



7030 Trans-Canada Highway Duncan, BC V9L 6A1 Canada www.northcowichan.ca T 250.746.3100

F 250.746.3154

Development Permit

MUNICIPALITY OF

NORTH

Cowichan

Permit No: DP000256

Registered Owner: 1251719 BC Ltd.

Applicant: Dylan Bryson, Core Group Consultants

Subject Property: 9090 Trans-Canada Highway Folio: 15038-000

Description of Land:

Parcel Identifier: 009-885-200

Legal Description: The East 60 Acres of Section 10, Range 5, Chemainus District, Except 16.5 Foot

Strip Along and Adjoining the North and East Boundaries thereof, Reserved for

Road Purposes, Except Parts in Plans 11489, 26194 and VIP68870

Development Permit (General - DPA 1, Natural Environment - DPA3, Hazard Proposal:

Lands - DPA4 and Farm Land Protection DPA5) for Construction of a Mobile

Home Park.

Conditions of Permit

- 1. This permit applies to the lands described above, and any buildings, structures, and other development thereon (hereinafter called 'the Lands').
- 2. This permit is issued subject to compliance with all relevant Municipality of North Cowichan bylaws, except as specifically varied or supplemented by this Permit.

Authorized Works

- 3. Authorization for works within Development Permit Areas 1, 3, 4 and 5 (General, Natural Environment, Hazard Lands and Farm Protection) are limited to the construction of a 100 unit mobile home park and:
 - a. associated internal roadways parking
 - b. ancillary play-park structures
 - c. stormwater outfall to watercourses
 - d. landscaping and raingardens
 - e. mail-boxes, enclosed garbage and recycling facilities
- 4. The construction will be phased (7 phases) as outlined in Schedule 1, Morgan Maples Lot Build -Out Phasing Plan prepared by Core Group Consultants.

5. The Lands which are subject to this Permit shall be developed strictly in accordance with the terms and conditions of this Permit and in accordance with the following schedules:

Schedule 1 DP000256 Core Group Drawing Package (21 pages)

Schedule 2 DP000256 Aquaparian RAPR Report (72 pages)

Schedule 3 DP000256 Letter Aquaparian East Wetland Setback (2 pages)

Schedule 4 DP000256 Diamond Head Wildfire Assessment Report (52 pages)

Schedule 5 DP000256 Core Group Rainwater Management Plan (35 pages)

Schedule 6 DP000256 Geopacific Geotechnical Report (38 pages)

Schedule 7 DP000256 PMG Landscape Estimate (2 pages)

Schedule 8 DP000256 Fire Truck Turnaround Plan (2 pages)

- Pursuant to section 504 of the Local Government Act, this permit will lapse two years from the date of the Development Permit approval unless construction, in accordance with the terms and conditions of this permit, has substantially started.
- 7. Construction is considered to be substantially started when a Mobile Home Park Permit for the development has been issued and shall not have lapsed; and excavation or construction works associated with the development hereby approved must have commenced to the satisfaction of the Director of Planning.
- 8. This Permit does not constitute a building, sign or awning permit, or a subdivision approval; nor does it exempt the applicant from obtaining all other federal and provincial approvals required to carry out the proposed development.

Archaeology

9. Section 13 of the Heritage Conservation Act protects heritage (archaeological) sites and heritage objects. This permit does not authorize the alteration of any such site or object. The permit holder is responsible for ensuring compliance with the Heritage Conservation Act, including taking any steps required to determine whether or not the subject property contains a heritage (archaeological) site or heritage object. Under section 36 of the Heritage Conservation Act, it is an offence to alter a heritage (archaeological) site or heritage object without first obtaining a permit to do so from the Province of British Columbia.

Geotechnical

10. Site excavation, placement of engineered fill, construction of retention walls over 1.2m in elevation and the establishment of final site grades shall be in accordance with Schedule 1 of this Permit. Retention walls must comply with property line setbacks requirements. All works are to be informed, monitored and completed by a professional geotechnical engineer.

Sediment and Erosion Control

11. The high level sediment and erosion control plan is attached as a schedule to this Permit. A detailed sediment and erosion control plan is to be submitted, reviewed and confirmed by North Cowichan prior to the issuance of a Mobile Home Park Permit and prior to any land clearing, site disturbance or construction.

Fencing and Buffering DPA3 and DPA5

12. Adjacent lands to the west are within the Agricultural Land Reserve (ALR) (thus subject to DPA – 5) identified as containing watercourses subject to Riparian Area Protection Regulation and assigned Stream Protection Enhancement Area (SPEA) buffering. Permanent wooden fencing is to be installed (replete with signage) identifying the greatest eastern extent of the SPEA boundary and / or DPA – 5 Farmland Protection setback minimum of 15 metres and no build 15 metres (whichever is the greater). The fencing will demarcate the area to remain un-disturbed and the signage is to contain explanatory language describing the nature of the farm protection area / watercourses beyond.

Environmental Protection

- 13. Upon receipt of the Modular Home Park Permit issued by the Building Inspector and prior to construction start, permitting and notification is required under the Water Sustainability Act through Section 11 in order to accommodate the extension of Henry Road (install of associated culvert) and stormwater outfalls.
- 14. The recommendations attached as Schedule 2 Aquaparian Riparian Area Protection Regulation (RAPR) Report form a requirement of this Permit. Prior to commencement of works:
 - a. A pre-construction site visit and monitoring regime (throughout construction and conclusion of activities) are to be conducted and organized respectively by a Qualified Environmental Professional (QEP) and the proponent in order to confirm SPEA protection plans and protocols.
 - b. A professional surveyor is to mark and identify the SPEA in order that orange snow fencing and signage stating *no disturbance riparian habitat* is installed in the appropriate locations warning contractors of the protected area.
 - c. Prior to any land clearing adjacent to the SPEA, an ISA Certified Arborist must be retained to assess the health of and determine protection measures for trees in and adjacent to the SPEA.
 - d. Ensure that the Sediment and Erosion Plan Fuel Management Measures are in place prior to the commencement of site works and include the emplacement of orange protective fencing, sediment fencing for the SPEA and spill kits are on board all heavy equipment in case of an event.
 - e. Additional monitoring may be required to achieve compliance with the *Wildlife Act* and/or *Migratory Birds Convention Act* timing dependent.
 - f. Environmental monitoring by a QEP is to be conducted throughout the construction phase. Submission of a final post construction RAPR report by a QEP to North Cowichan is required to confirm all SPEA protection measures have been adhered to.

Covenant Registration

- 15. The following Section 219 *Land Title Act* covenants are to be submitted to North Cowichan for review prior to registration on title and prior to issuance of a Mobile Home Park Permit:
 - a. Farm land protection covenant identifying the 30 metre no build and minimum 15 metre no vegetation removal areas adjacent the west boundary of the site.
 - b. Riparian protection covenant identifying the SPEA location by attached plan and prohibition against disturbance.
 - c. Wildfire protection covenant detailing fire resistant material choices for use in construction and on-going wildfire risk reduction strategies, as recommended in the Diamond Head Wildfire Assessment Report.
 - d. Rainwater management covenant -requiring the install of Individual modular home space water infiltration galleries and rain gardens as per the Rainwater Management Plan for Morgan Maples.

Servicing and Internal Road

16. All site servicing will be underground installation. The internal roadway connecting Henry Road to Country Maples (9010 Trans – Canada Highway) must be constructed as a completed connection (dust free for initial site clearing and preparation through issued construction approval associated with Mobile Home Park Permit) and paved, marked and signed prior to issuance of a building permit for a modular home.

Flood Construction Level and Setbacks

- 17. The flood construction level for the east water body adjacent the Trans Canada Highway is to be determined in accordance with Bylaw No. 1775, Section 3.01 b) i) as follows:
 - a) .6m above the 200 year flood level where it can be determined and;
 - b) not less than 3m above the natural boundary of the "lake" where the 200 year flood level cannot be determined.

Further, a structure setback of 7.6m is applied through Bylaw No. 1775 to structures adjacent the east "lake".

Landscaping Security and Wildfire Risk

- 18. As a condition of issuance of this permit, security, as authorized by Section 502 of the *Local Government Act*, is required to ensure that any conditions with respect to landscaping are satisfied.
- 19. Development permit security for landscaping in the amount of \$260,604.50 is to be provided by the Development Permit holder prior to Mobile Home Park Permit issuance in order to ensure the landscaping is installed and maintained, with 25% of the security to be held for 12 months upon written confirmation from the professional responsible of substantial completion as per the Municipality's Landscaping Policy.

20. Site landscaping will also incorporate recommendations provided through the Diamond Head Wildfire Assessment Report for this project and attached as a schedule to this Permit.

Monitoring and Inspections

21. The applicant is responsible for ensuring continual professional monitoring is performed and compliance with the Permit requirements being met at all times throughout the site preparation and construction phases of this project. Additional site inspections by Municipal staff may occur periodically.

Date of Development Permit Approval/Issuance by Council or its Delegate:

This permit was approved and issued on November 2, 2022.

This permit expires on November 2, 2024.

The Corporation of the District of North Cowichan

Rob Conway,

Director of Planning and Building

MODULAR HOME DEVELOPMENT

9090 ISLAND HIGHWAY CHEMAINUS, BC

DEVELOPMENT PERMIT PLANS



PROJECT LOCATION MAP

LEGAL DESCRIPTION:

DEVELOPER:

1251719 B.C. LTD. 320-8988 FRASERTON COURT BURNABY, BC V5J 5H8 TEL: 604-299-0605

COPEGROUP
CONSULTANTS
LAND DRIVEN COMPANY (SC VA) 99
Mc (604)99 000 fm, (604)99 000
Pent 15 Pratic No. 100127 (IIC)

DRAWING LIST:

CORE GROUP CONSULTANTS:

CORE GROUP CONSULTANTS:

0. COVER SIEFE

1. SITE FLAN

2. DPA-3 — NATURAL ENVIRONMENT

3. DPA-4 — HAZARO LANGS

4. DPA-5 — FARM LAND PROTECTION

5. SITE SECTIONS

6. BULDION GROWERNENDS & FLOOR PLANS

7. BULDION GENOTION WERS

6. CARRIGE GENOCHME & MAIR KIOSK DETAILS

10. ONISTE SERVICING & SIRREFLIGHT PLAN

11. GEFSITE SERVICING PLAN

12. GRADING DUT / PILL PLAN

14. STORMMATER MANAGEMENT PLAN

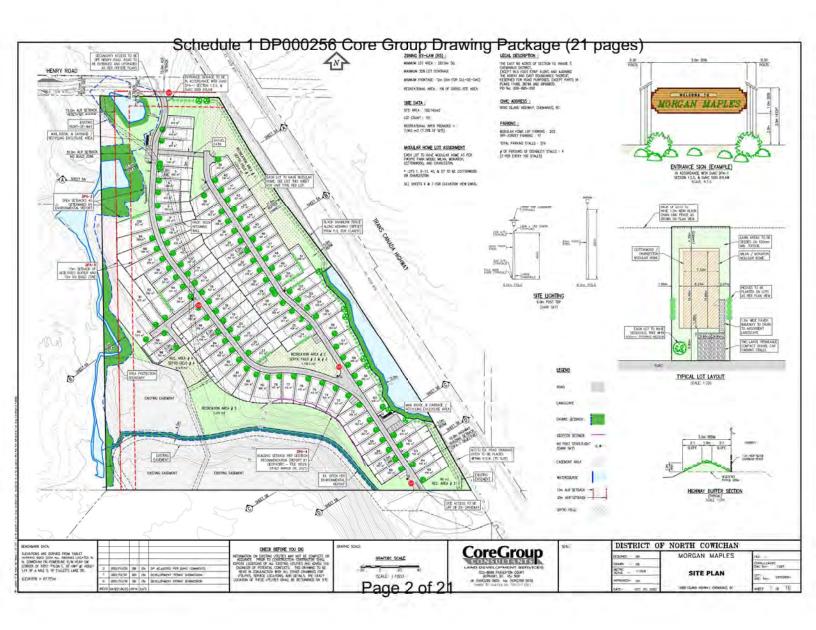
15. EROSION AND SEDMENT CONTROL PLAN

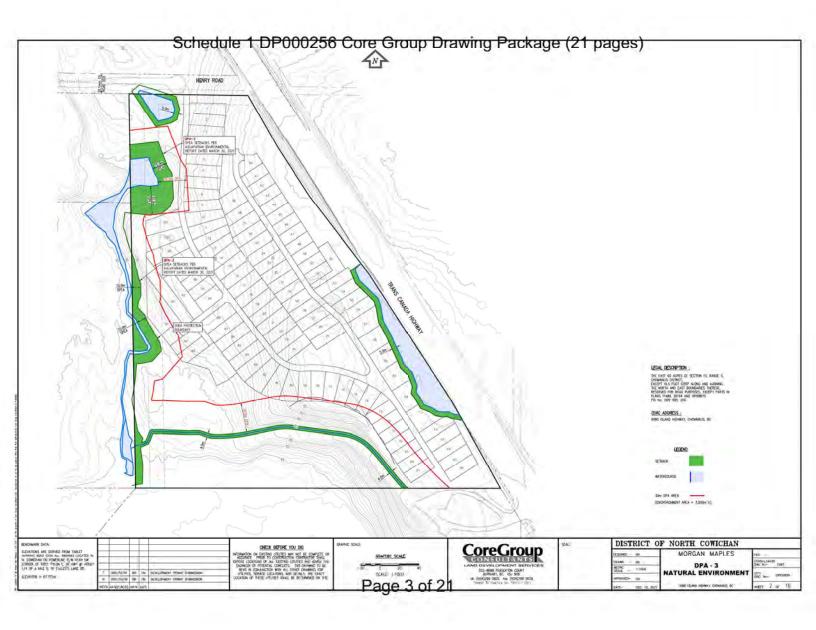
16. LOT BULLD OUT / PILL PLAN

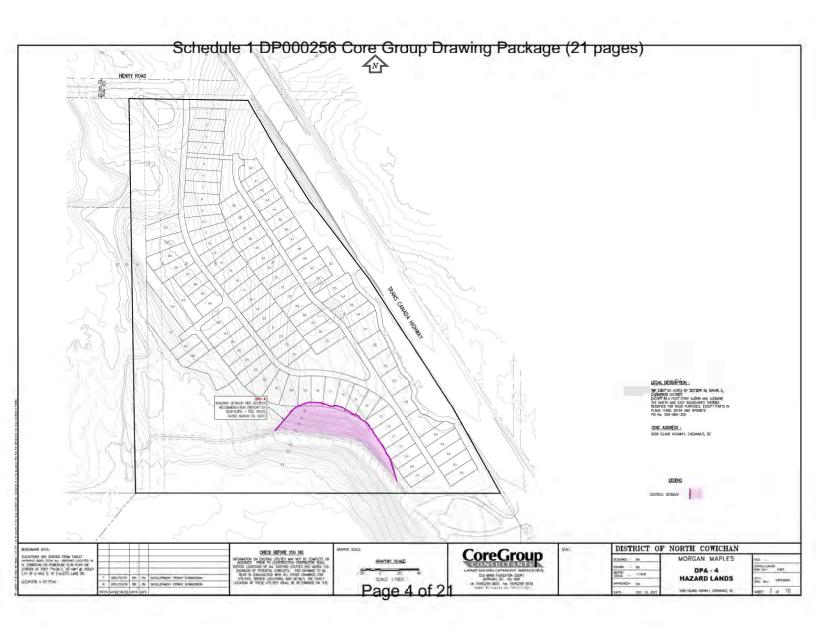
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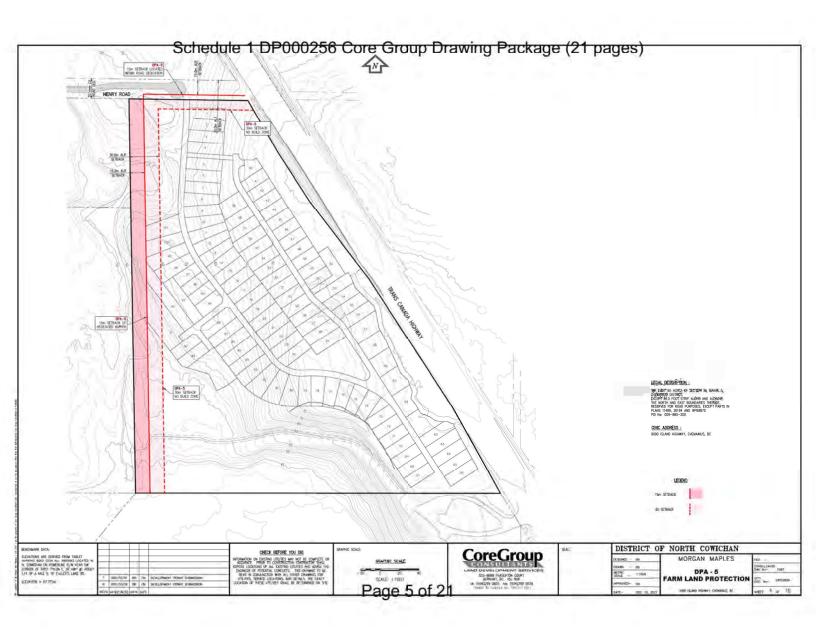
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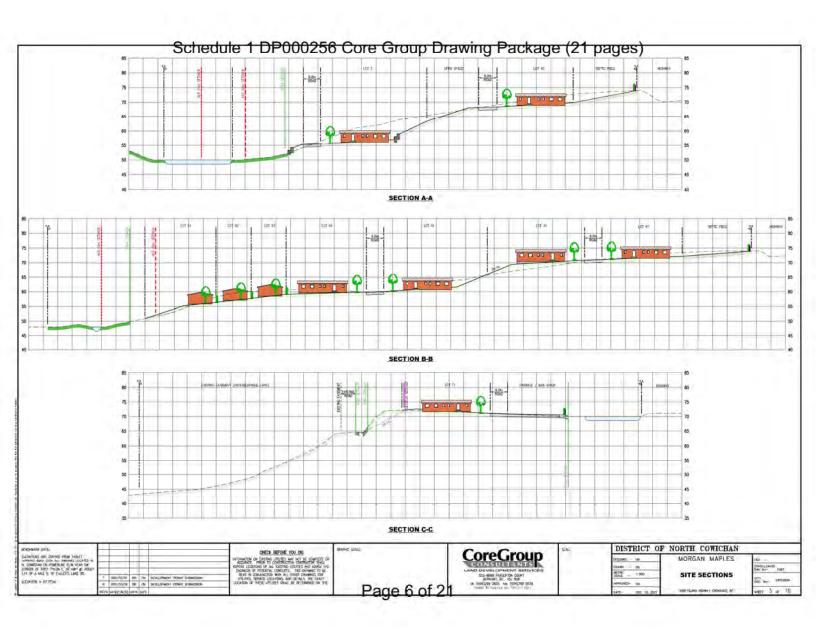
16. LOT BULLD OUT PHASING PLAN



























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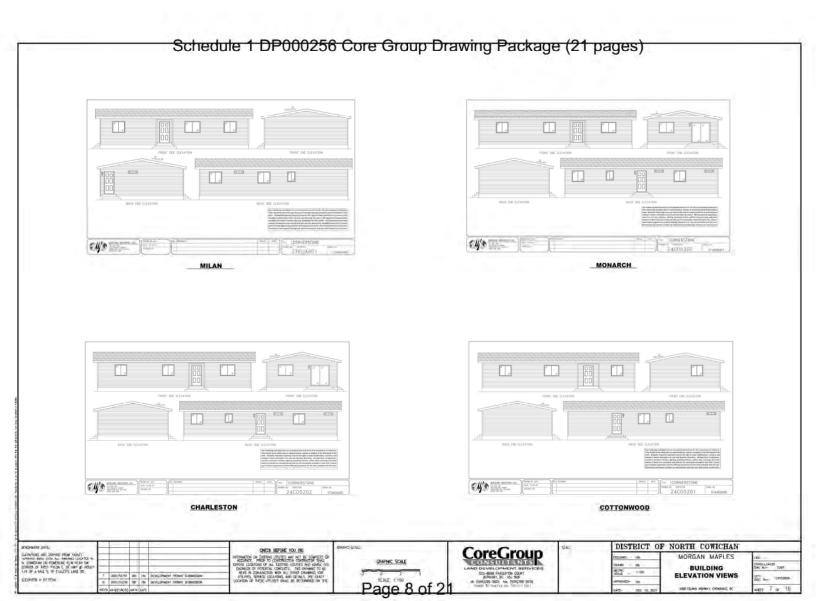
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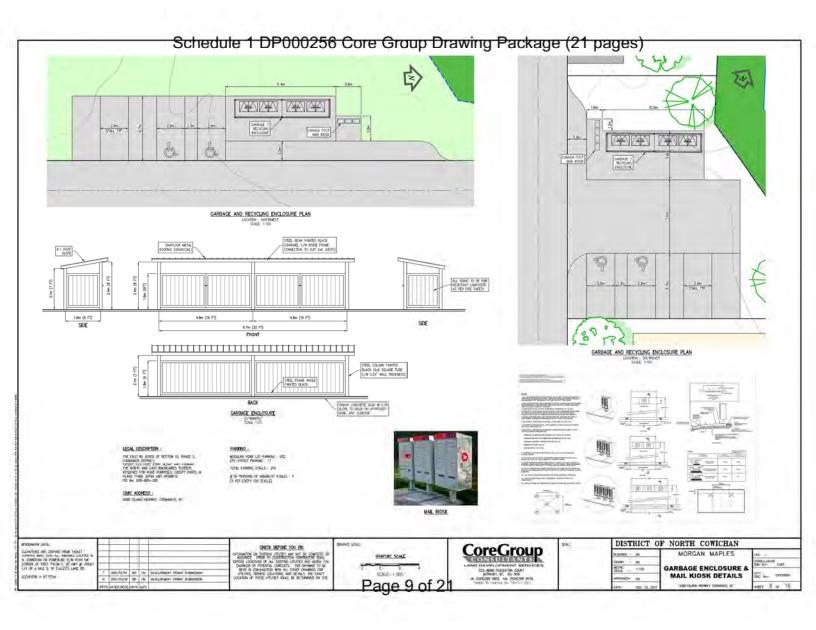
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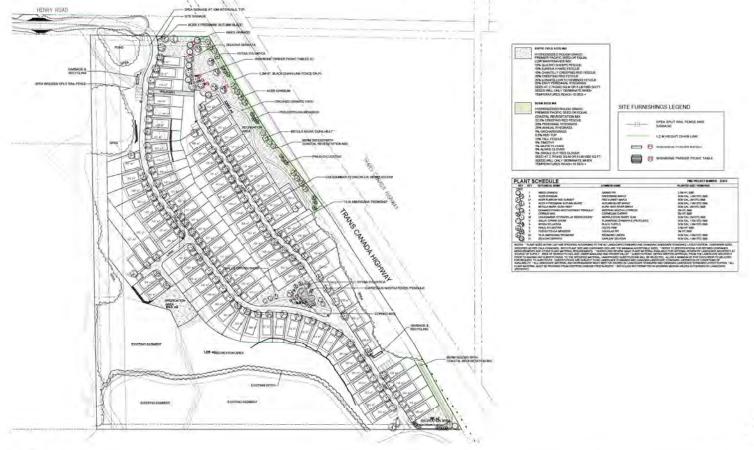
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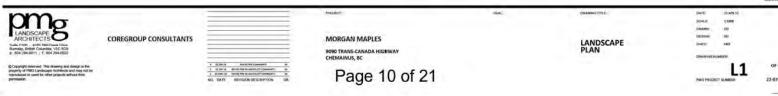
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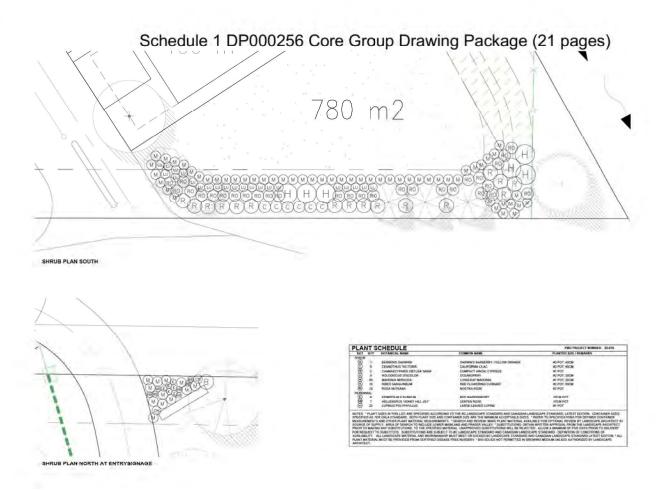






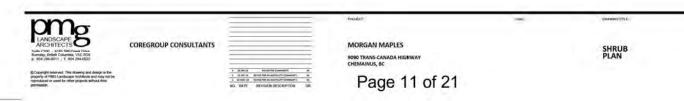


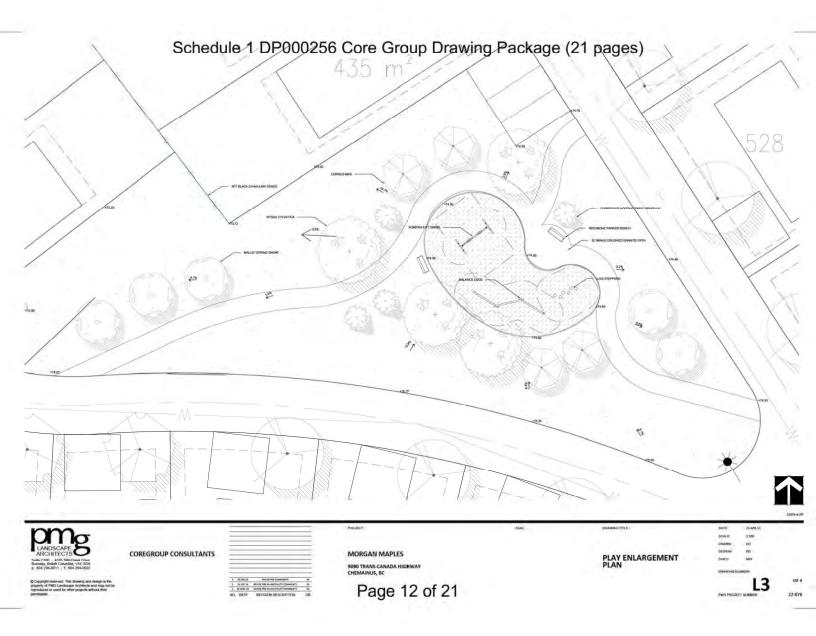


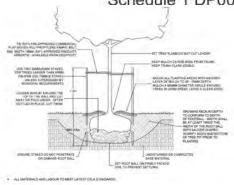




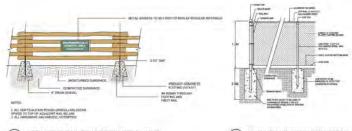
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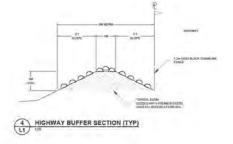




















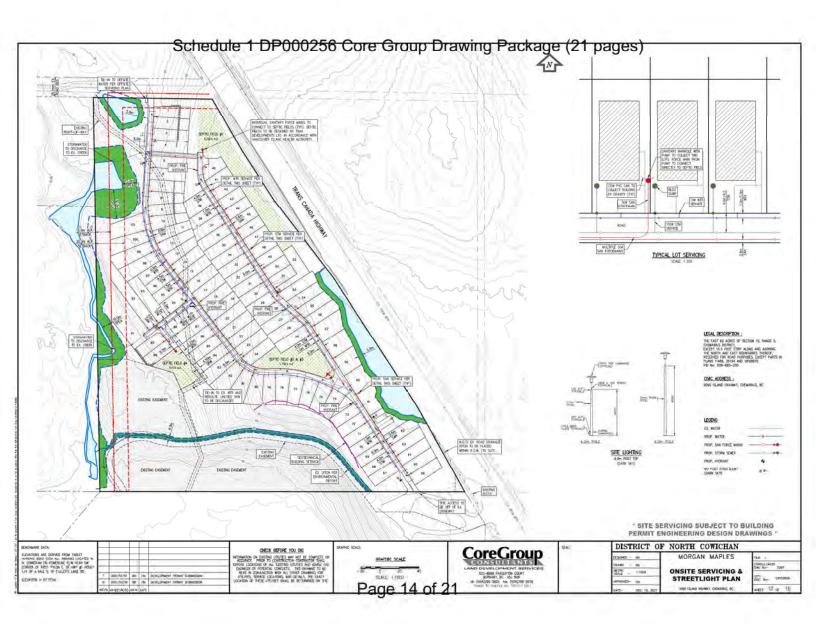
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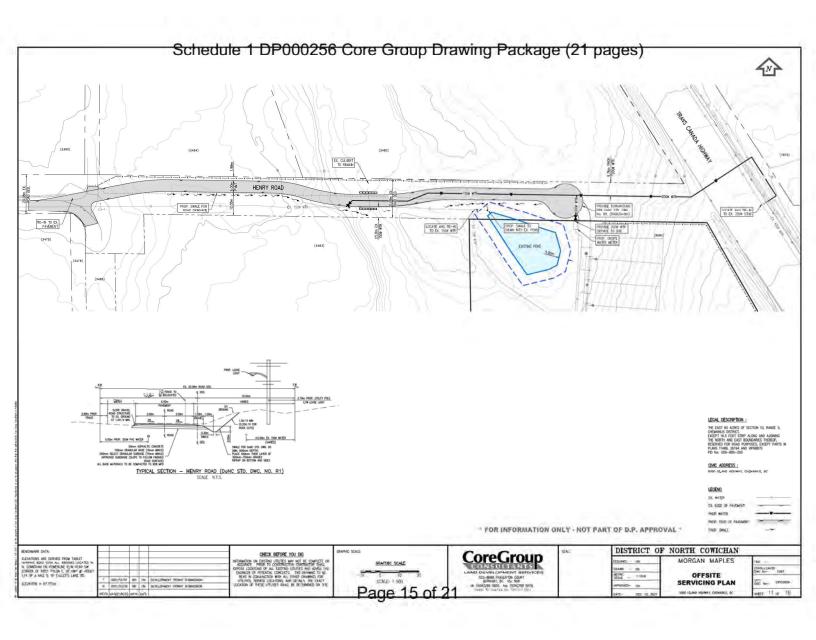
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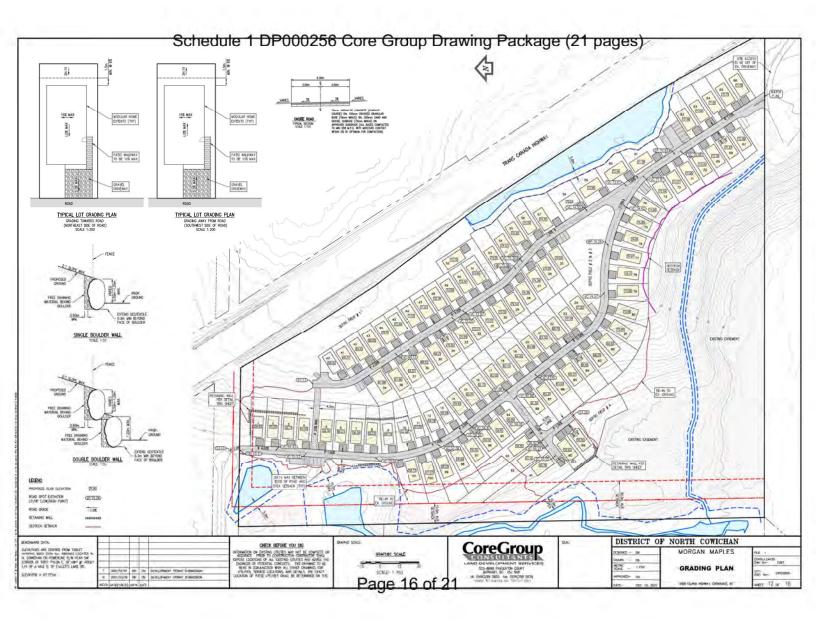
LANDSCAPE DETAILS

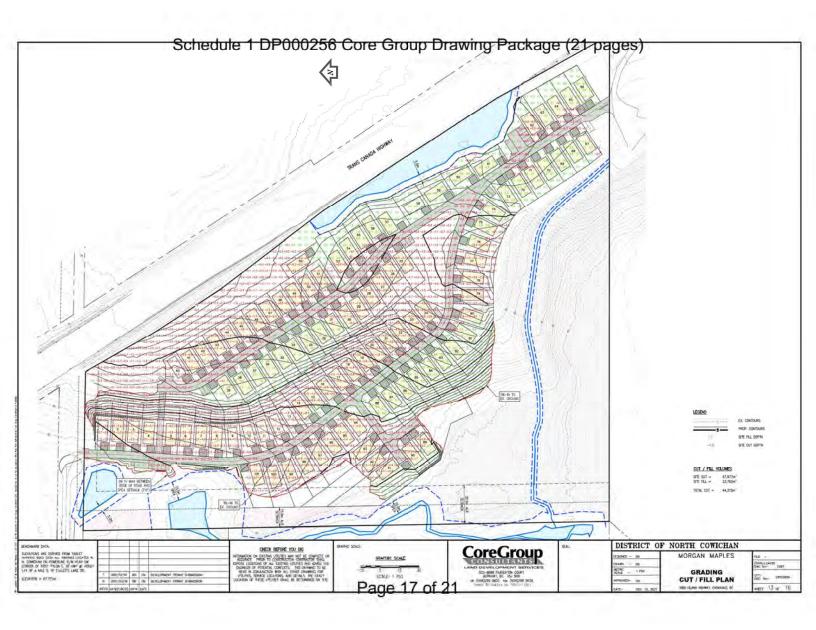


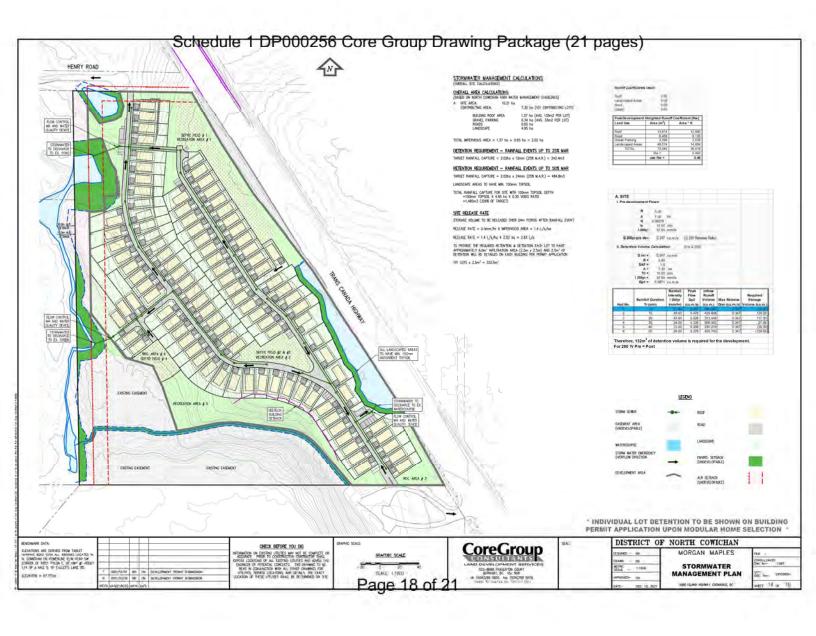


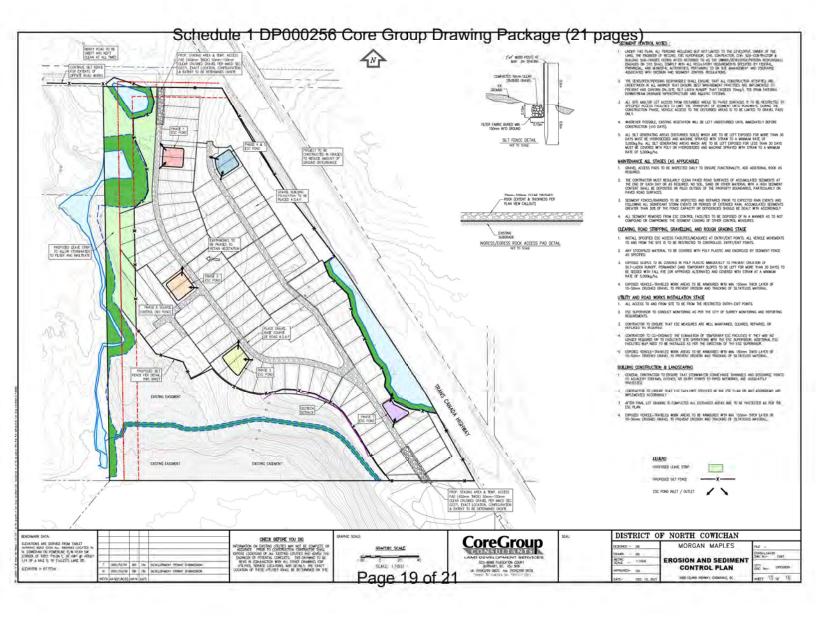


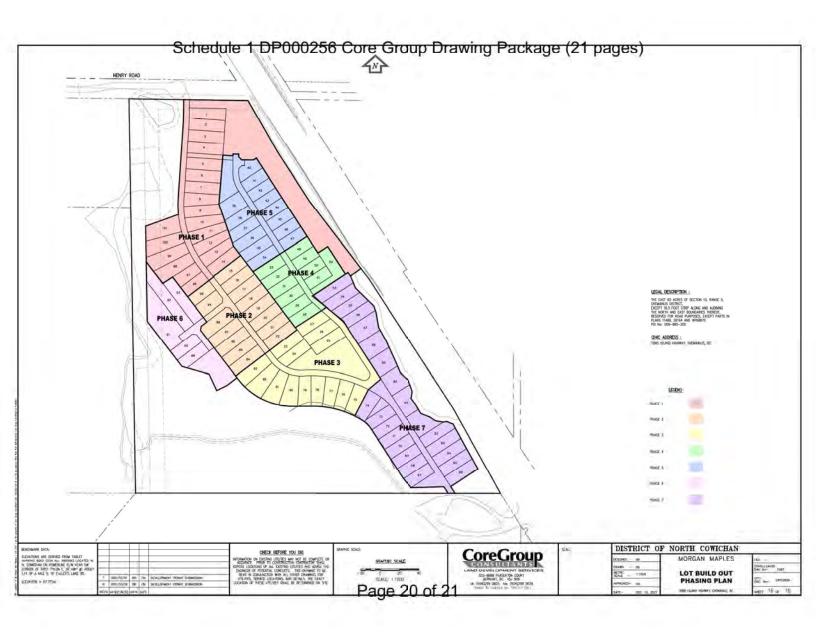


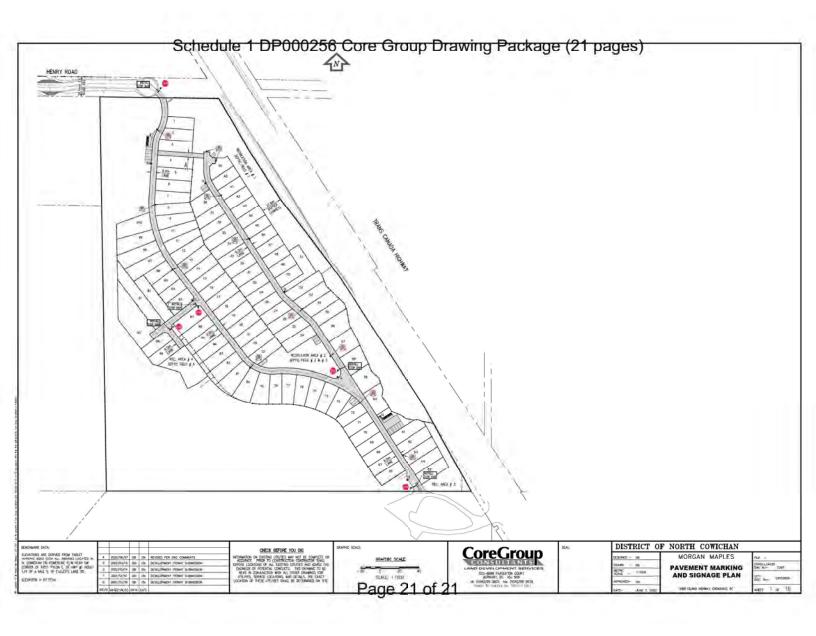












Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

iparian Areas Protection Regulation: Assessment Report	
ease refer to submission instructions and assessment report guidelines when completing this report.	
Data March 24 2022	

I. Primary	QEP	Information
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First Name	Sarah Middle Name E					
Last Name	Bonar					
Designation	R.P.Bio		Company: Aquaparian Environmental Consulting Ltd.			
Registration #	Registration # 1947		Email sbonar@aquaparian.com			
Address	203-321 Wallace	e Street				
City	Nanaimo	Postal/Zip	V9R 5B6	Phone #	250-591-2258	
Prov/state	BC	Country:	Canada			

II. Secondary QEP Information (use Form 2 for other QEPs)

First Name	Cormac	Middle	Middle Name G				
Last Name	Nolan						
Designation	P.Eng		Company Core Group Civil Consultants Ltd				
Registration #	18863		Email cnolan@coregroupconsultants.com				
Address	320-8988 Frase	erton Court					
City Burnaby		Postal/Zip	V5J 5H8	Phone # 604-299-0605			
Prov/state	BC	Country Canada					

III. Developer Information

First Name	Sean	Middle	Name		
Last Name	Carroll				
Company	1251719 BC Ltd				
Phone # 604-329-5630			Email: scarroll@coregroupconsultants.cor		
Address	320-8988 Fraserto	n Court			
City	Burnaby	Postal/Zip	V5J 5H8		
Prov/state	BC	Country	Canada		

IV. Development Information

	Construction (modular hor	: high density multi family re me park)	resider	ntial
Area of Development (ha)	7.25	Riparian Length ((m) 4	420
Lot Area (ha)	10.22	Nature of Development	New	
Proposed Start Date May	1, 2022	Proposed End Date	Dec 31	, 2023

V. Location of Proposed Development

Street Address (or nearest town)			9090 Trans-Canada Highway				
Local Government	Municipality of North Cowichan			City Chemainus			
Stream Name	Chemainus River unnamed tributary						
Legal Description (PID)	009-885-200			Region Vancouver Island			
Stream/River Type	Stream/wetland			DFO A	rea Sc	outh Coast	
Watershed Code	920-303500 (Chemainus River)			1			
Latitude	48°	53'	52.54"	Longitude	123°	43'	08.08"

Completion of Database Information includes the Form 2 for the Additional QEPs, if needed. Insert that form immediately after this page.

Schedule 2 DP000256 Aquaparian RAPR Report (72 pages) FORM 1 Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Table of Contents for Assessment Report

		Page Number
1.	Description of Fisheries Resources Values	
2.	Results of Riparian Assessment (SPEA width)	••••
3.	Site Plan	****
4.	Measures to Protect and Maintain the SPEA (detailed methodology only).	
	1. Danger Trees 2. Windthrow 3. Slope Stability 4. Protection of Trees 5. Encroachment 6. Sediment and Erosion Control 7. Floodplain 8. Stormwater Management	
5.	Environmental Monitoring	
6.	Photos	
7.	Assessment Report Professional Opinion	

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Section 1. Description of Fisheries Resources Values and a Description of the Development proposal

(Provide as a minimum: Species present, type of fish habitat present, description of current riparian vegetation condition, connectivity to downstream habitats, nature of development, specific activities proposed, timelines)

Introduction:

The subject parcel is located at the address 9090 Trans-Canada Highway in the Municipality of North Cowichan, BC. An unmapped, non-fish bearing stream that is tributary to the Chemainus River flows along the western boundary of the property primarily on the adjacent parcel. Figure 1 shows a site location map of the property. The property is legally identified as follows:

SECTION 10, RANGE 5, CHEMAINUS PORTION E 60 AC, EXC 16.5 FT STRIP ALONG & ADJ N & E BOUNDARIES THEREOF, RD PURPOSES, EXC PTS IN PLANS 11489, 26194 & VIP68870., MANUFACTURED HOME REG. # 72548. (PID 009-885-200)

Chemainus River (Watershed Code: 009-885-200) is a significant, fish-bearing watercourse that is 61.92km in length. A review of the provincial *Habitat Wizard* website identifies that the Chemainus River is known to support the following fish species:

- Atlantic salmon (Salmo salar)
- chinook salmon (Oncorhynchus tshawytscha)
- chum salmon (Oncorhynchus keta)
- coho salmon (Oncorhynchus kisutch)
- pink salmon (Oncorhynchus gorbuscha)
- cutthroat trout (Oncorhynchus clarkii clarkii)
- rainbow trout (Oncorhynchus mykiss)
- Dolly Varden (Salvelinus malma).

The Chemainus River flows from the west curving southeast below the subject parcel. The river continues east crossing the Trans-Canada Hwy then north crossing Chemainus Road (Hwy 1A) to the Chemainus River Estuary within Stuart Channel. The discharge to the ocean is approximately 6.1km east of the subject property along its alignment.

The 10.22ha (25.24 acre) subject property is mostly undeveloped forested land with some small cleared areas and a shared access road with the Country Maples RV Resort to the south. The southern portion of the subject parcel includes a paved access road, RV parking area in the southwest corner and previously cleared land in the southeast portion of the lot. The Trans-Canada Highway constitutes the eastern property boundary. An unnamed tributary stream and upstream wetland area are located along the western property boundary with undeveloped second-growth forest land to the west. Country Maples RV Resort is located to the south of the subject parcel and a hazelnut tree farm is located to the north separated by an undeveloped road Right-of-Way off the end of Henry Road.

The parcel is within the Municipality of North Cowichan (MNC) and subject to the Natural Environment Development Permit Area (DPA-3). The Natural Environment DPA for all watercourses applies to a 30m strip of land on both sides of the watercourse, measured from the natural boundary (MNC Official Community Plan). Easement Plan VIP67659 is located in the southwest portion of the parcel.

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Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

The proposed development project is the construction of a modular home park located outside the determined SPEA boundary of the watercourse. Only a small portion of the proposed development is within the 30m RAA. The development area is approximately 84,150m² in area (82% of the total area of the subject parcel) and would require clearing of vegetation and grading within the development footprint for construction of roads, modular home pads and RV parking. The development includes 108 modular home lots that front onto a branched, paved road with access to the existing shared driveway at the southeast corner of the site and propose to connect to Henry Road in the north end. A total of four septic fields are proposed to service the development.

The proposed development includes a new water system loop that ties into the existing watermain. Plans also include a watermain crossing the highway through steel casing pipe installed with trenchless technology at the north end of the property. Planned rainwater management includes roadside ditches that will collect road drainage and rooftop drainage to allow infiltration. Runoff control includes rain gardens, infiltration swales and absorbent landscaping. Sn engineered stormwater management plan has been prepared by the project engineers to mee the municipal requirements.

Aquaparian first visited the site October 19, 2020 to complete a detailed assessment using the RAPR methodology for the tributary stream and wetland along the western property boundary. Subsequent site assessments were completed to look at wetlands within the parcel. The general topography of the parcel is moderately rolling with multiple slopes and areas of bedrock extrusions. The high point of land is in the central-southeast portion of the lot. The land slopes down gently towards the highway on the east side and more steeply southwest towards the Chemainus River. The northwest corner of the lot is in a slight topographic depression forming a small wetland that is primarily disconnected to the stream within the parcel by an old water line and dirt road.

The parcel is partially developed with previously cleared land and an old remnant house foundation that is now colonized with terrestrial herbaceous vegetation in the southeast portion of the lot near the highway and an RV parking area and paved access road within the south portion of the property. The majority of the parcel has been left undeveloped with mature, second-growth mixed forest cover of approximately 50-60 years old.

The small wetland identified in the northwest corner of the parcel is vegetated by a tree canopy of red alder (Alnus rubra), willow species and crab apple (Malus sp.), with western redcedar (Thuja plicata) and bigleaf maple (Acer macrophyllun) around the wetland edge. Understorey species within the wetland include hardhack (Spiraea douglasii), salmonberry (Rubus spectabilis), skunk cabbage (Symplocarpus foetidus), sword fern (Polystichum munitum), lady fern (Athyrium filixfemina), bracken fern (Pteridium aquilinum), slough sedge (Carex obnupta), red elderberry (Sambucus nigra), water parsley (Oenanthe sarmentosa) and creeping buttercup (Ranunculus repens). This wetland area is isolated most of the year with no inflow or outflow channels, but does connect to the tributary by surface water during very high seasonal floods. A small 15cm diameter concrete culvert was installed at the south end of the wetland area crossing under an old dirt road that is runs from the northwest corner of the site around the south end of the wetland. This culvert appears to have been installed during the road construction and water line installation for high flood conditions. The culvert outlet south of the old road flows over an old dirt road through the forest to the south. It appears that prior to construction of the dirt road and water line, the wetland was once connected to the tributary. As the wetland has some hydrological connection to the tributary and was once part of the natural hydrology of the watercourse, it has been conservatively included in the stream assessment and SPEA determination. This wetland will provide some seasonal surface water to fish bearing water downstream and also provides important functions as habitat to other aquatic organisms, food,

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

water and migration corridors for birds and wildlife, water storage and cleansing and greenway values.

The tributary stream of the Chemainus River flows south along the western property boundary, primarily on the adjacent parcel. This watercourse with reportedly seasonal flows, is not shown on the MNC map nor is it mapped on the provincial Habitat Wizard website. The stream flows south and drops into a steep ravine section of the Chemainus River approximately 110m south of the southwest property boundary. On the adjacent property, a metal spillway (half-pipe) directs flows over the top of the embankment and part way down the slope. Flows exit the spillway to a concrete spill pad (broken cement chunks remain) then a small waterfall (~2m high) continuing down the steep slope (~100% slope) towards the river. The steep ravine slope, waterfall and spillway constitute an impassable barrier to fish.

The tributary stream flows in a southerly direction with a riffle/pool complex and an average channel width of 2.12m. Stream banks are low and the main channel becomes braided along the lower downstream end with wetland reaches. The streambed materials are silty with some gravel at the lower end transitioning to gravel with cobble at the upstream end. Downed wood debris is accumulated in the stream in several sections. At two locations wooden plank foot bridges cross the stream. The stream banks are fully vegetated and appear to be stable.

The riparian area of the tributary stream is fully vegetated and intact. The tree canopy is a mixed second-growth forest composed primarily of bigleaf maple and western redcedar with some red alder and minor amounts of western hemlock (*Tsuga heterophylla*) and Douglas fir (*Pseudotsuga menziesii*). Understorey species include grand fir saplings (*Abies grandis*), salmonberry, sword fern, bracken fern (*Pteridium aquilinum*), lady fern, licorice fern (*Pilypodium glycyrrhiza*), red elderberry, cascara (*Rhamnus purshiana*), oceanspray (*Holodiscus discolor*), dull Oregon-grape (*Mahonia nervosa*), salal (*Gaultheria shallon*), red huckleberry (*Vaccinium parvifolium*), vanillaleaf (*Achlys triphylla*), trailing blackberry (*Rubus ursinus*), fringecup (*Tellima grandiflora*), creeping buttercup, foamflower (*Tiarella trifoliata*), stinging nettle (*Urtica dioica*), common horsetail (*Equisetum arvense*), skunk cabbage, slough sedge, herb robert (*Geranium robertainum*), moss and grass species. Invasive species include spurge laurel (*Daphne laureola*), Himalayan blackberry (*Rubus armeniacus*) and common holly (*Ilex aquilfolium*).

An excavated roadside ditch with an average channel width of 0.43m and a depth of 0.40m runs along the site access driveway and connects to the stream in the southwest corner of the parcel. The ditch is ephemeral and originates with no natural headwater source. The ditch receives surface storm water runoff from the roadway. The ditch is culverted across the driveway entrance to the RV parking area and across the entrance to the dog run area at the bottom of the hill. The ditch bottom is bare soil with some grass with vegetation along the north side including red alder, bigleaf maple, grand fir, sword fern, red huckleberry, salmonberry, and spurge laurel. The ditch alignment veers off the roadside and into the forested area beside the dog run to drain into the main tributary stream channel. The ditch was determined to be non-fish bearing as the downstream end of the tributary stream drops into a steep ravine slope that is an impassable barrier to fish passage. A 2m SPEA setback was determined for the non-fish bearing ditch.

An isolated linear wetland is located on a portion of the eastern property boundary adjacent to the Island Highway. This feature appears to have been incorporated into the highway ditch system in the past as a stormwater detention area that is connected to the highway ditch going south. A berm is located on the west side of the wetland with an old construction fence along the top. The vegetation that has established within this area is characteristic of wetland areas including red alder, cattails (*Typha latifolia*), hardhack, willow, reed canary grass (*Phalaris arundinacea*) and slough sedge. The wetland drains south into the highway ditch which continues approximately 150m south of the entrance driveway to the Country Maples RV Resort then fans out down a

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

steep forested slope (no channelization) adjacent to the highway that leads down into a forested gully. The wetland and ditch are isolated and not connected to any fish-bearing watercourse and as such, are not subject to the Riparian Areas Protection Regulation. The highway ditch beside the north end of the parcel flows north from a topographic high point then into a low topographic area of the adjacent hazelnut tree far. The land then begins to gain in elevation towards the Fuller Lake Road intersection. Discussions with MoTI have been initiated as the wetland is partially on the subject parcel.

Several bird species were observed amongst the riparian vegetation and surrounding mixed forest. Deer droppings were observed within the wetland area. No eagle or other bird nests were observed during the site survey. A search of provincial databases (Wildlife Tree Stewardship Atlas and Great Blue Heron Atlas) did not identify any raptor nests in the vicinity of the subject parcel and no mature trees that could support eagle nests were found. Several wildlife trees were identified within wetland areas. The mixed forest habitat with a combination of dense and open canopy structure alongside riparian stream and wetland habitat is suitable habitat for owls and other raptors (excluding eagles and herons). The site assessment was conducted outside of the nesting season for these species. Although no evidence of raptor presence was found at the time of the site assessment, some of these bird species such as owls and small raptors may be present during the breeding season. Pre-clearing nest surveys may be required depending on the timing proposed for clearing.

The watercourse within the subject property was assessed to determine the Streamside Protection and Enhancement Area (SPEA). A 10m SPEA was determined for the tributary stream channel reaches measured from the high-water mark. A 15 to 30m SPEA was determined for the wetland reaches of the tributary and the wetland in the northwest corner of the parcel (30m shade ZOS on the south side). A 2m SPEA was determined for the south end roadside ditch that connects to the tributary stream. The SPEA boundaries are to be considered as a No-Go zone for development or disturbance. No encroachment into the SPEA is to be allowed.

Form 1 Page 6 of 17

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Section 2. Results of Riparian Assessment (SPEA width)

Attach or insert the Form 3 or Form 4 assessment form(s). Use enough duplicates of the form to produce a complete riparian area assessment for the proposed development

Form 1 Page 7 of 17

Schedule 2 DP000256 Aquaparian RAPR Report (72 pages) Form 3 Detailed Assessment Form

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

2. Results of	Detail	ed Ripa	arian Assessme	nt			
Refer to Section 3 of	Technical	Manual		Date: March 21, 2022			
Description of Wa	ater bod	ies invol	ved (number, type)	Unnamed wetland (northwest)			
Stream							
Wetland		X	1				
Lake							
Ditch							
Number of reaches	3		1				
Reach#	1		1				
Channel width and only provide				use only if water body is a stream or a ditch,			
Cha	nnel Wi	dth(m)	Gradient	(%)			
starting p				I, Sarah Bonar R.P.Bio, hereby certify that:			
upstre				a) I am a qualified environmental professional, as defined in the			
24.20	Sp3.50,11			Riparian Areas Protection Regulation made under the Riparian Areas Protection Act;			
			19,000	b) I am qualified to carry out this part of the assessment of the			
				development proposal made by the developer: 1251719 BC Ltd;			
			1	c) I have carried out an assessment of the development proposal			
downstream			1	and my assessment is set out in this Assessment Report; and d) In carrying out my assessment of the development proposal, I			
downout	downstream			have followed the technical manual to the Riparian Areas			
				Protection Regulation.			
	-						
		-	14/				
First Secretary		-					
	Total: minus high /low						
m	ean						
R/P		R/P	C/P S/P				
Channel T	ype						
Site Potential \	/egeta	tion Ty	pe (SPVT)				
	Yes	No					
SPVT Polygons		X	Tick yes only if mult	tiple polygons, if No then fill in one set of SPVT data boxes			
or virion gone		1.	I, Sarah Bonar R.P.Bi				
			a) I am a qualified en Regulation made u b) I am qualified to ca made by the devel c) I have carried out set out in this Assa d) In carrying out my	invironmental professional, as defined in the Riparian Areas Protection under the Riparian Areas Protection Act; arry out this part of the assessment of the development proposal loper 1251719 BC Ltd; an assessment of the development proposal and my assessment is essment Report; and assessment of the development proposal, I have followed the to the Riparian Areas Protection Regulation.			
Polygon No:	1 LC	SH		employed if other than TR			
SPVT Type		1	X				
Polygon No:			Method	l employed if other than TR			
	LC	SH	TR	And Anthon About and Anna .			
SPVT Type	L						
Polygon No:		1	Method	employed if other than TR			

SPVT Type

Form 3 Detailed Assessment Form

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Zone of Ser	nsitivity	(ZOS)	and r	esultant SPE	A			
Segment No:	1	If two sides of a stream involved, each side is a separate segment. For all water bodies multiple segments occur where there are multiple SPVT polygons						
LWD, Bar St Litter fall a	ability Zo	OS (m)	15 15					
Shade ZC			30	South bank	Yes	X	No	
Ditch	Justifica	tion des	cription	for classifying	as a ditc	h (manmad		- '
Ditch Fish Yes Bearing				No			nsert no fish s report	
SPEA max	cimum	30	(Fo	or ditch use tal	ole3-7)			
No: LWD, Bar St Litter fall a	ability Zo and inse	OS (m) ct drop	bodie	es multiple seg	ments oc	cur where t	here are mi	ultiple SPVT polygons
57.00.00		OS (m)			Inches and		127	
Shade ZOS (m) max SPEA maximum			South bank Yes No (For ditch use table3-7)					
Segment No:		If tw						segment. For all water
LWD, Bar St	k and C ability Z							
Litter fall a	Z	OS (m)						
Shade ZC		nax	120.5	South bank			No	
SPEA max	cimum		(For	ditch use tabl	e3-7)			
Areas Prote b) I am qualifie c) I have carrie	fied enviro ection Act; ed to carry ed out an a out my ass	out this passessment	orofession art of the ont of the	assessment of the	e developme osal and my	ent proposal m	ade by the de	made under the <i>Riparian</i> veloper 1251719 BC Ltd; s Assessment Report; and to the Riparian Areas

Comments

This small wetland is isolated from the stream for most of the year, but was historically part of the natural hydrology of the tributary and does flow into the wetland reach of the stream tributary during high flood waters. It has conservatively been considered a RAPR wetland for this assessment. A 15m SPEA has been determined around the west and east side, while the south side will receive a 30m SPEA due to the Shade ZOS.

Schedule 2 DP000256 Aquaparian RAPR Report (72 pages) Form 3 Detailed Assessment Form

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

2. Results of	Detail	ed Ripa	arian Assessme	ent			
Refer to Section 3 of	Technical	Manual		Date: March 21, 2022			
Description of W	ater bod	ies invol	ved (number, type)	Unnamed Wetland Reach			
Stream							
Wetland	5	X					
Lake							
Ditch							
Number of reaches	3						
Reach #	2						
Channel width and only prov				use only if water body is a stream or a ditch,			
Cha	annel Wi	dth(m)	Gradient	(%)			
starting point				I, Sarah Bonar R.P.Bio, hereby certify that:			
upstream				a) I am a qualified environmental professional, as defined in the			
				Riparian Areas Protection Regulation made under the Riparian Areas Protection Act;			
			1	b) I am qualified to carry out this part of the assessment of the			
				development proposal made by the developer: 1251719 BC Ltd; c) I have carried out an assessment of the development proposal			
				and my assessment is set out in this Assessment Report; and			
downstream				d) In carrying out my assessment of the development proposal, I			
				have followed the technical manual to the Riparian Areas			
				Protection Regulation.			
	- 1						
Total: minus high	/low						
n	nean						
R/I		R/P	C/P S/P				
Channel 7	Туре						
Site Potential	Vegeta	tion Ty _l	pe (SPVT)				
	Yes	No					
SPVT Polygons		X	Tick yes only if mu	only if multiple polygons, if No then fill in one set of SPVT data boxes			
			a) I am a qualified end Regulation made b) I am qualified to commade by the development out set out in this Assign In carrying out my technical manual	iio, hereby certify that: nvironmental professional, as defined in the Riparian Areas Protection under the <i>Riparian Areas Protection Act</i> ; carry out this part of the assessment of the development proposal eloper 1251719 BC Ltd; an assessment of the development proposal and my assessment is essment Report; and y assessment of the development proposal, I have followed the to the Riparian Areas Protection Regulation.			
Polygon No:	LC	SH	TR Method	d employed if other than TR			
SPVT Type			Х				
Polygon No:]		d employed if other than TR			
SPVT Type	LC	SH	TR				
Polygon No:		-	Mothor	d employed if other than TR			
Fulyguii No.		1	INICTIO	chiployed if other than 11x			

SPVT Type

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Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Zone of Sen	sitivity	(ZOS)	and res	sultant SPE	Α			
Segment No:	1	If two						gment. For all water ble SPVT polygons
LWD, Ban	k and Chability ZC		15					
Litter fall a		t drop	15					
Shade ZO	S (m) m	ax	30	South bank	Yes X		No	
				or classifying s or springs, s				
Ditch Fis Bearing	h Yes		No		If non-fish be			
	imum	30	(For	ditch use tab		Ĭ		
Segment No:	-	If tw						egment. For all water tiple SPVT polygons
LWD, Ban Sta Litter fall a	ability ZC nd insec ZC	os (m) et drop os (m)						apie er er penjgene
Shade ZO SPEA max		ax	(For d	South bank litch use table		No.		
Segment No:		If tw						egment. For all water tiple SPVT polygons
LWD, Bani Sta	k and Chability ZC							
Litter fall a		t drop OS (m)						
Shade ZO		ax	Dec 11	South bank		No		
SPEA max	imum		(For d	ditch use table	3-7)			
I, <u>Sarah Bonar R.</u> a) I am a qualifi Areas Protec b) I am qualifie c) I have carrie	P.Bio, her ied environ ction Act; d to carry d out an a	nmental pout this passessme	y that: professional art of the as	I, as defined in th	ne Riparian Areas development proposal and my asse	oposal made	by the deve	eloper 1251719 BC Ltd; Assessment Report; and

Comments

The wetland area within the northwest corner of the subject property is connected to the tributary stream at the upstream end. The east side has a 15m SPEA, the south side has a 30m SPEA.

Form 3 Detailed Assessment Form

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

2. Results of Detailed Riparian Assessment		
Refer to Section 3 of Technical Manual	Date:	March 2

Description of Water bodies involved (number, type)

Unnamed stream (tributary to Chemainus River WSC: 920-303500)

Stream X
Wetland
Lake
Ditch
Number of reaches 3
Reach # 3

Channel width and slope and Channel Type (use only if water body is a stream or a ditch, and only provide widths if a ditch)

Channel	Width(m)	Gradient	(%)
starting point upstream	2.8 2.0 2.9 2.9 3.9			I, Sarah Bonar R.P.Bio, hereby certify that: a) I am a qualified environmental professional, as defined in the Riparian Areas Protection Regulation made under the Riparian Areas Protection Act; b) I am qualified to carry out this part of the assessment of the development proposal made by the developer: 1251719 BC Ltd; c) I have carried out an assessment of the development proposal
downstream	2.1 2.1 1.1 1.9 1.2		1%	and my assessment is set out in this Assessment Report; and d) In carrying out my assessment of the development proposal, I have followed the technical manual to the Riparian Areas Protection Regulation.
Total: minus high /low mean	19.1 2.12 R/P	C/P	S/P	
Channel Type	Χ			

Site Potential Vegetation Type (SPVT)

	Yes	No		
SPVT Polygons	1	X	Tick yes	s only if multiple polygons, if No then fill in one set of SPVT data boxes
			a) I am a Regulb) I am a made c) I have set of d) In car	Bonar R.P.Bio, hereby certify that: a qualified environmental professional, as defined in the Riparian Areas Protection alation made under the Riparian Areas Protection Act; qualified to carry out this part of the assessment of the development proposal by the developer 1251719 BC Ltd; e carried out an assessment of the development proposal and my assessment is ut in this Assessment Report; and rrying out my assessment of the development proposal, I have followed the nical manual to the Riparian Areas Protection Regulation.
Polygon No:	1 LC	SH	TR	Method employed if other than TR
SPVT Type			X	
Polygon No:		Ť		Method employed if other than TR
r diygon ivo.	LC	SH	TR	Method employed if other than 114
SPVT Type				
Polygon No:				Method employed if other than TR

1, 2022

Schedule 2 DP000256 Aquaparian RAPR Report (72 pages) Form 3 Detailed Assessment Form Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Segment	-				ultant SPE/ stream invol		ch sid	e is a	sepai	rate	segr	men	t. Fo	r all wa	ter
No:		16 (27)			ultiple segme										
LWD, Ban Sta	k and Chability ZC		10		9.55	-20	75					7		001	
Litter fall a	ind insec	100	10												
Shade ZO			6.4		South bank	Yes			1	Vo	X				
Ditch	Justificat	ion des			r classifying a or springs, se			nmad							
Ditch Fis Bearin	h Yes			No		If non-fis	sh bea		insert s repo		sh				
PEA max		10		(For c	ditch use table			Clare	S.ope						
			-7												
Segment No:		If tw			a stream inv multiple segn										
LWD, Ban					, 9						17.75			, ,,,	
Litter fall a	ability ZC			-											
Litter fall a		OS (m)													
Shade ZO					South bank	Yes	1		No	11/1			1		
PEA max			(F	or di	tch use table	3-7)	a T			-					
0		164.				م المحادات		142.12				2411			
Segment No:		II tw			f a stream inv multiple segn										
LWD, Ban	k and Ch	nannel	50	ulc3 i	multiple segn	101113 00	oui w	HOLO	inor c	al C I	Hulu	pic (OI V	polyg	0113
	ability ZC														
Litter fall a															
		OS (m)													
Shade ZO		ax			South bank	Yes			No						
PEA max	imum		(F	or di	tch use table	3-7)									
	D Ric har				as defined in the	e Riparian	Areas	Protec	tion Re	gulati	on ma	ade u	ınder 1	the <i>Ripar</i>	ian
I have carrie	fied environ ction Act; d to carry ed out an a out my asse	out this p	art of t	he ass	sessment of the elopment propos pment proposal,	sal and my	asses	sment	is set o	ut in	this A	ssess	sment	Report;	

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Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Refer to Section 3 of		G CO - 0.5 LT 1 1 - 1 - 1 - 1			Date: Mar 21, 2022
Description of Wa	ater b	odies inv	olved (number	er, type) Unnamed ditch
Stream					
Wetland			1		
Lake					
Ditch	-	X			
Number of reaches	1		-1		
Reach #	1				
Channel width	and	slope a	nd Channe	І Туре	(use only if water body is a stream or a ditch,
and only provi	de w	idths if	a ditch)	77	
Cha	nnel	Width(m)		Gradier	nt (%)
starting p		0.4	_	2%	I, Sarah Bonar R.P.Bio, hereby certify that:
upstr		0.4		-	a) I am a qualified environmental professional, as defined in the
		0.4	1 1	4%	Riparian Areas Protection Regulation made under the Riparian Areas Protection Act;
		0.5	1 1		b) I am qualified to carry out this part of the assessment of the
		0.5			development proposal made by the developer: 1251719 BC Ltd
		0.4	1 15	6%	c) I have carried out an assessment of the development proposal and my assessment is set out in this Assessment Report; and
downstr	eam	0.4			d) In carrying out my assessment of the development proposal, I
		0.4			have followed the technical manual to the Riparian Areas
		0.4			Protection Regulation.
		0.5		1%	
		0.6			7
Total: minus high	/low	3.9			7
	nean	0.43			
		R/P	C/P	S/P	
Channel 7	Гуре	X			
Site Potential	Vege Ye		ype (SPVT)		
SPVT Polygons		X	Tick yes	only if m	ultiple polygons, if No then fill in one set of SPVT data boxes
			I, Sarah Bo a) I am a Regula b) I am qu made I c) I have set out d) In carn	onar R.P. qualified ation madualified to by the de carried o in this A ying out r	Bio, hereby certify that: environmental professional, as defined in the Riparian Areas Protection le under the Riparian Areas Protection Act; carry out this part of the assessment of the development proposal veloper 1251719 BC Ltd; ut an assessment of the development proposal and my assessment is ssessment Report; and my assessment of the development proposal, I have followed the late to the Riparian Areas Protection Regulation.
Polygon No: SPVT Type	LC	SH	TR X		od employed if other than TR
Polygon No:			70	Meth	od employed if other than TR
	LC	SH	TR	1	
SPVT Type				1	

Polygon No:

SPVT Type

Method employed if other than TR

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Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Zone of Ser												
Segment No:	1	If two			stream invo							
LWD, Ban	k and	Channel	2									1 70
		ZOS (m)	100									
Litter fall a			2									
		ZOS (m)	-									
Shade ZC			2	- 5	South bank	Yes			No	X		
Ditch	Justific	ation des		on for	classifying or springs, s	as a ditch		made,	roads head	side wate	ditch w	emeral,
Ditch Fis	h Ye	s		No	X	If non-fis	h bear	ing inse	rt no fi	sh	Downs	stream barrier
Bearin		\$**		16.7-	77			status re				passage:
	٦								Pares -			ravine slope
SPEA max	cimum	2	(1	For di	itch use tab	le3-7)						
Segment		If tw	o side	es of a	a stream in	volved, ea	ach sid		eparate	se		For all water
No:			haa					ara than			NO COL	/T nolugone
	L and	Ohanad	boo					ere ther	e are n	nulti	ple SPV	/T polygons
LWD, Ban			boo					ere ther	e are n	nultij	ple SPV	/T polygons
LWD, Ban Sta	ability 2	ZOS (m)	boo					ere ther	e are n	nultij	ple SPV	/T polygons
LWD, Ban	ability 2 and ins	ZOS (m) ect drop	boo					ere ther	e are n	nultij	ple SPV	/T polygons
LWD, Ban Sta Litter fall a	ability and ins	ZOS (m) ect drop ZOS (m)	boo	dies m	nultiple segi	ments occ				nultij	ple SPV	/T polygons
LWD, Ban Sta Litter fall a	ability 2 and ins 2 OS (m)	ZOS (m) ect drop ZOS (m) max		dies m	nultiple segr	Yes		ere ther		nultij	ple SPV	/T polygons
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LWD, Ban Sta Litter fall a Shade ZC SPEA max	ability 2 and ins 2 OS (m)	ZOS (m) ect drop ZOS (m) max	(F	dies m	nultiple segr South bank ch use table	Yes	cur who	No)]			
LWD, Ban Sta Litter fall a Shade ZC SPEA max Segment	ability 2 and ins 2 OS (m)	ZOS (m) ect drop ZOS (m) max	(F	or dito	South bank ch use table	Yes e3-7)	cur who	No	eparate	e se	gment.	For all water
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LWD, Ban Sta Litter fall a Shade ZC SPEA max Segment No: LWD, Ban Sta	ability 2 and ins OS (m) kimum	ZOS (m) ect drop ZOS (m) max If tw Channel ZOS (m)	(F	or dito	South bank ch use table	Yes e3-7)	cur who	No	eparate	e se	gment.	For all water
LWD, Ban Sta Litter fall a Shade ZC SPEA max Segment No: LWD, Ban	ability 2 and ins OS (m) kimum	ZOS (m) ect drop ZOS (m) max If tw Channel ZOS (m)	(F	or dito	South bank ch use table	Yes e3-7)	cur who	No	eparate	e se	gment.	For all water
LWD, Ban Sta Litter fall a Shade ZC SPEA max Segment No: LWD, Ban Sta	ability 2 and ins 2 2 3 5 5 6 6 7 7 8 8 8 8 8 8 8 8 8 8 8 8 8 9 8 8 9 8	ZOS (m) ect drop ZOS (m) max If tw Channel ZOS (m)	(F	or dito	South bank ch use table	Yes e3-7)	cur who	No	eparate	e se	gment.	For all water
LWD, Ban Sta Litter fall a Shade ZC SPEA max Segment No: LWD, Ban Sta	ability 2 and ins DS (m) kimum kk and a ability 2 and ins	ZOS (m) ect drop ZOS (m) max If tw Channel ZOS (m) ect drop ZOS (m)	(F	or dito	South bank ch use table	Yes e3-7) volved, ea	cur who	No	eparate	e se	gment.	For all water
LWD, Ban State Interfall a Shade ZC SPEA max Segment No: LWD, Ban State Interfall a	ability 2 and ins DS (m) kimum kk and a ability 2 and ins	ZOS (m) ect drop ZOS (m) max If tw Channel ZOS (m) ect drop ZOS (m)	(Fo	or dito	South bank ch use table a stream in nultiple segi	Yes e3-7) volved, ea ments occ	cur who	No de is a s ere ther	eparate	e se	gment.	For all water
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Comments

The roadside ditch flows into the tributary stream that discharges to the Chemainus River.

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

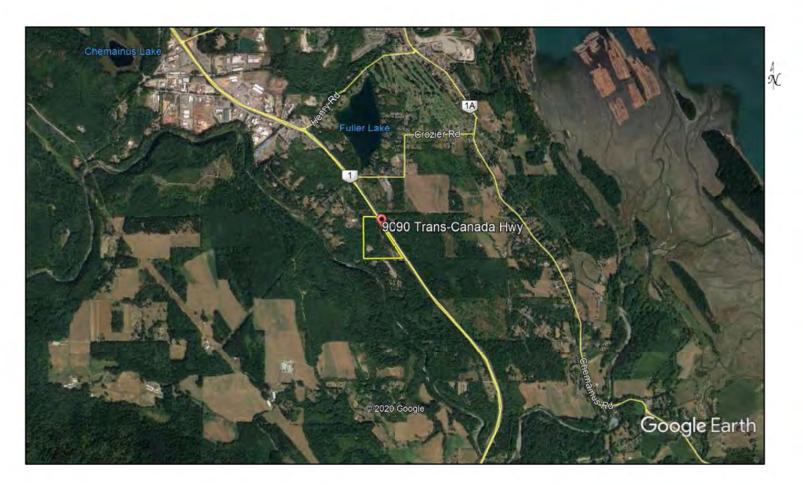
Section 3. Site Plan

Insert jpg file below

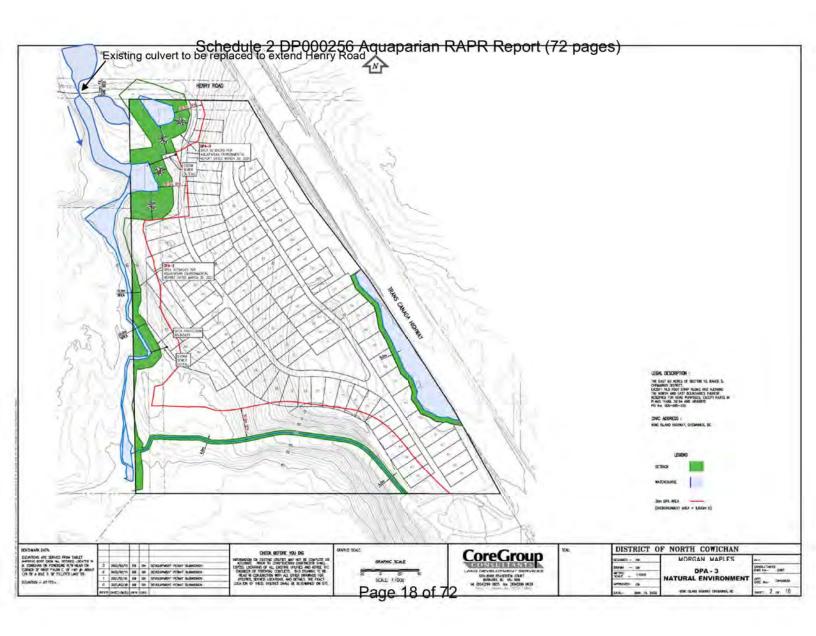
Site Plan

Form 1 Page 8 of 17

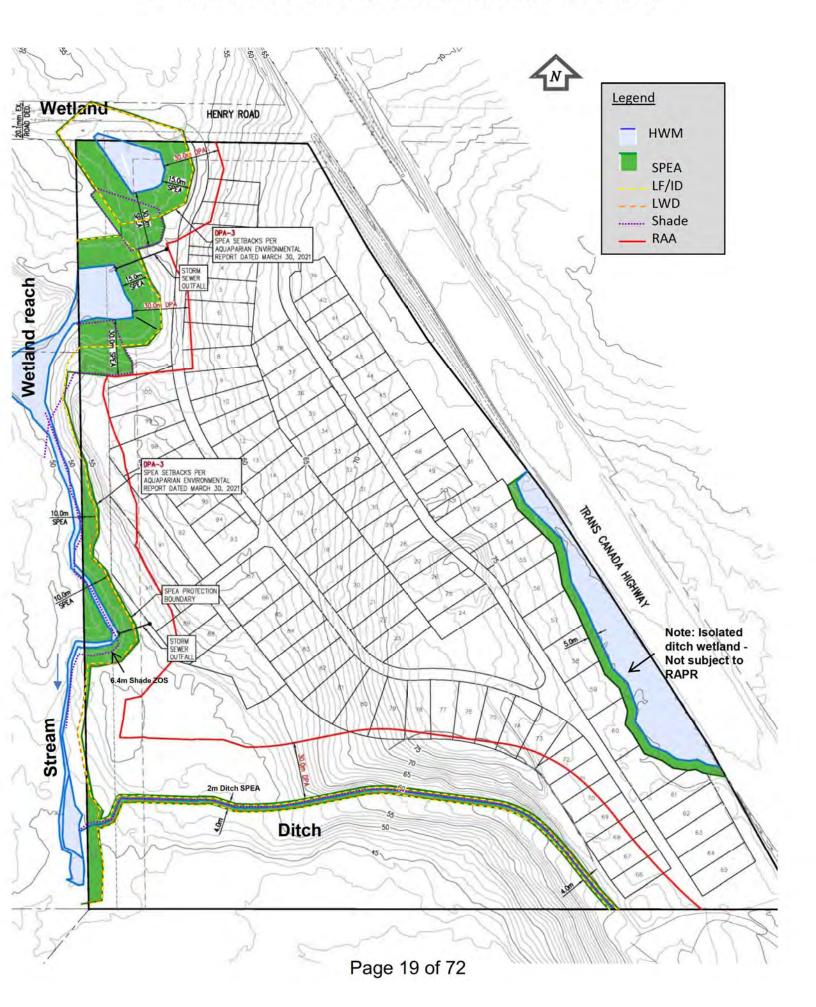
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Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Section 4. Measures to Protect and Maintain the SPEA

<u>This section is required for detailed assessments.</u> Attach text or document files, as need, for each element discussed in Part 4 of the RAPR. It is suggested that documents be converted to PDF *before* inserting into the assessment report. Use your "return" button on your keyboard after each line. You must address and sign off each measure. If a specific measure is not being recommended a justification must be provided.

Danger Trees	Potential danger trees (leaning or dead trees) were observed in the SPEA. Prior to any land clearing within 30m of the watercourse, a Certified Arborist should be retained to assess the health and protection needs of the trees in and immediately adjacent to the SPEA.
Riparian Areas Protection Act I am qualified to carry out this BC Ltd; I have carried out an assess Report; and in carrying out n	al professional, as defined in the Riparian Areas Protection Regulation made under the
2. Windthrow	Downed trees were observed in the SPEA. The removal of trees on such a large portion of the parcel may increase the risk of windthrow issues within the SPEA even though they are located in the topographically lowest portion of the parcel. A Certified Arborist should be retained to assess the risk of windthrow issues.
Riparian Areas Protection Acts I am qualified to carry out this BC Ltd; I have carried out an assess Report; and in carrying out n	al professional, as defined in the Riparian Areas Protection Regulation made under the
Slope Stability	The stream banks are fully vegetated with trees and understorey species and appear to be stable with no obvious signs of failure/erosion. No change in stability is expected to result from the proposed development.
Riparian Areas Protection Acts I am qualified to carry out thi BC Ltd; I have carried out an assess Report; and in carrying out n	certify that: al professional, as defined in the Riparian Areas Protection Regulation made under the
4. Protection of Trees	 Prior to clearing, install temporary fencing at the limits of clearing outside the SPEA and other recommended setbacks. Minimize clearing areas and stay within predetermined clearing boundaries. Ensure that site clearing and placement of building pads are not planned right up to the SPEA boundary. The SPEA setback needs to be protected from soil disturbance and trees along the boundary need to be protected from damage including avoiding disturbance within the drip line of trees; Clearing of trees and ground vegetation to be completed outside of the migratory bird nesting season

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Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

(March 1st to August 15th) or have a biologist complete a bird nesting survey prior to the start of clearing. Avoid the peak season due to high probability of finding nests.

- Prior to any land clearing within 30m of the stream, an ISA Certified Arborist must be retained to assess the health and protection needs of the trees in and immediately adjacent to the SPEA. This assessment shall include hazardous trees and windthrow risk. The arborist shall consider other management options for hazardous trees rather than removing them;
- Tree removal (except danger trees) on steep slopes immediately adjacent to the SPEA shall be avoided and only conducted where necessary and undertaken with due care to ensure the integrity of the SPEA is not compromised.

I, Sarah Bonar, R.P.Bio, hereby certify that:

- I am a qualified environmental professional, as defined in the Riparian Areas Protection Regulation made under the Riparian Areas Protection Act;
- I am qualified to carry out this part of the assessment of the development proposal made by the developer 1251719
 BC Ltd;
- c. I have carried out an assessment of the development proposal and my assessment is set out in this Assessment Report; and in carrying out my assessment of the development proposal, I have followed the assessment methods set out in the Minister's technical manual to the Riparian Areas Protection Regulation.
- Encroachment

The SPEA is considered to be a "No-Go" zone. No encroachment into the SPEA is permitted. No refuse or yard waste is allowed to be dumped into the SPEA. To prevent future encroachment, Aquaparian recommends permanently marking the SPEA boundary with fencing with signage that identifies the sensitive riparian area.

I, Sarah Bonar, R.P.Bio, hereby certify that:

- I am a qualified environmental professional, as defined in the Riparian Areas Protection Regulation made under the Riparian Areas Protection Act;
- I am qualified to carry out this part of the assessment of the development proposal made by the developer 1251719
 <u>BC Ltd</u>;
- c. I have carried out an assessment of the development proposal and my assessment is set out in this Assessment Report; and in carrying out my assessment of the development proposal, I have followed the assessment methods set out in the Minister's technical manual to the Riparian Areas Protection Regulation.
- Sediment and Erosion Control
- As understood, the project is to be developed in phases. Stage earthworks and construction to minimize areas of exposed soils and reduce the potential risk of sedimentation to the watercourse. Any areas of exposed or disturbed soil in the riparian area of the watercourse should be seeded or replanted as soon as possible to provide sediment control and prevent erosion. Grass seed (west coast seed mix) and straw mulch should be applied to finished graded soils to prevent surface erosion as soon as possible;
- Aquaparian recommends that earthworks be completed during dry periods if possible and that a silt fence be installed along the toe of the construction zone to prevent the migration of sediment into the SPEA of the watercourse. If

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Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

earthworks cannot be completed during the dry months, work should be completed when there is minimal precipitation in the forecast;

- No sediment is to be allowed to enter watercourses, the determined SPEAs or other off-site drainages: sediment and erosion measures are to be implemented. Install a silt fence along the toe of the construction zone prior to the start of earthworks/construction and inspect and maintain regularly. Additional sediment control that may be required include temporarily covering the exposed soils with sheets of poly and weighing it down to prevent it blowing off, containing or redirecting/diversion of runoff with sand bags (or similar), interceptor ditches, temporary sediment pond installation, rock check dams, placement of additional silt curtains between work areas and drainages, or temporary work stoppages;
- Do not store stockpiled soils on site for extended periods of time. Management of stockpiled soils including no stockpiling within 15m of the SPEA, covering with plastic, etc;
- Prevent track-out onto paved roads. Sweep up and remove sediments as often as necessary.
- Part-time environmental monitoring is recommended. The EM will be on-site to conduct water quality monitoring when necessary and provide additional mitigation measures when required. The following turbidity guidelines apply to the Project where "background" is defined as the level at an appropriate adjacent reference site (upstream) that is neither affected by works at the site, nor by sediment-laden, induced suspended sediments, or induced turbidity resulting from works or activities within the work site:
 - Total Suspended Solids (TSS) should not exceed 25 mg/L;
 - Turbidity should not exceed background by more than 8NTU when background is between 8 to 80 NTU;
 - Turbidity should not exceed 2NTU when background is less than 8NTU; and
 - Turbidity should not exceed background by more than 10% when background is >80NTU.

Should the Project result in TSS or NTU levels in excess of the criteria outlined above, then those works and activities that might be contributing to these conditions must be halted until measures are

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Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

in place to ensure compliance with the criteria outlined above are put in place.

- No deleterious substances are to be allowed to enter the watercourse or its riparian area or other off-site drainages;
- Do not dump yard waste / refuse within the SPEA of the watercourse;
- All heavy equipment used on-site should be inspected daily and have a proper spill prevention kit on board in case of any leakage or spills of hydrocarbon. No refuelling is to take place within 30m of the watercourse. Conduct daily inspections to ensure no leaking of equipment;
- If a leak or spill occurs, work is to immediately stop, isolate the spill, clean the spill and dispose of contaminated materials appropriately (according to regulations). The EM will be made aware immediately of any fuel, oil and chemical spills that occur in or around the water. All spills to watercourses are to be reported to EMBC (1-800-663-3456) immediately either by the Project Manger, Site Supervisor or the EM if directed to do so by the PM or site supervisor.
- During concrete works (i.e. concrete curbs, fence, building pads), concrete wash water from cast-inplace concrete works (within the first 72hrs) shall not enter any surface water or storm water at or near the worksite. The following concrete management measures should be followed:
 - Construct all concrete forms so that they are properly sealed;
 - Deliver concrete without spillage;
 - Isolate concrete from the aquatic environment during curing;
 - Ensure concrete applications that have the potential to impact surface waters are monitored by a qualified environmental professional.
 Maintain surrounding surface water pH within 7 to 9 pH units;
 - Do not perform concrete work if precipitation events are anticipated within 72 hours and the work cannot be contained;
 - Wash concrete trucks, pumping equipment, and tools off-site or construct a designated, contained concrete wash area on-site where all concrete washing shall occur.

I, Sarah Bonar, R.P.Bio, hereby certify that:

a. I am a qualified environmental professional, as defined in the Riparian Areas Protection Regulation made under the

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

	Dinarian Areas Protection Act	
b.	Riparian Areas Protection Act; I am qualified to carry out this part of the BC Ltd;	he assessment of the development proposal made by the developer 1251719
C.	I have carried out an assessment of th Report; and in carrying out my assess	the development proposal and my assessment is set out in this Assessment ment of the development proposal, I have followed the assessment methods ual to the Riparian Areas Protection Regulation.
7.	Stormwater Management	Stormwater management will include a series of roadside ditches and the roof leaders will be directed to the ground to allow infiltration. The stormwater management has been designed by the project engineering consultant (see attached
1, <u>C</u>	ormac Nolan P.Eng , hereby certify that	
a.		ional, as defined in the Riparian Areas Protection Regulation made under the
b.	Riparian Areas Protection Act;	he assessment of the development proposal made by the developer 1251719
D.	BC Ltd:	the assessment of the development proposal made by the developer 1251119
C.	I have carried out an assessment of th Report; and In carrying out my assess	the development proposal and my assessment is set out in this Assessment ment of the development proposal, I have followed the assessment methods and to the Riparian Areas Protection Regulation.
8.	Floodplain Concerns (highly mobile channel)	No evidence of flooding of the main channel of the watercourse was identified within the subject property during this assessment. The wetland areas may periodically flood during very wet periods however this is not a highly mobile channel.
I, S	arah Bonar, R.P.Bio, hereby certify that	
a.	I am a qualified environmental profess Riparian Areas Protection Act;	ional, as defined in the Riparian Areas Protection Regulation made under the
b.	I am qualified to carry out this part of the BC Ltd;	he assessment of the development proposal made by the developer 1251719
C.	Report; and In carrying out my assess	ment of the development proposal, I have followed the assessment methods

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Section 5. Environmental Monitoring

Attach text or document files explaining the monitoring regimen Use your "return" button on your keyboard after each line. It is suggested that all document be converted to PDF before inserting into the PDF version of the assessment report. Include actions required, monitoring schedule, communications plan, and requirement for a post development report.

If vegetation clearing is scheduled during the migratory bird nesting season, avoid the peak season and have pre-clearing nest surveys completed prior to clearing in manageable phases.

Part-time environmental monitoring during clearing, grading and civil works is recomended on a weekly basis or as necessary by changing site conditions, heavy rain events, or spills, to ensure that no erosion or sedimentation is occurring and that the recommended environmental protection measures are being followed and to provide additional recommendations as necessary.

A post construction report is to be completed and submitted to the provincial RAPR notification system to document the project was completed as planned and that all measures to protect the SPEA have been followed. Aquaparian will be available upon request to complete and submit the post construction assessment.

Form 1 Page 14 of 17

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Section 6. Photos

Provide a description of what the photo is depicting, and where it is in relation to the site plan.





Photos 1 & 2. The tributary stream along the western boundary of the subject property at 9090 Trans-Canada Hwy in North Cowichan, BC. The stream flows south into the Chemainus River to the southwest of the parcel.



Photo 3. The riparian area of the stream is intact with trees and understory vegetation. The tree canopy is predominantly bigleaf maple and western redcedar. A 5m high slope is located on the east side of the stream.

Schedule 2 DP000256 ACRES APR Report (72 pages)



Photo 4. The metal spillway where the tributary stream flows over the top of the steep slope that leads down to the Chemainus River to the southwest of the parcel.



Photo 5. The spillway discharges to a broken cement spill pad then drops down a small waterfall (~2m high) then continues down the steep ravi

Schedule 2 DP000256 AHD SHEFT RAPR Report (72 pages)



Photo 6. The roadside ditch on the north side of the access road flows west down the hill and past the RV parking area.



Photo 8. The ditch flows through the dog run pulyert the of 72 into the forest where it joins with the tributary stream.

Photo 7. The ditch continues through the RV parking area culvert.

Schedule 2 DP000256 AHD SHEFT RAPR Report (72 pages)



Photo 9. Showing the existing cleared RV parking area in the southwest portion of the lot.



Photo 10. Many old access roads traverse through the second-growth forest of the property.

Schedule 2 DP000256 AtQ TO STAPR Report (72 pages)



Photo 11. Wetland reach of the stream northwest of the property boundary on the adjacent parcel and beside the Henry Road alignment.



Photo 12. Wetland in the depressional area in the northwest corner of the parcel.



Photo 13. Panoramic view of the northwest corner wetland. Vegetation includes salmonberry, skunk cabbage, willow, sword fern and bracken fern with a tree canopy of red alder and surrounded by western redcedar and bigleaf maple.

Page 31 of 72

Schedule 2 DP000256 AtQ TO SHEET RAPR Report (72 pages)



Photo 14. Old dirt road and water line between the wetland in the northwest corner beside the Henry Road ROW and the stream wetland to the south.

Photo 15. Showing the outlet of the 15cm diameter concrete culvert pipe under the dirt road and water line. The culvert drains the wetland during high flood conditions.

Culvert outlet



Photo 16. The culvert outlet to the south of the dirt road fans out overland flowing down an old dirt road towards the stream wetland to the south.



Photo 17. Overflow has formed a section of eroded channel that transitions to unconfined overland flows over an old dirt road before entering the stream wetland to the south.

Schedule 2 DP000256 AHD SHEFTRAPR Report (72 pages)



Photo 18. Showing the barbed-wire fence along the Henry Rd ROW between the hazelnut tree farm to the north and Henry Road ROW and the subject parcel.



Photo 19. The northwest corner property boundary stake and watermain stake.

Schedule 2 DP000256 AGA APR Report (72 pages)



Photo 20. The gated east boundary access to the subject property from the Island Highway.



Photo 21. The previously cleared area near the eastern property boundary. Cut and downed trees were observed.



Photo 22. An old house foundation is located within the cleared area in the eastern portion of the parcel.



Photo 23. There are piles of garbage/refuse within the cleared area.

Schedule 2 DP000256 AGA APR Report (72 pages)



Photo 24. The ditched highway wetland along the eastern property boundary with characteristic wetland vegetation including cattails, hardhack, reed canary grass, slough sedge, willow and red alder.



Photo 26. An excavated ditch from the wetland is connected to the highway ditch.



Photo 25. Showing wildlife tree snags within the highway wetland area.

Schedule 2 DP000256 A QUaparter RAPR Report (72 pages)



Photo 27. The highway ditch along the eastern property boundary. Facing north the gradient rises and then slopes downward slightly near the north end of the property.



Photo 29. The highway ditch continues south past the entrance to Country Maples RV Resort.



Photo 28. Showing the culvert crossing the entrance road from the highway into Country Maple RV Resort.



Photo 30. The highway ditch terminates by fanning out over the top of the slope leading down to the property just south of the subject parcel. No channel present over the slope.



Photo 31. The ditch channel terminates at the top of the steep slope pictured.

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Section 7. Professional Opinion

Qualified Environmental Professional opinion on the development proposal's riparian assessment.

Date March 21, 2022

1. I/We Sarah Bonar, R.P.Bio & Cormac Nolan P.Eng

hereby certify that:

- a) I am/We are qualified environmental professional(s), as defined in the Riparian Areas Protection Regulation made under the *Riparian Areas Protection Act*:
- I am/We are qualified to carry out the assessment of the proposal made by the developer <u>1251719 BC Ltd</u>, which proposal is described in section 3 of this Assessment Report (the "development proposal"),
- I have/We have carried out an assessment of the development proposal and my/our assessment is set out in this Assessment Report; and
- d) In carrying out my/our assessment of the development proposal, I have/We have followed the specifications of the Riparian Areas Protection Regulation and assessment methodology set out in the minister's manual; AND
- 2. As qualified environmental professional(s), I/we hereby provide my/our professional opinion that:
 - a) N/A the site of the proposed development is subject to undue hardship, (if applicable, indicate N/A otherwise) and
 - b) A the proposed development will meet the **riparian protection standard** if the development proceeds as proposed in the report and complies with the measures, if any, recommended in the report.

[NOTE: "Qualified Environmental Professional" means an individual as described in section 21 of the Riparian Areas Protection Regulation.]

Form 1 Page 16 of 17

Riparian Areas Protection Regulation - Qualified Environmental Professional - Assessment Report

Submission Instructions

Riparian Areas Protection Regulation – Qualified Environmental Professional –
Assessment Report RAR-QEP-AR

Forms you will need to complete are

- Form 1 which has the database information, the description of the fisheries resources, development site plan, measures to protect and maintain the SPEA, and environmental monitoring.
- Form 2, if more QEPs are part of the project team.
- ➤ Either Form 3 the detailed assessment form(s) or Form 4 simple assessment form(s) which is for the results of the riparian assessment (SPEA width). Use enough copies of the form to complete the assessment of the site.
- Form 5 is the photo form(s). Duplicate for additional photos.

NB: Refer to Part 4 of the RAPR and the Technical Manual for detailed instructions on the information required for completing the Assessment Report.

A complete Riparian Assessment Report based on the template forms must be converted to a single Portable Document Format PDF file prior to uploading onto the Notification System.

The Assessment Report must be submitted complete with all information specified and posted to the notification system to be reviewed by the province. Upon approval notification will be provided to the local government.

Tips for working with MS Word Template Forms

Using the forms

- Before beginning, print a hard copy of the form and the guidance files for reference
- Open the template
- Enter data into the shaded fields on the form
- Use TAB to move from one field to another: SHIFT-TAB to go in reverse
- Text and digital photos may be inserted from other applications
- The amount of text that can be entered in each box is limited and cannot be changed by the user; boxes with date information, for example, require input like: yyyy-mm-dd.

Saving the completed form

- Assign name to the completed form
- Save a word document (*.doc file)
- Do not overwrite the Template (*.dot file) with your completed form
- · If you do overwrite the template, you can download a new copy from this web site

Rainwater Management Plan Preliminary Report Morgan Maples

9090 Trans-Canada Highway North Cowichan, British Columbia

Prepared By:

Core Group Civil Consultants Ltd

320 – 8988 Fraserton Court Burnaby, British Columbia V5J 5H8 Phone: (604) 299-0605

Fax: (604) 299-0629

Permit to Practice # 1001017(BC)

February 14, 2022

Core Project: 2087

Rainwater Management Pla	ın
Preliminary Report	

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REVISION HISTORY

REVISION NUMBER	DATE
0	February 2022

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Rainwater Management Plan Preliminary Report

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Rainwater Management Plan Preliminary Report

Introduction

INTRODUCTION

Project Overview

The Project is located in the Chemainus community of North Cowichan and consists of one lot. The property is bounded by the Trans-Canada Highway to the east, Henry Road to the north, agricultural and rural properties to the west, and an RV resort to the south. The property is currently zoned R5, Residential Mobile Home Park Zone. The developer is proposing to construct residential mobile homes in accordance with the current zoning By-law.

Basis of Report

The following interim report has been prepared in support of the Development Permit Application for this project. The finalized report will be provided at Building Permit Application.

The report meets and exceeds the requirements of the Municipality of North Cowichan's "Stormwater and Rainwater Design Guidelines" attached in **Appendix C**.

REPORT

Topography and Geotechnical Overview

The project slopes, in general, from East to West with total vertical elevation difference of 15 meters. Re-grading the site will be required as part of the development and the proposed Grading Plan is contained in **Appendix A**.

Stormwater Management Overview

The Municipality of North Cowichan's Stormwater and Rainwater Design Guidelines requires that proposed Developments detain the 5-year storm event. Based on the proposed design, the development will provide sufficient detention storage for the 200-year event. Therefore the 200-year Pre-development Flows will match the Post Development flows for the 200-year event. The current design exceeds the Municipal requirements, and the Developer reserves the right to reduce the storage capacity to the Municipal requirements.

The proposed Stormwater Management Plan will provide a variety of Source Control measures located throughout the site. Dispersing these facilities around the site will reduce the concentration of both infiltration and flows. The proposed facilities will include the following:

- a) Absorbent Topsoil: Impermeable surfaces will be directed, where possible, to topsoil and landscaped areas. This will promote infiltration, retention and exfiltration.
- b) Each Modular Home "lot" will have individual infiltration galleries which will help evenly infiltrate and distribute rainfall back into the ground throughout the development. A typical detail is included in **Appendix D**;
- c) Each Modular Home "lot" will have a small rain garden which will provide both attenuation and water quality to the stormwater and will again provide a more evenly distribution of stormwater.
- d) Stormwater discharge to receiving Creeks and ponds will have water quality manholes and flow control manholes prior to their discharge point.

Drainage Design

a) Storm water Source Controls will be installed on a "lot" by "lot" basis. Each Modular Home "lot" will provide a source control infiltration gallery to compensate for the introduced impermeable surface on the "lot" and roadworks fronting the "lot". Calculations show that an average infiltration area of 6 m2 and a detention volume varying between 3.4 m3 and 4.1 m3 will be required per "lot". Detailed calculations are provided in Appendix D and final calculations for the project will

be provided at Building Permit stage. A Typical detail of the proposed infiltration gallery is also contained in **Appendix D**.

- b) In addition to the above a rain garden (1 m3) will also be provided on each "lot" to provide additional attenuation and water quality.
- c) Underground Storm Sewer pipes will convey rainwater runoff from the roadways and any overflows from the Infiltration Galleries to three (3) discharge points as shown on the Stormwater Management Plan contained in Appendix A. A water quality manhole and a flow control manhole will be provided prior to each discharge point to the creek or ditch system to provide cleansing of the stormwater and flow control to the eliminate erosion in the receiving waters. Energy dissipaters will also be provided at the headwalls.

Storm sewer pipes will be sized to accommodate the 10-year peaks flows "in pipe" and the 200-year peak flows will surcharge the pipes but remain below surface.

d) Storm water Release Rate.

As noted above the release rates will be controlled at Flow Control Manholes located before each discharge point.

<u>Application Commentary Concerns – dated January 14, 2022</u>

- a) Risks to the groundwater regime from the proposed development have been evaluated by the Geotechnical Engineer. The proposed development will have no risk on the groundwater regimes, the memo is included as Appendix B
- b) The Predevelopment and Post Development flows for the 10-, 25- and 200-year events are detailed in Appendix D. Detention is provided to reduce the Post development Peak Flows to the Pre Development Peak Flows.
 - In summary the development provides a total of <u>373 m3</u> of detention volume. Below are summarized the Peak flows generated from the three different catchment areas for the various storm events and the detention storage volumes required to maintain the Pre Development peak flows.

Catchment Area A

Storm Event	Pre Dev Peak Flow m3/s	Max release m3/s	Detention Volume m3
5-year	0.022	0.022	68
10-year	0.025	0.025	86
25-year	0.031	0.031	100
200-year	0.039	0.039	165

Catchment Area B

Storm Event	Pre Dev Peak Flow m3/s	Max release m3/s	Detention Volume m3
5-year	0.013	0.013	41
10-year	0.015	0.015	51
25-year	0.018	0.018	60
200-year	0.023	0.023	98

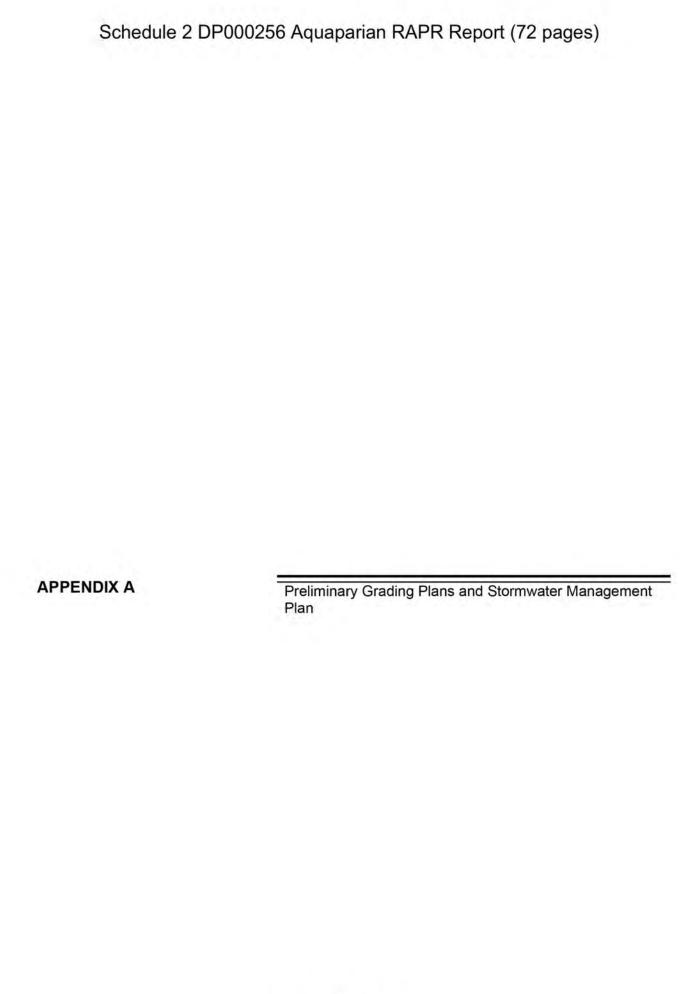
Catchment Area C

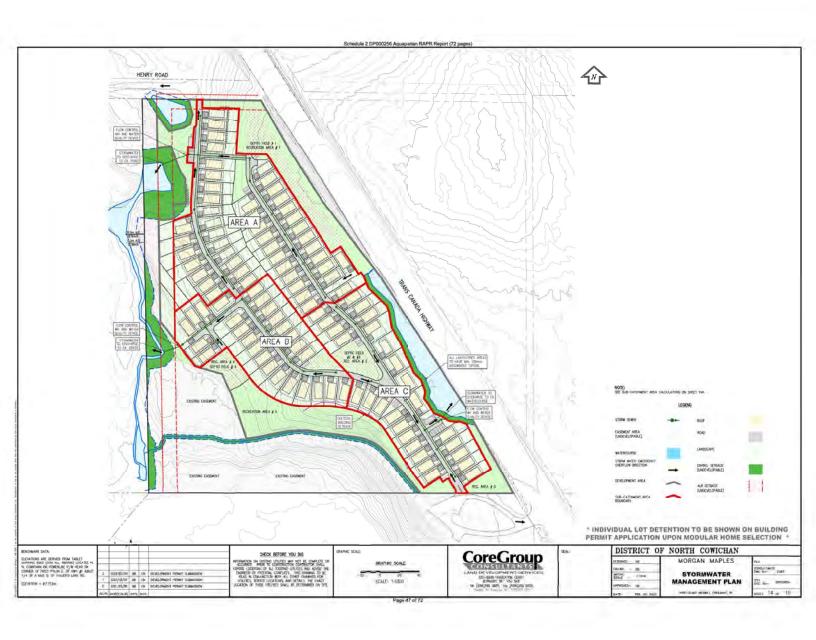
Storm Event	Pre Dev Peak Flow m3/s	Max release m3/s	Detention Volume m3
5-year	0.014	0.014	46
10-year	0.017	0.017	57
25-year	0.020	0.020	67
200-year	0.026	0.026	110

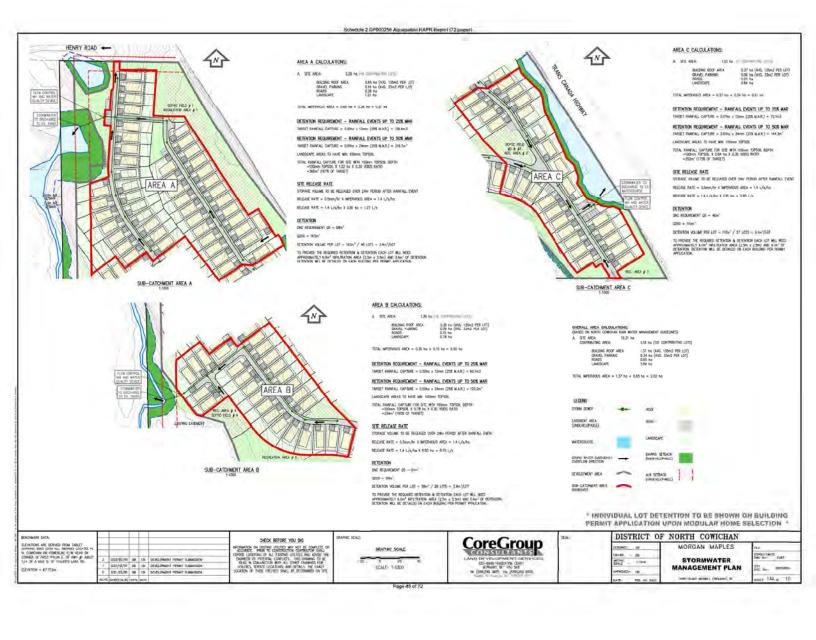
The proposed storage volume **373 m3** will maintain the Predevelopment flows up to the 200-year storm event.

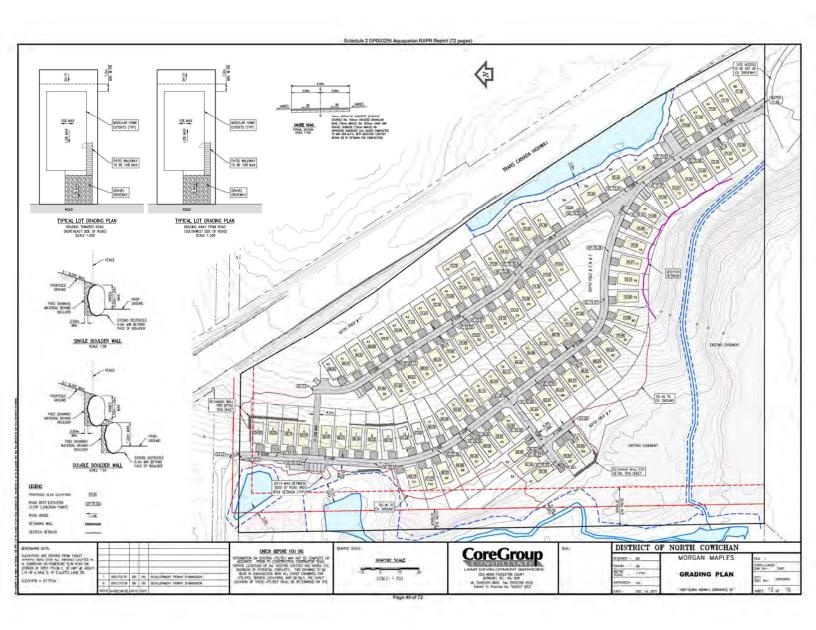
System Maintenance

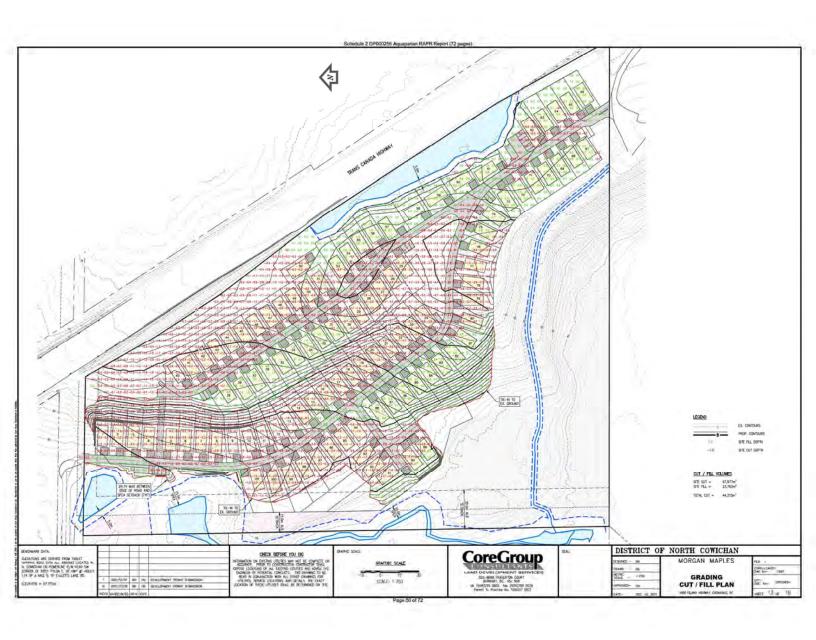
The final RWMP will include a maintenance and operations guide for the rainwater management system. As maintenance of the systems is important for the continued efficiency of the systems designed, the guide will be provided to the eventual owner or party responsible for maintenance.













Core Group Civil Consultants Ltd. #320 – 8988 Fraserton Court Burnaby, BC V5J 5H8

Attention: Dylan Bryson

Re: Geotechnical Comments on Proposed Stormwater Management Systems Proposed Modular Home Park - 9090 Island Highway, Chemanius, BC

We understand our comments are required regarding the stormwater management systems proposed onsite and their impact on the groundwater regime and slope stability. We understand each modular home lot will have a raingarden and infiltration gallery to direct water into the ground across the development. We further understand grade changes are proposed across the site with grade increases of up to 9 m towards the south, and grade decreases of up to 8 m to the north.

GeoPacific previously completed a test pit investigation of the subsurface and groundwater conditions on February 23 and 24, 2021. At that time, a total of 22 test pits were excavated across the site between 0.8 m and 3.5 m below current site grades, including two infiltration tests near the centre of site. The results of our investigation are outlined in our Geotechnical Investigation Report, dated March 9, 2021. The subsurface soil conditions across the site generally consist of a layer of topsoil, overlying compact to dense sand to very stiff sandy silt. Some rock outcrops were observed along the west side of site. The static groundwater table was not encountered during the investigation. Some perched groundwater is expected to occur on the boundary of the till-like soils. We expect the stormwater management systems will be located in the native sand to sandy silt, or engineered fill.

We have reviewed the Rainwater Management Plan Report (dated January 24, 2022), provided by Core Group Civil Consultants Ltd. The report indicates stormwater will be managed through the use of stormwater infiltration and detention systems.

Based on the grading plan provided, we expect some permanent slopes will be present. From a geotechnical perspective, we recommend any infiltration galleries have a minimum setback of 5 m away from the top of any permanent slope and be located a minimum of 2 m above the static groundwater table or bedrock contact. If these conditions cannot be met, then stormwater detention systems should be employed in these areas. GeoPacific intends to review the conditions during construction, as outlined in our Geotechnical Investigation Report, to confirm the subsurface conditions on the lots and provide additional recommendations as necessary. Given the above, both stormwater management by infiltration and/or detention is feasible from a geotechnical perspective and an acceptable level of slope stability will be maintained.

We are pleased to be of assistance to you on this project and we trust that our comments and recommendations are both helpful and sufficient for your current purposes. If you would like further details or would like clarification of any of the above, please do not hesitate to call.

For:

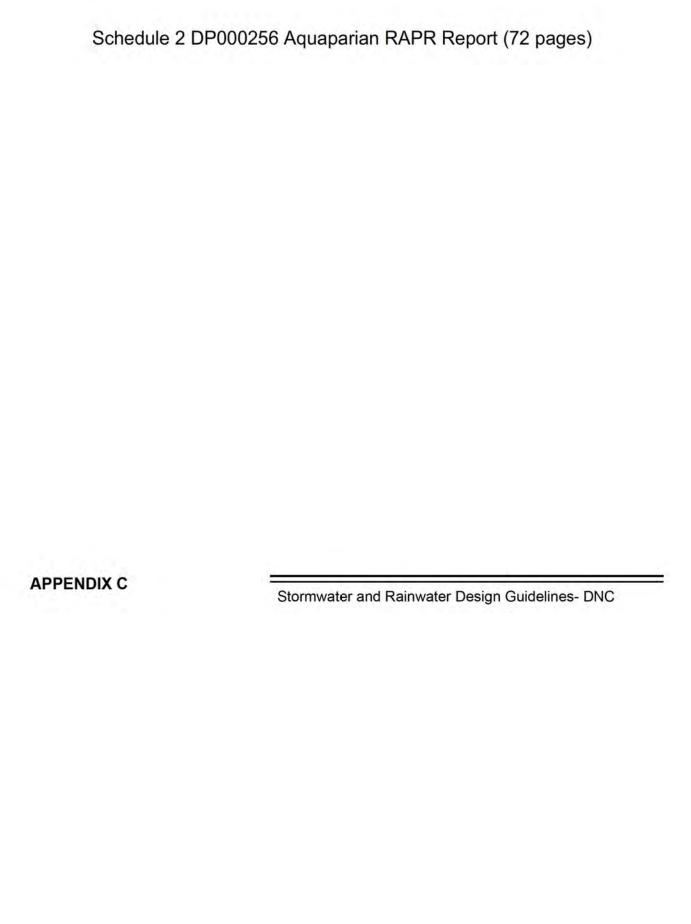
GeoPacific Consultants Ltd.

Austin Lockstidt, B.A.Sc., EIT Engineer In Training

Kevin Bodnar, M.Eng., P.Eng. Principal

February 11, 2022

File: 18529



Storm Water and Rain Water Design Guidelines

The following guidelines are provided to supplement the information contained in the Municipality's Engineering Standards. They are focused primarily on residential and commercial developments, but the objectives are also applicable to industrial and institutional projects. The intention is to ensure that drainage systems are designed to handle significant storm events in accordance with conventional storm water management principles, while also implementing some alternative rain water management approaches to deal with the smaller, more frequent rainfall events in an environmentally responsible way. As the area of storm water and rain water management continues to evolve, we look forward to your comments and suggestions.

Storm Water Management - Design Guidelines

Objectives

- Primary purpose is to limit damage to the community and the environment from significant storm events.
- Focus is on larger storm events ie. 2 yr, 5 yr, 10 yr, 25 yr, 200 yr. Smaller rainfall events are to be handled by rain water management (source control) measures.
- Need to ensure that flows from storm events can be handled onsite and offsite by municipal infrastructure and natural systems so as to limit impacts to the community and the environment.
- For typical residential development, water quality objectives are to be met through rain water management measures. For commercial, industrial, institutional and high density residential development, additional water quality treatment measures may be required.

Design Criteria

- Limit post-development peak flow rate to pre-development peak flow rate for the 5 yr event, unless downstream conditions require additional flow control.
- Design detention ponds for the 5 yr event, unless downstream conditions require additional flow control. Provide overflow capacity for the 200 yr event. Refer to MOE/DFO Land Development Guidelines, Section 4, for pond construction details.
- Review downstream capacity and flood risk for 10, 25 and 200 yr events. If necessary, upgrade downstream works and/or provide additional detention and flow control.

Storm Water Management - Design Guidelines (cont'd)

- Include drainage from upstream tributary areas, assuming full development as indicated by the OCP, unless otherwise directed.
- Design minor drainage system (pipes, swales, ditches) for 10 yr event peak flows. For pipes 600mm and larger, design for 25 yr event.
- Design major drainage system (overland flow routes) for 200 yr event.
- Size culverts for 10 yr event with HW/D=1.0 (no surcharge), and 200 yr event with maximum surcharge of HW/D = 2.0 (surcharge of one pipe diameter) if site conditions permit; otherwise size for 200 yr event with HW/D=1.0.
- Use the Rational Method to calculate peak flows to size pipes and culverts for basic conveyance systems for drainage areas 20 ha. or less. Refer to DNC Engineering Standards for details. For larger drainage areas use hydrograph methods. Use DNC IDF curves as per Std Dwg D12.
- On residential sites where rain water management/source control measures have been implemented as outlined below, the Rational Method runoff coefficient "C" may be adjusted as follows:

Land Use (Assumes composite "C" for site)	"C" without Source Control	"C" with Source Control
Residential (>700m²)	0.5	0.45
Small Lot Residential (<700m²)	0.6	0.55
Multi-family Residential	0.7	0.65

- On sites with extensive impervious areas (i.e. commercial sites) where source control
 measures are implemented, the minimum enter time, Te, may be increased from 10
 minutes to 15 minutes when calculating the time of concentration for areas tributary to
 the source controls.
- · Use hydrograph methods to:
 - analyze large or complex drainage areas.
 - o calculate pre and post development flows to size detention facilities.
 - o assess downstream capacity and flood risk for various storm events.
 - Refer to MMCD Design Guideline Manual for additional information.
- Provide site specific Storm Water Management Plan in accordance with MMCD Design Guideline Manual, Section 4.3, as directed.
- For commercial, industrial, institutional and high density residential development, design water quality treatment works to meet the following:
 - o treat 90% of the annual runoff volume of the catchment area.
 - meet removal targets of 80% TSS and 95% oil.

Rain Water Management - Design Guidelines

Objectives

- Primary purpose is to limit adverse impacts to the environment when land is developed.
- · Deals with both water quantity and water quality.
- Focus is on smaller, frequent rainfall events, ie. smaller than 2 yr events.
- Post-development hydrology to mimic pre-development hydrology using small scale, onsite, non-pipe, "low impact" approaches.
- Often called "source control", two specific techniques outlined below are infiltration chambers and rain gardens. Other techniques that will be considered on a case by case basis include swales, permeable pavement, absorbent landscaping, increased topsoil and other "low impact", Water Balance Model type approaches.

Design Criteria

- Source control works shall be designed to handle runoff from onsite impervious surfaces, ie. typically roofs, driveways and parking areas. The primary goal is to make use of onsite infiltration to reduce runoff from the site. The secondary goal is to provide detention so as to allow runoff that is not handled by infiltration to be discharged to the storm drainage system at a rate similar to pre-development conditions.
- Source control works shall be installed on all sites regardless of soil conditions, unless
 otherwise approved. It is recognized that where sites have soils that drain poorly, the
 effectiveness of infiltration systems will be limited, particularly during winter months.
 This is acceptable because it mimics the pre-development conditions of sites with soils
 that drain poorly.
- Design of source control works shall be based on 50% of the Mean Annual Rainfall (MAR) 24 hour event. For the Municipality of North Cowichan, an MAR of 48mm shall be assumed, resulting in a 24 hour design rainfall of 24mm, or an average rate of 1.0mm/hr. The intention is that the source control works shall be designed to handle this rainfall amount through a combination of infiltration and detention.
- Source control works shall include a detention component sized to provide a minimum storage volume based on 25% of the MAR, or 12mm, over the impermeable areas, assuming no infiltration or outflow. This equates to a storage volume of 1.2m³ for every 100m² of impervious area. For a typical residential lot with 200m² of impervious area, the works shall provide a minimum storage volume of 2.4m³.

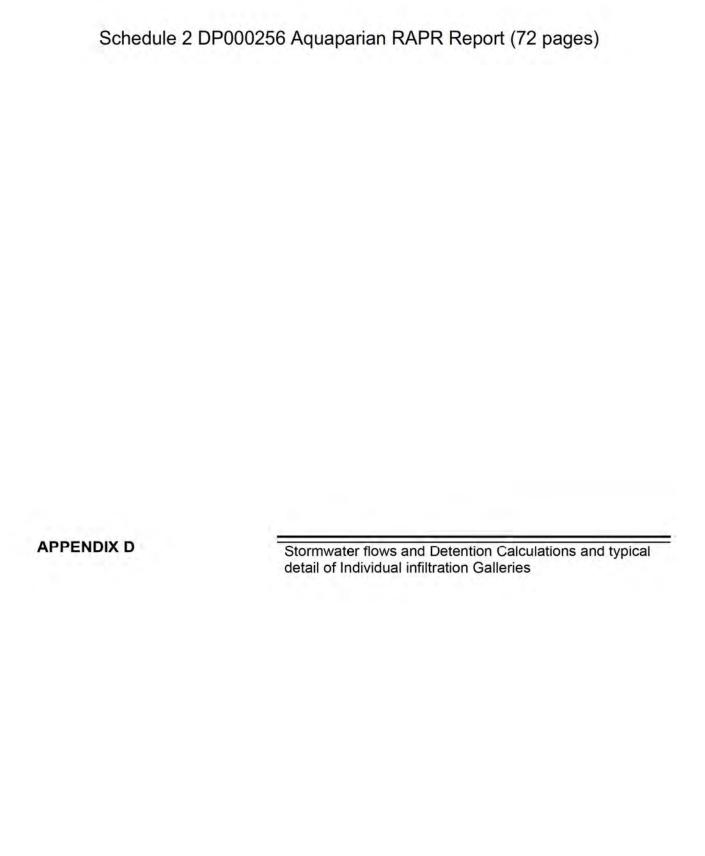
Rain Water Management – Design Guidelines (cont'd)

- Unless otherwise approved, a flow controlled outlet shall be provided so that, if necessary, the above storage volume is drained to the piped drainage system over a 24 hour period after the rainfall event. This equates to an outflow rate of 0.50mm/hr X the impervious area, which further equates to a rate of 1.4 l/s/ha. For a typical residential lot with 200m² of impervious area, the discharge rate will be 100 l/hour or 0.028 l/s. Simple orifice type flow control is not recommended for such low flow rates as the orifice diameter would only be about 5mm, which would be susceptible to plugging. As an alternative, flow control may be achieved by using an infiltration layer above an under-drain as shown on the detail drawings.
- The requirement for a flow controlled outlet may be waived upon submission of evidence by a Geotechnical Engineer that subsurface soil infiltration rates are adequate to handle the full design flow of 24mm of rainfall from onsite impervious surfaces over a 48 hour period. The basis for this requirement is that during the first 24 hours, half of the rainfall is infiltrated and the other half stored, then during the second 24 hours, the stored rainfall is infiltrated. This equates to an infiltration rate of 0.50mm/hr X the impervious area. For a typical residential lot with 200m² of impervious area, 100 l/hr will need to be infiltrated into the soil. For a typical infiltration system with 10m² of area, an average infiltration rate of 10mm/hr will need to be sustained over a 48 hour period.
- Infiltration chambers shall typically occupy an area equal to about 5% of the site impervious area. For a residential lot with 200m² of impervious area, the infiltration chamber works will occupy an area of about 10m² or 3.0mx3.0m.
- Rain gardens shall typically occupy a minimum area equal to about 10% of the site impervious area. For a residential lot with 200m² of impervious area, the rain garden will occupy an area of about 20m². To meet the storage requirement outlined above, a ponding depth of 150mm will be typical.
- Refer to Standard Drawings xx and xx for typical infiltration chamber and rain garden design details. Alternate designs meeting the requirements outlined above will be considered on a case by case basis.

Rain Water Management - Design Guidelines (cont'd)

Other Considerations:

- Subsurface infiltration systems are preferred by the Municipality for single family residential lots, as they have lower maintenance requirements and a smaller footprint than surface systems such as rain gardens.
- Where soil conditions are poor for subsurface infiltration, rain gardens are a good alternative, as their larger area supports lower infiltration rates, and shallow depth is suited to areas with a high water table.
- The ability to combine rain gardens with site landscaping makes them well suited to many multifamily and commercial sites.



Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA A

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 2.29 ha N 0.00278 tc 40.00 min I-5yr 17.00 mm/hr

Q 5yr-pre dev 0.022 cu.m./s (Q 5 Pre Dev)

II. Detention Volume Calculation: (For Q 5)

Q rel = 0.022 cu.m/s
R = 0.45
SAF = 1.0
A = 2.29 ha
Tc = 10.00 min
I 5yr = 30.00 mm/hr
Qp1 = 0.0859 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 5yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	30.00	0.086	51.566	0.022	38.58
2	15	26.00	0.074	67.036	0.022	47.81
3	20	22.00	0.063	75.630	0.022	50.25
4	30	19.00	0.054	97.976	0.022	59.96
5	40	17.00	0.049	116.883	0.022	66.19
6	50	15.00	0.043	128.916	0.022	65.62
7	60	14.00	0.040	144.385	0.022	68.33
8	120	10.00	0.029	206.265	0.022	53.69
9	240	7.00	0.020	288.771	0.022	(17.54)

Therefore, 68m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA A

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 2.29 ha N 0.00278 tc 40.00 min I-10yr 20.00 mm/hr

Q 10yr-pre dev 0.025 cu.m./s (Q 10 Release Rate)

II. Detention Volume Calculation: (For Q 10)

Q rel = 0.025 cu.m/s
R = 0.45
SAF = 1.0
A = 2.29 ha
Tc = 10.00 min
I 10yr = 38.00 mm/hr
Qp1 = 0.1089 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 10yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	38.00	0.109	65.317	0.025	50.04
2	15	30.50	0.087	78.638	0.025	56.16
3	20	28.00	0.080	96.257	0.025	66.34
4	30	23.00	0.066	118.602	0.025	73.93
5	40	20.00	0.057	137.510	0.025	78.00
6	50	18.00	0.052	154.699	0.025	80.29
7	60	17.00	0.049	175.325	0.025	85.86
8	120	10.00	0.029	206.265	0.025	27.92

Therefore, 86m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA A

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 2.29 ha N 0.00278 tc 40.00 min I-25yr 24.00 mm/hr

Q 25yr-pre dev 0.031 cu.m./s (Q 25 Release Rate)

II. Detention Volume Calculation: (For Q 25)

Q rel = 0.031 cu.m/s
R = 0.45
SAF = 1.0
A = 2.29 ha
Tc = 10.00 min
1 200yr = 43.00 mm/hr

Qp1 = 0.1232 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 25yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	43.00	0.123	73.912	0.031	55.58
2	15	38.00	0.109	97.976	0.031	70.77
3	20	32.00	0.092	110.008	0.031	74.12
4	30	27.00	0.077	139.229	0.031	85.57
5	40	24.00	0.069	165.012	0.031	93.47
6	50	22.00	0.063	189,076	0.031	99.57
7	60	19.50	0.056	201.108	0.031	93.84

Therefore, 100m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA A

Location: 9090 Trans-Canada Hwy

A. SITE AREA A

I. Pre-development Flows:

R 0.20 A 2.29 ha N 0.00278 tc 40.00 min I-200yr 31.00 mm/hr

Q 200yr-pre dev 0.039 cu.m./s (Q 200 Release Rate)

II. Detention Volume Calculation: (For Q 200)

Q rel = 0.039 cu.m/s

R = 0.49 SAF = 1.0 A = 2.29 ha Tc = 10.00 min I 200yr = 59.00 mm/hr Qp1 = 0.1840 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 200yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	59.00	0.184	110.428	0.039	86.75
2	15	48.00	0.150	134.760	0.039	99.82
3	20	43.00	0.134	160.963	0.039	114.54
4	30	34.00	0.106	190.910	0.039	121.73
5	40	31.00	0.097	232.086	0.039	139.65
6	50	28.50	0.089	266.712	0.039	151.02
7	60	27.00	0.084	303.209	0.039	164.13
8	120	19.50	0.061	437.969	0.039	158.93
9	240	15.00	0.047	673.799	0.039	112.87

Therefore, 165m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA B

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.36 ha N 0.00278 tc 40.00 min I-5yr 17.00 mm/hr

Q 5yr-pre dev 0.013 cu.m./s (Q 5Release Rate)

II. Detention Volume Calculation: (For Q 5)

Q rel = 0.013 cu.m/s R = 0.45 SAF = 1.0 A = 1.36 ha Tc = 10.00 min I 5yr = 30.00 mm/hr Qp1 = 0.0510 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 5yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	30.00	0.051	30.624	0.013	22.91
2	15	26.00	0.044	39.812	0.013	28.39
3	20	22.00	0.037	44.916	0.013	29.84
4	30	19.00	0.032	58.187	0.013	35.61
5	40	17.00	0.029	69.415	0.013	39.31
6	50	15.00	0.026	76.561	0.013	38.97
7	60	14.00	0.024	85.749	0.013	40.58
8	120	10.00	0.017	122.498	0.013	31.89
9	240	7.00	0.012	171.497	0.013	(10.42)
10	360	6.00	0.010	220.496	0.013	(53.28)
11	540	5.00	0.009	275.620	0.013	(136.02)

Therefore, 41m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA B

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.36 ha N 0.00278 tc 40.00 min I-10yr 20.00 mm/hr

Q 10yr-pre dev 0.015 cu.m./s (Q 10 Release Rate)

II. Detention Volume Calculation: (For Q 10)

Q rel = 0.015 cu.m/s
R = 0.45
SAF = 1.0
A = 1.36 ha
Tc = 10.00 min
I 10yr = 38.00 mm/hr
Qp1 = 0.0647 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 10yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	38.00	0.065	38.791	0.015	29.72
2	15	30.50	0.052	46.702	0.015	33.35
3	20	28.00	0.048	57.166	0.015	39.40
4	30	23.00	0.039	70.436	0.015	43.91
5	40	20.00	0.034	81.665	0.015	46.32
6	50	18.00	0.031	91.873	0.015	47.68
7	60	17.00	0.029	104.123	0.015	50.99
8	120	10.00	0.017	122.498	0.015	16.58

Therefore, 51m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA B

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.36 ha N 0.00278 tc 40.00 min I-25yr 24.00 mm/hr

Q 25yr-pre dev 0.018 cu.m./s (Q 25 Release Rate)

II. Detention Volume Calculation: (For Q 25)

Q rel = 0.018 cu.m/s
R = 0.45
SAF = 1.0
A = 1.36 ha
Tc = 10.00 min
1 200yr = 43.00 mm/hr
Qp1 = 0.0732 cu.m./s

0.018 33
0.040
0.018 42
0.018 44
0.018 50
0.018 55
0.018 59
0.018 55
0

Therefore, 60m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA B

Location: 9090 Trans-Canada Hwy

A. SITE AREA C

I. Pre-development Flows:

R 0.20
A 1.36 ha
N 0.00278
tc 40.00 min
I-200yr 31.00 mm/hr

Q 200yr-pre dev 0.023 cu.m./s (Q 200 Release Rate)

II. Detention Volume Calculation: (For Q 200)

Q rel = 0.023 cu.m/s

R = 0.49 SAF = 1.0 A = 1.36 ha Tc = 10.00 min I 200yr = 59.00 mm/hr Qp1 = 0.1093 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 200yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	59.00	0.109	65.582	0.023	51.52
2	15	48.00	0.089	80.032	0.023	59.28
3	20	43.00	0.080	95.594	0.023	68.03
4	30	34.00	0.063	113.379	0.023	72.29
5	40	31.00	0.057	137.833	0.023	82.94
6	50	28.00	0.052	155.618	0.023	86.96
7	60	27.00	0.050	180.072	0.023	97.47
8	120	19.50	0.036	260.104	0.023	94.38
9	240	15.00	0.028	400.160	0.023	67.03

Therefore, 98m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA C

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.53 ha N 0.00278 tc 40.00 min I-5yr 17.00 mm/hr

Q 5yr-pre dev 0.014 cu.m./s (Q 5Release Rate)

II. Detention Volume Calculation: (For Q 5)

Q rel = 0.014 cu.m/s
R = 0.45
SAF = 1.0
A = 1.53 ha
Tc = 10.00 min
I 5yr = 30.00 mm/hr
Qp1 = 0.0574 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 5yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	30.00	0.057	34.453	0.014	25.78
2	15	26.00	0.050	44.788	0.014	31.94
3	20	22.00	0.042	50.530	0.014	33.57
4	30	19.00	0.036	65.460	0.014	40.06
5	40	17.00	0.033	78.092	0.014	44.22
6	50	15.00	0.029	86.131	0.014	43.84
7	60	14.00	0.027	96.467	0.014	45,65
8	120	10.00	0.019	137.810	0.014	35.87
9	240	7.00	0.013	192.934	0.014	(11.72)

Therefore, 46m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA C

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.53 ha N 0.00278 tc 40.00 min I-10yr 20.00 mm/hr

Q 10yr-pre dev 0.017 cu.m./s (Q 10 Release Rate)

II. Detention Volume Calculation: (For Q 10)

Q rel = 0.017 cu.m/s R = 0.45 SAF = 1.0 A = 1.53 ha Tc = 10.00 min I 10yr = 38.00 mm/hr Qp1 = 0.0727 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 10yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	38.00	0.073	43.640	0.017	33.43
2	15	30.50	0.058	52.540	0.017	37.52
3	20	28.00	0.054	64.311	0.017	44.32
4	30	23.00	0.044	79.241	0.017	49.40
5	40	20.00	0.038	91.873	0.017	52.12
6	50	18.00	0.034	103.358	0.017	53.64
7	60	17.00	0.033	117.139	0.017	57.36
8	120	10.00	0.019	137.810	0.017	18.66

Therefore, 57m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA C

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.53 ha N 0.00278 tc 40.00 min I-25yr 24.00 mm/hr

Q 25yr-pre dev 0.020 cu.m./s (Q 25 Release Rate)

II. Detention Volume Calculation: (For Q 25)

Q rel = 0.020 cu.m/s
R = 0.45
SAF = 1.0
A = 1.53 ha
Tc = 10.00 min
1 200yr = 43.00 mm/hr
Qp1 = 0.0823 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 25yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	43.00	0.082	49.382	0.020	37.13
2	15	38.00	0.073	65.460	0.020	47.29
3	20	32.00	0.061	73.499	0.020	49.52
4	30	27.00	0.052	93.022	0.020	57.17
5	40	24.00	0.046	110.248	0.020	62.45
6	50	22.00	0.042	126,326	0.020	66,53
7	60	19.50	0.037	134.365	0.020	62.70

Therefore, 67m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA C

Location: 9090 Trans-Canada Hwy

A. SITE AREA C

I. Pre-development Flows:

R 0.20 A 1.53 ha N 0.00278 tc 40.00 min I-200yr 31.00 mm/hr

Q 200yr-pre dev 0.026 cu.m./s (Q 200 Release Rate)

II. Detention Volume Calculation: (For Q 200)

Q rel = 0.026 cu.m/s
R = 0.49
SAF = 1.0
A = 1.53 ha
Tc = 10.00 min
1 200yr = 59.00 mm/hr
Qp1 = 0.1230 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 200yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	59.00	0.123	73.779	0.026	57.96
2	15	48.00	0.100	90.036	0.026	66.69
3	20	43.00	0.090	107.543	0.026	76.53
4	30	34.00	0.071	127.551	0.026	81.33
5	40	31.00	0.065	155.062	0.026	93.30
6	50	28.00	0.058	175.070	0.026	97.84
7	60	27.00	0.056	202.581	0.026	109,66
8	120	19.50	0.041	292.617	0.026	106.18
9	50	28.00	0.058	175.070	0.026	97.84

Therefore, 110m³ of detention volume is required for the development.

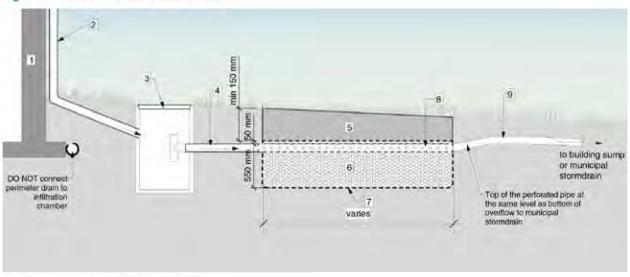
Infiltration Chambers

An infiltration chamber system typically includes an inlet pipe or water source, catch basin sump, infiltration chamber, overflow to the storm sewer system and perforated distribution pipe (for rock-filled structures). Two types of infiltration chambers are considered here: rock-filled structures and open chamber type systems. These two types are shown as underground rock pits of any shape, and underground open chamber systems.

- A rock infiltration chamber/trench is an underground water storage facility constructed with course aggregate.
- An open infiltration chamber/infiltration tank is an underground water storage facility constructed with manufactured modular structures to create large void spaces for temporary storage of stormwater.

In both types water fills the void spaces, and the facility will typically be designed to exfiltrate this water into the surrounding soil.

Figure 21: Rock Infiltration Chamber Detail



Rock Filtration Chamber Materials

- 1. Structural wall
- 2. Building rainwater leader/downspout
- 3. Infiltration chamber sump
- 4. Solid pipe to infiltration chamber
- 5. Growing medium
- 6. Drain rock, 550 mm depth
- 7. Non-woven geotextile on bottom, sides and top of drain rock
- 8. 100 mm diameter (min) perforated pipe
- 9. Solid overflow pipe complete with PVC backflow preventer valve (if required) as per City Plumbing Code.



June 13, 2022

Sean Carroll,P.Eng. Core Group Civil Consultants Ltd. 320 8988 Fraserton Court Burnaby, BC V5J 5H8

RE: 9090 TRANS CANADA HIGHWAY CHEMAINUS BC WETLAND ADJACENT TO ISLAND HIGHWAY

Aquaparian Environmental Consulting Ltd. (Aquaparian) was retained to provide environmental services for the proposed modular home development located at 9090 Trans Canada Highway in Chemainus BC. The project is currently moving through the preliminary layout and design stage for a modular home park.

The property contains a portion of a wetland located on the east boundary immediately adjacent to the Island Highway. This wetland has been incorporated into the highway stormwater drainage ditching. A short section of ditching drains into the wetland from the north starting at a height of land at an old access driveway into the parcel. When winter flows are high enough, it appears to overflow south into the highway ditch continuing south before flowing down a steep forested slope in unconfined overland flow through vegetation. The highway ditch is typically dry through most of the year. Until recent ditching by MoTI to improve ditch drainage, the ditch was fully vegetated and appeared to have accumulated fines from highway runoff.

Aquaparian was requested to provide additional information to determine if this wetland met the definition of a *Watercourse* as defined by the Municipality of North Cowichan's Mobile Home Park Bylaw 1775 (BL 3700) in order to determine the appropriate setback for development.

This bylaw provides guidance for preventing flooding mobile home parks. Section 3.1 (b) identifies setbacks in relation to the flood construction elevation and in proximity of a *Watercourse* or *Lake*:

Flood Construction Elevation, in this case the ground level of mobile home shall be:

- ≥0.6m above 200yr event where it can be determined; or ≥3m above the Natural Boundary of nearby watercourse or lake if it can't be determined; or
- Within 7.6m of the Natural Boundary of the sea and a lake; or
- Within 30m of the Natural Boundary of any nearby watercourse or source of water supply.

The bylaw defines Watercourse as: "any natural or manmade depression with well defined banks and a bed of 0.6m or more below surrounding land serving to give direction to a current of water at least 6 months of the year or having a drainage area of 2.5km² or more or as required by an official of the BC MOE".

I do not believe this wetland meets this bylaw's definition of a *Watercourse* as it is supported by perched groundwater and contributed to by localized surface water with a small catchment area as it is positioned near a topographic high point. The winter overflow does not drain down the highway ditch very often or with much volume. Though there are no flow records, I doubt it would flow more than 6 months of the year based on the winter and summer site visits we have completed for the parcel. This wetland is not considered to be a lake; however, the bylaw does not include a definition of a wetland. Therefore, using the 7.5m setback for a lake appears to be a reasonable rationale to determine a setback distance for this wetland with regard to this bylaw.

Determination of the 200-year flood elevation and Flood Construction Elevation is an engineering task and outside of Aquaparian's scope of services.

Regards,

AQUAPARIAN ENVIRONMENTAL CONSULTING LTD



Sarah Bonar, B.Sc., R.P.Bio.

Principal

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Interface Wildfire Assessment Report

9090 Island Highway North Cowichan, BC

April 9, 2021



Submitted to:

Sean Carroll, P.Eng.
Core Group Civil Consultants Ltd.
E: scarroll@coregroupconsultants.com
P: 604-299-0605





Schedule 4 DP000256 Diamond Head Wildfire Assessment Report (52 pages)

The following Diamond Head Consulting staff conducted the site visit and prepared or reviewed the report.

All general and professional liability insurance and staff accreditations are provided below for reference.

Project Staff:



Matthew Shields

Registered Professional Forester (5137)

ISA Certified Arborist (PN-8871A)

ISA Tree risk Assessment Qualified (TRAQ)

Date: April 9, 2021

Please contact us if there are any questions or concerns about the contents of this report.

Contact Information:

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Email: mattshields@diamondheadconsulting.com

Website: www.diamondheadconsulting.com

Insurance Information:

WCB: # 657906 AQ (003)

General Liability: Northbridge General Insurance Corporation - Policy #CBC1935506, \$10,000,000

Errors and Omissions: Lloyds Underwriters – Policy #1010615D, \$1,000,000

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Executive Summary

- The nearest intact forest edge is approximately 25 m north of the proposed building envelope. This forest was assessed to have a moderate fire behavior risk rating applying methods from the <u>2020 Wildfire Threat Assessment Guide and Worksheets</u> (MFLNRO, 2020).
- Future structural hazard of the proposed development using the <u>FireSmart</u>
 Homeowners Manual (Partners in Protection and Province of BC, 2019) found the new
 development would likely have a moderate overall wildfire risk rating, if
 recommendations in this report for building construction, landscaping, and vegetation
 management are followed.
- Ensure roofing within the development meets the standards of Class B Fire Spread
 Rating (CAN/ULC S107-M). Prefer "ignition-resistive" and "non-combustible" building
 materials, as these terms are defined in the most recent edition of the National Fire
 Protection Association (NFPA) 1144 standard. See Section 5.2 for more information.
- Landscaping requirements from within this report must be followed. Establish 10 metre
 setbacks to forest vegetation from all homes, unless retaining forest cover is required
 for environmental goals. Remove coniferous shrubs and small trees where they occur
 on-site within 10 m of new homes or accessory structures. Remove scotch broom
 wherever it is found on the development site. See Sections 5.1 and 5.4 for more
 information.

1.0 Introduction

Diamond Head Consulting Ltd. (DHC) was retained to prepare an assessment of the interface wildfire hazard and propose mitigation of hazard through construction or landscaping for the development application at 9090 Island Highway in the Municipality of North Cowichan. The property under development is within North Cowichan's Development Permit Area for Natural Hazard Lands (DPA4), with respect to "fire hazard lands" identified as having high or extreme wildfire risk during community wildfire planning.

Civic address: 9090 Island Highway, North Cowichan.

Legal Address: Section 10 Range 5 Land District 08 Portion E 60 AC EXC 16.5 FT STRIP

ALONG & ADJ N & E BOUNDARIES THEREOF, RD PURPOSES, EXC PTS IN

PLANS 11489, 26194 & VIP68870 Manufactured Home Reg.# 72548

Client name: 1251719 BC Ltd.

Date of site visit: March 31, 2021

The development in question is a 10.2 ha lot at 9090 Island Highway. The proposed development is to create a modular home park plus infrastructure and recreation areas. The overall objective of this report is to assess the potential wildfire threat to the development and provide recommendations and tools to reduce this threat. This assessment report is meant to be submitted as a part of the Development Permit application. It must be prepared and signed by a qualified professional. Specific goals for this assessment are:

- Assess interface fuels to determine the extent, location, and presence of wildfire hazard.
- Recommend site-specific fuel treatments for high fuel hazards that will reduce the risk to structures, human lives, and critical natural features.
- Make recommendations for improving suppression capabilities in and around the proposed development.
- Make recommendations for access, building and landscape materials that will minimize wildfire threat.

1.1 Site Planning Documents Reviewed

Diamond Head Consulting was provided with the following documentation from the client that provides the basis for all comments and recommendations:

 Morgan Maples [Site Plan] DWG No. 2087. Issued December 3, 2020 by Core Group Consultants.

Our investigations are based on information provided by the client and a review of the legal setbacks for development on the property. It is the responsibility of the client and project team to incorporate the recommendations of this report into the development plan.

1.2 Policy Considerations for Wildfire Threat Mitigation

North Cowichan's DPA4 was developed based on the recommendations of the Community Wildfire Protection Plan. The municipality guides the design of buildings and landscaping in areas of wildfire hazard to improve wildfire protection and mitigate risk to property and life. DPA4 contains certain minimum standards for new developments in the wildland-urban interface (Section 4.3.2, items A-H) and references the NFPA-1144 (Standard for Reducing Structure Ignition Hazards from Wildland Fire) preferred by the municipality. The standards and additional guidelines are based on FireSmart Canada guidance for building and landscaping.

1.3 Determinants of Wildfire Hazard in the Wildland-Urban Interface

The subject site is within an area identified as having high potential wildfire hazard in the 2011 Official Community Plan. The site is located on higher ground 150 m to the northeast of the Chemainus River and is surrounded by a mix of forested and rural land. Large continuous areas of forest vegetation are east, southeast, and southwest of the site (including area across the Chemainus River). During a wildfire, buildings in the interface are at risk of ignition through direct flame contact, radiant heat from fires within 10-30m of the home, and ember showers generated by fires in the surrounding landscape. While ember showers can affect buildings several kilometres of a fire, the greatest risk is from fires within 100 m of a building.

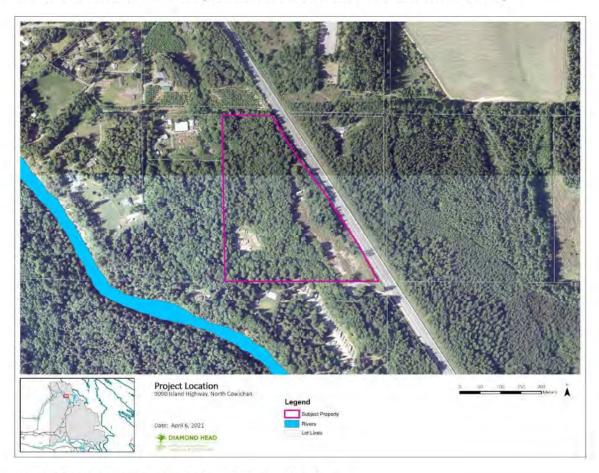


Figure 1. Location of the subject site - 9090 Island Highway.

2.0 Methodology

Fire behavior is influenced by the structure and composition of forest vegetation. In Canada, the national Canadian Fire Behaviour Prediction System is used to classify natural vegetation into "fuel types" associated with particular structural characteristics and expected fire behavior. There are no fuel classifications specific to the coastal BC region in the Canadian Fire Behaviour Prediction System; instead, the site has been classified as the CFBPS fuel type that best represents the fire behavior potential of the assessed forests. Fuel type interpretations can be reviewed in Appendix 2.

Detailed fuel hazard assessments were completed within 200m of the lot using the provincial assessment system, 2020 Wildfire Threat Assessment Guide and Worksheets (MFLNRORD, 2020). The location of plots is shown in Figure 3. Data collected at each fuel plot included:

- Soil and humus characteristics
- Slope, aspect, and terrain classification
- Forest stand composition by species
- Vertical and horizontal stand structure
- Quantity and distribution of ladder fuels
- Composition and coverage of understory brush, herbs, and grasses
- Quantity and distribution of ground fuels by size class.

Plots were only installed on the project site and adjacent public lands. The fuel and wildfire threat characteristics of adjacent forest vegetation on private land have been approximated from review of aerial imagery and accessible viewpoints.

Wildfire hazard to the property is broken down into two components:

- Current forest fuel threat in and adjacent to the proposed development using the 2020 Wildfire Threat Assessment Guide and Worksheets (MFLNRORD, 2020). This uses data collected at plots to categorize the likely fire behavior of forest vegetation within 200 m of the property and situates the property within wildfire threat at the landscape level.
- Future structural hazard of the proposed development using the <u>FireSmart Homeowners Manual</u> (Partners in Protection and Province of BC, 2019). This uses available information from the development plan and recommended construction guidelines from DPA4 to provide an estimate of the risk to on-site development following proposed land clearing and construction.

Guidelines for construction and landscaping in his report are based on the requirements of DPA4 and elaborated to suit the context of the development given the assessed wildfire threat and structural hazard.

3.0 Project Overview

The property is a lot zoned R5 (Residential Mobile Home Park) at 9090 Island Highway, North Cowichan. The closest urban community is Chemainus. The lot is currently vacant, and previously contained a single-family modular home. The lot is located on high ground northeast of the Chemainus River and includes west and south facing slopes that form the edge of the larger valley containing the river channel. The site and adjacent lands are primarily forested with a mixture of second-growth forest vegetation, including areas of primarily coniferous and deciduous forest cover, as well as large areas of "mixed" forest vegetation where both tree types are found. A small riparian area occupies the western portion of the property and flows from north to south towards the Chemainus River. Forested easements in the southern portion of the property provide road access from the Island Highway to the Country Maple RV Park, located in the valley bottom. Forest cover in these easements and the riparian area at the west of the property will be retained following development.

Outside of these areas, development will subdivide the remainder of the property into over 100 lots for single-family modular homes as well as areas for amenities and service infrastructure. This will require extensive regrading of the property, which contains minor but abrupt changes in elevation, resulting in the clearing of on-site vegetation. Access to the property from Island Highway will be shared with the Country Maples RV Park to the south. An additional access will be created in the north by extending Henry Road from its current terminus along an unopened road right of way.

Forest cover dominates surrounding properties. Forested private land, partly developed for the Country Maples property and other rural properties, separates the project site from the Chemainus River on the southwest. An orchard borders the site to the north. Across Island Highway (northeast) and beyond the Chemainus River (southwest) is extensive forest cover on public and private land. These areas are continuous with the landscape forest of southern Vancouver Island.



Figure 2. Schematic plan for development. Final unit numbers and lot layouts may vary.

4.0 Fuel Descriptions and Wildfire Threat Assessment

4.1 Summary of Fuel Types

Forested areas near the proposed development site were classified into the fuel types mapped in Figure 3. The fuels have been divided into classifications based on the sixteen national benchmark fuel types that are used by the Canadian Fire Behaviour Prediction System (Appendix 3). Within the assessment area, the C5 (Coniferous), M2 (Mixedwood), and D1 (Deciduous) fuel-types are found. In the project area, coniferous forests dominate higher ground and older forest margins of the Chemainus River Valley. Upland stands in the C5 fuel type consist of the conifer Douglas-fir (*Pseudotsuga menziesii*) with minor elements of other species. Valley-edge forests in this fuel type consist of mixtures of Douglas-fir, western redcedar (*Thuja plicata*), grand fir (*Abies grandis*) and minor amounts of western hemlock (*Tsuga heterophylla*). Minor numbers of deciduous or broadleaved species can be found in these areas, including bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), and arbutus (*Arbutus menziesii*). The C5 fuel type is comprised of at least 75% conifer trees. Coniferous forests tend to support more severe wildfire behavior than deciduous forests.

Mixedwood forests with 25%-75% composition of deciduous tree species are found in the vicinity of riparian areas on site and within the valley of the Chemainus River. The composition of these stands includes all the species mentioned above, generally led by Douglas-fir with significant components of bigleaf maple, western redcedar, and red alder. Mixtures may be intimate, with trees of different species occurring singly or in small groups, or patchy, with larger groups of trees forming a finely textured forest matrix. Deciduous composition is generally between 40% and 60% of on-site stands. Characteristics of mixedwood stands can vary widely, leading to different wildfire behavior.

Deciduous forests with greater than 75% composition of deciduous trees are found in small areas within the vicinity of the project site, generally in riparian areas or on disturbed land. These forests are composed of red alder, bigleaf maple, and black cottonwood, and may have minor numbers of coniferous trees. Deciduous forest canopies tend not to support severe fire behavior, due to the moisture content of live foliage in deciduous vegetation and absence of flammable resins. Deciduous forests can support fire when poor stand health has caused large-scale tree mortality or during times of drought-induced senescence.

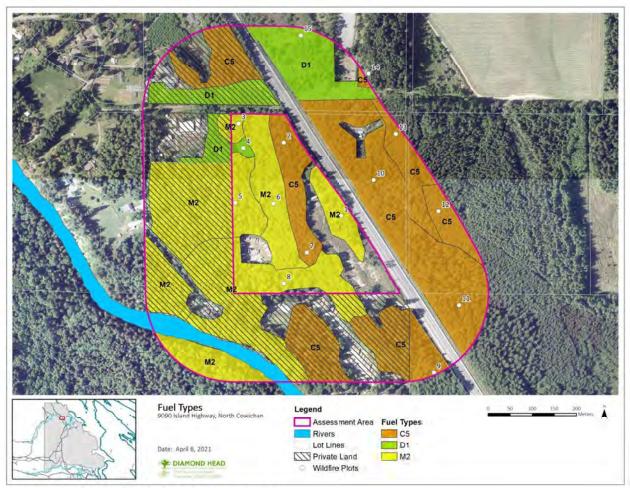


Figure 3. Location of the fuel types in relation to the project site.

4.2 Summary of Wildfire Threat

Each distinct forest stand was assessed for wildfire threat using the provincial Wildfire Threat Assessment Worksheets (2020 edition). Information about the structure, density, and composition of surface, ladder, and crown fuels is assigned a numerical rating by these worksheets. Numerical ratings are added to produce a threat score. Threat scores are assigned to one of four categories: *low, moderate, high,* and *extreme,* which represent potential fire behavior in the stand. Figure 4 outlines the wildfire threat for stands assessed. The threat associated with forest stands on adjacent private land are estimated based on interpretation of the aerial imagery, available viewpoints, and observed characteristics of similar fuel types during the site visit. The Threat Assessment results for each plot location are provided in Appendix 1.

The surrounding area was determined to have an overall *moderate* threat of wildfire. Most forest stands in the vicinity are characterized by *moderate* wildfire threat, including most stands of M2 and C5 fuel types. These areas are all characterized by over 50% coniferous forest canopy, scattered (10-25%) coverage of surface and ladder fuels, and moderate "fuel strata gap" of 5-9 metres between crown and other fuels. Low threat is associated with managed stands to the north and south of the project site. These areas are subject to modified fuel conditions due to the current land use. To the south, Country Maples RV Park maintains rights of way and campsites within its easement and recreational facility, reducing surface and ladder fuels. To the north, the "deciduous" stand is in fact a maintained orchard. Neither area corresponds well to the defined fuel types of the Canadian Fire Behavior Prediction System. A limited area of high threat is associated with a young coniferous forest east of Island Highway. This forest is characterized by high density of conifer trees with relatively little horizontal or vertical separation of forest fuels. Conditions in this stand are atypical of a mature C5 stand on the coast and are unlikely to persist indefinitely.

In moderate-threat forests, a crown fire (severe fire behavior) could generate during dry conditions, though this would likely also require accompanying high winds. A fire within the forests in the riparian area could expose the westernmost homes to radiant heat, although this risk may be reduced by planned land clearing. Ember showers from a nearby fire remain the likeliest ignition pathway. Prevailing winds in Chemainus are typically from the east and east-southeast, with winds from the west and southwest occurring with lower frequency (Figure 5). As a result, it is somewhat more likely that ember showers would fall from a fire to the east of the project site. Local wind conditions during a wildfire event can vary drastically from prevailing wind patterns. Creating a FireSmart landscape and building is the best defense against the wildfire risk to this property.

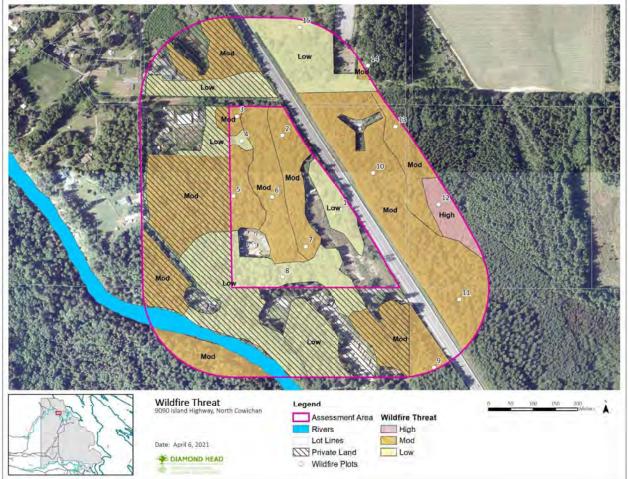


Figure 4. Wildfire threat mapping

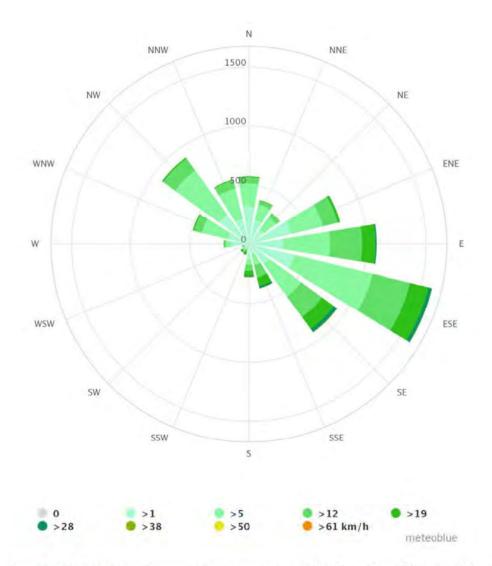


Figure 5. Wind directions by cumulative hours annually for Chemainus, BC. (meteoblue)



Photo 1. Deciduous (D1) stand, perspective.



Photo 2. Deciduous (D1) stand, crown composition.



Photo 3. Mixedwood (M2) stand, perspective.

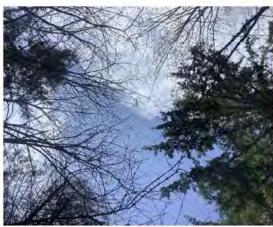


Photo 4. Mixedwood (M2) stand, crown composition.



Photo 5. Coniferous (C5) stand, perspective.



Photo 6. Coniferous (C5) stand, crown composition.

5.0 Wildfire Threat Mitigation Recommendations

The following are recommendations to mitigate risk to the development. Recommendations are made for on-site landscaping, building materials, setbacks from forested edges, and ongoing maintenance. The FireSmart Hazard Assessment (Section 6.0) provides an estimate of the risk to the development if it is implemented in accordance with the guidance in this report. It is the responsibility of the owner and their project team to understand and incorporate the following guidance to satisfy the requirements of the Municipality's DPA4.

5.1 Building setbacks from forested edges.

FireSmart recommends that a 10m fuel free zone be established and maintained between structures and wildland fuels. Hazardous fuels, including coniferous vegetation or other vegetation containing low moisture content or high concentrations of saps and resins, long grasses, leaf litter, dead branches and sticks, and stores of wood for domestic use, must be excluded from this zone. This zone should be established between the primary building, any accessory buildings within 10 metres of the primary building, and the outermost branch tip of hazardous vegetation.

Land clearing should establish this zone for any lot directly bordering retained forest. The only exceptions to this are lots that border Streamside Protection and Enhancement Areas (DPA3), where forest cover must be retained to preserve riparian values, and adjacent property, where control over vegetation is not available. If necessary to preserve forest character in an area of environmental concern, conifer trees under 20 cm diameter should be removed within 10 m of proposed buildings and deciduous trees should be planted/retained. Retained conifers should be lift pruned by a certified Arborist to remove branches with foliage within 3 m of the ground or building surfaces, unless this is likely to cause the decline of the tree. On any lot that cannot meet the requirement for establishing a fuel free zone of 10 metres, a buffer of noncombustible landscaping (e.g. river rocks, gravel, concrete pavers) should be used within 1.5 metres of the building exterior.

Table 1. Recommendations for creating setbacks from forest edges.

Feature	Guidance for establishing setbacks to hazardous fuels				
Preferred setbacks	 Use land clearing to establish fuel free zones of 10m between buildings and retained forests, unless: Forest cover must be retained inside a streamside protection and enhancement area. Adjacent vegetation is on another property and cannot be controlled. Forest cover must be retained in an area of environmental concern (steep slopes, rura setbacks) 				
Recommended measure if preferred setback not achieved	 Install a buffer of non-combustible landscaping within 1.5 metres of the building exterior. Remove coniferous trees of less than 20cm diameter within 10 m of proposed buildings and replant with suitable deciduous trees. Lift prune retained conifers to remove branches with foliage within 3m of the ground or building surfaces, on the advice of a certified Arborist. 				

5.2 Subdivision Design

Within the high and extreme fire hazard Development Permit areas must be designed in accordance with the *Fire Protection Guidelines for Subdivision Development in the Wildland Urban Interface at the Municipality of North Cowichan*, prepared by Strathcona Forestry Consulting. These guidelines reflect principles from National Fire Protection Association (NFPA) Standard 1141 *Standard for Fire Protection Infrastructure for Land Development in Wildland*, *Rural*, and Suburban Areas. Key guidance is summarized in Table 2.

Table 2. Guidelines for community design and infrastructure

Feature	Guidance for lot layout and water supply				
Access	 Access to the development should be provided by at least two distinct routes. Every dead-end roadway more than 90 metres in length should be provided at the closed end with a turnaround. Fire Lanes should be provided as required by the fire department having jurisdiction. Fire department personnel must have ready access to locking mechanisms on any gate restricting access to a fire lane. 				
Lot layout	 Wherever possible, buildings should be set back at least 10 metres from the crests of hills or ridges. Wherever possible, buildings should be located at least 10 metres from adjacent forest vegetation. Wherever possible, development should strive to achieve setbacks between buildings on neighbouring lots of no less than 9 metres. 				
Hydrants	 Fire hydrants should be installed and marked in a uniform manner at a spacing not to exceed 200 metres of vehicle travel distance. Additional hydrants and closer spacing are warranted where recommended setback dimensions cannot be achieved owing to local zoning and should be installed to the satisfaction of the local Fire Department. 				

Due to the R5 Zoning of the site, which permits interior side setbacks of 1.5 m and rear and front setbacks of less than 10 m, lot layout recommendations are unlikely to be achieved by the development. The development scheme includes two points of access in the north and south and a third emergency access from Island Highway. Dead end routes of 90 m or more length have been provided with hammerhead-configuration turnarounds. The Municipality's Fire Department should advise on the design of water supply to the development to ensure adequate fire protection.

5.3 Buildings and Construction

Construction standards and requirements for roofs, chimneys, balconies, decks, and porches are outlined in DPA4 of North Cowichan's Official Community Plan (4.3.2). The DPA guidelines state building design and construction must generally be consistent with the standards in the National Fire Protection Association (NFPA) Standard 1144 – Standard for Protection of Life and Property from Wildfire. These building standards are summarized in Table 3.

Table 3. Guidelines for buildings and construction

Feature	Guidance for building materials				
Roofing	 All roofing materials and insulation requirements must meet class "B" fire rating requirements contained within the current B.C. building code. [ULC/CAN S107-M – Standard Methods of Fire Tests of Roof Coverings]. 				
Siding	 Exterior walls should be of noncombustible or fire-resistant material. Stucco, fibre-cement, and metal sheathing are preferred. 				
Vents, openings, eaves, attics	 All eaves and attic vents must be screened using 3-mm non-combustible wire mesh at a minimum to prevent the entry and accumulation of combustible materials and wind-blown embers. Vents should not be installed in walls that face forest vegetation. 				
Exterior windows and doors	 All windows should be double glazed, or of glass block. Faces within 10m of the forest edge should be multi-paned with one pane glazed with annealed or tempered insulating glass. Limit the size and number of windows that face large areas of vegetation. Window screens should be non-combustible. Exterior doors should be of non-combustible or fire-resistant materials. 				
Decks, porches, balconies	 Decks, porches, and balconies should be sheathed with fire-resistant or non-combustible materials. Slotted deck surface allows needle litter to accumulate beneath the deck. Provide access to this space to allow for removal of this debris. Any covers should be built of the same fire-resistant materials as a roof. 				
Fences	 Where fencing is within 10 m of the building or accessory buildings, use fire-resistant or non- combustible materials. No wood fencing should be used within 1.5 metres of buildings or accessory structures. 				
Modular Homes	 Permanently located mobile and manufactured homes with an open space beneath shall have a skirt of noncombustible material. 				
Feature	Recommendations during construction				
Combustible materials	 During construction of houses, all waste construction materials including brush and land clearing debris; needs to be cleaned up on a regular basis, to minimize the potential risk. No combustible materials should be left at the completion of construction. 				
Hydrants	 Prior to construction of any wood frame buildings, there must be fire hydrants within operating range. 				
Fire Suppression	 The contractor should be familiar with the BC Wildfire Act and the current provincial standards for wildfire suppression and have the appropriate tools on-site for the duration of the project. 				

^{*} Non-combustible materials: means that a material meets the acceptance criteria of CAN/ULC S114, (Standard Method of test for determination of non-combustibility in Building Materials)

Fire-resistant materials: means that a material meets the acceptance criteria of CAN/ULC-S101, (Fire Endurance Tests of Building Construction and Materials)

Rated roofing materials: Class A, B or C is a measure of the external spread of flame on a roof surface. Tests are conducted using CAN/ULC S107M methods of fire tests of roof coverings, or equivalent. The best rating achieved is Class A, which may be described as effective against severe fire exposure.

Roofing must be Class B certified. These products are not readily flammable under "moderate fire exposures", and do not carry or communicate (i.e., spread) fire under these conditions. CAN/ULC S107-M, "Tests for Fire Resistance of Roof Covering Materials," and ASTM E 108, "Standard Test Methods for Fire Tests of Roof Coverings," are the fire-resistance capacity tests used to determine a product's or roof assembly's classification. Because roofing occupies a large portion of the home's exterior surface area and is oriented to down-falling embers, roofs are the most vulnerable part of the home's assembly.

Exterior siding should be fire resistant (stucco, brick, fibre cement boards/panels and poured concrete). Untreated wood products do not meet this standard. Flame resistant coatings that require ongoing maintenance or reapplication do not meet this standard. Exterior wall assemblies that have exterior wood that is untreated and rely on the interior wall for fire resistance are not acceptable. Wood products that have permanent treatments or are naturally fire resistant can be accepted if certification is documented and produced on request.

Modular homes are frequently specified with materials that may vary from interface fire standards. Models selected for the development should be chosen carefully to generally comply with the requirements of DPA4. Preferred building construction is reflected in Section 6, the FireSmart Structure and Hazard Assessment. Vinyl siding can be accepted under conditions specified in the FireSmart Structure and Hazard Assessment.

5.4 FireSmart Landscaping and Fuel Mitigation

Landscaping and maintenance for the site should follow FireSmart principles as laid out in the most recent edition of the FireSmart describes zones 1, 2, and 3, of increasing distance from the structure where different treatments and maintenance regimes are recommended to reduce wildfire behavior. Due to the presence of moderate threat fuels behind the development, we recommend planning and maintenance of landscaping on the developed portion of the lot follow the requirements of Zone 1 (<10m from structures) outlined in the FireSmart program. The goal in this zone is to remove hazardous fuels and convert vegetation to fire-resistant species to produce an environment that does not support combustion. Recommendations for landscape and maintenance are summarized in Table 4. It is recommended that new coniferous trees and shrubs, including coniferous hedging, be excluded from the landscape plan.

Table 4. Guidelines for Landscaping

Feature	Recommendations				
Planting	 Remove all highly flammable vegetation and other combustibles from around the homes This includes all conifers, including small decorative shrubs or hedging, as well as the invasive plant Scotch Broom. No conifer trees species should be planted within 10m of any buildings. No long grasses (mature height >= 10cm) should be planted within 10m of any buildings. Landscaping should incorporate species that are fire resistant. These types of plants tend to have moist, supple leaves with low amounts of sap or resin. They also have a tendency not to accumulate dead material. A list of fire resistant plants and trees can be found at the FireSmart Canada website¹. A list of suitable species has also been provided in Appendix 6. Ensure that vegetation will not grow to touch or overhang buildings through appropriate tree selection and proactive maintenance. Irrigation sprinklers may be installed in landscaping but are not required. Where possible use plants that are tolerant of drought. 				
Maintenance	 Annual grasses within 10 meters of buildings should be kept mowed to 10 centimeters or less and watered regularly during the summer months. Ground litter and downed trees should be removed regularly and prior to the fire season Wood piles cannot be kept within 10 m of the home, unless in a fully enclosed, non-combustible shelter. 				

5.5 Ongoing Maintenance

To ensure that FireSmart standards are maintained on the property, periodic re-treatment or maintenance is recommended in Table 5.

Table 5. Guidelines for ongoing maintenance

Schedule	Recommendation
Short-term	 Regularly remove debris from roofs, gutters and beneath overhanging projections. Grass and landscaping should be kept mowed to 10 cm or less and watered regularly during the summer months. Remove any local accumulations of woody or combustible material (e.g., no woodpile or yard waste accumulations). Ensure off-site and encroaching trees are pruned to eliminate contact between foliage and building surfaces.
Long-term (yearly)	 Landscape sprinkler systems should be installed and maintained by the homeowner to encourage the health of on-site vegetation. Remove any over mature, dead, or dying shrubs and trees. Plant only fire resistant trees and shrubs. A list of fire resistant plants and trees can be found at the FireSmart Canada website (https://www.firesmartcanada.ca/images/uploads/resources/FireSmart-Guide-to-Lanscaping.pdf).

6.0 Future Condition FireSmart Structure and Hazard Assessment

The form below provides an assessment of the proposed development using the FireSmart Structure and Hazard Assessment form. Assessment ratings are made assuming that the recommendations outlined in this report are adhered to.

Table 6. FireSmart Structure and Hazard Assessment

ZONE 1					
HOME/10 m	Criteria	Rating Options	RATING		
What type of roofing	Metal, clay tile, asphalt shingle or ULC rated shakes (may be affected by the condition of your roof)	0	0		
material do you have?	Unrated Wood Shakes	30			
THURSDAY WILLIAM	No needles, leaves or other combustible materials	0			
How clean is your roof?	A scattering of needles and leaves	2	0		
	Clogged gutters and extensive leaves	3			
What is the exterior of your	Non-combustible material, stucco, metal siding or brick	0			
home built of?	Logs of heavy timbers	1	0		
	Wood, vinyl siding or wood shakes	6			
	Tempered glass in all doors/windows	0			
	Double-pane glass - small/medium (smaller than 1 metre x 1 metre)	1	2		
How fire-resistant are your	Double-pane glass - large (greater than 1 metre x 1 metre)	2			
windows and doors?	Single-pane glass - small/medium (smaller than 1 metre x 1 metre)	2			
	Single-pane glass - large (greater than 1 metre x 1 metre)	4			
Are your eaves closed up	Closed eaves, vents screened with 3-millimetre wire mesh	0	- 5		
and your vents screened?	Closed eaves, vents without mesh	1	0		
	Open eaves, vents not screened	6			
Have you sheathed-in the	Sheathed with fire-resistant materials	0			
underside of your balcony,	Sheathed with combustible materials	2	0		
deck, porch or open foundation?	Not sheathed	6			
Is your home set back from the edge of a slope?	Building is located on the bottom or lower portion of a hill	0			
	Building is located on the mid to upper portion of a hill or the crest of a hill	6	6		
	ZONE 1 HOME SCORE		8		

	ZONE 1				
YARD/within 10 m	Criteria	Rating Options	RATING		
Where are your	More than 10 metres from home	0	0		
outbuildings (or adjacent buildings) located	Less than 10 metres from home	6	· ·		
Where is your woodpile	More than 10 metres from any building	0	0		
ocated?	Less than 10 metres away from any building	6			
What type of forest* grows	Deciduous trees	0	.5		
within 10 metres of your	Mixed wood trees (deciduous and conifer)	30	0		
home?	Conifer trees	30			
What kind of surface vegetation and combustible	Well-drained lawn or non-combustible landscaping material	0			
materials are within 10	Uncut grass or shrubs	30	0		
metres of your home and outbuildings?	Twigs, branches and tree needles on the ground	30			
	ZONE 1 YARD SCORE		0		

^{*}A forest is considered a continuous intact treed area

	ZONE 2			
YARD/10 – 30 m	Criteria	Rating Options	RATING	
	Deciduous trees	0		
What type of forest	Mixed wood trees (deciduous and conifer)	10	10	
surrounds your home?	Conifer trees separated	10		
	Conifer trees continuous	30		
Miles I de de confesso	Well-drained lawn or non-combustible landscaping material	0		
What kind of surface	Uncut grass or shrubs	5		
vegetation grows within 10- 30 metres of your home and around your buildings?	Scattered twigs, branches and tree needles on the ground	5	0	
	Abundant twigs, branches and tree needles on the ground	30		
Are there shrubs and low	None within 10-30 metres	0		
branches (within 2 metres	Scattered within 10-30 metres of buildings	5	5	
of the ground) in the	Abundant within 10-30 metres of buildings	30		
surrounding forest?	CAST STREET, S			
	ZONE 2 YARD SCORE		15	
TOTAL SCORE			1000	
		-	Rating	
ZONE 1/ Home and Yard	Home		8	
	10 metres from home	0		
ZONE 2 / Yard	10 – 30 metres from home		15	
		TOTAL	23 - Moderate	

HAZARD SCORE: Low: <21 Moderate: 21-29 High: 30 - 35 Extreme: >35

Following the recommendations in this report will achieve a FireSmart hazard score of moderate.

The FireSmart Hazard Assessment Sheet gives the property a **moderate** hazard rating if recommendations in this report are followed. This rating reflects the building materials and landscaping prescribed by this report.

Modular homes are frequently specified with materials that may vary from interface fire standards. Models selected for the development should be chosen carefully to generally comply with the requirements of DPA4. In particular, vinyl siding is standard on many modular homes. While not fire-resistant, the FireSmart Hazard Assessment shows homes could be specified with vinyl siding and remain within a moderate hazard rating. Vinyl homes are acceptable on lots that do not directly abut the forest edge. Vinyl homes may also be acceptable wherever a 10 m fuel free zone, or 1.5 m buffer of non-combustible landscaping, can be maintained on all sides of the home; however recommended materials (fibre cement, stucco, etc.) remain preferred.

7.0 Final Remarks

The Municipality of North Cowichan requires that the proposed development is consistent with the Wildfire Development Permit Guidelines. In the context of limited options for non-combustible building materials for a modular home park, it is critical that vegetation management guidelines are followed and models with Class B or better roofing supplied. This report contains guidance on how and when deviations from NFPA 1144 should be allowed. Planners, engineers, and landscape architects should refer to this report and the FireSmart manual during the design phase of this development.

If there are any questions or concerns as to the contents of this report, please contact us at any time.

Sincerely,

Project staff:

Matthew Shields, RPF ISA Certified Arborist

Mother Sal

ISA Qualified Tree Risk Assessor

Appendix 1 Wildland Urban Interface Plots

Location	Plot 1		Date	31-Ma
Assessor	MS			
Crown species composition (speci	1110		Cw)	
Component/subcomponent	PULLDO	WNS	SCORE	
Depth of organic layer	1-<2		1	
	and ladder fuel	.1-3m in hei	ght)	
Surface fuel composition	Moss, herbs and	deciduous	4	
Dead and down material continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Mixedwood		5	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	<500		2	
Stand structure a	nd composition (d	ominant and	co-dominant)	
Overstory composition/CBH	Mixwood	50%	2	
Crown closure	20-40% or deciduous (any closure)		1	
Fuel strata gap	6-9		1	
Stems/ha (overstory)	401-60	00	2	
Dead and dying (% of dominant and co-dominant stems)	Standing dead/partial down <20%		2	
Comments:	TOTAL		36	
	RATIN	G	LOW	

		Threat Rating (Ma Score 110)	ax	
Eco - province	Low	Moderate	High	Extreme
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +

Location	Plot 2	Date		31-Ma
Assessor	MS			
Crown species composition (speci	1110)	
Component/subcomponent	PUI	LDOWNS	SCORE	
Depth of organic layer	2-<5		3	
	and ladder	fuel (.1-3m in hei		*****
241140	CONTRACTOR OF THE PARTY OF THE	s and deciduous)	
Surface fuel composition		shrubs	4	
Dead and down material continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Other conifer		8	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	801-1,200		6	
Stand structure ar	nd compositi	ion (dominant and	d co-dominant)	
Overstory composition/CBH	Conifer wit	th high CBH (>10 m)	3	
Crown closure	4	1-60%	2	
Fuel strata gap		6-9	1	
Stems/ha (overstory)	6	01-900	3	
Dead and dying (% of dominant and co-dominant stems)	Standing dead/partial down <20%		2	
Comments:	TOTAL		48	
	R	ATING	MODERAT	E

Threat Rating (Max Score 110)						
Eco - province	Low	Moderate	High	Extreme		
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +		

Location	Plot 3		Date	31-Ma	
Assessor	MS				
Crown species composition (speci	es %)	Fd5Dr2Mb2((CwBgHw)		
Component/subcomponent	PUI	LDOWNS	SCO	RF	
Depth of organic layer		2-<5	3	-	
	and ladder	fuel (.1-3m in hei	ight)		
3.31712.0	CONTRACTOR OF THE PARTY OF THE	s and deciduous			
Surface fuel composition	shrubs		4		
Dead and down material continuity (<7cm)	10-25% coverage		8		
Ladder fuel composition	Other conifer		8		
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8		
Stems/ha (understory)	<500		2		
Stand structure ar	nd compositi	on (dominant and	d co-dominant)		
Overstory composition/CBH	Mix	wood 50%	2		
Crown closure	Value 1 200 1 200 2	deciduous (any losure)	1		
Fuel strata gap		3-6	3		
Stems/ha (overstory)	4	01-600	2		
Dead and dying (% of dominant and co-dominant stems)	Standing dead/partial down <20%		2		
Comments:		TOTAL	43		
	R	ATING	MODE	RATE	

Threat Rating (Max Score 110)						
Eco - province	Low	Moderate	High	Extreme		
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +		

Wildfire Threat A		Norksheet - Fuel	Setting Scoring	
Location	Plot 4		Date	31-Ma
Assessor	MS			
Crown species composition (species %)		Dr9(MbCw)		
Component/subcomponent	PUI	LDOWNS	SCOR	
Depth of organic layer		1-<2	1	
Surface	and ladder	fuel (.1-3m in he	eight)	
Surface fuel composition		os and deciduous shrubs	4	
Dead and down material continuity (<7cm)	Scattered <10% coverage		4	
Ladder fuel composition	Deciduous/None		0	
Ladder fuel horizontal continuity	Sparse <10% coverage		2	
Stems/ha (understory)	<500		2	
Stand structure ar	d composit	ion (dominant ar	nd co-dominant)	
Overstory composition/CBH	Deciduou	s (<25% conifer)	0	
Crown closure	4	11-60%	2	
Fuel strata gap	-	6-9	1	
Stems/ha (overstory)	90	1-1,200	4	
Dead and dying (% of dominant and co-dominant stems)	272 274 5.5	g dead/partial wn <20%	2	
Comments:		TOTAL	22	
	F	RATING	LOW	

		Threat Rating (Ma Score 110)	ax	
Eco - province	Low	Moderate	High	Extreme
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +

Plot 5	Da	ate	31-Mai
MS			
ies %)	Fd3Mb3Cw2Dr	2(Bg)	
BUUL	NOW/NIC	CCORE	
1			
	The last two desired in the la	וזו	
		4	
10-25% coverage		8	
Other conifer		8	
Scattered 10-39% coverage		8	
<500		2	
nd composition	n (dominant and	co-dominant)	
Mixwo	ood 50%	2	
		1	
3	3-6	3	
401	L-600	2	
	Control of the Contro	2	
TC	TAL	43	
PΔ	TING	MODERAT	TF
	Plot 5 MS ies %) PULLE 2 e and ladder fu Moss, herbs sh 10-25% Other Scattered 10 <500 Mixwo 20-40% or d clos 3 401 Standing of down	Plot 5 MS ies %) PULLDOWNS 2-<5 e and ladder fuel (.1-3m in height with the second shrubs 10-25% coverage Other conifer Scattered 10-39% coverage <500	MS Fd3Mb3Cw2Dr2(Bg) Fd3Mb3

Threat Rating (Max Score 110)						
Eco - province	Low	Moderate	High	Extreme		
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +		

Location	Plot 6		Date	31-Mar
Assessor	MS			
Crown species composition (speci	ies %) Fd4Mb3Dr2Cv		Cw	
Component/subcomponent	PUI	LLDOWNS	SCOR	E
Depth of organic layer		2-<5	3	
Surface	e and ladder	fuel (.1-3m in he	ight)	
Surface fuel composition	Moss, herl	bs and deciduous shrubs	4	
Dead and down material continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Other conifer		8	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	<500		2	
Stand structure ar	nd composit	ion (dominant an	d co-dominant)	
Overstory composition/CBH	Mix	wood 50%	2	
Crown closure		r deciduous (any closure)	1	
Fuel strata gap		3-6	3	
Stems/ha (overstory)	4	101-600	2	
Dead and dying (% of dominant and co-dominant stems)	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	g dead/partial wn <20%	2	
Comments:		TOTAL	43	
	F	RATING	MODER	ATE

Threat Rating (Max Score 110)						
Eco - province	Low	Moderate	High	Extreme		
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +		

Assessor Crown species composition (species Component/subcomponent Depth of organic layer	PULL	Fd8(MbCw)	ate	31-Ma
Crown species composition (species Component/subcomponent Depth of organic layer	s %)			
Component/subcomponent Depth of organic layer	PULL			
Depth of organic layer		D.014010		
		DOWNS	SCORE	
Surface :	1-<2		1	
	and ladder f	uel (.1-3m in heig	ht)	
Surface fuel composition		and deciduous rubs	4	
Dead and down material continuity (<7cm)	26-50% coverage		12	
adder fuel composition	Other conifer		8	
adder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	<500		2	
Stand structure and	composition	on (dominant and	co-dominant)	
Overstory composition/CBH		moderate CBH -9 m)	4	
Crown closure	41	L-60%	2	
uel strata gap		3-6	3	
Stems/ha (overstory)	60	1-900	3	
Dead and dying (% of dominant and co-dominant stems)		dead/partial n <20%	2	
Comments:	T	OTAL	49	
	RA	ATING	MODERA	TE

Threat Rating (Max Score 110)						
Eco - province	Low	Moderate	High	Extreme		
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +		

Location	Plot 8		Date	31-Ma
Assessor	MS			
Crown species composition (speci	es %)	Dr5Mb3Fd2	(Cw)	
Component/subcomponent	PU	LLDOWNS	SCORE	
Depth of organic layer		1-<2	1	
Surface	The second second second	r fuel (.1-3m in he	ight)	
Surface fuel composition	Moss, her	bs and deciduous shrubs	4	
Dead and down material continuity (<7cm)	Scattered <10% coverage		4	
Ladder fuel composition	Mixedwood		5	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	<500		2	
Stand structure ar	nd composit	tion (dominant an	d co-dominant)	
Overstory composition/CBH	Mix	wood 25%	0	
Crown closure	Vania - 300 / 700	r deciduous (any closure)	1	
Fuel strata gap		6-9	1	
Stems/ha (overstory)	4	401-600	2	
Dead and dying (% of dominant and co-dominant stems)	Standing dead/partial down <20%		2	
Comments:		TOTAL	30	
		RATING	LOW	
VISUAL ASSESSMENT ONLY - Mod Deciduous with large maple and p confirmed.				

Threat Rating (Max Score 110)						
Eco - province	Low	Moderate	High	Extreme		
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +		

		Worksheet - Fuel S		24.44
Location	Plot 9		ate	31-Mai
Assessor	MS			
Crown species composition (speci	es %)	Fd5Cw2Mb2B	g	
Component/subcomponent	PUL	LDOWNS	SCORE	
Depth of organic layer		2-<5	3	
Surface	and ladder	fuel (.1-3m in heig	sht)	
Surface fuel composition	A CONTRACTOR	os and deciduous shrubs	4	
Dead and down material continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Other conifer		8	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	<500		2	
Stand structure ar	nd compositi	ion (dominant and	co-dominant)	
Overstory composition/CBH	Conifer wit	th high CBH (>10 m)	3	
Crown closure	41-60%		2	
Fuel strata gap		6-9	1	
Stems/ha (overstory)	4	01-600	2	
Dead and dying (% of dominant and co-dominant stems)	100000000000000000000000000000000000000	g dead/partial wn <20%	2	
Comments:		TOTAL	43	
	F	RATING	MODERA	TE

Threat Rating (Max Score 110)					
Eco - province	Low	Moderate	High	Extreme	
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +	

Location	Plot 10		Date	31-Ma
Assessor	MS		0.4	
Crown species composition (speci	es %)	Fd10		
Component/subcomponent	PUL	LDOWNS	SCORE	
Depth of organic layer		2-<5	3	
Surface	and ladder	fuel (.1-3m in hei	ght)	
Surface fuel composition		s and deciduous hrubs	4	
Dead and down material continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Other conifer		8	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	<500		2	
Stand structure ar	nd compositi	on (dominant and	d co-dominant)	
Overstory composition/CBH	Conifer wit	h high CBH (>10 m)	3	
Crown closure	41-60%		2	
Fuel strata gap		6-9	1	
Stems/ha (overstory)	40	01-600	2	
Dead and dying (% of dominant and co-dominant stems)	120000000000000000000000000000000000000	Standing dead/partial down <20%		
Comments:	Т	OTAL	43	
	R	ATING	MODERAT	ГЕ

Threat Rating (Max Score 110)					
Eco - province	Low	Moderate	High	Extreme	
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +	

Location	Plot 11		Date	31-Mai
Assessor	MS			
Crown species composition (speci	es %)	Fd9(CwMbDi	r)	
Component/subcomponent	PULI	LDOWNS	SCORE	
Depth of organic layer		2-<5	3	
Surface	and ladder	fuel (.1-3m in hei	ght)	
Surface fuel composition		s and deciduous hrubs	4	
Dead and down material continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Other conifer		8	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	<500		2	
Stand structure ar	nd composition	on (dominant and	d co-dominant)	
Overstory composition/CBH	Conifer wit	h high CBH (>10 m)	3	
Crown closure	20-40% or deciduous (any closure)		1	
Fuel strata gap		6-9	1	
Stems/ha (overstory)	40	01-600	2	
Dead and dying (% of dominant and co-dominant stems)	100000000000000000000000000000000000000	dead/partial	2	
Comments:	Т	OTAL	42	
	R	ATING	MODERA	TE

Threat Rating (Max Score 110)					
Eco - province	Low	Moderate	High	Extreme	
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +	

Location	Plot 12		Date	31-Mai
Assessor	MS		Date	31 1910
Crown species composition (speci	1144	Fd10		
crown species composition (speci	es 70)	Fulo		
Component/subcomponent	PUL	LDOWNS	SCORE	
Depth of organic layer	2-<5		3	
Surface	and ladder	fuel (.1-3m in he	ight)	
	Moss, herb	s and deciduous		
Surface fuel composition		shrubs	4	
Dead and down material	1			
continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Other conifer		8	
Ladder fuel horizontal continuity	Patchy 40-60% coverage		10	
Stems/ha (understory)	501-800		4	
Stand structure ar	nd compositi	on (dominant an	d co-dominant)	
	Conifer wit	h moderate CBH		
Overstory composition/CBH	(5-9 m)	4	
Crown closure	6	1-80%	5	
Fuel strata gap		<3	5	
Stems/ha (overstory)	>	1,200	5	
Dead and dying (% of dominant	Standing	g dead/partial		
and co-dominant stems)	200	wn <20%	2	
Comments:		TOTAL	58	
	R	ATING	HIGH	
Plantation, entering stem exclusion	n. Some win	dthrow on stand	edges elevates surfa	ce fuel

Threat Rating (Max Score 110)					
Eco - province	Low	Moderate	High	Extreme	
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +	

Location	Plot 13	Worksheet - Fuel S	ate	31-Mai
50.000000			ate	31-Ma
Assessor	MS			
Crown species composition (speci	es %)	Fd10		
Component/subcomponent	PUI	LDOWNS	SCORE	
Depth of organic layer	2-<5		3	
Surface	and ladder	fuel (.1-3m in heig	ght)	
	Moss, herl	os and deciduous		
Surface fuel composition	12	shrubs	4	
Dead and down material	1			
continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Other conifer		8	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	501-800		4	
Stand structure ar	nd composit	ion (dominant and	co-dominant)	
	Conifer wi	th high CBH (>10		
Overstory composition/CBH		m)	3	
Crown closure	(51-80%	5	
Fuel strata gap		>10	0	
Stems/ha (overstory)	90	01-1,200	4	
Dead and dying (% of dominant	Standin	g dead/partial		
and co-dominant stems)	277 274 2	wn <20%	2	
Comments:		TOTAL	49	
	F	RATING	MODERAT	Έ
Plantation, older than plot 12. Fev	v fines on st	ems and increased	vertical senaration	of fuels

Threat Rating (Max Score 110)					
Eco - province	Low	Moderate	High	Extreme	
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +	

Location	Plot 14	Vorksheet - Fuel S	Date	31-Mai
Assessor	MS		Jace	31-19101
Crown species composition (speci	1144	Fd(MbCwRa)		
crown species composition (speci	es 70)	Fu(IVIDCWRa)		
Component/subcomponent	PUL	LDOWNS	SCORE	
Depth of organic layer	5-<10		5	
Surface	and ladder	fuel (.1-3m in heig	ght)	
Surface fuel composition	A STATE OF THE STA	s and deciduous hrubs	4	
Dead and down material continuity (<7cm)	10-25% coverage		8	
Ladder fuel composition	Other conifer		8	
Ladder fuel horizontal continuity	Scattered 10-39% coverage		8	
Stems/ha (understory)	501-800		4	
Stand structure ar	nd compositi	on (dominant and	co-dominant)	
Overstory composition/CBH	Conifer wit	h high CBH (>10 m)	3	
Crown closure	4	1-60%	2	
Fuel strata gap		>10	0	
Stems/ha (overstory)	4	01-600	2	
Dead and dying (% of dominant and co-dominant stems)	Standing dead/partial down <20%		2	
Comments:		TOTAL	46	
	R	ATING	MODERAT	TE

Threat Rating (Max Score 110)					
Eco - province	Low	Moderate	High	Extreme	
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +	

Wildfire Threat A		orksheet - Fuel S	Setting Scoring	
Location	Plot 15		Date	31-Ma
Assessor	MS			
Crown species composition (speci	es %)	Dr6Act3(BgC	w)	
Component/subcomponent	PUL	LDOWNS	SCORE	
Depth of organic layer		1-<2	1	
Surface	and ladder	fuel (.1-3m in hei	ght)	
	Moss, herb	s and deciduous		
Surface fuel composition	S	hrubs	4	
Dead and down material	6-0-0-1	DAY OF SA		
continuity (<7cm)	Scattered	<10% coverage	4	
Ladder fuel composition	Mixedwood		5	
Ladder fuel horizontal continuity	Sparse <10% coverage		2	
Stems/ha (understory)	<500		2	
Stand structure ar	d compositi	on (dominant and	d co-dominant)	
Overstory composition/CBH	Deciduous	(<25% conifer)	0	
Crown closure		<20%	0	
Fuel strata gap	6-9		1	
Stems/ha (overstory)	40	01-600	2	
Dead and dying (% of dominant and co-dominant stems)	120 000000	dead/partial vn <20%	2	
Comments:	Т	OTAL	23	
	R	ATING	LOW	

native and invasive shrubs, including patches of the fire-supporting scotch broom.

		Threat Rating (Ma Score 110)	эх	
Eco - province	Low	Moderate	High	Extreme
Coast and Mountains, Georgia Depression	0 - 41	42 -57	58 - 69	70 +

Appendix 2 Description of Forest Fuel Types

Fuel Type C5 - Coniferous dominated stand

These stands are typical of mature, native forest vegetation on the coast of British Columbia. Generic characteristics for the C5 fuel type consist of a mature second growth canopy of even aged, moderately stocked (300 – 700 stems per hectare) conifers Douglas-fir (Pseudotsuga menziesii), western redcedar (Thuja plicata) and, outside of the Coastal Douglas-fir zone, western hemlock (Tsuga heterophylla). Forests of this type in the project area are primarily pure stands of Douglas-fir, or mixtures of Douglas-fir with minor amounts of western redcedar and bigleaf maple, with trees reaching heights of 30-35 m and moderate densities of 500-600 overstorey trees per hectare. Understorey vegetation is usually a mixture of salal with other plants, including sword fern, red huckleberry, and Oregon-grape. Surface fuel loads are low or moderate, and originate from the loss of fine branches and foliage due to wind in tree crowns or shading of lower crowns. This fuel type usually poses a moderate wildfire threat. It takes a large amount of energy to create a crown fire in this fuel type. For a crown fire to generate in these stands would likely require extreme fire weather conditions, where temperature exceeds relative humidity during a period of drought. Table 7 outlines the general stand characteristics of a C5 stand.

Table 7. Stand characteristics for fuel type C5.

Characteristic	Risk Level	Description
Surface fuel continuity (% cover)	Low	20-40 % cover
Vegetation fuel composition	Low	Herbs and deciduous shrubs
Fine woody debris continuity (<=7cm) (% cover)	Med	10-25% coverage
Large woody debris Continuity (>=7cm) (% cover)	Low	<10% coverage
Live conifer canopy closure (%)	Med	41-60% crown closure
Live deciduous canopy closure (%)	High	<20% crown closure
Live and dead conifer crown height (m)	Low	3-5m
Live and dead suppressed and understory conifer (stems/ha)	Low	<500 stems/ha

Fuel Type M2 - Mixed conifer and deciduous stand

Mixedwood forests can vary considerably in their composition and associated wildfire threat. They pose moderate or low threat within the project area. Stands on and near the project site are generally around 50% deciduous and 50% conifer, with small patches dominating the canopy texture. Tree species include western redcedar, Douglas-fir, grand fir, bigleaf maple, red alder, and western hemlock. Canopy gaps in these stands allows shade-tolerant conifers to extend their crowns lower to the ground, which may allow forest cover in these areas to "spot" or involve isolated crown fuels during a wildfire. Decomposition tends to reduce surface fuel loads in these areas quite quickly, due to favourable soil moisture and soil biota.

The fire behavior potential in these stands varies depending on the percentage content of coniferous species. To generate a crown fire in these stands would require extreme drought weather conditions and high winds. Table 8 outlines general stand characteristics.

Table 8. Stand characteristics for fuel type M2.

Characteristic	Risk Level	Description
Surface fuel continuity (% cover)	Low	20-40 % cover
Vegetation fuel composition	Low	Herbs and deciduous shrubs
Fine woody debris continuity (<=7cm) (% cover)	Low	Scattered, <10% coverage
Large woody debris Continuity (>=7cm) (% cover)	Low-Med	10-25% coverage
Live conifer canopy closure (%)	Low-Med	20-40% crown closure
Live deciduous closure (%)	Med	20-40% crown closure
Live and dead conifer crown height (m)	Med	2-<3 m
Live and dead suppressed and understory conifer (stems/ha)	Very Low	0-500 stems/ha

Fuel Type D1 - Deciduous dominated stand

Pure deciduous stands are found in riparian areas and modified land in the assessed area. This fuel type is typically dominated by native deciduous trees such as Red Alder (Alnus rubra), Bigleaf Maple (Acer macrophyllum), and/or Black Cottonwood (Populus balsamifera ssp. Balsamifera). D1 fuel types have a low flammability and would not support a fast spreading, high intensity wildfire. D1 stands pose a low wildfire risk and are expected to act as fuel breaks decreasing the overall wildfire threat to the site. Table 9 outlines general characteristics of D1.

Table 9. D1 general stand characteristics.

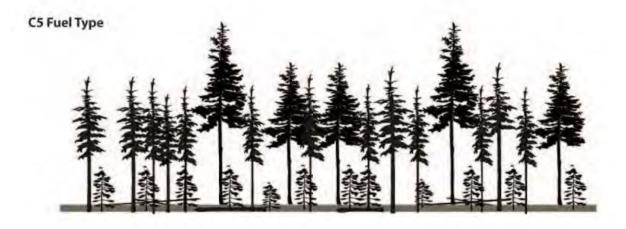
Characteristic	Risk Level	Description
Surface fuel continuity (% cover):	Low	20-40 % cover
Vegetation fuel composition	Low	Herbs and deciduous shrubs
Fine woody debris continuity (<=7cm) (% cover)	Low	Scattered, <10% coverage
Large woody debris Continuity (>=7cm) (% cover)	Low-Med	10-25% coverage
Live conifer canopy closure (%)	Very low	< 20% crown closure
Live deciduous canopy closure (%)	Very low	>80% crown closure
Live and dead conifer crown height (m)	Very low	5m+ or <20% conifer crown closure
Live and dead suppressed and understory conifer (stems/ha)	Very Low	0-500 stems/ha

Appendix 3 Generic Description of Coastal Fuel Types

The current Canadian Forest Fire Behavior Prediction (FBP) System does not include coastal forests in their fuel type descriptions. These fuel types reflect stand conditions that were modeled to predict fire behavior potential. On the coast the fuel type that most closely represents forest stand structure and conditions has been used. The following fuel types are the most common interpretations used on the coast.

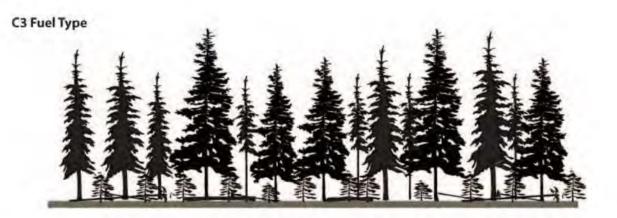
C5 - Uniform Second Growth Conifer Stand - Moderate Risk

This fuel type is characterized by mature second growth stands dominated by Western Red Cedar (Thuja plicata) and Western Hemlock (Tsuga heterophylla). There can be small component of dominant Douglas-fir (Pseudotsuga menziesii) in the overstory. This fuel type is moderately dense (500-1000 stems per ha) and has a high crown base height of 10 to 15m. The understory is of moderate density, usually consisting of Western Redcedar and Western Hemlock regeneration. The ground fuel component consists of moderately dense fine fuel layer (>7cm) and a low percent cover of large woody debris (>7cm). It takes a large amount of energy to create a crown fire.



C3 - Multistoried Second Growth Conifer Stand - High Risk

This fuel type is characterized by a uniform mature second growth conifer dominated stand. This stand consists of mature Western Red Cedar (Thuja plicata) and Western Hemlock (Tsuga heterophylla). There is also a minor component of dominant Douglas-fir (Pseudotsuga menziesii) in the stand. Compared to a C5 stand, a C3 stand is more densely stocked (1000-2000 stems per ha) and there is a lower crown base height (usually 4-8 m). The understory is more densely stocked with Western Redcedar and Western Hemlock. The ground fuel component consists of moderately dense fine fuel layer (>7cm) and a low percent cover of large woody debris (>7cm). A crown fire in a C3 stand takes less energy to create than a C5 stand.



M2 - Mature Stands Consisting of a mix of Conifer and Deciduous Trees – Low to Moderate Risk

This fuel type consists of a mixed conifer and deciduous tree type. This stand is not uniform in structure and is composed of a wide variety of species. These may include and not limited to:

Western Red Cedar (Thuja plicata), Western Hemlock (Tsuga heterophylla), Douglas-fir (Pseudotsuga menziesii), Red Alder (Alnus rubra), Bigleaf Maple (Acer macrophyllum), and Paper Birch (Betula papyrifera).

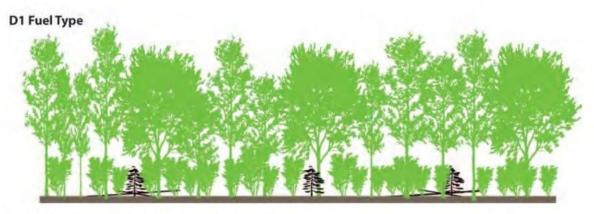
These stands usually consist of less than a 70% of conifer trees, reducing the wildfire risk. There is usually a low crown height (5m) and a high percentage of ladder fuels. There is a high percent cover of suppressed trees, but they are usually composed of deciduous species.

M2 Fuel Type



D1 - Deciduous Dominated Stands - Low Risk

This fuel type is dominated by deciduous trees consisting mostly of Red Alder (Alnus rubra), Bigleaf Maple (Acer macrophyllum), and Paper Birch (Betula papyrifera). D1 stand structure is not uniform with a wide variety of tree ages. There is a well-developed shrub layer, but is mostly composed of low-flammable species. Crown fires are not expected because of the deciduous fuel type. D1 stands on the coast can be used as fuel buffers as they present a low wildfire risk.



C4 - Uniform Densely Stocked Conifer Stand - High Risk

This fuel type is rare within the Lower Mainland as it is mostly defined by densely stocked Lodgepole pine (Pinus contorta). This fuel type can be found more towards Squamish and Pemberton. Some small densely stocked Western Red Cedar (Thuja plicata), Western Hemlock (Tsuga heterophylla), and Sitka Spruce (Picea sitchensis) can be found in the Lower Mainland, but these stands are often isolated and small. Stands are densely stocked, (approximately 10,000-30,000 stems/ha) with a large quantity of fine and large woody debris. These stands are characterized as having vertical and horizontal fuel continuity. The shrub community in this stand is of very low density.

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Appendix 5 **Description of Terminology**

Term	Definition
Co-dominant Trees	Defines trees with crowns forming the general level of the main canopy in even-aged groups of trees, receiving full light from above and partial light from the sides.
Coarse fuels (coarse woody debris)	Combustible material over 7cm in diameter
Crown base height	The height, above ground, where the live crown of coniferous trees begins. Measured in meters (m).
Crown Closure	An assessment of the degree to which the crowns of trees are nearing general contact with one another. The percentage of the ground surface that would be considered by a downward vertical projection of foliage in the crowns of trees.
Diameter at Breast Height	The diameter of a tree measured at 1.3m above the point of germination.
Dominant Trees	Defines trees with crowns extending above the general level of the main canopy of even-aged groups of trees, receiving full light from above and comparatively little from the sides.
Fire-resistant materials	These meet the acceptance criteria of CAN/ULC-S101, (Fire Endurance Tests of Building Construction and Materials)
Fuel Break	An area of non-combustible materials that inhibits the continuous burning of fuels.
Fuel Load	The mass of combustible materials expressed as a weight of fuel per unit area.
Fuel Moisture	Percent water content of vegetation. This is an important factor in rate of spread.
Fuel Types	Classification of forested stands as described by Canadian Forest Fire Behavior Prediction (FBP) System. There are currently no fuel type classifications specific to coastal fuels.
Fine fuels (fine woody debris)	Combustible woody debris under 7cm in diameter.
Fire Behaviour	The manner in which a fire reacts to the influences of fuel, weather, and topography
Intermediate Trees	Defines trees with crowns extending into the lower portion of the main canopy of even-aged groups of trees, but shorter in height than the co-dominants. These receive little direct light from above and none from the sides, and usually have small crowns that are crowded on the sides.

Term	Definition	
Ladder Fuels	Live or dead vegetation that allows a fire to burn into the canopy (crown) of a forested stand.	
Lift Pruned	The removal of ladder fuels to increase the crown base height.	
Litter Layer	Surface buildup of leaves and woody material.	
Live Crown Ratio	Is the percentage of the total stem length covered with living branches. It provides rough but convenient index of the ability of a tree's crown to nourish the remaining part of the tree. Trees with less than 30 percent live crown ratio are typically weak, lack vigor, and have low diameter growth, although this depends very much on the tree's age and species.	
Non-combustible materials	Means that a material meets the acceptance criteria of CAN/ULC S114, (Standard Method of test for determination of non-combustibility in Building Materials)	
Open Grown	Defines trees with crowns receiving full light from all sides due to the openness of the canopy.	
Rated roofing materials	Class A, B or C is a measure of the external spread of flame on a roof surface. Tests are conducted using CAN/ULC S107M methods of fire tests of roof coverings, or equivalent. The best rating achieved is Class A, which may be described as effective against severe fire exposure.	
Spotting	Fire producing sparks or embers that are carried by the wind and start new fires.	
Stems Per Hectare	The number or size of a population (trees) in relation to some unit of space (one hectare). It is measured as the amount of tree biomass per unit area of land.	
Suppressed Trees	Defines trees with entirely below the general level of the canopy of even-aged groups of trees, receiving no direct light either from above or from the sides.	
Wildfire	An unplanned, unwanted wildland fire, including unauthorized human-caused fires, escaped wildland fire use events, escaped prescribed fire projects, lightning strikes, downed power lines, and all other wildland fires where the objective is to put the fire out.	

Appendix 6 Fire Resistant Plants for Landscaping

ire resistant and drought tolerant ground covers		Fire resistant and drought tolerant perennials	
	Achillea species (when mowed, turf alternative) Ajuga reptans Arctostaphaylos uva-ursi Autennaria rosea Aubrieta detoidea Ceanothus prostatus Cerastium tomentosum Dianthus species Delosperma nubigenum and the less cold hardy cooperi Fragaria species (turf alternative) Phlox subulata Sedums Semperviums Thymus praecox turf alternative) Veronica species	 Achillea species Armeria maritima Aquilegia Aurinia saxatilis Coreopsis Echinacea purpurea Epilebium angustifolium Gaillardia varieties Geranium species Helianthemum Hemerocallis Kniphofia uvaria Iris - bearded Lavendula Lupinus Penstemon Oenothera species Papaver orientale Perovskia atriplicifolia Ratibida columnifera Salvia species Stachys byzantina 	
e re	esistant and drought tolerant shrubs: Amelanchier alnifolia	Fire resistant and drought tolerant trees:	
:	Caryopteris x clandonesis	 Acer circinatum, glabrum, macrophyllum, plantanoides, rubrum 	
	Ceanothus	Aesculus hippocastanum	
	Cistus	Alnus rubra tenuifolia	
	Cotoneaster species	Betula species	
	Euonymus alatus	Catalpa speciosa	
	Fremontoden on californium	Celtis occidentalis	
	5,5 C 11 E 1 C S S S 1 C S S S S S S S S S S S S S		
•	Fuchsia (dieback)	 Cercis canadensis 	
:	Fuchsia (dieback) Gaultheria shallow	Cercis canadensisCornus florida, stolonifera, nuttallii	
	Gaultheria shallow	 Cornus florida, stolonifera, nuttallii 	
:	Gaultheria shallow Holodiscus discolour	Cornus florida, stolonifera, nuttalliiCrataegus species	
:	Gaultheria shallow Holodiscus discolour Lagerstroemia indica	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species 	
:	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos 	
	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus 	
•	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia Pyracantha species	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus Juglans 	
	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus Juglans Liquidambar styraciflua 	
	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia Pyracantha species	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus Juglans Liquidambar styraciflua Malus species 	
	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia Pyracantha species Ribes species	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus Juglans Liquidambar styraciflua 	
	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia Pyracantha species Ribes species Rhus species	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus Juglans Liquidambar styraciflua Malus species 	
	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia Pyracantha species Ribes species Rhus species Rosa species and hardy own root shrub	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus Juglans Liquidambar styraciflua Malus species Populus species Prunus cherry 	
	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia Pyracantha species Ribes species Rhus species Rosa species and hardy own root shrub Spiraea bumalda	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus Juglans Liquidambar styraciflua Malus species Populus species Prunus cherry 	
	Gaultheria shallow Holodiscus discolour Lagerstroemia indica Mahonia Pachystima myrsinites Philadelphus speceis Paxistima myrthifolia Pyracantha species Ribes species Rhus species Rosa species and hardy own root shrub Spiraea bumalda Symphoricarpos albus	 Cornus florida, stolonifera, nuttallii Crataegus species Fagus species Fraxinus species Gingko biloba Gleditsia triacanthos Gymnocladus dioicus Juglans Liquidambar styraciflua Malus species Populus species Prunus cherry Quercus agrifolia, rubra, palustria, garryana 	

Source: Master Gardeners Association of BC. http://mgabc.org/node/1514.

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- 3. The findings, conclusions and recommendations made in this report reflect Diamond Head's best professional judgment in light of the information available at the time of preparation. This report has been prepared in a manner consistent with the level of care and skill normally exercised by arborists and foresters currently practicing under similar conditions in a similar geographic area and for specific application to the trees subject to this report as at the date of this report. Except as expressly stated in this report, the findings, conclusions and recommendations set out in this report are valid for the day on which the assessment leading to such findings, conclusions and recommendations was conducted. If generally accepted assessment techniques or prevailing professional standards and best practices change at a future date, modifications to the findings, conclusions, and recommendations in this report may be necessary. Diamond Head expressly excludes any duty to provide any such modification if generally accepted assessment techniques and prevailing professional standards and best practices change.
- Conditions affecting the trees subject to this report (the "Conditions", including
 without limitation structural defects, scars, decay, fungal fruiting bodies, evidence of
 insect attack, discoloured foliage, condition of root structures, the degree and direction

of lean, the general condition of the tree(s) and the surrounding site, and the proximity of property and people) other than those expressly addressed in this report may exist. Unless otherwise stated: information contained in this report covers only those Conditions and trees at the time of inspection; and the inspection is limited to visual examination of such Conditions and trees without dissection, excavation, probing or coring. While every effort has been made to ensure that the trees recommended for retention are both healthy and safe, no guarantees, representations or warranties are made (express or implied) that those trees will remain standing or will not fail. The Client acknowledges that it is both professionally and practically impossible to predict with absolute certainty the behaviour of any single tree, or groups of trees, in all given circumstances. Inevitably, a standing tree will always pose some risk. Most trees have the potential for failure and this risk can only be eliminated if the risk is removed. If Conditions change or if additional information becomes available at a future date, modifications to the findings, conclusions, and recommendations in this report may be necessary. Diamond Head expressly excludes any duty to provide any such modification of Conditions change or additional information becomes available.

- 5. Nothing in this report is intended to constitute or provide a legal opinion, and Diamond Head expressly disclaims any responsibility for matters legal in nature (including, without limitation, matters relating to title and ownership of real or personal property and matters relating to cultural and heritage values). Diamond Head makes no guarantee, representation or warranty (express or implied) as to the requirements of or compliance with applicable laws, rules, regulations, or policies established by federal, provincial, local government or First Nations bodies (collectively, "Government Bodies") or as to the availability of licenses, permits or authorizations of any Government Body. Revisions to any regulatory standards (including bylaws, policies, guidelines an any similar directions of a Government Bodies in effect from time to time) referred to in this report may be expected over time. As a result, modifications to the findings, conclusions and recommendations in this report may be necessary. Diamond Head expressly excludes any duty to provide any such modification if any such regulatory standard is revised.
- Diamond Head shall not be required to give testimony or to attend court by reason of
 this report unless subsequent contractual arrangements are made, including payment
 of an additional fee for such services as described in the fee schedule and contract of
 engagement.
- 7. In preparing this report, Diamond Head has relied in good faith on information provided by certain persons, Government Bodies, government registries and agents and representatives of each of the foregoing, and Diamond Head assumes that such information is true, correct and accurate in all material respects. Diamond Head accepts no responsibility for any deficiency, misinterpretations or fraudulent acts of or information provided by such persons, bodies, registries, agents and representatives.

- Sketches, diagrams, graphs, and photographs in this report, being intended as visual
 aids, are not necessarily to scale and should not be construed as engineering or
 architectural reports or surveys.
- 9. Loss or alteration of any part of this report invalidates the entire report.

Rainwater Management Plan Preliminary Report Morgan Maples

9090 Trans-Canada Highway North Cowichan, British Columbia

Prepared By:

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Permit to Practice # 1001017(BC)

February 14, 2022 Revision#1 March 15, 2022

Core Project: 2087

Schedule 5 DP000256 Core Group Rainwater Management Plan (35 pages)
Rainwater Management Plan
Preliminary Report
Revision History

REVISION HISTORY

REVISION NUMBER	DATE
0	February 2022
	March 2022
)	

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Schedule 5 DP000256 Core Group Rainwater Management Plan (35 pages)
Rainwater Management Plan
Preliminary Report

INTRODUCTION

Project Overview

The Project is located in the Chemainus community of North Cowichan and consists of one lot. The property is bounded by the Trans-Canada Highway to the east, Henry Road to the north, agricultural and rural properties to the west, and an RV resort to the south. The property is currently zoned R5, Residential Mobile Home Park Zone. The developer is proposing to construct residential mobile homes in accordance with the current zoning By-law.

Basis of Report

The following interim report has been prepared in support of the Development Permit Application for this project. The finalized report will be provided at Building Permit Application.

The report meets and exceeds the requirements of the Municipality of North Cowichan's "Stormwater and Rainwater Design Guidelines" attached in **Appendix C**.

Revisions requested by the Municipality:

i) A revised "Stormwater and Rainwater Design Guidelines" and Rainfall intensity formula was provided by the Municipality of North Cowichan which allows for Climate Change increase in rainfall intensity. The following report has been revised to reflect this increased rainfall. The following formula was provided:

The revised guidelines are also included in Appendix C

ii) Runoff coefficient was revised from 0.45 to 0.55

In summary the changes requested by the Municipality increase the overall detention volume requirements from 373 m3 to 546 m3.



REPORT

Topography and Geotechnical Overview

The project slopes, in general, from East to West with total vertical elevation difference of 15 meters. Re-grading the site will be required as part of the development and the proposed Grading Plan is contained in **Appendix A**.

Stormwater Management Overview

The Municipality of North Cowichan's Stormwater and Rainwater Design Guidelines requires that proposed Developments detain the 5-year storm event. Based on the proposed design, the development will provide sufficient detention storage for the 200-year event. Therefore the 200-year Pre-development Flows will match the Post Development flows for the 200-year event. The current design exceeds the Municipal requirements.

The proposed Stormwater Management Plan will provide a variety of Source Control measures located throughout the site. Dispersing these facilities around the site will reduce the concentration of both infiltration and flows. The proposed facilities will include the following:

- a) Absorbent Topsoil: Impermeable surfaces will be directed, where possible, to topsoil and landscaped areas. This will promote infiltration, retention and exfiltration.
- b) Each Modular Home "lot" will have individual infiltration galleries which will help evenly infiltrate and distribute rainfall back into the ground throughout the development. A typical detail is included in **Appendix D**;
- c) Each Modular Home "lot" will have a small rain garden which will provide both attenuation and water quality to the stormwater and will again provide a more evenly distribution of stormwater.
- d) Stormwater discharge to receiving Creeks and ponds will have water quality manholes and flow control manholes prior to their discharge point.

Drainage Design

a) Storm water Source Controls will be installed on a "lot" by "lot" basis. Each Modular Home "lot" will provide a source control infiltration gallery to compensate for the introduced impermeable surface on the "lot" and roadworks fronting the "lot". Calculations show that infiltration areas of 10m2 to 12 m2 and a detention volume varying between 5.1 m3 and 6 m3 will be required per "lot". Detailed calculations are provided in Appendix D and final calculations for the project will

be provided at Building Permit stage. A Typical detail of the proposed infiltration gallery is also contained in **Appendix D**.

- b) In addition to the above a rain garden (1 m3) will also be provided on each "lot" to provide additional attenuation and water quality.
- c) Underground Storm Sewer pipes will convey rainwater runoff from the roadways and any overflows from the Infiltration Galleries to three (3) discharge points as shown on the Stormwater Management Plan contained in Appendix A. A water quality manhole and a flow control manhole will be provided prior to each discharge point to the creek or ditch system to provide cleansing of the stormwater and flow control to the eliminate erosion in the receiving waters. Energy dissipaters will also be provided at the headwalls.

Storm sewer pipes will be sized to accommodate the 10-year peaks flows "in pipe" and the 200-year peak flows will surcharge the pipes but remain below surface.

d) Storm water Release Rate.

As noted above the release rates will be controlled at Flow Control Manholes located before each discharge point.

<u>Application Commentary Concerns – dated January 14, 2022</u>

- a) Risks to the groundwater regime from the proposed development have been evaluated by the Geotechnical Engineer. The proposed development will have no risk on the groundwater regimes, the memo is included as Appendix B
- b) The Predevelopment and Post Development flows for the 10-, 25- and 200-year events are detailed in Appendix D. Detention is provided to reduce the Post development Peak Flows to the Pre-Development Peak Flows.
 - In summary the development provides a total of <u>546 m3</u> of detention volume. Below are summarized the Peak flows generated from the three different catchment areas for the various storm events and the detention storage volumes required to maintain the Pre-Development peak flows.

Catchment Area A

Storm Event	Pre Dev Peak Flow m3/s	Max release m3/s	Detention Volume m3
5-year	0.024	0.024	121
10-year	0.030	0.030	151
25-year	0.036	0.036	182
200-year	0.048	0.048	242

Catchment Area B

Storm Event	Pre Dev Peak Flow m3/s	Max release m3/s	Detention Volume m3
5-year	0.014	0.014	72
10-year	0.018	0.018	90
25-year	0.022	0.022	108
200-year	0.029	0.029	143

Catchment Area C

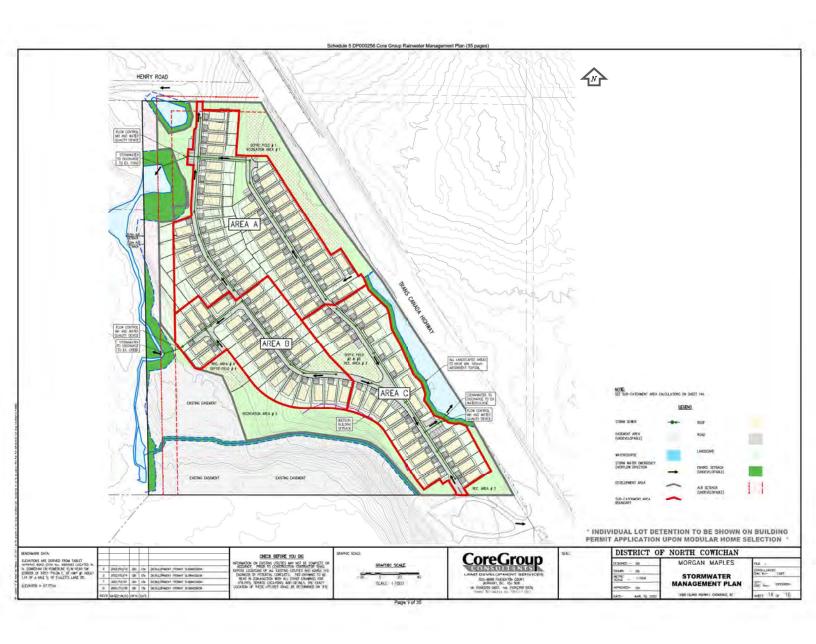
Storm Event	Pre Dev Peak Flow m3/s	Max release m3/s	Detention Volume m3
5-year	0.016	0.016	81
10-year	0.020	0.020	101
25-year	0.024	0.024	122
200-year	0.032	0.032	161

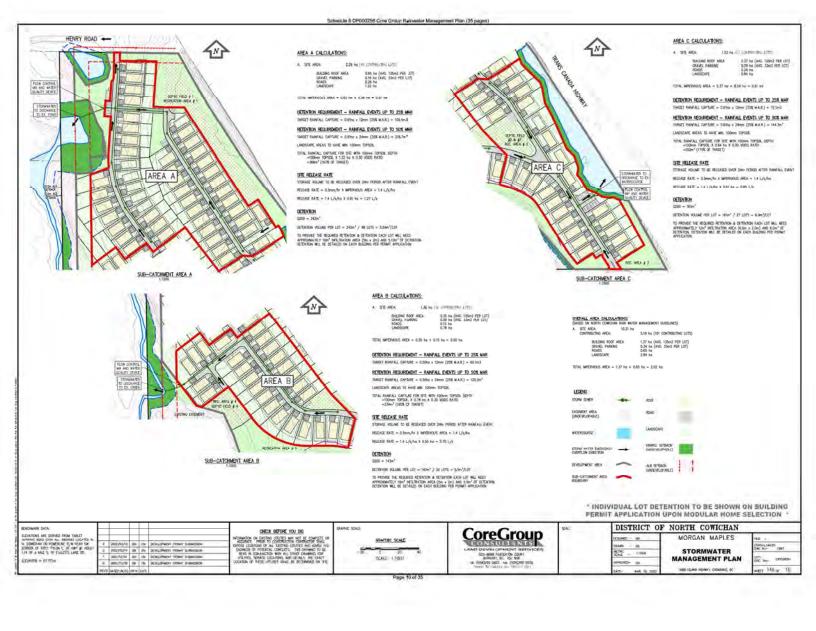
The proposed storage volume **546 m3** will maintain the Predevelopment flows up to the 200-year storm event.

System Maintenance

The final RWMP will include a maintenance and operations guide for the rainwater management system. As maintenance of the systems is important for the continued efficiency of the systems designed, the guide will be provided to the eventual owner or party responsible for maintenance.

Schedule 5 DP000256 Core	Group Rainwater Management Plan (35 pages)
APPENDIX A	Preliminary Grading Plans and Stormwater Management Plan





Schedule 5 DP000256 Core	Group Rainwater Management Plan (35 pages)
APPENDIX B	Geotechnical Memo
	Geotechnical Memo



604.439.0922 1779 W 75th Avenue Vancouver, B.C V6P 6P2

February 11, 2022

File: 18529

Core Group Civil Consultants Ltd. #320 – 8988 Fraserton Court Burnaby, BC V5J 5H8

Attention: Dylan Bryson

Re: Geotechnical Comments on Proposed Stormwater Management Systems Proposed Modular Home Park - 9090 Island Highway, Chemanius, BC

We understand our comments are required regarding the stormwater management systems proposed onsite and their impact on the groundwater regime and slope stability. We understand each modular home lot will have a raingarden and infiltration gallery to direct water into the ground across the development. We further understand grade changes are proposed across the site with grade increases of up to 9 m towards the south, and grade decreases of up to 8 m to the north.

GeoPacific previously completed a test pit investigation of the subsurface and groundwater conditions on February 23 and 24, 2021. At that time, a total of 22 test pits were excavated across the site between 0.8 m and 3.5 m below current site grades, including two infiltration tests near the centre of site. The results of our investigation are outlined in our Geotechnical Investigation Report, dated March 9, 2021. The subsurface soil conditions across the site generally consist of a layer of topsoil, overlying compact to dense sand to very stiff sandy silt. Some rock outcrops were observed along the west side of site. The static groundwater table was not encountered during the investigation. Some perched groundwater is expected to occur on the boundary of the till-like soils. We expect the stormwater management systems will be located in the native sand to sandy silt, or engineered fill.

We have reviewed the Rainwater Management Plan Report (dated January 24, 2022), provided by Core Group Civil Consultants Ltd. The report indicates stormwater will be managed through the use of stormwater infiltration and detention systems.

Based on the grading plan provided, we expect some permanent slopes will be present. From a geotechnical perspective, we recommend any infiltration galleries have a minimum setback of 5 m away from the top of any permanent slope and be located a minimum of 2 m above the static groundwater table or bedrock contact. If these conditions cannot be met, then stormwater detention systems should be employed in these areas. GeoPacific intends to review the conditions during construction, as outlined in our Geotechnical Investigation Report, to confirm the subsurface conditions on the lots and provide additional recommendations as necessary. Given the above, both stormwater management by infiltration and/or detention is feasible from a geotechnical perspective and an acceptable level of slope stability will be maintained.

We are pleased to be of assistance to you on this project and we trust that our comments and recommendations are both helpful and sufficient for your current purposes. If you would like further details or would like clarification of any of the above, please do not hesitate to call.

For:

GeoPacific Consultants Ltd.

Austin Lockstidt, B.A.Sc., EIT Engineer In Training

Kevin Bodnar, M.Eng., P.Eng. Principal



Schedule 5 DP000256 Core	Group Rainwater Management Plan (35 pages)
ADDENDIV C	
APPENDIX C	Stormwater and Rainwater Design Guidelines- DNC

Storm Water and Rain Water Design Guidelines

The following guidelines are provided to supplement the information contained in the Municipality's Engineering Standards. They are focused primarily on residential and commercial developments, but the objectives are also applicable to industrial and institutional projects. The intention is to ensure that drainage systems are designed to handle significant storm events in accordance with conventional storm water management principles, while also implementing some alternative rain water management approaches to deal with the smaller, more frequent rainfall events in an environmentally responsible way. As the area of storm water and rain water management continues to evolve, we look forward to your comments and suggestions.

Storm Water Management - Design Guidelines

Objectives

- Primary purpose is to limit damage to the community and the environment from significant storm events.
- Focus is on larger storm events ie. 2 yr, 5 yr, 10 yr, 25 yr, 200 yr. Smaller rainfall events are to be handled by rain water management (source control) measures.
- Need to ensure that flows from storm events can be handled onsite and offsite by municipal infrastructure and natural systems so as to limit impacts to the community and the environment.
- For typical residential development, water quality objectives are to be met through rain water management measures. For commercial, industrial, institutional and high density residential development, additional water quality treatment measures may be required.

Design Criteria

- Limit post-development peak flow rate to pre-development peak flow rate for the 5 yr event, unless downstream conditions require additional flow control.
- Design detention ponds for the 5 yr event, unless downstream conditions require additional flow control. Provide overflow capacity for the 200 yr event. Refer to MOE/DFO Land Development Guidelines, Section 4, for pond construction details.
- Review downstream capacity and flood risk for 10, 25 and 200 yr events. If necessary, upgrade downstream works and/or provide additional detention and flow control.

Storm Water Management - Design Guidelines (cont'd)

- Include drainage from upstream tributary areas, assuming full development as indicated by the OCP, unless otherwise directed.
- Design minor drainage system (pipes, swales, ditches) for 10 yr event peak flows. For pipes 600mm and larger, design for 25 yr event.
- Design major drainage system (overland flow routes) for 200 yr event.
- Size culverts for 10 yr event with HW/D=1.0 (no surcharge), and 200 yr event with maximum surcharge of HW/D = 2.0 (surcharge of one pipe diameter) if site conditions permit; otherwise size for 200 yr event with HW/D=1.0.
- Use the Rational Method to calculate peak flows to size pipes and culverts for basic conveyance systems for drainage areas 20 ha. or less. Refer to DNC Engineering Standards for details. For larger drainage areas use hydrograph methods. Use DNC IDF curves as per Std Dwg D12.
- On residential sites where rain water management/source control measures have been implemented as outlined below, the Rational Method runoff coefficient "C" may be adjusted as follows:

Land Use (Assumes composite "C" for site)	"C" without Source Control	"C" with Source Control
Residential (>700m²)	0.5	0.45
Small Lot Residential (<700m²)	0.6	0.55
Multi-family Residential	0.7	0.65

- On sites with extensive impervious areas (i.e. commercial sites) where source control
 measures are implemented, the minimum enter time, Te, may be increased from 10
 minutes to 15 minutes when calculating the time of concentration for areas tributary to
 the source controls.
- Use hydrograph methods to:
 - o analyze large or complex drainage areas.
 - o calculate pre and post development flows to size detention facilities.
 - assess downstream capacity and flood risk for various storm events.
 - Refer to MMCD Design Guideline Manual for additional information.
- Provide site specific Storm Water Management Plan in accordance with MMCD Design Guideline Manual, Section 4.3, as directed.
- For commercial, industrial, institutional and high density residential development, design water quality treatment works to meet the following:
 - o treat 90% of the annual runoff volume of the catchment area.
 - meet removal targets of 80% TSS and 95% oil.

Rain Water Management - Design Guidelines

Objectives

- Primary purpose is to limit adverse impacts to the environment when land is developed.
- · Deals with both water quantity and water quality.
- Focus is on smaller, frequent rainfall events, ie. smaller than 2 yr events.
- Post-development hydrology to mimic pre-development hydrology using small scale, onsite, non-pipe, "low impact" approaches.
- Often called "source control", two specific techniques outlined below are infiltration chambers and rain gardens. Other techniques that will be considered on a case by case basis include swales, permeable pavement, absorbent landscaping, increased topsoil and other "low impact", Water Balance Model type approaches.

Design Criteria

- Source control works shall be designed to handle runoff from onsite impervious surfaces, ie. typically roofs, driveways and parking areas. The primary goal is to make use of onsite infiltration to reduce runoff from the site. The secondary goal is to provide detention so as to allow runoff that is not handled by infiltration to be discharged to the storm drainage system at a rate similar to pre-development conditions.
- Source control works shall be installed on all sites regardless of soil conditions, unless
 otherwise approved. It is recognized that where sites have soils that drain poorly, the
 effectiveness of infiltration systems will be limited, particularly during winter months.
 This is acceptable because it mimics the pre-development conditions of sites with soils
 that drain poorly.
- Design of source control works shall be based on 50% of the Mean Annual Rainfall (MAR) 24 hour event. For the Municipality of North Cowichan, an MAR of 48mm shall be assumed, resulting in a 24 hour design rainfall of 24mm, or an average rate of 1.0mm/hr. The intention is that the source control works shall be designed to handle this rainfall amount through a combination of infiltration and detention.
- Source control works shall include a detention component sized to provide a minimum storage volume based on 25% of the MAR, or 12mm, over the impermeable areas, assuming no infiltration or outflow. This equates to a storage volume of 1.2m³ for every 100m² of impervious area. For a typical residential lot with 200m² of impervious area, the works shall provide a minimum storage volume of 2.4m³.

Rain Water Management - Design Guidelines (cont'd)

- Unless otherwise approved, a flow controlled outlet shall be provided so that, if necessary, the above storage volume is drained to the piped drainage system over a 24 hour period after the rainfall event. This equates to an outflow rate of 0.50mm/hr X the impervious area, which further equates to a rate of 1.4 l/s/ha. For a typical residential lot with 200m² of impervious area, the discharge rate will be 100 l/hour or 0.028 l/s. Simple orifice type flow control is not recommended for such low flow rates as the orifice diameter would only be about 5mm, which would be susceptible to plugging. As an alternative, flow control may be achieved by using an infiltration layer above an under-drain as shown on the detail drawings.
- The requirement for a flow controlled outlet may be waived upon submission of evidence by a Geotechnical Engineer that subsurface soil infiltration rates are adequate to handle the full design flow of 24mm of rainfall from onsite impervious surfaces over a 48 hour period. The basis for this requirement is that during the first 24 hours, half of the rainfall is infiltrated and the other half stored, then during the second 24 hours, the stored rainfall is infiltrated. This equates to an infiltration rate of 0.50mm/hr X the impervious area. For a typical residential lot with 200m² of impervious area, 100 l/hr will need to be infiltrated into the soil. For a typical infiltration system with 10m² of area, an average infiltration rate of 10mm/hr will need to be sustained over a 48 hour period.
- Infiltration chambers shall typically occupy an area equal to about 5% of the site impervious area. For a residential lot with 200m² of impervious area, the infiltration chamber works will occupy an area of about 10m² or 3.0mx3.0m.
- Rain gardens shall typically occupy a minimum area equal to about 10% of the site impervious area. For a residential lot with 200m² of impervious area, the rain garden will occupy an area of about 20m². To meet the storage requirement outlined above, a ponding depth of 150mm will be typical.
- Refer to Standard Drawings xx and xx for typical infiltration chamber and rain garden design details. Alternate designs meeting the requirements outlined above will be considered on a case by case basis.

Rain Water Management – Design Guidelines (cont'd)

Other Considerations:

- Subsurface infiltration systems are preferred by the Municipality for single family residential lots, as they have lower maintenance requirements and a smaller footprint than surface systems such as rain gardens.
- O Where soil conditions are poor for subsurface infiltration, rain gardens are a good alternative, as their larger area supports lower infiltration rates, and shallow depth is suited to areas with a high water table.
- The ability to combine rain gardens with site landscaping makes them well suited to many multifamily and commercial sites.

Storm Water and Rain Water Design Guidelines

The following guidelines are provided to supplement the information contained in the Municipality's Engineering Standards. They are focused primarily on residential developments, but the objectives are also applicable to commercial, industrial and institutional projects. The intention is to ensure that drainage systems are designed to handle significant storm events in accordance with conventional storm water management principles, while also implementing alternative rain water management approaches to deal with the smaller, more frequent rainfall events in an environmentally responsible way. These guidelines are meant to be a working document. As the area of storm water and rain water management continues to evolve, we look forward to your input and suggestions.

Storm Water Management - Design Guidelines

Objectives

- Primary purpose is to limit damage to the community and the environment from significant storm events.
- Focus is on larger storm events ie. 2 yr, 5 yr, 10 yr, 25 yr, 200 yr. Smaller rainfall events are to be handled by Rain Water Management (Source Control) measures.
- Need to ensure that flows from storm events can be handled onsite and offsite by municipal infrastructure and natural systems so as to limit impacts to the community and the environment.
- For typical residential development, water quality objectives are to be met through Rain Water Management measures. For commercial, industrial, institutional and high density residential development, additional water quality treatment measures may be required.

Design Criteria

- Limit post-development peak flow rate to pre-development peak flow rate for the 5 yr event, unless downstream conditions require additional flow control.
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- Review downstream capacity and flood risk for 10, 25 and 200 yr events. If necessary, upgrade downstream works and/or provide additional detention and flow control.
- Include drainage from upstream tributary areas, assuming full development as indicated by the OCP, unless otherwise directed.
- Design minor drainage system (pipes, swales, ditches) for 10 yr event peak flows. For pipes 600mm and larger, design for 25 yr event.
- Design major drainage system (overland flow routes) for 200 yr event.

- Size culverts for 10 yr event with HW/D=1.0 (no surcharge), and 200 yr event with maximum surcharge of HW/D = 2.0 (surcharge of one pipe diameter) if site conditions permit; otherwise size for 200 yr event with HW/D=1.0.
- Use the Rational Method to calculate peak flows to size pipes and culverts for basic conveyance systems for drainage areas 20 ha. or less. Refer to DNC Engineering Standards for details. For larger drainage areas use Hydrograph methods.
- Rainfall Intensity Formula Based On Std Dwg R12:

I =104.0*(Tc^-0.45)*RPIF (only used to develop ORIGINAL IDF curves) Rainfall Intensity Formula + 20% for climate change:

I =124.8*(Tc^-0.45)*RPIF (use for calculating rainfall intensities for design and analyses)

Where: I = Intensity in mm/hr

Tc = Time of concentration in minutes

RPIF = Return Period Intensity Factor below

Return Period (years)	2	5	10	25	50	100	200
Intensity Factor	0.6	0.8	1.0	1.2	1.3	1.4	1.6

 On residential sites where Rain Water Management/Source Control measures have been implemented as outlined below, the Rational Method runoff coefficient "C" may be adjusted as follows:

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- For commercial, industrial, institutional and high density residential development, design water quality treatment works to meet the following:
 - o treat 90% of the annual runoff volume of the catchment area.
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Rain Water Management - Design Guidelines

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Design Criteria

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- Source control works shall be installed on all sites regardless of soil conditions, unless
 otherwise approved. It is recognized that where sites have soils that drain poorly, the
 effectiveness of infiltration systems will be limited, particularly during winter months.
 This is acceptable because it mimics the pre-development conditions of sites with soils
 that drain poorly.
- Design of source control works shall be based on 50% of the Mean Annual Rainfall (MAR) 24 hour event. For the Municipality of North Cowichan, an MAR of 48mm shall be assumed, resulting in a 24 hour design rainfall of 24mm, or an average rate of 1.0mm/hr. The intention is that the source control works shall be designed to handle this rainfall amount through a combination of infiltration and detention over a 48hour period.
- Source control works shall include a detention component sized to provide a minimum storage volume based on 25% of the MAR, or 12mm, over the impermeable areas, assuming no infiltration or outflow. This equates to a storage volume of 1.2m³ for every 100m² of impervious area. For a typical residential lot with 200m² of impervious area, the works shall provide a minimum storage volume of 2.4m³.
- Unless otherwise approved, a flow controlled outlet shall be provided so that, if
 necessary, the above storage volume is drained to the piped drainage system over a 24
 hour period after the rainfall event. This equates to an outflow rate of 0.50mm/hr X the
 impervious area, or a rate of 1.4 l/s/ha from the impervious areas. For a typical

residential lot with 200m² of impervious area, the discharge rate will be 100 l/hour or 0.028 l/s. Simple orifice type flow control is not recommended for such low flow rates as the orifice diameter would only be about 5mm, which would be susceptible to plugging. As an alternative, flow control may be achieved by using an infiltration layer above an under-drain.

- The requirement for a flow controlled outlet may be waived upon submission of evidence by a Geotechnical Engineer that subsurface soil infiltration rates are adequate to handle the full design flow of 24mm of rainfall from onsite impervious surfaces over a 48 hour period. The basis for this requirement is that during the first 24 hours, half of the rainfall is infiltrated and the other half stored, then during the second 24 hours, the stored rainfall is infiltrated. This equates to an infiltration rate of 0.50mm/hr X the impervious area. For a typical residential lot with 200m² of impervious area, 100 l/hr will need to be infiltrated into the soil. For a typical infiltration system with 10m² of area, an average infiltration rate of 10mm/hr will need to be sustained over a 48 hour period.
- The above measures should result in a theoretical combined discharge of 1.0 l/s/ha from the permeable and impermeable areas of a typical 600m² lot for a 50% MAR event
- Infiltration chambers shall typically occupy an area equal to about 5% of the site impervious area. For a residential lot with 200m² of impervious area, the infiltration chamber works will occupy an area of about 10m² or 3.0mx3.0m.
- Rain gardens shall typically occupy a minimum area equal to about 10% of the site impervious area. For a residential lot with 200m² of impervious area, the rain garden will occupy an area of about 20m². To meet the storage requirement outlined above, a ponding depth of 150mm will be typical.
- Alternate designs meeting the requirements outlined above will be considered on a case by case basis.

Other Considerations:

- Subsurface infiltration systems are preferred by the Municipality for single family residential lots, as they have lower maintenance requirements and a smaller footprint than surface systems such as rain gardens.
- Where soil conditions are poor for subsurface infiltration, rain gardens are a good alternative, as their larger area supports lower infiltration rates, and shallow depth is suited to areas with a high water table. The ability to combine rain gardens with site landscaping makes them well suited to many multifamily and commercial sites.

Schedule 5 DP000256 Core (Group Rainwater Management Plan (35 pages)
APPENDIX D	Stormwater flows and Detention Calculations and typical
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Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA A

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20
A 2.29 ha
N 0.00278
tc 40.00 min
I-5yr 18.98 mm/hr

Q 5yr-pre dev 0.024 cu.m./s (Q 5 Pre Dev)

II. Detention Volume Calculation: (For Q 5)

Q rel = 0.024 cu.m/s
R = 0.55
SAF = 1.0
A = 2.29 ha
Tc = 10.00 min
I 5yr = 35.42 mm/hr
Qp1 = 0.1240 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 5yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	35.42	0.124	74.422	0.024	59.92
2	15	29.52	0.103	93.014	0.024	71.54
3	20	25.93	0.091	108.960	0.024	80.47
4	30	21.61	0.076	136.181	0.024	93.58
5	40	18.98	0.066	159.526	0.024	102.74
6	50	17.17	0.060	180.357	0.024	109.35
7	60	15.82	0.055	199.380	0.024	114.12
8	120	11.58	0.041	291.910	0.024	120.79
9	240	8.48	0.030	427.381	0.024	83.82

Therefore, 121m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA A

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 2.29 ha N 0.00278 tc 40.00 min I-10yr 23.73 mm/hr

Q 10yr-pre dev 0.030 cu.m./s (Q 10 Release Rate)

II. Detention Volume Calculation: (For Q 10)

Q rel = 0.030 cu.m/s
R = 0.55
SAF = 1.0
A = 2.29 ha
Tc = 10.00 min
I 10yr = 44.28 mm/hr
Qp1 = 0.1550 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 10yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	44.28	0.155	93.027	0.030	74.90
2	15	36.90	0.129	116.268	0.030	89.43
3	20	32.42	0.113	136.199	0.030	100.59
4	30	27.01	0.095	170.226	0.030	116.97
5	40	23.73	0.083	199.408	0.030	128.43
6	50	21.46	0.075	225.446	0.030	136.68
7	60	19.77	0.069	249.225	0.030	142.65
8	120	14.47	0.051	364.887	0.030	150.99
9	140	13.50	0.047	397.173	0.030	147.41

Therefore, 151m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA A

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 2.29 ha N 0.00278 tc 40.00 min I-25yr 28.48 mm/hr

Q 25yr-pre dev 0.036 cu.m./s (Q 25 Release Rate)

II. Detention Volume Calculation: (For Q 25)

Q rel = 0.036 cu.m/s
R = 0.55
SAF = 1.0
A = 2.29 ha
Tc = 10.00 min
I 200yr = 53.14 mm/hr
Qp1 = 0.1861 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 25yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	53.14	0.186	111.632	0.036	89.88
2	15	44.27	0.155	139.521	0.036	107.32
3	20	38.90	0.136	163.439	0.036	120.71
4	30	32.41	0.113	204.271	0.036	140.37
5	40	28.48	0.100	239.289	0.036	154.11
6	50	25.75	0.090	270.535	0.036	164.02
7	60	23.73	0.083	299.070	0.036	171.18
8	70	22.14	0.078	325.532	0.036	176.23
9	80	20.85	0.073	350.340	0.036	179.59
10	90	19.77	0.069	373.786	0.036	181.58
11	100	18.85	0.066	396.087	0.036	182.41
12	110	18.06	0.063	417.403	0.036	182.23
13	120	17.37	0.061	437.864	0.036	181.19

Therefore, 182m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA A

Location: 9090 Trans-Canada Hwy

A. SITE AREA A

I. Pre-development Flows:

Q 200yr-pre dev 0.048 cu.m./s (Q 200 Release Rate)

II. Detention Volume Calculation: (For Q 200)

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 200yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	70.85	0.248	148.843	0.048	119.84
2	15	59.03	0.207	186.028	0.048	143.09
3	20	51.86	0.182	217.919	0.048	160.94
4	30	43.21	0.151	272.361	0.048	187.15
5	40	37.97	0.133	319.052	0.048	205.48
6	50	34.34	0.120	360.713	0.048	218.69
7	60	31.63	0.111	398.760	0.048	228.24
8	120	23.16	0.081	583.819	0.048	241.58
9	240	16.95	0.059	854.762	0.048	167.63

Therefore, 242m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA B

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20
A 1.36 ha
N 0.00278
tc 40.00 min
I-5yr 18.98 mm/hr

Q 5yr-pre dev 0.014 cu.m./s (Q 5Release Rate)

II. Detention Volume Calculation: (For Q 5)

Q rel = 0.014 cu.m/s
R = 0.55
SAF = 1.0
A = 1.36 ha
Tc = 10.00 min
I 5yr = 35.42 mm/hr
Qp1 = 0.0737 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 5yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	35.42	0.074	44.198	0.014	35.59
2	15	29.52	0.061	55.240	0.014	42.49
3	20	25.93	0.054	64.710	0.014	47.79
4	30	21.61	0.045	80.876	0.014	55.57
5	40	18.98	0.039	94.740	0.014	61.02
6	50	17.17	0.036	107.111	0.014	64.94
7	60	15.82	0.033	118.409	0.014	67.77
8	120	11.58	0.024	173.361	0.014	71.74
9	240	8.48	0.018	253.816	0.014	49.78
10	360	7.06	0.015	317.226	0.014	10.54
11	540	5.88	0.012	396.478	0.014	(64.40

Therefore, 72m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA B

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.36 ha N 0.00278 tc 40.00 min I-10yr 23.73 mm/hr

Q 10yr-pre dev 0.018 cu.m./s (Q 10 Release Rate)

II. Detention Volume Calculation: (For Q 10)

Q rel = 0.018 cu.m/s
R = 0.55
SAF = 1.0
A = 1.36 ha
Tc = 10.00 min
I 10yr = 44.28 mm/hr
Qp1 = 0.0921 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 10yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	44.28	0.092	55.247	0.018	44.48
2	15	36.90	0.077	69.050	0.018	53.11
3	20	32.42	0.067	80.887	0.018	59.74
4	30	27.01	0.056	101.095	0.018	69.47
5	40	23.73	0.049	118.425	0.018	76.27
6	50	21.46	0.045	133.889	0.018	81.17
7	60	19.77	0.041	148.011	0.018	84.72
8	120	14.47	0.030	216.701	0.018	89.67
9	140	13.50	0.028	235.875	0.018	87.54

Therefore, 90m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA B

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20
A 1.36 ha
N 0.00278
tc 40.00 min
I-25yr 28.48 mm/hr

Q 25yr-pre dev 0.022 cu.m./s (Q 25 Release Rate)

II. Detention Volume Calculation:

(For Q 25)

Q rel = 0.022 cu.m/s
R = 0.55
SAF = 1.0
A = 1.36 ha
Tc = 10.00 min
1 200yr = 53.14 mm/hr
Qp1 = 0.1105 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 25yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	53.14	0.110	66.297	0.022	53.38
2	15	44.27	0.092	82.860	0.022	63.73
3	20	38.90	0.081	97.064	0.022	71.69
4	30	32.41	0.067	121.314	0.022	83.36
5	40	28.48	0.059	142.111	0.022	91.52
6	50	25.75	0.054	160.667	0.022	97.41
7	60	23.73	0.049	177.614	0.022	101.66
8	70	22.14	0.046	193.329	0.022	104.66
9	80	20.85	0.043	208.062	0.022	106.66
10	90	19.77	0.041	221.987	0.022	107.84
11	100	18.85	0.039	235.230	0.022	108.33
12	120	17.37	0.036	260.042	0.022	107.60

Therefore, 108 m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA B

Location: 9090 Trans-Canada Hwy

A. SITE AREA B

I. Pre-development Flows:

R 0.20
A 1.36 ha
N 0.00278
tc 40.00 min
I-200yr 37.97 mm/hr

Q 200yr-pre dev 0.029 cu.m./s (Q 200 Release Rate)

II. Detention Volume Calculation: (For Q 200)

Q rel = 0.029 cu.m/s
R = 0.55
SAF = 1.0
A = 1.36 ha
Tc = 10.00 min
1 200yr = 70.85 mm/hr
Qp1 = 0.1473 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 200yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	70.85	0.147	88.396	0.029	71.17
2	15	59.03	0.123	110.480	0.029	84.98
3	20	51.86	0.108	129.419	0.029	95.58
4	30	43.21	0.090	161.752	0.029	111.15
5	40	37.97	0.079	189.481	0.029	122.03
6	50	34.34	0.071	214.223	0.029	129.88
7	60	31.63	0.066	236.818	0.029	135.55
8	120	23.16	0.048	346.722	0.029	143.47
9	240	16.95	0.035	507.631	0.029	99.55

Therefore, 143m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA C

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20
A 1.53 ha
N 0.00278
tc 40.00 min
I-5yr 18.98 mm/hr

Q 5yr-pre dev 0.016 cu.m./s (Q 5Release Rate)

II. Detention Volume Calculation: (For Q 5)

Q rel = 0.016 cu.m/s
R = 0.55
SAF = 1.0
A = 1.53 ha
Tc = 10.00 min
I 5yr = 35.42 mm/hr
Qp1 = 0.0829 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 5yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	35.42	0.083	49.723	0.016	40.03
2	15	29.52	0.069	62.145	0.016	47.80
3	20	25.93	0.061	72.798	0.016	53.77
4	30	21.61	0.051	90.985	0.016	62.52
5	40	18.98	0.044	106.583	0.016	68.64
6	50	17.17	0.040	120.500	0.016	73.06
7	60	15.82	0.037	133.210	0.016	76.24
8	120	11.58	0,027	195.031	0.016	80.70
9	240	8.48	0.020	285.543	0.016	56.00

Therefore, 81m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA C

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.53 ha N 0.00278 tc 40.00 min I-10yr 23.73 mm/hr

Q 10yr-pre dev 0.020 cu.m./s (Q 10 Release Rate)

II. Detention Volume Calculation: (For Q 10)

Q rel = 0.020 cu.m/s
R = 0.55
SAF = 1.0
A = 1.53 ha
Tc = 10.00 min
I 10yr = 44.28 mm/hr
Qp1 = 0.1036 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 10yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	44.28	0.104	62.153	0.020	50.04
2	15	36.90	0.086	77.681	0.020	59.75
3	20	32.42	0.076	90.998	0.020	67.21
4	30	27.01	0.063	113.732	0.020	78.15
5	40	23.73	0.056	133.229	0.020	85.80
6	50	21.46	0.050	150.625	0.020	91.32
7	60	19.77	0.046	166.513	0.020	95.31
8	120	14.47	0.034	243.789	0.020	100,88
9	140	13.50	0.032	265.360	0.020	98.49

Therefore, 101m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA C

Location: 9090 Trans-Canada Hwy

A. SITE

I. Pre-development Flows:

R 0.20 A 1.53 ha N 0.00278 tc 40.00 min I-25yr 28.48 mm/hr

Q 25yr-pre dev 0.024 cu.m./s (Q 25 Release Rate)

II. Detention Volume Calculation:

(For Q 25)

Q rel = 0.024 cu.m/s
R = 0.55
SAF = 1.0
A = 1.53 ha
Tc = 10.00 min
I 200yr = 53.14 mm/hr
Qp1 = 0.1243 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 25yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	53.14	0.124	74.584	0.024	60.05
2	15	44.27	0.104	93.217	0.024	71.70
3	20	38.90	0.091	109.197	0.024	80.65
4	30	32.41	0.076	136.478	0.024	93.78
5	40	28.48	0.067	159.874	0.024	102.96
6	50	25.75	0.060	180.750	0.024	109.59
7	60	23.73	0.056	199.816	0.024	114.37
8	80	20.85	0.049	234.070	0.024	119.99
9	90	19.77	0.046	249.735	0.024	121.32
10	100	18.85	0.044	264.634	0.024	121.87
11	110	18.06	0.042	278.877	0.024	121.75

Therefore, 122m³ of detention volume is required for the development.

Consultant: Core Group Civil Consultants

Project No. 2087

Project: Drainage Capacity Calculations - Detention Calculation AREA C

Location: 9090 Trans-Canada Hwy

A. SITE AREA C

I. Pre-development Flows:

R 0.20
A 1.53 ha
N 0.00278
tc 40.00 min
I-200yr 37.97 mm/hr

Q 200yr-pre dev 0.032 cu.m./s (Q 200 Release Rate)

II. Detention Volume Calculation: (For Q 200)

Q rel = 0.032 cu.m/s
R = 0.55
SAF = 1.0
A = 1.53 ha
Tc = 10.00 min
1 200yr = 70.85 mm/hr
Qp1 = 0.1657 cu.m./s

Hyd No.	Rainfall Duration Tr (min)	Rainfall Intensity I 200yr (mm/hr)	Peak Flow Qp2 (cu.m./s)	Inflow Runoff Volume (cu.m.)	Max Release Qrel (cu.m./s)	Required Storage Volume (cu.m.)
1	10	70.85	0.166	99.445	0.032	80.07
2	15	59.03	0.138	124.290	0.032	95.60
3	20	51.86	0.121	145.597	0.032	107.53
4	30	43.21	0.101	181.971	0.032	125.04
5	40	37.97	0.089	213.166	0.032	137.29
6	50	34.34	0.080	241.001	0.032	146.11
7	60	31.63	0.074	266.421	0.032	152.49
8	120	23.16	0.054	390.063	0.032	161.41
9	50	34.34	0.080	241.001	0.032	146.11

Therefore, 161m³ of detention volume is required for the development.



P 604 439 0922 F 604.439.9189 geopacific.ca 1779 W 75th Ave. Vancouver, B.C. Canada V6P 6P2

March 9, 2021

File: 18529

Core Group Civil Consultants Ltd. #320 – 8988 Fraserton Court Burnaby, BC V5J 5H8

Attention: Dylan Bryson

Re: Preliminary Geotechnical Investigation Report – Proposed Modular Home Park 9090 Island Highway, Chemanius, BC

1.0 INTRODUCTION

We understand that it is proposed to develop the above referenced property with a modular home park. Preliminary concept drawings provided by CoreGroup Consultants (dated November 11, 2020) show that the development is to consist of 94 new lots with new onsite roads and utilities. We expect the modular homes will be constructed on re-inforced concrete slabs with relatively light loading.

This report presents the results of a geotechnical investigation of the soil and groundwater conditions at the site and makes preliminary recommendations for the design and construction of the proposed development. The report has been prepared exclusively for Core Group Civil Consultants, for their use, and the use of others on their design team.

2.0 SITE DESCRIPTION

The site is located in the Town of Chemanius, with the civic address of 9090 Island Highway. The site is triangular in shape and measures approximately 10 hectares in gross area. The site is bounded by The Island Highway to the east, a farm to the north, a forested area to the south, and an existing campground to the west. The site is presently unimproved and covered in a thick forest. The southern part of the site has been previously cleared and stripped. The site is at the top of a hill and slopes down to the northwest and south from the centre.

The location of the site with respect to the surroundings is shown on our Drawing No. 18529-01, following the text of this report.

3.0 FIELD INVESTIGATION

The subsurface ground conditions were investigated on February 23 and 24, 2021 using a track mounted excavator. A total of 22 Test Pits (TP) were excavated across the site between 0.8 m and 3.5 m below current site grades. Within two of the test pits, infiltration tests were completed in order to determine the infiltration potential of the native soils. Prior to our investigation, a BC one call was placed and a utility locate was completed by Municon West Coast to scan and clear any underground utilities. The investigation was supervised by a technician from our office who logged and sampled the soils encountered. All test pits were backfilled in accordance with provincial abandonment requirements following classification, sampling and logging.

The test pit logs are presented in Appendix A and the location of the test pits are shown on our Drawing 18529-01, following the text of this report.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Conditions

The surficial geology in the area of the development site in Map 2013-NVI-1-1 by GeoScience BC is described as being comprised of quaternary cover, consisting of alluvium, glaciofluvial gravels and sand, and till.

The subsurface soil conditions encountered at the test pit locations generally consist of organic soil, overlying sand to sand gravel to silty sand, then till-like soils to the final depth of our investigation. Bedrock outcrops were encountered at the west side of the site. Detailed subsurface soil conditions can be found below.

TOPSOIL

The majority of the site is covered in topsoil and is up to 0.8 m thick. The southern part of the site has been previously cleared and stripped at the time of our investigation. No topsoil was observed in TP21-11, TP21-19 to TP21-22.

FILL

Fill was encountered in TP1-12 to a depth of 1.2 m below current site grades. The fill consisted of sand and gravel, some roots, and was noted to be compact, moist, and brown in colour.

SANDY SILT TO SAND AND GRAVEL

The sandy silt to sand and gravel was observed underlying the topsoil and fill. The material was observed up to 3.5 m below current site grades. The material was noted to be stiff and very dense, moist to wet, and reddish brown to grey in colour. The sandy silt to sand and gravel was observed to the final depth of our investigation in the majority of the test pits.

TILL-LIKE SOILS

The sandy silt to sand and gravel is underlain by till-like soils consisting of silty sand and gravel. The till-like soil is very dense, moist, and grey in colour. The till-like soil was observed at the surface of TP21-20. The till-like soil was observed to the final depth of our investigation in TP21-03, and TP21-19 to TP21-22.

4.2 Groundwater Conditions

The static groundwater table was not encountered during the investigation. Some perched groundwater is expected to occur on the boundary of the till-like soils. Perched groundwater levels are expected to vary seasonally with generally higher level following sustained precipitation.

4.3 Infiltration

The infiltration rate of the native soil at DRIT21-01 and DRIT21-02 was variable due to the different soil conditions encountered. The results of the infiltration testing show that the unfactored infiltration rate is 8.4 mm/hr and 166 mm/hr.

5.0 DISCUSSION

Preliminary concept drawings show that the development is to consist of 94 new lots for modular homes, with new onsite roads and utilities. We understand cut and fills will be utilized to soften the site grades.

We expect the modular homes will be founded on concrete pads bearing on suitable native soils and/or engineered fill. Our recommended minimum stripping depths and recommendations for site preparation are provided in Section 6.1. The subsurface soils are not expected to be prone to liquefaction or other forms of ground softening under the design earthquake defined under the 2018 British Columbia Building Code.

Once the final grading plan has been provided to GeoPacific and the site has been cleared and stripped of all organic or deleterious material, we recommend to complete a secondary investigation of the site to determine the soil and groundwater conditions below the proposed cut elevations, especially in the north and central parts of the site where preliminary excavation depths are proposed to be over 3.5 m to achieve grades.

We expect some blasting may be required in the areas where bedrock is present. The bedrock was encountered within 0.3 m of the surface and was daylighting in some areas.

We confirm, from a geotechnical point of view, that the proposed development is feasible provided the recommendations outlined in Sections 6.0 are incorporated into the overall design.

6.0 RECOMMENDATIONS

6.1 Site Preparation

Preliminary grading plans have been provided, indicating a maximum cut and fill of approximately 7.7 m and 9.2 m, respectively. We expect the material in the areas of cuts would be re-used in the areas of fill to flatten the site grades, however, consideration will need to be given to the time of year and level of effort required as discussed below.

Prior to construction of foundations, floor slabs, or on-site roads, all vegetation, topsoil, other organic material, debris, unsuitable fills, refuse and loose or otherwise disturbed soils must be removed from the construction areas to expose a subgrade of compact silty sand, compact to dense sand to sand and gravel, stiff sandy silt or dense till-like soils. Our minimum stripping depths for concrete slabs and roads are provided in Table 1 below.

Table 1: Recommended Minimum Stripping Depths

Location	Stripping Depth (m)	Location	Stripping Depth (m)
TP21-01	0.2	TP21-12	0.1
TP22-02	0.2	TP21-13	0.8
TP23-03	0.2	TP21-14	0.3
TP21-04	0.2	TP21-15	0.2
TP21-05	0.4	TP21-16	0.3
TP21-06	0.3	TP21-17	0.3
TP21-07	0.6	TP21-18	0.1
TP21-08	0.5	TP21-19	0.1
TP21-09 0.8		TP21-20	0.1
TP21-10	0.2	TP21-21	0.1
TP21-11	0.1	TP21-22	0.1

The stripping depths provided in Table 1 are our <u>minimum</u> stripping depths at each of our test pit locations. It should be appreciated that the depth of stripping can vary across the site. For example where stands of trees are present, stripping depths may be deeper to remove organic constituents.

Where the depth of stripping exceeds proposed subgrade depth the footings may be supported on "engineered fill". Engineered fill is defined as clean sand to sand and gravel compacted in 300 mm loose lifts to a minimum of 95% Modified Proctor (ASTM D1557) dry density at a moisture content within 2% of optimum for compaction.

We expect the native granular and non-organic soils could be reused as engineered fill in the dryer months of the year, however, some moisture conditioning may be required to achieve optimum moisture content, prior to placement and compaction. All silty materials including the sandy silt, till and silty sands could require substantial drying prior to compaction in place.

Stripping should extend out beyond the building envelopes and pavement structures at a distance equal to the thickness of proposed engineered fill beneath the buildings and pavement structures. For example, if 1 metre of engineered fill will underlie a footing then stripping should extend a minimum distance of 1 metre beyond the outer edge of that footing.

Stripping is not required in landscaped areas unless the criteria stated in the previous paragraph requires the removal of that material.

It is very important that the stripped subgrades be protected through each construction phase. Any softened or disturbed portions of the subgrade should be removed and replaced with engineered fill in all foundation, slabs on grade, and pavement areas.

6.2 Concrete Pad Foundations

We expect the modular homes will be supported on concrete pads. Concrete pads which are founded on engineered fill, stiff to very stiff sandy silt, compact to dense silty sand to sand and gravel, or very dense till-like soils as described in Section 4.1, may be designed on the basis of a Serviceability Limit States

(SLS) bearing pressure of 100 kPa. Factored Ultimate Limit States (ULS) bearing pressure may be taken as 1.5 times greater than the Serviceability Limit States pressures.

We estimate for concrete slabs designed as recommended settlements will not exceed 25 mm total and 20 mm in 10 metres differential.

Adjacent concrete slabs constructed at differing elevations should be offset from each other by a minimum distance of twice the difference in elevation (2:1 Horizontal to Vertical). For example, two concrete slabs separated by 1 metre in elevation should be offset horizontally from each other by a minimum distance of 2 metres as measured from the inside edges of those slabs. Slabs constructed within 2:1 of each other may impose additional vertical and horizontal forces. GeoPacific should review layouts which do not achieve the minimum 2:1 offset.

All foundation subgrades should be protected using a 150 mm thick layer of 19 mm clear crush gravel.

Foundation subgrades of all buildings must be reviewed by a geotechnical engineer prior to footing construction.

6.3 Seismic Design of Concrete Pads

The subgrade conditions underlying the site may be classified as "Site Class C" in accordance with Table 4.1.8.4.A. of the 2018 British Columbia Building Code (BCBC). Peak ground acceleration on firm ground for the approximate site location is 0.49 g (Natural Resources Canada, Site Coordinates: 48.899 North, 122.719 West). We do not expect any of the soils used to support any structures to be prone to liquefaction or stain softening during cyclic loading caused by the design earthquake defined in the 2018 BCBC.

6.4 Utility Installation

We recommend that any trenches be sloped or shored as per the latest Work Safe BC regulations. We recommend that all service trenches be backfilled with clean granular material, which conforms to municipal standards, compacted to 95% "Modified Proctor" dry density (ASTM D1557), with a moisture content within 2% of optimum for compaction. If for any reason the backfill becomes saturated prior to compaction it must be removed and replaced with dry fill.

We anticipate that any groundwater seepage would be moderate initially, but will likely decrease with time. Excavations within the till-like soils may experience relatively light seepage. We envisage seepage may be handled with conventional sumps and sump pumps.

6.5 Temporary Excavations

Temporary excavations can be sloped at 1 horizontal to 1 vertical (1H:1V) in the native soils provided that the slopes are covered in poly sheeting to prevent erosion of the slope face. All topsoil, fill and loose soils should be benched back at a distance equal to the thickness of these materials. Temporary cut slopes in excess of 1.2 metres in height require inspection by a professional geotechnical engineer in accordance with WorkSafeBC guidelines, prior to worker entry.

Light to moderate seepage during the wetter months should be expected due to the formation of perched water tables. We expect that inflows may be handled with sumps and sump pumps.

6.6 Stormwater Management

Two infiltration tests were performed on the proposed development site to help aid in the septic system design. The tests were completed at 1.6 m and 1.8 m below current site grades in dense sand and gravel to stiff silt and sand. Unfactored infiltration rates are presented in Table 2 below. Detailed results are presented in Appendix B following the text of this report,

Table 2: Infiltration Rates

Location	Test Depth (m)	Infiltration Rate (mm/hr)
DRIT21-01	1.8	166
DRIT21-02	1.6	8.4

All subgrade soil beneath stormwater management systems that rely on natural infiltration should be reviewed by the geotechnical engineer prior to construction.

6.7 Payement Structures for On-Site Roads

6.7.1 Site Preparation for On-Site Roads

Following the recommended site preparation the stripped pavement structure subgrade should be reviewed by the geotechnical engineer. Subgrades of any loose material, if encountered should be compacted using a large vibratory roller and proof rolled under the review of the geotechnical engineer to locate any soft or loose zones. Where existing soils are soft/loose and cannot be recompacted to a minimum of 95% Modified Proctor dry density (ASTM D1557) they must be excavated and replaced with engineered fill. All base and subbase fills should be compacted to a minimum of 95% Modified Proctor dry density with a moisture content within 2% of optimum for compaction.

Density testing should be conducted by the geotechnical engineer on these materials to confirm compaction specifications have been achieved.

6.7.2 New Pavement Structures Recommendations

We expect that the new development would include new road construction for the interior access roads. Following the recommended site preparation, we expect the pavement structure, as shown in Table 2 for on-site roads is sufficient to carry the anticipated vehicle loads.

Table 2: Recommended Minimum On-Site Pavement Structure

Material	Thickness (mm)	CBR	
Asphaltic Concrete (surface course)	75	N/A	
19 mm minus crushed aggregate base course	100	80	
75 mm minus, well graded, clean sand and gravel sub-base course	200	20	

Pavement structure fills should be durable, uniform in quality, and have a minimum of 60% fractured faces as per ASTM D5821. The base aggregate shall consist of MMCD Granular Base and have a minimum soaked California Bearing Ratio (ASTM D1883) of 80 at 95% Modified Proctor Dry Density. The subbase

shall consist of Crushed Granular Sub-base and have a minimum soaked California Bearing Ratio of 20 at 95% Modified Proctor Dry Density.

New fill materials should be placed in maximum 300 mm loose lifts and compacted to 95% Modified Proctor Dry Density (ASTM D1557).

Density and CBR testing should be conducted by the geotechnical engineer to confirm that the material and densification standard have been achieved.

6.8 Slope Stability

The majority of the site is sloping at a gentle to moderate angle, except the south and west sides where the gradient is up to approximately 1.5H:1V. We also understand that significant cut and fills will be utilized to soften the site grades. GeoPacific must be provided with a detailed and finalized grading plan such that slope stability can be evaluated under the guidelines for LLA in BC (May 2010). For preliminary design purposes, we recommend all fills have a final slope of 2.5H:1V and that all setbacks for any concrete pads or other structures have a minimum setback of 2H:1V from the toe of all slopes.

7.0 DESIGN REVIEWS AND CONSTRUCTION INSPECTIONS

The preceding sections make recommendations for the design and construction for the proposed residential development and related earthworks. We have recommended the review of certain aspects of the design and construction. It is important that these reviews are carried out to ensure that our intentions have been adequately communicated. It is also important that any contractors working on the site review this document prior to commencing their work.

It is the responsibility of the contractor to contact GeoPacific a minimum of 48 hours in advance to notify us that a field review is required. In summary, field reviews are required for the following aspects of the work:

- 1. Review of site stripping
- 2. Review of foundation subgrade prior to concrete pad construction
- 3. Review of any native materials intended for re-use prior to placement as engineered fill
- 4. Review of engineered fill materials and compaction
- 5. Review of excavations in excess of 1.2 metres in height requiring worker entry

8.0 CLOSURE

This report has been prepared exclusively for our client for the purpose of providing geotechnical recommendations for the design and construction of the new buildings foundations, foundation walls, and related earthworks. The report remains the property of GeoPacific Consultants Ltd. and unauthorized use of, or duplication of, this report is prohibited.

We are pleased to be of assistance to you on this project and we trust that our comments and recommendations are both helpful and sufficient for your current purposes. If you would like further details or would like clarification of any of the above, please do not hesitate to call.

For:

GeoPacific Consultants Ltd.

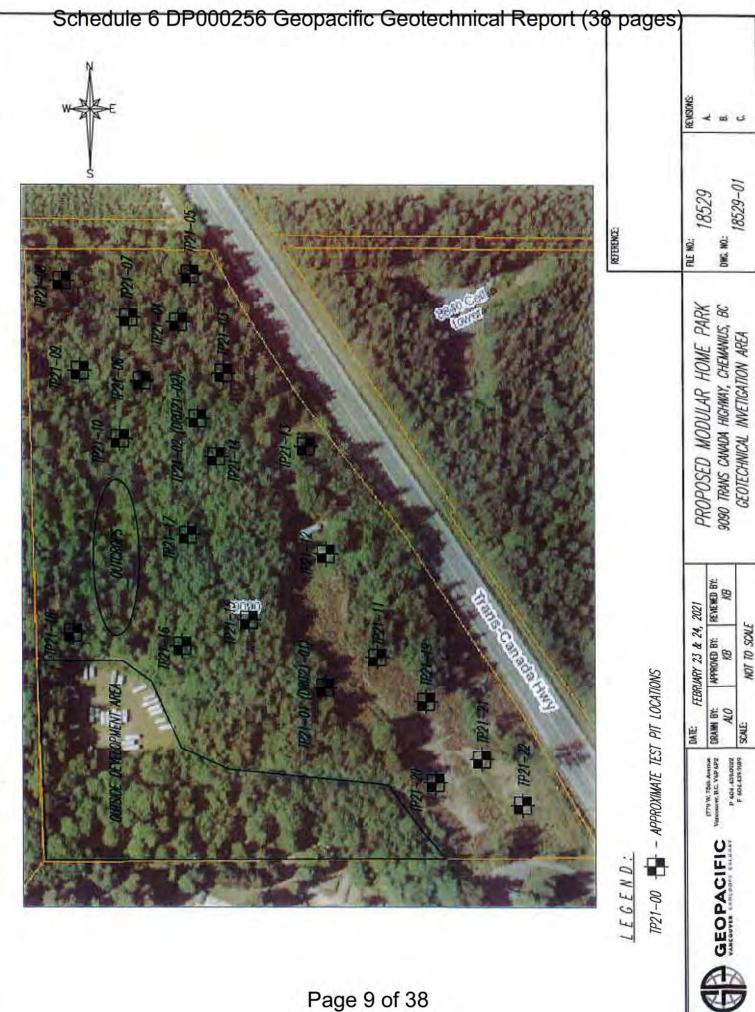
7

Reviewed By:

MAR 1 0 2021

Austin Lockstidt, B.A.Sc., EIT Engineer In Training

Kevin Bodnar, M.Eng., P.Eng. Principal



APPENDIX A – TEST PIT LOGS

Test Pit Log: TP21-01 (DRIT21-01)

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE		9		
Depth	SOIL DESCRIPTION		Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
ft m		Ground Surface				
Ŧ	2	Organic Soil	0.0	1		
		Sand And Gravel Medium grained sand and gravel, compact, moist, light brown. Becomes dense and grey at 0.8 m.	0.2	8.3%		
- 2		Becomes very dense at 2.0 m.	2.3	8.1%		Infiltration rate of 166.0 mm/hr at 1.8 m.
1114111		End of Test Pit	2.5			
7-3						4

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.1

Test Pit Log: TP21-02 (DRIT21-02)

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE		9		
Depth	SOIL DESCRIPTION		Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
oft m		Ground Surface				
1-	13 J	Sand Fine grained sand, some silt, trace rootlets, compact, moist, reddish brown. Seepage at 0.9 m.	0.0			
4-1		Fine grained sand and silt, stiff, moist, mottled grey to tan.	1.8	14.0%		Infiltration rate of 8.4 mm/hr at 1.6 m.
7		End of Test Pit	1.0			

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.2

Test Pit Log: TP21-03

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

	INFERRED PROFILE		9		
Depui	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
m _	Ground Surface				
~	Organic Soil	0.0			
	Sand Fine grained sand, some silt, trace roots up to 50 mm in diameter, compact, moist, reddish brown.	0.2			
-1	Sand And Silt Fine grained sand and silt, stiff, moist, light grey. Seepage at 1.3 m.	0.8	17.2%		
	Silty Sand and Gravel (Till-Like) Silty sand and gravel, very dense, moist, light brown. End of Test Pit	2.2	11.5%		

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.3

Test Pit Log: TP21-04

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

3.5		INFERRED PROFILE		(%		
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
oft m		Ground Surface				
	lyl	Organic Soil	0.0			
1-		Silty Sand Fine grained silty sand, compact, moist, tan.	0.2			
2-		Sand Fine grained sand, some silt, some gravel, dense, moist, tan.	0.4			
3-		Seepage at 1.0 m.				
4				13.5%		
5-		Becomes very dense at 1.6 m.				
6-		End of Test Pit	1.8			

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.4

Test Pit Log: TP21-05

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE		(%)	170	
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Moisture Content (* Groundwater	Remarks
oft m		Ground Surface				
1-	lllllll	Organic Soil	0,0			
2-	7	Sand Fine grained sand, some silt, some gravel, compact, moist, tan.	0.4			
3-1		Some roots at 1.0 m. Becomes very dense at 1.2 m.		23.1%		
4-7		Decomes very dense at 1.2 m.				
1	2233333	End of Test Pit	1.6	15.4%		
6-		End of Test Fit				

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.5

Test Pit Log: TP21-06

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE		9		
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
ft m		Ground Surface				
	$l_l l_l l_l$	Organic Soil	0.0			
1-	7	Sand Fine grained sand, some silt, compact, moist, tan.	0.3			
1				25.9%		
3-		Silty Sand Fine grained silty sand, some gravel, dense, moist, tan.	0.6			
4-		Becomes very dense at 1.2 m.				
1				20.8%		
5-1-1-1-6-		End of Test Pit	1.4			

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.6

Test Pit Log: TP21-07

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

42		INFERRED PROFILE		9		
Depth	Symbol		Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
oft m		Ground Surface	0.0			
3-1-1		Sandy Silt Sandy silt, stiff, moist to wet. mottled grey to tan.	0.6	27.6%		
5		Becomes very stiff at 1.7 m. End of Test Pit	1.8	22.3%		

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.7

Test Pit Log: TP21-08

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

	INFERRED PROFILE		(%			
Depth Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks	
m _o	Ground Surface					
llllll	Organic Soil	0.0				
- \(\)	Silty Sand Fine grained silty sand, compact, moist, grey.	0.5	34.1%			
-1	Sandy Silt Sandy silt, stiff, mosit, brown.	0.8				
	Seepage at 0.9 m.					
	Becomes very stiff at 1.8 m.		27.3%			
-2	End of Test Pit	2.0				

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.8

Test Pit Log: TP21-09

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE		<u>@</u>		
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
oft m		Ground Surface	0.0			
3-1-1		Sand Fine grained sand, some silt, some gravel, dense, mosit, grey. Refusal on large rock at 1.3 m.	0.8	38.0%		
5		End of Test Pit	1.3			

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.9

Test Pit Log: TP21-10

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE	_	98	1011		
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks	
ft m		Ground Surface	-				
	3/3/	Organic Soil	0.0				
		Sand Medium grained sand, some gravel, compact, moist, brown.	0,2				
1				15.2%			
2-7		Silty Sand Fine grained silty sand, some gravel, dense, mosit, grey.	0.5				
4		Becomes very dense at 1.3 m.		13.5%	-1-		
+	*******	End of Test Pit	1.4	10.070			
5-							

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 23, 2021

Datum: GROUND SURFACE

Figure Number: A.10

Test Pit Log: TP21-11

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

	, ,	INFERRED PROFILE		(%)		
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
oft m		Ground Surface				
3 -1 1 4 -1 1 6 -1 6 -1		Sand Medium grained sand, some gravel, compact to dense, moist, brown. Seepage at 1.4 m.	0.0	20.1%		
7-2		Silty Sand Fine grained silty sand, very dense, moist, brown.	1.9	17.0%		
8-1		End of Test Pit				

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.11

Test Pit Log: TP21-12

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE		9		
Depth		SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
ft m		Ground Surface			T 117	
-	2	Organic Soil	0.0			
3-1-1		Sand And Gravel (Fill) Sand and gravel fill, compact, trace roots, moist, brown.				
5-		Sand Medium grained sand, some gravel, dense, moist, grey.	1,2	11.7%		
6-		End of Test Pit	1.7			

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.12

Test Pit Log: TP21-13

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE	-	(%		
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
ft m		Ground Surface			1	
	llflflflflflflf	Organic Soil Sand Medium grained sand, trace gravel,	0.0			
		compact, mosit, light grey. Seepage at 1.2 m.	17			
3-2		Silty Sand Fine grained silty sand, compact to dense, moist, mottled tan to grey.	1.7	28.7%		
7-1		Becomes very dense at 2.1 m.			1	
8-		End of Test Pit	2.2			

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.13

Test Pit Log: TP21-14

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE	-	<u>@</u>		
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
ft m	4	Ground Surface				
1	ll	Organic Soil	0.0			
+	2			1		
1- 2- 3- 1-1		Sand Medium grained sand, trace gravel, some roots, moist, reddish brown. Becomes dense and brown at 0.6 m.	0.3	24.6%		
5-		Some silt at 1.6 m.				
3				/		
-2 7-		Becomes very dense at 2.0 m.		28.1%		
7	*******	End of Test Pit	2.2			
1						

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.14

Test Pit Log: TP21-15

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE				(Q)	100		
Depth	Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks	
oft m		Ground Surface	0.0		777		
4	li	Organic Soil	0.0				
	\{\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Sand And Gravel Sand and gravel, dense, moist, light brown.	0.2				
2-7			0.9	13.7%			
1-1		Sand Medium grained sand, some gravel, very dense, moist, light brown.	0.5				
5-		End of Test Pit	1.2				
6-1							

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.15

Test Pit Log: TP21-16

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE			· @			
Depth Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks	
ft m	Ground Surface					
100	Organic Soil	0.0				
1 2	4	0.3				
÷ 1	Sand Medium grained sand, some roots, compact, moist, reddish brown. Becomes dense and grey at 0.9 m.	0.3				
			13.5%			
-2	Seepage at 2.2 m.	1 J - V				
	Silty Sand Fine grained silty sand, very dense, moist, grey.	2.2	28.5%			
4	11:3					

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.16

Test Pit Log: TP21-17

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

	INFERRED PROFILE			. 0		
Ceptin	Symbol	SOIL DESCRIPTION	SOIL DESCRIPTION Oepth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
m		Ground Surface	1 (2 3		+	
- 0	13	Organic Soil	0.0			
		Sand Medium grained sand, some roots, compact, moist, reddish brown.	0.3			
-1		Sand Medium grained sand, some gravel, dense, moist, brown. Seepage at 1.6 m.	1.0	21.3%		
- 2		Silty Sand Fine grained silty sand, dense to very dense, moist, grey.	1.8			
-3			Ē			
			3.5	22.6%		
		End of Test Pit	3.5	1		

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.17

Test Pit Log: TP21-18

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE			(%		
Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
m ₀	Ground Surface	_1/2_24	771	Fall.	
المارا	Organic Soil	0.0			
	Sand Medium grained sand, some roots, compact, moist, reddish brown. Becomes light brown at 0.4 m.	0.1	31.8%		
	End of Test Pit	0.8			

Logged: ALO

Method: MANUALLY EXCAVATED

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.18

Test Pit Log: TP21-19

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE			· (%)		
Symbol	SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%	Groundwater	Remarks
	Ground Surface	150	75.95		
	Sand Medium grained sand, some gravel, dense, moist, brown.	0.0			
٠.	Silty Sand And Gravel (Till-like)	0.7			
	Silty sand and gravel, very dense, moist, grey.		7.4%		
5.7133633	End of Test Pit	1.0			
	Symbol	Soil Description Ground Surface Sand Medium grained sand, some gravel, dense, moist, brown. Silty Sand And Gravel (Till-like) Silty sand and gravel, very dense,	SOIL DESCRIPTION Ground Surface Ground Surface Sand Medium grained sand, some gravel, dense, moist, brown. Silty Sand And Gravel (Till-like) Silty sand and gravel, very dense, moist, grey.	SOIL DESCRIPTION Ground Surface Sand Medium grained sand, some gravel, dense, moist, brown. Silty Sand And Gravel (Till-like) Silty sand and gravel, very dense, moist, grey.	SOIL DESCRIPTION Ground Surface Sand Medium grained sand, some gravel, dense, moist, brown. Silty Sand And Gravel (Till-like) Silty sand and gravel, very dense, moist, grey. 7.4%

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.19

Test Pit Log: TP21-20

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax;604-439-9189

		INFERRED PROFILE		(0)		
Depth Symbol		SOIL DESCRIPTION	Depth/Elev (m)	Moisture Content (%)	Groundwater	Remarks
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		Ground Surface Silty Sand And Gravel (Till-like) Silty sand and gravel, dense, moist, grey. Becomes very dense at 1.0 m	0.0	7.9%		
5-		End of Test Pit	1.4			

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.20

Page: 1 of 1

Test Pit Log: TP21-21

File: 18529

Project: PROPOSED MODULAR HOME PARK **Client:** CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

		INFERRED PROFILE		(9)		
Depth	Symbol	SOIL DESCRIPTION		Moisture Content (%)	Groundwater	Remarks
oft m		Ground Surface			170.00	
3-1-1-5-1-5-1		Sand Medium grained sand, some gravel, dense, moist to wet, brown. Seepage at 1.0 m.	0.0	12.7%		
4						
6-	3	Silty Sand And Gravel (Till-like) Silty sand and gravel, very dense, moist, grey.	1.7			
-		End of Test Pit	1.9			

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

Figure Number: A.21

Page: 1 of 1

Test Pit Log: TP21-22

File: 18529

Project: PROPOSED MODULAR HOME PARK
Client: CORE GROUP CIVIL CONSULTANTS LTD.

Site Location: 9090 ISLAND HIGHWAY, CHEMANIUS, BC



1779 West 75th Avenue, Vancouver, BC, V6P 6P2 Tel: 604-439-0922 Fax:604-439-9189

	INFERRED PROFILE		9				
Depth	SOIL DESCRIPTION	Depth/Elev (m)	Depth/Elev (m) Moisture Content (' Groundwater		Moisture Content (%) Groundwater syland syla		Remarks
ft m	Ground Surface	0.0					
2- 3- 1- 1- 2- 3- 1-1	Sand Medium grained sand, some gravel, dense, moist to wet, brown. Seepage at 1.3 m.	0.0	12.5%				
5- 6- 7- 8-	Silty Sand And Gravel (Till-like) Silty sand and gravel, very dense, moist, grey. End of Test Pit	2.0	13.2%				

Logged: ALO

Method: EXCAVATOR

Date: FEBRUARY 24, 2021

Datum: GROUND SURFACE

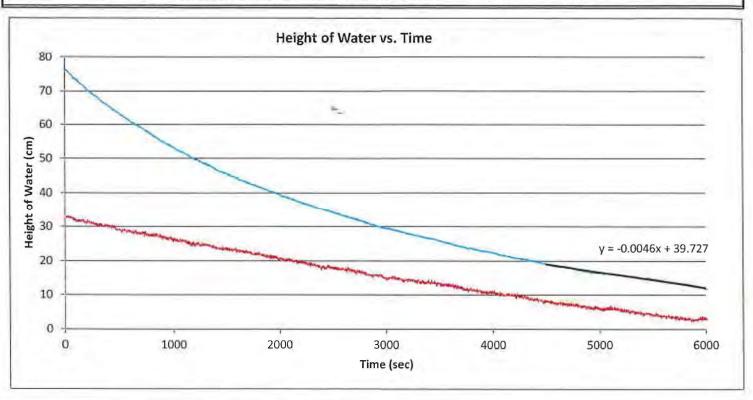
Figure Number: A.22

Page: 1 of 1

APPENDIX B – INFILTRATION RESULTS

CLIENT:	CORE GROUP CONSULTANTS LTD.	PROJECT #:	18529
PROJECT NAME:	PROPOSED MODULAR HOME PARK	DATE:	23-Feb-2021 12:00
PROJECT LOCATION:	9090 ISLAND HIGHWAY, CHEMANIUS, BC	TEST NO.:	DRIT21-01

ESTIMATED FIELD SATURATED	INFILTRATION RATE:	166.0	mm/Hr	



		TEST INFOR	RMATION			
LIQUID USED:	WATER	AREA INNER CYLINDER:	72965.63 mm ²	DEPTH OF TEST BELOW		
LIQUID pH:	7.1 ANNULAR AREA:		209777.71 mm ²	CURRENT SITE GRADE (m):	1.8	
SOIL DESCRIPTION:	SAND AND GRAVEL	CYLINDER ACCURACY:	± 0.5 mm	INFILTRATION RATE	4.611E-03	
SOIL TYPE:	NATIVE	LIQUID DEPTH INNER:	76.3 cm	(cm/sec):	4.0112-03	
WEATHER ON SITE:	CLEAR	LIQUID DEPTH OUTER:	33.2 cm	DEPTH TO WATER TABLE:	UNKNOWN	

Comments:

Per: Austin Lockstidt, B.A.Sc., EIT

Engineer In Training

Reviewed by: Jakub Szary, B.Sc., AScT

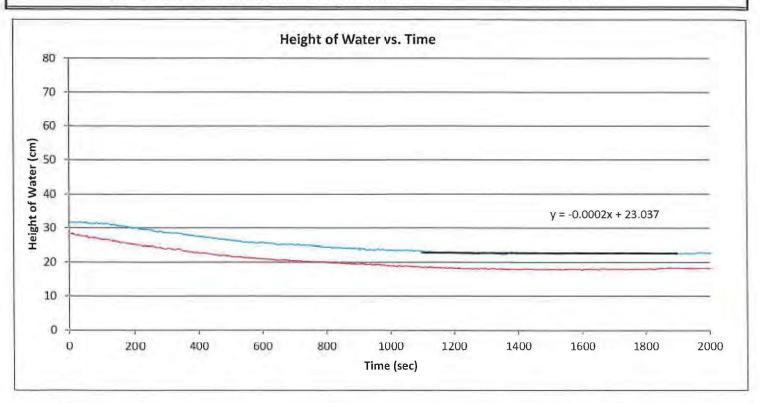
Lab Manager

256 Geografie Coeptechnical Report (381 pages) in Avenue Vancouver B.C. (ASTM D3385)

Ani Live	HUE
ancouver,	B.C
V6P	6P2

CLIENT:	CORE GROUP CONSULTANTS LTD.	PROJECT #:	18529
PROJECT NAME:	PROPOSED MODULAR HOME PARK	DATE:	23-Feb-2021 13:00
PROJECT LOCATION:	9090 ISLAND HIGHWAY, CHEMANIUS, BC	TEST NO.:	DRIT21-02

ESTIMATED FIELD SATURATED INFILTRATION RATE:	8.4	mm/Hr	



		TEST INFOR	RMATION		
LIQUID USED:	WATER	AREA INNER CYLINDER:	72965.63 mm ²	DEPTH OF TEST BELOW	
LIQUID pH:	7.1	ANNULAR AREA: 209777.71 mm ²		CURRENT SITE GRADE (m):	1.6
SOIL DESCRIPTION:	SAND AND SILT	CYLINDER ACCURACY:	± 0.5 mm	INFILTRATION RATE	2.344E-04
SOIL TYPE:	NATIVE	LIQUID DEPTH INNER:	33.7 cm	(cm/sec):	2.344E-04
WEATHER ON SITE:	CLEAR	LIQUID DEPTH OUTER:	29.2 cm	DEPTH TO WATER TABLE:	UNKNOWN

TEST WAS CONDUCTED UNTIL GROUNDWATER SEEPED INTO RNGS AT APPROXIMATELY 2000 SECONDS.

Per: Austin Lockstidt, B.A.Sc., EIT

Engineer In Training

Reviewed by: Jakub Szary, B.Sc., AScT

Lab Manager

APPENDIX C – LAB RESULTS



Vancouver Lab 1779 West 75th Avenue Vancouver, BC V6P 6P2

MOISTURE CONTENT REPORT (ASTM D2216)

CLIENT:	CORE GROUP CIVIL CONSULTANTS				JOB #:	18529	
PROJECT:	PROPOSED MODULAR HOMI	PARK			RECEIVED:	25-Feb-21	
OCATION:	9090 ISLAND HIGHWAY, CHEMAINUS		TESTED: 26-				
					REPORT #:	ì	
HOLE #:	TP21 - 01	TP21 - 01	TP21 - 02	TP21 - 03		TP21 - 03	
DEPTH:	1.2 m	2.1 m	1.2 m	1 m	11 10	2.2 m	
M/C:	8.3%	8.1%	14.0%	17.2%		11.5%	
HOLE #:	TP21 ~ 04	TP21 - 05	TP21 - 05	TP21 - 06		TP21 - 06	
DEPTH:	1.2 m	1 m	1.5 m	0.5 m		1,3 m	
M/C:	13.5%	23.1%	15.4%	25,9%		20.6%	
HOLE #:	TP21 - 07	TP21 - 07	TP21 - 08	TP21 - 08		TP21 - 09	
DEPTH:	0,9 m	1.7 m	0.6 m	1.8 m		1 m	
M/C:	27.6%	22.3%	34.1%	27.3%		38.0%	
HOLE #:	TP21 - 10	TP21 - 10	TP21 - 11	TP21 - 11		TP21 - 12	
DEPTH:	0.4 m	1,3 m	1 m	2 m	n 1.5 m		
M/C:	15.2%	13.5%	20.1%	1/.0%		11.7%	
HOLE #:	TP21 - 13	TP21 - 14	TP21 - 14	TP21 - 15		TP21 - 16	
DEPTH:	2 m	1.1 m	1.9 m	0.6 m		1.5 m	
M/C:	28.7%	24.6%	28.1%	13.7%		13.5%	
HOLE #:	TP21 - 16	TP21 - 17	TP21 - 17	TP21 - 18	3	TP21 - 19	
DEPTH:		1.5 m	3.2 m	0.6 m		0.8 m	
M/C:	28.5%	21.3%	22.6%	31.8%		7.4%	

COMMENTS: DISTRIBUTION: Austin Lockstidt, GeoPacific

Per: Cindy Marinovic, B.Sc.

Lab Technician

Reviewed By: Jakub Szary, B.Sc., AScT

Lab Manager



Vancouver Lab 1779 West 75th Avenue Vancouver, BC V6P 6P2

MOISTURE CONTENT REPORT (ASTM D2216)

CLIENT:	CORE GROUP CIVIL CONSUL		JOB #:	18529		
PROJECT:	PROPOSED MODULAR HOM	PROPOSED MODULAR HOME PARK				
OCATION:	9090 ISLAND HIGHWAY, CHE	MAINUS			TESTED:	26-Feb-21
					REPORT #:	1
HOLE #;	TP21 - 20	TP21 - 21	TP21 - 22	TP21 - 22		
DEPTH:	0.8 m	0.8 m	0.7 m	2.1 m		
M/C:	7.9%	12.7%	12.5%	13.2%		
HOLE #:						
DEPTH:						
M/C;	- 1					
HOLE #;						
DEPTH:						
M/C:						
HOLE #:	T					
DEPTH:						
M/C;	-321					
HOLE #:						
DEPTH:						
M/C:			1			
HOLE #:						
DEPTH:						
M/C:						

Per: Cindy Marinovic, B.Sc.

COMMENTS:

Lab Technician

Reviewed By: Jakub Szary, B.Sc., AScT

Austin Lockstidt, GeoPacific

Lab Manager

DISTRIBUTION:

Schedule 7 DP000256 PMG Landscape Estimate (2 pages)



May 16, 2022

Core Group Consultants 320-8988 Fraserton Court Burnaby BC

scarroll@coregroupconsultants.com

Attention: Sean Carroll

Re: PMG File No.: 22-076

Morgan Maples, 9090 Trans-Canada Highway

The following cost estimate for bonding purposes was based on our Landscape Plans dated May 16, 2022

		Size	Approximate Quantity	Unit Price	Total Price
1	Earthwork:				
	b) Topsoil (cost per m³)		100	\$ 35.00	3,500.0
2	Lawn (cost per m²)		Variable 5		-
	a) Seeded		3000	\$ 7.00	21,000.0
3	Hard Surfacing		7-5-5		377.57
	a) 3/4" Crushed Granite (per cubic m)		50	\$ 65.00	3,250.0
	b) Engineered wood fibre (per sq. m)		160	\$ 4.20	672.0
4	Fences & Walls (cost per lin. m)		-24-10-40	a - 75,3190	
	g) 6' ht chainlink fence		1300	\$ 100.00	130,000.0
5	Furnishings (itemize) installed				
	a) Bench		4	\$ 1,600.00	6,400.0
	b) Picnic table		3	\$ 3,750.00	11,250.0
	c) Balance logs		3	\$ 600.00	1,800.0
	d) Log steppers		6	\$ 400.00	2,400.0
	e) Swing set		1	\$ 4,500.00	4,500.0
6	Plant Material:				
	a) Trees				
	1) Malus 'Spring Snow'	5 cm cal.	5	\$ 250.00	1,250.0
	2) Nyssa sylvatica	5 cm cal.	9	\$ 250.00	2,250.0
	3) Acer griseum	6 cm cal.	8	\$ 300.00	2,400.0
	4) Acer rubrum 'Red Sunset'	6 cm cal	21	\$ 300.00	6,300.0
	5) Acer x freemanii 'Autumn Blaze'	6 cm cal	4	\$ 300.00	1,200.0
	6) Betula nigra 'Dura Heat'	6 cm cal.	8	\$ 300.00	2,400.0
	7) Liquidambar styraciflua 'Worplesdon'	6 cm cal.	30	\$ 300.00	9,000.0
	8) Tilia americana 'Redmond'	6 cm cal.	23	\$ 300.00	6,900.0
	9) Zelkova serrata	6 cm cal.	31	\$ 300.00	9,300.0
	10) Cornus mas	2 m ht.	6	\$ 180.00	1,080.0
	11) Chamaecyparis nootkatensis 'Pendula'	2 m ht.	4	\$ 200.00	800.0
	12) Abies grandis	2.5 m ht.	7	\$ 220.00	1,540.0
	13) Pseudotsuga menziesii	3 m ht.	9	\$ 330.00	2,970.0
	14) Pinus sylvestris	3.5 m ht.	6	\$ 260.00	1,560.0
	b) Shrubs / Groundcovers				
	Lupinus polyphyllus	#1 pot	26	\$ 5.00	130.0
	2) Mahonia nervosa	#1 pot	49	\$ 5.00	245.0
	3) Ceanothus 'Victoria'	#2 pot	18	\$ 10.00	180.0
	4) Holodiscus discolor	#2 pot	7	\$ 10.00	70.0
	5) Ribes sanguineum	#2 pot	16	\$ 10.00	160.0
	6) Rosa nutkana	#2 pot	30	\$ 10.00	300.0
	c) Installation			50%	25,017.5
7	Mulch (cost per m³)				
	a) Bark mulch		20	\$ 39.00	780.0

Schedule 7 DP000256 PMG Landscape Estimate (2 pages)

		TOTAL	\$ 260,604.50
		Total for 7	780.00
		Total for 6	75,052.50
		Total for 5	26,350.00
		Total for 4	130,000.00
		Total for 3	3,922.00
		Total for 2	21,000.00
8	Totals	Total for 1	3,500.00

Please note that this is only an estimate, and is subject to change due to economic conditions, availability of materials, and actual site conditions at the time of construction.

Yours truly,

Scott Archer

PMG Landscape Architects Ltd.

Reviewed By: Mary Chan Yip

Schedule 8 DP000256 Fire Truck Turnaround Plan (2 pages) MORGAN MAPLES VEHICLE TURNING MOVEMENTS RECREATION AREA # 1 🖖 SEPTIC FIELD # 1 39 5 VEHICLE TURING MOVEMENT PATH (FIRE TRUCK) 6 DISTRICT OF NORTH COWICHAN **GRAPHIC SCALE** LAND DEVELOPMENT SERVICES SCALE: 1:250 320-8988 FRASERTON COURT BURNABY, BC V5J 5H8 tel. (604)299 0605 fax. (604)299 0629 Permit To Practice No. 1001017 (BC) Page 1 of 2

October 24,2022 PROJECT: 2087

Municipality of North Cowichan 7030 Trans Canada Highway Duncan, BC V9L 6A1

TO: Glenn Morris, MCIP, RPP

RE: 9090 Trans Canada Highway Prospero # DP000256; Folio # 15038-000

Response to Email dated October 18, 2022

We are writing to respond to your email dated October 18, 2022 in reference to the Emergency Vehicle Access that will be provided for this project.

We wish to confirm the following:

- a) All internal private roads will be designed in accordance with the District of North Cowichan's (DNC) Local Road Standards and Specifications and will support Fire Truck loading;
- b) All internal Private roads will have a clear width of 6 metres;
- c) Turnarounds for Emergency Vehicles will be provided per the requirements of NFPA 1141 and dimensions of the turnarounds will meet the DNC Local Road specifications;
- d) The "Emergency Vehicle setup and operational dimensions" as attached to your email, dated October 18, 2022 will be provided in the design;
- e) All works will also meet the BC Building Code for Access Routes for Firefighting.

We trust that the above meets with your requirements, however, should you require any additional information or clarification please do not hesitate in contacting me.

Yours truly,

CORE GROUP CIVIL CONSULTANTS LTD

Permit to Practice: # 1001017(BC)

Cormac Nolan

Cormac Nolan, P.Eng.

Cc: Rob Conway

Robyn Kelln