30 Gostick Place | North Vancouver, BC V7M 3G3 | 604.980.6011 | www.nhcweb.com

nhc
northwest hydraulic consultants ltd

NHC Ref. No. P03003468

2018 May 15

**GARY FIELDS ARCHITECUTRE INTERIOR DESIGN PLANNING INC.**
382 David Road, Bowen Island
British Columbia, V0N 1G1

Via email: gary@garyfields.ca

**Re: Flood Hazard Assessment at 38482 Bell Road, Deroche, BC**
**Transmittal of Technical Report**

Mr. Fields,

Please find attached a technical report, dated May 15, 2018, prepared by Mr. Jamie Stirling, P.Geo. of Stirling Geosciences (late of NHC). We trust this report meets the needs of the required Flood Hazard Assessment for the proposed development at 38482 Bell Road, Deroche, BC.

Please do not hesitate to contact myself or Mr. Derek Ray should you have any questions or concerns regarding this report.

Sincerely,

**Northwest Hydraulic Consultants Ltd.**

Derek Ray, P.Geo.
Principal Geoscientist

*Attachment: Flood Hazard Assessment prepared by Stirling Geosciences*

2018 May 15

18-001

**WFS PHARMAGREEN INC.**
12293 Cardinal St
Mission, BC, V4S 1L3

**Attention:** **Peter Wojcik**
CEO/Director

**Via email:** pwojcik@telus.net
cc: Gary Fields (gary@garyfields.ca)

**Subject:** **38482 Bell Road, Deroche, BC**
**Natural Hazards Assessment**

# 1 INTRODUCTION

Northwest Hydraulic Consultants Ltd. (NHC) was engaged by Peter Wojcik CEO/Director of WFS Pharmagreen Inc. to conduct a Natural Hazards Assessment for the property at 38482 Bell Road, Deroche, BC (the Subject Property) which is within the Fraser River Regional District (FVRD) Electoral Area "G". Jamie Stirling, M.Sc., P.Geo. of Stirling Geoscience, was contracted by NHC to prepare this report which was reviewed by NHC.

Mr. Wojcik is proposing a 40,000 square foot industrial building on the Subject Property. The purpose of the Natural Hazards Assessment is to support the Development Permit, the Building Permit and the Site Specific Exemption applications for the proposed development. The Site Specific Exemption is required because the Subject Property is on the floodplain of the Fraser River and in a non-dyked area. The primary hazards addressed in this report are flooding and scour from the Fraser River and Norrish Creek. This report summarizes the results of the Natural Hazards Assessment.

The Subject Property is situated north of Highway 7 near Dewdney and east of Hatzic and west of Deroche, 3.1 km north of the Fraser River (Figure 1). The property is on the alluvial fan of Norrish Creek and the Floodplain of the Fraser River between Norrish Creek 500 m to the east and Chilqua Creek 400 m to the west (Figure 2). The legal description of the property is:

*Lot 4 Plan NWP29269 Section 33 Township 20 Land District 36 & OF NW 1/4 SEC 34; EXC PCL A REF PL 53267*

The search results from the Chilliwack and District Real Estate Board identified that the property has no legal notations, charges, liens and interests, transfers, pending applications as well as no outstanding duplicate indefeasible titles. It is our understanding that there are no restrictive covenants registered against the property title that pertain to natural hazards.

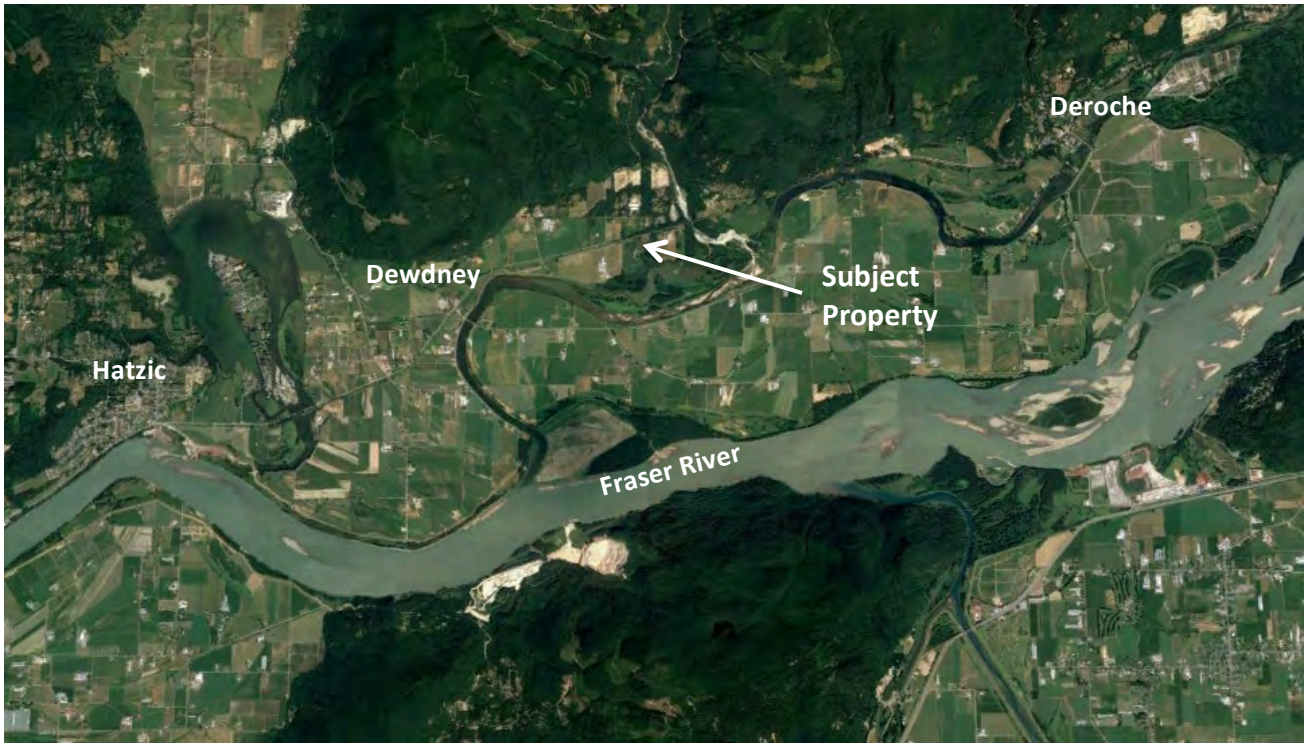


**Figure 1: 38482 Bell Road Study Site (Google Earth 2017)**

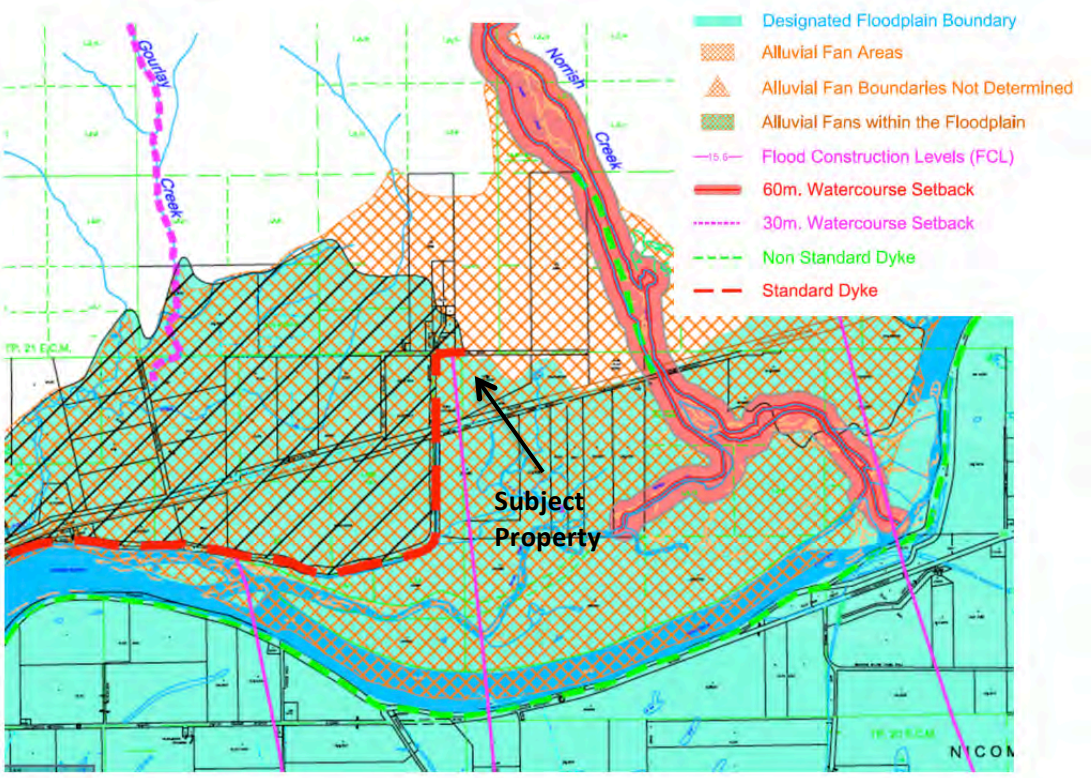


**Figure 2: Subject Property and the Norrish Creek Fan (FVRD Flood Hazard Bylaw No. 0681-2005, Sch A, Map 8)**

## 2 PROPOSED DEVELOPMENT

WFS Pharmagreen Inc., long-term owner of the Subject Property, proposes to develop a licensed medicinal marijuana grow operation on the site. Phase 1 will include a federal government licensed marijuana tissue culture laboratory and Phase 2 will include a federal government licensed marijuana grow operation. The Subject Property is approximately 24.4 ha, all of which is on the alluvial fan of Norrish Creek and most of the property is on the floodplain of the Fraser River except for the northeast portion. The site is within a non-dyked area of the Fraser River and the Dewdney Dyke (Standard Dyke) is immediately to the west of the property protecting land to the west and south (Figure 2).

With respect to Zoning, the Subject Property is within the FVRD Electoral Area G and is zoned Rural 3 (R-3) pursuant to Dewdney-Alouette Regional District Land Use and Subdivision Regulation Bylaw No. 559, 1992. With respect to the Official Community Plan (OCP), the Subject Property is designated Limited Use (LU) pursuant to FVRD OCP for Electoral Area "G", Bylaw No. 0866, 2008. A re-zoning application will not be required for the proposed industrial building as the area is zoned to permit industrial development.

With respect to Development Permit Areas (DPA), a portion of the Subject Property is located within Development Permit Area 1-G (Geologic and Stream Hazard DPA). Therefore, a Geotechnical Hazard Assessment (i.e., Natural Hazards Assessment) and a Development Permit is required prior to any construction, alteration of land or subdivision. The Subject Property is located within Development Permit Area 2-B (Riparian Areas DPA). A Riparian Assessment would be required prior to any residential, commercial, institutional or industrial uses that propose construction, alteration of land, or subdivision within 30 m of a watercourse. A Riparian Assessment will not be required as the proposed building is not within 30 m of a watercourse.

With respect to the Floodplain Bylaw, the Subject Property is identified as being in the Fraser River Floodplain in a non-dyked area pursuant to the FVRD Floodplain Management Bylaw 0681, 2005 as well as being in an alluvial fan hazard area. The Floodplain Bylaw states that all development on properties on alluvial fans is subject to Section 56 of the Community Charter and a Site Specific Geotechnical Hazard Assessment would need to be completed and registered on title and/or Section 920 of the Local Government Act. The Hazard Assessment would be the same as that conducted to satisfy the DPA 1-G requirement mentioned above. The flood protection regulations in the Bylaw do not apply to alluvial fans. However, these flood protection regulations should be taken into consideration where development is proposed on alluvial fans. The Floodplain Bylaw also states, that "No building or structure is permitted to be constructed in the designated floodplain of the Fraser River outside the area protected by the Dewdney Dyke and Nicomen Island Dyke". Dewdney Dyke is a classified as a Standard Dyke and the Nicomen Island Dyke is a Non-Standard Dyke (Figure 2). A Standard Dyke is a dyke that meets government standards of design and construction and is maintained by one or more levels of government. A Non-Standard Dyke (also referred to as an Orphan Dyke) may or may not meet government standards of design and construction and is not currently maintained by a public authority. The Norrish Creek Dyke is classified as a Non-Standard Dyke (Figure 2).

In order to be able to construct on the Subject Property a Site Specific Exemption would be required. To satisfy the requirements of a Site Specific Exemption application, a comprehensive hydrological hazard assessment is required and is to be conducted by a person who is registered or licensed to practice as a Professional Engineer or Professional Geoscientist under the Engineer and Geoscientists Act, specialized in hydrological engineering for large river systems.

The Subject Property is not located within the Agricultural Land Reserve. Zoning Bylaw 559 was recently amended by FVRD Zoning Amendment Bylaw No. 1257, 2014 which was adopted by the Regional Board on April 23, 2014 to include a definition for medical marihuana grow operation as follows:

"Medical Marihuana Grow Operation means the cultivation, growth, storage, distribution, testing or research of marihuana for medical purposes as lawfully permitted and authorized under the applicable federal or provincial laws."

Zoning Amendment Bylaw No. 1257 also amended the list of permitted uses in the Rural 3 (R-3) zone to include medical marihuana grow operation as a permitted use for properties within that designation. Medical marihuana grow operations, as defined above, are considered a permitted use for 38482 Bell Road, Electoral Area "G".

Specific FVRD development requirements, including Building Permits and Development Permits, are required with any new construction, addition to existing structures, or change in occupancy to existing structures to permit a research or production facility for medical marihuana.

Gary Fields of Gary Fields Architecture Interior Design Planning Inc. is designing the proposed facility. The latest schematic architecture drawings are provided in Appendix A.

## 3 PROJECT OBJECTIVE

The Subject Property is susceptible to high water levels due to flooding on the Fraser River and potential hydrotechnical hazards emanating from nearby Norrish Creek. Hydrotechnical hazards are defined as flooding, erosion, deposition, scour and avulsion, typically due to channelized flow or coastal water levels. In addition, flood hazards may arise from local surface water management and site drainage. Such localised hazard is not discussed in this study but is addressed within the stormwater management plan (i.e., the proposed building drainage plan) (Appendix A).

The objective of this Natural Hazards Assessment is to identify and assess the flood and erosion hazards that may affect the safe development and use of this property. This assessment is based on the criteria specified by FVRD's Floodplain Management Bylaw 681, 2005, Area G – OCP Bylaw 0866, and the *Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate in BC* prepared by the Association of Professional Engineers and Geoscientists of BC (APEGBC, 2012). The recommendations based on the above guidelines are intended to be applied to the proposed development as well as potential future development on the property.

The Natural Hazards Assessment was conducted based on a review of available information, including existing reports, site information, orthophoto imagery, LiDAR data, topographic survey data collected the week of March 26, 2018 and a site investigation conducted on March 28, 2018 by Jamie Stirling. This information was used to determine the flood level for the design flood at the property. The data was then used to determine mitigative measures such as: Flood Construction Level (FCL), setback from watercourses, and erosion and scour protection. Hydraulic modelling on the Fraser River has recently been carried out (FLNRO, March 2014 and FLNRO May 2014). Therefore no new modelling was performed as part of this Natural Hazards Assessment. With regards to flood and erosion hazards from Norrish Creek, no modelling was done as part of this assessment. Potential hazards could include flooding, erosion, debris floods, debris flows and avulsions. Due to the nature of alluvial fans, hazards from Norrish Creek exist at the Subject Property. These hazards are partially mitigated because of the armoured Norrish Creek Dyke along the

right (west) bank (Figure 2 and Figure 3). The hazards are only partially mitigated because the dyke is classified as a Non-Standard Dyke and therefore cannot be relied upon to fully protect the Subject Property from creek hazards.

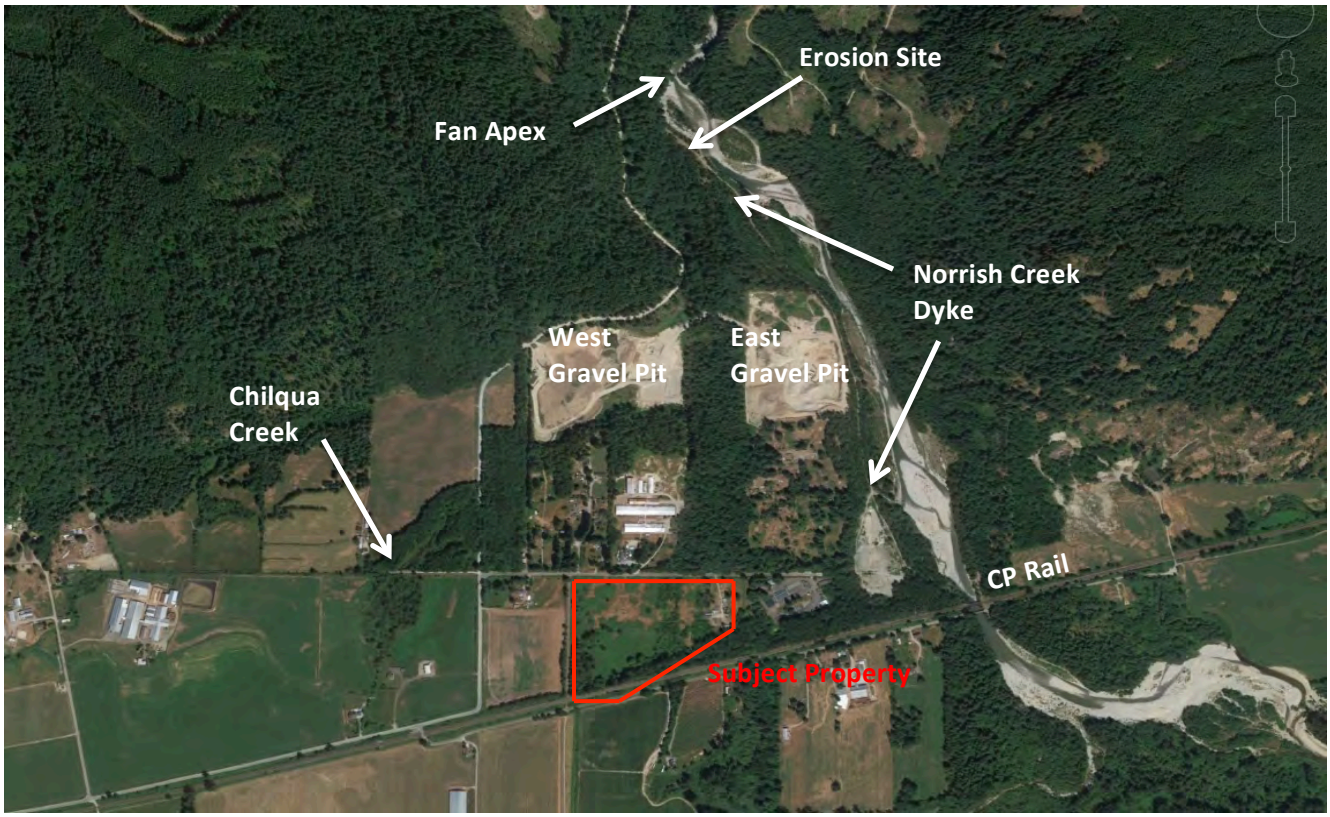


**Figure 3: Norrish Creek Fan (Google Earth 2017)**

## 4 STUDY AREA

Norrish Creek has its source in Dickson Lake located at the bases of Mount Wardrop and Mount Catherwood. The watershed is 117 $km^2$ and the creek runs parallel to the Norrish Creek Forest Service Road (FSR) and is fed my numerous tributaries. Norrish Creek is used as a water supply by the City of Abbotsford and the intake and water treatment plant are located approximately 6 km upstream of the Subject Property. There were two Water Survey of Canada (WSC) stations on Norrish Creek. Station 08MH058 Norrish Creek Near Dewdney, which is near the fan apex, operated from 1959 to 2007 and had a watershed area of 117 $km^2$. Station 08MH150 Norrish Creek Above Rose Creek, which was near the water treatment plant operated from 1984 to 2006 and had a watershed area of 78.2 $km^2$. Norrish Creek experienced a large flood in 1984 estimated at 500 $m^3/s$. (NHC, 1988). The 100-year and 200-year instantaneous discharge is estimated to be 664 and 775 $m^3/s$, respectively (NHC, 1999). Inch Creek flows south, parallel and west of Norrish Creek and is groundwater fed from the fan. Fisheries and Oceans Canada operates a fish hatchery immediately east of the Subject Property (Figure 4).


**Figure 4: Subject Property and Proposed Building Location (Google Earth 2017)**

Norrish Creek from the fan apex to the Canadian Pacific (CP) Railway Bridge is 1.65 km long and drops in elevation 23 m from 32 m to 9 m Geodetic Datum (GD) for an average slope of 1.4%. The width of the creek in this reach ranges from 50 to 175 m. Appendix B shows two LiDAR images of the Norrish Creek Fan, one is a hillshading image and the other shows 2 m contours. The LiDAR data is from 2008 and is from the Fraser Basin Council. The LiDAR images were provided from the FVRD. Both sides of the channel are constrained by dykes that were constructed in the 1980s in response to flooding on Norrish Creek. The right (west) bank dyke is significantly longer and larger than the dyke on the left (east) bank. The Norrish Creek fan begins where the creek emerges from a bedrock canyon. Just downstream of the apex, the fan is constrained on both sides by steep bedrock slopes to the west and by an elevated fluvial terrace and bedrock slopes to the east. The width of the fan in this area varies from 200 m to 400 m. South of this area the fan is unconstrained and widens considerably as it approaches the floodplain of the Fraser River (Figure 2). The fan extends west of Norrish Creek merging into the smaller fan of Chilqua Creek west of the Norrish Creek FSR about 1.2 km west of Norrish Creek and 400 m west of the northwest corner of the Subject Property (Figure 3 and Appendix B).

The gradient of the Norrish Creek fan ranges from 0% to 10% and there are several incised relic channels, which are up to 5 m wide and 3 m deep. Based on mature second growth trees and older stumps in the relic channels, significant flows have not occupied these channels within the last 200 years. No levee deposits are present along the edges of the relic channels, so it appears that they were formed by water only flows that eroded into the existing fan sediments rather than by debris floods or debris flows (Westrek, 2013). Two main relic side channels were documented by Westrek (2013). They are both west of the Norrish Creek Dyke and one is downstream of

the fan apex and the other is in proximity to the East Gravel Pit (Figure 3). It was noted that these channels sometime contain pools or standing water or even ephemeral streamflow but there was no evidence of flow reaching as far downstream as Bell Road. Also, there are no drainage structures crossing under Bell Road. These relic channels can be clearly seen on the hillshading LiDAR image (Appendix B).

The bed sediment of Norrish Creek from the apex to the CP Railway Bridge is primarily gravel-sized, ranging from boulders near the apex to mostly pebble to cobble sized sediment in the lower fan. Historically, much of the fan was logged prior to and during the 1940s and large forest fires affected the area in the late 1860s and early 1940s.

## 5 FIELD INVESTIGATION AND SITE DESCRIPTION

A site investigation was conducted on March 28, 2018 by Jamie Stirling. The Subject Property is fenced and occupied by tree cover, brush and grass. The CP Railway is near the south boundary, Bell Road parallels the north boundary, Dewdney Dyke parallels the west boundary, and the neighbouring Inch Creek Hatchery is along the east boundary. Access to the site is near the northeast corner through Bell Road (Figure 4).

The March 2018 topographic survey of the property shows that the site is relatively flat with a gentle downslope away from Norrish Creek from the northeast to the southwest of approximately 1% (Appendix C). This topographic survey shows more detail than the LiDAR contours in Appendix B. Based on the topographic survey, the western half of the property averages from 8 to 9 m GD (Photo 1) and the eastern half averages from 9 to 10.5 m GD (Photo 2). Photos of the study area are provided in Appendix D. The lowest area on the property is in the southwest corner and averages approximately 7 m GD (Photo 3) and the highest area is near the northeast corner averaging approximately 11 m GD (Photo 4). The property currently has one residential building along the eastern part of the property and the proposed industrial building would be located immediately northwest of the existing building (Figure 4 and Photos 2 and 4). The proposed development would not tie into the Dewdney Dyke nor would it be located in proximity to the dyke. This area of higher ground where development is proposed is just outside of the Fraser River floodplain as shown on Figure 2.

The Subject Property drains from northeast to southwest and drainage is controlled on the south side by the elevated CP Railway embankment and drainage is controlled on the west side by the Dewdney Dyke. The elevation of the crest of the Dewdney Dyke varies from 10.0 m to 10.2 m GD as identified by the March 2018 topographic survey (Appendix C). The elevation of the CP Railway south of the property appears to be at a similar elevation as the dyke based on visual observations during the field investigation and as shown on the LiDAR contour image. The crest of the railway embankment was not surveyed in as part of this project.

Surface water that collects at the low point on the Subject Property (the southwest corner) drains through a 450 mm concrete culvert (Photo 5). The invert of the inlet of this culvert is the lowest point on the property at 6.35 m GD. Flow through this culvert is controlled with a culvert gate and the wheel to adjust this gate is located on the top of the Dewdney Dyke (Photo 3). The culvert was dry at the time of the field investigation (Photo 5) and the gate was not visible but it is assumed that the gate would normally be in the open position and would be manually closed during a flood to keep floodwaters from inundating the area inside (west) of the Dewdney Dyke.

Drainage under the CP Railway in proximity to the Subject Property occurs through a steel box culvert, which has a span of 2000 mm and a height of 1600 mm. This culvert conveys Inch Creek and is shown in Photo 6. A 500 mm diameter concrete culvert was located under the CP Railway adjacent to the middle of the Subject Property. The outlet on the south side of the railway embankment is shown in Photo 7 and there was no evidence of recent flow through the pipe or evidence of past flow in the ditch immediately downstream of the outlet. The culvert inlet could not be located on the north side of the railway embankment and there was no defined ditch adjacent to the inlet, suggesting this culvert may not provide reliable drainage for the property during a flood.

The LiDAR images in Appendix B include a layer showing the location of watercourses and this information is likely taken from the BC Freshwater Atlas Stream Network Database. The field investigation confirmed that Chilqua Creek to the west of the Subject Property is accurately represented by the watercourse database but Inch Creek is not. The alignment of Inch Creek is well represented on the LiDAR hillshading image from the Fish Hatchery and southward but the blue creek symbol from the watercourse database incorrectly shows Inch Creek flowing under the CP Railway through the 500 mm diameter culvert and not through the steel box culvert (Appendix B). The blue creek symbol also shows Inch Creek as a surface channel upstream of Bell Road, which is not accurate as the creek is subsurface in this area. Finally, the blue creek symbol shows a creek passing the southwest corner of the Subject Property and there is no creek following this alignment. With respect to Norrish Creek, the watercourse symbol on the LiDAR images shows the low-lying area along the right bank at the end of Bell Road and just upstream of the CP Railway Bridge as part of the active channel. However, this area is isolated from the mainstem by the Norrish Creek Dyke as shown by the green line symbol. The low-lying area was one of the borrow sources for construction of the dyke.

The Norrish Creek Dyke was visually assessed as apart of this assessment. The entire length of the dyke was walked during the field investigation. The dyke extends along the right bank of the creek from the apex of the fan to the CP Railway for a length of 1,630 m as measured in the field (Figure 3 and Appendix B). The field investigation identified that the lower 680 m of the dyke is continuously armoured and only portions of the upper 950 m is armoured. Although the dyke extends upstream to the fan apex, the FVRD Flood Hazard Map 8 (Figure 2) only shows the dyke as occurring along the lower 900 m, which likely is intended to represent the portion of the dyke that is continuously armoured.

The Norrish Creek Dyke is setback from the active channel in most locations. The downstream 80 m is a river dyke with the toe of the armoured dyke in the active channel (Photos 8 and 9). The $D_{50}$ of the dyke riprap is 600 mm along this reach. The setback portion of the dyke varies in distance from the active channel and is up to 75 m from the channel in some locations. Photo 10 shows a typical section of the armoured setback dyke 100 m upstream of the CP Railway Bridge. The $D_{50}$ of the dyke riprap is 500 mm along this reach. The riparian forest between the setback portion of the dyke and the active channel is mature and well established. This forest would likely be effective in reducing flow velocity and bank erosion adjacent to the dyke during flooding. Figure 3 shows the mature forest area between the dyke and the active channel and the LiDAR hillshade image shows the right bank of the active channel defined as a shaded ridge but the blue watercourse shading shows the forested area as part of the active channel.

The height of the setback dyke portion of the structure throughout the fan is approximately 2 m above the creek side floodplain. The height of the river dyke portion of the structure is 3 to 4 m high. The crest of the dyke averages 8 to 12 m wide but is up to 20 m wide at the upstream end where the dyke is not armoured. Photo 11 shows a typical view

of the dyke crest and Photo 12 shows a typical view of the armouring. Both photos are taken just downstream of the upstream limit of continuous dyke armouring 680 m from the CP Railway Bridge.

The Norrish Creek Dyke is a river dyke for its upstream 270 m. Photo 13 shows a portion of the armoured dyke adjacent to the active channel 250 m downstream of the fan apex. The $D_{50}$ of the dyke riprap is 300 mm along this reach. Although the riprap in this reach is smaller than that downstream, there is no evidence that this rock has been recently mobilized as it is well established with moss and there were no observed areas of failure or scour on the armoured slope.

A 30 m long section of the unarmoured portion of the dyke is eroding along the right bank of the creek 130 m downstream of the fan apex (Figure 3) and the bank is approximately 3 m high along this reach (Photo 14). The dyke crest is 20 m wide in the area adjacent to the erosion (Photo 15) and closer to 30 m wide at the toe of the dyke. Westrek (2013) documented this eroding bank and they identified that the face of the dyke has eroded up to 3 m back when compared to the extent of the adjacent armoured section. Conditions observed during the March 28, 2018 site investigation appears similar to that observed by Westrek in 2013. A comparison of photos of the eroding bank suggests the condition of the bank has not noticeably changed over the five-year period from 2013 to 2015. Amec prepared a dyke inspection report in 2002 and also identified this eroding bank. Details of the Westrek and Amec report findings are documented below in Section 6.2.

An avulsion of the creek is possible at this eroding location if erosion of this bank continues. However, the likelihood of an avulsion, especially during a single event is considered low due to the width of the dyke in this area, the height of the dyke and the straight reach of the creek at this location. If an avulsion were to occur in this area, the flow path would travel south and likely inundate the east and west gravel pits before reaching the Subject Property further downslope (Figure 4). The west pit is associated with 38447 Bell Road and the east pit is associated with 38555 Bell Road. These quarries are vary large excavations on the fan and would likely represent a sediment trap for material and debris in the event of an avulsion (Photo 16). The quarries would also likely attenuate the avulsion flow before the water could potentially reach the Subject Property.

# 6 REVIEW OF BACKGROUND INFORMATION

## 6.1 General Information

The following government documents have been relied upon in the preparation of this Natural Hazards Assessment:

- Hazard Acceptability Thresholds for Development Approvals by Local Government. BC Geological Hazards workshop Feb 20-21, 1991. Revised Nov. 1993. A paper by Dr. Peter Cave, Director of Planning, Regional District of Fraser-Chem.
- City of Chilliwack Floodplain Regulation Bylaw 2004, No. 3080, Schedule C.
- FEMA. Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures, Appendix D Alluvial Fan Flooding.
- Flood Hazard Area Land Use Management (BC Ministry of Water, Land and Air Protection, 2004).
- FVRD Bylaw No. 0681, 2005. A Floodplain Management Bylaw Pursuant to Section 910 of the Local Government Act. As amended by Bylaw 0746, 2006 and Consolidated as enacted by Bylaw 0748, 2006.

- FVRD Floodplain Regulation Bylaw 2004, No. 3080 – Schedule C – Guidelines for Application for Site Specific Exemption.
- FVRD Flood Hazard Area Land Use Management – Guidance for Selection of Qualified Professionals and Preparation of Flood Hazard Assessment Reports.
- Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use (BC MoE, 2011).
- Coastal Floodplain Mapping Guidelines and Specifications (FLNRO, 2011).
- Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate in BC (APEGBC, 2012).
- Fraser River Design Flood Level Update – Hope to Mission, Final Report. FLNRO, Flood Safety Section, March 2014.
- Simulating the effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios, Final Report. FLNRO, Flood Safety Section, May 2014.
- Guide to Geo-Hazard - Assurance Statement for Development Approvals, APEGBC and FVRD.
- Geo-Hazard Assurance Statement for Development Approvals, APEGBC and FVRD.
- FVRD Hazard Acceptability Thresholds for Development Approvals. June 2017.

## 6.2 Site Specific Information

Information regarding natural hazards in proximity to the Subject Property is extensive with respect to the Fraser River and the Norrish Creek alluvial fan. Numerous site-specific hazard assessments have been carried out on properties on the Norrish Creek Fan and several reports on Norrish Creek and its watershed have also been completed. The most relevant documents were reviewed as part of this assessment and include:

- Norrish Creek Hydrology Study 1993-94 by Dayton and Knight Ltd. Stage 1 March 1993 and Stage 2 July 1994.
- 38740 Hawkins Pickle Road, Dewdney, BC by Levelton Associates July 27, 1994.
- Norrish Creek and Chehalis River Watershed Cutblock Assessments by Hay and Company Inc. September 1995.
- Sawdust Shed at 38447 Bell Road, Dewdney, BC by J. W. Wedler and Associates Ltd. November 7, 1997.
- Geomorphology and Hydraulics of Norrish Creek. Report to David Lund, Cascade Construction by Northwest Hydraulic Consultants Ltd. August 1999.
- Norrish Creek Supply of Gravel from the Upper Watershed. Report to CP Railway by Northwest Hydraulic Consultants Ltd. May 2001.
- Norrish Creek Dyke – Norrish Creek by AMEC. March 22, 2002.
- Norrish Creek 2002 Gravel Removal. Report to CP Railway by Northwest Hydraulic Consultants Ltd. August 2002.
- Norrish Creek Future Gravel Removal Recommendations. Report to CP Railway by Northwest Hydraulic Consultants Ltd. June 1, 2004.
- Area G Official Community Plan, Hatzic Lake to Deroche, Geotechnical Hazard Overview. Report to FVRD by Thurber Engineering Ltd. September 2004.
- Geotechnical Hazard Assessment 38083 Hawkins Pickle Road, Dewdney, BC by Golder Associates. May 24, 2006.

- Geotechnical Hazard Site Assessment Report for 38275 Bell Road by Levelton Engineering Solutions. February 8, 2007.
- Geotechnical Hazard Site Assessment Report for 38205 Bell Road by Levelton Engineering Solutions. November 29, 2007.
- Supplemental Geotechnical Hazard Site Assessment Report for 38205 Bell Road by Levelton Engineering Solutions. April 25, 2008.
- Proposed Gravel Pit, 38447 Bell Road, Norrish Creek, FVRD Electoral Area G by Madrone Environmental Ltd. June 16, 2011.
- 38555 Bell Road, Dewdney, Norrish Creek Fan – Geotechnical Hazard Assessment, Westrek Geotechnical Services Ltd. April 30, 2013.
- Fraser River Design Flood Level Update – Hope to Mission, Final Report. FLNRO, Flood Safety Section, March 2014.
- Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios, Final Report. FLNRO, Flood Safety Section. May 2014.
- Geohazard Assessment for the Proposed Residence – 9708 Hess Road, Dewdney, BC by Fraser Valley Engineering Ltd. February 19, 2016.

Many of the above reports comment on the 200-year design criteria for the Fraser River and this is currently the requirement with respect to the FVRD Flood Hazard Bylaw No. 0681-2005 as discussed in Section 2 and shown on Figure 2. However the two 2014 FLNRO reports noted above suggest the current FVRD Bylaws should be updated. Details of this are provided below in Section 7. The key findings from the above documents from 1999 onward with respect to hazards on Norrish Creek are summarized below.

### 6.2.1 NHC 1999 Report

NHC's 1999 report is a gravel management plan on Norrish Creek to support excavation of gravel in proximity to the CP Railway Bridge in order to maintain hydraulic capacity at the crossing. The report carried out an analysis of historical air photos and documented the extensive logging history in the watershed and noted over 44 clearcuts and over 200 landslides related to historical logging activity. Many of these clearcuts had reforested but mass wasting was still contributing to the sediment in the main channel. The report noted that a 6 km reach of the mainstem located 10 km upstream of the CP Railway Bridge was highly aggraded and this would continue to provide a significant sediment source for the fan area, especially the lower fan where the gradient flattens on the Fraser River Floodplain. Much of the sand and gravel deposition occurred downstream of the CP Railway Bridge.

The historical air photos suggest that gravel removal and dyke construction on Norrish Creek began on the fan between 1963 and 1979. As a result the width of the creek had been reduced from approximately 200 m to 70 m. Initially the dykes were not armoured and constructed by bulldozing the gravel in the channels to the sides. Excavation of gravel also occurred on the fan and floodplain. Dyke and bank armouring occurred immediately upstream of the CP Railway Bridge during the initial dyke construction. The 1986 air photos show conditions after the 1984 flood. Dyke construction on both banks expanded following the initial works and armouring of the dykes had occurred by 1986. Gravel extraction occurred in the channel in 1996 and the 1999 air photos shown conditions following the removal where gravel had not yet infilled the extraction area.

The 1999 NHC report estimated that annual sediment supply to the Norrish Creek Fan was 12,000 $m^3$ and recommended a similar annual removal to maintain capacity at the bridge. NHC estimated that the CP Railway Bridge was capable of passing a 1 in 35-year flood.

### 6.2.2 NHC 2001 Report

NHC's 2001 report identified that Norrish Creek produced about 23,000 $m^3$ of gravel annually, which was deposited upstream and downstream of the CP Railway Bridge. This was a significant increase from the estimate in their 1999 report. Gravel traps with a capacity of 40,000 $m^3$ were excavated upstream of the bridge. Documentation of gravel extraction began in 1951 and occurred in 1966, 1967, 1969, 1971,1972, 1984-85, 1987, 1990, 1993, 1996 and 2000. Volumes are known for only seven of the 13 years and the total is 614,7000 $m^3$ for the known years. The primary source of the gravel was identified as landslides in the Rose Creek tributary as well as Dickson Creek and East Norrish Creek. The landslides are attributed to logging which started in the 1950s. A total of 135 landslides were documented throughout the watershed. The report identifies that although the annual load could be 23,000 $m^3$, large rainfall events can also contribute a slug of gravel computed to be 20,000 $m^3$ over a five-day period. Therefore, the existing traps may only be adequate for under the scenario of one large storm plus an annual load of gravel.

### 6.2.3 Amec 2002 Report

Amec carried out a dyke inspection in 2002 on the Norrish Creek Dyke. The inspection identified that the dyke was 960 m long, ran downstream from the fan apex, was constructed in 1984 and riprap was last added in 1990. The dyke was built by CP Rail and the Province and continued from the apex to the CP Railway Bridge. The report noted the large flood that occurred in 1963. Large amounts of gravel were removed from the channel following the 1984 flood to build the dykes. Following the 1990 flood and avulsion, large riprap was placed on the bank near the apex of the fan for a length of 160 m. The report documented the 30 m long erosion site immediately upstream of the riprap that was placed in 1990. The dyke crest at this erosion site was approximately 15 m wide.

### 6.2.4 NHC 2002 Report

Following NHC's 1999 report, CP Rail was permitted to excavate gravel from several traps upstream of the bridge in order to reduce the build up of downstream gravel bars, which were found to create backwater at the bridge. Removal occurred at four pits in 2000 and high flows in the spring of 2002 resulted in extensive infilling of the gravel traps even though the flows had discharges less than the 2-year return period. The 2002 NHC report quantified the extent of the trap infilling and provided future extraction recommendations. The sediment traps were identified as almost full and it was recommended to re-excavate them. The sediment in the traps was primarily gravel having a $D_{50}$ of about 45 mm and there was little sand within this material. The gravel bars downstream of the bridge had not changed but they were still causing backwatering and NHC recommended lowering the downstream creek bed.

### 6.2.5 NHC 2004 Report

The NHC 2004 report summarized the performance and conditions of the works completed in 2003 as well as future recommendations for gravel removal. A flood occurred on Norrish Creek in October 2003 estimated to have a 5-year return period. The report documented that the 2003 excavation pits for storage of 40,000 $m^3$ had

filled in following this flood and recommended the new traps be increased to store a minimum of 50,000 $m^3$. NHC estimated that approximately 59,000 $m^3$ of material was deposited and 19,000 $m^3$ was eroded resulting in a net deposition of approximately 40,000 $m^3$ which was twice the previously estimated annual expected amount transported into this area.

### 6.2.6 Thurber 2004 Report

The 2004 Thurber report noted that Norrish Creek is confined by dykes between the mountain front and the railway so coarse sediment will continue to be deposited in channels below the bridge where creek flood back up effects are generated. A debris jam at the CP Railway Bridge could cause the flooding creek to cut through the railway grade and Hawkins Pickle Road or breach the creek dykes. If breaching occurs, floodwater could reach the lowest portions of the Norrish Creek fan to the east or west. In a worse case scenario, the west dyke would be breached during a 200-year Fraser River flood. This would cause extensive flooding in the Chilqua Slough area where the dyke on the west margin of Nicomen Slough would be outflanked. Thurber states that in their judgment, debris loading and flood issues on Norrish Creek's lower channel are approaching a critical state. Although these issues warrant attention from a hazard perspective, this investigation was beyond the scope of their work. The Thurber 2004 report estimated the average annual probability of the Norrish Creek Dyke to be breached or overtopped as 1:200. The Thurber 2004 report estimated that the CP Railway Bridge was only capable of passing a 1 in 10-year flood, which is different from the 1 in 35-year event that NHC reported in 1999.

### 6.2.7 Golder 2007 Report

The 2007 Golder hazard assessment was for 38083 Hawkins Pickle Road, which is 500 m west of the western edge of the Subject Property. The property is inside the Dewdney Dyke and far enough from the hillside to not be affected by slope related hazards. The estimated risk for debris flow and debris flood was given a low probability at 1:500 to 1:10,000 but that the annual probability of avulsions from Norrish Creek was high at 1:10 to 1:100. They also note that the probability of occurrence of flooding from Chilqua Creek, which flows through the property, is moderate at 1:100 to 1:200. Mitigation for buildings should include scour protection with well-graded ($D_{50}$ = 350 mm) riprap placed around proposed concrete foundation walls. The protection should extend to the base of the proposed foundation wall/footing. They recommend appropriate geotechnical inspections be carried out during site grading and construction of the foundation and scour protection.

### 6.2.8 Levelton 2007 Reports

Levelton prepared a hazard report dated February 2007 for a proposed soda ash facility on the property at 38275 Bell Road, which is immediately northwest of the Subject Property. The report considered four hazards; debris flow, debris flood, allusion and inundation by flood waters. The estimated risk for debris flow and debris flood was given a probability of 1:500 to 1:10,000. The probability for avulsion was determined as <1:500 and inundation from flood waters was 1:200. Other hazards related to steep slopes were not considered as the site is far enough away from the mountainside slopes. Levelton concluded that the site is suitable for the support of the soda ash silo and that specific hazard mitigation to support the facility is unnecessary. They note that the probability of the site being impacted by debris flows, debris floods or avulsions is low but that these hazards cannot be completely eliminated based on the site location.

The November 2007 hazard assessment by Levelton was carried out in connection with the proposed sale of the property at 38205 Bell Road, which is the neighbouring property to the northwest of the Subject Property and inside the Dewdney Dyke. The overview assessment concluded by stating that the site will be used for agricultural purposes and no permanent structures are planned. Therefore, it was premature to provide a risk assessment and avoidance and mitigative measures for the hazards discussed in the report.

### 6.2.9 Levelton 2008 Report

The 2008 Levelton hazard assessment was a follow up to the November 2007 report and included defining safe building sites on the property as per a request from the FVRD. As the property extends from Bell Road to the hillside to the north, the property was divided into three hazard zones; the hillside, the toe of the hillside as well as the creek fan area and the third area is the floodplain of the Fraser River. This most southern area (Area 1) would be similar to that of the Subject Property to the east. Levelton identified that this area is subject to flooding and soil liquefaction during a design basis earthquake (1:475 or 1:2,475 return period events). They note that amplification of ground motions may also occur during a design basis earthquake, resulting in more intense shaking of the structure(s) compared to buildings constructed on firm ground (Site Class C soils). They recommend a site-specific liquefaction assessment be conducted for any future permanent structures. They also recommend a site specific dynamic analysis to assess the site response spectrum which may also be required for structures falling under Part 9 of the 2006 BC Building Code. The need for dynamic analysis will depend on the extent of liquefiable soils and the type of foundation system employed.

Area 2 is on the alluvial fan of Norrish Creek and Chilqua Creek and recommendations for this area include scour protection along the perimeter concrete foundations of any proposed buildings. This protection should be 0.6 m deep and 1.5 m wide and include $D_{50}$ = 150 to 300 mm riprap wrapped in non-woven geotextile and the protection can be covered with 0.3 m of soil, grass and or landscaping.

### 6.2.10 Madrone 2011 Report

The Madrone 2011 hazard assessment was for the development of a proposed gravel pit in the north portion of the property at 38447 Bell Road. This pit is shown as the eastern half of the West Gravel Pit on Figure 3. The report identified that the three upslope hazards (debris flow, small-scale landslide and rockfall) are only likely to affect terrain within 30 m of the based of the steep slopes north of the proposed pit. The report also identified that flooding on the Norrish Creek fan is likely to occur only if the existing dyke along the west side of Norrish Creek is breached or overtopped. It was suggested to protect the proposed pit by constructing berms to divert water away from the pit.

### 6.2.11 Westrek 2013 Report

Westrek Geotechnical Services Ltd. (Westrek) carried out a Geotechnical Hazard Assessment in 2013 at 38555 Bell Road, which is the neighbouring property to the northwest of the Subject Property. The assessment was for the development of a proposed 6.9 ha gravel pit in the north portion of the property at 38555 Bell Road (See East Gravel Pit on Figure 3). This report is similar to the 2011 Madrone report discussed above for the adjacent gravel pit but provides different estimated average annual probabilities for some of the hazards. The Westrek report is the most detailed and recent report documenting hazards on the Norrish Creek fan.

Air photos of the Norrish Creek fan were reviewed for their 2013 project for the years 1995, 1999, 2001, 2004, 2006 and 2009. Westrek had previously reviewed historical air photos for Norrish Creek for other assessments and relied on notes from those assessments for their 2013 project. The photos did not identify any specific noteworthy information that was reported in their 2013 report.

For the proposed gravel pit upslope of the Subject Property, Westrek considered each of the hazard categories identified in Cave (1993) which includes debris flows, debris floods, channel avulsions, inundation by floodwaters, snow avalanches, rock falls, localized and large scale landslides and earthquakes. Westrek identified that snow avalanches are not a hazard of concern and that the annual return frequency for large-scale landslides is <1:10,000 and that the probability of soil liquefaction following an earthquake is <1:475 for the lower Norrish Creek fan. The average annual probabilities of occurrence of rock fall or small-scale landslides is estimated as <1:10,000. These probabilities would be considered similar or lower for the Subject Property, which is downslope from the gravel pit.

Chilqua Creek has reportedly experienced debris flows in the past that have affected its fan (Westrek, 2013). The eastern edge of the Chilqua fan is 500 m from the gravel pit and Westrek estimated the average annual probability that debris flows in Chilqua Creek could reach the proposed pit is <1:10,000. This probability would likely be similar or slightly lower for the Subject Property as the northwest corner of the Subject Property is 400 m from Chilqua Creek and further downslope on the Norrish Creek fan than the gravel pit.

Debris flows and debris floods on Norrish Creek are not likely a concern and this is supported in the 2013 Westrek report. The watershed Melton Ratio (the ratio of relief to the square root of area) and watershed length used to classify fans suggest the Norrish Creek fan is subject to clear water floods and not debris flows or debris floods. For example, fans with Melton Ratios <0.4 and watershed lengths >3 km were subject to water flows and fans with ratios in the range 0.35 to 0.6 and lengths of 1.8 km to 10 km were subject to debris floods and ratios >0.6 and lengths <2.7 km were subject to debris flows.

The Melton Ratio for Norrish Creek is 0.13 and the length is 18 km suggesting Norrish Creek is well within the clear water range and well out of the debris flood and debris flow range. It is worth nothing that Sally Creek is a steep tributary of Norrish Creek, which flows into Norrish Creek 0.5 km upstream of the fan apex. Sally Creek has a Melton Ratio of 0.44 and a length of 5.1 km and is known to have experienced both past debris floods and debris flows. Westrek identified that historic debris flows from Sally Creek had not reached the Norrish Creek fan, and Westrek conservatively evaluated the average annual probability for debris flows to affect the proposed pit area, located 700 m downstream of the apex of the fan, at <1:2,000. The probability for the Subject Property, which is 1.5 km downstream of the fan apex, would likely be similar or less.

Westrek noted that the probability of hazards from debris floods, clear water floods and avulsions on Norrish Creek affecting the gravel pit depends on both the probability of the event occurring and the probability of the Norrish Creek Dyke failing or overtopping. Failure or overtopping of the dyke depends on dyke maintenance and gravel removal from within the channel. Climate change may increase the probability of such hazards occurring but logging practices in the watershed have improved which may decrease the probability. This would also apply to the Subject Property.

If the dyke were to breach or overtop it would likely occur at the erosion site and the flow would likely travel down the relic channel which would direct flow into the east gravel pit. With respect to the Subject Property, as mentioned in the above section, these quarries would likely represent a sediment trap for material and debris in the event of an avulsion. The quarries would also likely attenuate the avulsion flow before the water could

potentially reach the Subject Property. However, berms were proposed around the proposed pit by Westrek and it is understood that berms were currently in place on the existing pit to the west.

Westrek noted that a significant channel avulsion is unlikely to occur at the erosion site because the active channel is approximately 3 m lower than the surface of the fan. If the dyke does fail at this point then it is likely to occur during a period of high flow and not as a result of a complete channel avulsion through this point. Westrek suggested that the breach could possibility accommodate up to about 1/5 to 1/4 of the total discharge in Norrish Creek, or up to about 100 $m^3/s$ as the $Q_{200}$ is in the 400 to 500 $m^3/s$ range.

If the bed of Norrish Creek were to raise several meters due to aggradation then the potential for a complete channel avulsion is more likely. However, it is unlikely that a single event could raise the bed of the creek several meters resulting in a complete avulsion. This suggests that the probability of a complete channel avulsion is unlikely to increase unexpectedly such as during a single event but would occur over time. Westrek identified that the present annual average probability that a debris flood or flood will breach or overtop the existing dyke and cause flooding on the fan is presently about 1:200. They note that this probability is not random and depends on the rate of erosion of the dyke at the erosion point and aggradation rates in excess of any gravel removal programs.

The 2013 Westrek report recommended the construction of berms along the boundary of the pit and adjacent access road so that floodwaters are temporarily impeded or diverted by the berm and directed back into Norrish Creek. Westrek noted that the berms are intended to reduce or delay flooding, not prevent flooding. They suggest the proposed pit will not increase downslope hazards as a result of its operation and that downslope hazards are likely to be reduced by the pit because it will act to intercept, delay or detain events, which might otherwise propagate downslope unrestricted.

The proposed east pit has been constructed as shown in Figure 3 and as observed during the March 2018 field investigation but the gravel pit property was not accessed to confirm if the proposed berms were built and if built, what their condition may be. Westrek noted that the recommended berms were not intended to be long-term flood protection and they did not recommend scour protection or armouring of the berms.

### 6.2.12 FVEL 2016 Report

Fraser Valley Engineering Ltd. (FVEL) conducted a geohazards assessment for the proposed residential development at 9708 Hess Road, which is 160 m north of the northwest corner of the Subject Property. Hess Road extends north immediately north of the Dewdney Dyke (Figures 2, 3 and 4). FVEL reviewed historical air photos from 1938, 1949, 1954, 1963, 1969, 1975, 1979, 1984, 1989, 1996, and 2004. The photos document historical development in the watershed and on the fan. The earliest photos show that by 1938 the fan was logged and Bell Road was built. The Norrish Creek FSR was built by 1949 and Hess Road was built by 1954. The air photos show that, with the exception of logging activity, the mountain slopes in proximity to the fan have remained unchanged over the period of record and that large-scale landslides were not identified.

FVEL considered the probabilities of occurrence of rockfalls and debris slides for the subject site to be <1:10,000. FVEL noted the relic channels west of the Norrish Creek Dyke could provide preferential flow paths and that hazards from Norrish Creek with respect to debris flows, channel avulsions and flooding could occur if the dyke were to fail or be overtopped. The report noted that the forested terrain between the subject site and the creek would help reduce the debris flow onto the property to a certain degree. They conclude that the annual probability for debris flow or avulsion to affect the property is estimated to be <1:1,000. They also recommend

that to minimize potential impact of debris flow on the proposed building, the reinforced concrete foundation wall should be extended at least 0.6 m above the exterior grade. FVEL noted that the proposed residential building may be used safely for the use intended in accordance with the Cave Criteria.

The FVEL report is the most recent report on the Norrish Creek fan with relevant information to the Subject Property but does not provide the level of detail or analysis compared to the Westrek report from three years earlier.

# 7 FRASER RIVER FLOOD HAZARD

The existing Fraser River Flood Construction Level (FCL) for the Subject Property is 10.0 m and this includes 0.6 m freeboard. An FCL by definition is the minimum elevation of the underside of a floor system or the top of a concrete slab of a building used for habitation, business, or storage of goods damageable by floodwater. Figure 2 shows the 10.0 m FCL isoline transecting the western portion of the Subject Property. As identified in the FVRD Flood Hazard Bylaw No. 0681-2005, this is the current requirement for development. This FCL is based on the estimated 200-year flood of 15,200 $m^3/s$, which produces a water level of 9.2 m without freeboard at the Subject Property. The value of 10.0 m is 0.2 m higher than 9.2 m plus the 0.6 m freeboard. This difference may be attributed to the specific cross section selected and projected to the Subject Property compared to the isoline on Map 8 of the Bylaws. The information is documented in the *Fraser River Design Flood Level Update – Hope to Mission Final Report, March 2014.* The report was issued by BC Ministry of Forest, Lands, and Natural Resource Operations (MFLNRO) and NHC provided guidance and technical review of the model development work. The report recommends that current development no longer use the 200-year flood as the design criteria but adopt the flood of record, which is the 1894 event that has an estimated discharge of 17,000 $m^3/s$ and is considered to represent approximately the 500-year event. The recurrence of the 1894 flood of record should be adopted as the design flood and this produces a water level at the Subject Property of 10.2 m without freeboard (FLNRO, March 2014).

It is recommended that the influence of Climate Change and Sea Level Rise (SLR) be considered on top of the 500-year design flood. Factoring the Moderate Climate Change Flow Scenario A at the Subject Property increases the water level 0.2 m from 10.2 to 10.4 m (without freeboard). In addition to this, factoring in SLR would increase the water level an additional 1 m from 10.4 m to 11.4 m (without freeboard). Climate Change and SLR are documented in the report *Simulating the Effect of Sea Level Rise and Climate Change on Fraser River Flood Scenarios, May 2014.* The report was issued by MFLNRO and this was a joint project with NHC.

The Moderate Climate Change Flow Scenario A plus 1 m SLR (11.4) is described by MFLNRO as “a plausible scenario for a future standard”. When designing large residential developments with lifespans of many decades this flood level is recommended. For an industrial development, such as the proposed development at Bell Road it would be excessive.

A recurrence of the 1894 flood of record is the Fraser River adopted design flood standard and should be applicable to the Subject Property. The flood corresponds roughly to a 500-year flood and two conservative assumptions are made: 1) All dykes in the Fraser Valley are raised to confine flows except at this location; and, 2) The site is set-back from the river by over 3 km and the flood level is likely lower here than along the river. However, without detailed 2D modeling, the estimate cannot be refined. Note that the Subject Property is 3.1 km from the Fraser River.

Since the FCL calculated on the 1894 flood of record is the adopted standard (10.2 m), it is not recommended designing to the 200-year flood (9.2 m). As noted above, Figure 2 shows the FVRD FCL for the Subject Property as 10.0 m and this includes freeboard. The Subject Property is immediately east (upstream) of the northern end of the Dewdney Dyke and the FCL within the dike to the west is 9.3 m. The March 2018 topographic survey of the Subject Property identified that the crest of the Dewdney Dyke is between 10.1 and 10.2 m.

A freeboard allowance of 0.6 m should be applied to all residential development and critical infrastructure. According to 2004 Land Use Guidelines it is not a requirement for industrial sites, but advisable. At a minimum, all electrical/mechanical equipment and potential pollutants should be installed/placed at a minimum level of 10.2 m plus 0.6 m or above Elev. 10.8 m. The finished floor of any proposed buildings must have an elevation of 10.2 m or higher.

If there were livable space proposed for the development at the Subject Property then it would be appropriate to propose the flood level of 11.4 m plus 0.6 m freeboard for an FCL of 12.0 m. As the proposed development is industrial, then a minimum FCL of 10.2 m would be required but 10.8 m is recommended. This FCL would apply to the entire Subject Property.

# 8 MITIGATION MEASURES

Typical mitigation measures implemented to reduce the effects of a hazardous flood can be generally divided into structural and non-structural measures. Structural mitigation measures include physical structures that separate the hazard from the area to be protected. Examples include dikes, floodwalls and seawalls, bank protection works, and elevated building pads or foundations. Examples of non-structural measures include planning and regulations to avoid the hazard, or to only allow activities and infrastructure in flood-prone areas that won't be damaged during flood events.

It is recommended that an FCL of 10.8 m be adopted for the Subject Property for the proposed industrial building. This FCL would apply to the entire Subject Property. This is based on a water level of 10.2 m representing the 1894 flood of record corresponding to a 500-year flood plus 0.6 m freeboard. This freeboard will also allow for sufficient elevation above the existing surrounding ground to account for potential inundation from flooding or an avulsion from Norrish Creek. In general, all development on fans such as the Norrish Creek fan should have an FCL 0.6 m above the surrounding ground. This value is recommended in the absence of a 2D model that could identify flood depths on the fan from Norrish Creek in the event of an avulsion or breach of the dyke. This recommendation of a FCL 0.6 m above the existing ground on fans is suggested in some of the site specific reports in Section 6 and is also documented in a report prepared by FEMA titled *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures, Appendix D Alluvial Fan Flooding*.

Although not proposed as part of this assessment, for habitable development an FCL of 12.0 m would be recommended and would apply to the entire Subject Property.

The proposed building should include scour protection along the perimeter concrete foundation. This will protect the building from scour from Norrish Creek during an avulsion or dyke over topping as well as scour from extreme flooding from the Fraser River. Potential scour from the river would likely be less than that from the creek. The design criteria for the mitigation includes the following: the scour protection should be durable, angular, quarried rock, which is well-graded with a $D_{50}$ of 350 mm. Rock of this size represents 50 kg riprap class.

The rock should be placed around the proposed concrete foundation walls. The protection should extend to the base of the proposed foundation walls/footings. This protection should be a minimum of 0.6 m thick and a minimum of 1.5 m wide. If the rock is placed on a slope then the slope should be no steeper than 2H:1V. The rock can be covered with soil (e.g., 0.3 m thick) and grass and or landscaping.

Scour would be greatest on the north (upslope) and east (upstream) facing sides of the building from an event on Norrish Creek and less on the west and south sides from an event on the Fraser River. If concrete sidewalks or asphalt parking lots are proposed on the west or south sides of the building, this may suffice for scour protection but would not be suitable for the north and east sides alone.

The proposed development and recommended mitigation measures for flooding and scour will not increase potential natural hazards on other nearby properties or infrastructure nor transfer the potential risk to other properties or infrastructure.

# 9 SUMMARY AND RECOMMENDATIONS

A summary of the natural hazards assessment for the property at 38482 Bell Road, Deroche, BC (the Subject Property) is provided below. Mr. Wojcik is proposing a 40,000 square foot industrial building on the Subject Property. The purpose of the Natural Hazards Assessment is to support the Development Permit, the Building Permit and the Site Specific Exemption applications for the proposed development. Table 1 below provides the estimated average annual probability for potential natural hazards that may impact the Subject Property.

**Table 1. Summary of Natural Hazards Assessment**

| Natural Hazard | Estimated Average Annual Probability |
|---|---|
| Chilliwack River Valley Erosion or Avulsion | n/a |
| Debris Flow | <1:2,000 |
| Debris Flood | Unmitigated <1:200 / Mitigated <1:500 |
| Fraser River and Tributaries Flooding | Unmitigated 1:200 / Mitigated 1:500 |
| Mountain Stream Erosion or Avulsion | Unmitigated <1:200 / Mitigated <1:500 |
| Major Catastrophic Landslide | Not assessed |
| Seismic Effects/Liquefaction | Not assessed |
| Rockfall - Small Scale Detachment | Not assessed |
| Slope Stability | Not assessed |
| Small Scale Localized Landslide | Not assessed |
| Snow Avalanche | Not assessed |
| Tsunami | n/a |

Hazards from the Chilliwack River and tsunamis are not applicable to this site and debris flows are unlikely to occur on Norrish Creek based on the Melton Ratio and the watershed length. Debris flows on tributaries of

Norrish Creek have occurred but have not likely reached the fan area as noted by Westrek (2013). The probability of a debris flow reaching the Subject Property is low at <1:2,000.

Westrek (2013) identified the estimated average annually probability of steep slope related hazards to be <1:10,000 for the gravel pit property which is upslope from the Subject Property and near the toe of the mountainside slopes. Therefore these hazards would likely have even lower probability at the Subject Property. Hence, steep slope related hazards were not specifically assessed for the Subject Property as part of this assessment as the site is approximately 650 m from the toe of the mountain hillsides and is considered a safe distance from the toe.

With respect to seismic effects and liquefaction, Levelton (2008) and Westrek (2013) note that for neigbouring properties the area is subject to soil liquefaction during a design basis earthquake (1:475 return period event). Levelton recommended a site-specific liquefaction assessment be conducted for any future permanent structures for the neighouring property. They also recommend a site specific dynamic analysis to assess the site response spectrum which may also be required for structures falling under Part 9 of the 2006 BC Building Code. The need for dynamic analysis will depend on the extent of liquefiable soils and the type of foundation system employed. Based on this information it would be recommended to conduct a site-specific liquefaction assessment for the Subject Property.

With respect to flood hazards from the Fraser River, the two FLNRO reports from March 2014 and May 2014 were relied upon for determining the flood levels and probabilities for the Fraser River for both unmitigated and mitigated conditions.

The Subject Property is subject to hazards from debris floods, clear water floods and avulsions from Norrish Creek and mitigation to protect from these hazards is recommended. The Subject Property is partially protected from these hazards by the Norrish Creek Dyke but this protection cannot be relied upon as the dyke is a non-standard dyke and is not maintained or protected by a government agency. Also there is a section of the dyke near the fan apex that is not armoured and is eroding. If an avulsion or overtopping of the dyke were to occur then it would likely happen at this location. However, a significant channel avulsion is unlikely to occur at the erosion site because the active channel is approximately 3 m lower than the surface of the fan. If the dyke does fail at this point then it is likely to occur during a period of high flow and not as a result of a complete channel avulsion through this point. Westrek (2013) suggested that the breach could possibility accommodate up to about 1/5 to 1/4 of the total discharge in Norrish Creek, or up to about 100 $m^3/s$ as the $Q_{200}$ is in the 400 to 500 $m^3/s$ range. If the bed of Norrish Creek were to raise several meters due to aggradation then the potential for a complete channel avulsion is more likely. However, it is unlikely that a single event could raise the bed of the creek several meter resulting in a complete avulsion. This suggests that the probability of a complete channel avulsion is unlikely to increase unexpectedly such as during a single event but would occur over time. Westrek (2013) identified that the present annual average probability that a debris flood or flood will breach or overtop the existing dyke and cause flooding on the fan is presently about 1:200. They note that this probability is not random and depends on the rate of erosion of the dyke at the erosion point and aggradation rates in excess of any gravel removal programs.

It is recommended that an FCL of 10.8 m be adopted for the Subject Property for the proposed industrial building. This FCL would apply to the entire Subject Property. This is based on a water level of 10.2 m representing the 1894 flood of record corresponding to a 500-year flood plus 0.6 m freeboard. This freeboard

will also allow for sufficient elevation above the existing surrounding ground to account for potential inundation from flooding or an avulsion from Norrish Creek. In general, all development on fans such as the Norrish Creek fan should have an FCL 0.6 m above the surrounding ground. As shown on the drawings in Appendix A, some elements of the development, such as the loading bay, the driveway (9.0 m) and the parking lot are below the FCL of 10.8 m and this is acceptable. The parking lot slopes away from the building from an elevation of 10.60 m next to the building to 9.76 m at the parking lot adjacent to Bell Road and the loading bay is at an elevation of 9.58 m.

Although not proposed as part of this assessment, for habitable development an FCL of 12.0 m would be recommended and would apply to the entire Subject Property.

The proposed building should include scour protection along the perimeter concrete foundation. This will protect the building from scour from Norrish Creek during an avulsion or dyke over topping as well as scour from extreme flooding from the Fraser River. Potential scour from the river would likely be less than that from the creek. The design criteria for the mitigation includes the following: the scour protection should be durable, angular, quarried rock, which is well-graded with a $D_{50}$ of 350 mm. Rock of this size represents 50 kg riprap class. The rock should be placed around the proposed concrete foundation walls. The protection should extend to the base of the proposed foundation walls/footings. This protection should be a minimum of 0.6 m thick and a minimum of 1.5 m wide. If the rock is placed on a slope then the slope should be no steeper than 2H:1V. The rock can be covered with soil (e.g., 0.3 m thick) and grass and or landscaping.

Scour would be greatest on the north (upslope) and east (upstream) facing sides of the building from an event on Norrish Creek and less on the west and south sides from an event on the Fraser River. If concrete sidewalks or asphalt parking lots are proposed on the west or south sides of the building, this may suffice for scour protection but would not be suitable for the north and east sides alone.

Prior to construction it is recommended to have a suitable professional review the overall building design and perimeter layout to see how the recommended FCL and scour protection design has been incorporated and if suitable protection is in place on the west and south sides in the possible absence of riprap. A suitable professional should also inspect the site grading, and construction of the foundation and scour protection during construction. If these steps are taken to involve a suitable professional then operation and maintenance actions for the mitigation will likely not be required unless significant changes occur in the future to the proposed structure and perimeter area.

Flood hazards may arise from local surface water management and site drainage. Such localised hazard is not discussed in this study but is addressed within the stormwater management plan (i.e., the proposed building drainage plan) (Appendix A). Site drainage is not part of the Natural Hazards Assessment but has been mentioned only as a possible control on the local FCL.

The Geohazards Assurance Statement for Development Approvals has been completed for this project and is included in Appendix E.

Schedule C – Guidelines for Application for Site Specific Exemption from the City of Chilliwack Floodplain Regulation Bylaw 2004, No. 3080 is provided in Appendix F.

# 10 SAFE CERTIFICATION

The proposed development and recommended mitigation measures for flooding and scour will not increase potential natural hazards on other nearby properties or infrastructure nor transfer the potential risk to other properties or infrastructure. The author of this report certifies that the Subject Property is considered safe for the use intended if the recommendations are adhered to for the specific components of the development proposal as summarized below:

1. An FCL of El. 10.8 m is to be adopted for the industrial building and an FCL of 12.0 m is to be adopted for any part of the building used for habitation.
2. The FCL for the building should be 0.6 m above the surrounding ground. Below FCL elements of the project include the loading bay, the parking lot and the driveway.
3. The scour protection design includes using 50 kg class riprap, which should be incorporated along the perimeter of the building.
4. Any below grade infrastructure should be designed with safe unobstructed egress up to the FCL to avoid potential entrapment during a flood or lack of electrical power.
5. The underside of any wooden floor system, or the top of any concrete flood system used for habitation, business, the storage of goods damageable by floodwaters, or the installation of fixed equipment is above the FCL.
6. Prior to construction a suitable professional should review the overall building design and perimeter layout to see how the recommended FCL and scour protection design has been incorporated. Also a suitable professional should inspect the site grading, and construction of the foundation and scour protection during construction.
7. Short- and long-term maintenance, if required, for the flood protection works are outlined by a qualified registered professional and these requirements are followed by the owner/operator of the property.
8. Any future flood works constructed on the Subject Property or by others on nearby properties does not concentrate or direct flow towards the proposed building or Subject Property.
9. Site drainage and seepage mitigation internal to the property are designed by a qualified registered professional. This mitigation has not been addressed as part of this assessment and is included in the building and site drawings (Appendix A).
10. Final building plans and as-built conditions have been assessed and approved for compliance with the conditions specified herein by a qualified registered professional.

# 11 CLOSURE

The author trusts this work and report meets your current needs. If you have any questions or would like to further discuss these findings, please do not hesitate to contact Jamie Stirling by email (Jamie@stirlinggeoscience.com) or by telephone (604) 349-7709.

Sincerely,

**Stirling Geoscience**

Prepared by:


Jamie Stirling, M.Sc. P.Geo.
Principal Consultant

Reviewed by:


Derek Ray, M.Sc., P.Geo.
Principal
Northwest Hydraulic Consultants Ltd.

## DISCLAIMER

This document has been prepared by Stirling Geoscience in accordance with generally accepted geoecience and engineering practices and is intended for the exclusive use and benefit of WFS Pharmagreen Inc. and their authorized representatives for specific application to the natural hazards assessment at 38482 Bell Road, Deroche, BC.

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# APPENDIX A

# 38482 BELL ROAD – SCHEMATIC DRAWINGS FROM GARY FIELDS ARCHITECTURE INTERIOR DESIGN PLANNING INC.

## PROPERTY INFORMATION

| | |
|---|---|
| CIVIC ADDRESS | 38482 BELL ROAD, DEROCHE, BC |
| LEGAL DESCRIPTION | PLAN NUMBER 29269, LOT NUMBER 4, PID 009-064-885 |
| ORIGINAL SURVEY INFORMATION TAKEN FROM: | PLAN OF SURVEY BY AXIS LAND SURVEYING LTD., DATED ___ |
| EXISTING BUILDING INFORMATION FROM OWNER: | N/A |
| EXISTING TENANT IMPROVEMENT INFORMATION SUPPLIED BY OWNER | N/A |
| DATES OF ORIGINAL CONSTRUCTION | N/A |

## GENERAL DESCRIPTION

| | |
|---|---|
| DESCRIPTION | PHARMACEUTICAL-TYPE LABORATORY FACILITY FOR BOTANICAL TISSUE CULTURE |
| CONSTRUCTION | NONCOMBUSTIBLE - STEEL |
| BUILDING GROSS FLOOR AREA | 4,933.2m² / 53,100sf |
| OFF-STREET PARKING | OFF-STREET PARKING PROVIDED |

## ZONING BY-LAW ANALYSIS

| | |
|---|---|
| AGRICULTURAL LAND RESERVE | PROPERTY IS NOT LOCATED WITHIN AGRICULTURAL LAND RESERVE. |
| APPLICABLE OFFICIAL COMMUNITY PLAN | FRASER VALLEY REGIONAL DISTRICT OFFICIAL COMMUNITY PLAN FOR ELECTORAL AREA "G", BYLAW NO. 0866, 2008 |
| OCP DESIGNATED USE | LIMITED USE (LU) |
| APPLICABLE ZONING BYLAW | DEWDNEY-ALOUETTE REGIONAL DISTRICT LAND USE AND SUBDIVISION REGULATION BYLAW NO. 559, 1992 |
| MINIMUM PARCEL SIZE | 8.0 HECTARES |
| ACTUAL PARCEL SIZE | 9.0 HECTARES |
| SITE COVERAGE PERMITTED | 30% |
| SITE COVERAGE ACTUAL | 5.1% |
| SCREENING | NOT APPLICABLE / NO RESOURCE USE |

| | |
|---|---|
| PART 400, SECTION 414 | 1(b) MEDICAL MARIHUANA GROW OPERATION PERMITTED IN R-3 ZONE EXCEPT WITHIN ELECTORAL AREA "F" AS INCICATED ON SCHEDULE "D" MAP (BYLAW 1257, 2014) |

PART 409, ACCESSORY OFF-STREET PARKING USE

| USE | PARKING REQUIREMENT | PARKING PROVIDED |
|---|---|---|
| GENERAL COMMERCIAL | 2 SPACES @ 2.8m X 6.0m PER 35m² OF GROSS FLOOR AREA, NOT INCLUDING MECHANICAL, STORAGE | REFER TO SCHEDULES ON ARCHITECTURAL DRAWINGS |
| GENERAL INDUSTRIAL | 2 SPACES @ 2.8m X 6.0m PER 200m² OF GROSS FLOOR AREA, NOT INCLUDING MECHANICAL, STORAGE | REFER TO SCHEDULES ON ARCHITECTURAL DRAWINGS |
| LOADING SPACE | 1 SPACE @ 3.2m X 10.7m REQUIRED IF MORE THAN 10 PARKING SPACES REQUIRED | REFER TO SCHEDULES ON ARCHITECTURAL DRAWINGS |
| DISABLED PERSONS' PARKING SPACES | 1 SPACE @ 3.8m X 6.0m PER 50 PARKING SPACES PROVIDED NEAR BUILDING ENTRY | REFER TO SCHEDULES ON ARCHITECTURAL DRAWINGS |

PARKING GENERAL DESIGN STANDARDS

| | | |
|---|---|---|
| GENERAL COMMERCIAL | DESIGN AND INSTALL TO COMPLY WITH SCHEDULE B1 OR B2 AS MINIMUM STANDARD 90 DEGREE PARKING SPACE 2.8m X 6.0m 90 DEGREE AISLE 7.8m | REFER TO SCHEDULES ON ARCHITECTURAL DRAWINGS |
| PARKING, LOADING AND DRIVEWAY SURFACING | ASPHALT OR OTHER DURABLE DUST-FREE MATERIAL, WHEEL STOPS, PAINTED LINES IF HARD SURFACE | |

PART 409, SITING FOR BUILDINGS, STRUCTURES AND USES

| | | |
|---|---|---|
| ALL BUILDINGS AND STRUCTURES | SETBACK | NOT LESS THAN 6.0m |
| GENERAL INDUSTRIAL USES | SETBACK | NOT LESS THAN 15m |

| | | |
|---|---|---|
| BUILDING HEIGHT | MAXIMUM HEIGHT | 11.0m ABOVE GRADE |
| | "EAVE LINE" OF PRINCIPAL ROOF | 9.0m ABOVE GRADE |

PART 603, RURAL R-3 ZONE

| | |
|---|---|
| CURRENT ZONING | RURAL 3 (R-3), MEDICAL MARIHUANA USE PERMITTED UNDER SECTION 414, SECTION 414 BYLAW #1257, 2014 |
| | 414.1(b) MEDICAL MARIHUANA GROW OPERATION PERMITTED IN R-3 ZONE EXCEPT WITHIN ELECTORAL AREA "F" AS INCICATED ON SCHEDULE "D" MAP (BYLAW 1257, 2014) |
| PROPOSED ZONING | RURAL 3 (R-3), MEDICAL MARIHUANA USE |
| MINIMUM PARCEL SIZE | 8.0 HECTARES |
| ACTUAL PARCEL SIZE | 9.0 HECTARES |
| SITE COVERAGE PERMITTED | 30% |
| SITE COVERAGE ACTUAL | 5.2% = 4,645.8 m² BUILDING COVERAGE / 90,000 m² LOT AREA |
| EXISTING BUILDING GROSS FLOOR AREA | 0m2 / 0sf (EXISTING BUILDINGS/STRUCTURES TO BE DEMOLISHED) |
| MAXIMUM BUILDING GROSS FLOOR AREA | NO MAXIMUM |



| | |
|---|---|
| PROPOSED BUILDING GROSS FLOOR AREA | 4,389.7m2 / 47,250sf |
| SCREENING | NOT REQUIRED FOR PROPOSED USES / NO RESOURCE USES |
| DEVELOPMENT PERMIT AREAS | · PORTION OF PROPERTY IS LOCATED WITHIN DEVELOPMENT PERMIT AREA 1-G (GEOLOGIC & STREAM HAZARD HAZARD DPA). GEOTECHNICAL HAZARD ASSESMENT AND DEVELOPMENT PERMIT REQUIRED PRIOR TO CONSTRUCTION, ALTERATION OF LAND OR SUBDIVISION.<br>· PROPERTY LOCATED WITHIN DEVELOPMENT PERMIT AREA 2-B (RIPARIAN AREAS DPA). RIPARIAN ASSESSMENT AND DEVELOPMENT PERMIT REQUIRED PRIOR TO RESIDENTIAL, COMMERCIAL, INSTITUTIONAL OR INDUSTRIAL USES HAVING CONSTRUCTION, ALTERATION OF LAND, OR SUBDIVISION WITHIN 30 METRES OF A WATERCOURSE. |
| FLOODPLAIN BYLAW | · PROPERTY IS IN FRASER RIVER FLOODPLAIN IN AN UNDYKED AREA PURSUANT TO "FRASER VALLEY REGIONAL DISTRICT FLOODPLAIN MANAGEMENT BYLAW 0681, 2005"<br>· PROPERTY IS IN AN ALLUVIAL FAN HAZARD AREA. DEVELOPMENT SUBJECT TO SECTION 56 OF THE COMMUNITY CHARTER (A SITE SPECIFIC GEOTECHNICAL HAZARD ASSESSMENT WOULD NEED TO BE COMPLETED AND REGISTERED ON TITLE) AND/OR SECTION 920 OF THE LOCAL GOVERNMENT ACT. THE HAZARD ASSESSMENT SAME AS THAT CONDUCTED TO SATISFY THE DEVELOPMENT PERMIT DPA 1-G REQUIREMENT ABOVE.<br>· FLOOD PROTECTION REGULATIONS IN THE BYLAW DO NOT APPLY TO ALLUVIAL FANS. HOWEVER, FLOOD PROTECTION REGULATIONS SHOULD BE TAKEN INTO CONSIDERATION WHERE DEVELOPMENT IS PROPOSED ON ALLUVIAL FANS.<br>· FLOODPLAIN BYLAW STATES THAT "NO BUILDING OR STRUCTURE IS PERMITTED TO BE CONSTRUCTED IN THE DESIGNATED FLOODPLAIN OF THE FRASER RIVER OUTSIDE THE AREA PROTECTED BY THE DEWDNEY DYKE AND NICOMEN ISLAND DYKE". SITE SPECIFIC EXEMPTION REQUIRED. COMPREHENSIVE HYDROLOGICAL HAZARD ASSESSMENT IS REQUIRED TO BE DONE BY A PROFESSIONAL ENGINEER OR PROFESSIONAL GEOSCIENTIST SPECIALIZED IN HYDROLOGICAL ENGINEERING FOR LARGE RIVER SYSTEMS. |
| MEDICAL MARIJUANA USE | · FRASER VALLEY REGIONAL DISTRICT ZONING BYLAW 559, AMENDMENT BYLAW NO. 1257, 2014 INCLUDES A DEFINITION FOR MEDICAL MARIHUANA GROW OPERATION AS FOLLOWS: "MEDICAL MARIHUANA GROW OPERATION MEANS THE CULTIVATION, GROWTH, STORAGE, DISTRIBUTION, TESTING OR RESEARCH OF MARIHUANA FOR MEDICAL PURPOSES AS LAWFULLY PERMITTED AND AUTHORIZED UNDER THE APPLICABLE FEDERAL OR PROVINCIAL LAWS."<br>· ZONING AMENDMENT BYLAW NO. 1257 ALSO AMENDED THE LIST OF PERMITTED USES IN THE RURAL 3 (R-3) ZONE TO INCLUDE MEDICAL MARIHUANA GROW OPERATION AS A PERMITTED USE FOR PROPERTIES WITHIN THAT DESIGNATION. MEDICAL MARIHUANA GROW OPERATIONS, AS DEFINED ABOVE, AREA CONSIDERED A PERMITTED USE FOR 38482 BELL ROAD, ELECTORAL AREA "G".<br>· PLEASE NOTE THAT SPECIFIC PVRD DEVELOPMENT REQUIREMENTS, INCLUDING BUILDING PERMITS AND DEVELOPMENT PERMITS, WILL BE REQUIRED WITH ANY NEW CONSTRUCTION, ADDITION TO EXISTING STRUCTURES, OR CHANGE IN OCCUPANCY TO EXISTING STRUCTURES TO PERMIT A RESEARCH OR PRODUCTION FACILITY FOR MEDICAL MARIHUANA. |
| BUILDING PERMIT REQUIREMENTS | FRASER VALLEY REGIONAL DISTRICT DEVELOPMENT REQUIREMENTS, INCLUDING BUILDING PERMITS AND DEVELOPMENT PERMITS REQUIRED FOR NEW CONSTRUCTION, ADDITION TO EXISTING STRUCTURES, OR CHANGE IN OCCUPANCY TO EXISTING STRUCTURES TO PERMIT A RESEARCH OR PRODUCTION FACILITY FOR MEDICAL MARIHUANA. |

1 (00) ZONING & CODE ANALYSIS
A00A



## BUILDING CODE ANALYSIS

| | |
|---|---|
| APPLICABLE CODES AND STANDARDS | APPLICABLE BUILDING CODE IS BRITISH COLUMBIA BUILDING CODE 2012. BCBC 1.3.3.2. DESIGN AND CONSTRUCTION OF BUILDING SHALL COMPLY WITH PART 3. |
| RECORD DRAWINGS AND DOCUMENTS | Choose an item. |
| EXISTING USES IN BUILDING | Choose an item. |
| PROPOSED USES | LOW-HAZARD INDUSTRIAL |

| PROPOSED BCBC 3.1.2.1. MAJOR OCCUPANCY CLASSIFICATIONS | MAJOR OCCUPANCY | USE |
|---|---|---|
| EXISTING | N/A | |
| NEW | GROUP F3 - LOW-HAZARD INDUSTRIAL | BOTANICAL TISSUE CULTURE LABORATORY |

## FACTORS DETERMINING CONSTRUCTION REQUIREMENTS

BUILDING CLASSIFICATION - EXISTING BUILDING

BCBC2012 3.2.2.4. BUILDINGS WITH MULTIPLE MAJOR OCCUPANCY GROUPS; AND 3.2.2.6. MULTIPLE MAJOR OCCUPANCIES

| MOST RESTRICTIVE MAJOR OCCUPANCY | SUBSECTION 3.2.2 CLASSIFICATION | BUILDING AREA | IF BUILDING HEIGHT NOT MORE THAN | NUMBER STREETS FACED | CONSTRUCTION TYPE | FLOOR ASSEMBLIES (FRR) | ROOF ASSEMBLIES | SUPPORTING CONSTRUCTION |
|---|---|---|---|---|---|---|---|---|
| NEW GROUP F3 - LOW-HAZARD INDUSTRIAL | BCBC 3.2.2.85. GROUP F DIVISION 3, ONE STOREY | MAX. 7,000m²<br>ACTUAL: 5,421.2m² | 1 STOREYS<br>1 ACTUAL | 2 MIN.<br>N/A | NONCOMBUSTIBLE<br>ACTUAL: COMBUSTIBLE | N/A<br>NO REQUIREMENT<br>ACTUAL: __min FRR | N/A<br>ACTUAL: ___ | SAME AS SUPPORTED CONSTRUCTION<br>ACTUAL: COMBUSTIBLE __min FRR |

NOTES:

## SEPARATION OF MAJOR OCCUPANCIES / OTHER FIRE SEPARATIONS / COMPARTMENTATION

| | | | |
|---|---|---|---|
| BCBC2012 3.1.3. MULTIPLE OCCUPANCY REQUIREMENTS | AREA /ROOM<br>A2 TO A2 | [-] FIRE SEPARATION RATING (FR[ ]<br>N/A | CODE REFERENC[ ]<br>BCBC 3.1.3.1.(1) |

| | | |
|---|---|---|
| BCBC2012 3.6.2.1. FIRE SEPARATIONS AROUND SERVICE ROOMS | AREA /ROOM | FIRE SEPARATION RATING (FRR) & CODE REFERENCE |
| | SERVICE ROOMS CONTAINING FUEL-FIRED APPLIANCE | 1h FRR / BCBC2012 3.6.2.1.(1) |
| | FUEL-FIRED APPLIANCE SERVING ONLY ONE ROOM OR SUITE | NO SERVICE ROOM SEPARATION REQUIRED / BCBC2012 3.6.2.1.(2) |
| | SERVICE ROOMS CONTAINING EQUIPMENT THAT USES A LIQUID HAVING A **FLASH POINT** BELOW 93.3°C | 1h FRR / BCBC2012 3.2.6.1.(5) |



| | | |
|---|---|---|
| | SERVICE ROOMS FOR ELECTRICAL EQUIPMENT REQUIRED TO BE LOCATED IN A SERVICE ROOM AS PER BC ELECTRICAL SAFETY REGULATION | 1h FRR / BCBC2012 3.2.6.1.(6) |
| | IN UNSPRINKLERED STOREY, SERVICE ROOMS CONTAINING SERVICE EQUIPMENT NOT ADDRESSED ABOVE | 1h FRR / BCBC2012 3.2.6.1.(7) |
| | ELECTRICAL CLOSET / NON FIRE SAFETY EQUIPMENT | NO FIRE SEPARATION / BCBC2012 3.2.6.1.(8) |
| | OTHER SERVICE ROOMS HAVING NO SERVICE EQUIPMENT WHICH CONSTITUTES A FIRE HAZARD AND NO FIRE SAFETY SYSTEMS | NO RATING BCBC2012 3.6.2.1.(8) |
| | ROOF-TOP APPLIANCE | NO FIRE SEPARATION / BCBC2012 3.2.6.1.(10) |

## BCBCB2012 3.3.1.1. SEPARATION OF SUITES / BCBC 2012 3.3.1.4. PUBLIC CORRIDOR SEPARATIONS

| | | |
|---|---|---|
| BCBC2012 3.3.1.1.(1) SEPARATION OF SUITES | SUITE SEPARATIONS | BCBC2012 3.3.1.1.(2) FIRE SEPARATION 45min FRR WHERE FLOOR ABOVE IS LESS THAN 1h FRR, OR NO FLOOR ABOVE |
| BCBC2012 3.3.1.4. PUBLIC CORRIDOR SEPARATIONS | CORRIDOR SEPARATION IS A FIRE SEPARATION | BCBC2012 3.3.1.4.(1) PUBIC CORRIDOR SEPARATED FROM REMAINDER OF STOREY BY FIRE SEPARATION |
| | CORRIDOR FIRE SEPARATION 45min FRR EXCEPT AS PERMITTED BY 3.3.1.4.(3)OR(4) | BCBC2012 3.3.1.4.(2) CORRIDOR FIRE SEPARATION NOT LESS THAN 45min FRR |
| | CORRIDOR SEPARATION WITH NO FRR IN SPRINKLERED STOREY | NOT APPLICABLE |
| | CORRIDOR SEPARATION NOT A FIRE SEPARATION IN SPRINKLERED FLOOR AREA | NOT APPLICABLE |
| | WASHROOM TO CORRIDOR SEPARATION IN SPRINKLERED FLOOR AREA | NOT APPLICABLE |

## BCBC2012 3.3., 3.4. EGRESS AND EXIT SYSTEMS

| | | |
|---|---|---|
| BCBC2012 3.3.1.9.(1) | CORRIDOR WIDTH | MINIMUM WIDTH OF PUBLIC CORRIDOR 1100MM. |
| BCBC2012 3.3.1.13 | DOORS IN ACCESS TO EXIT PATHS | DOORS IN ACCESS TO EXIT PATHS TO PROVIDE CLEAR WIDTH NOT LESS THAN 800MM. |
| BCBC2012 3.4.1.2.(1) | EXITS SEPARATED | TWO SEPARATE EXITS. EACH EXIT SEPARATE FROM EVERY OTHER EXIT LEADING FROM EACH FLOOR AREA. |
| BCBC2012 3.4.2.1. | AT LEAST 2 EXITS | EVERY FLOOR AREA SHALL BE SERVED BY AT LEAST 2 EXITS. |
| BCBC2012 3.4.2.3.(1)(B) | DISTANCE BETWEEN EXITS | DISTANCE BETWEEN EXITS NOT LESS THAN ½ DIAGONAL AND NOT LESS THAN 9m. |
| BCBC2012 3.4.2.4. | TRAVEL DISTANCE PERMITTED TO BE MEASURED FROM EGRESS DOOR OF SUITE OR ROOM SEPARATED FROM FLOOR AREA BY A FIRE SEPARATION | 45min FRR FIRE SEPARATION WHERE BUILDING NOT SPRINKLERED THROUGHOUT |
| BCBC2012 3.4.3.2. | EXIT WIDTH | CAPACITY OF ACCESS TO EXIT / EXIT WIDTHS BASED ON 6.1MM/PERSON FOR DOORWAYS, CORRIDORS. |



## BCBC2012 3.2.7. MINIMUM LIGHTING REQUIREMENTS

| | AREA | AVERAGE LEVEL OF ILLUMINATION AT FLOOR (LUX): |
|---|---|---|
| BCBC2012 3.2.7.3.(1) | EXITS, PUBLIC CORRIDORS, CORRIDORS PROVIDING ACCESS TO EXIT FOR THE PUBLIC | 10 |
| | EMERGENCY LIGHTING MINIMUM (LUX): | 10 |
| | EXITS | 10 |
| | PRINCIPAL ACCESS TO EXIT ROUTES | 10 |
| | PUBLIC CORRIDORS/CORRIDORS USED BY PUBLIC | 10 |
| | AREAS WHERE OCCUPANTS MAY CONGREGATE | 10 |
| BCBC2012 3.2.7.3.(2) | SERVICE SPACE | 10 |
| BCBC2012 3.2.7.4.(1)(iii) | EMERGENCY LIGHTING POWER | NOT LESS THAN 30min BY BATTERY OR GENERATOR. |

## BCBC2012 3.2.4. FIRE ALARM AND DETECTION SYSTEMS

| | |
|---|---|
| BCBC2012 3.2.4.1. | NO AUTOMATIC SPRINKLER SYSTEM - FIRE ALARM SYSTEM NOT REQUIRED. |
| BCBC2012 3.2.4.2.(2) | MULTIPLE MAJOR OCCUPANCIES - SINGLE FIRE ALARM SYSTEM SHALL SERVE ALL OCCUPANCIES. |
| BCBC2012 3.2.4.2.(3) | FIRE ALARM SYSTEM SHALL BE INSTALLED THROUGHOUT THE BUILDING. |

NOTES:

## BCBC2012 3.1.17.1. OCCUPANT LOAD, 3.4.3.1. EXIT WIDTH BASED ON OCCUPANT LOAD

| | |
|---|---|
| BCBC2012 3.1.17.1 & 3.4.3.1. | REFER TO SCHEDULES AND NOTES ON THIS DRAWING SHEET. |

## BCBC2012 3.7.2.2. WATER CLOSETS

| | |
|---|---|
| BCBC2012 3.7.2.2. | REFER TO SCHEDULES AND NOTES ON THIS DRAWING SHEET.<br>ADDITIONAL NOTES: |

## BCBC2012 3.8. BARRIER-FREE DESIGN

| | | |
|---|---|---|
| BCBC2012 3.8.2.1.(1) | BARRIER-FREE DESIGN | BARRIER-FREE DESIGN REQUIREMENTS APPLY TO THE BUILDING. |
| BCBC 3.8.1.1.(3) | ACCESS IN ALTERATIONS AND CHANGE OF OCCUPANCY | (BCBC) ACCESS SHALL BE PROVIDED TO ALTERATIONS, ADDITIONS AND CHANGES IN OCCUPANCY TO THE EXTENT REQUIRED IN SUBSECTION 3.8.4. |



| | | |
|---|---|---|
| BCBC2012 3.8.4.5. | ALTERATIONS AND OCCUPANCY CHANGE | (BCBC) ACCESS SHALL BE PROVIDED TO ALTERATIONS, ADDITIONS AND CHANGES IN OCCUPANCY TO THE EXTENT REQUIRED IN SUBSECTION 3.8.4.<br>WHERE AN EXISTING BUILDING IS ALTERED OR RENOVATED, OR WHERE THE OCCUPANCY IS CHANGED, ACCESS SHALL BE PROVIDED IN CONFORMANCE WITH SUBSECTIONS 3.8.2. AND 3.8.3. WHERE<br>a) PERSONS WITH DISABILITIES COULD REASONABLY BE EXPECTED TO BE EMPLOYED IN, OR COULD REASONABLY BE EXPECTED TO USE, SUCH AN OCCUPANCY OR BUILDING, AND<br>b) PROVIDING SUCH ACCESS WOULD BE PRACTICAL. |
| BCBC 3.8 ... | BARRIER-FREE PATH OF TRAVEL | (BCB2012) BARRIER-FREE DESIGN REQUIREMENTS NOT APPLICABLE |
| BCBC 3.8.3.3. | MAIN ENTRANCE | (BCB2012) BARRIER-FREE DESIGN REQUIREMENTS NOT APPLICABLE |
| BCBC 3.8.3.3. | CLEAR AND LEVEL AREA AT ENTRANCE DOOR | (BCB2012) BARRIER-FREE DESIGN REQUIREMENTS NOT APPLICABLE |
| BCBC 3.8.3.3 | RAMPS | (BCB2012) BARRIER-FREE DESIGN REQUIREMENTS NOT APPLICABLE |
| BCBC2012 3.8.3.5(4) | POWER DOOR OPERATOR | (BCB2012) BARRIER-FREE DESIGN REQUIREMENTS NOT APPLICABLE |
| BCBC 3.8.5.3.(3) | DOORWAYS | (BCB2012) BARRIER-FREE DESIGN REQUIREMENTS NOT APPLICABLE |
| BCBC2012 3.8.2.3. | WASHROOMS | (BCB2012) BARRIER-FREE DESIGN REQUIREMENTS NOT APPLICABLE<br>ADDITIONAL NOTES: NONE |



(00) INDEX - ARCHITECTURAL DRAWING SHEETS



| REV. | DATE | ISSUED FOR |
|---|---|---|

REVISION SCHEDULE

Registered Professional

DRAFT
ISSUED FOR:
DESIGN DRAWINGS 4/24/2018 11:41:15 AM
NOT FOR OFFICIAL USE

GARY FIELDS ARCHITECTURE INTERIOR DESIGN PLANNING INC
Gary Fields, Owner
Architect AIBC, MRAIC, LEED®AP
tel 604-947-9740
cel 604-868-8227
fax 1-866-826-4244
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www.garyfields.ca

DO MORE WITH LESS®
1225 Adams Road, Bowen Island
British Columbia V0N 1G2 CANADA
web

Owner

38482 BELL ROAD, DEROCHE, BC

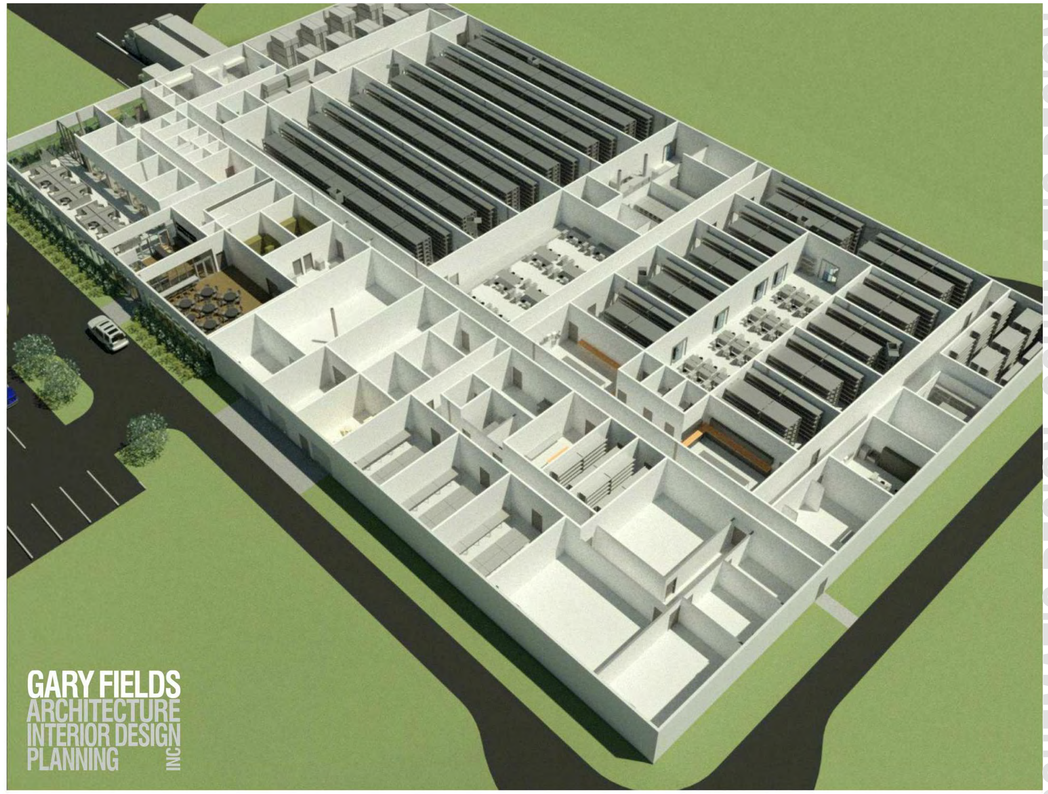
| | |
|---|---|
| GF Project Number | 1811 |
| Original Scale | 12" = 1'-0" |
| Plot Date | 4/24/2018 11:41:15 AM |
| Original Sheet Size | Arch D 24 x 36 |

ZONING & CODE ANALYSIS

PROJECT NORTH

A00A

P:\1811 34842 Bell Road Deroche BC\A Design\04 Drawings\01 Current\1811 Drawings.rvt





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| Plot Date | 4/24/2018 11:41:21 AM |
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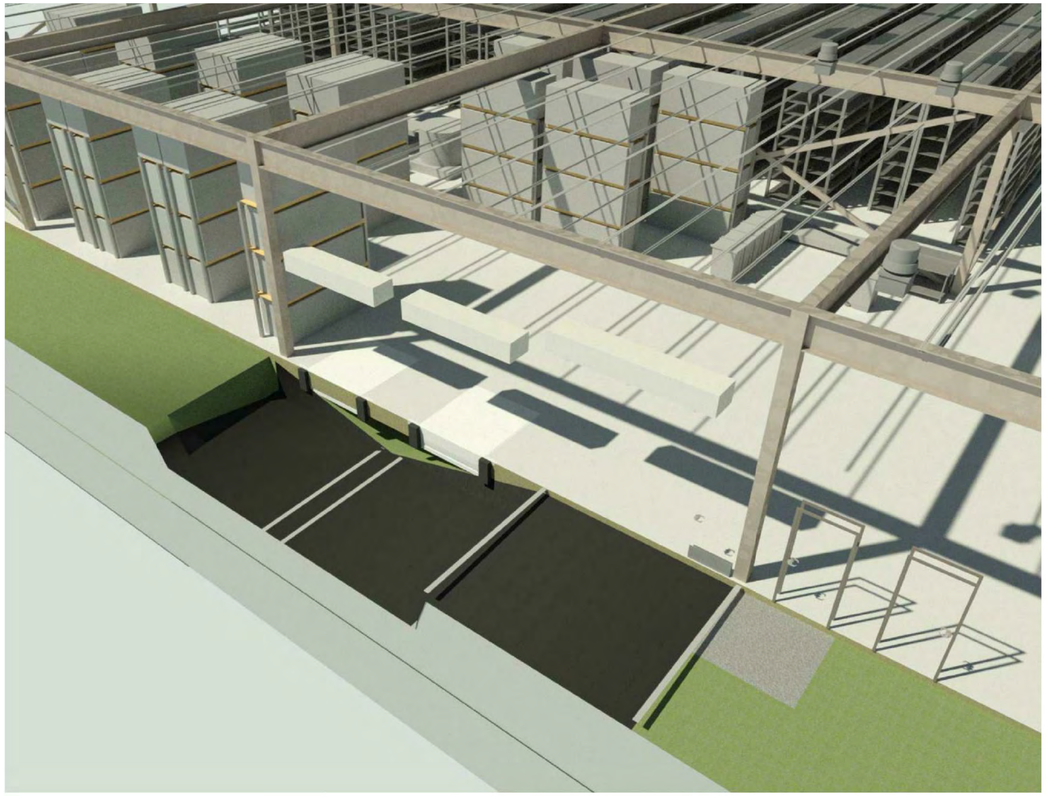
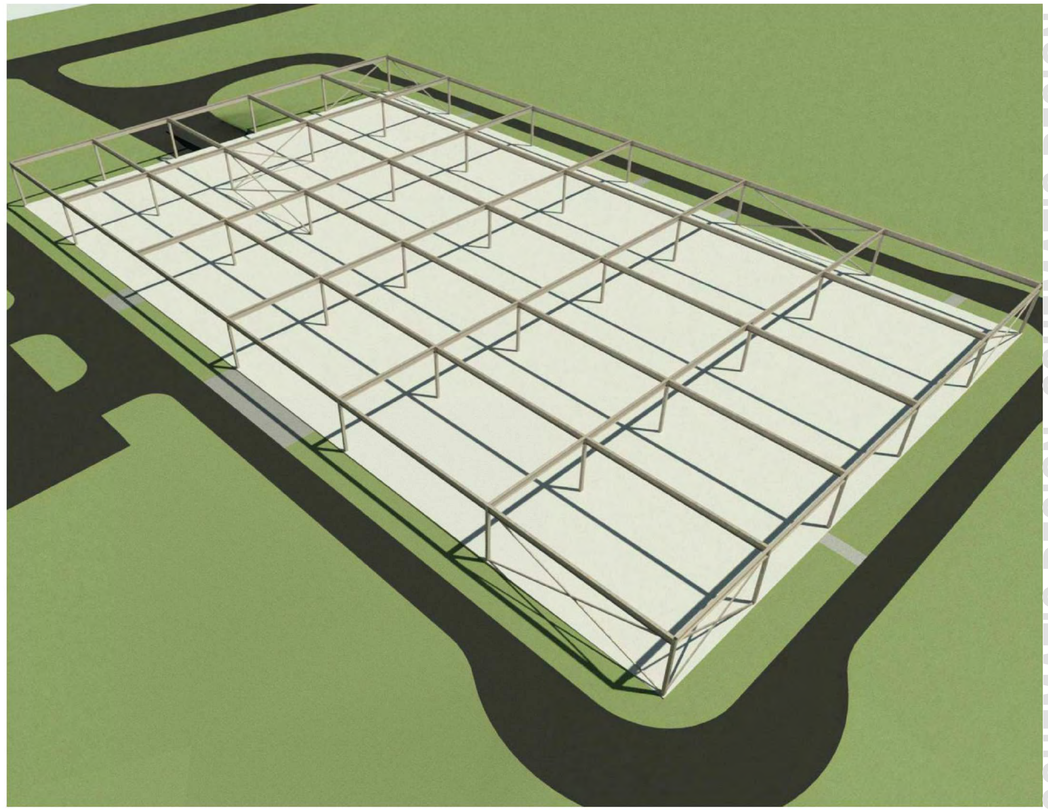
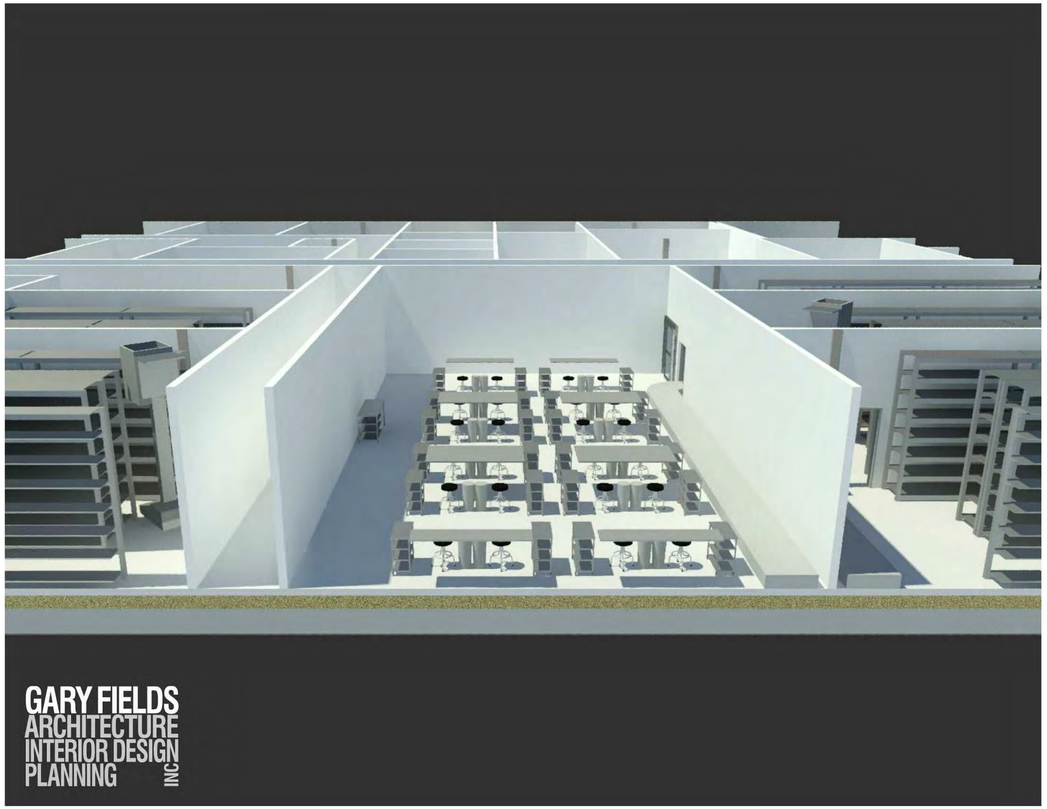
3D VIEWS

PROJECT NORTH

A01







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SCHEMATIC DESIGN



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3D VIEWS

PROJECT NORTH

# A01A

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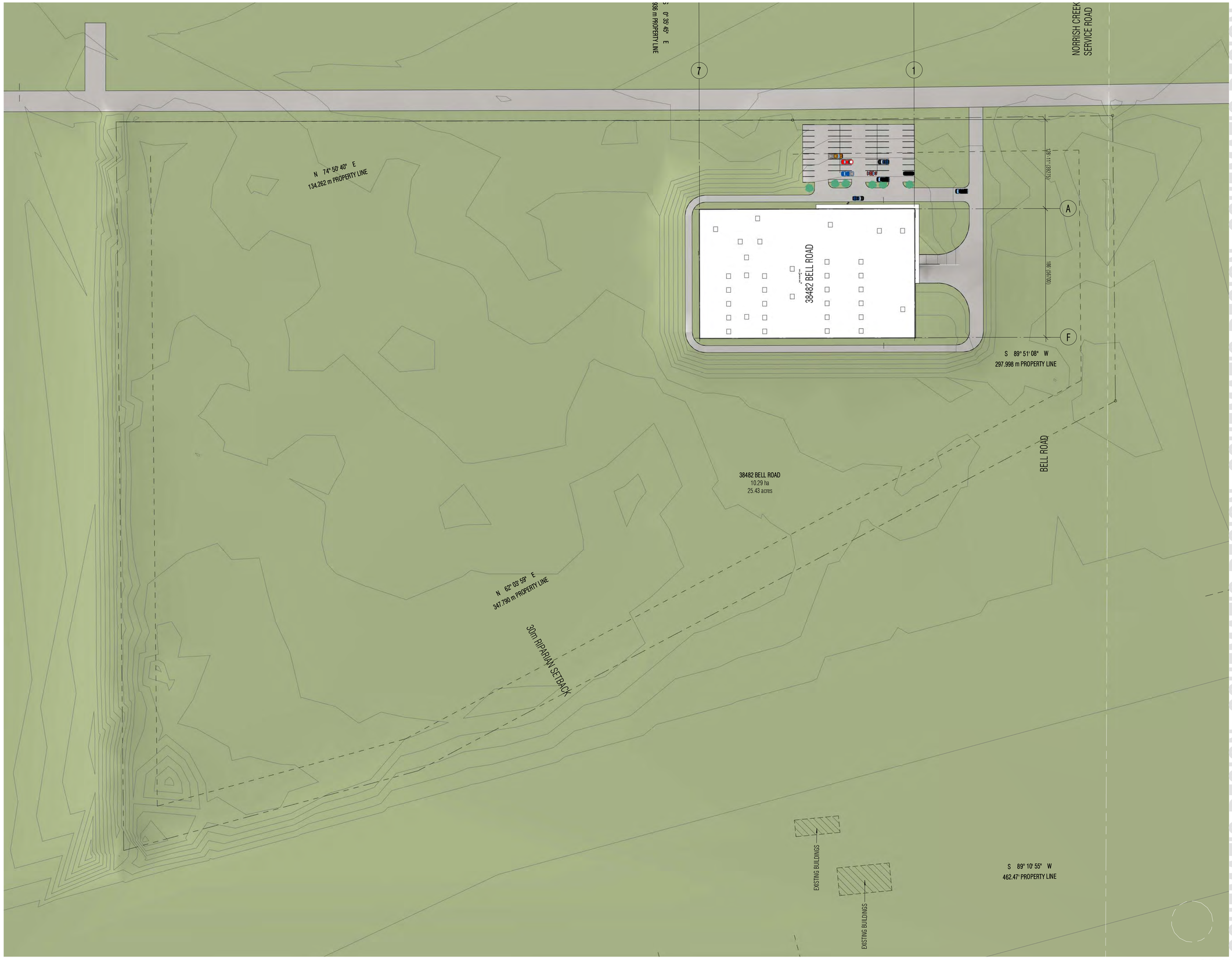


SCHEMATIC DESIGN SCHEMATIC DESIGN SCHEMATIC DESIGN



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| Plot Date | 4/24/2018 11:41:30 AM |
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SITE PLAN

PROJECT NORTH

A02B


1 DETAIL SITE PLAN
Scale: 1/32" = 1'-0"
A02C

### (00) PARKING CALCULATION - GENERAL COMMERCIAL

| ROOM NUMBER | ROOM NAME | NET AREA | NET AREA PER STALL IN PARKING BYLAW | PARKING STALLS REQUIRED |
|---|---|---|---|---|
| BUSINESS OFFICE | | | | |
| 119 | B/F TOILET | 4.5 m² | 17.50 m² | 0.3 |
| 122 | BOARD ROOM | 44.1 m² | 17.50 m² | 2.5 |
| 116 | CLOS | 1.3 m² | 17.50 m² | 0.1 |
| 111 | CORRIDOR | 27.2 m² | 17.50 m² | 1.6 |
| 113 | IT/COMM | 3.3 m² | 17.50 m² | 0.2 |
| 121 | KITCHENETTE | 5.2 m² | 17.50 m² | 0.3 |
| 120 | OFFICE MACHINES | 8.8 m² | 17.50 m² | 0.5 |
| 105 | OPEN OFFICE | 173.6 m² | 17.50 m² | 9.9 |
| 115 | PASSAGE | 2.4 m² | 17.50 m² | 0.1 |
| 118 | PASSAGE | 3.3 m² | 17.50 m² | 0.2 |
| 104 | RECEPTION | 8.9 m² | 17.50 m² | 0.5 |
| 107 | SENIOR MGMT | 15.8 m² | 17.50 m² | 0.9 |
| 110 | SENIOR MGMT | 21.9 m² | 17.50 m² | 1.2 |
| 109 | SENIOR MGMT | 18.3 m² | 17.50 m² | 1.0 |
| 108 | SENIOR MGMT | 18.3 m² | 17.50 m² | 1.0 |
| 106 | SENIOR MGMT | 15.8 m² | 17.50 m² | 0.9 |
| 117 | TOILET | 3.9 m² | 17.50 m² | 0.2 |
| 112 | TRAINING OR RECORDS | 20.7 m² | 17.50 m² | 1.2 |
| TOTALS | | 397.1 m² | | 22.7 |

### (00) PARKING CALCULATION - INDUSTRIAL

| ROOM NUMBER | ROOM NAME | NET AREA | NET AREA PER STALL IN PARKING BYLAW | PARKING STALLS REQUIRED |
|---|---|---|---|---|
| INDUSTRIAL | | | | |
| 134 | AIR SHOWER | 6.31 m² | 100.0 m² | 0.1 |
| 157 | AIRWASH | 13.33 m² | | |
| 124 | BREAK | 120.36 m² | 100.0 m² | 1.2 |
| 128 | CLEAN GEAR | 49.59 m² | 100.0 m² | 0.5 |
| 189 | CLEAN PRE-ROOTING EQUIPMENT | 29.08 m² | 100.0 m² | 0.3 |
| 185 | CORRIDOR | 50.28 m² | 100.0 m² | 0.5 |
| 166 | CORRIDOR | 60.32 m² | 100.0 m² | 0.6 |
| 151 | CORRIDOR | 40.41 m² | 100.0 m² | 0.4 |
| 133 | CORRIDOR | 30.87 m² | 100.0 m² | 0.3 |
| 200 | CORRIDOR | 24.75 m² | 100.0 m² | 0.2 |
| 142 | CORRIDOR | 46.19 m² | 100.0 m² | 0.5 |
| 158 | CORRIDOR | 28.31 m² | 100.0 m² | 0.3 |
| 204 | DESTRUCTION | 9.95 m² | 100.0 m² | 0.1 |
| 149 | DRYING | 9.40 m² | 100.0 m² | 0.1 |
| 103 | ENTRY | 16.52 m² | 100.0 m² | 0.2 |
| 160 | EXTRACTION | 83.25 m² | 100.0 m² | 0.8 |
| 127 | FEMALE | 36.94 m² | 100.0 m² | 0.4 |
| 130 | FEMALE LOCKER | 25.34 m² | 100.0 m² | 0.3 |
| 159 | FORMULATION | 55.11 m² | 100.0 m² | 0.6 |
| 161 | GENOMICS | 56.82 m² | 100.0 m² | 0.6 |
| 144 | GROW PREPARATION | 18.06 m² | 100.0 m² | 0.2 |
| 145 | IRRIGATION | 18.06 m² | 100.0 m² | 0.2 |
| 191 | LAB MANAGER | 13.46 m² | 100.0 m² | 0.1 |
| 206 | LOADING | 32.12 m² | 100.0 m² | 0.3 |
| 126 | MALE | 25.68 m² | 100.0 m² | 0.3 |
| 129 | MALE LOCKER | 25.25 m² | 100.0 m² | 0.3 |
| 167 | MEDIA PREP WASHING | 43.18 m² | 100.0 m² | 0.4 |
| 171 | MEDIA PREPARATION (C) | 125.95 m² | 100.0 m² | 1.3 |
| 153 | OFFICE | 7.69 m² | 100.0 m² | 0.1 |
| 162 | PACKAGING | 26.98 m² | 100.0 m² | 0.3 |
| 254 | PACKAGING | 41.91 m² | 100.0 m² | 0.4 |
| 190 | PASSAGE | 6.49 m² | 100.0 m² | 0.1 |
| 150 | PROCESSING | 7.08 m² | 100.0 m² | 0.1 |
| 203 | REFUSE | 15.23 m² | 100.0 m² | 0.2 |
| 187 | REJECTED PRE-ROOTING | 29.08 m² | 100.0 m² | 0.3 |
| 208 | SHIP/REC OFFICE | 4.01 m² | 100.0 m² | 0.0 |
| 186 | SOIL PREP | 25.54 m² | 100.0 m² | 0.3 |
| 168 | STAGE 1 WORKSTATIONS | 35.92 m² | 100.0 m² | 0.4 |
| 154 | TC MEDIA PREP | 32.89 m² | 100.0 m² | 0.3 |
| 152 | TC WORKSTATION | 33.53 m² | 100.0 m² | 0.3 |
| 170 | TEST TUBE GROWTH | 71.34 m² | 100.0 m² | 0.7 |
| 192 | TRAY PREPARATION | 195.68 m² | 100.0 m² | 2.0 |
| 102 | TURNSTILES | 20.50 m² | 100.0 m² | 0.2 |
| 101 | VESTIBULE | 5.74 m² | 100.0 m² | 0.1 |
| 188 | WASHING AREA | 85.78 m² | 100.0 m² | 0.9 |
| 175 | WORKSTATIONS 1 | 172.97 m² | 100.0 m² | 1.7 |
| TOTALS | | 1,913.23 m² | | 19.0 |

### (02) PARKING SCHEDULE

| GENERIC TYPE | COUNT | WIDTH | LENGTH |
|---|---|---|---|
| PARKING - BARRIER-FREE | 2 | 3.80 | 5.15 |
| PARKING - LOADING | 3 | 4.25 | 10.70 |
| PARKING - VEHICLE | 56 | 2.54 | 5.15 |
| TOTAL STALLS: 61 | 61 | | |

### (02) TOPOGRAPHY SCHEDULE

| NAME | PHASE CREATED | CUT | FILL | NET CUT/FILL | PROJECTED AREA |
|---|---|---|---|---|---|
| RAISE BUILDING GRADE | NEW CONSTRUCTION | 392 CY | 14330 CY | 13939 CY | 2,736,513 SF |
| BUILDING PAD | NEW CONSTRUCTION | 446 CY | 7 CY | -439 CY | 37,453 SF |
| TOTAL: 2 | | 838 CY | 14337 CY | 13499 CY | 2,773,966 SF |



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DETAIL SITE PLAN

PROJECT NORTH

A02C

SCHEMATIC DESIGN SCHEMATIC DESIGN

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PROGRAM COMPONENTS

- SECURITY
- ADMIN - PRIVATE
- AIR SHOWER
- ADMIN - PUBLIC
- SUPPORT
- CIRC - STREET
- CIRC - CLEAN
- SECURE STORAGE
- SERVICE
- SHIP/REC
- TISSUE CULTURE
- R&D
- EXTRACTION
- Calculating...


1 FLOOR PLAN - 1/16" SCALE
Scale: 1/16" = 1'-0"
A03A

(00) AREA SUMMARY - GROSS FLOOR AREA

| AREA NAME | AREA |
|---|---|
| LEVEL 1 GROSS FLOOR AREA | 58,072 SF |
| Grand total: 1 | 58,072 SF |



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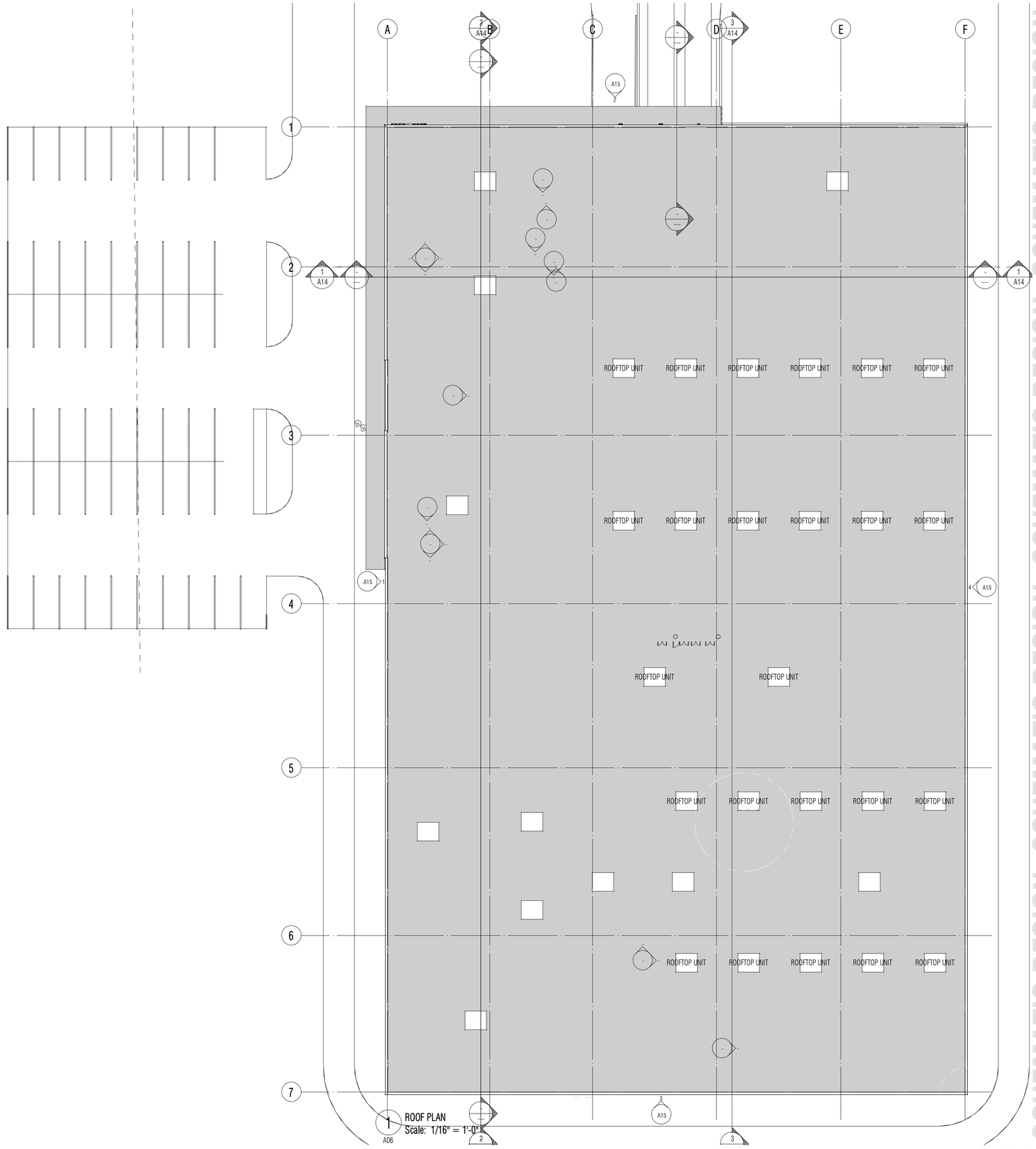
FLOOR PLAN

PROJECT NORTH

A03A

SCHEMATIC DESIGN SCHEMATIC DESIGN



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|---|---|---|
| A0 | SITE PLAN | HC LICENCE APPLS |
| A1 | DETAIL SITE PLAN | HC LICENCE APPLS |
| A2 | FLOOR PLAN | HC LICENCE APPLS |
| A3 | FLOOR PLAN - SECURITY | HC LICENCE APPLS |
| A4 | DETAIL PLAN - DL SECURE STORAGE | HC LICENCE APPLS |
| A5 | DETAIL PLAN - LP SECURE STORAGE | HC LICENCE APPLS |

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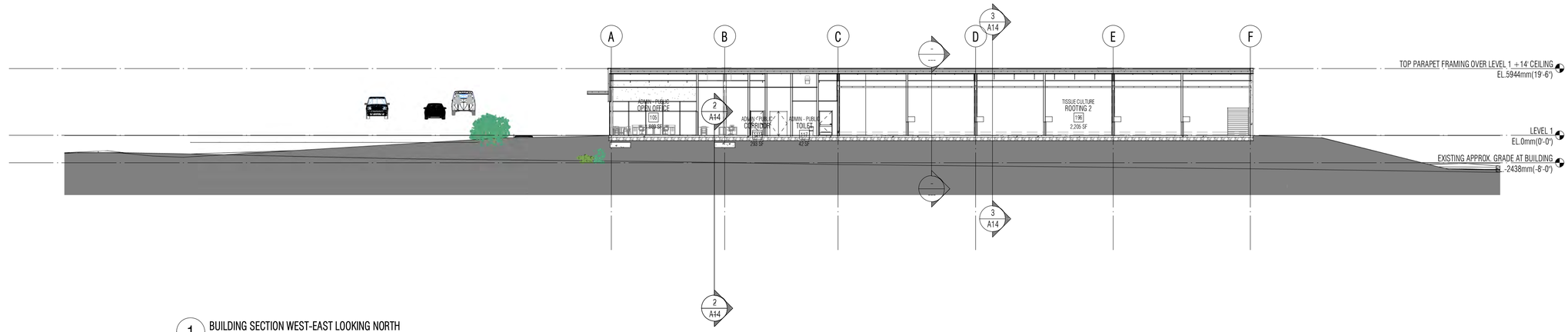
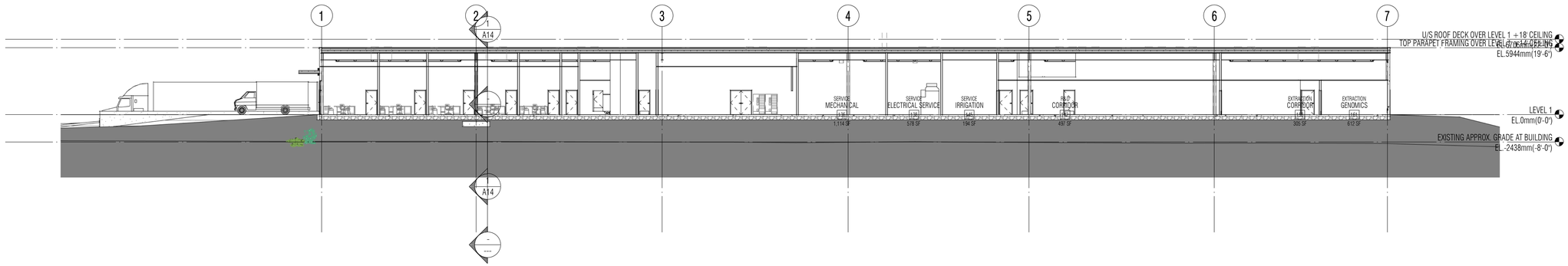
ROOF PLAN

PROJECT NORTH

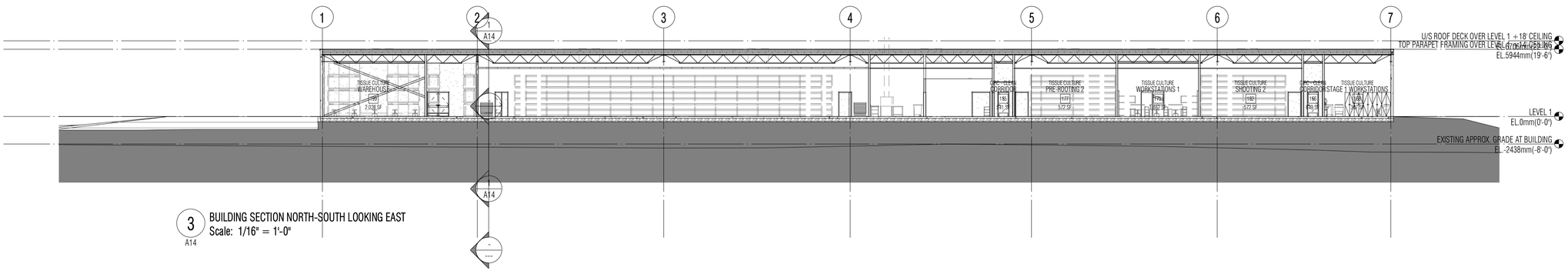
A06




1 A14 BUILDING SECTION WEST-EAST LOOKING NORTH
Scale: 1/16" = 1'-0"




2 A14 BUILDING SECTION NORTH-SOUTH LOOKING EAST
Scale: 1/16" = 1'-0"




3 A14 BUILDING SECTION NORTH-SOUTH LOOKING EAST
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| A5 | DETAIL PLAN - LP SECURE STORAGE | HC LICENCE APPLS |

TOTAL SHEETS: 6

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BUILDING SECTIONS

PROJECT NORTH

A14

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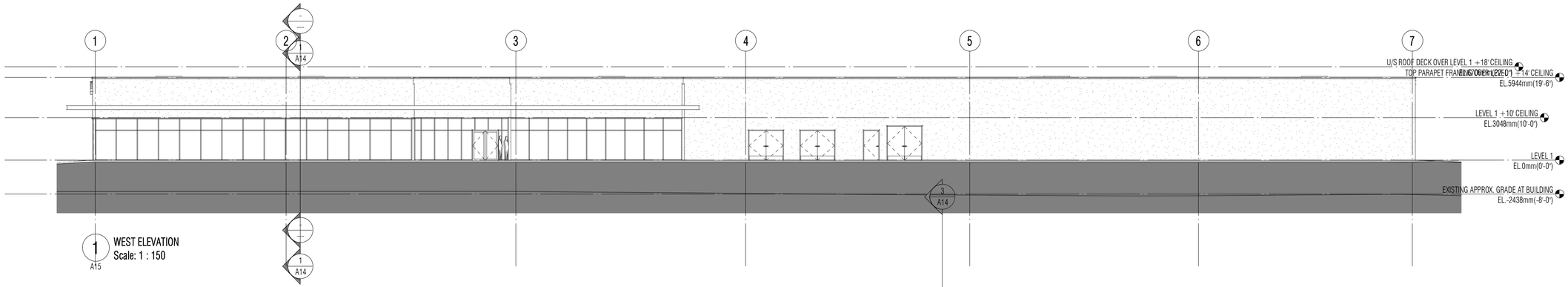


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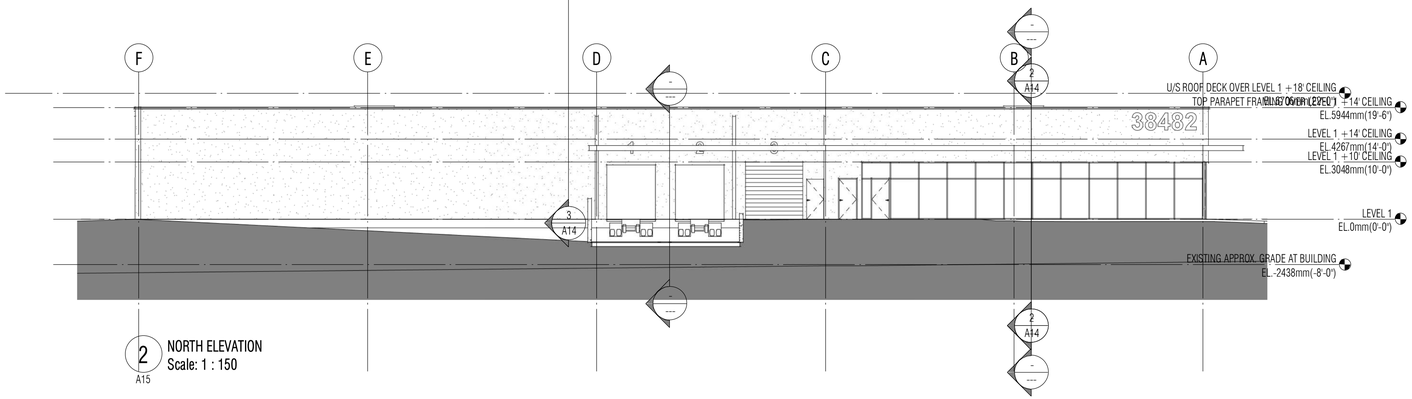
Scale: 1 : 150
A15




2 NORTH ELEVATION
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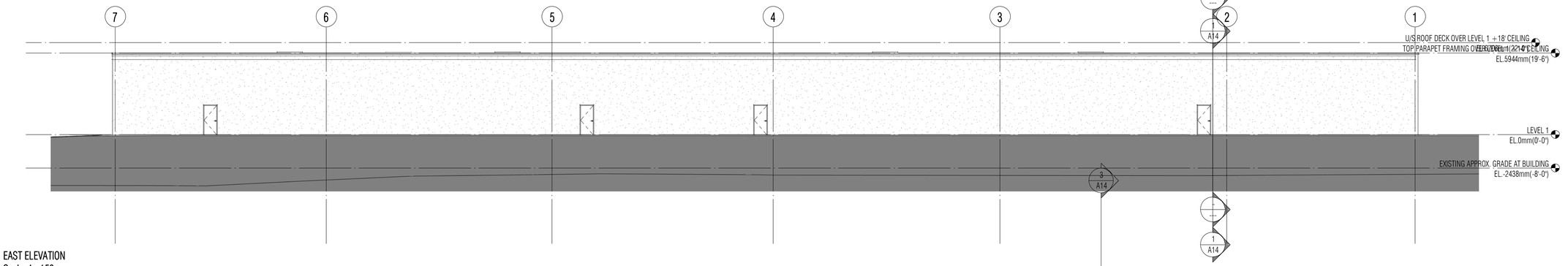


4 EAST ELEVATION
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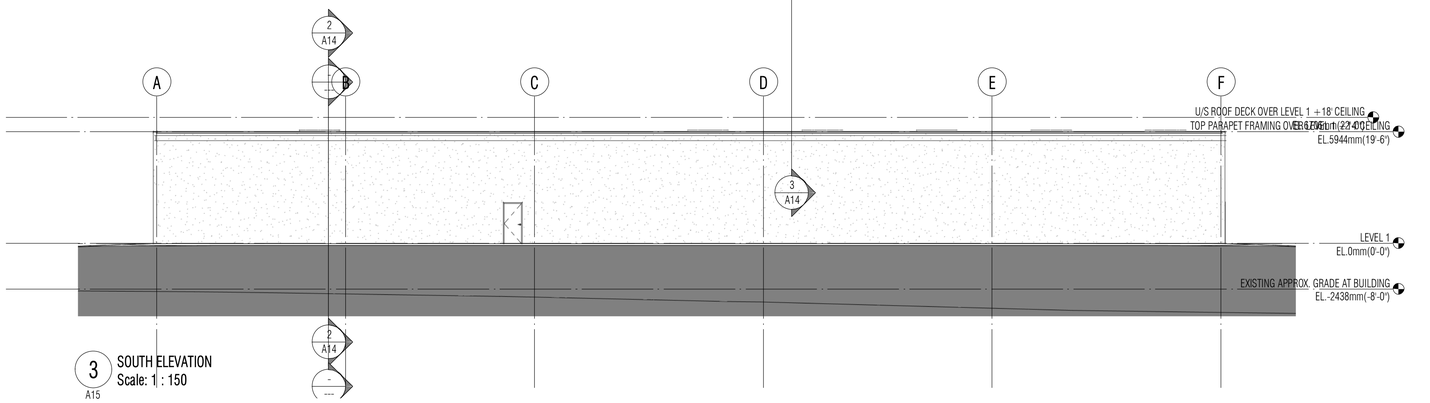
A15




3 SOUTH ELEVATION
Scale: 1 : 150
A15



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| A0 | SITE PLAN | HC LICENCE APPLS |
| A1 | DETAIL SITE PLAN | HC LICENCE APPLS |
| A2 | FLOOR PLAN | HC LICENCE APPLS |
| A3 | FLOOR PLAN - SECURITY | HC LICENCE APPLS |
| A4 | DETAIL PLAN - DL SECURE STORAGE | HC LICENCE APPLS |
| A5 | DETAIL PLAN - LP SECURE STORAGE | HC LICENCE APPLS |

TOTAL SHEETS: 6

| REV. | DATE | ISSUED FOR |
|---|---|---|

REVISION SCHEDULE

Registered Professional(s)

DRAFT
ISSUED FOR:
DESIGN DRAWINGS 4/24/2018 11:42:55 AM
NOT FOR OFFICIAL USE


GARY FIELDS ARCHITECTURE INTERIOR DESIGN PLANNING INC.
DO MORE WITH LESS®
Gary Fields, Owner
Architect AIBC, MRAIC, LEED® AP
tel 604-947-9740
cell 604-868-8227
fax 1-866-826-4244
gary@garyfields.ca
www.garyfields.ca
1225 Adams Road, Bowen Island
British Columbia V0N 1G2 CANADA
web


Owner

38482 BELL ROAD, DEROCHE, BC

| | |
|---|---|
| GF Project Number | 1811 |
| Original Scale | 1 : 150 |
| Plot Date | 4/24/2018 11:42:55 AM |
| Original Sheet Size | Arch D 24 x 36 |

ELEVATIONS

PROJECT NORTH

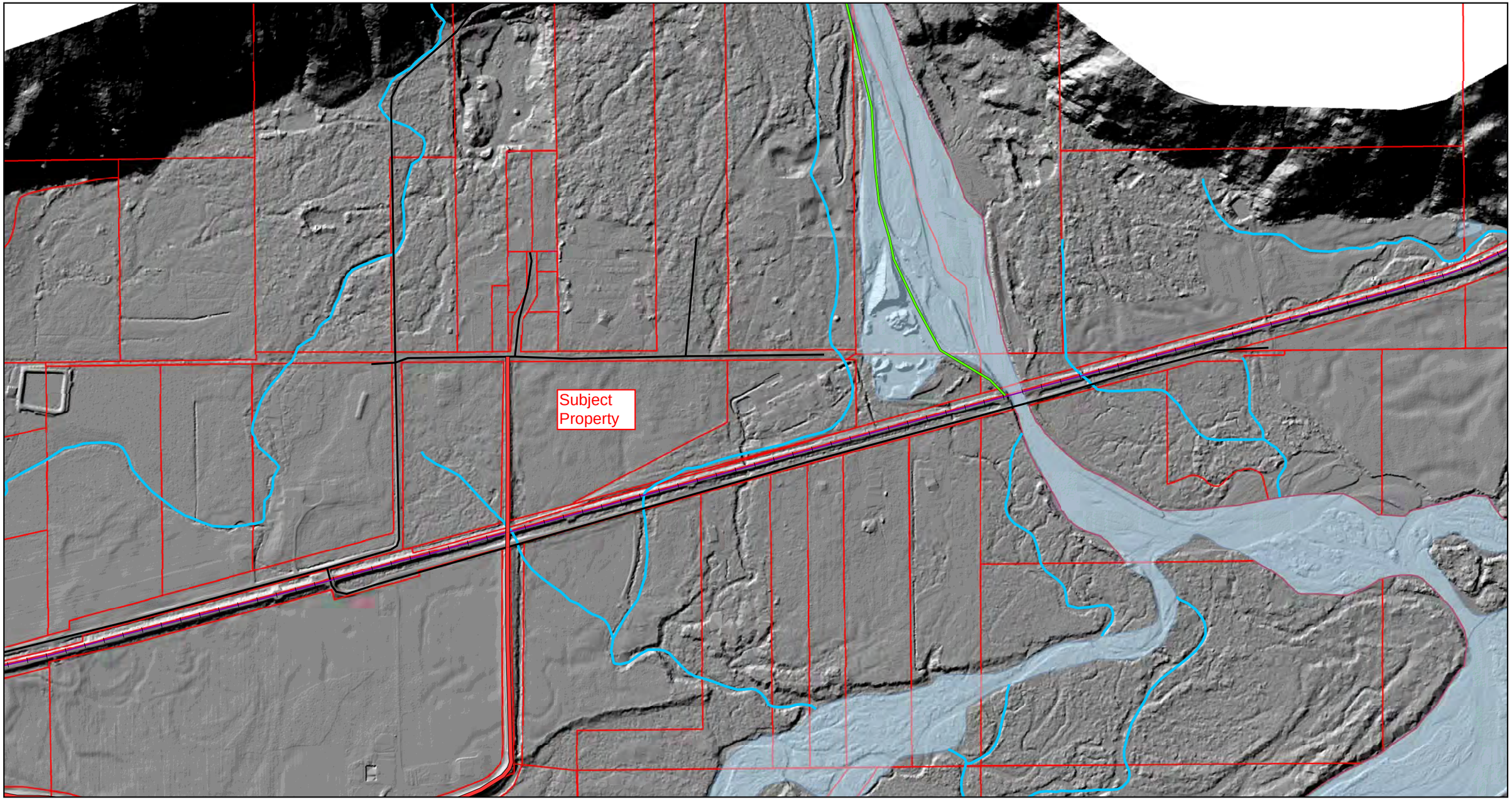
A15

P:\1811 34842 Bell Road Deroche BC\A Design\04 Drawings\01 Current\1811 Drawings.rvt

SCHEMATIC DESIGN SCHEMATIC DESIGN

# APPENDIX B

# LIDAR IMAGES OF THE NORRISH CREEK FAN




Non Standard Dyke or Berm
Standard Dyke
Streams
Waterbodies
Roads
Railways
Properties
2m Contours

Disclaimer: This map was compiled by the Fraser Valley Regional District, using data believed to be accurate; however, a margin of error is inherent in all maps. This product is distributed without warranties of any kind, either expressed or implied, including but not limited to warranties of suitability of particular purpose or use. This map utilizes an orthophoto captured in 2009 and provided by GeoBC.

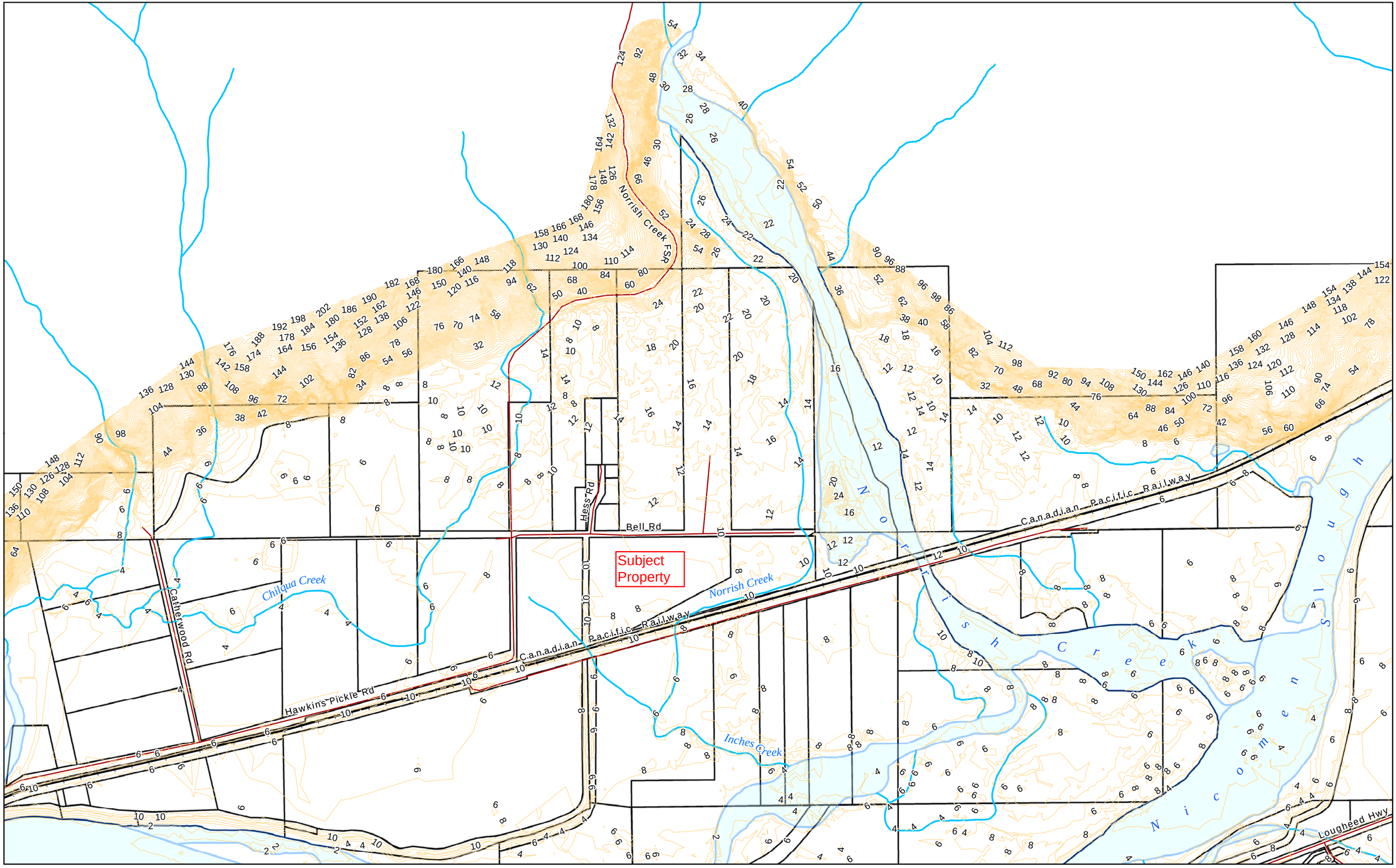
# LiDAR & Contour Map

## 38482 Bell Rd

0 50 100 200 300 400 500 Meters

Fraser Valley Regional District

May 08, 2018




2m. Contour Map

0 200 400 800 Meters

# APPENDIX C

# 38482 BELL ROAD –
# TOPOGRAPHIC SURVEY FROM AXIS LAND SURVEYING LTD.

BELL ROAD

CROWN OF ROAD
EDGE OF ASPHALT

297.998

140.961

125.683

347.790

134.262

Rem 4
PLAN 29269

PARCEL ONE
PLAN 83793

REM H
PLAN 1912

PARCEL A
REFERENCE PLAN 1346

320.936

SRW E.C. PLAN LMP47849

TOP OF BANK

BOTTOM OF BANK

EDGE OF GRAVEL

ROOF OVERHANG

CANADIAN PACIFIC RAILWAY
PLAN 908

0 5 10 25 50

DISTANCES ARE IN METRES

THE INTENDED PLOT SIZE OF THIS PLAN IS 1120mm IN WIDTH BY 864mm IN HEIGHT (E SIZE) WHEN PLOTTED AT A SCALE OF 1:500

CERTIFIED CORRECT THIS 29th DAY OF MARCH, 2017.

DARRYL MITCHELL B.C.L.S.

SHEET 1 OF 1

JOB NO: A 5479

DATE: MARCH 29, 2018

**LEGAL DESCRIPTION:**

LOT 4 EXCEPT: PARCEL "A" (REFERENCE PLAN 53267); SECTION 33 AND OF THE NORTH WEST QUARTER OF SECTION 34 TOWNSHIP 20 NEW WESTMINSTER DISTRICT PLAN 29269

PARCEL IDENTIFIER: 009-064-885

**DERIVATIONS**

ELEVATIONS ARE IN METRES GEODETIC AND ARE DERIVED GPS OBSERVATIONS

PROPERTY LINE DIMENSIONS ARE DERIVED FROM FIELD SURVEY

**LEGEND**

- ×8.0 DENOTES SPOT ELEVATION
- CU DENOTES CULVERT
- GU DENOTES GUY WIRE
- MH DENOTES MANHOLE
- PP DENOTES POWER POLE
- TBM DENOTES TEMPORARY BENCH MARK

| No. | DATE: | REVISION: |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |


AXIS LAND SURVEYING LTD.
B.C. & CANADA LANDS SURVEYORS
101, 32885 VENTURA AVENUE
ABBOTSFORD, B.C. V2S 6A3
T. 604-853-2700 F. 604-853-2710


DRAWING: 5479-TOPO

DRAWN BY: AM

CHECKED BY: DJM

PROJECT:

# WFS PHARMAGREEN INC.
## 38482 BELL ROAD
## DEROCHE, B.C.

# APPENDIX D

# 38482 BELL ROAD – FIELD INVESTIGATION PHOTOS

**Photo 1** **Looking south from the western half of the Subject Property.**

**Photo 2** **Looking northwest from the southeast corner of the Subject Property at the existing residential building.**

**Photo 3** **Looking northeast from the southwest corner of the Subject Property. Note the wheel valve in the bottom right of the photo used to open and close the drainage culvert gate for the property.**

**Photo 4** **Looking southwest from the northeast corner of the Subject Property.**

**Photo 5** **450 mm diameter concrete culvert inlet at the southwest corner of the Subject Property. The invert of the inlet is the lowest point on the property at 6.35 m GD.**

**Photo 6** **Looking downstream on Inch Creek at the inlet of the steel box culvert under the CP Railway. The culvert has a span of 2000 mm and a height of 1600 mm.**

**Photo 7** **500 mm diameter concrete culvert outlet under the CP Railway adjacent to the middle of the Subject Property. The inlet could not be located and there was no evidence of past flow in the pipe.**

**Photo 8** **Looking downstream from the crest of the armoured Norrish Creek Dyke 80 m upstream from the CP Railway Bridge. The $D_{50}$ of the riprap is 600 mm.**

**Photo 9** **Looking downstream at the armoured Norrish Creek Dyke 80 m upstream from the CP Railway Bridge where the dyke transitions from a river dyke to a setback dyke. The $D_{50}$ of the riprap is 600 mm.**

**Photo 10** **Norrish Creek Dyke along a typical armoured setback portion. Photo is 100 m upstream of the CP Railway Bridge. The height of dyke is approximately 2 m above the creek side floodplain. The $D_{50}$ of the riprap is 500 mm.**

**Photo 11** **Typical view of the crest of the Norrish Creek Dyke. The crest averages 8 to 12 m wide but is up to 20 m wide at the upstream end where the dyke is not armoured.**

**Photo 12** **Norrish Creek Dyke along a typical armoured setback portion. Photo is just downstream of the upstream limit of continuous armouring 680 m from the CP Railway Bridge. The height of the dyke is approximately 2 m above the creek side floodplain. The $D_{50}$ of the riprap is 500 mm.**

**Photo 13** **Looking downstream at the armoured Norrish Creek Dyke 250 m downstream of the fan apex. The $D_{50}$ of the riprap is 300 mm.**

**Photo 14** **Norrish Creek Dyke along the 25 m long eroded bank section which is located 130 m downstream of the fan apex. The bank is approximately 3 m high.**

**Photo 15** **Looking downstream at the 20 m wide Norrish Creek Dyke crest adjacent to the eroding bank section.**

**Photo 16** **Looking south at the west gravel pit. The east pit is to the left, out of the photo.**

# APPENDIX E

# 38482 BELL ROAD – GEOHAZARD ASSURANCE STATEMENT FOR DEVELOPMENT APPROVALS

# Geo-Hazard Assurance Statement
for Development Approvals

## A. Project Information

Date: May 15, 2018

FVRD File No.: File to be assigned by the FVRD

### Property Information

Project Name & Description: Natural Hazards Assessment for the property at 38482 Bell Road, Deroche, BC

Legal Description: Lot 4 Plan NWP29269 Section 33 Township 20 Land District 36 & OF NW 1/4 SEC 34; EXC PCL A REF P

Site Address: 38482 Bell Road, Deroche, BC

PID:

### Client Information

Name: WFS Pharmagreen Inc. c/o Peter Wojcik CEO/Director

Role: ☑ Property Owner ☐ Developer ☐ Other

Client Address: 12293 Cardinal St, Mission, BC, V4S 1L3

### Qualified Professional Information

Name: Jamie Stirling, M.Sc. P.Geo.

APEGBC Designation: ☐ P.Eng. ☑ P. Geo. ☐ Eng.L ☐ Geo.L

Company Name: Stirling Geoscience

Mailing Address: 1506 Sowden St.

Email Address: jamie@stirlinggeoscience.com

Phone #: 604-349-7709

### Geo-Hazard Report Reference

Title: Natural Hazards Assessment for the property at 38482 Bell Road, Deroche,

Date: May 15, 2018

*Personal information on this form is being collected in accordance with Section 27 of the Freedom of Information and Protection of Privacy Act, RSBC 1996 Ch. 165; Part 9, Division 1 [Building Regulation] and Part 14 [Planning and Land Use Management] of the Local Government Act, RSBC 2015 Ch. 1; and Section 56 of the Community Charter, SBC 2003 Ch. 26 and will only be collected, used and disclosed for the purpose of administering geo-technical hazard reviews and assurance statements related to development approvals. Questions? Contact FVRD Privacy Officer at 45950 Cheam Avenue, Chilliwack, BC V2P 1N6; 604-702-5000 or 1-800-528-0061; or FOI@fvrd.ca.*

# B. Assurance

Based on the contents of this Assurance Statement and the Report, I hereby give assurance that:
*(check as applicable)*

| | | |
|---|---|---|
| ☑ | Development Permit | The Report will "assist the local government in determining what conditions or requirements under it will impose in the permit", as required by the *Local Government Act* (Division 7) |
| ☑ | Building Permit<br>☑ Community Charter | "The land may be used safely for the use intended", as required by the *Community Charter* (Section 56) |
| | ☐ Seismic Slope | The Report addresses the requirements of the BC Building Code 2006, 4.1.8.1.6 (8) and 9.4.4.4 (2), as detailed in the BC Building & Safety Policy Branch Information Bulletin B10-01, Jan 18, 2010 |
| ☑ | Floodplain Management Bylaw Exemption | "The land may be used safely for the use intended", as required by the *Local Government Act*. (Section 524) |
| ☐ | Subdivision | "The land may be used safely for the use intended", as required by the *Land Title Act* (Section 86). |
| ☐ | Other *(e.g. Zoning Bylaw Amendment, Official Community Plan Amendment, Temporary Use Permit, etc.)* | <Insert statement as appropriate> |

# C. APEGBC Professional Practice Guidelines

The Report and this Assurance Statement should be completed in accordance with the current version of one or both of the following Professional Engineers and Geoscientists of BC (APEGBC).

- *Legislated Flood Assessments in a Changing Climate in BC*
- *Legislated Landslide Assessments for Proposed Residential Development in British Columbia, ("APEGBC Landslide Guidelines").*

These two documents are collectively referred to as the "APEGBC Guidelines". The italicized words in this Assurance Statement are defined in the APEGBC Guidelines.

The Report has been prepared pursuant to the following APEGBC Guidelines *(check one or both as applicable)*.

☑ APEGBC Flood Guidelines

☐ APEGBC Landslide Guidelines

If the Report is **not** prepared pursuant to either of the APEGBC Guidelines, please explain.

## D. Background Information

Qualified Professionals **must** confirm and check that each item is included in the Report.

☑ 1. Property location map — 8.5 x 11 size

☑ 2. Development proposal site plan — 8.5 x 11 size. *If a subdivision, show the parent parcel and all lots to be created, including any remainder.*

☑ 3. Description of the proposed development project (including building use) to the extent this is known at the time of Report preparation.

- ☐ residential
- ☑ industrial
- ☐ commercial
- ☐ institutional
- ☐ other _____

# E. Technical Requirements

Qualified Professionals **must** review, confirm and check completed items (as applicable).

## Report Content

☑ 4. Relevant information pertaining to the Property and pertinent potential hazards from appropriate background sources, including the FVRD online library.

☑ 5. Time limitation or condition statement to describe extent the FVRD may rely on the Assurance Statement and Report for development approvals, and when resubmittal is recommended.

☑ 6. Maps, illustrations and diagrams to illustrate areas referred to in the Report.

☑ 7. Description of field work conducted on and, if required, beyond the Property.

☑ 8. Contact and consultation with the Fraser Valley Regional District. Provide name and title of contact.

Dawn Smith, Planner II and Andrea Antifaeff, Planning Technician

☑ 9. Review of relevant FVRD bylaws and other statutory requirements.

☑ 10. Restrictive covenants registered against the Property title that pertain to geo-hazards (if registered, the Report provides relevant information about the covenants).

☑ 11. Notation of any visibly apparent natural hazards or other hazards identified in background reports, which are not identified and addressed in this Report. If yes, provide details in Section H: Geo-Hazard Summary Table.

- ○ Yes
- ◉ No

☑ 12. Does the report rely on one or more supporting reports, each of which is independently reviewed, signed and sealed. If yes, provide details in Section H: Geo-Hazard Summary Table.

- ● Yes
- ○ No

☐ 13. For subdivision approval, the Report addresses natural hazards for:

- ☐ the parent parcel prior to subdivision
- ☐ any lots to be created (including any remainder)

## Geo-hazard Assessment, Risk Acceptability and Risk Transfer

☑ 14. In considering the above-noted potential hazards that may affect the property, I have:

- ☑ reviewed and characterized the potential hazard(s)
- ☑ estimated the potential frequency and magnitude of the potential hazard(s)
- ☑ relied on supporting reports as noted above
- ☑ relied on a pre-existing assessment of hazard frequency and magnitude
- ☑ considered the potential effects of climate change in the context identified in the Report
- ☑ considered the potential effects of changed future conditions (upstream watershed changes, forestry activity, land use changes, sea level rise, etc.) in the context identified in the Report

☑ 15. This Assurance Statement pertains to all geo-hazards that are assessed in the Report and any supporting reports, and accurately reflects the contents of those documents.

☑ 16. The FVRD has adopted "Hazard Acceptability Thresholds for Development Approvals by Local Government", which provides a specific level of hazard or risk tolerance. I have included a Hazard Summary Table which:

- ☑ lists all the potential hazards addressed by the Report and any supporting reports
- ☑ provides an annual return frequency and acceptability threshold classification for the unmitigated condition
- ☑ proposes mitigative measures to appropriately reduce the geo-hazard risk
- ☑ provides an annual return frequency and acceptability threshold classification for the mitigated condition

☑ 17. The Report describes the potential transfer of natural hazard risk to other properties or infrastructure as a result of the proposed project (including any proposed *mitigation works*) and

- ☑ considered the potential for transfer of natural hazard risk
- ☑ concludes that there is no significant transfer of natural hazard risk
- ☐ identifies the potential transfer of natural hazard risk and proposes measures to offset such transfer of risk

## Mitigation and Design Recommendations (if recommended)

The Report contains the following items:

- [x] 18. Implementation steps for the identified structural mitigation works (in terms of design, construction and approval).
- [x] 19. Clearly identified safe locations for building(s), ancillary structures, and onsite utility services (as applicable, such as a septic field) out of the natural hazard area as a preferred development alternative.
- [x] 20. Commentary on the effectiveness of proposed structural mitigation works in terms of ability to reduce the potential hazard impact, and identification of any residual risk that would remain.
- [x] 21. Proposed Flood Construction Level (FCL) for future development and including specification of an appropriate method of achieving the FCL.
- [x] 22. Proposed watercourse setback, which is clearly referenced from the natural boundary, top of bank or another suitable basis.
- [ ] 23. Proposed operation and maintenance actions that will be necessary in order for the level of safety to be maintained in the future, with indications of who should be responsible for those actions and when.

## Riparian Area Regulation (if applicable)

- [ ] 24. QP must review RAR assessment report to avoid conflict with Geo-Hazard Report recommendations.

# F. FVRD Supplemental Requirements

The following points are understood by the Qualified Professional when submitting a Report:

- [x] 25. Permission is granted to the FVRD to use the Report in considering approval of the proposed development on the property, provided that such permission is limited only to the proposed development project for which the Report was prepared.
- [x] 26. Methodology used in the Report is described in sufficient detail to facilitate a professional review of the study by the FVRD when necessary.
- [x] 27. Professional liability insurance coverage of at least $1 million per claim is carried by the QP.
- [ ] 28. Third party review or supplemental information may be required by the FVRD where complex development proposals warrant.
- [x] 29. Permission is granted to the FVRD to include the Report in the online FVRD geo-hazard report library (as background information, not for other parties to rely).

## G. Qualified Professional (QP)

### Prepared by: (QP of Record)

Name: Jamie Stirling, M.Sc. P.Geo.

Designation: ☐ P.Eng. ☑ P. Geo. ☐ Eng.L ☐ Geo.L

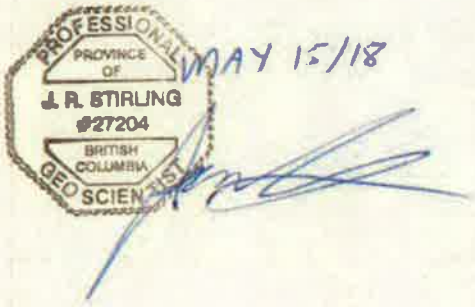
### Reviewed by:

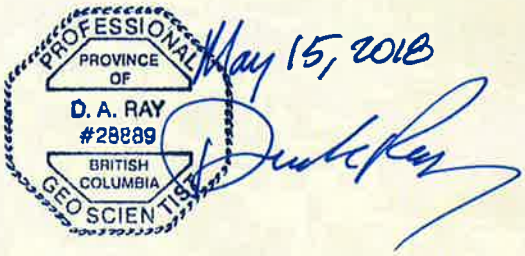
Name: Derek Ray, M.Sc. P.Geo.

Designation: ☐ P.Eng. ☑ P. Geo.

The Report has received appropriate technical review which is consistent with both the APEGBC Professional Practice Guidelines, and APGBC Quality Management Guidelines. The name of the reviewer is noted in the Report and below.

### Professional Seal, Signature and Date:




☑ I am a Qualified Professional as defined in the APEGBC Guidelines, and I fulfill the education, training and experience requirements as outlined in the APEGBC Guidelines

☑ I have signed, sealed, dated and thereby certify, this Assurance Statement and the attached report.

## H. Geo-Hazard Summary Table

The geo-hazard report and/or any supporting reports addresses the following hazard types.

| Geo-Hazard Type #1<br>Fraser River and tributaries flooding | Geo-Hazard Type #2<br>Debris Flow and Debris Torrent |
|---|---|
| Annual Return Frequency (Unmitigated)<br>1:200 | Annual Return Frequency (Unmitigated)<br><1:2,000 |
| Acceptability Threshold Classification: 5 | Acceptability Threshold Classification: 1 |
| **MITIGATION (if necessary)** | |
| Proposed Mitigation Measures: Yes ● No ○ | Proposed Mitigation Measures: Yes ○ No ◉ |
| Annual Return Frequency (Mitigated)<br>1:500 | Annual Return Frequency (Mitigated) |
| Acceptability Threshold Classification: 4 | Acceptability Threshold Classification: |
| Comments | Comments |
| **SUPPORTING REPORT** | |
| Was this report prepared by others? Yes ● No ○ | Was this report prepared by others? Yes ○ No ◉ |
| If yes, list report name, date and author.<br>Fraser River Design Flood Level Update, FLNRO, Mar 2014 | If yes, list report name, date and author. |

| Geo-Hazard Type #3<br>Debris Flood | Geo-Hazard Type #4<br>Mountain Stream Erosion or Avulsion |
|---|---|
| Annual Return Frequency (Unmitigated)<br><1:200 | Annual Return Frequency (Unmitigated)<br><1:200 |
| Acceptability Threshold Classification: 5 | Acceptability Threshold Classification: 5 |
| **MITIGATION (if necessary)** | |
| Proposed Mitigation Measures: Yes ● No ○ | Proposed Mitigation Measures: Yes ● No ○ |
| Annual Return Frequency (Mitigated)<br><1:500 | Annual Return Frequency (Mitigated)<br><1:500 |
| Acceptability Threshold Classification: 4 | Acceptability Threshold Classification: 4 |
| Comments | Comments |
| **SUPPORTING REPORT** | |
| Was this report prepared by others? Yes ● No ● | Was this report prepared by others? Yes ○ No ◉ |
| If yes, list report name, date and author. | If yes, list report name, date and author. |

Indicate which hazards were **NOT** reviewed:

- [x] Chilliwack River Valley Erosion or Avulsion
- [ ] Debris Flow and Debris Torrent
- [ ] Debris Flood
- [ ] Fraser River & tributaries flooding
- [ ] Mountain Stream Erosion or Avulsion
- [x] Major Catastrophic Landslide
- [x] Seismic Effects/Liquefaction
- [x] Rockfall - Small Scale Detachment
- [x] Slope Stability
- [x] Small Scale Localized Landslide
- [x] Snow Avalanche
- [x] Tsunami

Hazard Acceptability Thresholds Classification, as per Hazard Acceptability Thresholds for Development Approvals by Local Government dated November 1993 by Dr. Peter Cave.

1 Approval with conditions relating to hazards.
2 Approval, without siting conditions or protective works conditions, but with a covenant including "save harmless" conditions.
3 Approval, but with siting requirements to avoid the hazard, or with requirements for protective works to mitigate the hazard.
4 Approval as (3) above, but with a covenant including "save harmless" conditions as well as siting conditions, protective works or both.
5 Not approvable.

## Additional Comments

# APPENDIX F

# 38482 BELL ROAD – SCHEDULE C – GUIDELINES FOR APPLICATION FOR SITE SPECIFIC EXEMPTION

*Schedule "C"*

## *Guidelines for Application for Site-Specific Exemption*

1. ***Quality Assurance Statement***

*I hereby certify:*

*I am a professional engineer or professional geoscientist, with experience in geotechnical engineering, geohazard assessment and river hydrology;*

*I am licensed in the Province of British Columbia; and,*

*I am qualified to carry out the following flood hazard assessment and that I have performed an evaluation of the area of the proposed development in accordance with the "Flood Hazard Area Land use Management Guidelines of the Province of British Columbia.*

*Name:* JAMIE STIRLING *Signature* _____

2. ***General Requirements***

(1) *Legal Description of the property.*

(2) *General Location map of the property.*

(3) *Detailed map of the property showing property boundaries, safe areas for development, watercourses, topography and physical features.*

(4) *Statement of conformance to the Floodplain Regulation Bylaw, in force from time to time, and Provincial Guidelines.*

(5) *Review of all relevant restrictive covenants registered on title (copies of covenants, if relevant, should be attached to the report.)*

(6) *Review of all relevant previous reports and flood hazard maps affecting the site and surrounding area.*

(7) *Review of current and historical air photos.*

(8) *Description of site visits and observations.*

(9) *Review of historical flood information including stream flow data, climate data and local observations.*

2. *General Requirements (continued)*

(10) *Assessment of the nature extent, magnitude, frequency and potential effect of all flood or debris flow hazards that may affect the property.*

(11) *Description of the scientific methodology(s) and assumptions used to undertake the assessment in sufficient detail to facilitate a professional review.*

(12) *The location of all proposed building sites and specified setback distances from the natural boundary of watercourses. (Maps must be delineated with sufficient accuracy and detail to allow the preparation of a legal reference plan for attachment to a restrictive covenant).*

(13) *Recommendations to ensure safe use of a site. (These should be clearly stated with sufficient detail and clarity to facilitate inclusion in a Land Title Act, Section 219 Covenant).*

(14) *Description of proposed mitigation works and/or actions designed to mitigate the hazard with confirmation that the Guidelines, and specifically Section 5.7 have been considered.*

(15) *Where mitigation works and or actions area proposed, an assessment of the effects that the proposed works and or actions may have on other properties including public infrastructure.*

(16) *Where mitigative works and or actions designed to reduce hazards are contemplated, prior to completion the report and expending time and money on the detailed design, the proponent should confirm that the works and or actions proposed will be accepted by local government and that they would meet regulatory Provincial requirements and will be approved by the Inspector of Dikes.*

*SPECIAL CASES*

3. *Watercourses*

(1) *Where floodplain maps are used to recommend FCLs, document which map was used.*

(2) *Where an existing FCL shown on a floodplain map is deemed inappropriate, or where a new FCL is recommended, provide details of the calculation and confirmation that the Guidelines were considered in the process.*

(3) *For property adjacent to or within a meandering and/or braided river floodplain, use air photos, maps and other information to describe and assess relevant ongoing river processes that may pose a hazard to the property.*

(4) *When recommending the use of minimum setback and elevation guidelines for smaller streams, provide a map of the stream watershed area to determine drainage area.*

4. *Alluvial Fans*

(1) *Provide a suitably scaled topographic map depicting watershed area, fan boundaries, existing and abandoned channels, hydraulic structures, existing and proposed mitigation works, potential avulsion and overland flow paths for the 1 in 200 year flood event, features on the fan that would serve to give direction to and/or impede overland and/or channel avulsion flow paths and the property boundaries.*

(2) *Provide channel cross-sections, stream profiles, and depths of flow and flow velocities used in the analysis.*

(3) *Provide an assessment of the sensitivity of the watershed area, with respect to hydrology and sediment and debris loading.*

(4) *Provide an assessment of the long-term channel bed load and debris maintenance requirements in relation to any recommended flood hazard mitigation measures.*

(5) *Where existing channel capacity and topographic features on the fan are identified as features contributing to the safe use of the property, provide an assessment of the effects of any future changes to the channel or fan topography.*

(6) *Provide plan, cross-sections and design specification for proposed building foundation treatments and to the site-specific measures.*

5. ***Area Subject to Debris Flows***

(1) *Provide a suitably scaled topographic map and/or air photographic base map depicting watershed area, all existing and potential debris flow start, transport and run out zones, hydraulic structures, existing and proposed mitigation works, features on the debris flow transport path and/or run out area which could serve to give direction and/or impede debris flows, existing depositional features, cohorts, soil test pit locations, carbon dating and dendrochronology sample sites, and property boundaries.*

(2) *Provide a statement of return periods considered in the hazard assessment and design of proposed mitigation works.*

(3) *Provide a centerline profile from debris flow start zones to toe of run out zones.*

(4) *Provide plans, cross-sections and design specifications for proposed mitigation works, event volume, depth and velocity of flow and impact forces used in the design of mitigation works.*

(5) *Provide an assessment of the sensitivity of watershed area with respect to hydrology and sediment and debris loading.*

(6) *Where existing channel capacity and topographic features on the fan are identified as features contributing to the safe use of the property, provide an assessment of the effects of any future changes to the channel or fan topography.* (AB #3142)