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March 3rd, 2022
Project #7591

G.D. Nielsen Homes Ltd.
#129 – 1305 Welch Street,
NORTH VANCOUVER, B.C.
V7P 1B3

Attention: Mr. Greg Nielsen

Dear Sir:

Re: PRELIMINARY SLOPE HAZARD ASSESSMENT
PROPOSED NEW INFILL DEVELOPMENT
6155 EAGLERIDGE PLACE, WEST VANCOUVER, B.C.

1.0 INTRODUCTION

In accordance with your request, Terrane Engineering Group Limited (Terrane Group) conducted a preliminary slope hazard assessment at the above referenced site. The purpose of the assessment was to examine site conditions and report on slope hazards that may impact the feasibility of developing the site. It is proposed to construct a number of detached multi-unit infill housing units including a driveway with turnaround. It is understood that a "Sites with Difficult Terrain" Development Permit (DP) will be required by the District of West Vancouver for this site. The assessment has been undertaken in accordance with Engineers and Geoscientists B.C "Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in B.C." (Reference 1).

This report presents the assessment.

2.0 SITE LOCATION

The site is located at 6155 Eagleridge Place in the "Eagleridge/Gleneagles" area of the District of West Vancouver, B.C. The legal description is Lot 1, Blocks F & G, District Lot 771, New Westminster District, Group 1, Plan 18047. It is irregular in shape, has dimensions of about 135 m north/south by about 38 m east/west, and has a total area of about 4,613 m^2. Figure 1 shows the location and configuration of the site. It is bounded by undeveloped forested land to the north, by Highway 1 (Ministry of Transportation & Infrastructure) to the east, by Eagleridge Place and residential properties to the south, and by Marine Drive and the Gleneagles Golf Course to the west.

3.0 PROPOSED DEVELOPMENT

It is proposed to construct 10 multilevel detached infill housing structures, including a driveway with turnaround, on the site as illustrated on Figure 2.

4.0 SITE DESCRIPTION

The site is located in an area underlain by Late Jurassic granodioritic intrusive rock. Mesozoic metamorphic rock is present immediately adjacent to the site to the east. The site topography is bedrock controlled. It slopes downward from east to west at an overall average of about 35°. The topography undulates within the site. Figure 3 shows the general topography in and adjacent to the site. There are some minor rock bluffs up to 4 m in height sloped at up to 90°. There are also some north/south oriented benched areas.

Granodioritic bedrock is extensively exposed throughout the site area. Where it is not exposed, it is covered with a thin mantle of colluvium or forest litter. The site area is generally moderately vegetated with coniferous and deciduous trees with trunk diameters of up to 0.8 m as well as shrubs/bushes and moss cover. Photos 1 to 4 show the topography and vegetation cover in the central portion of the site.

The granodioritic bedrock is competent and strong. It is moderately jointed with joint spacing varying from about 0.3 m to 2.0 m. Some joints appear to be continuous or semi-continuous and are relatively "tight." There are also frequent non-continuous joints/discontinuities. No shear zones were identified nor were any joints/discontinuities identified that showed indication of movement along the joint/discontinuity planes. It is noted that detailed mapping of the rock structure was not undertaken, however, the major joint orientations are summarized as follows:

- NNE/SSW dipping 75°W to 90°
- N/S dipping 80°E to 90°
- N/S dipping 40°W to 50°W
- E/W dipping 80°S to 80°N

There is a talus rock slope on the adjacent site uphill to the east. The top of the talus rock slope as along the west side of Highway 1 and with toe area terminating close to the eastern uphill boundary of the site. Some of the talus rock is located within the site. It is understood that the talus rock is actually blast rock that was pushed over onto the original rock slope during construction of Highway 1 above the site as there is no visible source zone for the talus rock slope. The talus rock slope varies in overall height from 30 m at the south end to about 12 m at the north end and has a measured angle of 38°. This is the typical angle of repose for an angular rock (talus) slope. The rock blocks in the slope have a dimension of up to 3 m but the median size is about 0.6 m. The largest rocks are typically located in the toe area of the talus rock slope. Some bedrock outcrops are visible within the talus rock slope. No soil exposures were observed in the talus except perhaps some localized areas with colluvium. No trees were growing within the talus and no tree stumps were identified protruding from the talus. It is estimated that the talus rock slope is

not more than about 2.5 m thick and is underlain by competent bedrock. Photos 5 to 7 show the talus rock slope.

The northern half of the western site boundary is located along the crest of a steep rock cut on the east side of Marine Drive. The cut is oriented approximately north/south (parallel to Marine Drive). The rock cut varies in height from about 5 m at the south end to about 10 m at the north end. The rock cut is sloped at between 65° and 90°. There are a number of spot rock bolts and dowels visible on the rock cut which were likely installed to stabilize loose or potentially loose blocks following blasting. Photos 8 & 9 show the rock cut. Photo 10 shows typical rock bolts/dowels on the cut face.

South of the rock cut described above, competent bedrock sloping to the west is exposed. The major north/south oriented joint set that dips downward to the west at between 40° and 50° is visible (Photo 11). The overall slope reduces to some 35° close to the southwest property corner.

5.0 GEOTECHNICAL ASSESSMENT

5.1 Talus Rock Slope

A talus rock slope is present on the adjacent site uphill to the east. The toe of the talus rock slope typically extents a short distance into the site area. As there is no source area for the talus rock, there is no rock fall hazard that will impact the site from uphill to the east. There are a few large rock blocks at the toe of the talus rock slope in the southern end of the site that are judged to be only marginally stable (Photo 12). These rocks should be repositioned (stabilized) during site development.

Both static and pseudo-static limit equilibrium analyses were undertaken to assess the overall stability of the talus rock slope using computer program XSTABL Version 5.2. The analyses were undertaken using Spencer's Method (complete force and moment equilibrium). The 2015 National Building Code Seismic Hazard Calculation on the Natural Resources Canada website determines a Peak Ground Acceleration (PGA) of 0.362g for a 1:2,475 annual chance of exceedance. Using Method 2 (Bray) in Appendix E from Reference 1 yields a seismic coefficient (k_{15}) of 0.176 for pseudo-static analysis. The seismic coefficient k_{15} is compatible with 15 cm of slope displacement along a slip surface. It is understood that the District of West Vancouver has not specified criteria for acceptable landslide risk. For the stability analyses, the Factor of Safety Method was used. For new residential development, slope stability analyses using the Factor of Safety Method must typically yield a Factor of Safety (FS) of greater than 1.5 for static conditions and a FS of greater than 1.0 for seismic conditions (1:2,475 annual chance of exceedance). The risk level "As Low As Reasonably Possible" (ALARP) was also considered.

For the purposes of analysis, the talus rock slope is considered to be underlain by competent bedrock and that the bedrock surface undulates in both the east/west and north/south directions. The thickness of the talus rock slope therefore likely varies with it having an estimated maximum thickness of 2.5 m. No soil zones or accumulated organic debris is considered to be present below the talus. The talus rock slope is judged to be statically stable as there is no indication of active movement. The static stability analyses yielded a static FS of 1.2 and pseudo-static FS of 0.9 considering a uniform (smooth) slope underlying the

talus rock. A static FS of greater than 1.5 and pseudo-static FS greater than 1.0 was determined for an undulating (uneven) slope below the talus rock. The latter determinations are likely more indicative of overall slope conditions. It is noted, however, that localized areas of the talus rock slope likely have a static FS closer to 1.0 and pseudo-static FS slightly less than 1.0. Under earthquake loading, some limited movement of portions of the talus rock slope are likely to occur but the movements are expected to stop as soon as the earthquake motion stops. Total slope movements during a seismic event (if any occurs) are not expected to be sufficient enough to allow talus rock to reach any of the proposed structures on the upper eastern side of the site (Proposed Units 1 to 11). It is noted that there is a natural bench at the toe of the talus rock slope in the northern half of the site which will severely limit any downslope movement in this area (adjacent to Proposed Units 3 to 11). In addition, the talus rock slope is a maximum of 12 m high in this area. Proposed Units 1 & 2 are located closest to the toe of the talus rock slope. As a precaution, it is recommended that the rocks in the toe of the talus rock slope be notched into the slope at least 2 m to further stabilize the toe in the area above Proposed Units 1 & 2.

5.2 Main Site Area

The central (main) portion of the site in underlain by competent granodioritic bedrock. There are no steep rock outcroppings greater than about 4 m total height. No problematic rock instabilities were identified in this area. Any instability that occurs in this area will be generated during site development; rock cuts to accommodate the building foundations and access driveway with hammerhead turnaround. Temporary and permanent rock stabilization works will likely be required during the development phase. Specific geotechnical recommendations for rock cuts and any stabilization works required will be provided during the development phase.

5.3 Western Edge of Site

Proposed Units 12 to 20 will be located adjacent to the western property line. Proposed Units 12 to 16 will be located adjacent to the steep rock cut and Proposed Units 17 & 18 adjacent to a moderately steep rock slope. The rock cut and rock slope adjacent to the western property line appear to be relatively stable. It does not appear that there has been any sizeable or frequent rock fall from the cut face and that the original spot bolting and doweling appears to be sufficient to maintain stability. The major north/south oriented joint set that dips downward to the west at between 40° and 50° is visible on the rock cut and slope, however, this joint set does not appear to be continuous enough to cause large scale instability on the rock cut or rock slope that would negatively impact the proposed units. It is judged that it is feasible to construct the proposed units adjacent to the west property line. It does not appear that additional rock stabilization works will be required on the rock cut face to facilitate construction of the proposed units. However, the following is recommended:

1. Detailed rock structure mapping will be required during subgrade preparation to accommodate the foundations of the proposed structures; If problematic rock structure is encountered, foundation stabilization works including ground anchors may be required in the footprint of the structure foundations; Detailed geotechnical recommendations would be provided at that time;

2. Controlled blasting techniques should be employed where blasting is required to accommodate installation of the foundations of Proposed Units 12 through 18 to limit (minimize) blast damage to the rock cut and rock slope adjacent to Marine Drive; A blasting engineer should be retained to review blast designs.

5.4 Overall Site Stability

In consideration of the above, it is judged that a more detailed study is not required and that the proposed development is within the acceptable range for risk tolerance in consideration of societal norms. It is understood that the DWV does not have or has not adopted risk tolerance guidelines. The undersigned has assessed the lands in consideration of natural hazards and the proposed development and judges that the land may be used safely for the use intended.

6.0 CLOSURE

It is trusted that the information presented fulfills your current requirements. If you have any questions, please do not hesitate to contact the undersigned at your convenience.

For
Terrane Engineering Group Limited (#1001310)

2022-03-03

Geoffrey G. Dyer, M.Eng., P.Eng.
Senior Geotechnical Engineer

Reviewed by:

J. Troy Issigonis, M.Eng., P.Eng.
Principal

cc: District of West Vancouver
Land Development

7.0 REFERENCES

1. Association of Professional Engineers and Geoscientists of British Columbia (now Engineers & Geoscientists British Columbia), Revised May 2010. Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in B.C.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

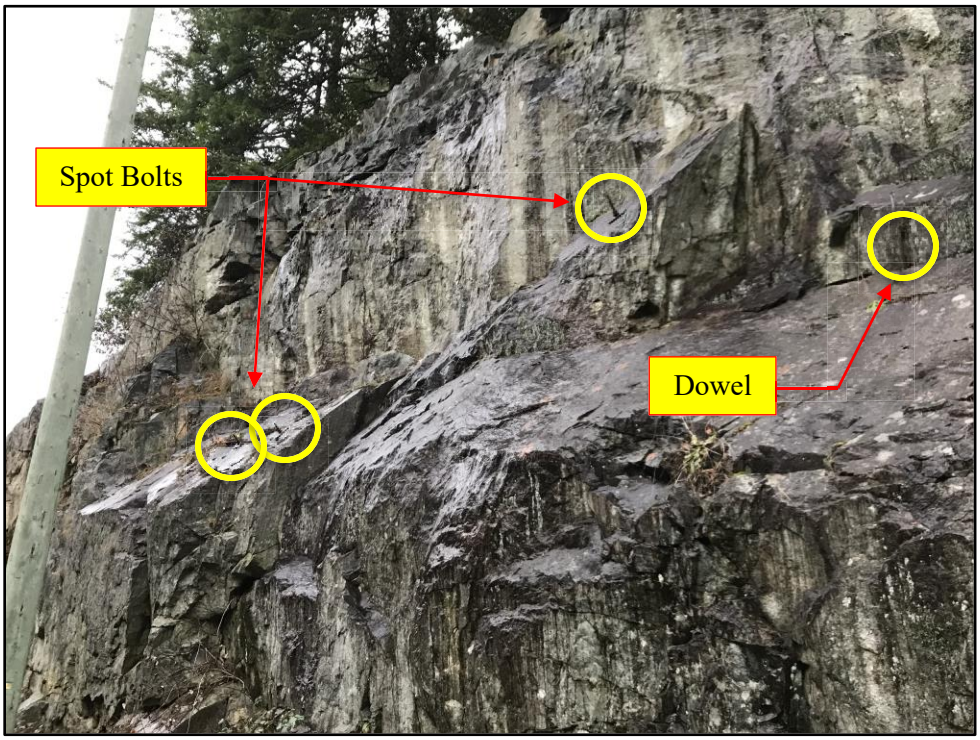
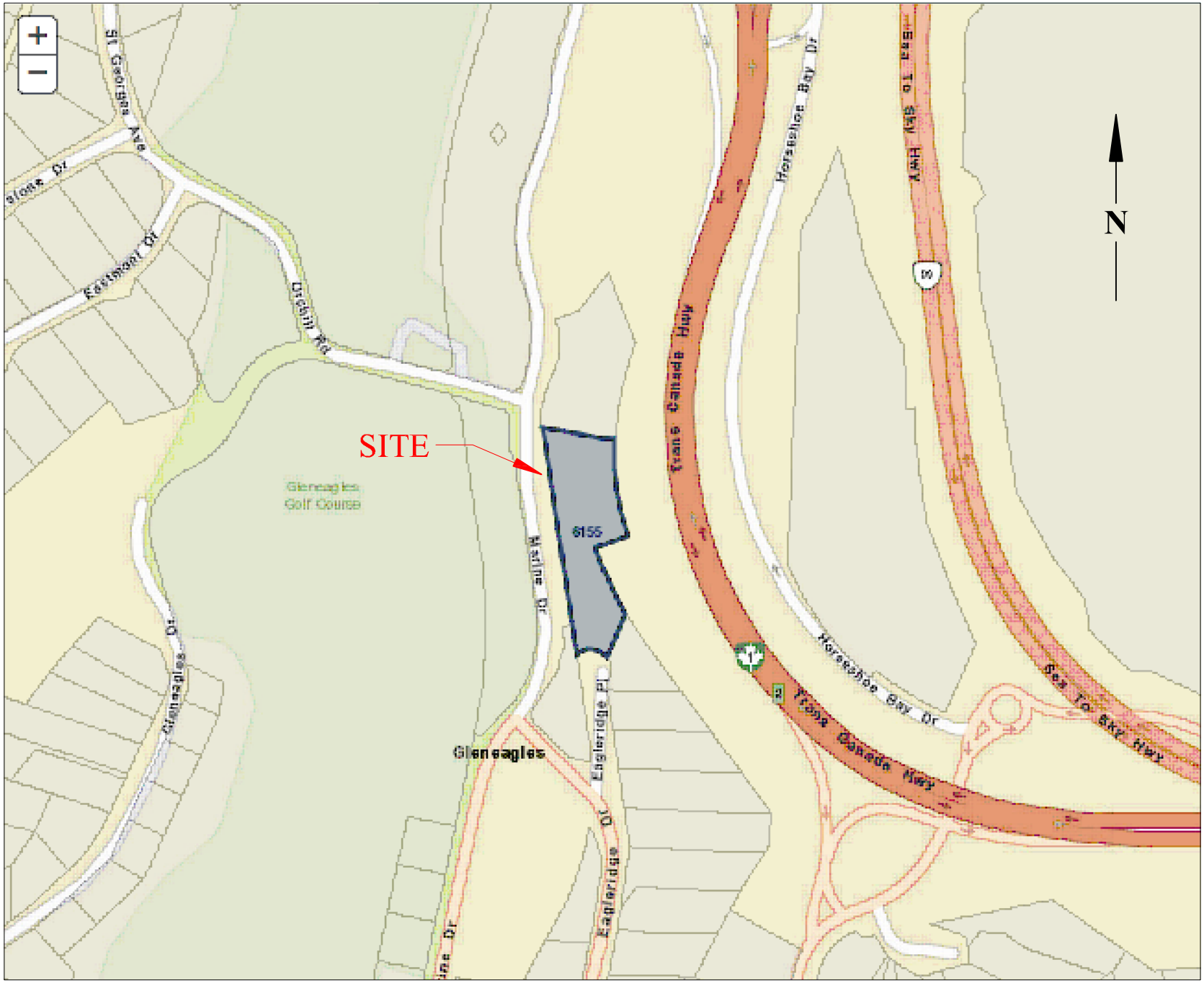


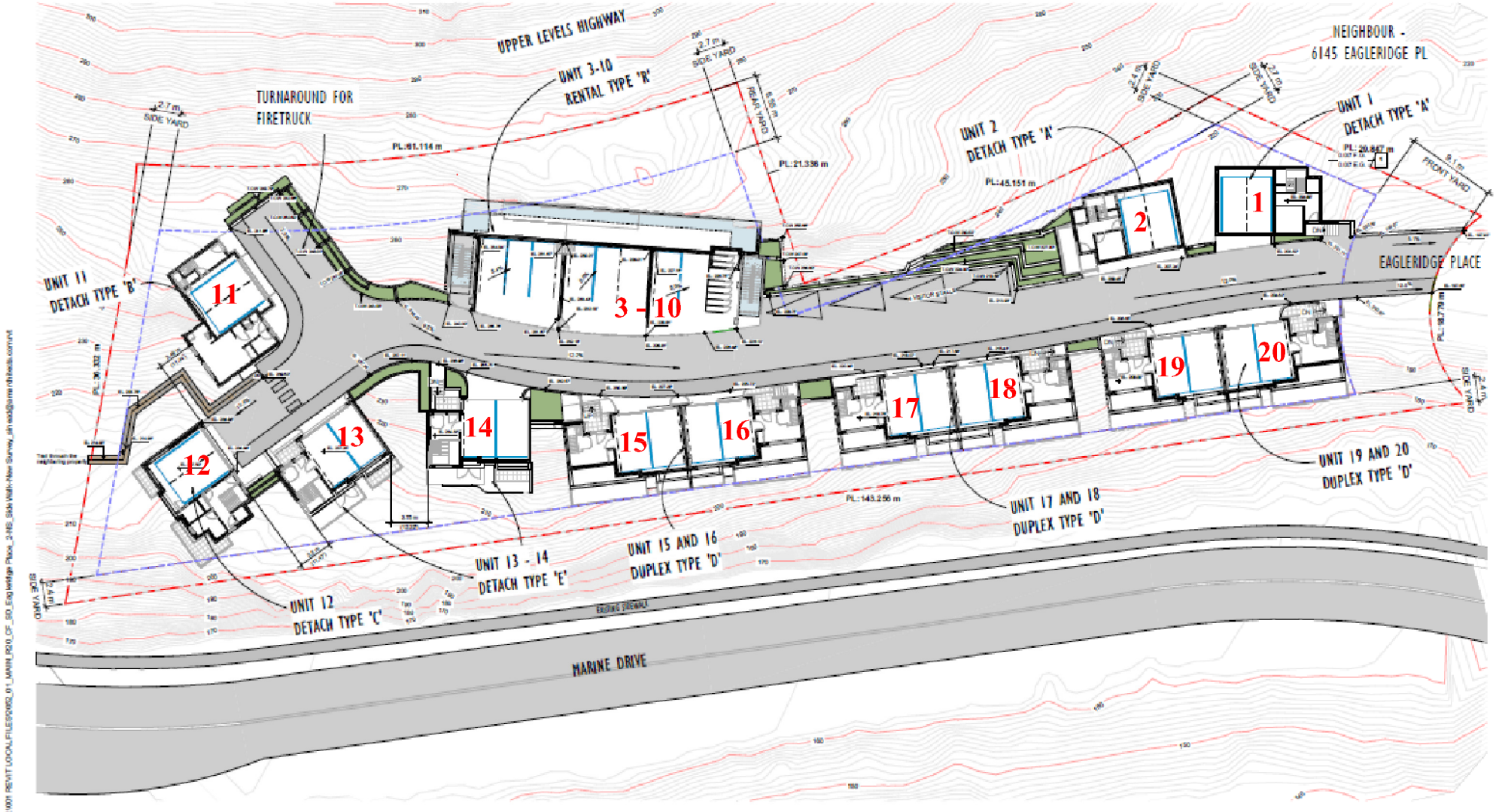
Photo 10

Photo 11

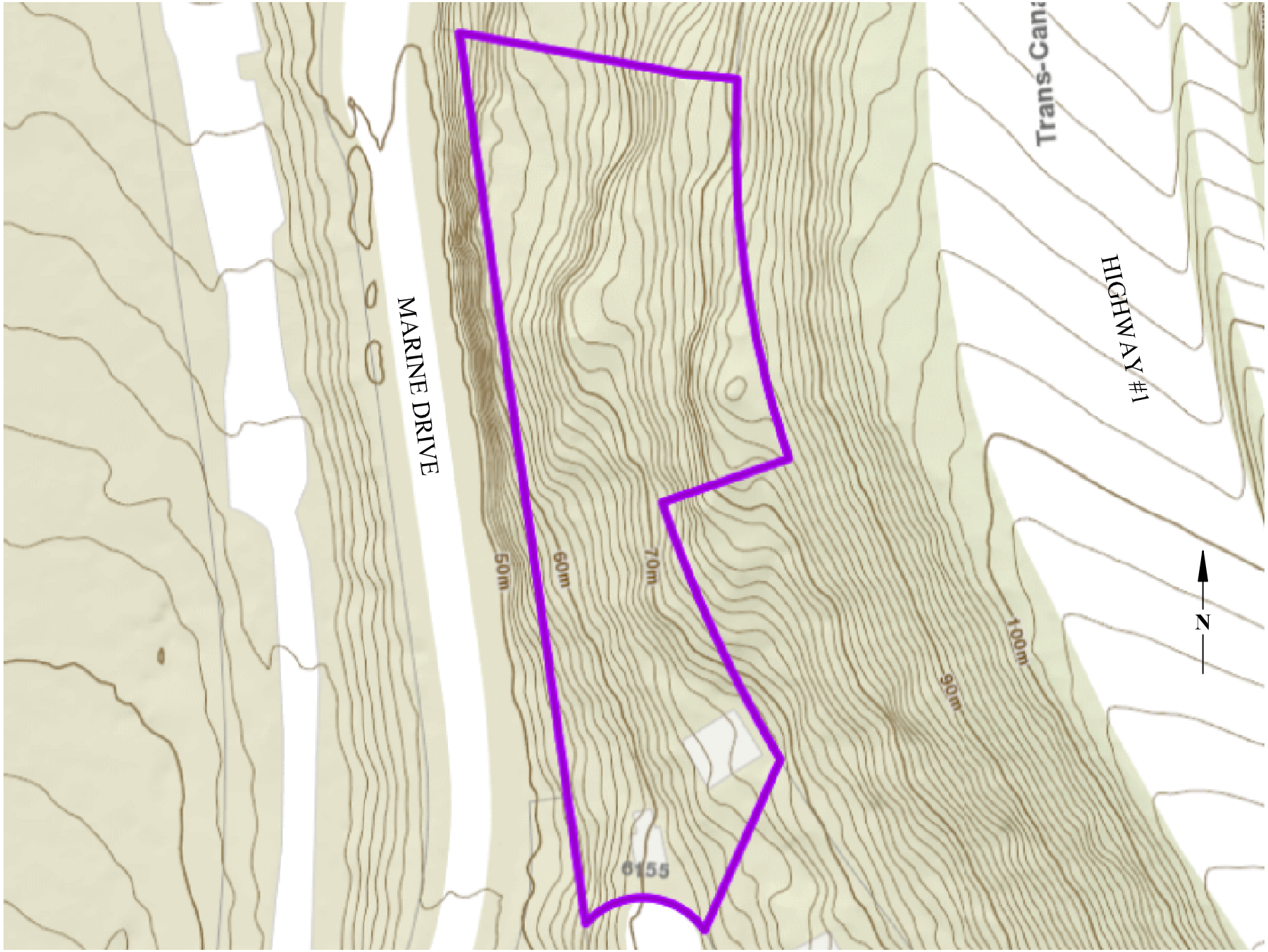
Photo 12



DATE: 2022 Mar 3	DRAWN BY: GGD	SITE LOCATION SLOPE HAZARD ASSESSMENT 6155 Eagleridge Place, West Vancouver, B.C.	TERRANE GEOTECHNICAL GROUP	FIGURE 1
PROJECT: 7591	CLIENT: G.D. Nielsen			



DATE: 2022 Mar 3	DRAWN BY: GGD	SITE PLAN PROPOSED DEVELOPMENT 6155 Eagleridge Place, West Vancouver, B.C.	TERRANE GEOTECHNICAL GROUP	FIGURE 2
PROJECT: 7591	CLIENT: G.D. Nielsen			



DATE: 2022 Mar 3	DRAWN BY: GGD	SITE TOPOGRAPHY SLOPE HAZARD ASSESSMENT 6155 Eagleridge Place, West Vancouver, B.C.	TERRANE GEOTECHNICAL GROUP	FIGURE 3
PROJECT: 7591	CLIENT: G.D. Nielsen			