2. Methods

2.1 SAMPLING LOCATIONS

In 2010, surveys of fish habitat and sampling of fish and macrobenthos communities were conducted at five potential marine port and/or barge sites in Roberts Bay (abbreviated as P1 to P5) and at one reference site (REF) in Reference Bay (Figure 2.1-1). Three of these sites (P1, P5 and REF) had previously been surveyed as part of the 2009 Marine Fish Baseline Program (Rescan 2010). Sites P2, P3, and P4 were surveyed for the first time in 2010. Sites P1, P2, and P4 are potential Barge Port Options and sites P3 and P5 are potential Deep Water Port Options.

Fish sampling for the purpose of assessing nearshore habitat use was also conducted using four trap nets (abbreviated as TN1 to TN4) installed along the western shoreline of Roberts Bay (Figure 2.1-2). TN1 was installed south of site P1, TN2 and TN3 were installed between sites P2 and P3, and TN4 was installed north of site P5.

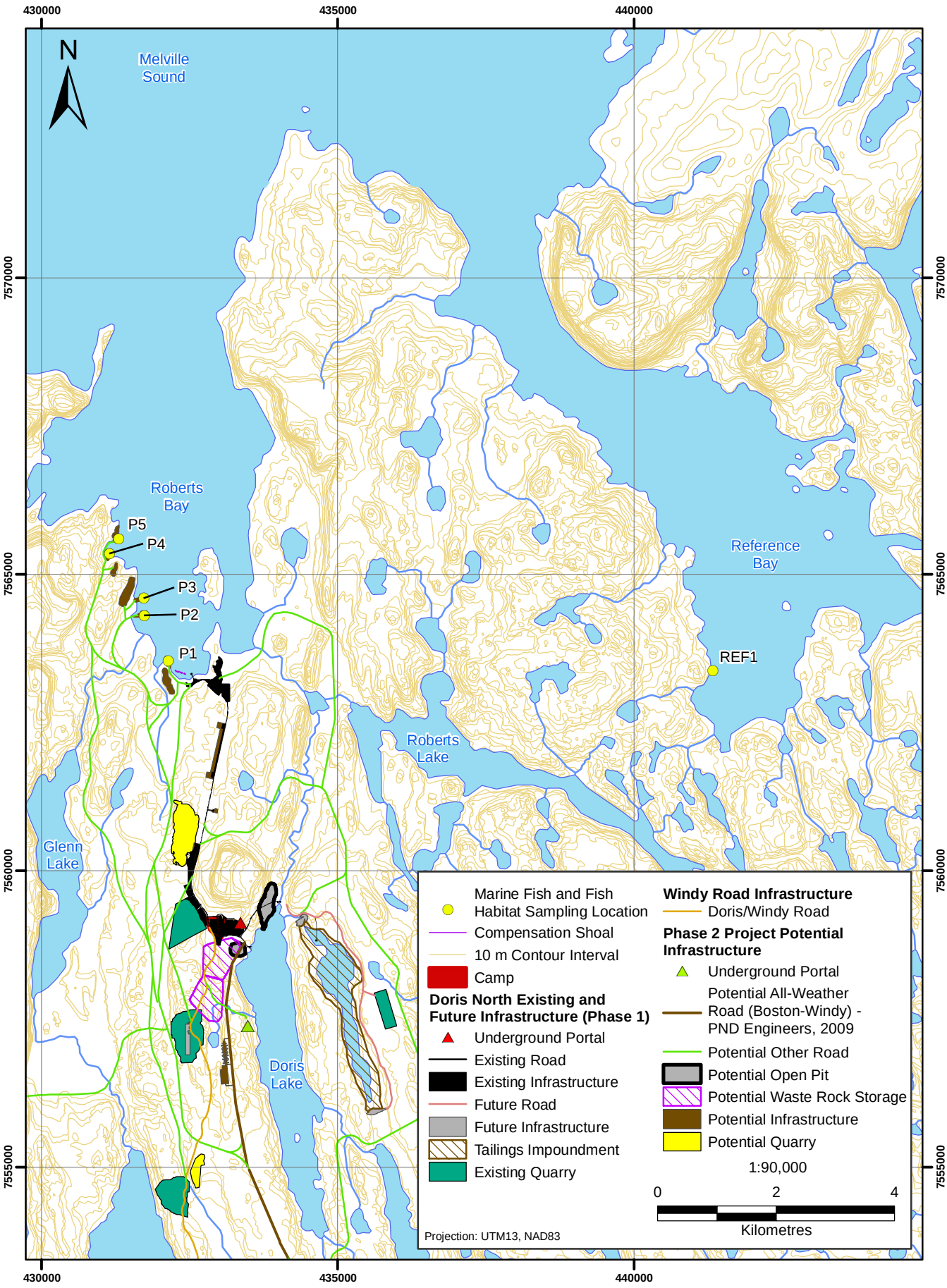
2.2 FISH HABITAT

Surveys of nearshore fish habitat at sites P2 to P5 and REF were conducted by walking along the shoreline and visually delineating habitat units (i.e., areas of uniform substrate). Site P1 was not surveyed in 2010 because it had been surveyed in 2009. All shoreline habitat surveys were conducted during the late sampling period and were coordinated with the predicted low tide to ensure the maximum amount of exposed habitat.

Habitat units were identified based on the proportion of the following substrate types: bedrock (>4,000 mm diameter), boulder (256 to 4,000 mm), cobble (64 to 256 mm), gravel (2 to 64 mm), and fines (0 to 2 mm) (Orth 1983). The coordinates of the boundaries of each unit were measured using a handheld GPS unit. Within each habitat unit, substrate composition was recorded as percent coverage (e.g., 70% cobble, 20% gravel, and 10% fines) and the length of each unit was measured with a surveyors tape. Photographs were taken of the various habitat units. In the office, a combination of field notes, GPS waypoints, and photographs were used to prepare habitat maps using ArcGIS 10 mapping software.

Hydroacoustic methods were used to survey those areas of Roberts Bay that were deeper than 2 m and not clearly visible to shoreline surveyors. Surveys were conducted using a 5.8 m-long boat with an outboard engine. Depth measurements were taken with a digital echo sounding system that consisted of a BioSonics DTX scientific echo sounder with a 6.7°, 201 kHz transducer, a computer to control the sounder and record data, and a Garmin GPSmap 182 differential GPS to geo-code collected data (Table 2.2-1). The transducer was mounted, facing downwards, on a pole 56 cm below the water surface. Soundings were made continuously as the boat moved along linear transects at a speed of 1 to 2 m/s. A depth calibration, performed during the survey using a target suspended at known distances 2 to 8 m below the transducer, showed an error of ≤0.6% (range of values = -0.6 to 0.5 %, or -0.1 to 3.8 cm deviation from known depths). During the survey, an electronic monitor installed at the Roberts Bay jetty continuously measured and recorded the water level in order to provide a correction for tidal influence.

After the survey, digital data files were processed using Myriax Echoview software to track the bottom, measure water depths, and create ASCII files of depths and geo-coordinates. Depth computations in Echoview adjusted sound velocity using average water column values of 10.8°C, pH 7.9, and salinity of 21.1 ppt. Those measurements were taken on August 15, 2010, during marine baseline water quality sampling (Rescan 2011b). Depths in Echoview output files were corrected for the depth of the transducer face below the water surface and for aquatic plants, where present (i.e., reported depths are to the substrate, not to the top of plants).



NEWMONT NORTH AMERICA

Sampling Locations for Fish and Fish Habitat Studies, Hope Bay Belt Project, 2010

Figure 2.1-1

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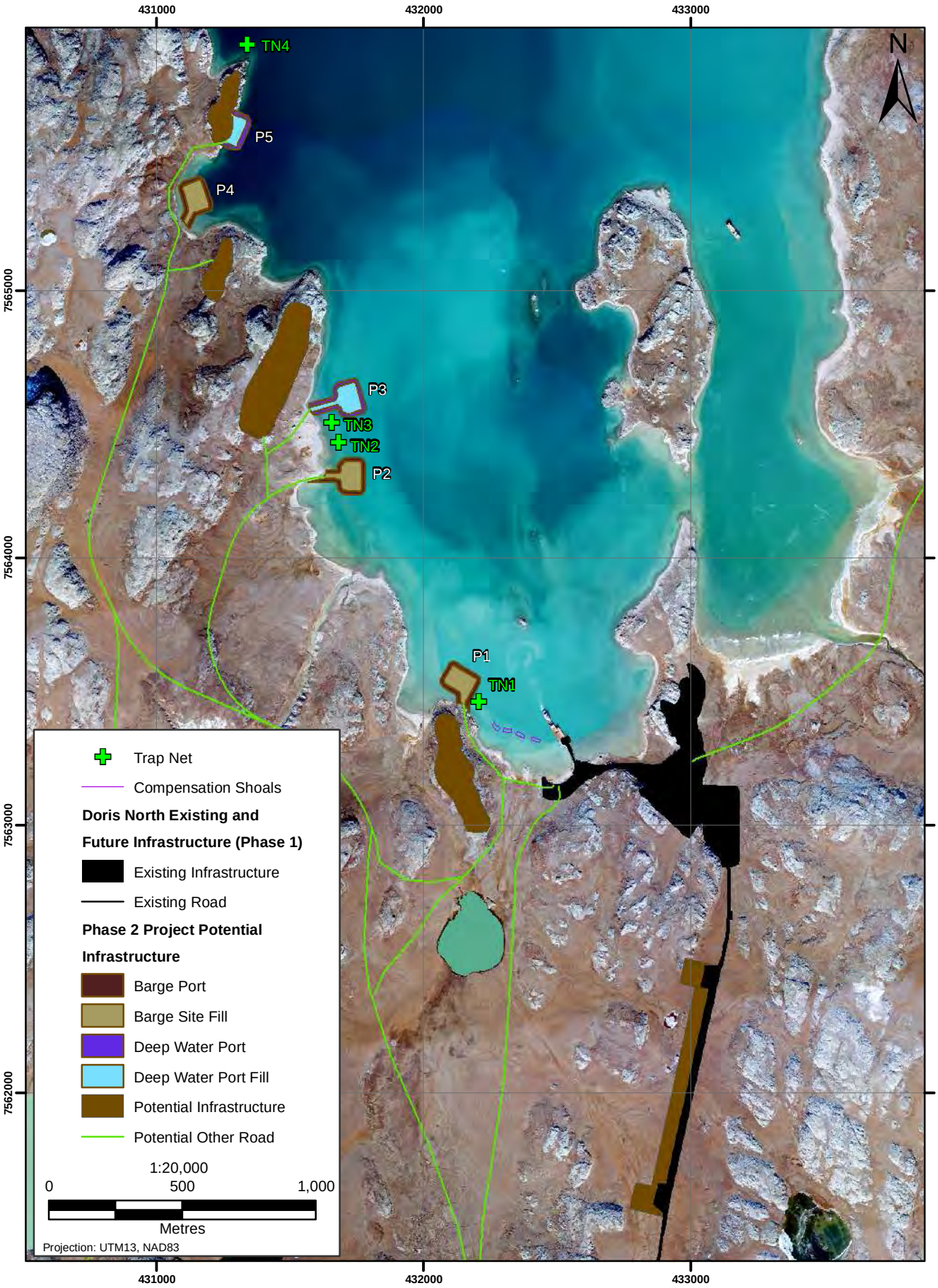

Figure 2.1-2

Trap Net Locations in Roberts Bay, Hope Bay Belt Project, 2010

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Table 2.2-1. Acoustic System Specifications for Collection of Bathymetric and Substrate Data from Roberts Bay, 2010

Category	Variable	Value
Echo Sounder	type	BioSonics DTX
Transducer	type	BioSonics split-beam
	sound frequency	201 kHz
	nominal beam angle	6.7°
	depth of transducer face	0.40 m
Settings	pulse width	0.4 ms
	Transmit power level	low (-10.3 dB)
	data collection threshold	-100 dB
	minimum data range	0.5 m
	time varied threshold	40 log R
	ping rate	5 pps
DGPS	Type	WAAS-differential[1]
	Datum	NAD83
Other	transecting speed	1.4-1.9 m/s

[1] *A Wide Area Augmentation System (WAAS) satellite signal was received during sampling with typical nominal position accuracy of 2 to 3 m.*

Additional line transects were conducted to fill in any data gaps which could not be collected due to shallow water depth or poor weather conditions. Where possible, the boat followed a straight transect from east to west. Where boat access was not possible, water depths were measured by wading. A meter stick and handheld GPS unit were used to manually read and record water depths every 5 to 20 m.

All data collected during the bathymetric surveys were corrected for tide effects and were referenced to an onshore benchmark (Table 2.2-2).

Table 2.2-2. Benchmark and Tide Gauge Location and Elevation, Doris North Project, 2010

Location	UTM Coordinates (Zone 13 NAD 83)		Elevation (m)
Benchmark	432337 E	7563181 N	1.180
Tide Gauge	432212 E	7563352 N	-0.922

The standardized data were imported into ArcGIS 10 to create bathymetric maps. Displacement between depth data from the manual and echo sounding surveys were approximately 5 to 20 m and 0.25 m, respectively. To minimize interpolation effect on the more widely distributed data and to avoid excessive grouping of closely spaced data, values interpolated from a Triangulated Irregular Network (TIN) were created using 3D Analyst. These values supplemented the widely spaced manual survey data with points at a minimum of every 7.5 m. These interpolated points, the echo sounding survey data, and depths from manual sampling done adjacent to the shoreline were converted in a Topo to Raster tool in the Spatial Analyst extension to create a grid of 1 m by 1 m cells and produce a map of predicted depths. Bathymetry contours were set at intervals of 0.5 m.

An underwater video camera was used to verify the acoustic classification of substrate types via video images taken at 32 random locations ranging in depth from 1 to 25 m. Images were collected with a Splashcam Deltavision underwater video camera recording to a Sony VRD-MC6 DVD recorder. The camera was suspended from the side of the boat with its lens aimed straight down about 50 to 100 cm above the

substrate. At each location the recording covered several meters or more of linear distance as the boat drifted. A 3.5 cm-diameter lead ball on a 50 cm string served as a size reference, sediment probe, and gauge of proximity to the bottom. Parallel lasers (10 cm apart) provided a secondary size reference. Time and GPS coordinates were recorded continuously to the video image by way of a video overlay device. Nominal position accuracy of the GPS was two to three m during the survey.

Video recordings were reviewed in the lab on a computer to confirm the substrate classifications. For each sampling location, the minimum, maximum, and dominant substrate size classes were noted.

2.3 FISH COMMUNITY

2.3.1 Sampling Frequency

The fish community at the five potential port and/or barge sites in Roberts Bay and at site REF in Reference Bay were sampled twice: in late July and early August (the early period) and in late August and early September (the late period). The number of sampling days spent at each site varied due to weather delays and logistical constraints. Therefore, although attempts were made to keep sampling effort consistent among sites, effort varied by sampling period and site (Table 2.3-1). Each site was sampled using a combination of six different types of fishing gear to cover a wide range of fish sizes, life history stages and water depths.

Table 2.3-1. Sampling Dates and Effort for Fish Community Surveys in Roberts Bay and Reference Bay, Hope Bay Belt Project, 2010

Bay	Site ID	Sampling Period	Set Dates	Number of gear sets					
				GNF	GNS	LL	BS	MT	CT
Roberts	P1	Early	July 30, 31; Aug 1, 4, 12	5	6	5	5	30	15
Roberts	P1	Late	Aug 28 – Sept 3	6	6	6	6	30	15
Roberts	P2	Early	Aug 5, 8, 9, 12	5	6	5	2	10	5
Roberts	P2	Late	Sept 1 - 4	6	6	6	6	30	15
Roberts	P3	Early	Aug 8, 9, 10, 12	5	6	6	5	20	15
Roberts	P3	Late	Sept 8 - 13	6	5	6	2	30	16
Roberts	P4	Early	Aug 9, 10, 11, 13	5	6	5	5	10	15
Roberts	P4	Late	Sept 4, 5, 7, 8, 18, 19	6	6	6	6	30	15
Roberts	P5	Early	Aug 15 - 19	6	6	3	0	6	10
Roberts	P5	Late	Sept 18 - 21	6	6	6	0	18	17
Reference	REF	Early	Aug 13, 14	6	6	4	5	17	16
Reference	REF	Late	Sept 22 - 24	5	5	6	6	30	17

Notes: GNF = Floating Gillnet; GNS = Sinking Gillnet; LL = Long line; BS = Beach Seine; MT = Minnow Trap; CT = Crab Trap.

2.3.2 Sampling Gear

2.3.2.1 General

Two sampling crews worked during each of the two sampling periods. All sampling was done from either an aluminum 5.8 m-long boat with a 70 hp outboard engine or flat bottom aluminum 5.4 m-long landing craft equipped with an 80 hp outboard engine. The UTM of each gear set were recorded with a handheld GPS unit and depths were recorded with a handheld depth sounder. The times of installation and retrieval of each gear were recorded.

2.3.2.2 Gillnets

A combination of floating and sinking gillnets were used to capture fish that move in the water column (pelagic) and along the seafloor (demersal), respectively. Each gillnet consisted of six panels of monofilament mesh tied together in the following order: Panel 1 (25 mm mesh); Panel 2 (76 mm); Panel 3 (51 mm); Panel 4 (89 mm); Panel 5 (38 mm); and Panel 6 (64 mm). Each panel measured 15.2 m long by 2.4 m deep for an area of 36.6 m^2. Total gillnet area was 219.6 m^2 per net.

Both types of gillnets had an upper float line with small buoys that kept the net upright in the water column. Sinking gillnets had a weighted lower lead line that forced the bottom of the net to rest along the sea bottom. Floating index gillnets did not have a weighted lead line and so their float lines rested at the sea surface.

Gillnets were set perpendicular and parallel to shore for approximately 1 h to minimize mortality of fish. If catch rates were low, then set times were increased. Figures 2.3-1 to 2.3-12 show the locations of each set of floating and sinking gillnets set in Roberts and Reference bays.

2.3.2.3 Long Lines

Long lines were used to capture actively-feeding fish. A 20 m-long cord was rigged with seven hooks attached at intervals of 2.5 m. Hooks were baited with raw fish and attached to the main line with short secondary lines and buoys. At both ends, the main line was weighted with lead and attached to a surface buoy. Once set, the long line sat in the water column with the hooks suspended in the water column.

Long lines were set perpendicular and parallel to shore for an initial period of 2 h. Set times were increased if catch rates were low. Figures 2.3-1 through 2.3-12 show the locations of each long line set in Roberts and Reference bays.

2.3.2.4 Beach Seines

A beach seine was used to capture small fish that use shallow nearshore habitat. The seine net was 12 m long, 2 m deep with 2 mm mesh. While one end was held at the waterline, the other end was walked out perpendicular to shore and then arced around into a horseshoe shape until it enveloped a portion of the shoreline (Plate 2.3-1). Once onshore, both ends were slowly drawn onto the beach, keeping the lead line on the seafloor and forcing fish into the bunt of the seine. A series of between two to six seine hauls were conducted at each site. The exception was site P5 where the shoreline was too steep and rocky to allow safe beach seining. Figures 2.3-13 to 2.3-24 show the locations of beach seines in Roberts and Reference bays.

2.3.2.5 Minnow Traps

Minnow traps were used to sample juvenile and small adult fishes. The traps consisted of two 6.3 mm galvanized metal mesh cylinders measuring 42 cm long and 23 cm in diameter with a 2 cm diameter opening and 6.5 mm mesh. The cylinders were locked together using a clip attached to a rope and buoy. Each minnow trap was baited with a small amount of dry, commercial crab bait and placed along the shoreline of each sampling site. Figures 2.3-13 to 2.3-24 show the locations of each minnow trap set. Traps were left to soak overnight and retrieved the next day, though weather delays occasionally extended this soak time.

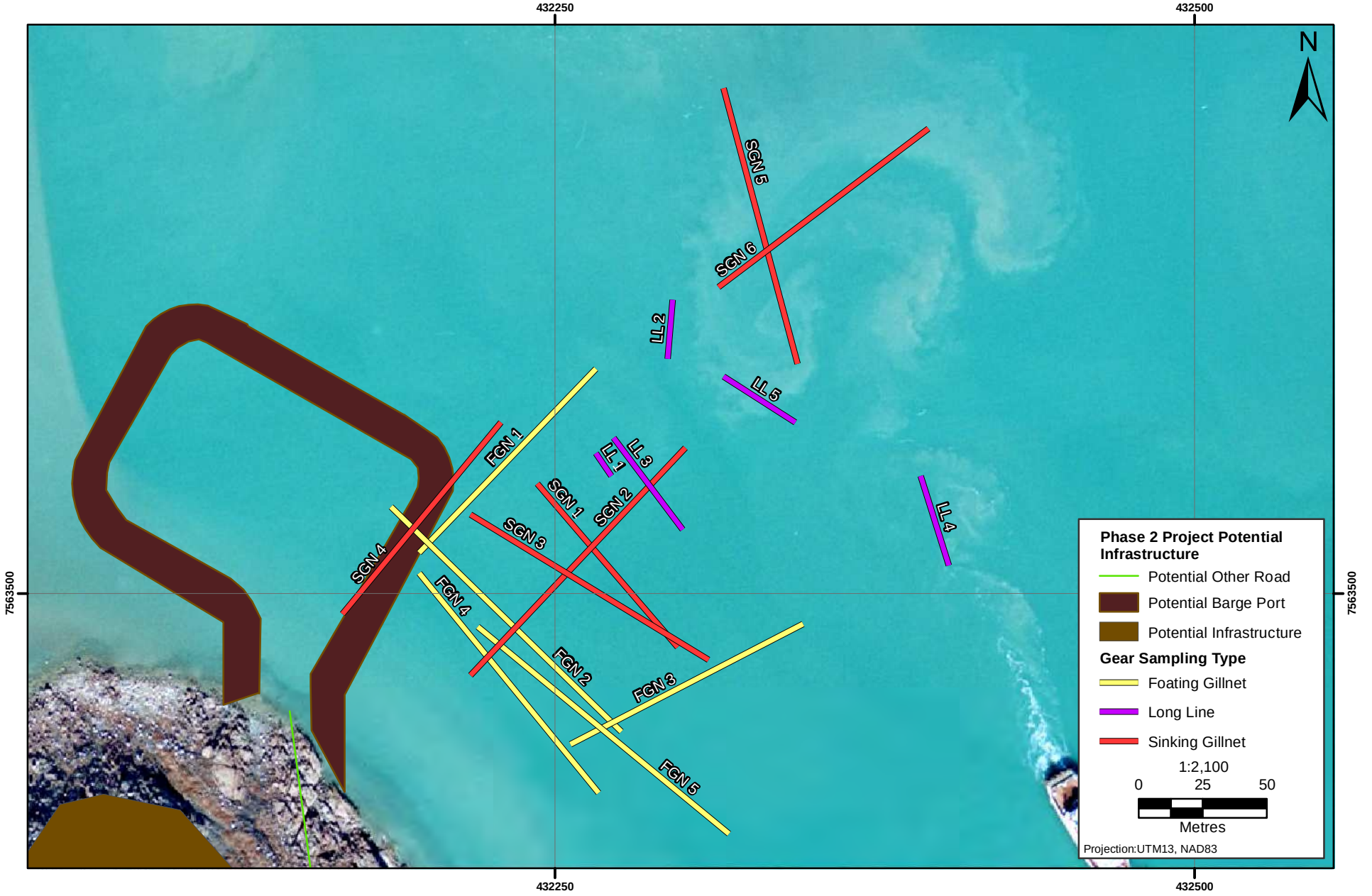

Figure 2.3-1

NEWMONT NORTH AMERICA

Gillnet and Long Line Locations During the Early Sampling Survey of the Fish Community at Site P1 in Roberts Bay, Hope Bay Belt Project, 2010

Figure 2.3-1

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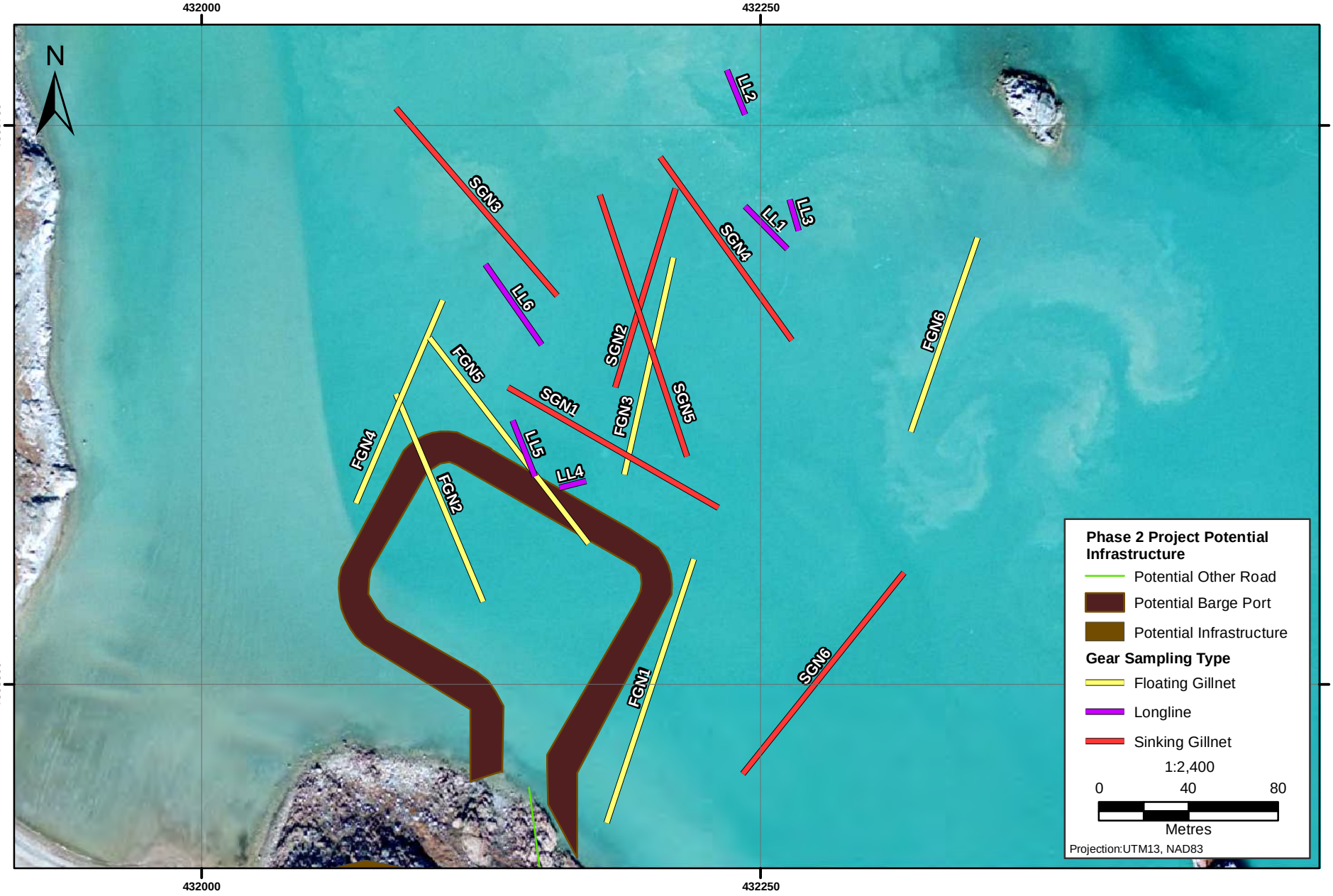

Figure 2.3-2

NEWMONT NORTH AMERICA

Gillnet and Long Line Locations During the Late Sampling Survey of the Fish Community at Site P1 in Roberts Bay, Hope Bay Belt Project, 2010

Figure 2.3-2

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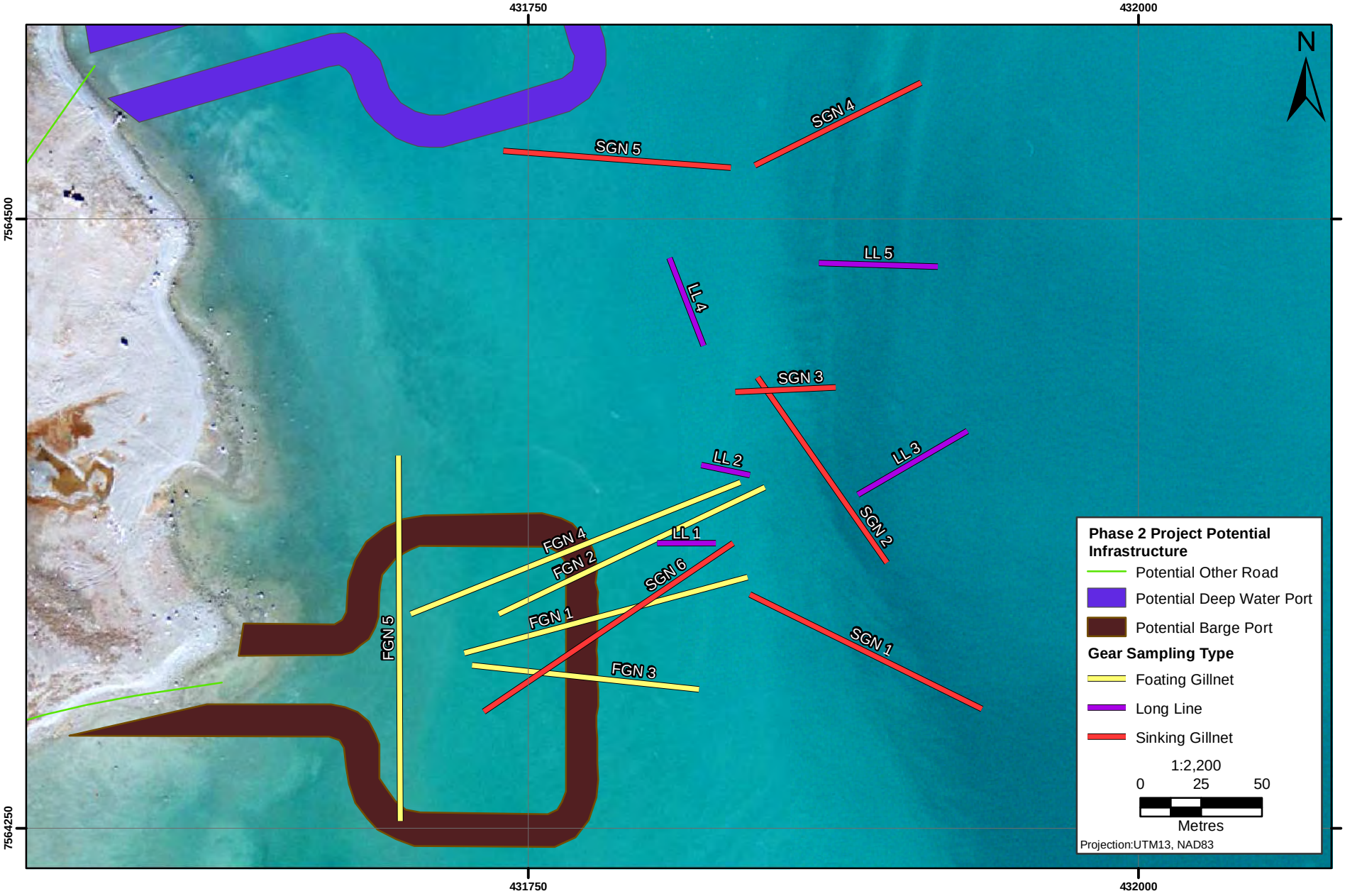

Figure 2.3-3

NEWMONT NORTH AMERICA

Gillnet and Long Line Locations During the Early Sampling Survey of the Fish Community at Site P2 in Roberts Bay, Hope Bay Belt Project, 2010

Figure 2.3-3

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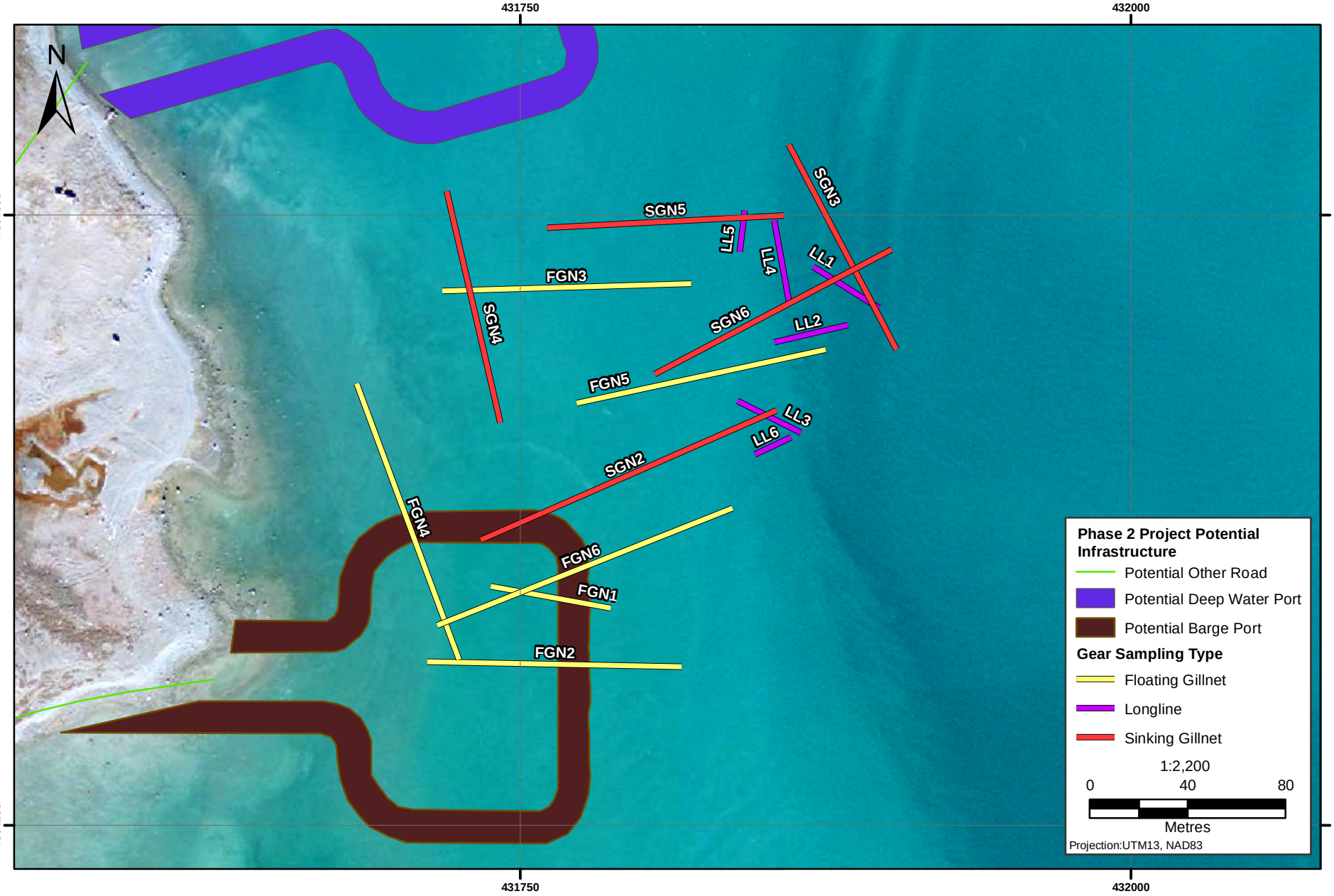

Figure 2.3-4

NEWMONT NORTH AMERICA

Gillnet and Long Line Locations During the Late Sampling Survey of the Fish Community at Site P2 in Roberts Bay, Hope Bay Belt Project, 2010

Figure 2.3-4

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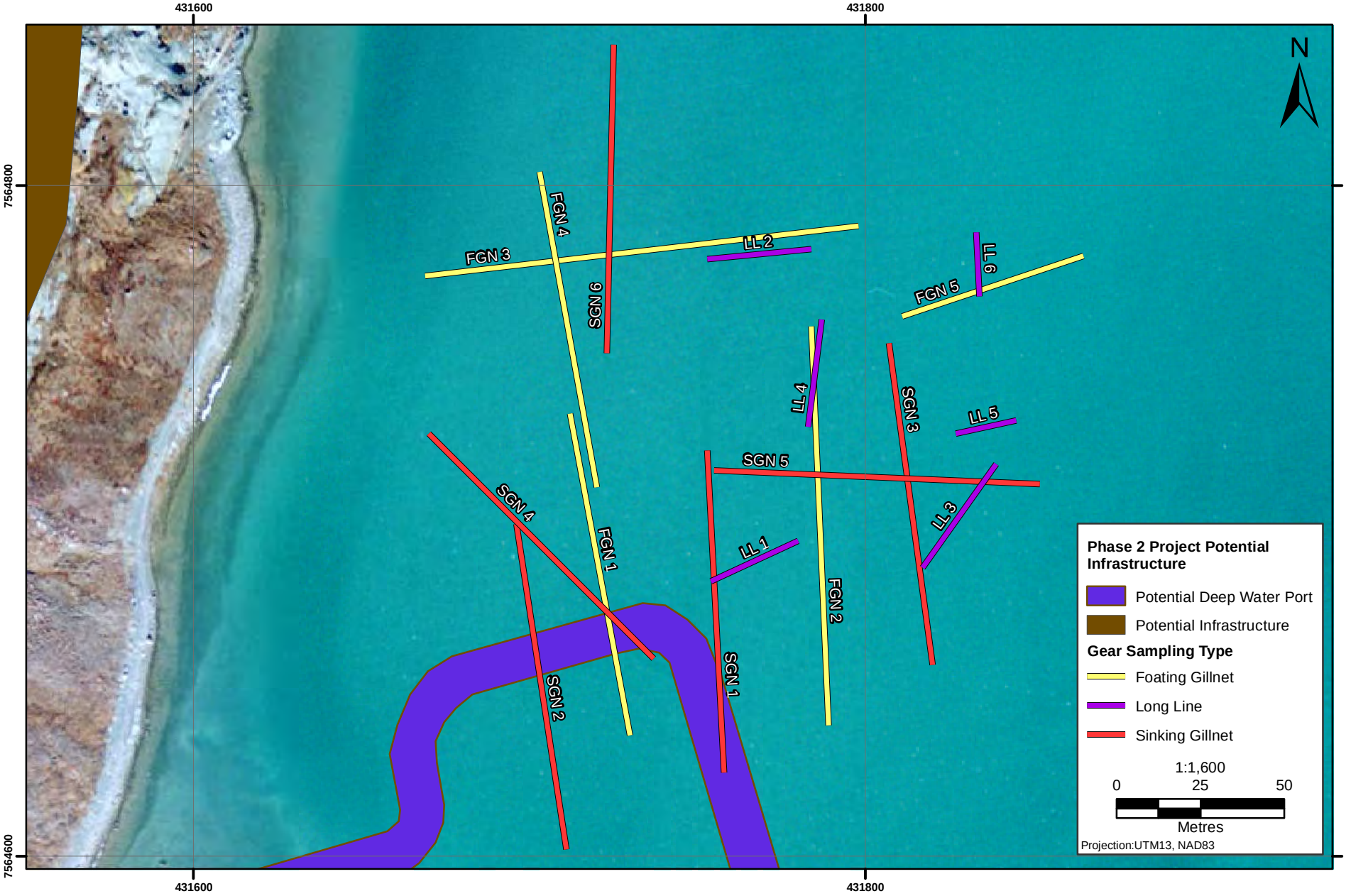

Figure 2.3-5

NEWMONT NORTH AMERICA

Gillnet and Long Line Locations During the Early Sampling Survey of the Fish Community at Site P3 in Roberts Bay, Hope Bay Belt Project, 2010

Figure 2.3-5

Rescan Engineers & Scientists

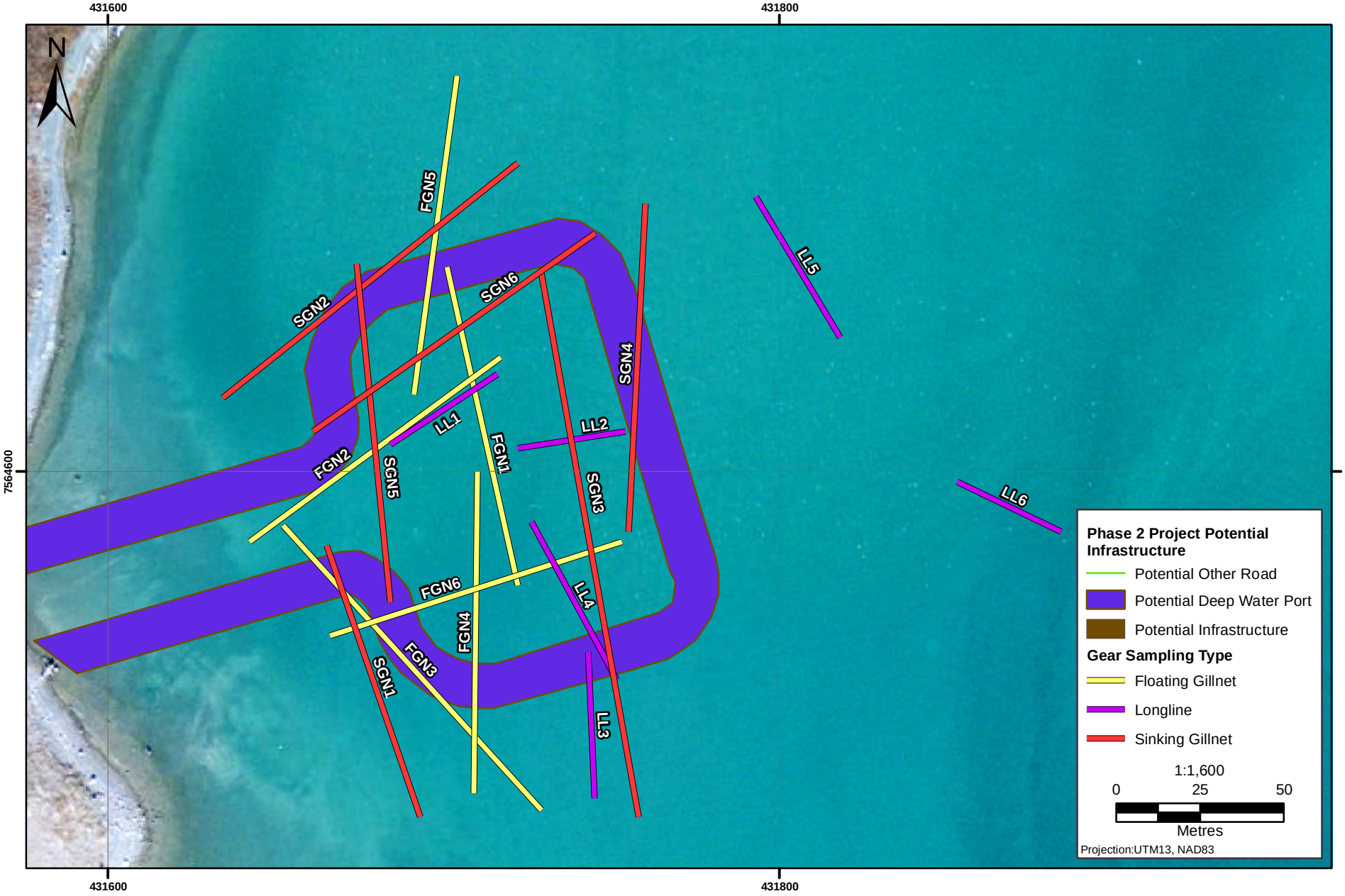

Figure 2.3-6

NEWMONT NORTH AMERICA

Gillnet and Long Line Locations During the Late Sampling Survey of the Fish Community at Site P3 in Roberts Bay, Hope Bay Belt Project, 2010

Figure 2.3-6

Rescan Engineers & Scientists

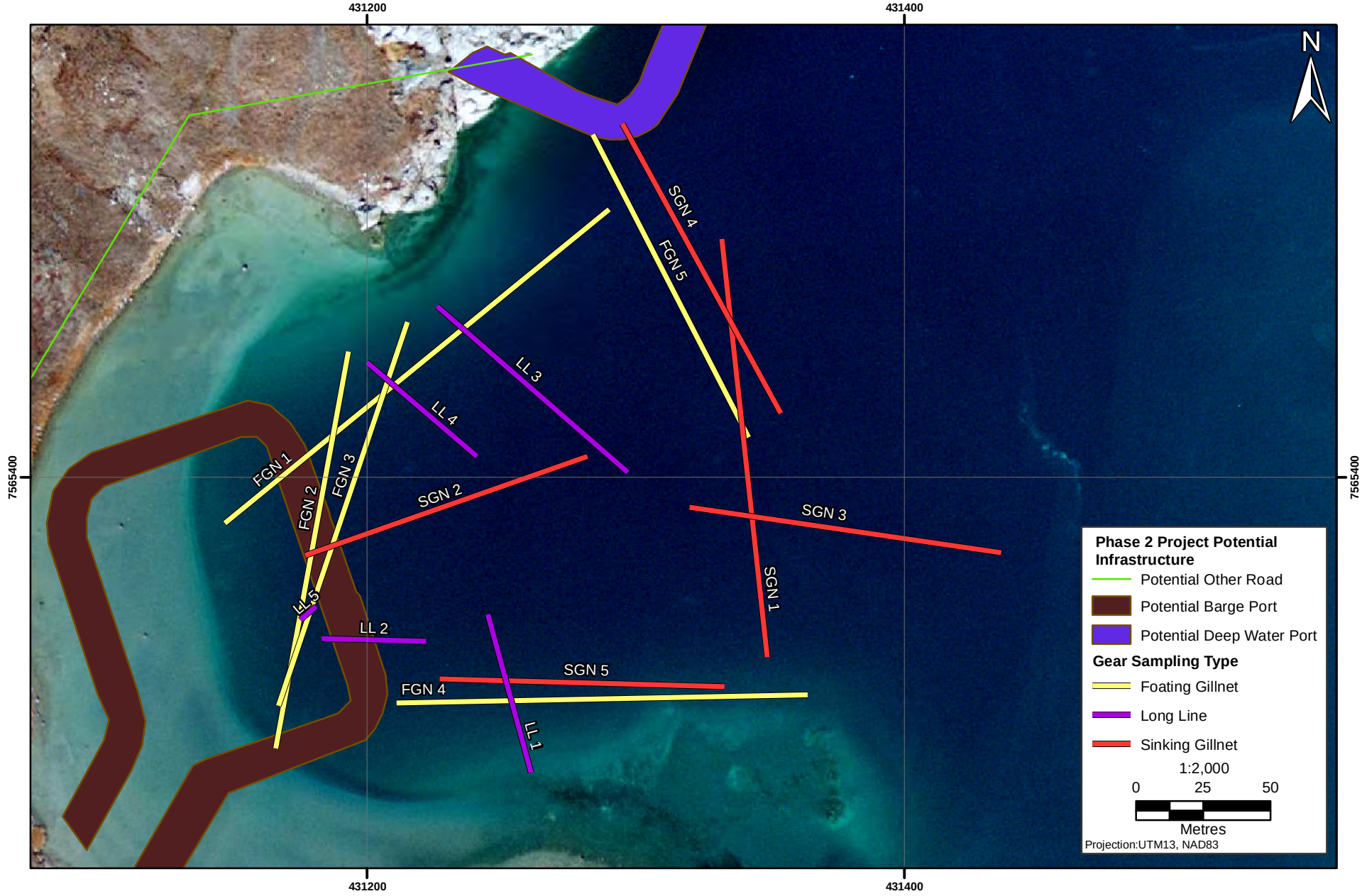

Figure 2.3-7

NEWMONT NORTH AMERICA

Gillnet and Long Line Locations During the Early Sampling Survey of the Fish Community at Site P4 in Roberts Bay, Hope Bay Belt Project, 2010

Figure 2.3-7

Rescan Engineers & Scientists

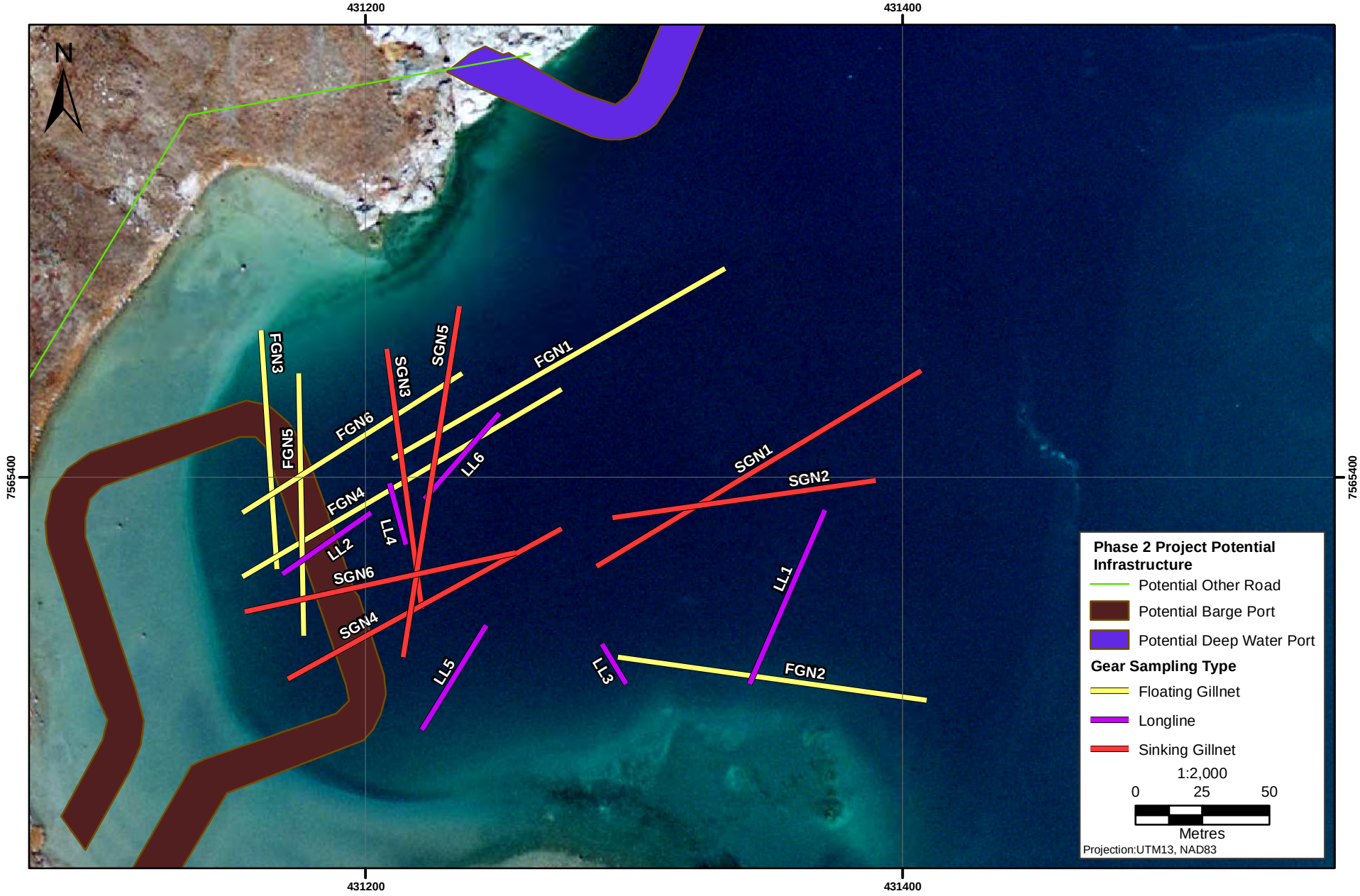

Figure 2.3-8

NEWMONT NORTH AMERICA

Gillnet and Long Line Locations During the Late Sampling Survey of the Fish Community at Site P4 in Roberts Bay, Hope Bay Belt Project, 2010

Figure 2.3-8

Rescan Engineers & Scientists