Figure 4.2-1

Roberts Bay and Regional Marine Setting

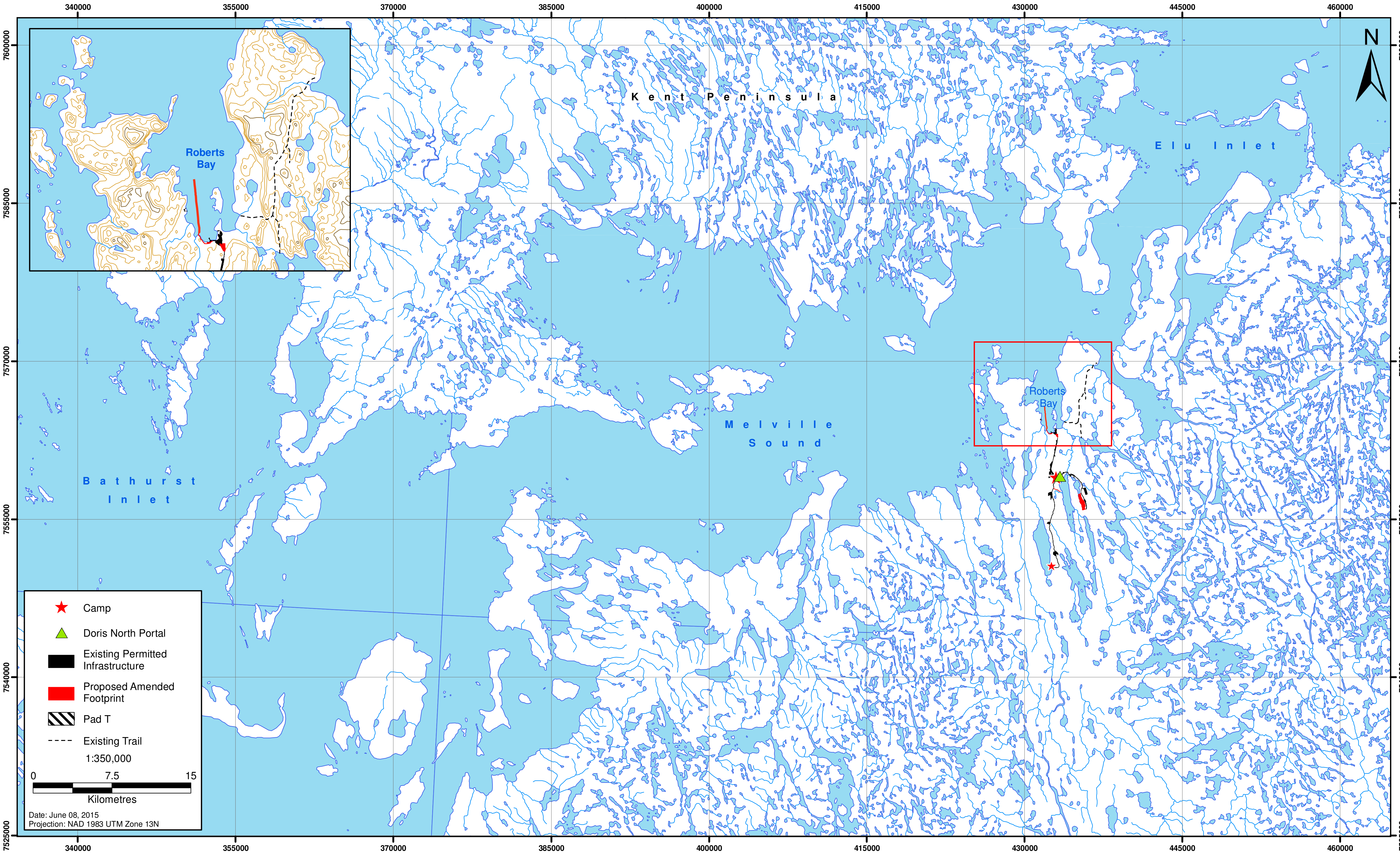


Figure 4.2-2

Roberts Bay and Surrounding Freshwater Catchments

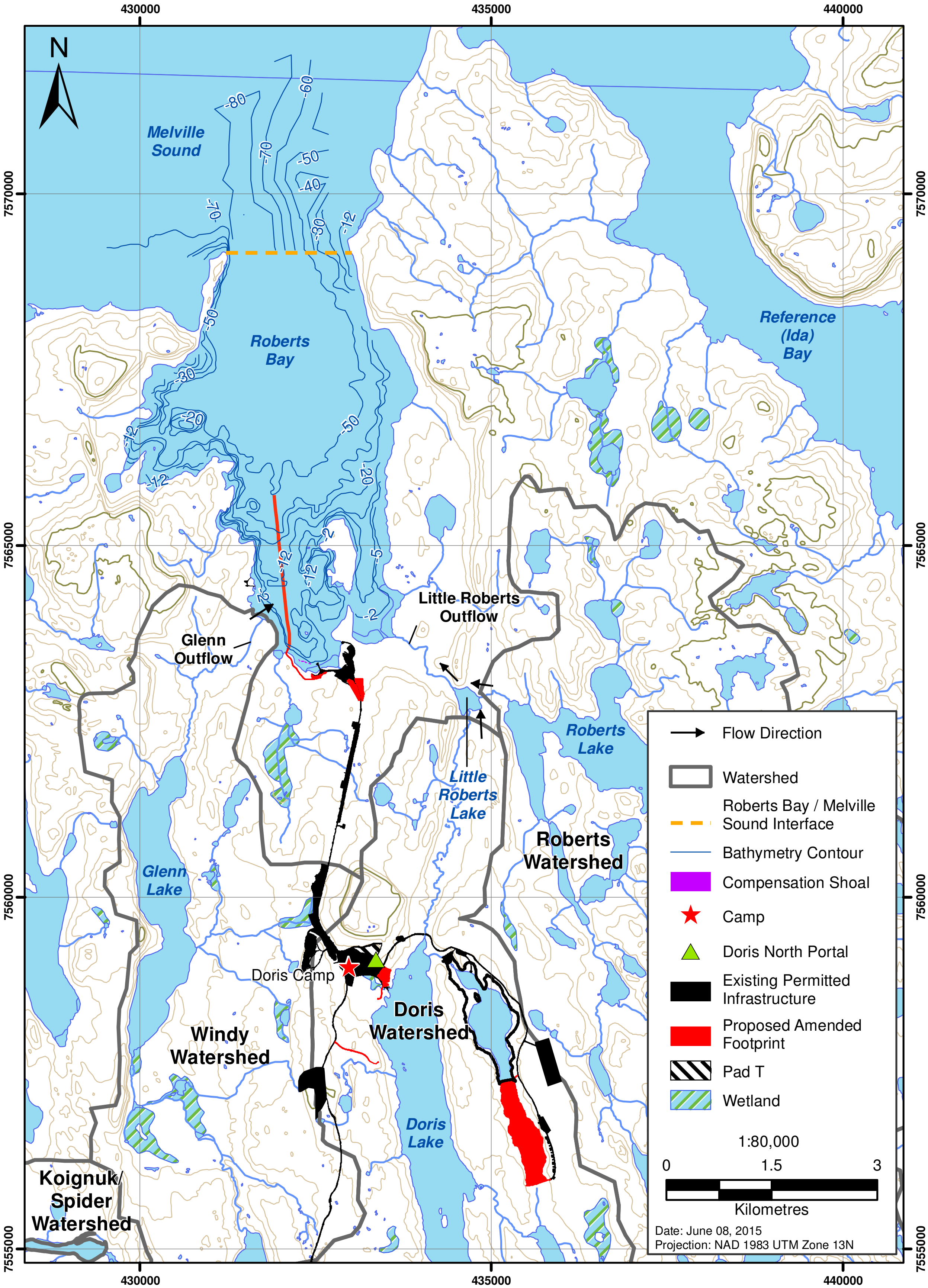


Figure 4.3-1
Proximity of Roberts Bay to Designated Environmental Areas

ERM

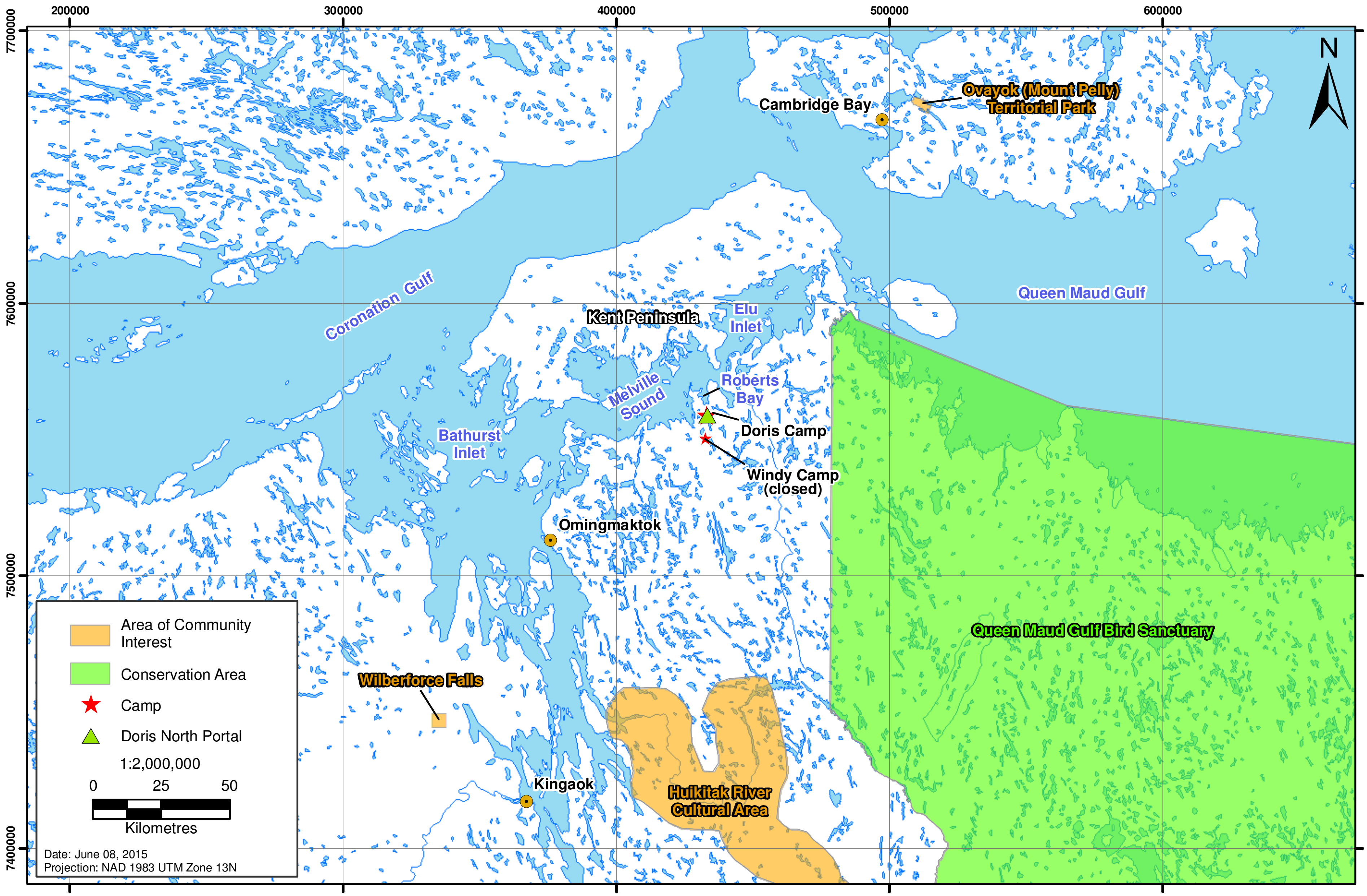
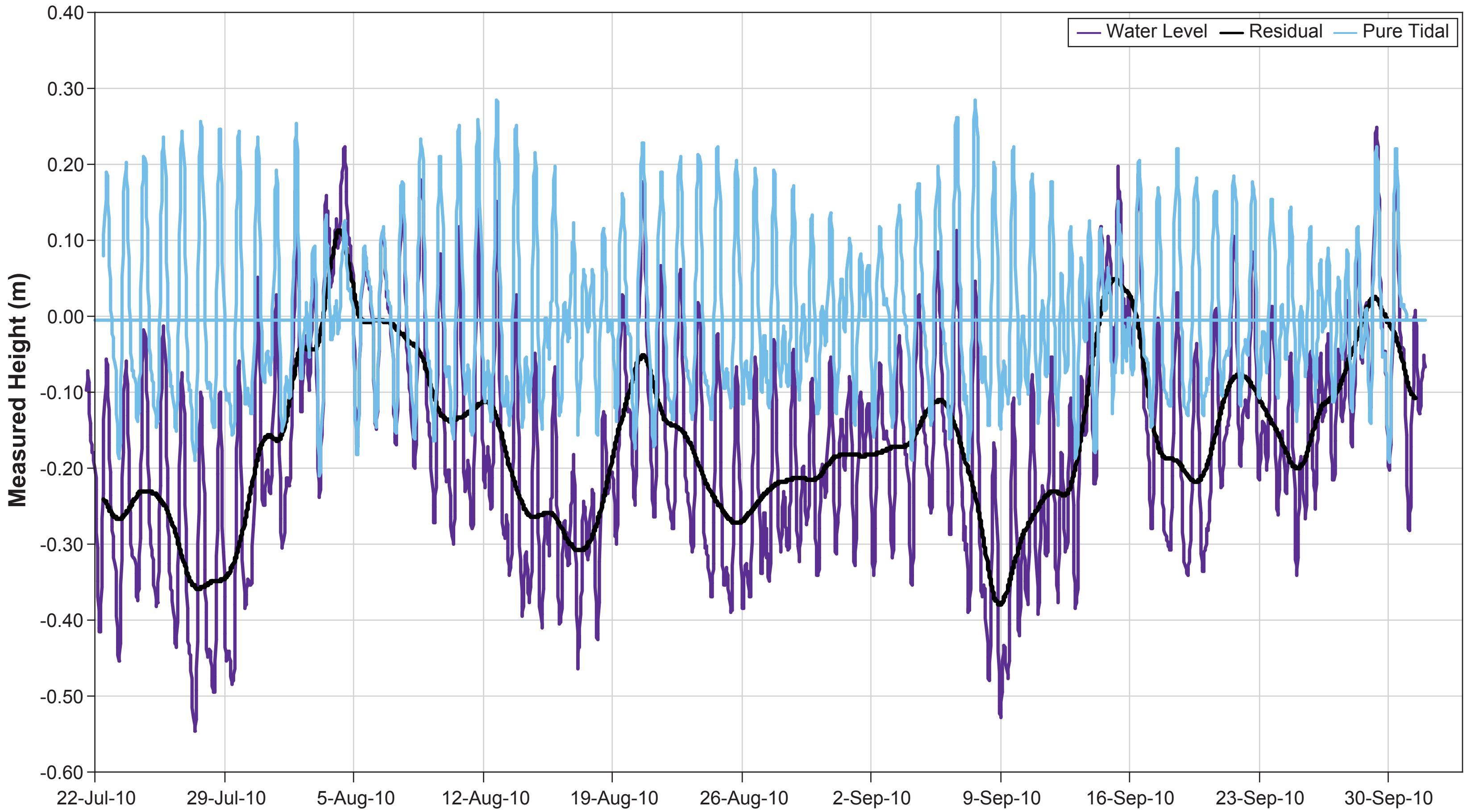


Figure 4.3-2

Water Level Measurements in Roberts Bay with Tidal and Non-tidal Components



Note: The Pure Tidal component is modelled as the sum of a finite set of sinusoids at specific frequencies related to astronomical parameters.
The Residual component, which refers to water height changes due to physical processes other than tides (e.g., wind waves, freshwater discharges, etc.), is obtained by subtracting the Pure Tidal component from the total Water Level.

Summer

During the summer (ice-free) months, water circulation is dominated by wind-driven flows rather than freshwater discharge, with the direction and strength of flow depending on the prevailing wind conditions. As displayed in the current measurements of Rescan (2012b), the combination of southern/easterly winds and freshwater inputs resulted in a positive-type two-layered estuarine circulation for roughly 70% of the measurement period, where the top layer flowed seaward and the deeper waters flowed into Roberts Bay from Melville Sound. A schematic interpretation of this type of circulation in Roberts Bay can be found in Figure 4.3-3. For the other ~30% of the time, the general estuarine circulation was shown to reverse itself as illustrated in Figure 4.3-4, where strong and generally northerly winds drive the surface layer southward into Roberts Bay, which results in a return, outward, northerly flow below at depth.

Site-specific wind data and current measurements were used to model the summer circulation of Roberts Bay water, with the results detailed in Rescan (2012a). Figures 4.3-5 and 4.3-6 shows examples from the resulting numerically simulated current fields of July and August 2011. The numerical simulation showed that all of the deeper waters of Roberts Bay were exchanged with those of Melville Sound over a period of 3 weeks to over a month under various circulation scenarios. Thus, it was surmised from the modelling results that Roberts Bay would be effectively flushed multiple times with Melville Sound waters during the four-month open-water season.

Winter

During the ice-covered season, a 1 to 2 m thick ice layer forms that shelters Roberts Bay waters from wind. Over time, the under-ice convection generated from the ice growth leads to the formation of a two-layer thermohaline structure with weak stratification in the water column, and a colder, fresher layer of 25 to 30 m thickness atop a more saline, warmer layer extending to the bottom.

Under-ice currents were generally very weak, with mean horizontal current velocities between 1 and 2 cm/s. Deep currents, which were driven either by density gradients formed through episodic ice formation/brine release or advection of waters from Melville Sound, had slightly stronger velocities. Tidal flows are weak and likely have little effect on exchange between Roberts Bay and Melville Sound.

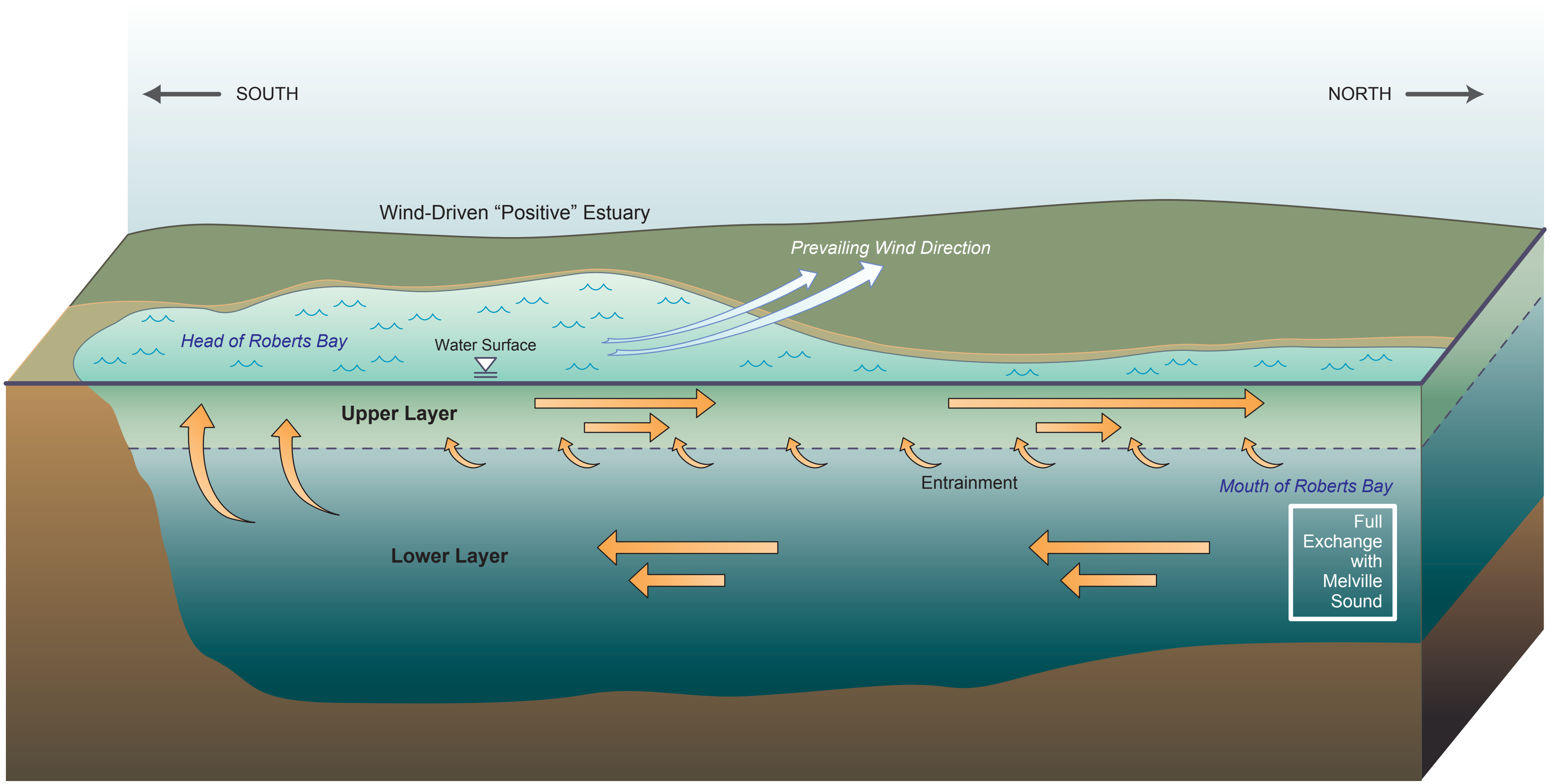
The weak convectively driven flow and tidal currents combine to gently stir Roberts Bay during the winter ice-covered season, tending to laterally homogenize the density-stratified bay. The overall circulation pattern in the surface waters appeared to be a sluggish clockwise flow, with occasional larger currents recorded directly under the sea ice, particularly in shallow areas where brine rejection flows were likely to occur. A schematic interpretation of the general winter circulation in Roberts Bay can be found in Figure 4.3-7.

4.3.4 Roberts Bay Bathymetry

Roberts Bay is included on a Canadian Hydrographic Service map (chart 7790) that shows the bathymetry along the southern coast of Melville Sound. However, soundings are sparse at the mouth of Roberts Bay where the depth is indicated as greater than 50 m and where a single sounding of 83 m is shown in the centre.

Figure 4.3-3

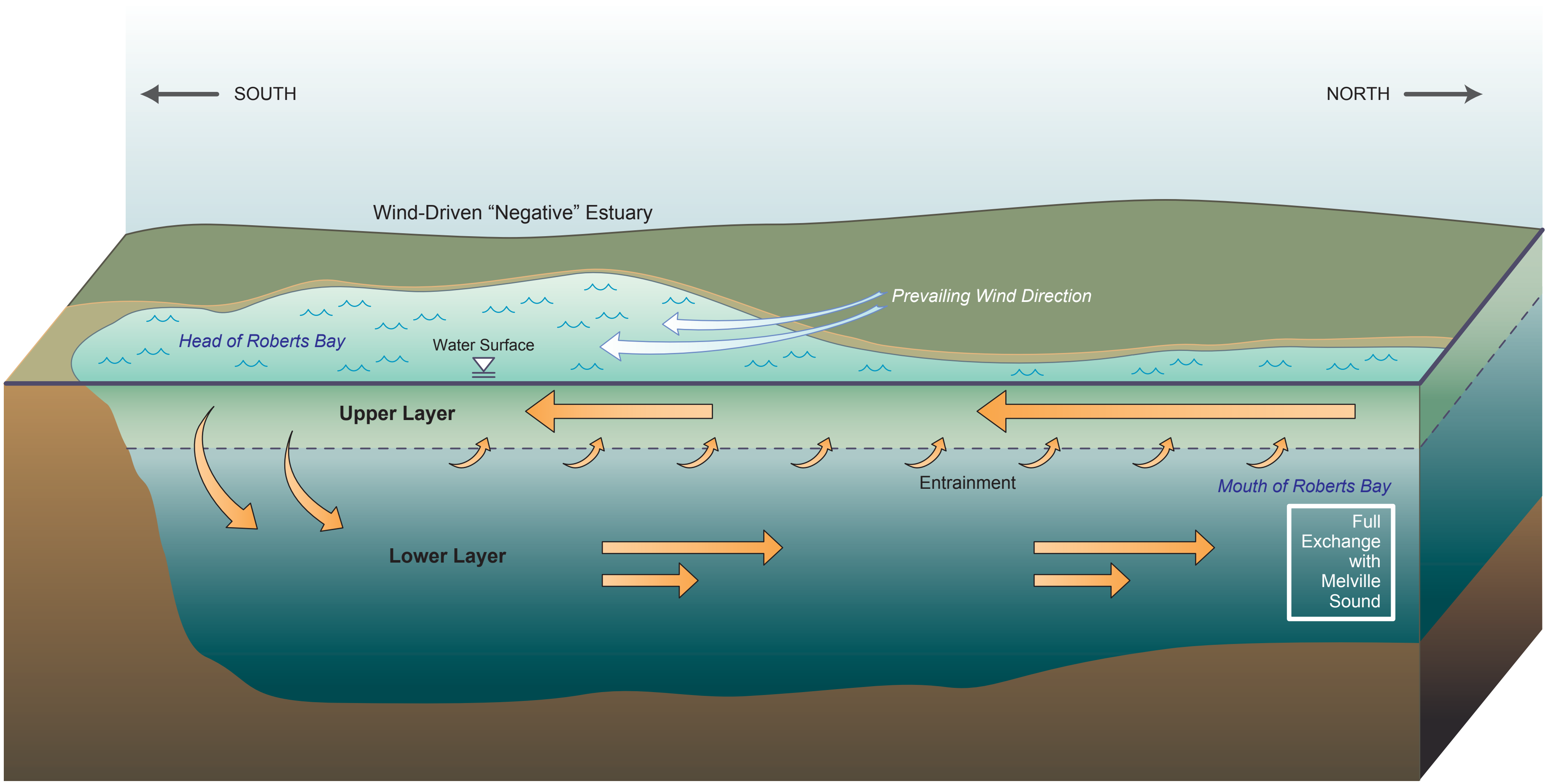
Example of Roberts Bay "Positive" Estuarine Circulation during the 2011 Summer: Vertical Side View



Note: The Prevailing Wind Direction refers to the wind direction that will most easily drive the circulation shown in the figure.

Figure 4.3-4

Example of Roberts Bay "Negative" Estuarine Circulation during the 2011 Summer: Vertical Side View



Note: The Prevailing Wind Direction refers to the wind direction that will most easily drive the circulation shown in the figure.