Southwest Nova Scotia
Tidal Energy Resource Assessment
Volume 1:
Tidal Energy Potential Reconnaissance

Greg Trowse[1,2], Richard Cheel[2], and Alex Hay[2]

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[1]**Fundy Tidal Inc.**
[2]**Dalhousie University**

Abstract

The Southwest Nova Scotia Tidal Energy Resource Assessment (the Project) included initial evaluation (reconnaissance) of several coastal sites in Shelburne, Yarmouth and Digby counties. A method was developed for assessing tidal currents using surface flow measurements. The method allows for low-cost assessment of the spatial and temporal variability in tidal flows, and was applied to evaluate several in-stream tidal energy development opportunities.

Criteria for site selection include estimated flow speed, depth, distance from shore (and grid connection), and existing use (including navigation, fishing, and marine habitat). Information for site selection was obtained from; a) review of Canadian Hydrographic Service (CHS) nautical charts (bathymetry) and tidal range predictions, b) recommendations from community meetings, c) informal discussions with local water users, and d) sites identified in the Inventory of Canada's Marine Renewable Energy Resources (*Cornett*, 2006).

Initial equipment testing and method development occurred in Grand Passage, followed by high-flow testing in Petit Passage. The drifters performed well in both environments, and the effect of windage was minimal. Data processing involved calculation of flow velocity from Global Positioning System (GPS) observations of latitude, longitude, and time using a centred numerical scheme. Nondimensional parameters were formulated to account for temporal variation in the velocity measurements, one representing the time between consecutive low tides, the other the tidal range during the observation period relative to the maximum annual range at the site.

Tidal energy potential reconnaissance was conducted at 9 sites. Flow speeds were measured with maximum site values ranging from 1.26 m/s (Port L'Hebert) to 4.16 m/s (The Gap), and flow speeds $\geq$ 3 m/s were observed at 6 of the 9 sites assessed for tidal energy potential.

The potential for small-scale tidal energy development is notable at Indian Sluice near the Indian Sluice Bridge (between Sluice Point and Surettes Island) due to flow speed, accessibility, and presence of bridge infrastructure. An acoustic Doppler current profiler (ADCP) was deployed at Indian Sluice as part of the Project based on the reconnaissance results.

In addition to recording maximum flow speeds, the surface flow data was used to generate stage of tide velocity charts for each site. The charts show temporal and spatial variation in tidal flows, and asymmetry is shown at sites where flood and ebb measurements were collected.

The focus of reconnaissance data collection was assessing high flow sections of tidal channels during peak ebb and/or flood tide. Additional data collection to fill in spatial and temporal data gaps in the charts is recommended at sites deemed attractive for potential tidal energy development. Further investigation should also include; a) water level measurements, b) ADCP deployments, and c) multi-beam bathymetry.

Acknowledgements

In addition to the listed authors, this work would not have been possible without

- knowledge of the sea shared by several local fishermen,
- safety support provided by Graham Carter, Clifton Pratt, and Jan-Sebastian La Pierre,
- Captain Reid Gillis and his rigid-hulled inflatable boat (RHIB) Zippin Zodiac at The Gap and the Big Tusket region, and
- funding support provided by the Offshore Energy Research Association (OERA) of Nova Scotia.

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Chapter 1

Introduction

The Southwest Nova Scotia Tidal Energy Resource Assessment (the Project) included initial evaluation (reconnaissance) of several coastal sites in Shelburne, Yarmouth and Digby counties. A method was developed for assessing tidal currents using surface flow measurements. The method allows for low cost assessment of the spatial and temporal variability in tidal flows, and was applied to evaluate several in-stream tidal energy development opportunities.

The following chapters outline site selection, methodology, results, and recommendations of the Tidal Energy Potential Reconnaissance portion of the Project. Select figures and site photographs have been included in the main body of text. Additional figures and photographs have been included as Appendix A and B, respectively. Field notes are included as Appendix C. Site video is available upon request.

Chapter 2

Site Selection

Criteria for site selection include estimated flow speed, depth, distance from shore (and grid connection), and existing use (including navigation, fishing, and marine habitat). Information for site selection was obtained from:

- review of Canadian Hydrographic Service (CHS) nautical charts (bathymetry) and tidal range predictions;
- recommendations from community meetings;
- informal discussions with local water users; and
- sites identified in the Inventory of Canadas Marine Renewable Energy Resources (*Cornett*, 2006).

Sites where flow measurements were collected are shown in Figures 2.1 and 2.2 and include the following:

- Grand Passage [44°16.0'N 66°20.5'W] (equipment and method development)
- Petit Passage [44°23.5'N 66°12.5'W] (equipment and method development)
- The Gap [44°13.3'N 66°22.7'W]
- Passages West of Big Tusket Island [43°38.3'N 66°2.5'W]
- Indian Sluice Bridge [43°46.3'N 65°56.9'W]
- The Sluice [43°45.6'N 65°53.4'W]
- The Tittle [43°43.3'N 65°54.3'W]
- Cat Island Bridge [43°47.5'N 65°51.9'W]
- Pubnico Harbour [43°36.0'N 65°47.0'W]
- Port Clyde Bridge [43°36.2'N 65°28.1'W]

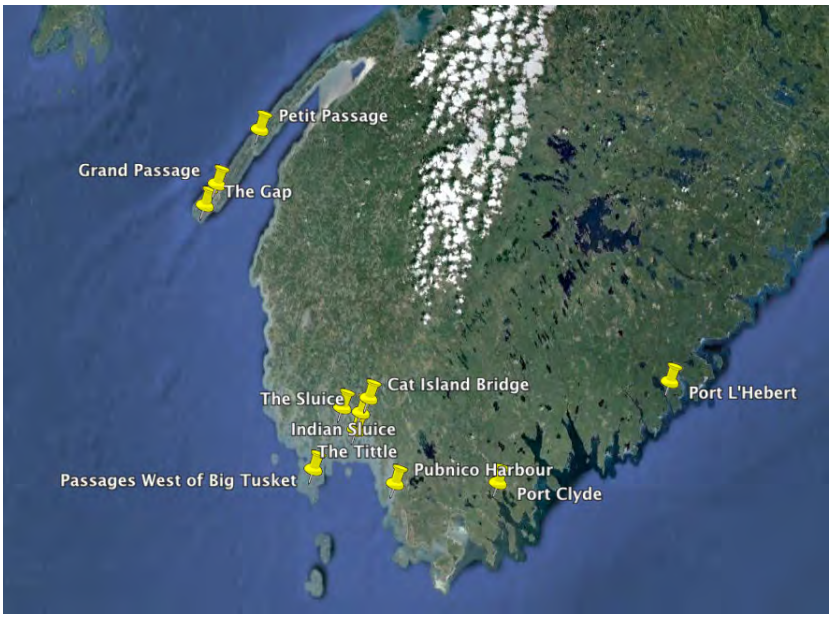

Figure 2.1: SWNS Recon Sites

Figure 2.2: SWNS Recon Sites - Tusket detail

- Port LHebert [43°49.5'N 64°56.1'W]

Additional sites were identified and visited for initial assessment, but flow measurements were not collected due to site prioritization based on time, budget, logistical and safety constraints. These locations include:

- Cape Sable [43°23.1'N 65°37.5'W]
- Baccaro Point [43°26.8'N 65°28.2'W]
- Lockeport Rail Bridge [43°42.2'N 65°7.2'W]
- Black Point Bay [43°41.8'N 65°3.9'W]
- Barrington Passage [43°31.0'N 65°36.8'W]
- Tusket River Estuary at Squires Island [43°47.2'N 65°59.8'W]
- Sissiboo River Estuary [44°26.0'N 66°0.0'W]

With respect to remaining sites identified by *Cornett* (2006),

- The Hospital [43°27.0'N 66°0.0'W] was not assessed due to distance from shore resulting in safety/logistical constraints and technical/cost challenges for development of tidal energy,
- Northwest Ledge [44°17.8'N 66°25.7'W] was not assessed due to conflict with marine mammal habitat, and
- Trinity Ledge [44°0.0'N 66°17.4'W] was not assessed due to distance from shore and fishing conflicts.

Chapter 3

Methodology

Surface flow drifters with internally recording Global Positioning System (GPS) units were deployed repetitively from small vessels throughout the tidal cycle to obtain spatial and temporal coverage of a site. The drifters were deployed upstream of the site of interest, collected downstream, then returned to an upstream position for redeployment. Deployments continued until a trend of decreasing flow velocities was observed (flow decreasing towards slack water), or environmental factors (such as darkness or gale force wind) limited sampling time.

Vessels were selected based on site characteristics, including spatial extent, accessibility, and water depth. GPS sampling frequency was selected based on estimated flow speed, typically 0.5 Hz for flows up to 2 m/s and 1 Hz for flows faster than 2 m/s. Drifts ranged in duration from approximately 3 to 20 minutes based on flow speed and the size of the focus area.

Initial equipment testing and method development occurred in Grand Passage, followed by high-flow testing in Petit Passage. The drifters performed well in both environments, and the effect of windage was minimal based on qualitative observation of the differential between drifter and boat velocity while a drift.

Data processing was carried out using Matlab and involved calculation of flow velocity from GPS observations of latitude, longitude, and time using a centred numerical scheme (in time and space). Nondimensional parameters were formulated to account for temporal variation in the velocity measurements.

α represents the position in time between two low waters (tide time), allowing grouping of site data collected during different ebb or flood tides. α is defined as,

$$\alpha = \frac{t - t_0}{T} \tag{3.1}$$

where t_0 is the time of low water occurring prior to collection of the drift data, t is the measurement time, and T is the tidal period.

To calculate α it is necessary to correlate flow observations with water levels, either predicted or observed. If flow conditions at the water level reference site and flow observation site are in phase $0 \leq \alpha \leq 1$, with $0 < \alpha < 0.5$ representing flood tide, $\alpha = 0.5$ high water, $0.5 < \alpha < 1$ ebb tide, and $\alpha = 0, 1$ low water. However, due to

Figure 3.1: Surface flow drifter photo 1

Figure 3.2: Surface flow drifter photo 2

Figure 3.3: Surface flow drifter photo 3

Figure 3.4: Surface flow drifter photo 4

Figure 3.5: Surface flow drifter photo 5

Site	$R_{F,max}$ (m)	$R_{F,min}$ (m)	$R_{E,max}$ (m)	$E_{E,min}$ (m)
Westport (340)	6.3	3.2	-6.5	-3.0
Tiverton (337)	5.8	2.4	-6.1	-2.2
Pinkney Point (370)	4.1	2.0	-4.5	-1.8
Wedgeport (375)	3.6	1.8	-3.8	-1.6
Abrams River (380)	3.4	1.6	-3.6	-1.5
Abbotts Harbour (382)	3.4	1.7	-3.7	-1.5
Lower East Pubnico (385)	3.6	1.4	-3.9	-1.3
Shelburne (425)	2.1	0.8	-2.4	-0.7
Lockeport (430)	2.1	0.7	-2.3	-0.5

Table 3.1: Water level reference station maximum and minimum ebb (R_E) and flood (R_F) tidal ranges (2012 CHS predictions)

limited availability of water level information phase shift was observed at many of the study sites.

For the case of a positive phase shift (the tide phase at reference site proceeds the observation site, thus the reference site is upstream on flood and downstream on ebb) values of $\alpha > 1$ are observed late in the ebb tide and $\alpha_{min} > 0$.

For the case of a negative phase shift (the tide phase at reference site follows the observation site, thus the reference site is downstream on flood and upstream on ebb) values of $\alpha < 0$ are observed early in the flood tide and $\alpha_{max} < 1$.

For all cases the range of alpha must equal 1, which is representative of the tidal period. For the plots presented in this report, flow data were grouped temporally using spans of $\alpha = 1/12$ (≈ 1 hour time steps). On each plot the span of α is shown in red, overlain with data coverage in blue.

β represents the relative strength of tidal forcing during the observation period and is defined as,

$$\beta = \frac{R}{R_{E,F}^{max}} \tag{3.2}$$

where R is the tidal range corresponding with the flow observations, and $R_{E,F}^{max}$ is the maximum ebb or flood (as applicable) tidal range. For this assessment the maximum values predicted for 2012 were used, however longer term variation could be accounted for.

Water level predictions obtained from the CHS website (www.waterlevels.gc.ca) were used as reference values. This allows easy reference of observed flow conditions to water levels published online, however increased accuracy (reduction in α phase shift and refinement of β) should be obtained by measuring water levels at study sites selected for further characterization. The maximum and minimum predicted ebb and flood tidal ranges at each reference site are summarized in Table 3.1.

Chapter 4

Results

4.1 Grand Passage

Grand Passage [44°16.0'N 66°20.5'W] is the name of the tidal channel that flows between Brier Island and Long Island. As shown in Figure 4.1, the primary orientation of Grand Passage is north-south, with the Bay of Fundy located to the north and the mouth of St. Marys Bay to the south. The flood tide runs south to north through Grand Passage. Westport (340) is the nearest CHS water level prediction site.

Grand Passage is approximately 4.25 km long, measuring from the northern tip on the Brier Island side (North Point), to the southern tip on Long Island (Dartmouth Point). Grand Passage is approximately 0.75 km wide at its narrowest point, and approximately 1.75 km at its widest. There is a notable east-west jog in the channel on the Brier Island side which provides the shelter utilized for Westport Harbour and two aquaculture sites. On the Long Island side there is a large intertidal zone named Northeast Cove, which provides sheltered waters to Freeport. Peters Island is located at the southern entrance to Grand Passage, creating two small channels with approximate widths of 0.2 km and 0.6 km measuring from Peters Island to Brier Island and Long Island, respectively.

A small automobile ferry provides regular transportation between the communities of Freeport and Westport, which are located to the east and west of Grand Passage, respectively. The main industries in these communities are fishing and tourism, including whale watching.

Surface flow measurements were collected on several occasions including flood and ebb tide conditions. The primary purposes were a) equipment testing and method development, and b) numerical model validation. The surface flow drifter was also utilized to map significant surface flow features and provide flow information for an Acadia University led study to assess the use of X-band Radar for measuring surface currents in high flow environments. A summary of observation dates and tidal conditions is provided in Table 4.1.

Flow data representative of peak flood and ebb tides are shown in Figures 4.3 and 4.4. All flow data are shown based on stage of tide in Figures A.2 through A.6. The maximum flow speed measured was 4.75 m/s, which occurred during the ebb tide on

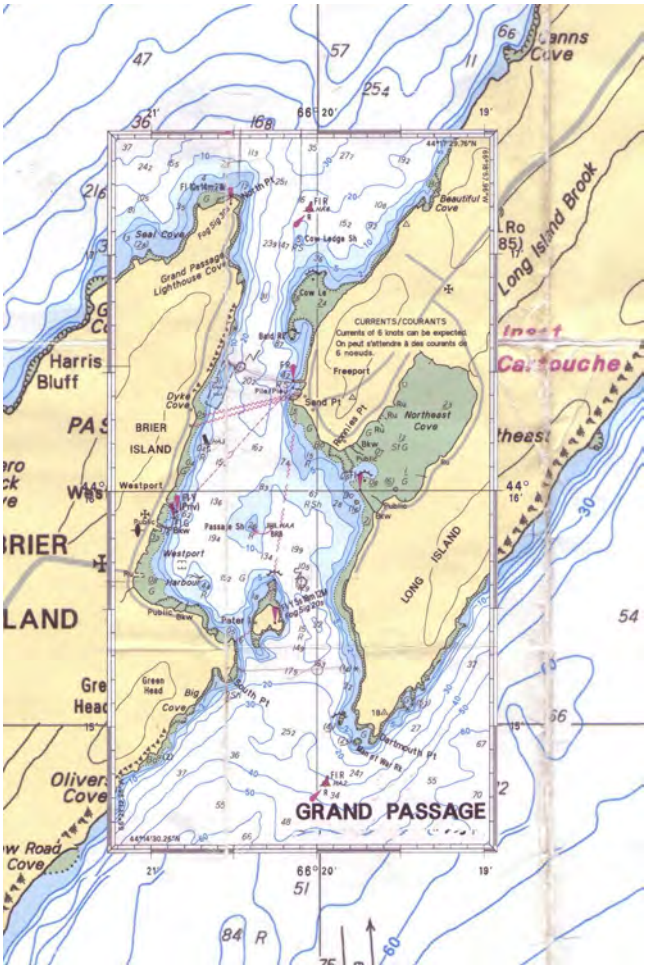

Figure 4.1: Grand Passage nautical chart

Figure 4.2: Grand Passage site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2011/10/09	5.3	0.7	-4.6	E	0.71 - 0.77	0.71
2011/10/10	5.3	0.7	-4.6	E	0.76 - 0.81	0.71
2011/10/23	0.7	5.3	4.6	F	0.23 - 0.27	0.73
2011/10/26	6.1	-0.1	-6.2	E	0.69 - 0.75	0.95
2011/10/27	6.2	-0.2	-6.4	E	0.66 - 0.78	0.98
2011/10/28	6.2	-0.3	-6.5	E	0.62 - 0.75	1.00
2012/06/05	-0.2	5.7	5.9	F	0.19 - 0.29	0.94
2012/07/05	5.7	0.2	-5.5	E	0.63 - 0.81	0.85
2012/07/05	-0.1	5.7	5.8	F	0.17 - 0.33	0.92

Table 4.1: Grand Passage observation dates and tidal conditions

October 9, 2011 at a localized spot near the north side of Peters Island in shallow water. Based on surface flow observations conducted to date, flow speeds of approximately 2.5 to 3.5 $\pm$ 0.5 m/s can be expected through the main channel of Grand Passage.

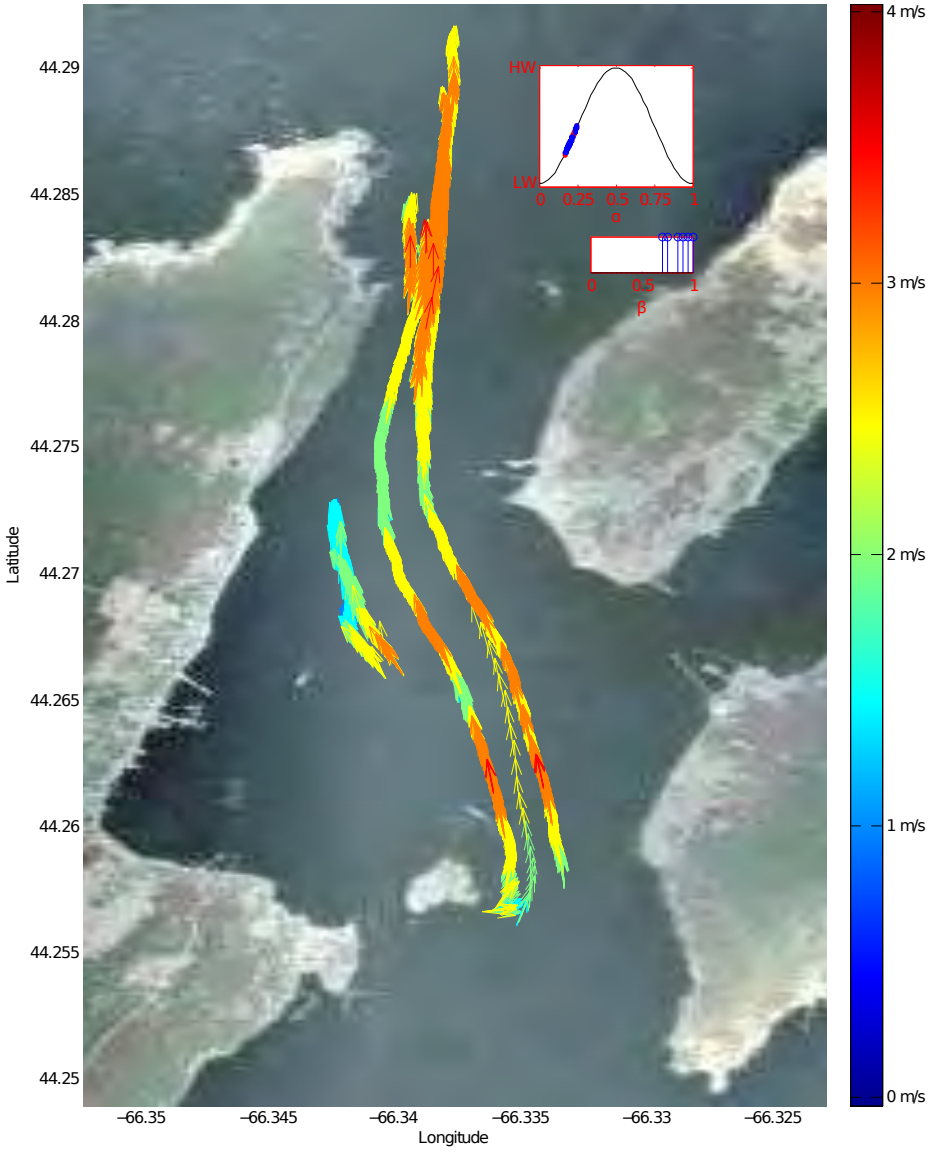

Figure 4.3: Grand Passage peak flood tide

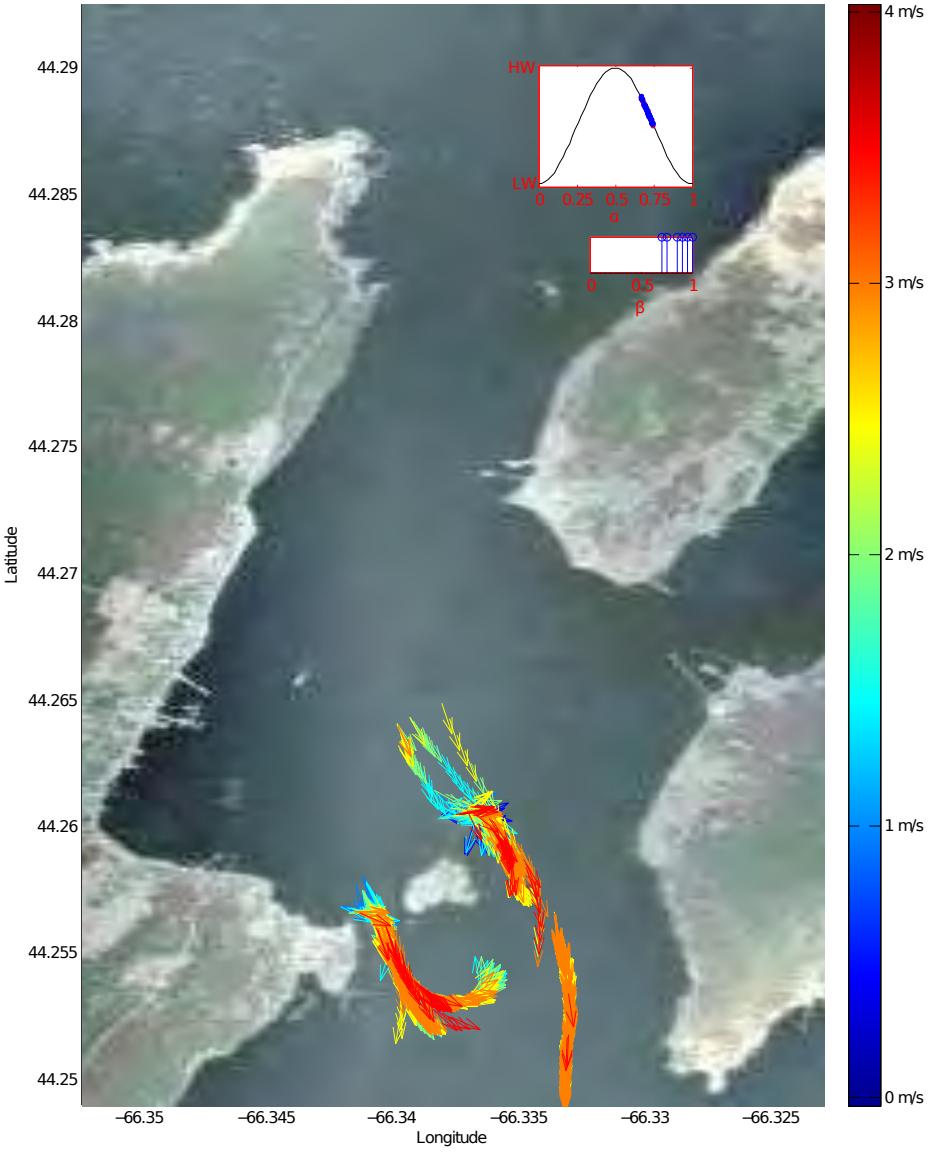

Figure 4.4: Grand Passage peak ebb tide

4.2 Petit Passage

Petit Passage [44°23.5'N 66°12.5'W] is the name of the tidal channel that flows between Long Island and Digby Neck. Petit Passage is located approximately 20 km northeast of Grand Passage. As shown in Figure 4.5, the primary orientation of Petit Passage is north-south, with the Bay of Fundy located to the north and St. Marys Bay to the south. The flood tide runs south to north through Petit Passage. Tiverton (337) is the nearest CHS water level prediction site.

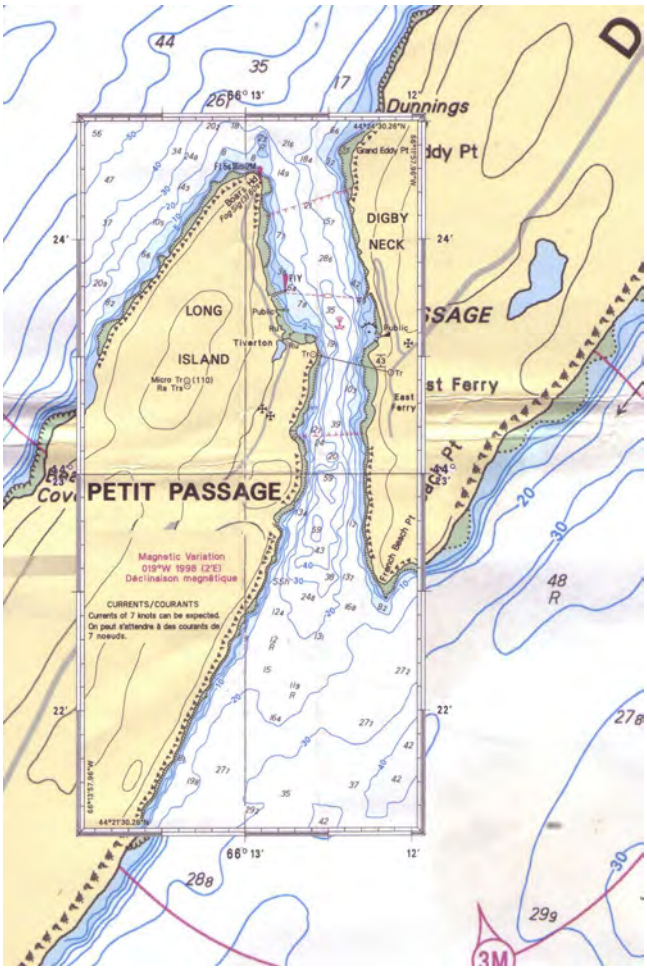

Figure 4.5: Petit Passage nautical chart

Petit Passage is approximately 3.4 km long, measuring from the northern tip on the Long Island side (Boars Head), to the southern tip on Digby Neck (French Beach Point). Petit Passage is approximately 0.4 km wide at its narrowest point, and approximately

Figure 4.6: Petit Passage site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/06/04	5.7	0.5	-5.2	E	0.69 - 0.83	0.85
2012/07/04	5.7	0.5	-5.2	E	0.64 - 0.79	0.85

Table 4.2: Petit Passage observation dates and tidal conditions

0.8 km at its widest. The width constriction provides somewhat sheltered waters on the Tiverton side of the channel, most notably on the flood tide.

A small automobile ferry provides regular transportation between the communities of East Ferry and Tiverton, which are located to the east and west of Petit Passage, respectively. The main industries in these communities are fishing and tourism, including whale watching.

Surface flow measurements were collected during ebb tide conditions for the purposes of a) high-flow equipment testing and method development, and b) numerical model validation. A summary of observation dates and tidal conditions is provided in Table 4.2.

Flow data representative of peak ebb tide are shown in Figure 4.7. All flow data are shown based on stage of tide in Figures A.8 through A.11. The maximum flow speed measured was 3.97 m/s. Based on surface flow observations conducted to date, flow speeds of approximately 3 to 4 $\pm$ 0.5 m/s can be expected through Petit Passage.

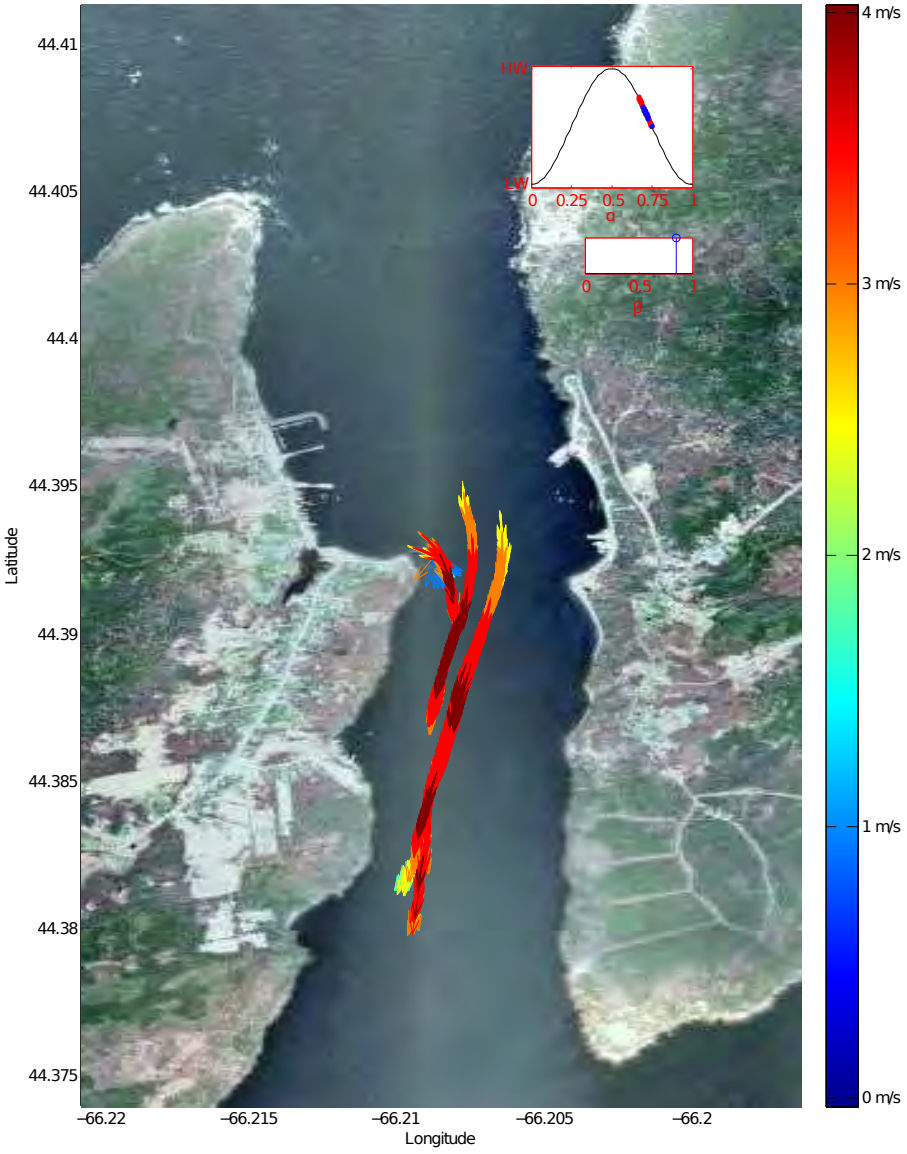

Figure 4.7: Petit Passage peak ebb tide

4.3 The Gap

The Gap [44°13.3'N 66°22.7'W] is the name of a narrow passage through the Gull Rock Bars which extend southwest from Pond Cove at the southern end of Brier Island. As shown in Figure 4.8, the orientation of The Gap is southeast-northwest, with the Bay of Fundy located to the northwest and the mouth of St. Marys Bay to the southeast. The flood tide runs southeast to northwest through The Gap. Heavy sea states are often present due to strong tidal currents and significant wind fetch from the northeast through south to nothwest. Westport (340) is the nearest CHS water level prediction site.

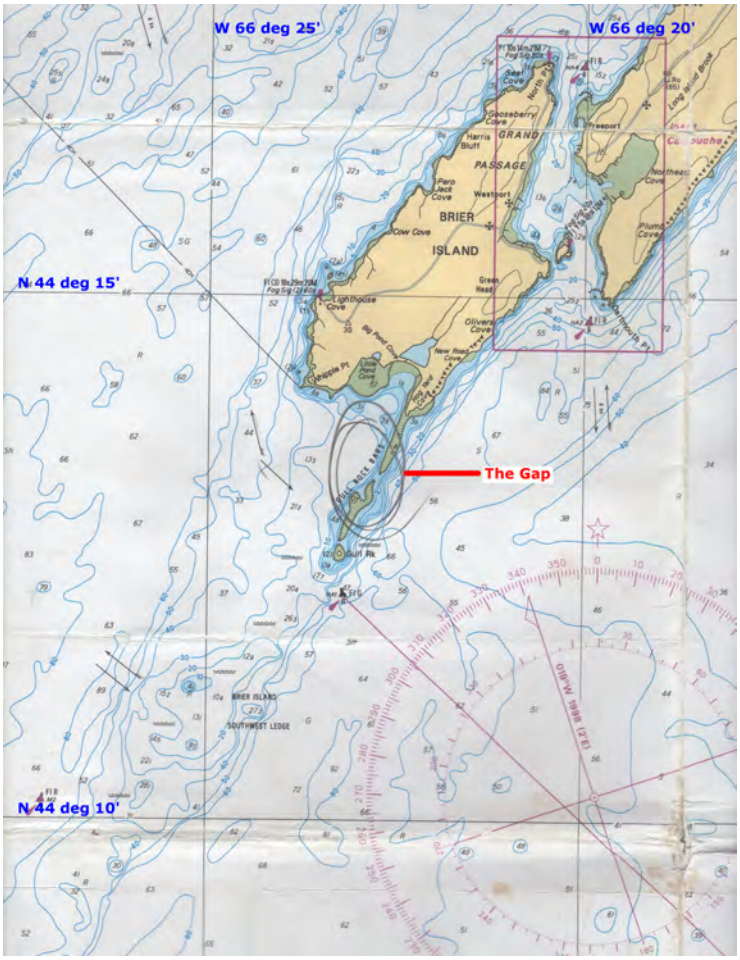

Figure 4.8: The Gap nautical chart

Westport is the nearest community to The Gap. The main industries in Westport are fishing and tourism, including whale watching. Whale tours do not regularly operate

Figure 4.9: The Gap site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/09/17	5.8	0.1	-5.7	E	0.66 - 0.76	0.88
2012/09/18	0.3	5.9	5.6	F	0.05 - 0.33	0.89

Table 4.3: The Gap observation dates and tidal conditions

through The Gap, however there is a large population of seals in the area.

Surface flow measurements were collected during flood and ebb tide conditions for the purposes of a) site investigation, and b) numerical model validation. The Gap is a significant flow feature within the domain of the high-resolution numerical model operated by Dr. Richard Karsten's group at Acadia University. A summary of observation dates and tidal conditions is provided in Table 4.3.

Flow data representative of peak flood and ebb tides are shown in Figures 4.10 and 4.11. All flow data are shown based on stage of tide in Figures A.13 through A.19. The maximum flow speed measured was 4.16 m/s. Significant asymmetry was observed in flow speed magnitude for ebb and flood conditions, with flood tide dominant. Based on surface flow observations conducted to date, flow speeds of approximately 3.5 to 4.5 $\pm$ 0.5 m/s can be expected through The Gap.

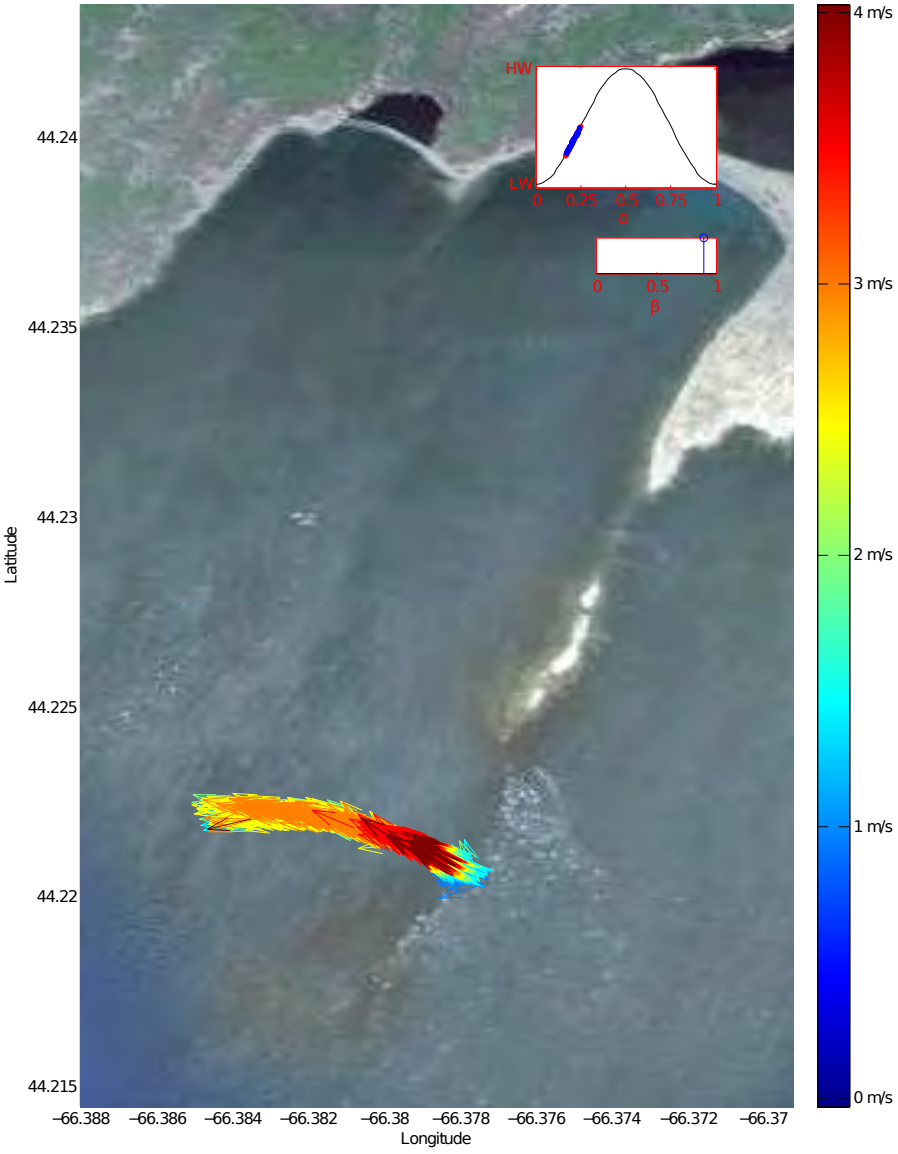

Figure 4.10: The Gap peak flood tide

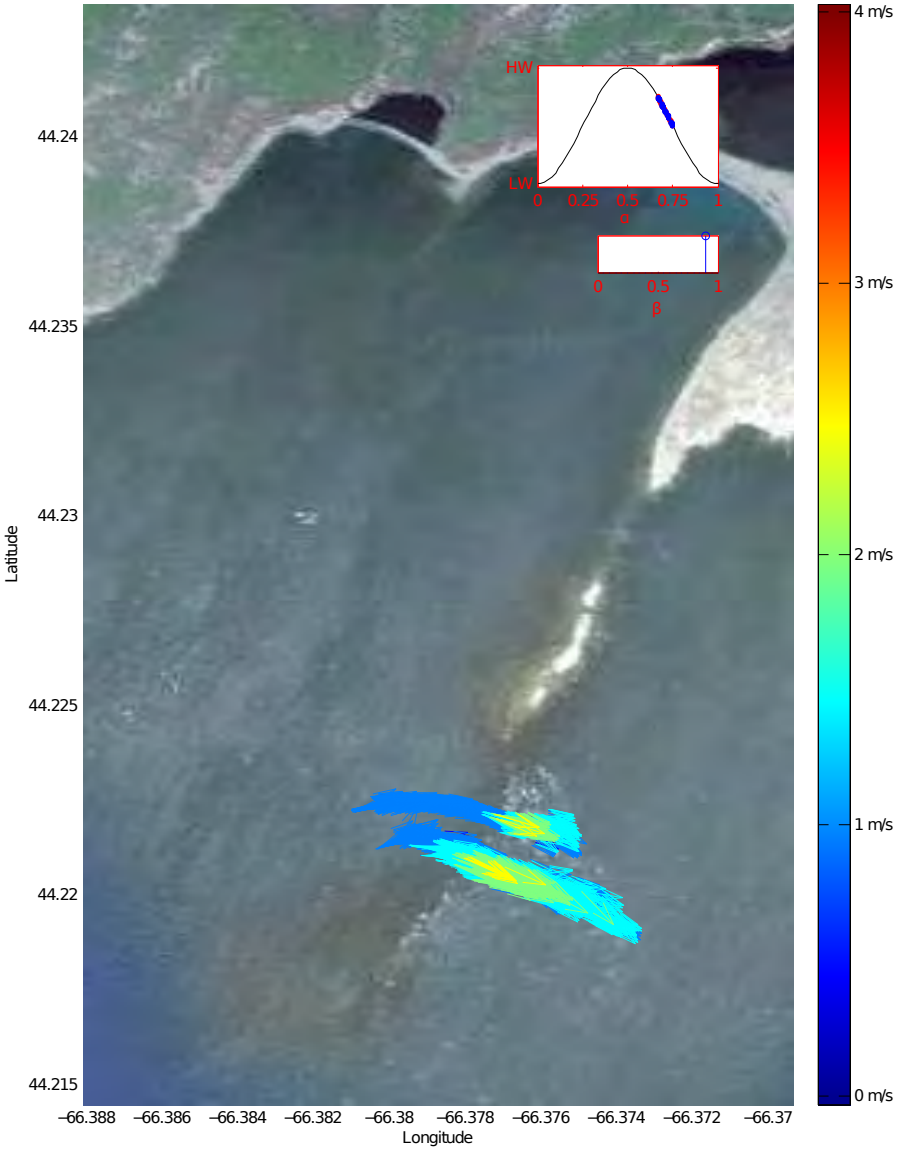

Figure 4.11: The Gap peak ebb tide

4.4 Passages West of Big Tusket Island

The passages west of Big Tusket Island [43°38.3'N 66°2.5'W] include Schooner Passage, Ellenwoods Channel, and several smaller passages between the islands of the area. The location of the passages are shown in Figure 4.12. The flood tide runs east-southeast to west-northwest through the passages. Pinkney Point (370) is the nearest CHS water level prediction site.

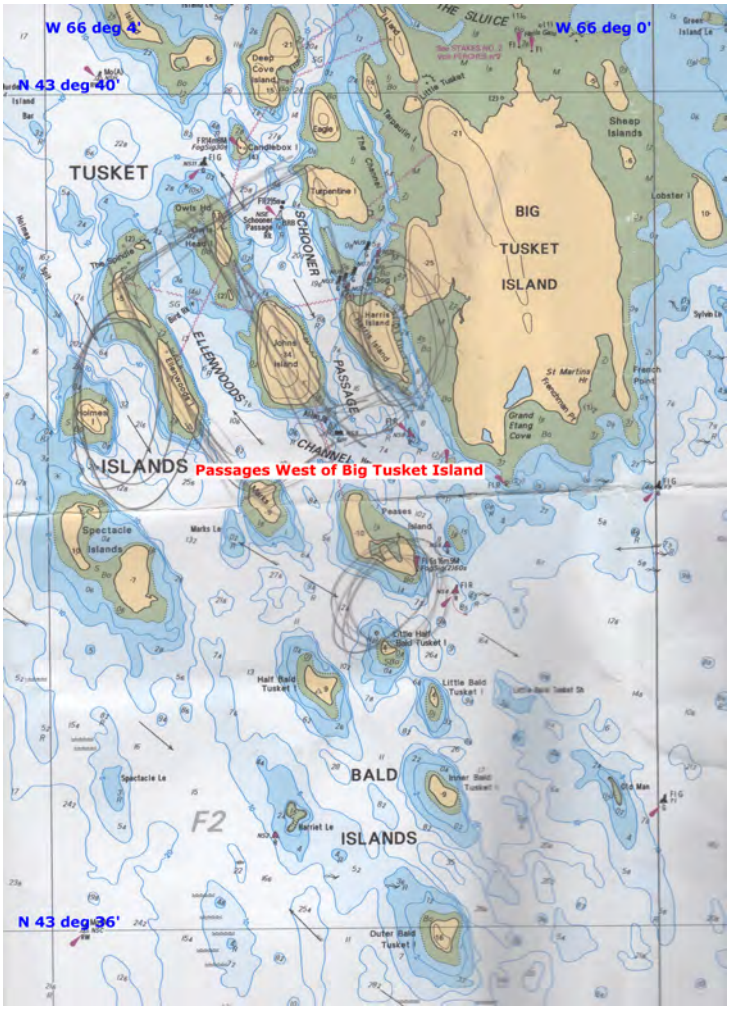

Figure 4.12: Passages West of Big Tusket Island nautical chart

Schooner Passage and Ellenwoods Channel are parallel channels, both with primary orientation of southeast-northwest. Both channels are approximately 2 km long, measuring from the northern tip of Owls Head to the southern tip of Johns Island. Ellenwoods

Figure 4.13: Passages West of Big Tusket Island site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/09/29	4.1	0.6	-3.5	E	0.65 - 0.87	0.78
2012/09/30	4.2	0.6	-3.6	E	0.52 - 0.80	0.80
2012/09/30	0.7	4.2	3.5	F	0.21 - 0.30	0.85

Table 4.4: Passages West of Big Tusket Island observation dates and tidal conditions

channel has a uniform width of approximately 0.6 km, measuring between The Spindle and Owls Head Island for the northern portion of the channel, and between Ellenwoods Island and Johns Island for the southern portion. The northern portion of Schooner Passage is approximately 0.75 km wide measuring between Owls Head Island and Turpentine Island. The southern portion of Schooner Passage is approximately 0.35 km wide measuring between Johns Island and Harris island.

Seasonal communities and camps are located on the islands, most notably Harris Island. The main industry is fishing, and a large wharves are attached to seasonal homes lining in the passage between Harris Island and Big Tusket Island.

Surface flow measurements were collected during flood and ebb tide conditions for the purpose of tidal energy potential reconnaissance. A summary of observation dates and tidal conditions is provided in Table 4.4.

Flow data representative of peak flood and ebb tides are shown in Figures 4.14 and 4.15. All flow data are shown based on stage of tide in Figures A.21 through A.27. The maximum flow speed measured was 3.00 m/s, which occurred during the flood tide in the passage between Peases Island and Little Half Bald Tusket Island. Based on surface flow observations conducted to date, flow speeds of approximately 2 to 3 $\pm$ 0.5 m/s can be expected through the passages west of Big Tusket Island.

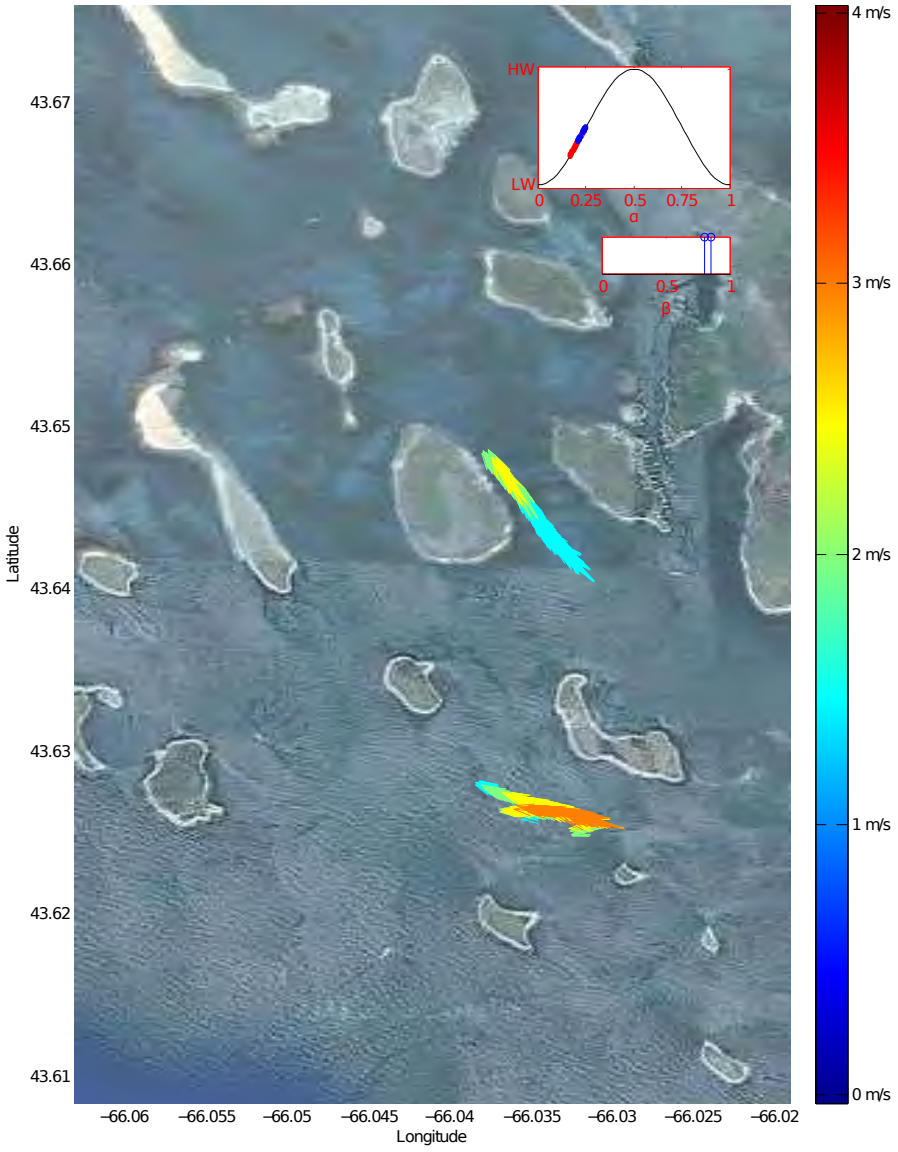

Figure 4.14: Passages West of Big Tusket Island peak flood tide

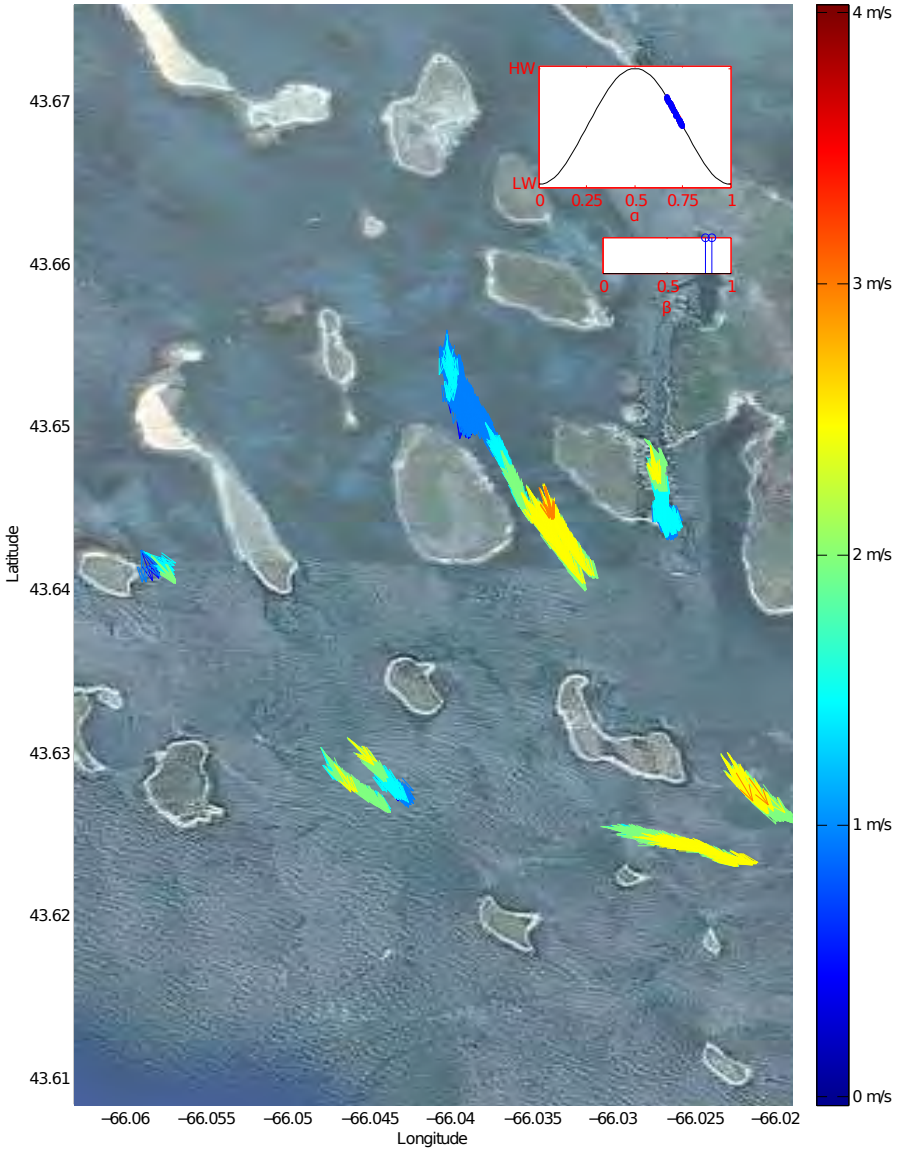

Figure 4.15: Passages West of Big Tusket Island peak ebb tide

4.5 Indian Sluice

Indian Sluice is the name of a tidal channel in the Tusket Islands region that flows between mainland Nova Scotia (Sluice Point, Indian Bay, Beach Point, and Widgegum Islands) located to the northwest and Morris Island and Surettes Island to the southeast. As shown in Figure 4.16, the focus area was the vicinity of Indian Sluice Bridge [43°46.3'N 65°56.9'W] which connects Sluice Point to Surettes Island. The flood tide runs southwest to northeast through Indian Sluice. Wedgeport (375) is the nearest CHS water level prediction site.

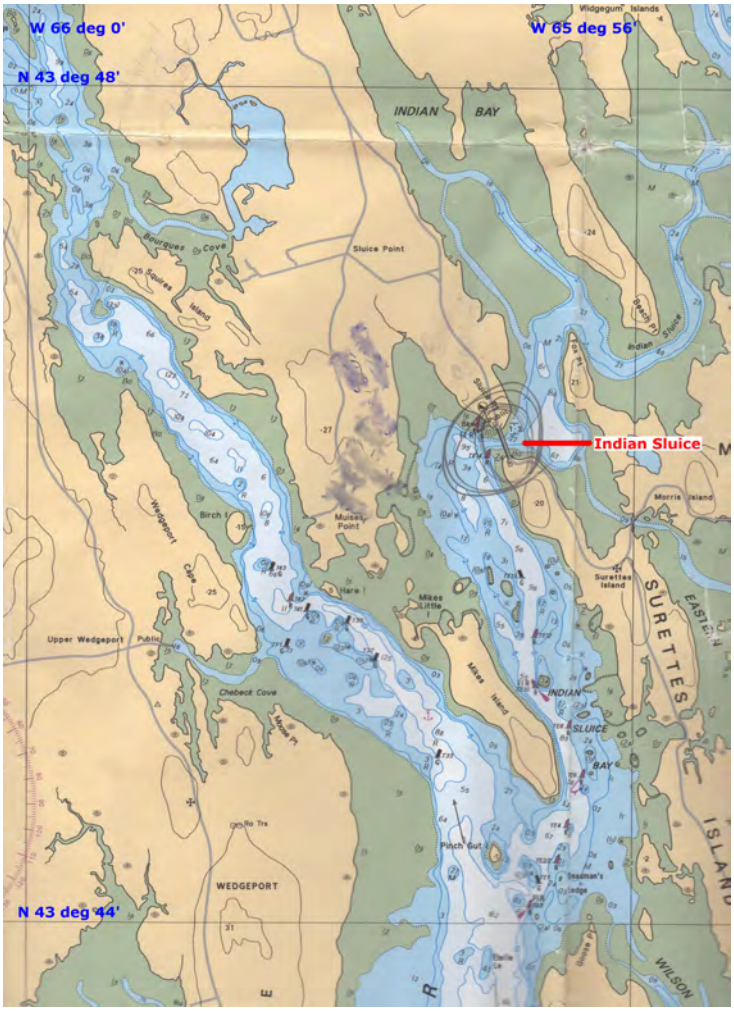

Figure 4.16: Indian Sluice nautical chart

Indian Sluice is approximately 4.75 km long, measuring a path length running from

Figure 4.17: Indian Sluice site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/05/08	3.7	0.7	-3.0	E	0.78 - 0.96	0.79
2012/06/07	3.7	0.8	-2.9	E	0.75 - 1.04	0.76
2012/09/28	0.6	3.8	3.2	F	0.26 - 0.33	0.89

Table 4.5: Indian Sluice observation dates and tidal conditions

Sluice Point (south) to Widgegum Islands (north). Channel width is highly variable ranging from approximately 2 km to 0.15 km based on location and stage of tide, with the banks of Indian Sluice being large intertidal zones.

Small communities are located throughout the Tusket Islands. The main industries are fishing and seaweed harvesting. A community wharf is located at Sluice Point. Fishing occurs primarily in Indian Sluice Bay (south of Sluice Point) and seaward including Lobster Bay. Seaweed harvesting occurs within the large intertidal zones of the Tusket Islands, including Indian Sluice.

Surface flow measurements were collected during flood and ebb tide conditions for the purpose of tidal energy potential reconnaissance. A summary of observation dates and tidal conditions is provided in Table 4.5.

Positive phase shift exists between the water level reference site (Wedgeport) and flow at Indian Sluice, such that the tide phase at Wedgeport proceeds that at Indian Sluice. Ebb tide measurements were conducted up to $\alpha = 1.04$, thus the phase shift is greater than $\alpha = 0.04$ (≈ 30 min). Continuation of flow measurements up to low water slack tide would allow calculation of the phase shift.

Flow data representative of peak flood[1] and ebb tides are shown in Figures 4.18 and 4.19. All flow data are shown based on stage of tide in Figures A.29 through A.34. The maximum flow speed measured was 4.09 m/s. Based on surface flow observations conducted to date, flow speeds of approximately 3 to 4 $\pm$ 0.5 m/s can be expected through Indian Sluice at Sluice Point.

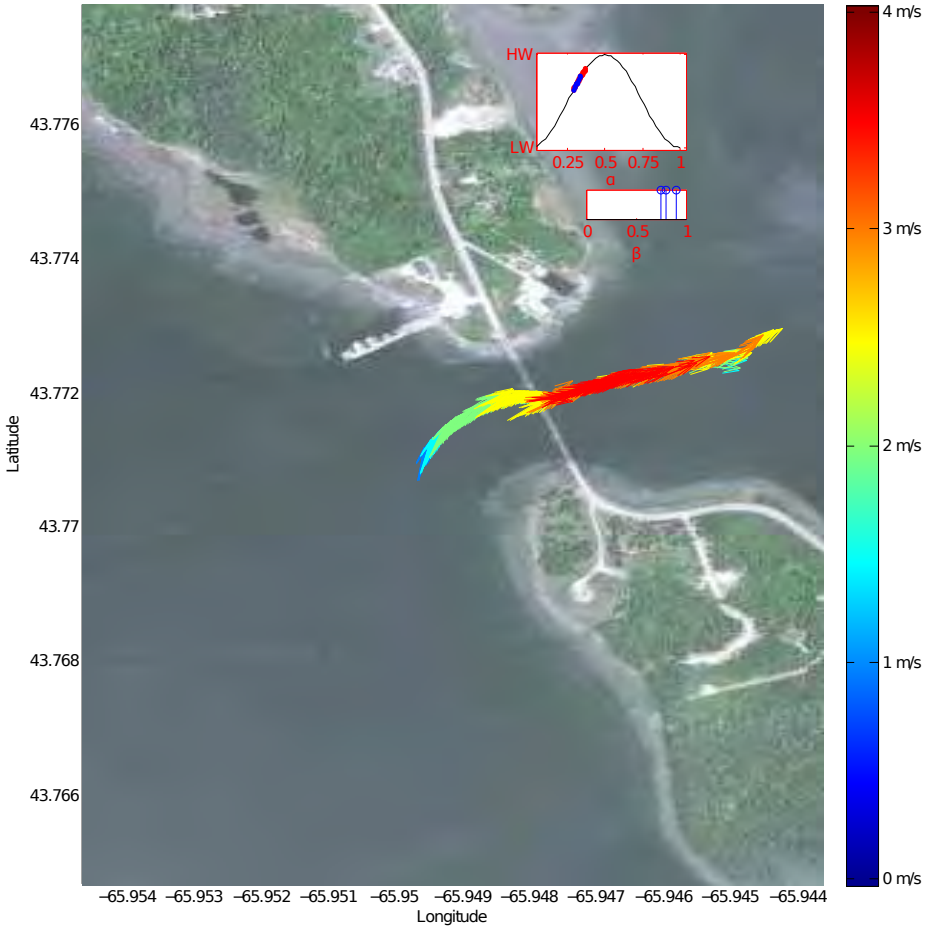

Figure 4.18: Indian Sluice peak flood tide

[1]Flood measurements may have ceased prior to peak flow speed due to darkness. Data trend indicated that flow speeds were stable or slightly building when measurements stopped. Figure 4.18 shows the maximum observed flow speeds.

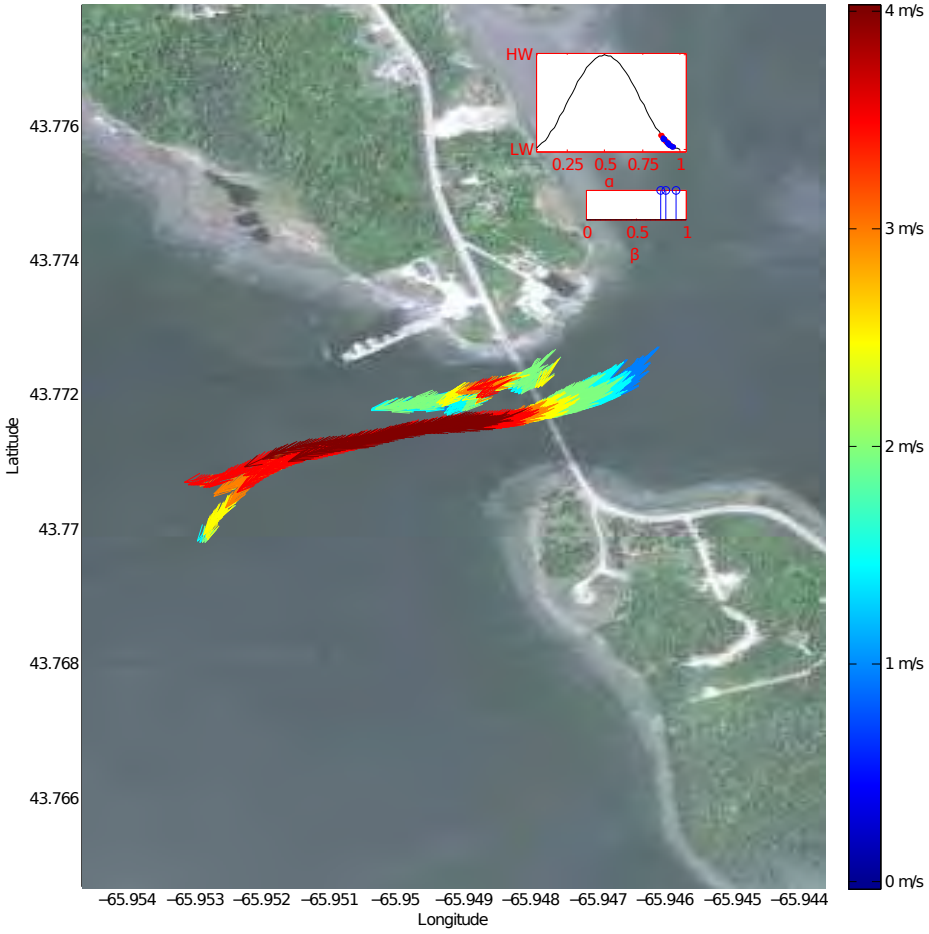

Figure 4.19: Indian Sluice peak ebb tide

4.6 The Sluice

The Sluice [43°45.6'N 65°53.4'W] is the name of a tidal channel in the Tusket Islands region that flows between Morris Island located to the west and Little Calf Island to the east. As shown in Figure 4.20, the primary orientation of The Sluice is north-south. The flood tide runs south to north through The Sluice. Wedgeport (375) is the nearest CHS water level prediction site.

Figure 4.20: The Sluice nautical chart

The Sluice is approximately 0.5 km long and the narrowest point is approximately 0.1 km wide.

Small communities are located throughout the Tusket Islands. The main industries

Figure 4.21: The Sluice site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/06/07	0.4	3.7	3.3	F	0.24 - 0.46	0.92

Table 4.6: The Sluice observation dates and tidal conditions

are fishing and seaweed harvesting. Fishing occurs primarily seaward of The Sluice including Lobster Bay. Seaweed harvesting occurs within the large intertidal zones of the Tusket Islands, including those north and south of The Sluice.

Surface flow measurements were collected during flood tide conditions for the purpose of tidal energy potential reconnaissance. A summary of observation dates and tidal conditions is provided in Table 4.6.

Positive phase shift exists between the water level reference site (Wedgeport) and flow at The Sluice, such that the tide phase at Wedgeport proceeds that at The Sluice. Flood tide conditions were observed beyond $\alpha = 0.5$. Continuation of flow measurements up to high water slack tide would allow calculation of the phase shift.

Flow data representative of peak flood tide are shown in Figure 4.22. All flow data are shown based on stage of tide in Figures A.36 through A.38. The maximum flow speed measured was 3.21 m/s. Based on surface flow observations conducted to date, flow speeds of approximately 2.5 to 3.5 $\pm$ 0.5 m/s can be expected through The Sluice.

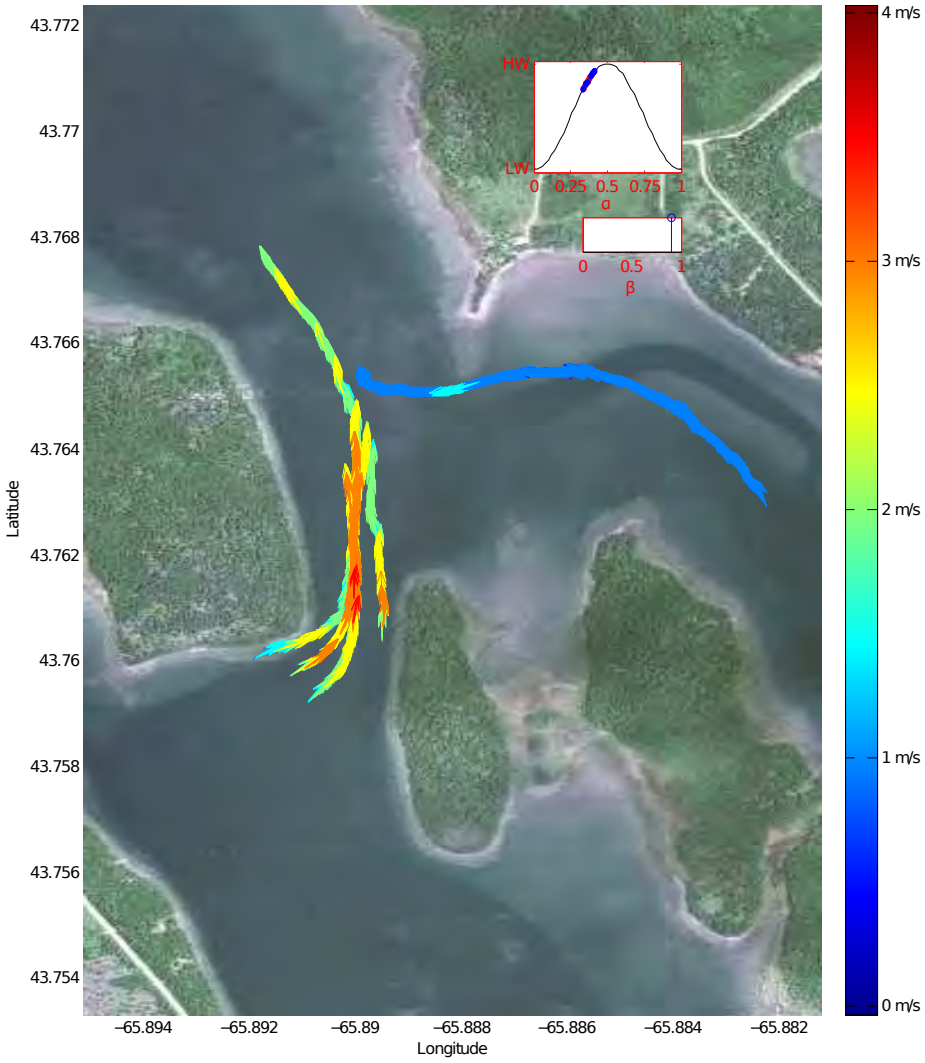

Figure 4.22: The Sluice peak flood tide

4.7 The Tittle

The Tittle [43°43.3'N 65°54.3'W] is the name of a tidal channel in the Tusket Islands region that flows between Surettes Island located to the west and Outer Sheep Island to the east. As shown in Figure 4.23, the primary orientation of The Tittle is northwest-southeast. The flood tide runs southeast to northwest through The Tittle. Wedgeport (375) is the nearest CHS water level prediction site.

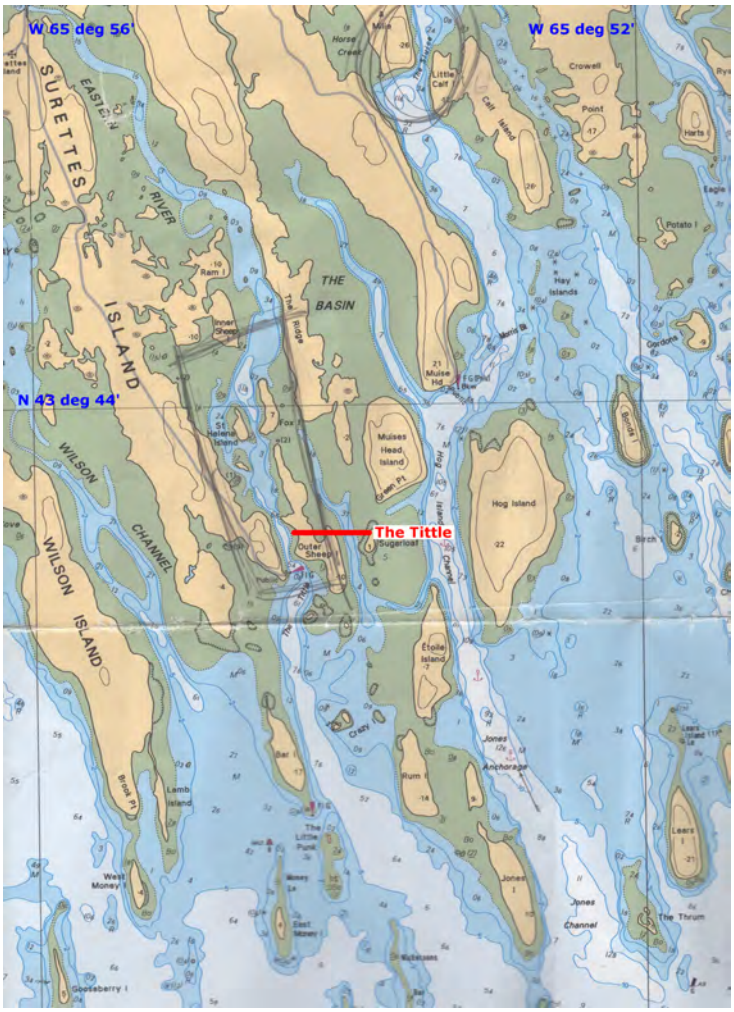

Figure 4.23: The Tittle nautical chart

The Tittle is approximately 1 km long, measuring from the southern tip of Surettes Island to the northern tip of Outer Sheep Island. Channel width ranges from approximately 0.5 km in the north to 0.1 km in the south, with additional variability based on

Figure 4.24: The Tittle site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/06/06	3.7	0.7	-3.0	E	0.72 - 1.01	0.79

Table 4.7: The Tittle observation dates and tidal conditions

stage of tide.

Small communities are located throughout the Tusket Islands. The main industries are fishing and seaweed harvesting. A community wharf is located at The Tittle. Fishing occurs primarily seaward of The Tittle, including Lobster Bay. Seaweed harvesting occurs within the large intertidal zones of the Tusket Islands, including The Tittle.

Surface flow measurements were collected during ebb tide conditions for the purpose of tidal energy potential reconnaissance. A summary of observation dates and tidal conditions is provided in Table 4.7.

Positive phase shift exists between the water level reference site (Wedgeport) and flow at The Tittle, such that the tide phase at Wedgeport proceeds that at The Tittle. Ebb tide measurements were conducted up to $\alpha = 1.01$, thus the phase shift is greater than $\alpha = 0.01$ (≈ 8 min). Continuation of flow measurements up to low water slack tide would allow calculation of the phase shift.

Flow data representative of peak ebb tide are shown in Figure 4.25[2]. All flow data

[2]An error exists in the positioning of the Google Maps aerial photograph covering the eastern half of the reference photos, including the location of The Tittle. The photograph should be shifted southwest, consistent with the GPS tracks.

are shown based on stage of tide in Figures A.40 through A.43. The maximum flow speed measured was 2.43 m/s. Based on surface flow observations conducted to date, flow speeds of approximately 1.5 to 2.5 $\pm$ 0.5 m/s can be expected through The Tittle.

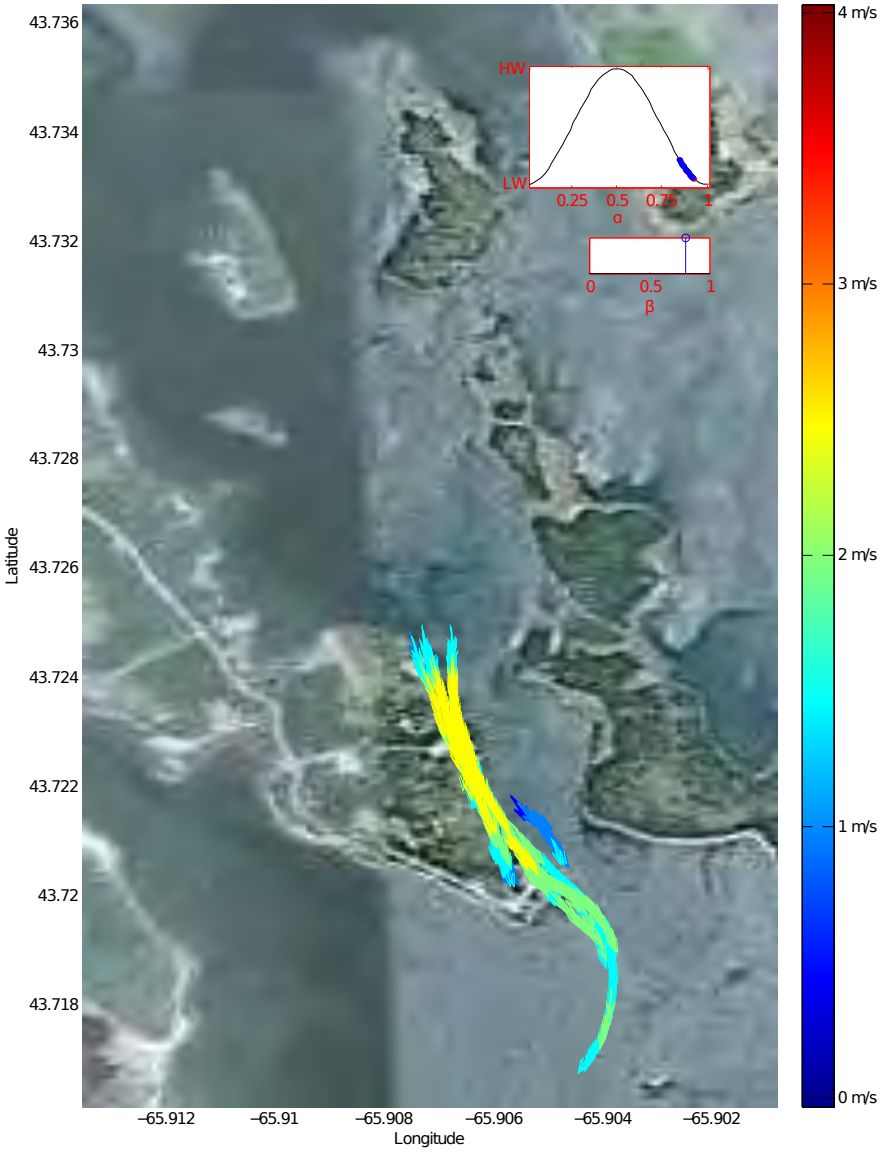

Figure 4.25: The Tittle peak ebb tide

4.8 Argyle River Estuary at Cat Island Bridge

The Argyle River Estuary connects the Argyle River to the sea at the northeastern end of the Tusket Islands region. As shown in Figure 4.26, the focus area was the vicinity of former bridge structure that connected Cat Island (east) with McKinnon Neck (west) [43°47.5'N 65°51.9'W]. The primary orientation of this estuary section is northwest-southeast, with the flood tide flowing southeast to northwest. Abbotts Harbour (382) is the nearest CHS water level prediction site.

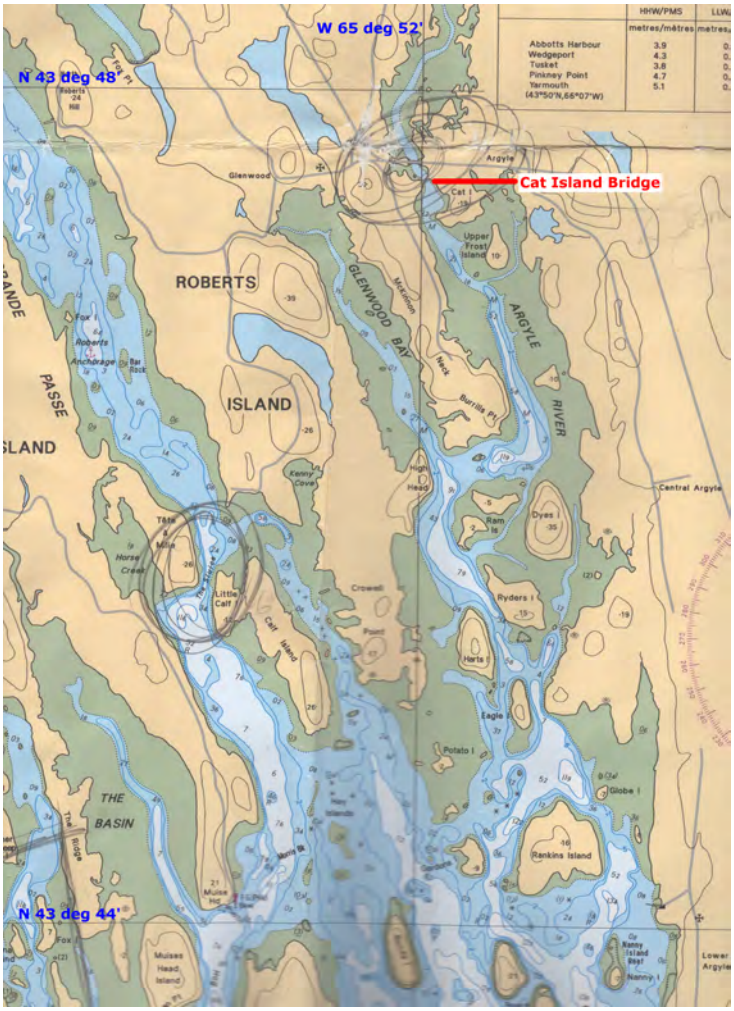

Figure 4.26: Cat Island Bridge nautical chart

Three concrete pillars remain from the former bridge structure. The channel with at this location is approximately 50 m.

Figure 4.27: Cat Island Bridge site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/09/28	3.3	0.5	-2.8	E	0.77 - 1.03	0.76

Table 4.8: Cat Island Bridge observation dates and tidal conditions

The closest community is Argyle. The main industries are fishing, tourism, and seaweed harvesting. Fishing and seaweed harvesting occur primarily seaward of the former Cat Island Bridge.

Surface flow measurements were collected during ebb tide conditions for the purpose of tidal energy potential reconnaissance. A summary of observation dates and tidal conditions is provided in Table 4.8.

Positive phase shift exists between the water level reference site (Abbotts Harbour) and flow at Cat Island Bridge, such that the tide phase at Abbotts Harbour proceeds that at Cat Island Bridge. Ebb tide measurements were conducted up to $\alpha = 1.03$, thus the phase shift is greater than $\alpha = 0.03$ (≈ 25 min). Continuation of flow measurements up to low water slack tide may allow calculation of the phase shift, with complication due to river flow.

Flow data representative of peak ebb tide are shown in Figure 4.28. All flow data are shown based on stage of tide in Figures A.45 through A.48. The maximum flow speed measured was 3.30 m/s. Based on surface flow observations conducted to date, flow speeds of approximately 2.5 to 3.5 m/s can be expected through the Cat Island Bridge.

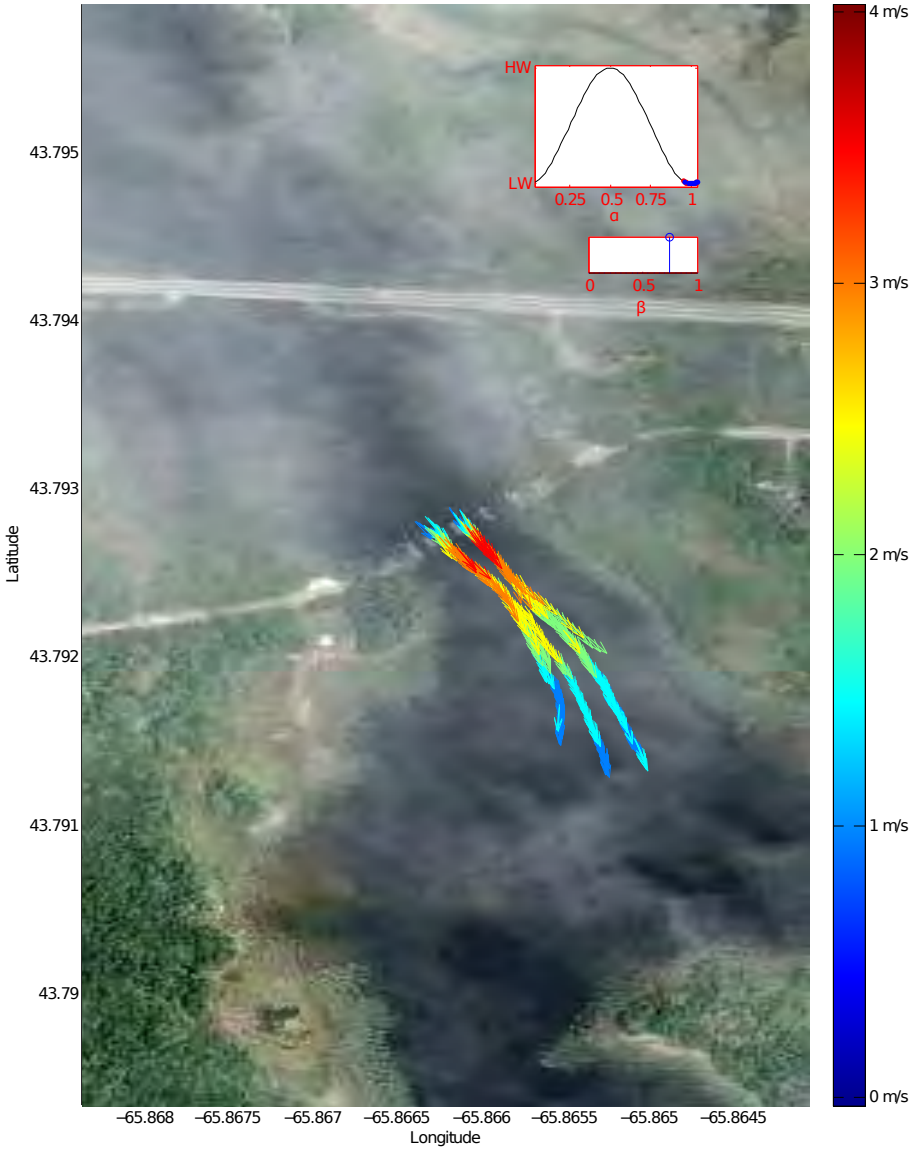

Figure 4.28: Cat Island Bridge peak ebb tide

4.9 Pubnico Harbour

Pubnico Harbour [43°36.0'N 65°47.0'W] is an enclosed bay that is bordered by the communities of Lower West Pubnico, Middle West Pubnico, West Pubnico, Pubnico, East Pubnico, Middle East Pubnico, Centre East Pubnico, and Lower East Pubnico. As shown in Figure 4.29, the primary orientation of Pubnico Harbour is north-south. The flood tide flows south to north into Pubnico Harbour. Lower East Pubnico (385) is the nearest CHS water level prediction site.

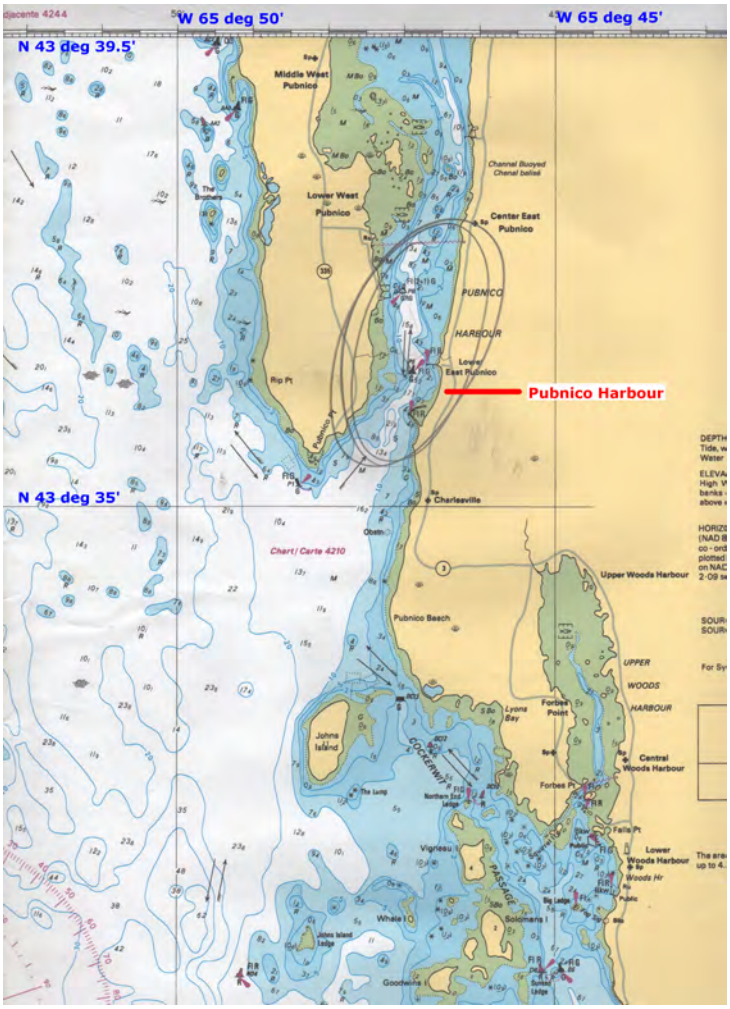

Figure 4.29: Pubnico Harbour nautical chart

Pubnico Harbour is approximately 12 km long measuring from Pubnico Point (south) to Pubnico (north). The harbour width ranges from approximately 2.5 km within the

Figure 4.30: Pubnico Harbour site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/05/09	0	3.4	3.4	F	0.24 - 0.34	0.94

Table 4.9: Pubnico observation dates and tidal conditions

main harbour to 0.75 km at the mouth. The focus area was the mouth of the harbour between Lower East Pubnico and Pubnico Point.

The primary industry in the Pubnico communities is fishing, with activities focused seaward of the harbour. The largest wharves are located in Lower West Pubnico and Lower East Pubnico, resulting in significant boat traffic through the mouth of the harbour. A large wind farm is located south of Lower West Pubnico at Pubnico Point.

Surface flow measurements were collected during flood tide conditions for the purpose of tidal energy potential reconnaissance. A summary of observation dates and tidal conditions is provided in Table 4.9.

Flow data representative of peak flood tide are shown in Figure 4.31. All flow data are shown based on stage of tide in Figures A.50 through A.52. The maximum flow speed measured was 1.61 m/s. Based on surface flow observations conducted to date, flow speeds of approximately 1 to 2 $\pm$ 0.5 m/s can be expected through Pubnico Harbour.

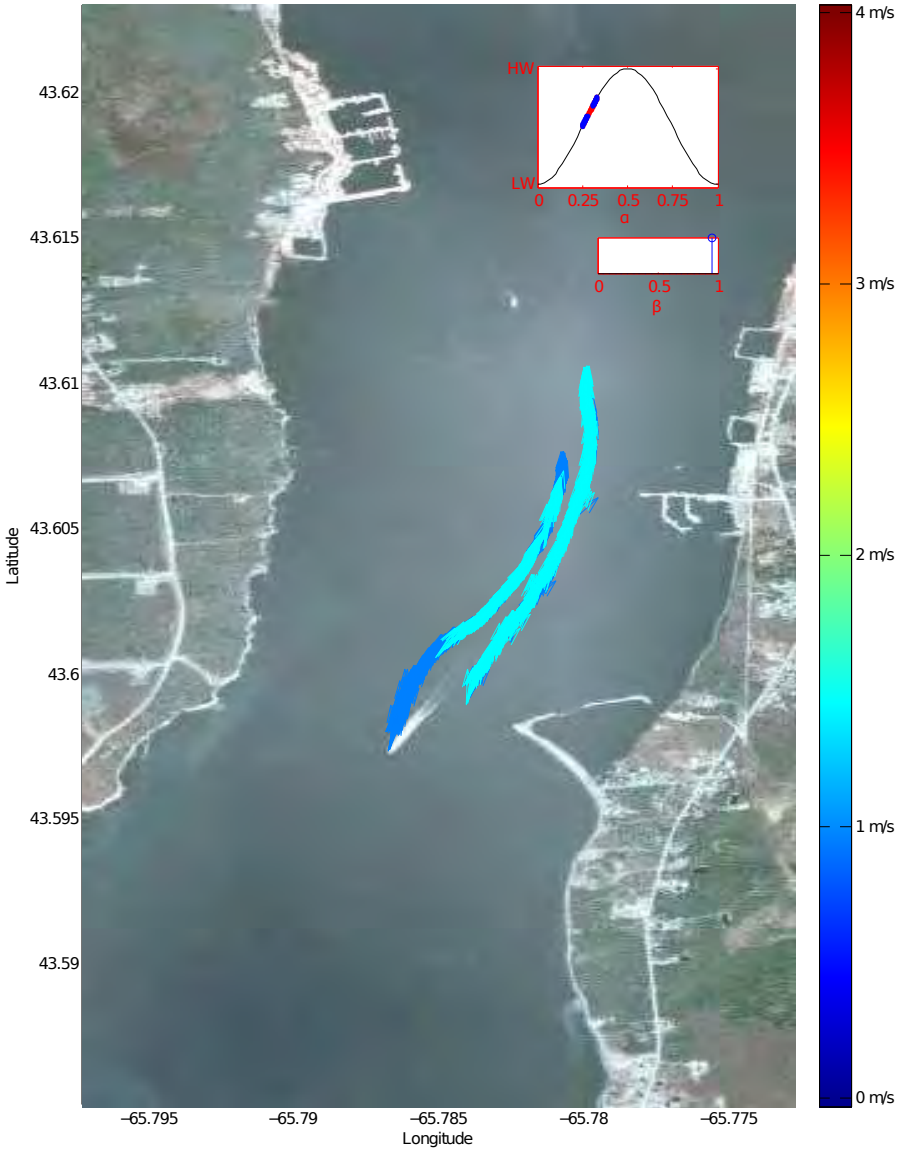

Figure 4.31: Pubnico Harbour peak flood tide

4.10 Clyde River Estuary at Port Clyde Bridge

The Clyde River Estuary connects the Clyde River to the sea at Negro Harbour. As shown in Figure 4.32, the focus area was a channel connecting Lyles Bay (northwest) to Negro Harbour (southeast) [43°36.2'N 65°28.1'W]. Two bridge structures are present in the channel. The Port Clyde road bridge is located at the northern end of the channel on Highway 309. A rail bridge is located at the southern end of the channel. The primary orientation of the channel is northwest-southeast, with a significant jog such that the channel runs north-south through its midsection. The flood tide flows southeast to northwest through the channel. Shelburne (425) is the nearest CHS water level prediction site.

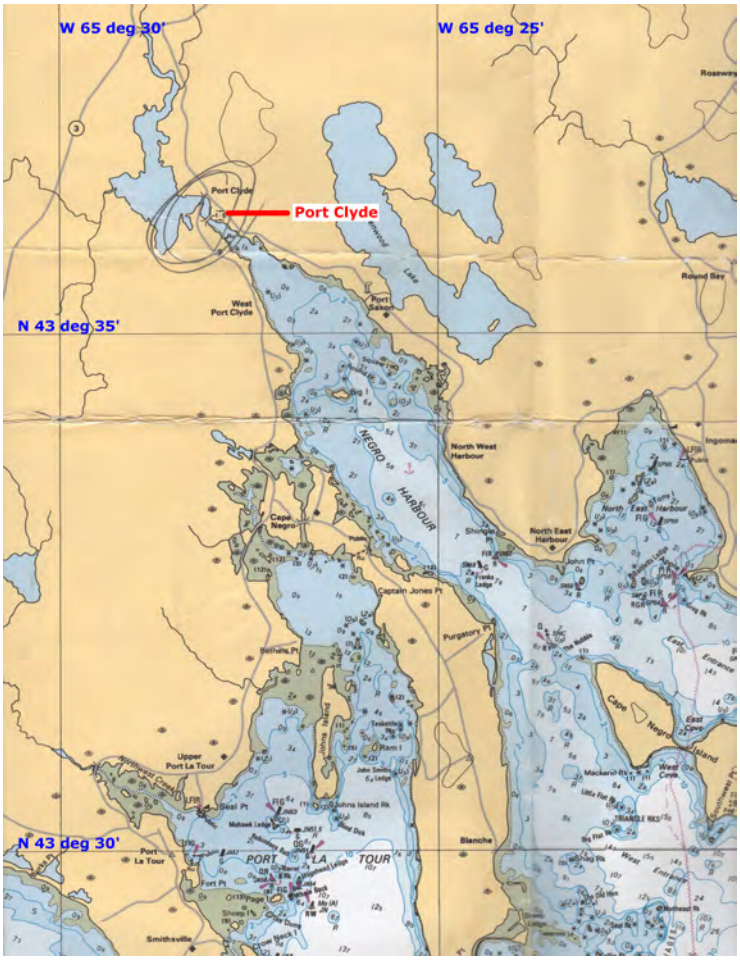

Figure 4.32: Port Clyde Bridge nautical chart

Figure 4.33: Port Clyde Bridge site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/10/01	2.2	0.4	-1.8	E	0.62 - 1.09	0.75

Table 4.10: Port Clyde Bridge observation dates and tidal conditions

The channel length is approximately 0.4 km measuring between the bridges. The channel width ranges from approximately 70 m at both bridges to 150 m at mid-section.

The closest community is Port Clyde, with Clyde River and Barrington nearby. The primary industries are fishing and tourism, with fishing activities focused seaward of the channel. The River Hills Golf & Country Club is located less than 1 km north of the channel on the banks of Lyles Bay / Clyde River Estuary.

Surface flow measurements were collected during ebb tide conditions for the purpose of tidal energy potential reconnaissance. A summary of observation dates and tidal conditions is provided in Table 4.10.

Positive phase shift exists between the water level reference site (Shelburne) and flow at Port Clyde, such that the tide phase at Shelburne proceeds that at Port Clyde. Ebb tide measurements were conducted up to $\alpha = 1.09$, thus the phase shift is greater than $\alpha = 0.09$ (≈ 67 min). Continuation of flow measurements up to low water slack tide may allow calculation of the phase shift, with complication due to river flow.

Flow data representative of peak ebb tide are shown in Figure 4.34. All flow data are shown based on stage of tide in Figures A.54 through A.59. The maximum flow speed measured was 3.04 m/s. Based on surface flow observations conducted to date, flow speeds of approximately 2 to 3 $\pm$ 0.5 m/s can be expected through Port Clyde Bridge.

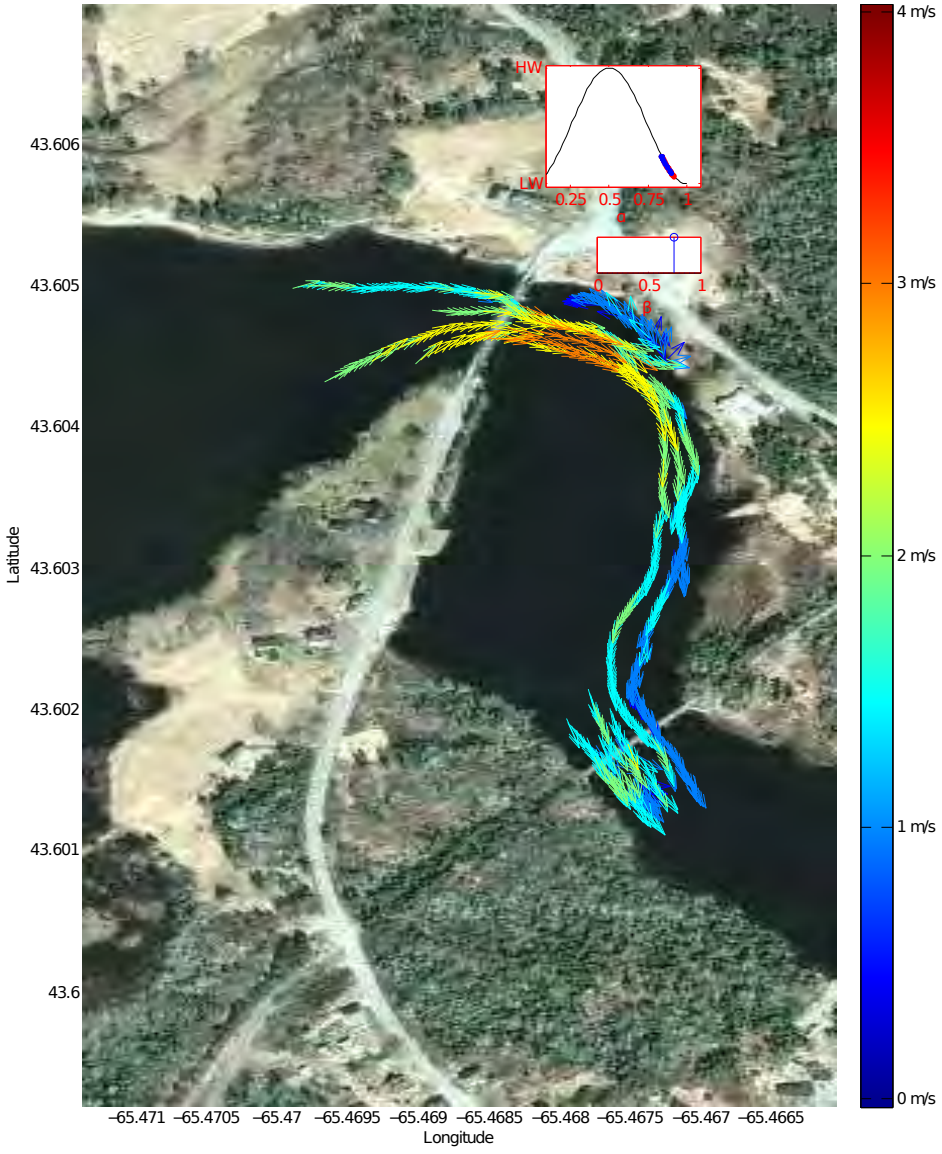

Figure 4.34: Port Clyde Bridge peak ebb tide

4.11 Port L'Hebert

Port L'Hebert [43°49.5'N 64°56.1'W] is an enclosed bay bordered by the communities of Port L'Hebert, Granite Village, and East Side Port L'Hebert. As shown in Figure 4.35, the primary orientation of Port L'Hebert is northwest-southeast. The flood tide flows southeast to northwest into Port L'Hebert. Lockeport (430) is the nearest CHS water level prediction site.

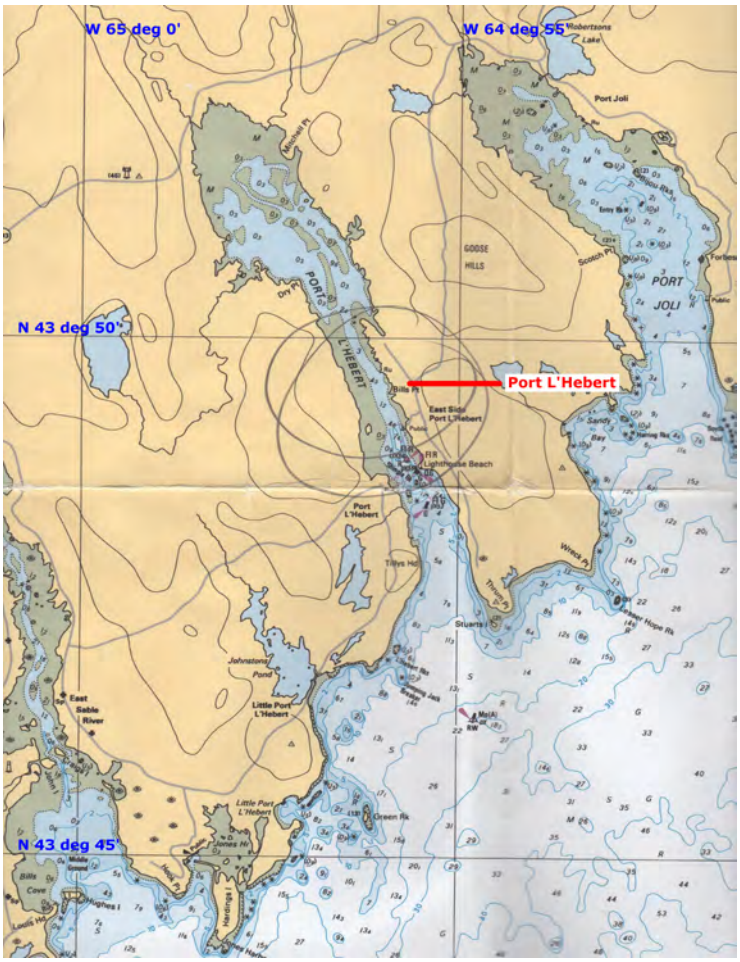

Figure 4.35: Port L'Hebert nautical chart

Port L'Hebert is approximately 10 km long measuring from Thrum Point (south) to Granite Village (north). The width ranges from approximately 1.7 km within the head to 0.5 km through the mid-section channel, with additional variability based on stage of tide reducing channel width to less than 0.25 km at low water. The focus area was a 2.5

Figure 4.36: Port L'Hebert site photograph 1

Date	WL_1 (m)	WL_2 (m)	R (m)	Tide	α	β
2012/10/02	2.2	0.6	-1.6	E	0.73 - 0.94	0.69

Table 4.11: Port L'Hebert observation dates and tidal conditions

km long channel near East Side Port L'Hebert.

The primary industry is fishing and a community wharf is located in East Side Port L'Hebert. Fishing activities are focused seaward of Port L'Hebert.

Surface flow measurements were collected during ebb tide conditions for the purpose of tidal energy potential reconnaissance. A summary of observation dates and tidal conditions is provided in Table 4.11.

Flow data representative of peak ebb tide are shown in Figure 4.37. All flow data are shown based on stage of tide in Figures A.61 through A.64. The maximum flow speed measured was 1.26 m/s. Based on surface flow observations conducted to date, flow speeds of approximately 0.5 to 1.5 $\pm$ 0.5 m/s can be expected through Port L'Hebert.

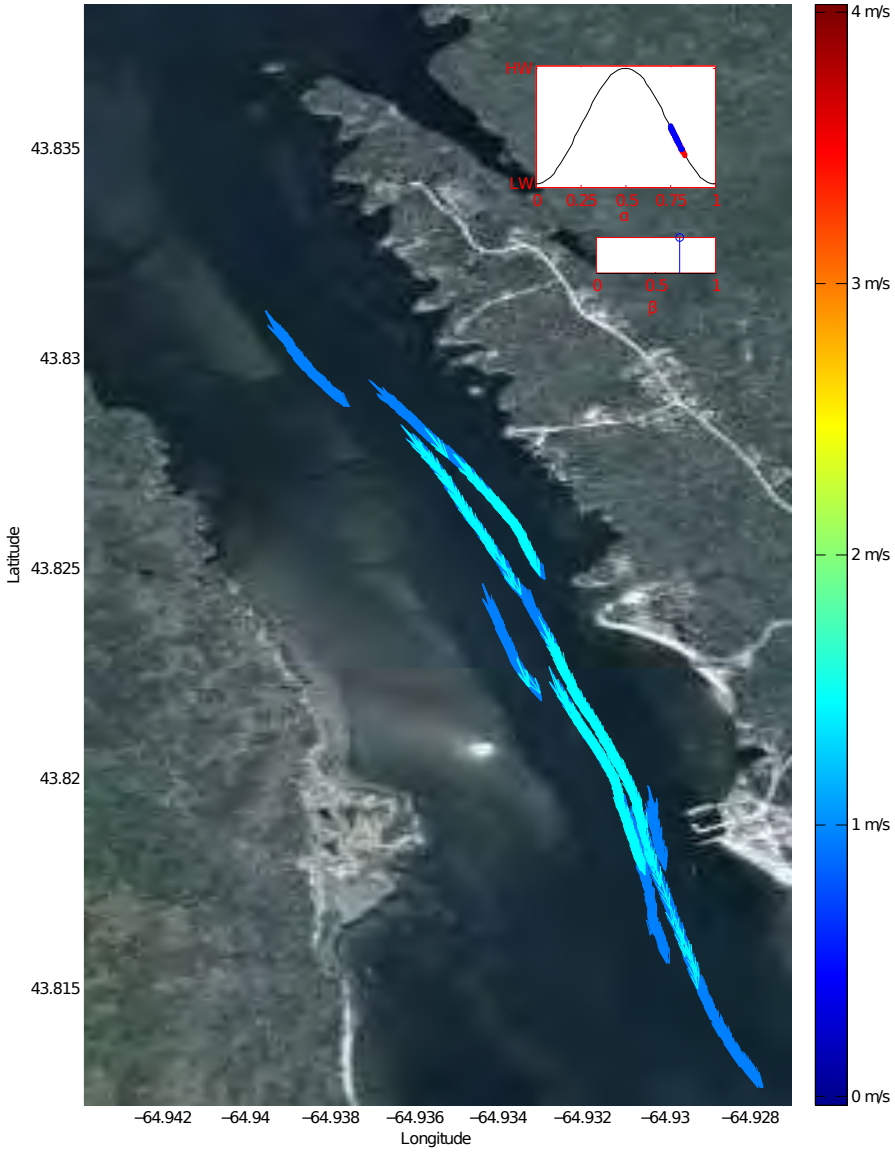

Figure 4.37: Port L'Hebert peak ebb tide

Chapter 5

Conclusions and Recommendations

Tidal energy potential reconnaissance was conducted at 9 sites in Southwest Nova Scotia. A method for conducting reconnaissance level assessments was developed and implemented within the Scope of Work for the Project. The method involves the use of GPS surface flow drifters deployed from small vessels to provide a cost effective means to assess the spatial and temporal variability in tidal flows.

Flow speeds were measured with maximum site values ranging from 1.26 m/s (Port L'Hebert) to 4.16 m/s (The Gap), and flow speeds $\geq$ 3 m/s were observed at 6 of the 9 sites assessed for tidal energy potential. A summary of the maximum flow speed (V_{max}) measured at each site is provided in Table 5.1.

The potential for small-scale tidal energy development is notable at Indian Sluice near the Indian Sluice Bridge (between Sluice Point and Surettes Island) due to flow speed, accessibility, and presence of bridge infrastructure. An acoustic Doppler current profiler (ADCP) was deployed at Indian Sluice as part of the Project based on the reconnaissance

Site	V_{max} (m/s)
The Gap	4.16
Passages West of Big Tusket Island	3.00
Indian Sluice	4.09
The Sluice	3.21
The Tittle	2.43
Cat Island Bridge	3.30
Pubnico Harbour	1.61
Port Clyde Bridge	3.04
Port LHebert	1.26

Table 5.1: Summary of maximum flow speeds measured at reconnaissance sites

results.

Additional sites were identified and visited for initial assessment, but flow measurements were not collected due to site prioritization based on time, budget, logistical and safety constraints. Additional tidal energy reconnaissance in Southwest Nova Scotia could include data collection at any, or all of: Cape Sable, Baccaro Point, Lockeport Rail Bridge, Black Point Bay, Barrington Passage, Tusket River Estuary at Squires Island, and Sissiboo River Estuary. The Hospital may also be worth investigation for the purpose of characterizing all major resources for future development potential, while noting technical and financial challenges associated with distance from shore.

In addition to recording maximum flow speeds, the surface flow data was used to generate stage of tide velocity charts for each site. The focus of reconnaissance data collection was assessing high flow sections of tidal channels during peak ebb and/or flood tide. Additional data collection to fill in spatial and temporal data gaps in the charts is recommended at sites deemed attractive for potential tidal energy development. Further investigation should also include; a) water level measurements, b) ADCP deployments, and c) multi-beam bathymetry.

Further development of the surface flow method is warranted, with research objectives of; a) use of drifters for detailed site characterization including mapping and investigation of significant flow features such as eddies and shear lines, b) investigating the relationship between tidal forcing and flow velocity for use of β as a non-dimensional velocity prediction factor, and c) use of surface flow information (including drifters and X-band radar) for numerical model validation.

Appendix A

Figures

A.1 Grand Passage

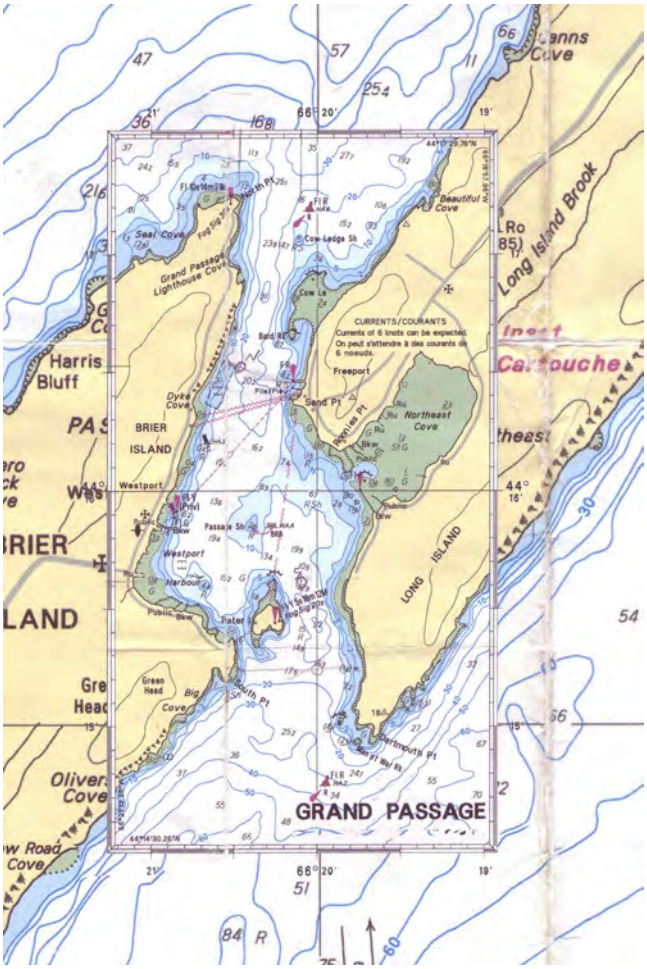

Figure A.1: Grand Passage nautical chart

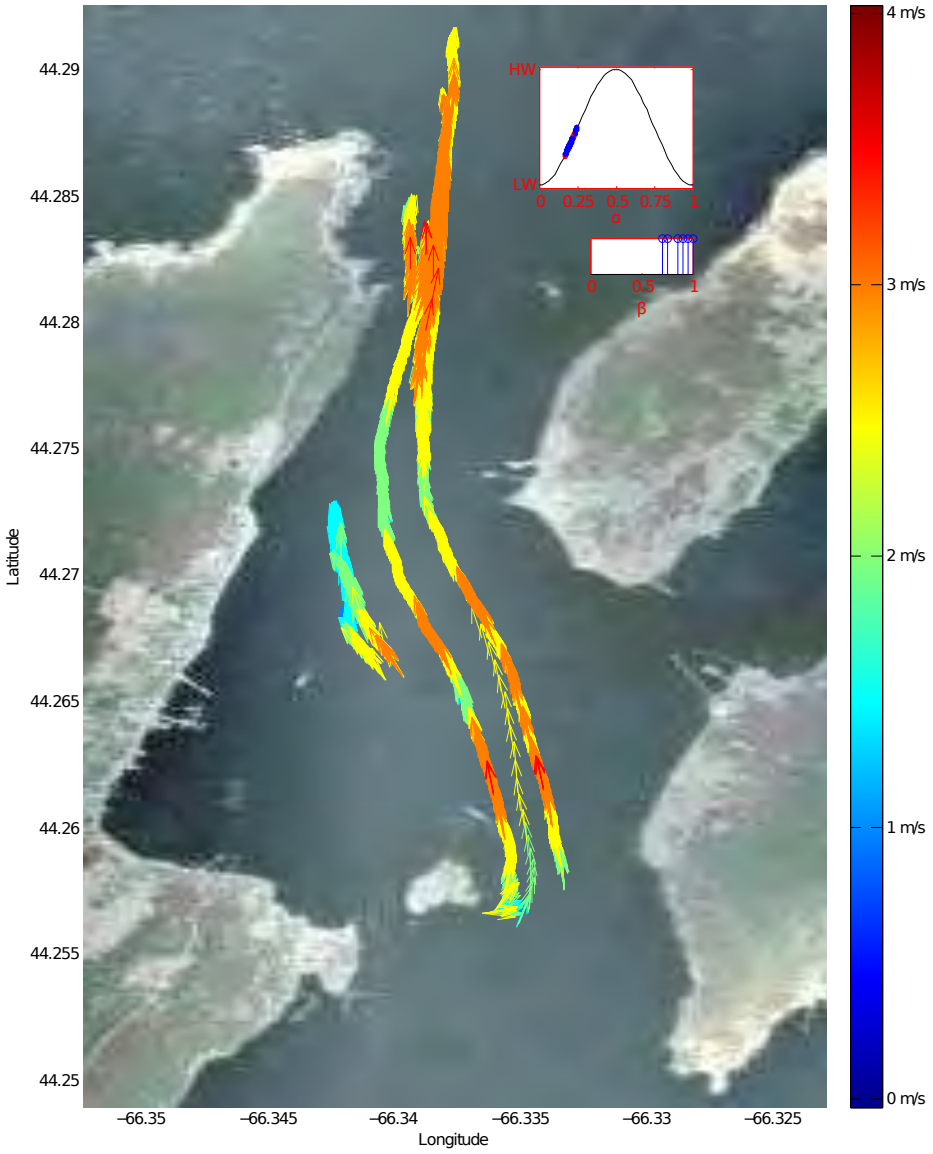

Figure A.2: Grand Passage flood tide, $2/12 < \alpha < 3/12$

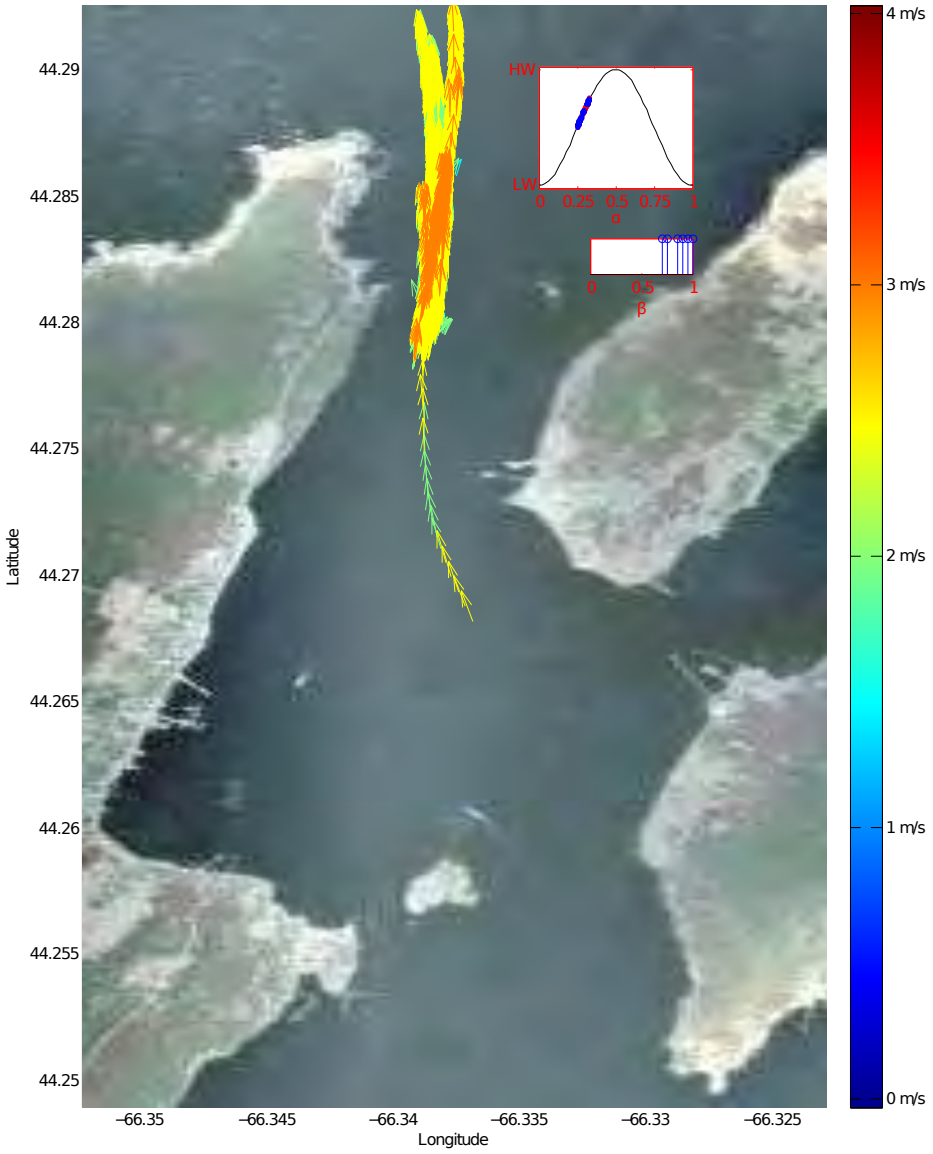

Figure A.3: Grand Passage flood tide, $3/12 < \alpha < 4/12$

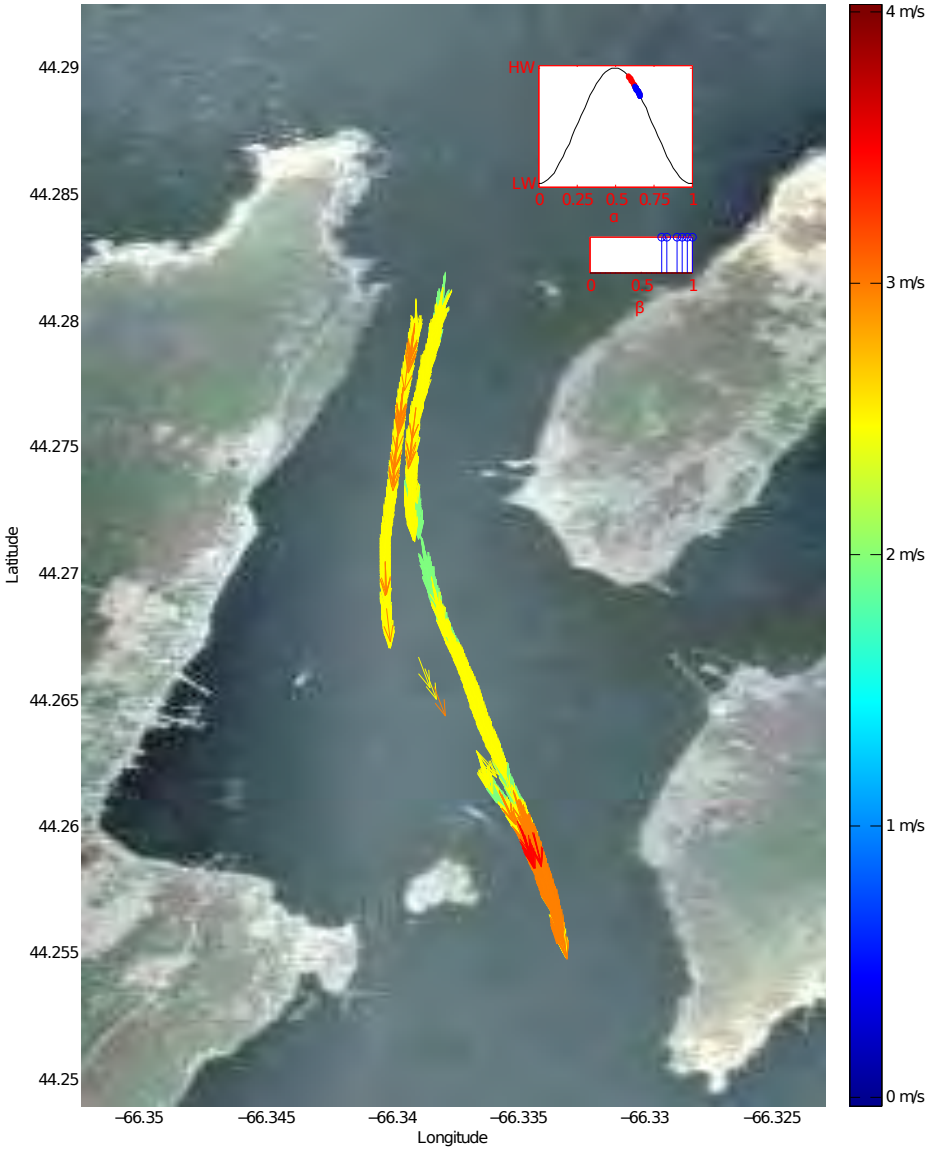

Figure A.4: Grand Passage ebb tide, $7/12 < \alpha < 8/12$

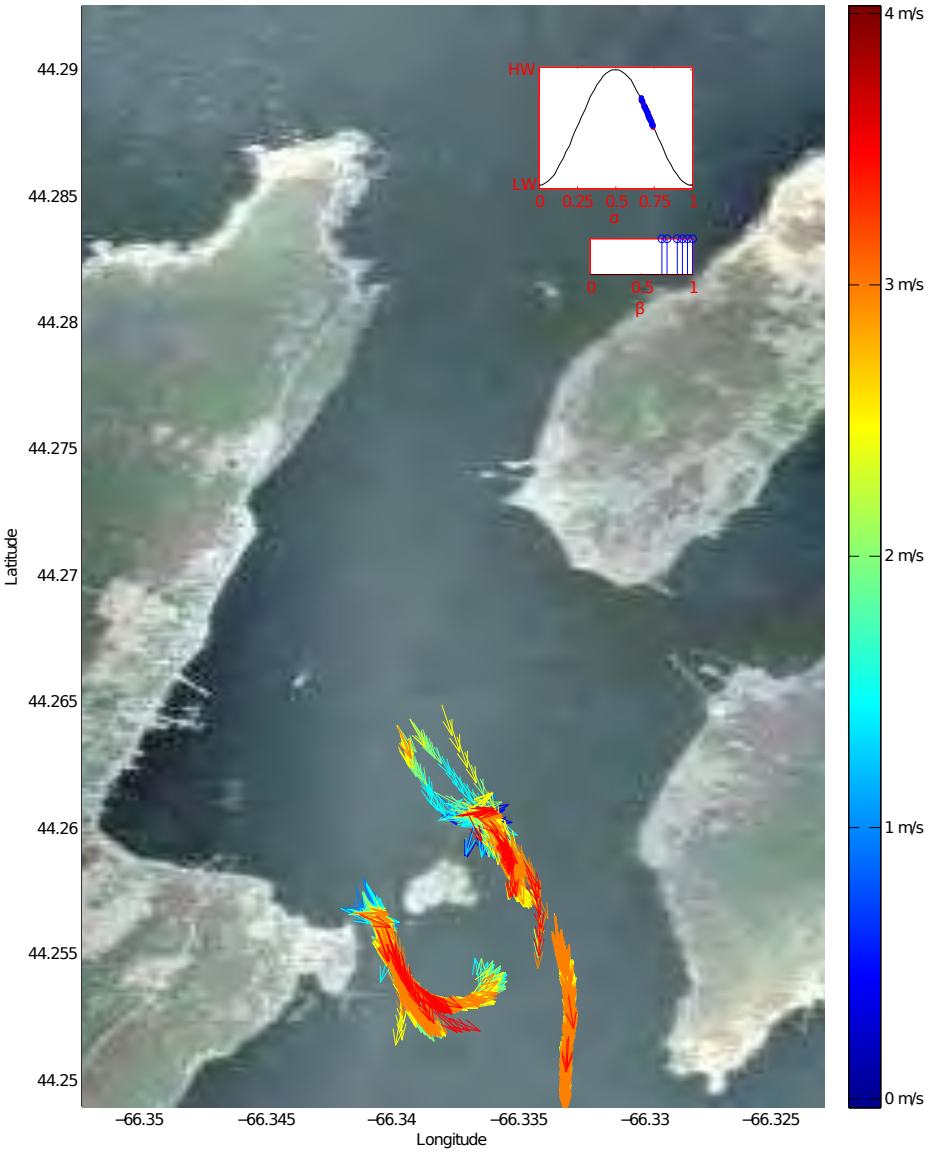

Figure A.5: Grand Passage ebb tide, $8/12 < \alpha < 9/12$

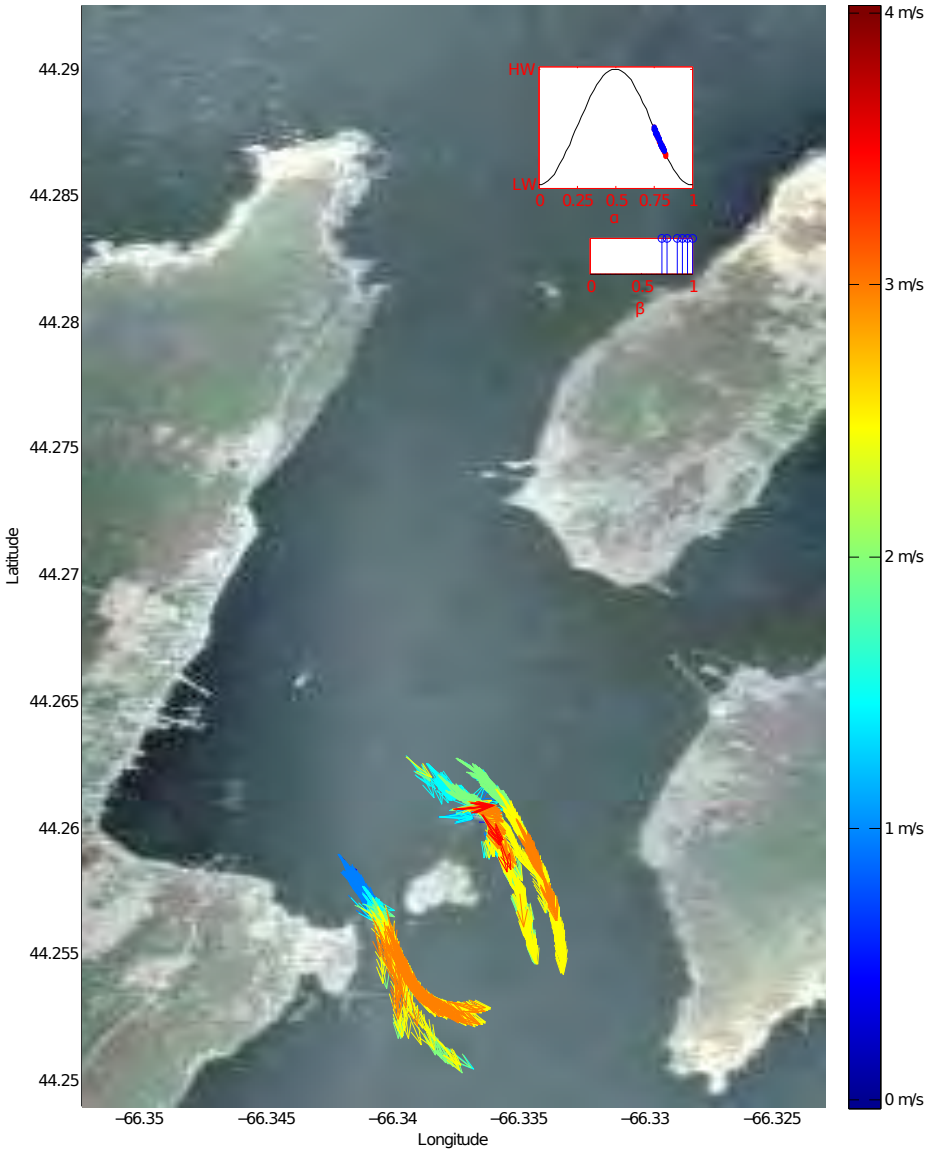

Figure A.6: Grand Passage ebb tide, $9/12 < \alpha < 10/12$

A.2 Petit Passage

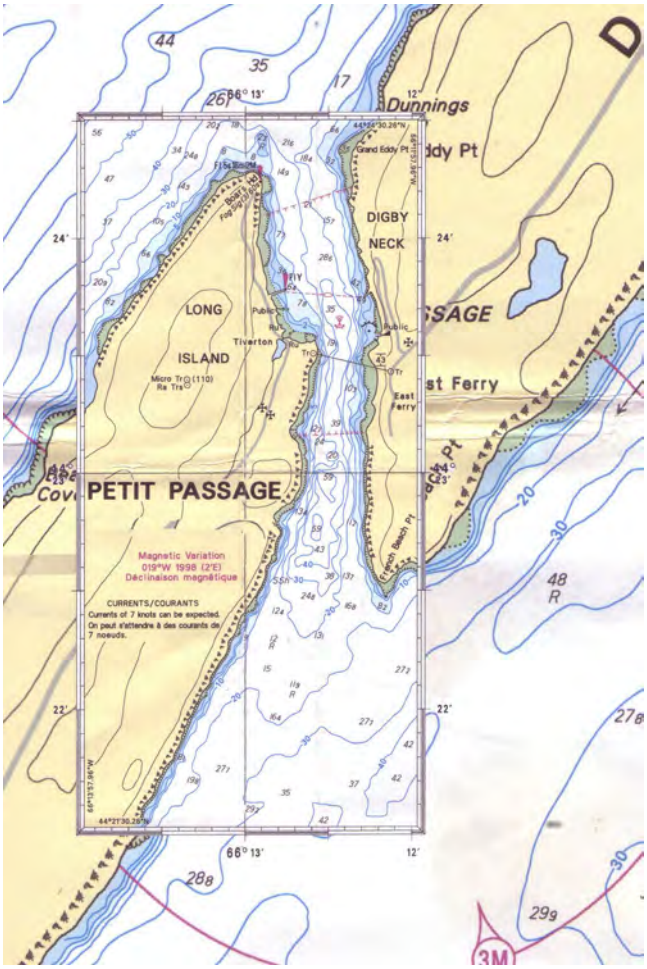

Figure A.7: Petit Passage nautical chart

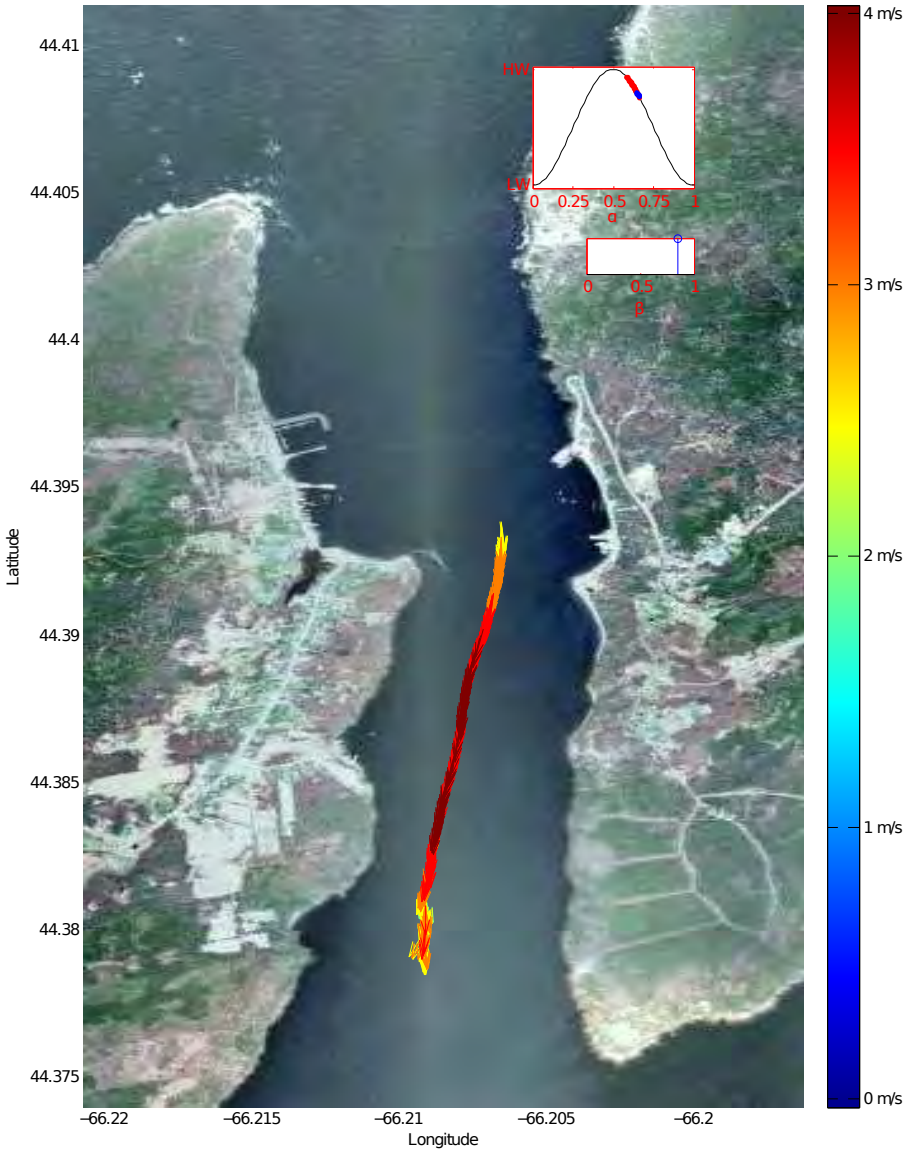

Figure A.8: Petit Passage ebb tide, $7/12 < \alpha < 8/12$

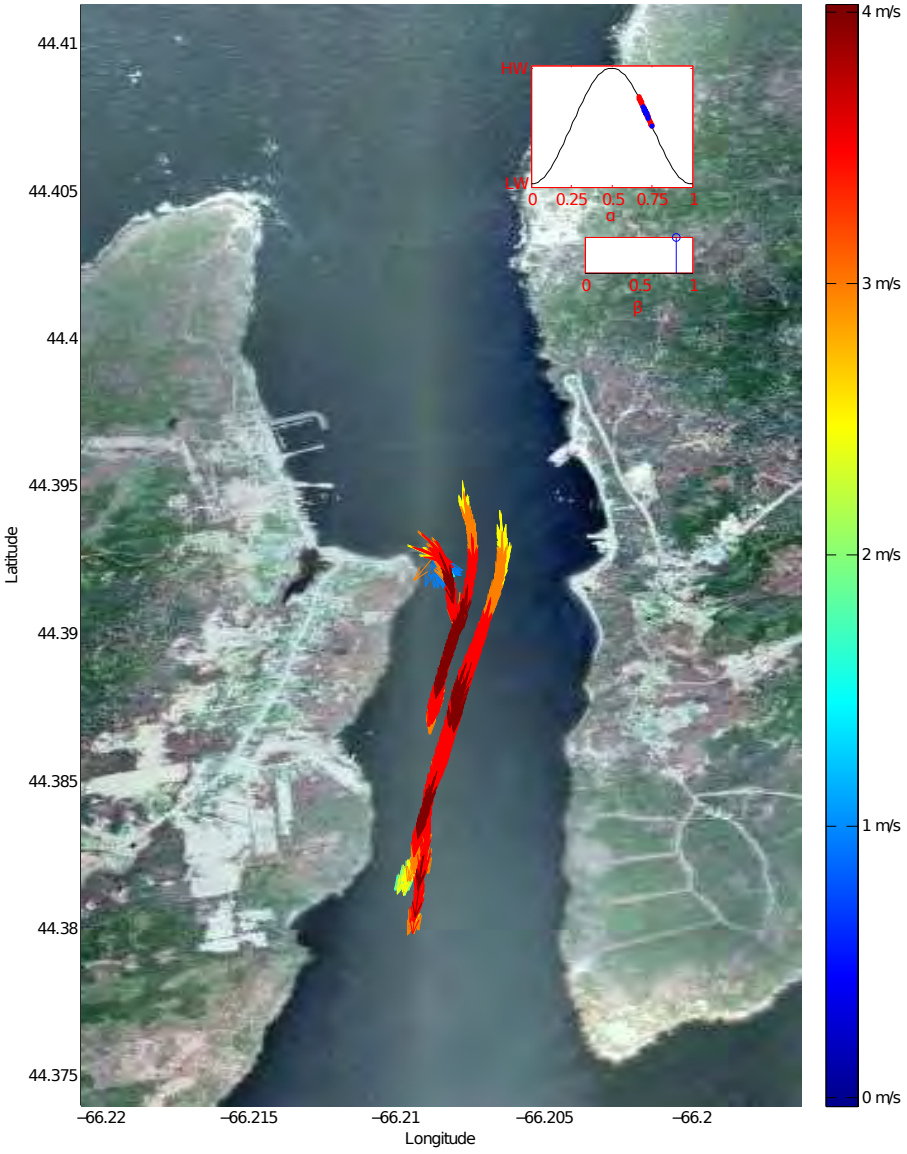

Figure A.9: Petit Passage ebb tide, $8/12 < \alpha < 9/12$

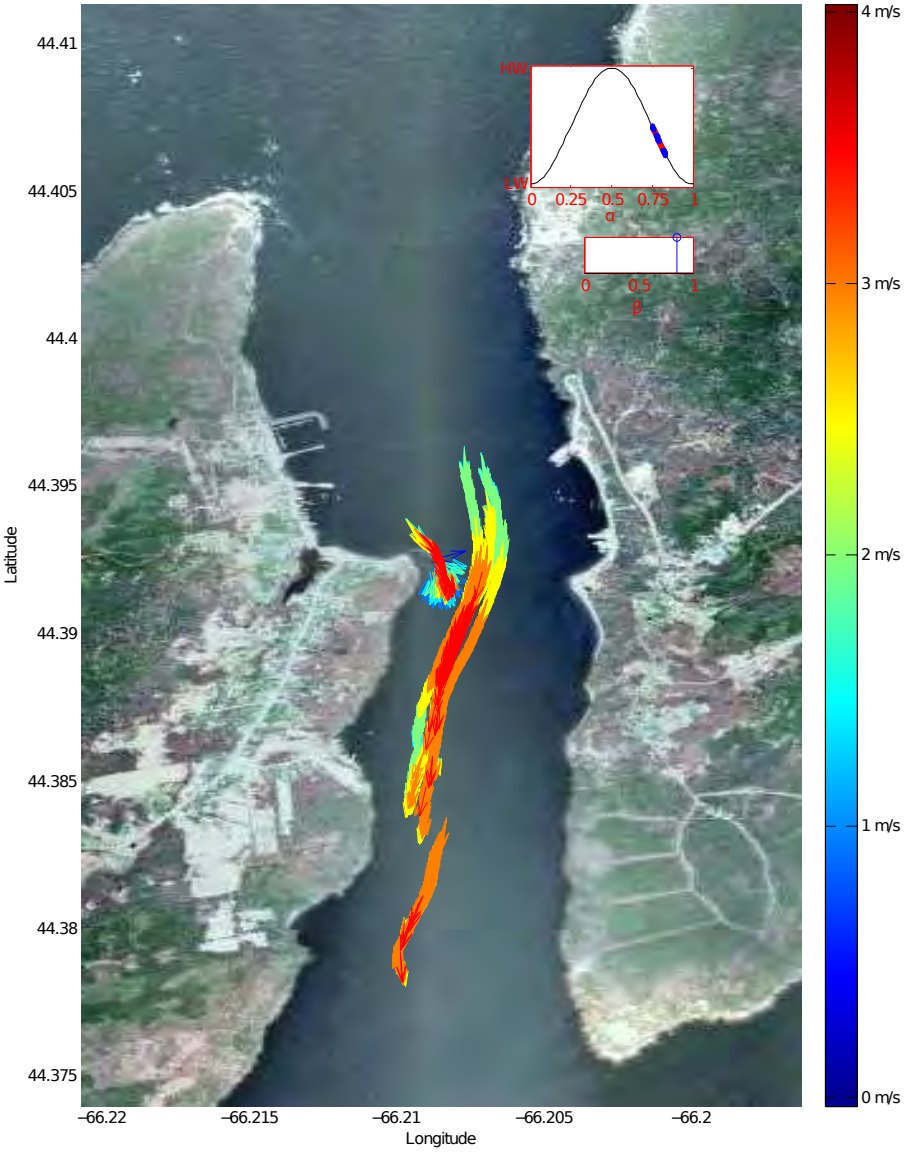

Figure A.10: Petit Passage ebb tide, $9/12 < \alpha < 10/12$

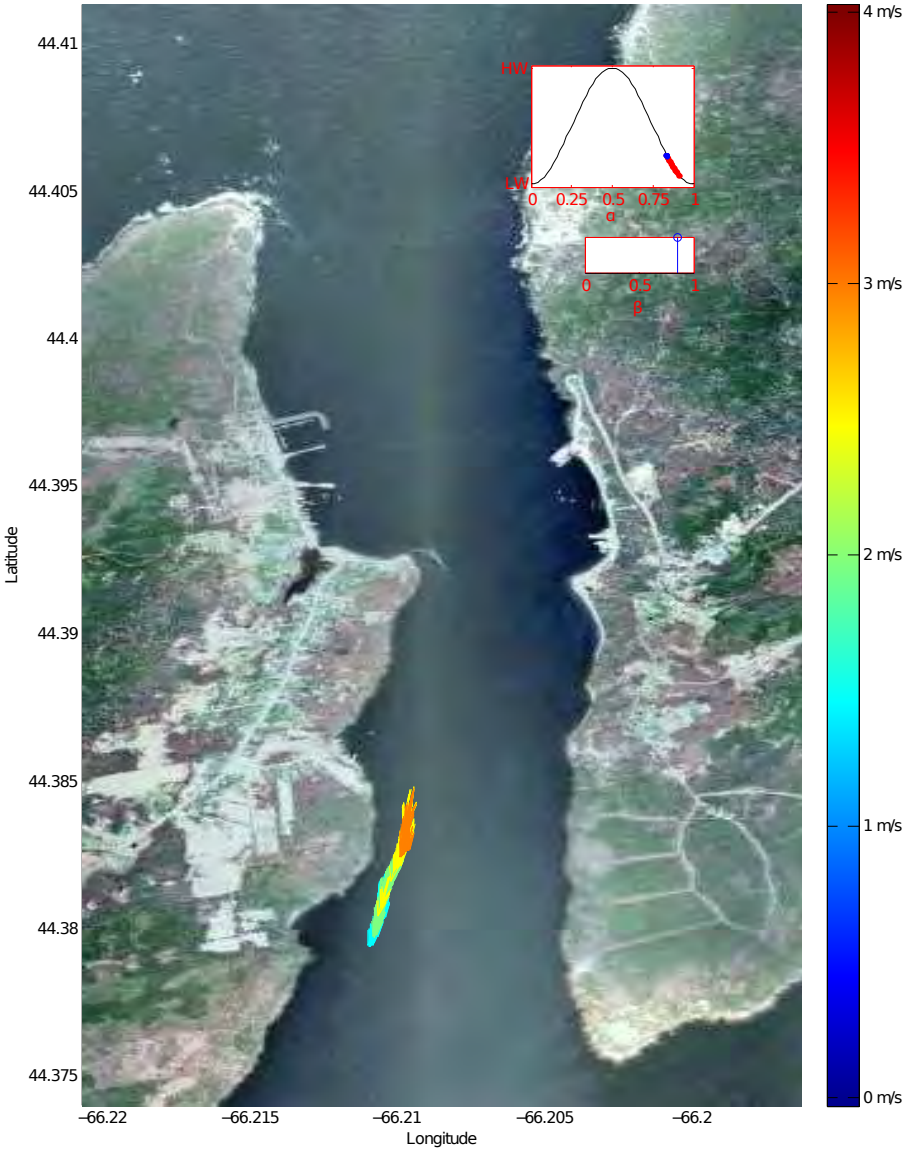

Figure A.11: Petit Passage ebb tide, $10/12 < \alpha < 11/12$

A.3 The Gap

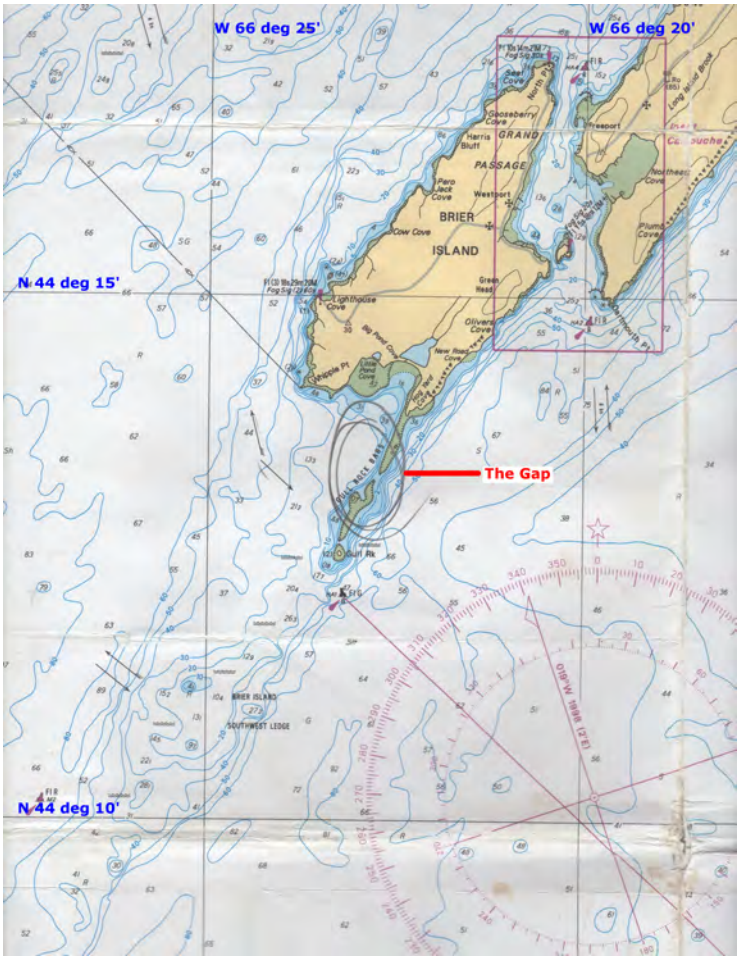

Figure A.12: The Gap nautical chart

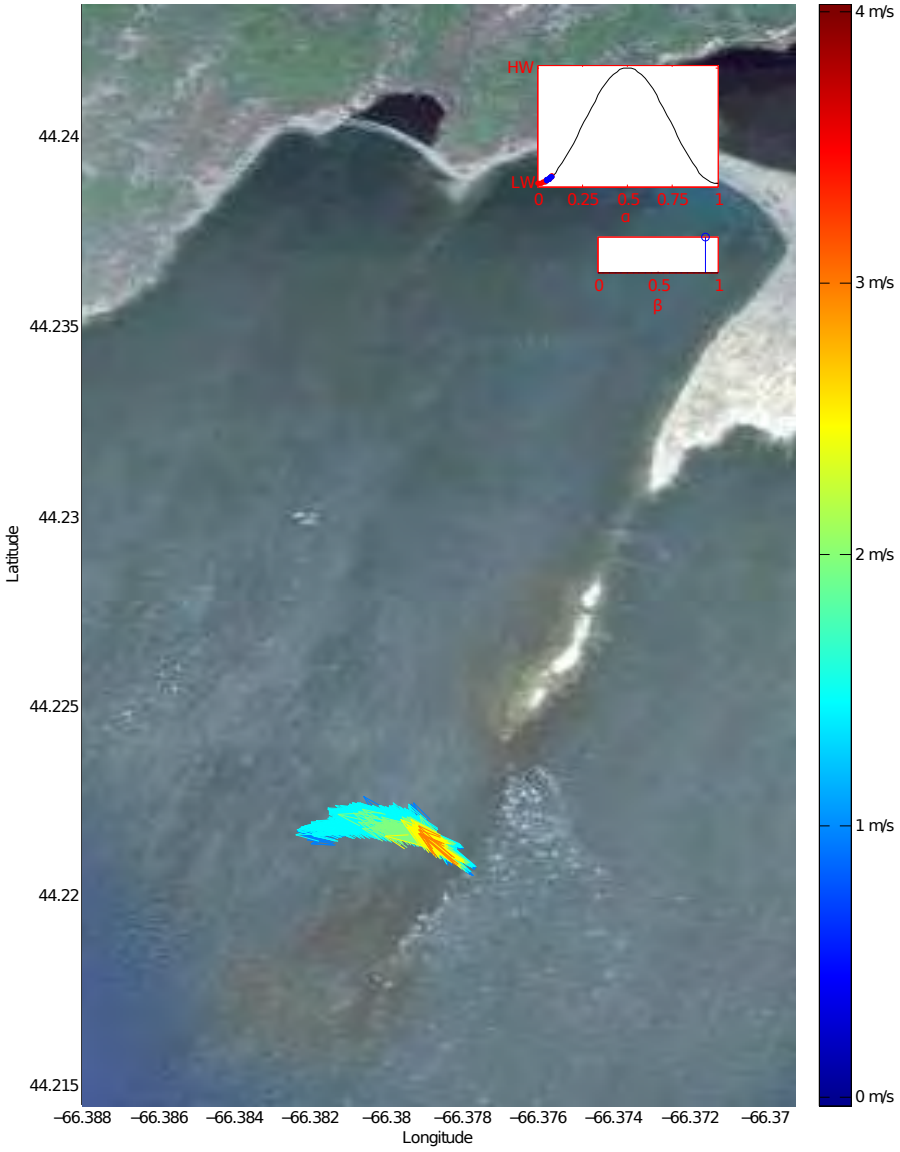

Figure A.13: The Gap flood tide, $0 < \alpha < 1/12$

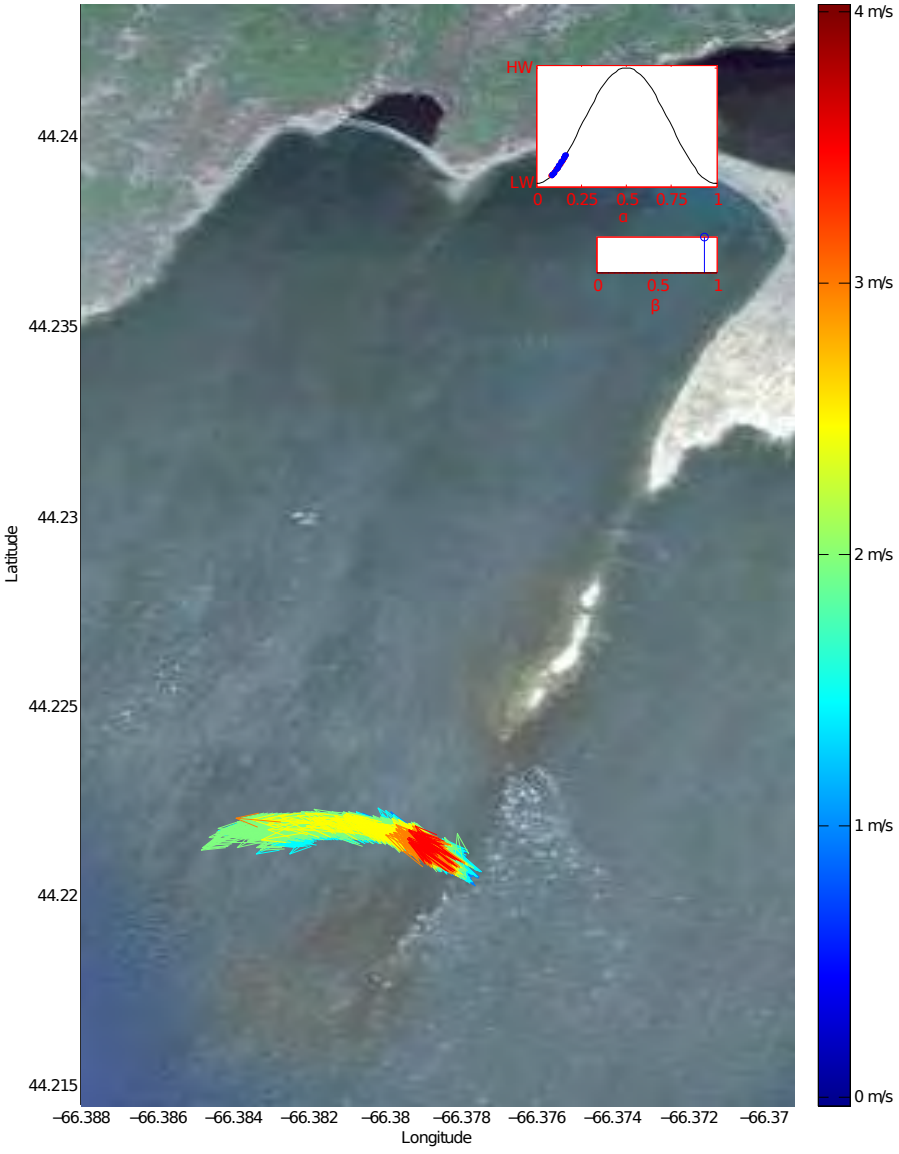

Figure A.14: The Gap flood tide, $1/12 < \alpha < 2/12$

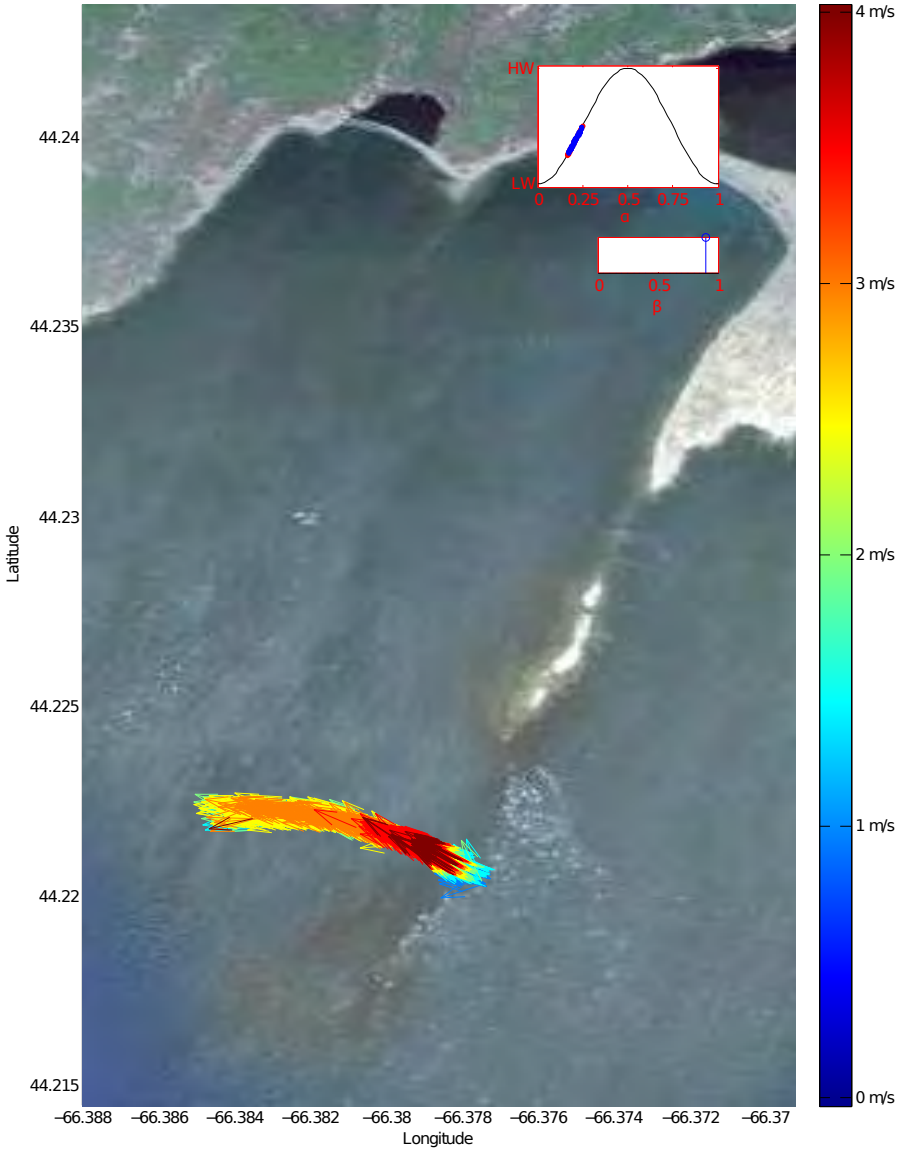

Figure A.15: The Gap flood tide, $2/12 < \alpha < 3/12$

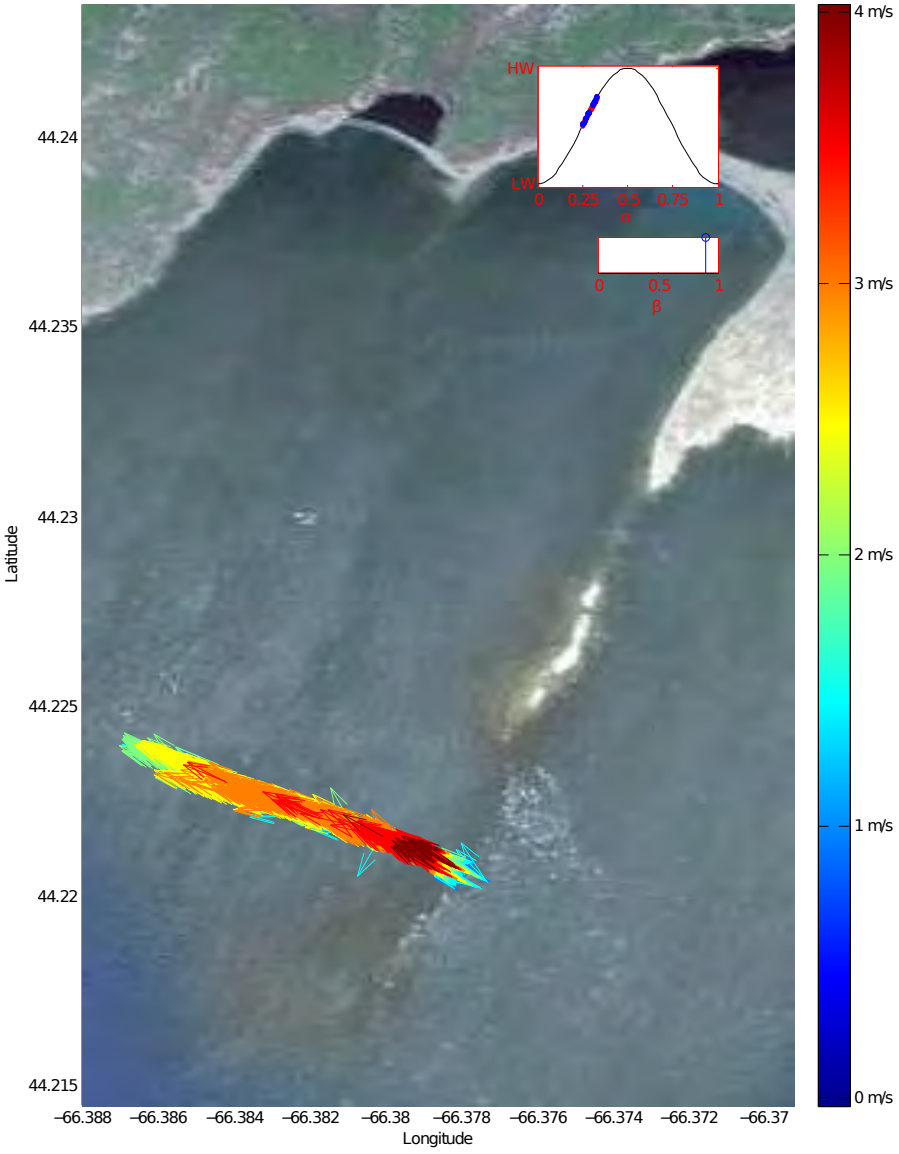

Figure A.16: The Gap flood tide, $3/12 < \alpha < 4/12$

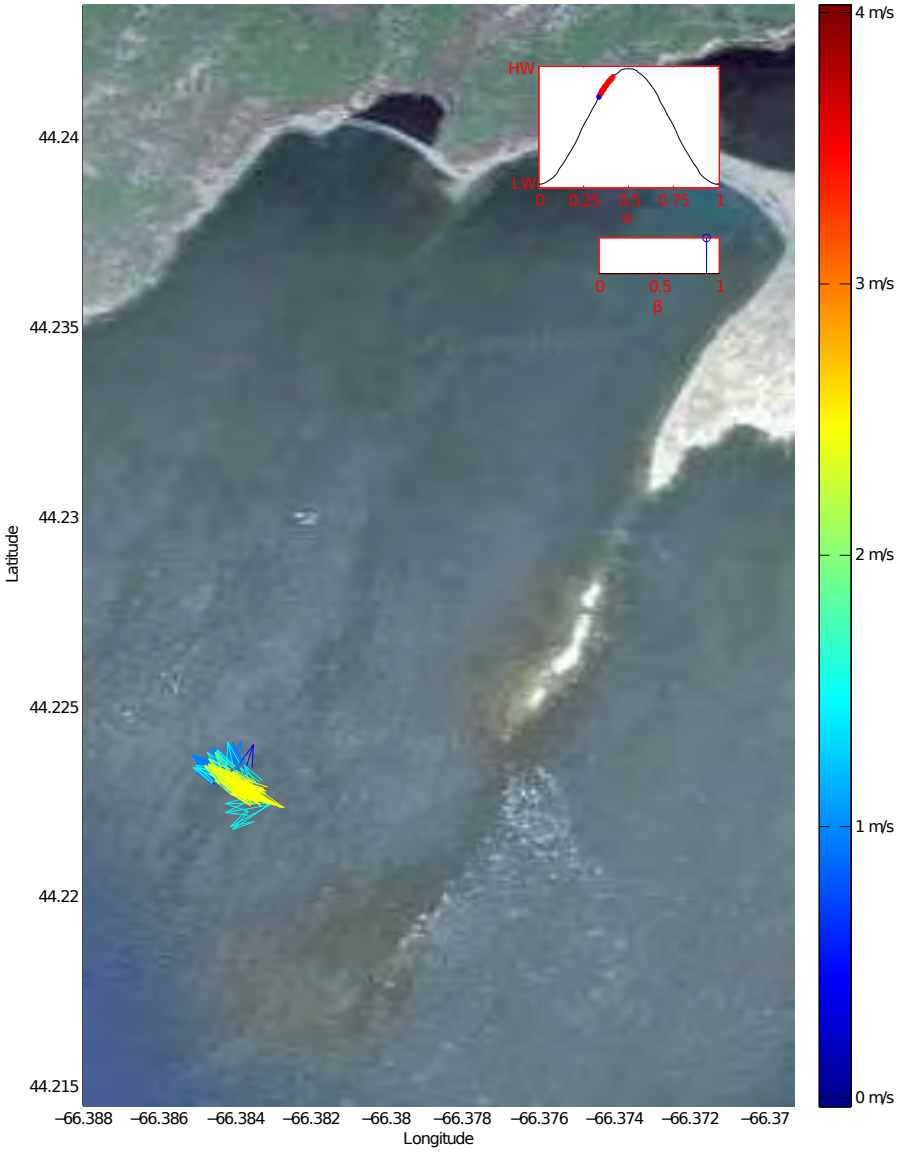

Figure A.17: The Gap flood tide, $4/12 < \alpha < 5/12$

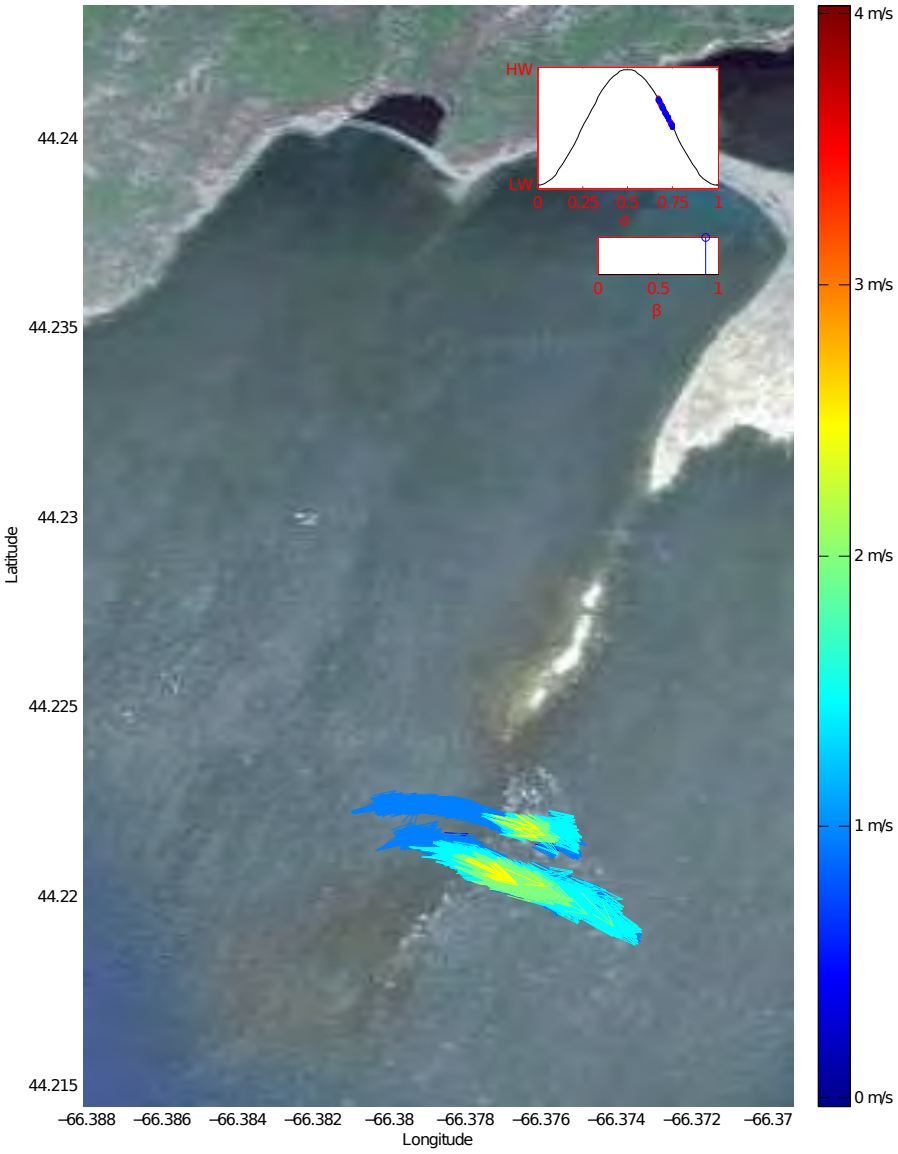

Figure A.18: The Gap ebb tide, $8/12 < \alpha < 9/12$

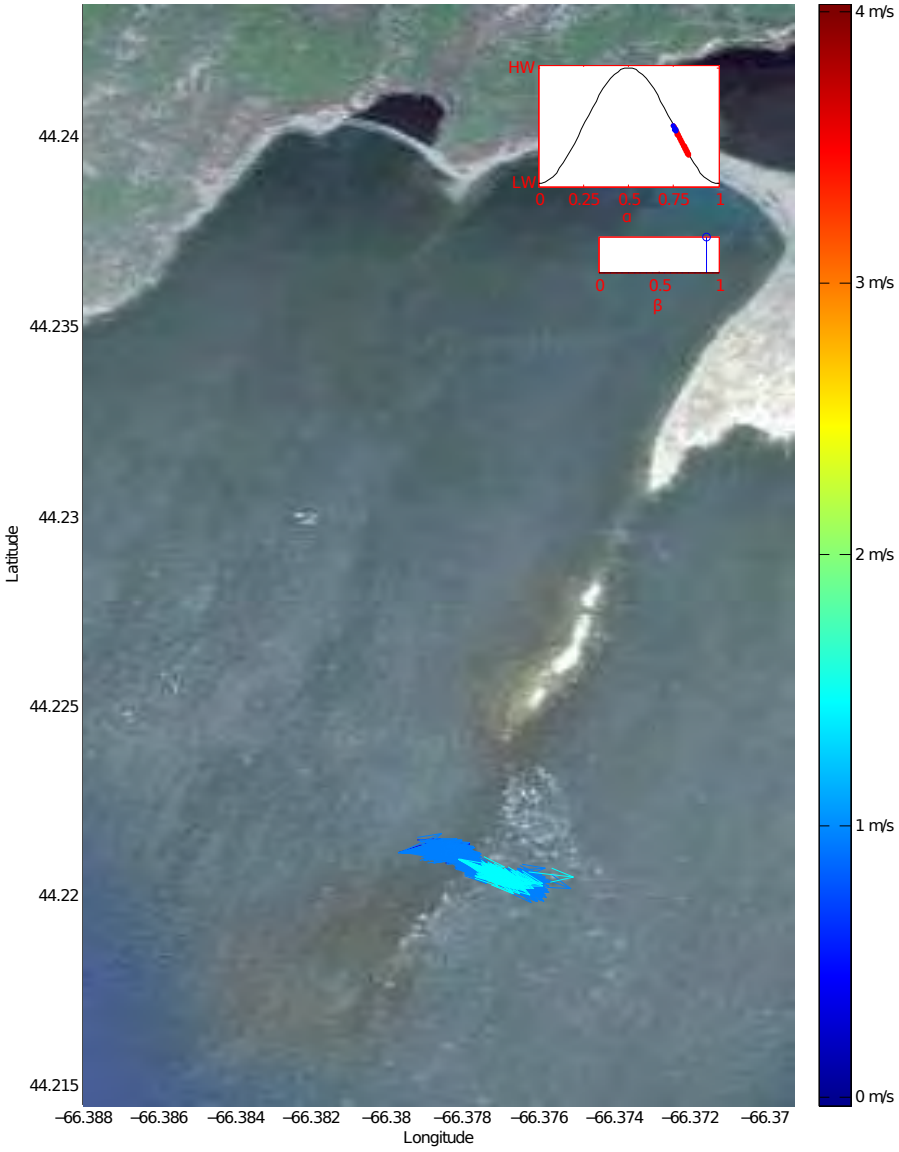

Figure A.19: The Gap ebb tide, $9/12 < \alpha < 10/12$

A.4 Passages West of Big Tusket Island

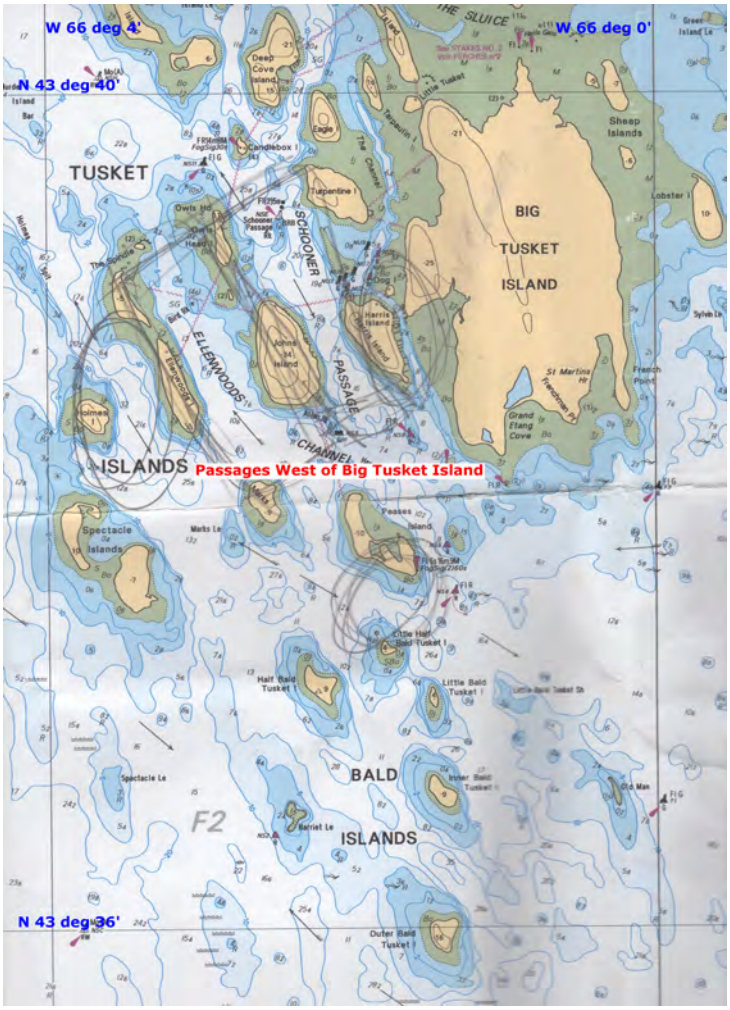

Figure A.20: Passages West of Big Tusket Island nautical chart

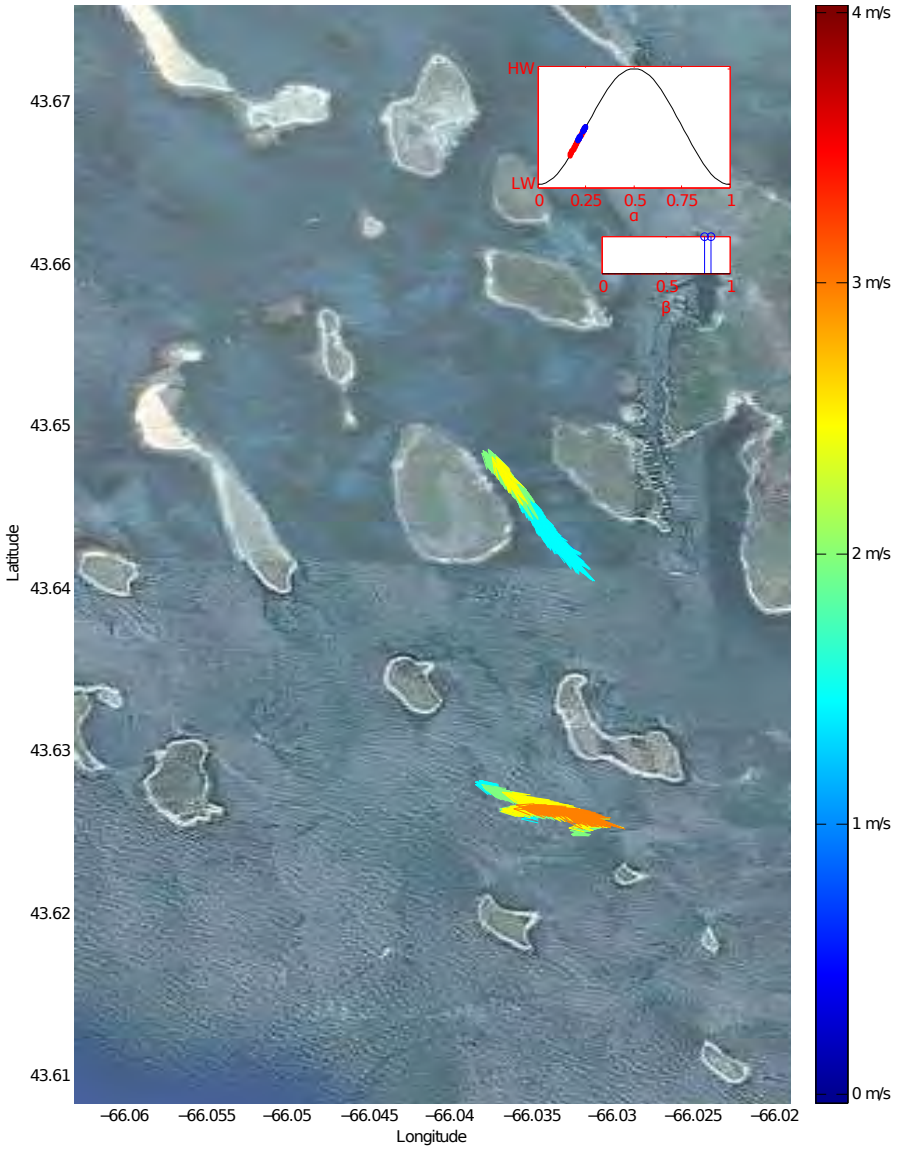

Figure A.21: Passages West of Big Tusket Island flood tide, $2/12 < \alpha < 3/12$

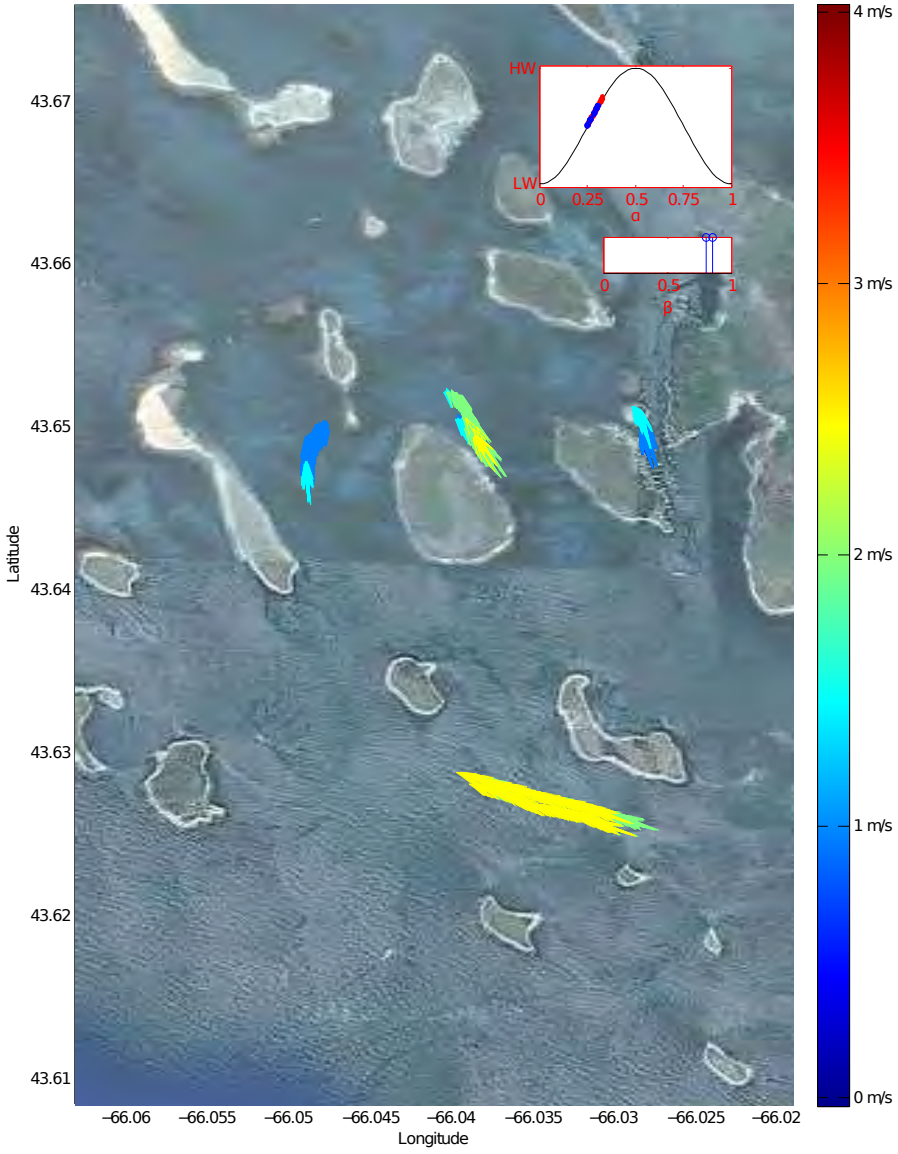

Figure A.22: Passages West of Big Tusket Island flood tide, $3/12 < \alpha < 4/12$

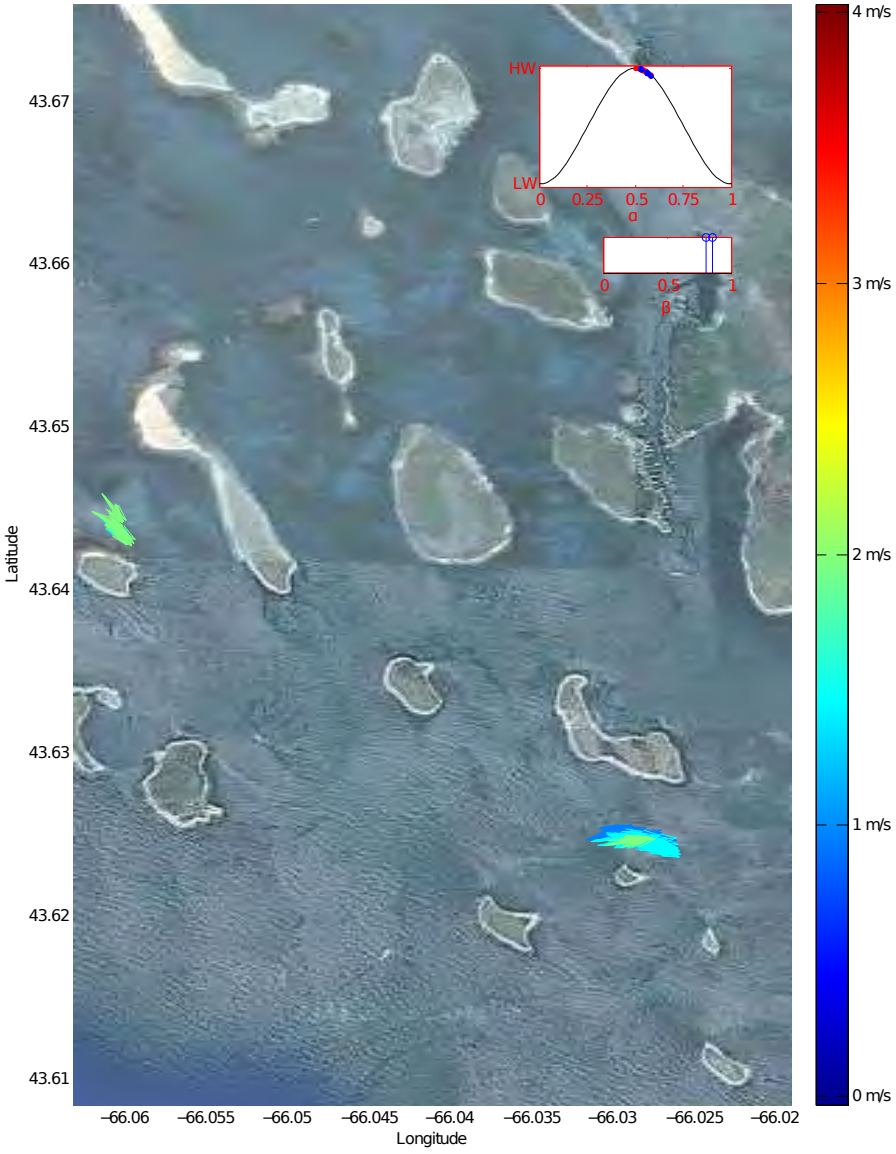

Figure A.23: Passages West of Big Tusket Island ebb tide, $6/12 < \alpha < 7/12$

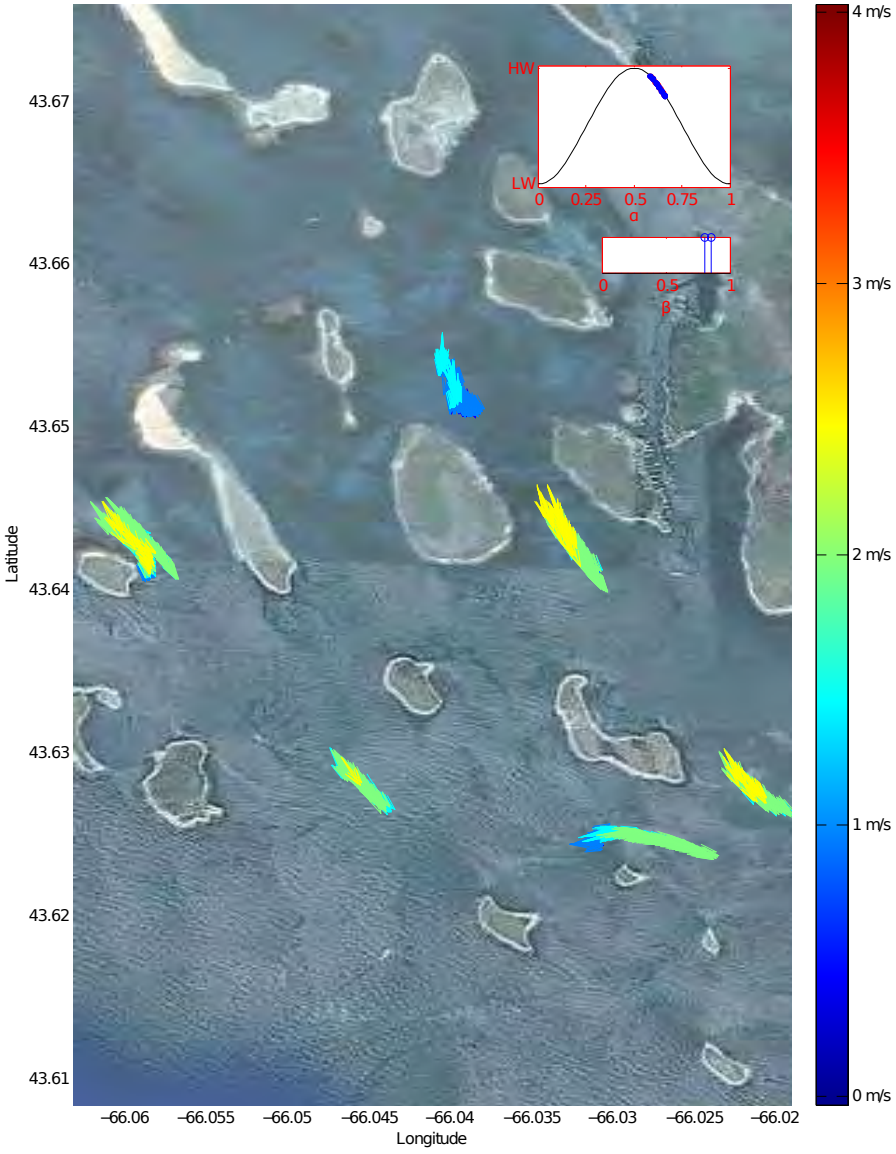

Figure A.24: Passages West of Big Tusket Island ebb tide, $7/12 < \alpha < 8/12$

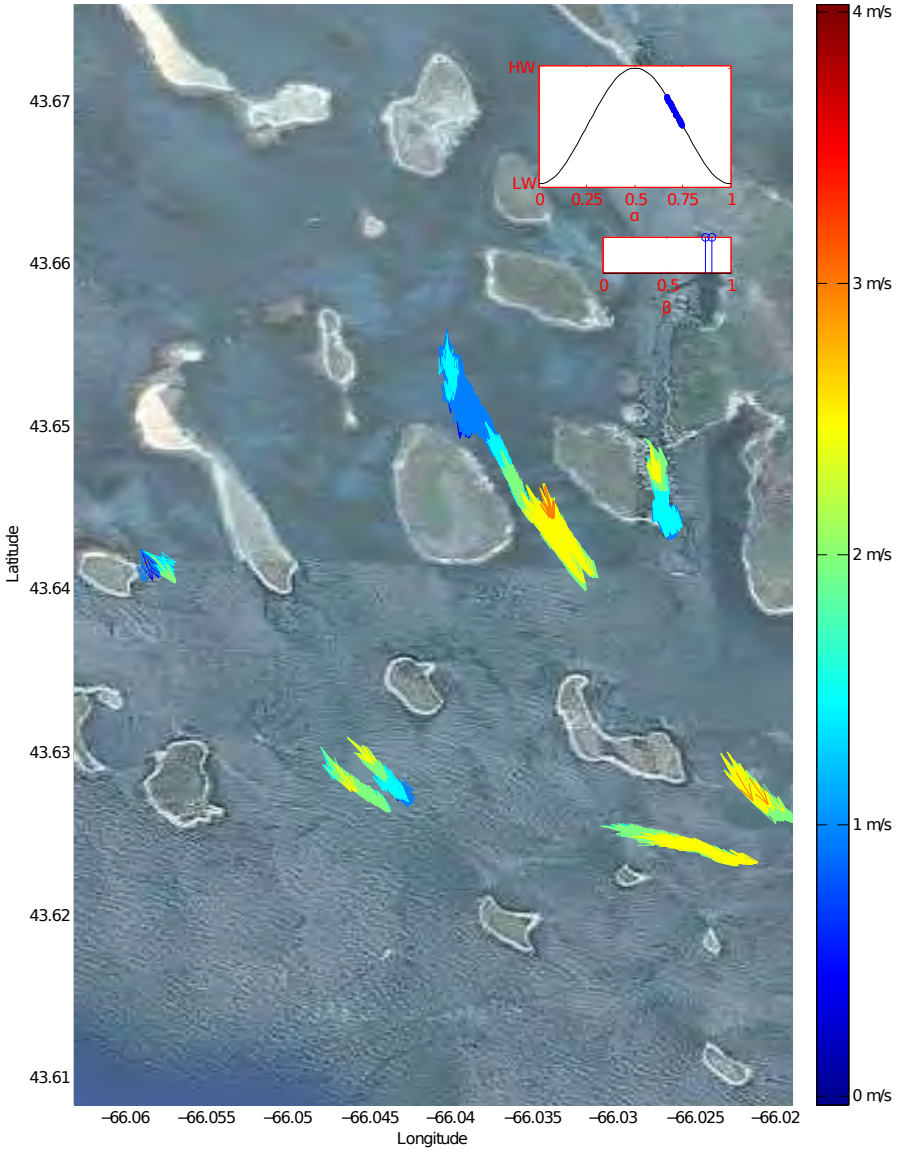

Figure A.25: Passages West of Big Tusket Island ebb tide, $8/12 < \alpha < 9/12$

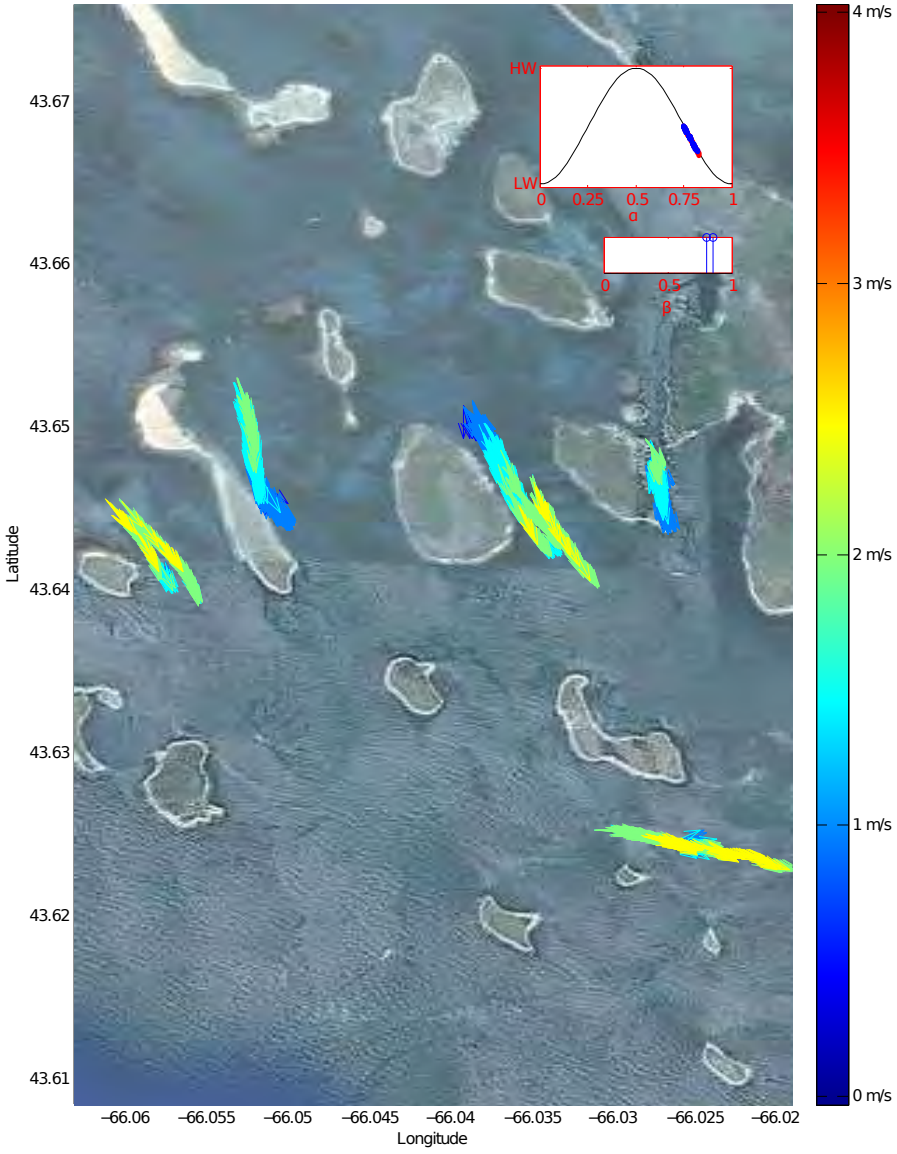

Figure A.26: Passages West of Big Tusket Island ebb tide, $9/12 < \alpha < 10/12$

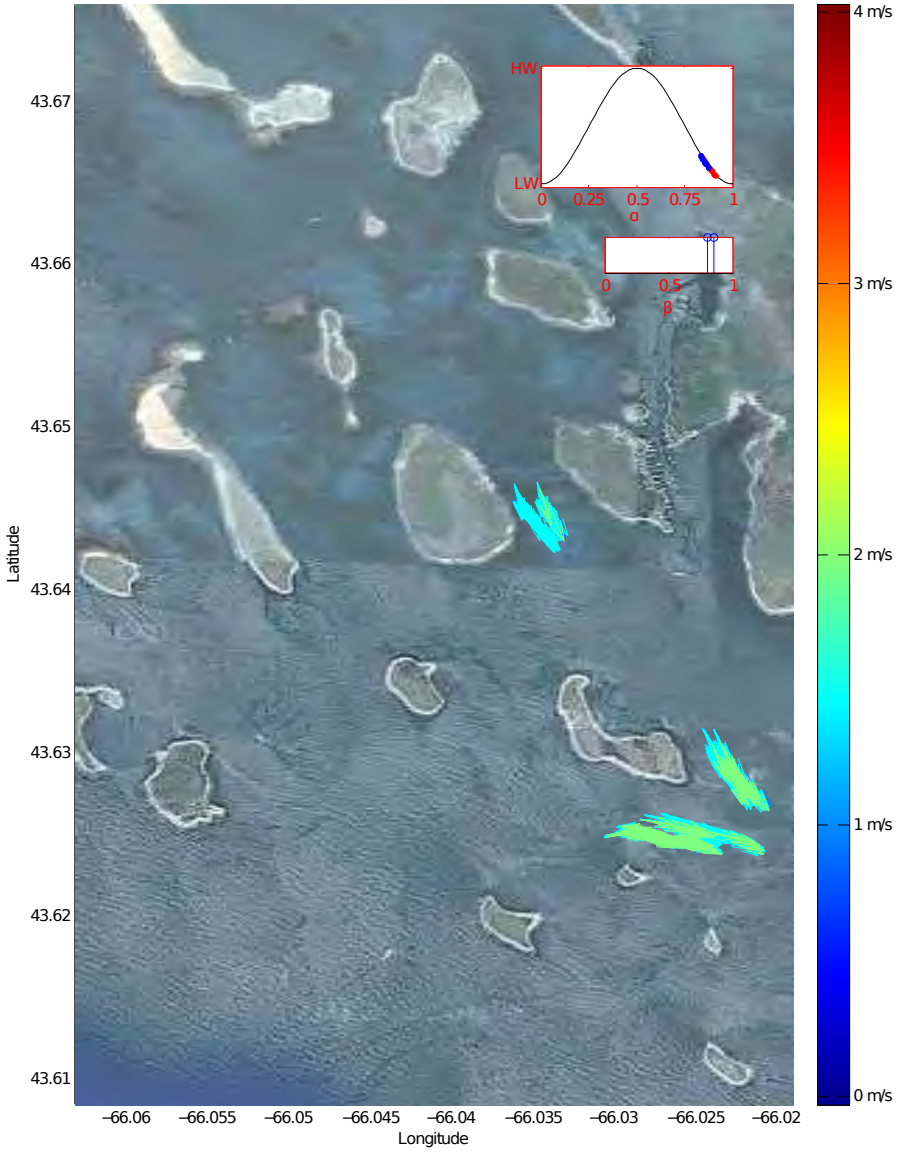

Figure A.27: Passages West of Big Tusket Island ebb tide, $10/12 < \alpha < 11/12$

A.5 Indian Sluice

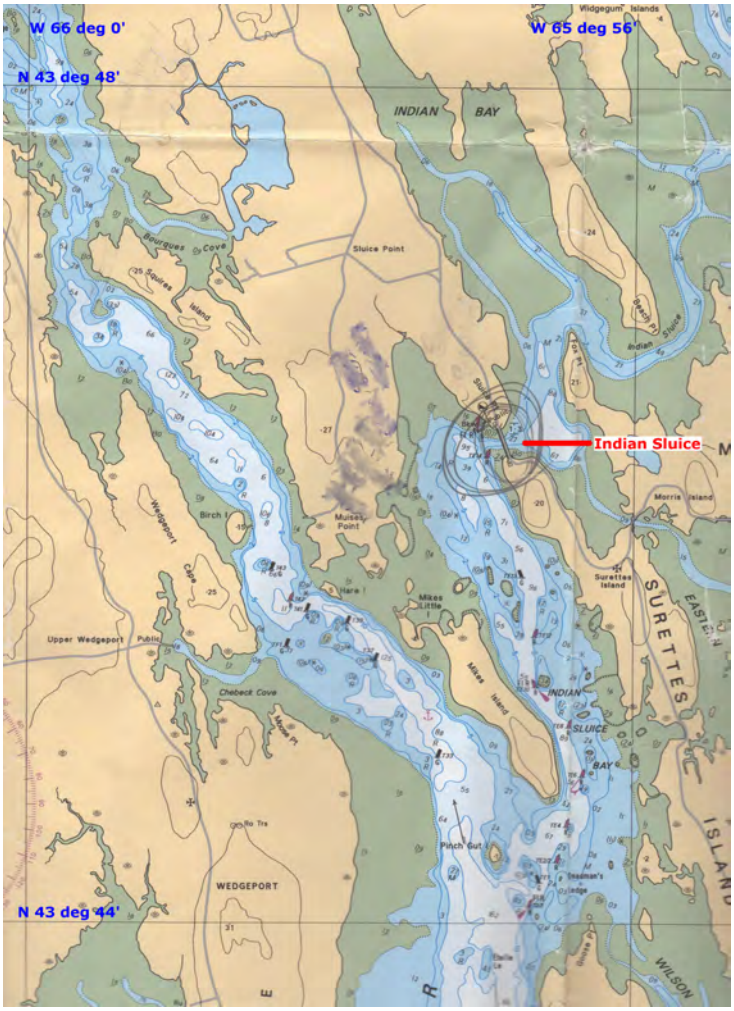

Figure A.28: Indian Sluice nautical chart

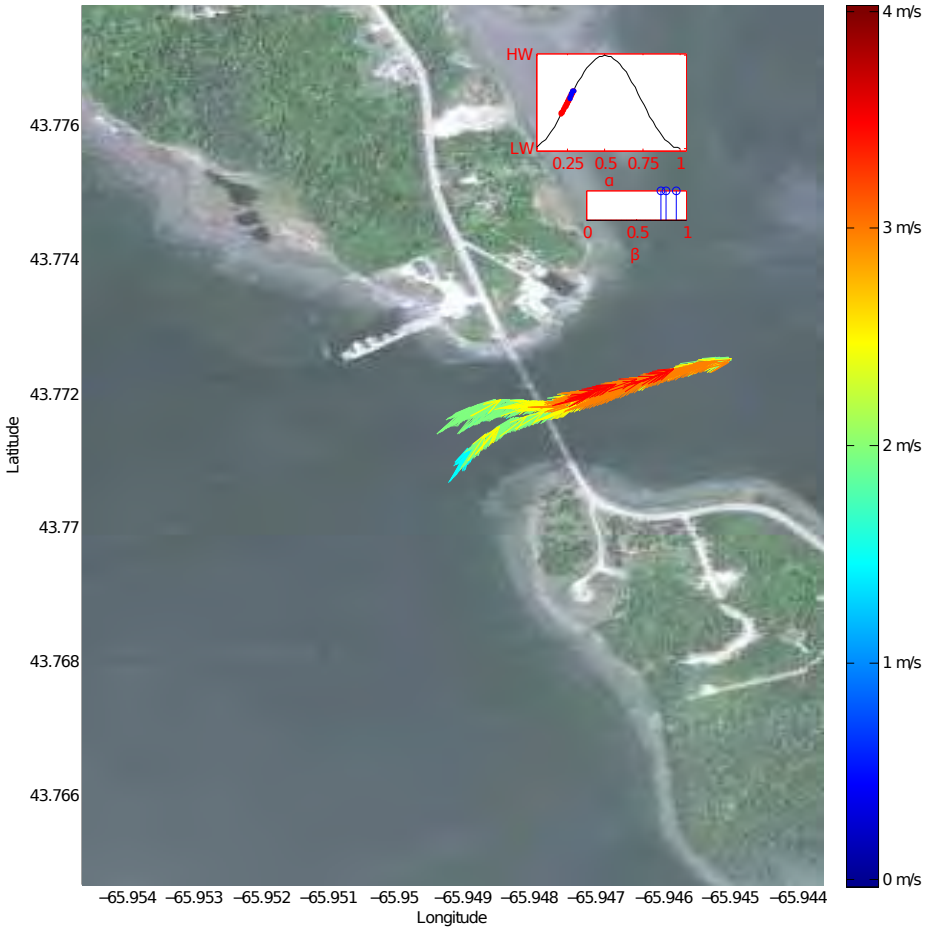

Figure A.29: Indian Sluice flood tide, $2/12 + 0.04 < \alpha < 3/12 + 0.04$

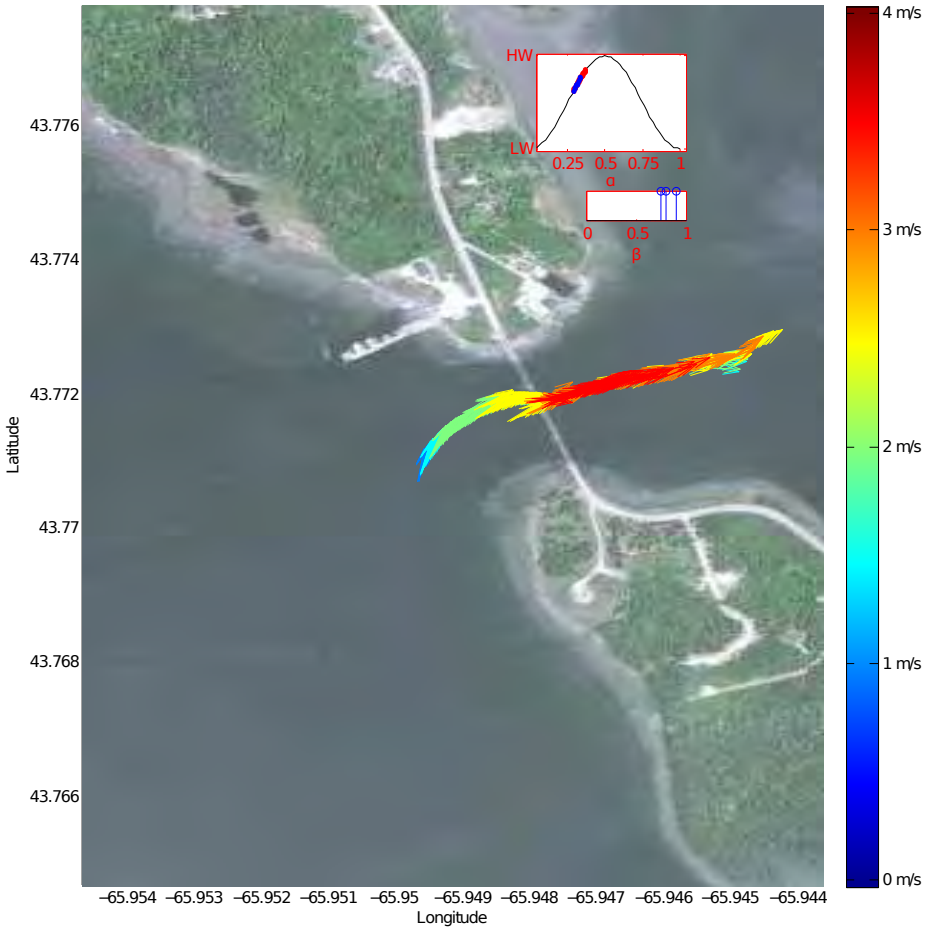

Figure A.30: Indian Sluice flood tide, $3/12 + 0.04 < \alpha < 4/12 + 0.04$

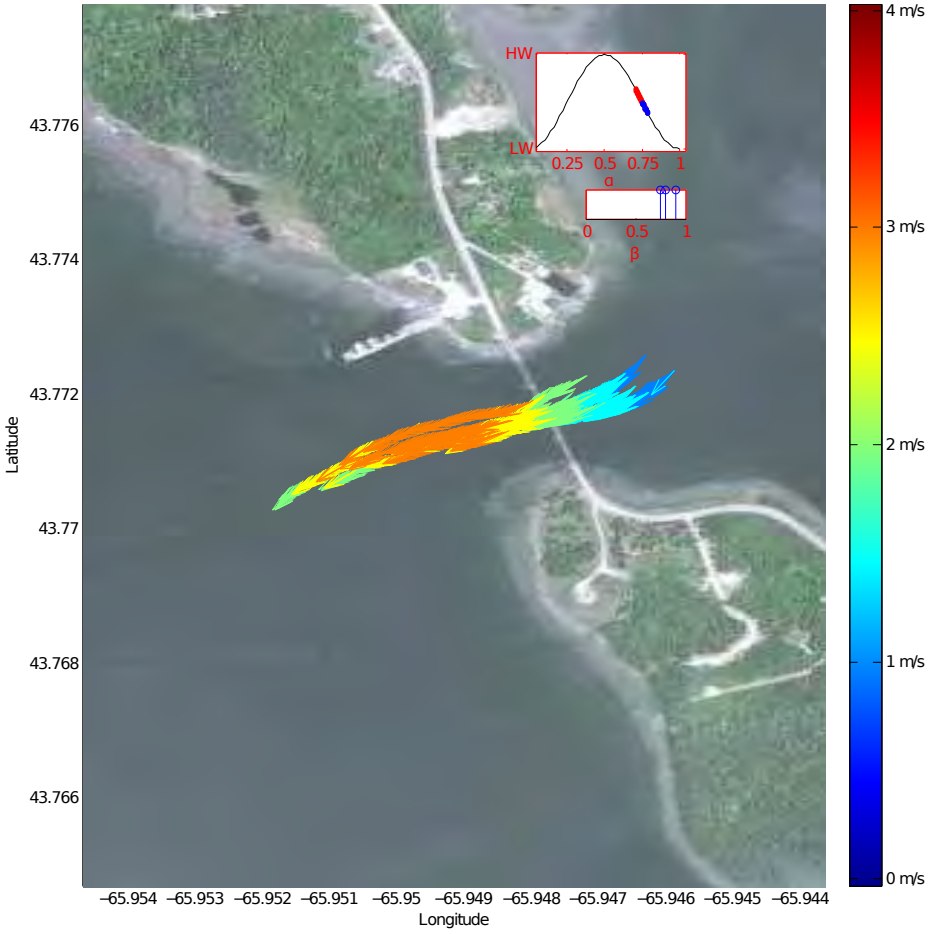

Figure A.31: Indian Sluice ebb tide, $8/12 + 0.04 < \alpha < 9/12 + 0.04$

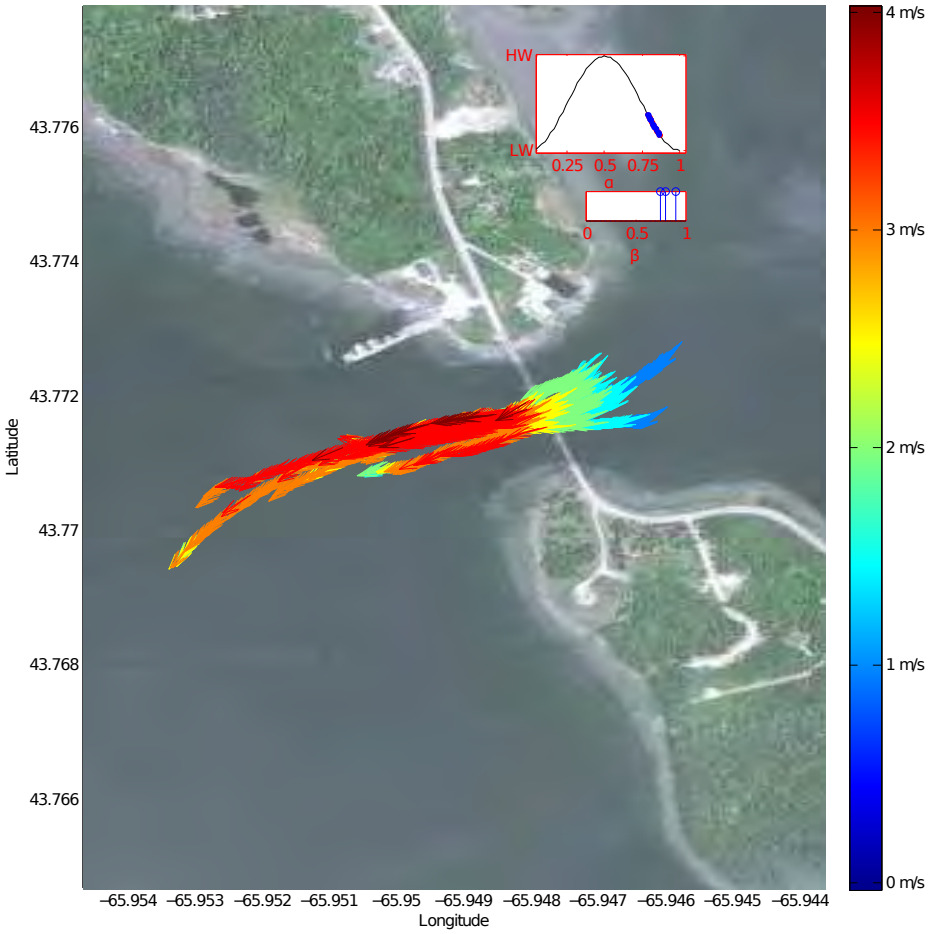

Figure A.32: Indian Sluice ebb tide, $9/12 + 0.04 < \alpha < 10/12 + 0.04$

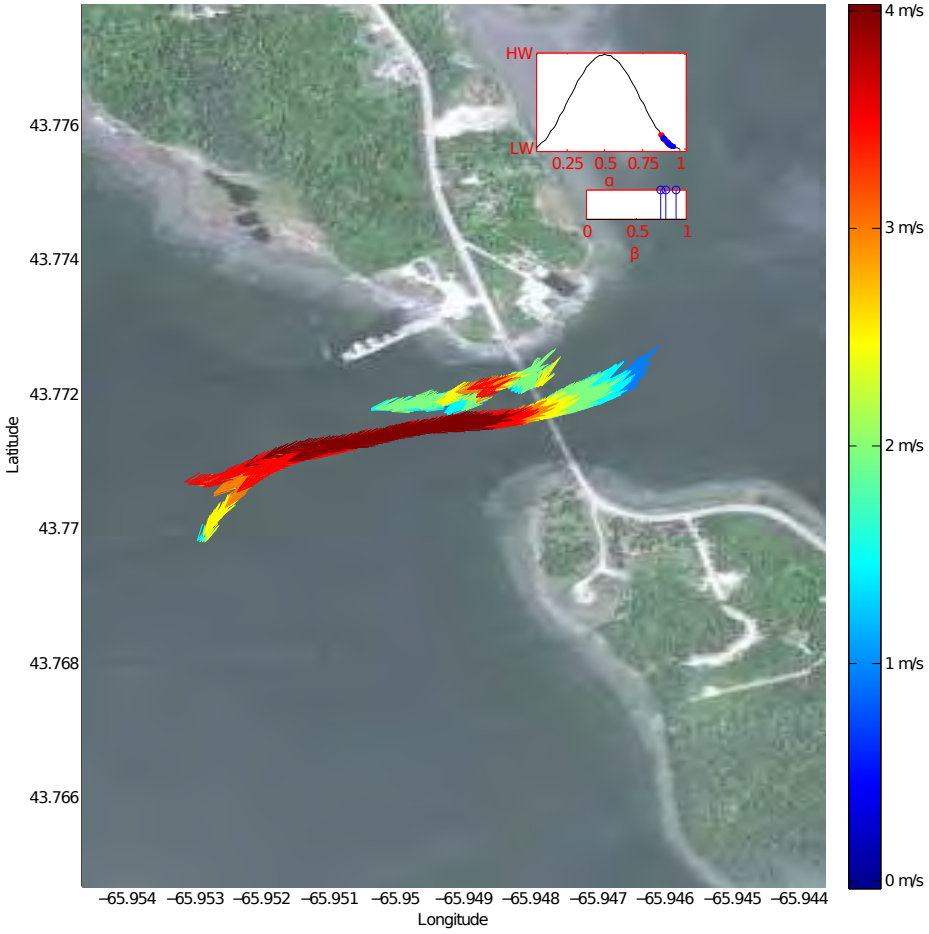

Figure A.33: Indian Sluice ebb tide, $10/12 + 0.04 < \alpha < 11/12 + 0.04$

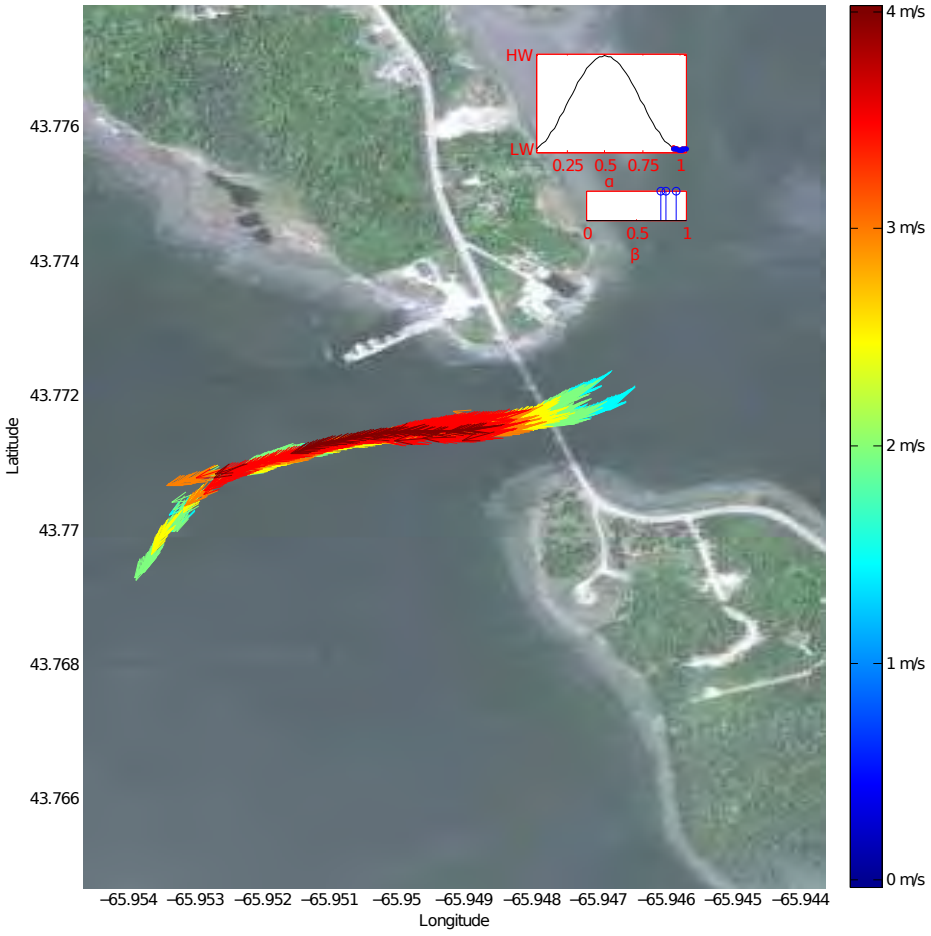

Figure A.34: Indian Sluice ebb tide, $11/12 + 0.04 < \alpha < 1.04$

A.6 The Sluice

Figure A.35: The Sluice nautical chart

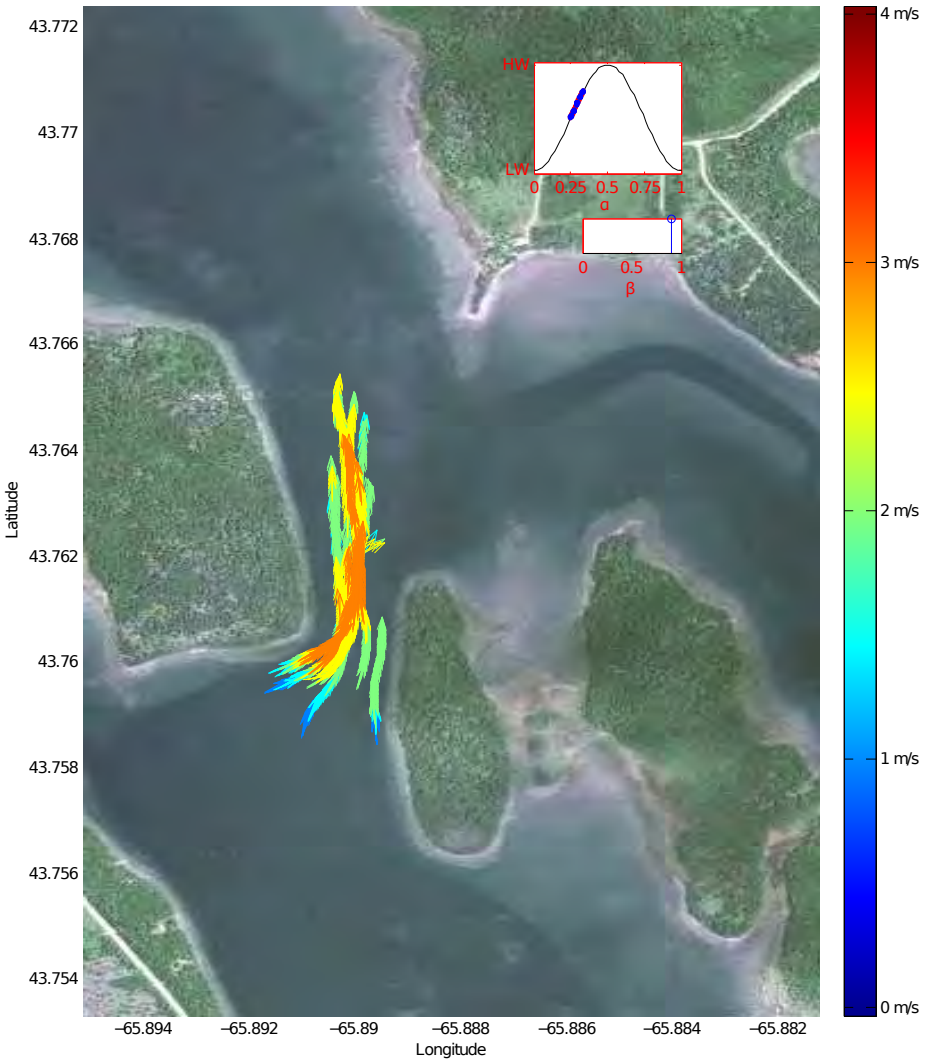

Figure A.36: The Sluice flood tide, $3/12 < \alpha < 4/12$

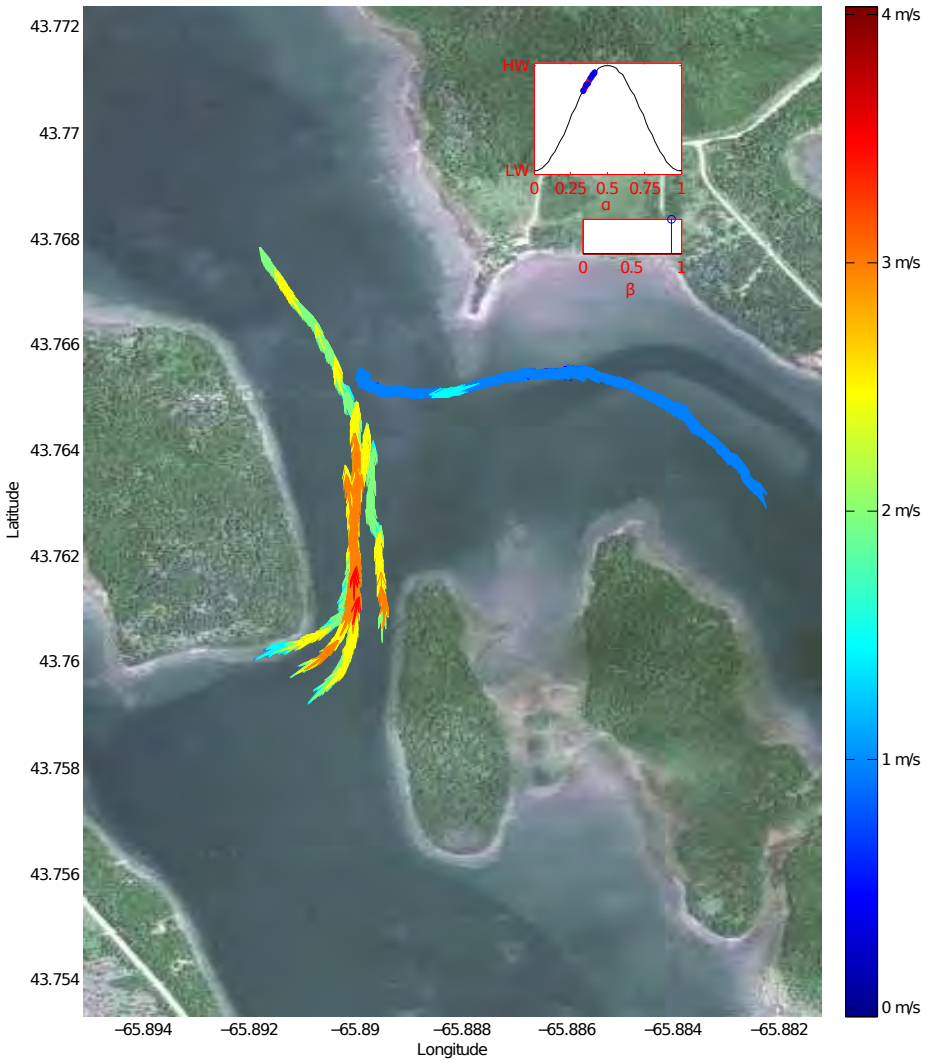

Figure A.37: The Sluice flood tide, $4/12 < \alpha < 5/12$

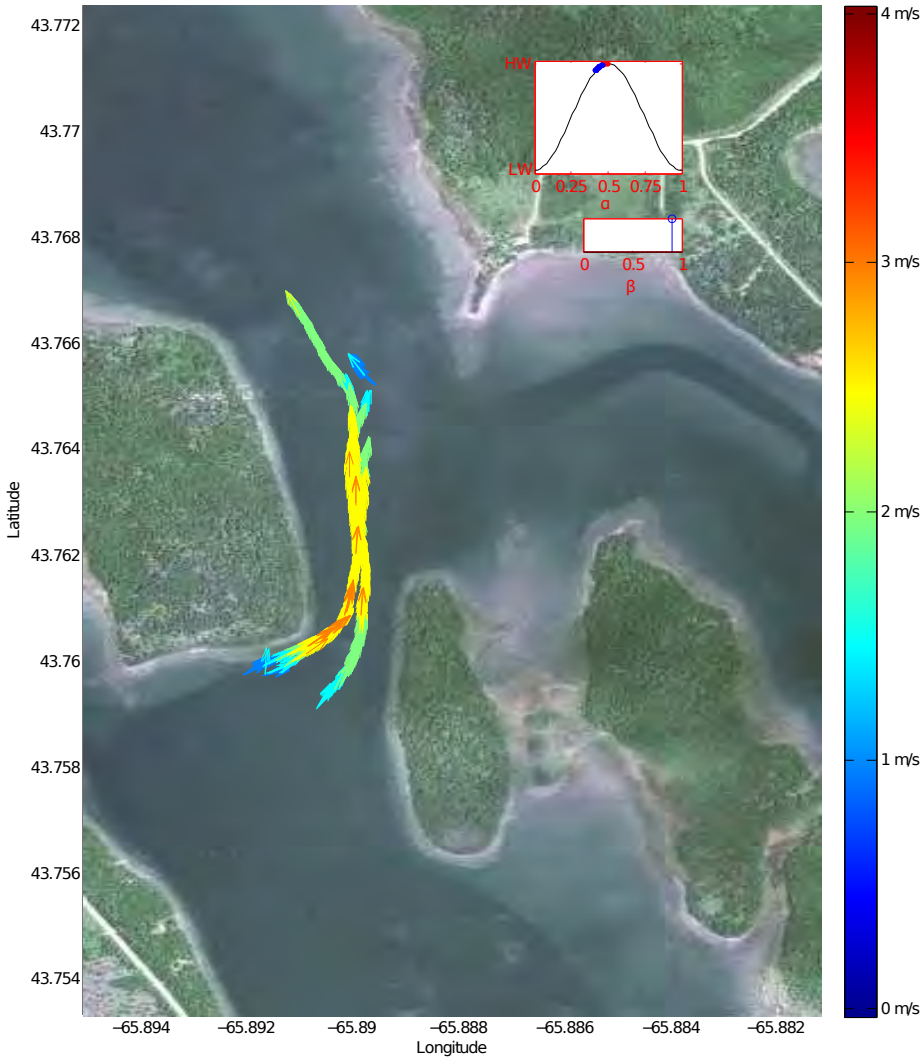

Figure A.38: The Sluice flood tide, $5/12 < \alpha < 6/12$

A.7 The Tittle

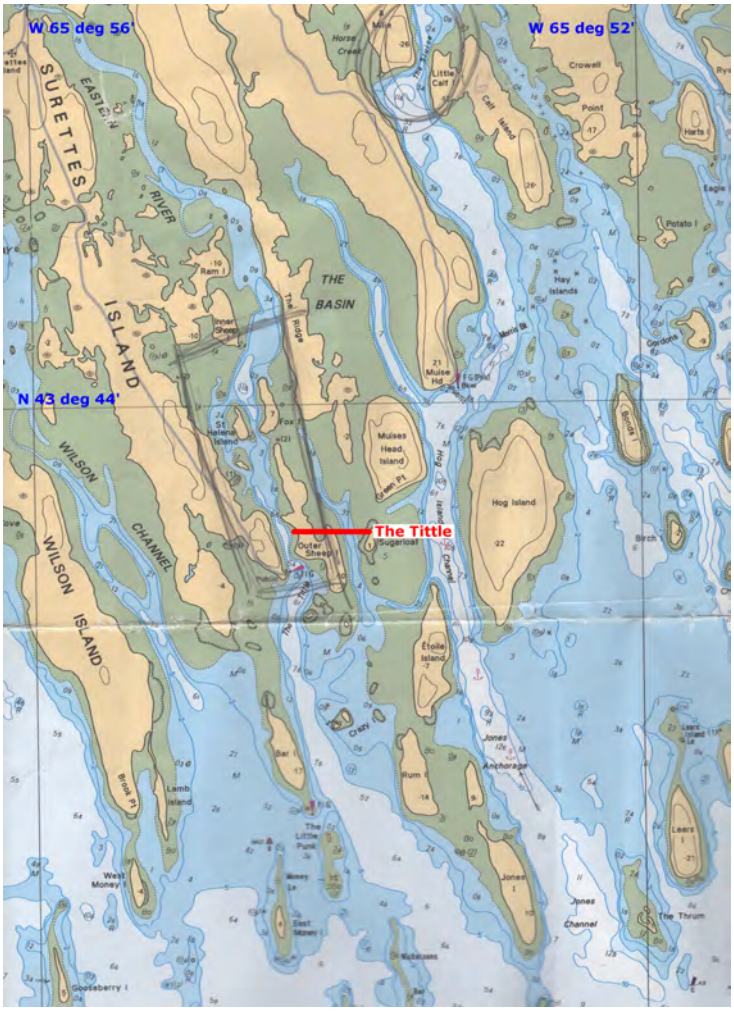

Figure A.39: The Tittle nautical chart

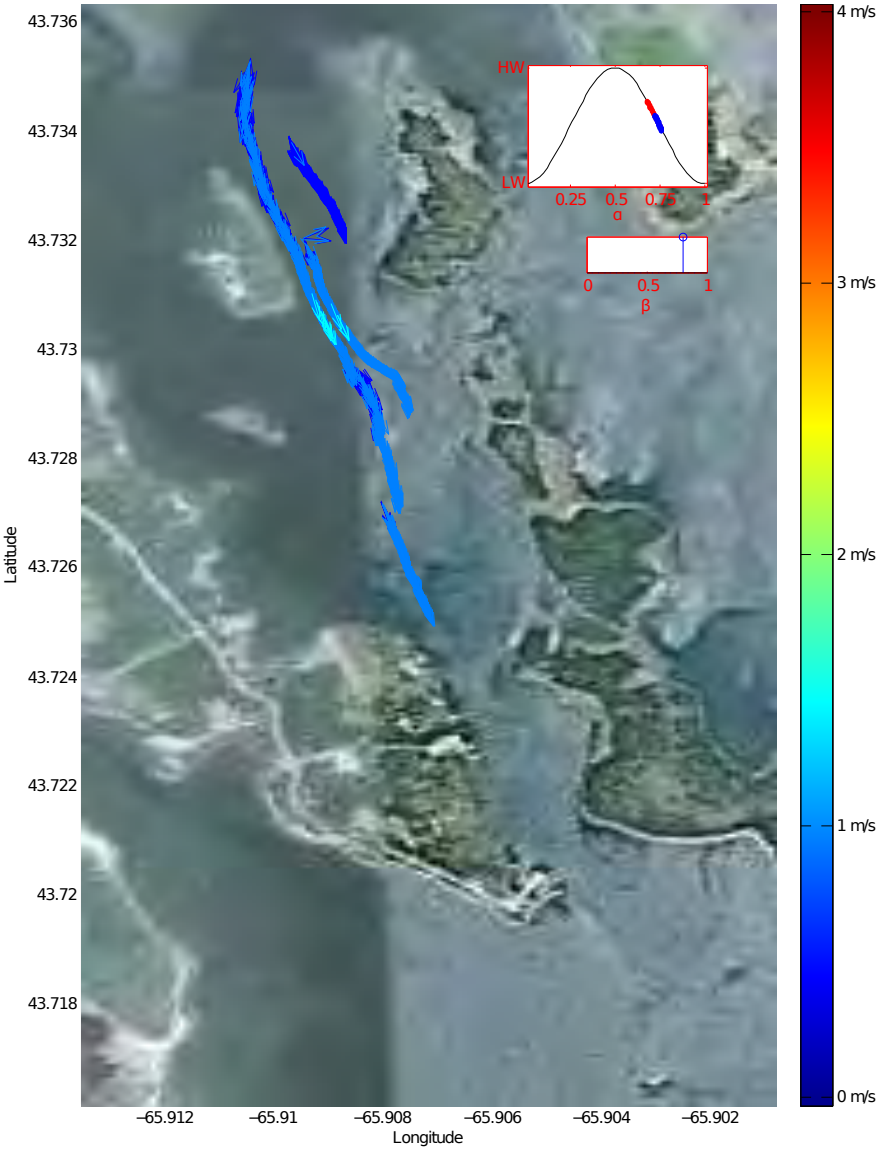

Figure A.40: The Tittle ebb tide, $8/12 + 0.01 < \alpha < 9/12 + 0.01$

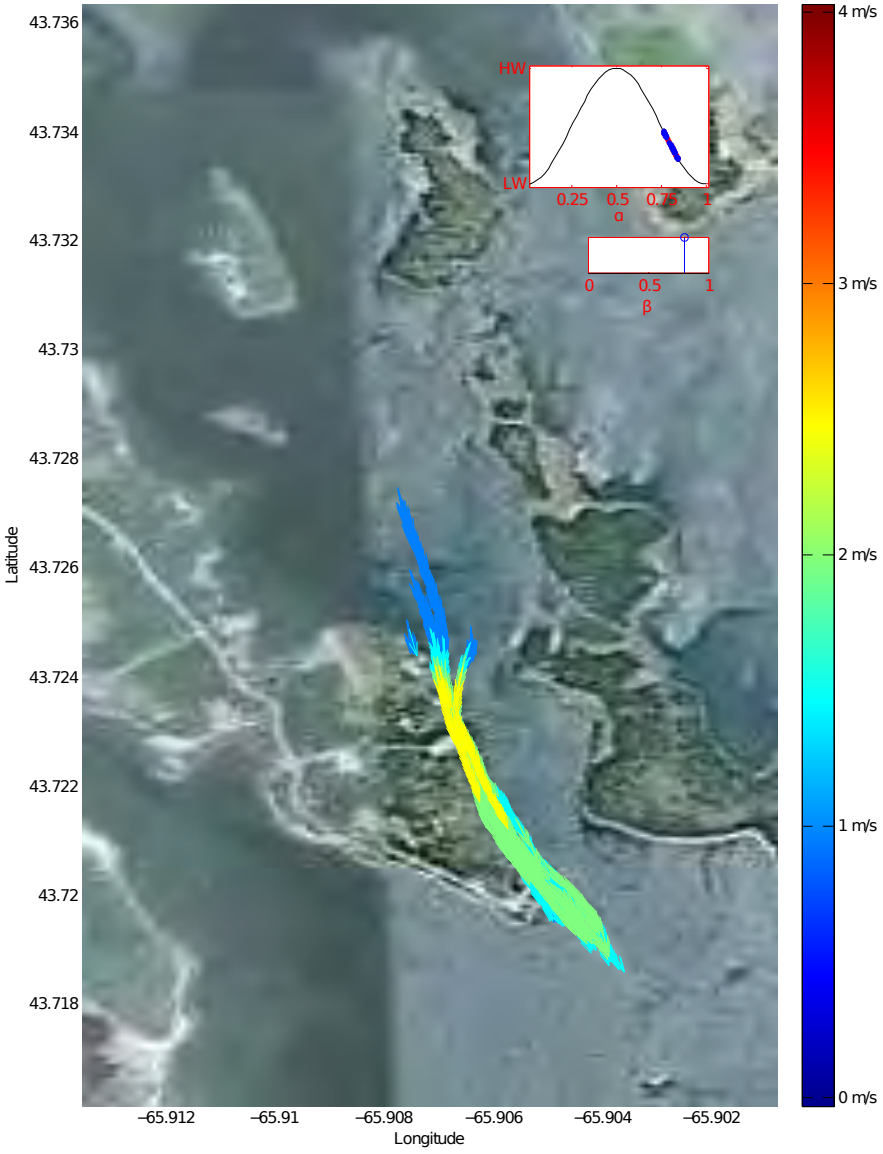

Figure A.41: The Tittle ebb tide, $9/12 + 0.01 < \alpha < 10/12 + 0.01$

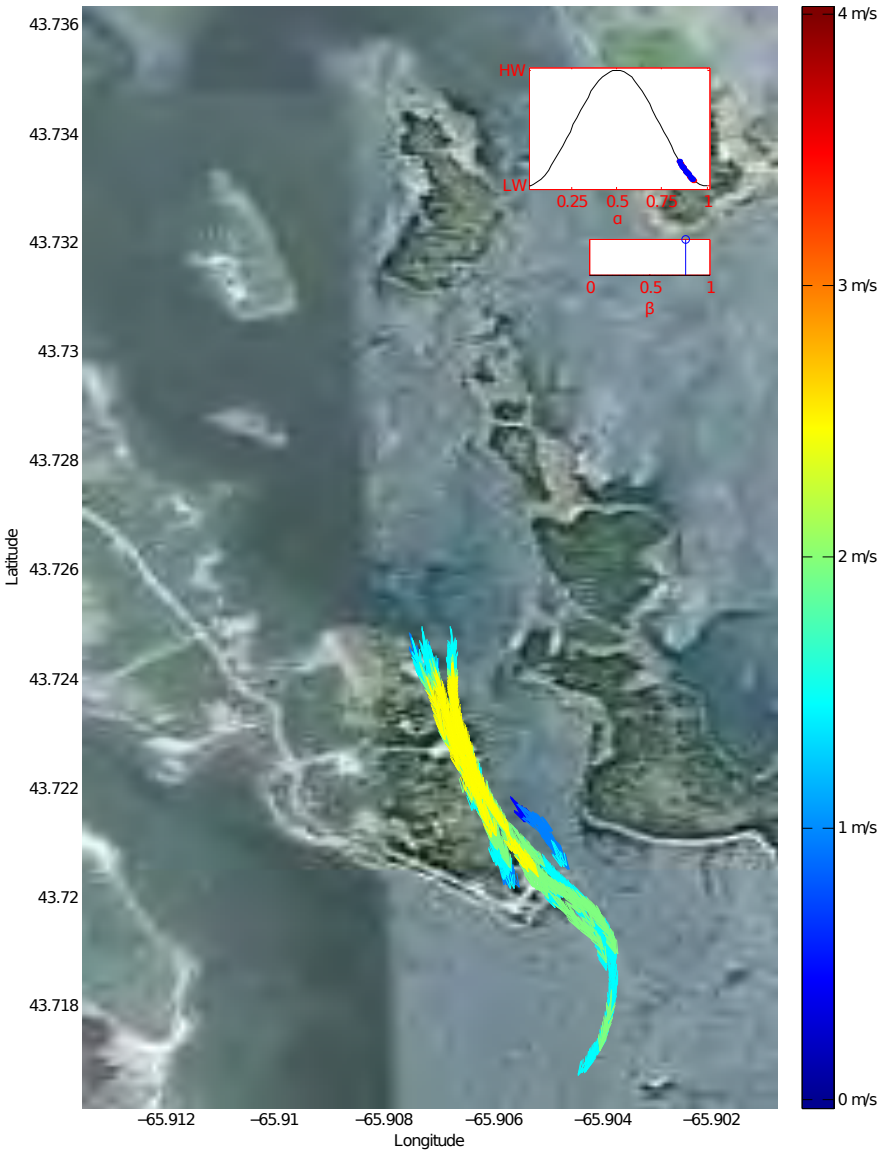

Figure A.42: The Tittle ebb tide, $10/12 + 0.01 < \alpha < 11/12 + 0.01$

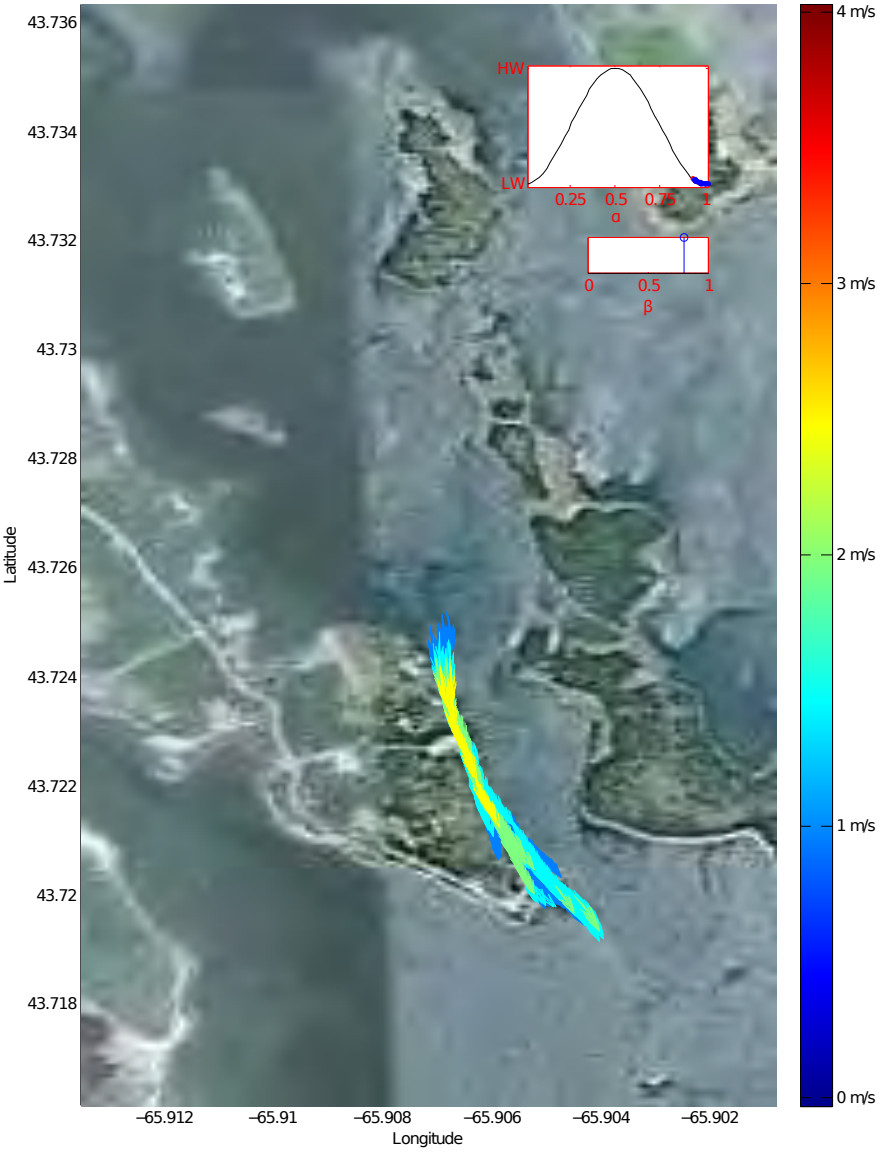

Figure A.43: The Tittle ebb tide, $11/12 + 0.01 < \alpha < 1.01$

A.8 Argyle River Estuary at Cat Island Bridge

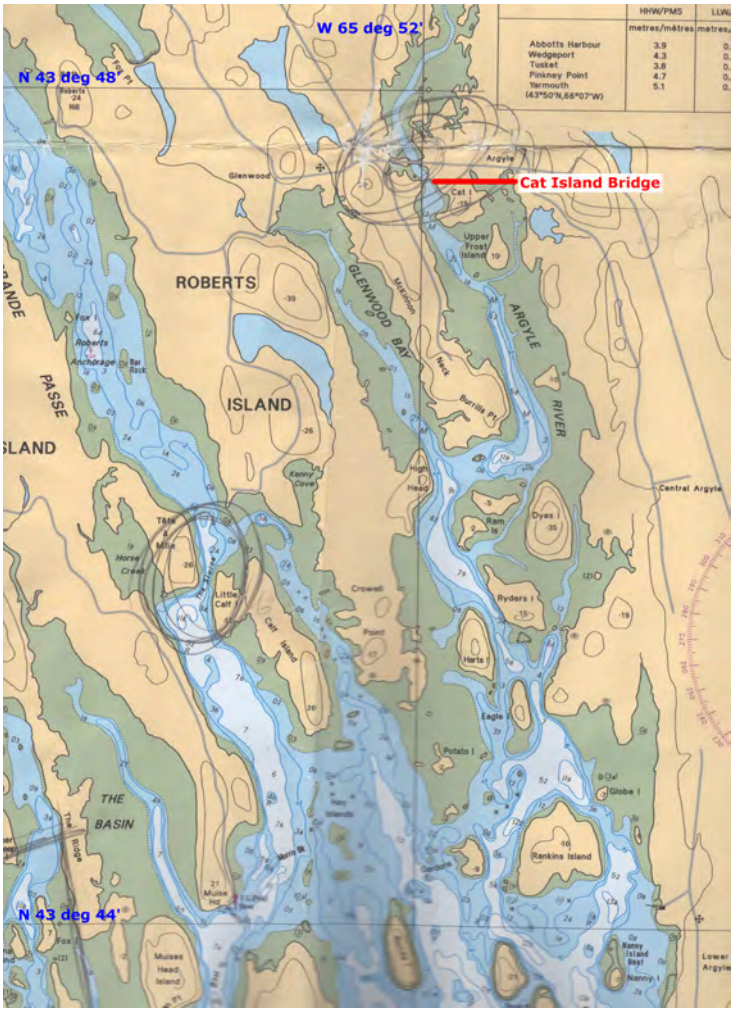

Figure A.44: Cat Island Bridge nautical chart

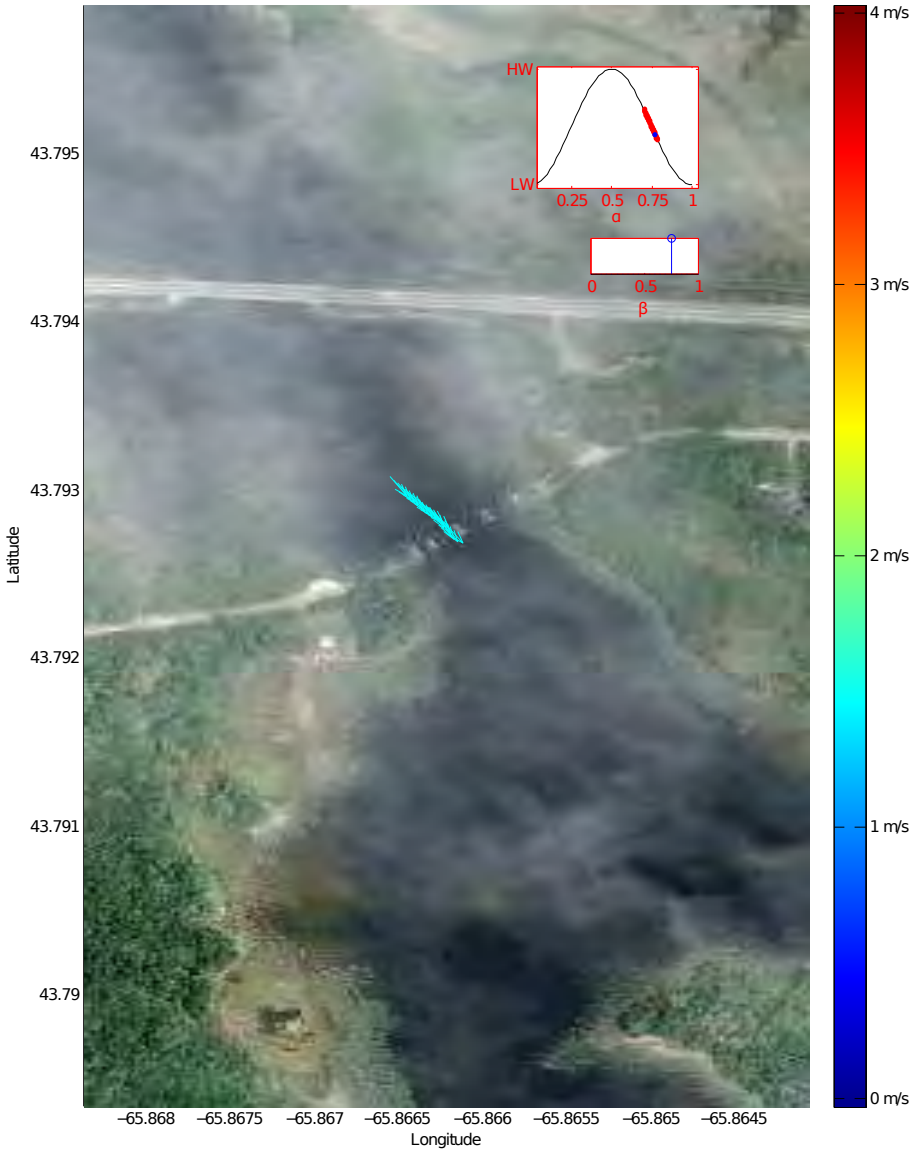

Figure A.45: Cat Island Bridge ebb tide, $8/12 + 0.03 < \alpha < 9/12 + 0.03$

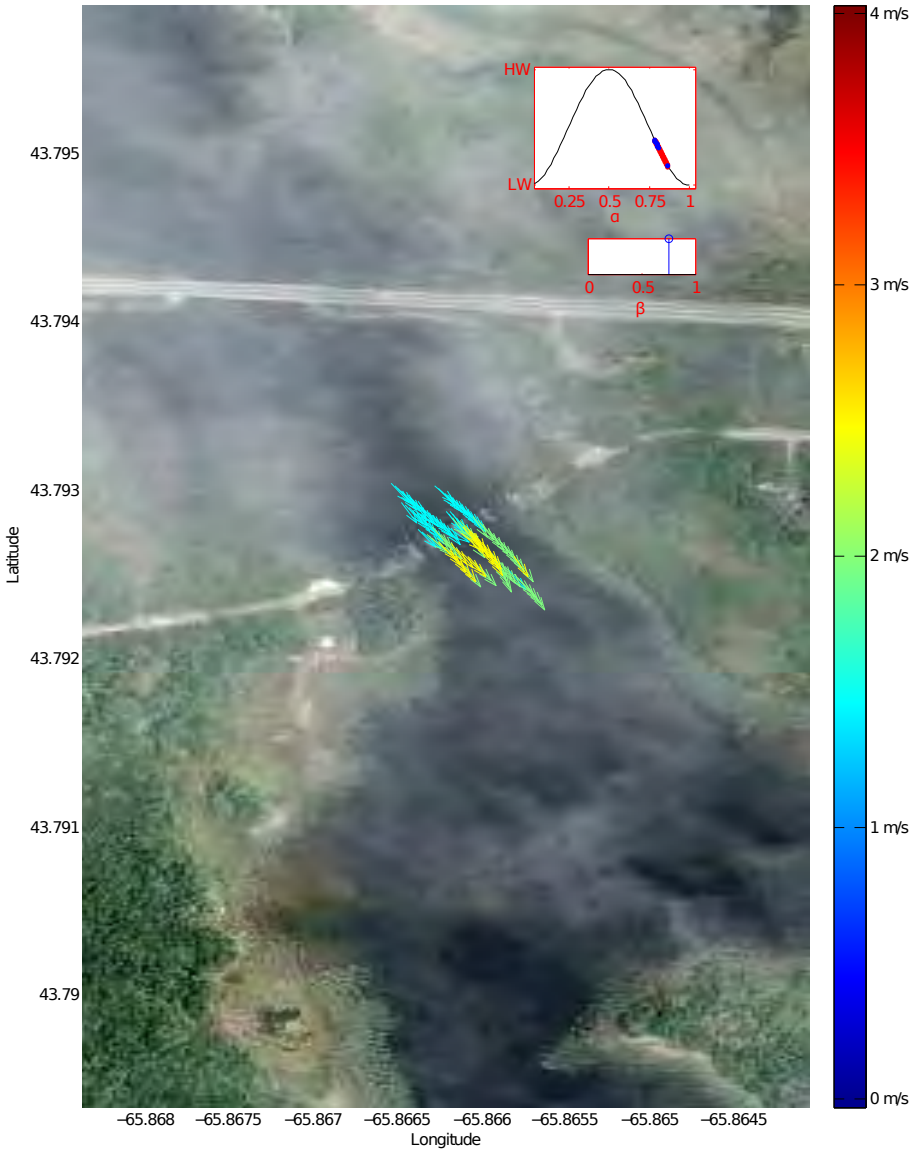

Figure A.46: Cat Island Bridge ebb tide, $9/12 + 0.03 < \alpha < 10/12 + 0.03$

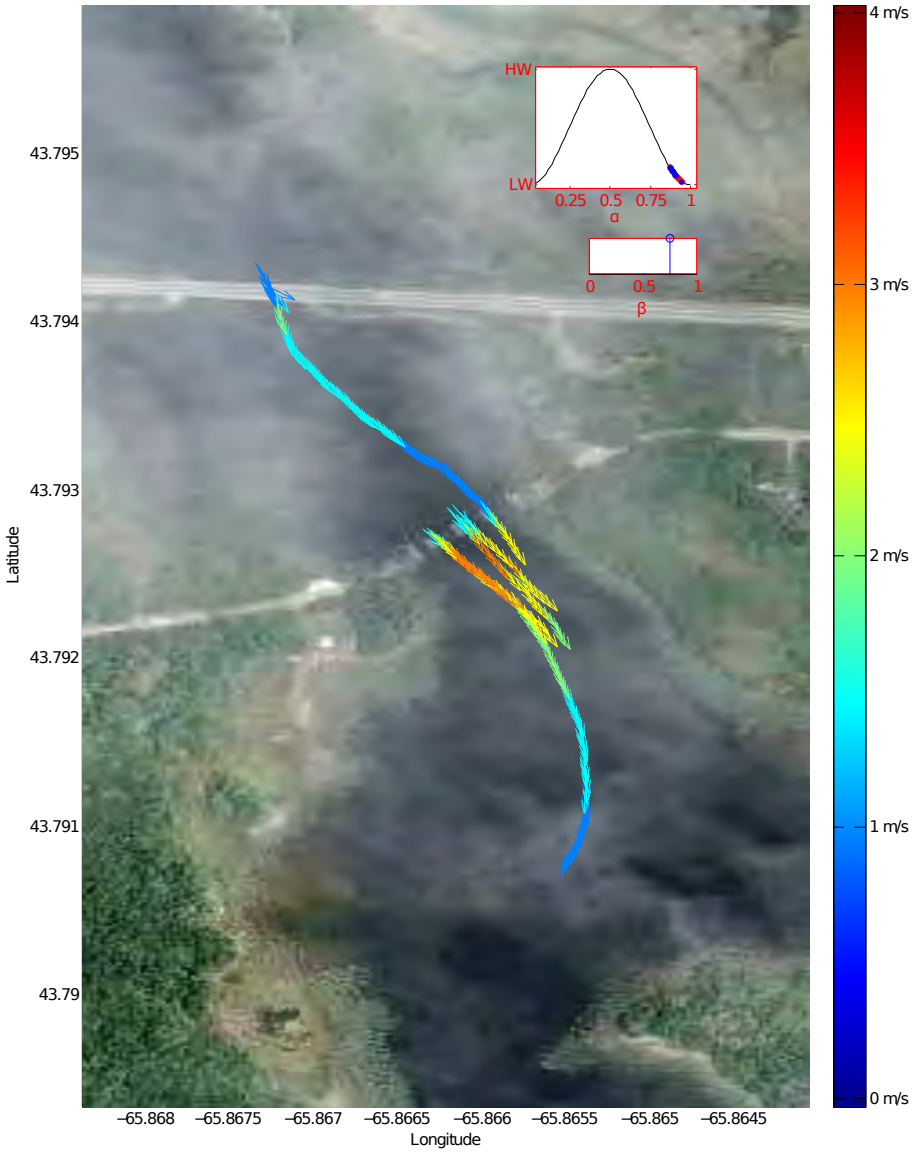

Figure A.47: Cat Island Bridge ebb tide, $10/12 + 0.03 < \alpha < 11/12 + 0.03$

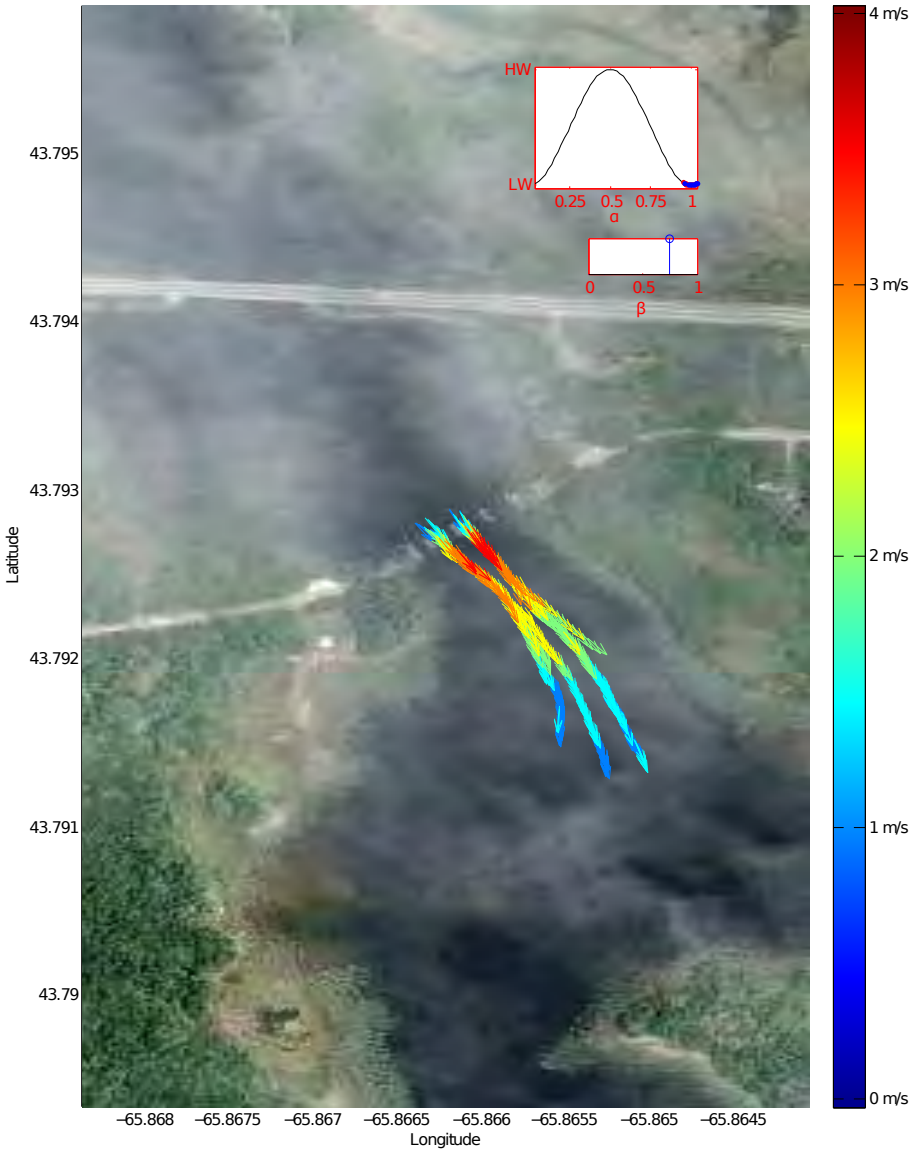

Figure A.48: Cat Island Bridge ebb tide, $11/12 + 0.03 < \alpha < 1.03$

A.9 Pubnico Harbour

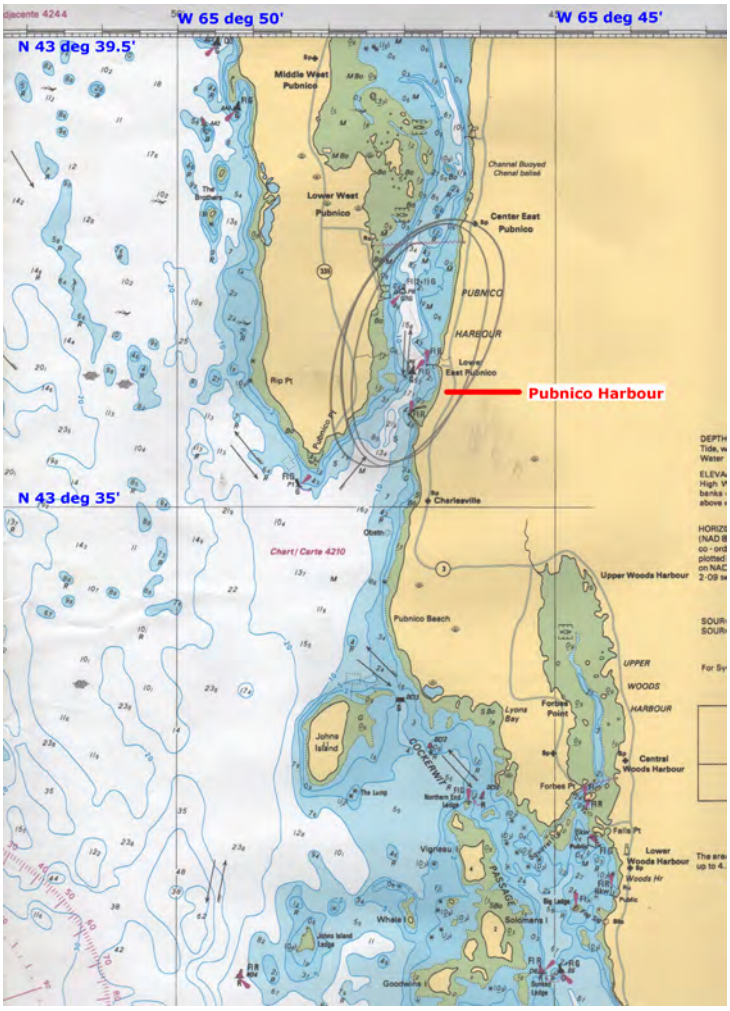

Figure A.49: Pubnico Harbour nautical chart

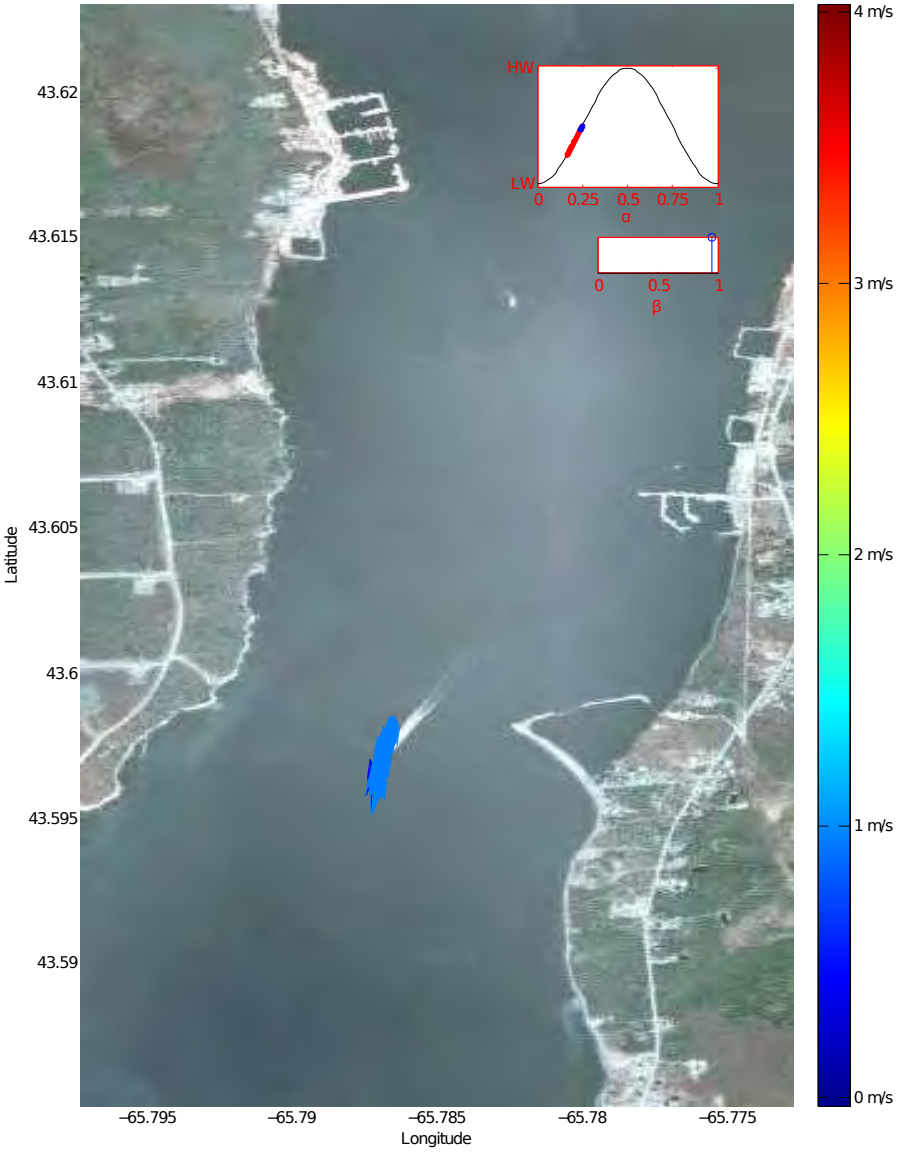

Figure A.50: Pubnico Harbour flood tide, $2/12 < \alpha < 3/12$

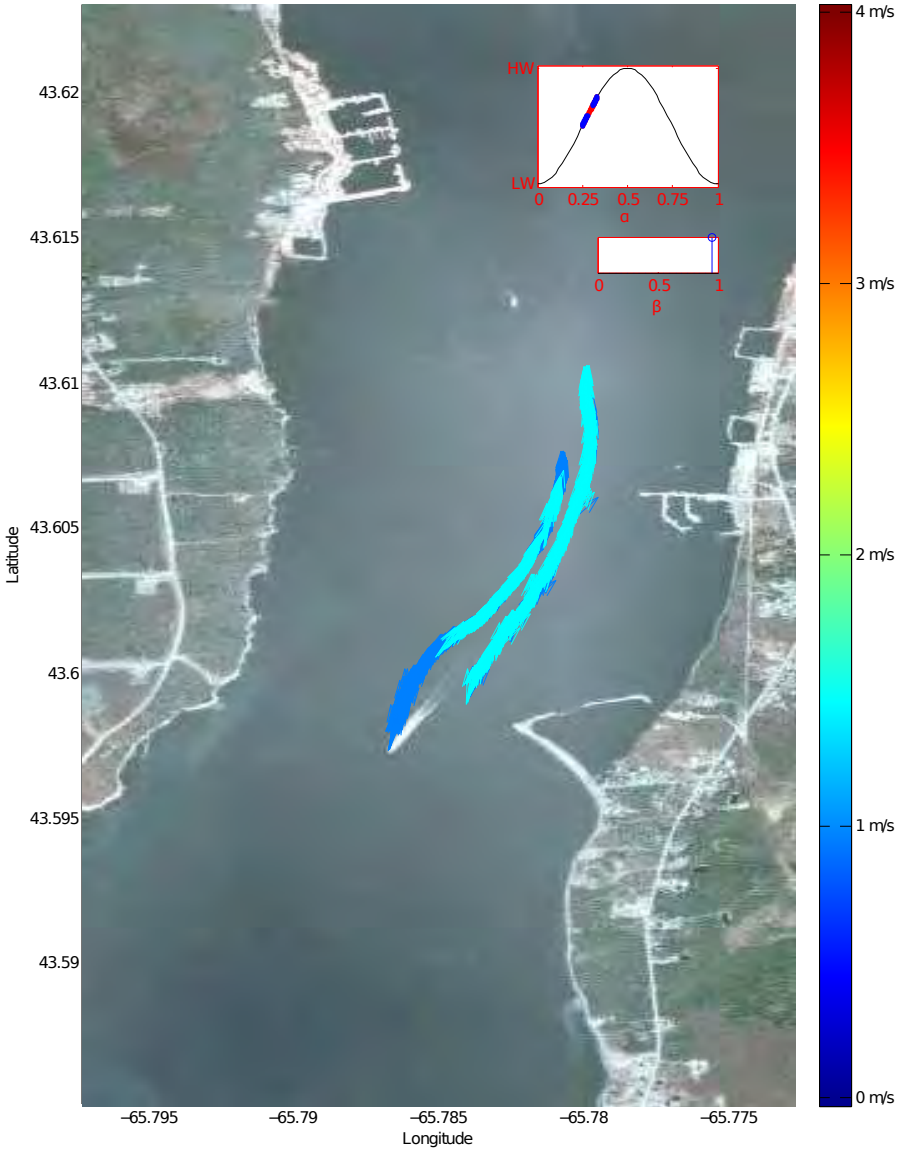

Figure A.51: Pubnico Harbour flood tide, $3/12 < \alpha < 4/12$

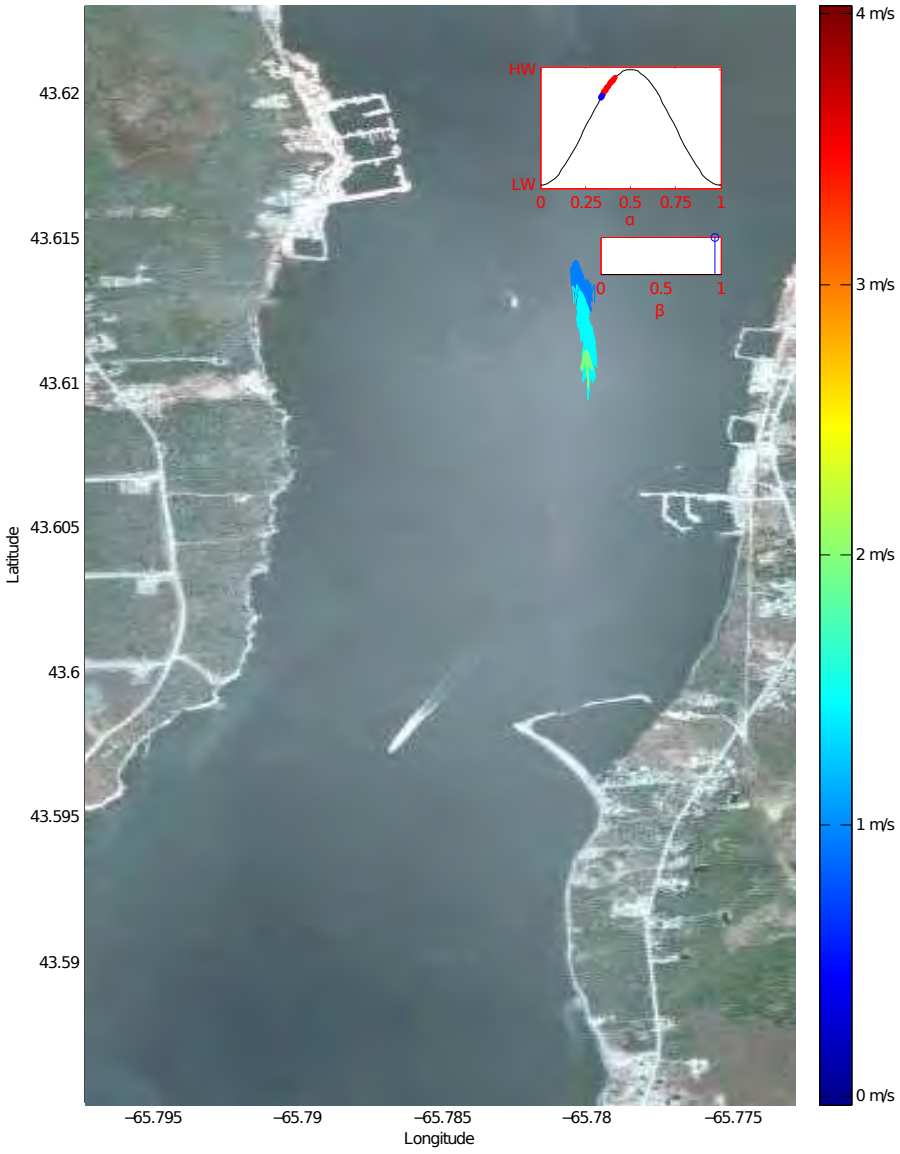

Figure A.52: Pubnico Harbour flood tide, $4/12 < \alpha < 5/12$

A.10 Clyde River Estuary at Port Clyde Bridge

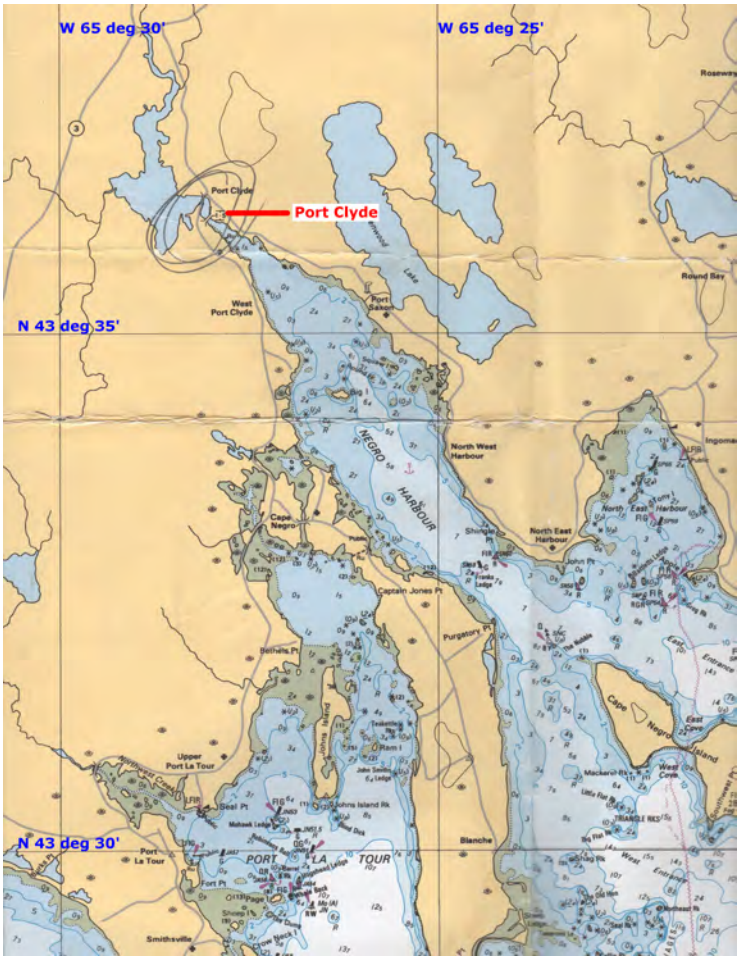

Figure A.53: Port Clyde Bridge nautical chart

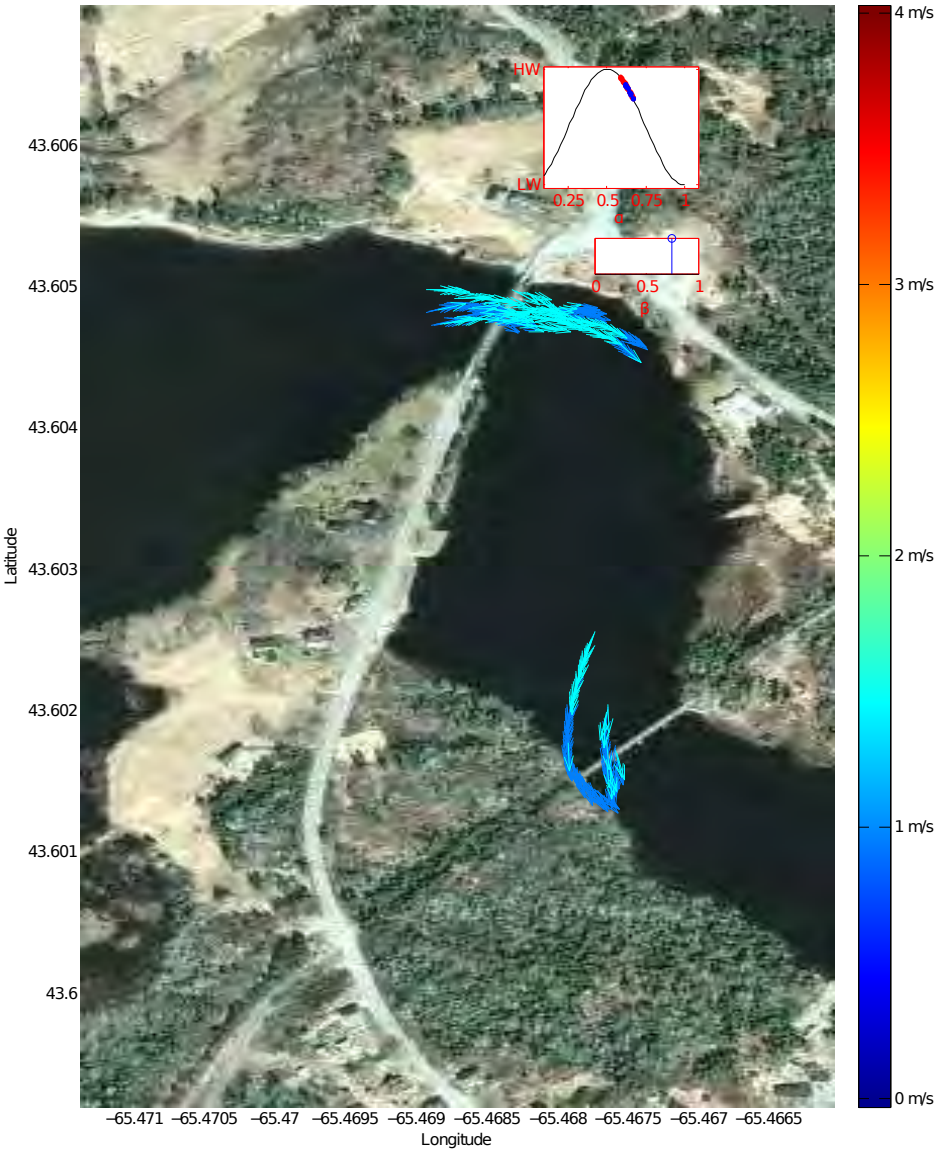

Figure A.54: Port Clyde Bridge ebb tide, $6/12 + 0.09 < \alpha < 7/12 + 0.09$

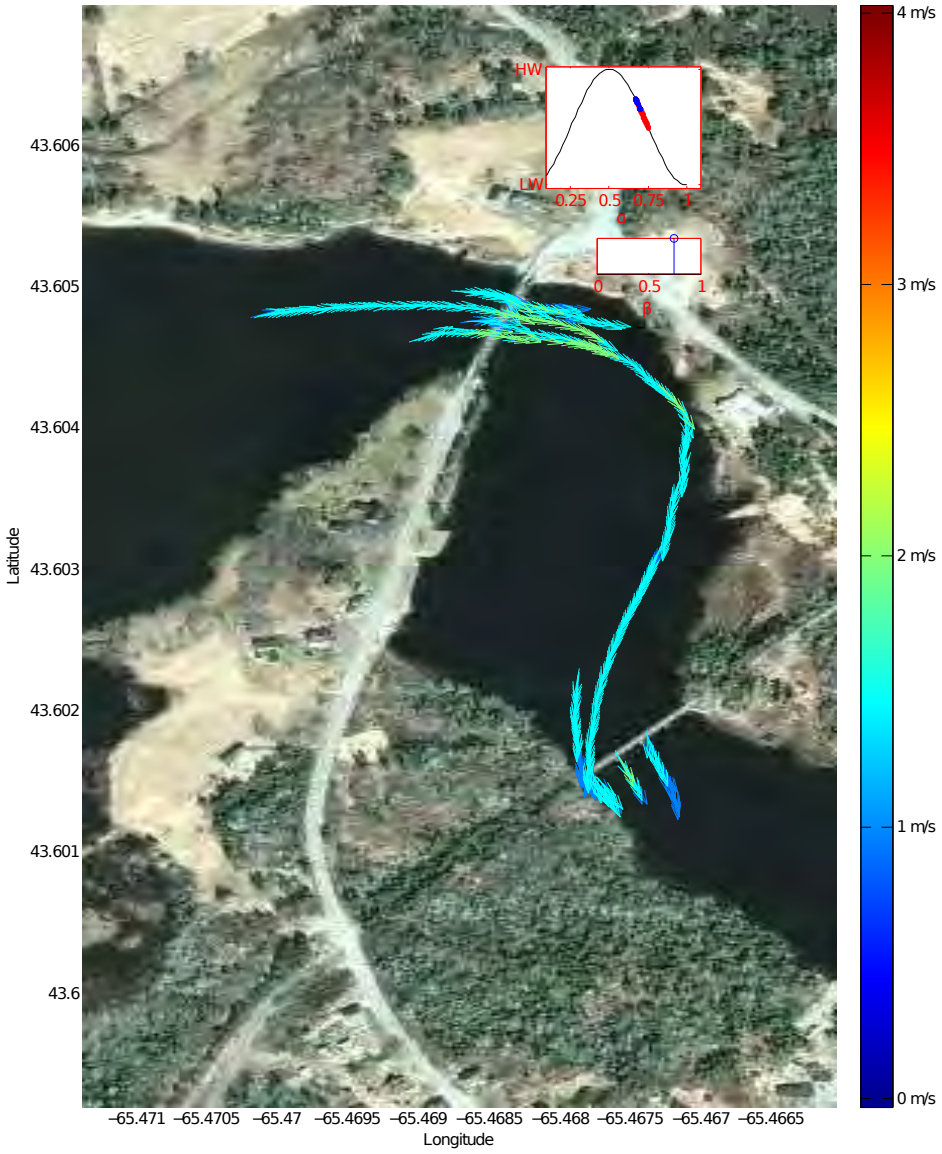

Figure A.55: Port Clyde Bridge ebb tide, $7/12 + 0.09 < \alpha < 8/12 + 0.09$

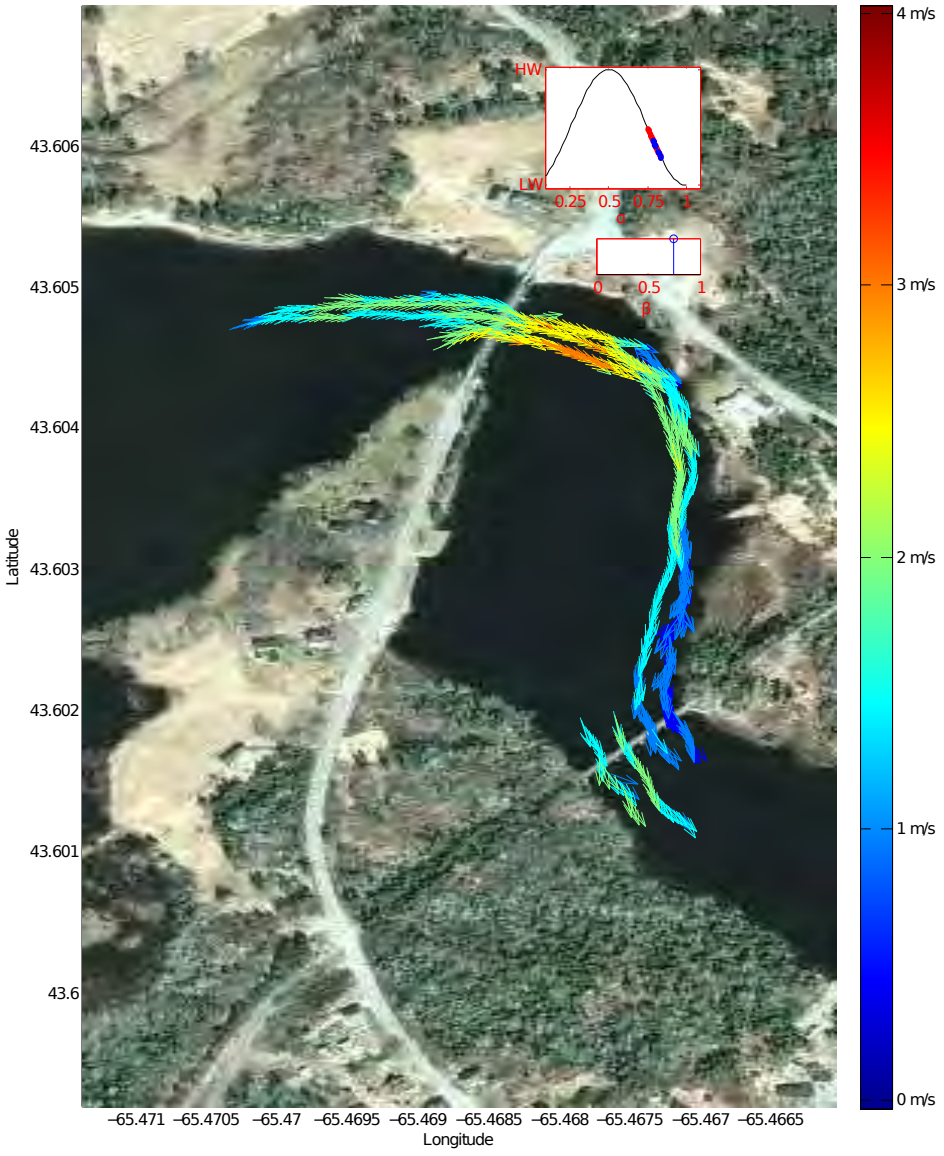

Figure A.56: Port Clyde Bridge ebb tide, $8/12 + 0.09 < \alpha < 9/12 + 0.09$

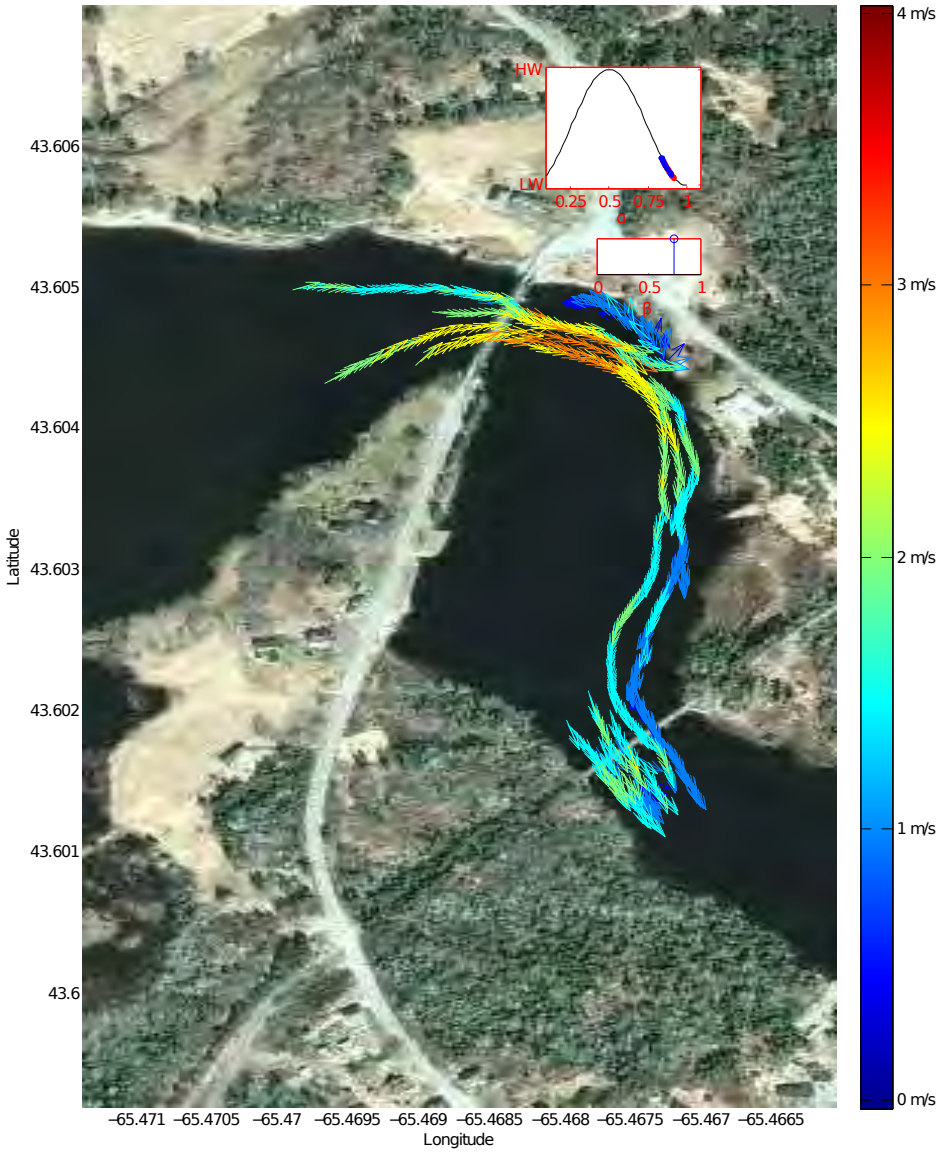

Figure A.57: Port Clyde Bridge ebb tide, $9/12 + 0.09 < \alpha < 10/12 + 0.09$

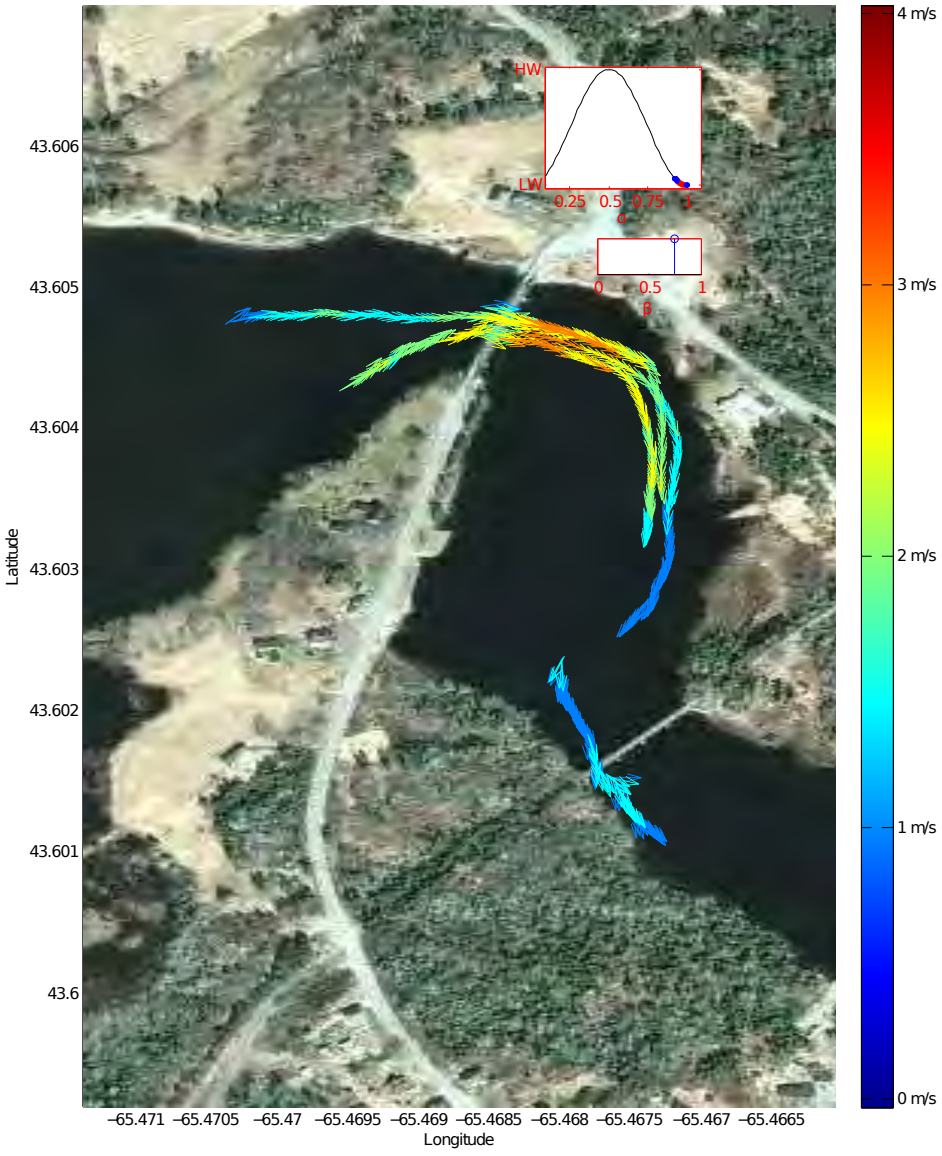

Figure A.58: Port Clyde Bridge ebb tide, $10/12 + 0.09 < \alpha < 11/12 + 0.09$

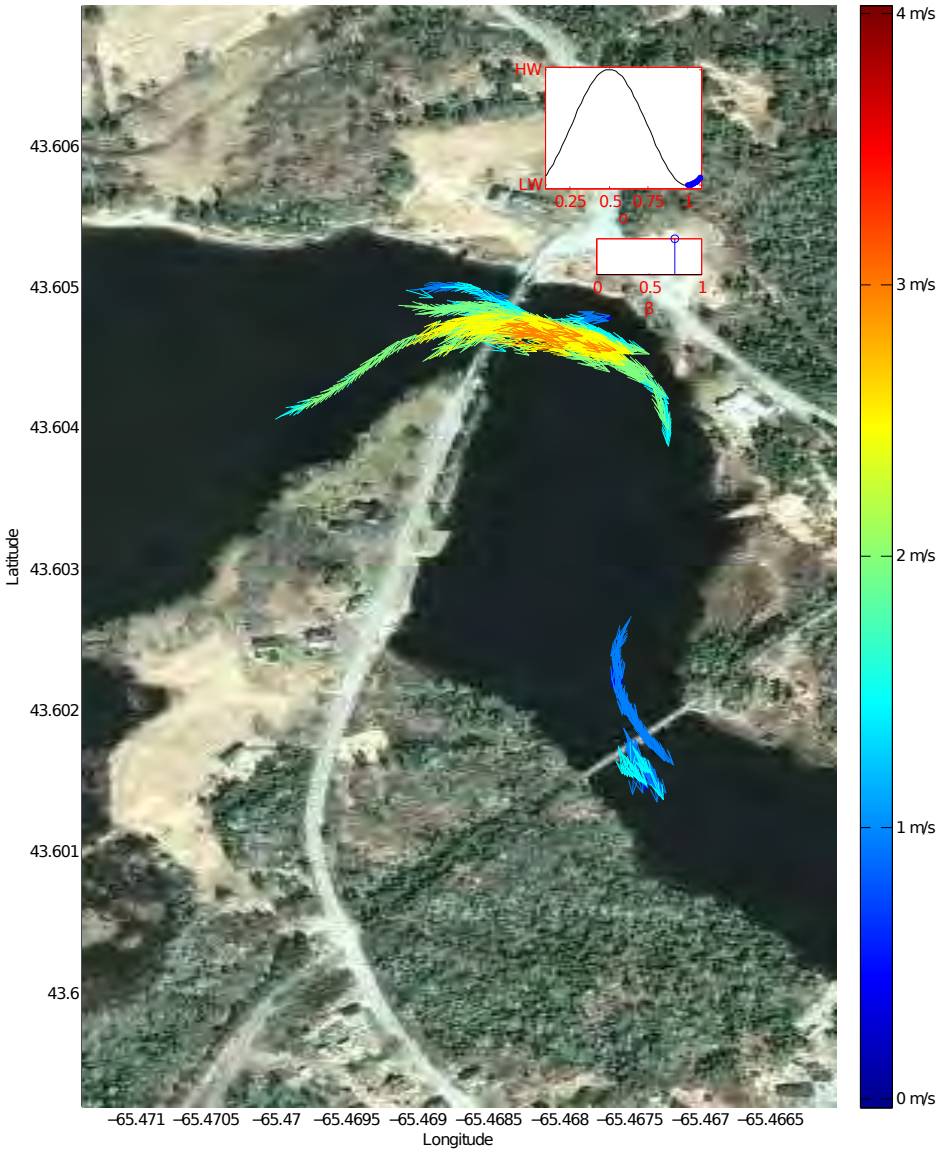

Figure A.59: Port Clyde Bridge ebb tide, $11/12 + 0.09 < \alpha < 1.09$

A.11 Port L'Hebert

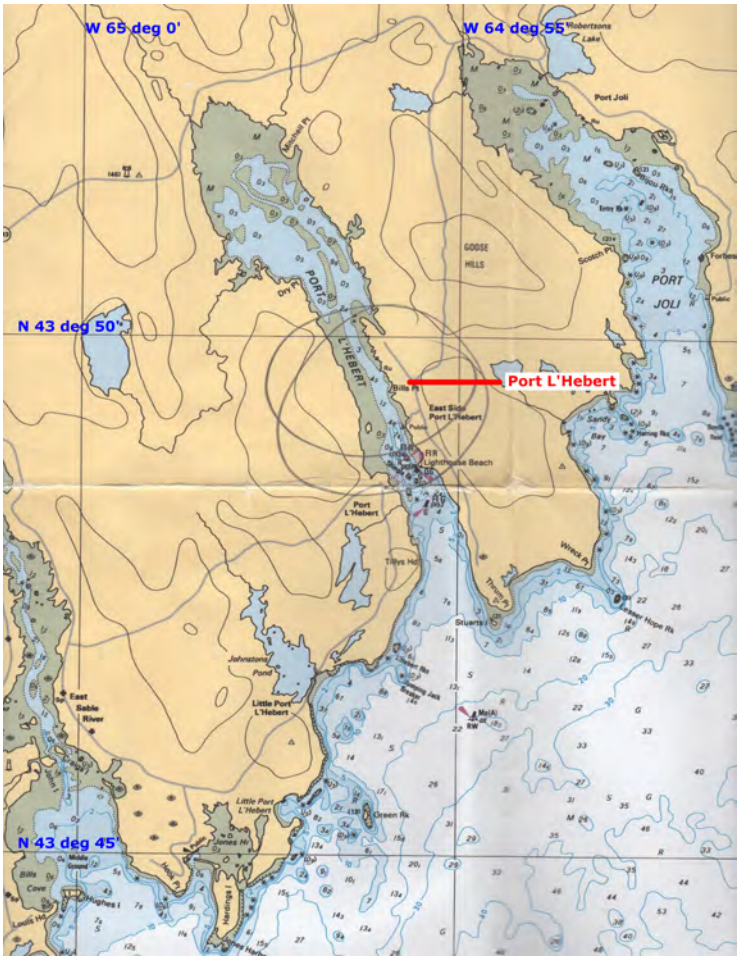

Figure A.60: Port L'Hebert nautical chart

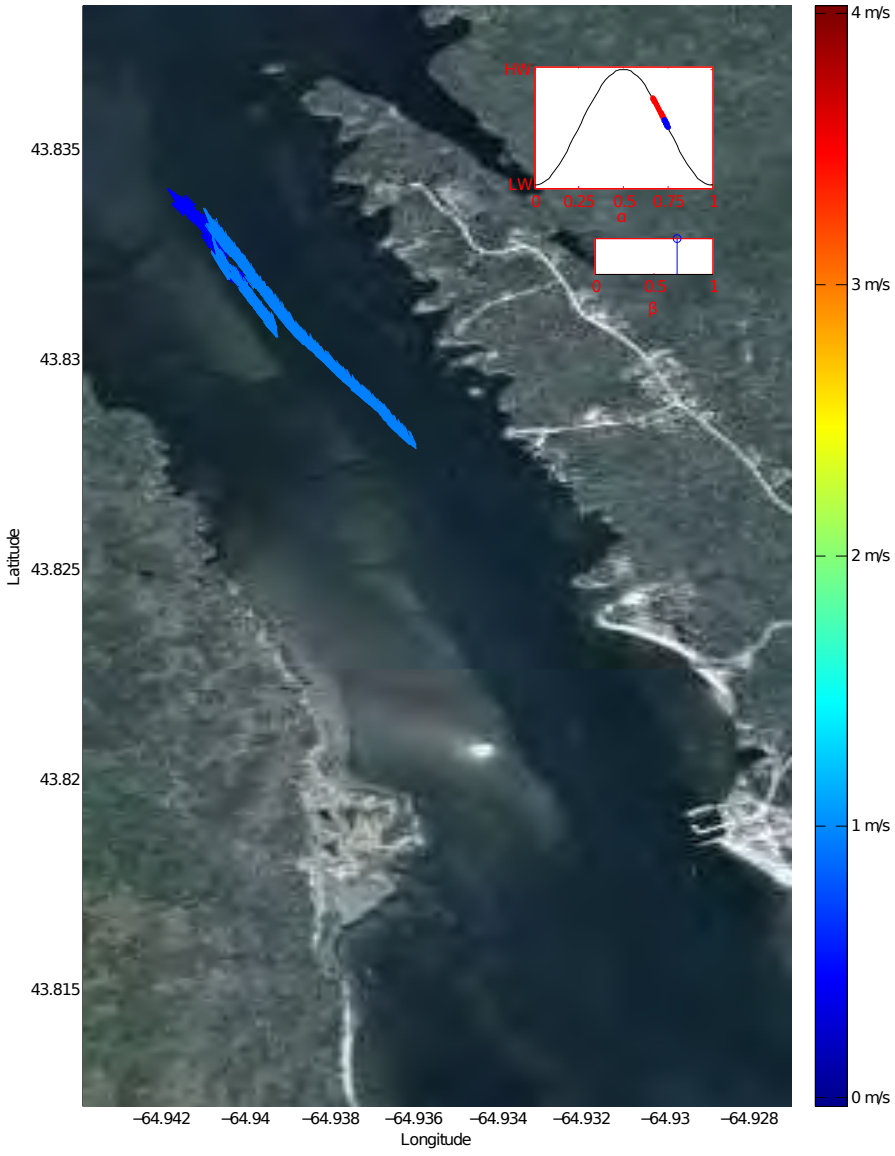

Figure A.61: Port L'Hebert ebb tide, $8/12 < \alpha < 9/12$

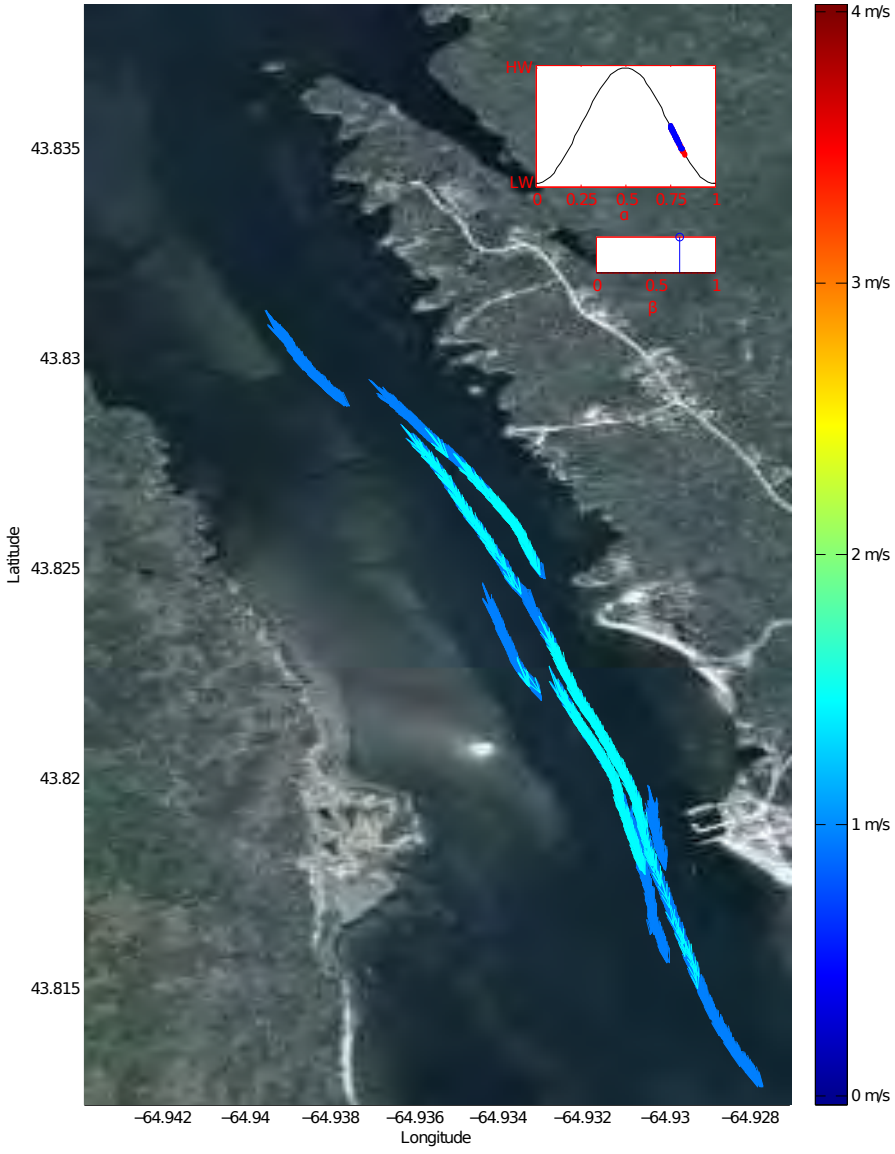

Figure A.62: Port L'Hebert ebb tide, $9/12 < \alpha < 10/12$

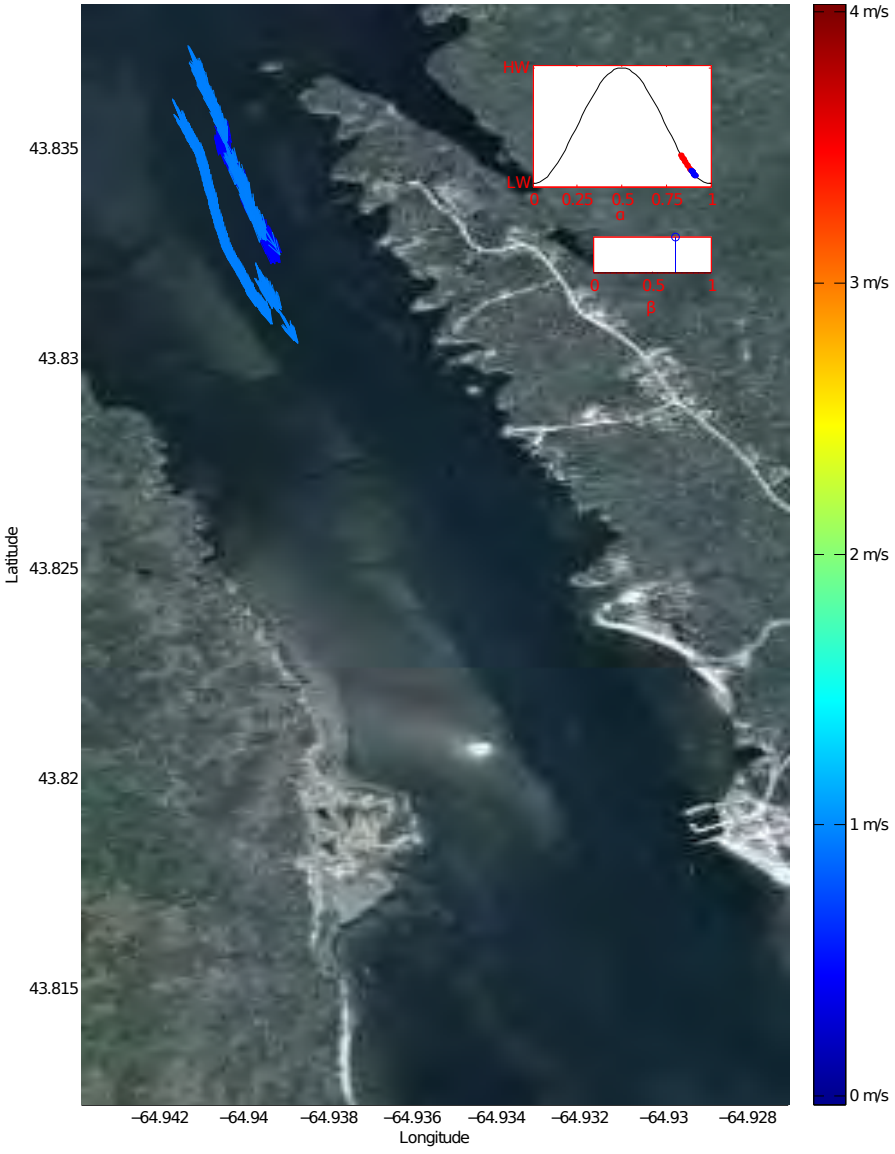

Figure A.63: Port L'Hebert ebb tide, $10/12 < \alpha < 11/12$

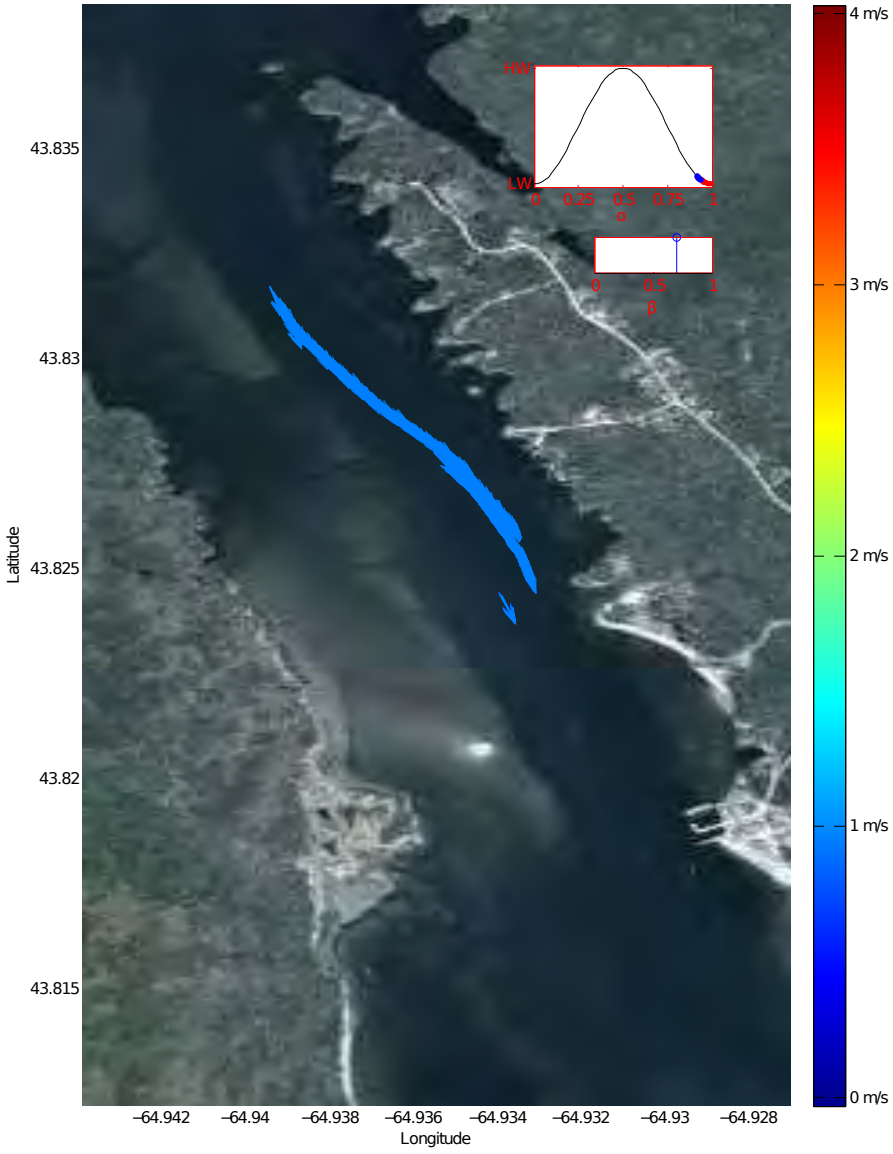

Figure A.64: Port L'Hebert ebb tide, $11/12 < \alpha < 1$

Appendix B

Photographs

Figure B.1: Grand Passage site photograph 2

Figure B.2: Grand Passage site photograph 3

Figure B.3: Petit Passage site photograph 2

Figure B.4: The Gap site photograph 2

Figure B.5: The Gap site photograph 3

Figure B.6: The Gap site photograph 4

Figure B.7: The Gap site photograph 5

Figure B.8: The Gap site photograph 6

Figure B.9: The Gap site photograph 7

Figure B.10: Passages West of Big Tusket Island site photograph 2

Figure B.11: Passages West of Big Tusket Island site photograph 3

Figure B.12: Indian Sluice site photograph 2

Figure B.13: Indian Sluice site photograph 3

Figure B.14: Indian Sluice site photograph 4

Figure B.15: The Sluice site photograph 2

Figure B.16: The Sluice site photograph 3

Figure B.17: The Tittle site photograph 2

Figure B.18: The Tittle site photograph 3

Figure B.19: The Tittle site photograph 4

Figure B.20: Cat Island Bridge site photograph 2

Figure B.21: Cat Island Bridge site photograph 3

Figure B.22: Cat Island Bridge site photograph 4

Figure B.23: Cat Island Bridge site photograph 5

Figure B.24: Cat Island Bridge site photograph 6

Figure B.25: Pubnico Harbour site photograph 2

Figure B.26: Pubnico Harbour site photograph 3

Figure B.27: Pubnico Harbour site photograph 4

Figure B.28: Pubnico Harbour site photograph 5

Figure B.29: Port Clyde Bridge site photograph 2

Figure B.30: Port Clyde Bridge site photograph 3

Figure B.31: Port L'Hebert site photograph 2

Figure B.32: Port L'Hebert site photograph 3

Figure B.33: Port L'Hebert site photograph 4

Figure B.34: Port L'Hebert site photograph 5

Figure B.35: Baccaro Point site photograph 1

Figure B.36: Baccaro Point site photograph 2

Figure B.37: Baccaro Point site photograph 3

Figure B.38: Cape Sable site photograph 1

Figure B.39: Cape Sable site photograph 2

Figure B.40: Cape Sable site photograph 3

Figure B.41: Squires Island site photograph 1

Appendix C

Field Notes

C.1 May 8, 2012

Wedgeport water levels
HW 3.7 m @ 12:30
LW 0.7 m @ 18:03

- Met with Warren (Yarmouth Crane)
- Discussed flows and marked up charts
- Visit Lower Plymouth at 12:30
- end of flood.
- photos
- 13:00 at Indian Sluice. Near HW. Still looks like flood.
- 13:20 at Muise Head on Morris Island. Near HW. Maybe start of ebb. Southerly wind, so difficult to distinguish surface flow.
- Spoke to local. Not much tide through Hog Island Channel, but strong flow through The Sluice (between Morris and Calf islands)
- 13:30 looking through The Sluice. Southerly wind against flow. Ebb started.
- 13:55 at Indian Sluice, ebb tide started and building
- 14:10 at The Tittle, ebb tide for sure. Building and good flow. Talked to locals. Ebb just starting. Not sure on strength, but they're running 80-100 hp on their skiffs... estimate +6 knots.
- 14:40 at Indian Sluice, stronger ebb. Significant southerly, but suit up to collect drifts.
- 18:10 out of water at Indian Sluice. Ebb still strong. Max measured approx 7.9 knots.

C.2 May 9, 2012

Lower East Pubnico water levels
LW 0.0 m @ 6:50
HW 3.4 m @ 13:17

- Wind - S 20-25 knots
- 8:15 at Lower West Pubnico. Flood tide started. Strong wind blowing with tide. Photo, then drive around to LE Pub.
- 9:00 at Lighthouse near Lower East Pubnico.
- 12:00 off water at Lighthouse. Did 2 drifts. Max speed approx 3 knots.
- 13:50 at The Hawk. Beautiful. Near HW. Strong southerly wind.
- 14:15 at Barrington causeway. Looks like head differential. Potential to predict flow for causeway alteration from pressure sensors.
- 15:10 at Baccaro Point. HW was approx 13:00. Ebb tide for sure. Strong wind. Fairly heavy swell. Photos. Fairly strong current.

C.3 June 4, 2012

- Wind NE 15-20 knots
- Drift measurements on PP afternoon ebb tide

C.4 June 5, 2012

- Wind NE 15-20 knots
- Drift measure GP morning flood
- 2-3 m waves at north end of passage

C.5 June 6, 2012

- Wind N 10 knots and diminished
- Drift measure Tittle afternoon ebb
- Met - Leland Ducette at the Tittle.
- Suggested I talk to Blair Beaudreau
- Lives on Tuna Wharf Rd (Lower Wedgeport)

- Blair has boat and lots of knowledge regarding Tuskets and flows. Lives in Lower Wedgeport. First house on the right. School teacher, camp on islands.
- Current rebuild of Indian Sluice bridge, has been tendered. Suggest talk to Guy Surette - Muni of Argyle. Councillor for the region.

C.6 June 7, 2012

Wedgeport water levels
LW 0.4 @ 06:34
HW 3.7 @ 13:12
LW 0.8 @ 18:46

- Wind N 5-10 knots
- 08:00 @ Indian Sluice, near LW, weak ebb
- 08:20 @ Muise Hd, LW slack tide
- 08:45 @ the Sluice, LW, flood started
- 09:15 @ the Sluice, flood tide, start drift measure.
- 12:45 out of water at the Sluice
- 13:10 at Indian Sluice, still flood, but near HW.
- 14:40 @ Indian Sluice, ebb started, near HW
- Talked to locals on Wharf. See chart for notes.
- 15:35 hitting water at Indian Sluice
- Met Chris and Terry Surette on wharf prior to paddle. Discussed flows and local interest in community energy projects. Identified areas around Big Tusket Island, see chart. Also experience at 'The Hospital'. Can take boats through... but also responsible for blowing out windshields. Wind/tide interactions. Can take me out this summer. Chris has OLEX running single beam.

C.7 September 17, 2012

Westport water levels
00:14 5.7
06:33 0.3
12:36 5.8
18:56 0.1

- Plan to measure ebb tide through 'The Gap' SW of Brier

- Reid Gillis taking me out on his RIB at 14:00
- 2 Drifters
- Checked in with CCG Westport at 13:40
- First drift was fastest, ebb might ramp up early. Approx 4.5 knots
- LOTS of seals! +30 swimming/surfing in standing waves ;-)

C.8 September 18, 2012

Westport water levels
01:01 5.7
07:18 0.3
13:21 5.9
19:44 0.1

- Measure flood through 'The Gap'
- Meet Reid at Westport ferry ramp at 07:30.
- Graham and I to share 2 drifters
- Got out early, flood tide builded to +7 knots following regular pattern... peak approx. 2-4 hrs after LW prediction at Westport

C.9 September 28, 2012

Abbotts Harbour waterlevels
02:22 0.5m
09:05 3.3m
14:50 0.5m
21:31 3.4m

- Argyle, Cat Island Bridge pile site
- On site at 10:30, near HW, slight ebb.
- 3 phase power runs directly over/across site.
- Met at site with Brian Giroux
- On water approx 12:00
- Stopped measurements at 15:30, still ebb, peaked approx 6.5 knots, last measure approx 5.5 knots.
- Leaving site at 16:30, LW slack, still slight ebb or river flow outgoing.

- Approx 2-5 ft depth at LW

Wedgeport waterlevels
02:53 0.6m
09:24 3.7m
15:18 0.6 m
21:46 3.8

- 17:00 at Indian Sluice Bridge
- Flood tide started, less than 4 knots
- 17:30 flood building approx 4 knots
- Hitting the water at 18:30
- Off water at 19:45, max flow approx 6.7 knots, stable or slightly building when measurements stopped due to darkness.

C.10 September 29, 2012

Pinkney Point water levels
04:29 0.7m
10:53 4.1m
16:51 0.6m
23:16 4.1m

- Wind SE 20-25knots and HEAVY rain
- Meet at Reid Gillis at wharf at 11:00 to assess
- Ebb peak should be approx 1-3
- Ebb measure target 12-4
- Plan to head out at noon. Heavy rain has let up. Wind strong easterly, but measurements should be in the lee of Big Tusket Island
- Started measurements approx 12:30. Strong ebb south end of Schooner Passage. Was in lee of island, good non wind driven data. Wind against flow. +1 m waves. Larger outside by Peases Island lighthouse. Strong wind outside. Focused measurements to Schooner Passage, passage with wharves (just east of Big Tusket) and measured Elenwoods Channel late in ebb then Peases after wind and waves dropped. Likely past peak flow based on return measure at Schooner Passage.

C.11 September 30, 2012

Pinkneys Point water levels
05:10 0.7m
11:32 4.2m
17:32 0.6m
23:45 4.1m

- Plan to hit the water at first light, will be mid flood tide.
- On water approx 7:30, foggy, flood tide, first measure channel south of Peases, approx 6 knots, likely close to max flood. Measured Schooner, wharf passage, Peases again, dropping off, then Ellenwoods.
- Back to wharf at 09:30
- On water at 11:30 for ebb, focused measurements outside Peases and Ellenwood, also covered inner channels.

Shelburne water levels
15:39 0.4m
21:48 2.1m

- 19:30 at Port Clyde Bridge.
- 1-2 knot flood.

C.12 October 1, 2012

Shelburne water levels
03:49 0.5m
09:59 2.2m
16:18 0.4m
22:28 2m

- Plan to be on site at Port Clyde bridge at 10:00 to measure ebb tide
- 10:00 at Port Clyde Bridge, still slight flood tide. Approx 1 knot. Near HW
- Sandy Hiltz, lives by the bridge. Ebb can run 8 hours due to river flow. Predicts average 4 knots, max 8-10 knots.
- Has considered installing small tide generator.
- Periodic ice, sheets break off, but not frequent.
- Sable river worth a look. Old bridge. Wildlife sanctuary.
- Port L'Hebert, sand bottom. Shifting sand, predicts 6-8 knots.

- International Tuna Cup, Ram Island Lockport, Soldiers Rib, Wedgeport.
- 10:45 slight ebb.
- 11:30 hitting the water.
- 12:45 out of water, ebb building, 3-4 knots
- 13:30 hitting the water.
- 15:30 off the water, ebb peaked at about 5.5 knots road bridge, 4 knots rail bridge
- 16:00 hitting the water.
- 17:30 off the water, past peak ebb, still 4 knots at road bridge, approx 2 or less at rail.

C.13 October 2, 2012

Lockeport water levels
04:22 0.7m
10:32 2.2m
16:52 0.6m
23:01 2.0m

- 10:40 at Port L'Hebert, just past HW slight ebb less than 1 knot.
- Talked to local fisherman at wharf, expect 1-2 knots current. No problem with skiff and local elderly ladies kayaker here.
- 13:00 mid ebb, maybe 2 knots.
- Hitting the water for a couple drifts.
- 16:20 off the water, max ebb approx 2.5-3 knots, has dropped off to approx 1 knot.

Bibliography

Cornett, A., Inventory of canada's marine renewable energy resources, *Tech. rep.*, Canadian Hydraulics Centre, 2006.