APPENDIX 9A

MILNE PORT FUEL SPILL MODELLING

Milne Inlet
Spill Trajectory Modelling
for the
Mary River Project

Final Report – Issued for DEIS Report

Prepared for

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EXECUTIVE SUMMARY

As related study for the Environmental Assessment for Baffinland Iron Mines Corporation's Mary River Project, AMEC Earth & Environmental (AMEC), a division of AMEC Americas Limited, has undertaken a diesel fuel spill assessment for Milne Inlet, Baffin Island, in the Canadian Arctic. As part of the Mary River Trucking Feasibility Option study it is proposed that diesel fuel would be transported by tanker to a freight dock at the head of Milne Inlet. The hypothetical accidental release of 5 million litres of diesel fuel at the proposed port in Milne Inlet during the open water season has been modelled for the purpose of estimating the marine and coastal areas potentially affected and the initial weathering fate of the diesel fuel.

The AMEC in-house software, OST, was used to model spill probability distributions to indicate which regions of Milne Inlet might be affected, how frequently, and how soon. The ASA OILMAP software was used for estimation of spill fate including amounts of fuel weathered due to evaporation or dispersion into the water column by wave action, as well as amounts brought ashore. To simulate the open water season time period, the month of September was selected.

Wind, ocean tide and current, sea temperature and sea ice conditions bordering the open water season, which might affect the trajectory and fate of a fuel spill, were assessed for use in the spill models. Wind measurements from the met station in operation near the head of Milne Inlet since June 2006 were employed together with a 30-year NCEP/NCAR wind hindcast. A hydrodynamic numerical model forced by water level variations derived from tide gauge records from Milne Inlet predicted that tidal currents should be expected to be very weak in Milne Inlet, and even weaker (probably barely detectable) at the dock site. Acknowledging this, the sole primary driver for the advection of a spill was expected to be the winds, and no currents were applied in the spill modelling scenarios completed. Measurements from an oceanographic program conducted in Milne Inlet in September 2010 confirmed that tidal currents are only about 0.02 m/s near Cape Kwaunang and barely detectable by the instruments at the dock site. Residual currents were also found to be very small. Currents associated with the adjustment of a strongly stratified Milne Inlet to wind setup were observed intermittently.

From the OST spill probability modelling, it is predicted that the vast majority, over 90%, of all trajectories, will first reach shore in the port site area within about 4 km of the head of Milne Inlet in as soon as 30 minutes and on average in four hours, with an associated small amount of fuel weathering having taken place. Between 3 and 10% of the time trajectories might be expected to first contact shore another 6 km farther out in the reach of the inlet leading to Cape Kwaunang. First impacts to the north for shores in Koluktoo Bay, the Bruce Head region on the Borden Peninsula, and the southern tip of Stephens Island are much less likely, and expected to occur less than 1% of the time. Due to the short times to shore for most of the trajectories, weathering of the fuel prior to first shoreline contact is correspondingly low. Also due to short times to shore, the observed intermittent currents associated with adjustment to wind setup would have limited effect on the spill trajectories predicted using wind forcing only and the ultimate fate of the spills would remain fundamentally the same.

Winds in Milne Inlet are predominantly from the northeast into the inlet. Just 20% of winds in September are from the south, southwest, and west directions; however, to estimate the potential fate of a spill farther afield for winds blowing out of the inlet eight events from the Milne Inlet met station wind record were modeled using OILMAP. The scenarios considered are not a definitive collection to completely describe all possible spill outcomes; however, they do provide in particular an indication of possible trajectories farther out into Milne Inlet. A ninth scenario for when winds kept the slick generally within the confines of the head of Milne Inlet was selected: given the predominance of winds into the

inlet, this scenario provides an indication of a more likely weathering fate in terms of amounts of fuel evaporated, dispersed into the water column, or brought ashore.

For the scenarios ‘out of the inlet’, diesel fuel was predicted to come ashore as far as 5 to 36 km away from the port site, a trajectory not too dissimilar from several predicted with the OST model. For the same scenarios, fuel amounts predicted to reach shore just past Cape Kwaunang, about 11 km to the north, ranged from no fuel to 2 ML. Overall, estimates of fuel lost due to evaporation over the first three days of a spill range from 7% for light winds to as much as 15%. While in many cases little fuel is dispersed into the water column over the first two to three days, this amount can also be as high as 80% in the event of higher winds. By four days, the median amount of fuel remaining on the water surface is about 30%, with some simulations having none and others as much as 50%. After the first two days the amount of fuel ashore ranges from about 7 to 38% of the spill amount with a median of 12% (600,000 L of a 5 ML spill). The maximum percent of fuel ashore is 80% when the spill is confined to the upper 5 or 6 km of the inlet.

Estimates of subsurface fuel concentration, based on the amount of fuel dispersed into the water column and an assumed mixing depth of 50 cm, are a maximum over 1000 ppm after one day for a spill generally confined to the head of the inlet. For ‘out of inlet’ trajectories a maximum concentration of 42 ppm is reached in three hours and median concentrations range from about 1 to 10 ppm over the first three days.

To assess the sensitivity of results to spill volume, a spill one tenth the volume of the original spill scenario (i.e., 500,000 L) was modelled. At the time that the trajectory ‘ends’ and any fuel has completely disappeared from the surface, it is noted that while the amounts ashore, evaporated, and in the water column are less for the smaller spill size as expected, the percentages ashore and evaporated are greater.

The spill modelling results highlight the importance of spill prevention and oil spill response plan preparedness to minimize any adverse effects in the unlikely event of a fuel release of any size in Milne Inlet. While recognizing the general trend for winds to blow in towards the head of Milne Inlet, it is important to note as well the variations in local wind possible and the potential transport of a spill north from the port site.

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VERSION TRACKING

Date	Name	Change
29-Oct-2010	John McClintock	Rev 0: Preliminary draft report issued.
30-Nov-2010	John McClintock	Rev 1: Final report issued. Client comments on Rev 0 of report addressed. Added sections on ocean current and ice considerations, and additional OILMAP spill fate modelling.

Milne Inlet, Baffin Island, 1 October 2010

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1. INTRODUCTION

1.1 Objectives

As related study for the Environmental Assessment for the Baffinland Mary River Iron Ore Project, AMEC Earth & Environmental (AMEC), a division of AMEC Americas Limited, has undertaken a diesel fuel spill assessment for Milne Inlet, Baffin Island, in the Canadian Arctic. As part of the Baffinland Mary River Trucking Feasibility Option study it is proposed that diesel fuel would be transported by tanker to the head of Milne Inlet and unloaded by means of flexible hoses to shore.

The specific requirement is to model a hypothetical accidental release of diesel fuel at the proposed port in Milne Inlet during the open water season. Objectives include estimation of the marine and coastal areas potentially affected together with the initial weathering fate of the diesel fuel.

Two spill models are employed: the AMEC in-house software OST, which, based on consideration of the wind and current climate, estimates the probability distribution of a spill trajectory, and the ASA OILMAP software for estimation of spill fate including amounts of fuel weathered and brought ashore. This report presents the results of the modelling study.

1.2 Spill Scenario Selection

Under the Baffinland Mary River Trucking Feasibility Option study diesel fuel for the Mary River Project would be transported by offshore ocean-going tanker through Baffin Bay, Pond Inlet and Eclipse Sound to port at the head of Milne Inlet (Figure 1-1 and Figure 1-2).

While an unlikely event, an accidental fuel spill could hypothetically occur as a result of collision or accident or while transferring fuel between an ocean tanker and shore base. This spill assessment considers open water season, e.g., September, when transport of diesel fuel to Milne Inlet may be considered. Shipping of fuel in pack ice or under landfast ice conditions is not planned.

For the purpose of the Trucking Feasibility option, fuel will be unloaded by means of flexible hoses from tanker to shore. The proposed fuel unloading location is illustrated in Figure 1-3[1]. In the figure, the distance between the eastern edge of the freight dock and the tanker is about 400 m.

An open water season spill scenario originally developed for fuel shipment into Steensby Inlet as part of the Mary River Project was selected for use at Milne Inlet as well (AMEC, 2010). The development of that scenario is summarized here for completeness.

[1] In the future, tankers will berth and unload at the freight dock once it has been built, e.g., consult the Location Plan and General Arrangement drawings for freight dock particulars

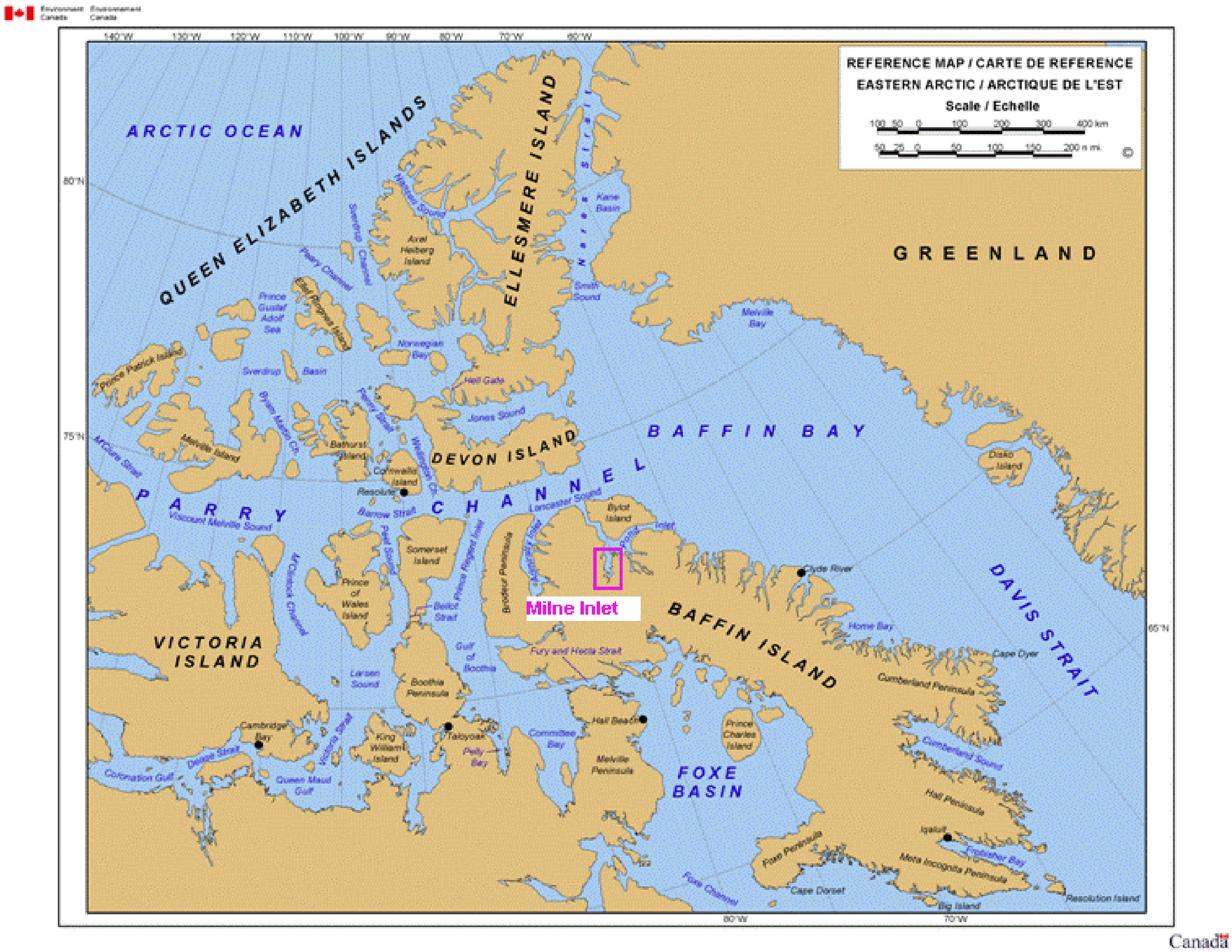

Figure 1-1 Eastern Arctic: Reference Map with Milne Inlet Study Area Highlighted. (Source: CIS, 2010a)

The starting point was an assumed total cargo volume of 50 ML (50 million litres or 5,000 m^3) arctic diesel fuel coming to port. The total amount of 50 ML spilled was judged to be too large a spill and not a credible amount. Instead, three possible 'modes' of release or of estimating the amount were put forward:

a) for a hypothetical fuel transfer loss at the port (Figure 1-3). Assuming a 3 ML/h transfer rate (equates to about 16.7 h where the entire offloading might be typically expected to take about 24 h), there would be potential release of 50,000 L/min. Assuming a period of 10 minutes before the spill is stopped this would represent a spill volume of 0.5ML. Clearly the assumed time before spill stoppage is a key factor;
b) if one assumes six or seven tanker compartments and complete loss of one, this would release from 7.1 to 8.3 ML. Again, the number of compartments damaged is a factor; and
c) historical spill statistics can also be considered. Some research/review (e.g., McKenna and McClintock, 2005) indicates spill amount is best expressed as a proportion of fuel transported, with 5% a most likely estimate, and 10% a conservative one: 10% yields 5 ML

From this workup, it was agreed that an amount on the order of 5 ML was a worst case amount worth carrying forward. It was felt that the Port site was a reasonable location to take for the spill; as it matches scenario a) above and could be considered possible even for b) for a collision and hull damage accident.

One spill scenario location is identified in Table 1-1 and also shown in Figure 1-2.

Table 1-1 Spill Scenario Locations

Spill Scenario Location	Latitude (N)	Longitude (W)
Port Site, located near the fuel tanker (~E 535,500, N 7,977,150) just east of freight dock located at head of Milne Inlet	71° 53.66'	80° 53.95'

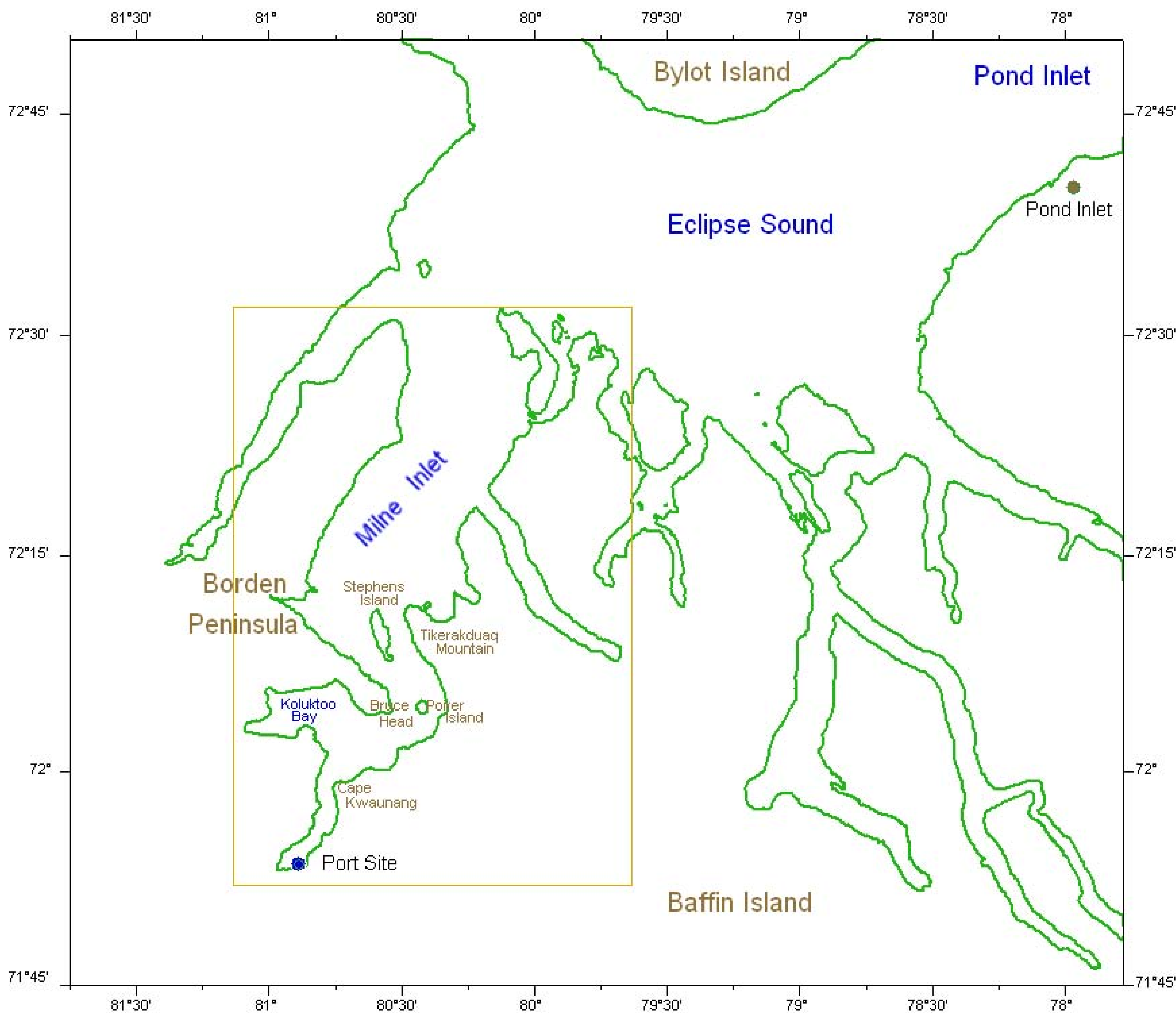

Figure 1-2 Milne Inlet: Port Site Spill Scenario Location

1.3 Report Structure

Pertinent details of the OST trajectory model theory, input and output data, and presentation of results for simulations completed for the spill scenario location at the head of Milne Inlet are presented in Section 2. Complementary fate predictions for the same location completed using OILMAP are presented in Section 3. Conclusions are presented in Section 4, and References follow in Section 5.

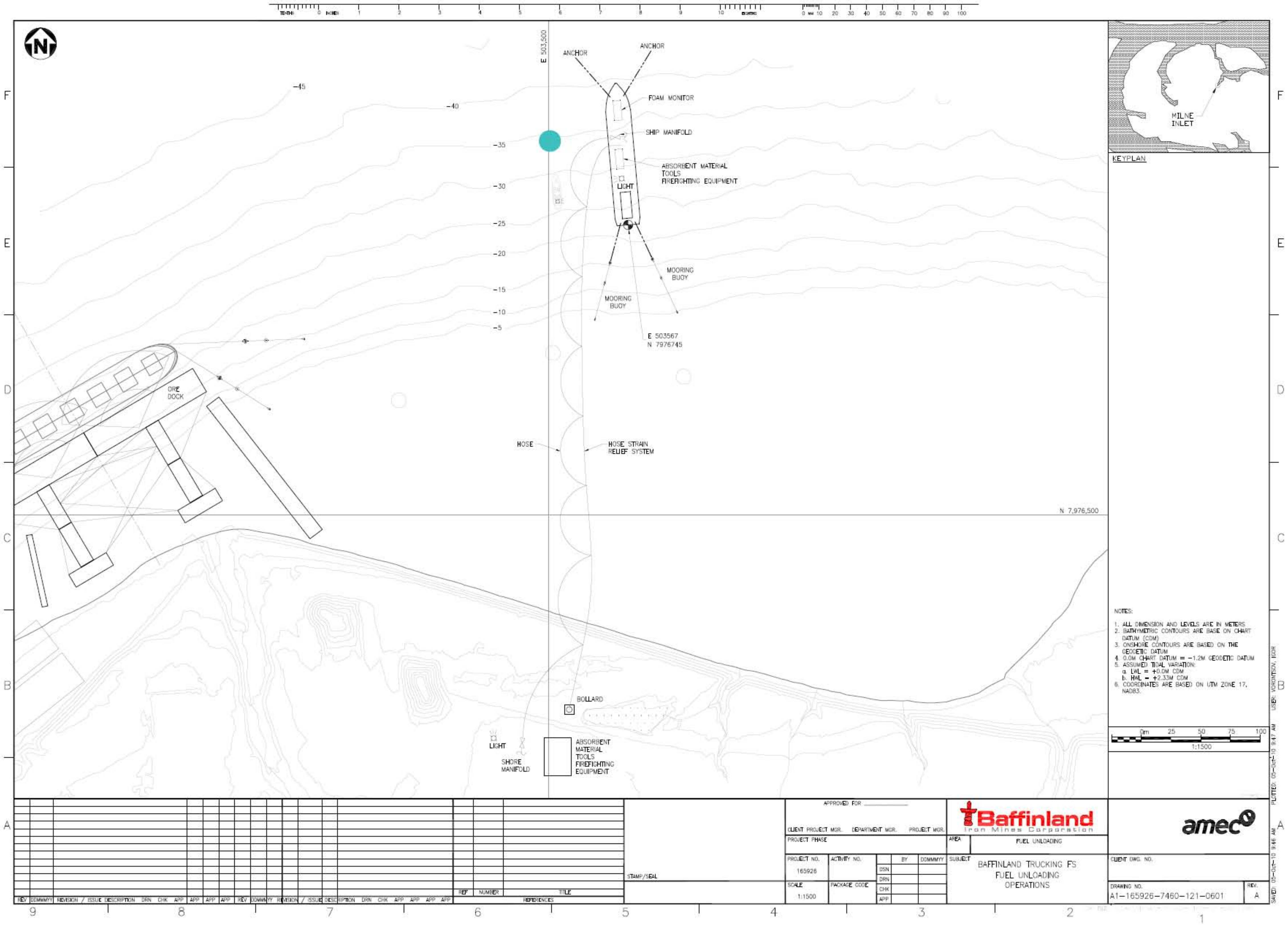

Figure 1-3 Baffinland Trucking Feasibility Study Fuel Unloading Operations, with Spill Scenario Location Marked, Off Port Side of Tanker (Source: AMEC Drawing # A1-165926-7460-121-0601 Rev. A)

2. SPILL TRAJECTORY MODELLING: OST

The analysis of the open water scenarios was accomplished by making use of the numerical computer model OST developed by AMEC to determine probabilistic spill trajectories. To accompany the delivery of the fuel spill trajectory results, a description of the model and techniques used, and observations based on the modelling activity are presented.

2.1 Model Setup

2.1.1 Model Theory Overview

An oil spill trajectory model is defined for purposes of the present discussion as a computerized sequence of calculations designed to predict some aspects of the behaviour of oil spilled on the surface of water. Such behavioural aspects may include the transport (advection), and/or the spreading, and/or the weathering of spills. Attention is generally restricted to the behaviour of oil on the sea surface.

Oil spill trajectory scenario models (as distinguished from real-time models) are typically employed to provide a prediction of potential spill behaviour. Scenario models attempt to predict typical (or most probable) and extreme answers, for a given spill site, to such questions as:

- What is the likely speed and direction of slick motion?
- What combination of environmental (wind and current) conditions generates the most severe spill scenario?
- How frequently do such conditions occur?

A distinction is drawn between the two basic types of scenario models: deterministic and statistical. The differences relate not so much to the mechanics of the model but to the nature of wind and current data input to the model. A deterministic scenario model employs actual or hindcast data as input to the advection aspect of its calculations. These data may possibly be modified to be made more representative of the site under consideration, but the root of the input is a measured or hindcast time-series of values. Deterministic scenario model mechanics are such that input of a given data series will always yield the identical predicted output. Thus, to gain statistical significance in the interpretation of output, deterministic models must be run on a variety of input data sets or must group predictions by some appropriate time average (such as monthly). Thirty years of conditions for each of 30 days in a month yields 900 individual trajectories, a large number, which yields good confidence in the overall resultant statistics.

In contrast, the statistical variety of scenario model employs some volume of measured data as a standard or guide to creating a synthetic input data set. This approach is most commonly encountered with wind input. The synthetic data, generated by some statistical process (Monte Carlo simulation, Markov chain) employing a random number generator, are the input to the scenario model. Each iteration of the model, commencing with a specific set of fixed parameters except for the random number seed used in the synthesis, which changes each time, will generate a distinctly different predicted output. Such models must also be run a sufficient number of times to assure statistical significance in the interpretation of the output data.

The AMEC spill trajectory model, OST, is a scenario model of the deterministic variety. It was developed initially for use offshore eastern Canada in the early 1980's and has been used on numerous occasions since, for example:

- for the Newfoundland Transshipment Terminal Project, Placentia Bay (Newfoundland, Environmental Assessment, 1996)
- as part of the Voisey's Bay, Labrador nickel and copper mine project, including a number of oil spill in ice scenarios (McKenna and McClintock, 2005)
- in the domain of James Bay during the Environmental Assessment for the De Beers Victor Diamond Project (McClintock, 2004)
- as part of delineation drilling screening for the Norsk Hydro and Husky Energy 2006 program at West Bonne Bay F-12, Offshore Newfoundland (AMEC, 2006)
- nearshore, in Placentia Bay in support of the Long Harbour Commercial Nickel Processing Plant (AMEC, 2007).

2.1.2 Model Geometry

The transport (and spatial extent) and fate of a spill is modelled as a function of time. A spill time step is assigned which is appropriate for the geographic scale and model grid of the study area and the wind and current conditions which will be used in the model to transport the spill. At each time step in the model a new location and spill volume is calculated. Selection of too large a time step may yield to inaccurate results. Too small a time step makes for overly intensive computations in the model. For the Milne Inlet domain, a time step of 15 minutes is appropriate (using winds for the given hour over each of those four time steps).

A grid is employed in the model to track the spatial extent of the spill. The grid serves three simultaneous purposes, these being: (i) it serves as the gridded coordinate system for the computation of successive displacements of the slick over each time step; (ii) it is the spatial grid upon which the winds and surface current vectors are mapped; and (iii) it provides a coordinate system for summarizing the predicted first contacts with the shorelines. This single grid is therefore referenced at various times as the model or computational grid, the wind or current grid, and the external grid.

The model grid is a Cartesian grid which includes Milne Inlet as far north as Ragged Island. The model grid has its origin at 72° 32' N latitude, 81° 08' W longitude, and extends eastward to 79° 38' W longitude and southward to 71° 52' N latitude.

Grid element dimensions are defined as 16” latitude, or 493 m in the north-south (Y) direction and 48” longitude, or 503 m in the east-west direction, i.e., on the order of 500 m x 500 m. The choice of a Cartesian grid requires the specification of a fixed east-west (X) grid scale, and consequently demands the Mercator projection of land elements on the grid. The computational grid is of minimal consequence to the model user who is simply interested in viewing printed and plotted model output. All results appearing as printed output refer to geographical coordinates and distances which are exactly computed and are independent of grid dimensions. Model output plots of oil distribution probabilities represent all computational grid elements as appropriately scaled rectangles and thus are valid as representing correct relative positions.

Along with the geographical (longitude, latitude) coordinates and the Cartesian (X, Y) coordinates employed with the computational grid, a column (J) and row (I) coordinate system is also imposed to identify grid elements. In the present case, with the grid spanning 1° 30’ of longitude and 40’ of latitude, and with 12” row by 40” column grid element definitions, these latter coordinates range as follows:

Column (J) 1 - 135
Row (I) 1 - 200

The model grid is summarized in Table 2-1 and illustrated in Figure 2-1 where lines for every second row and column are drawn. The computational grid boundaries are shown as a gold rectangle in the spill probability figures in Section 2.4.

Table 2-1 OST Spill Model Grid Setup

	Grid Size						**Cell Size (latitude x longitude)**	
Domain	*latitude*	*longitude*	*# rows*	*# columns*	*latitude (km)*	*longitude (km)*	*latitude*	*longitude*
Milne Inlet	40’ 71° 52' to 72° 32' N	90’ 79° 38' to 81° 08' W	200	135	74	50.9 (at 72° 12’ N)	12” or 370 m	40” or 377 m
	grid mid-latitude is at 72° 12’N							

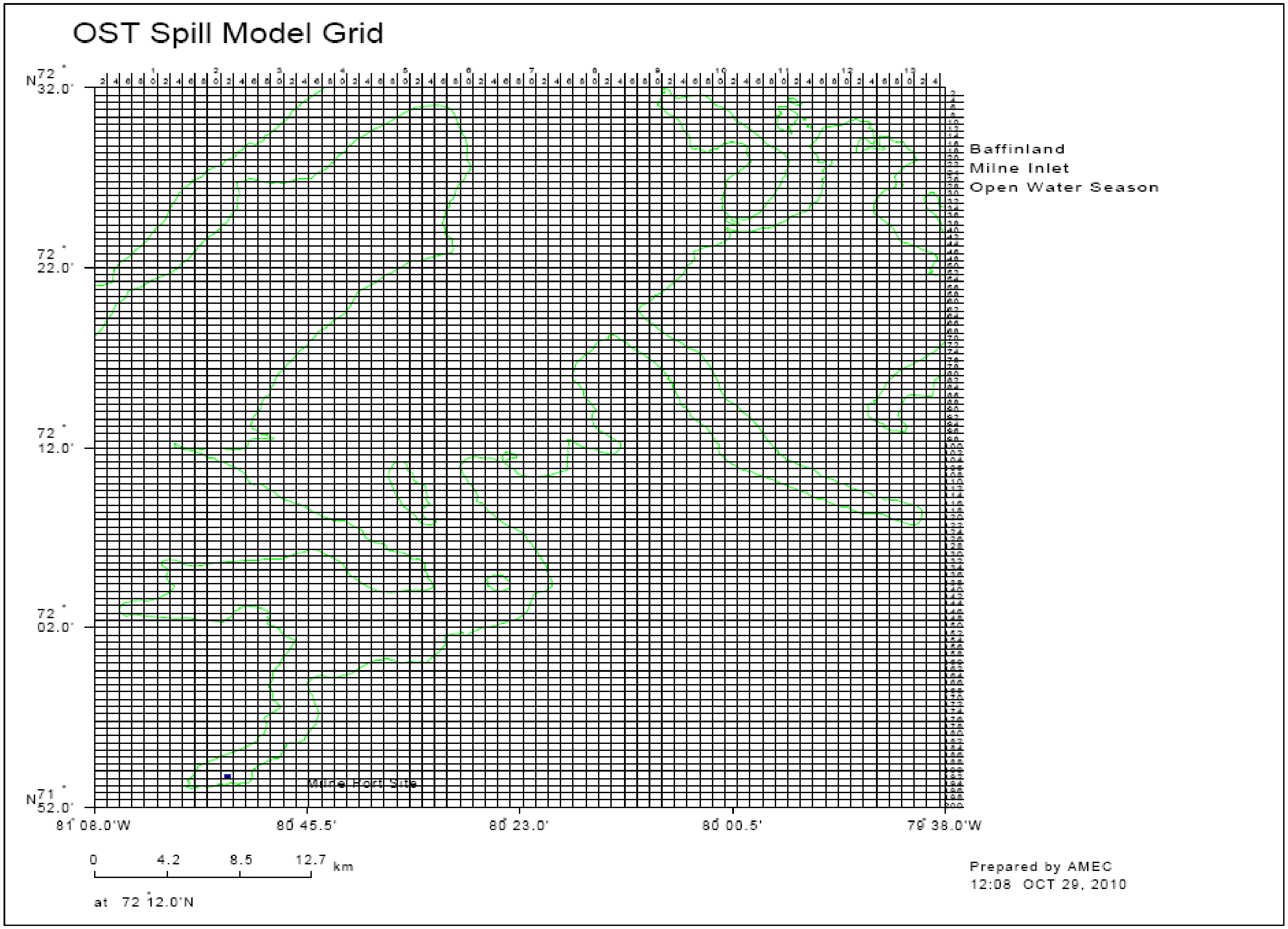

Figure 2-1 OST Spill Model Grid

2.1.3 Transport (Advection)

A simple transport computation is employed to simulate the advection of a point (assumed to represent the centroid of a slick) through two-dimensional space (representing the sea surface).

At any given time the point is assumed to be subject to two independent displacing forces. The presence of an ocean surface current is assumed to displace the point (centroid) in the direction of the current at 100% of the current speed. Simultaneously, but independently, the presence of wind is assumed to generate an instantaneous surface current directed 10° (Westeng, et al., 1977) to the right of the wind (in the northern hemisphere) and having a magnitude of 3.0 to 3.5% of the wind speed. A value of 3.5% is used in the model. This current is also assumed to directly transport the slick. Over the time-step of the available wind data the displacements due to surface current and due to wind-driven surface currents are vectorially added to yield a new slick position. Sequential vector additions are computed over each successive time-step until the simulation terminates on one of two endpoint conditions:

- a coastal boundary is reached; or
- an external grid boundary is reached.

A third possibility for ending a trajectory in the model is if the percent oil weathered rises above 95%. The selection of the current vector and the wind vector to be employed in the transport computation at any given time during the simulation is determined strictly by the present location of the slick centroid.

For the present model implementation, the wind velocity is available hourly. Due to the short distances to shore, a sub-interval of 15 minutes is employed, where the winds and currents for a given hour are used at each of the four sub-steps in that hour.

2.1.4 Weathering

The scenario trajectory model is provided with a switch to globally control the use of weathering routines. If weathering routines are enabled, a series of subroutines are executed after the displacement computation (described above) is completed in each time step. The processes of evaporation and vertical dispersion or loss into the water column, are simulated to yield estimates of the total volume of oil remaining. This is expressed as a percentage of initial spill volume. If weathering is switched off, these calculations are omitted.

<u>Background</u>

Arctic diesel fuel is to be transported as cargo, which may vary slightly in composition depending on source.

Upon release in the marine environment, fuel oil is subject to weathering processes, including spreading, evaporation, dissolution, dispersion of oil droplets into the water column, photochemical oxidation, emulsification, microbial degradation, adsorption onto particulate matter, ingestion by aquatic organisms, sinking and sedimentation (Payne et al., 1991). Immediately after the oil is spilled, it starts spreading over the sea surface, at a rate that is largely dependent on the viscosity (resistance to flow) of the oil. The rate of spreading also depends on the wind speed, significant wave height, as well as the presence of tidal and mean currents. The dynamic viscosity of diesel fuel changes drastically with temperature from 2 mPa·s at 25° C to 4 mPa·s at 0° C (ESTD, Environment Canada, 2010). Another property of oil that is especially significant in Arctic conditions is the pour point, which is the lowest temperature at which the oil will flow, typically at -30° C (ESTD, Environment Canada, 2010). At temperatures below the pour point, the oil solidifies rapidly and the spreading is minimized. During periods of high winds and waves, the oil can form narrow bands that are aligned with the wind direction, a state in which the slick movement is controlled by the sea state rather than the oil properties (ITOPF, 2010).

Another major weathering process within the first days of a spill is evaporation. According to ITOPF (2010), most of the oil components with a boiling point under 200° C tend to evaporate within the first few days. For diesel fuel, these components represent 34% of the weight (ESTD, Environment Canada, 2010). Therefore, due to the higher volatility of diesel fuel compared to crude oil, a comparatively higher fraction of the amount of spilled oil would evaporate. Evaporation is facilitated by the ambient temperature and the presence of wind.

The oil fraction that is not lost to evaporation or dilution in water is eventually broken up into droplets of varying sizes which are subject to dispersion. The process of dispersion, often accelerated by the application of dispersants, contributes towards faster biodegradation, dissolution and sedimentation of the spilled oil. Dispersion can be hindered by emulsification of the oil under the action of waves, which is a common cause for the persistence of spilled oil in the marine environment. On a timescale longer than a week, the dominant weathering processes become biodegradation by microorganisms and sedimentation and sinking processes (ITOPF 2010).

While a spill in ice is not considered in this study, it is noted that in ice-covered waters, the different forms of sea ice can impact drastic changes to the rates and relative importance of the weathering processes. Thus, during growing slush ice conditions (late fall and early winter), the oil is subject to stranding on the ice surfaces and rapid emulsification, followed by submersion and incorporation into the ice canopy (Payne et al., 1991). Thus, the oil found on the upper ice surface weathers predominantly through evaporation, but the portion incorporated in the ice does not undergo weathering until the melting season.

In practice, the presence of sea ice will tend to slow the advection of a fuel spill and to reduce evaporation and dispersion. McKenna and McClintock (2005) modelled spills in landfast and moving sea ice for Voisey's Bay, Labrador. In that work, a range of sea ice concentrations were considered. For ice concentrations below 3/10ths coverage, spill advection was calculated using an open water spill model (essentially that employed here). For ice concentrations between 3/10ths and 8/10ths, advection was the weighted average of open water spill and sea ice drift velocities. Above 8/10ths concentration, spill advection was governed entirely by sea ice drift. In the presence of sea ice, the evaporation rate is reduced and can be approximated to consider only the open water fraction, while the dispersion rate also is reduced due to the ice's damping effect on motion of the sea surface.

Where ice is present in significant concentrations, potential spills will be transported with and fully integrated into the ice. Recovery of any remaining fuel may only be possible by restraining the sea ice using ice booms and removing the fuel when the ice melts.

While oil in ice effects were not modelled in this exercise these observations should be generally applicable for the Milne Inlet region.

The characterization of diesel fuel properties used in this modelling study is given in Figure 2-2.

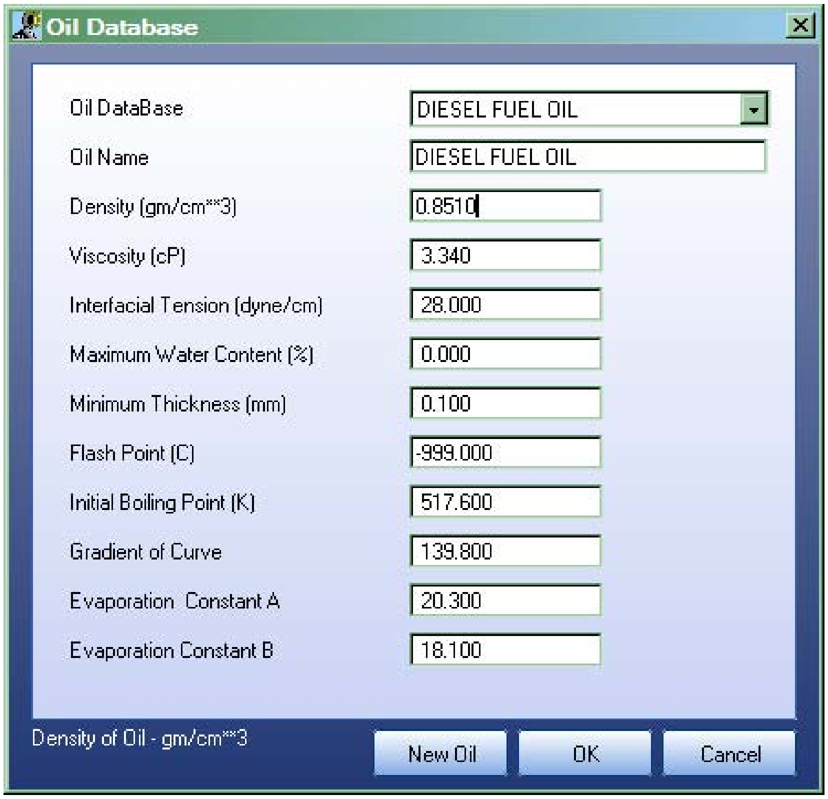

Figure 2-2 Diesel Fuel Oil Physical Parameters (Source: OILMAP v 6.4.0)

Effects of Wind and Temperature

Wind speed and water temperature will affect the amount of weathering loss due to evaporation and vertical dispersion of the spilled fuel into the water column. A review of conditions for Milne Inlet is presented here followed by description of the weathering algorithm implementation in the OST software.

Milne Inlet CTD data summary

The temperature and salinity structure in the Inlet has been captured through CTD profile measurements conducted by CORI in 2007 and 2008 (CORI, 2010), as well as by measurements conducted by AMEC in 2010 (AMEC, 2010b). The CTD data span the months of June, August, and September, thus representing some indication of both early and late summer conditions. A subset of the reviewed profiles is presented in the following figures to illustrate the observed temporal variations. Most of the data originate in the area adjacent to the Milne Dock; however, two of the profiles taken by AMEC are from farther north, at stations AMEC 4 and 5 towards Cape Kwaunang (Figure 2-10).

The water column in June is characterized by a shallow (approximately 5-10 m depth) and steep thermocline and halocline, with temperatures ranging from -1 to 5^{o} C, and salinities between 2 and 33 PSU in the top 10 m (Figure 2-3). This relatively warm and fresh surface layer can be explained by the input of melt water from the surrounding terrain, and the subsequent solar heating which further increases the density stratification. Below the surface layer the water is relatively uniform with depth, with a temperature of approximately -1^{o} C and salinity around 33 PSU.

In late summer (August and September) the water column is still very well stratified, with the thermocline and halocline extending deeper within the 30 to 50 m range. The temperature and salinity gradients are the steepest near the surface, where water temperatures reach above 7^{o}C, and salinities range from 5 to 25 PSU. The temperature-salinity structure is similar between the area adjacent to the Milne Dock (stations AMEC 1,2,3) and the entrance of Milne Inlet (stations AMEC 4,5), as seen in Figure 2-4. The deeper water exhibits little variability from early summer conditions.

For the formation of landfast ice typically by the beginning of October (Section 2.2.4) temperatures at that time could be expected to be down to from -1 or -1.8° C depending on salinity.

Given there will be this variability in sea water temperature in Milne Inlet from the end of summer to fall and the formation of landfast ice, it is instructive to consider the effect of water temperature on evaporation loss. Accordingly, three values intended to span the likely temperature range during open water season, -1, 1, and 7° C were considered for a constant wind speed of 5 m/s (Figure 2-5). After one day, for a water temperature of 7° C evaporation loss is 3.2% compared with 1.7% for 1° C and 1.3% for -1° C. After five days, for a water temperature of 7° C evaporation loss is 12% compared with 7% for 1 °C and 6% for -1° C.

From a conservative (less evaporation loss) view 1° C is selected for the spill weathering.

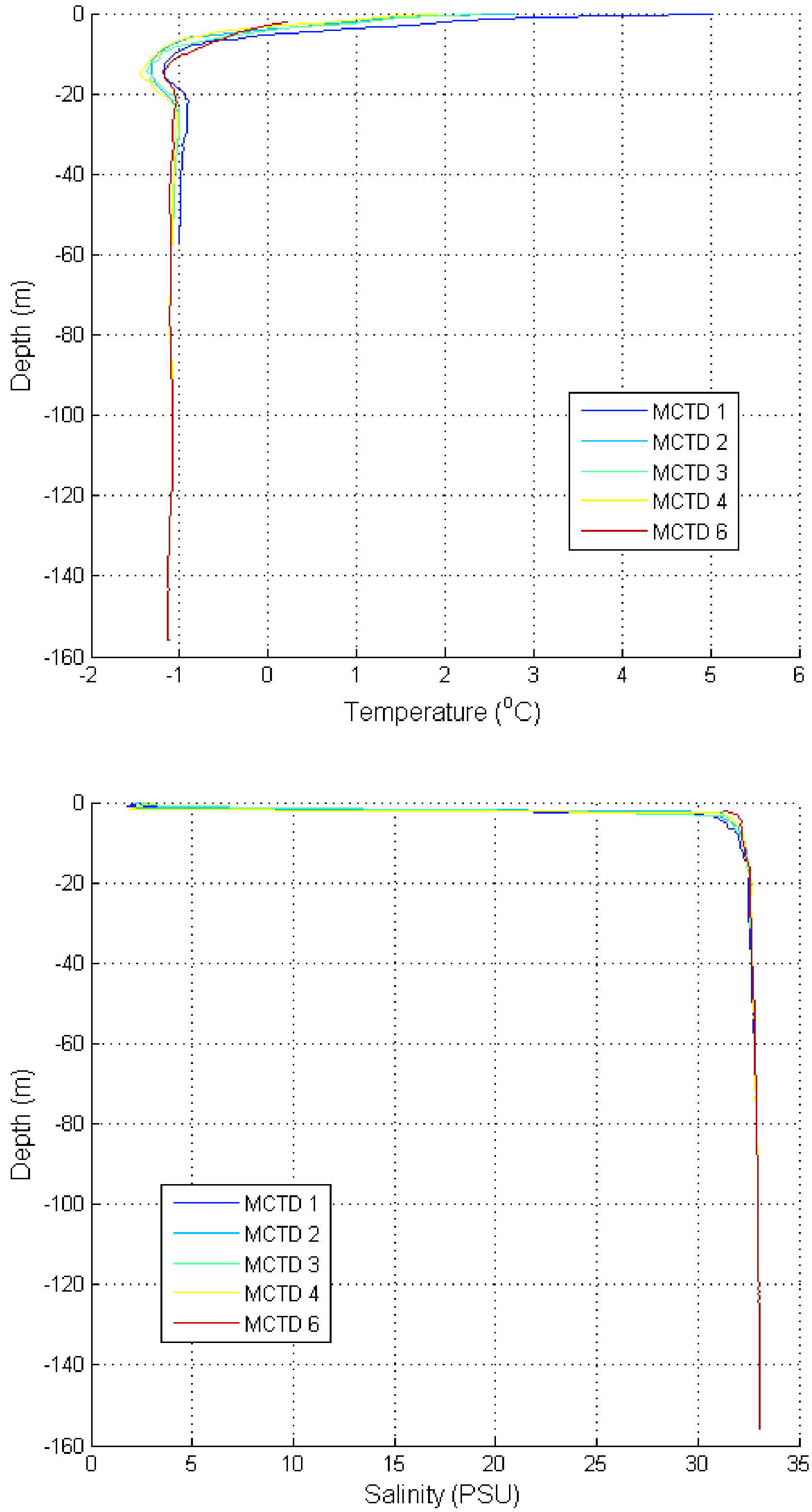

Figure 2-3 Milne Inlet: CTD Temperature and Salinity Profiles, 14,15 Jun 2008 (Data based on: CORI, 2010)

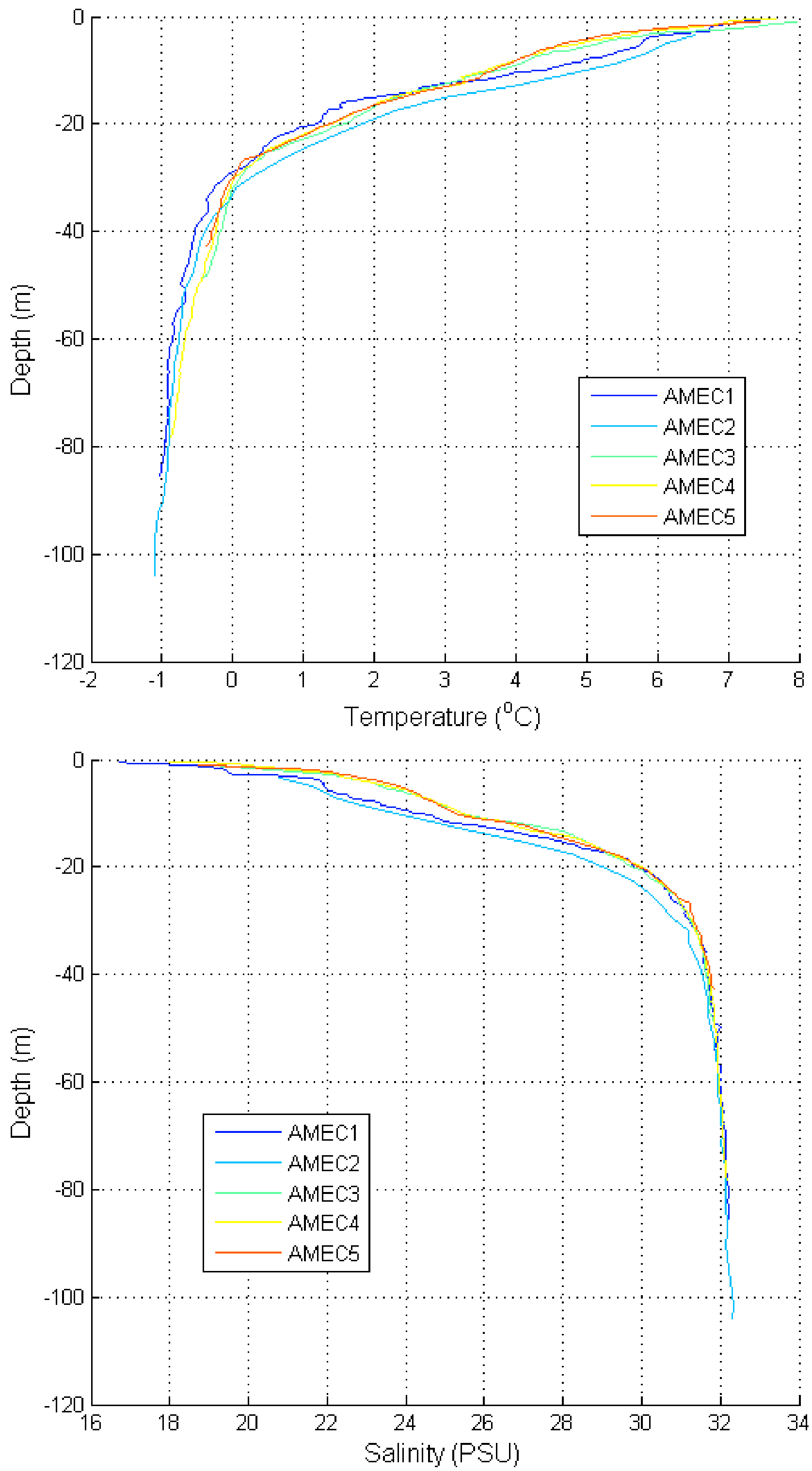

Figure 2-4 Milne Inlet: CTD Temperature and Salinity Profiles, 31 Aug, 1 Sep 2010 (Source: AMEC, 2010b)

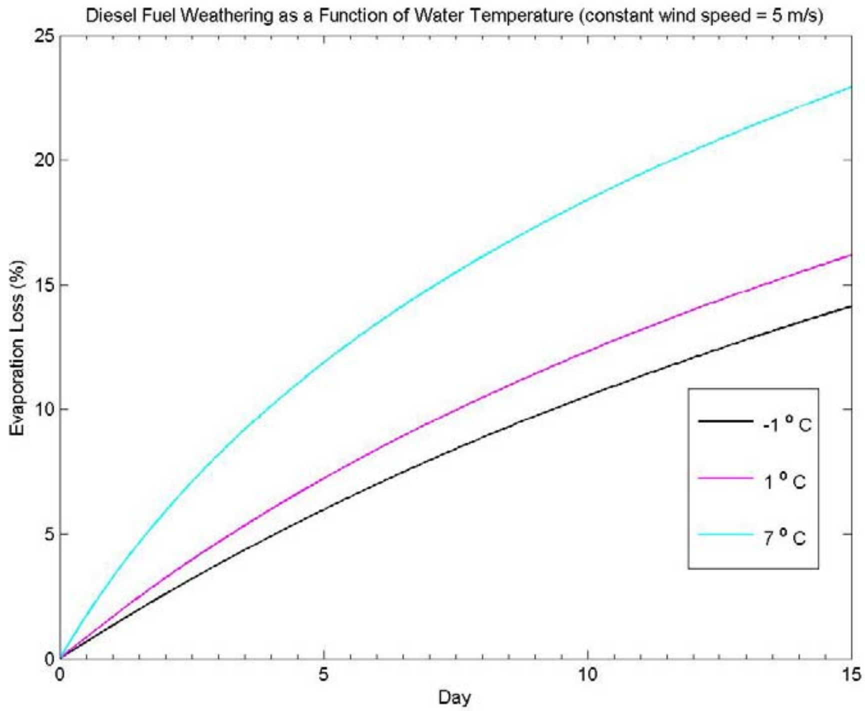

Figure 2-5 Diesel Fuel Weathering: Evaporation Loss as a Function of Water Temperature (Source: OILMAP v 6.4.0)

Model Implementation

The weathering algorithm for diesel fuel in the OST software is based on simulations with the OILMAP software[2] (ASA, 2009). OILMAP will calculate the evaporation, dispersion, and remaining percentage for a given spill scenario where the user defines an oil product type, weather conditions, properties of the receiving water, and the amount of oil released.

For this algorithm development, scenarios of a diesel fuel amount of 5,000,000L (5 ML) released under a range of wind speed conditions and constant water temperature were used. This estimation was developed as part of Steensby Inlet companion spill work and is fully detailed in that report (AMEC, 2010a). An assumed horizontal dispersion coefficient of 3 m^2/s intended to be representative of a low energy level environment (ASA, 2004) was selected. The simulations considered a water temperature of 1.0 °C (greater evaporation occurs at warmer surface temperatures), and were run for 30 days. A

[2] OILMAP is a user-friendly, Windows-based, oil spill model system suitable for use in oil spill response and contingency planning. It includes simple graphical procedures for entering both wind and hydrodynamic data and specifying the spill scenario. The standard system is delivered with an oil spill trajectory and fates model, environmental data tools and visualization tool. The oil spill model predicts the surface trajectory of spilled oil for either instantaneous or continuous release spills. The model includes algorithms for oil spreading, evaporation, emulsification, entrainment, and oil shoreline interaction. The distribution and mass balance of oil with respect to time are predicted for the type of oil spilled.

wind speed range of 0 to 10 m/s was considered for OILMAP simulations. Mean winds for Milne Inlet in September are 4.9 m/s and the 95% upper limit is 11.7 m/s (Section 2.2.2.1) and so are consistent with the approach put forward for Steensby Inlet (AMEC, 2010a).

Figure 2-6 and Figure 2-7, reproduced from the Steensby modelling present the weathering losses due to evaporation and water column entrainment for the six constant wind speed scenarios. It is seen that evaporation increases with wind speed, on the order of 2.4% per day under calm conditions to 8.1% per day for winds of 10 m/s. Loss of diesel fuel into the water column is even more strongly influenced by wind speed. While there are very small water column losses for wind speeds of 4 m/s, on the order of 0.1%, and negligible losses for winds lighter than 4 m/s, for the 5 m/s simulation, about 1.7% per day is lost over the first five days. This increases slightly to about 2.6% per day by day 20. For the simulated larger wind speeds of 6, 8, and 10 m/s, the loss rates are on the order of 15, 60, and 119% per day, respectively.

These results are tabulated in Table 2-2 and Table 2-3 which in turn were implemented in the OST weathering routine. A simple lookup based on time into the spill, and wind speed, was used to calculate the percentage weathering losses, at each time step in the trajectory simulation.

The spill modelling does not treat a specific volume of oil, rather the percentage oil remaining is estimated, and provided in the OST listings (Section 2.3.3), and so one can apply the percentages to any chosen volume.

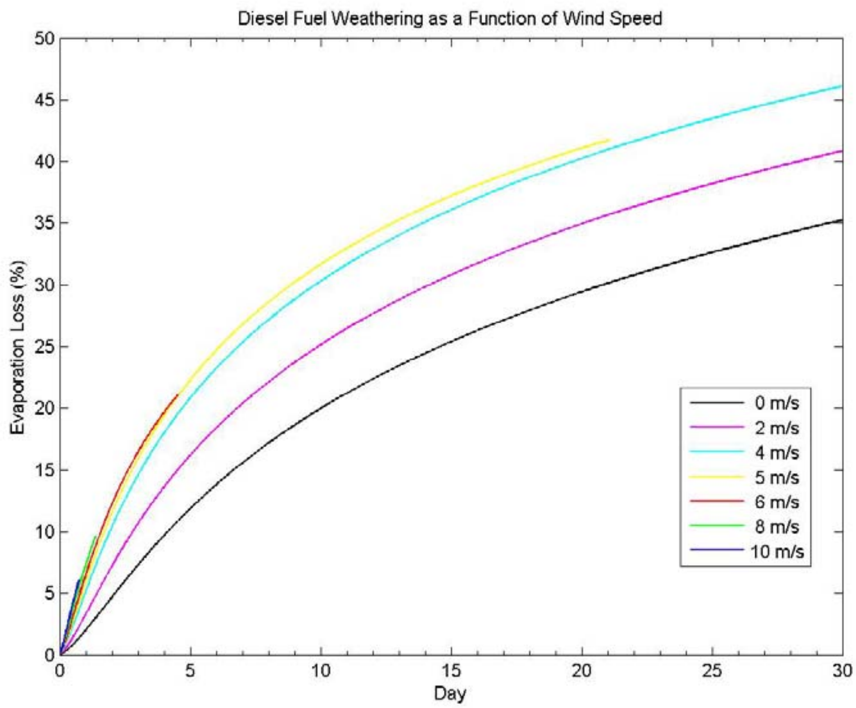

Figure 2-6 Diesel Fuel Weathering: Evaporation Loss as a Function of Wind Speed (Source: OILMAP v 6.4.0)

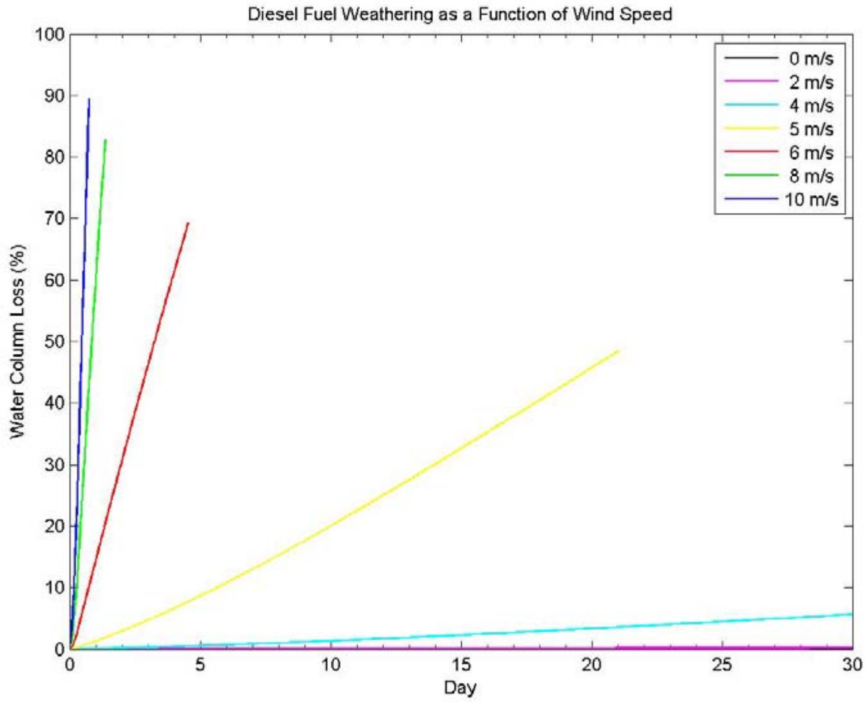

Figure 2-7 Diesel Fuel Weathering: Water Column Loss as a Function of Wind Speed (Source: OILMAP v 6.4.0)

Table 2-2 Diesel Fuel Weathering: Evaporation Loss as a Function of Wind Speed

Wind Speed (m/s)	**Evaporation Loss Rate (% per day) for time into Spill (days)**			
	0-5 days	**5-10**	**10-20**	**20+**
0-1	2.4	1.6	0.9	0.6
1-3	3.2	1.8	1.0	0.6
3-4.5	4.2	1.9	1.0	0.6
4.5-5.5	4.5	1.9	0.9	0.1
5.5-7	4.6	3.1	0.9	0.9
7-9	7.0	4.7	1.4	1.4
9+	8.1	5.4	1.6	1.6

Table 2-3 Diesel Fuel Weathering: Water Column Loss as a Function of Wind Speed

Wind Speed (m/s)	Water Column Loss Rate (% per day) for time into Spill (days)			
	0-5 days	**5-10**	**10-20**	**20+**
0-1	0	0	0	0
1-3	0.004	0.006	0.008	0.009
3-4.5	0.1	0.2	0.2	0.2
4.5-5.5	1.7	2.3	2.6	0.3
5.5-7	15.2	15.2	15.2	15.2
7-9	60.2	60.2	60.2	60.2
9+	119.2	119.2	119.2	119.2

A concise summary, prepared by NOAA, of characteristics of small diesel spills is also presented in Figure 2-8 and Figure 2-9 which may assist in assessing potential weathering fates and related consequences. While the Milne scenario spill size of 5 ML, or 5000 m^3, is much larger than the 5000 gallon (19 m^3) value noted here, the information should still have applicability in particular for any small releases which might occur. Diesel is also not very viscous or sticky, so that while porous shoreline sediments may be oiled, less-porous shorelines, e.g., those with a lower oil residence index time, may tend to be washed off due to wave or tidal flushing. For many regions of Milne Inlet with its rocky shorelines this may be a likely scenario.

Small Diesel Spills (500-5000 gallons)

Diesel fuel is most often a light, refined petroleum product. Small diesel spills will usually evaporate and disperse within a day or less. This is particularly true for typical spills from a fishing vessel (500-5,000 gallons), even in cold water. Thus, seldom is there any oil on the surface for responders to recover. However, what is commonly referred to as "marine diesel" is often a heavier intermediate fuel oil that will persist longer when spilled. When spilled on water, diesel oil spreads very quickly to a thin film of rainbow and silver sheens except for marine diesel, which may form a thicker film of dull or dark colors.

Characteristics of Small Diesel Spills (500-5000 gallons)

- Diesel oil has a very low viscosity and is readily dispersed into the water column when winds reach 5-7 knots or with breaking waves.
- Diesel oil is much lighter than water (specific gravity is between 0.83 and 0.88), compared to 1.03 for seawater). It is not possible for this oil to sink and accumulate on the seafloor as pooled or free oil unless adsorption occurs with sediment.
- However, it is possible for the diesel oil that is dispersed by wave action, to form droplets that are small enough be kept in suspension and moved by the currents.
- Oil dispersed in the water column can adhere to fine-grained suspended sediments(adsorption) which then settle out and get deposited on the seafloor. This process is more likely to occur near river mouths where fine-grained sediment are carried in by rivers. It is less likely to occur in open marine settings. This process is not likely to result in measurable sediment contamination for small spills.
- Diesel oil is not very sticky or viscous, compared to black oils. When small spills do strand on the shoreline, the oil tends to penetrate porous sediments quickly, but also tend to be washed off quickly by waves and tidal flushing. Thus, shoreline cleanup is usually not needed.
- Diesel oil is readily and completely degraded by naturally occurring microbes, under time frames of one to two months.
- In terms of toxicity to water-column organisms, diesel is considered to be one of the most acutely toxic oil types. Fish, invertebrates and seaweed that come in direct contact with a diesel spill may be killed. However, small spills in open water are so rapidly diluted that fish kills have never been reported. Fish kills have been reported for small spills in confined, shallow water.
- Crabs and shellfish can be tainted from small diesel spills in shallow, nearshore areas. These organisms bioaccumulate the oil, but will also depurate the oil, usually over a period of several weeks after exposure.
- Small diesel spills can affect marine birds by direct contact, though the number of birds affected is usually small because of the short time the oil is on the water surface. Mortality is caused by ingestion during preening as well as to hypothermia from matted feathers. Experience over the last 10 years in Alaska, with hundreds of small diesel spills, is that few birds are directly affected by diesel spills from fishing vessels. However, small spills could result in serious impacts to birds under the "wrong" conditions, such as a grounding right next to a large nesting colony or transport of sheens into a high bird concentration area.

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Figure 2-8 Small Diesel Spills (500-5000 gallons): Characteristics (Source: NOAA, 2006)

Small Diesel Spills (500-5000 gallons)

Over 90% of the diesel in a small spill incident into the marine environment is either evaporated or naturally dispersed into the water column in time frames of a couple of hours to a couple of days. Percent ranges, in parentheses above, represent effects of winds ranging from 5 to 30 knots.

Adsorption (sedimentation) The process by which one substance is attracted to and adheres to the surface of another substance without actually penetrating its internal structure

Biodegradation The degradation of substances resulting from their use as food energy sources by certain micro-organisms including bacteria, fungi, and yeasts

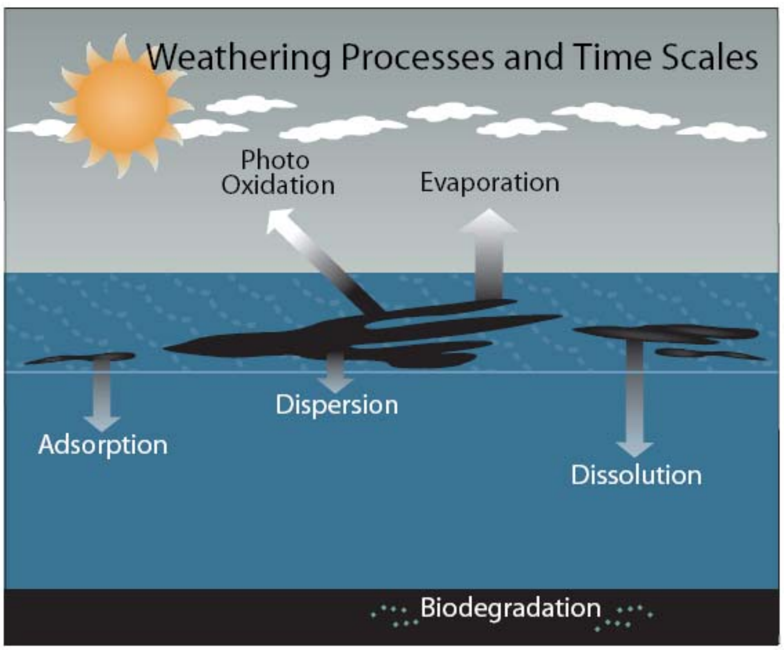
Dispersion The distribution of spilled oil into the upper layers of the water column by natural wave action or application of chemical dispersants

Dissolution The act or process of dissolving one substance in another

Emulsification The process whereby one liquid is dispersed into another liquid in the form of small droplets

Evaporation The process whereby any substance is converted from a liquid state to become part of the surrounding atmosphere in the form of a vapor

Photo Oxidation Sunlight-promoted chemical reaction of oxygen in the air and oil



For more information:
NOAA's Office of Response and Restoration
Emergency Response Division
7600 Sand Point Way NE
Seattle, Washington 98115
206.526.6317

November 2006

Figure 2-9 Small Diesel Spills (500-5000 gallons): Weathering Processes and Time Scales (Source: NOAA, 2006)

2.2 Model Input

2.2.1 Milne Inlet Met-Ocean Data Sources

To provide orientation for the reader before detailed discussion of the model setup and various model inputs, Milne Inlet met-ocean measurement data applicable for the open water season study are introduced.

The data sources are summarized in Table 2-4. The oceanographic measurement locations are shown in Figure 2-10. The met station location is shown in Figure 2-11.

Data collection commenced in June 2006 with weather station installation near the port site. Measurements from the weather station include hourly wind speed and direction, and air temperature. Details of the weather station winds and their utility for input to the spill model are presented in Sections 2.2.2.1 and 2.2.2.3.

Ocean current and directional wave data are available following execution of the September 2010 Milne Inlet Oceanographic Program. The month-long oceanographic program consisted of the following:

- Two 1-month-long Acoustic Doppler Current Profiler (ADCP) current profile datasets recorded near Cape Kwaunang. Both instruments recorded currents from September 1 to 30. The two instruments were set at mid-depth of a 145 m mooring, one looking up and the other looking down, allowing for full profiling of the water column
- Two 1-month-long ADCP current profile datasets recorded near the Milne dock face site. One instrument was deployed at the bottom at a depth of about 30 m looking up. A second instrument with added capability of measuring wave spectra and sea state parameters was mounted looking up on a floatation collar about 7 m below the surface. The ADCP at the bottom recorded currents from September 1 to 30. The ADCP in the floatation collar recorded currents and waves from September 1 to 19
- Two water level (tide gauge) records and a tidal constituent analysis based on the tide data. One tide gauge was deployed along the shore close to each of the ADCP sites. The tide gauge at the entrance of the Inlet recorded from September 1 to 7 when a grounding iceberg appears to have buried it into the shore where it was discovered at the end of September. The tide gauge located near the proposed dock recorded sea surface elevation from September 1 to 29
- Conductivity (and hence salinity) Temperature Depth (CTD) casts were completed at both sites at the beginning of the deployment
- Directional wave data recorded near the Milne wharf site during September 2010.

All relevant data plots from this September 2010 oceanographic monitoring are grouped in Appendix A.

Additional CTD profiles were also carried out by CORI in August 2010 (CORI, 2010) near the head of Milne Inlet. As presented in Section 2.1.4 these provide indication of sea surface temperature as input to fuel weathering estimation.

Table 2-4 Milne Inlet: Met-Ocean Data for Spill Modelling Summary

Source	Data	ID/Location	Period of Record
(RWDI, 2008)	1-hourly wind speed and direction[3], air temperature[4]	Milne Inlet Met Station 70° 17.68' N, 78° 25.54' W See Figure 2-11	22-Jun-2006 to 29-Sep-2010
(AMEC, 2010b)	ADCP[5] current speed and direction	Two 300 kHz instruments were deployed at the centre of the Inlet near cape Kwaunang; one 600 kHz and one 1200 kHz unit were deployed at the proposed dock site. See Figure 2-10	Sep-2010
(CORI, 2008, 2010) (AMEC, 2010b)	CTD (sea temperature and salinity vs. depth profiles)	CTD profiles at several stations at the head of Milne Inlet.	14/15-Jun-2008, 17-Sep-2008, 24-Aug-2010

[3] RM Young 5103 anemometer, winds at 10 m
[4] Campbell Scientific HMP45C212 Temperature and Relative Humidity probe
[5] Additional parameters include sea temperature, pitch, roll, pressure, and compass heading

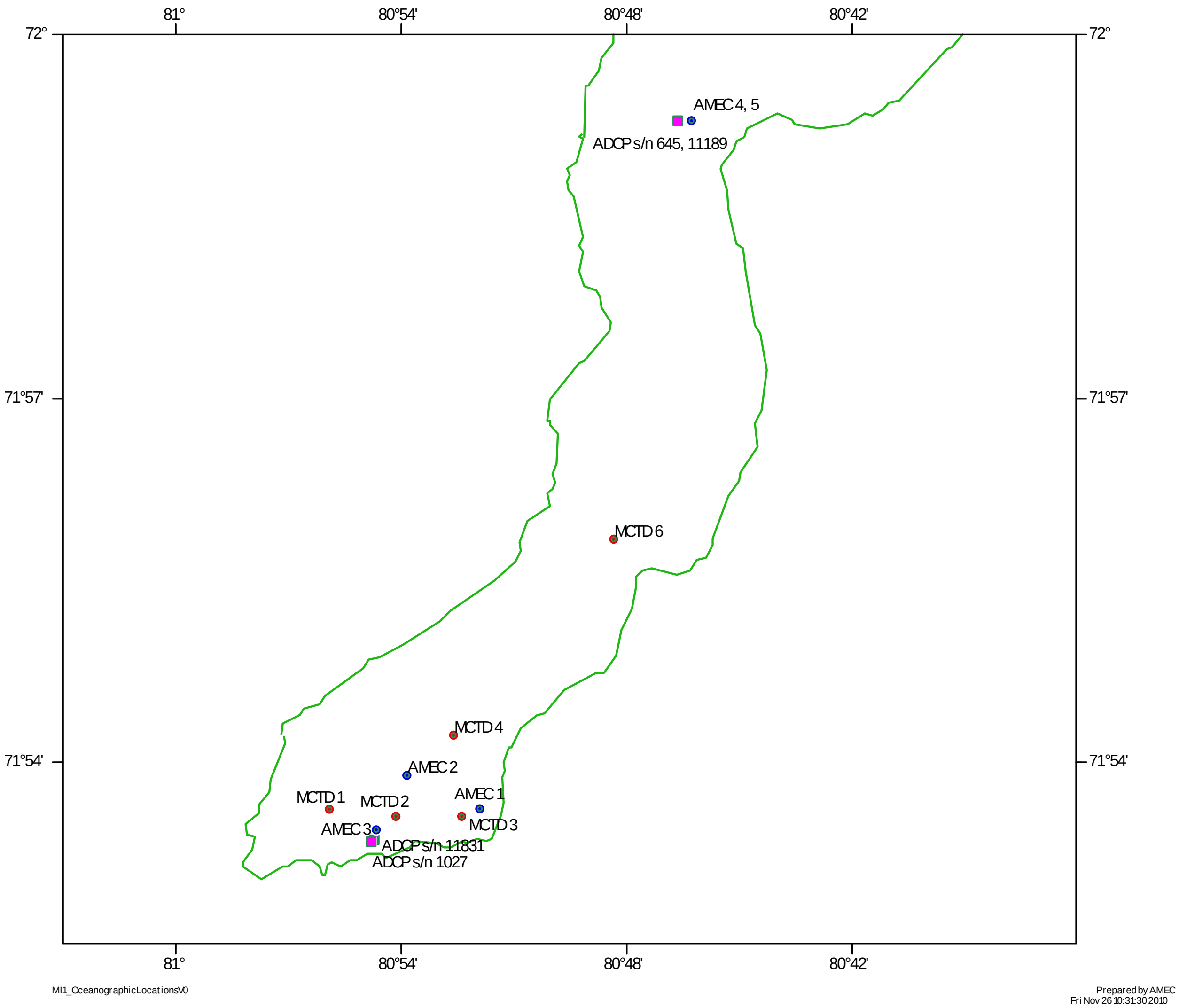


Figure 2-10 Milne Inlet: Oceanographic Measurement Locations. CORI CTD Stations as Red Circles; AMEC CTD Stations as Blue Circles; AMEC ADCP Deployments as Magenta Squares

2.2.2 Wind

As wind is the key factor in determining how far fuel may potentially be dispersed in the event of a spill, it is important to employ a good characterization of local wind behaviour as a driving force for the trajectory model. It is essential that any wind information be representative of the spill site and its surroundings, and that the wind data be available in the form of long (many year) time-series of speed and direction pairs, regularly spaced in time (hourly, three-hourly, six-hourly, etc.).

To be representative, the wind data must reasonably reflect conditions at or near the sea surface in the vicinity of any particular scenario spill site. The length of the record is important because it dictates the statistical reliability of conclusions drawn from its analysis. The regularity of time spacing is essential due to the structure of the advection calculations in the model.

For the winds in Milne Inlet, two data resources were examined as described in Sections 2.2.2.1 and 2.2.2.2.1: the Milne Met Station and NECEP/NCAR Reanalysis Winds. The selection of winds for model input is presented in Section 2.2.2.3.

2.2.2.1 Milne Met Station

There are wind measurements from the met station at the Milne camp located near the port site (RWDI, 2008) at position 71° 52.649' N, 80° 49.921' W (Figure 2-11). Primary parameters of interest include 1-hourly mean, minimum and maximum wind speed, and wind direction mean and standard deviation, measured with a RM Young 5103 anemometer. Additional hourly parameters from the met station include the following:

- hourly and 24 hour total rainfall
- air temperature
- minimum and maximum relative humidity
- mean and total solar radiation
- wind direction
- std. dev. wind direction
- total rainfall
- dew point
- mean heat index
- hours of sunshine
- mean, minimum and maximum wind chill

Measurements from the station are available for 17 June 2006 to 30 September 2010 with some gaps:

- 16 to 24 July 2007
- 25 May to 16 June 2008
- 9 Aug to 21 Sep 2008
- 17 Aug to 7 July 2010 (gaps due to experimental nature of some of the data logging/communication)
- intermittent from 7 July to 30 Sep 2010 (limited data due to remote access to the data logger)

AMEC assembled and reviewed the available digital data for a quality control check. The record 2010 Sep 25 1100h had a wind speed value of 21.6 m/s. Given neighbouring records one hour on either side of 1.6 m/s and 9.8 m/s, this was judged to be a spike and an interpolate of 5.7 m/s was inserted.

Linear interpolation of wind gaps of length one hour to as long as one day was completed.

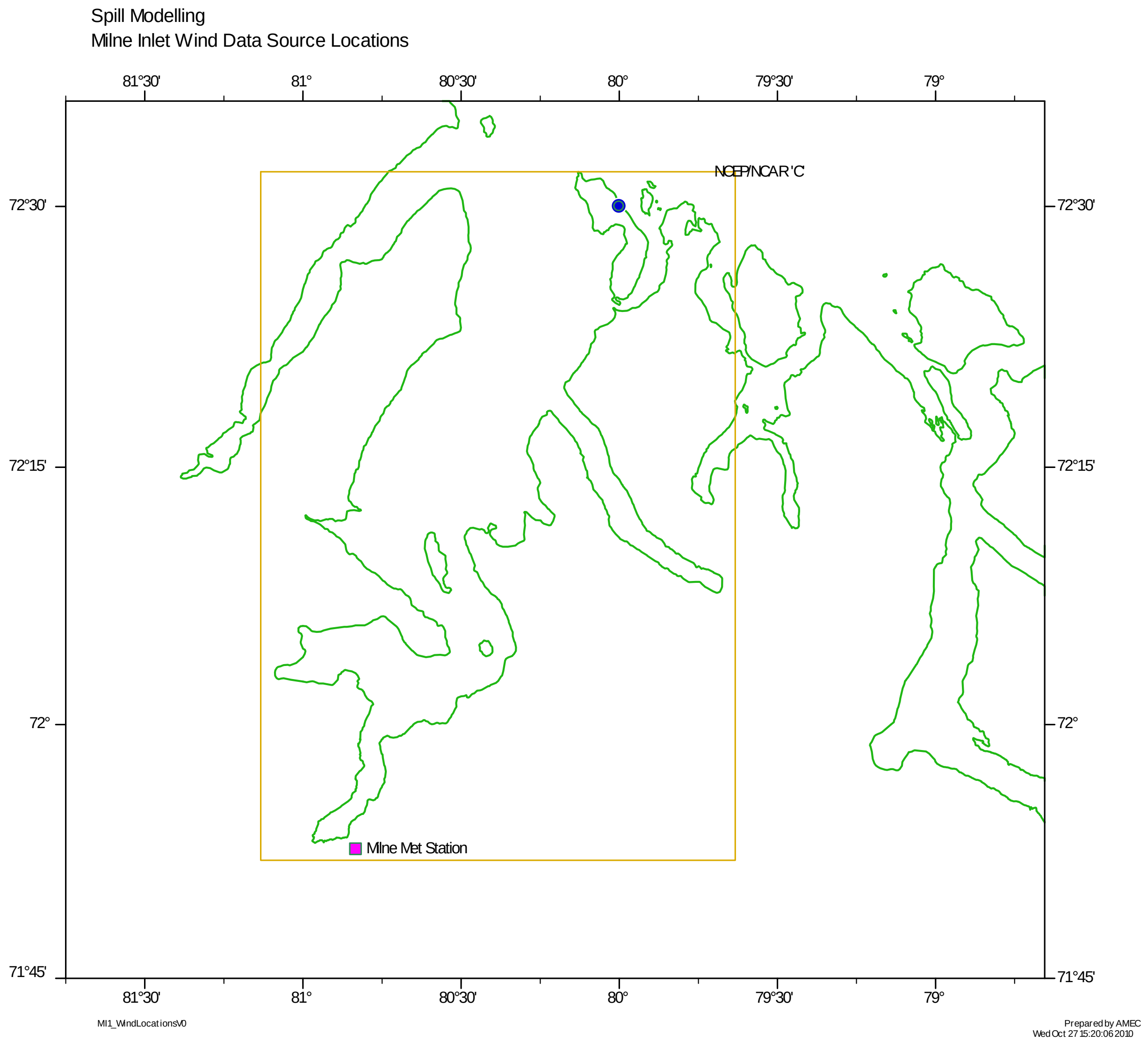


Figure 2-11 Milne Inlet: Wind Data Source Locations

Mean monthly wind speed statistics for the resulting Milne met station are presented in Table 2-5. Mean speeds range from 3.4 m/s in February to 5.5 m/s August and are 4.9 m/s in September. Monthly wind roses are presented in Figure 2-12. Appendix B presents time-series of open water season (August to October shown here) met station measurements including wind speed and direction together with a vector stick plot representation of the winds, and air temperature.

In September, the focus for open water season, winds from the met station are most frequently from the northeast at 31.9% of the time as reported in Table 2-8 Milne Inlet: September Wind Speed vs. Direction, 2006-2010 and also from the northwest and north at 17 and 16% of the time.

2.2.2.2 NCEP/NCAR Reanalysis Winds

The NCEP/NCAR Reanalysis Project (at the NOAA/ESRL Physical Sciences Division) (Kalnay et al., 1996) is a state-of-the-art analysis/forecast system that performs data assimilation using data from 1948 to the present. The winds are near-surface modelled winds representative of a 10 m elevation. The NCAR/NCEP data consist of six-hourly U (east-west) and V (north-south) components of wind velocity on a 2.5° latitude by 2.5° longitude grid. The nearest grid point for Milne Inlet are at 72.5° N, 80°W, a location 'C' approximately 75 km north of the Milne met station (Figure 2-11). This was selected for comparison purposes. Monthly wind speed statistics for 'C' are presented in Table 2-6 and Table 2-7. Both the 2006-2010 (since some recent July-September 2010 data were available) comparison period and the period 1980-2009 are presented; the latter since it was anticipated that a 30 year record would ultimately be required for the simulation.

Bivariate tables of wind speed vs. wind direction for September are presented in Table 2-9 and Table 2-10, listed below the Milne Site table counterpart. Monthly wind roses are presented in Figure 2-12 to Figure 2-14. In September, winds for the NCEP/NCAR location are most frequently from the northwest from about 27% of the time for the 2006-2010 period and 22% of the time for the 30 year record.

Table 2-5 Milne Inlet: Monthly Wind Speed (m/s) and Direction (from) Statistics, 2006-2010

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean hourly speed	3.7	3.4	4.5	4.2	3.8	5.3	5.4	5.5	4.9	5.2	4.5	4.2	4.6
Most frequent direction	SE	SE	SE	SE	NE	NE	NE	NE	NE	SE	SE	SE	SE
Max. hourly speed	24.2	19.5	19.3	22.6	15.9	18.1	21.7	19.1	19.4	24.8	28.8	20.9	28.8
Direction of max. hourly speed	NE	SE	SE	SE	NE	SE	SE	SE	SE	SE	NE	SE	NE

Table 2-6 NCEP/NCAR ‘C’: Monthly Wind Speed (m/s) and Direction (from) Statistics, 2006-2010

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean hourly speed	5.1	4.7	4.5	5.0	4.2	4.8	4.8	4.8	5.4	6.0	4.8	4.8	4.9
Most frequent direction	NW	W	W	NW	NW	E	E	E	NW	NW	W	W	NW
Max. hourly speed	13.6	13.5	15.4	13.0	13.8	15.0	14.2	13.9	19.2	16.4	11.6	15.2	19.2
Direction of max. hourly speed	E	E	E	SW	W	NE	E	E	E	NE	E	NE	E

Table 2-7 NCEP/NCAR ‘C’: Monthly Wind Speed (m/s) and Direction (from) Statistics, 1980-2009

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean hourly speed	5.2	5.1	5.1	5.1	4.7	4.6	4.9	5.2	5.5	6.0	5.5	5.3	5.2
Most frequent direction	W	W	W	W	NW	NW	W	NW	NW	W	W	W	W
Max. hourly speed	15.3	16.1	15.8	16.8	17.7	15.3	14.7	17.7	22.8	22.1	18.7	20.8	22.8
Direction of max. hourly speed	W	E	NW	E	E	E	SW	E	E	E	N	NE	E

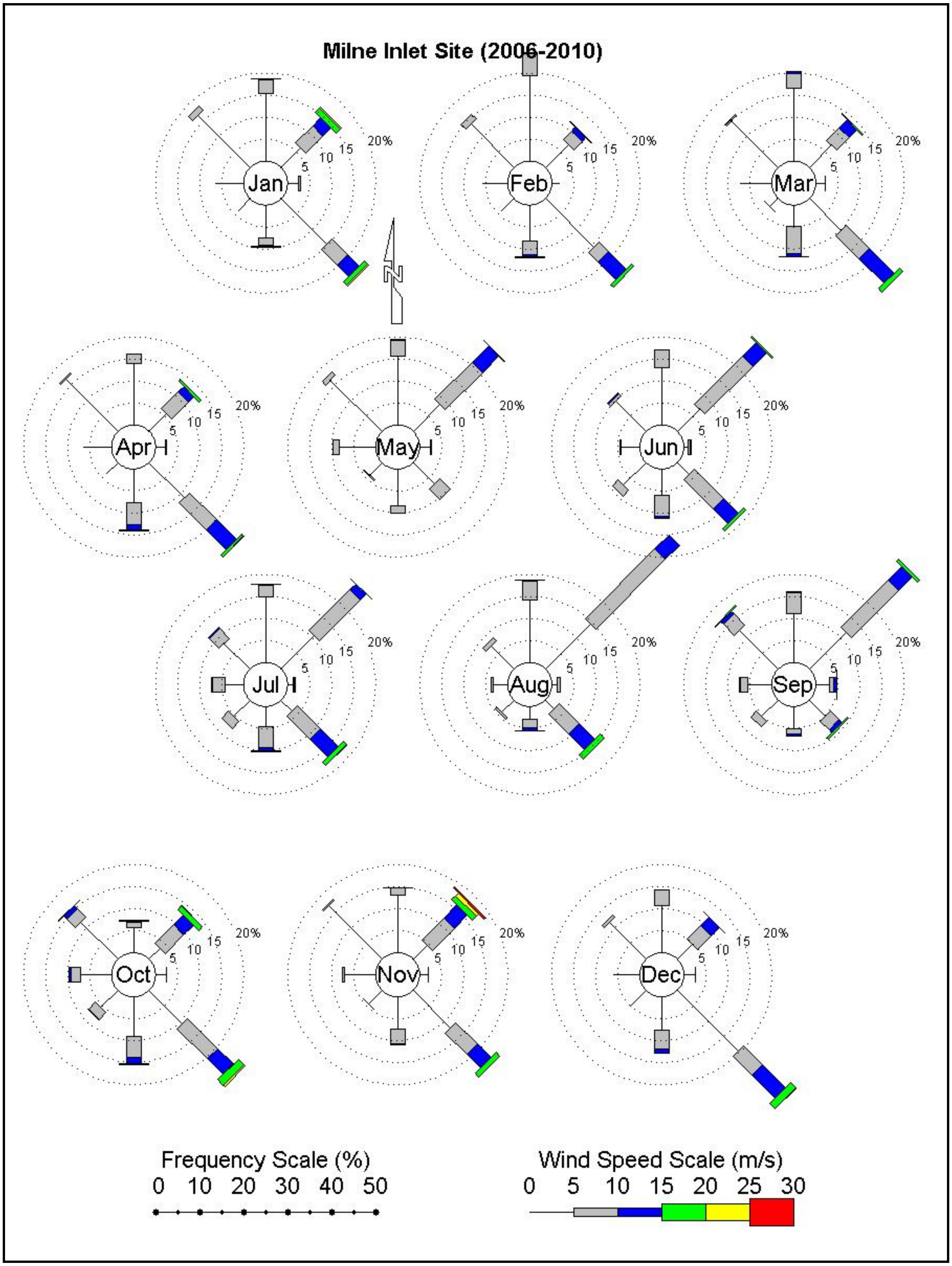


Figure 2-12 Milne Inlet: Monthly Wind Roses, June 2006- September 2010

Table 2-8 Milne Inlet: September Wind Speed vs. Direction, 2006-2010

Speed (m/s)	Direction (from) N	NE	E	SE	S	SW	W	NW	Total
15-20	0.0	0.5	0.1	0.5	0.0	0.0	0.0	0.2	1.4
10-15	0.1	4.5	0.5	0.8	0.5	0.0	0.1	0.8	7.3
5-10	4.9	15.1	1.1	2.9	1.2	1.8	1.8	3.6	32.3
0- 5	11.1	11.8	3.0	5.1	5.0	5.3	5.4	12.4	59.0
Total	16.1	31.9	4.8	9.3	6.6	7.1	7.3	17.0	100.0

Table 2-9 NCEP/NCAR ‘C’: Monthly Wind Speed vs. Direction, 2006-2010

Speed (m/s)	Direction (from) N	NE	E	SE	S	SW	W	NW	Total
15-20	0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.2	0.8
10-15	0.5	0.8	0.8	0.0	0.0	0.0	0.5	2.8	5.5
5-10	4.8	4.7	8.3	1.8	1.0	2.3	6.7	13.3	43.0
0- 5	8.8	5.7	6.5	3.3	1.5	5.2	9.2	10.5	50.7
Total	14.3	11.2	16.2	5.2	2.5	7.5	16.3	26.8	100.0

Table 2-10 NCEP/NCAR ‘C’: Monthly Wind Speed vs. Direction, 1980-2009

Speed (m/s)	Direction (from) N	NE	E	SE	S	SW	W	NW	Total
20-25	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
15-20	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.2	0.6
10-15	0.2	0.7	1.6	0.4	0.3	0.4	1.0	1.9	6.4
5-10	3.8	3.8	5.7	3.2	2.5	4.2	9.1	11.1	43.3
0- 5	7.3	6.0	5.6	4.9	4.0	5.0	7.7	9.1	49.6
Total	11.2	10.4	13.3	8.5	6.8	9.6	17.9	22.3	100.0

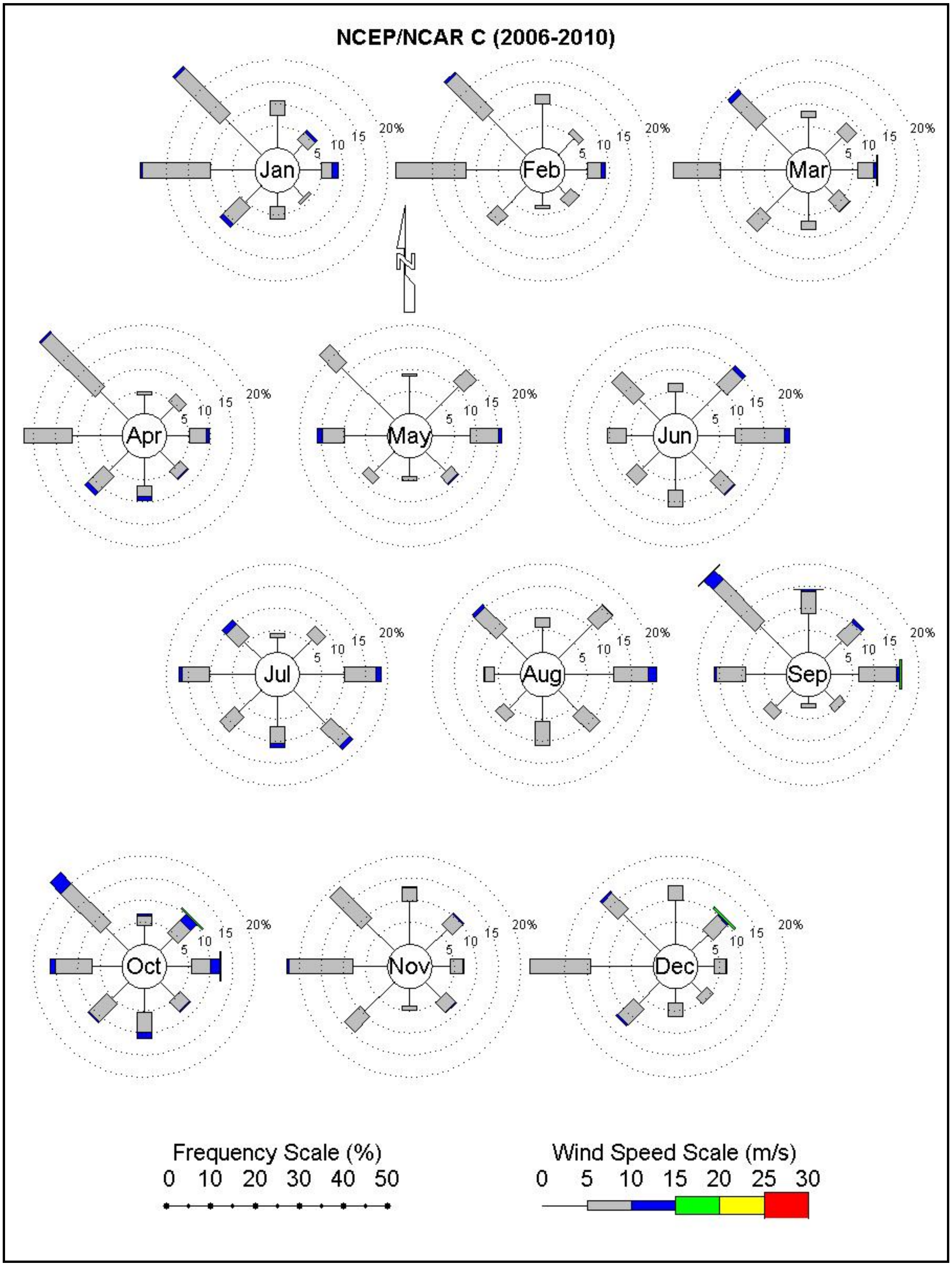


Figure 2-13 NCEP/NCAR 'C': Monthly Wind Roses, 2006-September 2010

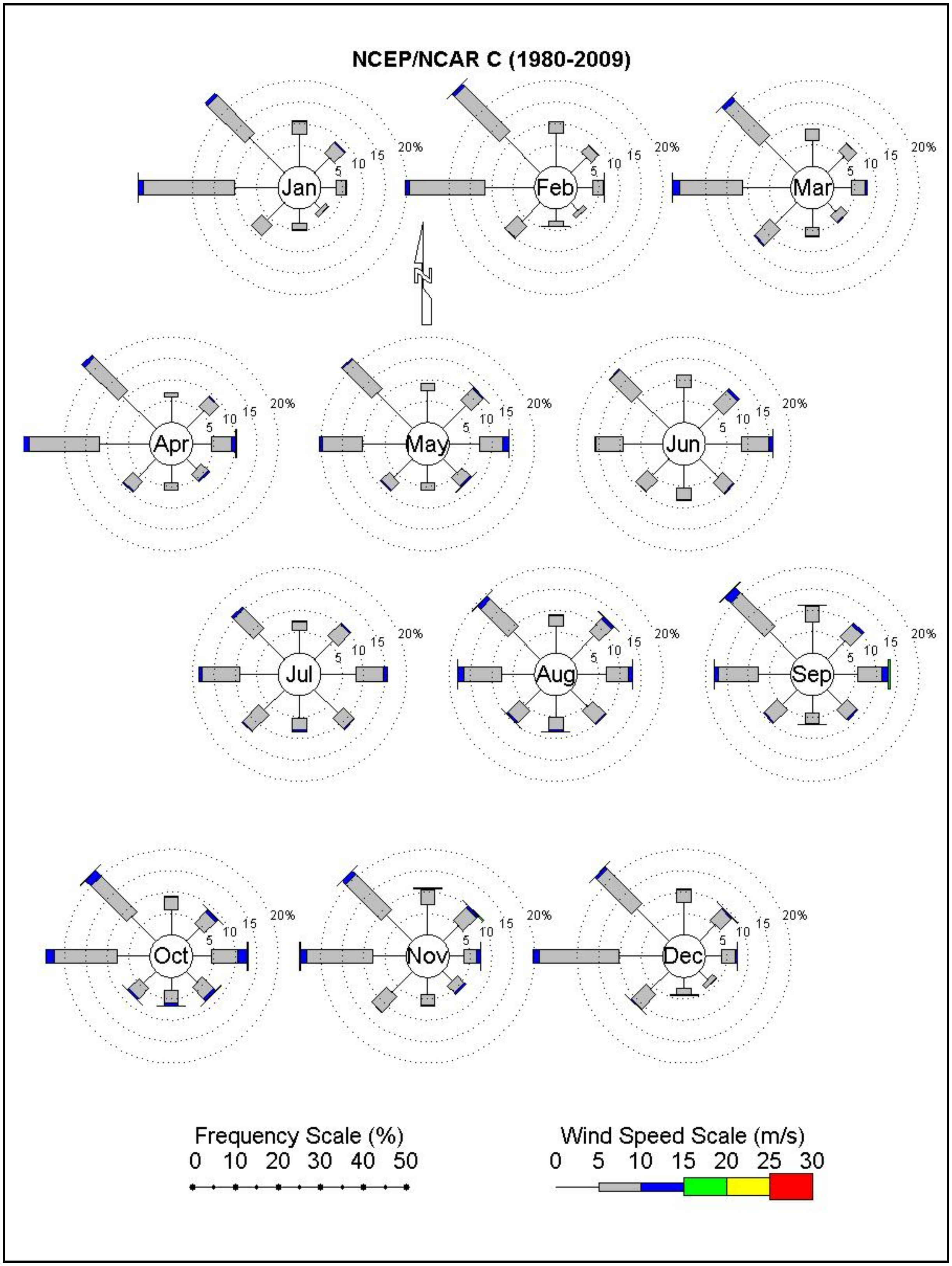


Figure 2-14 NCEP/NCAR 'C': Monthly Wind Roses, 1980-2009

2.2.2.3 Selection of Wind Inputs

To determine an appropriate wind input data set, it was anticipated that the NCAR/NCEP winds would offer the greatest utility due to their long record length of many years; however, some measure of calibration was required to ensure these winds were appropriate for the study area.

The measured Milne met station site winds from 2006 to 2010 were compared with the NCAR/NCEP winds at grid point 'C' for the same time period. A visual comparison between the winds, as shown in Figure 2-15 and Figure 2-16 for the August to October time periods in 2007 and 2008 respectively, indicates generally quite close agreement both in terms of wind speed and wind direction.

A statistical comparison of the winds was next undertaken focusing on the coincident 2006 to 2010 interval. As shown in Figure 2-17, good agreement is found for mean wind speed. For larger wind speeds, as indicated by the 95% upper limit value, while the agreement in September is good, for other months the Milne met station winds are about 30% on average greater than those for the NCEP/NCAR 'C'. Agreement in mean wind speed by wind direction is less of a match as shown in Figure 2-18. This directional difference, specifically for September, was also evident from the wind roses presented above. Given the fjord topography of the inlet, it is likely that wind channelling, the tendency of the wind to blow along the axis of a channel or to be deflected by the land, is a major factor contributing to changes in wind direction for Milne Inlet. One may infer that this and the given the distance between the two locations, of about 75 km, are the contributing factors for the differences seen. Nevertheless, the NCEP/NCAR 'C' represented the closest long time-series record available, and was selected to provide a reasonable wind input for the spill model.

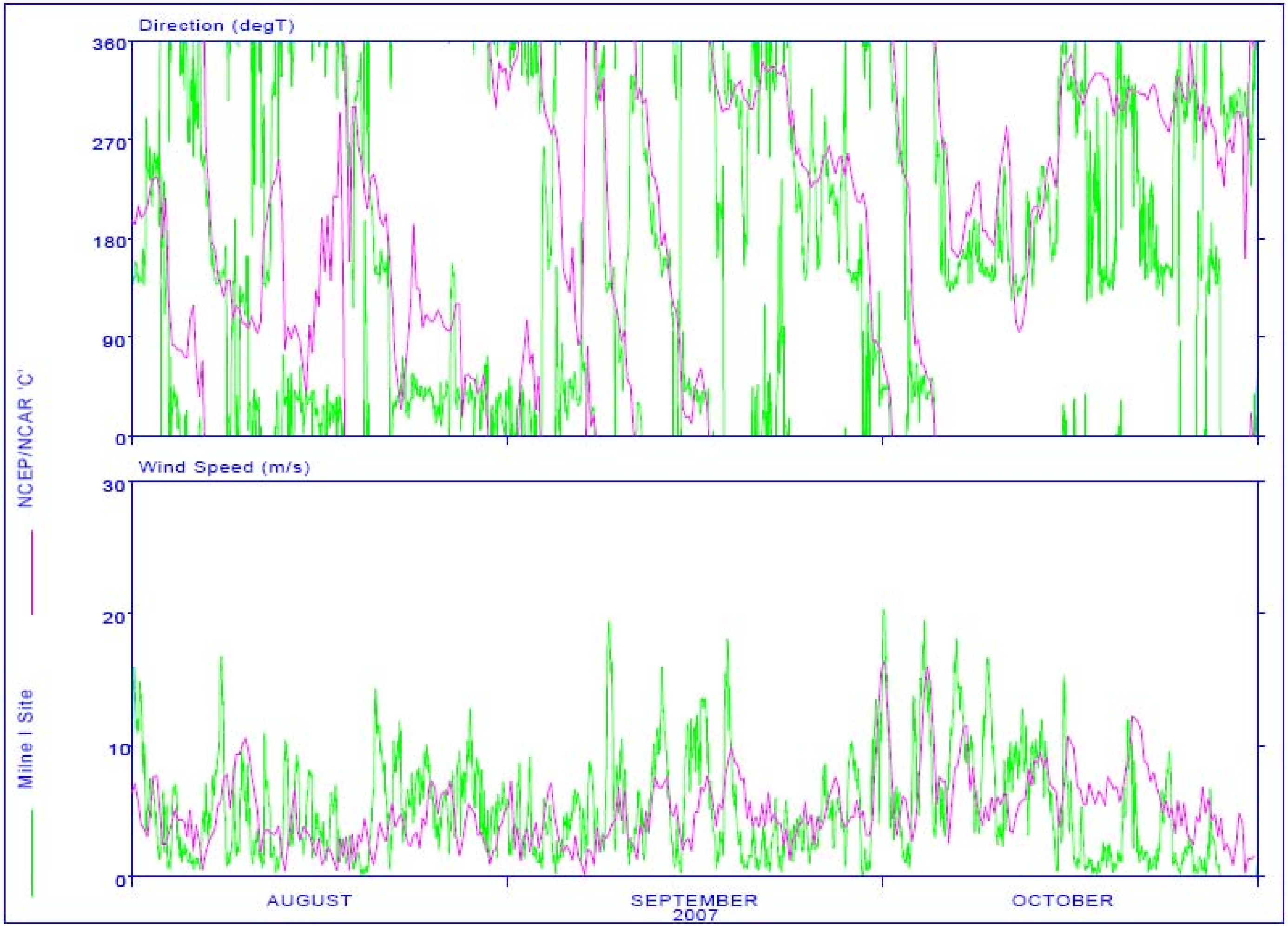


Figure 2-15 Milne Inlet, NCEP/NCAR: Wind Speed Comparison, August-October, 2007

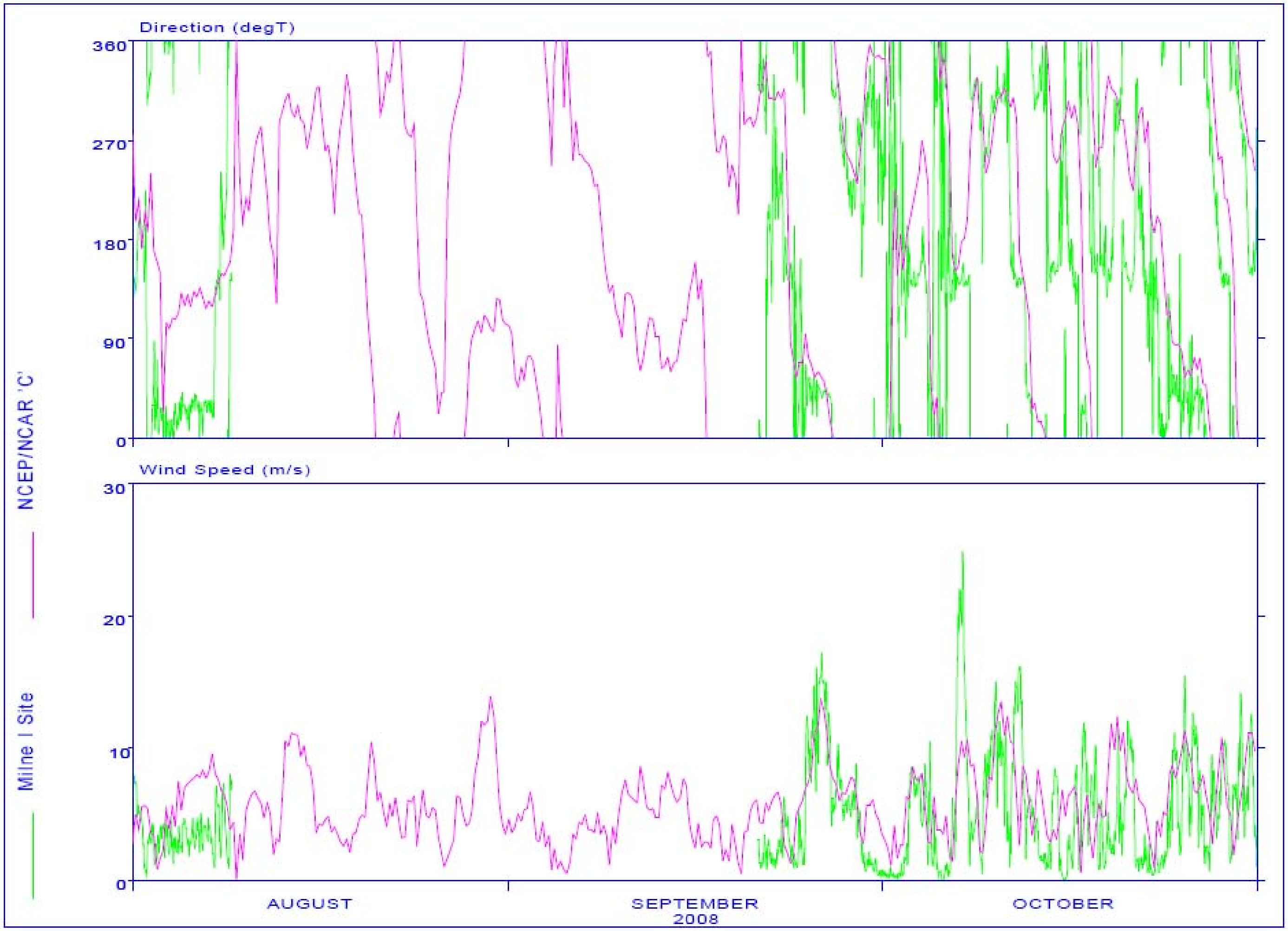


Figure 2-16 Milne Inlet, NCEP/NCAR: Wind Speed Comparison, August-October, 2008

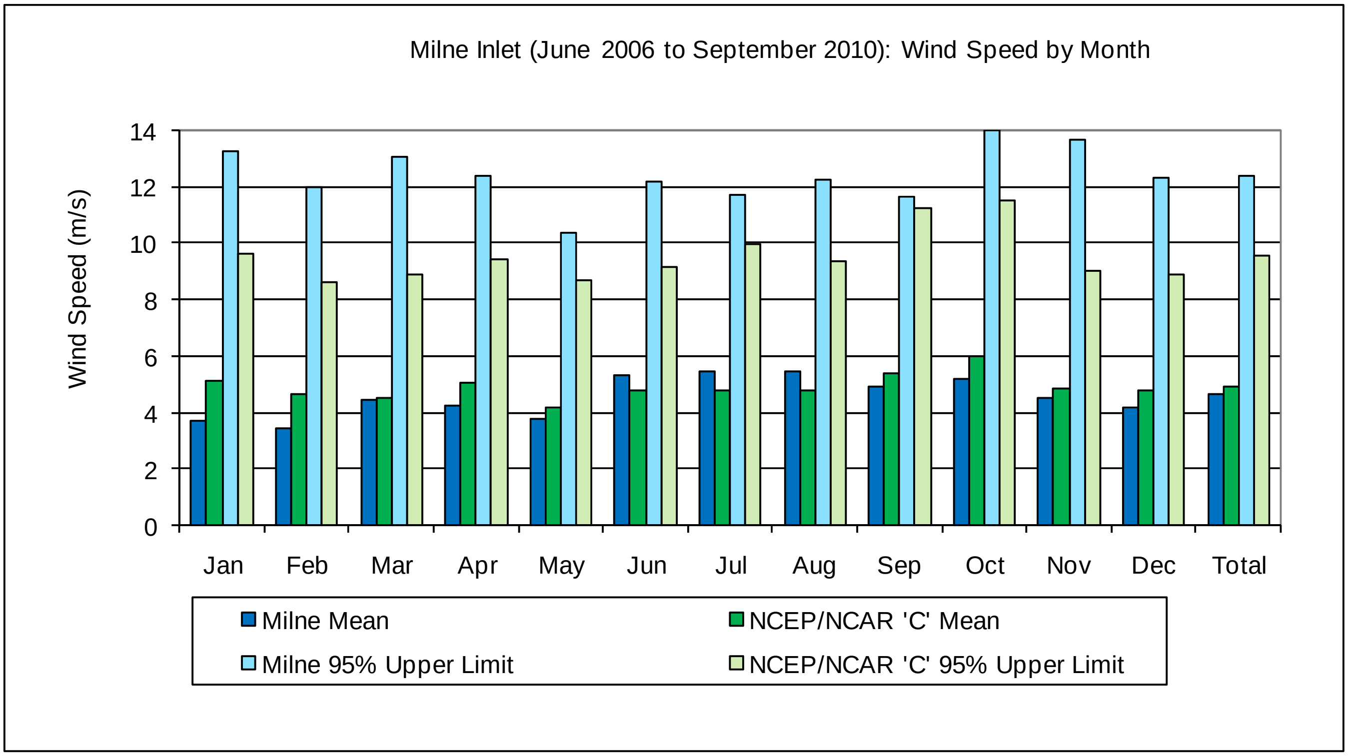


Figure 2-17 Milne Inlet: Wind Speed by Month (Met Station, NCEP/NCAR 'C')

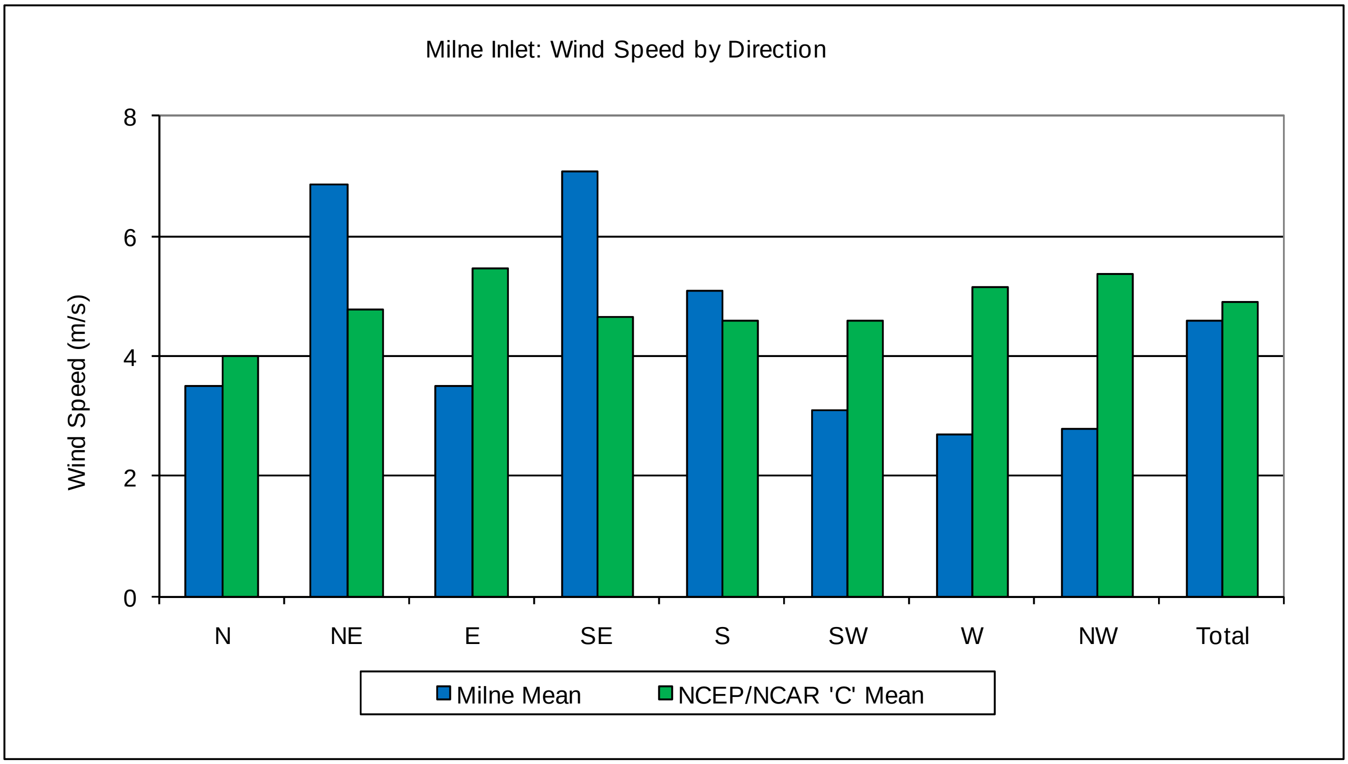


Figure 2-18 Milne Inlet: Mean Wind Speed by Direction, (Met Station, NCEP/NCAR 'C')

2.2.3 Ocean Currents

For the spill model, ocean currents, including tidal current and residual components were assessed for consideration of a spill in Milne Inlet. Prediction of tidal currents and initial analysis of measurements indicates that tidal currents are so small that they were considered negligible for spill modeling. The oceanographic program data are presented here in order to confirm *a posteriori* the validity of this decision (made before analysis of oceanographic program data was complete) and assess the strength of non-tidal currents, mainly resulting from atmospheric forcing. This provides a basis for the discussion on how such currents would affect or modulate the predicted fate of spills by the model using wind only.

The September 2010 oceanographic program introduced in Section 2.2.1 provides current, tide, and water property measurements necessary for understanding any aspects of the circulation from the head of Milne Inlet out to Cape Kwaunang. The companion oceanographic program report (AMEC, 2010b) provides detailed results, description, and interpretation. The following findings drawn from that work are presented here in the light of their likely application for the spill modelling exercise.

Predicted tidal water level variations are in good agreement with measured water levels both at the site entrance to the upper portion of Milne Inlet near Cape Kwaunang and at the site of the proposed dock. This indicates that the model performs overall correctly, allowing the right volume of water to flow in and out of the Inlet at each tidal cycle.

Tidal analysis was performed on the depth-averaged current records at both sites for comparison with the modelled currents. At the site near Cape Kwaunang there is an overall reasonable agreement for the north components of the current, i.e., roughly the current in and out of the Inlet. There is good agreement for the phases, but the model predicts stronger currents than measured especially during the ebb (flow out to the north). There is poor agreement for the east component as was expected because the measurements are at the open boundary of the model and the geometry of the Milne Inlet north of Cape Kwaunang just outside is complex. The maximum measured tidal current is about 0.02 m/s.

Near Cape Kwaunang, tides represent about 30% of the total observed variability of the currents indicating that other processes such as atmospheric forcing are dominant. At the proposed dock site, results from the tidal analysis of the measured currents show that the main tidal constituents have a signal to noise ratio of about 1 and that estimated tidal currents are smaller than the standard deviation of the instrument measurement error: tidal currents are effectively not discernable from measurement noise. This supports the decision based on modeled tidal currents that tidal currents are negligible and that spill modelling can be undertaken driven by wind only.

The colour plots of the current profiles in Appendix A show several events when currents up to about 0.3 m/s occur at various depths. Near Cape Kwaunang, the strongest currents are confined within the top 40 m of the water column. The main event stretches between 7 and 13 September. The peak currents are confined to a relatively narrow range of depth (about 5 to 10 m) with weaker currents below and above. The current speed and direction plots from the upper ADCP clearly show that during this event there are two layers of stronger currents, roughly above and below 20 m, moving in opposite directions. The top layer actually moves to the northeast, opposite to the wind, which indicates the presence of a third layer above the topmost ADCP bin where currents would be downwind. This top layer with current in the same direction as the wind is visible in the record of the dock site ADCP at a depth of 7 m which is able to measure currents up to less than 2 m deep. From 22 September onwards, there appears to be three and even four layers with currents in alternating opposite directions. Records from the ADCPs at the dock site also show frequently three or four layers in alternating opposite directions.

Such complex vertical current structure can develop in the presence of strong vertical stratification. The CTD casts from 30 August and 1 September show strong stratification in temperature and even stronger in salinity over the top 40 m over a relatively homogeneous layer down to the bottom: temperatures decrease from about 8° C at the surface to -0.5° C at the bottom while the salinity increases from about 18 PSU at the surface to 32 PSU. This results in very strong density stratification over the top 40 m.

Temperature records from the tide gauges near Cape Kwaunang and near the dock site (average depths of 9 m and 11 m respectively), as well as from the two ADCPs at the dock site (average depths of depths of 7 m and 29 m) show rapid temperature variations of up to 4° C. These variations are relatively well-correlated with each other and with changes in wind direction (especially the three shallow records): temperature increases when the wind is blowing from the northeast and decrease when the wind veers to the north. Based on the CTD profiles taken at the beginning of September, such temperature variations at these depths correspond to vertical displacements of the density layers (isopycnals) of more than 10 m. Events of stronger current coincide relatively well with these temperature variations (vertical motions of the isopycnals) and changes in wind direction. This suggests that these peaks of currents are associated with the adjustment of the very strongly vertically stratified subsurface water to the surface wind setup not only at the scale of the head of Milne Inlet monitored and modelled but of the entire convoluted fjord system that Milne Inlet is.

Because of the strong vertical stratification, adjustment of Milne Inlet to wind involves a complex combination of forced motions and free oscillation (internal waves). Plots of current speed and direction show many instances where peaks and directions are migrating upward with time. This upward propagation of the horizontal oscillations is characteristic of internal waves (most likely internal seiche in the confined environment of Milne Inlet).

At dock side, with a water depth of about 30 m, the entire water column is in the strongly stratified layer. Interaction of stratification with the steep slope of the banks adds additional complexity in the form of locally generated internal waves resulting from isopycnals being driven up or down the slope by the ambient Inlet scale currents. This results in very finely structured two or three layer patterns in the top few metres of the water column as is visible in the dock site current records from 16 to 19 September.

Although strictly speaking surface currents are not measured by ADCPs, it is possible to extrapolate from the sub-surface measurements. As mentioned above, the horizontal oscillatory currents associated with internal waves propagate to the surface so that currents of strength similar to those of measured sub-surface currents can be expected. Surface currents associated with internal waves are commonly observed in fjords because they affect the aspect of the water surface (slicks).

How these currents associated with adjustment of strongly stratified Milne Inlet to wind setup might affect spill trajectories predicted using a model driven by wind only will be discussed in Section 4.

2.2.4 Ice Considerations

While not intended to be an exhaustive discussion of landfast and sea (or pack) ice conditions in the Milne Inlet region and factors affecting its formation, this Section provides an illustration of the likely September open water (spill scenario) season period and ice conditions which might be expected near that time.

The Canadian Ice Service (CIS) Sea Ice Climatic Atlas, Eastern Arctic (CIS 2010a) provides descriptions of the ice regime for Baffin Island and approaches. The products in the atlas were obtained from a statistical compilation of the regional charts for the years 1971 to 2000.

On average, for Milne Inlet, freeze-up occurs around the week of October 8 (Figure 2-19). Break up occurs by the last week of July and first week of August (Figure 2-20)[6]. A cold, southerly, current along the Baffin Island coast results in early ice formation and delayed spring breakup for this region which includes the waters at the mouth of Milne Inlet.

An illustration of the timing of break-up and development of sea ice in Milne Inlet is provided in Figure 2-21 and Figure 2-22 which present median ice concentration[7]. For the week of July 30 ice is present at 1/10 to 3/10 concentration from the head of the inlet to concentrations of 7/10 to 8/10 at the mouth of the inlet including some ice at 9/10 to 9+/10 in Eclipse Sound. A week later, August 6, the inner portion of Milne Inlet almost to the northern tip of the Borden Peninsula is ice free: there is some ice at 1/10 to 6/10 concentrations into Eclipse Sound. The median ice presence is then zero until the week of October 1 when some ice at 1/10 to 3/10 ice concentration has formed in the passage with Baffin Island west of Bylot Island. By October 8, ice has filled the inlet at concentrations of 9/10 to 9+/10 from the head of the inlet to as far as Eclipse Sound.

Young ice, with thickness 10-30 cm, is present in the early season in Milne Inlet. Figure 2-23 shows the median of predominant ice type when ice is present for the week of October 8. For Milne Inlet this consists of new (< 10 cm) ice, with smaller patches of and grey (10-15 cm) ice in Eclipse Sound. By the week of October 15 the upper quarter to third of the inlet is predominantly grey ice. Two weeks later, Milne Inlet, Eclipse Sound, and the western portion of Pond Inlet is predominantly grey-white (15-30 cm) ice.

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[6] Dates of Freeze-up and Break-up: The "Dates of Freeze-up and Break-up" depicts the extent of ice on a bi-weekly basis during the freeze-up and break-up seasons. They provide a pictorial representation of the evolution of ice during those periods. These products are constructed using the Median of Ice Concentration charts and thus the confidence level is high. (CIS 2010a, Chapter 1 “Regional Ice Charts and The Atlas Products”)

[7] The ice concentration legend shows: blue, less than 1/10; green, 1-3/10; yellow, 4-6/10; tan, 7-8/10; red, 9-9+/10; black, 10/10; and land, light brown.

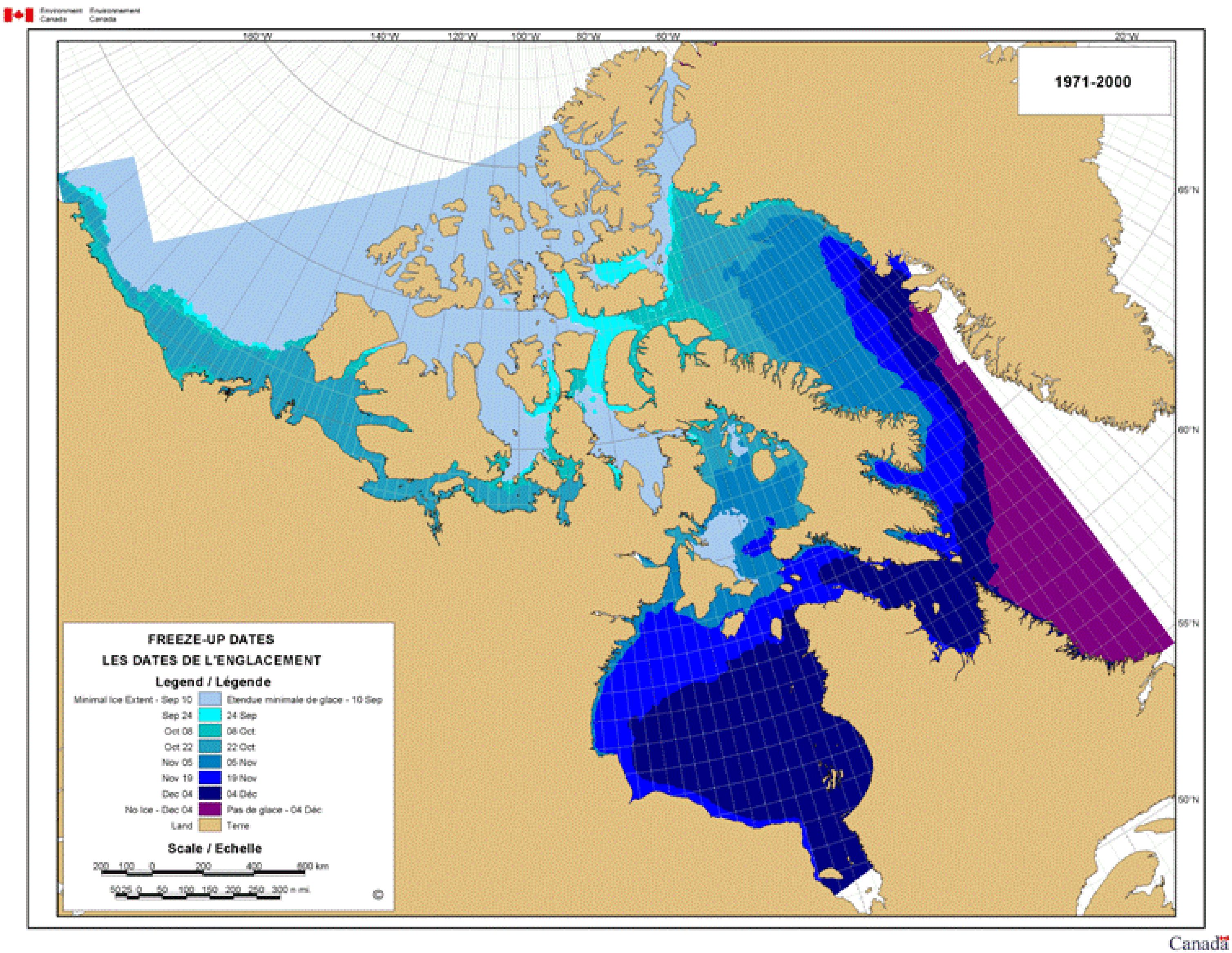

Figure 2-19 Eastern Arctic: Freeze-up Dates (Source: CIS 2010a)

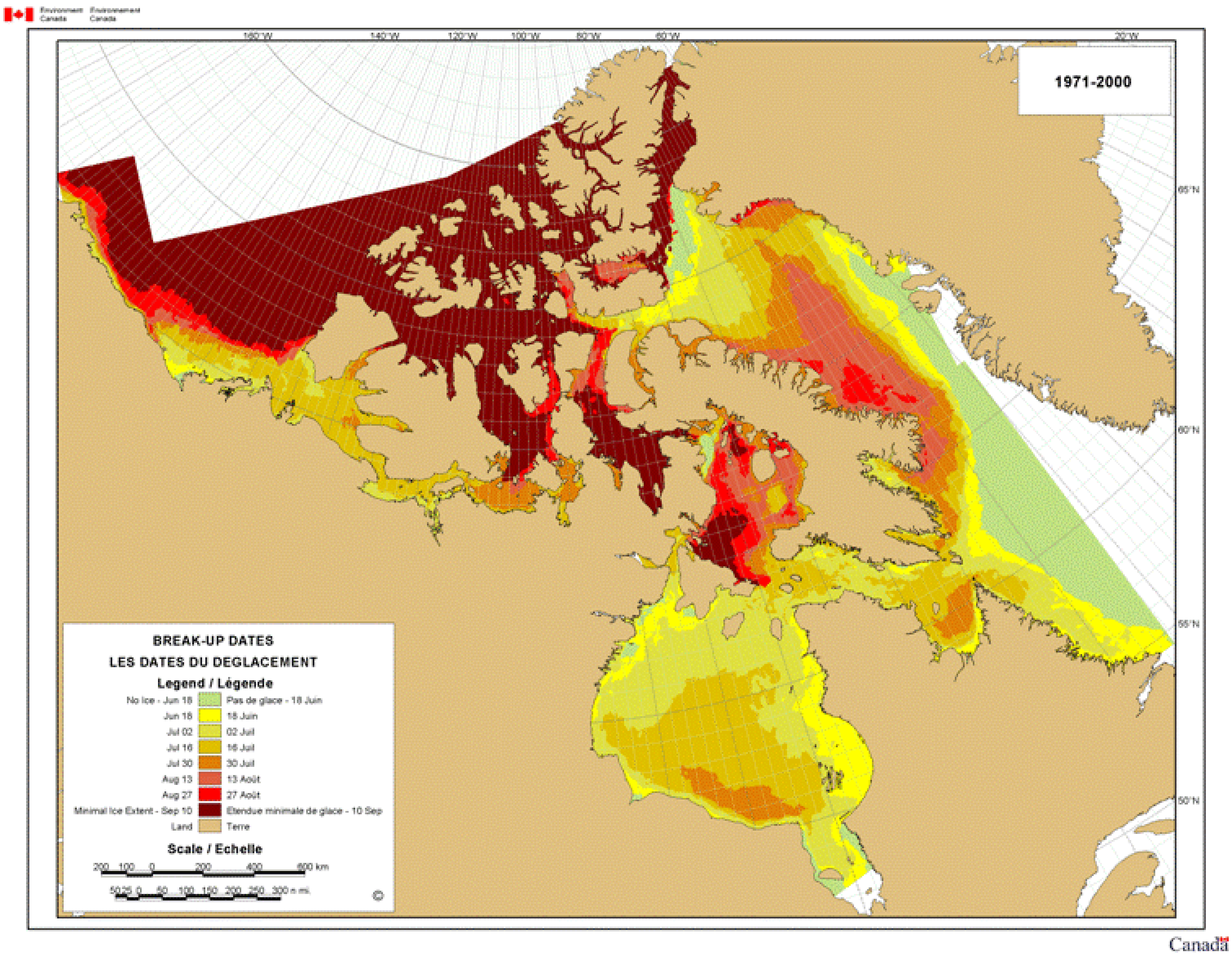

Figure 2-20 Eastern Arctic: Break-up Dates (Source: CIS 2010a)

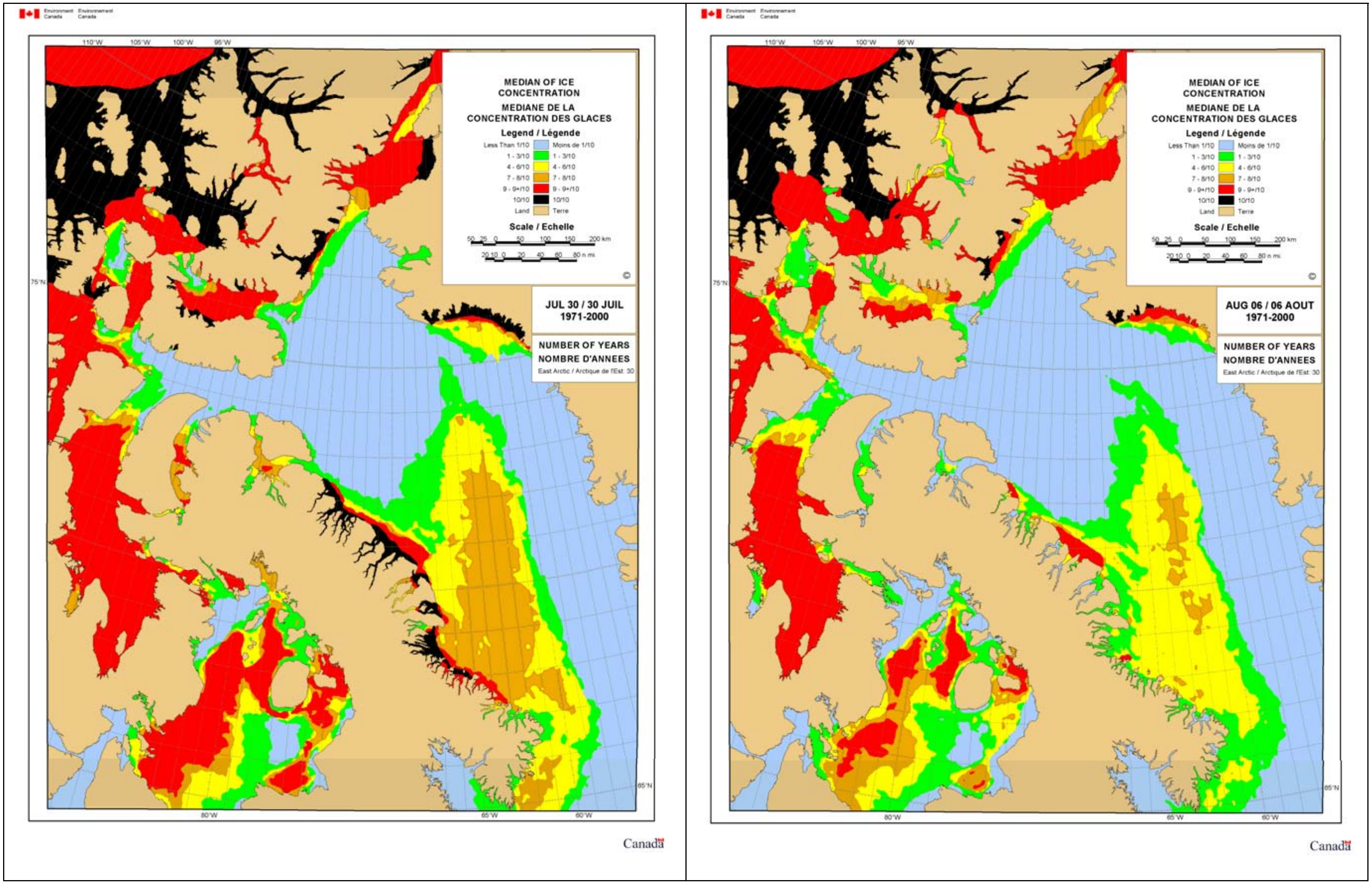

Figure 2-21 Median of Ice Concentration: Weeks of July 30 and August 6 (Source: CIS 2010a)

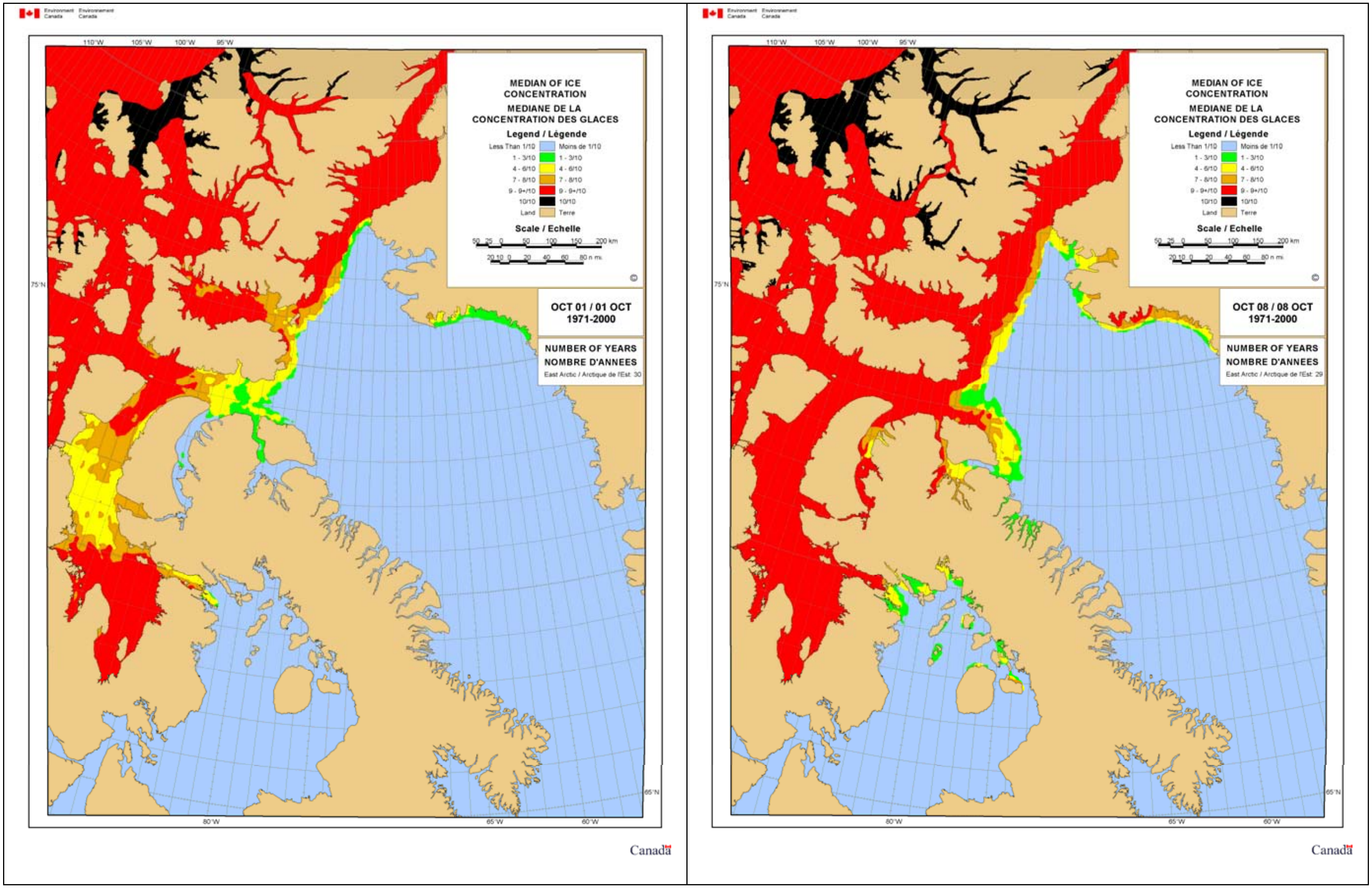

Figure 2-22 Median of Ice Concentration: Weeks of October 1 and 8 (Source: CIS 2010a)

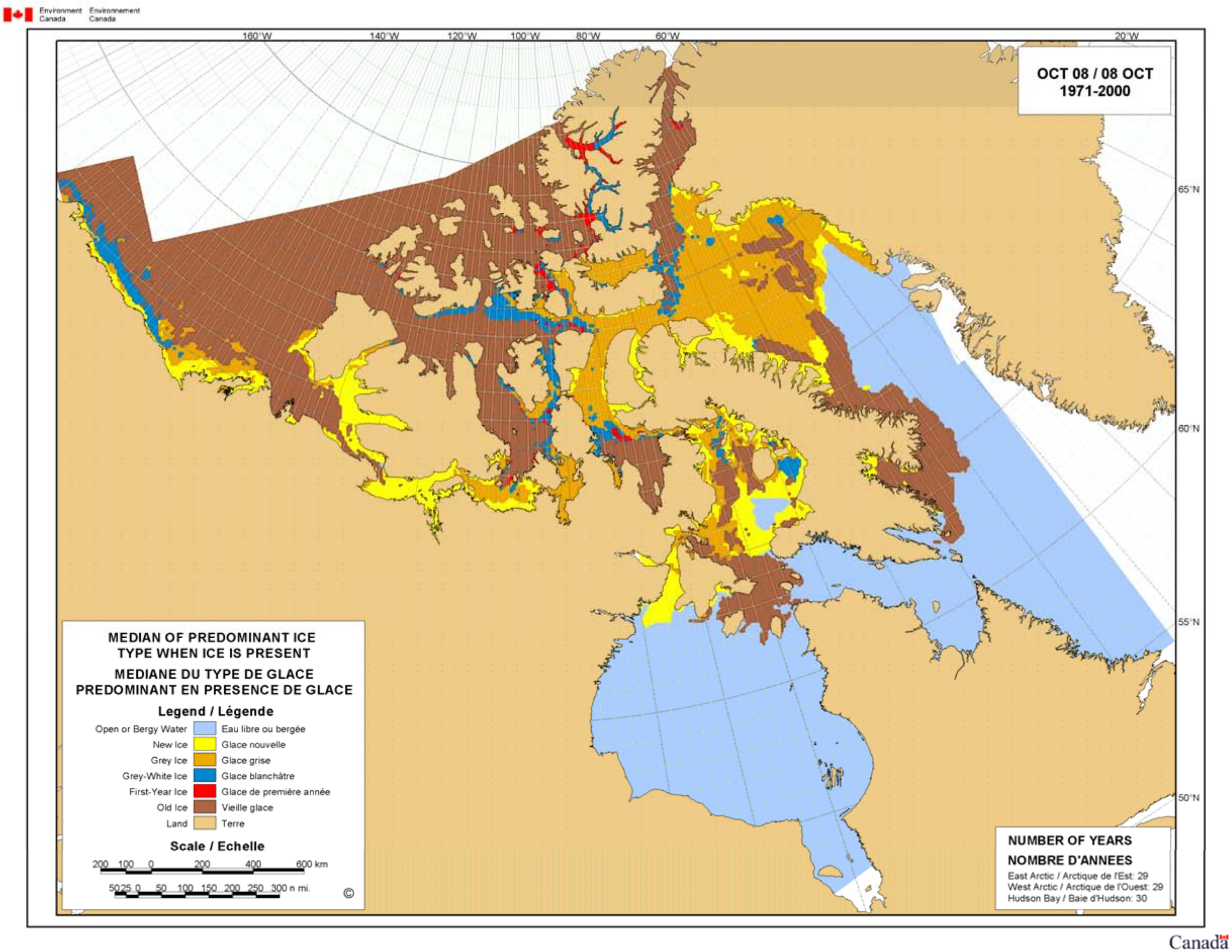

Figure 2-23 Median of Predominant Ice Type When Ice is Present, Week of October 8 (Source: CIS 2010b)

2.3 Model Output

2.3.1 Individual Day Spill Trajectory Plots

The basic spill modelling result is generated by introducing a spill on any given day of a given month, e.g., September, of any year, at the scenario location. The trajectory of the spill is computed over an ensuing time interval until the trajectory eventually terminates on a coastline or on an external boundary (e.g., latitude 70° 32'N at the north of the model grid) or until a maximum duration of thirty days is reached. For example, a spill initiated on 1 September 1980 would take as input the portion of the 1980-2009 wind time-series that commences on 1 September 1980 (thirty years is taken as a representative period to characterize the wind climate for this study). The model trajectory then traces out the path the spill would take over the subsequent thirty days: 1 September, 2 September ..., 30 September or until, as noted above, the trajectory terminates on a coastline or model grid boundary. (Any spill that continues into October uses the corresponding October winds.) This trajectory is one "representative case" and illustrates the possible geographical distribution of fuel which could have evolved for a spill originating on that day in the given month and year (e.g., 1 September 1980).

2.3.2 Shoreline Zone Definitions

For a scenario in which at least one trajectory terminates ashore, the fuel distribution probability calculations yield an accompanying set of shoreline summary statistics (e.g., at the end of Table 2-11). These statistics identify, by geographical region, the percentage of trajectories that reach shore, and the earliest, mean, and latest times to shore. For the Milne Inlet study area six regions are defined to cover the southern half of the model domain. After the grid was defined it was determined from trial model runs that there was little potential transport beyond this portion of the inlet. These regions are illustrated in Figure 2-24.

The basic underlying result of the model is illustrated through an example in Figure 2-25 which shows spills originating from the Port Site for all all September 27ths for each of the 30 years 1980 to 2009, respectively. The end point of each trajectory is labeled with that trajectory's day, or year as the case may be. A plus sign, '+', is marked at midnight of each day.

Companion model output listings presented in Table 2-11 report statistics for each day/year trajectory as follows:

- row and column of the grid cell where the trajectory ended
- "ORI" land ('I') or water ('O') designation of the end point
- range, bearing, and latitude and longitude or the end point
- whether the trajectory reached shore or a model boundary
- elapsed time of the trajectory, until it ended
- path length and mean speed
- percent of original fuel volume remaining after weathering

These examples illustrate the individual day trajectories. By introducing a spill at the beginning of each day of September for each of the 30 years of wind data, and superimposing the resulting 900 daily trajectories on a single plot, a representative indication of possible slick motion for that month is achieved. This is quantified through a count of the number of individual trajectories that travel through a given square, e.g., 18 is 2% of the 900 trajectories so that one can estimate a 2% probability of fuel reaching that grid square. This is described further in Section 2.3.3.

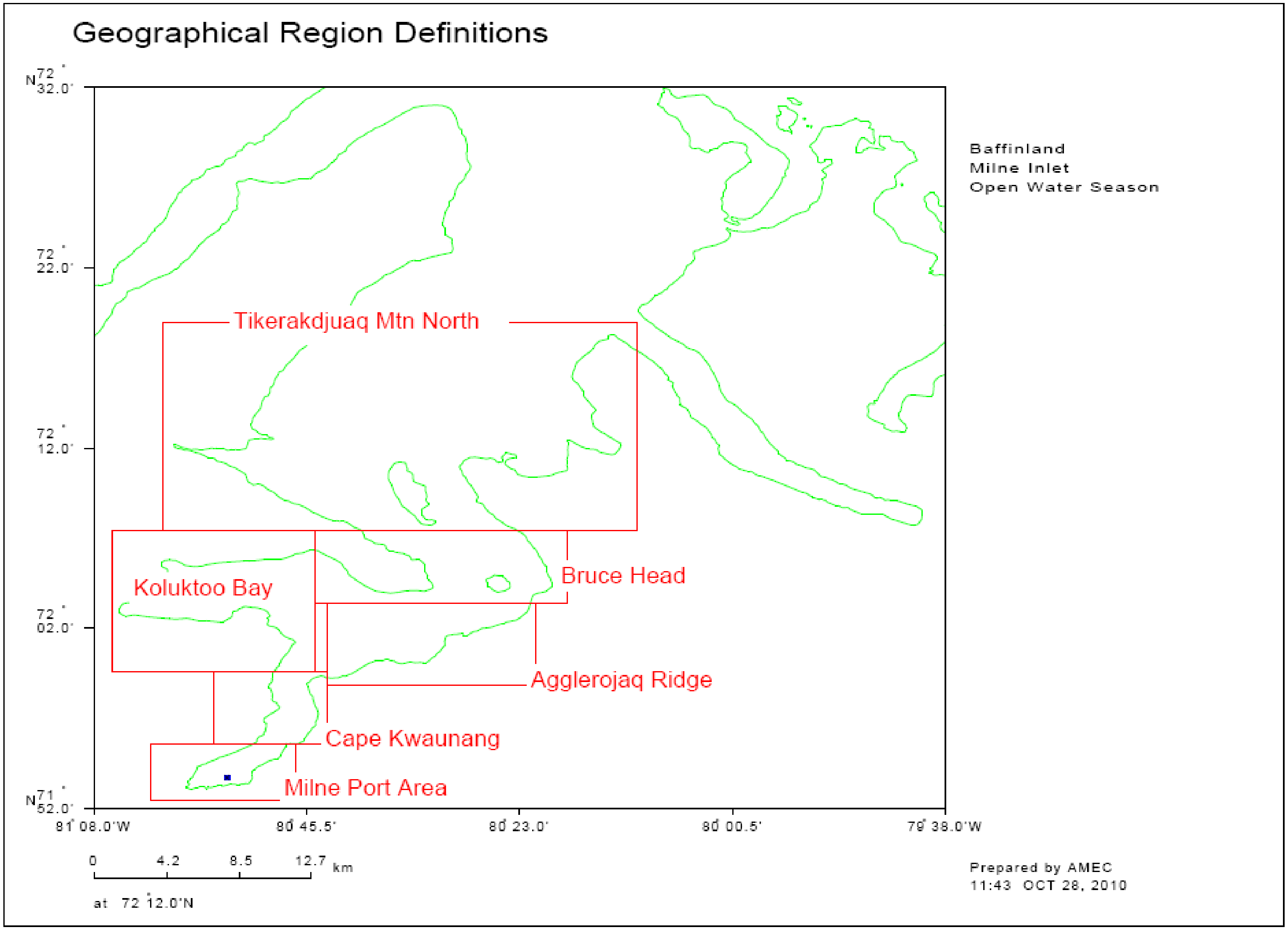

Figure 2-24 Definition of Geographical Regions for Interpretation of Shoreline Statistics

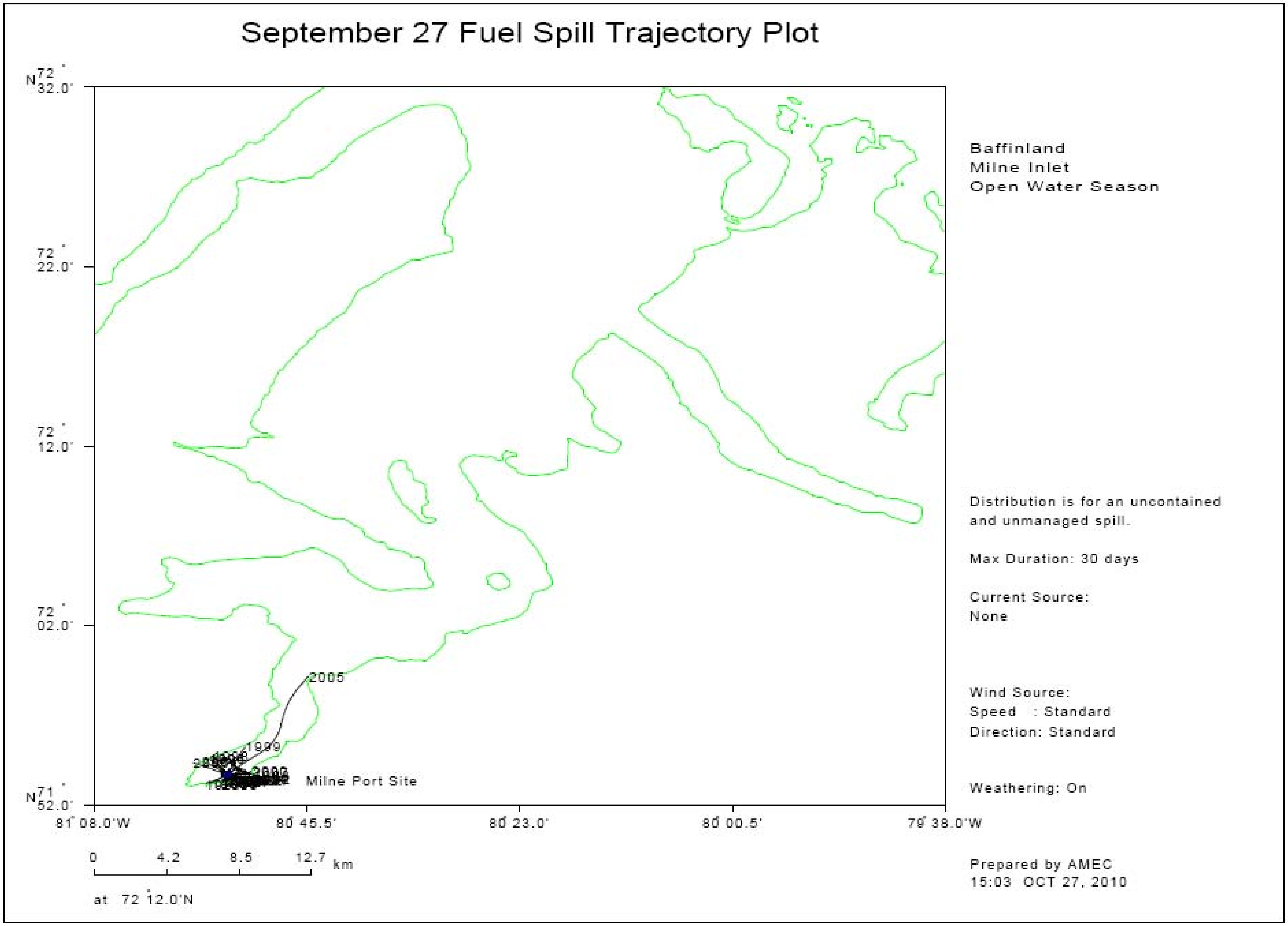

Figure 2-25 September 27, 1980-2009 Fuel Spill Trajectory Plot, Port Site

Table 2-11 September 27, 1980-2009, Trajectory Results, Port Site

Baffinland Port Site SPILL BEGINS AT 0000 HRS, 27 SEPTEMBER

WIND SOURCE: DIRECTION STANDARD WITH SPEED STANDARD
CURRENT SOURCE: None

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	22	I	1.	171.	71.89	80.90	YES	0.75	0.6	18.14	99.4
1981	194	22	I	1.	160.	71.89	80.89	YES	0.75	0.8	26.91	97.9
1982	194	22	I	1.	182.	71.89	80.90	YES	1.50	0.6	9.27	99.7
1983	195	21	I	1.	200.	71.89	80.91	YES	1.25	1.0	19.23	99.0
1984	194	22	I	1.	153.	71.89	80.89	YES	1.25	0.7	13.37	99.7
1985	195	19	I	1.	226.	71.89	80.93	YES	2.50	1.4	13.37	99.5
1986	194	25	I	1.	116.	71.89	80.86	YES	1.75	1.4	19.53	98.6
1987	194	23	I	1.	144.	71.89	80.88	YES	1.50	0.8	13.10	99.7
1988	192	26	I	2.	91.	71.89	80.88	YES	2.00	1.6	19.20	98.3
1989	194	24	I	1.	123.	71.89	80.87	YES	1.00	1.0	24.80	97.2
1990	193	26	I	2.	105.	71.89	80.85	YES	2.25	1.7	17.64	98.1
1991	195	18	I	2.	233.	71.89	80.94	YES	2.75	1.7	14.52	99.3
1992	193	26	I	2.	105.	71.89	80.85	YES	1.50	1.7	27.62	93.3
1993	194	22	I	1.	154.	71.89	80.89	YES	1.50	0.7	10.58	99.7
1994	187	19	I	2.	327.	71.91	80.93	YES	1.25	2.0	39.01	93.4
1995	194	22	I	1.	184.	71.89	80.90	YES	1.00	0.7	16.63	99.2
1996	187	19	I	2.	327.	71.91	80.93	YES	4.50	2.0	10.79	99.2
1997	193	26	I	2.	109.	71.89	80.85	YES	2.00	1.7	20.41	98.3
1998	187	19	I	2.	335.	71.91	80.92	YES	1.75	2.1	28.94	90.7
1999	184	24	I	3.	20.	71.92	80.87	YES	1.75	3.1	42.21	90.7
2000	191	26	I	2.	75.	71.90	80.85	YES	51.00	10.4	4.90	93.4
2001	188	18	I	2.	311.	71.91	80.94	YES	4.00	2.1	12.32	99.2
2002	194	22	I	1.	185.	71.89	80.90	YES	9.25	3.9	10.12	98.5
2003	194	22	I	1.	180.	71.89	80.90	YES	0.75	0.7	21.47	97.9
2004	193	26	I	2.	107.	71.89	80.85	YES	5.00	1.6	7.56	99.3
2005	165	35	I	11.	26.	71.99	80.76	YES	18.75	11.5	14.78	91.5
2006	189	16	I	2.	301.	71.91	80.96	YES	3.75	2.4	15.48	99.0
2007	191	26	I	2.	83.	71.90	80.85	YES	2.00	1.6	18.75	98.3
2008	195	21	I	1.	197.	71.89	80.91	YES	1.00	1.1	26.31	97.2
2009	194	22	I	1.	164.	71.89	80.89	YES	1.00	0.7	16.63	99.2

SEPTEMBER SHORE IMPACT STATISTICS FOR Milne Port Area

POSITION ROW	COL	ORI	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
184	24	I	1	90.	90.	90.00	1.75	1.75	1.75
187	19	I	3	90.	99.	94.00	1.25	4.50	2.50
188	18	I	1	99.	99.	99.00	4.00	4.00	4.00
189	16	I	1	99.	99.	99.00	3.75	3.75	3.75
191	26	I	2	93.	98.	95.50	2.00	51.00	26.50
192	26	I	1	98.	98.	98.00	2.00	2.00	2.00
193	26	I	4	93.	99.	97.00	1.50	5.00	2.69
194	22	I	9	97.	99.	98.44	0.75	9.25	1.97
194	23	I	1	99.	99.	99.00	1.50	1.50	1.50
194	24	I	1	97.	97.	97.00	1.00	1.00	1.00
194	25	I	1	98.	98.	98.00	1.75	1.75	1.75
195	18	I	1	99.	99.	99.00	2.75	2.75	2.75
195	19	I	1	99.	99.	99.00	2.50	2.50	2.50
195	21	I	2	97.	98.	97.50	1.00	1.25	1.13

SEPTEMBER SHORE IMPACT STATISTICS FOR Cape Kwaunang

POSITION ROW	COL	ORI	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
165	35	I	1	91.	91.	91.00	18.75	18.75	18.75

2.3.3 Composite Monthly Fuel Distribution Probability Maps

To define the probability of oil distribution by month, every possible spill originating each day over the 30 year duration of the wind record is considered. That is, all possible trajectories (up to 30 days at 30 per day) for the month of September are simulated. Note that any month may be modelled. Thus, for September there are a total of 900 trajectories. For each element or cell of the computational grid (135 columns by 200 rows) a record of the number of (monthly) trajectories passing through that element is maintained. By knowing the total number of trajectories simulated for a given month, it is thus possible to identify the percentage of those trajectories which passed through any particular grid element. Due to the large number of trajectories simulated for a given month this percentage can be interpreted as the probability that fuel released at the spill site in the given month, would reach the particular grid element. Grid elements having similar levels of probability can be grouped to present a contoured display of fuel distribution probabilities.

The probable directions of slick motion and probable spill destinations are now more precisely defined by the probability plots than by the representative case, or individual day, scenarios described in the previous section. The basic probability plots have been developed from simulations of every possible day spill over the duration of the available 30-year wind record.

2.4 Presentation and Interpretation of Results

The September, Port Site, probability map is shown in Figure 2-26, and is discussed in detail in Section 2.4.1. In the map, the following probability colour code is used.

Probability Range	*Colour*
25% < P ≤ 100%	Orange
15% < P ≤ 25%	Red
5% < P ≤ 15%	Pink
2% < P ≤ 5%	Yellow
1% < P ≤ 2%	Light Blue
0% < P ≤ 1%	Grey

Baffin Island, and Stephens Island and Poirier Islands in Milne Inlet appear in green.

The percentages can be interpreted as presenting the probability that fuel would reach any particular location on the map, given a spill originating on any day of the particular calendar month. In this instance, the 25%, 15%, 5%, 2%, 1%, and 0% contours of probability are illustrated.

Orange contours indicate that 25 to 100% of all trajectories (in the case of 900 simulations, 225 to 900 trajectories) will pass through that location (grid cell in the model). Grey contours indicate that 1% or less of all trajectories (in the case of 900 simulations, 1 to 9 of 900 trajectories) will pass through that location.

There is no implication that a spill could cover the entire zone enclosed by a contour, only that the fuel would drift through or be located at some position within this zone. The contours represent the maximum possible affected zone and in reality any spill would be likely to affect only some modest subset of the region, depending on wind and current conditions over the duration of the spill, and the weathered fate of the spill slick. These probabilities are derived from scenarios in which the hypothetical spills are both uncontained and unmanaged, conditions that would be limited given an appropriate oil spill emergency contingency planning and response plan in place.

2.4.1 Spill at Head of Milne Inlet Port Site

The base case spill scenario run consisted of using 30 years of NCEP/NCAR winds. Figure 2-26 presents the potential September spill distribution for a spill originating at the Port Site. In the plot, every second model grid cell is shown, i.e., one cell encompasses four cells and covers an area of about 750 m x 750 m. Companion model output listings for the base case run are presented in Appendix C.

Four sensitivities were additionally run to consider variations in wind speed or direction. Table 2-12 summarizes the five model runs. Runs 'B' and 'C' consider a reduction or increase in wind speed, while runs 'D' and 'E' consider a rotation of wind direction which are logical sensitivities to consider given the difference in predominant wind directions reported for the Milne met station and the NCEP/NCAR location (Sections 2.2.2.1 and 2.2.2.2).

Figure 2-27 to Figure 2-30 present the results for sensitivity runs 'B' to 'E'.

Table 2-12 Spill Scenario Locations

Spill Scenario	Wind Speed	Wind Direction
Base Case, Run A	standard	standard
Sensitivity, Run B	x 0.7	standard
Sensitivity Run C	x 1.3	standard
Sensitivity Run D	standard	rotate counter-clockwise 90°
Sensitivity Run E	standard	rotate clockwise 90°

Due to the close proximity from the spill scenario location to shore at the head of Milne Inlet, each section of shoreline within about 2-3 km would be impacted by fuel at a likelihood of 5 to 25% (yellow to red contours). A 1% probability is predicted for shorelines as far out as Cape Kwaunang and on two September days, as far as Bruce Head on the Borden Peninsula. These two trajectories, for 16 September 1989 and 2 September 1997 each cover a path length of 23 km in times of 28 and 24 hours respectively. Associated weathering estimates are that 48 and 41% of the initial fuel volume would remain at this point.

Figure 2-31 reports the percentage of trajectories reaching shore. Figure 2-32 reports the mean time to shore for each region. Figure 2-33 shows statistics for the percent amount of oil remaining at the end of each trajectory.

For the Milne Port Area region 95.6% of trajectories first reach shore there in an average time of 3.6 hours. Times to shore are relevant for response considerations and for weathering processes of the fuel. Most of the remaining trajectories, 3.7%, reach shore in the Cape Kwaunang region another 6 km farther out. One trajectory (0.11%) reaches shore in the Koluktoo Bay region (actually just outside the Bay, more in the inlet) and the aforementioned two trajectories (0.22%) reach the Bruce Head region.

Considering the four sensitivity scenarios, the results are generally quite similar. Overall, considering all five scenario runs, one might estimate that the Milne Port Area region, which extends from the head of the inlet about 4 km, would see first shoreline impacts about 89 to 97% of the time. The Cape Kwaunang region will see generally first shoreline impact 3 to 3.7% of the time though in scenario ‘D’, when winds are backed 90°, this values is as much as 10%.

The percent of trajectories ashore north of these two regions is small, less than 1%. Under the reduced wind speed scenario ‘B’ there is one trajectory that reaches the southern tip of Stephens Island (Tikerakdjuaq Mtn North region) travelling a distance of 29 km in 67 hours, and with 31% volume remaining. The increased wind speed scenario ‘C’ has one trajectory that reaches the Borden Peninsula west of Bruce Head (22 km in 18 hours) and one that reaches the southern entrance to Koluktoo Bay (15 km in 14 hours). The greatest number of trajectories, seven, escape to Koluktoo Bay with one (under the scenario ‘D’) as far as the eastern shore between Poirier and Stephens Islands (a distance of 45 km in 88 hours). Under the scenario ‘E’ where winds are backed 90°, two trajectories reach the northern shore of Koluktoo Bay.

As shown in Figure 2-32, if one considers the regions outwards from the Milne Port Area, the predicted mean time to shore for regions increase from about 3-6 hours near the Port Area, to 10-17 hours for Cape Kwaunang, 15-27 hours for Koluktoo Bay, 19-26 hours for Bruce Head, and 67-88 hours for (the two trajectories that travel as far as) Tikerakdjuaq Mountain North. No trajectories were predicted to reach shore for the defined Agglerojaq Ridge region.

Currents associated with Inlet adjustment to surface wind setup have peaks at about 0.3 m/s but on average are on the order of 0.1 m/s. At the dock site, the duration of the peaks is only a few hours so that distance traveled is between a few hundreds of meters to about 2 km. At the entrance to the head of Milne Inlet peaks last up to about 6 hours resulting in travel distances of 2 km to 6 km. How much the occurrence of such currents would affect spill trajectories predicted by model using wind only depends on how long they can act on the spill relatively to how long it takes for the spill to reach shore.

Because the Milne Port Area is secluded and the majority of the trajectories are expected to first reach shore there in a matter of several hours (see Section 2.4), the occurrence of such currents would not impact the ultimate fate of the spill, but only affect the time and exact location of arrival to shore. In the worst case travel time could be cut in half and weathering of the spill would be similarly reduced.

Other spill trajectories with longer travel time (between 6 and 28 hours) would be less affected as currents would act on the spill during a shorter portion of the total travel time. The longer trajectories would still be dominated by persistent wind condition, so that duration and location of arrival would only be slightly modified by the occurrence of such currents.

The collection of spill probability plots, and associated derived statistics for a spill to reach shore, presented, provide a basic definition of the probable geographic distributions of any hypothetical, uncontained, and unmanaged spill for the Project domain of operations at the Port Site and in Milne Inlet. These probabilities are derived from scenarios in which the hypothetical spills are both uncontained and unmanaged.

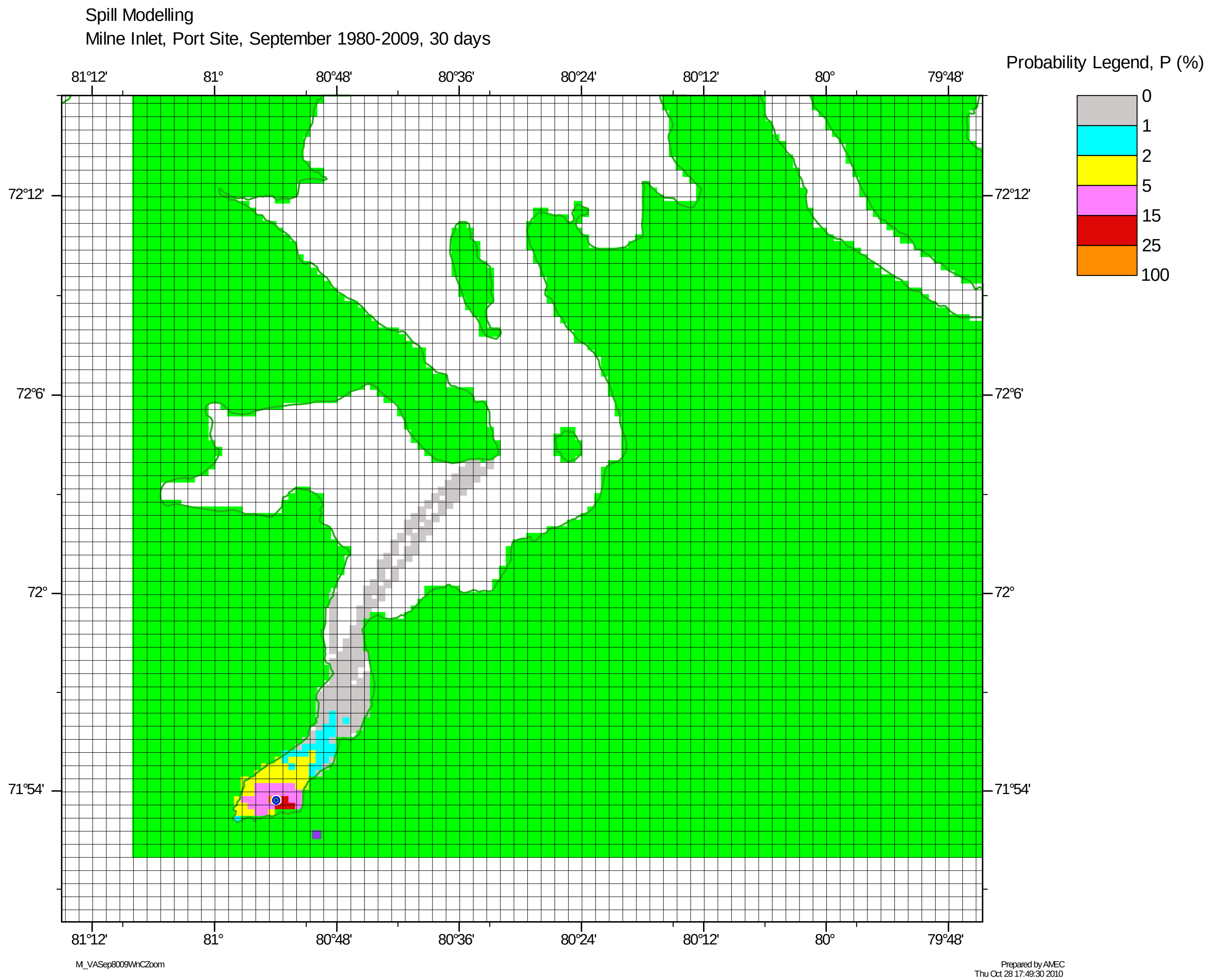

Figure 2-26 Spill Distribution Probability Plot, Port Site, September, Base Case

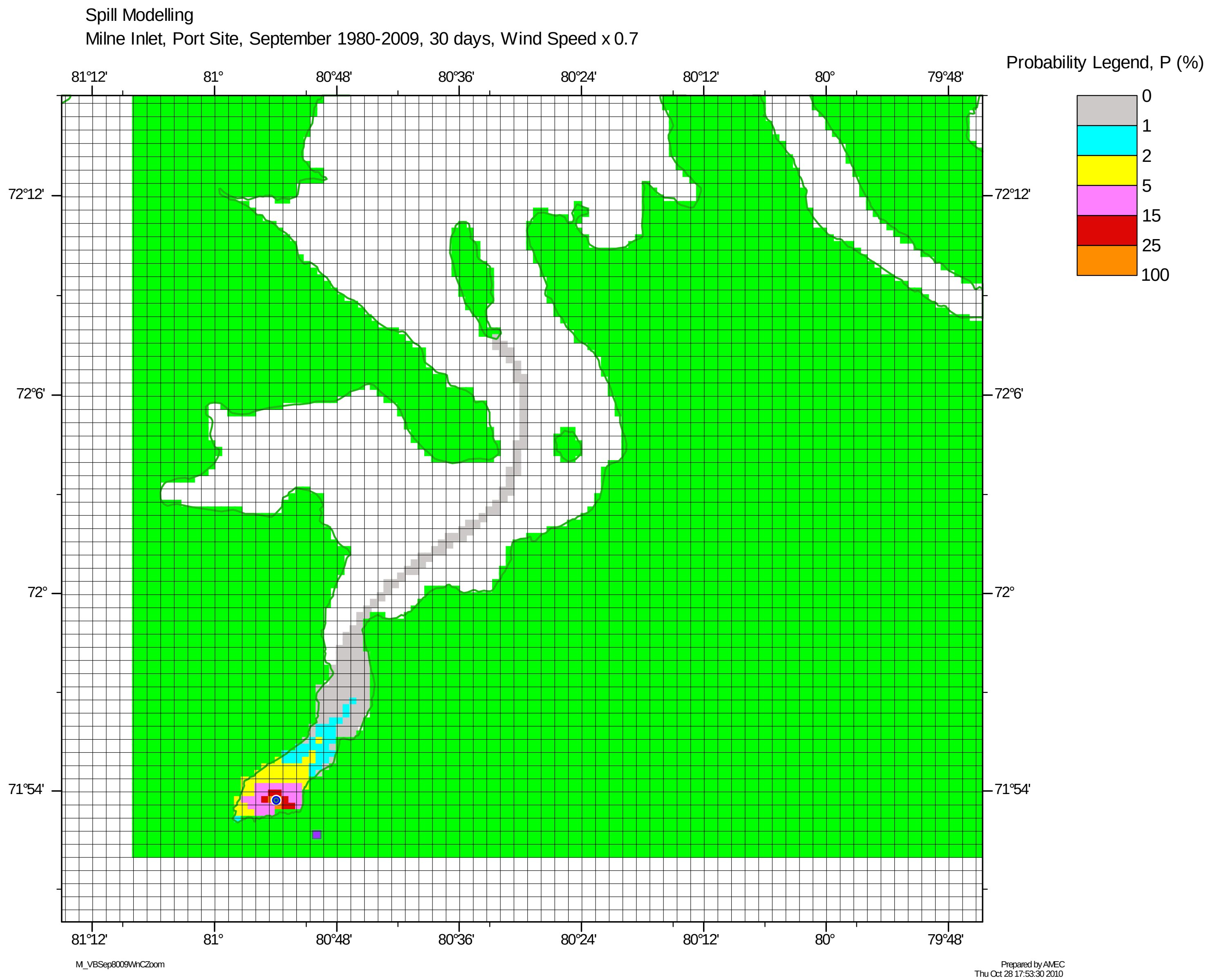

Figure 2-27 Spill Distribution Probability Plot, Port Site, September, Wind Speed x 0.7

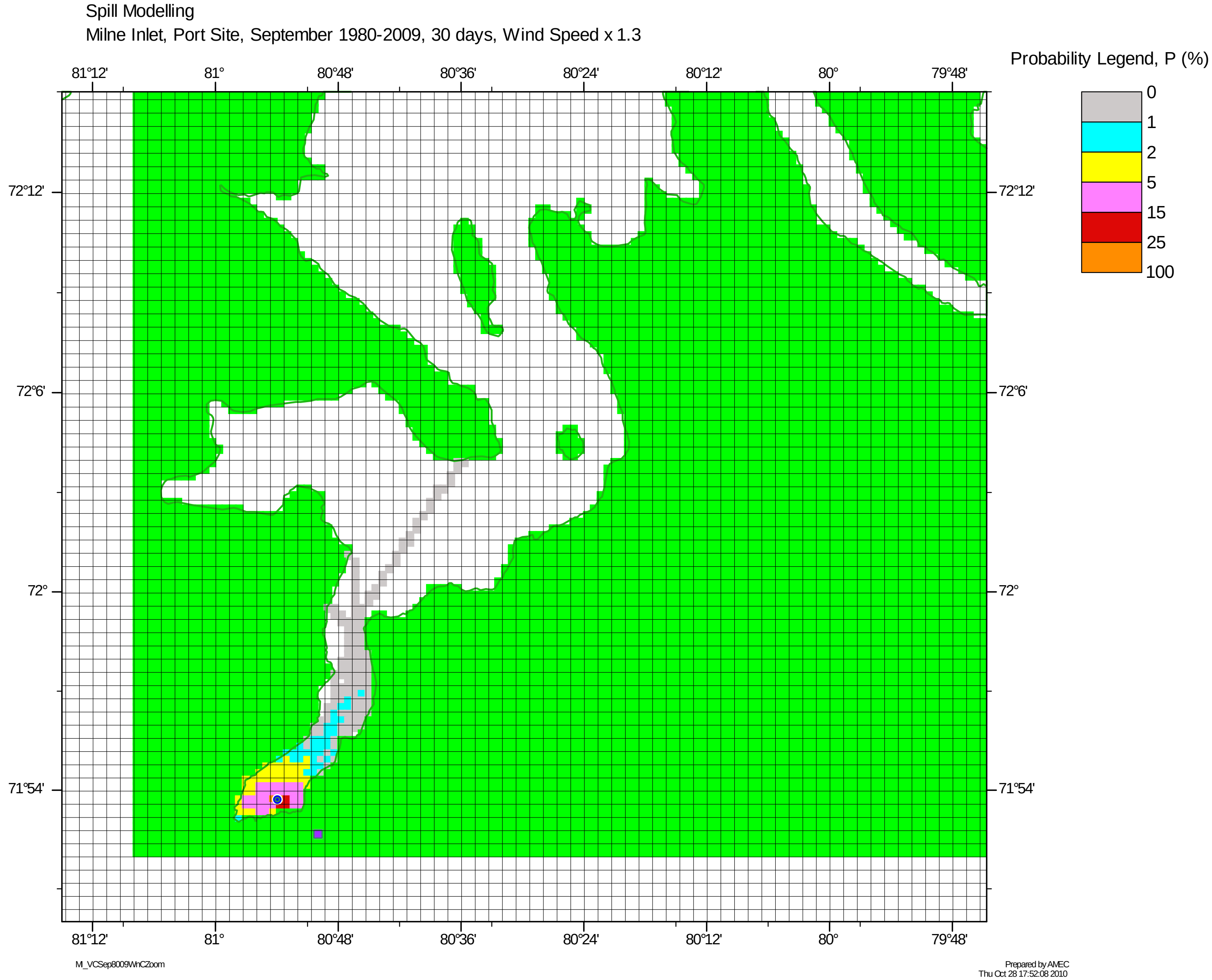

Figure 2-28 Spill Distribution Probability Plot, Port Site, September, Wind Speed x 1.3

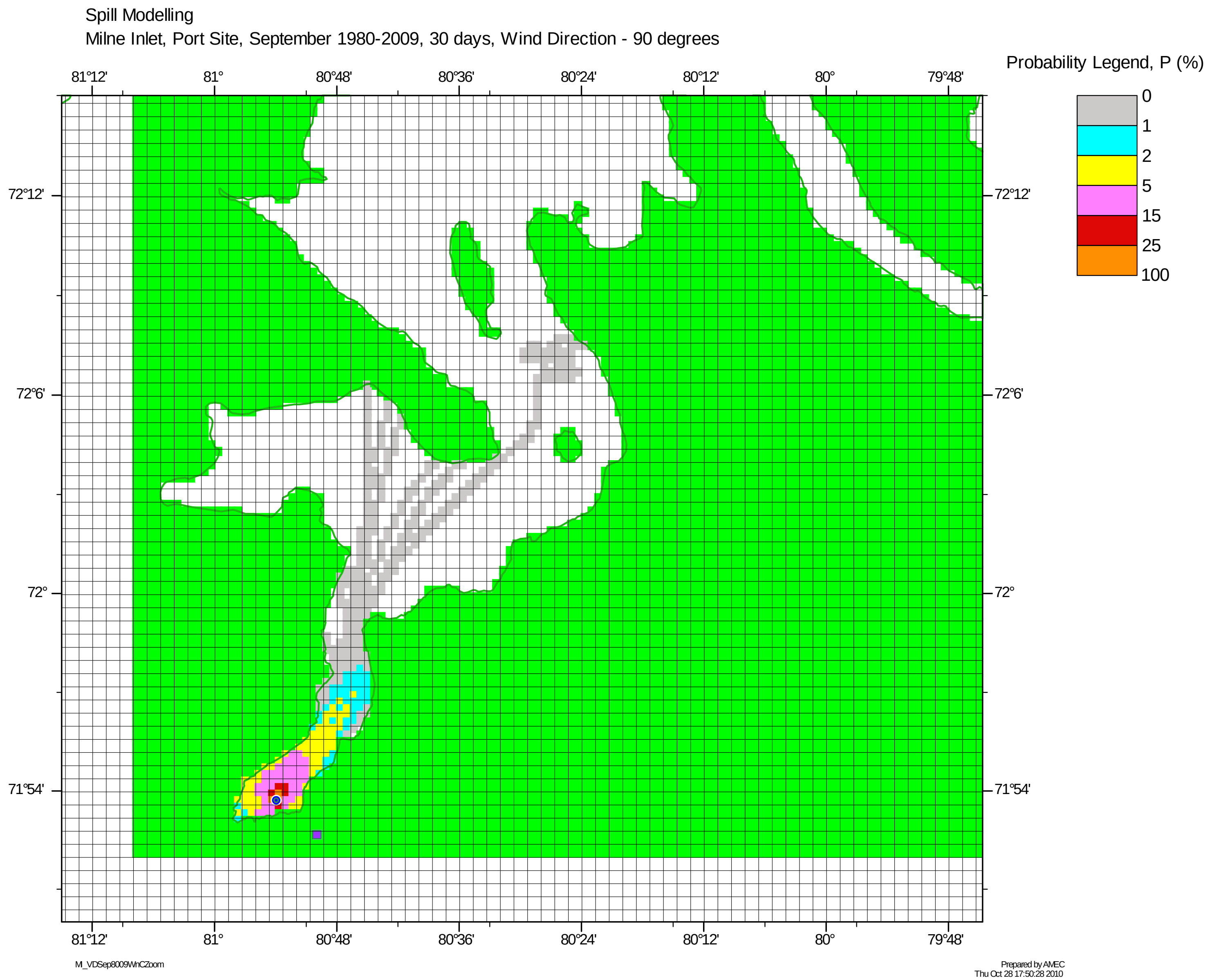

Figure 2-29 Spill Distribution Probability Plot, Port Site, September, Wind Direction - 90°

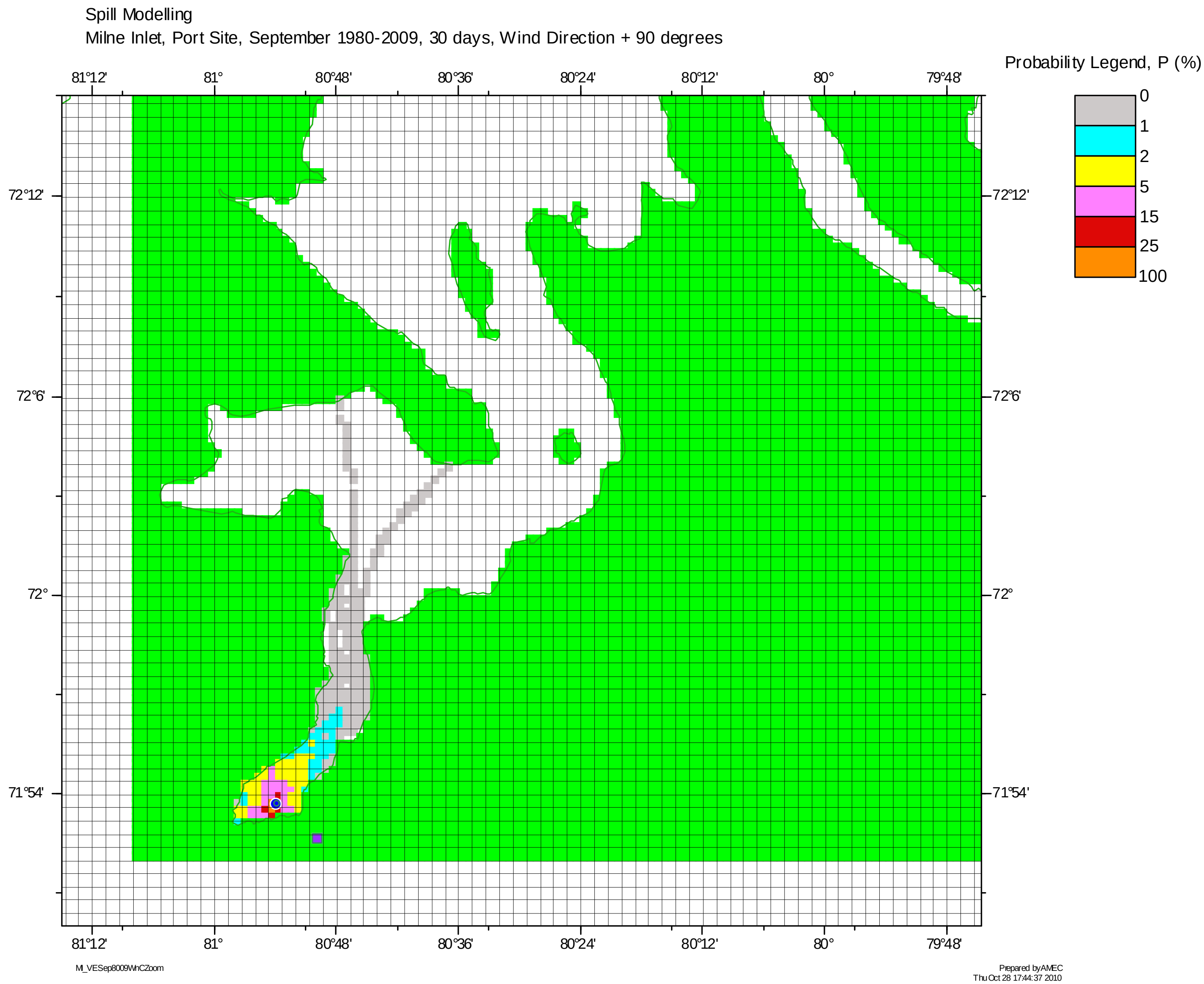

Figure 2-30 Spill Distribution Probability Plot, Port Site, September, Wind Direction + 90°

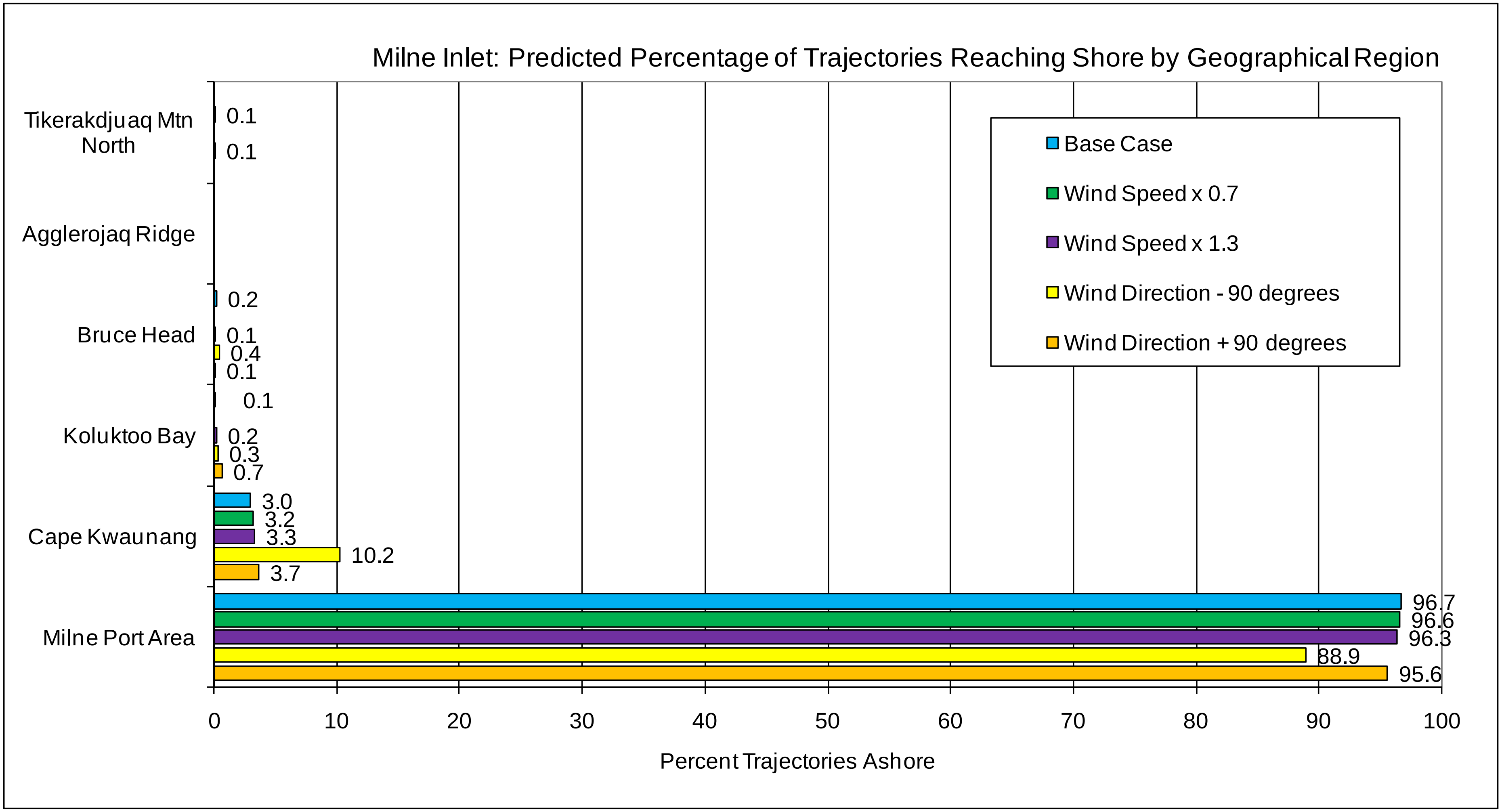

Figure 2-31 September Percentage of Trajectories Reaching Shore by Geographical Region

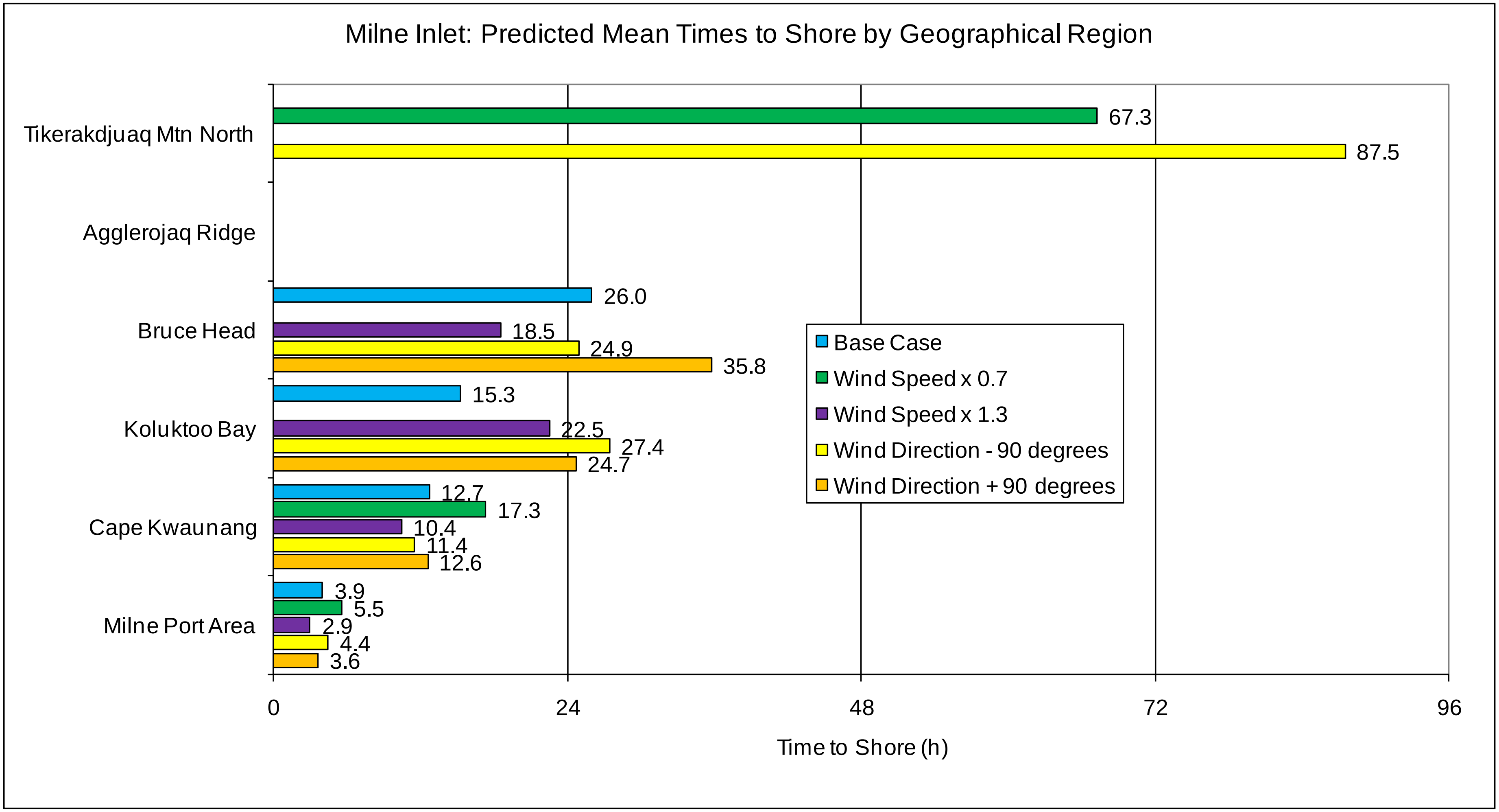

Figure 2-32 September Mean Times to Shore by Geographical Region

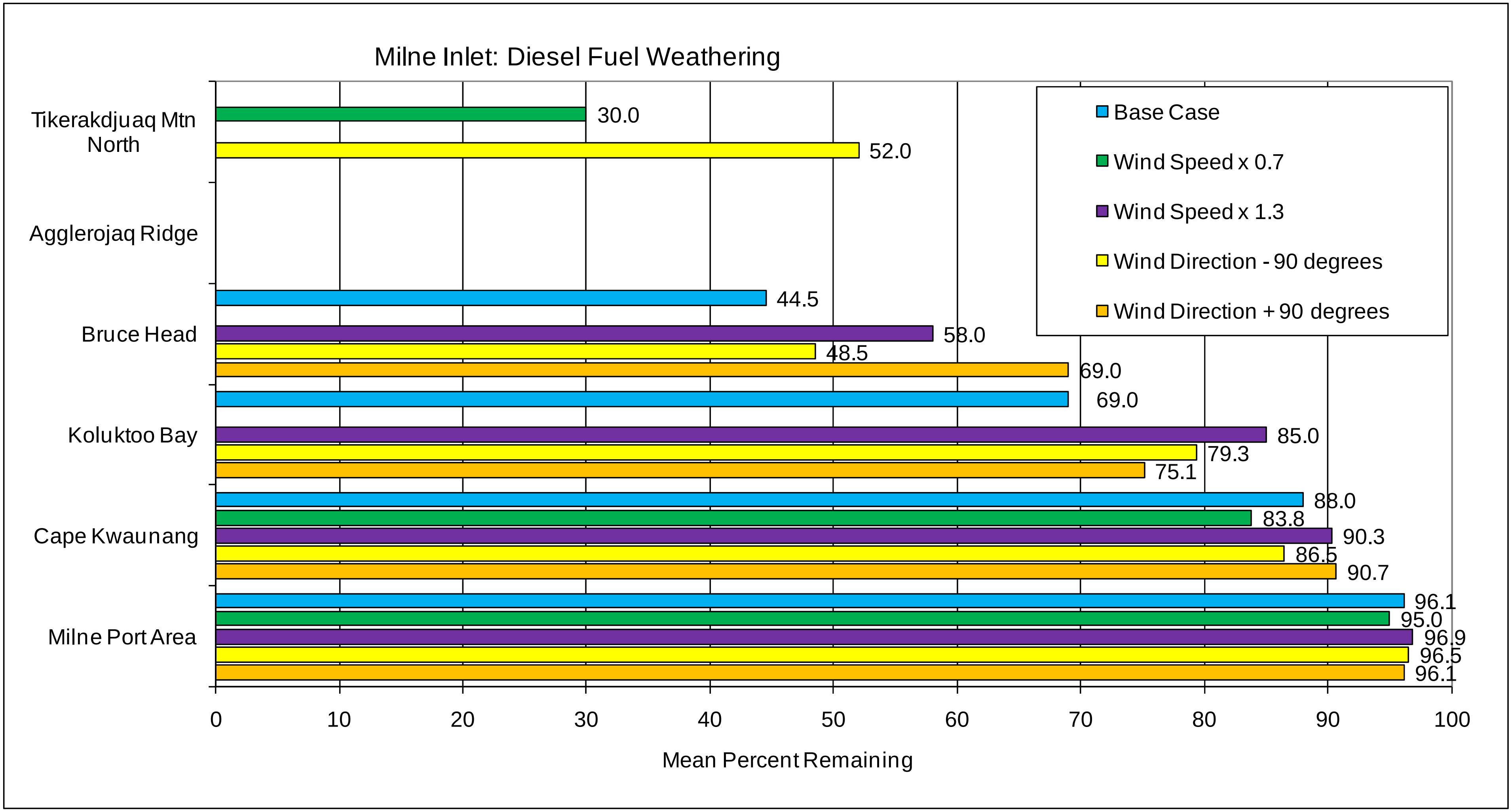

Figure 2-33 Diesel Fuel Weathering: Mean Percent Remaining by Geographical Region

3. SPILL FATE MODELLING: OILMAP

The OILMAP oil spill model system introduced in Section 2.1.4 was used to provide additional estimates of spilled fuel fate, in particular, slick characteristics and weathering. OILMAP will calculate the evaporation, dispersion and remaining percentage for a given spill scenario where the user defines an oil product type, weather conditions, properties of the receiving water, and the amount of oil released. The same 5 ML diesel fuel scenario, released from the Port Site (Table 1-1) location over a period of 15 minutes, was simulated for seven days and with a 1° C water temperature.

The fate or weathering processes considered were evaporation, the conversion of liquid oil into a gaseous component, and natural dispersion, the breakup of an oil slick into small droplets that are mixed into the sea by wave action. These are two important weathering processes that typically occur over the first five days following a spill and act to remove oil from the sea surface. Fuel will also be brought to shore depending on the prevailing currents and winds at the time as well as the type and amount of oil, and type of shoreline. Consideration of the amounts lost due to these processes yields an estimate of the remaining amount of oil on the surface at any time. These are the key fates modeled and tracked by OILMAP. No containment or recovery of spilled oil is assumed in the simulations considered here.

3.1 Model Implementation

A 100 x 100 cell land/water grid of cell size ~320 m east-west x ~490 north-south was created as shown in Figure 3-1.

OILMAP's ability to characterize shore types was employed. An oil, or fuel, handling capacity based on oil type, and beach or shore type is calculated (ASA, 2004). Each shore type has an associated maximum oil thickness. Wind or current may bring oil ashore depositing it on the shoreline. Deposition ceases when the holding capacity for the shoreline surface is reached. Any subsequent oil brought ashore to that shoreline cell will remain offshore on the water surface. The OILMAP shore types are listed in Table 3-1 together with an associated maximum oil thickness.

The selection of which shore types to use for Milne Inlet was based on the shoreline habitat classification work completed by CORI (2007). In that work, six primary shore types were identified for Milne Inlet: Rock Cliff, Rock Cliff with Beach, Alluvial Fan, Beach Ridge Complex, Alluvial Delta Complexes, and Delta Flats. The proportion of each shore type for each shoreline section was then classified (CORI, 2007).

For this application, a possible maximum surface oil thickness was estimated for each of the six shore types, and a total for each shoreline section was estimated by a weighted sum of the thicknesses that made up that section. These were in turn assigned to one of the three OILMAP shore types (Table 3-1) and the resulting approximations are shown in Figure 3-2. The resultant shore type grid is shown in Figure 3-3.

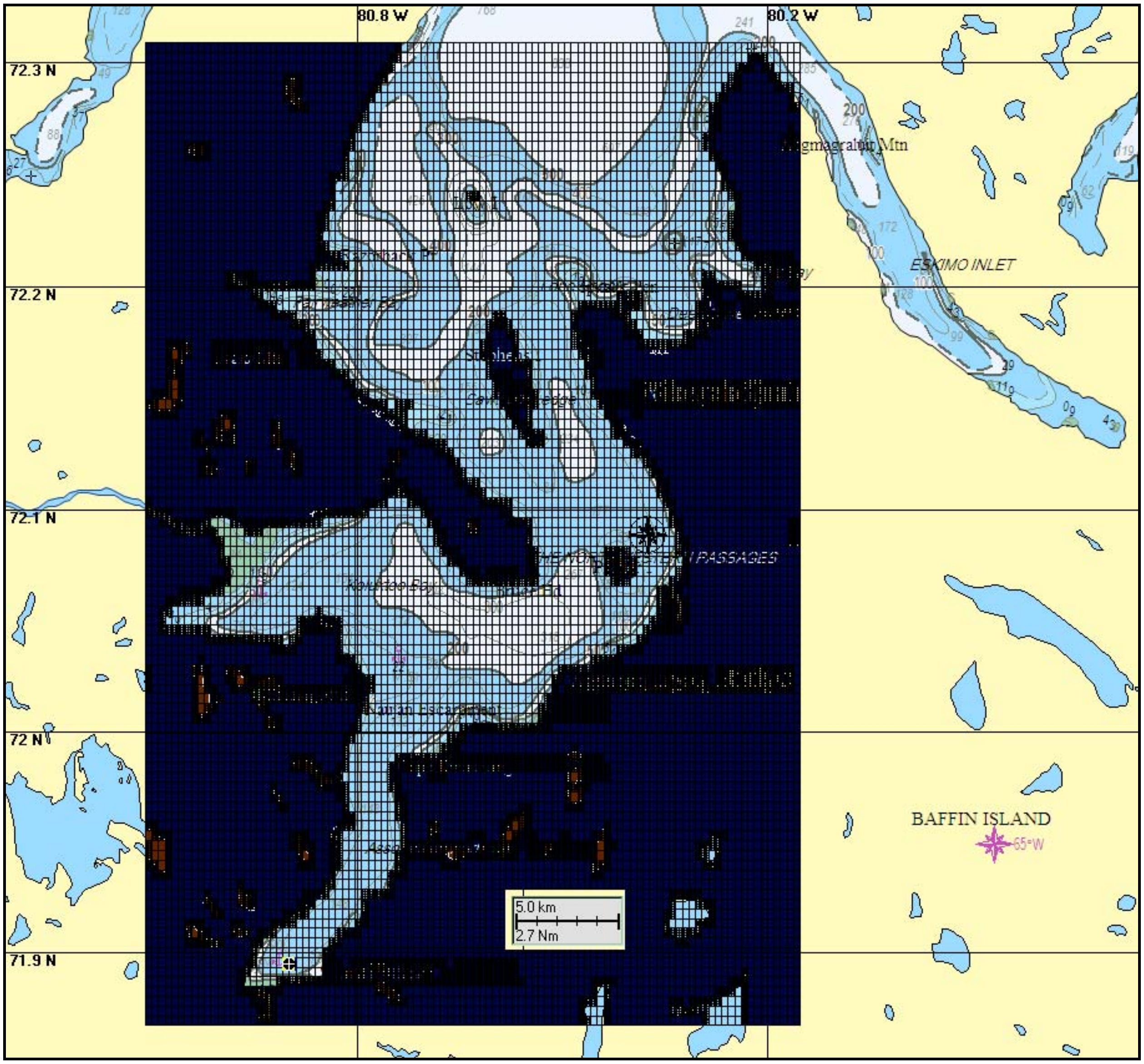

Figure 3-1 Milne Inlet: OILMAP Land/Water Grid

Table 3-1 Maximum Surface Oil Thicknesses for OILMAP Shore Types (Source: ASA 2004)

Shore Type	Oil Thickness (mm) for Light Oils (< 30 cSt), e.g., diesel
Rock Ledge	1
Sandy Beach	4
Tidal Flat	6

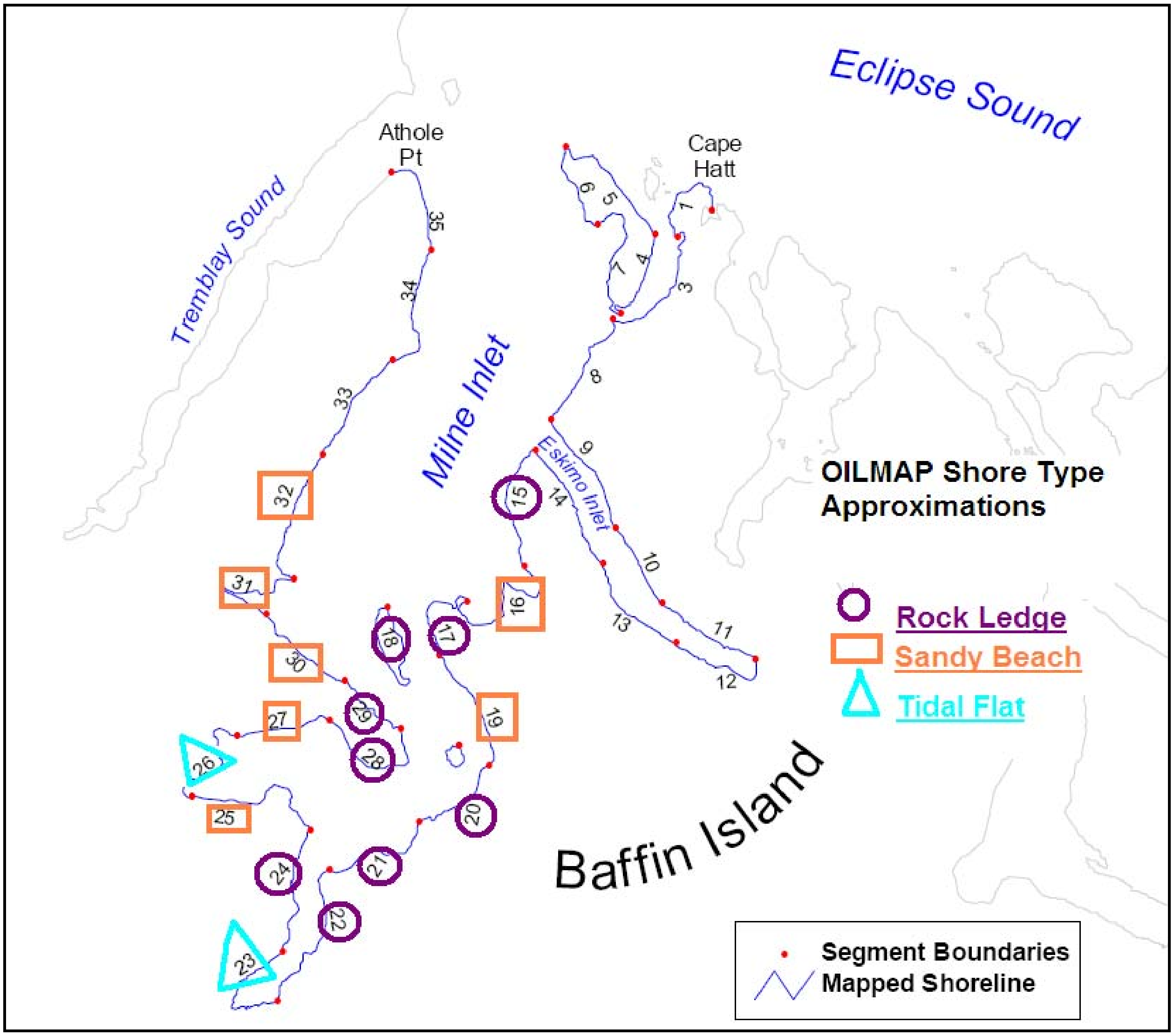

Figure 3-2 Milne Inlet Shore Habitat Mapping Segmentation (Source: CORI, 2007), with Annotated OILMAP Shore Type Approximations in Purple, Orange, and Light Blue

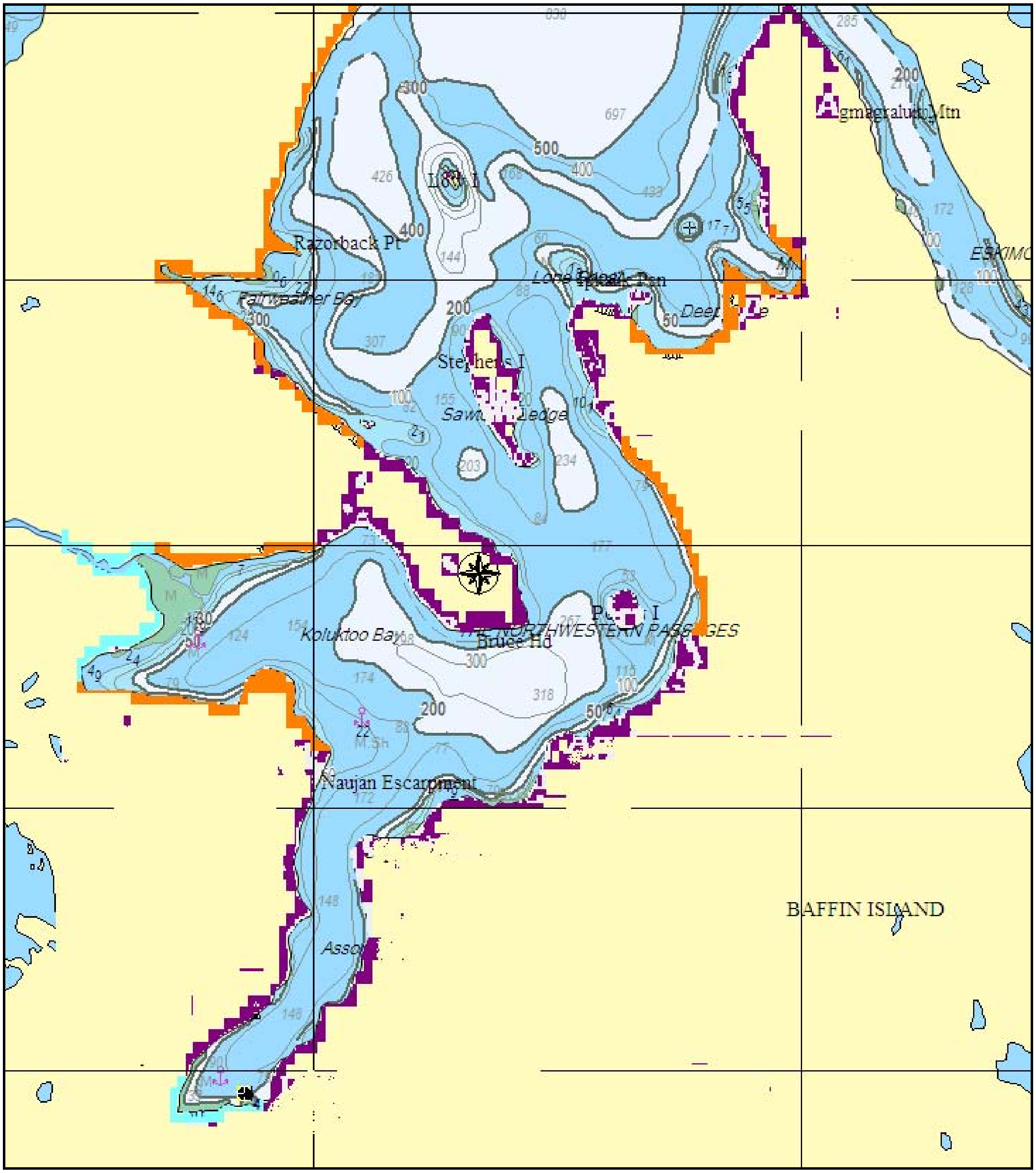

Figure 3-3 Milne Inlet: OILMAP Shore Type Grid

3.2 Wind and Scenario Selection for Spill Fate into Milne Inlet

A primary focus of the OILMAP scenarios was to consider possible winds blowing out of the inlet which might result in spill trajectory drift farther afield of a spill location at the head of the inlet and to estimate the potential fate of the fuel.

As presented in Section 2.2.2.1, and shown in the wind rose of Figure 2-12, winds in Milne Inlet are predominantly from the northeast into the inlet. Just 20% of winds in September are from the southwest quadrant. Consequently, the approach was taken to look for events with some period of winds blowing out of the inlet. This was accomplished by inspection of the wind record as illustrated in Figure 3-4. The stick plot presentations are useful for showing the direction the winds are blowing to, i.e., a vector directed directly downwards corresponds to winds to the south, a vector to the upper right portion about the time axis corresponds to winds from the southwest, and so on. The complete set of Milne Inlet met station wind plots for the 'open water' months of August, September, and October, is presented in Appendix B.

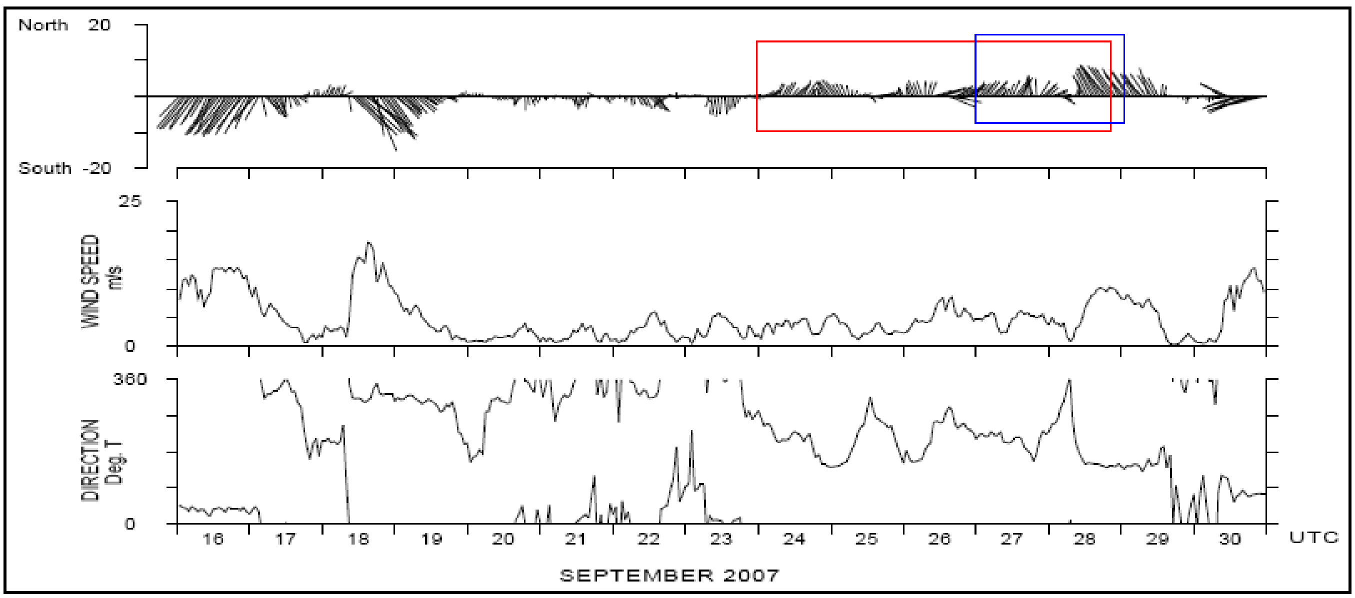

Figure 3-4 Milne Inlet: Winds for September 2007 (Wind Events for 24 and 27 September Scenarios Highlighted)

A number of candidate time periods were simulated with OILMAP and eight simulations as presented in Table 3-2 (discussed further below) were selected (the time-lines are highlighted in the Appendix B plots). It is emphasized these are not a definitive collection of scenarios to completely describe all possible spill outcomes; however, these scenarios do provide an indication of the possible trajectories, in particular how far out into Milne Inlet the slick may drift. A ninth scenario was also identified, 27 September 2006, for which winds kept the slick generally within the confines of the head of Milne Inlet. Given the predominance of winds into the inlet, this scenario provides an indication of a more likely fate one might expect.

For each of the nine scenarios, and OILMAP simulation map is provided below for a particular time during the simulation, e.g., just before completely weathering thereby showing spatial extent and shorelines oiled. These are presented in Figure 3-6 to Figure 3-14. A weathering fates chart is shown in the upper right of each trajectory snapshot. This shows the percentage of fuel on the surface, in the water column, ashore, or evaporated. The spill volume is apportioned to a number of 'spillets', in this simulation, 100, which are each modeled separately; spillets with volume less than 10% are not tracked further. In addition, the slick thicknesses (Figure 3-5) are shown for three levels as follows:

- red 0.1 to 20 mm;
- rose 0.01 to 0.1 mm; and
- light pink 0.001 to 0.01 mm [8]

Slick swept area is shown in grey; surface oil spillets are shown in green; spillets ashore are shown in magenta.

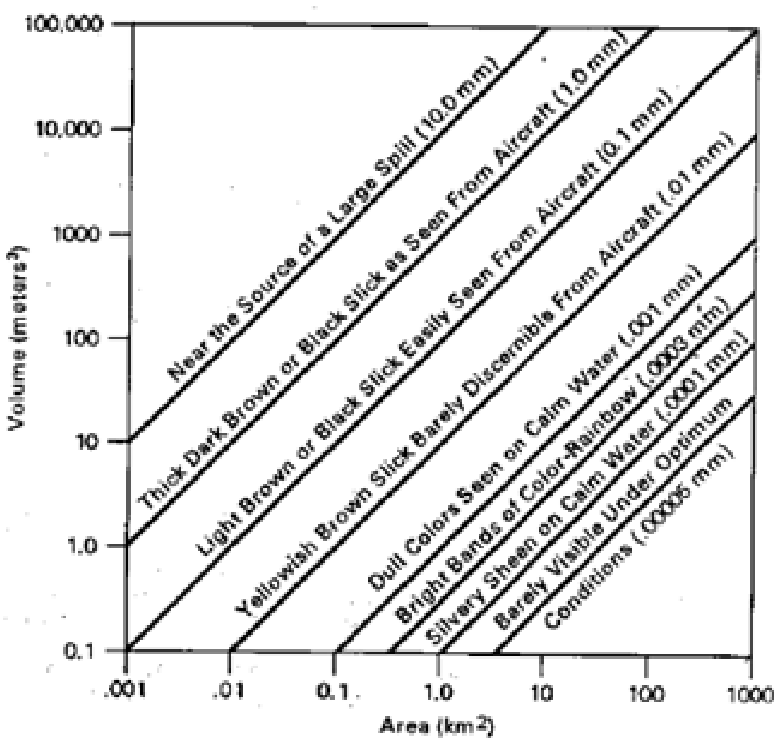

Figure 3-5 Areal coverage of spilled oil for different thicknesses (Source: CCG, 1995)

In addition to the scenario date identification, Table 3-2 reports the following:

- mean wind speed over the first day and over the simulation duration;
- time to end of slick, the point at which no further oil remains on the sea surface;
- farthest distance that fuel comes ashore, with distance taken on water along the channel; and
- amount of fuel ashore north of Cape Kwaunang after seven days

[8] 0.001 mm corresponds to duel colours seen on calm water; 0.01 mm corresponds to a yellowish brown slick barely discernable from aircraft; and 0.1 mm corresponds to a light brown or black slick easily seen from aircraft (CCG, 1995).

As can be seen from review of the simulations, the magnitude and variations in wind speed and direction, and the associated persistence and duration ultimately determine a spill slick's fate. As seen for the two 3 September 2007 simulations, a difference of 12 hours makes a large difference in outcome. Clearly, the environmental conditions at the time of a spill will be critical to the possible fate as well as dictating possible spill response measures.

While not an exhaustive treatment of possible wind conditions and subsequent spill fate, the data scenarios selected are intended to provide an indication of possible fate both for spills that stay generally at the head of the inlet, and for those that drift out of the inlet.

Table 3-2 OILMAP Spill Scenarios Summary

Scenario Date **(spill start times at 12 am unless noted)**	**Mean Wind Speed (m/s)** **(over first day of spill, and duration of spill)**	**Time to End of Slick**	**Farthest Distance to Fuel Ashore (km)**	**Amount of Fuel Ashore north of Cape Kwaunang after 7 days (%)**	**Comments**
'head of inlet' 25 Sep 2006	(5.5, 3.7 for 7 days)	still 20% oil on surface at 7 days	16	6	(Figure 3-6)
'out of inlet' 30 Aug 2006	(3.4, 5.2)	3 days 1 hour	15	2	70% of fuel dispersed into the water column after three days (Figure 3-7)
30 Sep 2006	(2.1, 3.3)	5 days 17 hours	16.5	10	Some oiling of shores north and east of Cape Kwaunang (Figure 3-8)
3 Sep 2007	(2.5, 3.5)	4 days 9 hours	4.7	-	The first simulation on this date (Figure 3-9) results in 80% of fuel ashore and less than 5% in the water column, compared with a spill occurring 12 hours later (Figure 3-10) for which 60% of fuel comes ashore and 20% is dispersed into the water column.
3 Sep 2007 12 pm	(2.9, 4.0)	4 days 3 hours	8.1	-	
12 Sep 2007	(8.7, 6.1 moderate breeze)	1 day 7 hours	25	3	Rapid transport to shore north of Koluktoo Bay in 1 day, 4 hours. Three hours later all fuel has weathered from surface or been brought ashore (Figure 3-11)

Scenario Date (spill start times at 12 am unless noted)	Mean Wind Speed (m/s) (over first day of spill, and duration of spill)	Time to End of Slick	Farthest Distance to Fuel Ashore (km)	Amount of Fuel Ashore north of Cape Kwaunang after 7 days (%)	Comments
24 Sep 2007	(3.2, 4.3 gentle breeze)	4 days 20 hours	36	42	This simulation represents an extreme case of northern drift out of inlet as far as Stephens Island (Figure 3-12) (Compare with OST Scenario prediction of Figure 2-29)
27 Sep 2007	(5.5, 7.0 moderate breeze)	2 days 1 hour	24	13	Slick reaches northern shore of Koluktoo Bay after 1 day, 20 hours. (Figure 3-13)
30 Sep 2008	(0.8, 2.4 for 7 days)	still 2% oil on surface at 7 days	8	-	Even though the slick is along the shoreline, due to lighter winds, most of the fuel remains offshore, and there is little fuel in the water column over the first 3 days, 12 hours (Figure 3-14)

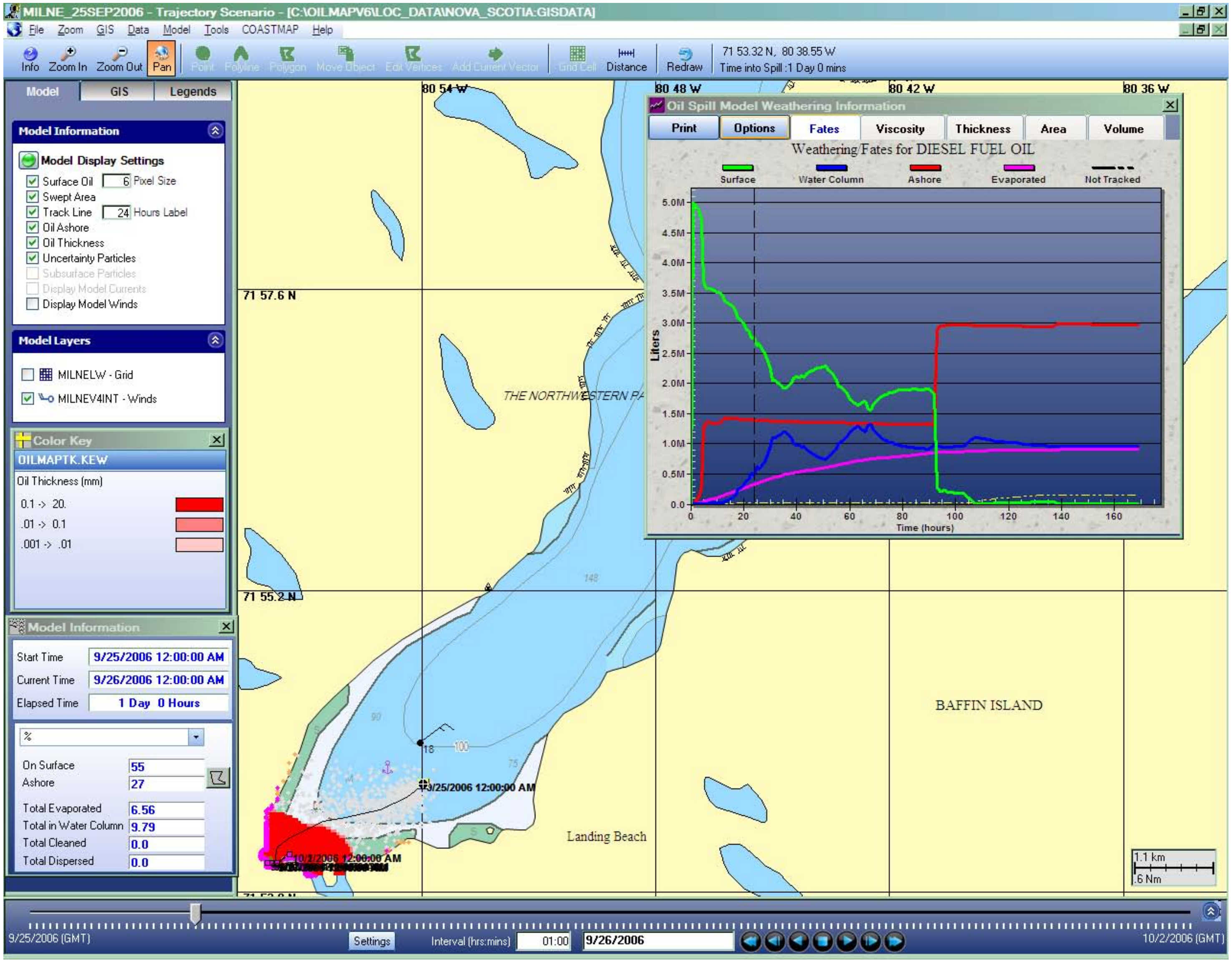

Figure 3-6 OILMAP Spill Simulation: 25 September 2006, after 1 day

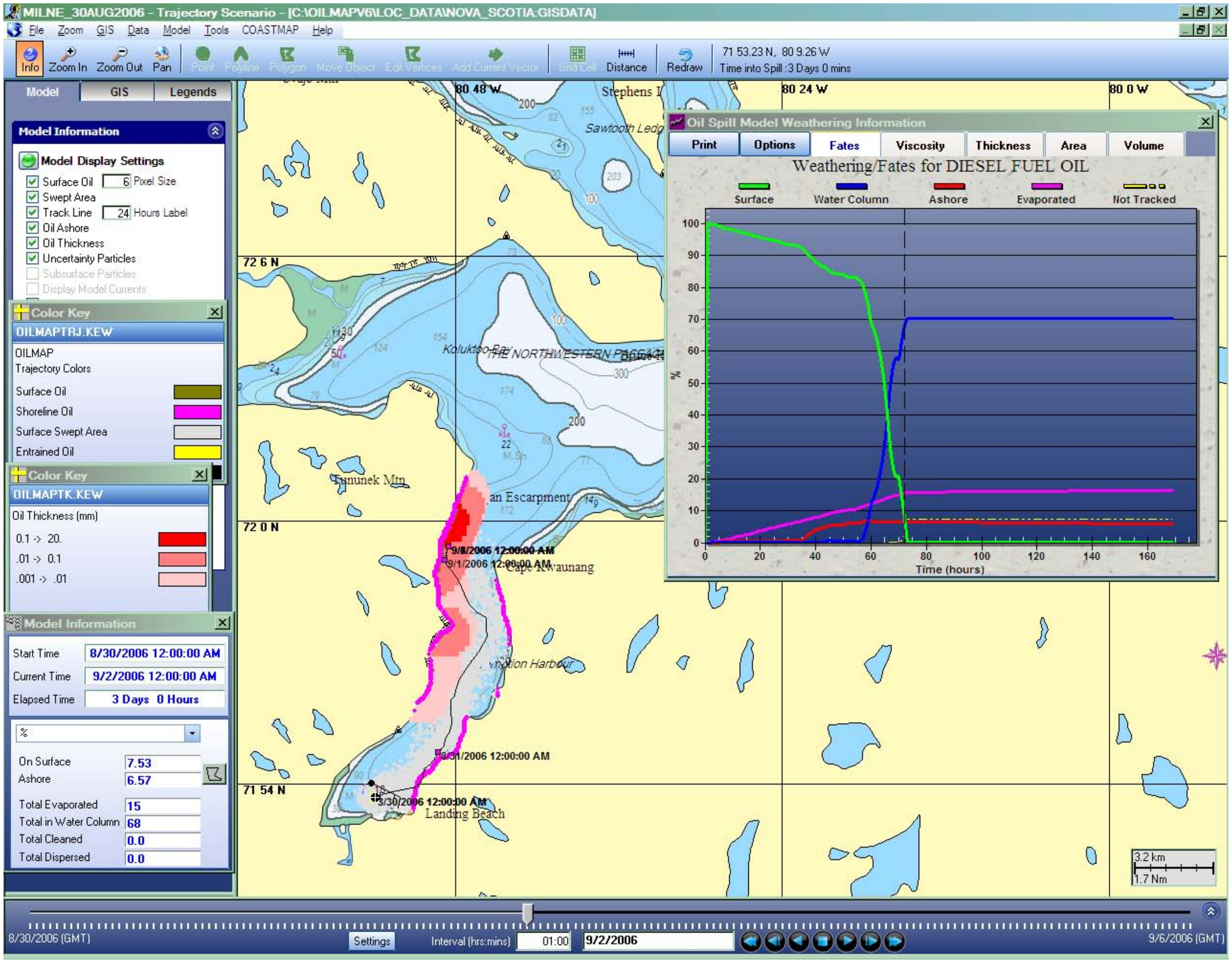

Figure 3-7 OILMAP Spill Simulation: 30 August 2006, after 3 days

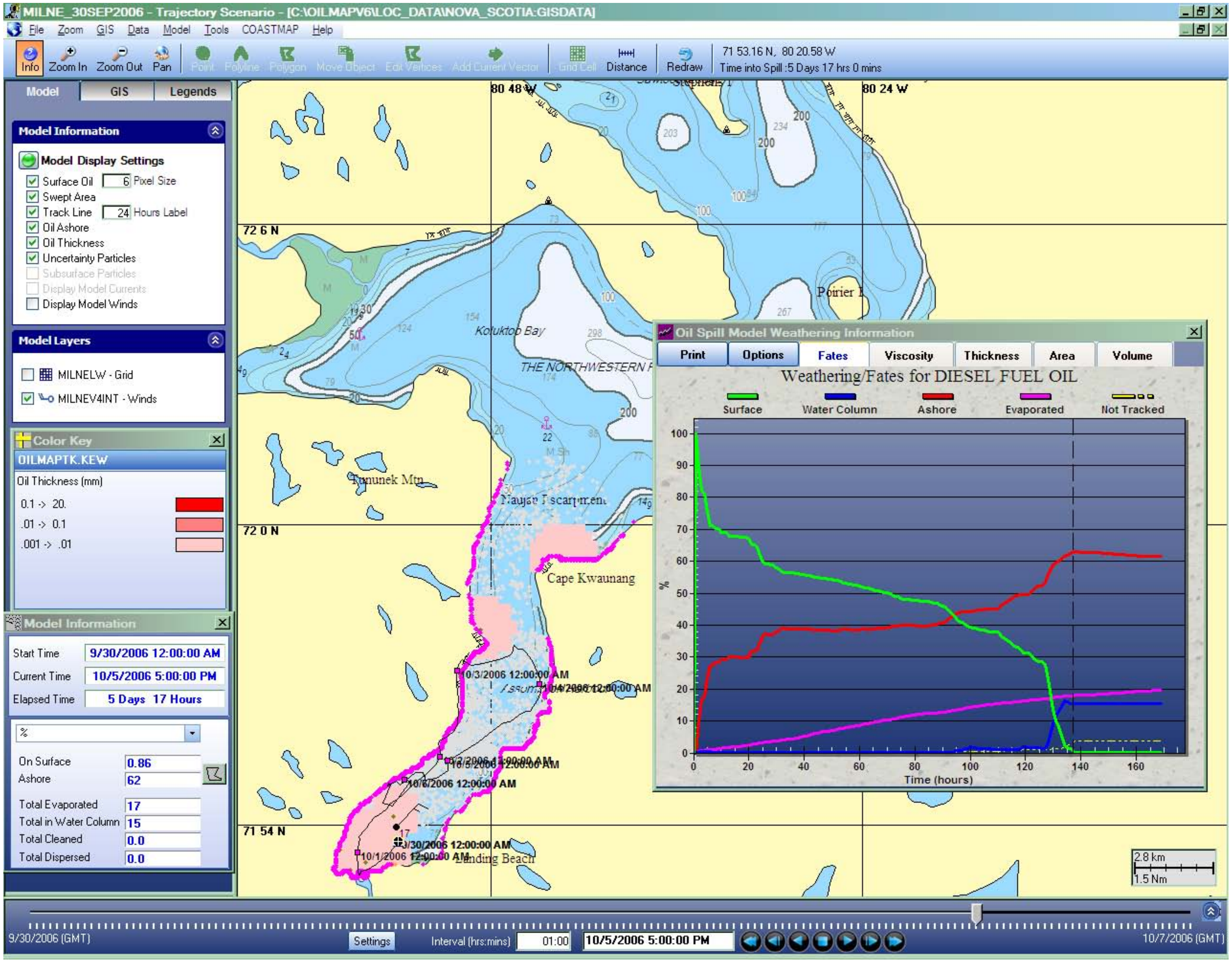

Figure 3-8 OILMAP Spill Simulation: 30 September 2006, after 5 days, 17 hours

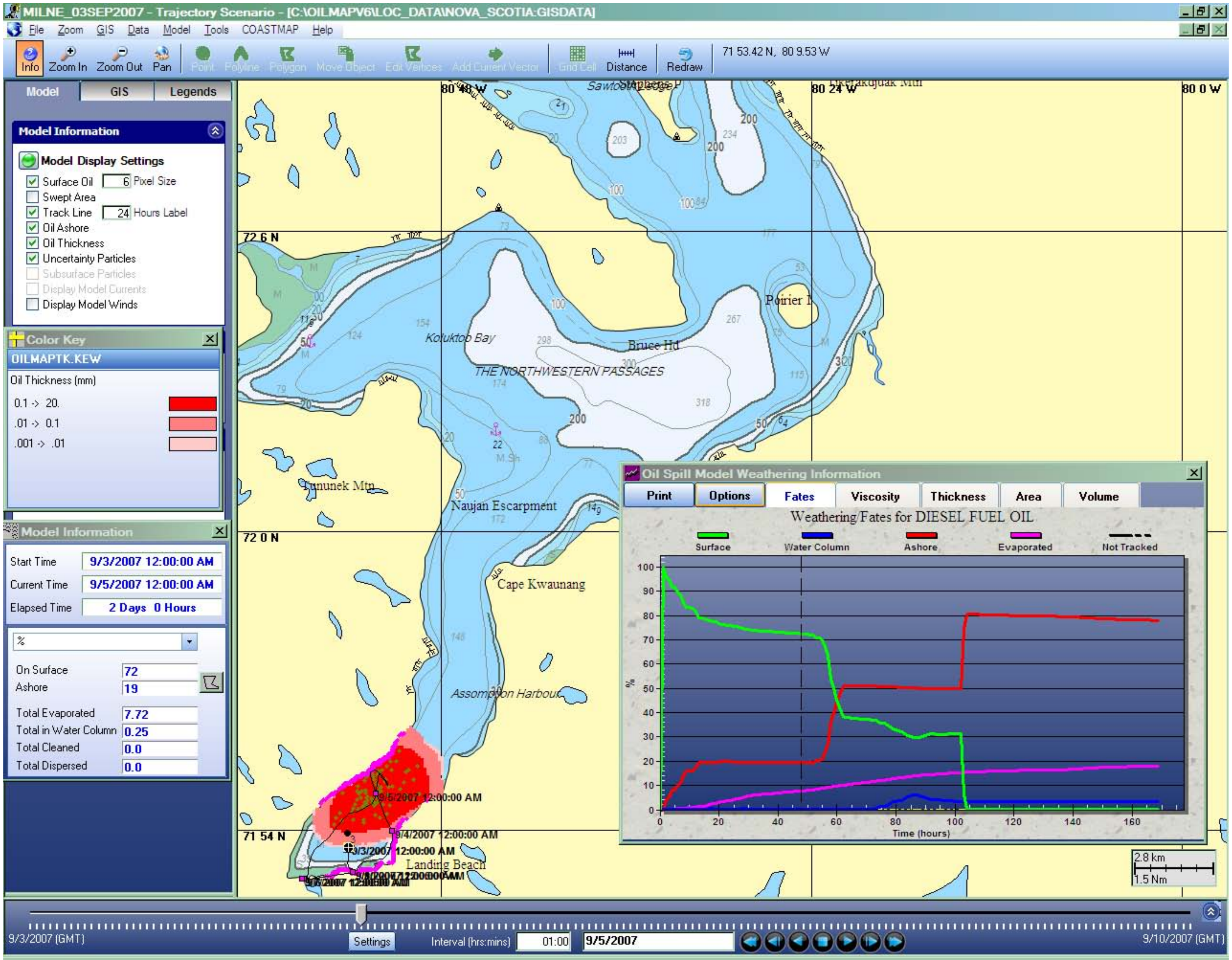

Figure 3-9 OILMAP Spill Simulation: 3 September 2007, after 2 days

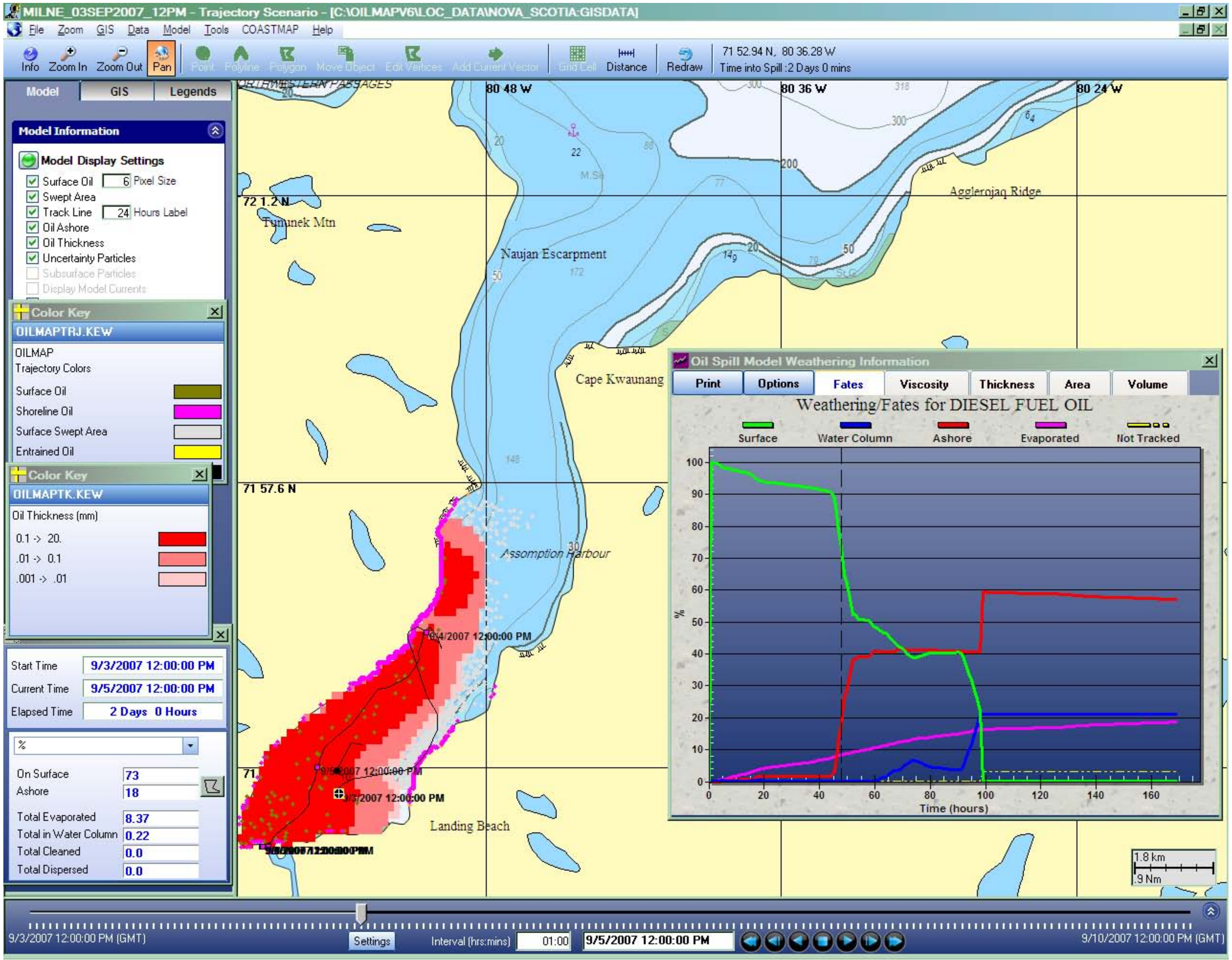

Figure 3-10 OILMAP Spill Simulation: 3 September 2007 12 pm, after 2 days

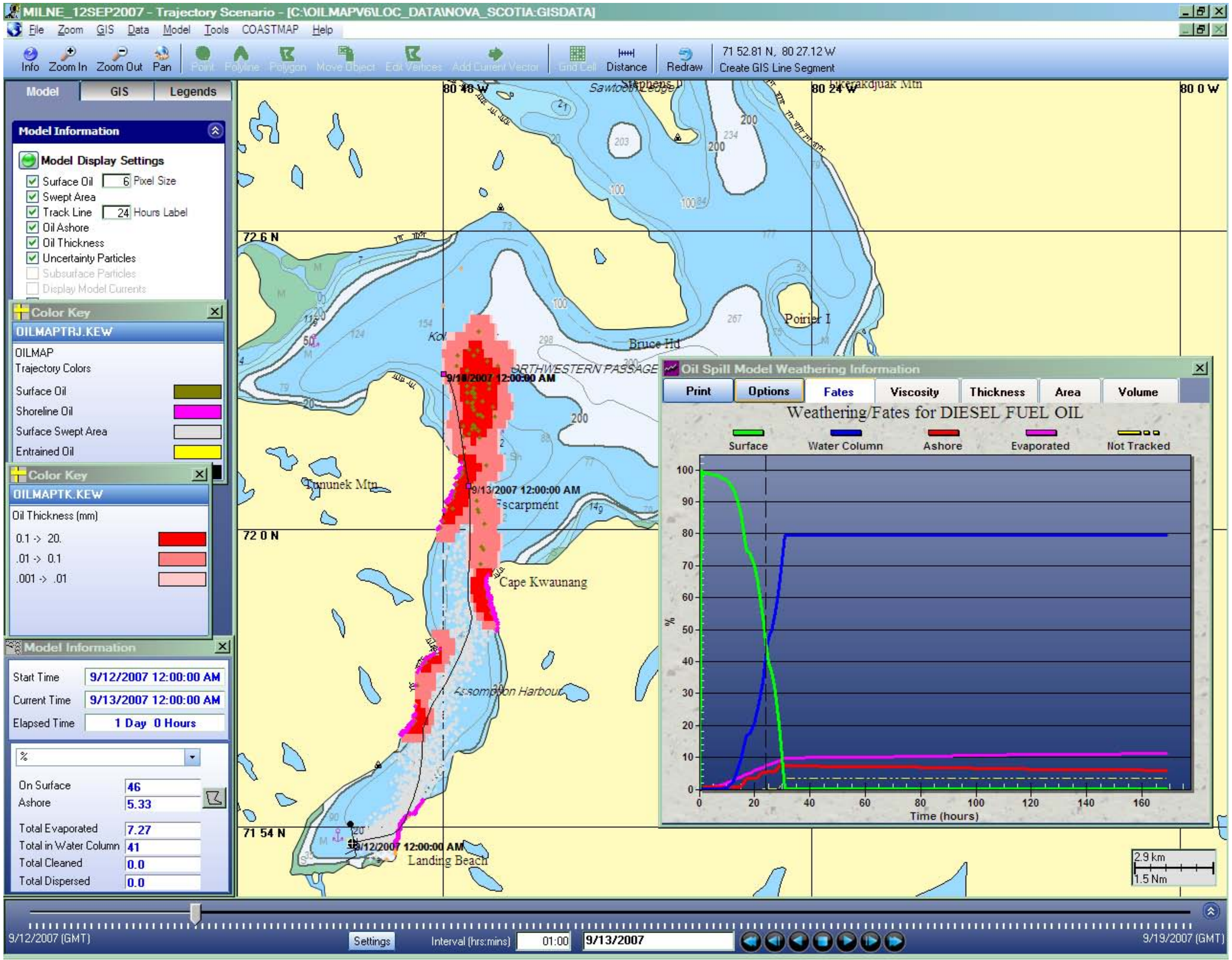

Figure 3-11 OILMAP Spill Simulation: 12 September 2007, after 1 day, 6 hours

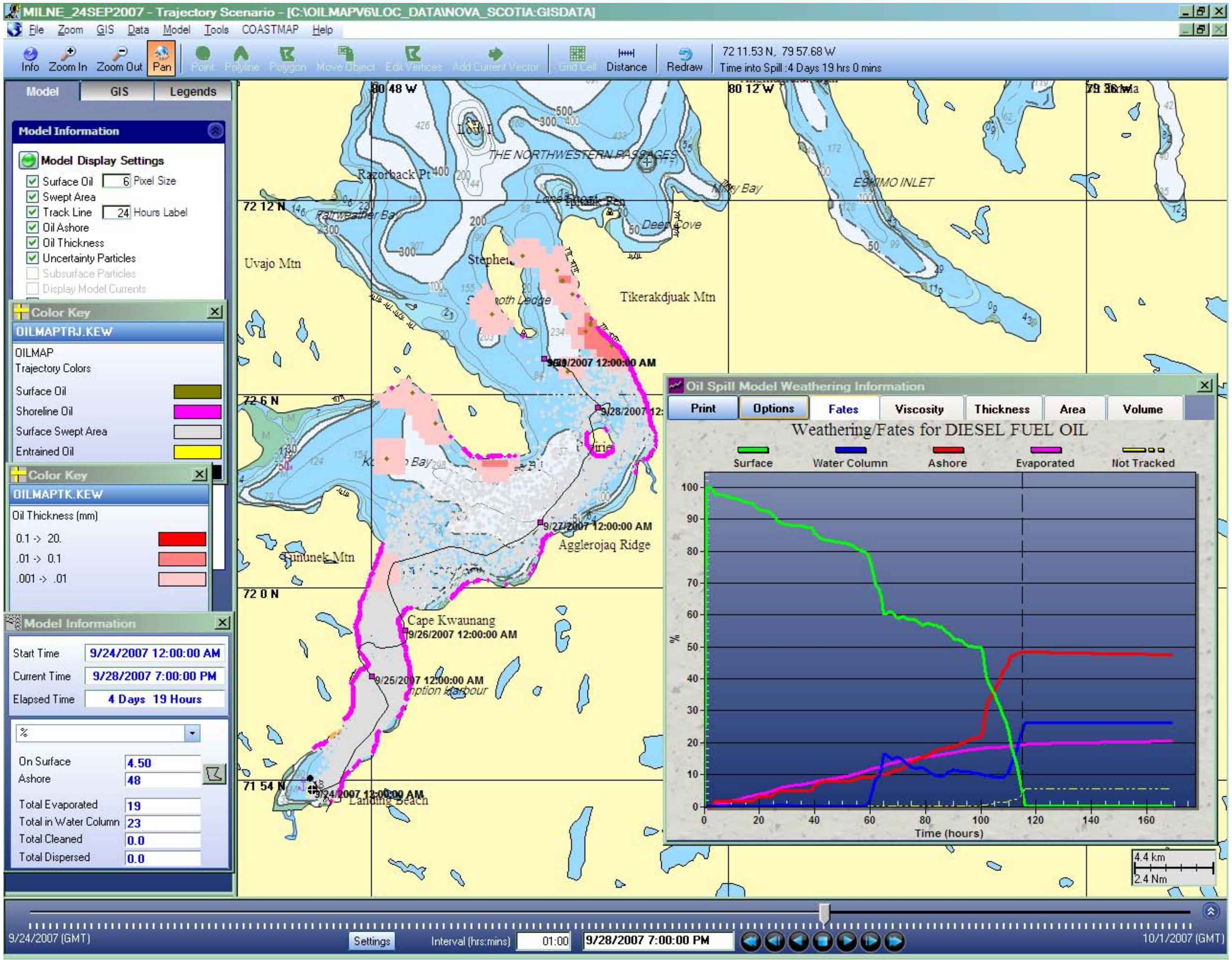

Figure 3-12 OILMAP Spill Simulation: 24 September 2007, after 2 days

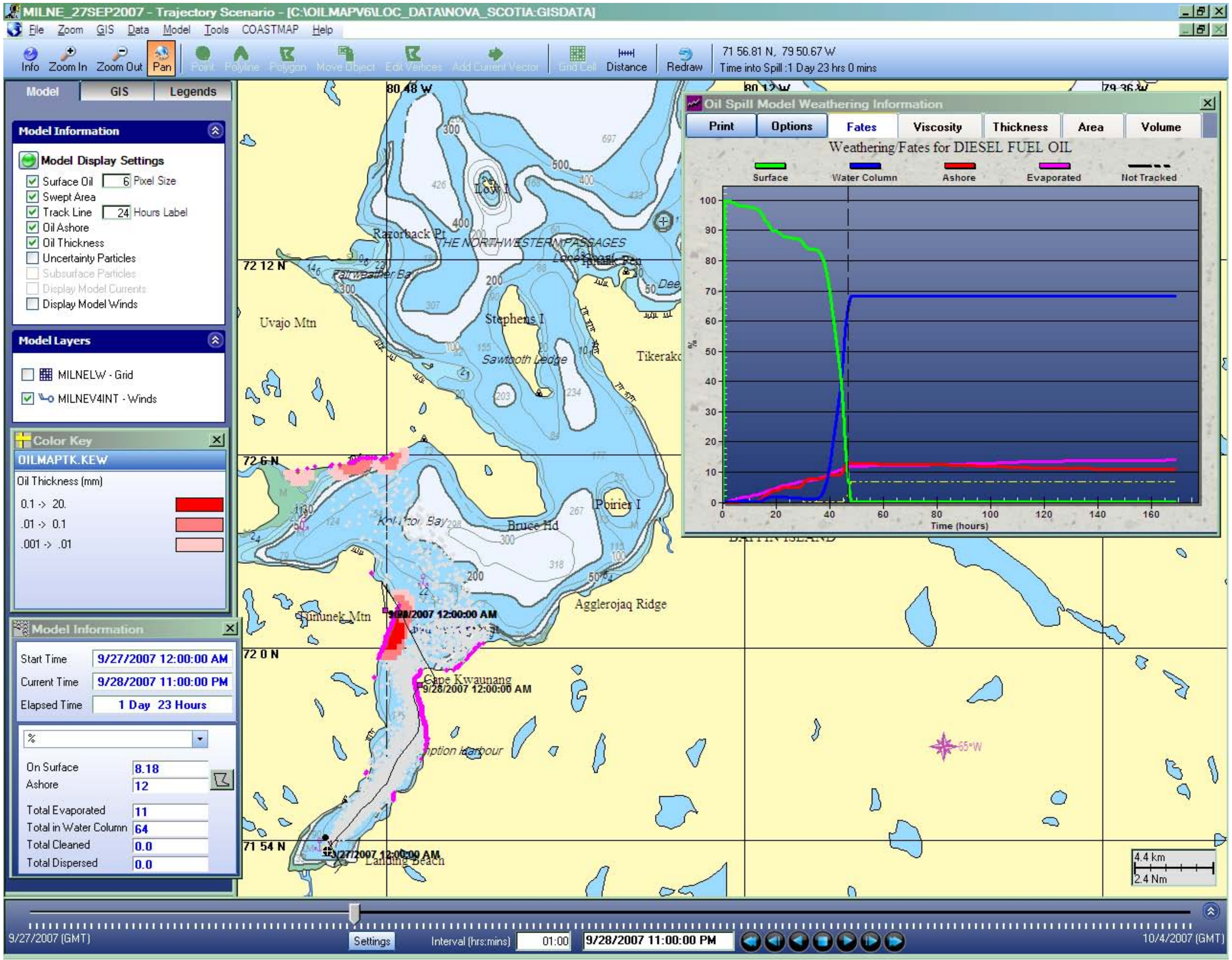

Figure 3-13 OILMAP Spill Simulation: 27 September 2007, after 1 day, 23 hours

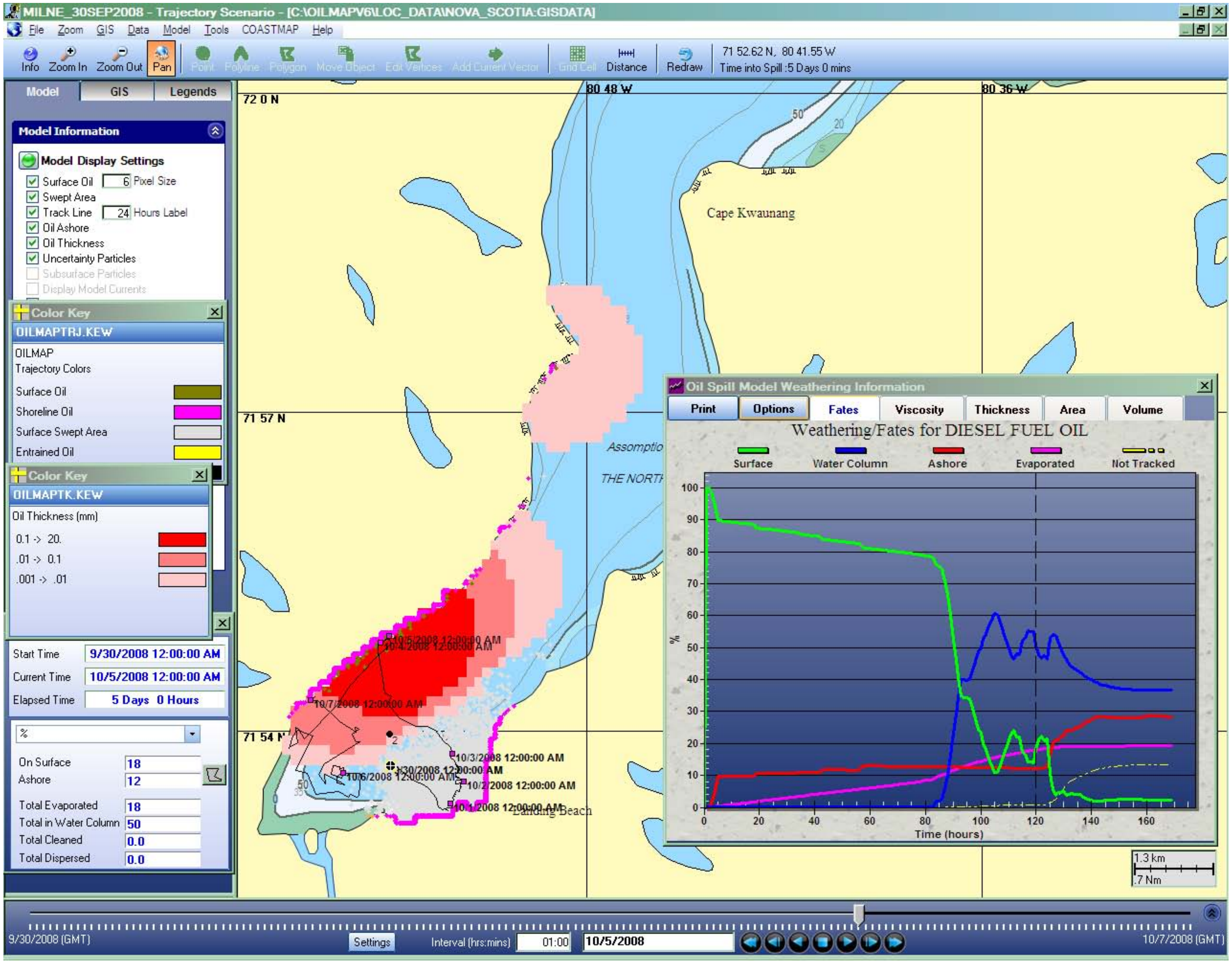

Figure 3-14 OILMAP Spill Simulation: 30 September 2008, after 5 days

3.3 Spill Weathering Fates

The OILMAP figures presented in Section 3.2 show the weathering fates for each scenario. A companion set of graphs prepared from these results are presented in Figure 3-15 to Figure 3-18 which each show one particular fate statistic, e.g., percent fuel ashore, for all scenarios together.

<u>Fuel on the Sea Surface</u>

For the scenarios considered, over the first 24 hours, 55 to 95% of the (5ML) spill remains on the surface, with the median (calculated just for the eight 'out of inlet' scenarios) being about 90% (Figure 3-15). After 48 hours, the median has dropped to 80% of the fuel on surface, while for two of the simulations the amount has dropped to zero. Clearly, as time into a spill increases there is greater variation in the possible fate outcomes. By four days, the median is down to about 30% fuel on surface, with some simulations having no fuel remaining and others as great as 50%. By about four and one half days the median amount remaining is zero. For the 'head of inlet' scenario of 25 September 2006, after 12 hours, 70% of the fuel remains on the surface. After four days this amount is 45%, and between three and one half and four days falls from almost 40% to 5%.

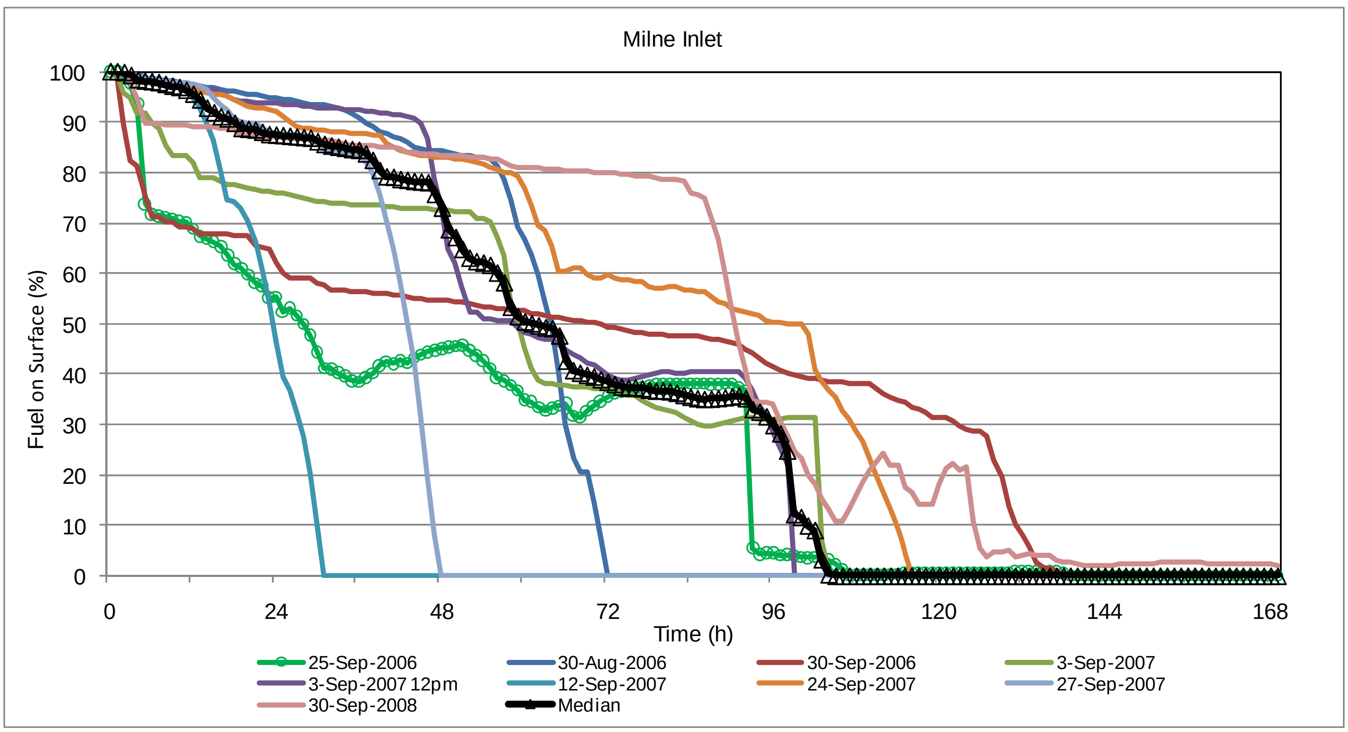

Figure 3-15 OILMAP Simulations: Percent Fuel on Surface

<u>Fuel in the Water Column</u>

For the scenarios considered, the median (calculated just for the eight 'out of inlet' scenarios) percent of fuel dispersed into the water column is zero out to two and one half days (Figure 3-16). For some individual scenarios this value is as high as 70 and 80% due to the higher wind speeds experienced. For the 'head of inlet' scenario shown with green circles, the amount over this time period is as high as 15 to 25%. After five days, the median percent of fuel in the water column is 40%, while there are still some scenarios for which the amounts are as low as 2 or 3%.

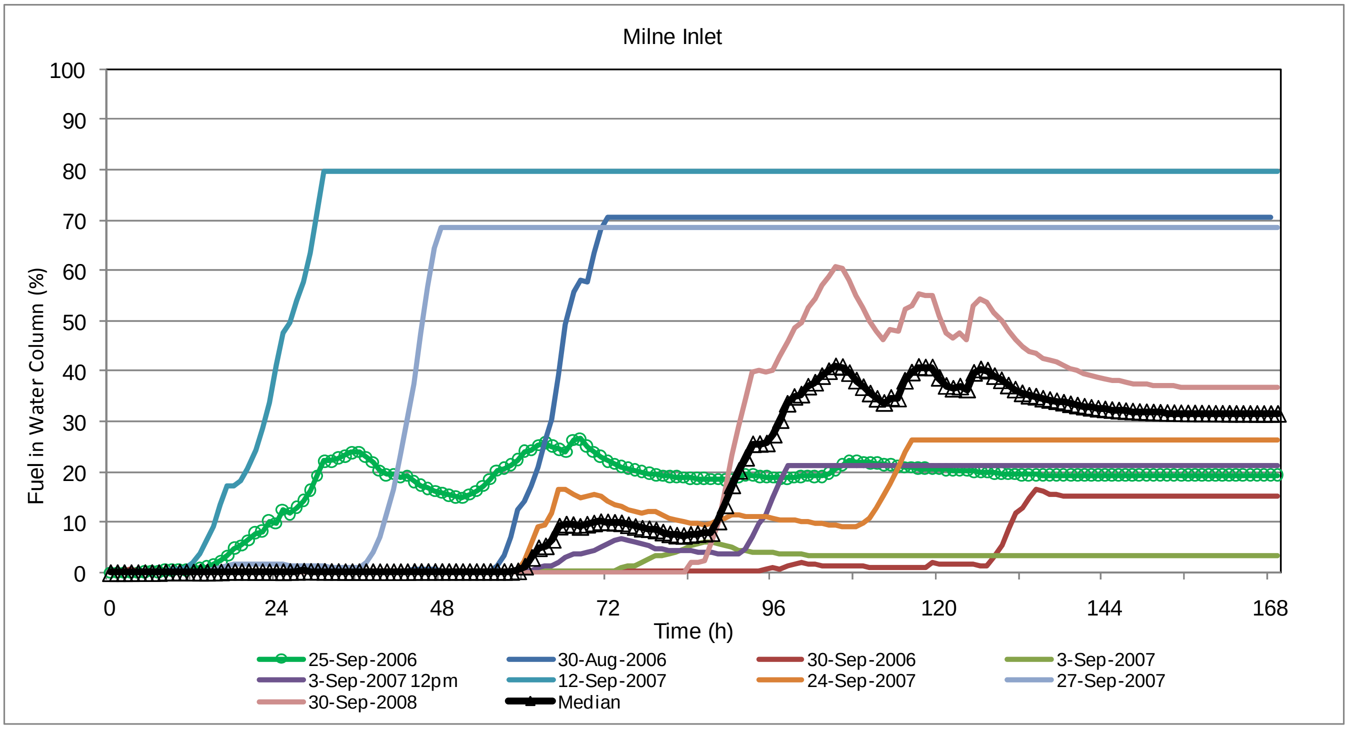

Figure 3-16 OILMAP Simulations: Percent Fuel in Water Column

<u>Fuel Evaporated</u>

There is generally good agreement in the estimates of fuel lost due to evaporation (Figure 3-17). Over the first 24 hours, the median percent fuel evaporated is 4% with values for individual scenarios ranging from 2 to 6%. After three days the median is 11.5% and the range is from 7% (for the scenario considered with the lightest wind conditions) to 15%. After five days, the median percent fuel evaporated is 16%. Due to the larger wind speeds, the 'head of inlet' scenario of 25 September 2006 experiences about the greatest evaporation loss over the first four days.

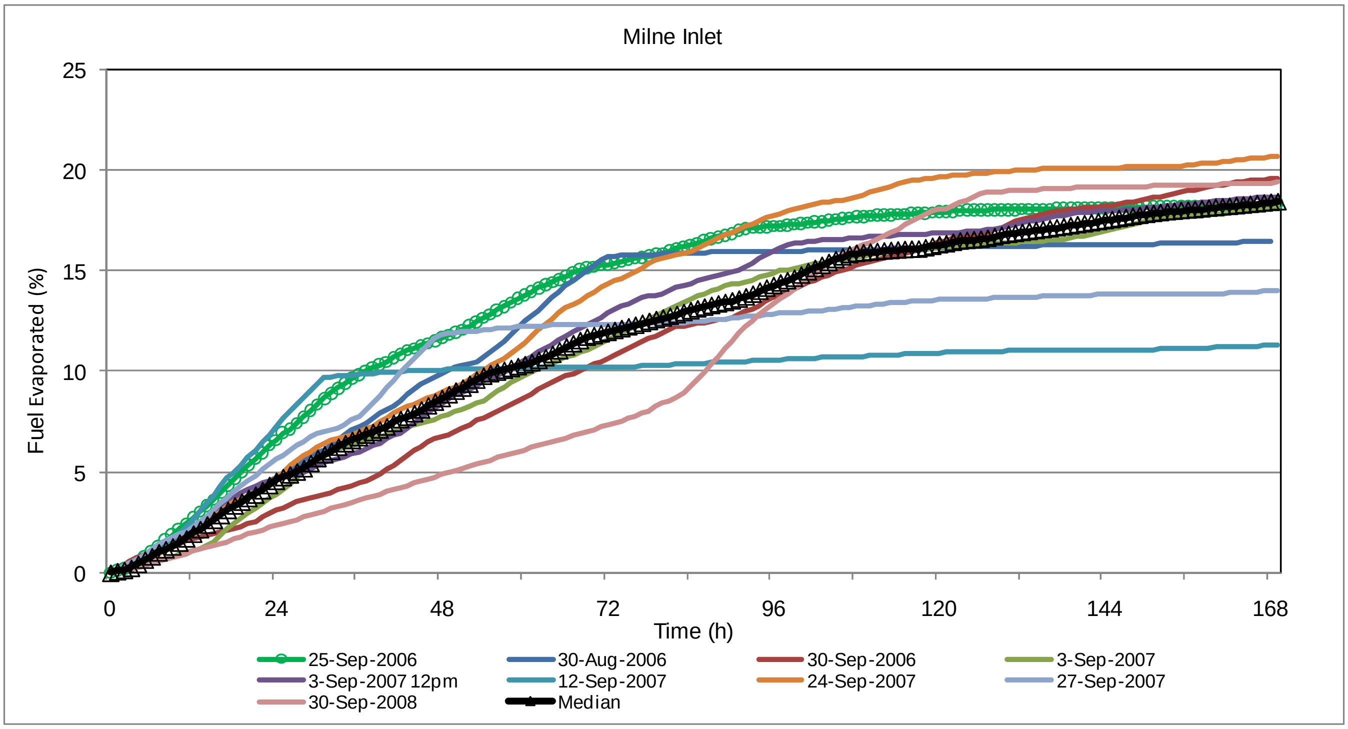

Figure 3-17 OILMAP Simulations: Percent Fuel Evaporated

Fuel Ashore

The median (calculated for the eight 'out of inlet' scenarios) percent fuel ashore is 3.5% after 24 hours (Figure 3-18). This graph does not provide an indication of which shores might be affected. After 48 hours the range is from 7 to 38% fuel ashore and a median of 12% (600,000 L of a 5 ML spill). Over the next 48 hours, out to day four, the percent of fuel ashore ranges from 7 to 50% (60% for the 'head of inlet' spill). The median remains near this value increasing gradually up to near 20% after four days. The maximum percent of fuel ashore is 80% for the 3 September 2007 scenario (Figure 3-9) in which the spill is confined to the upper 5 or 6 km of the inlet.

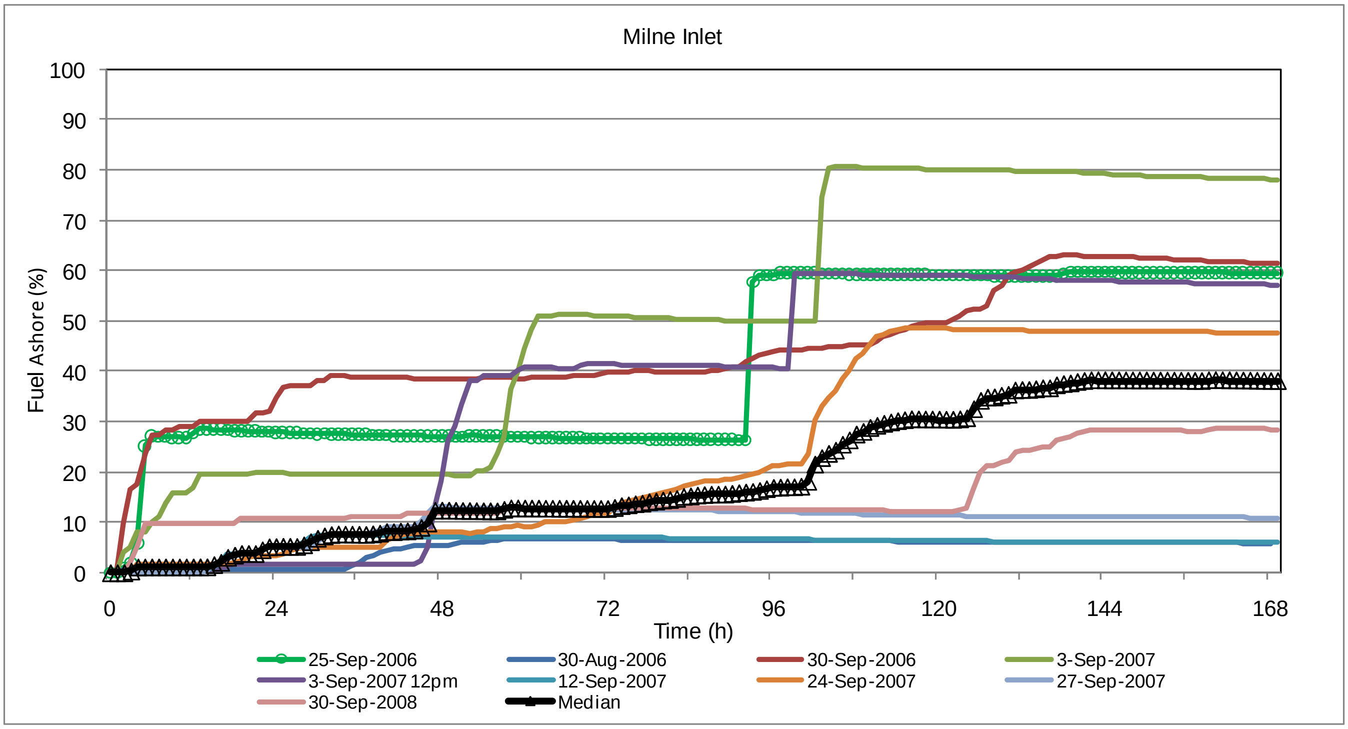

Figure 3-18 OILMAP Simulations: Percent Fuel Ashore

3.4 Oil Concentrations

Subsurface fuel concentration C, in ppm, may be estimated using outputs from the OILMAP simulations and equation (1).

$$C = (WaterCol \times 1{,}000{,}000)/(A \times h) \qquad (1)$$

where WaterCol = total oil volume in water column (m^3)
A = surface area with oil > 0.001 mm thick (m^2); and
h = depth of well-mixed surface layer estimated for oil entrainment, assumed = 0.5 m (ASA, 2004)

Figure 3-19 presents the oil concentration estimates for each of the nine scenarios (Table 3-2) together with the median concentration values. For the 25 September 2006 'head of inlet' spill, concentrations are a maximum of 2400 ppm after 31 hours, and due to the persistence of the slick at the surface, stay above 1000 ppm for the remainder of the seven day period simulated. For the other 'out of inlet' scenarios, a maximum concentration of 42 ppm is reached in three hours. Over this time period maximum concentrations for the other simulations are as low as 0.01 ppm or less. Median concentrations range from about 2 ppm at 12 hours; to about 10 ppm at 18 hours; 3 ppm after one day; 1.3 ppm after two days; and as large as 77 ppm after four days.

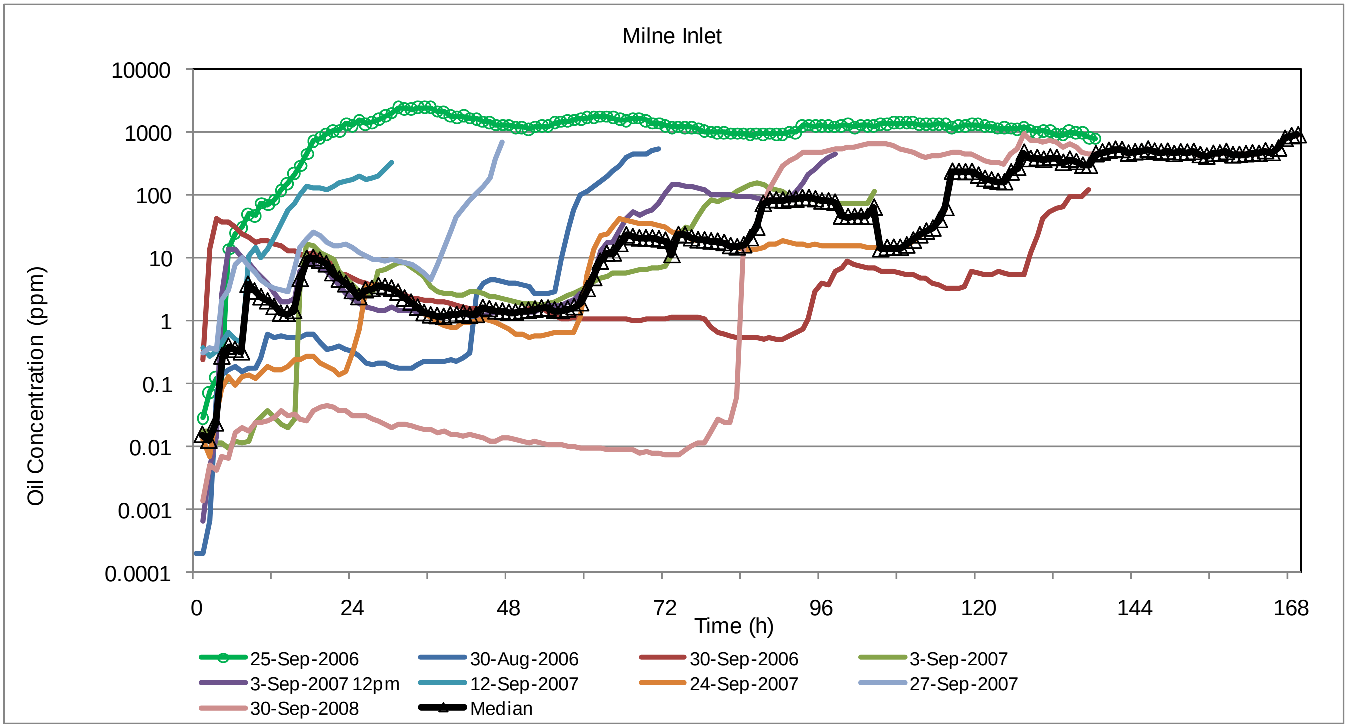

Figure 3-19 OILMAP Simulations: Near-Surface Oil Concentration

3.5 Sensitivity to Spill Volume

As illustrations of fate sensitivity to spill size, the simulations for 25 Sep 2006 and 24 Sep 2007 (Table 3-2) were repeated with one tenth of the original spill scenario volume, i.e., 500,000 L.

<u>25 September 2006</u>

Figure 3-20 and Figure 3-21 show spill trajectories for 500,000 L and 5,000,000 L diesel fuel releases after six hours. The weathering graphs shown amount of fuel in litres. Due to the northeasterly winds the slicks remain at the southwestern corner at the head of the inlet. For the smaller spill volume, after seven hours no fuel remains on the sea surface: 96% of it, or about 480,000 L, has come ashore, 3% has evaporated, and less than 1% has been dispersed into the water column.

By contrast, for the larger spill, after six hours, about 1.3 ML (27%) has come ashore. After this time, the oil holding capacity of this modeled tidal flats shoreline segment has been reached so that not much further accumulation ashore occurs until day four, with the overall result that about 60% of the fuel has come ashore, 20% has evaporated, and 20% was been dispersed into the water column.

<u>24 September 2007</u>

For a scenario of winds blowing out of the inlet, in just over one day, the slick has travelled north of Cape Kwaunang 11 km to the north. For the 500,000 L spill (Figure 3-22), fuel can reach Poirier Island 27 km to the north in three days. At this time the amount on the surface is 22,000 L or about 5% covering an area (at oil thickness of 0.001 mm or greater) of about 25 km^2. The amount on the surface does not fall below 1% or 5,000 L until four and one half days. By this time 350,000 L is estimated to have come ashore, 100,000 L has evaporated, just 26,000 L has been mixed into the water column, and 6,600 L remain on the surface, about two thirds of the way from the head of the inlet towards Cape Kwaunang.

For the 5,000,000 L spill (Figure 3-23), the western shores of the inlet opposite Cape Kwaunang are reached in a similar time of about one day. After three days, in comparison to the fate of the 500,000 L spill, much more fuel remains on the sea surface, 3,000,000 L, while 600,000 L has come ashore, and just over 700,000 L have each been evaporated and lost into the water column.

At the time that the trajectory 'ends' and any fuel has completely disappeared from the surface, it is noted that while clearly the amounts ashore, evaporated, and in the water column are less for the smaller spill size, the percentages ashore and evaporated are greater. For the smaller spill 66% of the spill has come ashore, 24% has evaporated, and 7% has been dispersed into the water column (and 3% of fuel is not tracked. For the 5 ML spill 47% of the spill has come ashore, 20% has evaporated, and 26% has been dispersed into the water column (and 7% of fuel is not tracked), a larger percentage lost to the water column partially due to the longer time the slick is subject to weathering, one more day.

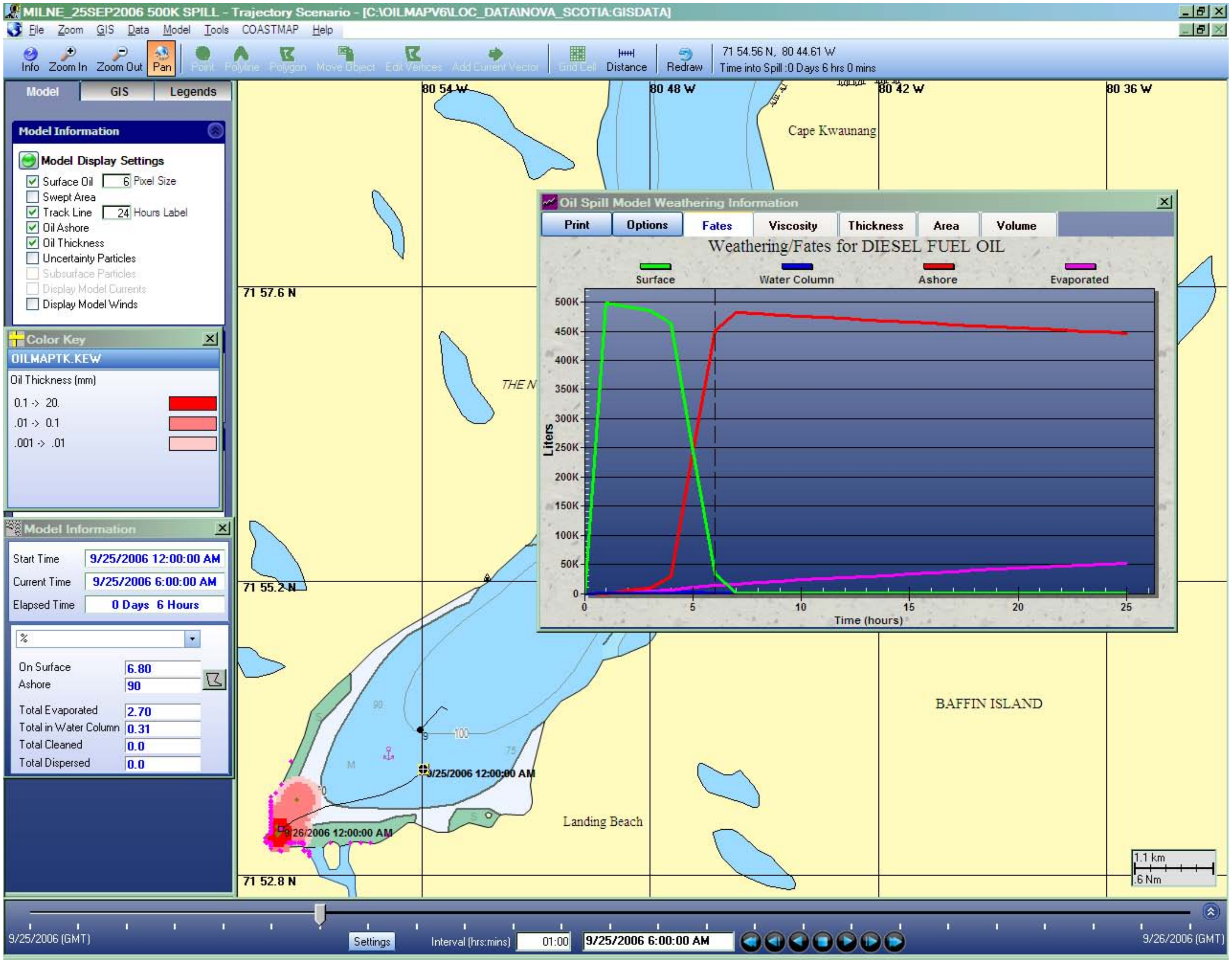

Figure 3-20 OILMAP Spill Simulation: 25 September 2006, 500,000 L spill after 6 hours

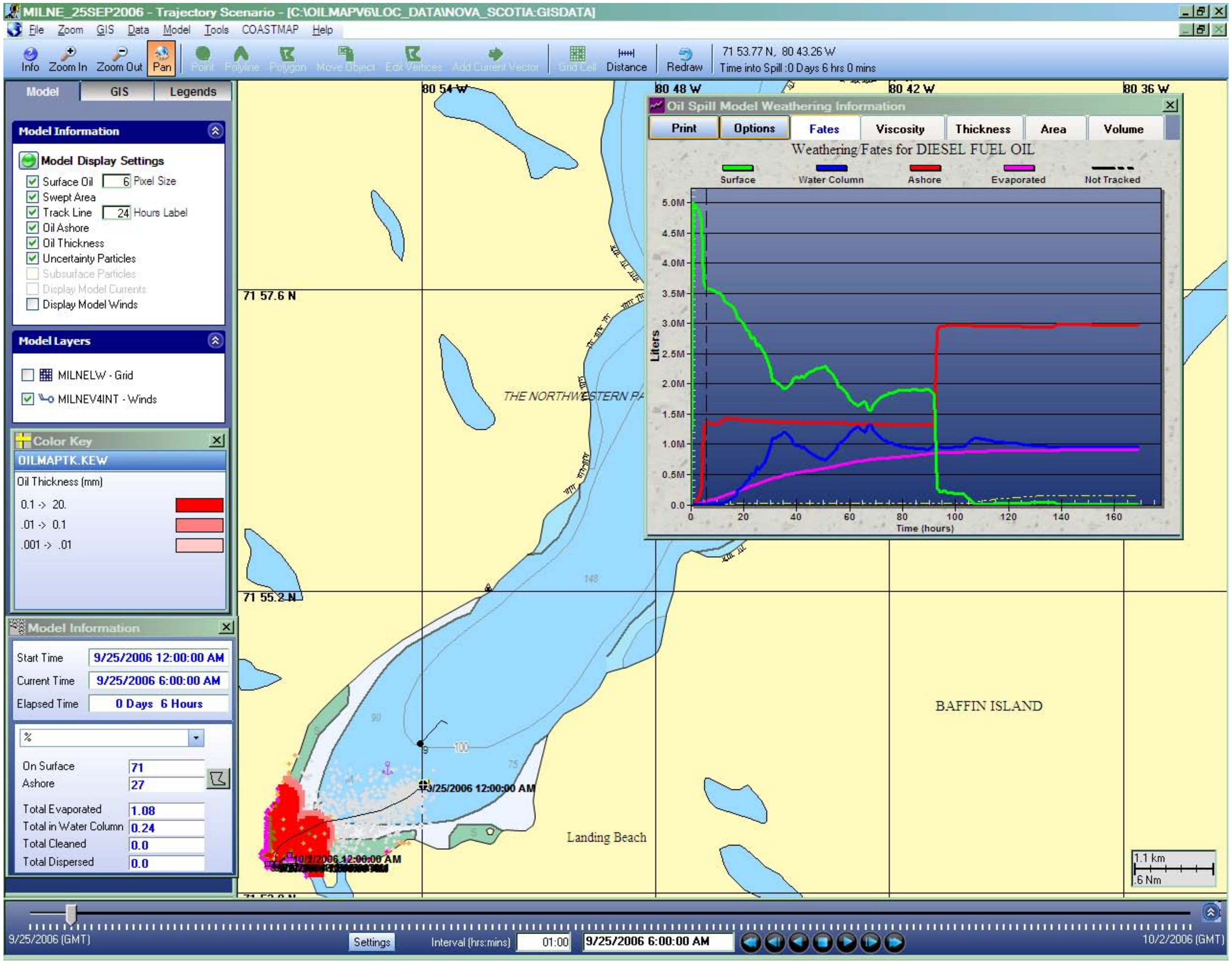

Figure 3-21 OILMAP Spill Simulation: 25 September 2006, 5,000,000 L spill after 6 hours

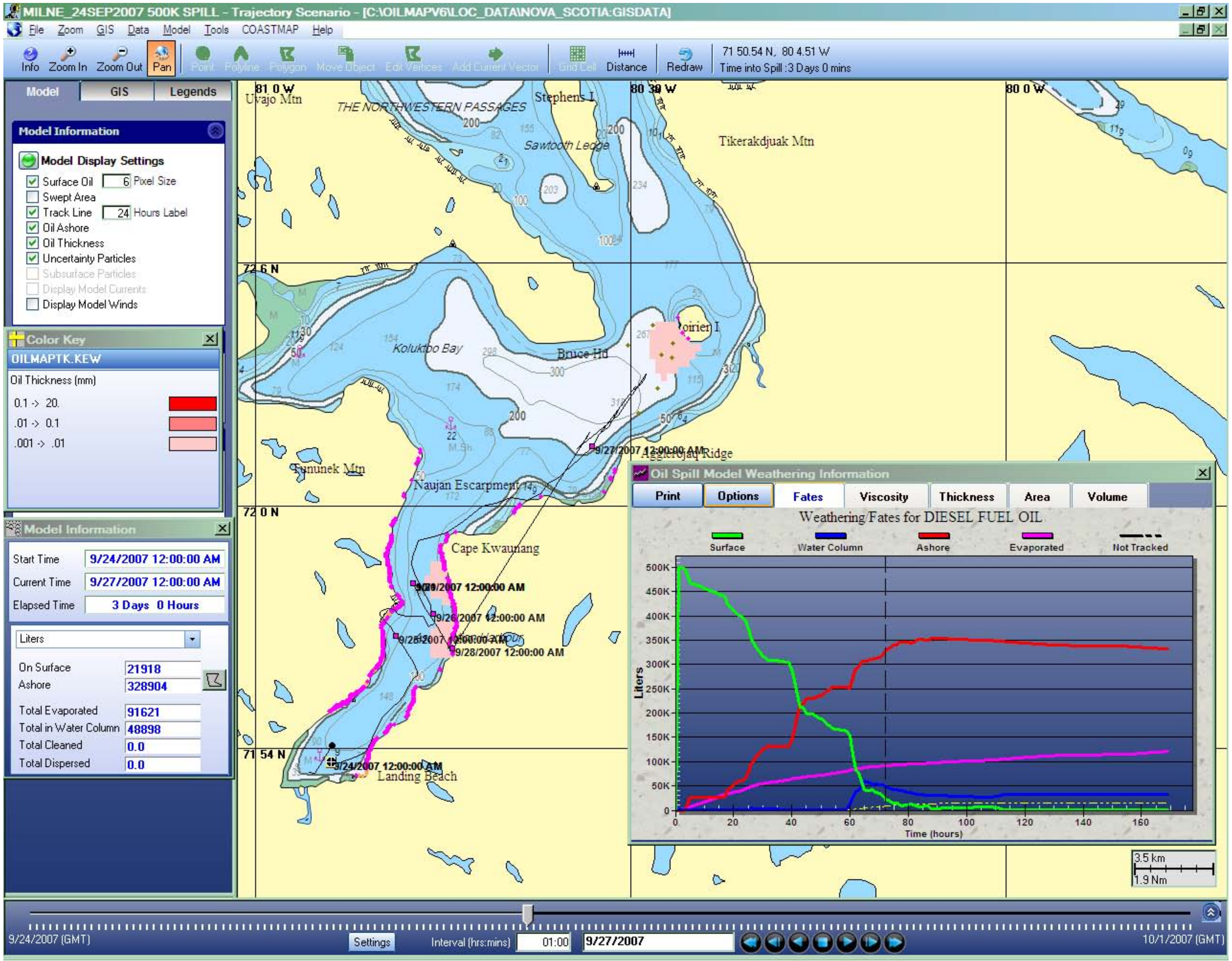

Figure 3-22 OILMAP Spill Simulation: 24 September 2007, 500,000 L spill after 3 days

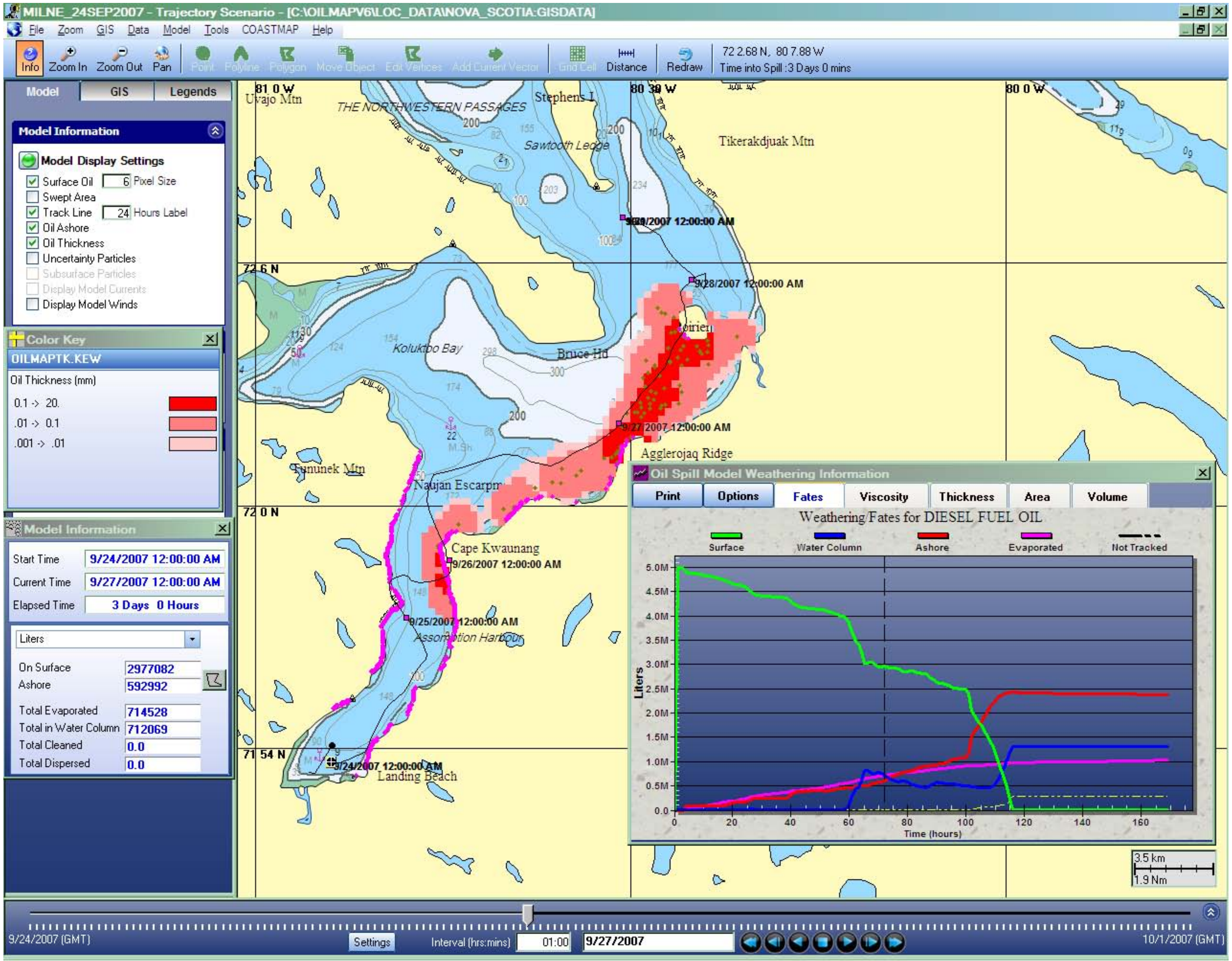

Figure 3-23 OILMAP Spill Simulation: 24 September 2007, 5,000,000 L spill after 3 days

4. CONCLUSIONS

The spill trajectory modelling study presented in this report modeled the hypothetical accidental release of diesel fuel at the proposed port site at the head of Milne Inlet during the open water season. Objectives included estimation of the marine and coastal areas potentially affected together with the initial weathering fate of the diesel fuel.

Two spill models were employed. The AMEC in-house software, OST, was used to produce spill distribution probability plots to indicate which regions of Milne Inlet might be affected and how frequently. The ASA OILMAP software was used for estimation of spill fate including amounts of fuel weathered due to evaporation or dispersion into the water column by wave action, as well as amounts brought ashore.

Consideration of wind, ocean tide and current, as well as sea ice conditions bordering the open water season, which might affect the trajectory and date of a fuel spill was completed. To simulate the open water season time period, the month of September was selected. Wind measurements from the met station in operation near the head of Milne Inlet since June 2006 were employed together with a 30-year NCEP/NCAR wind hindcast for the region as inputs to the trajectory model, OST. Although there was reasonable agreement in wind speeds, there were differences in the directional distributions of the measured and hindcast winds, likely due to the fjord topography of the inlet. The hindcast did represent the closest long duration time-series record available thereby enabling modelling of a number of spill trajectory samples from which to derive overall estimates of the probable distribution of a slick in Milne Inlet. Each trajectory is a prediction of the drift path until a first contact with shore. In addition to a base case scenario employing the 30-year hindcast, four additional model runs were completed for a reduction or increase in wind speed and for rotations of wind direction as logical sensitivities given the difference in predominant wind directions reported for the Milne met station and the NCEP/NCAR location.

A hydrodynamic numerical model forced by water level variations derived from tide gauge records from Milne Inlet predicted that tidal currents should be expect to be very weak In Milne Inlet, and even weaker (probably barely detectable) at the dock site. Acknowledging this, the sole primary driver for the advection of a spill was expected to be the winds, and no currents were applied in the spill modelling scenarios completed. Measurements from an oceanographic program conducted in Milne Inlet in September 2010 confirmed that tidal currents are only about 0.02m/s near Cape Kwaunang and barely detectable by the instruments at the dock site. Residual currents were also found to be very small. Currents associated with adjustment of strongly stratified Milne Inlet to wind setup were observed intermittently.

The primary outputs of the OST spill trajectory model include a distribution probability map of Milne Inlet developed by superimposing all possible open water spill trajectories over the 30-year wind record, together with a companion set of shore impact statistics which report the percent of trajectories impacting the shoreline and the earliest times to shore.

It is predicted that the vast majority, 90-97%, of all trajectories, will first reach shore in the port site area within about 4 km of the head of Milne Inlet in as soon as 30 minutes and on average in four hours, with an associated small amount of fuel weathering having taken place. Between 3 and 10% of the time trajectories might be expected to first contact shore another 6 km farther out in the reach of the inlet leading to Cape Kwaunang. First impacts for shores in Koluktoo Bay, the Bruce Head region on the

Borden Peninsula, and the southern tip of Stephens Island are much less likely, occurring less than 1% of the time. Due to the short times to shore for most of the trajectories, weathering of the fuel prior to first shoreline contact is correspondingly low. Also due to short times to shore, the observed intermittent currents associated with adjustment to wind setup would have limited effect on the spill trajectories predicted using wind forcing only and the ultimate fate of the spills would remain fundamentally the same. In the Milne Port Area on average about 4 to 5% of fuel are weathered due to evaporation or dispersion into the water column before any fuel reaches shore. This amount increases to 10 to 16% for trajectories reaching Cape Kwaunang and about 15 to 50% for trajectories north of there. These statistics are for distribution of a hypothetical, uncontained, and unmanaged spill, for the Project domain of operations in Milne Inlet for the open water season.

An important observation is that the trajectory model predicts the times and paths taken to first reach a shoreline in the inlet. More detailed characterization of the weathering fate of the spill, and amounts of fuel remaining on the surface and ashore, e.g., after initial shoreline contact, is better afforded with the OILMAP software. The hypothetical accidental release of 5 ML of diesel fuel at the proposed port was modeled. The primary focus of the OILMAP scenarios was to consider possible winds blowing out of the inlet which might result in spill trajectory drift farther afield of an assumed spill location at the head of the inlet and to estimate the potential fate of the fuel. Winds in Milne Inlet are predominantly from the northeast into the inlet. Just 20% of winds in September are from the southwest quadrant. Consequently, the approach was taken to look for events with some period of winds blowing out of the inlet. This was accomplished by inspection of the Milne Inlet met station wind record. Eight simulations were completed to provide an indication of possible trajectory fates, while less likely, of interest to assess how far out into Milne Inlet the slick may drift. A ninth scenario for when winds kept the slick generally within the confines of the head of Milne Inlet was selected: given the predominance of winds into the inlet, this scenario provides an indication of a more likely fate one might expect. It is emphasized the scenarios considered are not a definitive collection to completely describe all possible spill outcomes; however, these scenarios do provide an indication of the possible trajectories, in particular how far out into Milne Inlet the slick may drift.

For the scenarios ‘out of the inlet’, diesel fuel was predicted to come ashore as far as 5 to 36 km away from the port site, a trajectory not too dissimilar from several predicted with the OST model. Fuel amounts predicted to reach shore just past Cape Kwaunang, about 11 km to the north, ranged from no fuel to 2 ML.

In addition to OILMAP figures presented in Section 3.2 which show the weathering fates for each scenario, companion graphs each showing one particular fate statistic, e.g., percent fuel ashore, for all scenarios together have been provided. Each of these graphs is best viewed individually to interpret the range of fate statistics provided by the scenarios. Nevertheless, a summary is presented here.

Estimates of fuel lost due to evaporation over the first three days of a spill range from 7% for light winds to as much as 15%. While in many cases little fuel is dispersed into the water column over the first two to three days, this amount can also be as high as 80% in the event of higher winds. By four days, the median amount of fuel remaining on the water surface is about 30%, with some simulations having none and others as much as 50%. After the first two days the amount of fuel ashore ranges from about 7 to 38% of the spill amount with a median of 12% (600,000 L of a 5 ML spill). The maximum percent of fuel ashore is 80% when the spill is confined to the upper 5 or 6 km of the inlet.

Estimates of subsurface fuel concentration, based on the amount of fuel dispersed into the water column and an assumed mixing depth of 50 cm, are a maximum over 1000 ppm after one day for a spill generally confined to the head of the inlet. For ‘out of inlet’ trajectories a maximum concentration of

42 ppm is reached in three hours and median concentrations range from about 1 to 10 ppm over the first three days.

To assess the sensitivity of results to spill volume, a spill one tenth the volume of the original spill scenario (i.e., 500,000 L) was modelled. At the time that the trajectory 'ends' and any fuel has completely disappeared from the surface, it is noted that while the amounts ashore, evaporated, and in the water column are less for the smaller spill size as expected, the percentages ashore and evaporated are greater.

5. REFERENCES

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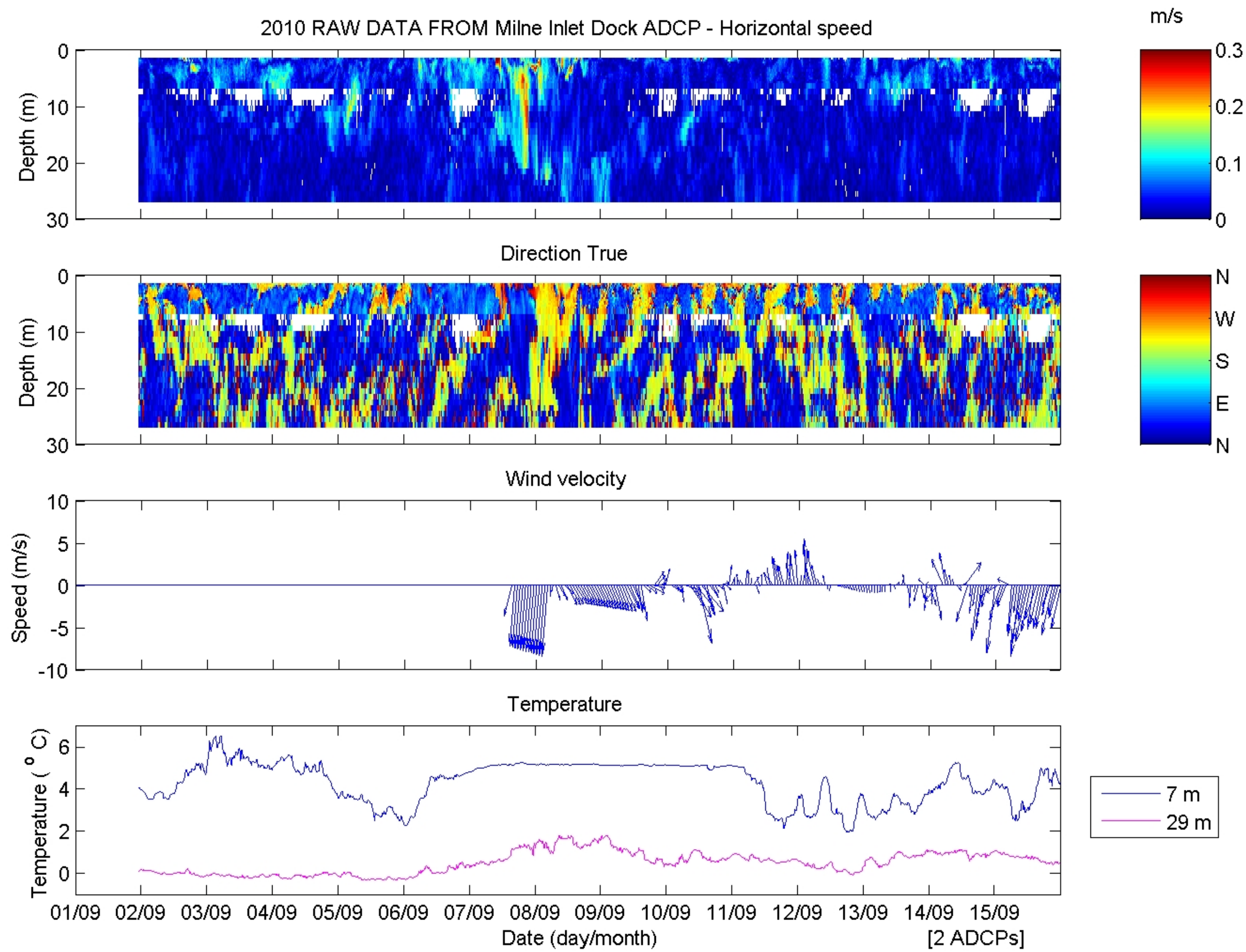
APPENDIX A

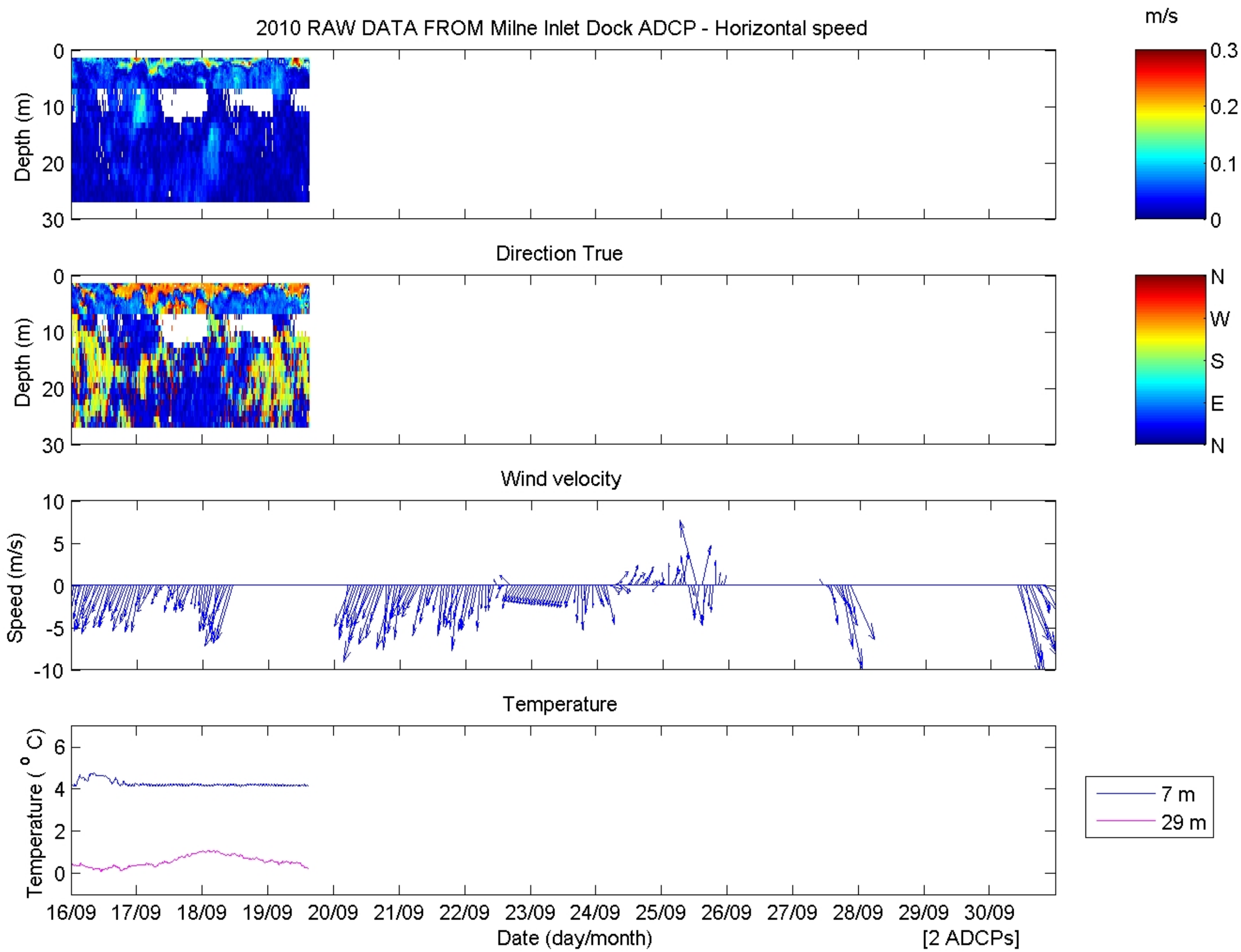
MILNE INLET SEPTEMBER 2010 OCEANOGRAPHIC PROGRAM

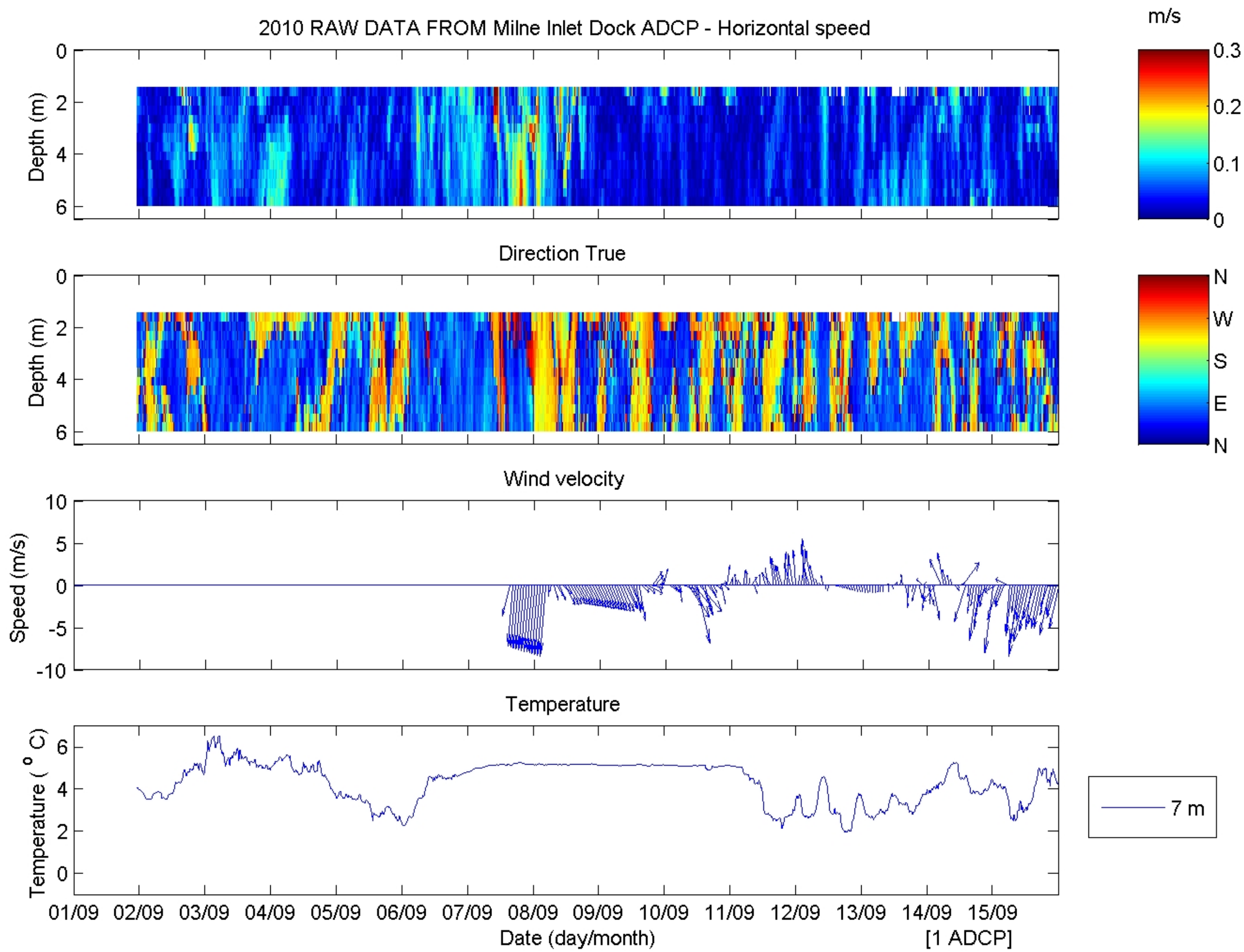
Current speed and direction, wind velocity and temperature time series;

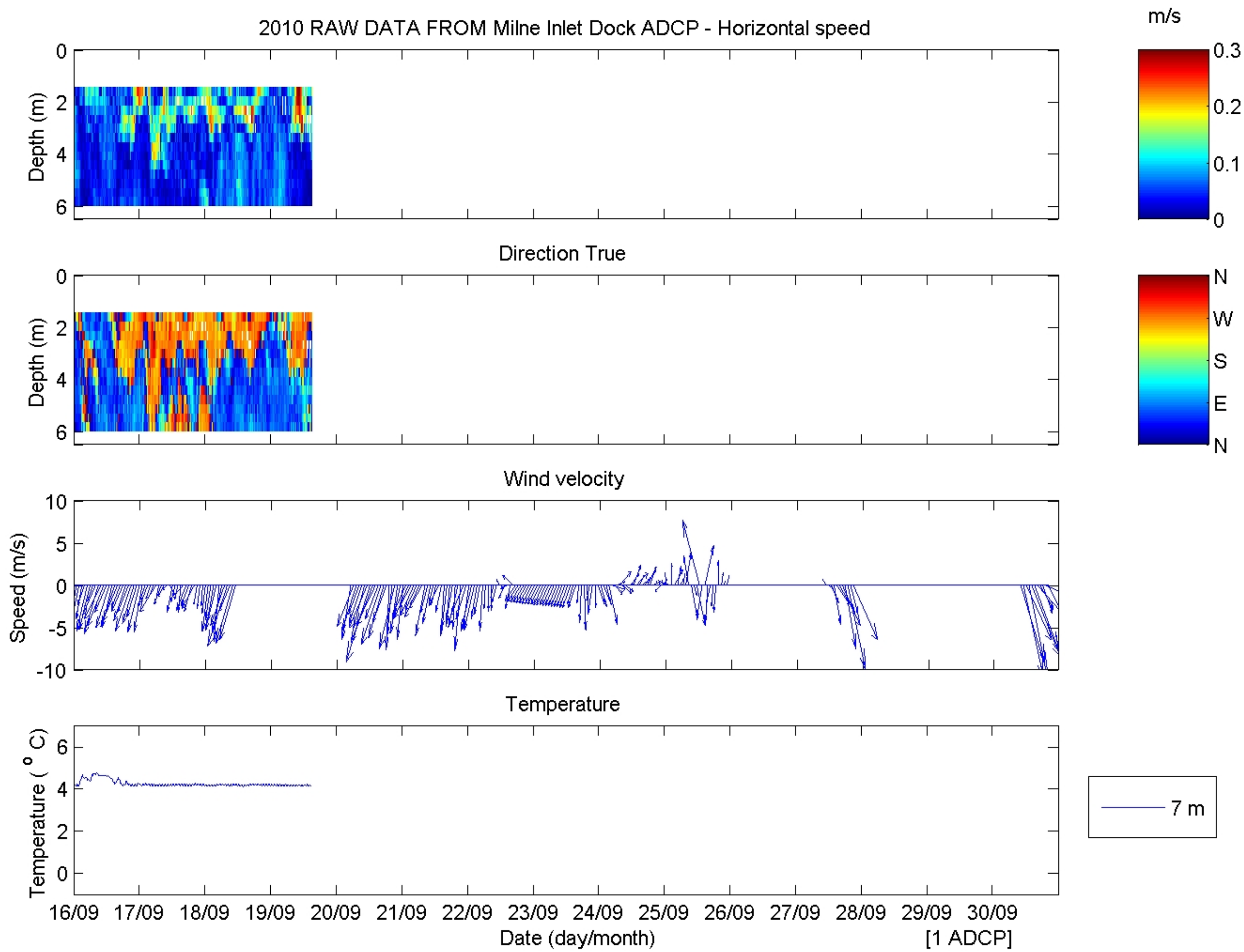
Tide gauge data and predicted tides; and

Temperature and Salinity Profiles from CTD casts.

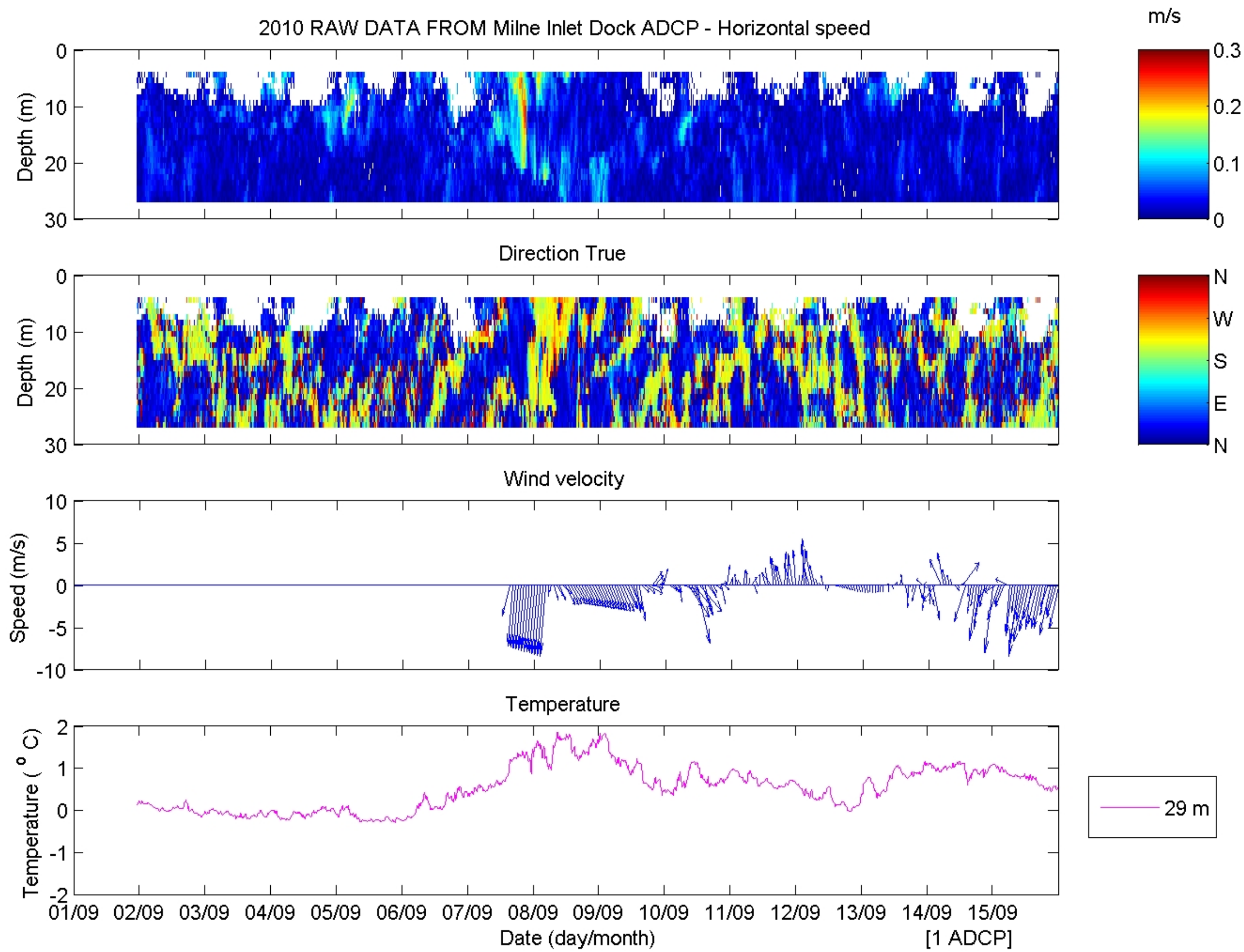

2010 RAW DATA FROM Milne Inlet Dock ADCP - Horizontal speed
Depth (m)
m/s
Direction True
Wind velocity
Speed (m/s)
Temperature
Temperature (° C)
7 m
29 m
Date (day/month)
[2 ADCPs]

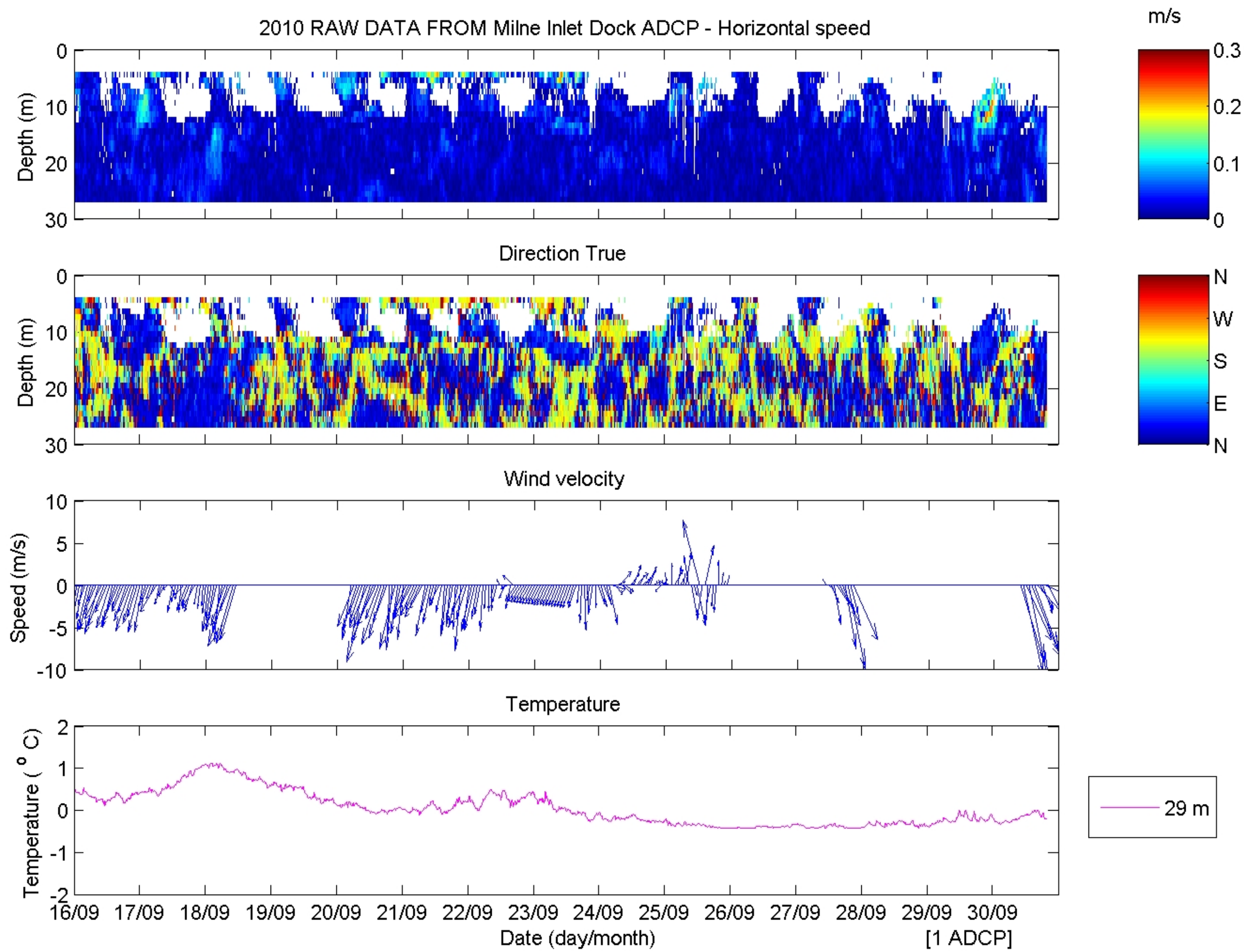

2010 RAW DATA FROM Milne Inlet Dock ADCP - Horizontal speed
Depth (m)
m/s
0.3
0.2
0.1
0
Direction True
N
W
S
E
N
Wind velocity
Speed (m/s)
Temperature
Temperature (°C)
7 m
29 m
16/09
17/09
18/09
19/09
20/09
21/09
22/09
23/09
24/09
25/09
26/09
27/09
28/09
29/09
30/09
Date (day/month)
[2 ADCPs]

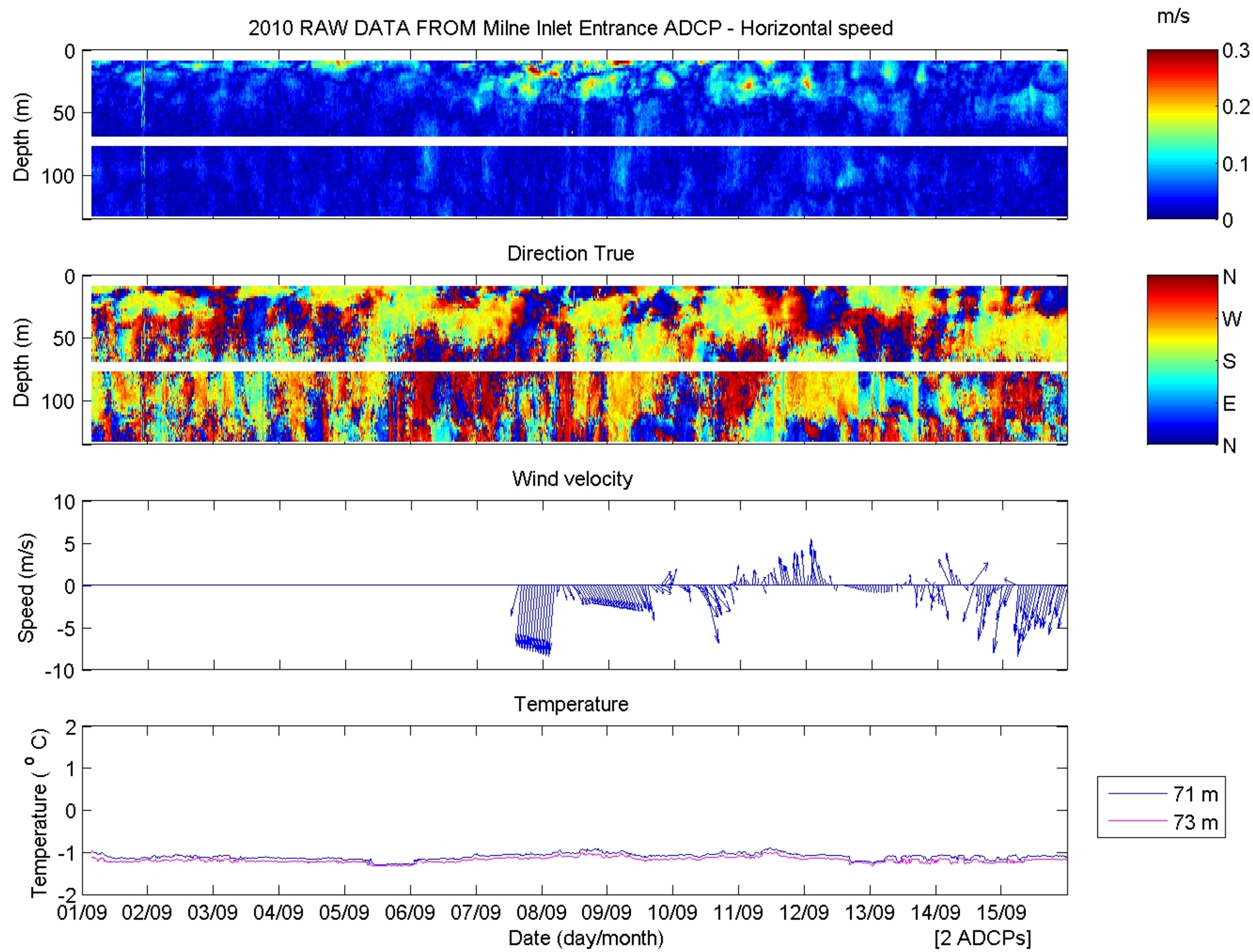

2010 RAW DATA FROM Milne Inlet Dock ADCP - Horizontal speed
m/s
0.3
0.2
0.1
0
Depth (m)
Direction True
N
W
S
E
N
Wind velocity
Speed (m/s)
Temperature
Temperature (^{o} C)
7 m
01/09 02/09 03/09 04/09 05/09 06/09 07/09 08/09 09/09 10/09 11/09 12/09 13/09 14/09 15/09
Date (day/month)
[1 ADCP]

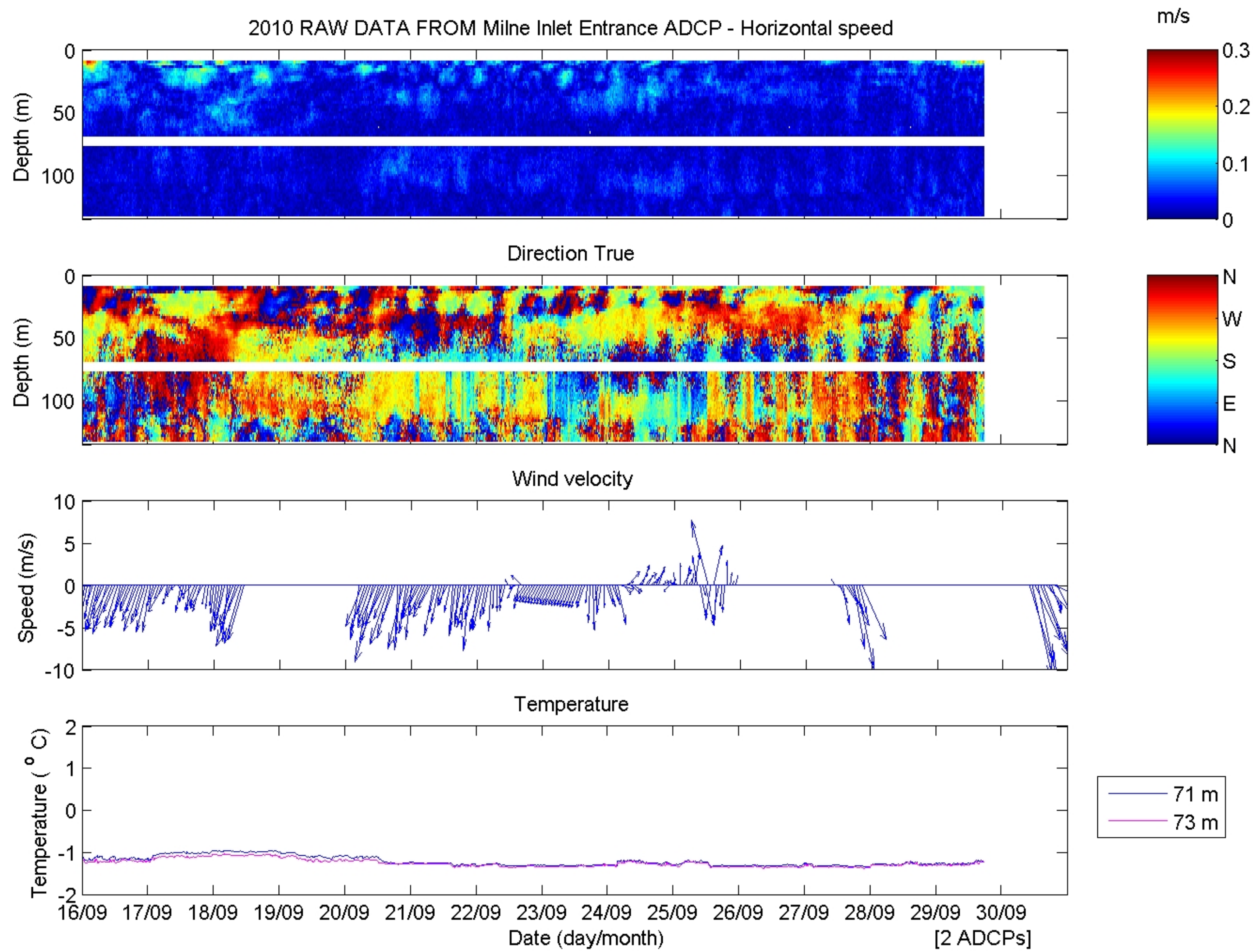


2010 RAW DATA FROM Milne Inlet Dock ADCP - Horizontal speed
Depth (m)
m/s
0.3
0.2
0.1
0
Direction True
N
W
S
E
N
Wind velocity
Speed (m/s)
Temperature
Temperature (° C)
7 m
16/09
17/09
18/09
19/09
20/09
21/09
22/09
23/09
24/09
25/09
26/09
27/09
28/09
29/09
30/09
Date (day/month)
[1 ADCP]

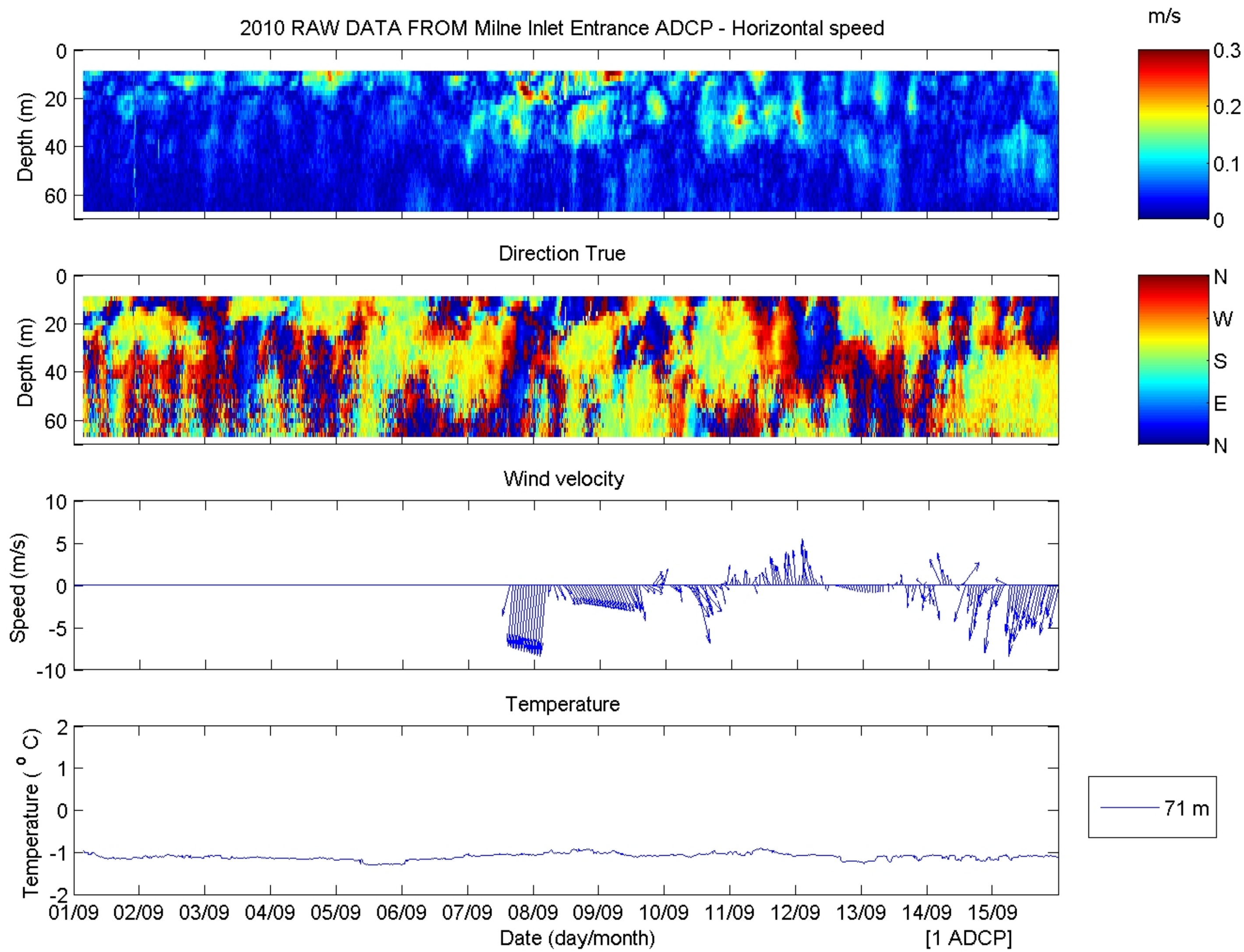

2010 RAW DATA FROM Milne Inlet Dock ADCP - Horizontal speed
m/s
Depth (m)
Direction True
Wind velocity
Speed (m/s)
Temperature
Temperature (° C)
29 m
Date (day/month)
[1 ADCP]

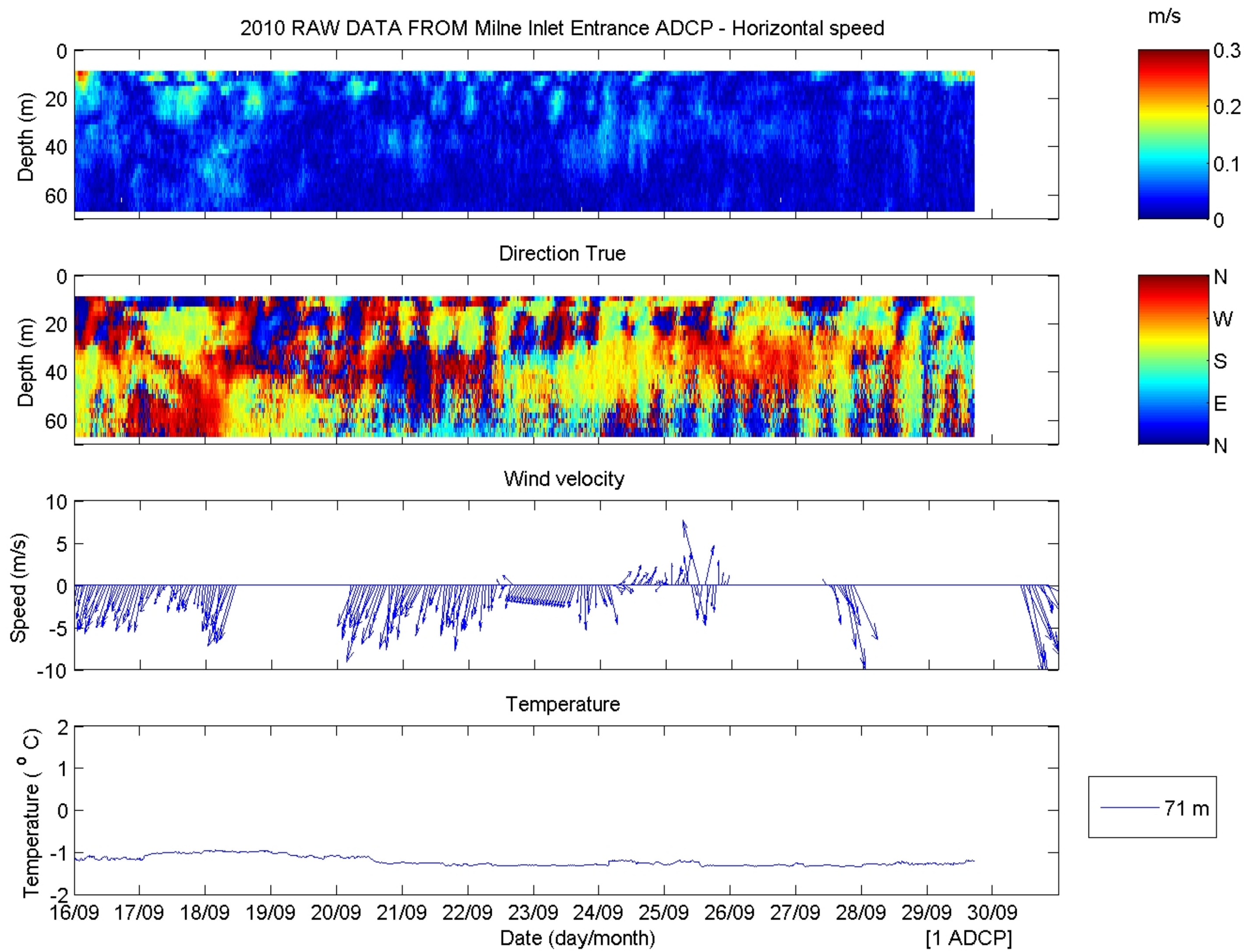

2010 RAW DATA FROM Milne Inlet Dock ADCP - Horizontal speed
m/s
Depth (m)
Direction True
Wind velocity
Speed (m/s)
Temperature
Temperature (° C)
29 m
16/09 17/09 18/09 19/09 20/09 21/09 22/09 23/09 24/09 25/09 26/09 27/09 28/09 29/09 30/09
Date (day/month)
[1 ADCP]


2010 RAW DATA FROM Milne Inlet Entrance ADCP - Horizontal speed
m/s
Depth (m)
0
50
100
0.3
0.2
0.1
0
Direction True
N
W
S
E
N
Wind velocity
Speed (m/s)
10
5
0
-5
-10
Temperature
Temperature (° C)
2
1
0
-1
-2
71 m
73 m
01/09
02/09
03/09
04/09
05/09
06/09
07/09
08/09
09/09
10/09
11/09
12/09
13/09
14/09
15/09
Date (day/month)
[2 ADCPs]

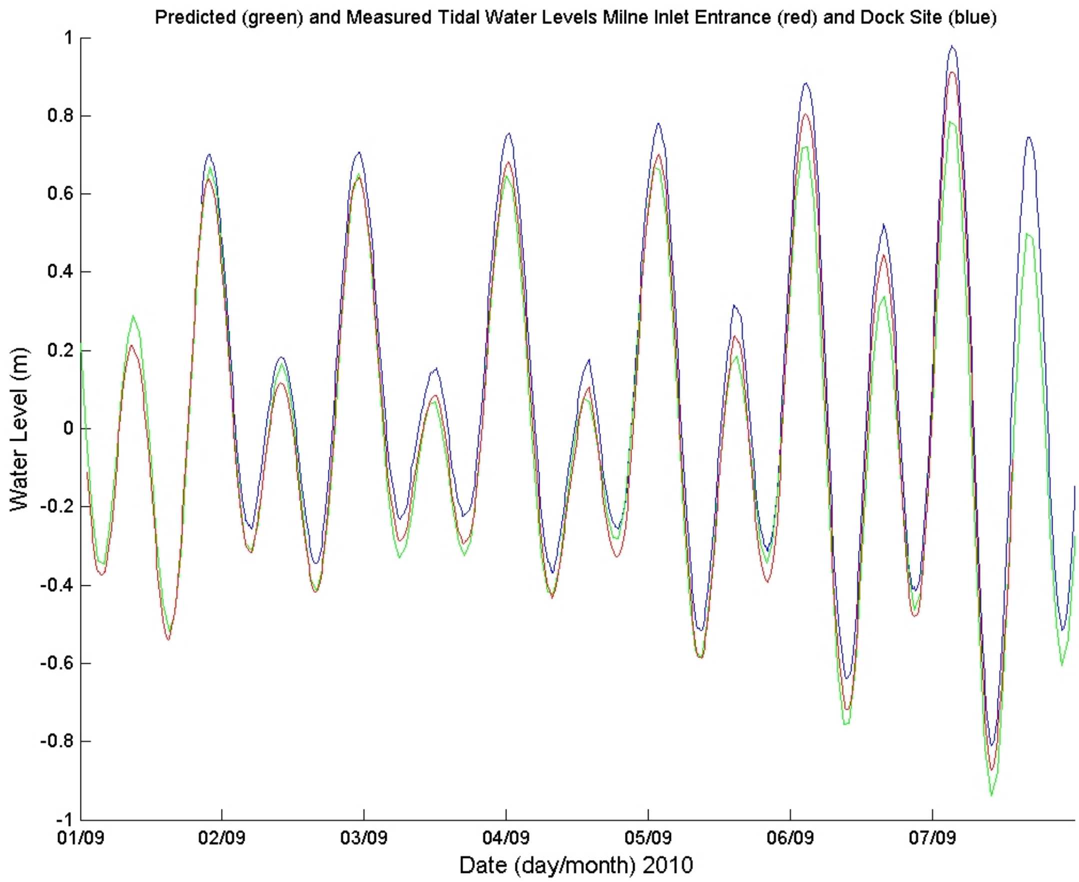


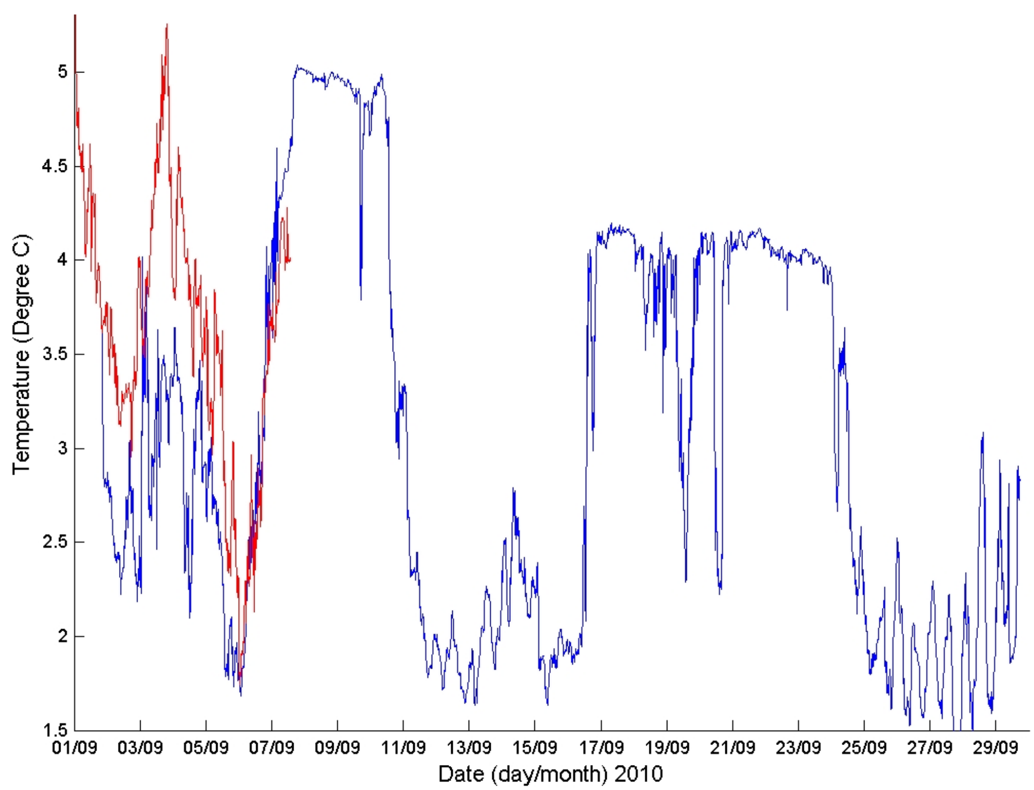
2010 RAW DATA FROM Milne Inlet Entrance ADCP - Horizontal speed
m/s
0.3
0.2
0.1
0
Depth (m)
0
50
100
Direction True
N
W
S
E
N
Wind velocity
Speed (m/s)
10
5
0
-5
-10
Temperature
Temperature (° C)
2
1
0
-1
-2
71 m
73 m
16/09 17/09 18/09 19/09 20/09 21/09 22/09 23/09 24/09 25/09 26/09 27/09 28/09 29/09 30/09
Date (day/month)
[2 ADCPs]

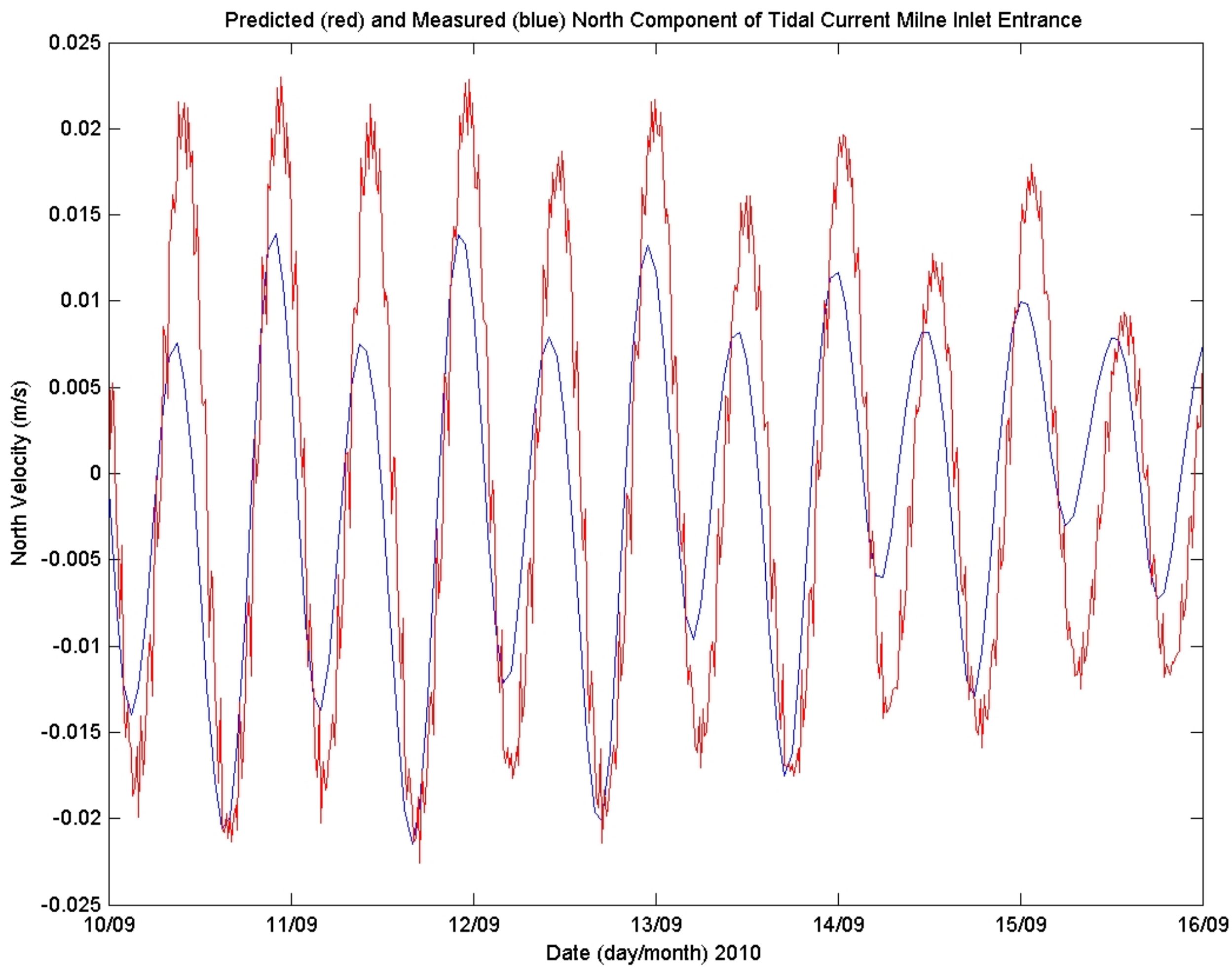

2010 RAW DATA FROM Milne Inlet Entrance ADCP - Horizontal speed
m/s
0.3
0.2
0.1
0
Depth (m)
0
20
40
60
Direction True
N
W
S
E
N
Wind velocity
Speed (m/s)
10
5
0
-5
-10
Temperature
Temperature (° C)
2
1
0
-1
-2
71 m
01/09
02/09
03/09
04/09
05/09
06/09
07/09
08/09
09/09
10/09
11/09
12/09
13/09
14/09
15/09
Date (day/month)
[1 ADCP]

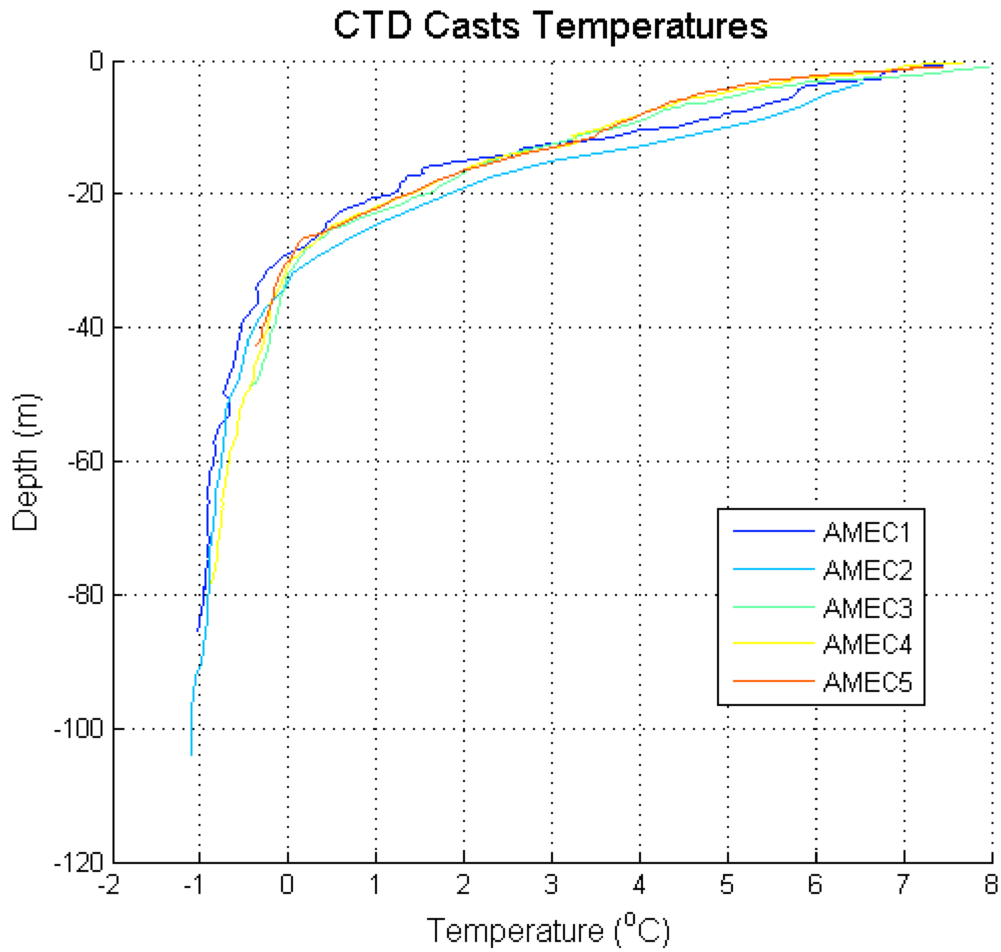


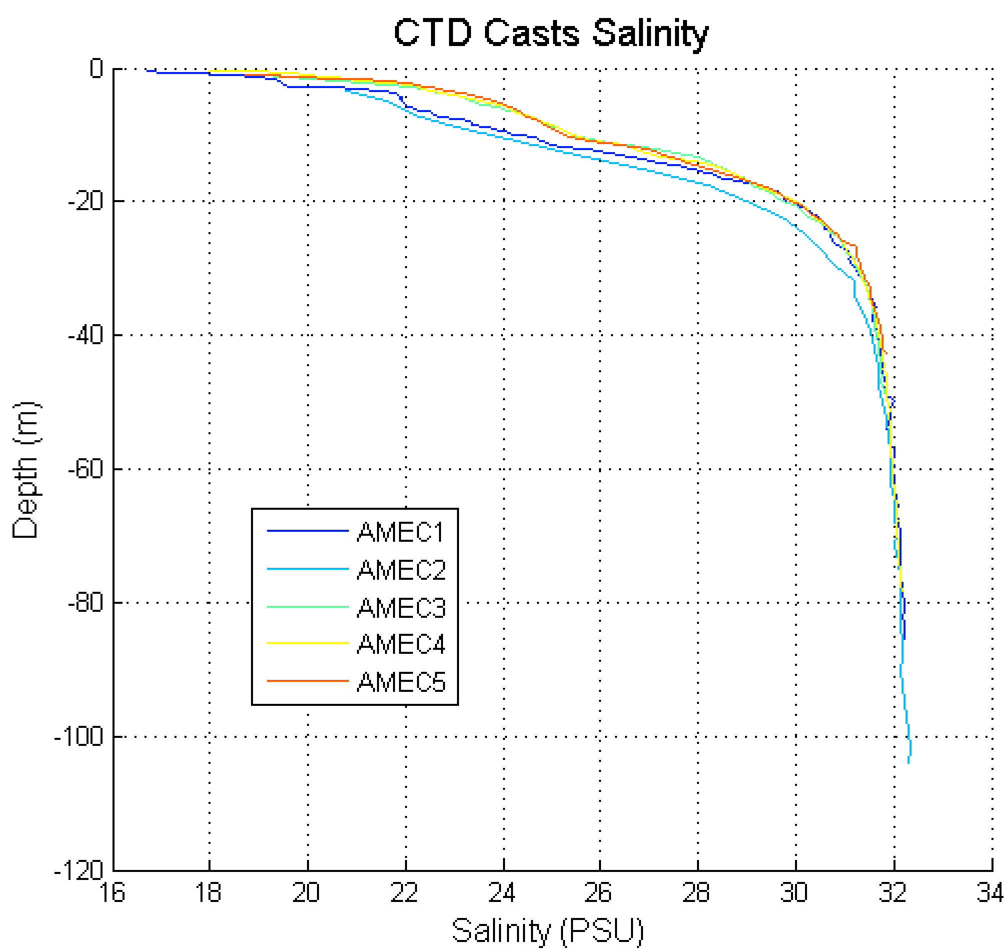
2010 RAW DATA FROM Milne Inlet Entrance ADCP - Horizontal speed
Depth (m)
0
20
40
60
m/s
0.3
0.2
0.1
0
Direction True
N
W
S
E
N
Wind velocity
Speed (m/s)
10
5
0
-5
-10
Temperature
Temperature (° C)
2
1
0
-1
-2
71 m
16/09 17/09 18/09 19/09 20/09 21/09 22/09 23/09 24/09 25/09 26/09 27/09 28/09 29/09 30/09
Date (day/month)
[1 ADCP]


Predicted (green) and Measured Tidal Water Levels Milne Inlet Entrance (red) and Dock Site (blue)
Water Level (m)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
01/09
02/09
03/09
04/09
05/09
06/09
07/09
Date (day/month) 2010


Temperature (Degree C)
5
4.5
4
3.5
3
2.5
2
1.5
01/09
03/09
05/09
07/09
09/09
11/09
13/09
15/09
17/09
19/09
21/09
23/09
25/09
27/09
29/09
Date (day/month) 2010


Predicted (red) and Measured (blue) North Component of Tidal Current Milne Inlet Entrance
North Velocity (m/s)
0.025
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
10/09
11/09
12/09
13/09
14/09
15/09
16/09
Date (day/month) 2010


CTD Casts Temperatures
Depth (m)
Temperature (°C)
AMEC1
AMEC2
AMEC3
AMEC4
AMEC5
0
-20
-40
-60
-80
-100
-120
-2
-1
0
1
2
3
4
5
6
7
8


CTD Casts Salinity
Depth (m)
Salinity (PSU)
AMEC1
AMEC2
AMEC3
AMEC4
AMEC5
0
-20
-40
-60
-80
-100
-120
16
18
20
22
24
26
28
30
32
34

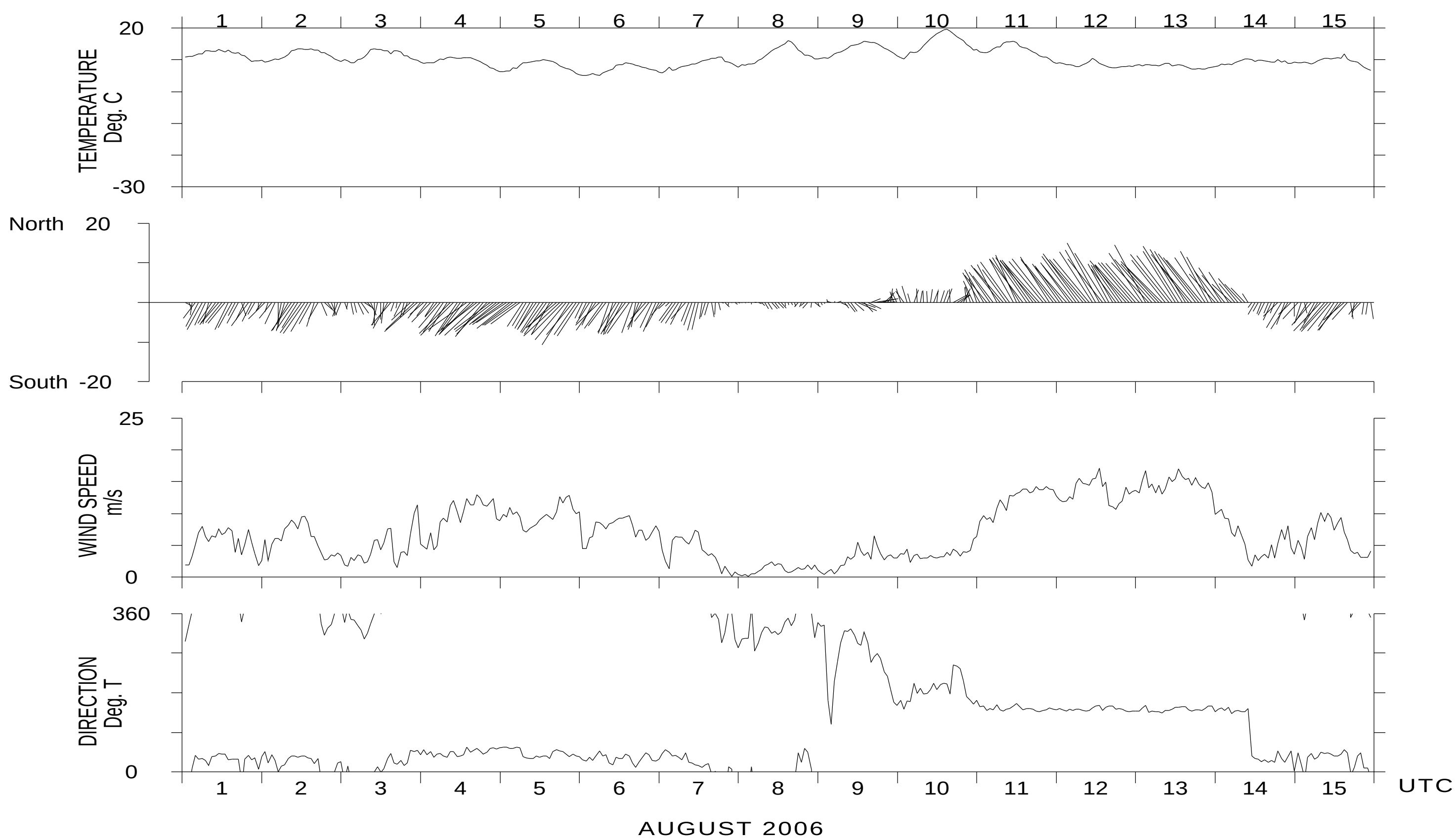
APPENDIX B

MILNE INLET MET STATION WINDS (August to October, 2006 to 2010)

SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

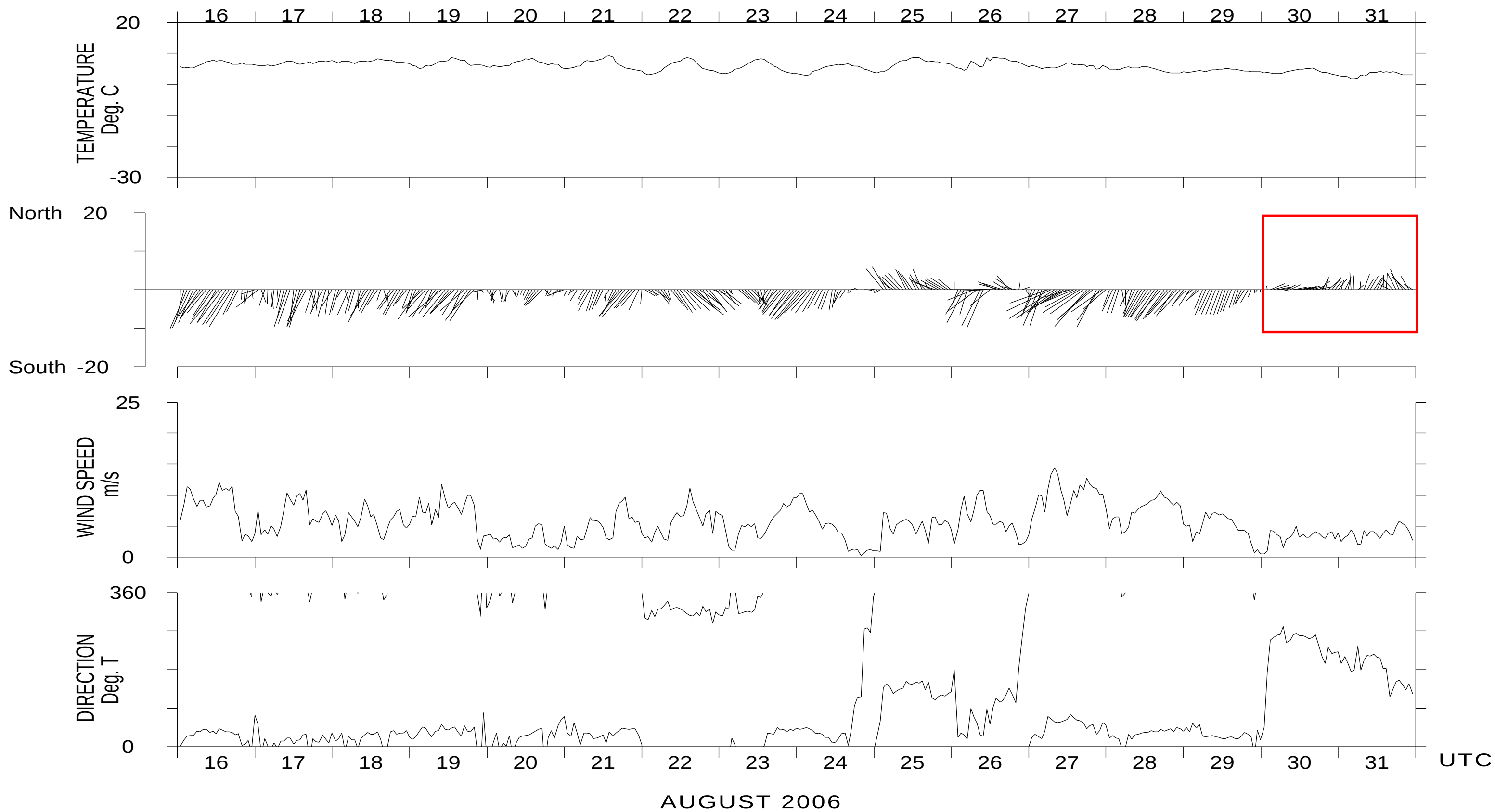
AMEC Earth & Environmental
16:35 NOV 2, 2010



SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

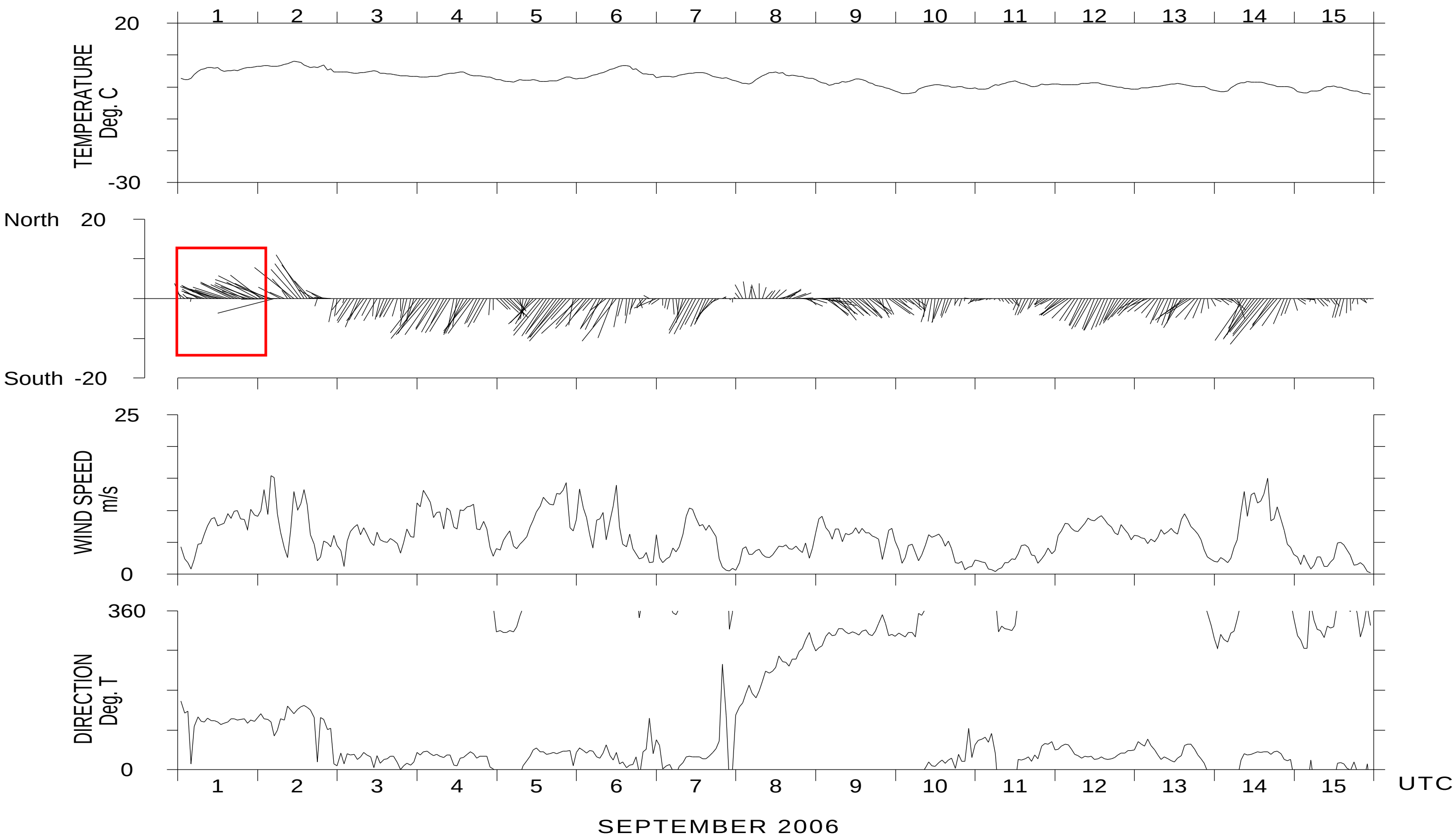
AMEC Earth & Environmental
16:35 NOV 2, 2010



SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

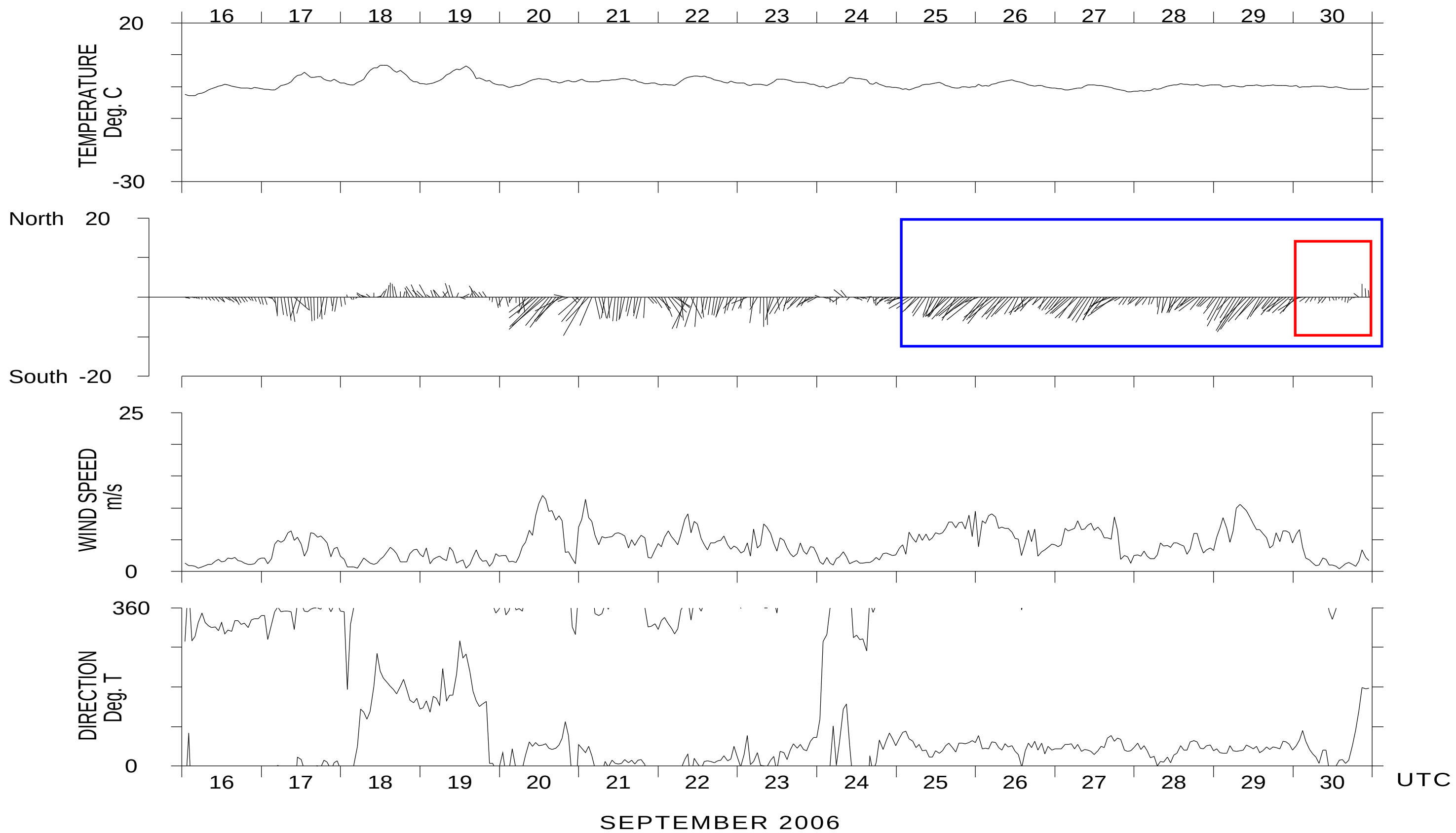
AMEC Earth & Environmental
16:35 NOV 2, 2010



SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

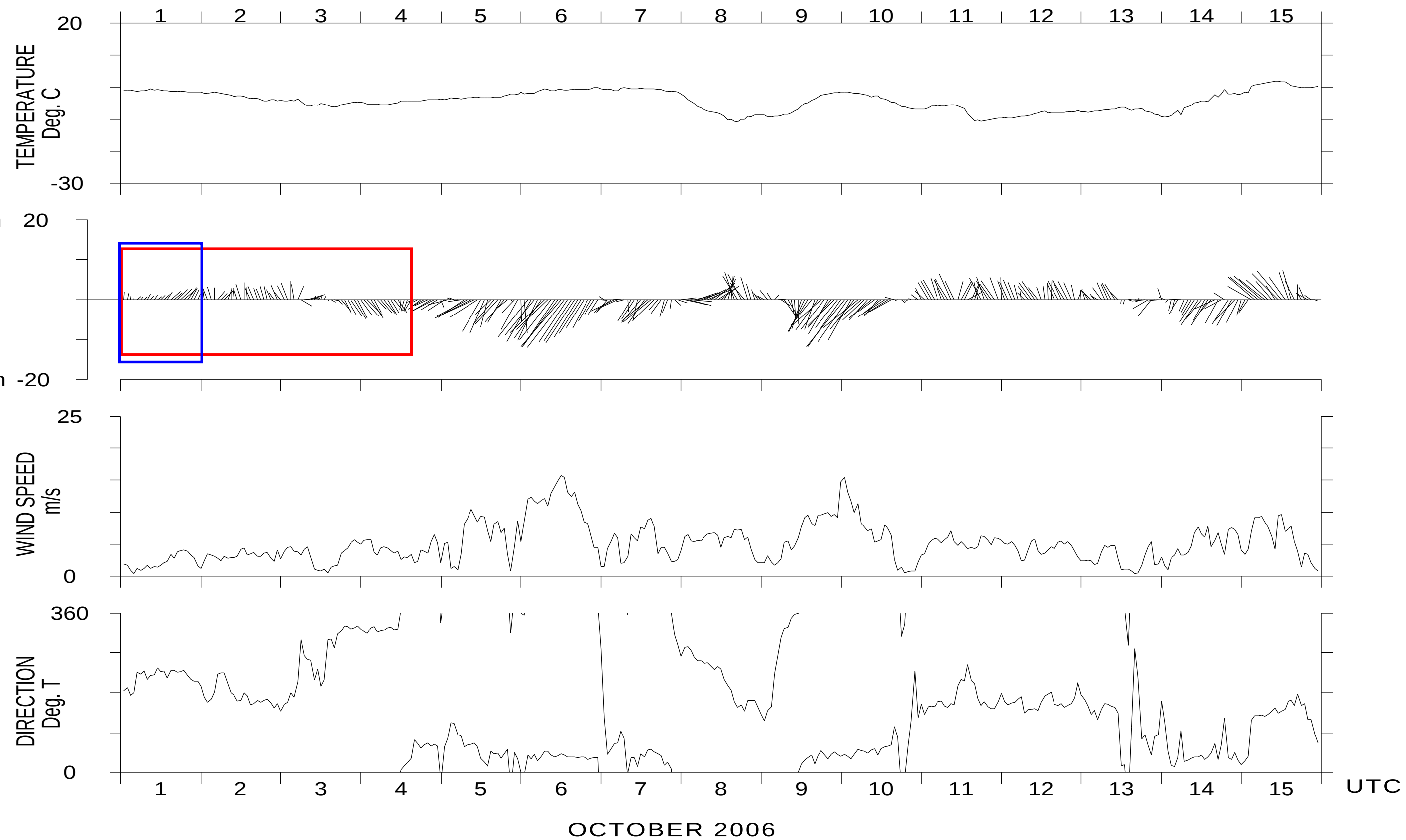
AMEC Earth & Environmental
16:35 NOV 2, 2010



SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

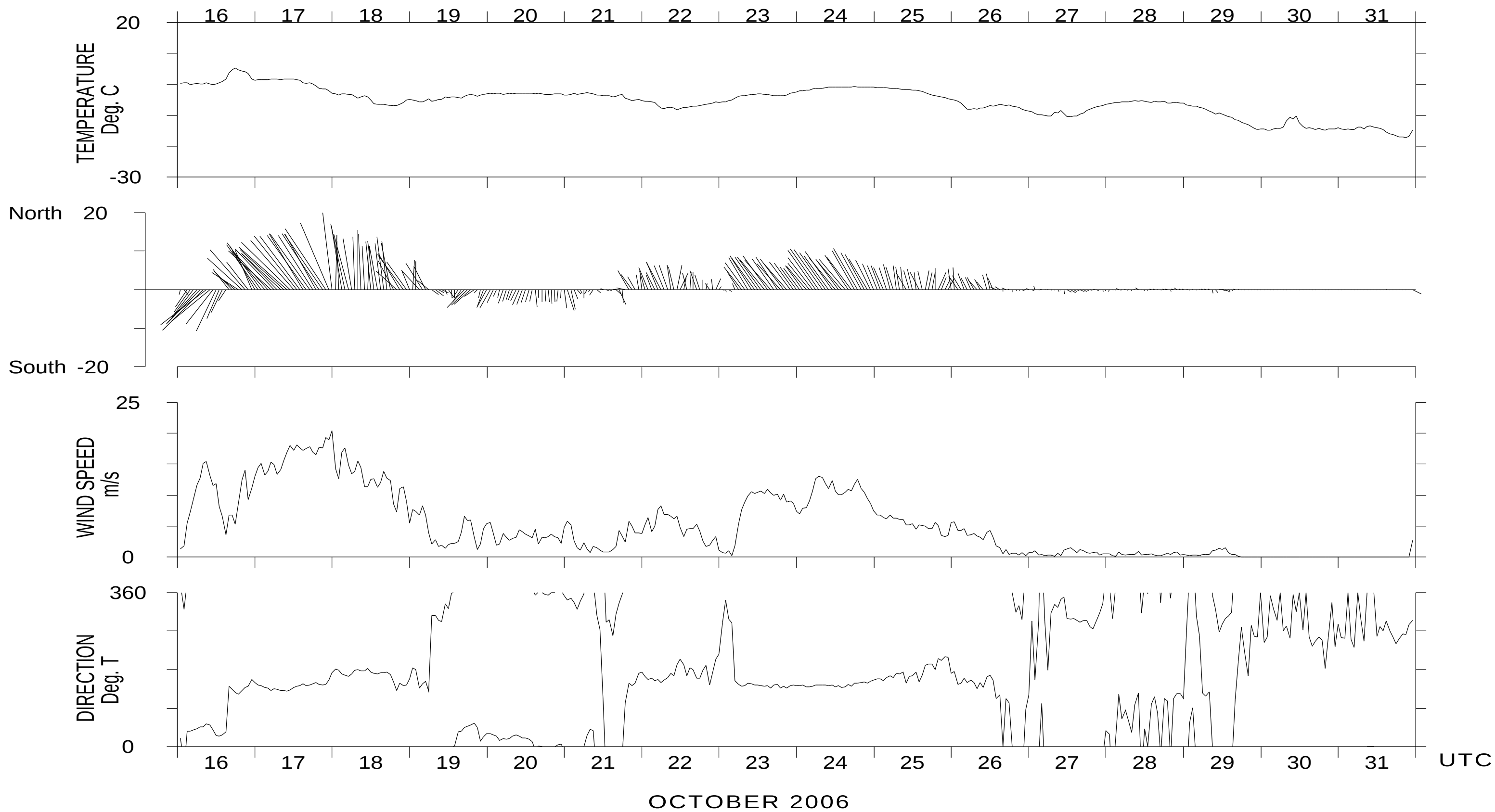
AMEC Earth & Environmental
16:35 NOV 2, 2010



SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

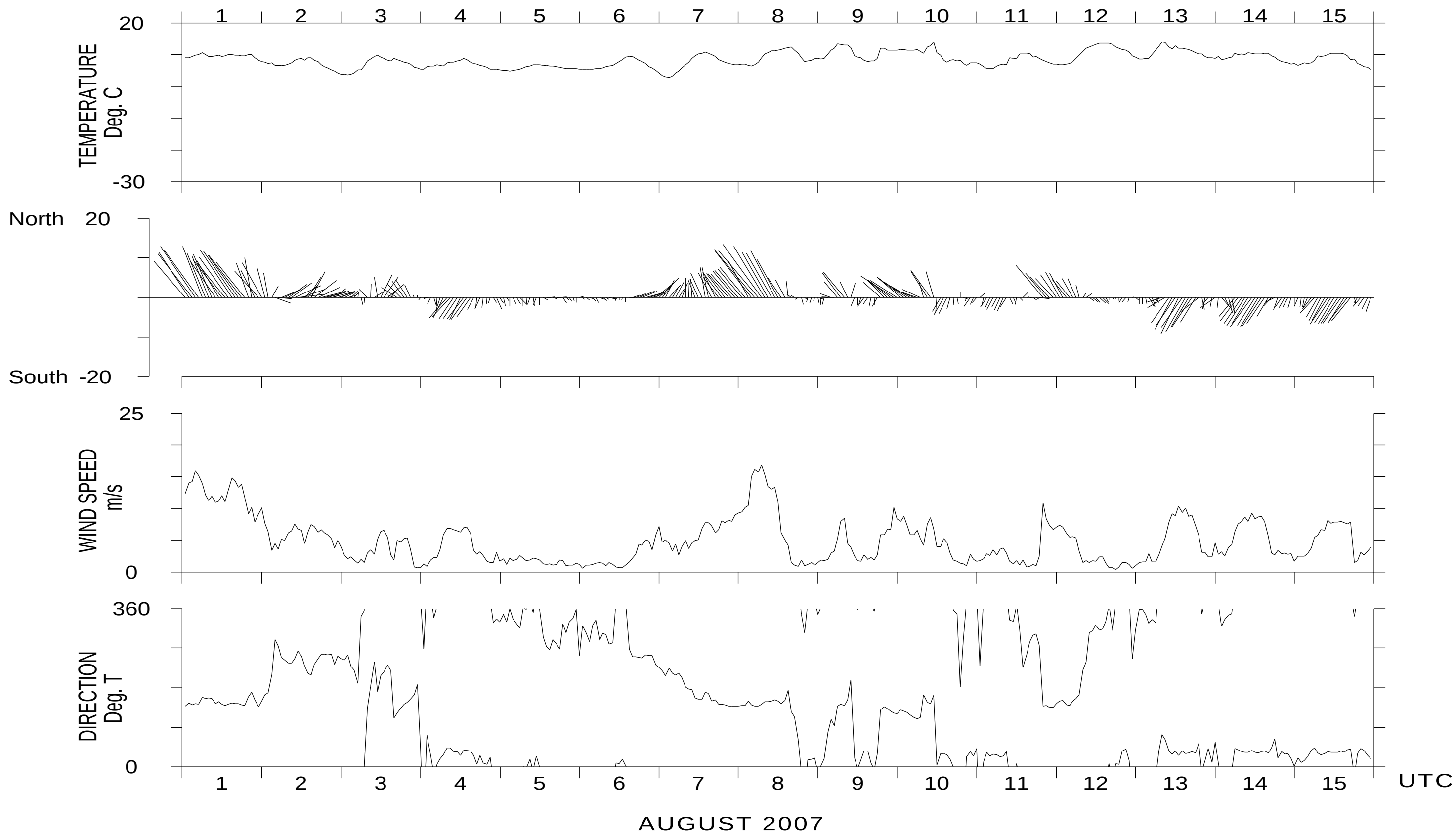
AMEC Earth & Environmental
16:35 NOV 2, 2010

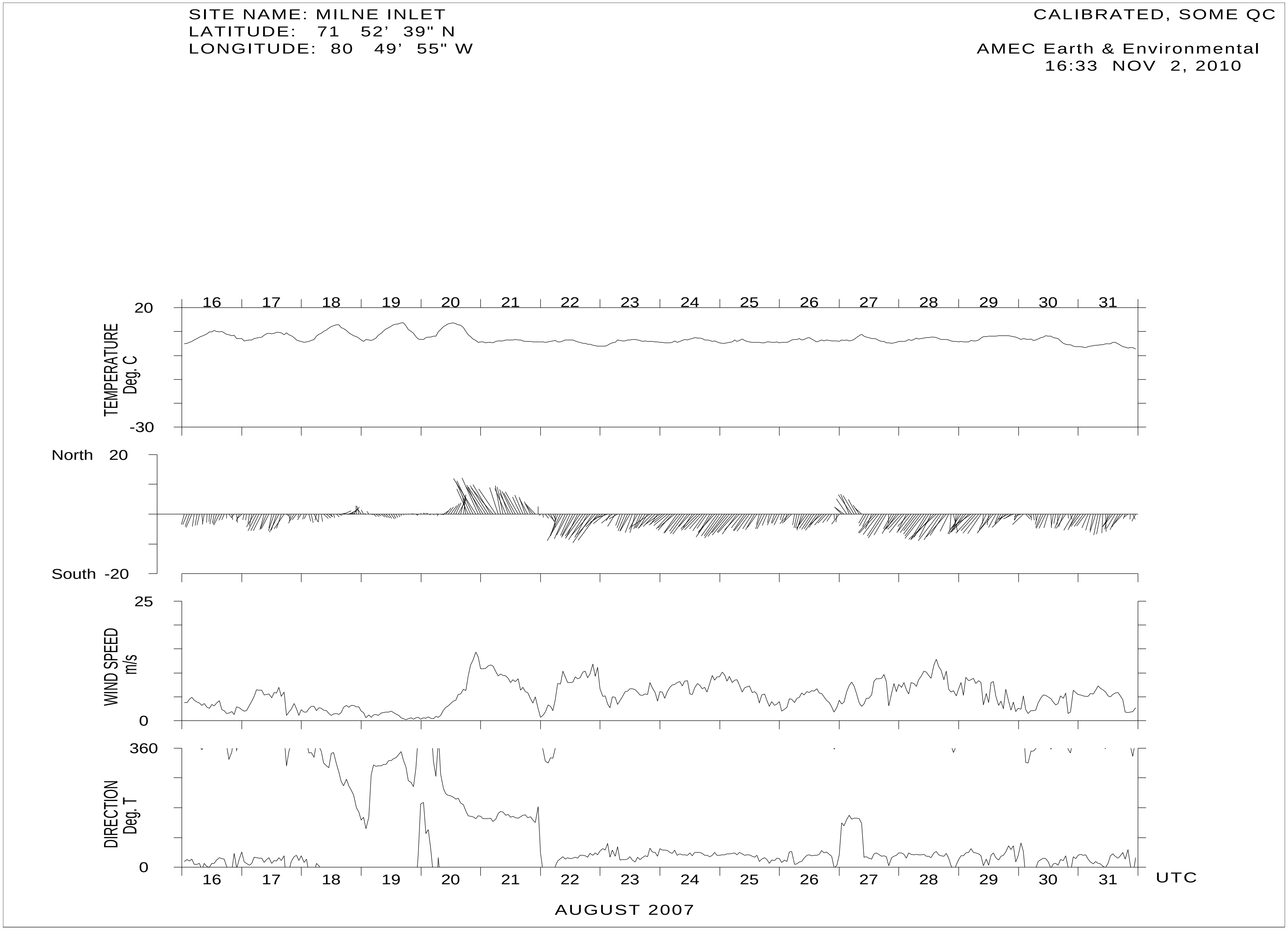


SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

AMEC Earth & Environmental
16:33 NOV 2, 2010

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LONGITUDE: 80 49' 55" W
CALIBRATED, SOME QC
AMEC Earth & Environmental
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20
-30
North 20
South -20
WIND SPEED m/s
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0
DIRECTION Deg. T
360
0
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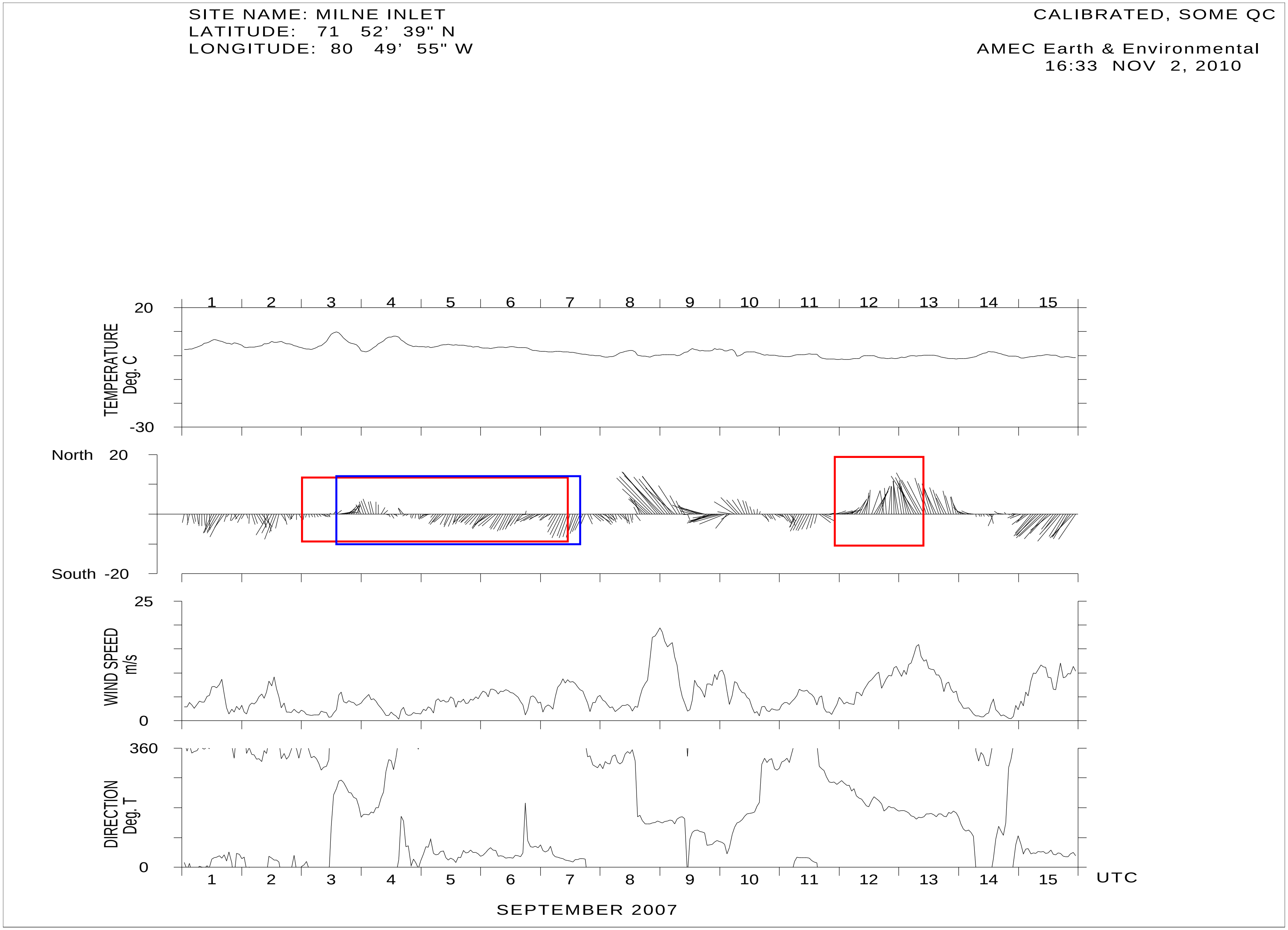
UTC
AUGUST 2007



SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W
CALIBRATED, SOME QC
AMEC Earth & Environmental
16:33 NOV 2, 2010
TEMPERATURE Deg. C
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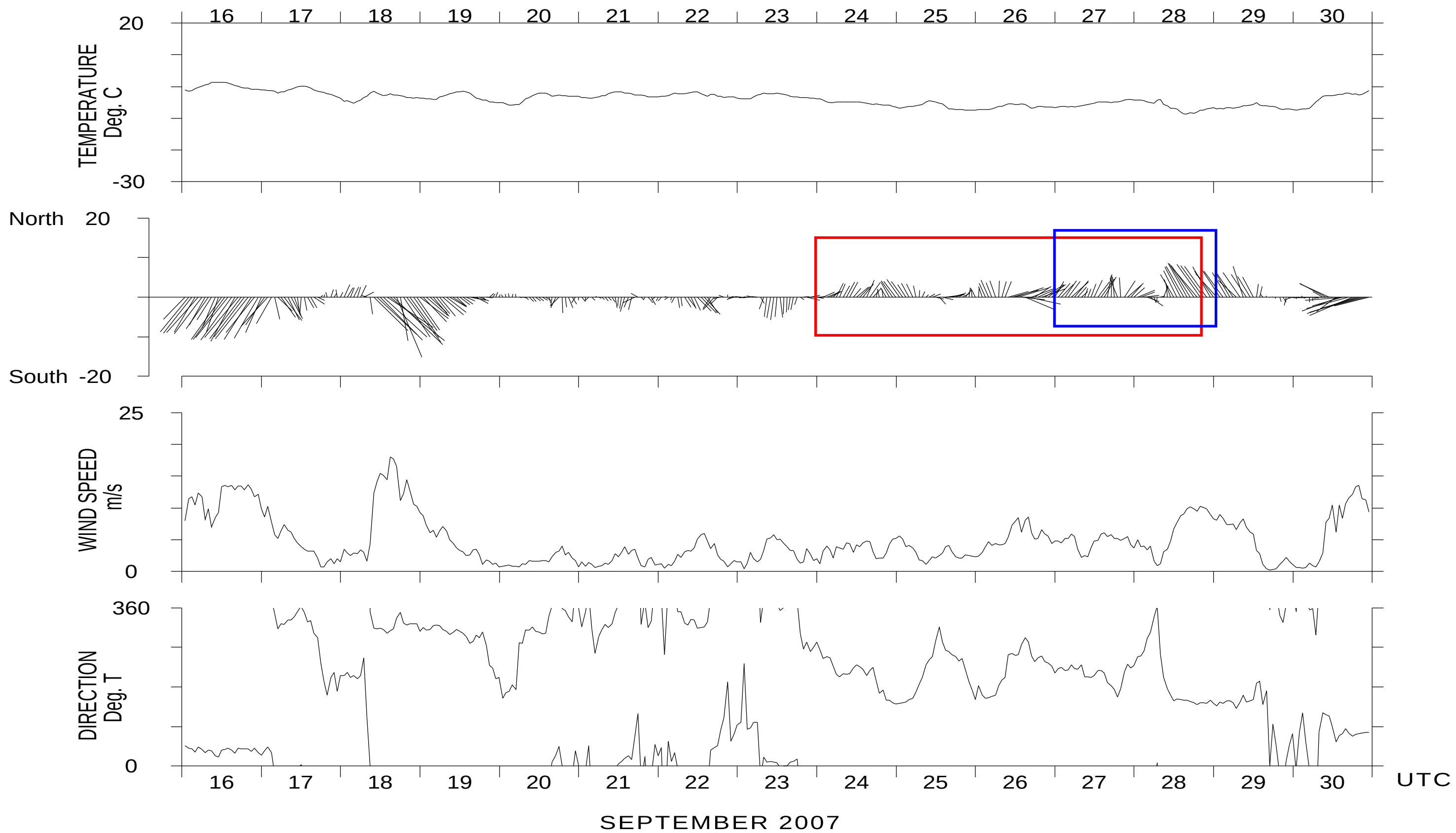
-30
North 20
South -20
WIND SPEED m/s
25
0
DIRECTION Deg. T
360
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
UTC
SEPTEMBER 2007

SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

AMEC Earth & Environmental
16:33 NOV 2, 2010



SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

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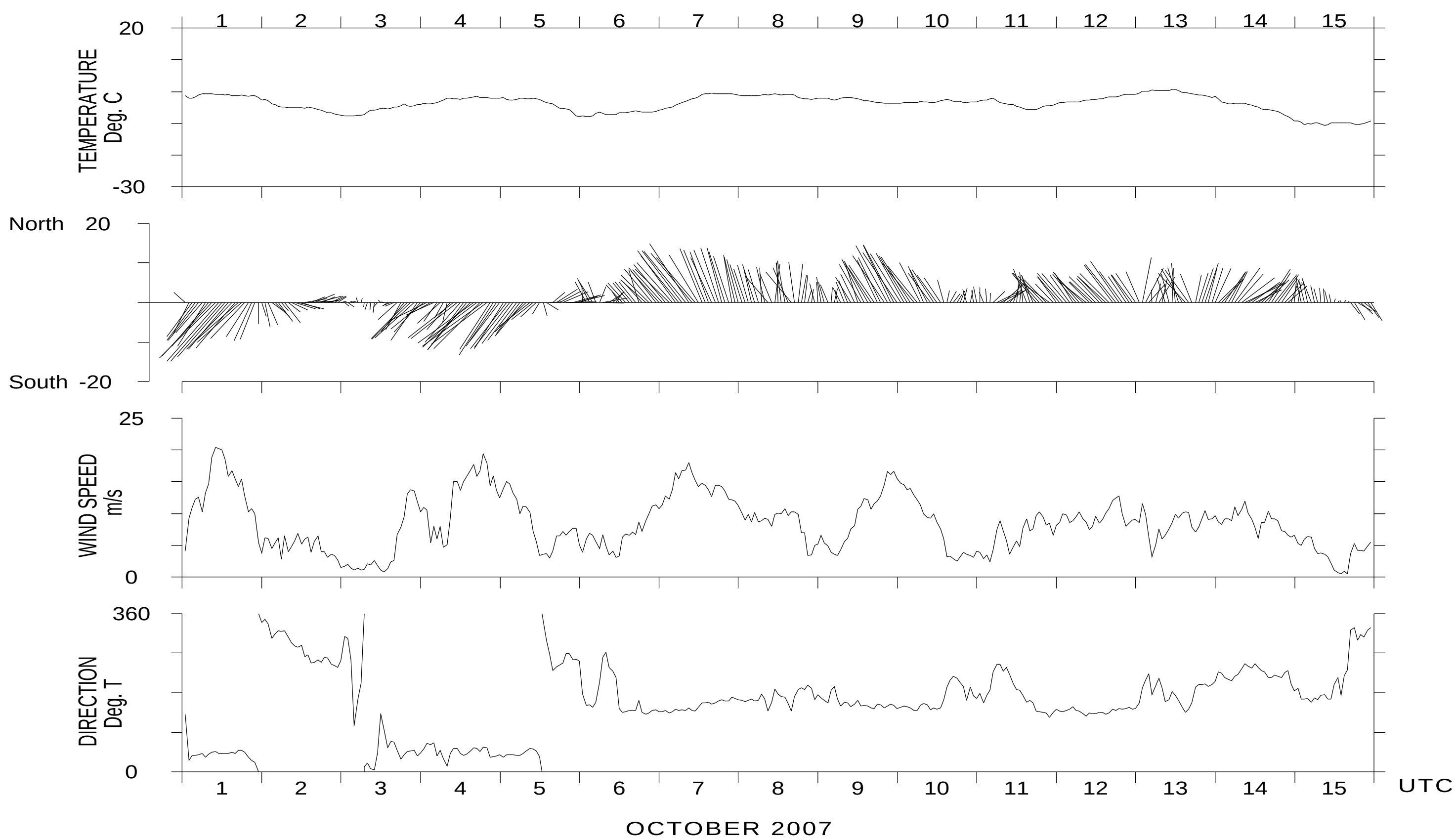
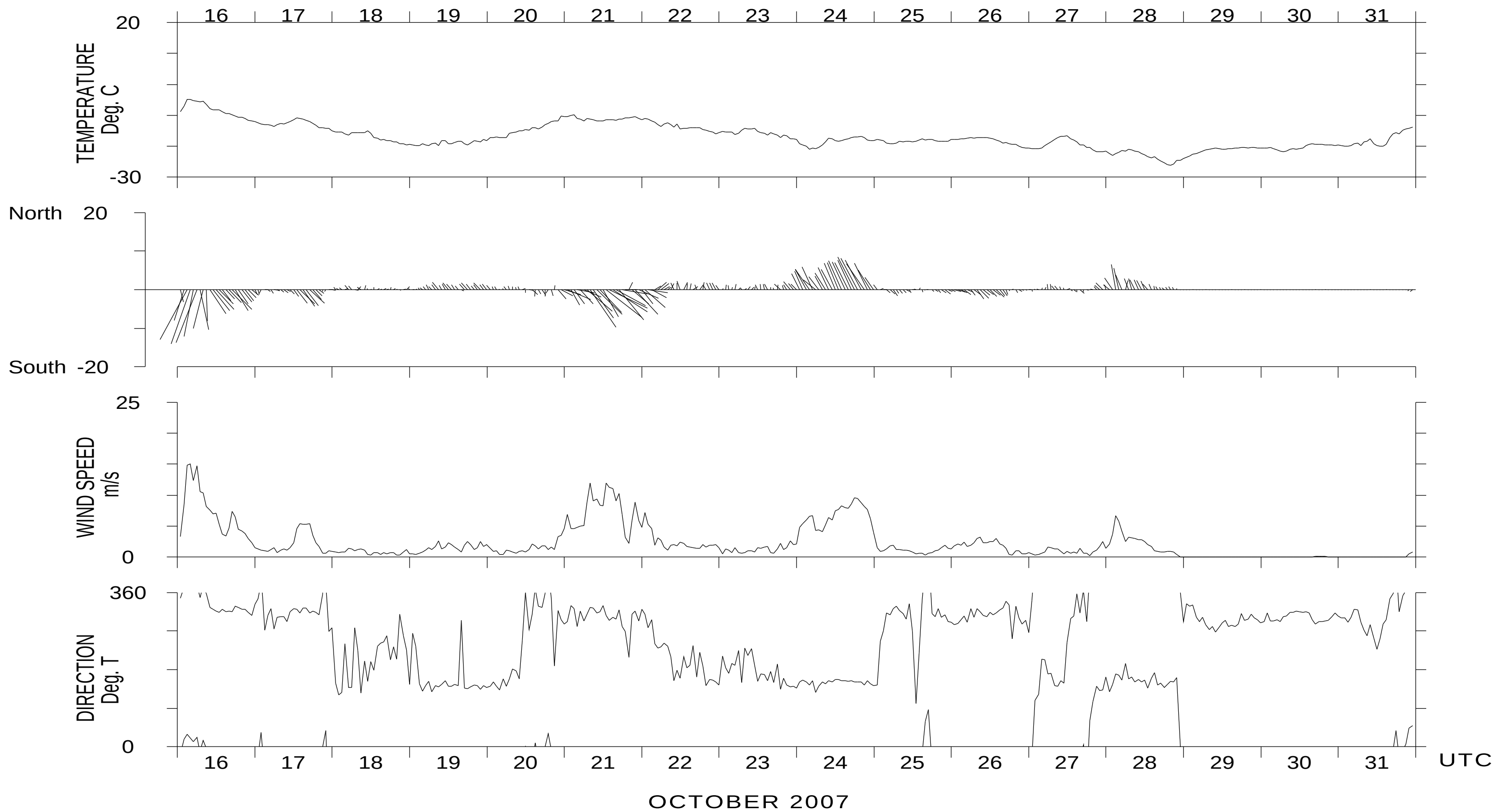
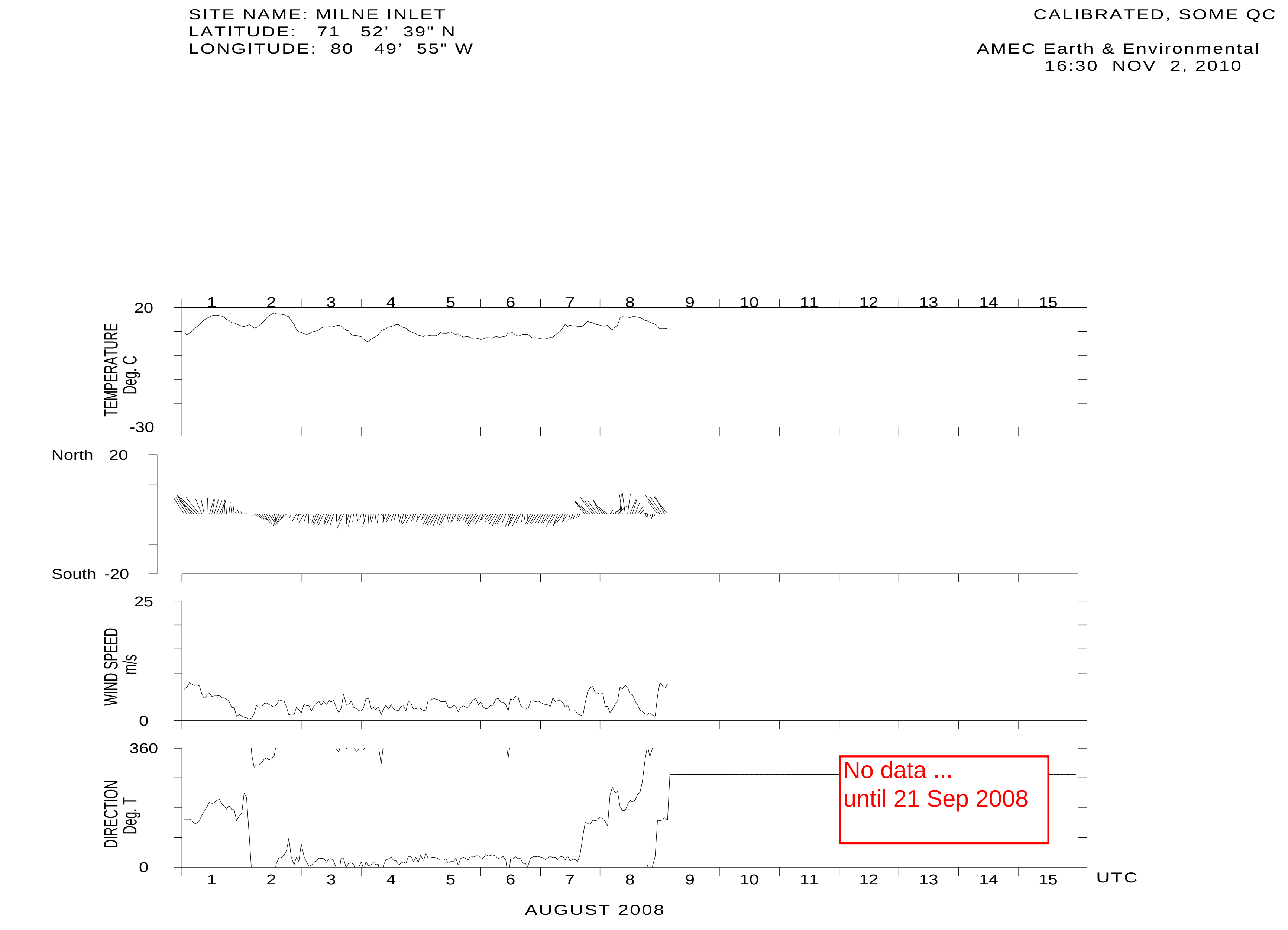


SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

CALIBRATED, SOME QC

AMEC Earth & Environmental
16:33 NOV 2, 2010

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LONGITUDE: 80 49' 55" W
CALIBRATED, SOME QC
AMEC Earth & Environmental
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-30
North 20
South -20
WIND SPEED m/s
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DIRECTION Deg. T
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until 21 Sep 2008
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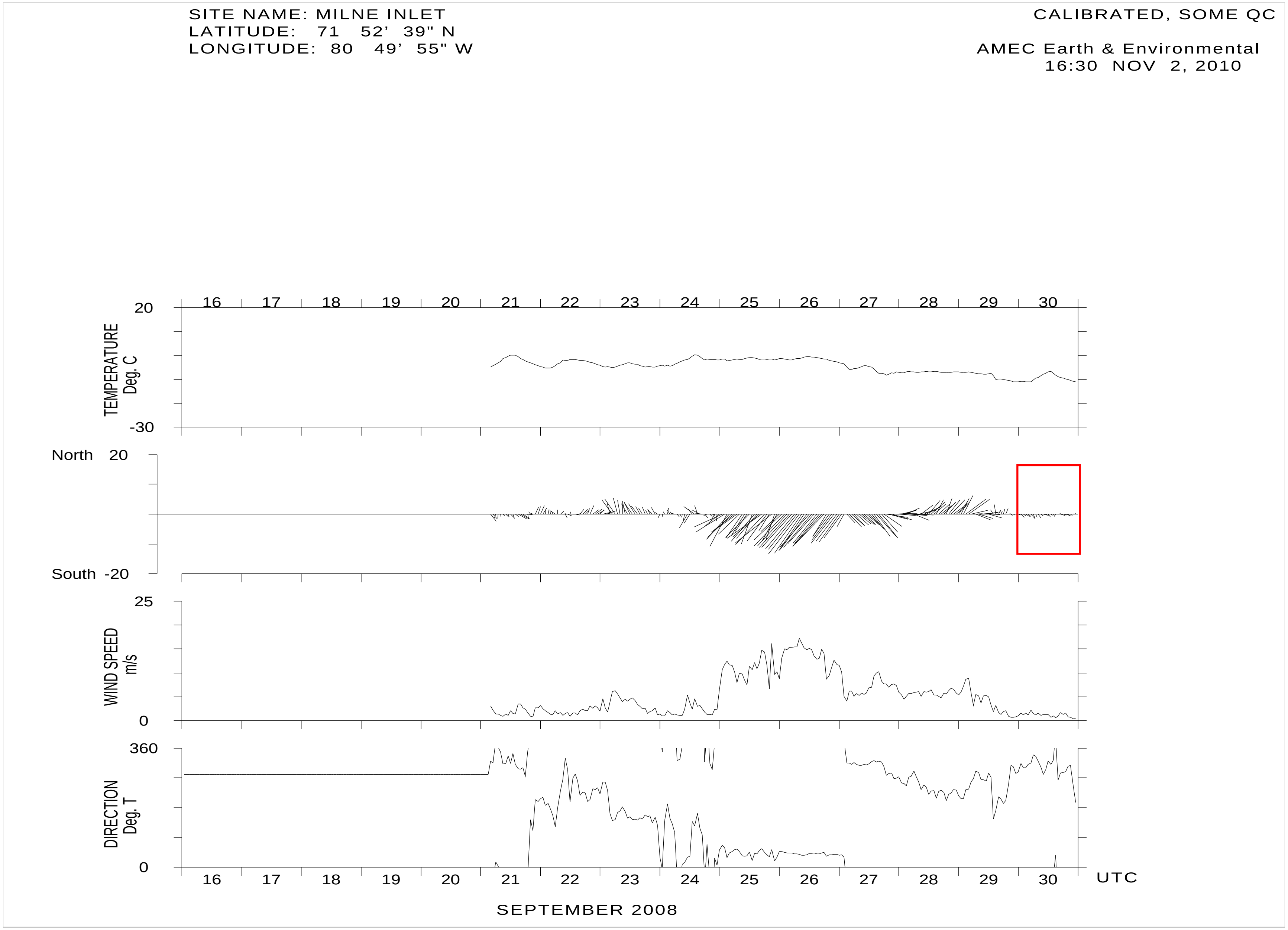
SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W
CALIBRATED, SOME QC
AMEC Earth & Environmental
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TEMPERATURE Deg. C
20
-30
North 20
South -20
WIND SPEED m/s
25
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DIRECTION Deg. T
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0
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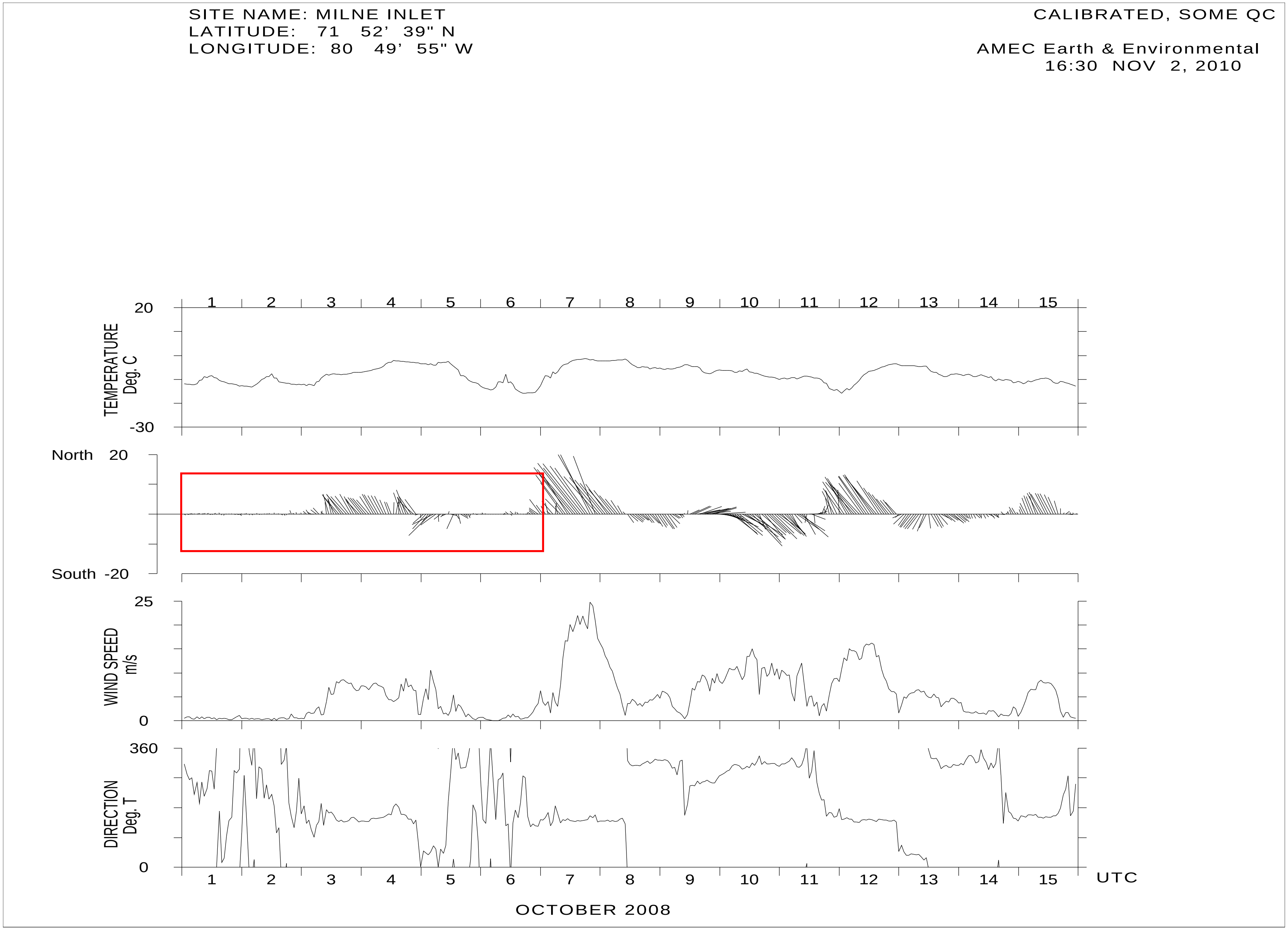
UTC
SEPTEMBER 2008

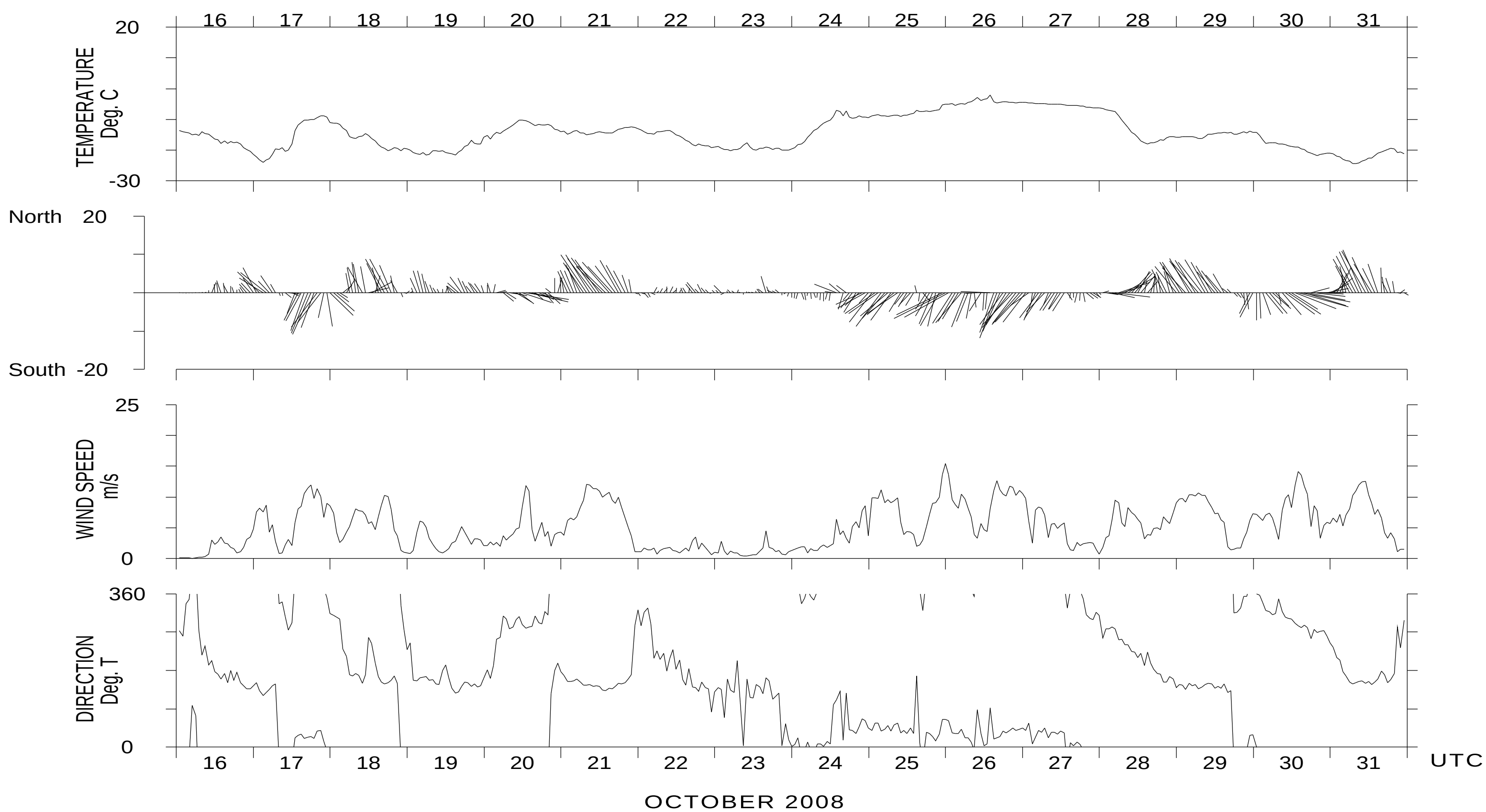


SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W
CALIBRATED, SOME QC
AMEC Earth & Environmental
16:30 NOV 2, 2010
TEMPERATURE Deg. C
20
-30
North 20
South -20
WIND SPEED m/s
25
0
DIRECTION Deg. T
360
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
UTC
OCTOBER 2008

SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

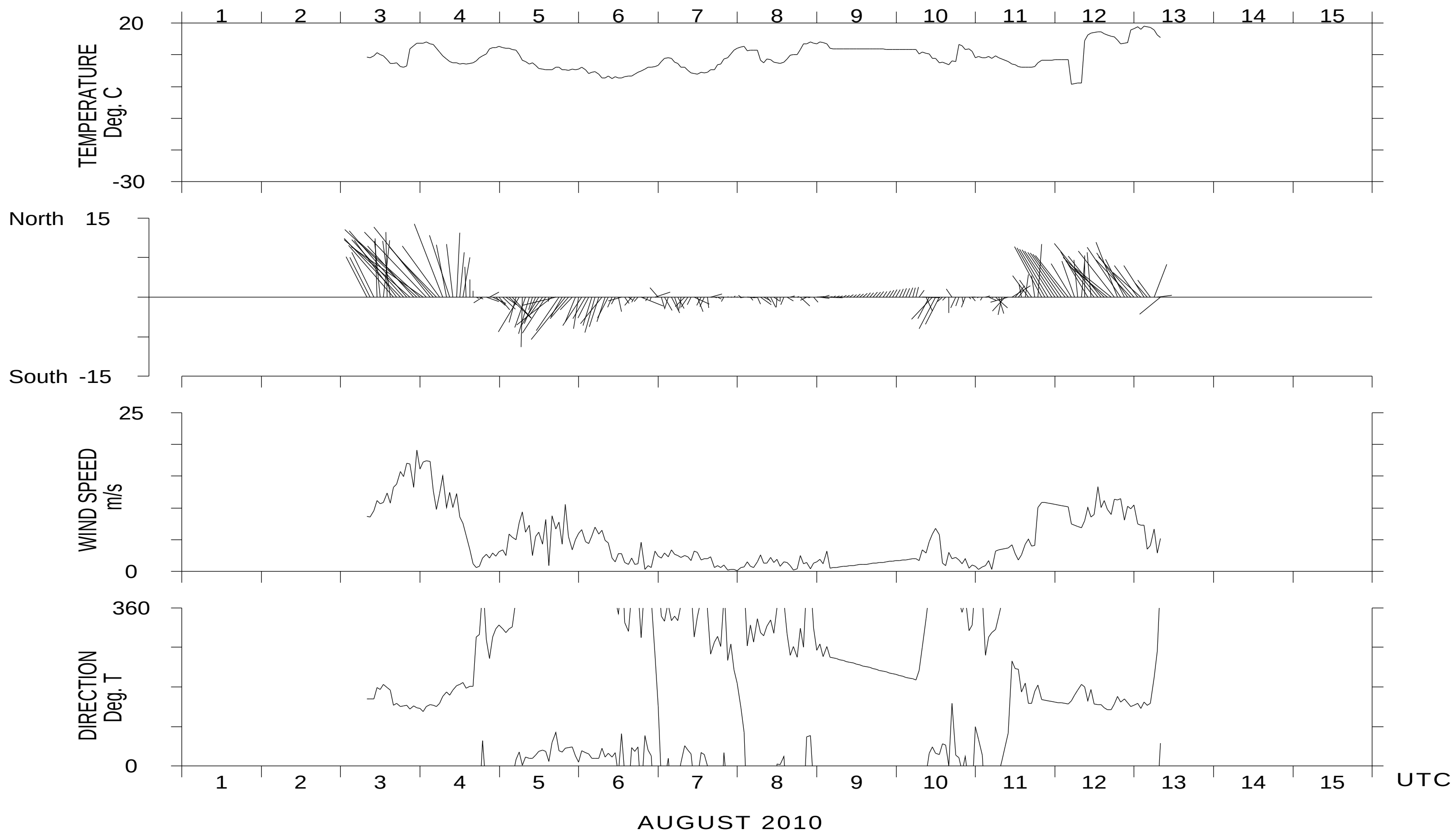
CALIBRATED, SOME QC

AMEC Earth & Environmental
16:30 NOV 2, 2010



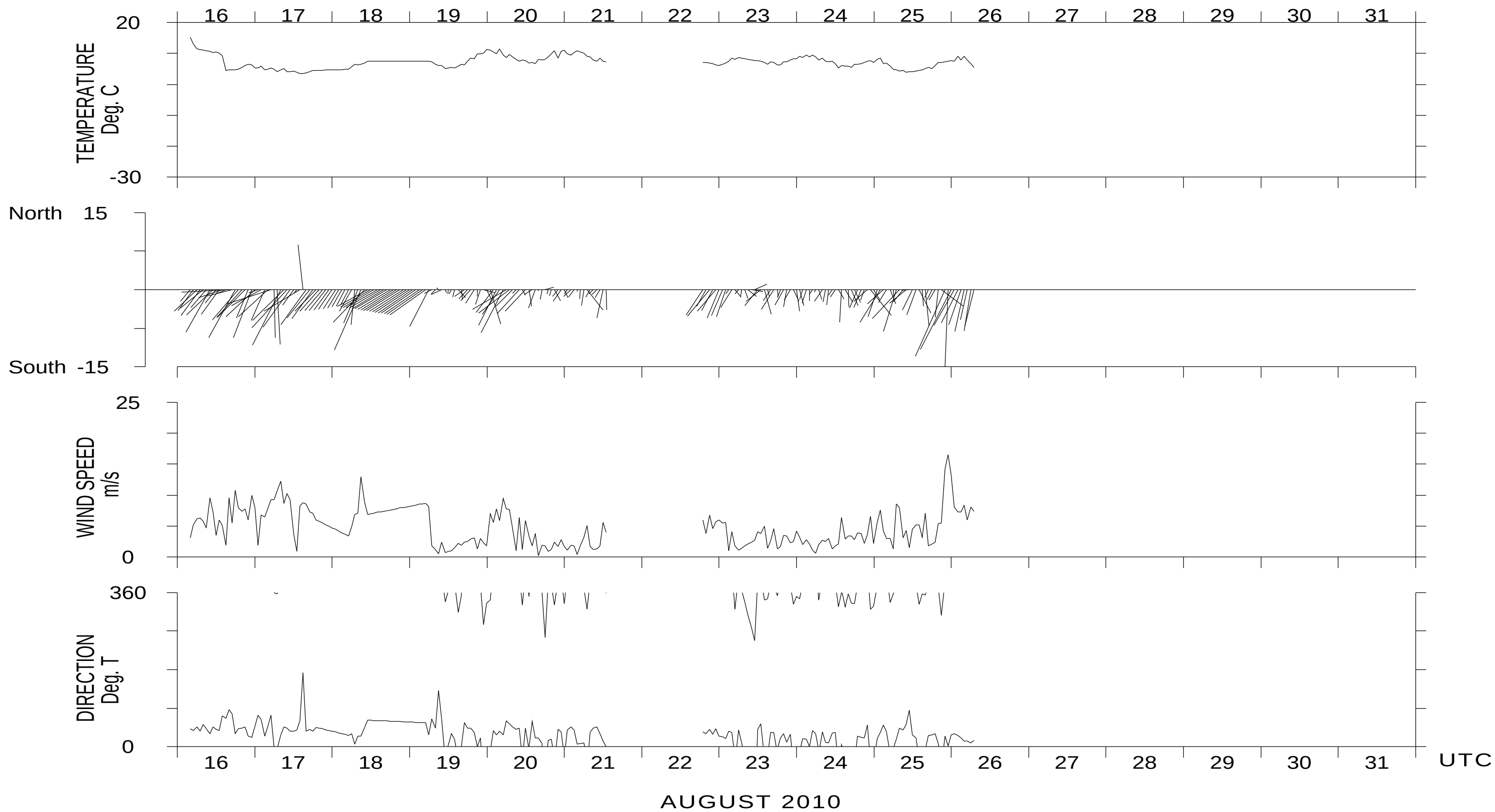
SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

AMEC Earth & Environmental
12:11 NOV 3, 2010



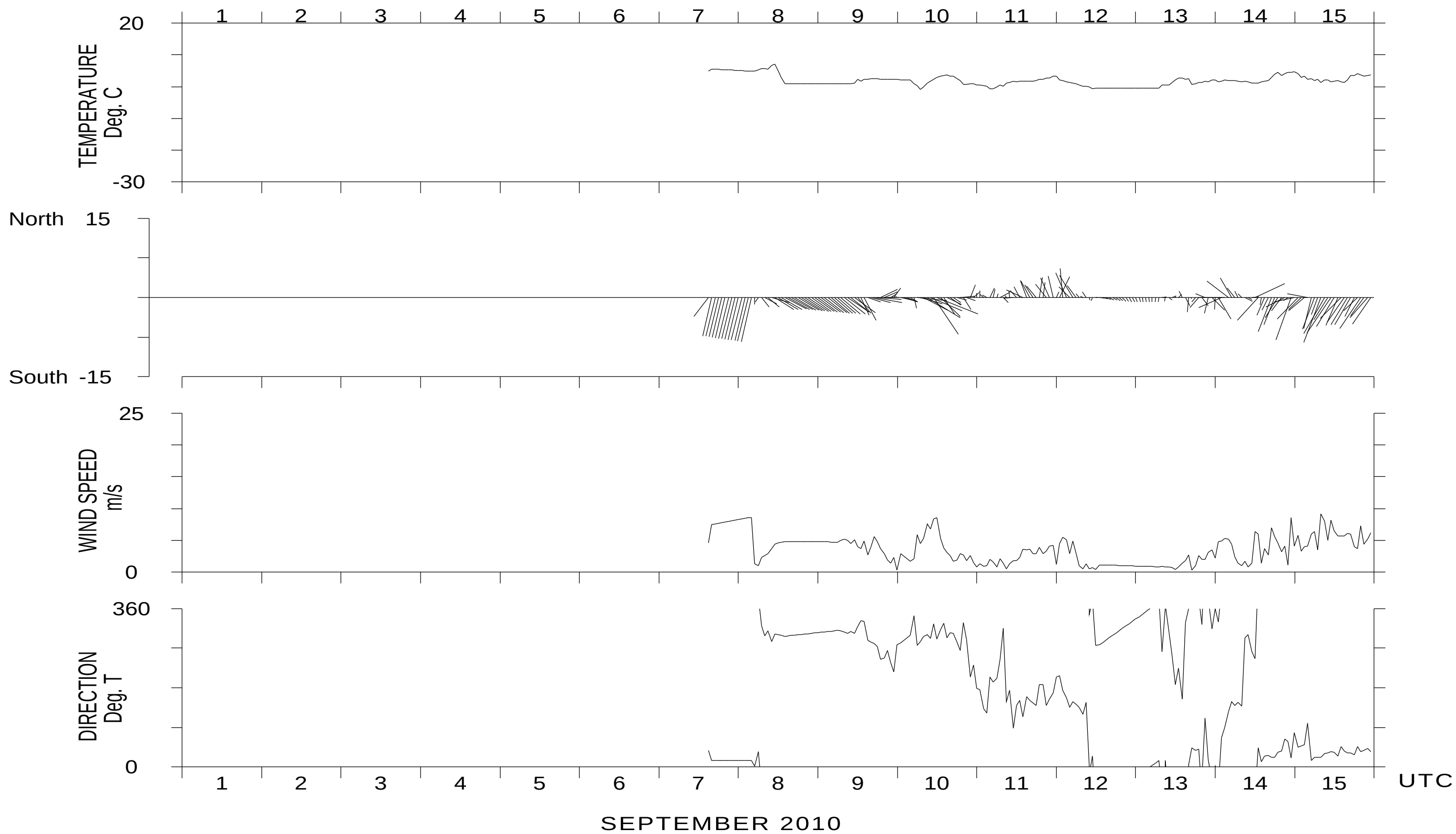
SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

AMEC Earth & Environmental
12:11 NOV 3, 2010



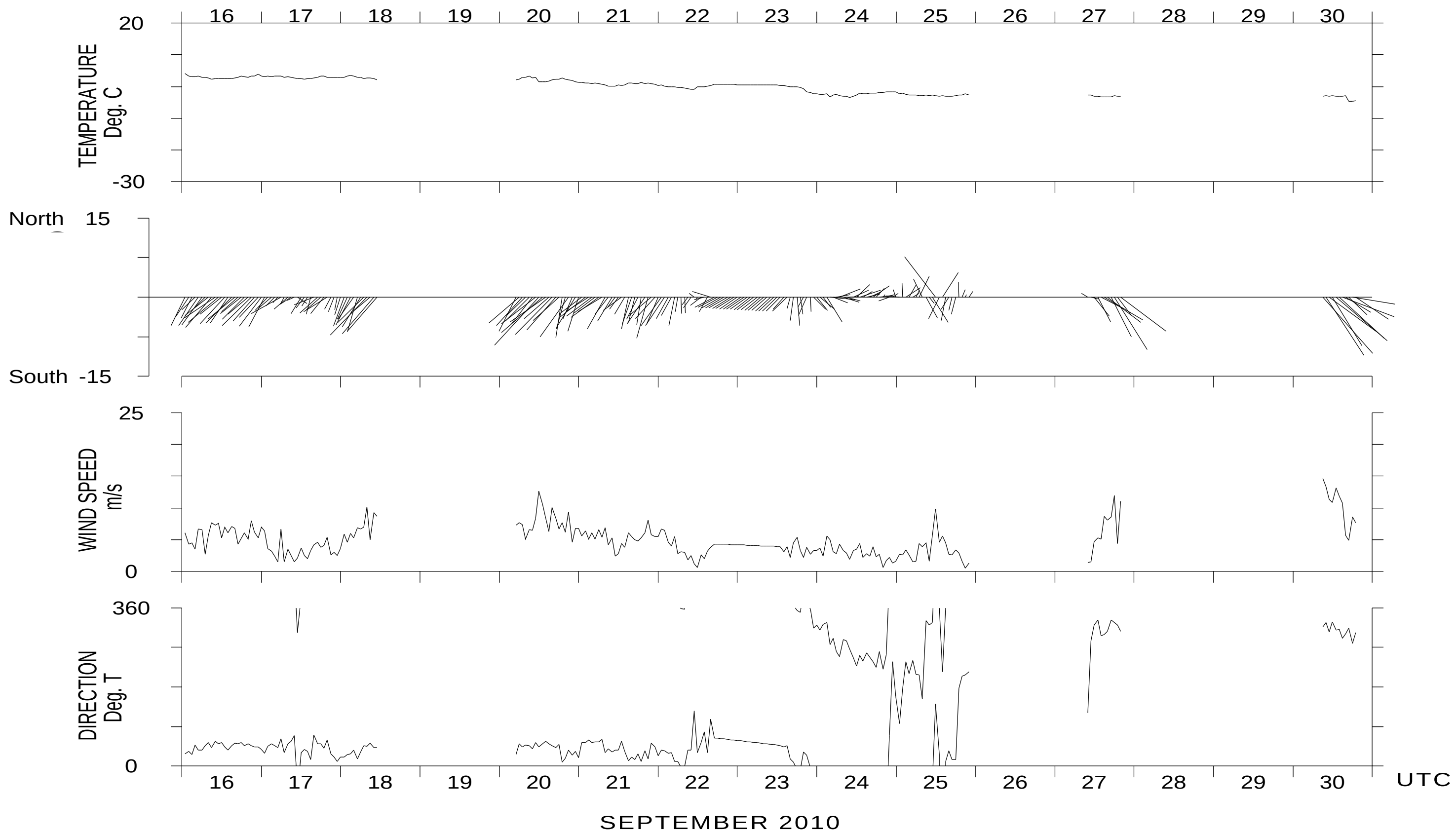
SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W

AMEC Earth & Environmental
12:11 NOV 3, 2010



SITE NAME: MILNE INLET
LATITUDE: 71 52' 39" N
LONGITUDE: 80 49' 55" W
HEIGHT ABOVE SEA LEVEL: 10 m

AMEC Earth & Environmental
12:11 NOV 3, 2010



APPENDIX C

OST SPILL MODEL LISTINGS

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 1 SEPTEMBER

WIND SOURCE: DIRECTION STANDARD WITH SPEED STANDARD
CURRENT SOURCE: None

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	22	I	1.	173.	71.89	80.90	YES	1.00	0.6	15.42	99.7
1981	186	20	I	2.	342.	71.91	80.92	YES	9.75	2.9	7.07	98.7
1982	194	24	I	1.	127.	71.89	80.87	YES	1.75	1.0	13.91	99.5
1983	187	19	I	2.	335.	71.91	80.92	YES	3.50	2.1	14.39	99.1
1984	195	15	I	3.	245.	71.88	80.97	YES	3.00	2.6	21.07	93.6
1985	192	15	I	2.	266.	71.89	80.97	YES	2.00	2.4	29.03	89.4
1986	192	26	I	2.	88.	71.90	80.85	YES	2.00	1.5	18.60	98.3
1987	174	36	I	8.	39.	71.95	80.74	YES	8.75	8.5	23.22	75.5
1988	185	22	I	3.	4.	71.92	80.89	YES	3.25	2.5	18.61	97.3
1989	193	15	I	2.	263.	71.89	80.97	YES	8.50	2.4	6.76	98.8
1990	195	21	I	1.	187.	71.89	80.90	YES	2.75	1.0	8.55	99.6
1991	193	26	I	2.	98.	71.89	80.85	YES	1.50	1.6	25.80	95.8
1992	194	22	I	1.	159.	71.89	80.89	YES	9.25	2.7	6.96	98.8
1993	189	16	I	2.	296.	71.90	80.96	YES	4.75	2.4	12.02	99.1
1994	194	23	I	1.	153.	71.89	80.89	YES	0.50	0.9	45.36	97.3
1995	187	19	I	2.	328.	71.91	80.93	YES	2.50	2.0	18.93	97.9
1996	194	22	I	1.	153.	71.89	80.89	YES	1.00	0.7	16.33	99.7
1997	194	22	I	1.	179.	71.89	80.90	YES	0.75	0.7	23.59	97.9
1998	187	19	I	2.	332.	71.91	80.92	YES	19.75	3.2	3.93	97.5
1999	194	25	I	2.	114.	71.89	80.86	YES	1.25	1.6	29.88	93.4
2000	194	23	I	1.	139.	71.89	80.88	YES	2.00	0.8	10.13	99.6
2001	194	22	I	1.	175.	71.89	80.90	YES	1.75	0.6	8.77	99.8
2002	189	27	I	2.	58.	71.91	80.84	YES	9.75	3.7	9.17	98.4
2003	194	24	I	1.	130.	71.89	80.88	YES	1.50	1.0	16.43	99.0
2004	190	27	I	2.	66.	71.90	80.85	YES	21.50	2.9	3.20	97.5
2005	195	20	I	1.	217.	71.89	80.92	YES	1.25	1.3	25.28	96.5
2006	185	22	I	2.	7.	71.92	80.89	YES	6.50	2.7	10.12	98.9
2007	194	22	I	1.	153.	71.89	80.89	YES	0.75	0.7	22.08	97.9
2008	193	15	I	2.	260.	71.89	80.97	YES	5.25	2.5	11.40	99.1
2009	189	16	I	2.	299.	71.91	80.96	YES	3.50	2.4	16.72	97.7

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 2 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	23	I	1.	150.	71.89	80.89	YES	1.50	0.8	12.20	99.7
1981	195	18	I	2.	231.	71.89	80.94	YES	1.00	1.8	42.03	94.7
1982	194	24	I	1.	122.	71.89	80.87	YES	2.50	1.1	10.77	99.6
1983	184	23	I	3.	9.	71.92	80.88	YES	3.25	2.9	21.40	90.9
1984	192	26	I	1.	89.	71.90	80.86	YES	3.50	1.5	10.24	99.4
1985	191	16	I	2.	284.	71.90	80.96	YES	1.25	2.1	40.70	93.4
1986	191	26	I	2.	70.	71.90	80.86	YES	2.00	1.6	19.05	98.3
1987	184	24	I	3.	19.	71.92	80.87	YES	2.50	3.0	28.37	86.7
1988	193	26	I	2.	102.	71.89	80.85	YES	2.75	1.6	14.16	99.3
1989	188	29	I	3.	62.	71.91	80.82	YES	20.75	6.5	7.46	96.9
1990	194	22	I	1.	170.	71.89	80.90	YES	2.00	0.6	7.11	99.7
1991	192	26	I	2.	96.	71.89	80.85	YES	2.00	1.6	19.50	98.3
1992	195	15	I	3.	245.	71.89	80.97	YES	11.50	2.7	5.73	98.5
1993	194	15	I	3.	250.	71.89	80.97	YES	2.25	2.6	28.12	88.1
1994	194	23	I	1.	138.	71.89	80.88	YES	0.50	0.8	36.89	97.3
1995	190	16	I	2.	292.	71.90	80.96	YES	2.50	2.2	20.99	96.0
1996	193	26	I	2.	104.	71.89	80.85	YES	2.00	1.7	20.87	96.4
1997	140	53	I	23.	32.	72.07	80.55	YES	24.25	23.1	22.90	41.3
1998	185	22	I	2.	5.	71.92	80.89	YES	9.00	2.5	6.65	98.8
1999	193	26	I	2.	107.	71.89	80.85	YES	1.25	1.8	33.63	93.4
2000	195	19	I	1.	222.	71.89	80.92	YES	3.00	1.3	10.58	99.5
2001	194	25	I	1.	114.	71.89	80.86	YES	2.75	1.4	12.04	99.5
2002	193	26	I	2.	98.	71.89	80.85	YES	3.25	1.5	11.31	99.4
2003	194	23	I	1.	139.	71.89	80.88	YES	0.75	0.8	26.01	97.9
2004	189	27	I	2.	60.	71.91	80.84	YES	4.75	2.3	11.62	99.1
2005	193	26	I	2.	99.	71.89	80.85	YES	1.75	1.5	21.12	97.1
2006	193	15	I	3.	265.	71.89	80.97	YES	1.75	2.6	35.64	90.7
2007	192	15	I	2.	268.	71.89	80.97	YES	6.25	2.5	9.43	99.0
2008	195	18	I	2.	235.	71.89	80.94	YES	2.50	1.7	16.21	99.4
2009	192	15	I	2.	269.	71.89	80.97	YES	3.00	2.5	19.96	97.5

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 3 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	23	I	1.	135.	71.89	80.88	YES	1.50	0.9	13.71	99.7
1981	182	26	I	4.	24.	71.93	80.85	YES	5.75	4.1	17.14	95.8
1982	186	20	I	2.	339.	71.91	80.92	YES	5.25	2.3	10.50	99.1
1983	184	24	I	3.	14.	71.92	80.88	YES	4.75	3.0	15.04	98.8
1984	188	17	I	2.	308.	71.91	80.95	YES	6.75	2.3	8.34	99.1
1985	190	16	I	2.	290.	71.90	80.96	YES	2.25	2.2	23.86	93.7
1986	190	27	I	2.	68.	71.90	80.84	YES	1.75	2.1	28.21	90.7
1987	191	26	I	2.	72.	71.90	80.85	YES	2.25	1.7	18.11	98.1
1988	184	24	I	3.	20.	71.92	80.87	YES	2.25	3.1	32.73	88.1
1989	191	26	I	2.	81.	71.90	80.85	YES	2.25	1.6	16.83	98.3
1990	191	26	I	2.	72.	71.90	80.86	YES	6.50	1.8	6.56	99.1
1991	192	26	I	2.	97.	71.89	80.86	YES	7.00	1.5	5.23	99.1
1992	195	15	I	3.	246.	71.89	80.97	YES	4.75	2.6	13.29	99.0
1993	195	21	I	1.	198.	71.88	80.91	YES	1.25	1.2	22.86	96.5
1994	194	24	I	1.	125.	71.89	80.87	YES	1.75	1.1	15.12	99.5
1995	194	22	I	1.	165.	71.89	80.89	YES	5.50	0.6	2.53	99.4
1996	194	24	I	1.	120.	71.89	80.87	YES	1.25	1.2	23.65	96.5
1997	189	27	I	2.	62.	71.90	80.84	YES	2.50	2.3	22.26	93.0
1998	188	18	I	2.	315.	71.91	80.94	YES	3.75	1.9	11.91	99.3
1999	193	26	I	2.	101.	71.89	80.85	YES	2.25	1.6	17.34	98.3
2000	194	22	I	1.	161.	71.89	80.89	YES	2.00	0.6	7.71	99.7
2001	194	23	I	1.	136.	71.89	80.88	YES	2.00	0.8	9.53	99.6
2002	190	27	I	2.	65.	71.90	80.85	YES	11.25	2.2	4.60	98.6
2003	194	25	I	1.	117.	71.89	80.87	YES	1.25	1.2	23.95	96.5
2004	174	36	I	8.	39.	71.95	80.74	YES	10.75	8.5	19.04	88.3
2005	194	23	I	1.	139.	71.89	80.88	YES	1.00	0.8	18.75	99.2
2006	192	15	I	3.	269.	71.89	80.97	YES	1.50	2.6	40.92	92.0
2007	195	20	I	1.	207.	71.89	80.91	YES	2.25	1.1	11.93	99.6
2008	195	19	I	1.	225.	71.89	80.93	YES	3.75	1.4	9.07	99.3
2009	195	20	I	1.	208.	71.89	80.91	YES	3.25	1.1	8.14	99.6

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 4 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	187	30	I	4.	57.	71.91	80.81	YES	9.25	3.6	9.28	98.5
1981	190	16	I	2.	286.	71.90	80.96	YES	1.75	2.3	31.92	90.7
1982	187	19	I	2.	332.	71.91	80.92	YES	5.25	1.9	8.84	99.2
1983	186	21	I	2.	356.	71.91	80.90	YES	4.75	2.1	10.41	99.2
1984	191	26	I	1.	80.	71.90	80.86	YES	2.75	1.5	13.09	99.4
1985	190	16	I	2.	291.	71.90	80.96	YES	2.00	2.2	26.01	94.4
1986	194	25	I	2.	113.	71.89	80.86	YES	3.00	1.6	12.70	99.5
1987	189	28	I	3.	61.	71.91	80.83	YES	20.75	5.7	6.59	97.1
1988	194	23	I	1.	133.	71.89	80.88	YES	0.75	0.9	27.52	96.0
1989	183	25	I	3.	24.	71.92	80.86	YES	7.50	3.5	11.21	98.6
1990	194	23	I	1.	134.	71.89	80.88	YES	3.50	0.8	5.57	99.5
1991	191	16	I	2.	282.	71.90	80.96	YES	4.25	2.2	12.24	99.1
1992	195	17	I	2.	244.	71.89	80.95	YES	2.50	2.2	20.93	96.9
1993	191	16	I	2.	277.	71.90	80.96	YES	3.25	2.0	15.12	99.2
1994	193	26	I	2.	98.	71.89	80.86	YES	3.50	1.6	10.93	99.4
1995	186	20	I	2.	346.	71.92	80.91	YES	2.25	2.3	24.63	93.7
1996	194	22	I	1.	172.	71.89	80.90	YES	7.50	4.7	14.94	98.1
1997	194	25	I	1.	117.	71.89	80.86	YES	0.75	1.3	41.73	96.0
1998	194	15	I	3.	249.	71.89	80.96	YES	8.25	2.6	7.64	98.8
1999	188	18	I	2.	314.	71.91	80.94	YES	18.75	3.5	4.42	97.7
2000	191	26	I	2.	80.	71.90	80.85	YES	1.75	1.6	21.34	95.1
2001	194	26	I	2.	114.	71.89	80.85	YES	1.25	1.7	32.18	93.4
2002	191	26	I	2.	80.	71.90	80.85	YES	4.25	1.6	8.89	99.3
2003	194	24	I	1.	119.	71.89	80.87	YES	2.00	1.2	14.52	99.5
2004	184	31	I	5.	48.	71.92	80.80	YES	3.75	4.6	29.76	80.1
2005	194	23	I	1.	142.	71.89	80.89	YES	2.75	0.8	6.60	99.6
2006	195	20	I	1.	208.	71.89	80.91	YES	1.75	1.1	14.64	99.5
2007	193	26	I	2.	104.	71.89	80.85	YES	2.00	1.7	19.81	98.3
2008	193	26	I	2.	104.	71.89	80.85	YES	5.00	1.6	7.62	99.2
2009	194	23	I	1.	132.	71.89	80.88	YES	1.00	0.9	21.77	97.2

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 5 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	26	I	2.	111.	71.89	80.85	YES	2.50	1.6	15.79	98.8
1981	192	15	I	3.	269.	71.89	80.97	YES	1.50	2.5	40.62	92.0
1982	192	15	I	2.	274.	71.90	80.97	YES	6.50	2.4	8.98	99.0
1983	185	22	I	2.	360.	71.92	80.90	YES	5.50	2.5	10.80	99.0
1984	192	26	I	2.	87.	71.90	80.85	YES	2.75	1.6	13.83	99.3
1985	191	16	I	2.	285.	71.90	80.96	YES	2.25	2.1	22.58	93.7
1986	194	23	I	1.	141.	71.89	80.88	YES	0.75	0.8	25.70	97.9
1987	194	22	I	1.	157.	71.89	80.89	YES	1.25	0.6	12.16	99.8
1988	194	22	I	1.	165.	71.89	80.89	YES	0.50	0.6	27.82	97.3
1989	194	24	I	1.	128.	71.89	80.87	YES	1.50	1.0	16.53	99.0
1990	195	18	I	2.	236.	71.89	80.94	YES	10.25	4.5	10.50	98.3
1991	195	15	I	3.	244.	71.88	80.97	YES	1.75	2.7	36.76	90.7
1992	194	15	I	3.	253.	71.89	80.97	YES	2.00	2.8	33.26	89.4
1993	195	20	I	1.	208.	71.89	80.91	YES	1.75	1.2	16.59	99.1
1994	188	18	I	2.	311.	71.91	80.94	YES	3.00	2.1	16.63	98.1
1995	189	27	I	2.	58.	71.91	80.84	YES	3.75	2.4	15.12	98.5
1996	194	24	I	1.	123.	71.89	80.87	YES	1.25	1.1	21.17	96.5
1997	194	24	I	1.	126.	71.89	80.87	YES	1.00	1.0	25.10	97.2
1998	192	15	I	2.	270.	71.90	80.95	YES	6.25	2.5	9.46	99.0
1999	193	15	I	3.	264.	71.89	80.97	YES	3.75	2.5	16.07	98.6
2000	192	26	I	2.	89.	71.90	80.85	YES	1.50	1.6	24.90	95.8
2001	184	23	I	3.	12.	71.92	80.88	YES	9.00	3.5	9.34	98.5
2002	183	31	I	5.	45.	71.93	80.80	YES	5.00	4.9	23.59	86.0
2003	186	20	I	2.	340.	71.91	80.92	YES	10.25	2.5	5.86	98.6
2004	173	36	I	9.	37.	71.96	80.74	YES	11.75	8.8	18.02	81.5
2005	187	19	I	2.	333.	71.91	80.92	YES	4.00	1.9	11.34	99.3
2006	194	22	I	1.	168.	71.89	80.89	YES	0.75	0.6	19.35	99.4
2007	186	21	I	2.	358.	71.92	80.90	YES	10.25	2.7	6.27	98.6
2008	194	22	I	1.	170.	71.89	80.90	YES	14.75	1.7	2.69	98.4
2009	194	24	I	1.	124.	71.89	80.87	YES	1.00	1.2	27.82	94.7

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 6 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	192	26	I	2.	85.	71.90	80.87	YES	4.00	1.6	9.37	99.3
1981	194	24	I	1.	123.	71.89	80.87	YES	10.75	4.2	9.35	98.3
1982	194	23	I	1.	139.	71.89	80.88	YES	1.50	0.8	13.41	99.7
1983	184	23	I	3.	7.	71.92	80.89	YES	10.50	2.9	6.70	98.6
1984	193	26	I	2.	109.	71.89	80.85	YES	6.00	1.7	6.65	99.2
1985	189	16	I	2.	298.	71.91	80.96	YES	3.25	2.4	17.73	97.5
1986	194	24	I	1.	125.	71.89	80.87	YES	1.25	1.2	22.20	96.5
1987	186	21	I	2.	350.	71.91	80.91	YES	3.25	2.2	16.47	98.5
1988	194	22	I	1.	172.	71.89	80.90	YES	0.75	0.7	21.77	97.9
1989	194	23	I	1.	138.	71.89	80.88	YES	1.50	0.7	12.00	99.7
1990	186	21	I	2.	348.	71.91	80.91	YES	10.25	2.4	5.55	98.6
1991	192	15	I	3.	274.	71.90	80.97	YES	2.00	2.5	30.24	89.4
1992	195	15	I	3.	244.	71.88	80.97	YES	3.00	2.8	22.08	93.6
1993	195	21	I	1.	201.	71.89	80.91	YES	1.00	1.1	27.22	94.7
1994	194	22	I	1.	163.	71.89	80.89	YES	0.75	0.8	25.10	97.9
1995	194	23	I	1.	151.	71.89	80.89	YES	1.50	0.7	11.39	99.7
1996	193	26	I	2.	107.	71.89	80.85	YES	2.00	1.7	20.56	98.3
1997	194	23	I	1.	147.	71.89	80.89	YES	1.00	0.7	16.03	99.7
1998	195	20	I	1.	215.	71.89	80.92	YES	6.25	1.2	4.50	99.2
1999	183	31	I	5.	46.	71.92	80.80	YES	14.75	4.9	8.01	97.8
2000	192	26	I	1.	91.	71.89	80.88	YES	1.75	1.5	20.48	98.6
2001	188	17	I	2.	307.	71.91	80.95	YES	3.50	2.3	15.77	99.1
2002	195	19	I	1.	225.	71.89	80.93	YES	9.75	3.8	9.38	98.4
2003	193	15	I	2.	263.	71.89	80.97	YES	4.00	2.4	14.36	99.0
2004	184	31	I	4.	50.	71.92	80.80	YES	6.00	4.5	17.99	94.2
2005	184	24	I	3.	14.	71.92	80.87	YES	10.50	3.8	8.74	98.3
2006	195	18	I	2.	236.	71.89	80.94	YES	1.75	1.8	24.19	95.1
2007	188	17	I	2.	309.	71.91	80.94	YES	7.75	2.2	6.86	98.9
2008	191	26	I	2.	80.	71.90	80.85	YES	3.75	1.6	10.30	99.3
2009	190	27	I	2.	71.	71.90	80.84	YES	3.25	2.1	15.42	99.2

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 7 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE	BEARING	LAT	LONG	ASHORE?	ELAPSED TIME	PATH LENGTH	MEAN SPEED	% AT ENDPT

				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	167	35	I	10.	28.	71.98	80.76	YES	21.00	10.4	11.92	93.5
1981	193	15	I	3.	262.	71.89	80.97	YES	4.75	2.5	12.73	99.0
1982	194	25	I	2.	112.	71.89	80.86	YES	3.00	1.5	12.40	99.5
1983	186	21	I	2.	358.	71.91	80.90	YES	16.50	2.5	3.65	97.9
1984	193	26	I	2.	100.	71.89	80.85	YES	21.75	4.2	4.66	97.1
1985	189	16	I	2.	301.	71.91	80.96	YES	4.50	2.4	12.57	99.2
1986	194	15	I	2.	256.	71.89	80.97	YES	4.75	2.5	12.38	99.1
1987	177	36	I	8.	44.	71.95	80.74	YES	6.25	7.9	30.46	66.8
1988	195	20	I	1.	212.	71.89	80.92	YES	2.50	1.1	10.58	99.6
1989	189	16	I	2.	299.	71.91	80.96	YES	16.00	3.5	5.29	97.9
1990	186	21	I	2.	356.	71.91	80.90	YES	7.50	2.1	6.75	99.0
1991	192	15	I	2.	271.	71.90	80.97	YES	8.50	2.6	7.22	98.9
1992	194	24	I	1.	119.	71.89	80.87	YES	3.00	1.2	9.98	99.5
1993	186	20	I	2.	347.	71.91	80.91	YES	7.25	2.3	7.59	98.9
1994	185	22	I	2.	5.	71.92	80.89	YES	6.50	2.5	9.33	98.9
1995	194	26	I	2.	110.	71.89	80.85	YES	2.00	1.6	19.66	98.3
1996	193	26	I	2.	105.	71.89	80.85	YES	1.75	1.6	22.12	95.1
1997	194	24	I	1.	122.	71.89	80.87	YES	1.25	1.3	24.49	96.5
1998	194	23	I	1.	140.	71.89	80.88	YES	1.00	1.0	22.98	97.2
1999	187	19	I	2.	336.	71.91	80.92	YES	5.75	2.3	9.45	99.1
2000	184	24	I	3.	19.	71.92	80.87	YES	9.00	4.2	11.26	98.4
2001	185	22	I	2.	5.	71.92	80.89	YES	6.75	2.6	9.34	98.9
2002	195	19	I	1.	229.	71.89	80.93	YES	2.00	1.7	19.81	98.3
2003	184	23	I	3.	10.	71.92	80.88	YES	6.00	2.8	11.39	98.9
2004	187	18	I	2.	325.	71.91	80.93	YES	2.25	2.2	23.12	93.7
2005	190	27	I	2.	68.	71.90	80.84	YES	2.75	2.2	18.97	97.7
2006	194	23	I	1.	148.	71.89	80.89	YES	0.75	0.7	23.59	97.9
2007	195	18	I	2.	237.	71.89	80.94	YES	14.50	2.9	4.73	98.2
2008	191	26	I	2.	71.	71.90	80.85	YES	2.75	1.7	14.57	99.3
2009	194	22	I	1.	173.	71.89	80.90	YES	0.50	0.7	33.57	97.3

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 8 SEPTEMBER

				END POSITION				ASHORE?	ELAPSED	PATH	MEAN	% AT
YEAR	ROW	COL	ORI	RANGE	BEARING	LAT	LONG		TIME	LENGTH	SPEED	ENDPT
				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	160	29	I	12.	14.	72.00	80.81	YES	15.25	12.8	20.22	69.9
1981	191	16	I	2.	284.	71.90	80.96	YES	4.50	2.2	11.56	99.2
1982	193	15	I	2.	266.	71.89	80.97	YES	5.25	2.4	11.02	99.1
1983	191	16	I	2.	276.	71.90	80.96	YES	10.75	2.3	5.06	98.6
1984	195	20	I	1.	219.	71.89	80.92	YES	9.50	2.5	6.19	98.7
1985	195	15	I	3.	245.	71.89	80.97	YES	7.50	2.7	8.53	98.8
1986	195	18	I	2.	237.	71.89	80.94	YES	3.00	1.8	14.11	99.3
1987	194	23	I	1.	150.	71.89	80.89	YES	0.75	0.8	24.49	97.9
1988	194	22	I	1.	173.	71.89	80.90	YES	8.00	3.3	9.75	98.6
1989	195	21	I	1.	203.	71.89	80.91	YES	2.25	1.1	11.59	99.6
1990	187	19	I	2.	328.	71.91	80.93	YES	2.75	2.1	17.90	97.7
1991	188	17	I	2.	307.	71.91	80.95	YES	3.00	2.3	18.45	97.5
1992	192	26	I	2.	83.	71.90	80.86	YES	1.50	1.5	24.19	95.8
1993	193	15	I	2.	261.	71.89	80.97	YES	3.00	2.4	19.15	97.5
1994	190	16	I	2.	293.	71.90	80.96	YES	4.00	2.2	13.15	99.3
1995	195	20	I	1.	216.	71.89	80.92	YES	1.50	1.3	21.57	95.8
1996	185	22	I	2.	3.	71.92	80.89	YES	6.00	2.5	9.98	99.0
1997	194	23	I	1.	149.	71.89	80.89	YES	0.75	0.7	22.38	97.9
1998	192	26	I	2.	85.	71.90	80.85	YES	1.50	1.6	25.91	95.8
1999	186	20	I	2.	346.	71.91	80.91	YES	3.50	2.2	15.16	99.1
2000	191	16	I	2.	277.	71.90	80.96	YES	3.50	2.0	13.87	99.2
2001	191	16	I	2.	280.	71.90	80.96	YES	2.50	2.0	19.60	97.9
2002	194	24	I	1.	127.	71.89	80.88	YES	0.75	1.0	30.84	96.0
2003	194	25	I	1.	113.	71.89	80.86	YES	2.75	1.5	13.00	99.5
2004	190	16	I	2.	293.	71.90	80.96	YES	3.00	2.2	17.54	97.5
2005	194	24	I	1.	123.	71.89	80.87	YES	1.75	1.1	15.51	99.5
2006	192	26	I	2.	92.	71.89	80.85	YES	12.00	4.1	8.29	98.1
2007	194	23	I	1.	137.	71.89	80.88	YES	1.75	0.8	11.10	99.7
2008	176	27	I	6.	20.	71.95	80.83	YES	13.00	6.7	12.38	97.4
2009	192	26	I	2.	87.	71.90	80.85	YES	1.50	1.6	25.00	95.8

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 9 SEPTEMBER

				END POSITION				ASHORE?	ELAPSED	PATH	MEAN	% AT
YEAR	ROW	COL	ORI	RANGE	BEARING	LAT	LONG		TIME	LENGTH	SPEED	ENDPT
				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	184	23	I	3.	12.	71.92	80.88	YES	2.50	2.9	28.06	88.0
1981	193	15	I	3.	266.	71.89	80.97	YES	2.50	2.6	24.80	93.0

1982	192	15	I	2.	271.	71.90	80.97	YES	5.25	2.4	10.90	99.1
1983	194	25	I	1.	112.	71.89	80.86	YES	7.00	1.5	5.18	99.1
1984	195	20	I	1.	212.	71.89	80.92	YES	2.00	1.2	14.67	99.5
1985	195	15	I	3.	244.	71.88	80.97	YES	9.00	2.7	7.09	98.8
1986	195	19	I	1.	223.	71.89	80.93	YES	1.50	1.5	23.28	95.8
1987	167	35	I	11.	28.	71.98	80.76	YES	17.00	10.8	15.21	89.8
1988	194	23	I	1.	140.	71.89	80.88	YES	1.25	0.7	14.39	99.7
1989	194	25	I	2.	112.	71.89	80.86	YES	2.25	1.5	16.53	98.9
1990	187	19	I	2.	333.	71.91	80.92	YES	3.75	1.9	12.40	99.3
1991	188	17	I	2.	308.	71.91	80.95	YES	5.00	2.2	10.58	99.1
1992	187	19	I	2.	332.	71.91	80.93	YES	3.50	2.0	14.00	99.1
1993	189	16	I	2.	298.	71.90	80.96	YES	4.00	2.3	14.06	99.0
1994	195	17	I	2.	244.	71.89	80.95	YES	3.50	2.1	14.43	99.1
1995	195	20	I	1.	206.	71.89	80.91	YES	1.50	1.2	18.95	98.8
1996	193	15	I	3.	266.	71.89	80.97	YES	2.50	2.5	24.31	93.0
1997	194	24	I	1.	126.	71.89	80.87	YES	1.75	1.0	14.17	99.6
1998	184	23	I	3.	8.	71.92	80.89	YES	6.00	2.9	11.74	98.9
1999	192	26	I	2.	94.	71.89	80.85	YES	2.75	1.6	13.61	99.3
2000	195	17	I	2.	241.	71.89	80.95	YES	6.25	1.9	7.32	99.1
2001	195	20	I	1.	217.	71.89	80.92	YES	2.25	1.3	13.57	99.5
2002	194	22	I	1.	172.	71.89	80.90	YES	0.75	0.7	20.87	99.4
2003	194	25	I	1.	121.	71.89	80.87	YES	1.50	1.3	20.66	98.8
2004	193	15	I	3.	259.	71.89	80.97	YES	2.50	2.6	24.62	93.0
2005	185	22	I	2.	7.	71.92	80.89	YES	14.25	3.8	6.35	98.0
2006	191	26	I	2.	80.	71.90	80.85	YES	1.75	1.7	22.72	95.1
2007	186	20	I	2.	346.	71.91	80.91	YES	5.00	2.2	10.77	99.1
2008	188	18	I	2.	315.	71.91	80.94	YES	6.25	1.9	7.45	99.1
2009	193	26	I	2.	100.	71.89	80.87	YES	3.00	1.6	12.70	99.4

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 10 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	23	I	1.	133.	71.89	80.88	YES	0.75	0.8	26.31	97.9
1981	193	14	I	3.	265.	71.89	80.98	YES	1.25	2.8	54.61	93.4
1982	195	20	I	1.	216.	71.89	80.92	YES	32.25	8.5	6.32	95.6
1983	194	24	I	1.	124.	71.89	80.87	YES	3.25	1.0	7.65	99.6
1984	194	25	I	1.	118.	71.89	80.86	YES	1.25	1.5	28.00	93.4
1985	194	24	I	1.	124.	71.89	80.87	YES	2.25	1.1	11.59	99.6
1986	186	20	I	2.	346.	71.91	80.91	YES	9.50	2.2	5.68	98.7
1987	183	31	I	5.	48.	71.92	80.80	YES	3.75	4.8	30.97	80.1
1988	194	22	I	1.	160.	71.89	80.89	YES	0.75	0.7	21.77	97.9
1989	194	23	I	1.	155.	71.89	80.89	YES	1.00	0.8	19.05	99.2
1990	191	27	I	2.	74.	71.90	80.85	YES	10.75	2.2	4.80	98.6
1991	191	16	I	2.	278.	71.90	80.96	YES	8.75	2.1	5.66	98.8
1992	188	18	I	2.	313.	71.91	80.94	YES	3.75	2.0	12.82	99.2
1993	188	17	I	2.	308.	71.91	80.95	YES	5.00	2.2	10.52	99.1
1994	194	22	I	1.	169.	71.89	80.90	YES	1.25	0.6	11.37	99.8
1995	194	22	I	1.	158.	71.89	80.89	YES	1.25	0.7	13.55	99.7
1996	193	26	I	2.	100.	71.89	80.85	YES	1.25	1.6	30.66	93.4
1997	195	17	I	2.	241.	71.89	80.95	YES	10.25	5.6	13.03	97.7
1998	188	18	I	2.	317.	71.91	80.94	YES	2.00	1.9	23.28	94.4
1999	183	25	I	3.	21.	71.92	80.86	YES	3.75	3.5	22.14	91.5
2000	195	19	I	1.	226.	71.89	80.93	YES	2.25	1.5	15.69	99.4
2001	193	26	I	2.	106.	71.89	80.85	YES	1.75	1.6	22.29	95.1
2002	195	15	I	3.	249.	71.89	80.97	YES	17.75	4.4	5.89	97.6
2003	184	23	I	3.	7.	71.92	80.89	YES	3.75	2.9	18.26	96.0
2004	188	18	I	2.	313.	71.91	80.94	YES	4.00	1.9	11.49	99.3
2005	194	23	I	1.	150.	71.89	80.89	YES	1.50	0.7	11.49	99.7
2006	194	24	I	1.	127.	71.89	80.87	YES	1.00	1.1	25.40	97.2
2007	192	15	I	2.	269.	71.89	80.96	YES	4.00	2.5	14.74	99.0
2008	191	16	I	2.	276.	71.90	80.96	YES	2.50	2.1	20.38	97.9
2009	194	22	I	1.	176.	71.89	80.90	YES	0.75	0.6	19.66	99.4

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 11 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	191	26	I	2.	79.	71.90	80.85	YES	2.50	1.6	15.72	99.4
1981	186	20	I	2.	346.	71.91	80.91	YES	2.25	2.2	23.25	93.7
1982	194	22	I	1.	154.	71.89	80.89	YES	7.75	3.4	10.46	98.7
1983	194	24	I	1.	123.	71.89	80.87	YES	2.75	1.1	9.57	99.6
1984	194	26	I	2.	111.	71.89	80.85	YES	2.00	1.6	19.66	98.3

1985	191	26	I	2.	73.	71.90	80.85	YES	2.50	1.7	16.39	99.1
1986	195	19	I	1.	224.	71.89	80.93	YES	2.75	1.4	12.26	99.4
1987	189	27	I	2.	56.	71.91	80.84	YES	4.25	2.3	13.07	98.9
1988	194	24	I	1.	135.	71.89	80.88	YES	1.00	1.0	24.49	97.2
1989	194	23	I	1.	143.	71.89	80.88	YES	1.25	0.8	15.85	99.7
1990	191	26	I	2.	82.	71.90	80.85	YES	2.00	1.6	19.35	98.3
1991	193	15	I	2.	262.	71.89	80.97	YES	3.75	2.5	15.72	99.0
1992	192	15	I	2.	267.	71.89	80.97	YES	6.50	2.4	8.98	99.0
1993	191	16	I	2.	278.	71.90	80.96	YES	3.50	2.1	14.52	99.1
1994	192	26	I	2.	84.	71.90	80.88	YES	2.00	1.7	19.81	98.3
1995	194	15	I	3.	254.	71.89	80.97	YES	3.00	2.6	20.97	95.5
1996	190	27	I	2.	68.	71.90	80.84	YES	2.50	2.1	20.20	97.9
1997	194	15	I	3.	253.	71.89	80.97	YES	1.75	2.7	37.45	90.7
1998	191	16	I	2.	280.	71.90	80.96	YES	1.25	2.2	41.31	93.4
1999	183	32	I	5.	50.	71.93	80.78	YES	25.50	10.1	9.50	94.7
2000	192	15	I	2.	270.	71.89	80.92	YES	4.25	2.4	13.59	99.1
2001	193	26	I	2.	99.	71.89	80.85	YES	2.00	1.7	20.26	96.4
2002	195	19	I	1.	224.	71.89	80.92	YES	4.75	1.3	6.72	99.4
2003	184	31	I	5.	51.	71.92	80.80	YES	7.25	4.8	16.00	98.1
2004	194	23	I	1.	141.	71.89	80.88	YES	1.50	0.8	12.30	99.7
2005	188	18	I	2.	319.	71.91	80.94	YES	4.00	2.0	11.87	99.2
2006	194	23	I	1.	137.	71.89	80.88	YES	1.25	0.9	17.66	99.0
2007	194	23	I	1.	141.	71.89	80.88	YES	10.00	2.5	5.99	98.7
2008	190	16	I	2.	292.	71.90	80.96	YES	3.00	2.3	18.35	97.5
2009	194	25	I	1.	123.	71.89	80.86	YES	0.75	1.4	45.06	96.0

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 12 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	23	I	1.	145.	71.89	80.89	YES	1.00	0.8	19.05	99.2
1981	189	27	I	2.	63.	71.90	80.84	YES	3.75	2.2	14.21	99.0
1982	194	24	I	1.	118.	71.89	80.87	YES	2.75	1.2	10.61	99.5
1983	194	23	I	1.	137.	71.89	80.88	YES	1.00	0.8	18.75	99.2
1984	192	26	I	2.	96.	71.89	80.85	YES	1.75	1.5	21.17	95.1
1985	183	31	I	5.	47.	71.93	80.79	YES	3.75	5.0	31.79	80.1
1986	195	20	I	1.	208.	71.89	80.91	YES	8.25	4.1	11.84	98.3
1987	177	36	I	8.	45.	71.94	80.74	YES	5.00	7.7	37.07	73.5
1988	194	24	I	1.	126.	71.89	80.87	YES	1.75	1.1	14.52	99.5
1989	194	23	I	1.	144.	71.89	80.89	YES	1.00	0.7	16.93	99.2
1990	194	23	I	1.	151.	71.89	80.89	YES	1.75	0.8	10.76	99.7
1991	189	16	I	2.	300.	71.91	80.96	YES	6.25	2.3	8.85	99.0
1992	193	15	I	2.	264.	71.89	80.97	YES	4.75	2.4	12.21	99.1
1993	193	15	I	2.	265.	71.89	80.97	YES	3.25	2.4	18.07	97.3
1994	191	16	I	2.	283.	71.90	80.96	YES	2.00	2.2	26.46	94.4
1995	194	22	I	1.	176.	71.89	80.90	YES	8.00	5.1	15.16	97.4
1996	189	27	I	2.	63.	71.90	80.84	YES	3.00	2.2	17.24	97.5
1997	195	19	I	1.	229.	71.89	80.93	YES	1.25	1.4	27.28	94.0
1998	190	16	I	2.	289.	71.90	80.96	YES	1.50	2.3	36.89	92.0
1999	194	22	I	1.	177.	71.89	80.90	YES	1.00	0.7	17.54	99.2
2000	194	15	I	3.	256.	71.89	80.97	YES	4.00	2.5	15.27	99.0
2001	184	24	I	3.	20.	71.92	80.87	YES	14.75	3.5	5.75	98.0
2002	194	24	I	1.	125.	71.89	80.87	YES	3.00	1.0	8.37	99.6
2003	191	16	I	2.	277.	71.90	80.96	YES	8.00	2.2	6.54	98.9
2004	194	25	I	1.	113.	71.89	80.86	YES	1.25	1.5	28.73	93.4
2005	185	22	I	3.	3.	71.92	80.89	YES	3.00	2.6	20.66	97.5
2006	195	20	I	1.	213.	71.89	80.92	YES	16.00	2.9	4.31	98.0
2007	194	24	I	1.	124.	71.89	80.87	YES	1.75	1.1	14.86	99.5
2008	191	16	I	2.	276.	71.90	80.96	YES	3.00	2.1	16.83	97.5
2009	194	24	I	1.	131.	71.89	80.87	YES	0.75	1.2	37.20	96.0

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 13 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	23	I	1.	144.	71.89	80.89	YES	1.25	0.7	13.73	99.7
1981	194	23	I	1.	141.	71.89	80.88	YES	1.25	0.8	15.97	99.7
1982	195	20	I	1.	216.	71.89	80.92	YES	1.50	1.2	19.56	98.8
1983	194	22	I	1.	156.	71.89	80.89	YES	0.75	0.7	23.59	97.9
1984	191	26	I	2.	70.	71.90	80.85	YES	2.00	1.6	19.35	98.3
1985	193	26	I	2.	108.	71.89	80.85	YES	1.50	1.7	27.52	92.0
1986	178	36	I	8.	46.	71.94	80.74	YES	23.25	10.4	10.68	81.4
1987	194	22	I	1.	175.	71.89	80.90	YES	14.25	2.4	3.98	98.3

1988	192	26	I	2.	83.	71.90	80.85	YES	3.75	1.5	9.92	99.3
1989	194	23	I	1.	145.	71.89	80.89	YES	1.00	0.7	17.24	99.2
1990	194	22	I	1.	173.	71.89	80.90	YES	1.00	0.6	14.52	99.7
1991	195	20	I	1.	218.	71.89	80.92	YES	17.75	2.9	3.93	97.6
1992	194	25	I	1.	119.	71.89	80.87	YES	2.00	1.3	15.27	99.5
1993	195	17	I	2.	242.	71.89	80.95	YES	3.00	2.1	16.43	98.7
1994	188	18	I	2.	314.	71.91	80.94	YES	2.75	1.9	16.96	97.7
1995	194	24	I	1.	133.	71.89	80.88	YES	1.25	1.0	19.35	99.0
1996	193	15	I	3.	264.	71.89	80.97	YES	2.50	2.6	25.22	93.0
1997	194	22	I	1.	163.	71.89	80.89	YES	1.25	0.6	12.16	99.8
1998	192	15	I	2.	268.	71.89	80.94	YES	1.50	2.5	39.61	92.0
1999	194	25	I	1.	118.	71.89	80.86	YES	1.25	1.4	26.79	96.5
2000	192	15	I	2.	271.	71.90	80.95	YES	4.50	2.4	12.80	99.1
2001	194	22	I	1.	150.	71.89	80.89	YES	1.50	0.6	10.28	99.7
2002	195	20	I	1.	217.	71.89	80.92	YES	3.75	1.2	7.62	99.5
2003	194	26	I	2.	110.	71.89	80.85	YES	10.25	5.2	12.13	98.2
2004	185	31	I	4.	53.	71.92	80.80	YES	6.50	4.3	15.79	97.8
2005	187	19	I	2.	328.	71.91	80.93	YES	4.00	2.1	12.55	99.2
2006	194	22	I	1.	160.	71.89	80.89	YES	1.00	0.6	14.52	99.7
2007	182	26	I	4.	24.	71.93	80.85	YES	4.75	4.1	20.56	96.1
2008	193	15	I	3.	264.	71.89	80.97	YES	3.75	2.5	16.21	98.0
2009	194	24	I	1.	129.	71.89	80.88	YES	1.00	1.0	22.98	97.2

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 14 SEPTEMBER

YEAR	ROW	COL	ORI	RANGE KM	END POSITION BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	195	20	I	1.	205.	71.89	80.91	YES	1.50	1.1	16.83	98.8
1981	194	22	I	1.	174.	71.89	80.90	YES	1.50	0.6	9.78	99.7
1982	194	22	I	1.	169.	71.89	80.89	YES	0.75	0.8	25.40	97.9
1983	193	26	I	2.	107.	71.89	80.85	YES	2.75	1.6	13.75	99.4
1984	195	19	I	1.	231.	71.89	80.93	YES	2.00	1.5	17.69	98.3
1985	194	24	I	1.	129.	71.89	80.87	YES	0.75	1.1	35.38	96.0
1986	189	27	I	2.	63.	71.90	80.84	YES	2.50	2.3	21.71	94.0
1987	186	19	I	2.	338.	71.91	80.92	YES	4.00	2.3	13.76	99.1
1988	194	26	I	2.	110.	71.89	80.85	YES	3.25	1.6	12.17	99.4
1989	185	31	I	4.	52.	71.92	80.80	YES	5.75	4.3	17.96	95.3
1990	194	23	I	1.	130.	71.89	80.88	YES	0.75	0.9	27.82	96.0
1991	194	22	I	1.	164.	71.89	80.89	YES	1.50	0.6	10.28	99.7
1992	193	26	I	2.	108.	71.89	80.85	YES	2.00	1.6	19.05	98.3
1993	195	20	I	1.	205.	71.89	80.91	YES	1.75	1.1	14.52	99.5
1994	178	36	I	7.	46.	71.94	80.74	YES	16.00	7.8	11.66	97.1
1995	194	22	I	1.	154.	71.89	80.89	YES	0.75	0.7	21.47	97.9
1996	194	15	I	3.	256.	71.89	80.97	YES	5.25	2.5	11.45	99.1
1997	194	25	I	1.	120.	71.89	80.87	YES	1.50	1.3	21.07	97.8
1998	186	21	I	2.	355.	71.91	80.90	YES	2.00	2.1	25.55	94.4
1999	190	27	I	2.	65.	71.90	80.84	YES	2.25	2.1	22.44	94.2
2000	195	20	I	1.	217.	71.89	80.92	YES	1.75	1.2	16.42	99.0
2001	192	26	I	1.	92.	71.89	80.86	YES	2.50	1.5	14.64	99.4
2002	194	24	I	1.	120.	71.89	80.87	YES	3.50	1.1	7.78	99.5
2003	190	27	I	2.	67.	71.90	80.84	YES	2.75	2.1	17.95	98.3
2004	174	36	I	8.	39.	71.95	80.75	YES	12.00	8.5	16.93	91.2
2005	193	15	I	2.	260.	71.89	80.97	YES	4.25	2.5	13.96	98.4
2006	194	22	I	1.	180.	71.89	80.90	YES	0.75	0.6	19.35	99.4
2007	188	18	I	2.	313.	71.91	80.94	YES	3.00	1.9	15.42	99.2
2008	195	17	I	2.	241.	71.89	80.95	YES	2.25	2.0	21.84	93.7
2009	194	23	I	1.	150.	71.89	80.89	YES	1.25	0.8	14.94	99.7

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 15 SEPTEMBER

YEAR	ROW	COL	ORI	RANGE KM	END POSITION BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	22	I	1.	185.	71.89	80.90	YES	7.50	4.0	12.66	98.7
1981	194	23	I	1.	141.	71.89	80.88	YES	1.00	0.9	20.87	99.2
1982	194	26	I	2.	111.	71.89	80.85	YES	1.50	1.8	28.83	92.0
1983	186	21	I	2.	358.	71.91	80.90	YES	6.75	2.1	7.48	99.0
1984	195	21	I	1.	192.	71.89	80.90	YES	1.75	1.0	13.52	99.6
1985	193	26	I	2.	106.	71.89	80.85	YES	1.25	1.6	30.06	93.4
1986	186	21	I	2.	357.	71.91	80.90	YES	8.25	2.8	8.13	98.9
1987	175	36	I	8.	40.	71.95	80.74	YES	7.75	8.3	25.76	73.3
1988	194	23	I	1.	144.	71.89	80.89	YES	1.25	0.7	14.33	99.7
1989	185	31	I	4.	53.	71.92	80.80	YES	4.75	4.5	22.57	86.7
1990	194	24	I	1.	123.	71.89	80.87	YES	0.75	1.1	36.59	96.0

1991	194	25	I	1.	116.	71.89	80.86	YES	1.25	1.3	25.22	96.5
1992	194	23	I	1.	151.	71.89	80.89	YES	1.00	0.8	19.35	99.2
1993	194	15	I	3.	257.	71.89	80.97	YES	3.75	2.5	16.11	99.0
1994	194	25	I	2.	113.	71.89	80.86	YES	1.50	1.5	24.09	95.8
1995	194	24	I	1.	125.	71.89	80.87	YES	1.75	1.1	14.56	99.5
1996	187	19	I	2.	327.	71.91	80.93	YES	3.75	2.1	13.69	99.0
1997	194	23	I	1.	134.	71.89	80.88	YES	0.75	1.0	31.15	96.0
1998	185	22	I	2.	6.	71.92	80.89	YES	8.75	2.5	6.81	98.8
1999	188	18	I	2.	321.	71.91	80.93	YES	2.00	2.0	23.74	94.4
2000	193	26	I	2.	107.	71.89	80.85	YES	1.75	1.8	24.11	95.1
2001	187	19	I	2.	336.	71.91	80.92	YES	3.75	2.0	13.10	99.3
2002	194	22	I	1.	167.	71.89	80.89	YES	1.25	0.7	13.49	99.7
2003	189	27	I	2.	62.	71.90	80.84	YES	2.25	2.2	23.96	93.7
2004	184	31	I	5.	49.	71.92	80.80	YES	8.25	4.6	13.27	98.2
2005	192	15	I	2.	267.	71.89	80.97	YES	2.50	2.4	22.98	93.0
2006	194	22	I	1.	175.	71.89	80.90	YES	1.25	0.7	12.76	99.8
2007	195	21	I	1.	203.	71.89	80.91	YES	3.75	1.1	6.83	99.5
2008	190	16	I	2.	287.	71.90	80.96	YES	2.25	2.2	23.08	93.7
2009	191	26	I	2.	82.	71.90	80.85	YES	2.25	1.7	17.84	98.1

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 16 SEPTEMBER

				END POSITION				ASHORE?	ELAPSED	PATH	MEAN	% AT
YEAR	ROW	COL	ORI	RANGE	BEARING	LAT	LONG		TIME	LENGTH	SPEED	ENDPT
				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	194	23	I	1.	131.	71.89	80.88	YES	1.25	0.9	16.81	99.1
1981	194	23	I	1.	145.	71.89	80.89	YES	0.75	0.7	22.98	97.9
1982	194	25	I	2.	112.	71.89	80.86	YES	1.50	1.5	24.80	95.8
1983	174	36	I	8.	39.	71.95	80.74	YES	15.50	8.5	13.12	96.7
1984	192	26	I	2.	86.	71.90	80.86	YES	5.50	1.5	6.71	99.2
1985	191	26	I	2.	74.	71.90	80.85	YES	3.75	1.7	10.60	99.3
1986	195	20	I	1.	209.	71.89	80.91	YES	2.75	1.1	9.84	99.5
1987	193	26	I	2.	106.	71.89	80.85	YES	1.50	1.6	25.00	95.8
1988	194	25	I	1.	117.	71.89	80.87	YES	4.75	1.3	6.53	99.3
1989	140	52	I	22.	31.	72.07	80.57	YES	27.75	23.0	19.91	48.3
1990	192	26	I	2.	96.	71.89	80.85	YES	1.75	1.7	23.63	95.1
1991	194	24	I	1.	123.	71.89	80.87	YES	1.00	1.1	25.70	97.2
1992	194	22	I	1.	169.	71.89	80.89	YES	2.00	0.6	7.56	99.7
1993	195	21	I	1.	204.	71.89	80.91	YES	2.00	1.0	12.25	99.6
1994	194	23	I	1.	140.	71.89	80.88	YES	1.00	0.8	19.05	99.2
1995	191	26	I	2.	81.	71.90	80.85	YES	4.25	1.5	8.70	99.3
1996	194	22	I	1.	163.	71.89	80.89	YES	1.75	0.6	8.77	99.7
1997	195	21	I	1.	203.	71.89	80.91	YES	2.25	1.1	11.69	99.6
1998	192	15	I	3.	271.	71.90	80.97	YES	3.25	2.6	18.89	97.3
1999	188	18	I	2.	321.	71.91	80.94	YES	3.75	2.0	13.06	99.2
2000	182	26	I	4.	27.	71.93	80.85	YES	7.75	4.7	14.43	97.2
2001	186	21	I	2.	354.	71.91	80.90	YES	3.50	2.2	15.12	99.1
2002	194	15	I	3.	250.	71.89	80.97	YES	13.00	5.1	9.47	97.9
2003	193	26	I	2.	103.	71.89	80.85	YES	1.75	1.6	22.25	96.6
2004	174	36	I	9.	40.	71.95	80.74	YES	8.50	8.7	24.55	76.2
2005	195	20	I	1.	210.	71.89	80.91	YES	1.00	1.1	27.52	94.7
2006	194	26	I	2.	111.	71.89	80.85	YES	2.50	1.7	16.57	98.5
2007	195	19	I	1.	224.	71.89	80.93	YES	2.25	1.4	14.82	99.4
2008	187	19	I	2.	326.	71.91	80.93	YES	5.25	2.1	9.50	99.2
2009	190	16	I	2.	285.	71.90	80.96	YES	3.00	2.2	17.34	97.5

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 17 SEPTEMBER

				END POSITION				ASHORE?	ELAPSED	PATH	MEAN	% AT
YEAR	ROW	COL	ORI	RANGE	BEARING	LAT	LONG		TIME	LENGTH	SPEED	ENDPT
				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	183	25	I	4.	24.	71.92	80.86	YES	18.00	3.9	5.24	97.6
1981	193	26	I	2.	102.	71.89	80.85	YES	2.75	1.6	13.99	99.3
1982	193	26	I	2.	104.	71.89	80.85	YES	1.75	1.6	21.64	95.1
1983	184	24	I	3.	20.	71.92	80.87	YES	4.50	3.0	15.79	98.0
1984	190	27	I	2.	66.	71.90	80.85	YES	12.25	2.4	4.75	98.4
1985	187	19	I	2.	329.	71.91	80.93	YES	2.75	2.0	17.37	97.7
1986	194	22	I	1.	172.	71.89	80.90	YES	8.00	3.0	9.07	98.7
1987	194	22	I	1.	173.	71.89	80.90	YES	0.75	0.6	18.75	99.4
1988	190	27	I	2.	68.	71.90	80.84	YES	3.50	2.1	14.69	99.1
1989	184	31	I	5.	50.	71.92	80.80	YES	5.00	4.6	22.08	86.0
1990	185	22	I	3.	1.	71.92	80.90	YES	4.50	2.6	13.74	99.0
1991	194	23	I	1.	138.	71.89	80.88	YES	1.50	0.9	14.41	99.6
1992	194	24	I	1.	129.	71.89	80.88	YES	1.25	0.9	18.20	99.0
1993	194	23	I	1.	144.	71.89	80.89	YES	1.50	0.8	12.20	99.7

1994	194	22	I	1.	176.	71.89	80.90	YES	1.00	0.6	13.61	99.7
1995	192	15	I	2.	270.	71.89	80.96	YES	21.25	5.7	6.49	97.0
1996	194	23	I	1.	143.	71.89	80.88	YES	0.75	1.0	30.84	96.0
1997	192	26	I	2.	86.	71.90	80.85	YES	1.50	1.7	27.01	93.3
1998	189	16	I	2.	300.	71.91	80.96	YES	3.00	2.4	19.15	97.5
1999	194	25	I	1.	116.	71.89	80.86	YES	4.00	1.3	8.01	99.5
2000	186	20	I	2.	343.	71.91	80.92	YES	3.25	2.3	16.98	97.9
2001	191	26	I	2.	73.	71.90	80.85	YES	3.25	1.6	12.14	99.4
2002	190	16	I	2.	285.	71.90	80.96	YES	2.75	2.1	18.47	97.7
2003	194	22	I	1.	168.	71.89	80.89	YES	4.50	0.6	3.06	99.5
2004	194	25	I	1.	120.	71.89	80.86	YES	1.25	1.4	26.55	96.5
2005	194	24	I	1.	118.	71.89	80.87	YES	1.00	1.2	29.33	94.7
2006	194	24	I	1.	122.	71.89	80.87	YES	1.75	1.0	14.39	99.5
2007	195	19	I	1.	231.	71.89	80.93	YES	1.75	1.7	23.03	95.1
2008	194	22	I	1.	166.	71.89	80.89	YES	1.75	0.6	8.64	99.8
2009	194	23	I	1.	134.	71.89	80.88	YES	0.75	0.9	29.33	96.0

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 18 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	193	15	I	2.	264.	71.89	80.95	YES	5.25	2.5	11.42	99.0
1981	195	20	I	1.	212.	71.89	80.92	YES	27.00	8.4	7.43	96.0
1982	184	24	I	3.	19.	71.92	80.87	YES	2.00	3.2	38.56	89.4
1983	189	27	I	2.	63.	71.90	80.84	YES	2.50	2.3	22.14	93.0
1984	194	24	I	1.	128.	71.89	80.88	YES	4.00	0.9	5.52	99.5
1985	189	16	I	2.	294.	71.90	80.96	YES	2.00	2.4	28.43	89.4
1986	193	26	I	2.	104.	71.89	80.85	YES	2.25	1.7	17.84	98.1
1987	187	19	I	2.	336.	71.91	80.92	YES	8.00	2.2	6.46	98.9
1988	190	27	I	2.	65.	71.90	80.84	YES	3.25	2.2	16.35	98.5
1989	185	22	I	3.	7.	71.92	80.89	YES	6.00	2.5	10.08	98.9
1990	195	18	I	2.	237.	71.89	80.94	YES	1.50	1.8	28.53	92.0
1991	194	22	I	1.	154.	71.89	80.89	YES	1.25	0.7	14.21	99.7
1992	194	23	I	1.	146.	71.89	80.89	YES	1.75	0.8	10.63	99.7
1993	193	15	I	2.	264.	71.89	80.97	YES	17.75	4.2	5.66	97.7
1994	185	22	I	3.	5.	71.92	80.89	YES	4.00	2.5	15.27	99.0
1995	194	15	I	3.	254.	71.89	80.97	YES	5.50	2.5	11.00	99.0
1996	191	26	I	2.	77.	71.90	80.85	YES	3.00	1.6	12.70	99.5
1997	194	26	I	2.	108.	71.89	80.85	YES	1.25	1.9	36.89	93.4
1998	195	15	I	3.	245.	71.88	80.97	YES	9.25	2.7	6.96	98.8
1999	193	26	I	2.	103.	71.89	80.85	YES	52.50	9.7	4.44	93.3
2000	193	15	I	2.	257.	71.89	80.97	YES	4.50	2.5	13.34	99.1
2001	189	16	I	2.	300.	71.91	80.96	YES	6.00	2.4	9.48	99.0
2002	189	16	I	2.	294.	71.90	80.96	YES	4.25	2.3	12.91	99.2
2003	194	24	I	1.	121.	71.89	80.87	YES	1.00	1.3	30.24	94.7
2004	193	26	I	2.	99.	71.89	80.85	YES	1.50	1.7	27.82	92.0
2005	188	29	I	3.	59.	71.91	80.81	YES	27.75	6.5	5.64	96.0
2006	191	26	I	2.	77.	71.90	80.85	YES	17.75	7.5	10.09	97.0
2007	194	24	I	1.	128.	71.89	80.87	YES	1.50	1.0	16.63	98.8
2008	191	26	I	1.	81.	71.90	80.86	YES	3.25	1.5	11.07	99.4
2009	194	24	I	1.	139.	71.89	80.88	YES	0.75	1.1	35.08	96.0

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 19 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	195	21	I	1.	202.	71.89	80.91	YES	1.75	1.1	14.60	99.5
1981	194	22	I	1.	164.	71.89	80.89	YES	1.50	0.7	10.68	99.7
1982	193	26	I	2.	107.	71.89	80.85	YES	1.25	1.7	32.30	93.4
1983	173	36	I	9.	38.	71.96	80.74	YES	7.50	8.9	28.32	65.2
1984	194	23	I	1.	135.	71.89	80.88	YES	3.00	0.8	6.75	99.6
1985	188	17	I	2.	304.	71.91	80.95	YES	2.75	2.3	20.43	95.8
1986	195	15	I	3.	245.	71.88	80.97	YES	27.25	7.3	6.41	96.1
1987	194	15	I	3.	257.	71.89	80.97	YES	4.00	2.5	15.27	99.0
1988	194	23	I	1.	133.	71.89	80.88	YES	1.50	0.9	14.52	99.6
1989	188	17	I	2.	307.	71.91	80.95	YES	2.75	2.3	19.66	97.7
1990	194	25	I	1.	113.	71.89	80.86	YES	1.75	1.4	19.79	98.6
1991	193	26	I	2.	100.	71.89	80.85	YES	2.00	1.7	20.11	98.3
1992	194	23	I	1.	144.	71.89	80.89	YES	9.00	2.9	7.86	98.8
1993	192	15	I	2.	270.	71.90	80.95	YES	5.25	2.5	11.28	99.1
1994	194	22	I	1.	155.	71.89	80.89	YES	19.75	5.7	6.98	97.1
1995	194	23	I	1.	130.	71.89	80.88	YES	1.50	0.9	14.21	99.6
1996	194	23	I	1.	143.	71.89	80.88	YES	1.25	0.8	15.36	99.7

1997	192	26	I	2.	86.	71.90	80.85	YES	1.00	1.5	36.89	94.7
1998	195	21	I	1.	198.	71.89	80.91	YES	5.25	1.0	4.58	99.3
1999	194	23	I	1.	145.	71.89	80.89	YES	2.75	0.7	6.41	99.6
2000	194	22	I	1.	181.	71.89	80.90	YES	0.50	0.7	31.75	97.3
2001	186	19	I	2.	338.	71.91	80.92	YES	4.00	2.2	13.46	99.1
2002	184	31	I	5.	48.	71.92	80.80	YES	8.75	4.6	12.71	98.4
2003	194	25	I	2.	113.	71.89	80.86	YES	1.25	1.6	29.88	93.4
2004	194	25	I	1.	118.	71.89	80.86	YES	1.00	1.4	33.87	94.7
2005	191	26	I	2.	79.	71.90	80.85	YES	3.25	1.6	11.58	99.4
2006	193	26	I	2.	98.	71.89	80.85	YES	2.25	1.6	16.83	98.1
2007	194	24	I	1.	126.	71.89	80.87	YES	1.00	1.2	29.64	94.7
2008	190	27	I	2.	65.	71.90	80.84	YES	4.50	2.1	11.36	99.2
2009	194	25	I	1.	114.	71.89	80.86	YES	1.50	1.4	22.18	95.8

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 20 SEPTEMBER

				END POSITION				ASHORE?	ELAPSED	PATH	MEAN	% AT
YEAR	ROW	COL	ORI	RANGE	BEARING	LAT	LONG		TIME	LENGTH	SPEED	ENDPT
				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	188	17	I	2.	309.	71.91	80.95	YES	11.25	2.6	5.62	98.5
1981	194	23	I	1.	138.	71.89	80.88	YES	1.25	0.9	17.12	99.0
1982	193	26	I	2.	98.	71.89	80.85	YES	2.00	1.7	20.41	98.3
1983	193	26	I	2.	104.	71.89	80.85	YES	1.50	1.7	27.82	92.0
1984	192	26	I	2.	89.	71.90	80.86	YES	6.50	1.8	6.56	99.1
1985	194	23	I	1.	148.	71.89	80.89	YES	0.75	0.8	24.49	97.9
1986	195	18	I	2.	236.	71.89	80.94	YES	3.75	1.7	11.09	99.3
1987	193	15	I	3.	261.	71.89	80.97	YES	3.75	2.5	16.07	98.5
1988	191	26	I	2.	71.	71.90	80.87	YES	9.00	2.1	5.48	98.8
1989	195	15	I	3.	249.	71.89	80.97	YES	2.25	2.7	29.33	88.7
1990	194	22	I	1.	152.	71.89	80.89	YES	1.75	0.7	9.63	99.7
1991	183	25	I	4.	21.	71.92	80.86	YES	4.00	3.6	21.62	88.8
1992	195	17	I	2.	241.	71.89	80.95	YES	4.00	2.0	11.87	99.3
1993	188	17	I	2.	307.	71.91	80.95	YES	5.75	2.2	9.30	99.0
1994	194	22	I	1.	156.	71.89	80.89	YES	0.50	0.6	31.15	97.3
1995	194	25	I	2.	113.	71.89	80.86	YES	2.00	1.6	19.05	98.3
1996	193	26	I	2.	106.	71.89	80.85	YES	3.50	1.6	11.10	99.4
1997	194	22	I	1.	182.	71.89	80.90	YES	1.25	0.6	11.73	99.8
1998	191	26	I	2.	83.	71.90	80.85	YES	3.00	1.6	12.90	99.5
1999	185	22	I	2.	2.	71.92	80.89	YES	12.75	3.3	6.30	98.3
2000	194	22	I	1.	162.	71.89	80.89	YES	0.50	0.6	29.64	97.3
2001	188	18	I	2.	318.	71.91	80.94	YES	2.25	2.0	21.20	96.2
2002	190	16	I	2.	293.	71.90	80.96	YES	21.00	6.2	7.13	97.1
2003	194	24	I	1.	129.	71.89	80.88	YES	1.25	1.0	18.87	99.0
2004	194	26	I	2.	113.	71.89	80.85	YES	1.00	1.7	41.43	94.7
2005	194	15	I	2.	256.	71.89	80.97	YES	2.75	2.5	21.80	94.3
2006	194	23	I	1.	143.	71.89	80.89	YES	1.25	0.7	14.39	99.7
2007	194	24	I	1.	127.	71.89	80.88	YES	1.00	0.9	22.68	97.2
2008	193	26	I	2.	105.	71.89	80.85	YES	3.50	1.6	11.02	99.4
2009	192	15	I	2.	268.	71.89	80.97	YES	6.25	2.4	9.33	98.9

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 21 SEPTEMBER

				END POSITION				ASHORE?	ELAPSED	PATH	MEAN	% AT
YEAR	ROW	COL	ORI	RANGE	BEARING	LAT	LONG		TIME	LENGTH	SPEED	ENDPT
				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	190	16	I	2.	291.	71.90	80.96	YES	2.25	2.2	23.02	93.7
1981	192	26	I	2.	94.	71.89	80.85	YES	5.75	1.6	6.78	99.2
1982	192	26	I	2.	96.	71.89	80.85	YES	2.00	1.6	19.35	98.3
1983	191	26	I	2.	83.	71.90	80.85	YES	1.25	1.7	32.78	93.4
1984	195	17	I	2.	244.	71.89	80.95	YES	10.75	2.3	5.13	98.6
1985	194	22	I	1.	182.	71.89	80.90	YES	0.50	0.6	28.43	97.3
1986	191	26	I	2.	82.	71.90	80.85	YES	3.00	1.5	12.20	99.5
1987	191	16	I	2.	284.	71.90	80.96	YES	2.50	2.2	21.23	94.0
1988	189	27	I	2.	57.	71.91	80.84	YES	2.75	2.3	19.66	97.7
1989	194	23	I	1.	135.	71.89	80.88	YES	2.00	0.8	9.98	99.6
1990	192	15	I	2.	269.	71.89	80.97	YES	3.50	2.4	16.72	98.0
1991	194	15	I	3.	251.	71.89	80.97	YES	2.50	2.6	24.74	93.0
1992	195	18	I	2.	230.	71.89	80.93	YES	2.00	1.6	19.66	98.3
1993	186	21	I	2.	355.	71.91	80.90	YES	3.50	2.1	14.26	99.1
1994	193	26	I	2.	100.	71.89	80.85	YES	1.75	1.5	21.00	97.1
1995	194	23	I	1.	144.	71.89	80.89	YES	1.00	0.7	17.24	99.2
1996	176	36	I	8.	41.	71.95	80.74	YES	11.50	8.1	16.83	93.3
1997	195	17	I	2.	244.	71.89	80.95	YES	6.25	2.2	8.30	99.2
1998	190	27	I	2.	66.	71.90	80.84	YES	3.00	2.2	17.44	98.1
1999	188	18	I	2.	313.	71.91	80.94	YES	5.00	2.0	9.37	99.2

2000	194	22	I	1.	163.	71.89	80.89	YES	1.00	0.6	14.52	99.7
2001	194	15	I	2.	256.	71.89	80.97	YES	6.00	2.4	9.78	99.0
2002	192	15	I	3.	269.	71.89	80.94	YES	4.00	2.5	15.20	98.5
2003	193	15	I	2.	262.	71.89	80.97	YES	3.50	2.4	16.59	98.2
2004	186	21	I	2.	356.	71.92	80.90	YES	9.50	3.6	9.09	98.2
2005	195	17	I	2.	240.	71.89	80.95	YES	1.50	2.2	35.08	92.0
2006	195	21	I	1.	192.	71.89	80.90	YES	1.25	1.0	18.33	99.0
2007	194	23	I	1.	134.	71.89	80.88	YES	1.50	0.9	13.81	99.6
2008	194	26	I	2.	112.	71.89	80.85	YES	2.25	1.7	17.84	98.1
2009	194	23	I	1.	136.	71.89	80.88	YES	1.00	0.9	21.47	97.2

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 22 SEPTEMBER

YEAR	ROW	COL	ORI	RANGE KM	END POSITION BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	189	16	I	2.	300.	71.91	80.96	YES	4.50	2.4	12.63	99.1
1981	193	26	I	2.	98.	71.89	80.85	YES	2.75	1.5	13.14	99.4
1982	194	24	I	1.	128.	71.89	80.88	YES	1.25	1.0	19.35	99.0
1983	192	26	I	2.	92.	71.89	80.85	YES	2.25	1.6	17.24	98.3
1984	195	20	I	1.	217.	71.89	80.92	YES	4.00	1.2	7.03	99.5
1985	194	23	I	1.	146.	71.89	80.89	YES	1.00	0.8	18.45	99.2
1986	191	26	I	2.	73.	71.90	80.85	YES	3.75	1.6	10.40	99.4
1987	193	15	I	2.	262.	71.89	80.97	YES	3.00	2.4	19.25	97.5
1988	169	36	I	10.	32.	71.97	80.74	YES	13.00	10.0	18.42	85.0
1989	194	25	I	1.	117.	71.89	80.86	YES	1.75	1.3	18.01	98.6
1990	194	22	I	1.	155.	71.89	80.89	YES	1.25	0.7	12.94	99.8
1991	191	15	I	2.	275.	71.90	80.97	YES	1.75	2.5	34.04	90.7
1992	193	15	I	2.	259.	71.89	80.97	YES	2.00	2.4	28.88	89.4
1993	191	16	I	2.	283.	71.90	80.94	YES	6.50	2.2	8.19	99.1
1994	194	25	I	2.	111.	71.89	80.86	YES	1.50	1.6	25.00	95.8
1995	194	22	I	1.	167.	71.89	80.89	YES	1.00	0.6	14.82	99.7
1996	184	24	I	3.	21.	71.92	80.87	YES	5.75	3.0	12.64	98.8
1997	194	22	I	1.	164.	71.89	80.89	YES	1.00	0.7	15.72	99.7
1998	185	22	I	2.	1.	71.92	80.90	YES	5.00	2.5	11.79	99.1
1999	194	23	I	1.	144.	71.89	80.89	YES	7.50	4.6	14.70	97.4
2000	185	31	I	4.	52.	71.92	80.80	YES	7.00	4.4	15.08	98.2
2001	195	19	I	1.	222.	71.89	80.92	YES	3.50	1.3	9.16	99.4
2002	189	16	I	2.	303.	71.91	80.96	YES	2.50	2.4	22.86	93.0
2003	195	20	I	1.	209.	71.89	80.91	YES	1.50	1.2	18.45	98.8
2004	192	15	I	3.	273.	71.90	80.98	YES	1.00	2.7	65.32	94.7
2005	191	26	I	1.	83.	71.90	80.86	YES	16.50	3.8	5.46	97.8
2006	194	22	I	1.	156.	71.89	80.89	YES	1.25	0.7	12.94	99.8
2007	194	23	I	1.	151.	71.89	80.89	YES	1.00	0.8	19.35	99.2
2008	194	24	I	1.	127.	71.89	80.88	YES	1.50	1.0	16.13	99.6
2009	194	24	I	1.	129.	71.89	80.87	YES	1.00	1.1	27.22	94.7

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 23 SEPTEMBER

YEAR	ROW	COL	ORI	RANGE KM	END POSITION BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	178	36	I	7.	46.	71.94	80.74	YES	18.25	7.8	10.29	96.9
1981	194	23	I	1.	135.	71.89	80.88	YES	0.75	0.9	29.94	96.0
1982	189	27	I	2.	61.	71.91	80.84	YES	2.25	2.3	24.90	93.7
1983	195	19	I	1.	228.	71.89	80.93	YES	7.00	1.4	4.97	99.1
1984	195	15	I	3.	248.	71.89	80.97	YES	7.25	2.6	8.60	99.0
1985	194	23	I	1.	133.	71.89	80.88	YES	2.25	0.8	8.77	99.6
1986	191	16	I	2.	282.	71.90	80.96	YES	6.00	2.1	8.27	99.1
1987	194	22	I	1.	167.	71.89	80.89	YES	8.25	2.8	8.18	98.9
1988	174	36	I	9.	38.	71.96	80.74	YES	10.50	8.7	19.96	91.3
1989	194	25	I	1.	114.	71.89	80.86	YES	1.75	1.4	18.84	98.6
1990	188	18	I	2.	318.	71.91	80.93	YES	7.50	2.0	6.31	99.0
1991	192	15	I	3.	270.	71.89	80.98	YES	2.00	2.6	31.15	89.4
1992	192	15	I	3.	268.	71.89	80.97	YES	3.75	2.5	16.09	98.5
1993	194	23	I	1.	146.	71.89	80.89	YES	0.75	0.7	22.98	97.9
1994	187	30	I	3.	61.	71.91	80.81	YES	27.00	4.9	4.37	96.7
1995	193	26	I	2.	107.	71.89	80.85	YES	3.50	1.6	10.89	99.4
1996	192	26	I	2.	94.	71.89	80.85	YES	2.00	1.6	19.35	98.3
1997	193	26	I	2.	107.	71.89	80.85	YES	2.00	1.7	20.71	98.3
1998	187	19	I	2.	325.	71.91	80.93	YES	7.25	2.1	6.84	99.0
1999	193	26	I	2.	99.	71.89	80.85	YES	2.75	1.6	13.64	99.3
2000	187	19	I	2.	329.	71.91	80.93	YES	3.25	2.1	15.24	99.2
2001	193	26	I	2.	101.	71.89	80.85	YES	2.50	1.5	14.88	99.4
2002	192	15	I	3.	274.	71.90	80.97	YES	2.25	2.5	26.91	90.6

2003	194	24	I	1.	124.	71.89	80.87	YES	1.50	1.2	18.55	98.8
2004	192	15	I	2.	266.	71.89	80.97	YES	1.75	2.4	33.35	90.7
2005	188	18	I	2.	316.	71.91	80.94	YES	25.25	5.9	5.64	96.5
2006	195	20	I	1.	214.	71.89	80.93	YES	8.75	3.4	9.28	98.6
2007	194	23	I	1.	150.	71.89	80.89	YES	1.50	0.8	12.10	99.7
2008	194	24	I	1.	128.	71.89	80.87	YES	1.50	1.0	16.73	99.0
2009	193	26	I	2.	106.	71.89	80.85	YES	1.00	1.6	38.40	94.7

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 24 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	22	I	1.	151.	71.89	80.89	YES	1.50	0.7	11.19	99.7
1981	194	23	I	1.	139.	71.89	80.88	YES	1.00	0.8	19.35	99.2
1982	188	18	I	2.	311.	71.91	80.94	YES	3.75	2.1	13.12	99.3
1983	195	20	I	1.	207.	71.89	80.91	YES	1.75	1.2	15.85	99.5
1984	194	22	I	1.	162.	71.89	80.89	YES	1.25	0.6	11.61	99.8
1985	192	26	I	2.	91.	71.89	80.85	YES	2.00	1.7	20.26	98.3
1986	192	15	I	2.	268.	71.89	80.97	YES	3.75	2.4	15.64	98.5
1987	194	22	I	1.	161.	71.89	80.89	YES	1.50	0.7	10.89	99.7
1988	186	20	I	2.	345.	71.91	80.91	YES	8.50	2.4	6.76	98.8
1989	194	23	I	1.	148.	71.89	80.89	YES	0.75	0.8	25.10	97.9
1990	191	26	I	2.	79.	71.90	80.85	YES	2.25	1.7	17.88	98.1
1991	193	15	I	3.	260.	71.89	80.97	YES	3.00	2.6	20.66	95.5
1992	195	15	I	3.	246.	71.88	80.97	YES	1.75	2.7	37.41	90.7
1993	194	23	I	1.	146.	71.89	80.89	YES	0.75	0.8	25.40	97.9
1994	194	24	I	1.	122.	71.89	80.87	YES	3.50	1.1	7.69	99.5
1995	195	22	I	1.	181.	71.89	80.90	YES	8.75	4.4	12.12	98.3
1996	194	25	I	1.	118.	71.89	80.86	YES	1.00	1.4	32.96	94.7
1997	194	25	I	1.	113.	71.89	80.86	YES	2.25	1.5	15.52	99.4
1998	189	16	I	2.	295.	71.90	80.96	YES	4.75	2.3	11.60	99.1
1999	187	19	I	2.	336.	71.91	80.92	YES	11.25	3.8	8.10	98.3
2000	189	16	I	2.	300.	71.91	80.96	YES	4.50	2.4	12.97	99.1
2001	186	21	I	2.	352.	71.91	80.91	YES	7.75	3.1	9.61	98.6
2002	191	16	I	2.	277.	71.90	80.96	YES	1.25	2.1	39.86	93.4
2003	193	26	I	1.	98.	71.89	80.85	YES	3.00	1.5	12.00	99.5
2004	194	23	I	1.	152.	71.89	80.89	YES	1.50	0.7	11.39	99.7
2005	191	16	I	2.	280.	71.90	80.96	YES	4.00	2.1	12.40	99.2
2006	194	22	I	1.	168.	71.89	80.89	YES	1.00	0.8	18.14	99.2
2007	193	26	I	2.	105.	71.89	80.85	YES	4.25	1.6	9.09	99.3
2008	195	17	I	2.	243.	71.89	80.95	YES	5.75	2.1	8.84	99.1
2009	194	23	I	1.	138.	71.89	80.88	YES	0.50	0.8	37.20	97.3

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 25 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	195	15	I	3.	244.	71.88	80.97	YES	3.75	2.7	17.34	97.3
1981	195	18	I	2.	238.	71.89	80.94	YES	2.50	1.7	16.75	98.5
1982	194	23	I	1.	130.	71.89	80.88	YES	8.00	5.2	15.50	96.3
1983	194	23	I	1.	129.	71.89	80.88	YES	1.25	0.9	17.54	99.0
1984	194	23	I	1.	132.	71.89	80.88	YES	1.50	0.9	13.61	99.6
1985	194	22	I	1.	184.	71.89	80.90	YES	8.00	4.4	13.19	98.5
1986	194	22	I	1.	174.	71.89	80.90	YES	1.00	0.7	16.03	99.7
1987	195	20	I	1.	218.	71.89	80.92	YES	2.25	1.3	14.11	99.4
1988	188	17	I	2.	305.	71.91	80.95	YES	8.00	2.4	7.11	98.9
1989	192	26	I	2.	87.	71.90	80.87	YES	3.00	1.6	12.50	99.4
1990	195	17	I	2.	241.	71.89	80.95	YES	12.00	3.4	6.73	98.4
1991	193	15	I	2.	259.	71.89	80.97	YES	3.50	2.5	16.85	97.1
1992	194	25	I	1.	115.	71.89	80.86	YES	2.25	1.4	14.99	99.4
1993	194	22	I	1.	156.	71.89	80.89	YES	1.50	0.7	11.39	99.7
1994	189	27	I	2.	63.	71.90	80.84	YES	6.25	2.2	8.27	99.1
1995	194	25	I	1.	116.	71.89	80.86	YES	1.25	1.4	26.25	96.5
1996	194	24	I	1.	124.	71.89	80.87	YES	1.00	1.1	26.61	97.2
1997	193	26	I	2.	106.	71.89	80.85	YES	3.00	1.6	13.00	99.4
1998	195	19	I	2.	230.	71.89	80.93	YES	1.50	1.5	24.19	95.8
1999	188	18	I	2.	322.	71.91	80.93	YES	2.75	2.0	17.46	97.7
2000	189	16	I	2.	299.	71.91	80.96	YES	3.25	2.4	17.98	97.3
2001	188	18	I	2.	314.	71.91	80.94	YES	2.25	2.0	21.17	96.2
2002	194	24	I	1.	128.	71.89	80.88	YES	1.00	0.9	22.08	97.2
2003	187	19	I	2.	326.	71.91	80.93	YES	2.75	2.1	18.34	97.7
2004	194	26	I	2.	109.	71.89	80.85	YES	1.50	1.8	28.32	92.0
2005	189	16	I	2.	296.	71.90	80.96	YES	5.75	2.3	9.43	99.1

2006	189	16	I	2.	303.	71.91	80.96	YES	3.75	2.4	15.26	99.0
2007	189	27	I	2.	63.	71.90	80.84	YES	3.25	2.2	16.19	98.6
2008	192	15	I	2.	271.	71.90	80.97	YES	2.75	2.5	21.44	92.3
2009	194	25	I	1.	119.	71.89	80.86	YES	1.00	1.4	34.47	94.7

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 26 SEPTEMBER

				END POSITION				ASHORE?	ELAPSED	PATH	MEAN	% AT
YEAR	ROW	COL	ORI	RANGE	BEARING	LAT	LONG		TIME	LENGTH	SPEED	ENDPT
				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	194	22	I	1.	173.	71.89	80.90	YES	1.50	0.6	10.28	99.7
1981	195	15	I	3.	248.	71.89	80.97	YES	3.75	2.6	16.93	97.9
1982	194	25	I	1.	119.	71.89	80.87	YES	2.25	1.3	14.01	99.4
1983	194	22	I	1.	181.	71.89	80.90	YES	0.75	0.7	21.17	97.9
1984	194	24	I	1.	128.	71.89	80.87	YES	1.00	1.1	26.61	97.2
1985	195	17	I	2.	240.	71.89	80.95	YES	2.75	2.0	17.57	97.7
1986	193	26	I	2.	101.	71.89	80.85	YES	3.25	1.6	11.61	99.4
1987	194	22	I	1.	159.	71.89	80.89	YES	0.75	0.6	19.35	99.4
1988	194	26	I	2.	111.	71.89	80.85	YES	3.75	1.6	10.40	99.3
1989	194	23	I	1.	135.	71.89	80.88	YES	1.00	0.8	19.66	99.2
1990	194	25	I	1.	117.	71.89	80.87	YES	2.75	1.3	11.19	99.5
1991	195	21	I	1.	194.	71.89	80.91	YES	8.75	4.2	11.45	98.4
1992	194	22	I	1.	151.	71.89	80.89	YES	1.00	0.7	15.72	99.7
1993	195	19	I	1.	226.	71.89	80.93	YES	3.75	1.5	9.50	99.3
1994	185	22	I	2.	2.	71.92	80.90	YES	5.75	2.5	10.24	99.0
1995	194	23	I	1.	148.	71.89	80.89	YES	1.00	0.8	19.35	99.2
1996	193	26	I	2.	100.	71.89	80.85	YES	1.50	1.6	25.30	95.8
1997	194	24	I	1.	129.	71.89	80.88	YES	1.25	1.0	18.51	99.0
1998	189	16	I	2.	299.	71.91	80.96	YES	1.75	2.4	32.40	90.7
1999	188	18	I	2.	323.	71.91	80.93	YES	2.00	2.0	24.19	94.4
2000	195	21	I	1.	193.	71.89	80.91	YES	2.75	1.0	9.02	99.6
2001	187	30	I	4.	58.	71.91	80.80	YES	10.00	4.2	10.16	98.2
2002	193	26	I	2.	99.	71.89	80.85	YES	2.50	1.5	14.88	99.4
2003	193	26	I	2.	99.	71.89	80.85	YES	8.25	2.9	8.58	98.7
2004	194	26	I	2.	111.	71.89	80.85	YES	1.50	1.7	27.62	93.3
2005	186	21	I	2.	349.	71.91	80.91	YES	7.25	2.1	7.08	99.0
2006	192	15	I	2.	269.	71.89	80.94	YES	3.75	2.4	15.58	98.6
2007	185	31	I	4.	54.	71.92	80.80	YES	8.25	4.2	12.26	98.4
2008	195	17	I	2.	240.	71.89	80.94	YES	1.25	1.9	35.56	93.4
2009	195	20	I	1.	217.	71.89	80.92	YES	2.50	1.2	11.67	99.6

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 27 SEPTEMBER

				END POSITION				ASHORE?	ELAPSED	PATH	MEAN	% AT
YEAR	ROW	COL	ORI	RANGE	BEARING	LAT	LONG		TIME	LENGTH	SPEED	ENDPT
				KM	DEG. T	NORTH	WEST		HOURS	KM	KM/DAY	
1980	194	22	I	1.	171.	71.89	80.90	YES	0.75	0.6	18.14	99.4
1981	194	22	I	1.	160.	71.89	80.89	YES	0.75	0.8	26.91	97.9
1982	194	22	I	1.	182.	71.89	80.90	YES	1.50	0.6	9.27	99.7
1983	195	21	I	1.	200.	71.89	80.91	YES	1.25	1.0	19.23	99.0
1984	194	22	I	1.	153.	71.89	80.89	YES	1.25	0.7	13.37	99.7
1985	195	19	I	1.	226.	71.89	80.93	YES	2.50	1.4	13.37	99.5
1986	194	25	I	1.	116.	71.89	80.86	YES	1.75	1.4	19.53	98.6
1987	194	23	I	1.	144.	71.89	80.88	YES	1.50	0.8	13.10	99.7
1988	192	26	I	2.	91.	71.89	80.88	YES	2.00	1.6	19.20	98.3
1989	194	24	I	1.	123.	71.89	80.87	YES	1.00	1.0	24.80	97.2
1990	193	26	I	2.	105.	71.89	80.85	YES	2.25	1.7	17.64	98.1
1991	195	18	I	2.	233.	71.89	80.94	YES	2.75	1.7	14.52	99.3
1992	193	26	I	2.	105.	71.89	80.85	YES	1.50	1.7	27.62	93.3
1993	194	22	I	1.	154.	71.89	80.89	YES	1.50	0.7	10.58	99.7
1994	187	19	I	2.	327.	71.91	80.93	YES	1.25	2.0	39.01	93.4
1995	194	22	I	1.	184.	71.89	80.90	YES	1.00	0.7	16.63	99.2
1996	187	19	I	2.	327.	71.91	80.93	YES	4.50	2.0	10.79	99.2
1997	193	26	I	2.	109.	71.89	80.85	YES	2.00	1.7	20.41	98.3
1998	187	19	I	2.	335.	71.91	80.92	YES	1.75	2.1	28.94	90.7
1999	184	24	I	3.	20.	71.92	80.87	YES	1.75	3.1	42.21	90.7
2000	191	26	I	2.	75.	71.90	80.85	YES	51.00	10.4	4.90	93.4
2001	188	18	I	2.	311.	71.91	80.94	YES	4.00	2.1	12.32	99.2
2002	194	22	I	1.	185.	71.89	80.90	YES	9.25	3.9	10.12	98.5
2003	194	22	I	1.	180.	71.89	80.90	YES	0.75	0.7	21.47	97.9
2004	193	26	I	2.	107.	71.89	80.85	YES	5.00	1.6	7.56	99.3
2005	165	35	I	11.	26.	71.99	80.76	YES	18.75	11.5	14.78	91.5
2006	189	16	I	2.	301.	71.91	80.96	YES	3.75	2.4	15.48	99.0
2007	191	26	I	2.	83.	71.90	80.85	YES	2.00	1.6	18.75	98.3
2008	195	21	I	1.	197.	71.89	80.91	YES	1.00	1.1	26.31	97.2

2009	194	22	I	1.	164.	71.89	80.89	YES	1.00	0.7	16.63	99.2

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 28 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	194	22	I	1.	154.	71.89	80.89	YES	1.00	0.7	16.93	99.2
1981	194	24	I	1.	133.	71.89	80.88	YES	1.00	1.0	24.19	97.2
1982	195	20	I	1.	211.	71.89	80.92	YES	2.50	1.2	11.19	99.6
1983	194	22	I	1.	165.	71.89	80.89	YES	1.75	0.6	7.91	99.8
1984	194	22	I	1.	157.	71.89	80.89	YES	0.75	0.7	21.17	97.9
1985	194	22	I	1.	165.	71.89	80.89	YES	2.00	0.6	7.11	99.7
1986	194	25	I	2.	119.	71.89	80.86	YES	1.00	1.5	36.59	94.7
1987	194	22	I	1.	167.	71.89	80.89	YES	1.00	0.7	16.63	99.2
1988	191	26	I	2.	77.	71.90	80.85	YES	1.75	1.6	22.59	95.1
1989	184	24	I	3.	19.	71.92	80.87	YES	2.25	3.1	33.13	88.1
1990	193	26	I	2.	102.	71.89	80.85	YES	1.75	1.6	21.34	95.1
1991	195	19	I	1.	222.	71.89	80.92	YES	4.25	1.3	7.54	99.4
1992	190	16	I	2.	292.	71.90	80.96	YES	2.00	2.4	29.03	89.4
1993	194	23	I	1.	152.	71.89	80.89	YES	1.00	0.7	17.24	99.2
1994	192	26	I	2.	96.	71.89	80.85	YES	2.00	1.7	20.11	98.3
1995	194	22	I	1.	158.	71.89	80.89	YES	1.00	0.7	17.24	99.2
1996	188	18	I	2.	317.	71.91	80.93	YES	1.25	1.9	35.62	93.4
1997	194	22	I	1.	185.	71.89	80.90	YES	7.25	5.8	19.12	94.0
1998	185	22	I	3.	3.	71.92	80.89	YES	3.25	2.5	18.63	97.3
1999	195	20	I	1.	208.	71.89	80.91	YES	1.75	1.1	14.64	99.5
2000	194	24	I	1.	126.	71.89	80.87	YES	8.00	1.4	4.16	99.0
2001	172	29	I	8.	21.	71.96	80.81	YES	15.50	8.9	13.78	95.8
2002	195	17	I	2.	239.	71.89	80.94	YES	3.25	1.9	13.93	99.2
2003	189	27	I	2.	57.	71.91	80.84	YES	3.75	2.3	14.78	99.0
2004	190	27	I	2.	69.	71.90	80.84	YES	2.25	2.1	22.04	94.2
2005	173	36	I	9.	36.	71.96	80.75	YES	13.75	8.9	15.55	94.2
2006	195	15	I	3.	249.	71.89	80.97	YES	6.00	2.6	10.48	99.0
2007	191	26	I	2.	71.	71.90	80.85	YES	3.00	1.7	13.31	99.4
2008	193	26	I	2.	105.	71.89	80.85	YES	2.00	1.7	19.96	98.3
2009	194	25	I	1.	118.	71.89	80.87	YES	2.50	1.2	11.98	99.6

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 29 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	193	26	I	2.	107.	71.89	80.85	YES	1.75	1.6	21.64	95.1
1981	194	22	I	1.	185.	71.89	80.90	YES	1.00	0.6	13.91	99.7
1982	193	26	I	2.	98.	71.89	80.85	YES	1.25	1.5	29.70	93.4
1983	191	16	I	2.	280.	71.90	80.96	YES	3.50	2.1	14.08	98.9
1984	194	23	I	1.	147.	71.89	80.89	YES	1.00	0.8	19.96	99.2
1985	194	26	I	2.	111.	71.89	80.86	YES	2.25	1.6	16.93	98.1
1986	189	16	I	2.	297.	71.90	80.96	YES	15.75	3.2	4.93	98.0
1987	194	24	I	1.	130.	71.89	80.88	YES	1.25	0.9	17.96	99.0
1988	189	27	I	2.	62.	71.90	80.84	YES	2.50	2.2	21.23	94.0
1989	180	35	I	7.	47.	71.94	80.75	YES	25.25	11.8	11.24	92.9
1990	186	21	I	2.	350.	71.91	80.91	YES	2.25	2.2	23.96	93.7
1991	194	24	I	1.	122.	71.89	80.87	YES	1.50	1.0	16.73	99.0
1992	188	18	I	2.	313.	71.91	80.94	YES	1.50	2.1	33.47	92.0
1993	194	22	I	1.	152.	71.89	80.89	YES	1.25	0.7	13.06	99.8
1994	184	31	I	5.	49.	71.92	80.80	YES	8.00	5.1	15.31	97.9
1995	194	25	I	1.	113.	71.89	80.86	YES	2.50	1.5	14.03	99.4
1996	188	17	I	2.	306.	71.91	80.95	YES	2.25	2.4	25.10	93.7
1997	194	24	I	1.	127.	71.89	80.88	YES	1.25	1.0	19.35	99.0
1998	188	18	I	2.	310.	71.91	80.94	YES	5.25	2.1	9.59	99.2
1999	192	26	I	2.	93.	71.89	80.85	YES	1.25	1.6	29.94	93.4
2000	193	26	I	2.	101.	71.89	80.85	YES	16.25	5.8	8.57	97.5
2001	187	19	I	2.	330.	71.91	80.93	YES	1.75	2.0	28.04	90.7
2002	188	18	I	2.	320.	71.91	80.93	YES	4.50	2.0	10.45	99.2
2003	195	21	I	1.	201.	71.89	80.91	YES	2.00	1.1	12.70	99.6
2004	191	26	I	2.	78.	71.90	80.85	YES	3.50	1.6	10.89	99.4
2005	189	16	I	2.	300.	71.91	80.94	YES	10.75	3.8	8.49	98.4
2006	194	15	I	3.	254.	71.89	80.97	YES	3.25	2.6	19.45	97.3
2007	173	36	I	9.	37.	71.96	80.74	YES	13.75	8.8	15.41	94.7
2008	189	27	I	2.	59.	71.91	80.84	YES	2.50	2.3	22.14	93.0
2009	193	26	I	2.	104.	71.89	80.85	YES	2.25	1.6	17.00	98.3

Baffinland Milne Port SPILL BEGINS AT 0000 HRS, 30 SEPTEMBER

YEAR	ROW	COL	ORI	END POSITION RANGE KM	BEARING DEG. T	LAT NORTH	LONG WEST	ASHORE?	ELAPSED TIME HOURS	PATH LENGTH KM	MEAN SPEED KM/DAY	% AT ENDPT
1980	193	26	I	2.	104.	71.89	80.85	YES	2.00	1.7	20.41	98.3
1981	195	15	I	3.	246.	71.89	80.97	YES	4.50	2.7	14.62	98.6
1982	192	26	I	2.	94.	71.89	80.85	YES	1.50	1.5	24.70	95.8
1983	195	15	I	3.	248.	71.89	80.97	YES	4.25	2.6	14.62	98.4
1984	190	16	I	2.	286.	71.90	80.96	YES	4.50	2.1	11.26	99.2
1985	191	26	I	2.	72.	71.90	80.85	YES	2.25	1.6	17.14	98.7
1986	189	16	I	2.	297.	71.90	80.96	YES	8.00	2.3	6.88	98.9
1987	194	24	I	1.	128.	71.89	80.88	YES	1.75	1.0	13.05	99.7
1988	192	26	I	2.	90.	71.90	80.85	YES	16.50	3.1	4.44	97.9
1989	194	23	I	1.	150.	71.89	80.89	YES	1.00	0.7	17.54	99.2
1990	188	18	I	2.	312.	71.91	80.94	YES	5.75	2.1	8.59	99.1
1991	194	25	I	1.	118.	71.89	80.87	YES	1.50	1.3	20.06	98.8
1992	189	27	I	2.	60.	71.90	80.84	YES	9.75	2.8	6.78	98.7
1993	189	27	I	2.	57.	71.91	80.84	YES	4.00	2.3	14.06	99.0
1994	194	22	I	1.	164.	71.89	80.89	YES	1.00	0.7	17.54	99.2
1995	192	26	I	2.	90.	71.89	80.91	YES	2.25	1.5	16.03	99.4
1996	194	15	I	3.	253.	71.89	80.97	YES	1.75	2.5	34.78	90.7
1997	194	24	I	1.	130.	71.89	80.87	YES	1.00	1.1	26.61	97.2
1998	192	15	I	2.	269.	71.89	80.94	YES	3.75	2.4	15.48	99.0
1999	191	26	I	2.	84.	71.90	80.85	YES	2.00	1.7	20.26	98.3
2000	192	26	I	2.	96.	71.89	80.85	YES	3.25	1.5	11.19	99.4
2001	188	17	I	2.	310.	71.91	80.95	YES	2.00	2.2	26.46	94.4
2002	195	18	I	2.	235.	71.89	80.94	YES	4.75	1.7	8.50	99.3
2003	194	23	I	1.	138.	71.89	80.88	YES	1.25	0.9	17.72	99.0
2004	195	20	I	1.	217.	71.89	80.92	YES	3.00	1.2	9.58	99.5
2005	189	16	I	2.	295.	71.90	80.96	YES	2.50	2.3	21.89	94.0
2006	195	17	I	2.	241.	71.89	80.95	YES	2.00	1.9	23.28	94.4
2007	185	22	I	2.	2.	71.92	80.90	YES	6.50	2.6	9.61	98.8
2008	194	22	I	1.	161.	71.89	80.89	YES	1.00	0.7	17.24	99.2
2009	194	25	I	1.	116.	71.89	80.86	YES	1.75	1.3	17.71	98.6

SEPTEMBER SHORE IMPACT STATISTICS FOR Milne Port Area

POSITION ROW	COL	ORI	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
183	25	I	4	88.	98.	93.50	3.75	18.00	8.31
183	31	I	4	80.	97.	85.75	3.75	14.75	6.81
183	32	I	1	94.	94.	94.00	25.50	25.50	25.50
184	23	I	7	87.	98.	94.86	2.50	10.50	5.86
184	24	I	11	86.	98.	93.45	1.75	14.75	5.45
184	31	I	7	80.	98.	93.00	3.75	8.75	6.71
185	22	I	18	97.	99.	98.00	3.00	14.25	6.51
185	31	I	5	86.	98.	94.80	4.75	8.25	6.45
186	19	I	2	99.	99.	99.00	4.00	4.00	4.00
186	20	I	11	93.	99.	97.27	2.25	10.25	6.07
186	21	I	15	93.	99.	97.67	2.00	16.50	6.88
187	18	I	1	93.	93.	93.00	2.25	2.25	2.25
187	19	I	23	90.	99.	97.39	1.25	19.75	4.87
187	30	I	3	96.	98.	97.33	9.25	27.00	15.42
188	17	I	13	93.	99.	97.31	2.00	11.25	5.06
188	18	I	26	92.	99.	97.27	1.25	25.25	5.00
188	29	I	2	96.	96.	96.00	20.75	27.75	24.25
189	16	I	24	89.	99.	97.08	1.75	16.00	5.38
189	27	I	19	93.	99.	96.26	2.25	9.75	4.00
189	28	I	1	97.	97.	97.00	20.75	20.75	20.75
190	16	I	15	89.	99.	94.80	1.50	21.00	3.85
190	27	I	14	90.	99.	96.86	1.75	21.50	5.48
191	15	I	1	90.	90.	90.00	1.75	1.75	1.75
191	16	I	21	93.	99.	96.86	1.25	10.75	4.05
191	26	I	36	93.	99.	97.92	1.25	51.00	5.11
191	27	I	1	98.	98.	98.00	10.75	10.75	10.75
192	15	I	31	89.	99.	95.65	1.00	21.25	4.33
192	26	I	35	93.	99.	97.34	1.00	16.50	3.31
193	14	I	1	93.	93.	93.00	1.25	1.25	1.25
193	15	I	26	89.	99.	96.54	1.75	17.75	4.32
193	26	I	62	92.	99.	96.81	1.00	52.50	3.77
194	15	I	17	88.	99.	95.35	1.75	13.00	4.34
194	22	I	93	94.	99.	98.40	0.50	19.75	2.50
194	23	I	86	96.	99.	98.27	0.50	10.00	1.59
194	24	I	62	94.	99.	97.60	0.75	10.75	1.81
194	25	I	43	93.	99.	96.86	0.75	7.00	1.95

194	26	I	15	92.	99.	96.07	1.00	10.25	2.58
195	15	I	18	88.	99.	95.78	1.75	27.25	7.13
195	17	I	16	92.	99.	96.88	1.25	12.00	4.83
195	18	I	12	92.	99.	97.33	1.00	14.50	4.19
195	19	I	18	93.	99.	97.83	1.25	9.75	3.31
195	20	I	33	94.	99.	98.03	1.00	32.25	5.42
195	21	I	16	94.	99.	98.19	1.00	8.75	2.56
195	22	I	1	98.	98.	98.00	8.75	8.75	8.75

SEPTEMBER SHORE IMPACT STATISTICS FOR Cape Kwaunang

POSITION ROW	COL	ORI	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
165	35	I	1	91.	91.	91.00	18.75	18.75	18.75
167	35	I	2	89.	93.	91.00	17.00	21.00	19.00
169	36	I	1	85.	85.	85.00	13.00	13.00	13.00
172	29	I	1	95.	95.	95.00	15.50	15.50	15.50
173	36	I	4	65.	94.	83.50	7.50	13.75	11.69
174	36	I	6	75.	96.	86.17	8.50	15.50	11.00
175	36	I	1	73.	73.	73.00	7.75	7.75	7.75
176	27	I	1	97.	97.	97.00	13.00	13.00	13.00
176	36	I	1	93.	93.	93.00	11.50	11.50	11.50
177	36	I	2	66.	73.	69.50	5.00	6.25	5.63
178	36	I	3	81.	97.	91.33	16.00	23.25	19.17
180	35	I	1	92.	92.	92.00	25.25	25.25	25.25
182	26	I	3	95.	97.	96.00	4.75	7.75	6.08

SEPTEMBER SHORE IMPACT STATISTICS FOR Koluktoo Bay

POSITION ROW	COL	ORI	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
160	29	I	1	69.	69.	69.00	15.25	15.25	15.25

SEPTEMBER SHORE IMPACT STATISTICS FOR Bruce Head

POSITION ROW	COL	ORI	NUMBER IMPACTS	MIN. VOL. PER CENT	MAX. VOL. PER CENT	MEAN VOL. PER CENT	EARLIEST TIME (HR)	LATEST TIME (HR)	MEAN TIME (HR)
140	52	I	1	48.	48.	48.00	27.75	27.75	27.75
140	53	I	1	41.	41.	41.00	24.25	24.25	24.25