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# Simulation of Sediment Transport and Deposition from Cable Burial Operations for the Alternative Site of the Cape Wind Energy Project

**ASA Final Report 05-128** **August 2006**

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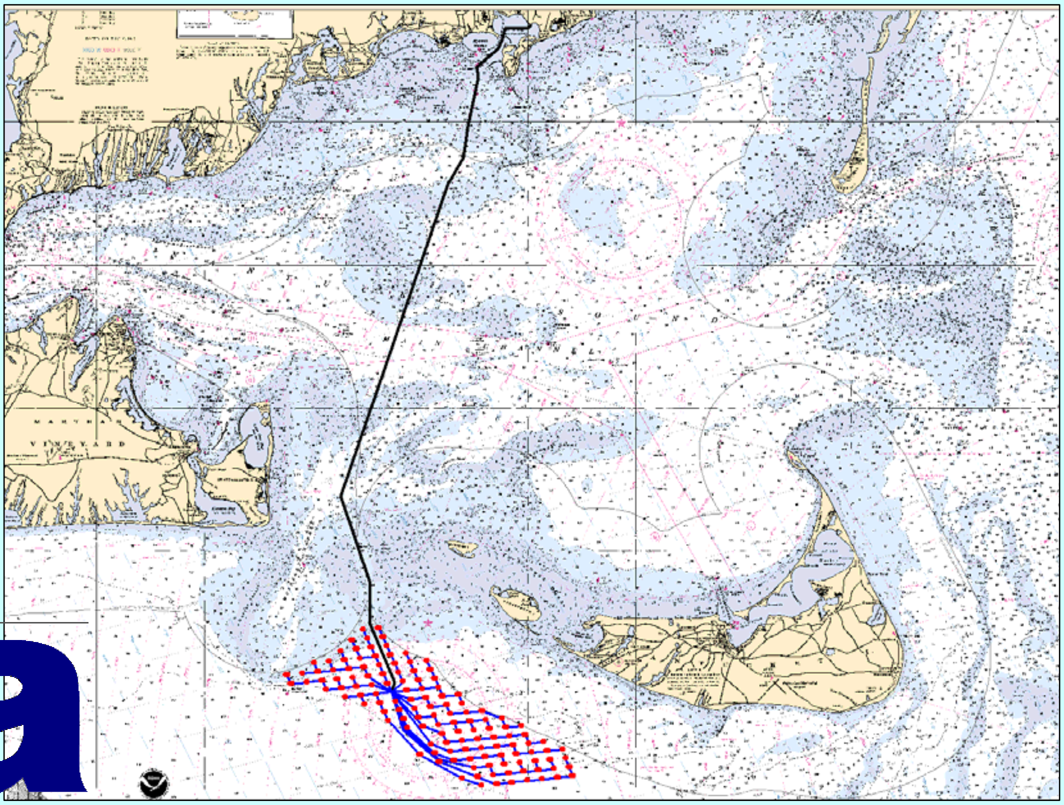

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# Executive Summary

Cape Wind Energy, LLC has proposed to build a wind turbine farm on Horseshoe Shoal in Nantucket Sound. This site has been evaluated in a previous study (Swanson and Isaji, 2005). An alternative site, 9 km (5.6 mi) southwest of Tucknernuck Island, is also being evaluated for the purposes of comparison and is the subject of this report. The project will consist of 130 wind turbine generators (WTG), an electric service platform (ESP) and a series of cables connecting the WTGs to the ESP and a pair of cables from the ESP to shore at Yarmouth. The cables are to be buried using a jetting technique whereby pressurized seawater is jetted below the seabed to fluidize the sediments along the cable route. The cable then sinks of its own weight through the fluidized sediments and is buried as the sediment returns to its pre jetted condition.

Questons have been raised during regulatory agency review concerning the environmental effects of the suspended sediment injected into the water column above the cable route during the jetting process. Specifically, questions concerning the concentration of suspended sediment and the subsequent deposition on the seabed as well as the spatial extent and duration that these processes last have been raised.

Cape Wind Energy, LLC contracted with Applied Science Associates, Inc. to perform a modeling study to estimate the resulting suspended sediment and deposition from the cable burial process for the cables connecting the WTGs to the ESP at the alternative site. The study used two models: HYDROMAP to calculate currents, and SSFATE to calculate suspended sediments in the water column and bottom deposition resulting from jetting operations.

The HYDROMAP model was applied to the area offshore Massachusetts and Rhode Island using its variable grid size capability to provide model predictions of sufficient resolution for use in the subsequent sediment transport calculation. Details of this application were reported in the analysis of the primary site on Horseshoe Shoal (Swanson and Isaji, 2005).

The SSFATE model was used to simulate jetting operations for burial of representative cables in trenches. Assumptions based on project estimates and past studies included a trench cross section of 3.0 $m^2$ (32 $ft^2$), a trenching speed of 91 m/hr (300 ft/hr) and that 30% of the trench volume was injected into the water column (Swanson and Isaji, 2005). Based on available data for the area, an equal mix of fine and coarse sand was used to characterize the sediment.

SSFATE was applied to four representative 33kV cable routes connecting the WTGs to the ESP. The 115kV cable route extension south from Horsehoe Shoal (the primary site) was not modeled since the primary site modeling already simulated the portion from Yarmouth to the shoal and is considered representative of the entire route. These 33kV routes showed similar deposition patterns with small deposition thicknesses of 1 to 5 mm (0.04 to 0.2 in) occurring within a few hundred meters (few hundred yards) of the cable route with larger thicknesses up 20 mm (0.8 in) adjacent to the route. The water column concentrations were typically less than 50 mg/L with some areas on the cable route peaking at 500 mg/L but restricted to the bottom layer. Concentration levels of 100 mg/L typically lasted less than 2 hrs with one small area on the route lasting up to 6 hrs.

In general the deposition of sediments resuspended by jetting operations will be minimal when compared to the active bed load sediment transport known to exist in the adjacent Nantucket Sound (45 to 71 mg/L [USACE, 2004]). These small deposition patterns would not be expected to remain in this dynamic environment where tidal currents reach 0.5 m/s (1 kt) and storm currents would add additional energy.  Water column concentrations due to jetting are restricted to the bottom layer and typically last for a few hours before returning to ambient conditions.

The SSFATE results for the alternative site are similar to that for the primary site at Horseshoe Shoal.  The depositon thicknesses are slightly smaller and water column concentrations are slightly lower for the alternative site because the grain size of the sediments at this site are slightly larger.

# Table of Contents

Executive Summary .......... i

Table of Contents .......... iii

List of Figures .......... iv

List of Tables .......... v

1 Introduction .......... 1

2 Description of the Study Area and Project .......... 2

3 HYDROMAP Hydrodynamic Model .......... 4

- 3.1 HYDROMAP Application .......... 4
- 3.2 HYDROMAP Model Results .......... 5

4 SSFATE Sediment Transport Model .......... 7

- 4.1 SSFATE Application .......... 7
- 4.2 SSFATE Model Results .......... 8

5 Conclusions .......... 19

6 References .......... 20

# List of Figures

Figure 2.1 Location of alternate wind farm site southwest of Tuckernuck Island showing WTGs as red circles, WTG connecting cables as thin blue lines and main power cable to shore as thick black line. Horseshoe Shoal, the primary wind farm location, is also shown. ........ 3
Figure 3.1 Hydrodynamic model grid cells for entire HYDROMAP domain........ 4
Figure 3.2 Hydrodynamic model grid depths for entire HYDROMAP domain. ........ 5
Figure 3.3 M2 flood vectors at alternative wind farm site. Scale of vectors shown in upper left corner as 1 kt (0.5 m/s). ........ 6
Figure 3.4 M2 ebb vectors at alternative wind farm site. Scale of vectors shown in upper left corner as 1 kt (0.5 m/s). ........ 6
Figure 4.1 Location of surface sediment samples used to characterize sediment grain sizes for 33kV cable routes. Green diamonds represent medium sand and red diamonds represent fine sand. ........ 8
Figure 4.2 Four representative 33kV cable paths (legs) chosen for analysis are highlighted in red. Other 33kv cable paths are shown in gray. Southern end of the main 115kV cable path is shown in blue. ........ 9
Figure 4.3 Model results of bottom deposition from cable jetting operations along a 33kV cable route from the ESP to the southwest. ........ 11
Figure 4.4 Model results of maximum extent of suspended sediment water column concentrations from cable jetting operations along a 33kV cable route from the ESP to the southwest. ........ 11
Figure 4.5 Model results of duration of 10 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the southwest. ........ 12
Figure 4.6 Model results of duration of 100 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the southwest. ........ 12
Figure 4.7 Model results of bottom deposition from cable jetting operations along a 33kV cable route from the ESP to the southeast. ........ 13
Figure 4.8 Model results of maximum extent of suspended sediment water column concentrations from cable jetting operations along a 33kV cable route from the ESP to the southeast. ........ 13
Figure 4.9 Model results of duration of 10 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the southeast. ........ 14
Figure 4.10 Model results of duration of 100 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the southeast. ........ 14
Figure 4.11 Model results of bottom deposition from cable jetting operations along a 33kV cable route from the ESP to the east. ........ 15
Figure 4.12 Model results of maximum extent of suspended sediment water column concentrations from cable jetting operations along a 33kV cable route from the ESP to the east. ........ 15
Figure 4.13 Model results of duration of 10 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the east. ........ 16
Figure 4.14 Model results of duration of 100 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the east. ........ 16

Figure 4.15 Model results of bottom deposition from cable jetting operations along a 33kV cable route from the ESP to the northwest. .................................. 17
Figure 4.16 Model results of maximum extent of suspended sediment water column concentrations from cable jetting operations along a 33kV cable route from the ESP to the northwest. ............................................................ 17
Figure 4.17 Model results of duration of 10 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the northwest. ..................................................... 18
Figure 4.18 Model results of duration of 100 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the northwest. ..................................................... 18

# List of Tables

Table 4.1 Sediment class sizes used in SSFATE. ......................................................... 7

# 1 Introduction

Cape Wind Energy, LLC has proposed to build a wind turbine farm on Horseshoe Shoal in Nantucket Sound. This site has been evaluated in a previous study (Swanson and Isaji, 2005). An alternative site, 9 km (5.6 mi) southwest of Tuckernuck Island, is also being evaluated for purposes of comparison and is the subject of this report. The project will consist of 130 wind turbine generators (WTG), an electric service platform (ESP) and a series of cables connecting the WTGs to the ESP and a pair of cables from the ESP to shore at Yarmouth. The cables are to be buried using a jetting technique whereby pressurized seawater is jetted below the seabed to fluidize the sediments along the cable route. The cable then sinks of its own weight through the fluidized sediments and is buried as the sediment returns to its pre jetted condition.

Questons have been raised during regulatory agency review concerning the environmental effects of the suspended sediment injected into the water column above the cable route during the jetting process. Specifically, questions concerning the concentration of suspended sediment and the subsequent deposition on the seabed as well as the spatial extent and duration that these processes last have been raised.

Cape Wind Energy, LLC contracted with Applied Science Associates, Inc. to perform an analysis to estimate the resulting suspended sediment and deposition from the cable burial process for both the primary and alternate sites. ASA developed in conjunction with the U.S. Army Corps of Engineers a modeling tool, SSFATE that can be used to simulate these processes from dredging activities. ASA subsequently modified the model to simulate the effects of the jetting process as well. The use of SSFATE requires information on the currents in the area, the sediment characteristics and the amount of sediment injected into the water column. SSFATE modeling results have been reviewed and accepted by regulatory agencies in Connecticut and New York and the USACE in connection with permit authorizations for similar submarine cable installation projects.

Currents were simulated by another ASA model, HYDROMAP, which calculates velocity vectors on a stepwise continuous variable rectangular grid system. The model allows coarse grid resolution in the areas offshore the coasts of Massachusetts and Rhode Island and finer resolution in Nantucket Sound. The model predicts water surface elevation and currents that are used directly by SSFATE.

This report documents the model applications and predictions of the extent and thickness of the deposition patterns and suspended sediment concentrations resulting from the jet plow operations at the alternative site. Section 1 presents the introduction to the study. Section 2 describes the study area and project, Section 3 presents the HYDROMAP model, application and results used to simulate currents, Section 4 presents the SSFATE model, application and results used to simulate sediment transport and deposition. Section 5 provides conclusions from the study and Section 6 lists references.

# 2 Description of the Study Area and Project

The proposed primary wind energy project site is to be located on Horseshoe Shoal in Nantucket Sound (Figure 2.1). Details of the analysis of that site are presented in Swanson and Isaji (2005). The alternative site, the subject of the analysis in this report, is located 9 km (5.6 mi) southwest of Tuckernuck Island, which is located just west of Nantucket Island (Figure 2.1). The site lies just outside of Nantucket Sound to the south in the Atlantic Ocean. The depths relative to Mean Lower Low Water (MLLW) range from 3.6 m (12 ft) to 27 m (90 ft) at the site based on NOAA Chart 13237.

The Wind Park at the alternative location south of Tuckernuck Island will consist of 130 wind turbine generators (WTG), an electric service platform (ESP) and a series of cables connecting the WTGs to the ESP and two cable circuits from the ESP to a landfall in Yarmouth on Cape Cod (Figure 2.1). The turbines will be located in an array designed to maximize energy production. Each WTG is mounted on a monopile or a quad-caisson, consisting of four piles, driven into the seabed. The monopile is between 5.1 and 5.5 m (16.75 and 18 ft) in diameter at the MLLW water line. The smaller diameter will be used in water depths from 3.6 to 12 m (12 to 39 ft) MLLW while the larger diameter will be used between depths of 12.2 to 15.2 m (40 to 50 ft). The quad-caisson consists of four piles 7.5 m (24.6 ft) in diameter tied together with cross members and connected to the tower supporting the WTG. The quad-caisson piles are located on the corners of a square 29 m (95 ft) on a side measured from the centerline of each pile. The quad-caisson design will be used in water depths from 15.2 to 27 m (50 to 90 ft). The spacing between the WTGs is approximately 0.63 km (0.34 nm) in the generally north / south direction and 1 km (0.54 nm) in the generally east / west direction.

The ESP is located near the center of the WTG array and is the termination point of all the 33kV cables from the WTGs and the two 115kV cables from shore. Water depth at the site is 28 m (78 ft) MLLW. The cables connecting the WTGs to the ESP vary in diameter from 132 mm (5.2 in) to 164 mm (6.5 in) depending on the number of WTGs to which they are connected (up to 10) and are rated at 33kV.

The cables are to be buried to a minimum depth of 1.8 m (6 ft) below present bottom using a jetting technique whereby pressurized seawater is jetted into the seabed to fluidize the sediments along the cable route. The cable then sinks of its own weight through the fluidized sediments and is buried as the sediment returns to its pre-jetted condition. It is estimated that the fluidized trench created by the jetting process is approximately 1.8 m (6 ft) wide at the seabed, 2.4 m (8 ft) deep and 0.6 m (2 ft) wide at the bottom. The jetting equipment moves at approximately 91 m/hr (300 ft/hr).

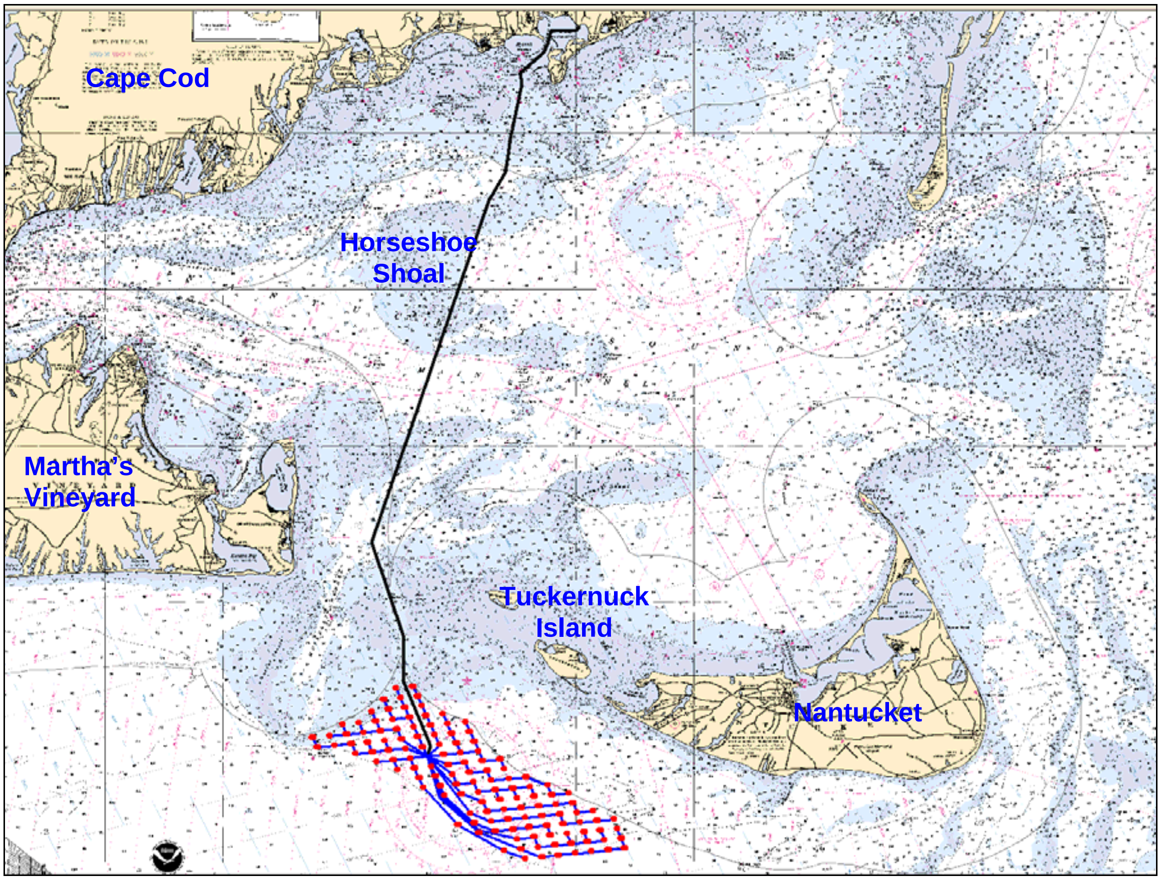

**Figure 2.1 Location of alternate wind farm site southwest of Tuckernuck Island showing WTGs as red circles, WTG connecting cables as thin blue lines and main power cable to shore as thick black line. Horseshoe Shoal, the primary wind farm location, is also shown.**

# 3 HYDROMAP Hydrodynamic Model

HYDROMAP is a globally re-locatable hydrodynamic model (Isaji, et al., 2001) capable of simulating complex circulation patterns due to tidal forcing, wind stress and fresh water flows quickly and efficiently anywhere on the globe. Description of the model and details of its application to the southern New England coastal waters, as part of the analysis of the primary location, Horseshoe Shoal within Nantucket Sound, is found in Swanson and Isaji (2005).

## 3.1 HYDROMAP Application

The southern New England coastal area is a complex topographic and bathymetric area which results in a complex current velocity structure. In order to account for this complexity the hydrodynamic model domain extended to deep waters (~200 m [660 ft]) in the south and east directions, to Block Island in the west direction and to the north end of Massachusetts Bay in the north direction. Figure 3.1 shows the computational model grid cells for the entire domain. At the open boundary and in the outer regions, a maximum cell size of ~2.5km (~1.6 mi) was assigned. Cell resolution was gradually increased toward Nantucket Sound, based on the primary site on Horseshoe Shoal, where a uniform cell size of 315 m (~1,030 ft) was employed. The alternative site south of Tuckernuck Island has a slightly larger cell size of 630 m (2060 ft), but adequate to represent the currents in that area.

The bathymetry data used in the model grid was assembled from various sources: survey data (supplied by Cape Wind Associates), the hydrographic survey data CD-ROM Set (NGDC 1998), and ETOPO2 (NGDC 2001). Figure 3.2 shows the bathymetry used in the model.

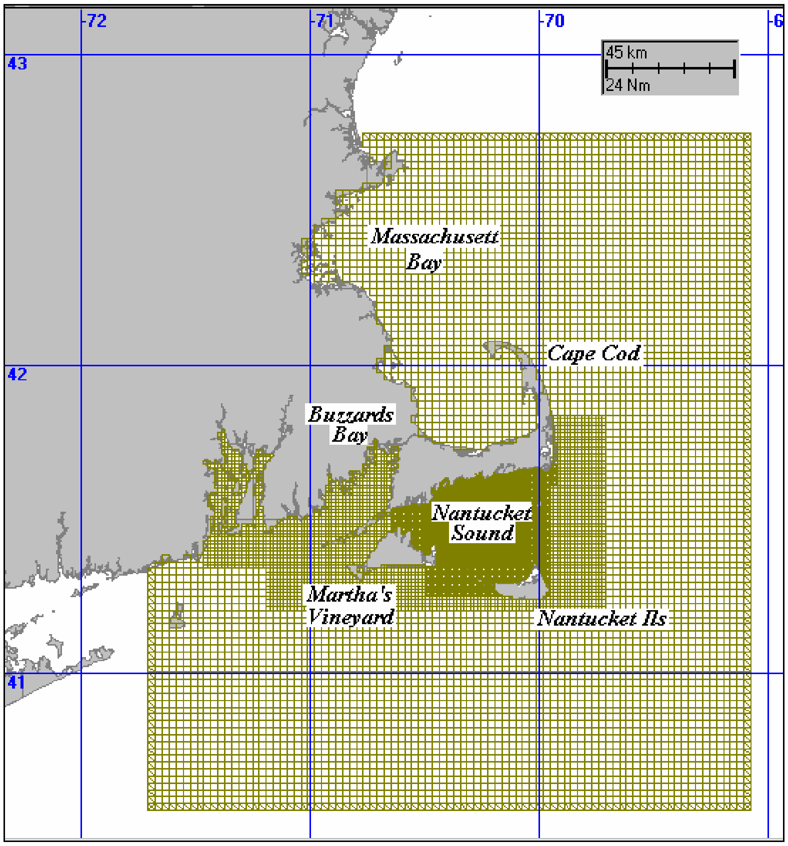

**Figure 3.1 Hydrodynamic model grid cells for entire HYDROMAP domain.**

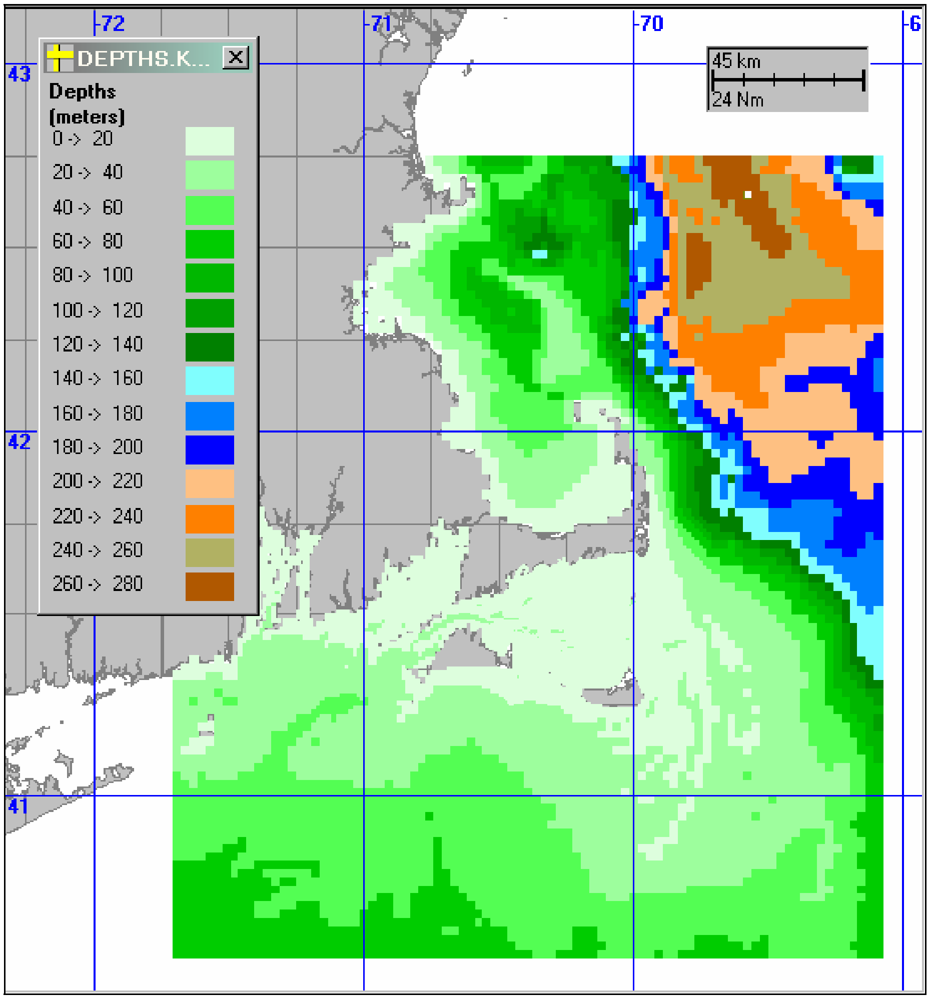

**Figure 3.2 Hydrodynamic model grid depths for entire HYDROMAP domain.**

## 3.2 HYDROMAP Model Results

The HYDROMAP model was successfully calibrated based on a comparison of multiple tidal constituents at various locations around Nantucket Sound. Details of the calibration process are found in Swanson and Isaji (2005). The model results are consistent with the data from MVCO.

Figures 3.3 and 3.4 show the predicted M2 tidal flood and ebb currents in the alternative site area, respectively. Currents flow primarily northward on flood and southward on ebb on the shallow areas just north of the alternative site. Highest speeds, (~0.5 m/s [~1 kt]) occur at the northwestern portion of the alternative wind farm site. Currents at the alternative wind farm site, located in deeper water, flow generally to the northeast or east at ~0.25 m/s (~0.5 kt) on flood and south or southwest at ~0.20 m/s (~0.4 kt) on ebb. The large variation in depths below the alternative wind farm site is clearly seen in these figures.

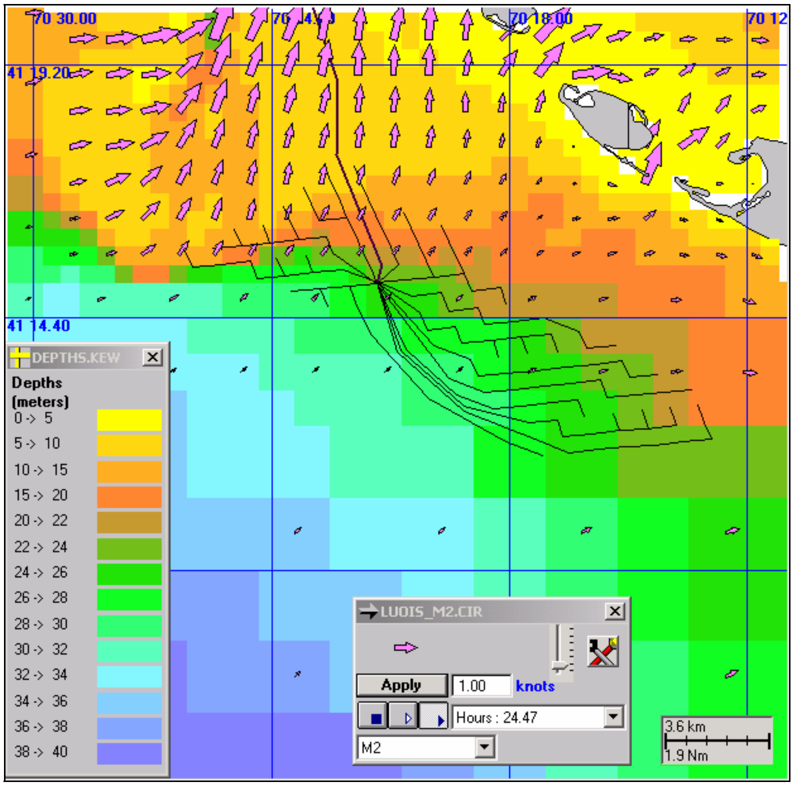

**Figure 3.3 M2 flood vectors at alternative wind farm site. Scale of vectors shown in upper left corner as 1 kt (0.5 m/s).**

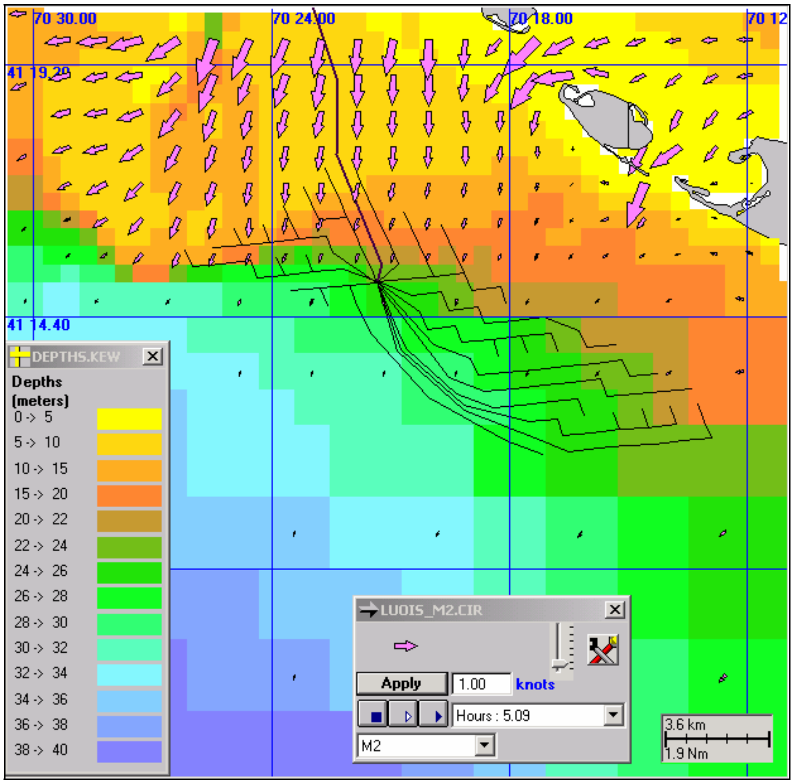

**Figure 3.4 M2 ebb vectors at alternative wind farm site. Scale of vectors shown in upper left corner as 1 kt (0.5 m/s).**

# 4 SSFATE Sediment Transport Model

To simulate the sediment suspension and deposition from the jet plow operations, SSFATE, a model jointly developed by ASA and the U.S. Army Corps of Engineers (USACE) Environmental Research and Development Center (ERDC) was used (Johnson et al., 2000; Swanson et al., 2000). Although originally developed to simulate dredging operations it has been modified by ASA to simulate the jetting process as well. Description of the model and details of its application to the southern New England coastal waters, as part of the analysis of the primary location, Horseshoe Shoal within Nantucket Sound, is found in Swanson and Isaji (2005).

## 4.1 SSFATE Application

The source strength is defined as the time rate of sediment that is injected into the water column from the jetting process. It is defined as the fraction of the cross sectional area of the trench times the forward speed of the jet as it moves along the trench. The cross sectional area determined from the dimensions given in Section 2 is 3.0 $m^2$ (32 $ft^2$). The jetting device was modeled to travel at 300 ft/hr (91 m/hr) along the cable path. Based on past studies of jetting it was assumed that 30% of the total sediment volume fluidized within the trench was distributed vertically through the overlying water column by the jetting device. The remaining 70% of the sediment was assumed to remain within the limits of the trench during the burial process. This resulted in 0.28 $m^3$ (0.36 $yd^3$) of suspended sediment injected into the water column along every 0.3 m (1 ft) of the cable route simulated.

One of the major factors that control suspended sediment concentration in the water column is how fast the sediment settles out to the seabed. In general, coarser materials have higher settling velocities and finer sediments (0-75 micron, clay and silt) take longer to settle out. The actual settling rate for each material class is a function of the concentration of other material classes (Teeter, 1998). In the SSFATE model, the sediment distribution is represented with five distinct size classes outlined below in Table 4.1.

**Table 4.1 Sediment class sizes used in SSFATE.**

| Class | Size | Name |
|---|---|---|
| 1 | 0-7 micron | Clay |
| 2 | 8-35 | Fine silt |
| 3 | 36-74 | Coarse silt |
| 4 | 75-130 | Fine sand |
| 5 | >130 | Coarse sand |

The Coastal and Marine Geology Program of the U.S. Geological Survey (Poppe et al., 2003) compiled surficial sediment data on the sea floor off the northeastern U.S., including the northern portion of the alternative wind farm site. These data contain information on sediment grain size and lithology. Most of the sediment data in the report are broken into data layers by their original source project. In the case of the data falling within the footprint of the site, the Smithsonian Institution is the source project. These data were abstracted from materials submitted to the Smithsonian by various groups and individuals.

The data locations are shown in Figure 4.1 along with the cable routes. The four red triangles indicate findings of fine sand and the 12 green triangles indicate medium sand. Since this description of grain size distribution is less than the detail that is used in the SSFATE model and since the coverage of sediment samples covers only a portion of the wind farm footprint, it was decided to assume that 50% of the sediment is fine sand and the other 50% is coarse sand over the entire area. It is also assumed that these surface samples are representative of the upper 2.4 m (8 ft) which is affected by the jetting process.

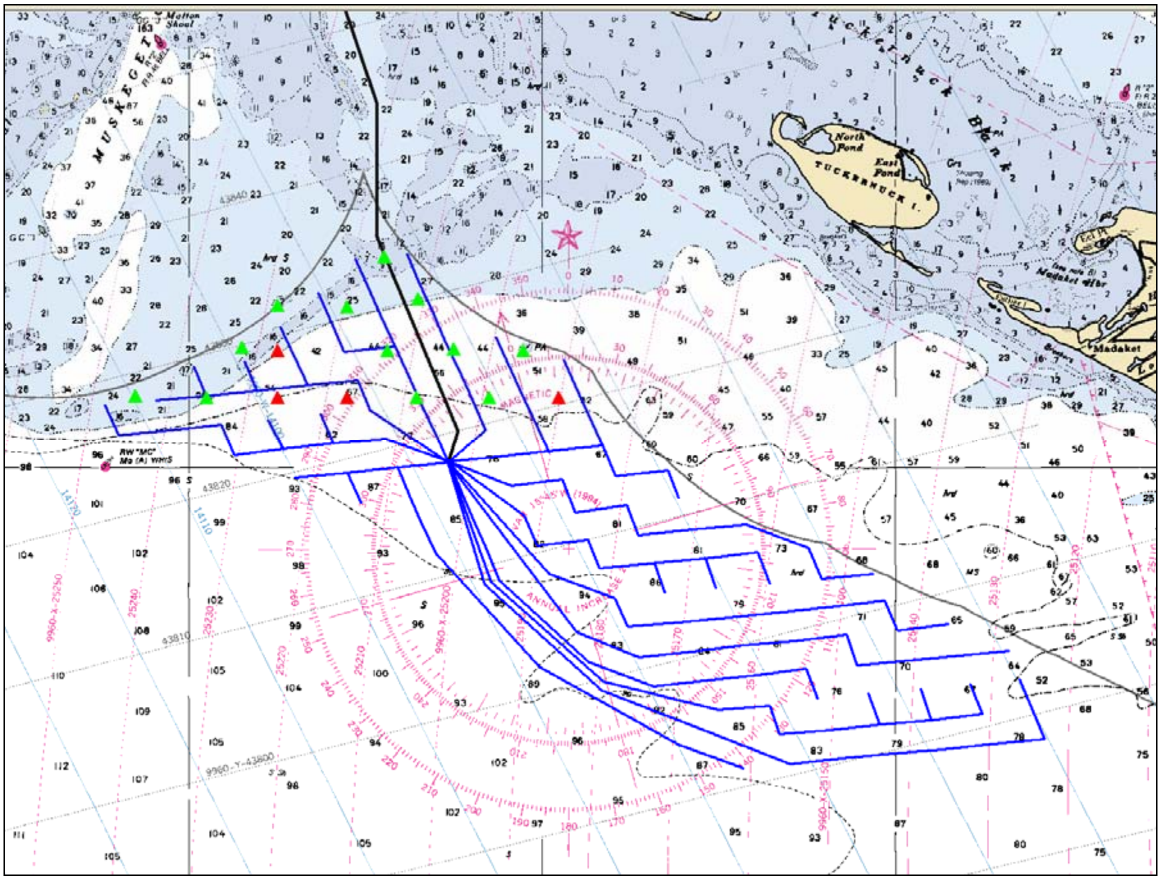

**Figure 4.1 Location of surface sediment samples used to characterize sediment grain sizes for 33kV cable routes. Green diamonds represent medium sand and red diamonds represent fine sand.**

## 4.2 SSFATE Model Results

The SSFATE model was run for four 33kV cable paths from the ESP to their respective ends (Figure 4.2). These legs are labeled as NW, SW, SE and NE. The routes were chosen to be representative of the burial of the cable connecting the wind turbine generators. The other figures in this section have been generated at different scales from Figure 4.2 to maximize the detail shown.

The extension of the 115kV cable path from Horseshoe Shoal to the alternative site ESP was not modeled because the general nature of the results modeled in the primary site report (Swanson and Isaji, 2005) are representative for the extension.

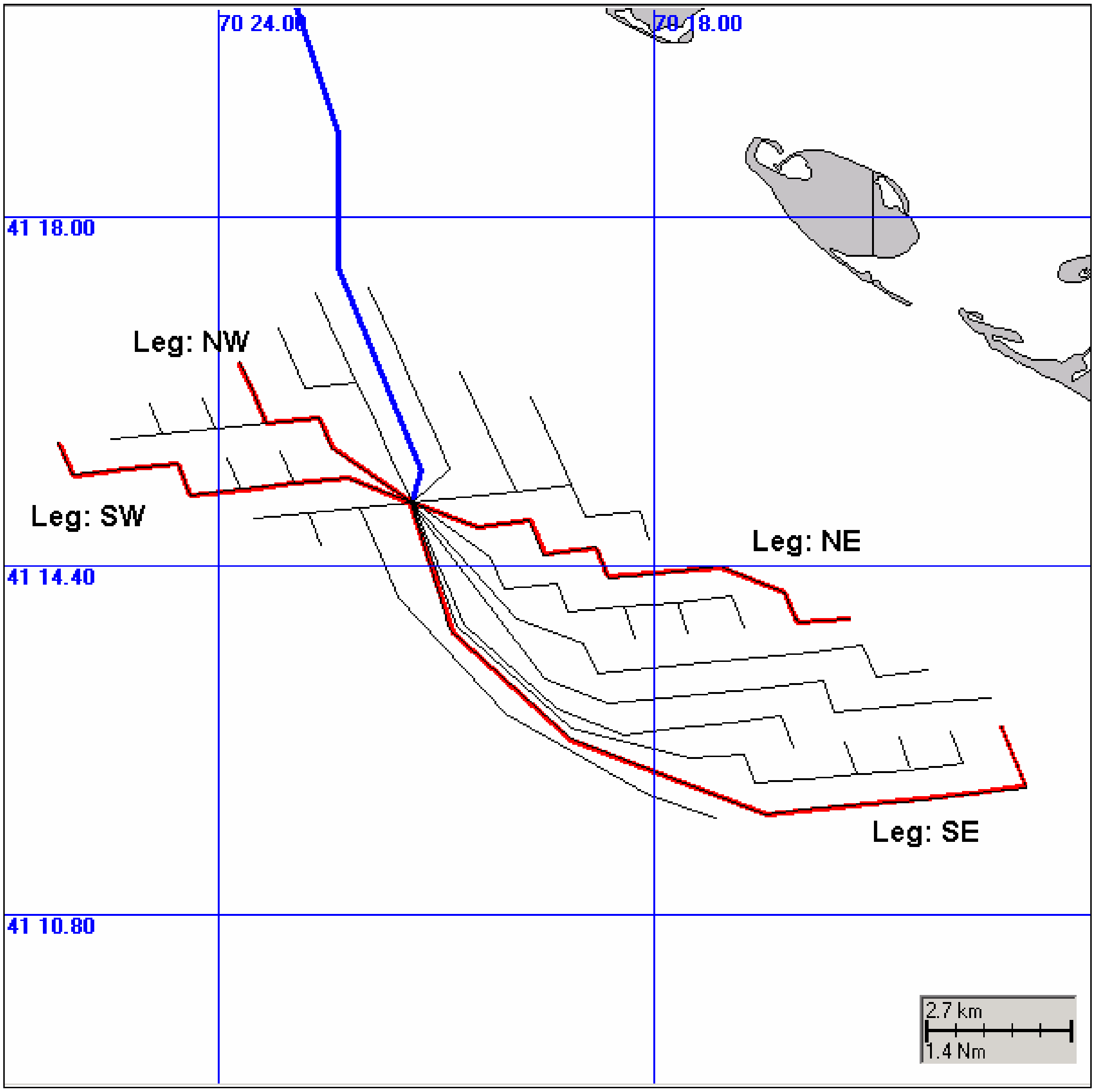

**Figure 4.2 Four representative 33kV cable paths (legs) chosen for analysis are highlighted in red. Other 33kv cable paths are shown in gray. Southern end of the main 115kV cable path is shown in blue.**

Figure 4.3 shows the deposition pattern predicted from jetting along a 33kV route from the ESP to the west (Leg SW in Figure 4.2). The results show that the sediments generally fall along the route due to the sand sized particles. The slight oscillations around the line are due to the effects of the tides transporting the sediment slightly away from the route. The actual location of these oscillations (but not the shape) will change since they are determined by the relationship between the time of the tide and the jetting start time. Generally the thickness ranges between 1 and 5 mm (0.04 and 0.20 in) (green and yellow) with local areas up to 10 mm (0.4 in) (red) and a few small locations up to 20 mm (0.8 in) (pink). These higher deposition areas occur when the tidal currents are at slack. Relatively narrow bands between 0.5 and 1 mm (0.02 and 0.04 in) thick are deposited on the fringes of the patterns.

Figure 4.4 shows the maximum extent of suspended sediment water column concentrations for the entire simulation resulting from jetting along the 33kV route from the ESP to the west (Leg SW. Here the tidal currents which are generally oriented north northeast / south southwest transport water column concentrations away from the route. The plume is color coded according to concentration with most levels below 50 mg/L and located near the bottom as shown in the lower panel. It is important to note that the concentration levels are short lived due to the tides flushing the plume away from the jetting equipment and the sediments settling out from the lower water column. To put the water column concentrations in perspective, Figure 4.5 shows the duration that a 10 mg/L excess (above background) suspended sediment concentration is seen. Most of the area shows a duration of less than 3 hrs with higher concentrations centered on locations of slack water. Figure 4.6 shows the duration of 100 mg/L concentration levels. Most of the area shows durations less than 2 hrs with some slack water locations reaching 4 to 5 hrs. These elevated concentrations are restricted to the near bottom (see vertical section panel at bottom of Figure 4.4).

Figure 4.7 shows the deposition pattern predicted from jetting along a 33kV route from the ESP to the southeast (Leg SE in Figure 4.2). The results are similar to those shown in Figure 4.3 with peak deposition up to 20 mm (0.8 in) during slack tide. Figure 4.8 shows the maximum extent of suspended sediment water column concentrations for this case. The effect of a more east / west current direction in seen in the patterns. Peak concentrations exceed 500 mg/L along the cable route near the bottom (see vertical section panel in lower left of figure), but most concentrations are below 50 mg/L. Figure 4.9 shows the duration where a 10 mg/L excess (above background) suspended sediment concentration is seen. Most of the area shows a duration of less than 3 hrs with portions up to 9 hrs during slack water conditions. Figure 4.10 shows the duration of 100 mg/L concentration levels. Most of the area shows duration less than 2 hrs with some areas showing duration up to 5 hrs. These elevated concentrations are restricted to the near bottom layer.

Figure 4.11 shows the deposition pattern predicted from jetting along a 33kV route from the ESP to the east (Leg NE in Figure 4.2). The results are similar to those shown in Figures 4.3 and 4.7. Some areas show up to 20 mm (0.08 in) deposition during slack water. Figure 4.12 shows the maximum extent of suspended sediment water column concentrations for this case which is similar to Figure 4.8, with elevated concentrations restricted to the bottom layer. Peak concentrations exceed 500 mg/L along the route (near the bottom). Figure 4.13 shows the duration for a 10 mg/L excess (above background) suspended sediment concentration. Most of the area shows a duration of less than 3 hrs with some sites up to 12 hrs at slack water. Figure 4.14 shows the duration of 100 mg/L concentration levels. Most of the area shows duration less than two 2 hrs with some sites showing duration to 6 hrs.

Figure 4.15 shows the deposition pattern predicted from jetting along a 33kV route from the ESP to the northwest (Leg NW in Figure 4.2). The results are somewhat less than those for the other directions with some sites along the route showing up to 10 mm (0.04 in) deposition during slack water. Figure 4.16 shows the maximum extent of suspended sediment water column concentrations for this case again with elevated concentrations only in the bottom layer. The areas are slightly larger due to higher currents (see Figures 3.3 and 3.4) in the shallower areas of the alternative wind farm site. Peak concentrations exceed 500 mg/L along the route but only near the bottom. Figure 4.17 shows the duration where a 10 mg/L excess (above background) suspended sediment concentration is seen. Most of the area shows a duration of less than 3 hrs with the slack water locations along the route up to 9 hrs. Figure 4.18 shows the duration of 100 mg/L concentration levels. Most of the area shows duration less than two 2 hrs with portions of the slack water locations showing duration up to 5 hrs.

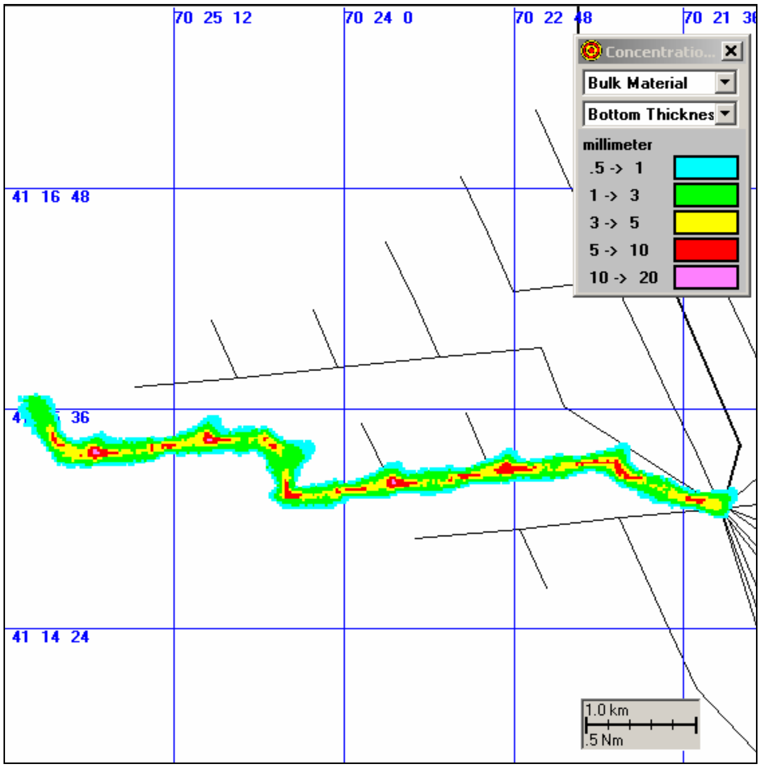

**Figure 4.3 Model results of bottom deposition from cable jetting operations along a 33kV cable route from the ESP to the southwest.**

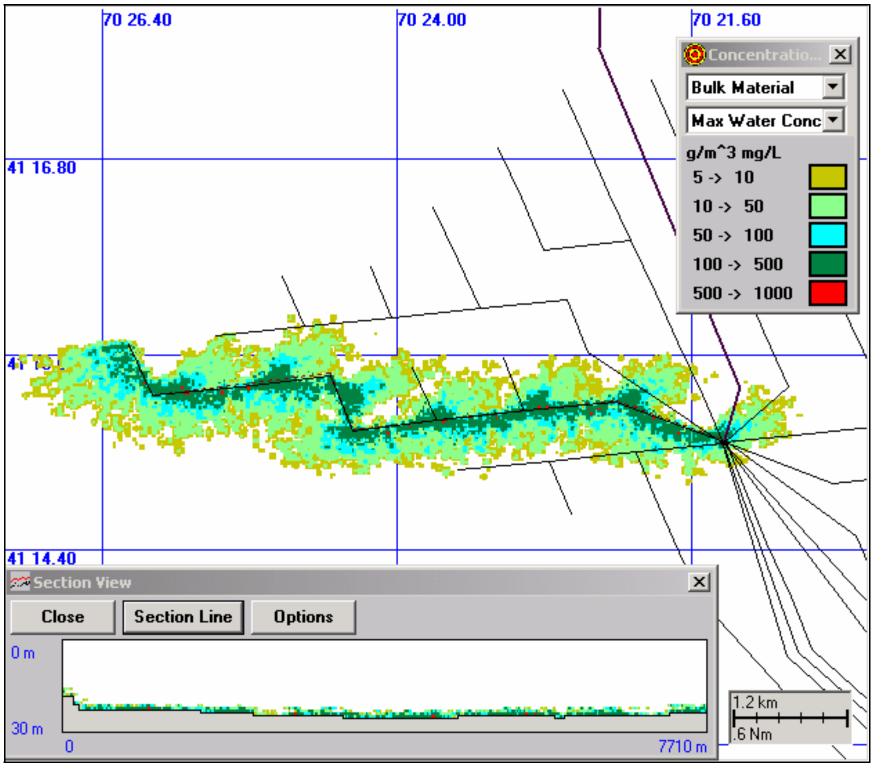

**Figure 4.4 Model results of maximum extent of suspended sediment water column concentrations from cable jetting operations along a 33kV cable route from the ESP to the southwest.**

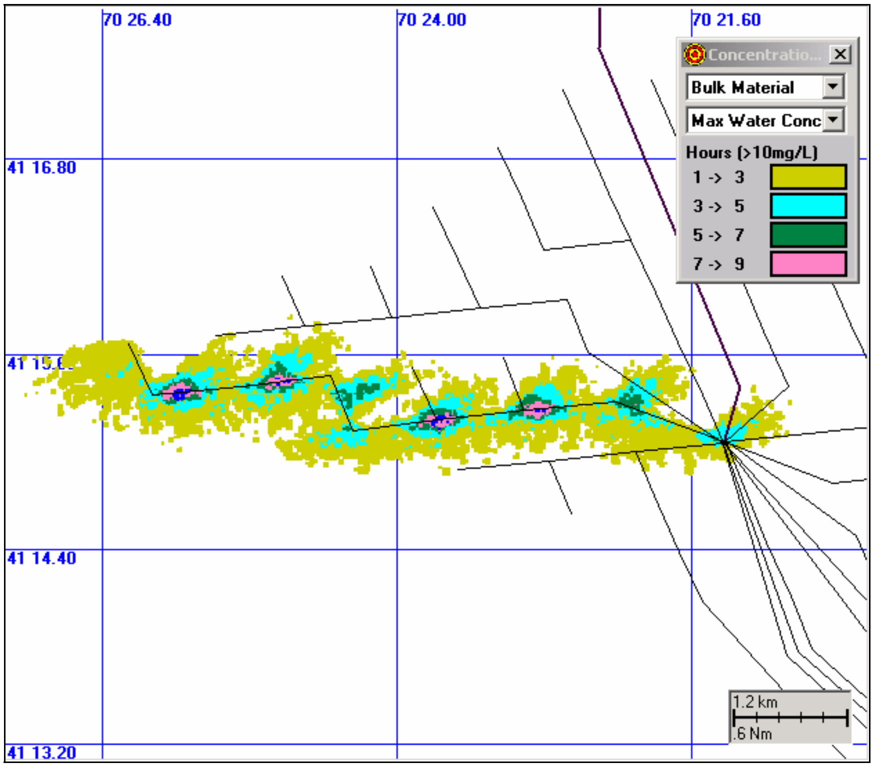

**Figure 4.5 Model results of duration of 10 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the southwest.**

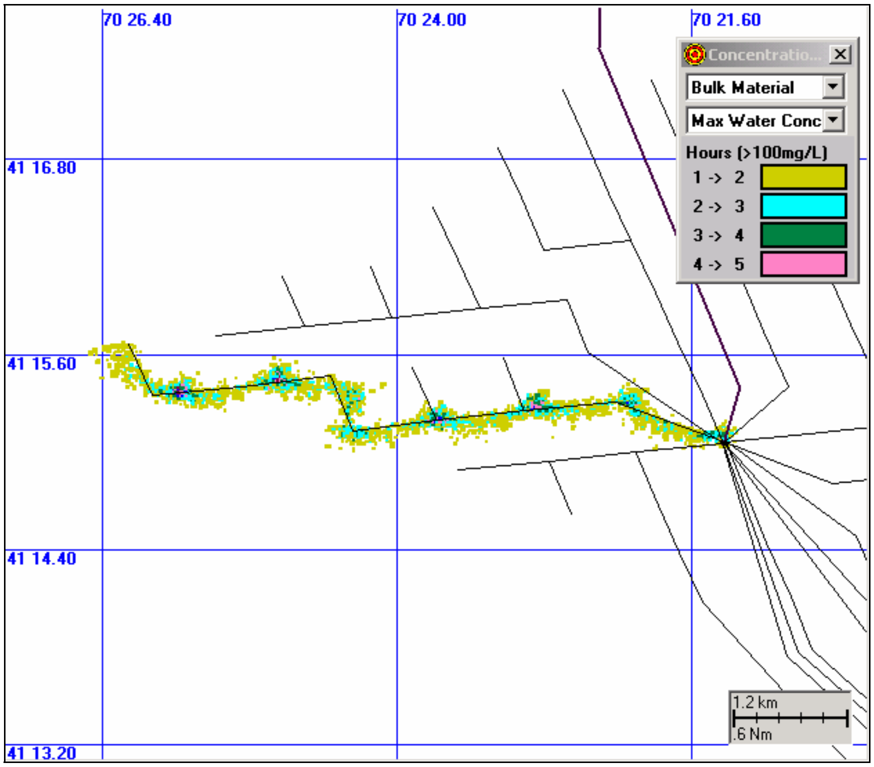

**Figure 4.6 Model results of duration of 100 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the southwest.**

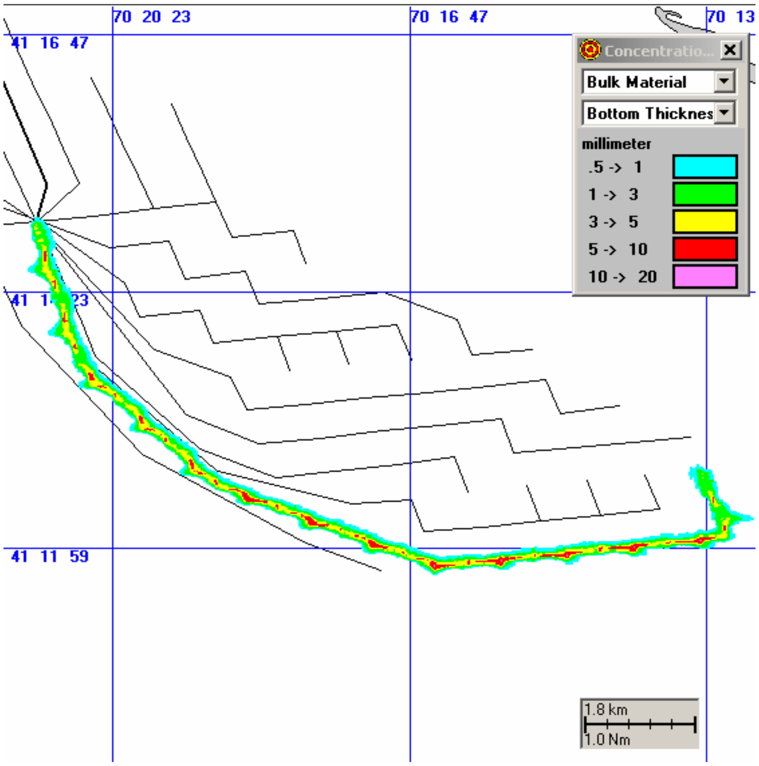

**Figure 4.7 Model results of bottom deposition from cable jetting operations along a 33kV cable route from the ESP to the southeast.**

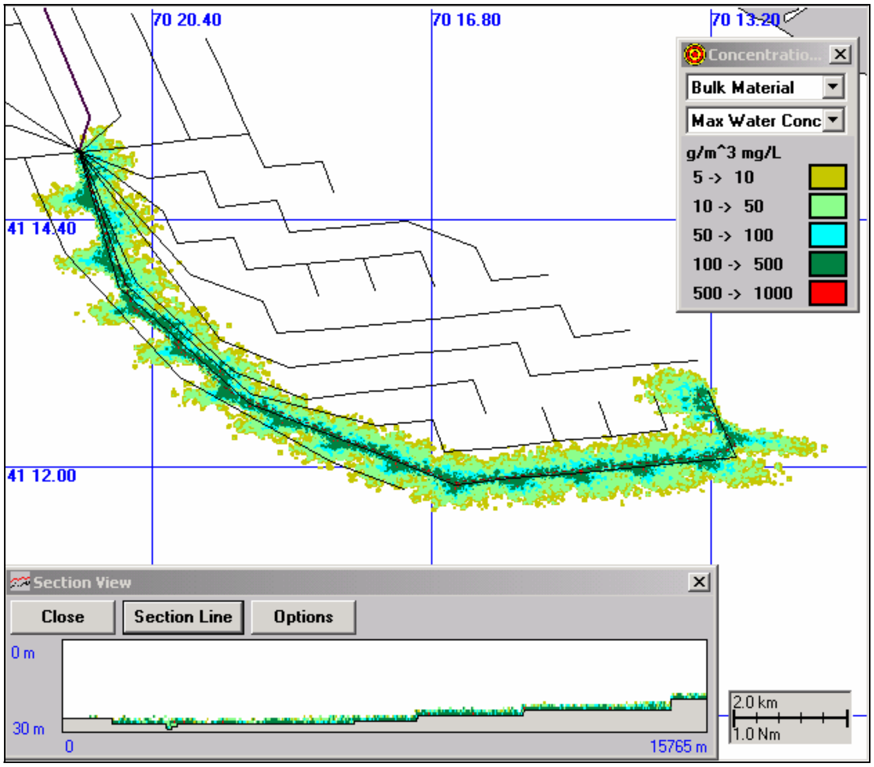

**Figure 4.8 Model results of maximum extent of suspended sediment water column concentrations from cable jetting operations along a 33kV cable route from the ESP to the southeast.**

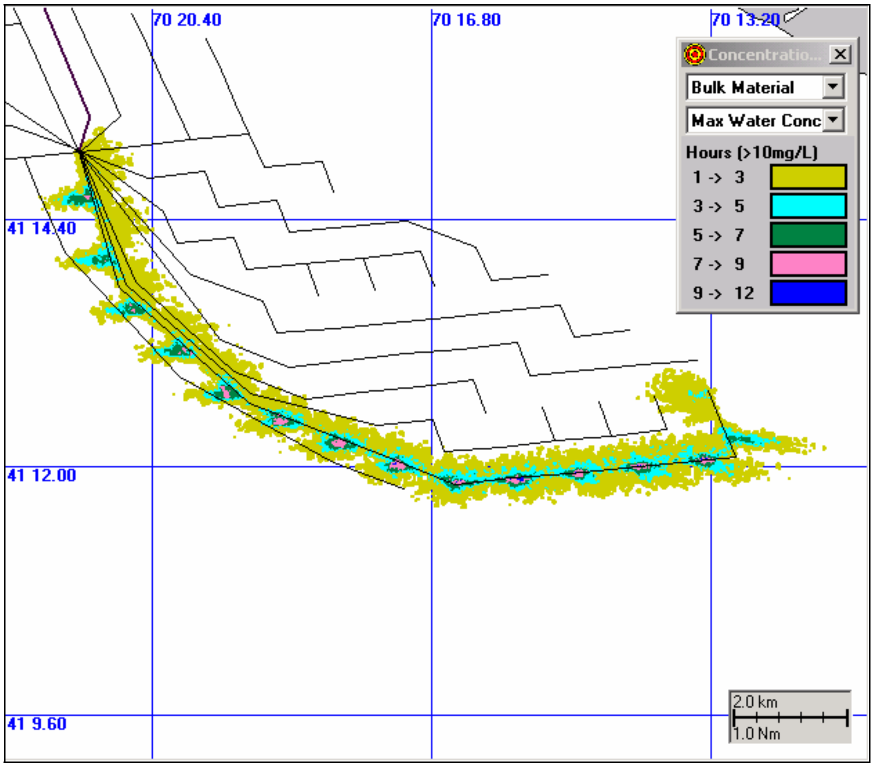

**Figure 4.9 Model results of duration of 10 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the southeast.**

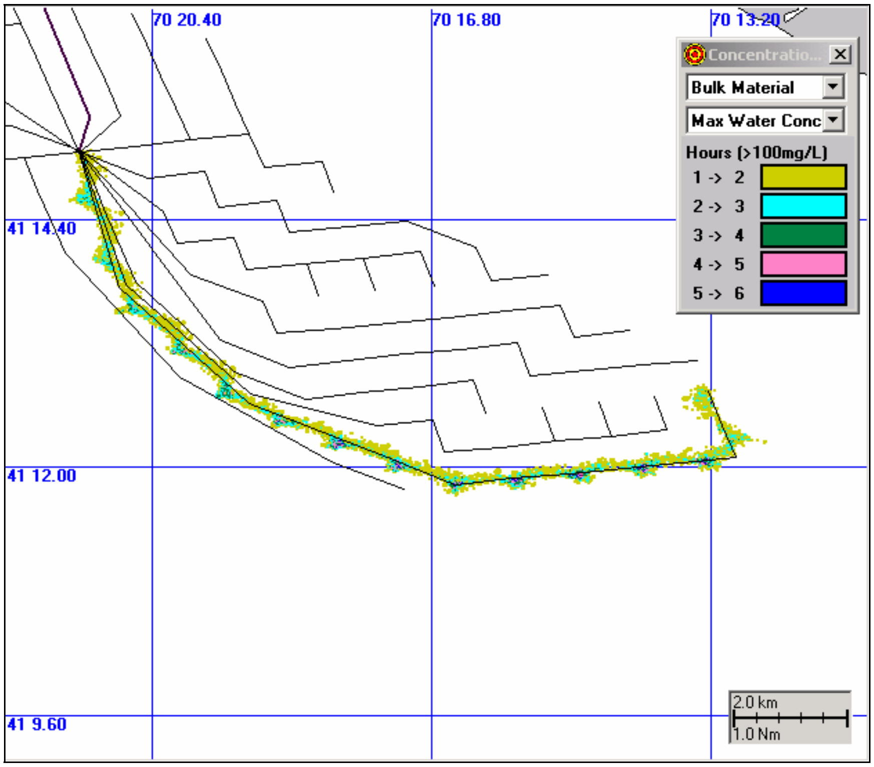

**Figure 4.10 Model results of duration of 100 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the southeast.**

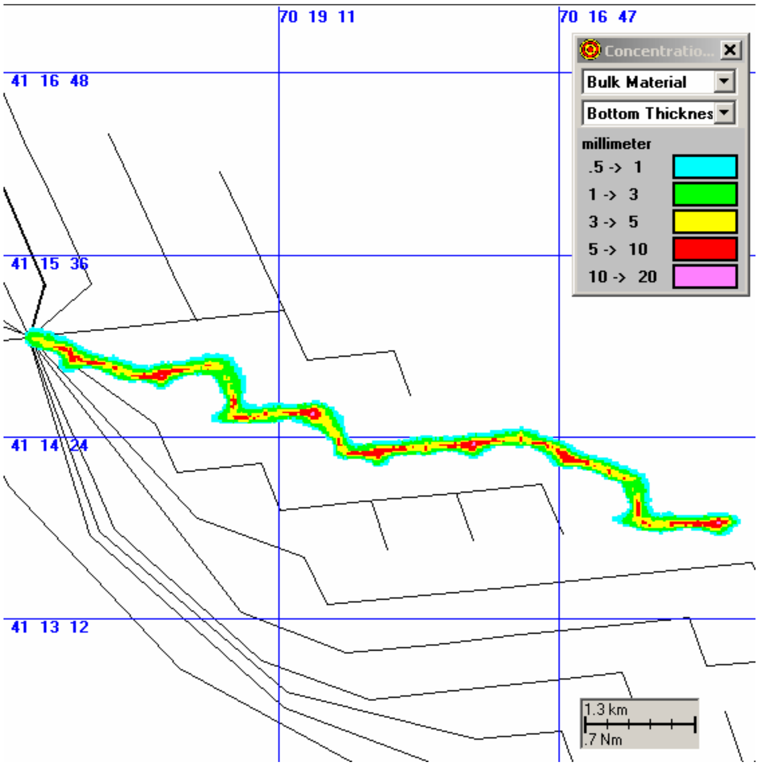

**Figure 4.11 Model results of bottom deposition from cable jetting operations along a 33kV cable route from the ESP to the east.**

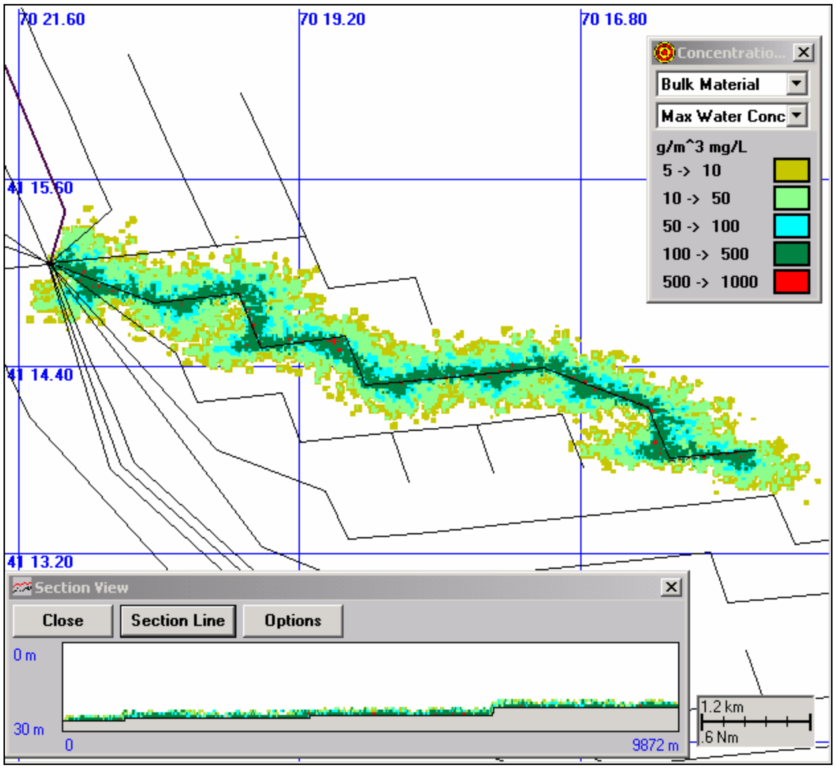

**Figure 4.12 Model results of maximum extent of suspended sediment water column concentrations from cable jetting operations along a 33kV cable route from the ESP to the east.**

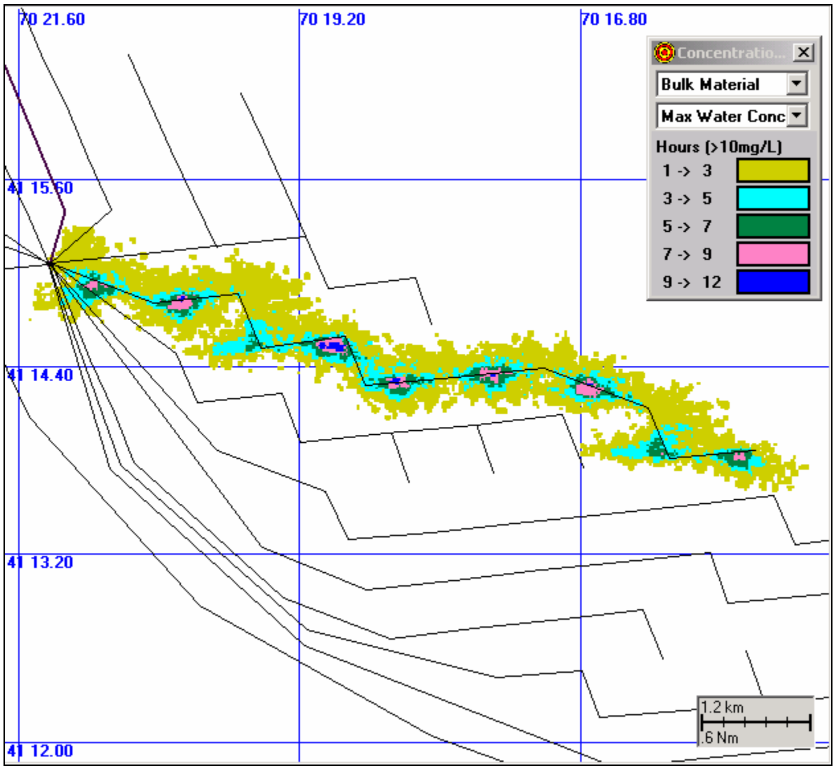

**Figure 4.13 Model results of duration of 10 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the east.**

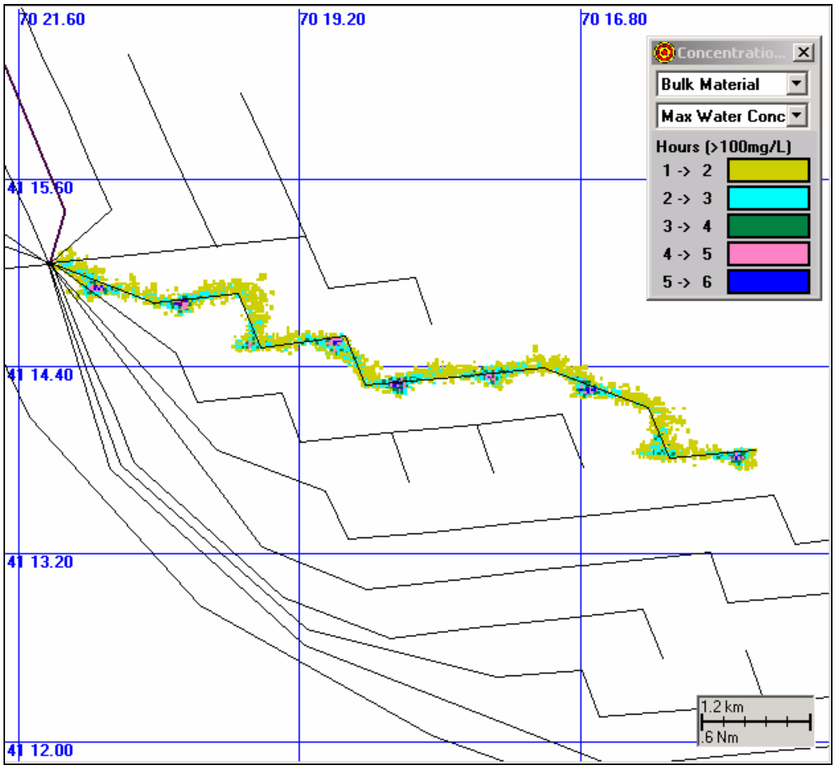

**Figure 4.14 Model results of duration of 100 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the east.**

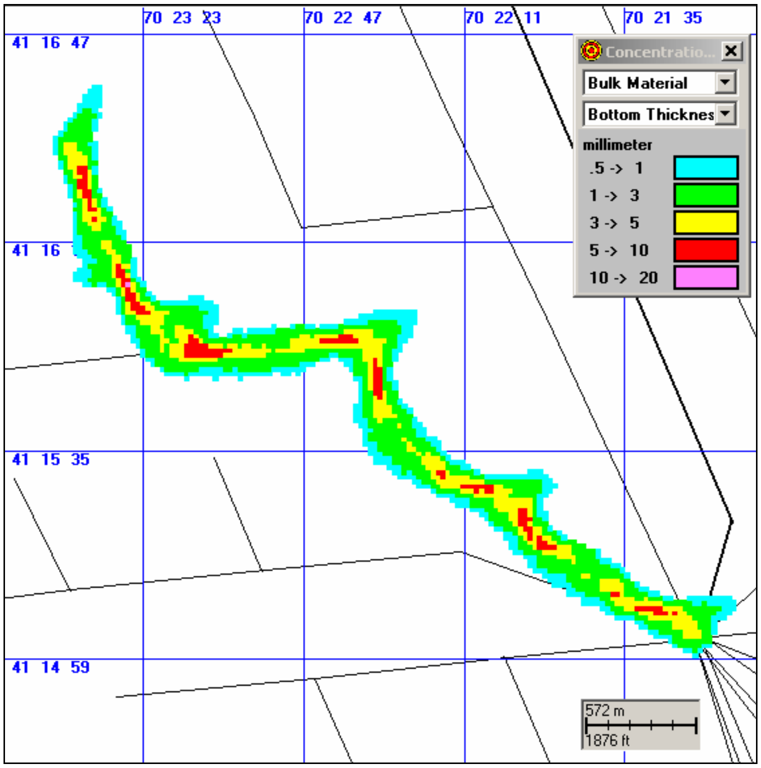

**Figure 4.15 Model results of bottom deposition from cable jetting operations along a 33kV cable route from the ESP to the northwest.**

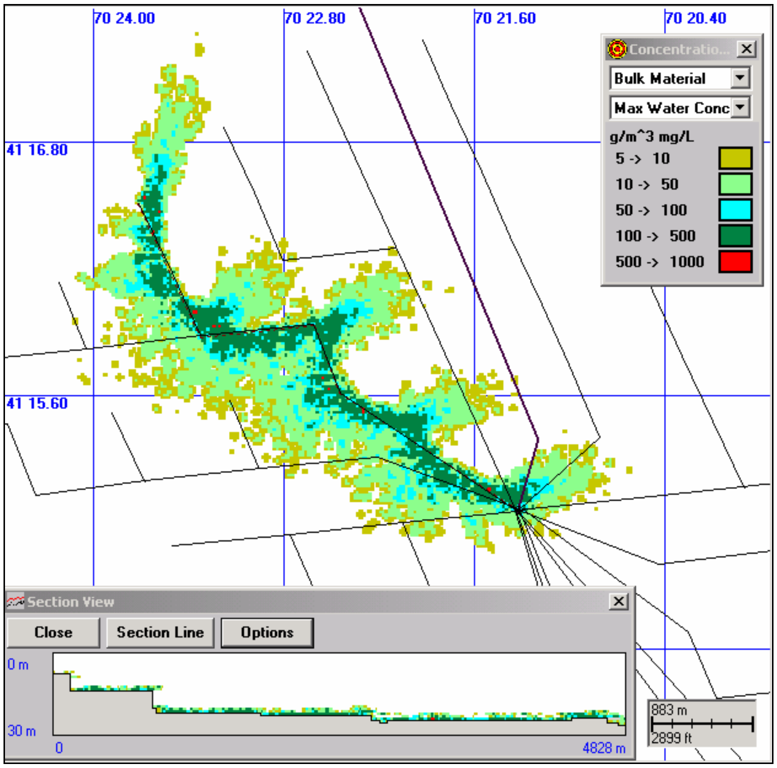

**Figure 4.16 Model results of maximum extent of suspended sediment water column concentrations from cable jetting operations along a 33kV cable route from the ESP to the northwest.**

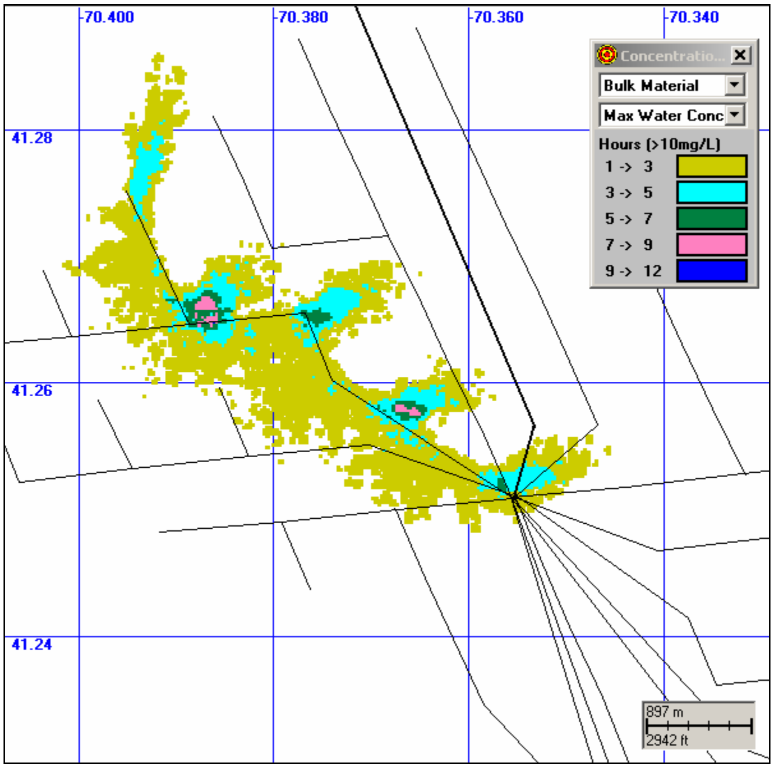

**Figure 4.17 Model results of duration of 10 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the northwest.**

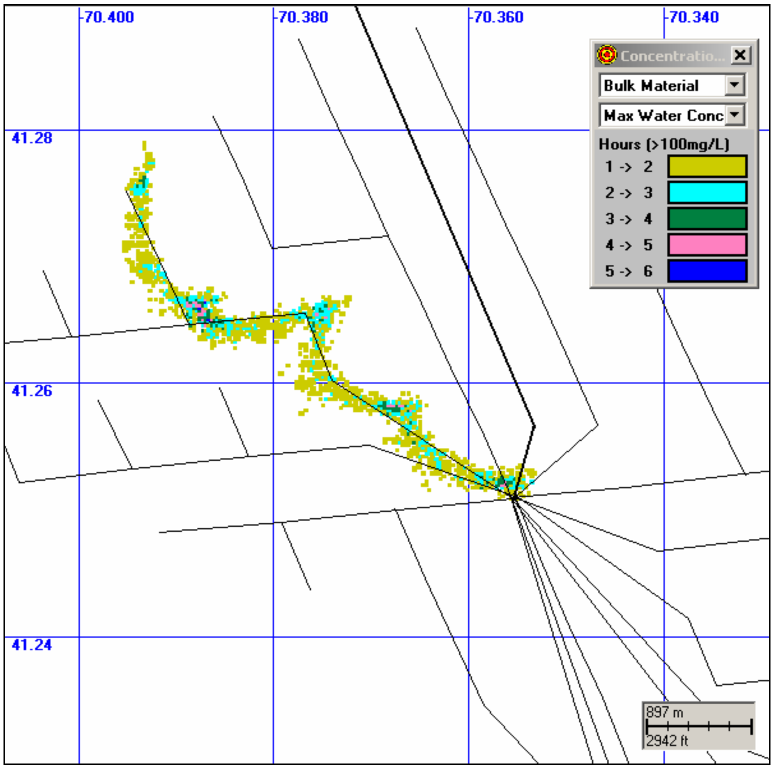

**Figure 4.18 Model results of duration of 100 mg/L excess suspended sediment water column concentration from cable jetting operations along a 33kV cable route from the ESP to the northwest.**

# 5 Conclusions

A modeling study was performed to assess the effects of jetting operations to bury the 33kV cables for the Cape Wind Energy Project at the alternative site southwest of Tuckernuck Island, just outside of Nantucket Sound. These cables connect the electric service platform (ESP) with the 130 wind turbine generators (WTGs). The study used two models: HYDROMAP to calculate currents, and SSFATE to calculate suspended sediments in the water column and bottom deposition resulting from jetting operations.

The HYDROMAP model was applied to the area offshore Massachusetts and Rhode Island using its variable grid size capability to provide model predictions of sufficient resolution for use in the subsequent sediment transport calculation. Details of this application were reported in the analysis of the primary site on Horseshoe Shoal (Swanson and Isaji, 2005).

The SSFATE model was used to simulate jetting operations for burial of representative cables in trenches. Assumptions based on project estimates and past studies included a trench cross section of 3.0 $m^2$ (32 $ft^2$), a trenching speed of 91 m/hr (300 ft/hr) and that 30% of the trench volume was injected into the water column (Swanson and Isaji, 2005). Based on available data for the area, an equal mix of fine and coarse sand was used to characterize the sediment.

SSFATE was applied to four representative 33kV cable routes connecting the WTGs to the ESP. The 115kV cable route extension south from Horsehoe Shoal (the primary site) was not modeled since the primary site modeling already simulated the portion from Yarmouth to the shoal and is considered representative of the entire route. These 33kV routes showed similar deposition patterns with small deposition thicknesses of 1 to 5 mm (0.04 to 0.2 in) occurring within a few hundred meters (few hundred yards) of the cable route with larger thicknesses up to 20 mm (0.8 in) adjacent to the route. The water column concentrations were typically less than 50 mg/L with some areas on the cable route peaking at 500 mg/L but restricted to the bottom layer of the water column. Concentration levels of 100 mg/L typically lasted less than 2 hrs with one small area on the route lasting up to 6 hrs.

In general, the deposition of sediments resuspended by jetting operations will be minimal when compared to the active bed load sediment transport known to exist in the adjacent Nantucket Sound (45 to 71 mg/L [USACE, 2004]). These small deposition patterns would not be expected to remain in this dynamic environment where tidal currents reach 0.5 m/s (1 kt) and storm currents would add additional energy. Water column concentrations due to jetting are restricted to the bottom layer and typically last for a few hours before returning to ambient conditions.

The SSFATE results for the alternative site are similar to that for the primary site at Horseshoe Shoal. The depositon thicknesses are slightly smaller and water column concentrations are slightly lower for the alternative site because the grain size of the sediments at this site are slightly larger.

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