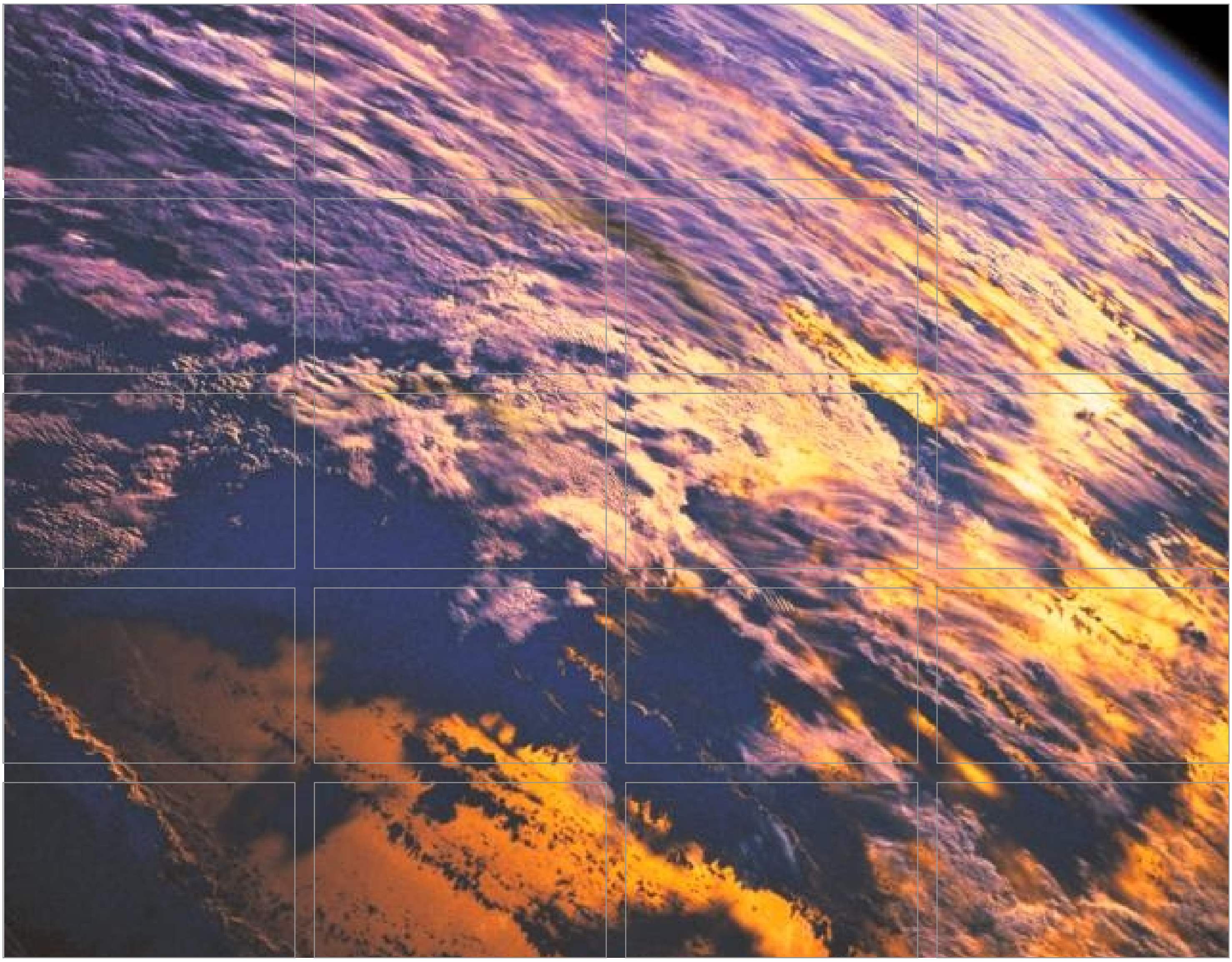
Annex D5

Cuttings Modelling

ERM conducted a study on the potential cuttings and mud discharge, which may be generated through the project.



Environmental Impact Assessment: Drill Cuttings and Muds Discharge Modelling Report

Exploration of the Block ER236 Block, South Africa

September 2018

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FINAL REPORT

Eni Upstream - AMTE and Eni South Africa BV

Environmental Impact Assessment for Proposed Exploration Drilling in Block ER 236, offshore of Kwa-Zulu Natal Coast of South Africa – Drill Cuttings and Muds Modelling Report

19 September 2018

For and on behalf of
Environmental Resources Management

Prepared by:	**Reviewed by:**	**Approved by:**
Michael J. Fichera, P.E..	*William A. Schew, Ph.D.*	*Shwet Prakash*

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1 CONTENT OF THE SPECIALIST REPORT CHECKLIST

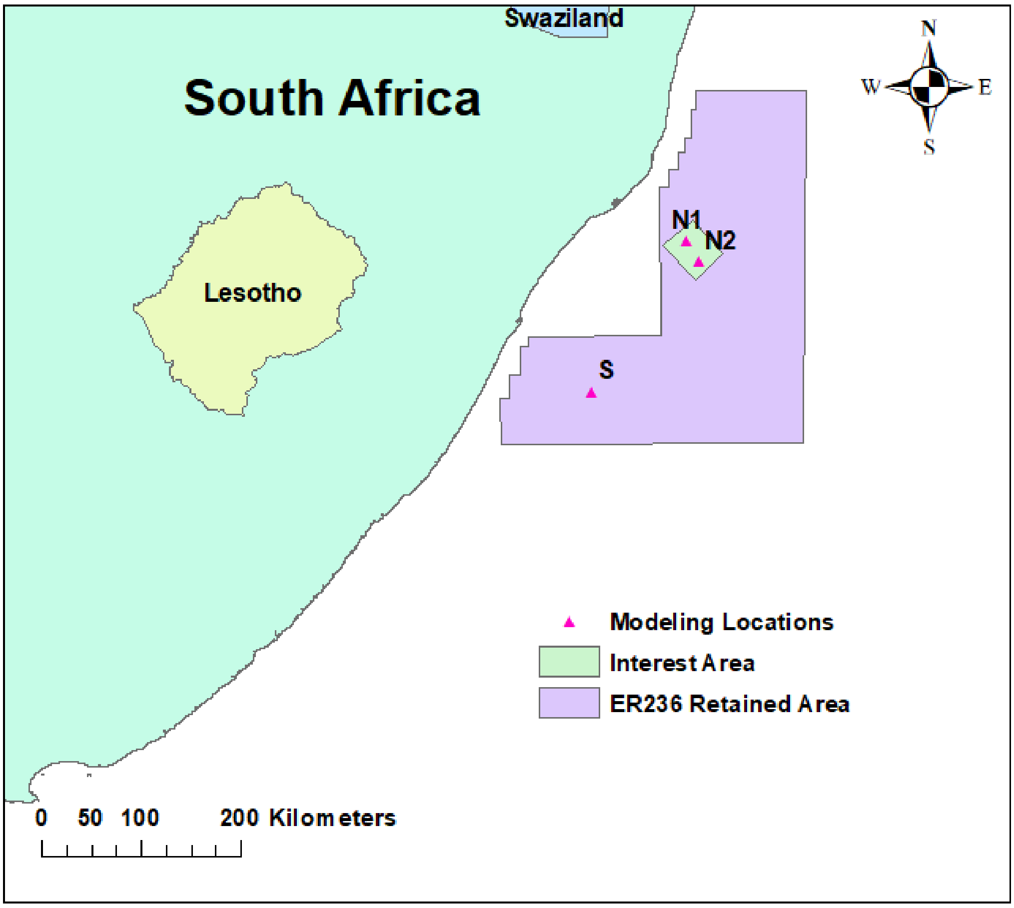
The content of this report has been prepared in terms of Regulation GNR 326 of 2014, as amended, Appendix 6, as shown in *Table 1.1*.

Table 1.1 Specialist Report Checklist

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6	**Cross-reference in this report**
(a) details of— the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 6
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Section 6
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1
(cA) an indication of the quality and age of base data used for the specialist report;	Section 1.1, 1.2
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 2
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 1.1
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 1
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;;	N/A
(g) an identification of any areas to be avoided, including buffers;	N/A
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 1
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.2
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities.	Section 3
(k) any mitigation measures for inclusion in the EMPr;	N/A
(l) any conditions for inclusion in the environmental authorisation;	N/A
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	N/A
(n) a reasoned opinion— (i) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	N/A
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(q) any other information requested by the competent authority.	N/A

Modeling was performed to assess potential environmental impacts due to the release of drill cuttings and mud during the planned exploratory drilling programme off of the Kwa-Zulu Natal coast of South Africa. Three locations were used for modeling drilling in Block ER 236 (*Figure 2.1*). These are N1 (Lat. -29.171510347, Lon. 32.773259341), N2 (Lat. -29.361772647, Lon. 32.901946107), and S (Lat. -30.539622500, Lon. 31.779959861), the midpoint between well locations in the southern region of the block under consideration for well locations, but not confirmed at the time of this writing.

Figure 2.1 Location Map Showing the Location of Block ER 236



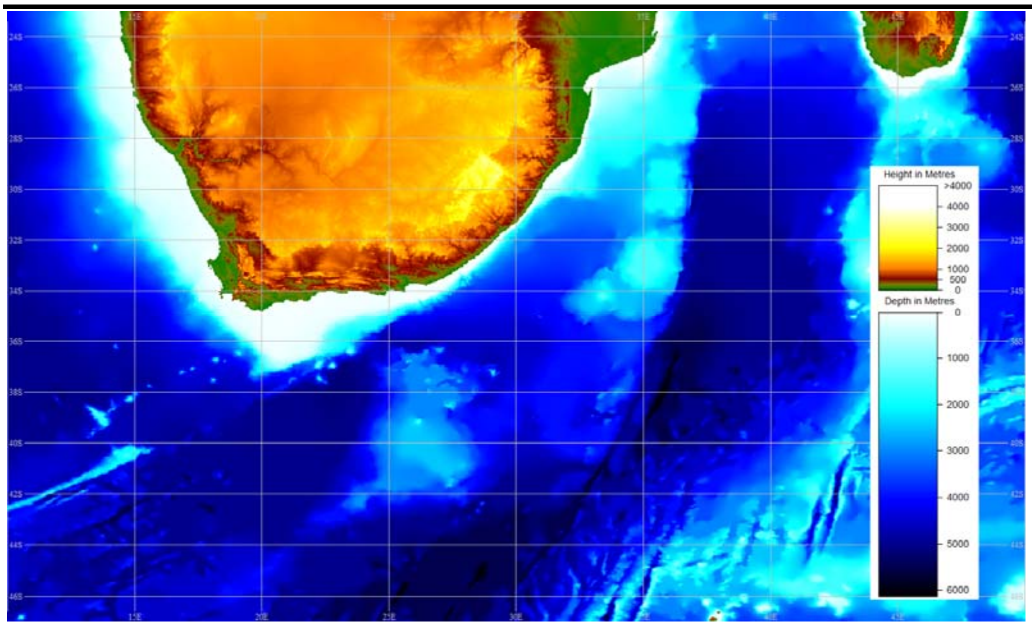
The objective of this drill cuttings modeling study was to determine whether the disposal of the drill cuttings will result in unacceptable adverse impacts to ocean life. Drill cuttings dispersion modeling was performed to estimate the amount of suspended sediment concentrations added to the water column above the background, the bottom accumulation of the drill cuttings (the "footprint"), and the rate of sedimentation on the seafloor for assessment of impacts to benthic organisms.

2.1 *SIMULATION DESIGN*

The planned dispersion and deposition of released drill cuttings and muds were quantified using hydrodynamic computer modeling techniques. Modeling allows for the description of the ocean current velocity and direction in offshore waters, specifically in the *ER 236 Block*, using the same hydrodynamic techniques employed in the oil spill modeling. Released material will pass vertically through the water column, because cuttings and muds generally are denser than the receiving water. Cuttings and mud dispersion is fundamentally a 3-D phenomenon.

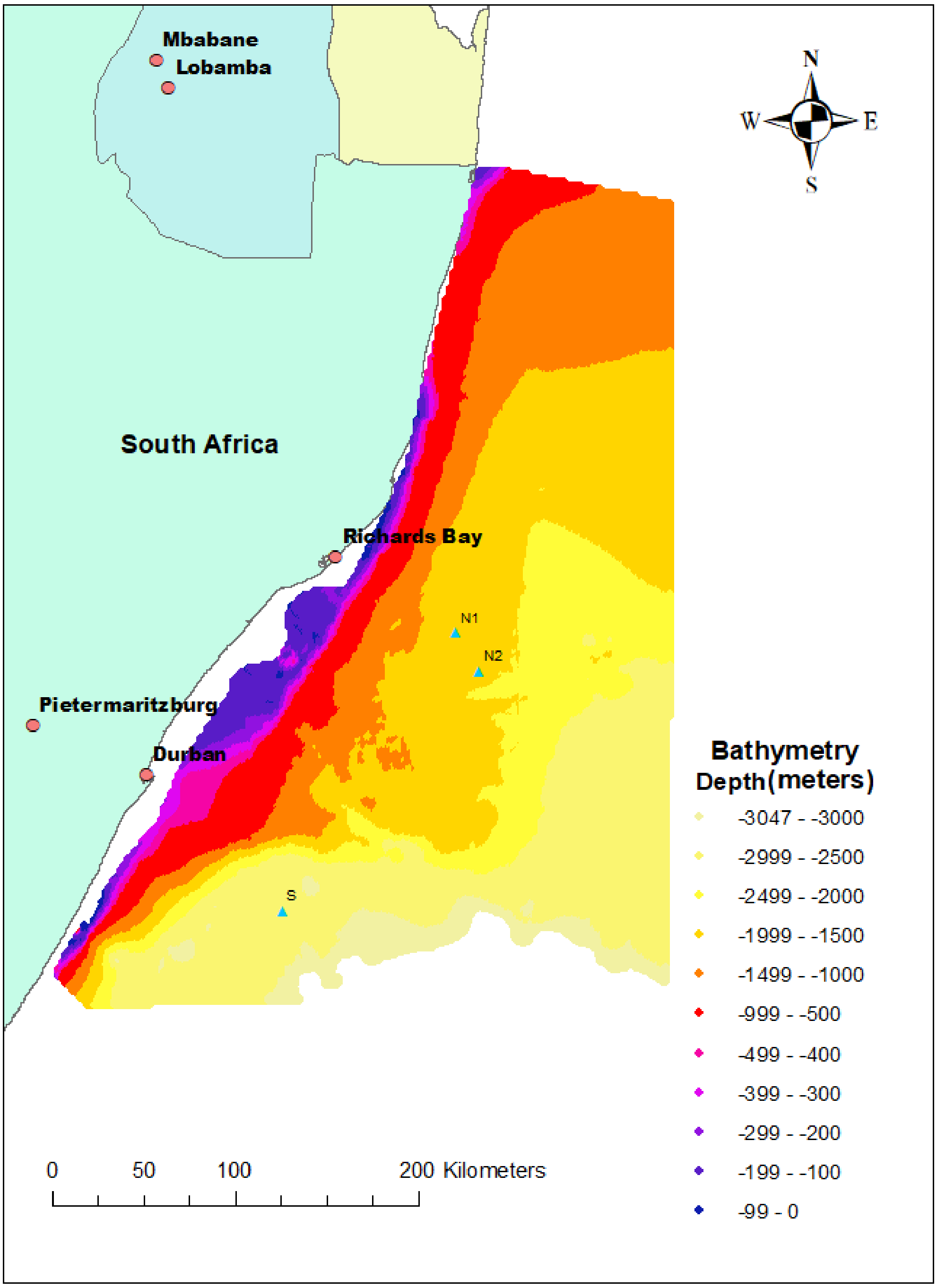
The bathymetric data is the primary spatial dataset used to describe the depth and shape of the seafloor and used to develop the modeling grids for the particle deposition model. The General Bathymetric Chart of the Oceans (GEBCO) was used to obtain seafloor bathymetry at the study site (IOC *et al.*, 2003). The database used for this study is the GEBCO_08 Grid which has a 30 arc-second resolution. GEBCO bathymetry offshore of South Africa is shown in *Figure 2.2.*

Figure 2.2 GEBCO bathymetry - Source: GEBCO (IOC et al, 2014)



In addition, Eni provided high-resolution bathymetric data in the vicinity of the block location (*Figure 2.3*). Depth values were provided every 1 km in an orthogonal grid roughly in the shape of a triangle approximately 450 km in the east-west direction by 330 km in the north-south direction along the coast.

Figure 2.3 *High-Resolution Bathymetry (Source: Eni, 2018)*



Time-varying currents data including daily depth-varying current, salinity, and water temperature values on a three-dimensional grid were obtained from a generalized ocean model known as HYCOM (HYbrid Coordinate Ocean Model), a data assimilative, hybrid isopycnal-sigma-pressure coordinate model (www.hycom.org). Examples of HYCOM's currents in the Indian Ocean offshore of South Africa are shown in *Figure 2.4* and *Figure 2.5*.

Figure 2.4 Example HYCOM Current Vectors at the Surface

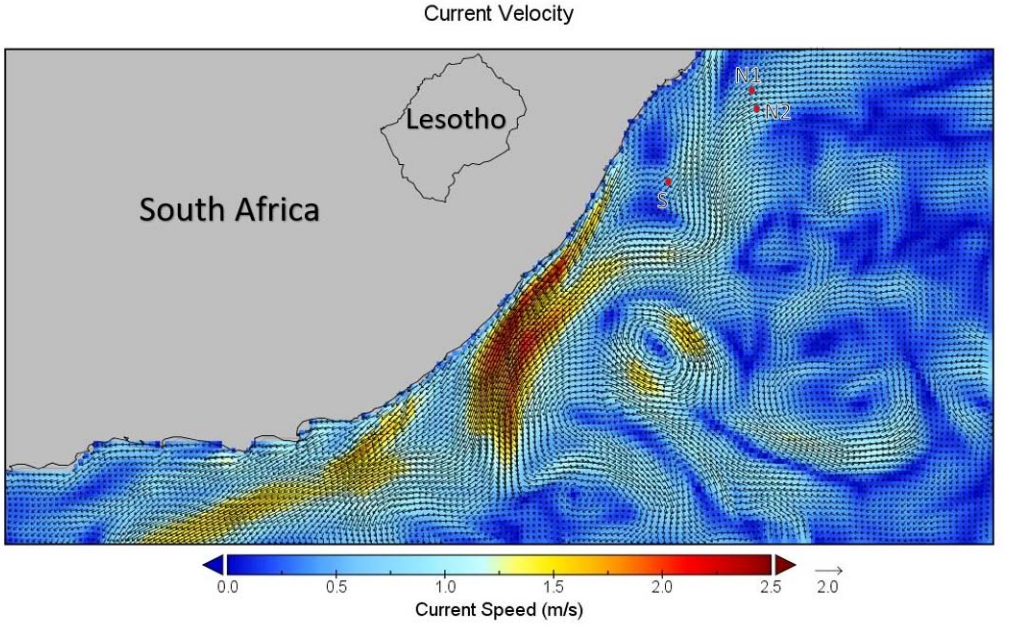
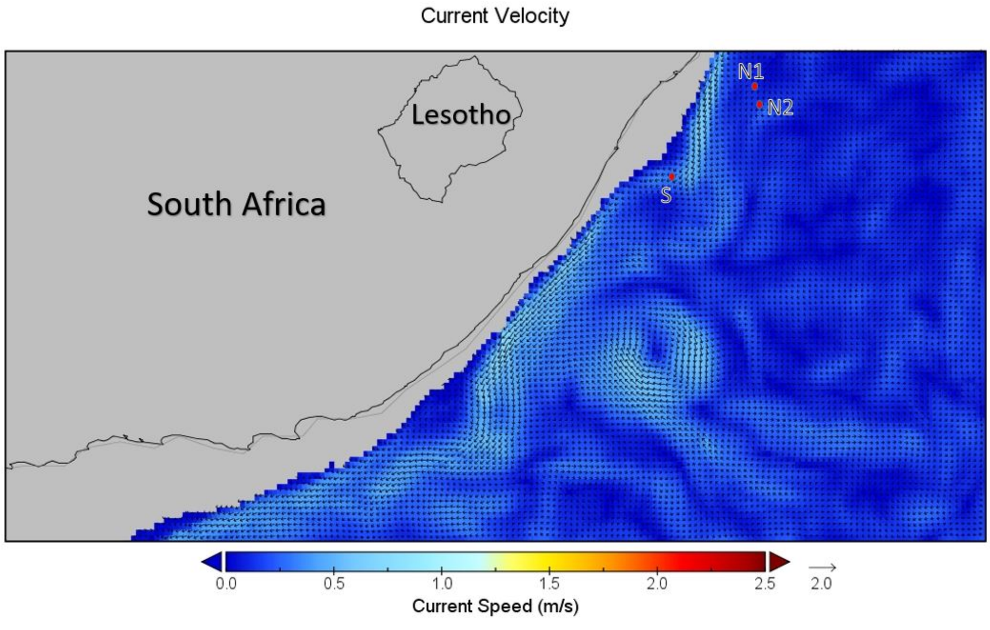


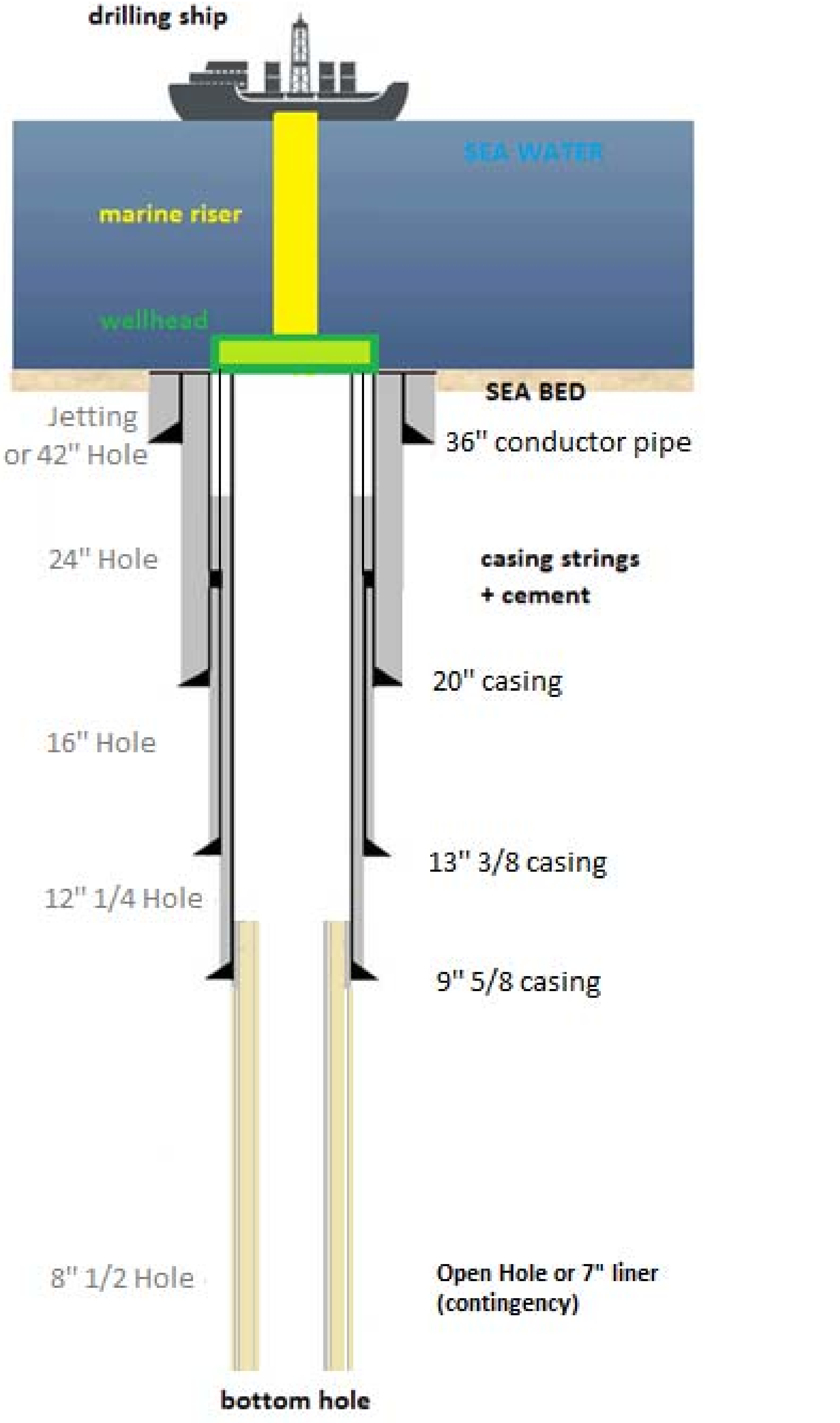
Figure 2.5 Example HYCOM Current Vectors at 1000m



Two scenarios were selected to represent a range of hydrodynamic conditions at each of the three proposed locations: 1) the minimum, and 2) the maximum depth-averaged monthly averaged ocean current speeds. These values were obtained from analysis of daily average current speed values, obtained from the HYCOM model at the location of each proposed well for a five year period from 2013 to 2017.

Drilling volumes and discharge rates were provided by Eni. Prior to installing the riser, seawater and high-viscosity sweeps will be used during the jetting of the first and second sections. Non-Aqueous Drilling Fluid (NADF) will be used during drilling of the third, fourth and fifth sections. During the first two sections, cuttings will be deposited to the seabed. Once the riser is installed, cuttings and muds are brought to the surface, treated and discharged. *Figure 2.6* provides the well profile and *Table 2.1* provides the volume estimates and schedule for the drilling operation.

Figure 2.6 Well Profile



Source: ENI, 2018

Table 2.1 Well Volume Estimates and Schedule

Hole Size (inches)	Casing Diameter (inches)	Drilling Interval (m)	Mud Type	Volume of Cuttings (m³)	Estimated Drilling Duration (days)
42	36	30	Sea water/sweeps	100	2
24	20	30 – 630	Sea water/sweeps	300	8
16	13 5/8	630 – 1230	NADF	120	10
12 ¼	9 5/8	1230 – 1930	NADF	70	12
8 ½	--	1930 – 2630	NADF	30	13
Total	–	2630	–	620	45

Two separate model runs were performed: one for the discharges at seabed level and one for the discharges at the ocean surface level. Cuttings discharged at seabed level are localized, whereas mud/cuttings discharged at the ocean surface disperse over a wide area and result in much lower deposition thicknesses than discharges at seabed level.

A 20 km by 20 km grid with grid cells sized 50 m by 50 m (and a finer resolution of 25 m by 25 m within a 6 km by 6 km region centered on each well location was constructed. Modeling was performed using GEMSS® (Generalized Environmental Modeling System for Surfacewaters) and its drill cuttings and muds discharge module, GIFT (Generalized Integrated Fate and Transport). GIFT simulates the fate of dissolved and particulate material discharged from dredging barges, mine tailings, drill cuttings and muds, and produced water. It is a three-dimensional particle-based model that uses Lagrangian algorithms in conjunction with currents, specified mass load rates, release times and locations, particle sizes, settling velocities, and shear stress values (Shields number).

Drill cuttings and muds were modelled as particles. Movement in the vertical direction resulted in the settling and deposition of cuttings on the seabed. The combined action of erosion and deposition, based on particle size distribution and the intensity of release, resulted in the net accumulation of drill cuttings on the seabed.

Modeling data requirements included:

- Drill cuttings properties
- Material types and distribution
- Grain size distribution
- Weight distribution by size
- Material density
- Release rate and depth

GEMSS and its component modules have met agency approval among federal and state governments within the U.S. and approved by regulatory agencies in the Bahamas, Qatar, India, Australia, UK, and Canada.

2.2 *CUTTINGS AND MUD PROPERTIES*

Table 2.2 below shows the properties of the cuttings and mud discharges at each section. The Water Based Mud (WBM) scenario has not been separately implemented as considered with a lower impact potential; based on this assumption, the model outputs represent the worst case scenario in terms of cuttings and mud discharges with Non-Aqueous Drilling Fluids (NADFs).

Table 2.2 Cuttings and Muds Discharges

Section	Discharge location	Cuttings Discharged (MT)	Cuttings Density (kg/m³)	NADF Discharged (MT)	NADF Density (kg/L)
1	Seabed	265	2650	N/A*	N/A*
2	Seabed	795	2650	N/A*	N/A*
3	Surface	318	2650	15.9	0.760
4	Surface	185.5	2650	9.28	0.760
5	Surface	79.5	2650	3.97	0.760

* High-viscosity sweeps used during jetting of the top hole in Section 1 and 2 are not appropriate for deposition modelling

The grain size distribution of the drill cuttings used in this study are presented in *Table 2.3.*

Table 2.3 Drill Cuttings Grain Size Distribution

Mean Particle size (µm)	% Distribution (by volume)
20	0.68
72	0.75
125	1.54
230	1.2
410	0.52
750	1.17
1,300	5.39
2,400	14.47
3,300	27.04
5,000	37.99
20,000	8.62
60,000	0.63

Source: Southwest Research Institute (2003)

3 ASSESSMENT CRITERIA

3.1 TOTAL SUSPENDED SOLIDS

Increases in the concentration of total suspended solids (TSS) will occur due to discharges of drill cuttings and adhered mud. The highest concentration increases will exist at the point of discharge from the drillship/platform or at the seafloor during upper well section drilling, and decrease over time and distance as the suspended solids plume dissipates and settles. Larger particles will settle out more quickly than fine particles, such that the TSS plume of tiny particles may linger and travel further than plumes of larger grain-sizes. As such, elevated TSS may form in regions where tiny suspended particles linger in a cloud and mix with subsequent discharges. Impacts related to elevated TSS may occur if light penetration is impeded significantly for long periods of time reducing the ability of plants (including zooxanthellae that live within most types of coral) and phytoplankton to photosynthesize. Increases in TSS may also decrease water clarity and clog fish gills. The guidance value for TSS provided by the International Finance Corporation (IFC) is 35 mg/L for effluent discharges (IFC, 2007).

3.2 DEPOSITIONAL THICKNESS

Drill cuttings and adhered mud discharges will create a footprint on the seabed. The deposition of cuttings and adhered muds may result in physical damage and habitat loss or disruption over a defined area of the seabed through physical smothering.

Burial by drill cuttings and adhered mud may cause physical impacts to benthic communities. The specific thickness of burial that may cause an impact can vary depending on the benthic species and the amount of oxygen depletion that may occur, causing anoxic conditions beneath the depositional layer.

The severity of burial impacts also depends on the sensitivity of the benthic organism, the thickness of deposition, the amount of oxygen depleting material, and the duration of the burial. Thickness thresholds vary by species and sediment impermeability. A suggested threshold thickness value of 5 cm above a substratum for a month deposition impacting benthic communities is recommended based on publications by Ellis and Heim (1985) and MarLIN (2011) and will be used as the threshold for this project. Smaller threshold values as low as 1 mm have been reported (e.g., Smit et al., 2006), however, they are associated with instantaneous burials on benthic species, not gradual smothering effects. Therefore, a threshold thickness of 5 cm was assumed in this assessment.

4 RESULTS

The results of the modeling are illustrated in the following sections for each well as contour plots. The plots presented indicate the location of the drill cuttings release point, taken as the drill center. The results are presented for the following parameters:

- TSS measured in mg/L, and
- Bottom thickness in mm

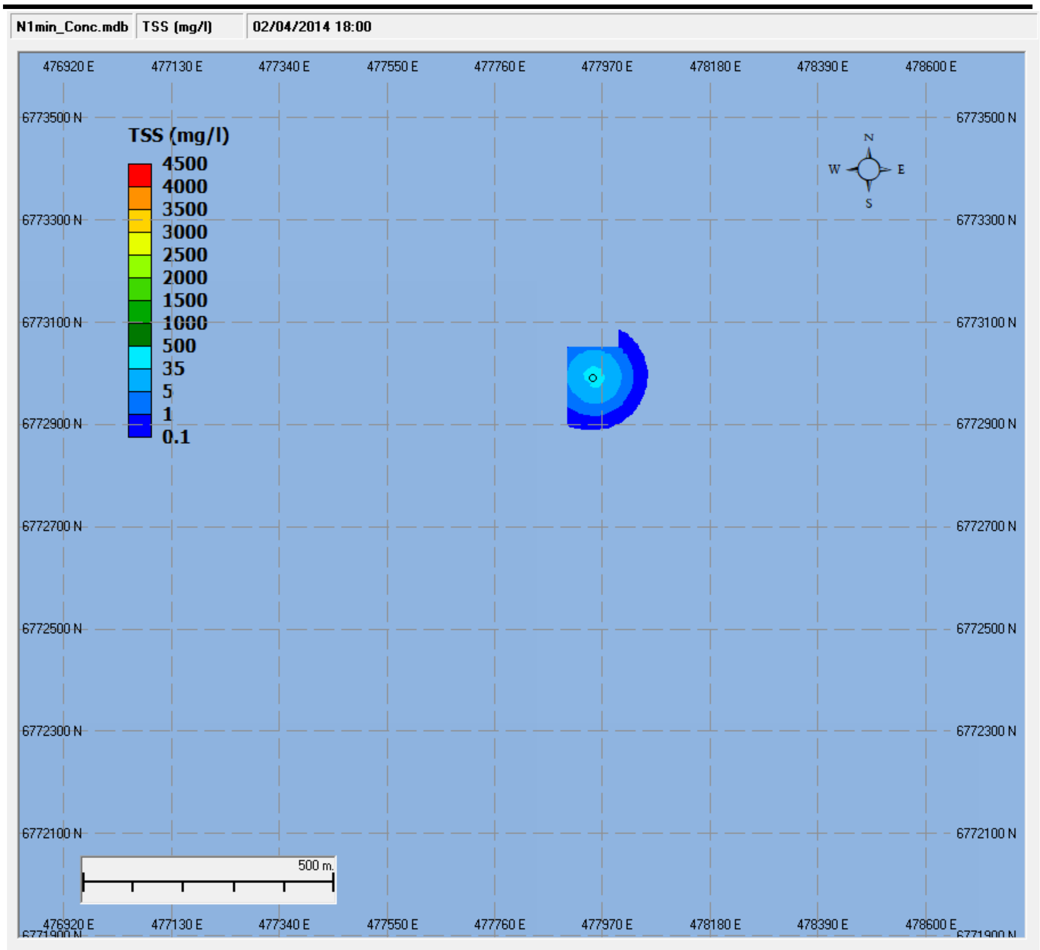
The model was run twice for each potential well location: Scenario 1 (minimum monthly average ambient currents) and Scenario 2 (maximum monthly average ambient currents).

4.1 TOTAL SUSPENDED SOLIDS

4.1.1 Well Location N1

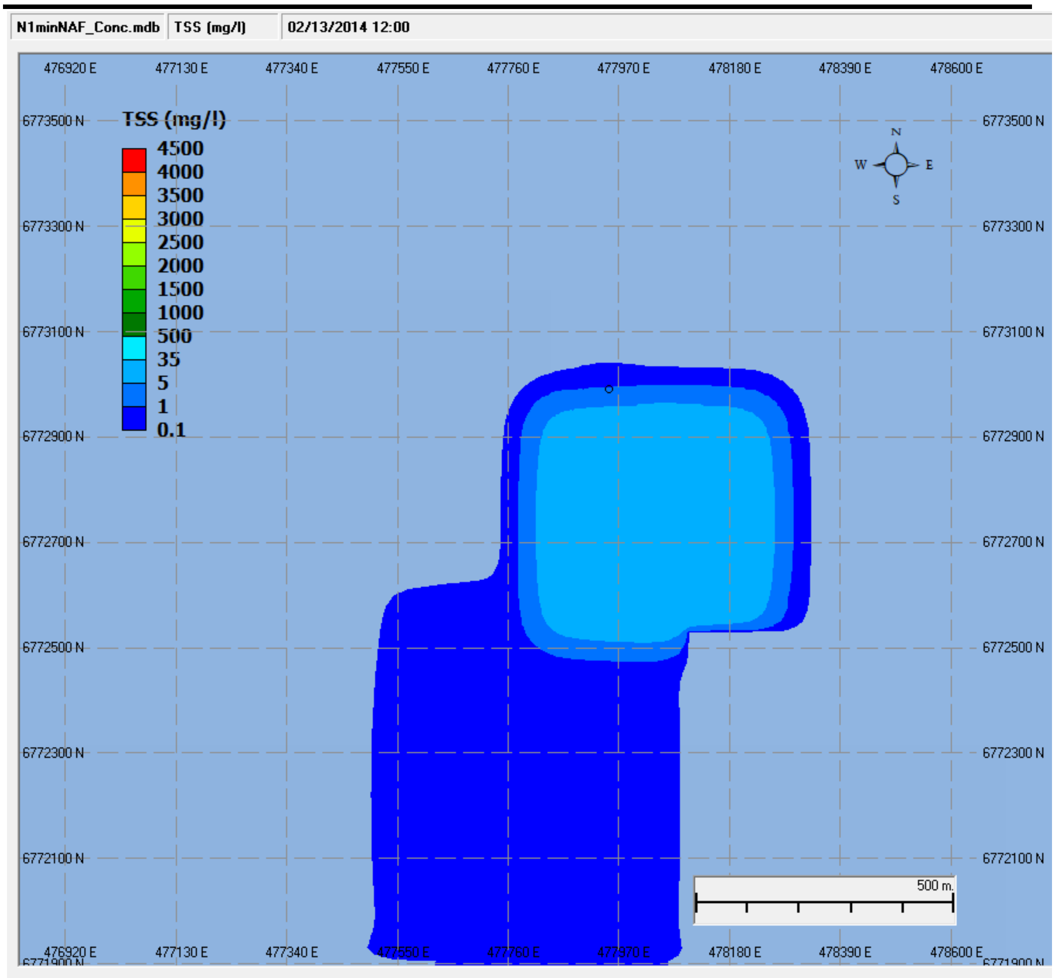
For Scenario 1, TSS levels exceeded the 35 mg/l threshold criterion in a very small area (< 0.01 km^2) surrounding the well center (*Figure 4.1*). TSS will not exceed the 35 mg/l threshold criterion at the surface (*Figure 4.2*).

Figure 4.1 Well Location N1 - Scenario 1: Maximum TSS, Minimum Monthly Average Currents – Sections 1 and 2



Source: ERM

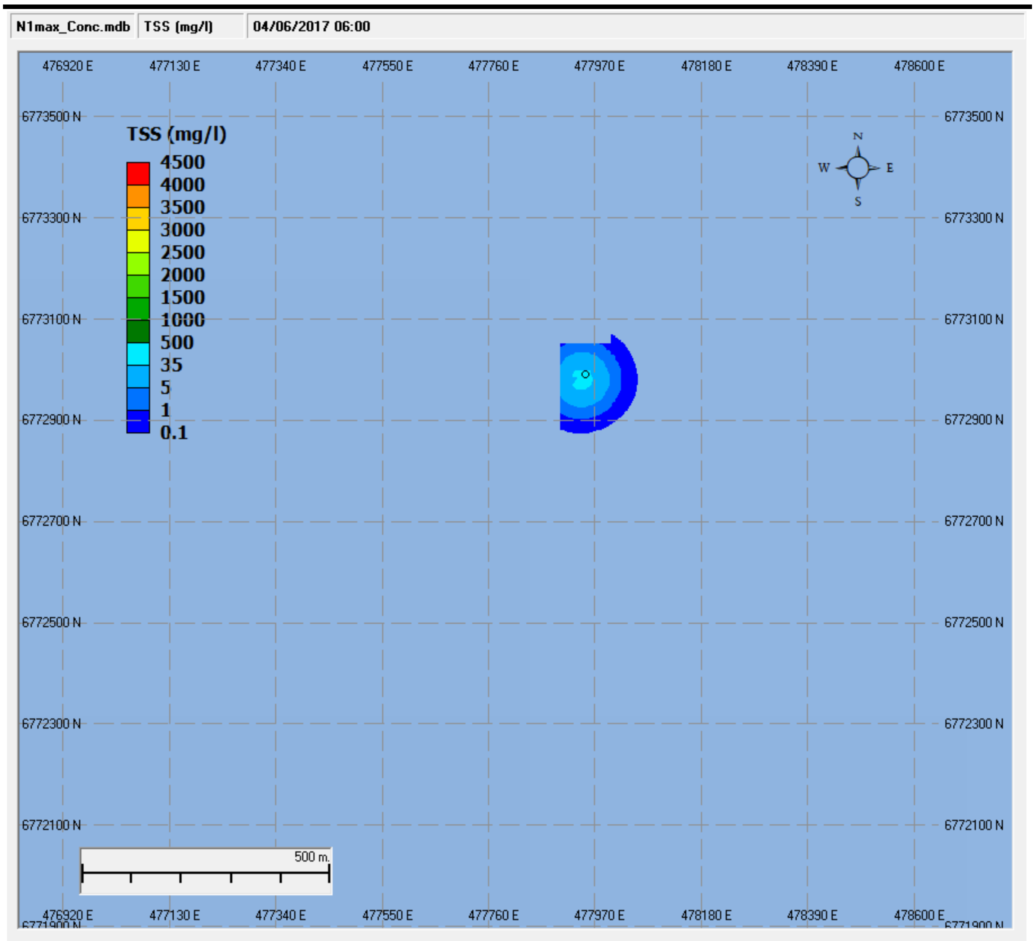
Figure 4.2 ***Well Location N1 - Scenario 1: Maximum TSS, Minimum Monthly Average Currents – Sections 3-5***



Source: ERM

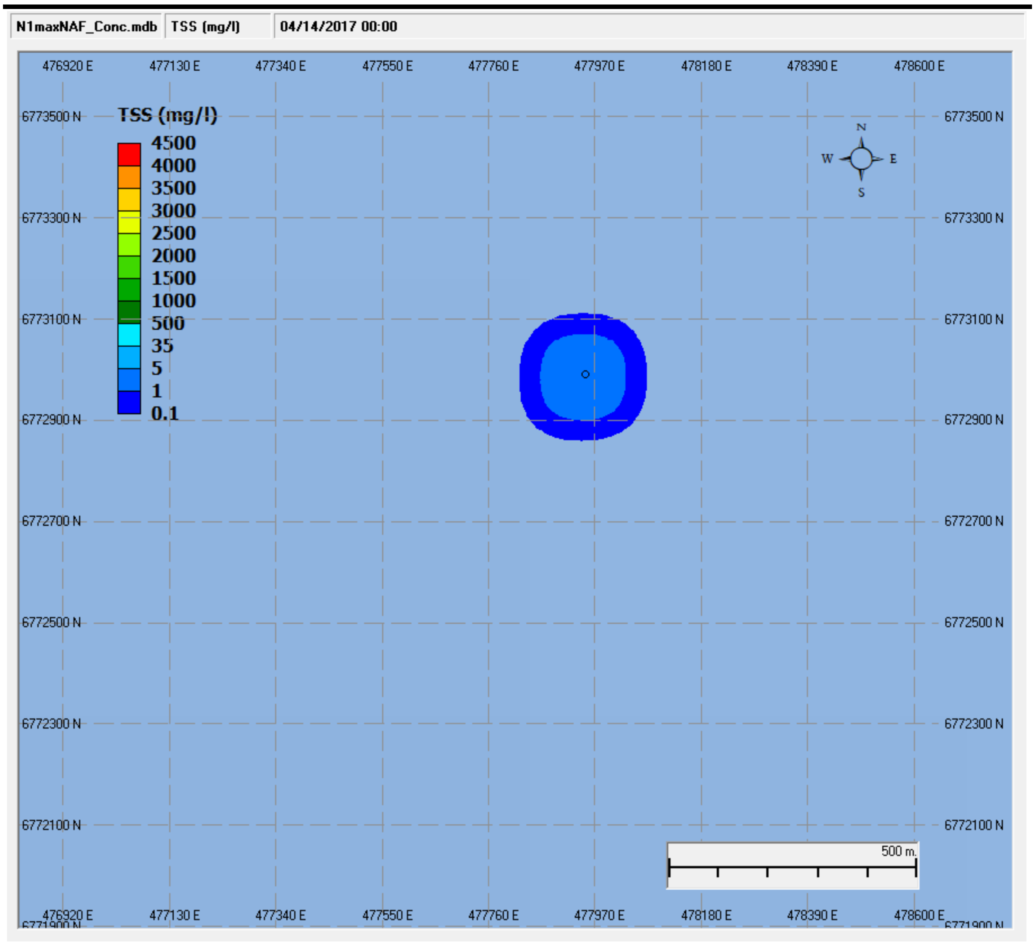
For Scenario 2, TSS levels exceeded the 35 mg/l threshold criterion in a very small area (< 0.01 km²) surrounding the well center (*Figure 4.3*). TSS will not exceed the 35 mg/l threshold criterion at the surface (*Figure 4.4*).

Figure 4.3 Well Location N1 - Scenario 2: Maximum TSS, Maximum Monthly Average Currents – Sections 1 and 2



Source: ERM

Figure 4.4 *Well Location N1 - Scenario 2: Maximum TSS, Maximum Monthly Average Currents – Sections 3-5*

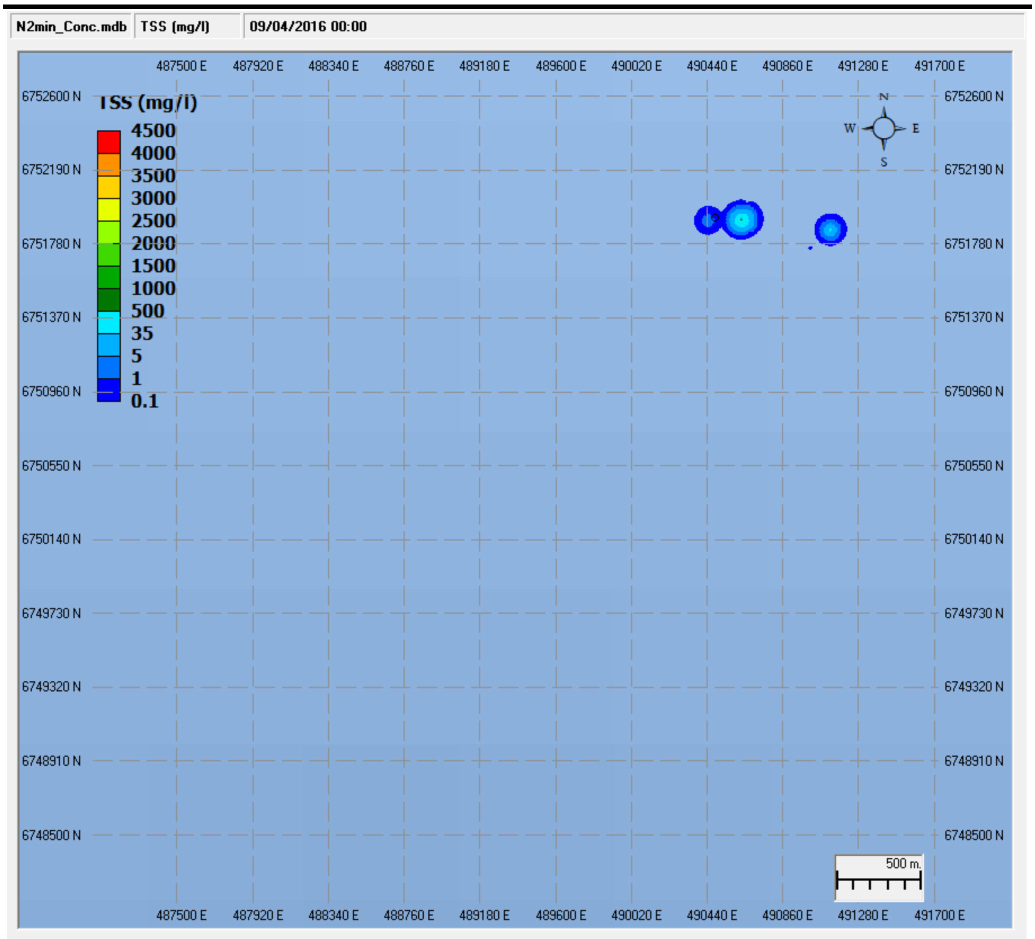


Source: ERM

4.1.2 Well Location N2

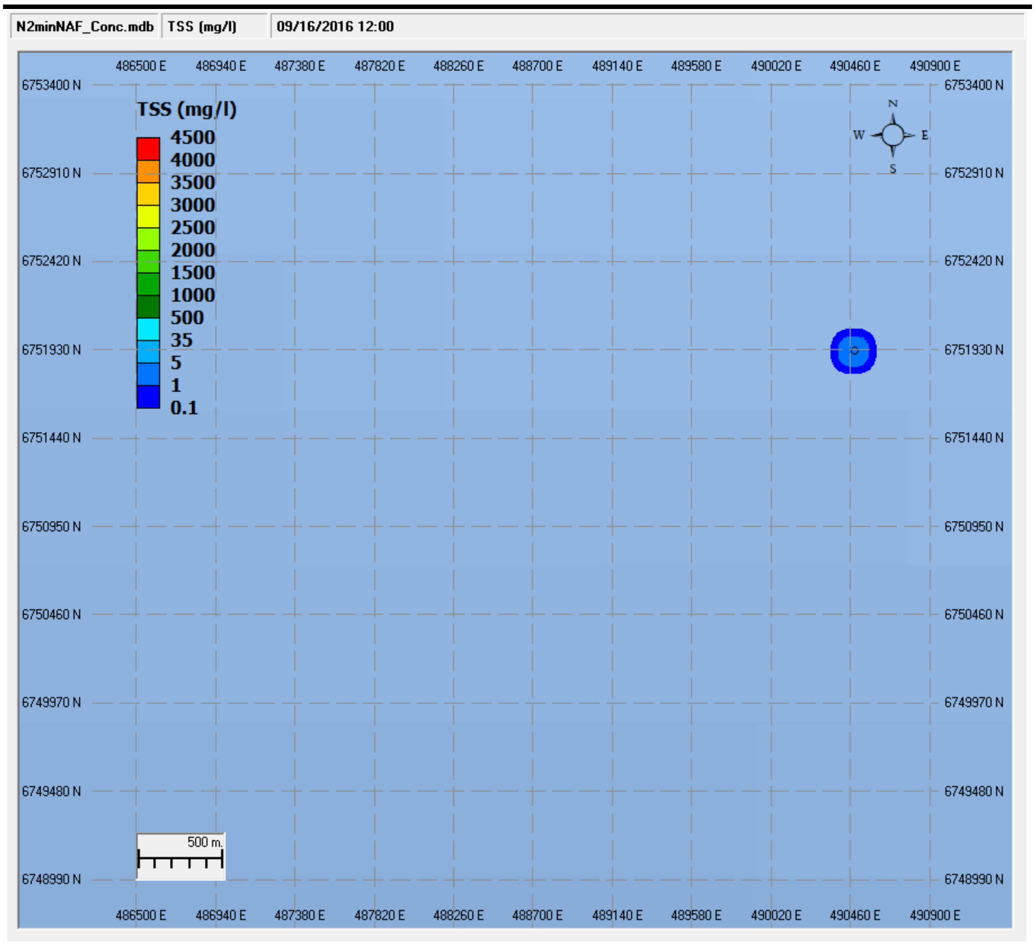
For Scenario 1, TSS levels exceeded the 35 mg/l threshold criterion in a very small area (< 0.01 km^2) surrounding the well center (*Figure 4.5*). TSS will not exceed the 35 mg/l threshold criterion at the surface (*Figure 4.6*).

Figure 4.5 Well Location N2 - Scenario 1: Maximum TSS, Minimum Monthly Average Currents – Sections 1 and 2



Source: ERM

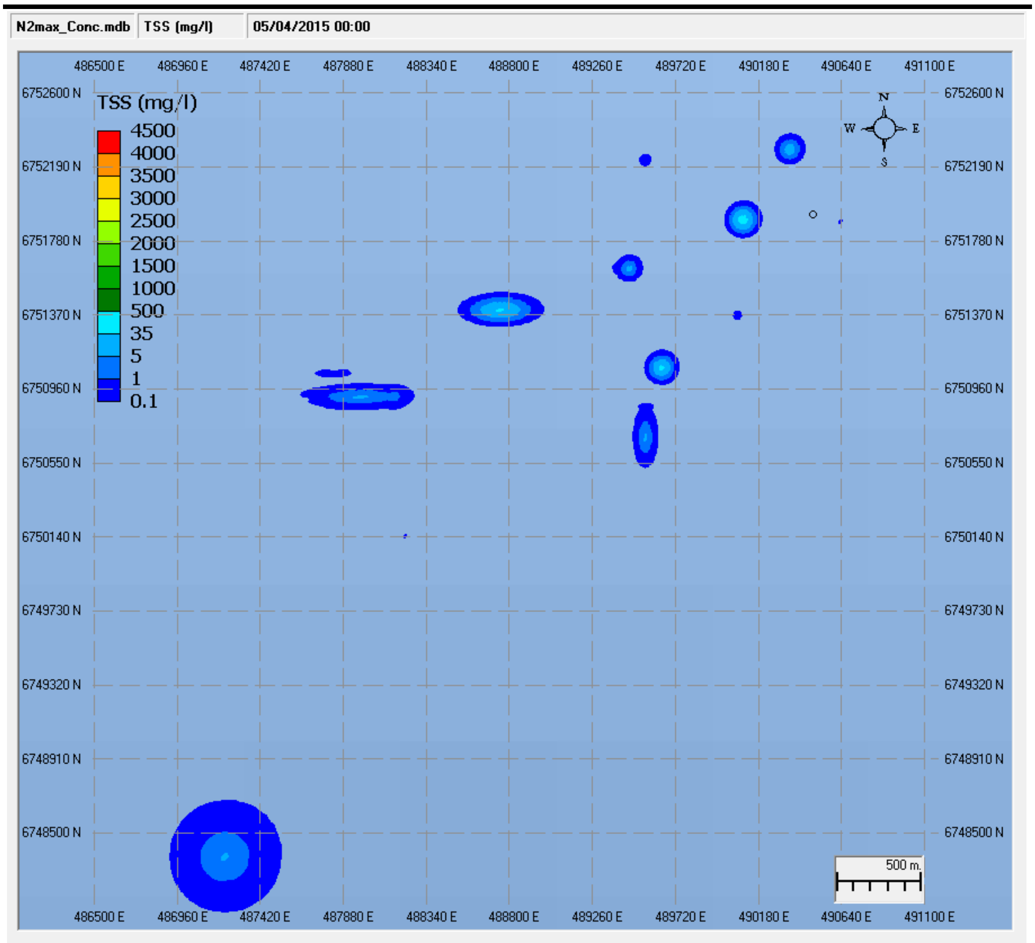
Figure 4.6 Well Location N2 - Scenario 1: Maximum TSS, Minimum Monthly Average Currents – Sections 3-5



Source: ERM

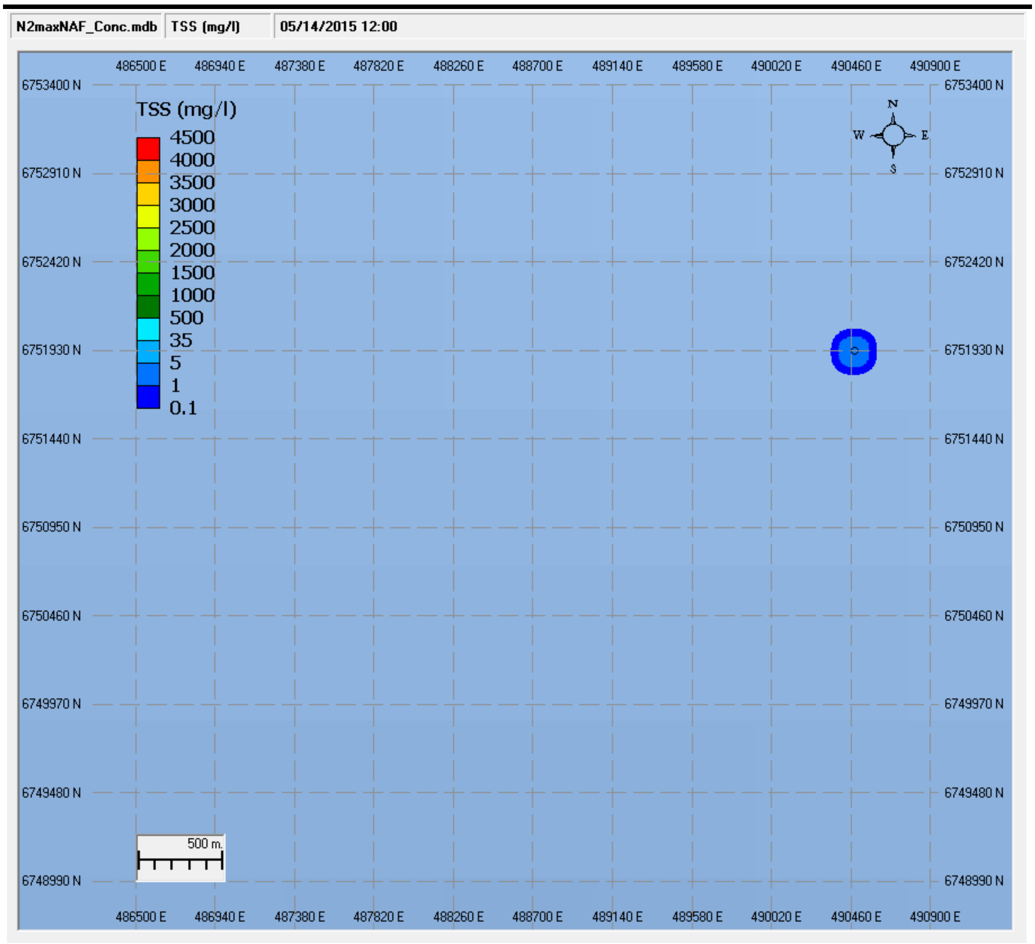
For Scenario 2, TSS levels exceeded the 35 mg/l threshold criterion in several small areas (< 0.01 km^2 total area) west and southwest of the well center (*Figure 4.7*). TSS will not exceed the 35 mg/l threshold criterion at the surface (*Figure 4.8*).

Figure 4.7 Well Location N2 - Scenario 2: Maximum TSS, Maximum Monthly Average Currents – Sections 1 and 2



Source: ERM

Figure 4.8 *Well Location N2 - Scenario 2: Maximum TSS, Maximum Monthly Average Currents – Sections 3-5*

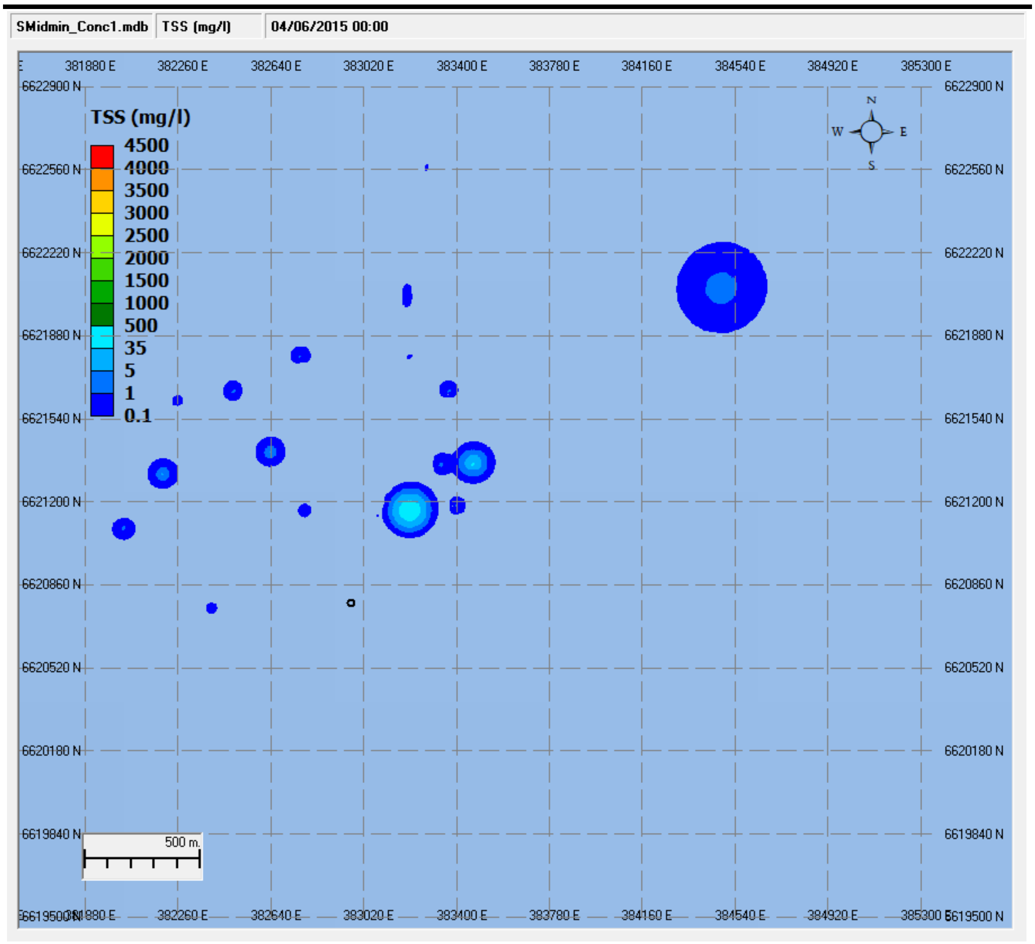


Source: ERM

4.1.3 *Well Location S*

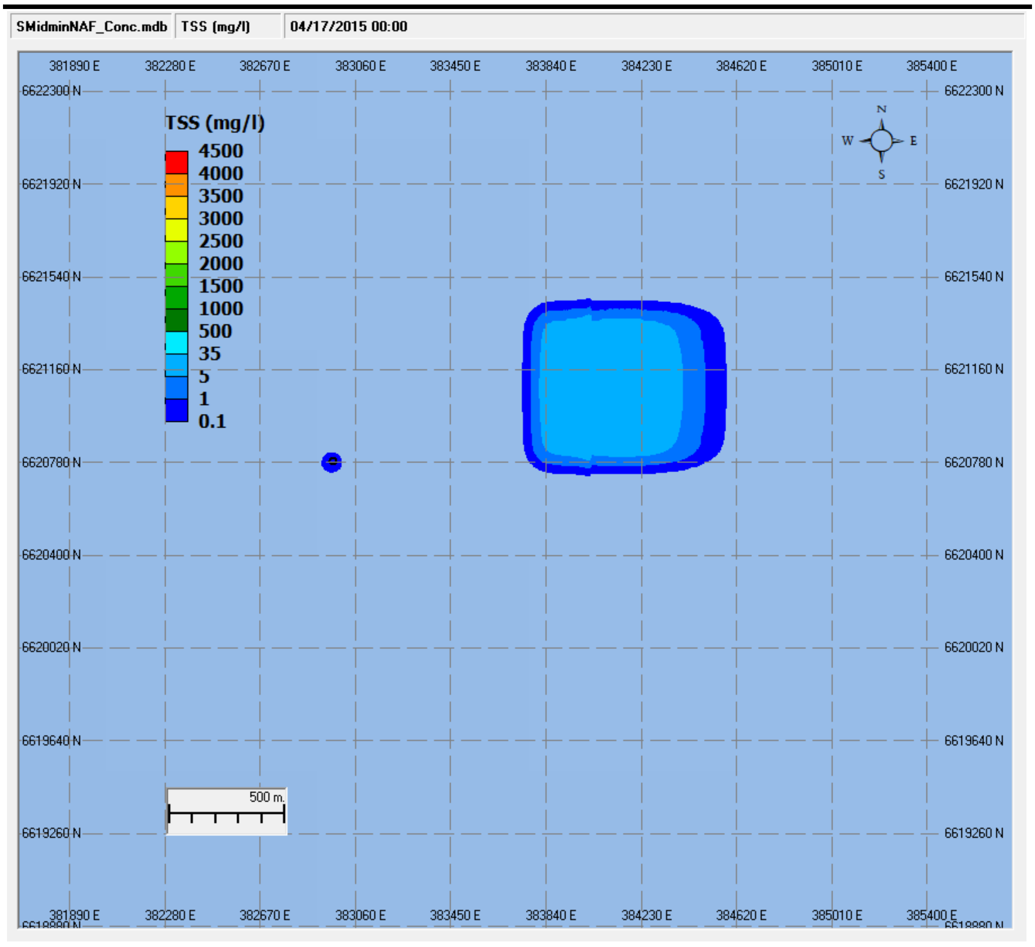
For Scenario 1, TSS levels exceeded the 35 mg/l threshold criterion in two very very small areas (< 0.01 km^2 total area) north- northwest of the well center (*Figure 4.9*). TSS will not exceed the 35 mg/l threshold criterion at the surface (*Figure 4.10*).

Figure 4.9 Well Location S - Scenario 1: Maximum TSS, Minimum Monthly Average Currents – Sections 1 and 2



Source: ERM

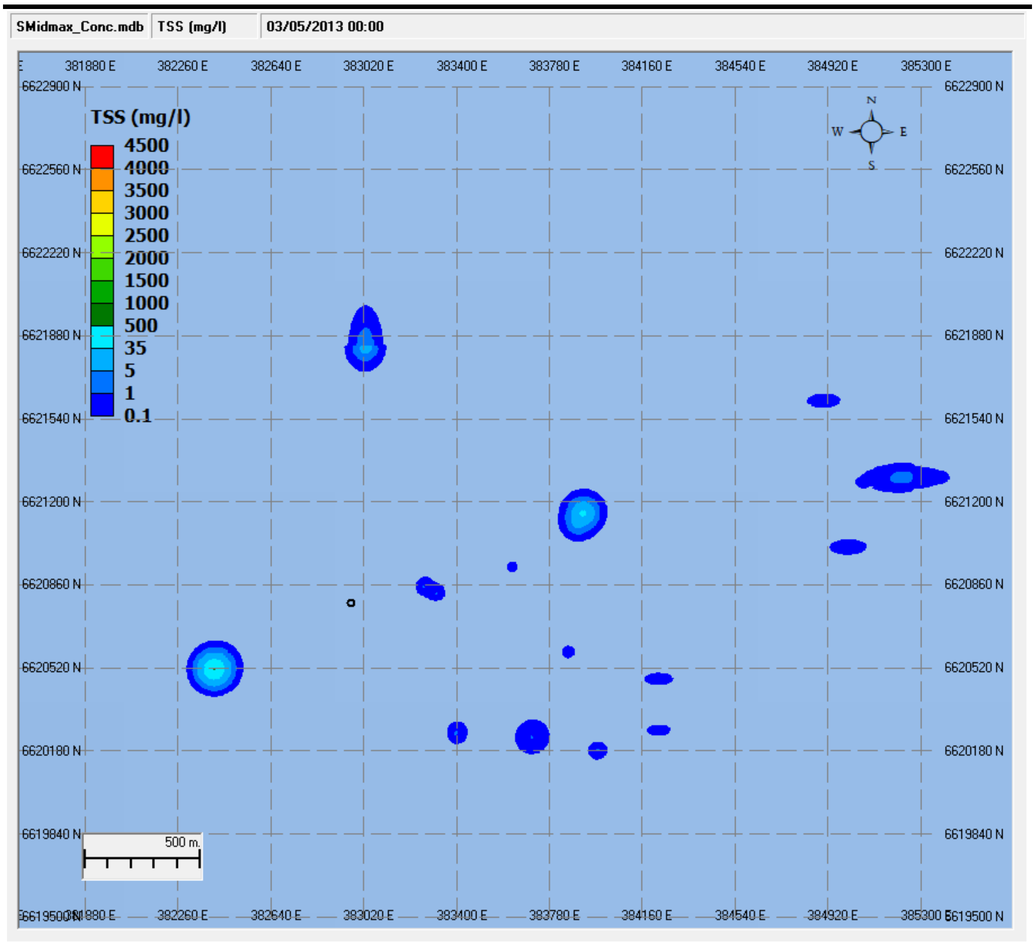
Figure 4.10 Well Location S - Scenario 1: Maximum TSS, Minimum Monthly Average Currents – Section 3-5



Source: ERM

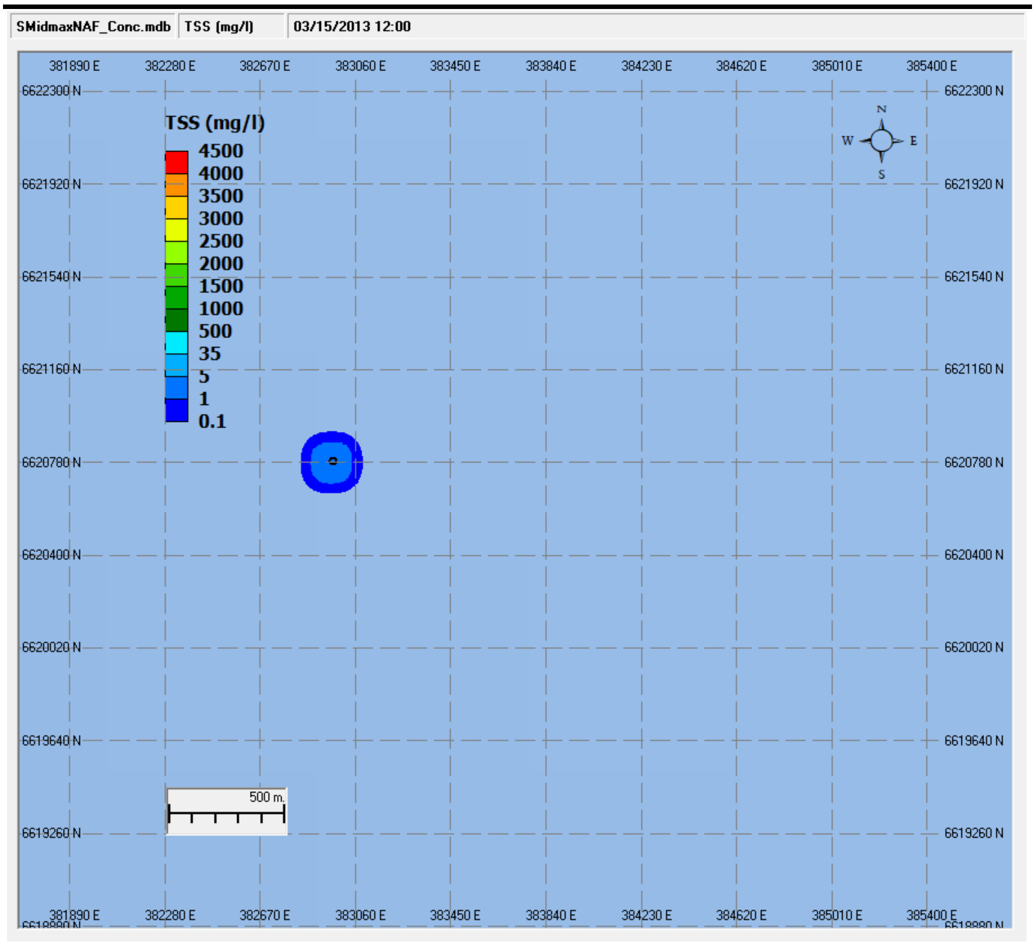
For Scenario 2, TSS levels exceeded the 35 mg/l threshold criterion in two small areas (< 0.01 km^2 total area) southwest and northeast of the well center (*Figure 4.11*). TSS will not exceed the 35 mg/l threshold criterion at the surface (*Figure 4.12*).

Figure 4.11 Well Location S - Scenario 2: Maximum TSS, Maximum Monthly Average Currents – Sections 1 and 2



Source: ERM

Figure 4.12 Well Location S - Scenario 2: Maximum TSS, Maximum Monthly Average Currents – Sections 3-5



Source: ERM

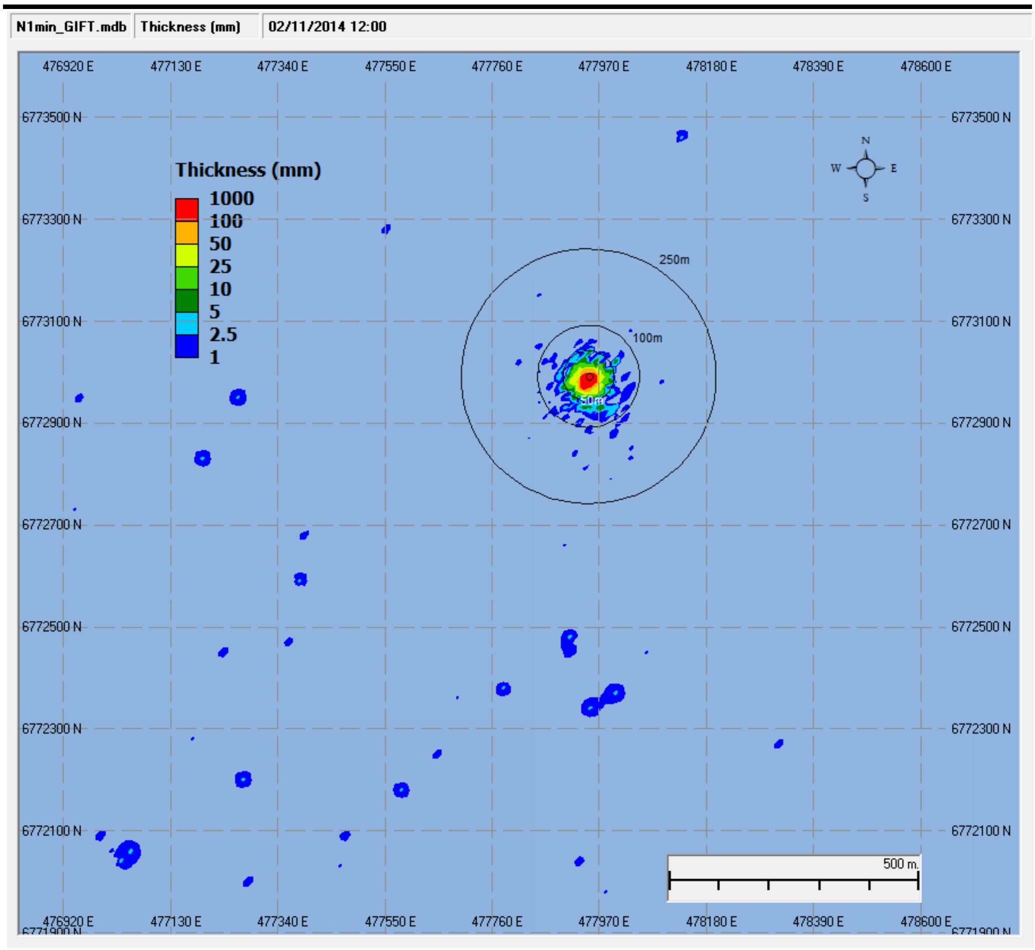
4.2 BOTTOM DEPOSITION

4.2.1 Well Location N1

Figure 4.13 and *Figure 4.14*, below show the expected thickness of cuttings and associated drilling fluids on the seabed as a result of drilling for Scenario 1 and Scenario 2, respectively.

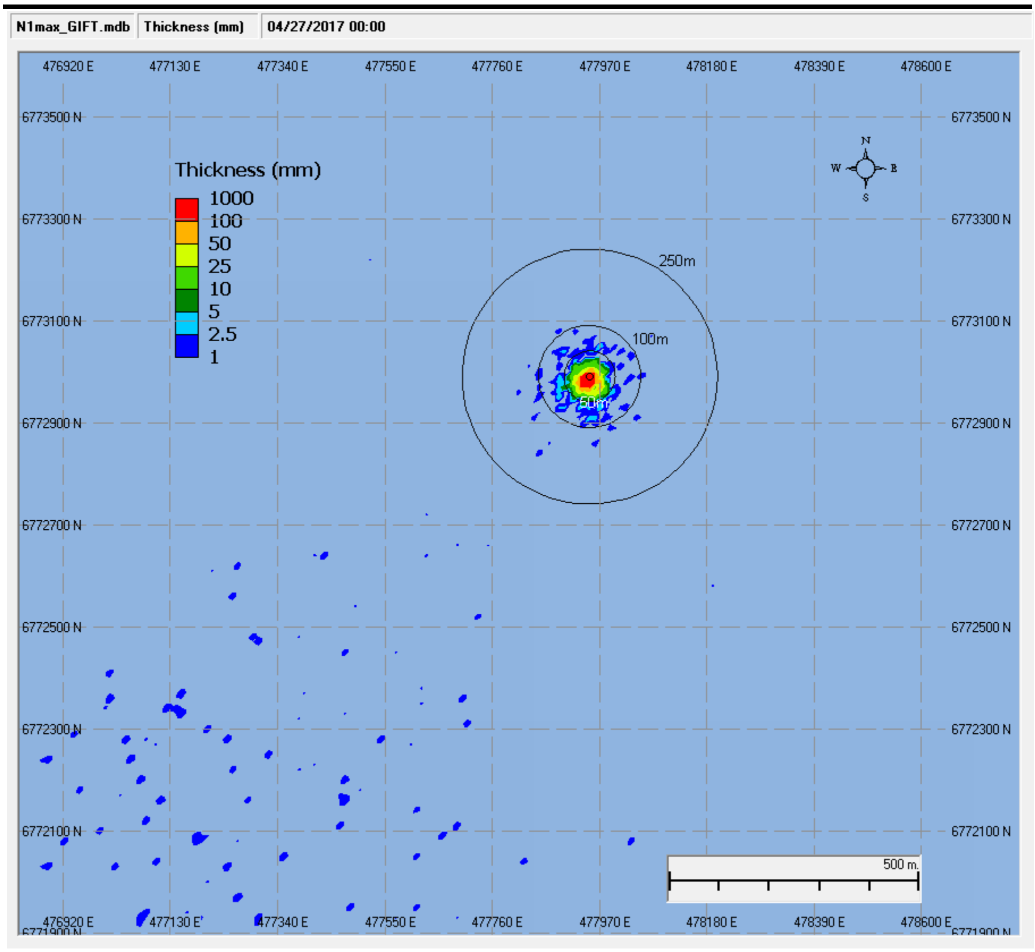
Benthic organisms located within the 5 cm thickness of deposited material contour will be impacted by the discharge. Smothering effects, including mortality, are considered possible within this area. In Scenario 1, the area of deposits above 5 cm is approximately 1500 m^2 that is irregularly oval shaped and with a minimum diameter of ~40 m and maximum diameter of ~50 m. In Scenario 2, the area of deposits above 5 cm is approximately 1400 m^2, irregularly oval shaped with a minimum diameter of ~45 m and maximum diameter of ~50 m.

Figure 4.13 Well Location N1 – Scenario 1: Bottom Deposition Thickness After Drilling Sections 1-5, Minimum Monthly Average Currents



Source: ERM

Figure 4.14 Well Location N1 – Scenario 2: Bottom Deposition Thickness After Drilling Sections 1-5, Maximum Monthly Average Currents



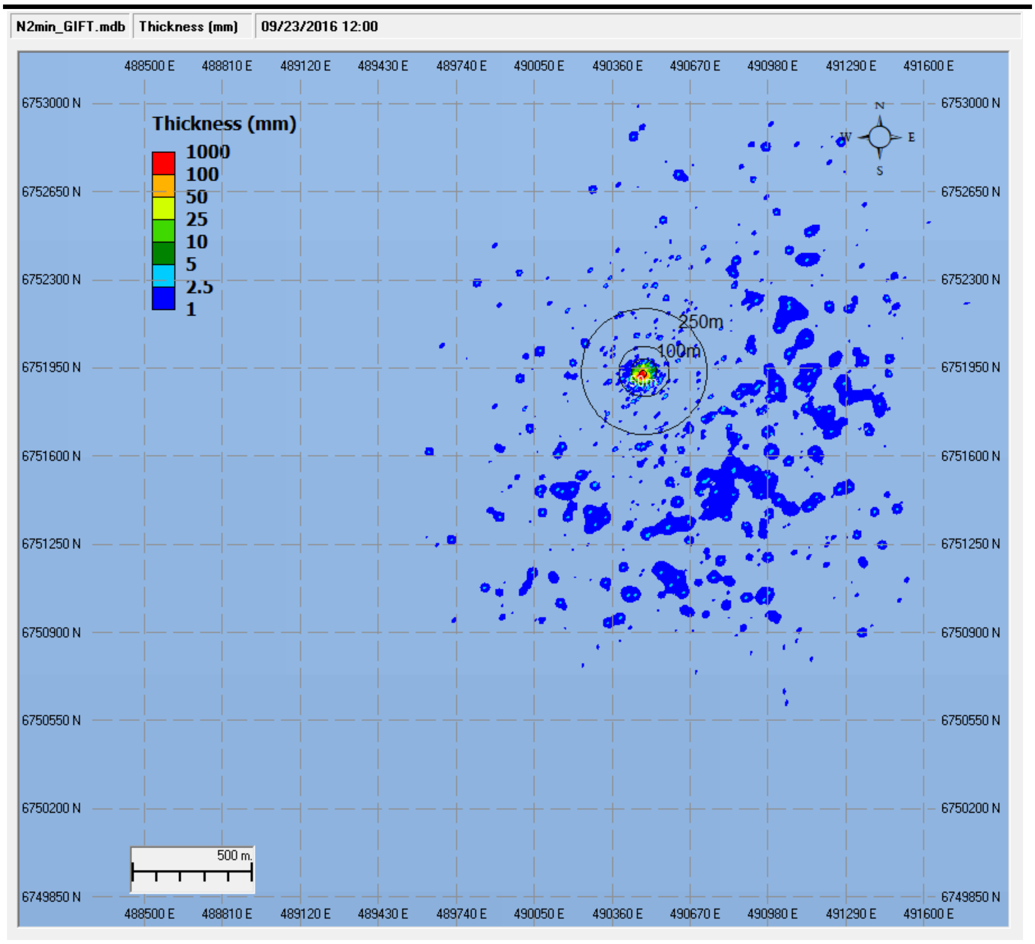
Source: ERM

4.2.2 Well Location N2

Figure 4.15 and *Figure 4.16*, below show the expected thickness of cuttings and associated drilling fluids on the seabed as a result of drilling for Scenario 1 and Scenario 2, respectively.

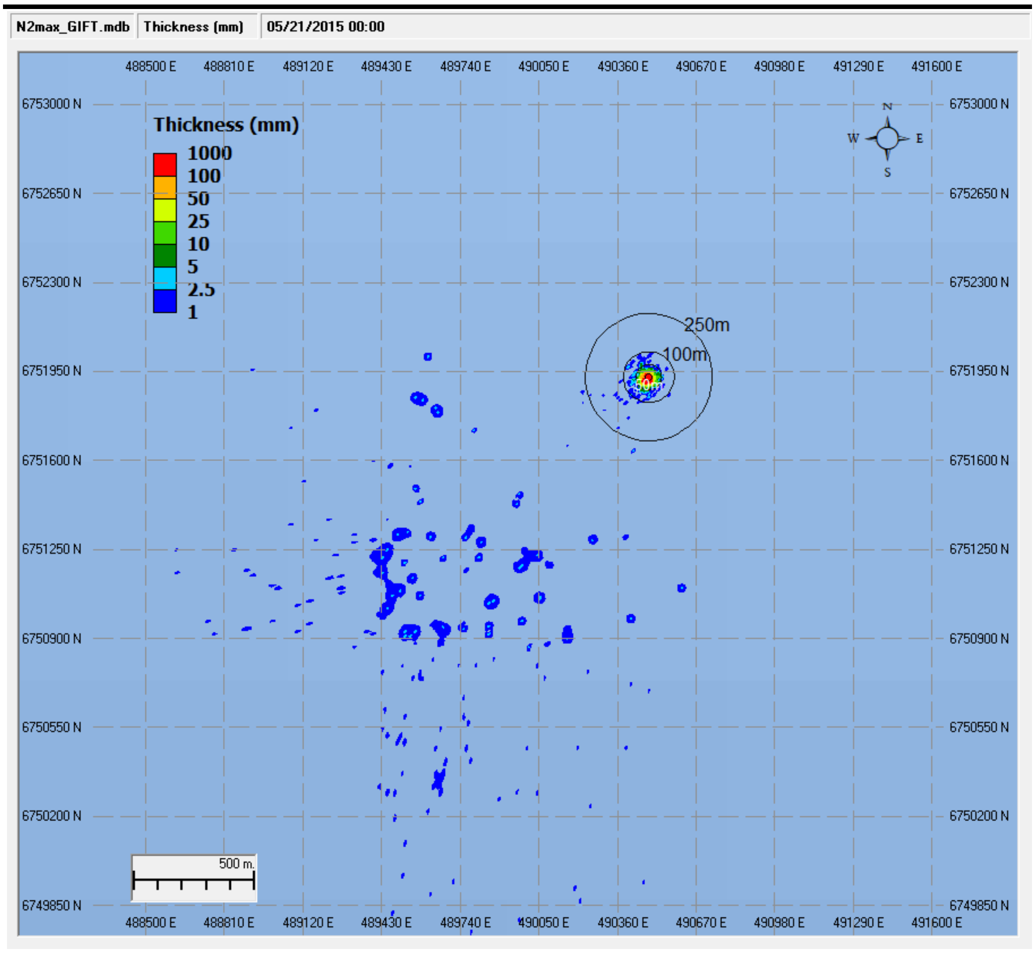
In Scenario 1, the area of deposits above 5 cm is approximately 1500 m² that is irregularly oval shaped and with a minimum diameter of ~45 m and maximum diameter of ~50 m. In Scenario 2, the area of deposits above 5 cm is approximately 2000 m², irregularly oval shaped with a minimum diameter of ~50 m and maximum diameter of ~55 m.

Figure 4.15 Well Location N2 – Scenario 1: Bottom Deposition Thickness After Drilling Sections 1-5, Minimum Monthly Average Currents



Source: ERM

Figure 4.16 Well Location N2 – Scenario 2: Bottom Deposition Thickness After Drilling Sections 1-5, Maximum Monthly Average Currents



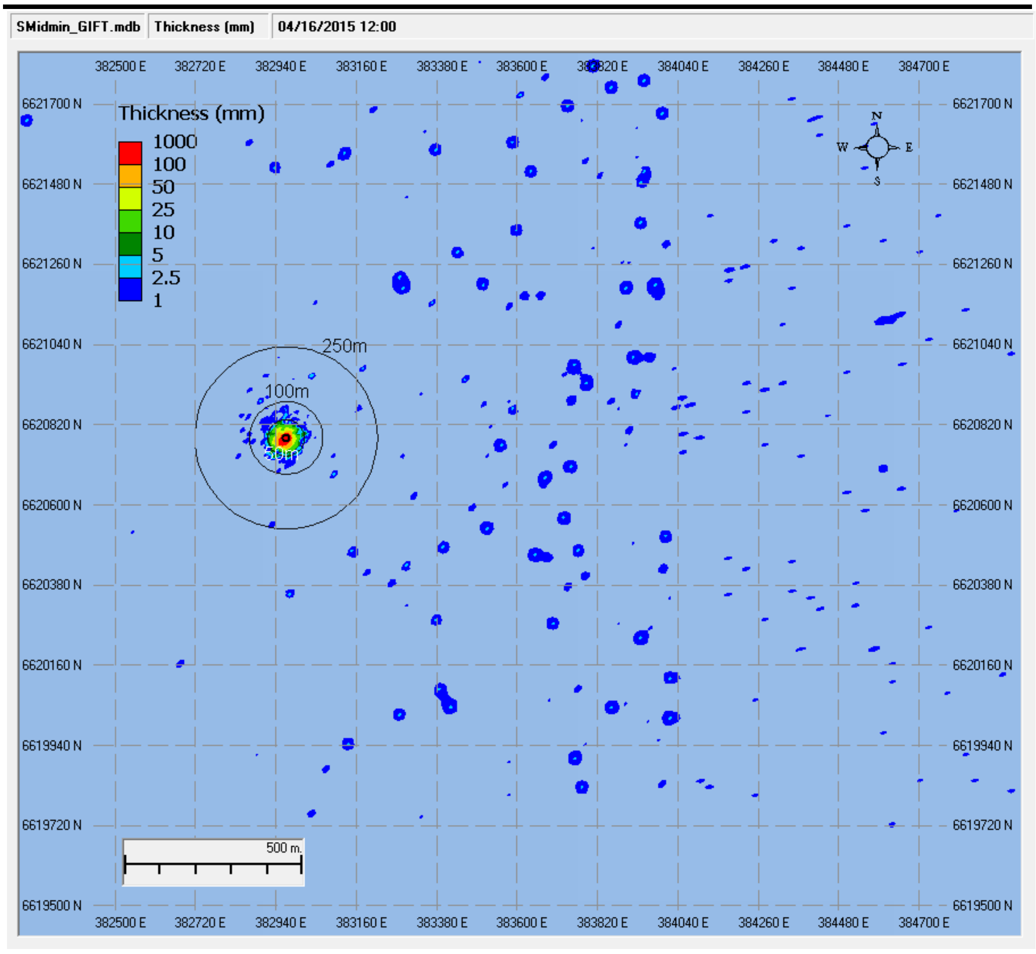
Source: ERM

4.2.3 Well Location S

Figure 4.17 and *Figure 4.18*, below show the expected thickness of cuttings and associated drilling fluids on the seabed as a result of drilling for Scenario 1 and Scenario 2, respectively.

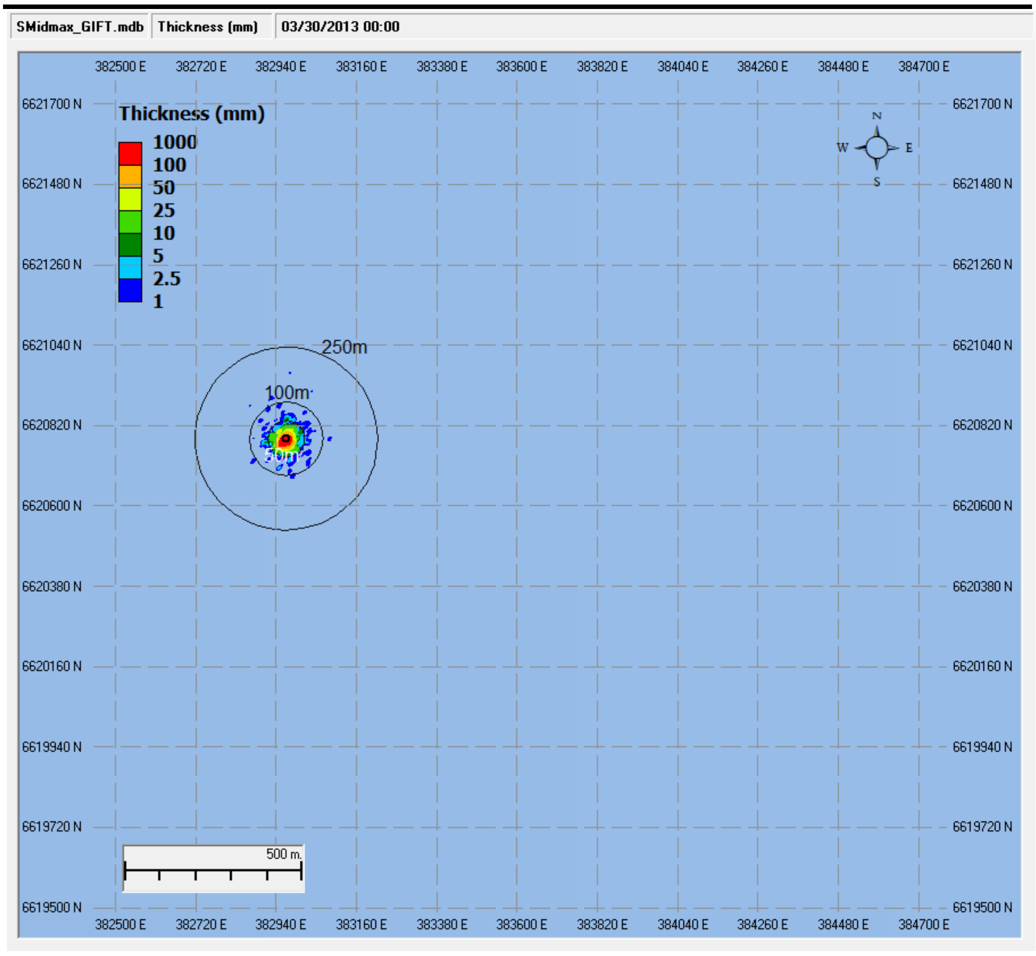
Benthic organisms located within the 5 cm thickness of deposited material contour will be impacted by the discharge. Smothering effects, including mortality, are considered possible within this area. In Scenario 1, the area of deposits above 5 cm is approximately 1700 m² that is irregularly oval shaped and with a minimum diameter of ~50 m and maximum diameter of ~50 m. In Scenario 2, the area of deposits above 5 cm is approximately 1750 m², irregularly oval shaped with a minimum diameter of ~50 m and maximum diameter of ~55 m.

Figure 4.17 Well Location S – Scenario 1: Bottom Deposition Thickness After Drilling Sections 1-5, Minimum Monthly Average Currents



Source: ERM

Figure 4.18 Well Location S – Scenario 2: Bottom Deposition Thickness After Drilling Sections 1-5, Maximum Monthly Average Currents



Source: ERM

5 CONCLUSIONS

The key findings from the drill cutting modeling include:

- ***Total Suspended Solids*** –TSS concentrations added to the ocean will only exceed the 35 mg/L threshold in a small area (< 0.01 km^2) immediately surrounding the well center at each location. Surface discharge is not expected to exceed the 35 mg/L threshold.

- ***Depositional Thickness*** – Smothering effects on benthic organisms are considered possible in areas where a layer with thickness of 5 cm or more is deposited within a month. The region on the seafloor with deposits greater than 5 cm is primarily due to the top hole sections discharging directly to the seafloor. The maximum area of deposits above 5 cm is less than 2800 m^2 at each location.

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7 *Details of Specialist and Declaration of Interest*

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE

Eni Upstream - AMTE and Eni South Africa BV - Eni Upstream - AMTE and Eni South Africa BV - Environmental Impact Assessment for Proposed Exploration Drilling in Block ER 236, offshore of Kwa-Zulu Natal Coast of South Africa – Drill Cuttings and Muds Modelling Report

Specialist:	Michael J. Fichera		
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Postal address:	75 Valley Stream Parkway, Suite 200, Malvern, PA, USA		
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E-mail:	michael.fichera@erm.com		
Professional affiliation(s) (if any)	SETAC		

Project Consultant:			
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

4.2 The specialist appointed in terms of the Regulations_

I, Michael J. Fichera ____________________ , declare that --

General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

ERM, Inc.

Name of company (if applicable):

2018-09-18

Date:

Michael J. Fichera

Senior Project Engineer

Michael is a senior project engineer with experience since 1993 in water quality and oil spill modeling, natural resource damage assessments (NRDA), risk assessment, and project management. He is skilled in modeling hydrodynamics, oil spills, dredge disposal / drill cutting transport, thermal plumes, water quality, eutrophication, toxicity, and food web simulations. His oil spill modeling experience has been applied in response to major accidents for live trajectory predictions and injury estimations, for investigating potential origins of mysteriously oiled shorelines, and for predicting impacts due to hypothetical spills for environmental impact assessments.

Experience: 24 years' experience in water quality and oil spill modeling, natural resource damage assessments (NRDA), and environmental risk assessment

Email: Michael.Fichera@erm.com

Education

M. E., Environmental Engineering, Manhattan College, 1993
B. S., Civil Engineering, Manhattan College, 1991

Professional Affiliations and Registrations

Professional Engineering License, Delaware, 1998
Society of Environmental Toxicology and Chemistry (SETAC)
Hudson Delaware Chapter of SETAC (HDC-SETAC)
Water Environment Federation (WEF)
Chi Epsilon Civil Engineering Society
Tau Beta Pi Engineering Society

Languages

English, native speaker

Fields of Competence

Environmental Engineering
Oil Spill Modeling
Drilling Mud and Cuttings Modeling
Water Quality Modeling
Environmental Impact Assessments
Environmental Chemistry

Key Industry Sectors

Oil and Gas
Power

Key Projects

Chemical/Oil Spill Emergency Response Plan

For a strategic initiative to develop a model to estimate the exposure, duration, and potential toxicological impacts of oil and chemical spills, worked to construct the Chemical / Oil Spill Impact Module (COSIM). The module, a plug-in component of ERM's Generalized Environmental Modeling System for Surfacewaters (GEMSS), was designed for use for emergency response, emergency planning or hindcasting. Within the GEMSS framework, COSIM can produce simulations of the fate and transport of the various oil constituents and produce 3-D visualizations and animations.

Oil Spill and Drill Cuttings Deposition Modeling
Performed oil spill and drill cuttings deposition modeling for Environmental Impact Assessments (EIA) for over 50 projects around the world including Argentina, Colombia, Guyana, around the African coast (including Algeria, Morocco, Mauritania, Ghana, Nigeria, Gabon, the Democratic Republic of the Congo, Angola, and Mozambique), northern and western Australian coasts, Southeast Asia (including Malaysia, Brunei, Sulawesi, Vietnam), New Zealand, Italy, and in the Gulf of Mexico.

Natural Resource Damage Assessments (NRDA)
Assessed the fate, transport, and toxicity of oil during several major US oil spills for Natural Resource Damage Assessments (NRDA). Acted as project manager for NRDA oil spill modeling during the Deepwater Horizon incident's aquatic injury assessment. Performed modeling processes concurrently with trustee-appointed modelers to facilitate the cooperative process. Assessed potential aquatic injuries associated with dissolved polyaromatic hydrocarbons (PAHs) in the water column. Designed and directed laboratory oil toxicity experiments.

Marine Oil Spill Models
Provided marine oil spill models for an oil company's terminals and pipelines as part of regulatory compliance with Washington State Dept. of Ecology and internal Oil Spill Preparedness & Response plans.

Oil Spill Study
Performed a baseline oil spill study for the Aleutian Islands Risk Assessment (AIRA). The goal of this study was to produce a comprehensive evaluation of the risk of vessel accidents and spills in the Aleutian Islands, with the ultimate goal of identifying risk reduction measures that can be implemented to improve the level of safety related to shipping operations in the region.

Expert Testimony
Provided oil spill modeling expertise for a class-action law suit related to large coastal oil spill.

Nutrient Water Quality Modeling
Designed, calibrated and validated a water quality model for a major phosphorus mine in Florida discharging into a local stream to assess potential water quality impacts and benefits related to relocation of the facility's effluent pipe.

Environmental Impact Assessment
Performed modeling to assess potential impacts related to dredging, dredge spoil deposition, and oil spills related to proposed construction of the Nicaragua Grand Canal.

Emergency Response Site Assessment
Provided emergency response site assessment for shoreline oiling and potential injury to local biota for the Port Mobil Explosion and Oil Spill, Staten Island, New York.

Hydrodynamic/Water Quality Modeling
Managed hydrodynamic / water quality modeling of the Delaware Inland Bays for TMDL analysis upon impaired waters on the State of Delaware 303(d) list. Modeling included linkage to USGS HSPF model for model input of non-point source loads.

Food Chain Modeling
Utilized food chain modeling from sediments, plankton, fish, and birds to determine pesticide contamination liability.

Sediment Chemistry Survey
Designed and managed a sediment chemistry survey / toxicity identification evaluation (TIE) for a U. S. Superfund site.

Acid Attenuation Modeling
Created an acid attenuation model to estimate the fate and transport of an acidic leak into an aquifer.

Publications

Fichera, M. J., V. S. Kolluru, L.M.O'Hanlon, Jessica G. Webber, S. L. Friant and R. K. Markarian. 2001. Oil Spill Water Column Injury Assessment Using PAH Specific Hydrodynamic Fate and Transport Modeling. Society of Environmental Toxicology and Chemistry 22nd Annual Meeting, November 11-15, 2001. Baltimore, Maryland.

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Tesch L., V. S. Kolluru, A. Southam, M. J. Fichera. 2015. “Synopsis of the 2010-2011 Aleutian Islands Oil Spill Risk Analysis” presented at the 38th AMOP Technical Seminar on Environmental Contamination and Response, Vancouver, British Colombia, Canada