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25 July 2024

Shaun Lee
shaun@stet.co.nz

Our ref: F35182
By email

Dear Shaun,

Official Information Act request for oil spill trajectory modelling from the wreck of the *RMS Niagara*

I refer to your email to Maritime NZ on 30 June 2024 in which you requested oil spill trajectory modelling from the wreck of the ***RMS Niagara***.

We have considered your request under the Official Information Act 1982 (the Act). Accordingly, please find attached the most recent oil spill modelling for ***RMS Niagara*** which was conducted in 2016.

This modelling is based on the hypothetical release of 100 cubic metres (which is 100,000 litres) of Heavy Fuel Oil in both summer and winter over a period of 30 days and assumes no attempt to contain the oil spill. This modelling was used to inform planning for a response to a potential oil spill from ***RMS Niagara*** and does not imply that Maritime NZ expects such a leak to occur.

Oil spill trajectory modelling (OSTM) is typically used during an oil spill response to predict where surface (free-floating) oil will travel, where the oil might be stranded on coastlines (noting that some oil spills do not result in oiled shorelines), the speed of the oil's spread, the timing of the spill's travel, and the timing of shoreline impacts.

The 100m^3 volume was deliberately selected as the quantity to input into the model because it is of sufficient size to ensure that the model could be run for 30 days without the spill naturally disappearing (and therefore the model ending early).

Any oil spill is subject to natural processes. We call this 'weathering', which changes the physical characteristics of the spilled oil as time goes by. The are many natural processes which affect an oil spill including: evaporation – some of the liquid may form a vapour and enter the surrounding atmosphere; dispersion – some of the oil may naturally disperse into the upper layers of the water column; photo-oxidation – where sunlight promotes chemical reactions between oxygen in the air and the oil; biodegradation – where bacteria in the ocean feeds on the oil; and emulsification – a mixture of water and oil droplets (these can be droplets of oil in water, or droplets of water in oil). It is important to remember that these processes are likely to affect the impact of the oil spill; for example, if oil contacts land ashore after three days, the oil will have very different characteristics to those of freshly-spilled oil.

OSTM takes into account a range of met-ocean conditions such as currents - including coastal currents and tidal currents and tidal flows, wind, sea state (i.e., how calm or choppy the sea surface is, and how much swell there is), wind-driven currents (as strong winds generate additional currents), sea surface temperature etc.

OSTM is a science; significant additional work is done to verify that the models generate outputs that are reliable; however, in an actual response we will always track the actual size, shape, trajectory and characteristics of surface oil using visual or remote-sensing techniques.

So all modelled outputs are indicative only, and will be verified through a new OSTM in the event of an actual oil spill taking into account actual and forecast weather and the meteorological ocean conditions.

The OTSM model was produced to deliberately illustrate very low-level shoreline impacts (with a probability of oil exposure between 1-10%) because it allows us to see the modelled oil spill trajectory in its entirety. If we had only mapped severe shoreline impacts there would be very few areas of potentially oiled shoreline shown.

I trust this fulfils your request. You have the right to seek an investigation and review by the Ombudsman of this decision. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

If you wish to discuss this decision, please feel free to email us at ministerial.services@maritimenz.govt.nz.

Yours sincerely

Christine Ross
Manager, Communication and Ministerial Services

MEMORANDUM

Date:	1/12/2016
To:	Dayne Maxwell – Maritime New Zealand
From:	Dr Ben Brushett and Dr Sasha Zigic
Reference:	R0030
Subject:	RMS Niagara – Seasonal Spill Modelling Assessment

1. Situation Details

RPS APASA was commissioned by Maritime New Zealand (MNZ) to carry out an oil spill modelling assessment for the RMS Niagara wreck, located north of Hauraki Gulf (refer to Figure 1 and Table 1) lying in approximately 120m of water.

As there is oil remaining on board the vessel there is a significant threat of an oil spill which may impact the Northlands east coast. A contingency plan has been developed to assist with responding to a spill from the Niagara and the seasonal modelling results within this memo will help to identify likely areas that may be affected.

The modelling study examined hypothetical discharge of 100 m^3 of furnace oil from the wreck, released over 24 hours and tracked for 30 days. A seasonal assessment was carried out to determine the likely risks based on the two main seasons, summer (November to April) and winter (May to October).

Table 1 shows details the oil spill model setup parameters used in this assessment.

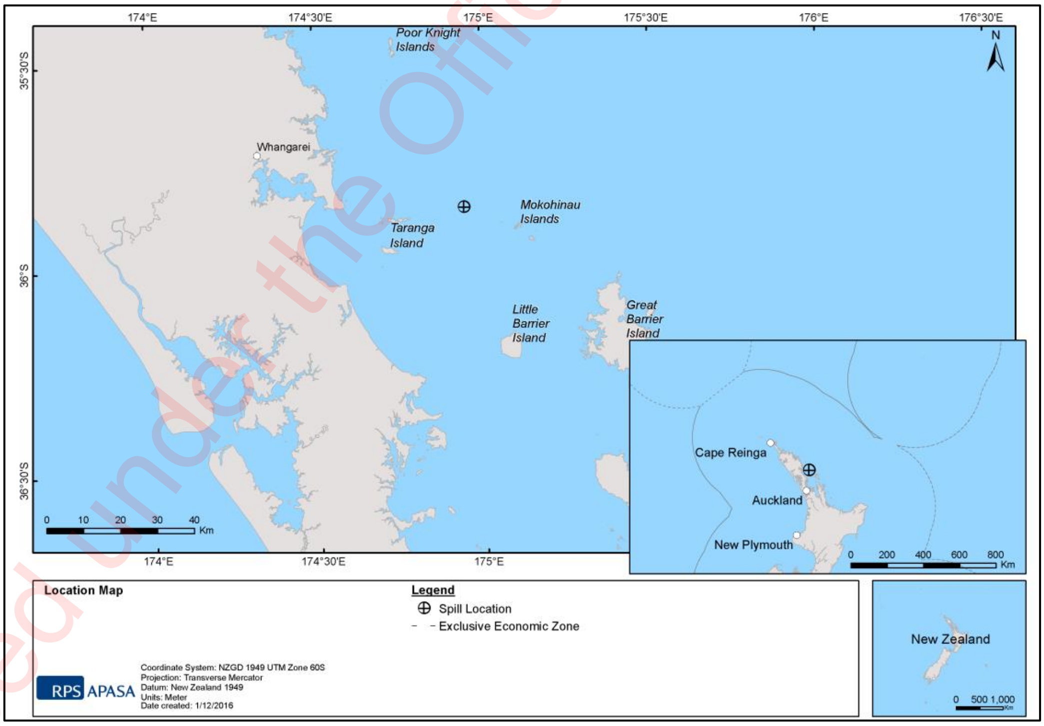

Figure 1: Location of the RMS Niagara wreck of the New Zealand North Island.

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Table 1: Oil spill model setup parameters

Shipwreck name	RMS Niagara
Spill location (WGS 84 datum)	35º 51.6' S, 174º 56.75' E
Total release volume (m^3)	100
Release duration (hours)	24
Simulation length (days)	30
Oil type	Furnace Oil (Heavy Fuel Oil used as a proxy)
Seasons	Summer (Nov – April), Winter (May – Oct)
Years Sampled	2011 – 2015 inclusive
Wind Data	CFSR
Current Data	HYCOM + Tides
Number of Simulations	100 per season (200 total)

2. Model Description

Oil Spill Model

The oil spill modelling was performed using OILMAP. OILMAP simultaneously calculates the movement, spreading, evaporation and shoreline exposure of spilled oil over time, based on the prevailing wind and current conditions and the physical and chemical properties of the oil type. The model uses the specific properties of each oil type to predict weathering under different conditions. These specific properties include the density, viscosity, surface tension and the slope of the distillation curve. These properties are used to determine the oil's spreading, evaporation, entrainment and shoreline interactions. If oil reaches the shorelines (as defined in the OILMAP GIS), details are recorded on the quantity, travel time to exposure the shore, and habitat resources at the stranding location. It also incorporates a geographic information system (GIS) for defining the location and nature of natural resources, which is often helpful in analysing and interpreting model predictions.

Predictions of the OILMAP model have been validated worldwide (Spaulding et. al., 1992; 1994), including Australia (King et. al., 1999) and New Zealand (Zigic et al., 2009).

Seasonal Modelling

The model (OILMAP) may be used to simulate the fate of a single hydrocarbon spill at a specified time and therefore under a given set of time-varying wind and current conditions. This is the general approach for an exercise or a known spill event.

As spills can occur during any set of wind and current conditions, to determine the potential oil exposure during each distinct season (seasonal results), one hundred spill trajectories were simulated per season. Each spill trajectory had the same spill information (release location, spill volume, duration and oil type) but randomly varied start dates and times between 2011–2015. This approach ensured that each spill trajectory was exposed to varying sets of current and wind conditions.

Once all of the spill trajectories have been run, the model then combines the results to determine the following:

(1) Probability of oil exposure to the sea surface and shoreline contact; and

(2) Minimum time before oil exposure to the sea surface and shoreline contact.

The seasonal results do not represent the extent of any one oil spill event (which would be substantially smaller) but rather provides a summary of all 100 spill trajectories for a given season. A total of **200** spill trajectories were modelled for the assessment.

Reporting Thresholds

The OILMAP model is able to track hydrocarbons to levels lower than biologically significant or visible to the naked eye. Therefore, reporting thresholds have been specified (based on the scientific literature) to account for “exposure” at meaningful levels. Results at low, moderate and high threshold levels have been presented for the sea surface and shorelines.

The low thresholds are considered below levels which would cause environmental harm and are more indicative of the areas perceived to be affected due to its visibility on the sea surface/shoreline and potential to trigger temporary closures of areas (i.e. fishing grounds) as a precautionary measure. It can be also referred to as the social threshold. The moderate threshold was defined according to levels likely to mortally impact wildlife and shorelines could be amenable to clean-up. This level can be considered the ecological threshold. The high threshold represents the zone which has the greatest potential for spill response strategies to be effective. This level can be considered the spill response threshold. Table 2 shows a summary of the oil spill modelling thresholds used during the study.

Table 2 Summary of oil spill modelling thresholds

Zone threshold	Zone description	Sea surface threshold and appearance	Shoreline threshold and appearance
Low	Social –potential for reduction in intrinsic values	0.5-10 g/m^2 Rainbow to metallic sheen	10–100 Oil Stain/Film ~ 2 tsp per 1 m^2
Moderate	Ecological – Potential toxicity effects/physical oiling	10-25 g/m^2 Metallic sheen	100–1,000 Oil Coat ~ ½ cup per 1 m^2
High	Spill response – Potential for effective spill response on surface waters and shorelines	>25 g/m^2 Metallic sheen to continuous true oil colour	>1,000 Oil Cover ~ 1 litre per 1 m^2

3. Oil Description

The oil type contained within the holds of the RMS Niagara is Furnace oil. An analysis of an oil sample was found to be consistent with a heavy fuel oil (HFO) with a high pour point. As such, a generic bunker C fuel oil was selected as a proxy for the spill modelling. The HFO had a density of 974.9 kg/m^3, a pour point of 7˚C and a dynamic viscosity of 22,800 cP at 15ºC. This HFO is composed of approximately 82.8% persistent compounds, which does not evaporate.

The following graph (Figure 2) indicates the weathering of a sample 100 m^3 release of HFO over 24 hours, tracked for 30 days. As indicated, shoreline contact first occurs at 92 hours (~4 days) after the spill started. By the end of the scenario (30 days), approximately 6.6 m^3 was predicted to evaporate and 93.4 m^3 was predicted to remain on the shorelines, whilst there was no oil predicted to be entrained into the water column or remain on the water surface. The low evaporation can be attributed to the highly persistent nature of the oil.

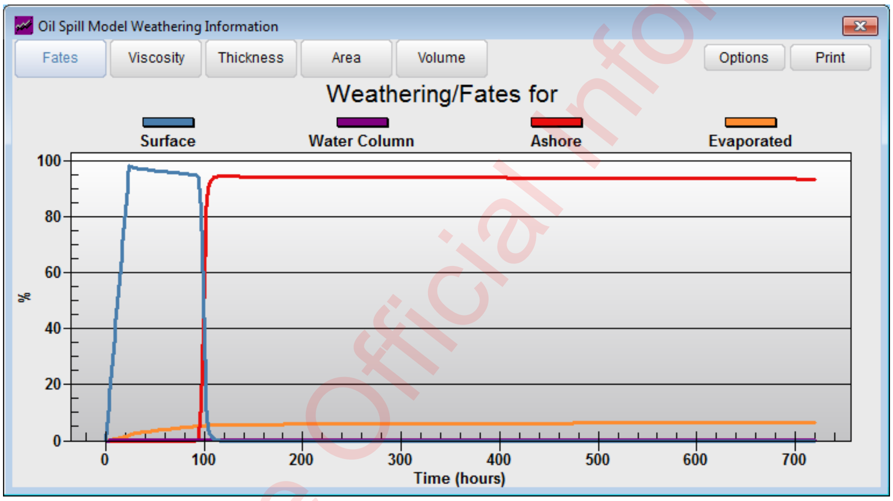

Figure 2: Example weathering and fates graph for a hypothetical release of 100 m^3 of HFO over 24 hours, tracked for 30 days.

4. Results

Table 3 below shows the summary of shoreline contact statistics for the two seasons assessed. Included are probability of shoreline contact, minimum time to accumulate on any shoreline, maximum volume of oil on any shoreline, maximum length of shoreline contacted (above the 10 g/m^2 threshold), and average length of shoreline contacted (above the 10 g/m^2 threshold).

Figure 3 and Figure 4 show the zones of potential oil exposure on the sea surface greater for summer and winter conditions, respectively. The probability of sea surface exposure above 0.5 g/m^2 is presented in Figure 5 and Figure 6 for summer and winter respectively.

The minimum time before sea surface exposure above 0.5 g/m^2 are presented in Figure 7 and Figure 8 for summer and winter respectively. Figure 9 and Figure 10 show the probability of shoreline contact above 10 g/m^2, for summer and winter conditions respectively.

Table 3: Summary of shoreline contact statistics in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara.

Season	Probability (%) of contact to any shoreline (above 10 g/m^2)	Minimum time (hrs) to accumulate on any shoreline (above 10 g/m^2)	Maximum volume (m^3) of oil on any shoreline	Average volume (m^3) of oil on any shoreline	Maximum shore length (km) contacted (above 10 g/m^2)	Average shore length (km) contacted (above 10 g/m^2)
Summer	92	7	96.5	70.6	16.3	10.6
Winter	82	5.75	97.2	52.2	16.3	9.3

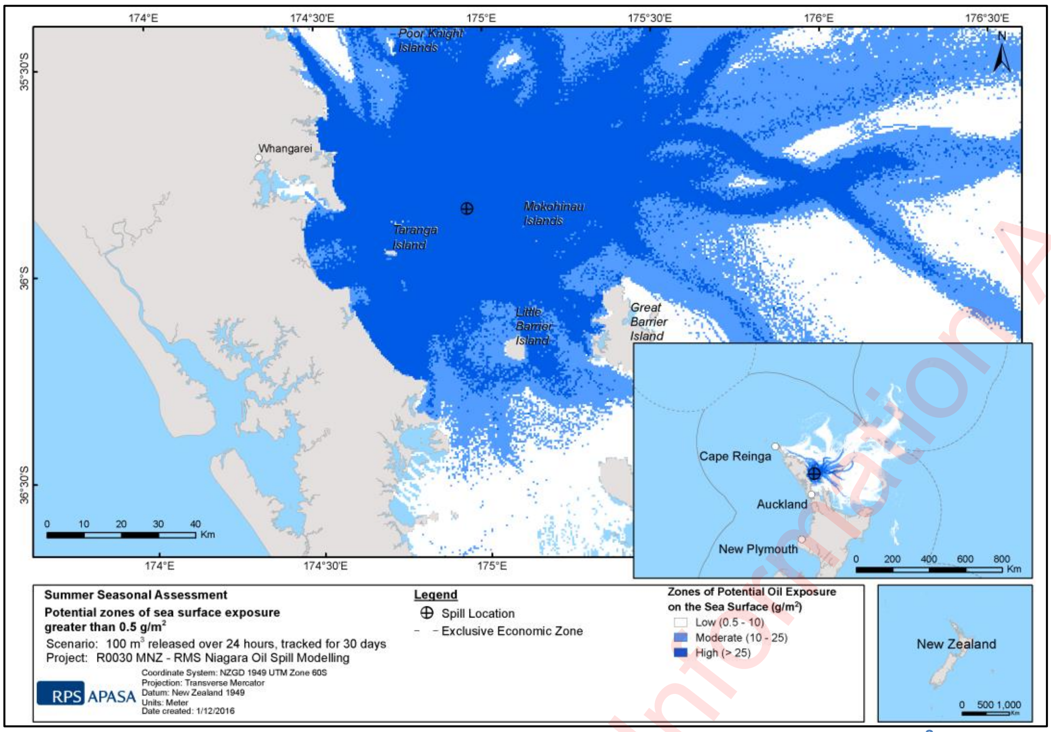

Figure 3: Zones of potential oil exposure on the sea surface, in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara. The results were calculated from 100 spill trajectories during summer conditions.

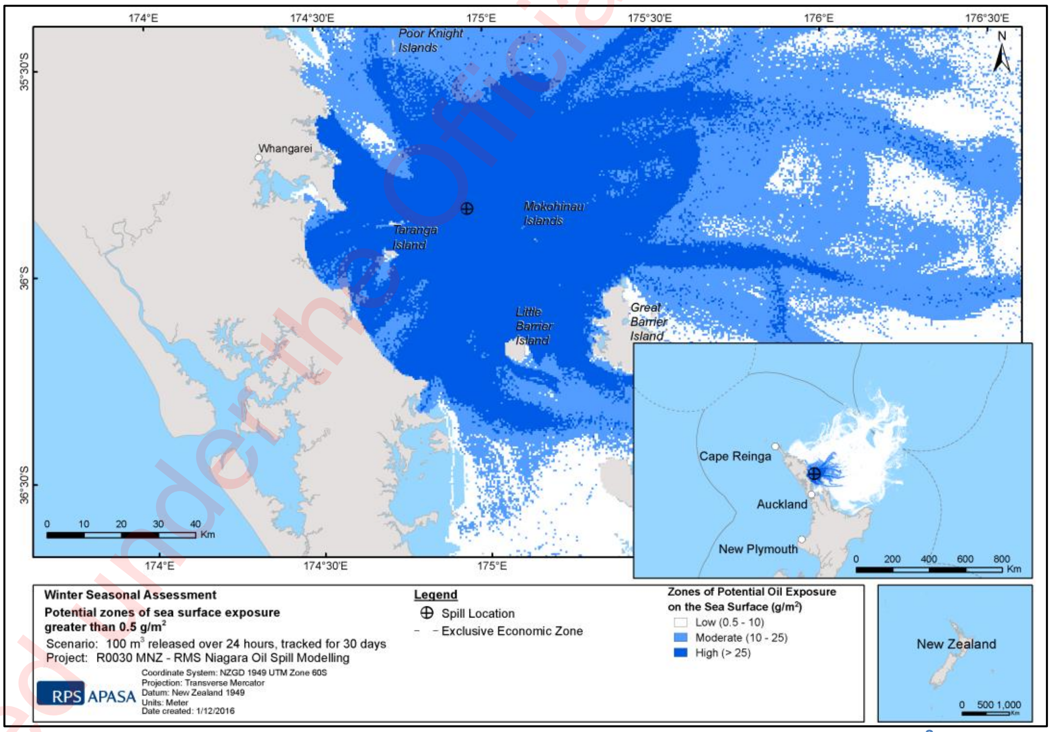

Figure 4: Zones of potential oil exposure on the sea surface, in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara. The results were calculated from 100 spill trajectories during winter conditions.

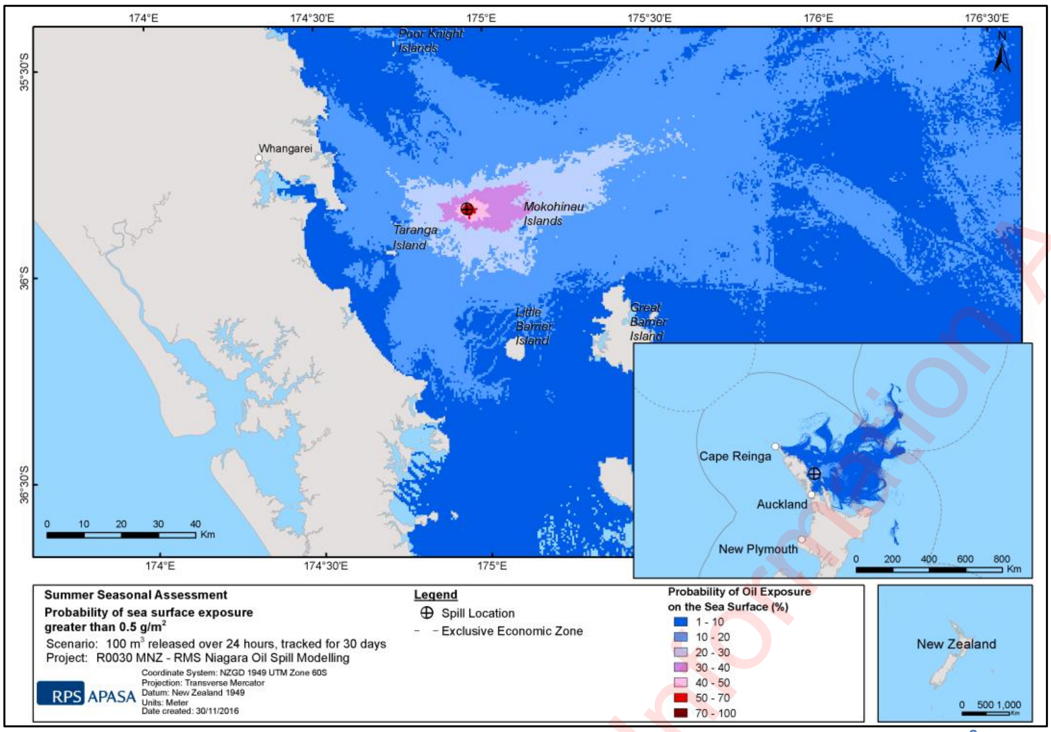

Figure 5: Probability of oil exposure on the sea surface above low exposure (≥ 0.5 g/m^2), in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara. The results were calculated from 100 spill trajectories during <u>summer</u> conditions.

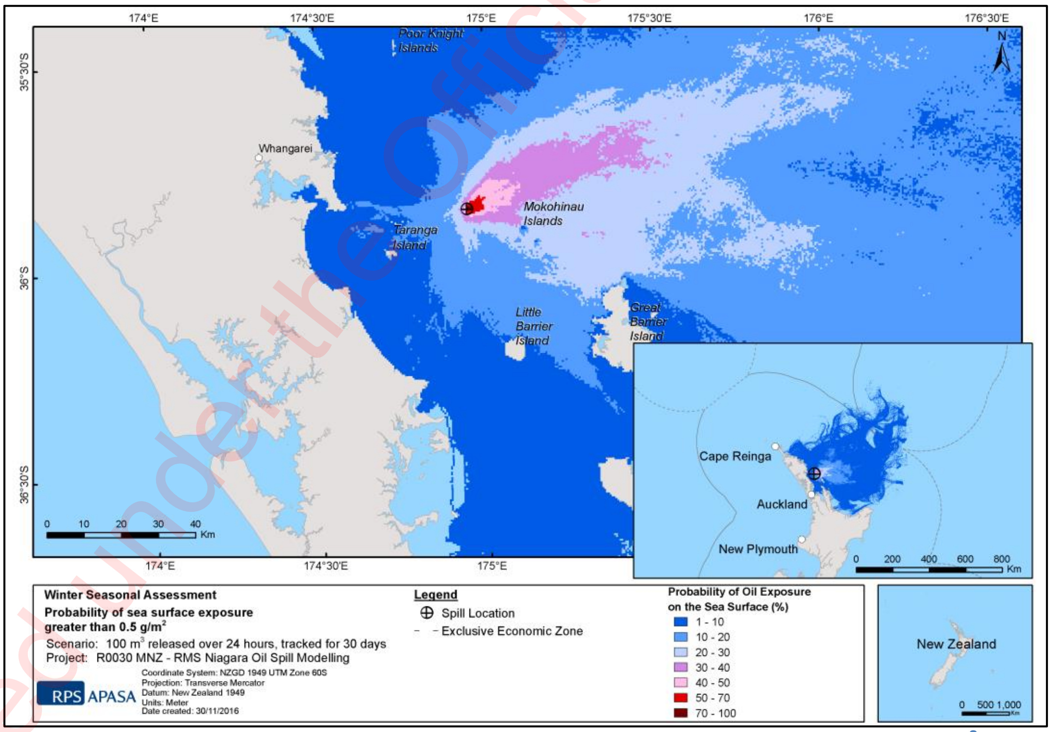

Figure 6: Probability of oil exposure on the sea surface above low exposure (≥ 0.5 g/m^2), in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara. The results were calculated from 100 spill trajectories during <u>winter</u> conditions.

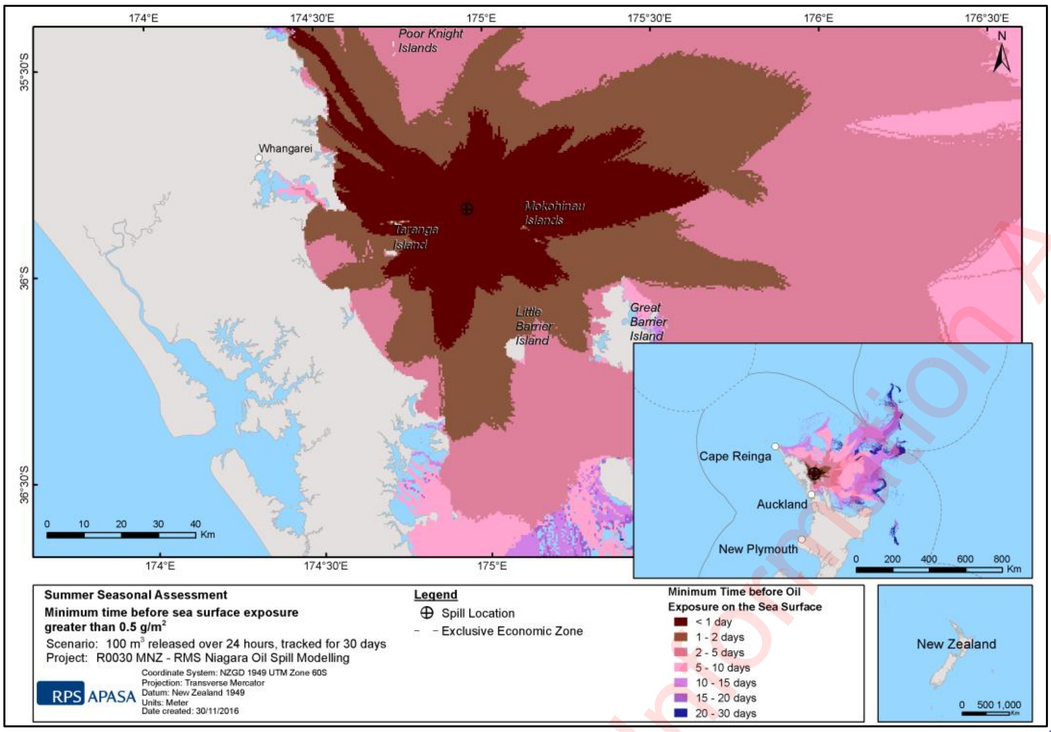

Figure 7: Minimum time before oil exposure on the sea surface above low exposure (≥ 0.5 g/m^2), in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara. The results were calculated from 100 spill trajectories during <u>summer</u> conditions.

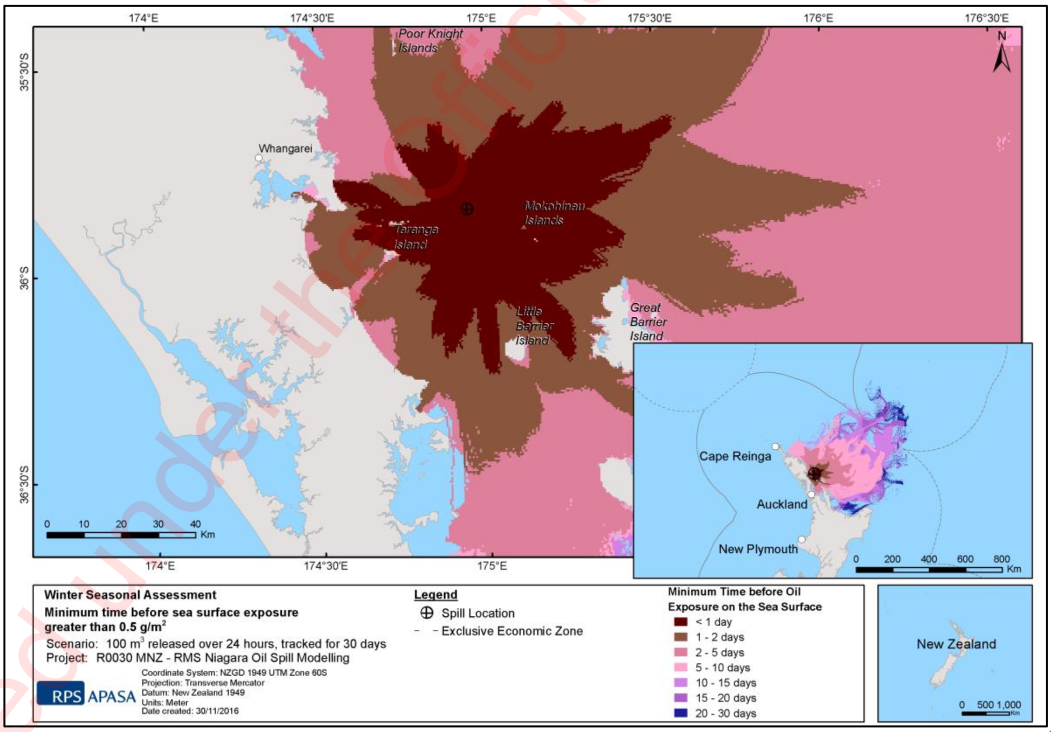

Figure 8: Minimum time before oil exposure on the sea surface above low exposure (≥ 0.5 g/m^2), in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara. The results were calculated from 100 spill trajectories during <u>winter</u> conditions.

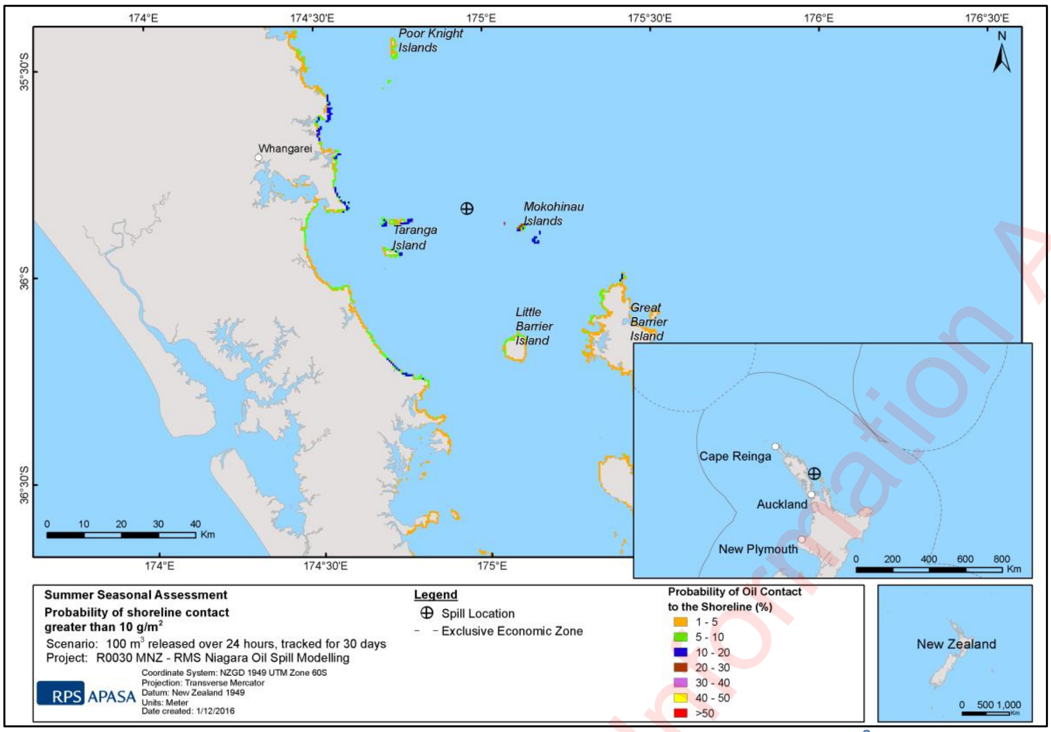

Figure 9: Probability of contact to the shoreline above low exposure (≥ 10 g/m^2), in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara. The results were calculated from 100 spill trajectories during summer conditions.

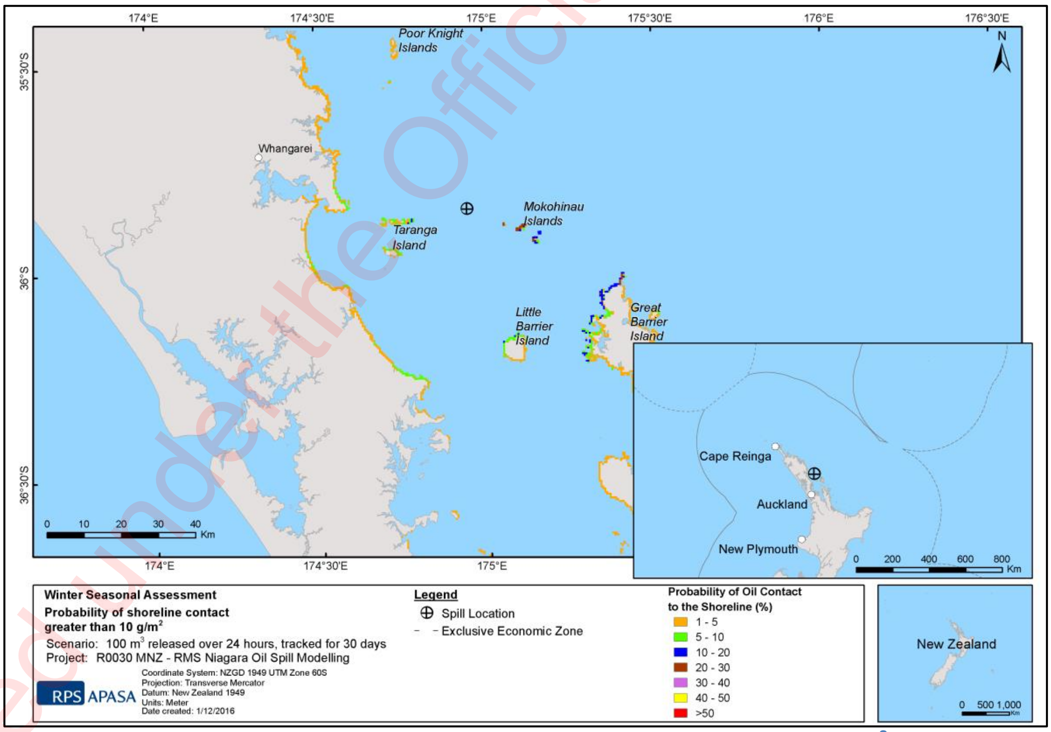

Figure 10: Probability of contact to the shoreline above low exposure (≥ 10 g/m^2), in the event of a 100 m^3 of HFO over 24 hours, tracked for 30 days, following a hypothetical loss of furnace oil from the sunken vessel RMS Niagara. The results were calculated from 100 spill trajectories during winter conditions.

5. Disclaimer

The opinions and interpretations presented in this report represent our best technical interpretation of the information made available to us. However, due to the uncertainty inherent in environmental modelling, we cannot, and do not guarantee the accuracy or correctness of any interpretation and we shall not, except in the case of gross or wilful negligence on our part, be liable or responsible for any loss, cost damages or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agent**s** or employees. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. The document may only be used for the purposes for which it was commissioned and in accordance with the Terms of Engagement for the commission.

6. References

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