**BEFORE THE INDEPENDENT HEARING COMMISSIONERS**
**FOR GISBORNE DISTRICT COUNCIL**

**IN THE MATTER:** of the Resource Management Act 1991

**AND**

**IN THE MATTER:** of an application by Gisborne District Council for resource consent associated with wastewater overflows

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# STATEMENT OF EVIDENCE OF DR BRETT JAMES BEAMSLEY – HYDRODYNAMIC MODELLING

24 June 2021

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CooneyLeesMorgan


247 Cameron Road
P O Box 143
TAURANGA

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|---|---|
| Telephone: | (07) 578 2099 |
| Facsimile: | (07) 578 1433 |
| Partner: | M H Hill |
| Senior Associate: | R C Zame |

## INTRODUCTION

### Qualifications and experience

1. My full name is Dr Brett James Beamsley. I am the General Manager of MetOcean Solutions (MOS) which in 2018 became fully amalgamated within The Meteorological Service of New Zealand (MetService). As well as providing operational forecasting, MOS is a science-based consultancy that offers specialist numerical modelling and analytical services in meteorology and oceanography. I have held this position for 3 years, prior to which I was held the position as senior scientist and project director within MetOcean Solutions Ltd.

2. I have a PhD in physical oceanography and nearshore sediment dynamics from the University of Waikato.

3. I have more than 25 years' experience in physical oceanography, coastal processes and ocean engineering application

4. I have prepared and presented hydrodynamic evidence at 6 Council resource consent hearings, and Environment Court hearings.

### Code of Conduct

5. My qualifications as an expert are set out above. I confirm that I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014. I have complied with the Code of Conduct in preparing this evidence. Except where I state that I am relying on the evidence of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

## SCOPE OF MY EVIDENCE

6. My evidence addresses the following aspects of the application:

   (a) My involvement in the Gisborne Wastewater Overflows Resource Consent Application (**Application**);

   (b) Hydrodynamic modelling;

   (c) Response to the requests for further information; and

(d) Summary and conclusion.

**MY INVOLVEMENT IN THE WASTEWATER OVERFLOW CONSENT PROJECT**

7. I first became involved in the Gisborne District Council (**GDC or Council**) project in 2017, when I began helping Gisborne District Council who were investigating options for wastewater management within their region.

8. I produced a Report for Gisborne District Council) titled 'Scour event modelling: Poverty Bay' dated February 2019, which was included as Appendix J to the Application.

9. I also provided input into the s92 response titled 'Technical Note – Gisborne District Council – Wastewater Overflow Consent' dated January 2021, which was included as Attachment C to the s92 Response dated 29 January 2021.

**HYDRODYNAMIC MODELLING**

10. Council has lodged resource consent applications for occasional and temporary wastewater overflows into Gisborne's rivers.

11. A numerical investigation was undertaken using the predicted discharge characteristics from different drain locations (Figure 1) for both the existing and upgraded stormwater network in 2- and 10-year Average Recurrence Intervals (ARI) rain events. The predicted discharge volumes were provided to me by Beca.


Figure 1 Poverty Bay and discharge locations.

12. The open-source hydrodynamic model SCHISM was used to model the 3D baroclinic hydrodynamics of Poverty Bay. SCHISM is computationally efficient in complex bathymetry associated with estuaries and it has been extensively used within the scientific community. Its governing equations are similar to other open-source models such as Delft3D and ROMS.

13. The model resolution ranged from 150 m at the boundary to 5 m in shallow water and inside the port/rivers and streams (Figure 2). The 3D model sigma layers range from 4 in shallow waters to 12 in deep waters near the open boundary.

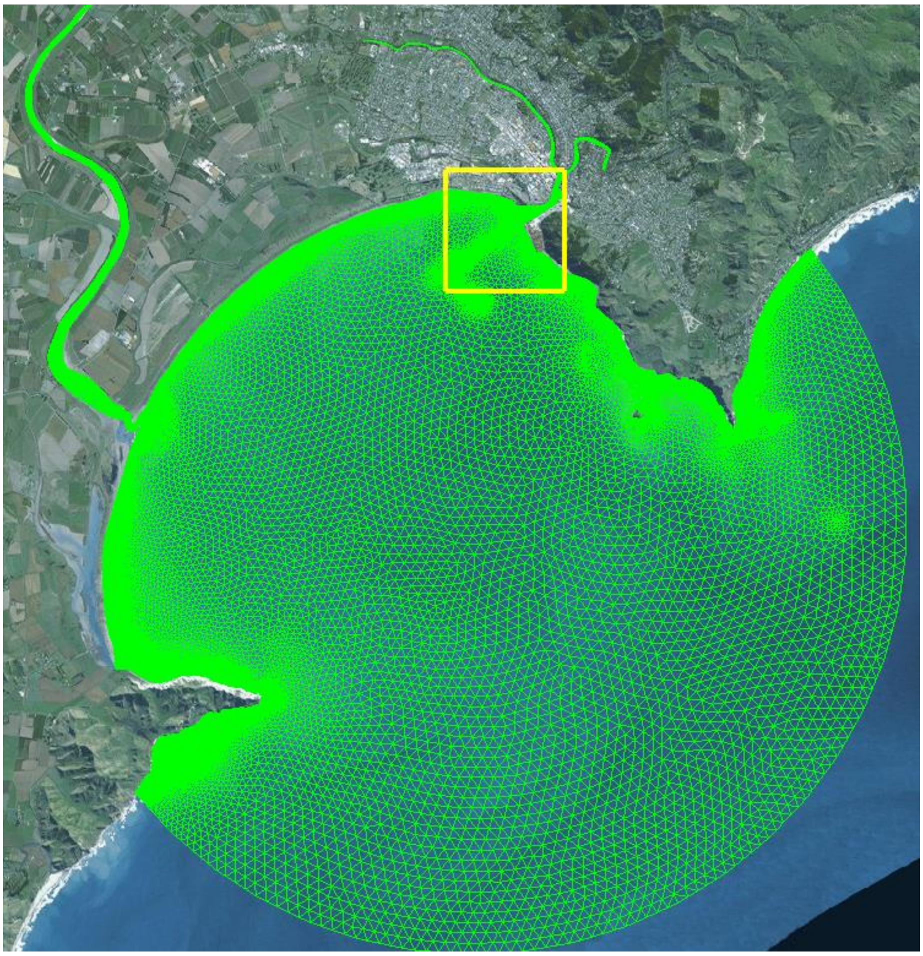

Figure 2 Poverty Bay model domain showing the Finite-Element triangular model mesh for the entire model domain.

14. The dispersion modelling simulated scour discharge rates for both 2- and 10-year ARI events assuming the existing wastewater and stormwater infrastructure[1], and at the 10-year ARI level assuming an upgraded wastewater and stormwater network[2] (capable of containing a 2-year ARI event without overflowing).

15. Different river discharges are applied in the dispersion modelling, and releases start at two initial tidal states: Mean High Water Spring (MHWS) and Mean Low Water Spring (MLWS).

16. Scenarios are modelled under different wind state, representative of typical wind speed during storm events. The conditions simulated are summarised in Table 1[3]. The associated fluvial and accidental discharges are presented in Table 2 and Table 3,

[1] Including private infrastructure and associated stormwater inflow.
[2] Including private infrastructure with a substantial component of the stormwater inflow excluded.
[3] Note that these tables were provided in the Application as Tables 2-1, 2-2 and 2-3 at pages 19-20 of Appendix J.

respectively. The modelling predicts the dilution of the discharge as it mixes with water in the in the rivers and the wider bay.

Table 1 Model scenarios.

| River flow conditions and scour name | Tide at start of the release | Wind velocity |
|---|---|---|
| **2 years current**<br>Wainui street<br>Seymour | MHWS | SE 15m.s$^{-1}$ |
| | | SE 25m.s$^{-1}$ |
| | | NW 15m.s$^{-1}$ |
| | | NW 25m.s$^{-1}$ |
| | MLWS | SE 15m.s$^{-1}$ |
| | | SE 25m.s$^{-1}$ |
| | | NW 15m.s$^{-1}$ |
| | | NW 25m.s$^{-1}$ |
| **10 years current**<br>Wainui street<br>Seymour<br>Oak street<br>Peel street | MHWS | SE 15m.s$^{-1}$ |
| | | SE 25m.s$^{-1}$ |
| | | NW 15m.s$^{-1}$ |
| | | NW 25m.s$^{-1}$ |
| | MLWS | SE 15m.s$^{-1}$ |
| | | SE 25m.s$^{-1}$ |
| | | NW 15m.s$^{-1}$ |
| | | NW 25m.s$^{-1}$ |
| **10 years future**<br>Wainui street<br>Peel street | MHWS | SE 15m.s$^{-1}$ |
| | | SE 25m.s$^{-1}$ |
| | | NW 15m.s$^{-1}$ |
| | | NW 25m.s$^{-1}$ |
| | MLWS | SE 15m.s$^{-1}$ |
| | | SE 25m.s$^{-1}$ |
| | | NW 15m.s$^{-1}$ |
| | | NW 25m.s$^{-1}$ |

Table 2 Model scour conditions for each of the return periods.

| Discharging location | River flow conditions | Scour Flow (m$^3$) | Scour duration (Hrs) |
|---|---|---|---|
| Wainui street | 2-year current | 17643 | 46 |
| | 10-year current | 17849 | 47 |
| | 10-year future | 1545 | 28 |
| Seymour | 2-year current | 914 | 21 |
| | 10-year current | 1710 | 29 |
| Oak street | 10-year current | 1358 | 29 |
| Peel street | 10-year current | 25782 | 47 |
| | 10-year future | 8010 | 28 |

Table 3 River flow conditions for each of the return periods.

| River name | Discharge 2-year ARI (m$^3$.s$^{-1}$) | Discharge 10-year ARI (m$^3$.s$^{-1}$) |
|---|---|---|
| Waipaoa | 1185 | 2690 |
| Taruheru | 38 | 75 |
| Shelly | 4.2 | 9 |
| Waimata | 430 | 1000 |
| Waikanae | 10 | 17 |

17. In general, under strong onshore S-E winds, for both 2- and 10-year ARI existing scenarios and both MHWS and MLWS release times, the plume is held against the coast along Waikanae Beach and towards the Waipaoa River mouth resulting in the lowest dilution in these areas (Figure 3, Figure 4, and Figure 5[4]).

18. The plume extends over the northern Poverty Bay and for the 10-year ARI existing scenario, the plume re-circulates back into southern Poverty Bay around Young Nicks Head, and potentially extends south beyond Young Nicks Head at T+48 hours (Figure 5, top).

19. Offshore N-W winds push the plume offshore and out into Poverty Bay along Kaiti Beach as the plume exits the Turanganui River and migrates southwards towards Tokomaru, Hawea and Te Moana Rocks (Figure 4 and Figure 5 - bottom). Dilution of 1:10,000 can be found up to 1000 m. Peak concentrations are expected along Kaiti Beach and out towards Tuaheni Point.

20. At T+48 hours dilution levels increase to > 1:10,000 for both ARI scenarios.

[4] Again noting that I have provided a selection of graphics from those presented in Appendix J to the Application.

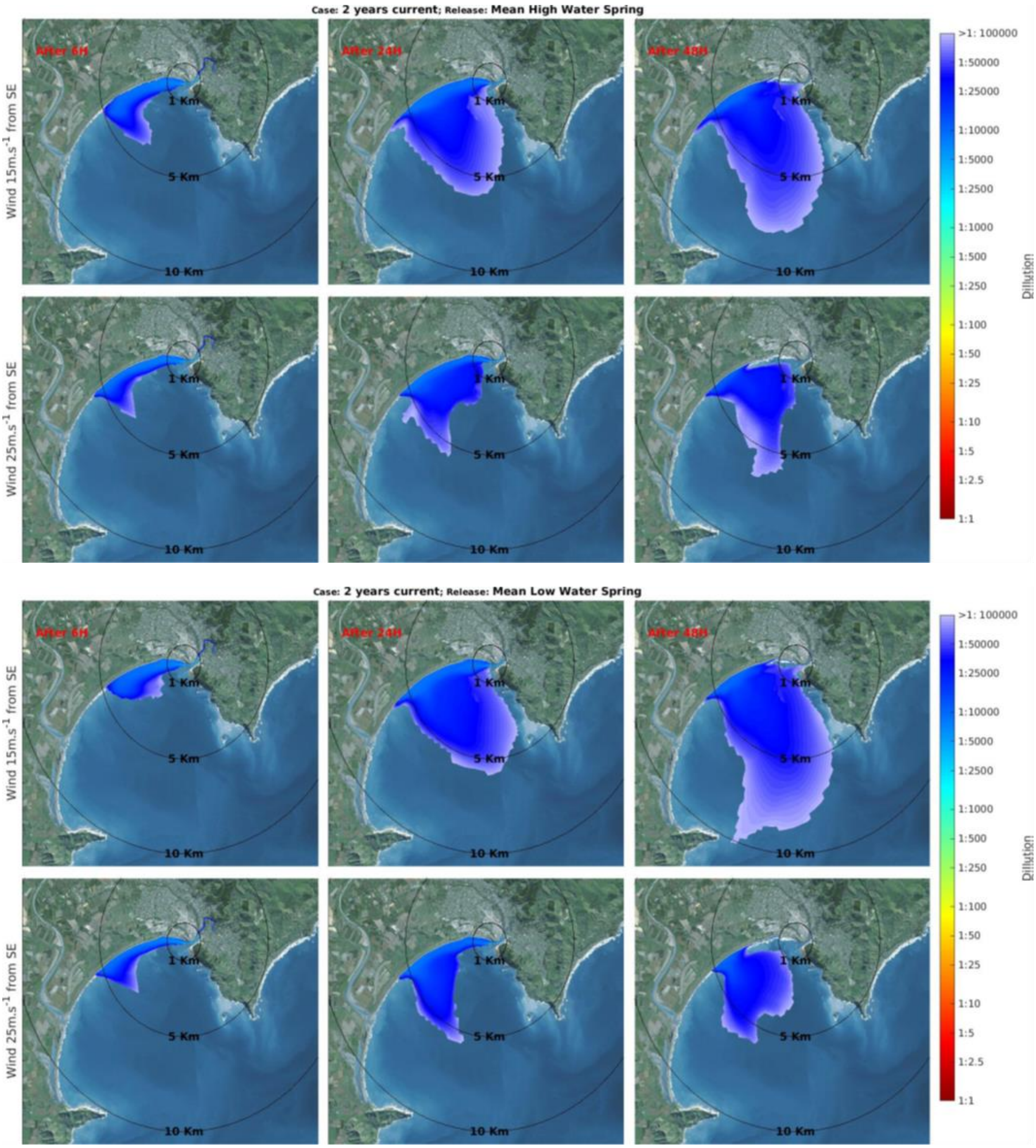


Figure 3 Poverty Bay view of the 2-year ARI current scenario of minimum dilution field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS (top) and MLWS (bottom) release with 15 and 25 m.s$^{-1}$ South-Easterly wind.

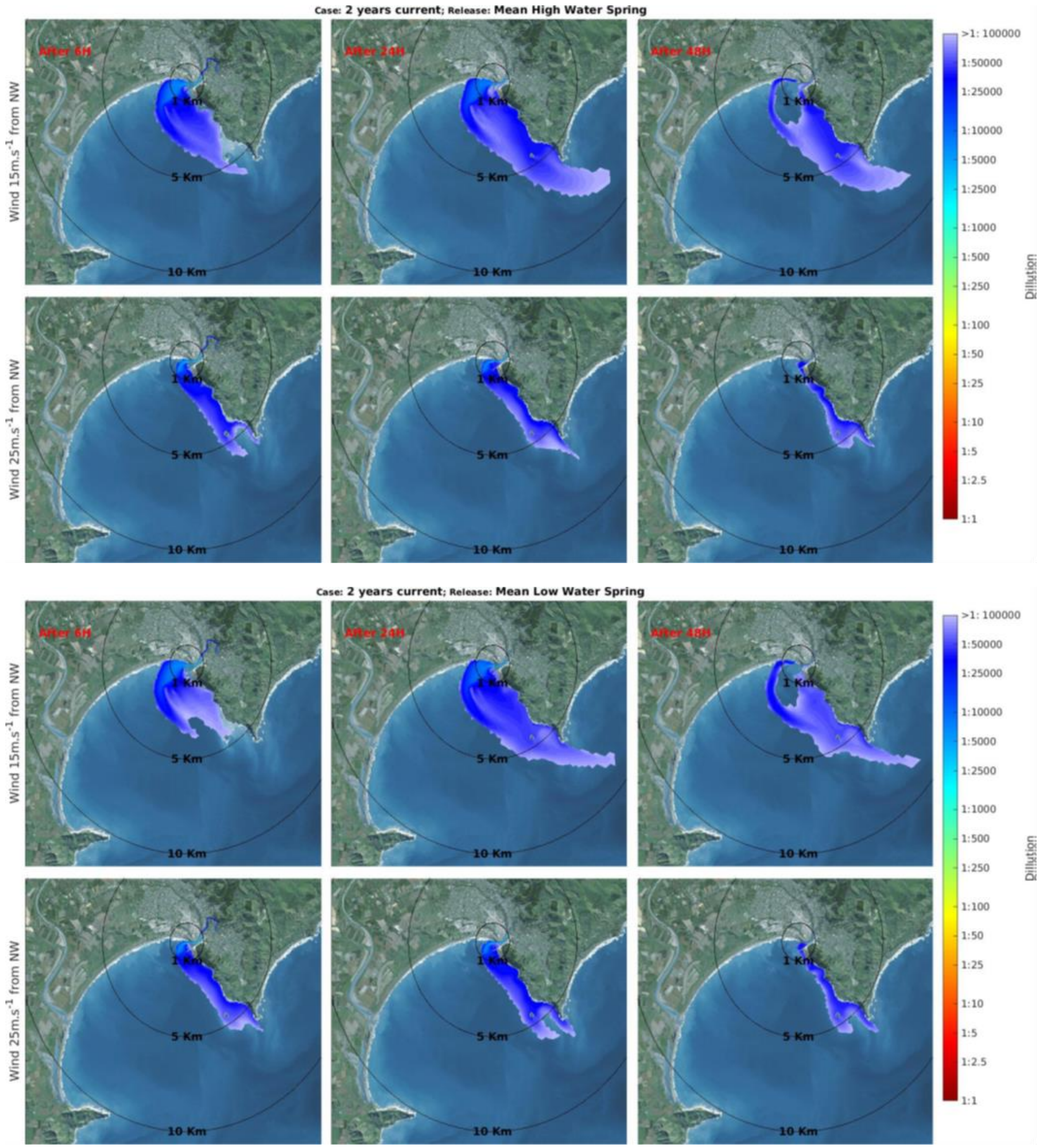


Figure 4 Poverty Bay view of the 2-year ARI current scenario of minimum dilution field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS (top) and MLWS (bottom) release with 15 and 25 m.s$^{-1}$ North-Westerly wind.

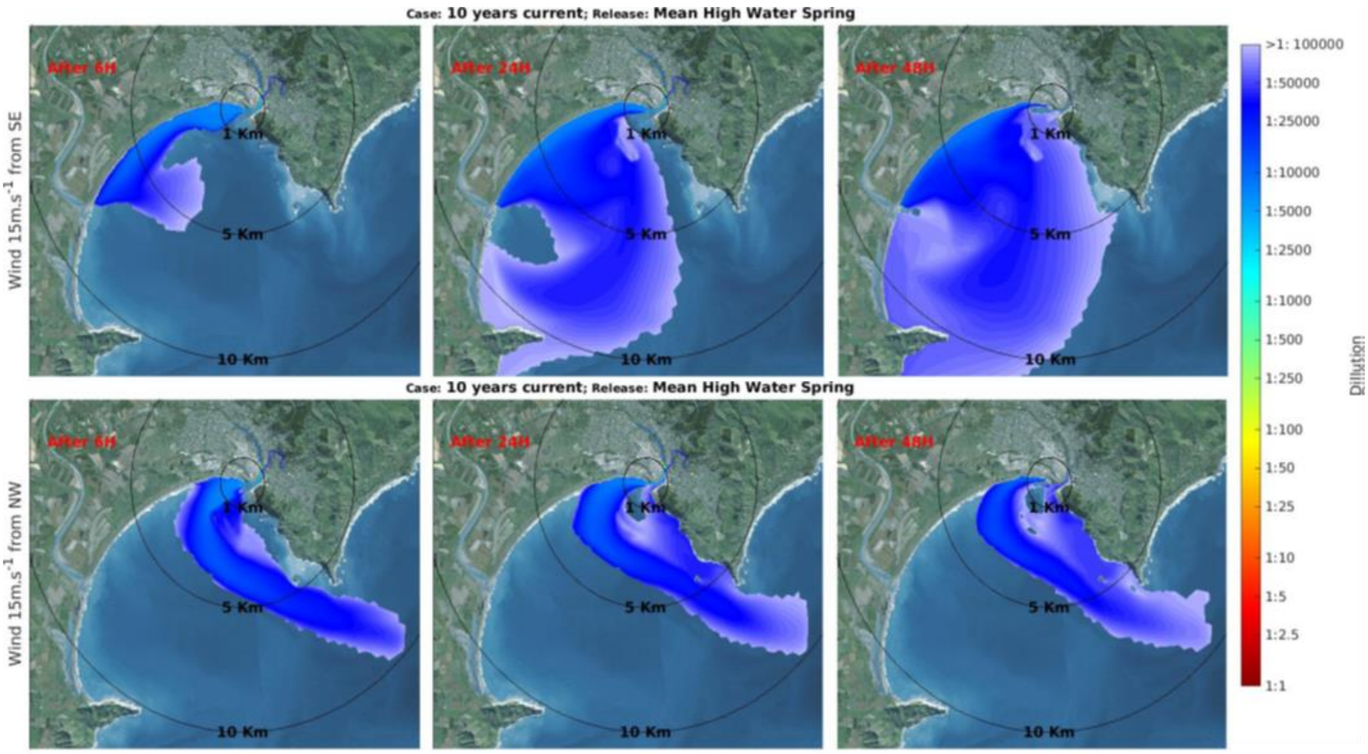


Figure 5 Poverty Bay view of the 10-year ARI current scenario of minimum dilution field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 m.s$^{-1}$ South-Easterly wind (top) and North-Westerly wind (bottom).

21. The 10-year ARI future scenario represents reduced discharge volumes resulting in a significant increase in the dilution levels, both at the immediate discharge point and within the broader environs (Figure 6).

22. Dilution levels within Poverty Bay outside the mouth of the Turanganui River exceed 1:10,000 and only limited concentrations are within the Turanganui, Taruheru and Waimata Rivers, and the Waikanae stream.

23. Lowest dilutions rates are found along Waikanae and Midway Beaches under strong S-E winds, and along Kaiti Beach under strong N-W winds.

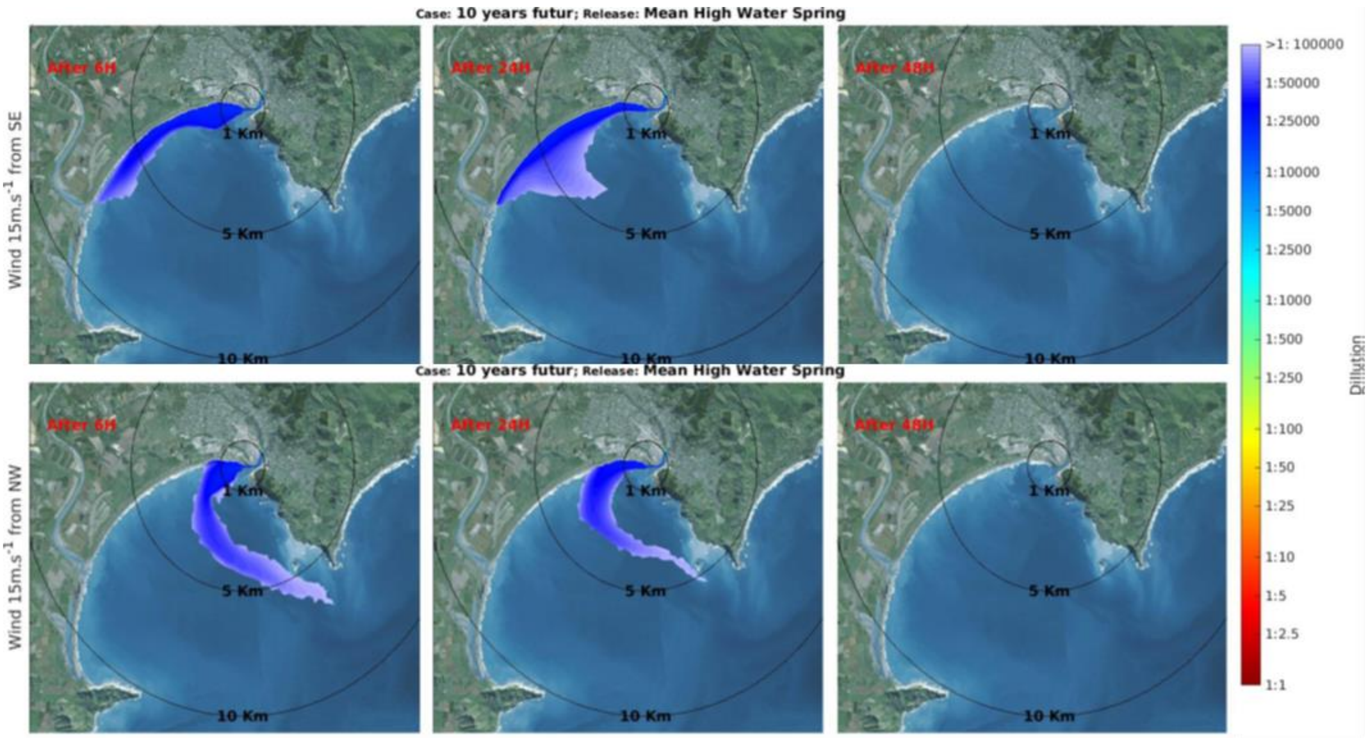


Figure 6 Poverty Bay view of the 10-year ARI future scenario of minimum dilution field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 m.s$^{-1}$ South-Easterly wind (top) and North-Westerly wind (bottom).

24. To characterise water quality, the model results were scaled with the pollutant concentration include in the Table 4. These concentrations were provided to me by Beca. Examples of Enterococci plumes for the current wastewater and stormwater network are presented in Figure 7 and Figure 8. Figure 9 shows Enterococci plumes for the post-upgrade network, demonstrating the level of improvement.

25. Plumes of viruses and nutrients are presented in my earlier report included with the Application.

Table 4 Pollutant and nutrient concentrations used at the outfall location.

| Analyte | Concentration |
|---|---|
| Enterococci | 2,500,000 (Ent/100 m.L$^{-1}$) |
| Viruses/ Parasites | 1,000 (CFU/100 m.L$^{-1}$) |
| Total Kjeldahl Nitrogen | 40 (g/m$^{-3}$) |
| Total P | 5.05 (g/m$^{-3}$) |
| Total Suspended Solids (TSS) | 240 (g/m$^{-3}$) |

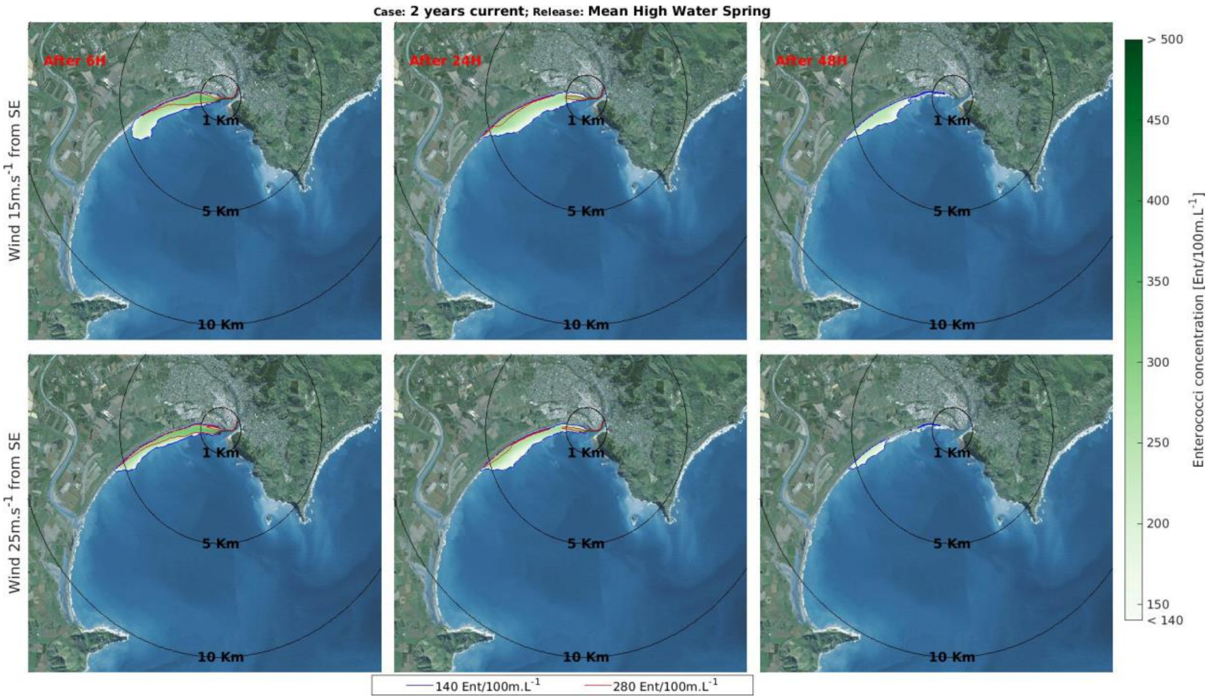

Figure 7 Poverty Bay view of the 2-year current scenario of maximum Enterococci concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 (top) and 25 m.s-1 (bottom) South-Easterly wind.

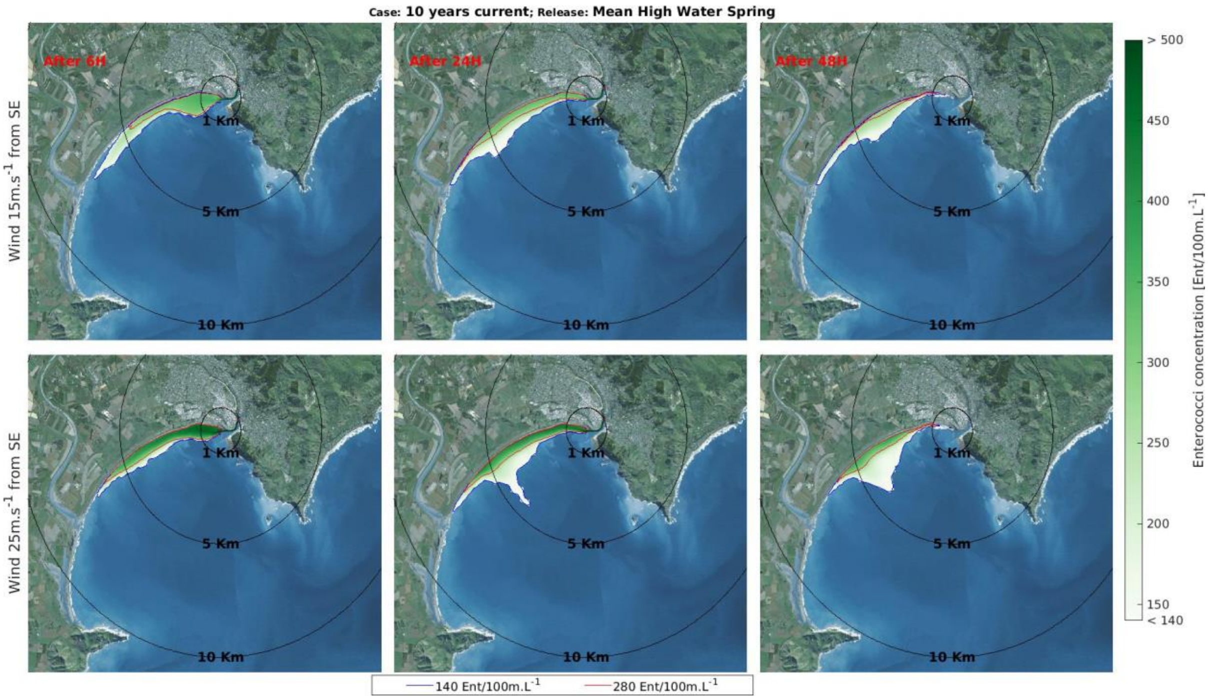


Figure 8 Poverty Bay view of the 10-year current scenario of maximum Enterococci concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 (top) and 25 m.s-1 (bottom) South-Easterly wind.

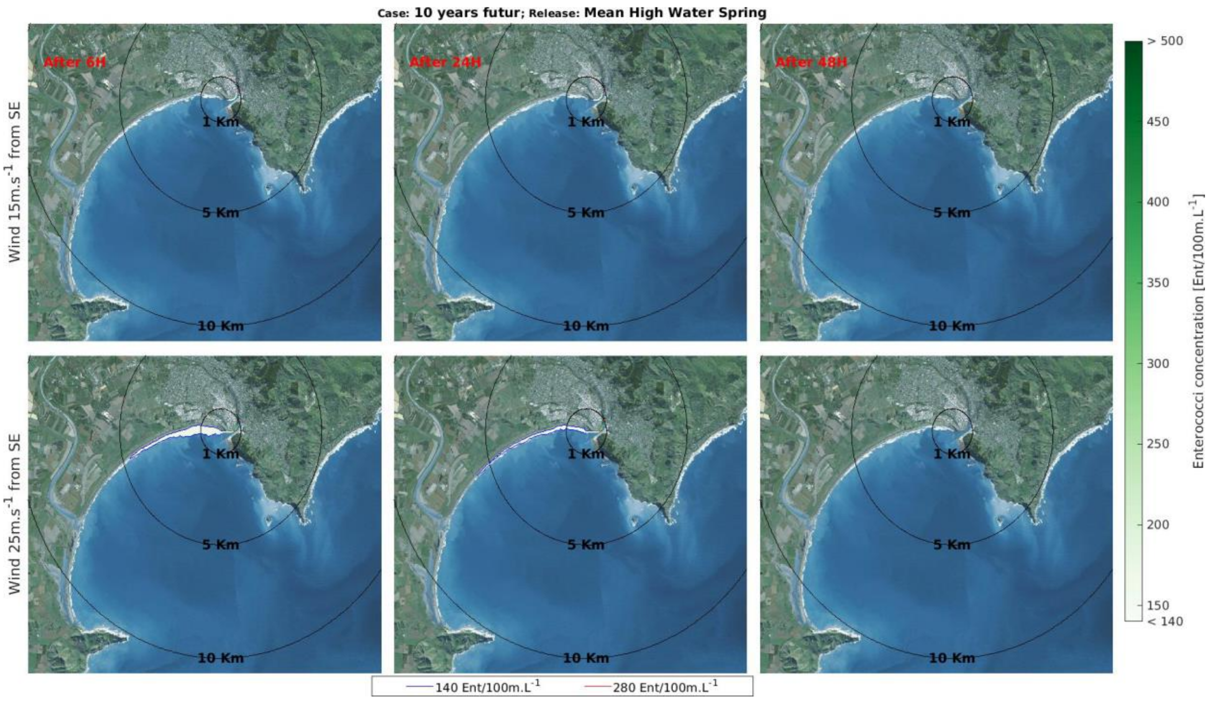


Figure 9 Poverty Bay view of the 10-year future scenario of maximum Enterococci concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 (top) and 25 m.s-1 (bottom) South-Easterly wind.

26. As noted earlier, I provided input into the s92 Response. Pertinent questions in the s92 were associated with the wind data used in the modelling:

27. Atmospheric forcing was derived from analysis of the Automatic Weather Station at the Gisborne Airport. The data was supplemented by model reanalysis over the area.

28. The validation shows the model agrees reasonably with the measured data (Figure 10), with hindcast wind speeds slightly higher (~0.75 $m.s^{-1}$) and peak wind speeds slightly lower (by 1-2 $m.s^{-1}$). Model and measured wind show a good directional correlation, with predominant NW winds in both model and measured data (more calibration figures in MetOcean Solutions, 2021 - Section 92 questions and responses).

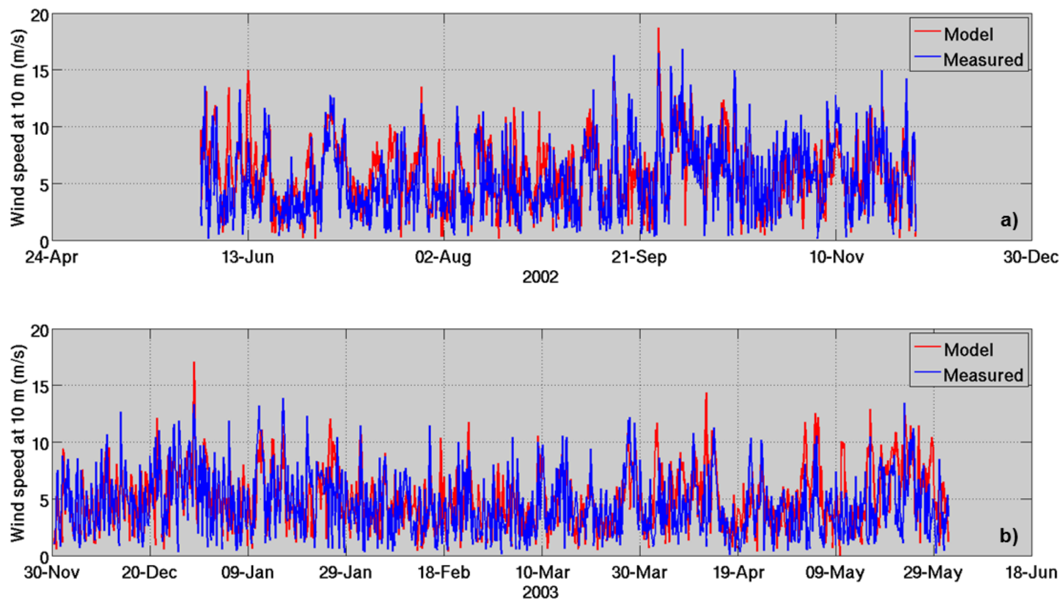


Figure 10 Measured and modelled wind speed at 10 m between (a) June and December 2002, and (b) January and June 2003.

29. The climatic variability based on model and observational data, and a review of Chappell (2016) were used to define contrasting wind forcing that are used in the simulations (NW and SE wind conditions).

## SUMMARY AND CONCLUSIONS

30. The scour event modelling has characterised the spatial distribution of dilution levels associated with the accidental discharges into streams and creeks at four locations within the boundaries of Gisborne City.

31. The dispersion modelling approach consisted of simulating realistic overflow discharge rates for both 2 and 10-year ARI events assuming the existing wastewater and stormwater infrastructure, and at the 10-year ARI level assuming an upgraded public and private wastewater and stormwater network that includes a significant reduction in stormwater inflow to the wastewater network.

32. To account for the potential impact of tidal stages on the discharge characteristics simulations were modelled beginning at both MHWS and MLWS tidal stages.

33. For both the exiting 2 and 10-year ARI events, under persistent and relatively strong S-E wind events the plume of contaminated water is held against the shoreline along Waikanae Beach and towards the Waipaoa River mouth. The plume is eventually

advected out into Poverty Bay and re-enters the southern end of the bay in the vicinity of Young Nicks Head (Figure 3 and Figure 5 - top).

34. Conversely, under persistent and relatively strong N-W wind events the plume is forced offshore and out into Poverty Bay away from the Turanganui River mouth and propagates southwards towards Tokomaru, Hawea and Te Moana Rocks and along Kaiti Beach (Figure 4 and Figure 5 - bottom).

35. At the 2-year ARI, dilution levels exceed 1:10,000 at T+48 hours after the initial start of the discharge for all events simulated, while only under strong N-W events (where the plume propagates offshore) are 1:10,000 dilution levels exceeded at T+48 hours. During strong onshore S-E wind events dilution levels of <1:10,000 can be expected along Waikanae Beach at T+48 hours (Figure 4 and Figure 3).

36. For the future 10-year ARI event scenario actual discharge volumes are significantly reduced, with resulting dilution levels significantly increased (i.e., decreased contaminant concentrations) with the plume reducing significantly and remaining mostly concentrated near the discharge locations and within the Turanganui River and along Waikanae and Kaiti Beach under S-E and N-W winds respectively (Figure 6).

**Dr Brett James Beamsley**

**24 June 2021**

**References**

Chappell, P. R. (2016). The climate and weather of Gisborne, 2nd Edition (ISSN 1173-0382; p. 40). NIWA.

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