TECHNICAL NOTE - Gisborne District Council – Wastewater Overflow Consent

Scour event modelling – Poverty Bay

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Approved for Release

MetOcean SOLUTIONS

Document History

Versions

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Distribution

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1.Introduction

1.1 Study Background

Gisborne District Council have lodged resource consent applications for occasional and temporary wastewater overflows into Gisborne's rivers at times where the network is inundated with stormwater (wet weather overflows) and because of network blockages/problems (dry weather overflows). Specialist technical reports provided by consultants were included as part of the application, including MetOcean Solutions, (2020b).

Council has since received submissions on the application and more recently a request for further information (under section 92 of the Resource Management Act (RMA)). The section 92 request relates to specific aspects of the application, including seeking more detail and assessment in relation to some (but not all) of the technical reports.

This technical note responds to the further information request relating to the hydrodynamic modelling of wet weather wastewater overflows, which was provided in a technical report provided as Appendix J of the application.'

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2. Section 92 questions and responses.

***Question**: How were tides implemented?*

Temporal and spatially variable tidal boundary conditions were prescribed at each offshore boundary node using tidal constituents derived from a validated regional scale ROMS model. The following constituents were used to define both elevations and 3D velocities: *M2, S2, N2, K2, K1, O1, P1, Q1, MF, MM, M4, MS4 and MN4*. For each offshore boundary node 3D velocities were defined assuming a logarithmic velocity profile.

***Question**: What was the initial density of the oceanic water?*

Offshore temperature boundaries were set to 15˚C with a salinity of 35 PSU.

***Question**: What was the riverine initial density and temperature inputs?*

All fluvial inputs were set to 15˚C with a salinity of 0 PSU

***Question**: What are the offshore boundary conditions?*

Offshore boundary conditions were purely tidal. Tidal boundary conditions are considered to represent a conservative approach to defining the likely dilution of overflow events discharging into Poverty Bay, as residual currents are expected to increase the dilution achieved.

***Question**: Where did the bathymetry come from?*

Bathymetry was sourced from a mix of LINZ ENC's (Electronic Navigation Charts) and survey data supplied by Eastland Port.

***Question**: Where did the wind estimates come from?*

Estimates of atmospheric forcings were derived from analysis of the Automatic Weather Station (AWS) maintained at the Gisborne Airport. These data were supplemented by an approximately 10-year 12 km resolution Weather Research and Forecast (WRF) reanalysis over the area, forced by CFSR boundary conditions.

***Question**: Can you provide a brief commentary on what post-processing (MetOcean Solutions, 2020b -p21) involved?*

Each overflow location was simulated as an individual Eulerian discharge. To get a representative value for the combined effect, some *post processing was required to merge the data appropriately. Once the data was available for the entire domain, and at each model sigma level, to get representative dilutions - a specific volume or layer of water was* *needed to be considered, i.e., the surface water as opposed to a depth averaged solution which would have produced higher, unrepresentative, dilutions.*

Question*: The wind conditions modelled;* MetOcean Solutions, 2020b *p17 refers to the scenarios modelled being "representative of typical wind speed during storm event" but no information source is provided for* MetOcean Solutions, 2020b *Table 2-1 (p19) to explain the selection of the scenarios in* MetOcean Solutions, 2020b *Table 2-1.*

A combination of available data from the AWS at Gisborne Airport and hindcast reanalysis wind velocities at 10 m were used to define the wind climate within Poverty Bay . The time series of model and measured wind speed for the period June 2002 - June 2003 are shown in Figure 2.1.

The quantitative validation (Figure 2.2) showed the model to exhibit a reasonable correspondence with the measured data. On average, hindcast wind speeds were biased slightly high by ~0.75 $m.s^{-1}$, while peak wind speeds were biased slightly low (by 1-2 $m.s^{-1}$, Table 2.1).

Comparisons of the model and measured wind roses are provided in Figure 2.3 and show a good directional correlation, with predominant NW octant winds in both model and measured data, consistent with the findings of Chappell, (2016), and consistent with Chappell, (2016) observations that SE airstreams usually produce heavy rain over the whole district.

In general, measured winds at Gisborne Airport tend to be primarily orientated NW/SE. In comparison, modelled winds tend to display more directional variance; due to the topographical sheltering effect afforded by Poverty Bay not being fully captured in the 12 km resolution atmospheric model.

An assessment of the climatic variability based on model and observational data, and a review of Chappell, (2016) were used to define contrasting wind forcings that are expected to result in increased and decreased dilution respectively (i.e. forcing the plume offshore under NW wind conditions, and maintaining the plume near the coast under strong onshore SE wind conditions).

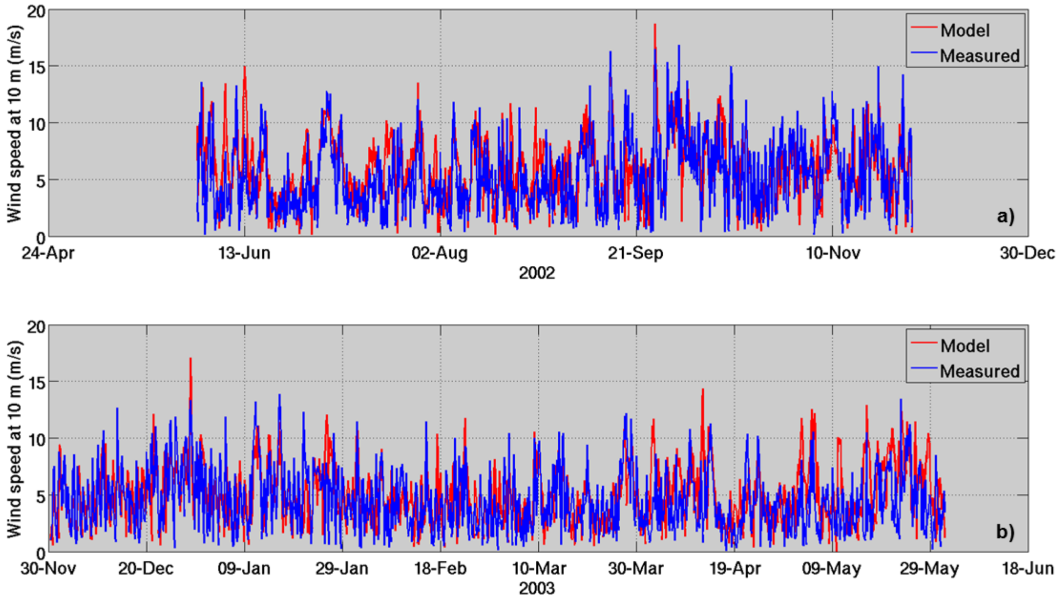

Figure 2.1 Measured and modelled wind speed at 10 m between (a) June and December 2002, and (b) January and June 2003.

Table 2.1 Comparison of measured and hindcast wind data. Accuracy measures for wind speed at Gisborne Airport between 2000 and 2008.

Statistics	Wind speed ($m.s^{-1}$)
MAE	2.24
RMSE	2.85
MRAE	0.93
Bias	0.75
Scatter Index	0.6

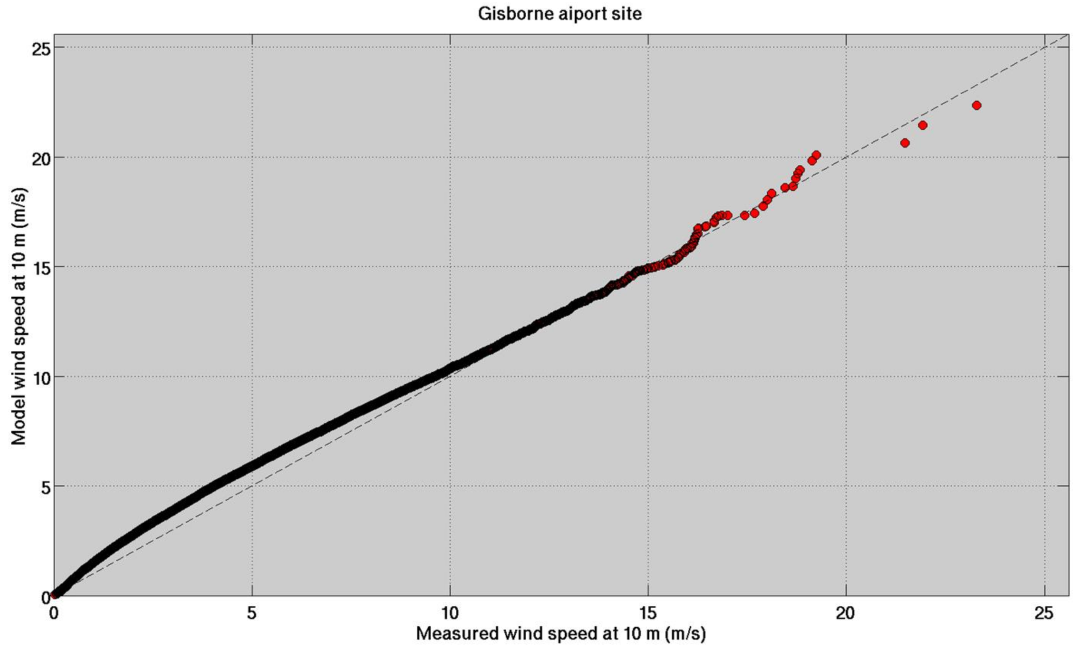

Figure 2.2 Quantile-Quantile plot of the 10 m measured and model wind speeds at Gisborne Airport for the period 2000 – 2008.

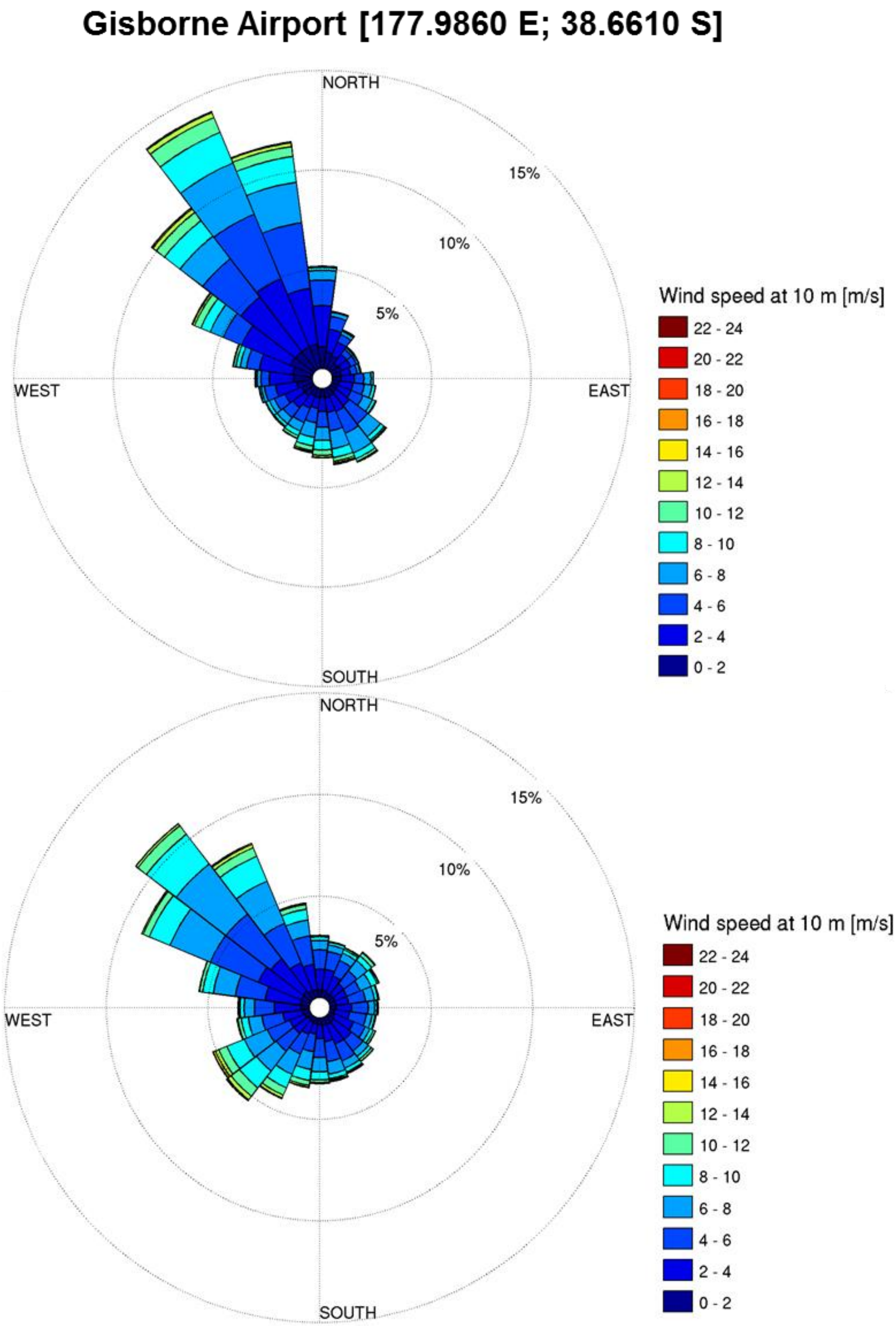

Figure 2.3 Measured (top) and model (bottom) wind roses at Gisborne Airport for the period 2000 – 2008. Winds are reported in the "coming from" directional reference.

Question: *Commentary on the rationale for the selection of a constant wind field and verification that using a constant wind field is likely to represent conservative or worst-case mixing.*

Because it is unrealistic to simulate every conceivable combination of potential wind velocity, the approach has been to bracket the potential dilutions by considering hypothetical wind situations that represent expected large and small dilutions of the overflow events discharges into Poverty Bay assuming realistic yet hypothetical wind fields. By maintaining a constant wind direction throughout the simulation, we are effectively considering worst case situations, in that increased mixing (and hence increased dilution) due to the plume being advected under variable wind velocities is not considered. We can model additional scenarios with spatially and temporally variable wind fields as required, however the expert opinion is that these additional simulations will not assist in bracketing the likely impact of the overflow discharges.

Question: *Clarification of the wastewater contaminant concentrations modelled, including the source of the data and rationale for the statistic(s) used. As part of this, please provide a detailed tabulated assessment of overflow contaminant concentrations, both monitored and modelled, including a suite of summary statistics (e.g. 10th, median, mean, 80th and 90th percentile nutrient, total suspended solids and faecal indicator bacteria concentrations and the number of data points on and date range over which these have been generated).*

Both overflow volumes and concentrations were provided by BECA

Question: *Overflow volumes and river flows modelled; no information source or explanation is provided for the numbers used in* MetOcean Solutions, 2020b *Tables 2-2 and 2-3 (e.g. date range, number of data points, statistic used and rationale for selection)*

Both overflow volumes and concentrations were provided by BECA. River discharges were supplied by GDC and represent expected discharge rates for the events considered.

Question: *A brief discussion about potential storm events and wind fields might change over the course of the proposed 20-year consent term and how these changes would affect the modelled results.*

New Zealand long range future projected rainfall and wind patterns show a more marked seasonality than was evident in models used in the IPCC Third Assessment, (2001). Westerlies are projected to increase in winter and spring, along with more rainfall in the west of both the North and the South Island and drier conditions in the east and north, including Gisborne. Conversely, the models suggest a decreased frequency of westerly conditions in summer and autumn, with drier conditions in the west of the North Island and possible rainfall increases in Gisborne and Hawke's Bay.

Projected New Zealand climate changes are based on results from 12 global climate models[1].

For the Gisborne region, the predicted seasonal changes in wind velocities (i.e., more westerlies in winter and spring and more easterlies in autumn and summer) leads to seasonal changes in the predicted climate change precipitation, with an increase in precipitation expected in the summer months, and a decrease in winter months. Annual precipitation values are expected to be less than 1990 values by 2040 (see Table 2.2 and Figure 2.4)[2]

Recent climate model simulations confirm the likelihood that heavy rainfall events will become more frequent. Studies have suggested empirical adjustments to historical rainfall distributions that can be applied to estimate a range of possible changes in extreme rainfall under global warming for a particular site.

Table 2.2 Projected changes for selected stations within each regional council area in seasonal and annual precipitation (in %) from 1990 to 2040. Lower and upper limits are shown in brackets.

Region: Location	Summer	Autumn	Winter	Spring	Annual
Gisborne: Gisborne	3 [–26, 33]	4 [–18, 46]	–11 [–30, –2]	–9 [–21, 3]	–4 [–15, 14]

[1] https://www.mfe.govt.nz/publications/climate-change/climate-change-effects-and-impacts-assessment-guidance-manual-local-51#source-of-footnote-12

[2] https://www.mfe.govt.nz/publications/climate-change/climate-change-effects-and-impacts-assessment-guidance-manual-local-51

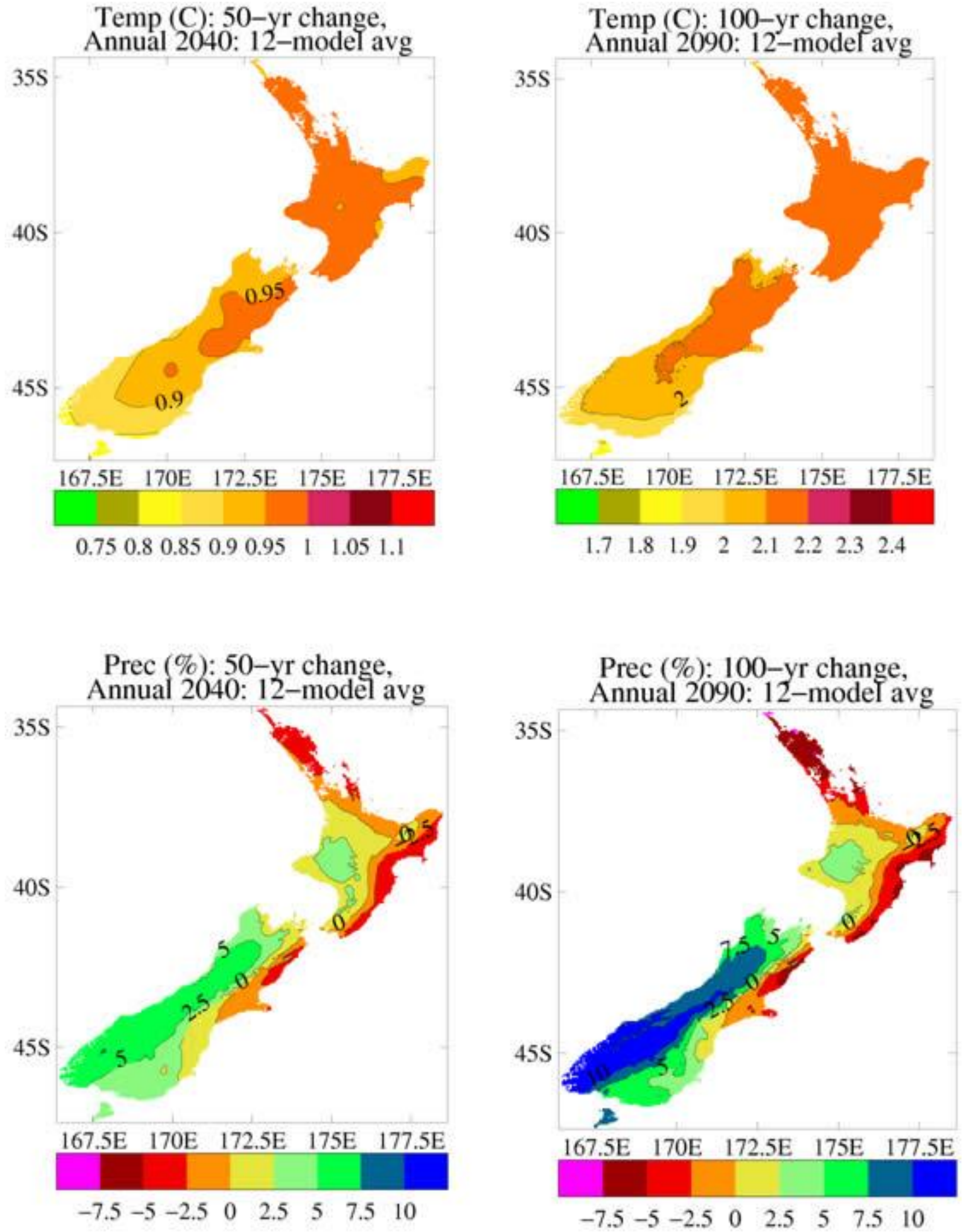

Figure 2.4 Projected changes in annual mean temperature (in °C) and in annual mean rainfall (in %), relative to 1990: average over 12 climate models for A1B emission scenario. Note the different temperature scales for 2040 and 2090.[3]

[3] https://www.mfe.govt.nz/publications/climate-change/climate-change-effects-and-impacts-assessment-guidance-manual-local-51

3. References

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

IPCC Third Assessment. (2001). *Climate Change 2001: Synthesis Report*.

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