Williamstown Maritime Precinct Wave, Wash and Surge Study - Stage 2 Data Analysis Report

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Synopsis	This BMT report presents the progress made in the study conducted for Parks Victoria, Victoria State Government. The study focuses on monitoring, data analysis, modelling, and assessment of high-level options to mitigate damaging wave, wash and surge intermittently experienced at the Williamstown Maritime Precinct. This report summarises the data analysis undertaken during Stage 2 of the study. It covers the desktop data analysis, wake generation/propagation model and identification of high-level potential mitigation options.

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Amendment Record

The Amendment Record below records the history and issue status of this document.

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00	10 September 2021	Parks Victoria – Jeska Dee	DRAFT for initial review
01	23 December 2021	Parks Victoria – Jeska Dee	FULL DRAFT
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Executive Summary

The Williamstown Maritime Precinct – Wave, Wash and Surge Study (this study) is concerned with 'wave, wash and surge' events intermittently experienced and reported by stakeholders at the Williamstown Maritime Precinct, southwest of Melbourne, Victoria. The study, commissioned by Parks Victoria (PV) and the Department of Transport (DOT), Victoria State Government, involves monitoring, data analysis, and identification of high-level options to mitigate the 'wave, wash and surge', which are regarded as both inconvenient and damaging by local stakeholders. The study comprises three stages, namely: Stage 1 – Data Collection; Stage 2 – Data Analysis; and Stage 3 – Potential Mitigation Options.

This report summarises the findings of Stage 2 – Data Analysis. Extensive data analyses were undertaken during Stage 2 of the study, aimed at better understanding the potential causes and dynamics of the 'wave, wash and surge' events. The report covers the desktop numerical analysis of the data collected during Stage 1, initial wake generation/propagation modelling and a list of high-level mitigation options. The measured data of events collected in Stage 1 was analysed in conjunction with metocean and marine traffic data from Automated Identification System (AIS), which was provided for the purposes of the study by the Victorian Ports Corporation Melbourne (VPCM). This analysis assisted in identifying the causes and better understanding the link between the boat motion events occurring in Williamstown, the prevailing environmental conditions, and the passage of different vessel types through the study area.

Key findings of Stage 2 – Data Analysis include:

- From the measured data, an extensive catalogue of detected events was developed, including over eight thousand event detections (8,378 in total) across the three boat motion sensors deployed during the data collection period. Insights derived from the analysis of the temporal and amplitude variation of the event detections encompass:
  - Events were detected on every single day of the data collection period, with an average of approximately 70 event detections per day. Similar to the reported events, the event detections showed a bimodal daily pattern with higher number of event detections in hours of the morning (about 4 per hour) decreasing in the early afternoon and peaking in the late afternoon (at about 6 per hour between 5pm and 6pm). However, events were also consistently detected throughout hours of the night (at a background frequency of 1 per hour), with a noticeable increase to more than 2 per hour between 1am and 2am. This daily patter of event detections matched a similar pattern in the daily marine traffic, which was observed from analysis of the AIS data.
  - The events detected varied in amplitude and duration, with events ranging from 0° to more than 25° roll, although approximately 90% of the event detections being of amplitude 10° or less. The duration of events ranged between less than 30 seconds and up to more than 6 minutes (360 seconds), with more than half of the detections lasting for less than 1 minute (60 seconds). These ranges of amplitude and duration resembled well those of the stakeholder reported events, which provides confidence in the measurement and analysis methodologies employed.
- A series of 37 'wave, wash and surge' events were reported by local stakeholders during the data collection period (Stage 1), between mid-December 2020 and mid-April 2021, with specific times of occurrence and other details. All 37 of these reported events were confirmed to be detected by one or more of the instruments deployed for the study, which validated the instrumentation and analysis methodology developed for the study.
- The 37 stakeholder reported events were collated in a 'catalogue' of reported events, with the information from the stakeholders, and analysed with the instrument measured data as well as against the AIS and metocean data. The analysis of the 37 stakeholder reported events found that:

- The majority (32 of the 37 reported events) had one or more vessels in the corresponding AIS data associated with the event.
- The remaining 5 of the 37 reported events showed no AIS traffic; however, from review of the camera footage, a variety of motorboats were observed to transit through the area at the time and in association with the events. This mostly included small and medium size motorboats, which appeared to be of both recreational and work-related use from the camera footage. In a couple of the events the identification of vessels associated with the events was inconclusive.
- Of the 32 reported events with corresponding AIS traffic, 27 showed Fast Ferries (both in the AIS data and the camera footage) passing shortly before or during the event, at speeds relatively higher than other commercial vessels.
- The remaining 5 of the 32 reported events with corresponding AIS traffic, were associated with vessel types other than Fast Ferries including: tugs, cargo ships, pilot vessels and/or multiples of these vessels.
- This analysis also indicated that the fact of vessels being detected from AIS data, does not necessarily exclude the possibility of other vessels without AIS passing through the area of interest and being associated with some of these events.
- No clear association could be observed in the reported events between the direction of travel of vessels (i.e., inbound versus outbound or other) and the occurrence nor the detected amplitude of the events (measured as roll oscillations).
- The amplitude of the stakeholder reported events, i.e., amplitude of 'boat rocking', measured as the maximum amplitude of oscillation in the roll direction of any of the three moored boats on which motion sensors were deployed, varied between approximately 3° and 22° roll. The measured duration of the reported events varied between close to 30 seconds and more than 6 minutes (up to approximately 380 seconds).
- The stakeholder reported events occurred between approximately 8am and 8pm (12 hours), with a tendency for events to be more frequently reported in hours of the morning and then in the late afternoon. However, one additional stakeholder report during the data collection period, did not have an estimated time but the narrative received suggests there was an event during the night.

- The complete catalogue of event detections was analysed against the marine traffic AIS data allowing the identification of a series of distinct vessel types passing through the area of interest, i.e., potentially generating boat wake waves that propagate and could be associated with 'wave, wash and surge' events of varying amplitude occurring in the Williamstown Maritime Precinct. From this analysis, 14 categories of vessel types were identified, including those associated with the stakeholder reported events as well as other vessel types. These were further summarised into four groups: No AIS vessels, One or more Fast Ferries, Port activities, and Other. Table 1 below summarises the percentage of event detections by vessel type category and event amplitude. Outcomes of this data analysis include:
  - The largest category (and standalone group), comprising 45% of the event detections did not have any associated vessels in the AIS data. Of these, approximately 30%, 13% and 2% corresponded to event detections of maximum amplitude roll measurements of less than 5°, less than 10° and more than 10°, respectively. Similar to some of the stakeholder reported events, review of the camera footage, showed a variety of vessels were observed to transit through the area at the time and in association with events. This mostly included small and medium size motorboats, which appeared to be of both recreational and work-boats.

- Fast Ferries (categories 2 and 3) were identified in 21% of the event detections, with 11.5% of the detections showing only these vessels in the AIS data and another 9.5% showing the Fast Ferries as well as other vessels.
- Vessels directly related to Port activities, accounted for 30% of the total event detections. For 13% of the event detections, a combination of tug boats with large ships (e.g., cargo, tanker, or container ships) appeared in the AIS data. Additionally, 4% of the event detections involved tugs only, 6% cargo ships only, 2% tankers only, 2% the Spirit of Tasmania only, 2% port tender vessel only and 1% pilot vessels only.
- The remaining 4% of the event detections were made up of:
  - 2% showed multiple vessels, excluding fast ferries, in the AIS marine traffic data
  - An additional 1% showed Search and Rescue (SAR) vessels as the only vessels passing by the study area; note, this category includes Victoria Police boats.
  - Less than1% of the event detections showed vessels classified as 'Pleasure craft' fitted with and transmitting AIS data; note this category relates mostly to private, recreational motorboats.
- It is worth noting that review of camera footage for a random sample of event detections indicated that, in some of the event detections, a combination of vessels with and without AIS data transmission were visible transiting through the area of interest at varying speed and generating wake waves. This indicated that non-AIS transmitting vessels (e.g., recreational and work motorboats) can be associated with some of the 'wave, wash and surge' events.
- Further, in some cases the analysis of the AIS data and camera footage revealed no specific vessels passing by that could be associated with event detections, particularly for some of the low amplitude (<5°) and short duration (<60s) events. A closer review of the metocean data indicated that some of these detections may have been related to naturally occurring wind and wave conditions.

- Examples of events caused by wake produced by the main vessel type categories identified and described above are illustrated in the body of this report with summary diagnostic plots showing the measured, AIS and metocean data, accompanied with screen captures from the camera footage. Further examples are included in the appendices.
- Preliminary modelling analysis of wake propagation for key vessel types associated with the events has been progressed for the Fast Ferries category and is included for reference in an appendix, to demonstrate how this type of modelling and analysis can be useful to further understand the dynamics of the events and to inform potential mitigation options.
- From the data analysis and work completed to date, six high-level categories of mitigation options have been proposed for consideration:

1. Relocating the marinas and yacht clubs away from the area of influence of the events (i.e., away from the Williamstown Maritime Precinct)
2. Relocating the Port of Melbourne
3. Reducing the generation of wake as the main cause of the events, i.e., operational options, such as managing vessel transit and speed limits.
4. Attenuating incident waves (including wake waves) that otherwise propagate into the Williamstown Maritime Precinct, i.e., structural options, such as wave attenuators and breakwaters.

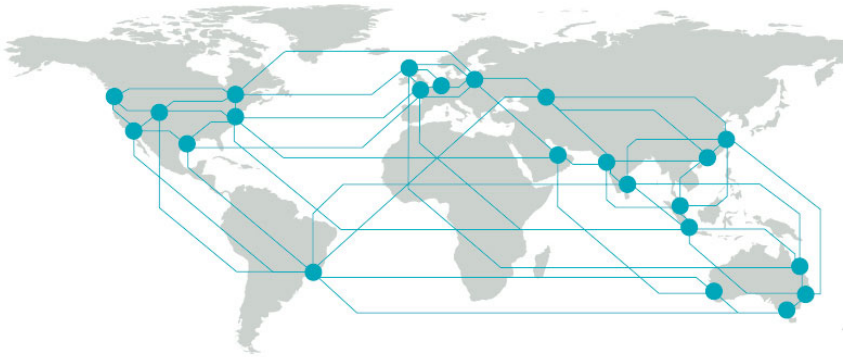
5. Reducing the effect of the incident waves (including wake waves) on the boats and infrastructure within the Williamstown Maritime Precinct, e.g., spacing of boats moored within local marinas and yacht clubs, reinforcement of infrastructure, improvement of fendering systems and joints.

6. Do nothing, accepting the current situation and risk of ongoing events.

- Following guidance from Parks Victoria and the Department of Transport, a comparative assessment will be conducted for mitigation options within categories 3 and 5 as part of Stage 3 of the study. Categories 1, 2 and 4 have been deemed to be cost prohibitive and thus not viable, at this point in time.

Table 1. Percentage of event detections by roll maximum amplitude and associated vessel type passage, from all the three boat motion sensors deployed during the data collection period, analysed against marine traffic AIS data

Vessel Type Category		Max Amplitude of Roll Detected at any of 3 Boat Motion Sensors						
		0-5°	5-10°	10-15°	15-20°	20-25°	>25°	Total (%)
1	No AIS Vessel Observed	30.46	12.77	1.74	0.29	0.01	0.01	45.29
2	Fast Ferry (only)	5.03	4.68	1.67	0.13	0.02	0.02	11.55
3	Fast Ferry + other	4.34	3.62	1.50	0.04	0.00	0.00	9.50
4	Tug (only)	3.17	0.94	0.14	0.02	0.00	0.00	4.29
5	Tug + large ship (cargo / tanker)	7.57	3.84	1.09	0.16	0.04	0.00	12.69
6	Cargo (only)	3.22	1.99	0.41	0.04	0.01	0.00	5.67
7	Tanker (only)	1.29	0.67	0.11	0.02	0.00	0.00	2.09
8	Spirit of Tasmania (only)	0.85	0.67	0.12	0.02	0.00	0.00	1.66
9	Port Tender (only)	1.31	0.44	0.07	0.01	0.01	0.00	1.85
10	Search And Rescue (SAR) boat (	0.49	0.25	0.06	0.01	0.00	0.00	0.81
11	Pilot Vessel (only)	0.84	0.29	0.10	0.04	0.00	0.00	1.25
12	Pleasure Craft (only)	0.19	0.08	0.05	0.02	0.00	0.00	0.35
13	Other Vessel Type (only)	0.57	0.29	0.04	0.00	0.00	0.00	0.90
14	Multiple vessels (no ferry)	1.35	0.58	0.17	0.01	0.00	0.00	2.11
15	**Total (%)**	60.68	31.12	7.26	0.81	0.10	0.04	100.00



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