mail@wavelengthconsulting.com.au
wavelengthconsulting.com.au
ABN 51 603 240 124

Technical Note

Date: 28/05/2021

Client: Kingston District Council

Subject: Maria Creek – Partial Breakwater Removal Concept

Executive Summary

Context and purpose

- Kingston District Council (KDC) are currently investigating long term management options for the Maria Creek boat launching facility (boat ramp), Kingston Jetty (jetty) and surrounding foreshore.
- Based on results of a recent community survey, KDC are pursuing closure of the boat ramp and are investigating the partial removal of the offshore portion of the Maria Creek southern breakwater.
- The partial breakwater removal aims to reduce the width of the beach at the jetty, improving jetty amenity.
- However, the partial breakwater removal has the potential to increase on-going management costs through increased storm wave exposure and subsequent sand and wrack accumulations within the creek.
- A detailed wave and hydrodynamic modelling study has been undertaken to investigate the potential impacts of shortening the southern breakwater by 80m.

Key findings

- The partial removal of the breakwater comes at a significant capital and on-going cost compared to the Do Nothing approach:
    - An **additional capital cost of $1.2M** to remove the offshore portion of the breakwater.
    - A **3-fold increase in the annual sand and wrack management costs** within the creek, resulting in an additional $70,000 per annum or a Net Present Value of **$0.7M** over a 25-year planning horizon.
  - Partial removal results in a **reduced beach width of 45m at the jetty** (compared to an increase in beach width of up to 25m for the Do Nothing concept).

Key recommendations

- Given that partial removal results in only a minor reduction of the total beach width at the jetty and is expected to significantly increase creek management costs and requirements, it is recommended that Council consider other pathways to improve jetty amenity and activate the foreshore and jetty area.
- Consideration should also be given to improved protection to the breakwater head under the Do Nothing approach, due to the poor condition of the existing breakwater head.

1 Introduction

Kingston District Council (KDC) is located approximately 300km to the south-east of Adelaide, South Australia. KDC operates and maintains a number of coastal assets adjacent to the Kingston SE townsite, including the Maria Creek recreational boating facility (boat ramp) and the 410 m long Kingston Jetty (jetty) shown in Figure 1.

Following on-going siltation and wrack accumulations within the entrance channel to the boat ramp, KDC engaged Wavelength to identify and consider concepts related to coastal infrastructure and management at the Kingston foreshore, focusing on the area bounded by the jetty and the boat ramp (Wavelength, 2020). Concepts were evaluated against the following criteria nominated by KDC:

1. Provide a boat ramp during peak times (October to May), that is financially sustainable (low maintenance) through an affordable capital solution.
2. Provide a jetty that services the needs of community and visitors.
3. To create an opportunity to activate open spaces and facilities, specifically the area between the jetty and breakwaters.
4. Consider the effects of the natural processes and the coastal environment.

Concepts included:

- Reinstating the boat ramp (Concepts 1 to 3),
- Closure of the boat ramp and full removal of the breakwaters (Concept 4), and
- Do Nothing, assuming the boat ramp is closed and creek flows are maintained for environmental and flood protection purposes through wrack removal.

KDC established a Community Focus Group (CFG) to review the concepts and select a preferred option for progression to detailed design.

Wavelength, at the request of KDC and the CFG, has been engaged to investigate the partial removal of 80m of the southern breakwater (Figure 1). This option assumes the boat ramp is closed and aims to reduce beach widths at the jetty, to improve jetty usage and amenity compared to the Do Nothing concept.

This option has the potential to increase on-going management costs, exposing the creek entrance to increased storm waves and subsequent wrack accumulations. Even with closure of the boat ramp, ongoing management of sand and wrack within the creek is likely to be required for environmental and flood control purposes.

This Technical Note outlines investigations into the partial removal concept, with particular focus on comparison to the Do Nothing concept. Wave and hydrodynamic modelling results for the partial removal concept are presented in Appendix A.

Figure 1: Partial removal concept layout plan

2 Effectiveness

2.1. Jetty and Foreshore

The following summarises the partial removal concept impact on the Jetty and Foreshore:

- **Jetty:**
  - In the Do Nothing option, the beach south of Maria creek is expected to widen further over time. By 2060 the shoreline at the Jetty is predicted to be 25m further seaward than currently (Figure 2).
  - Under the partial removal option:
    - the beach width at the jetty is anticipated to **reduce by up to 45m** compared to the 2020 shoreline position (Figure 2), equivalent to a reduction of 70m from the predicted **Do Nothing** shoreline (Figure 2),
    - the jetty over land walking distance (from the car park to the water line) would be reduced from approximately 300m to 230m, a reduction of approximately 25% compared to the Do Nothing option, and
    - the reduced beach width is still twice that of the pre-breakwater beach width in 1987 (Figure 2).
  - Given the above, jetty users would still have to walk over 230m of dune and beach to reach the water line, considered a minor improvement in the jetty amenity.
- **Foreshore:**
  - Given the presence of the breakwater structures, wrack is anticipated to continue to accrete on the southern beach under the partial removal concept.
  - Predicting beach wrack volumes can be difficult, as the wrack accumulation depends on a number of factors. However, wrack volumes are anticipated to be similar to the Do Nothing concept.
  - As such, the partial removal option is expected to have limited benefit to foreshore amenity with regards to wrack accumulation.

Figure 2:Comparison of jetty effectiveness

2.2. Creek - Wrack and sand management

Under the partial removal concept, the volume of wrack and sand accumulating within the creek is anticipated to **increase by a factor of 3** compared to the Do Nothing approach, as presented in Table 1. This increase in volume is due to:

- **Storm wind and waves**: an increase in storm wave and wind energy entering the entrance from the south-west to west quadrants, which can be seen in the wave modelling (Figure 3) and measured wind data (Figure 4). This is the key driver of wrack movement into the creek and it is likely the main reason the southern breakwater was extended in 2002.
- **Currents:** removal of the offshore end of the southern breakwater allows currents flowing northwards to flow more directly into the mouth of the creek, when they are currently diverted around the end of the breakwater. This is likely to increase sand and wrack movement into the creek on incoming tides.

Increased sand and wrack accumulations within the creek entrance, increases the flood risk upstream of Maria Creek boat ramp and has the potential to impact environmental flows and flushing of the creek. The potential increase in wrack blockages during storm events would also increase the wrack monitoring and management requirements of Council staff.

Table 1: Partial removal sand and wrack management requirements

Concept	Mixed sand and wrack volume (m^3)
Partial Removal	15,000
Do Nothing	5,000

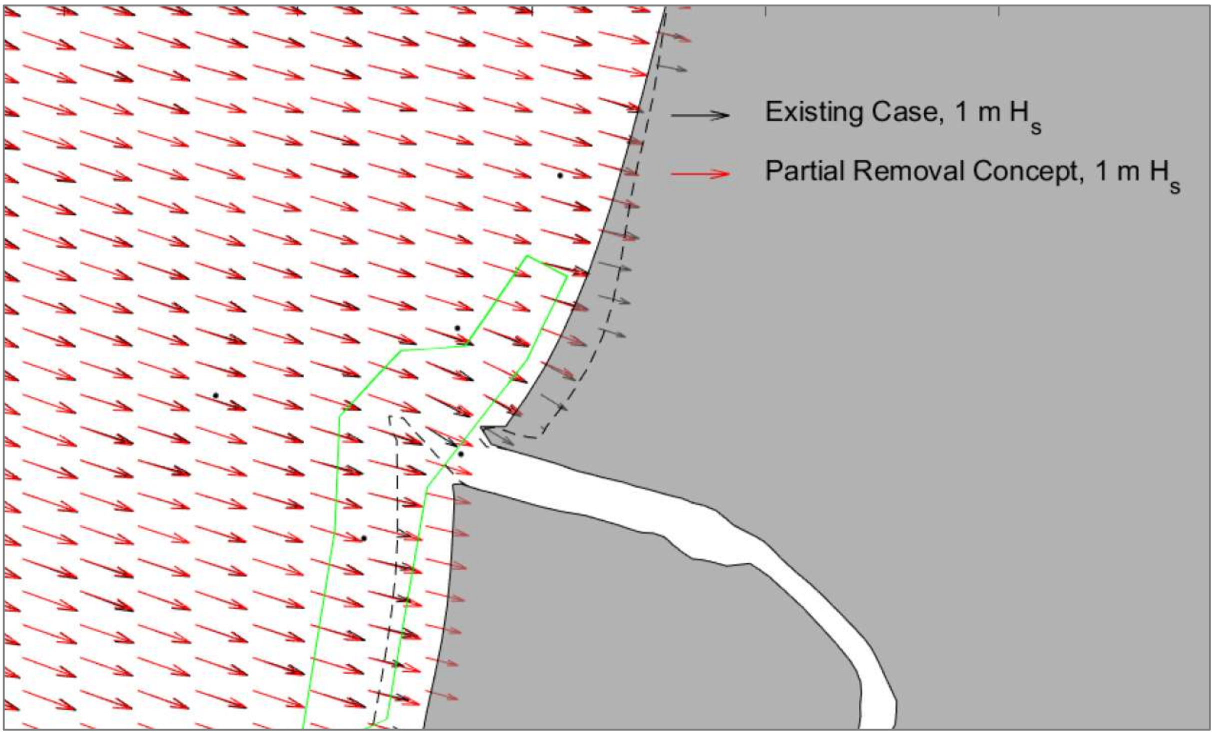


Figure 3: Wave modelling results west storm (full plot in Appendix A)

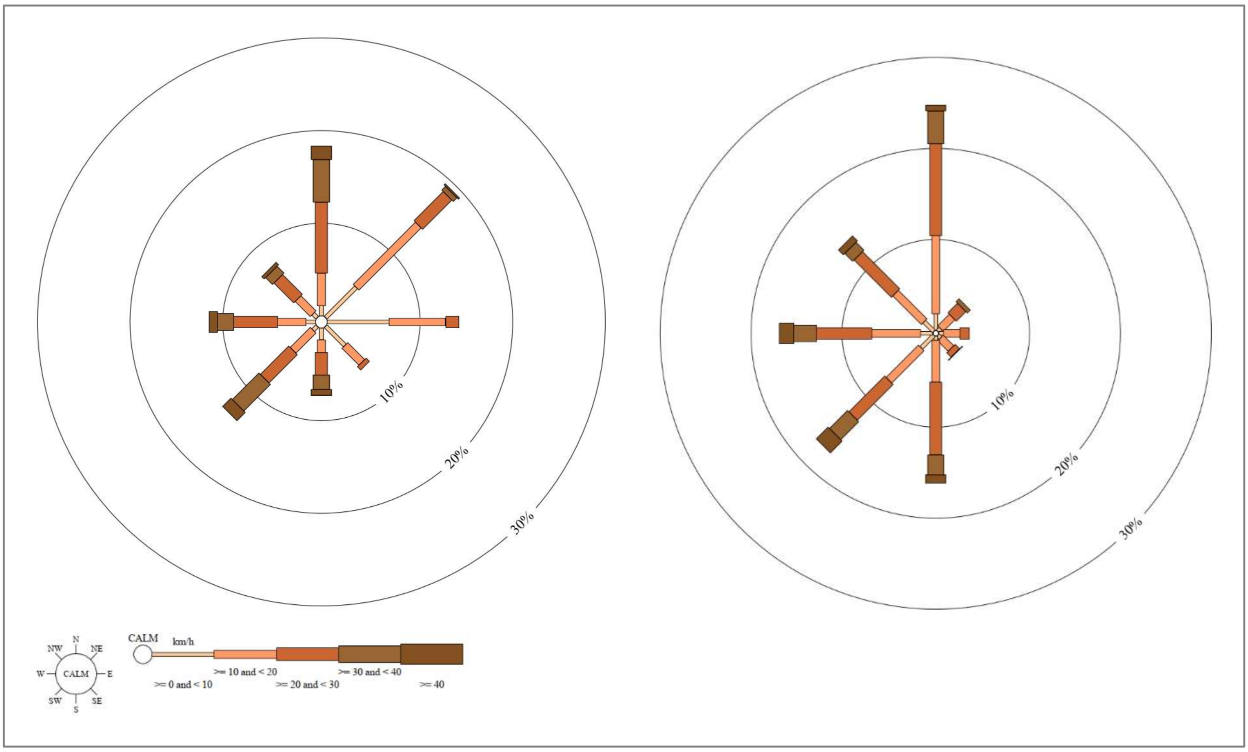


Figure 4: Cape Jaffa wind May wind roses: 9am (left) and 3pm (right)

3 Cost estimate

Order of magnitude capital and recurrent maintenance cost estimates for the partial removal concept have been prepared as presented in Table 2 below.

Net Present Value (NPV) analysis provides an indication of the relative costs of the concepts over a 25-year planning horizon, considering capital and on-going costs. The cost estimates presented are to be used as a guide only, detailed costings would be developed following selection of option to be progressed to detailed design. Capital and NPV cost breakdowns for the partial removal concept is presented in Appendix B.

Table 2: Concept Cost Estimates

Concept	Capital costs	Annual Management	25-year NPV
Partial Removal	$1.3M[1]	$67,500	**$2.3M**
Do Nothing	-[1]	$22,500	**$0.3M**

Notes: 1. No allowance for breakwater repairs

The capital cost estimate includes:

- removal of breakwater armour and core to -2.7 mAHD,
- sorting of removed rock,
- reconstruction of the breakwater head, re-using existing and imported 6t armour rock, and
- trucking surplus armour and core to a nearby stockpile, within 5km of Maria Creek.

Annual management costs include on-going sand and wrack management within the creek for environmental and flood control purposes.

NPV analysis assumptions are set out in Section 5.7 of Wavelength (2020).

Without repairs and ongoing maintenance, it is likely that the breakwaters will experience storm damage over time, resulting in exposure of the core layers, as experienced in the 2016 storm events. Such damage is unlikely to prevent the breakwaters from training the creek entrance, or significantly affect the findings above related to the beach width, and wrack accumulation south of Maria Creek. However, such damage could result in loss of smaller rock armour and core into the creek and surrounding coastline, impacting on beach amenity in the area. In this regard, the capital costs presented above do not include breakwater repair costs for the partial removal or Do Nothing concepts.

For reference, the approximate cost to repair the breakwaters in line with the recommendations made in Tonkin (2017) are outlined for the two concepts below. These repair costs (if required) could be added directly to the capital and 25-year NPV costs presented in Table 2.

Breakwater repair costs:

- **Partial removal:**
  - Re-armour external trunk using stockpiled armour rock **$0.3M**
- **Do Nothing:**
  - Supply and place 6t armour layers on breakwater head **$0.3M**
  - Supply and place 1.5t armour layers on external and internal trunk **$0.5M**

4 Summary

Key findings of the partial removal investigations are summarised below:

- The partial removal of the breakwater comes at a significant capital and on-going cost compared to the Do Nothing approach:
  - An **additional capital cost of $1.2M** to remove the offshore portion of the breakwater.
  - A **3-fold increase in the annual sand and wrack management costs** within the creek, resulting in an additional $70,000 per annum or a Net Present Value of **$0.7M** over a 25-year planning horizon.
- The financial costs of the partial removal should be weighed up against the benefit of a **reduced beach width of 70m at the jetty** (compared to the Do Nothing concept).
- Given that partial removal results in only a minor reduction of the total beach width at the jetty and is expected to significantly increase creek management costs and requirements, it is recommended that Council consider other pathways to improve jetty amenity and activate the foreshore and jetty area.
- Consideration should also be given to improved protection to the breakwater head under the Do Nothing approach, due to the poor condition of the existing breakwater head.

5 References

Tonkin, 2017. Maria Creek Breakwater Kingston Condition Assessment. Prepared for Kingston District Council.

Wavelength, 2020. Maria Creek Sustainable Infrastructure Project - Concept Study. Prepared for Kingston District Council.

Appendix A Partial Removal Concept Modelling Results Technical Note (PCS, 2021)

Technical Note

Date:	6th May 2021
To:	Brad Smith
From:	Rachel White
Subject:	Maria Creek – Partial Removal Concept
Classification:	Project Related
Version:	1.0

1. Introduction

Wavelength Consulting (Wavelength), on behalf of Kingston District Council (Council), commissioned Port and Coastal Solutions (PCS) to provide data analysis and numerical modelling services to inform the Maria Creek Concept and Design study. The study relates to the management of a boat ramp facility within Maria Creek, which over recent years has incurred untenable maintenance costs. These costs relate to maintaining the integrity of the existing training wall structures and maintaining access following periods of high seagrass wrack and sediment build up in the Creek. Council is seeking to identify a long-term solution that is financially sustainable and can be delivered through an affordable capital solution.

As part of this study, PCS (2020a and 2020b) assessed the implications of a number of design concepts on sediment transport and wrack accumulation using numerical modelling tools to help estimate the ongoing maintenance requirements. Following a review of the findings in PCS (2020a and 2020b), a new design concept was identified for consideration. This technical note summarises the modelling relating to this new design concept. For additional information on the study, including a characterisation of the site (including metocean conditions and a conceptual sediment budget), details of the model setup and performance, the previously assessed design concepts and the results from the assessment of the initial design concepts, the reader should refer to PCS (2020a and 2020b).

2. Partial Removal Concept

The hydrodynamic, wave and longshore sediment transport modelling tools developed by PCS (2020a) have been applied to assess a concept design which was proposed by Wavelength as an option to help ease the currently untenable costs associated with maintaining the Maria Creek boat ramp. The concept design considered in this technical note is a partial removal of the existing southern breakwater and as such the Concept is referred to as the 'Partial Removal Concept'.

The key elements of the Partial Removal Concept include the following:

- the removal of approximately 80 m (from the 'elbow') of the southern breakwater at its seaward end;
- a natural realignment of the shoreline with a retreat in shoreline to the south of Maria Creek and an advance in shoreline location to the north, with a smoothing of the bathymetric contours in response to the reduced blockage to longshore transport; and
- a sand bar across the entrance of the Creek which is expected to form following the partial removal of the southern breakwater. The existing case has some sedimentation in the entrance in the lee of the southern breakwater but at a slightly deeper depth (around -0.5 m AHD compared to -0.25 m AHD for the concept).

The hydrodynamic (HD) model mesh of the Partial Removal Concept is shown in Figure 1. The Spectral Wave (SW) model mesh was also updated to include the key elements of the Partial Removal Concept design, but does not include within the Creek (since propagation of waves into the Creek is likely to be small in view of the sand bar expected to form across the entrance).

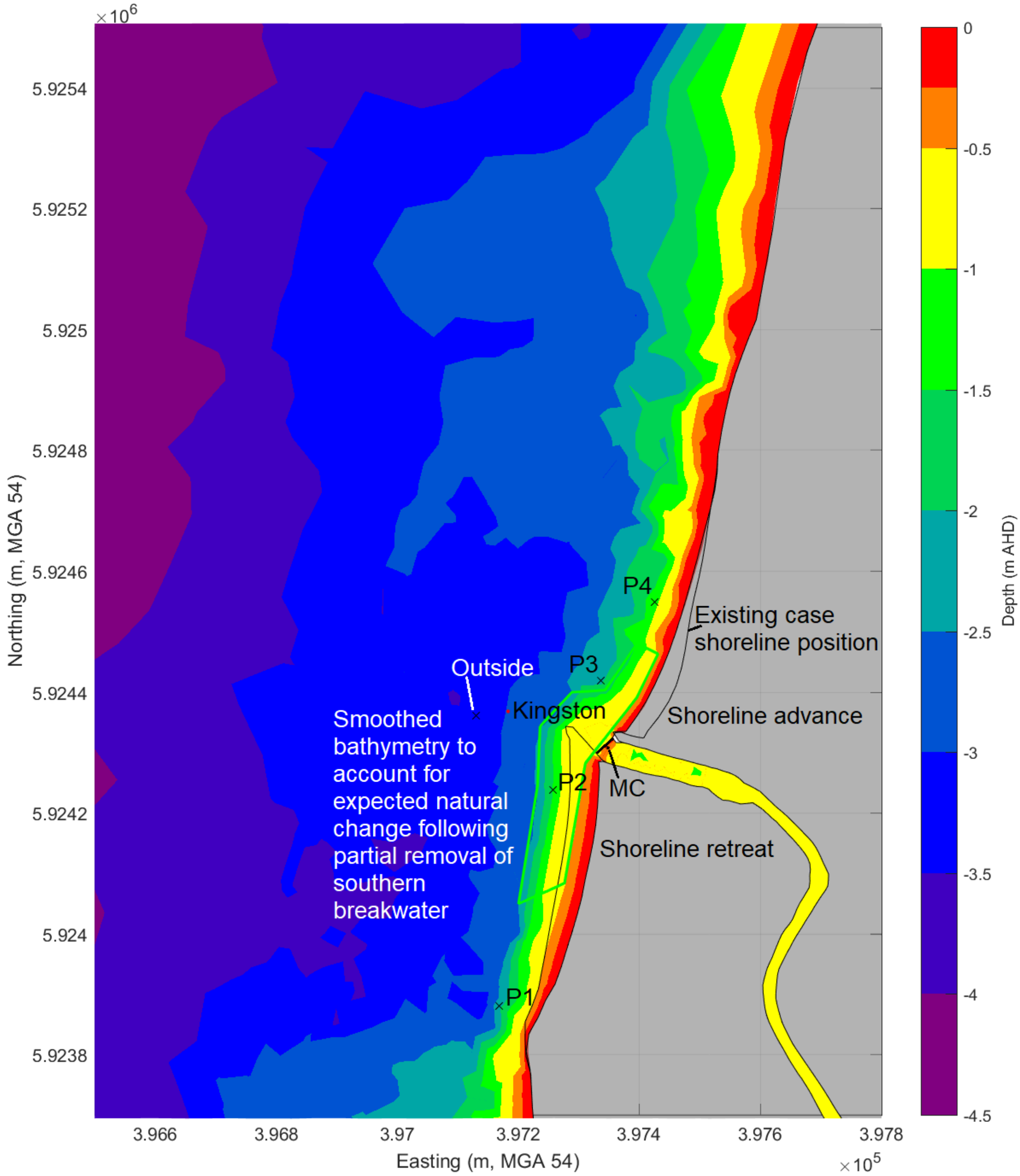


Figure 1. Partial Removal Concept: Removal of offshore section of southern breakwater.

3. Results

The results from the modelling of the Partial Removal Concept are presented in this section. For reference, some results from the existing case model simulations are also presented. Comparison against the existing case allows an assessment of the on-going management costs (relating to managing potential sand and wrack accumulations in the creek) for the Partial Removal Concept against the option of 'Do Nothing'.

3.1. Effect on Flows

Timeseries plots of flows outside (at Kingston) and inside Maria Creek (at MC – see Figure 1 for locations) are shown in Figure 2 and Figure 3, respectively. Results show that relative to the existing case, flows outside of the Creek are largely unchanged, with only a small reduction (of around 0.01 m/s on peak flows of around 0.2 m/s) and slight reorientation in flows due to the reduced extent of the breakwater and realigned bathymetry. Changes between the flows for the Partial Removal Concept and the existing case are more significant at the Creek entrance with flows increased by up to 0.1 m/s although this varies from tide to tide as a result of the variable wind conditions. There is also a change in flow directions with greater variability following the removal of the outer section of the southern breakwater (which currently acts to train the flows into and out of the Creek). The MC extraction point is located on the sand bar which is predicted to form across the entrance for the Partial Removal Concept, with the reduction in depth to -0.25 m AHD causing a local acceleration in flow. Flows at a location approximately 30 m to the east of MC (i.e. off the sand bar and into the Creek) are shown for the existing case and Partial Removal Concept in Figure 4 and show that differences inside the Creek between the two are very small, with the concept resulting in a slight reduction in flow speeds on the smaller semi-diurnal ebb tide when the water level in the Creek is close to or below the depth of the sand bar.

To show the flows in more detail, map plots of the tidal flows for the Partial Removal Concept design are plotted at incremental stages throughout a spring tide during a period of low winds in Figure 5 and Figure 6. Map plots at the time of peak flood are also shown for a spring tide during a period of high northerly winds and a neap tide during a period of high south westerly winds in Figure 7. Additional map plots showing the flows for all tidal states for each wind condition are included in Appendix A (Figure A1 to Figure A4).

The map plots confirm that offshore of the existing breakwater, flows for the Partial Removal Concept are broadly similar to those for the existing case (see Appendix B) with a small reduction and reorientation in flows resulting from the removal of the offshore portion of the breakwater. Shoreward of where the breakwater was removed the map plots generally show that the flows directly to the north of Maria Creek are increased compared to the existing case when flows are to the north, while flows directly to the south of Maria Creek are increased compared to the existing case when flows are to the south. As indicated by the time series plot of flows to the east of MC (Figure 4), flows within the Creek actually show very little difference following the removal of the offshore section of the southern breakwater, confirming that the changes in flows which occur at the entrance (at MC) are highly localised.

As a result of the partial breakwater removal there is a reduction in discharge through the Creek entrance (Figure 8). This is not a direct consequence of the partial removal of the breakwater but results from the shallowing of the entrance following the formation of a sand bar across the entrance which is likely to form following the partial removal of the southern breakwater. The sand bar reduces the cross sectional area of the entrance and restricts the exchange of water between the Creek and offshore, particularly at the time of low water. The change in discharge is equivalent to a reduction of approximately 5,600 m^3 of water flowing into and out of the entrance during a large spring tide which equates to around an 8% reduction (71,500m^3 for the existing case, compared to 65,900m^3 for the Partial Removal Concept). This change is unlikely to influence the stability of the entrance relative to the longshore transport compared to the existing case, with sediment expected to accumulate in the entrance for both the existing case and for the Partial Removal Case. Changes to the longshore transport for the Partial Removal Concept are discussed further in Section 3.3.

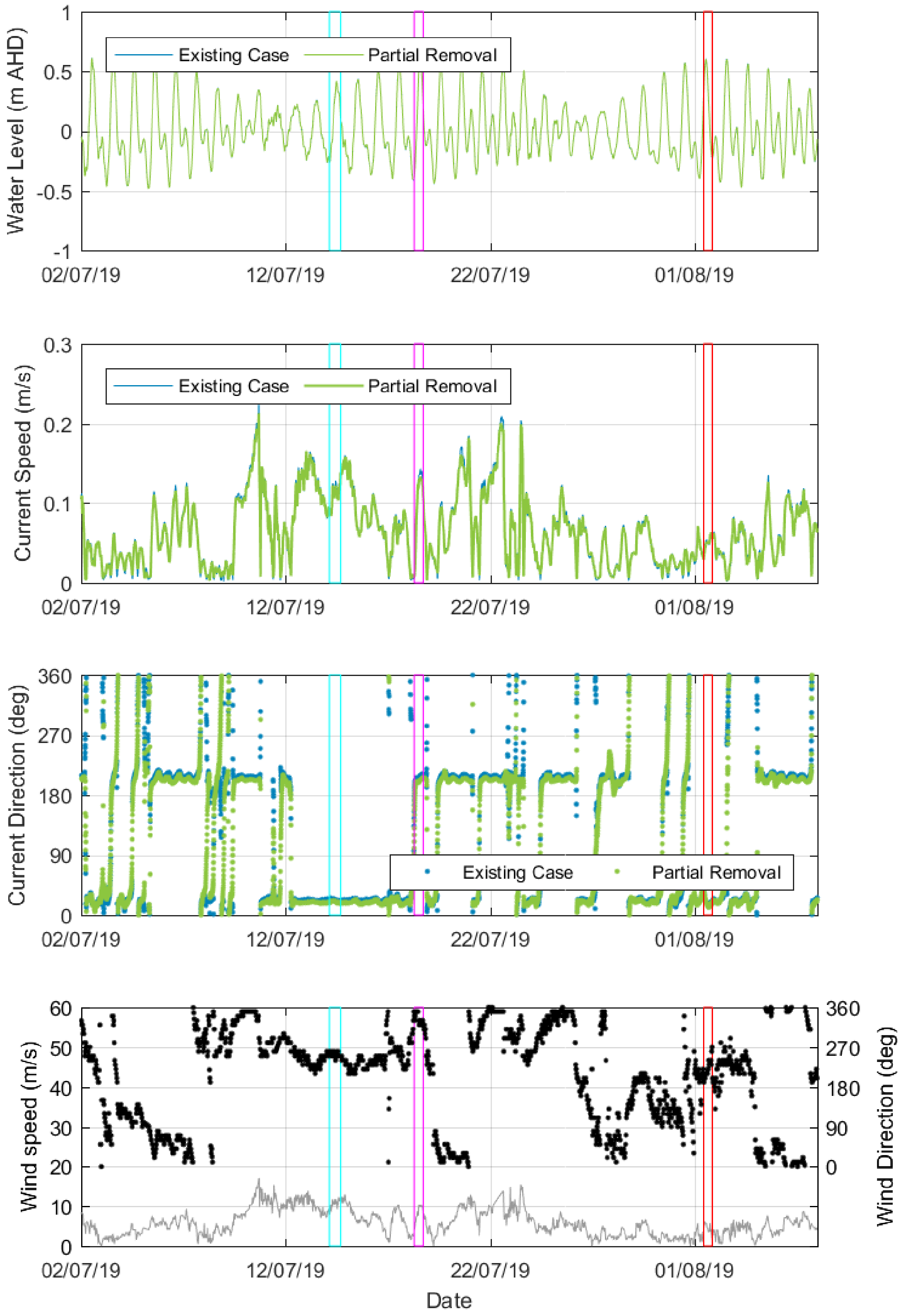


Figure 2. Timeseries of modelled tidal levels and flows at Kingston for Existing Case and Partial Removal Concept design.

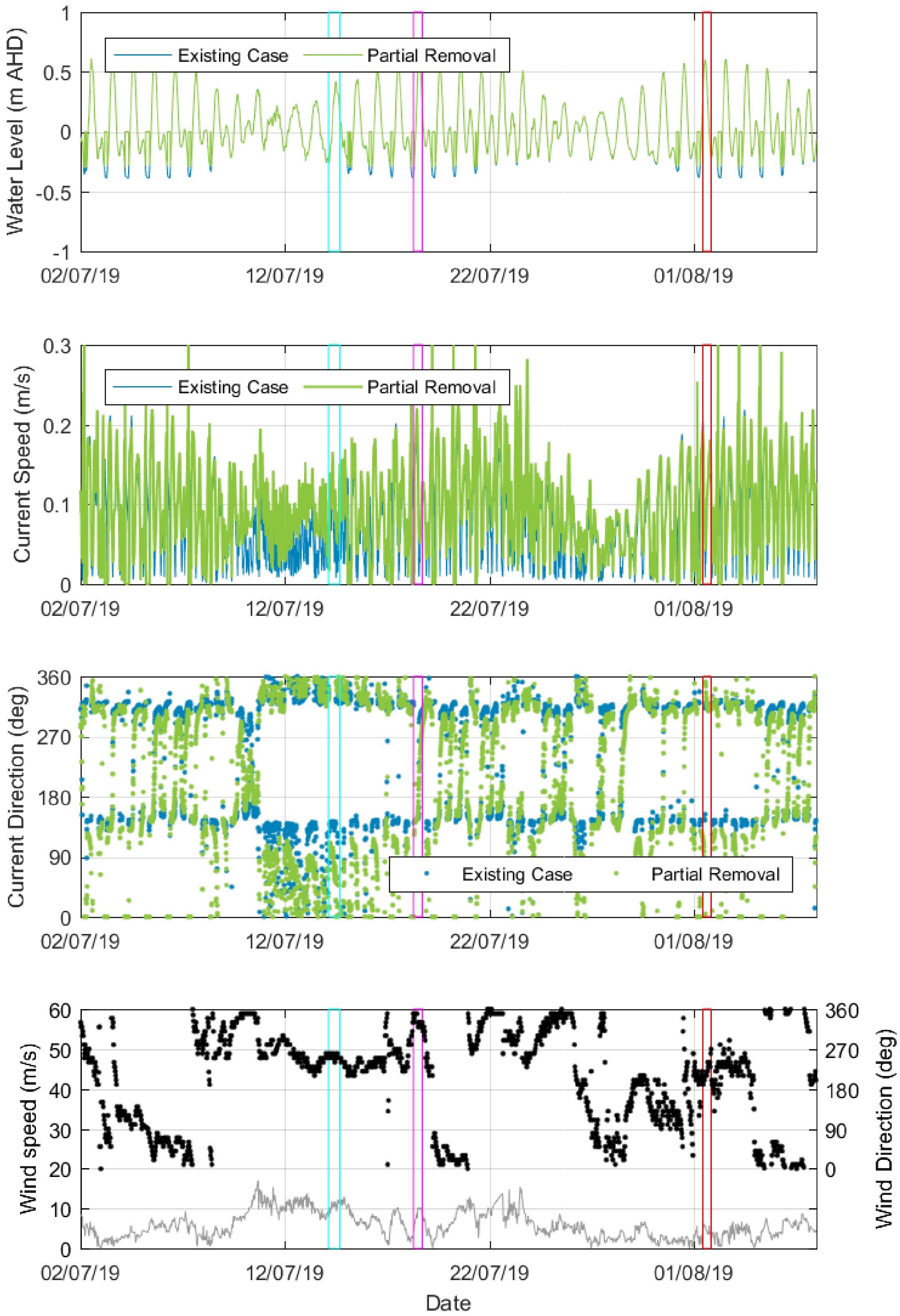


Figure 3. **Timeseries of modelled tidal levels and flows in Maria Creek (in MC) for the Existing Case and Partial Removal Concept design.**

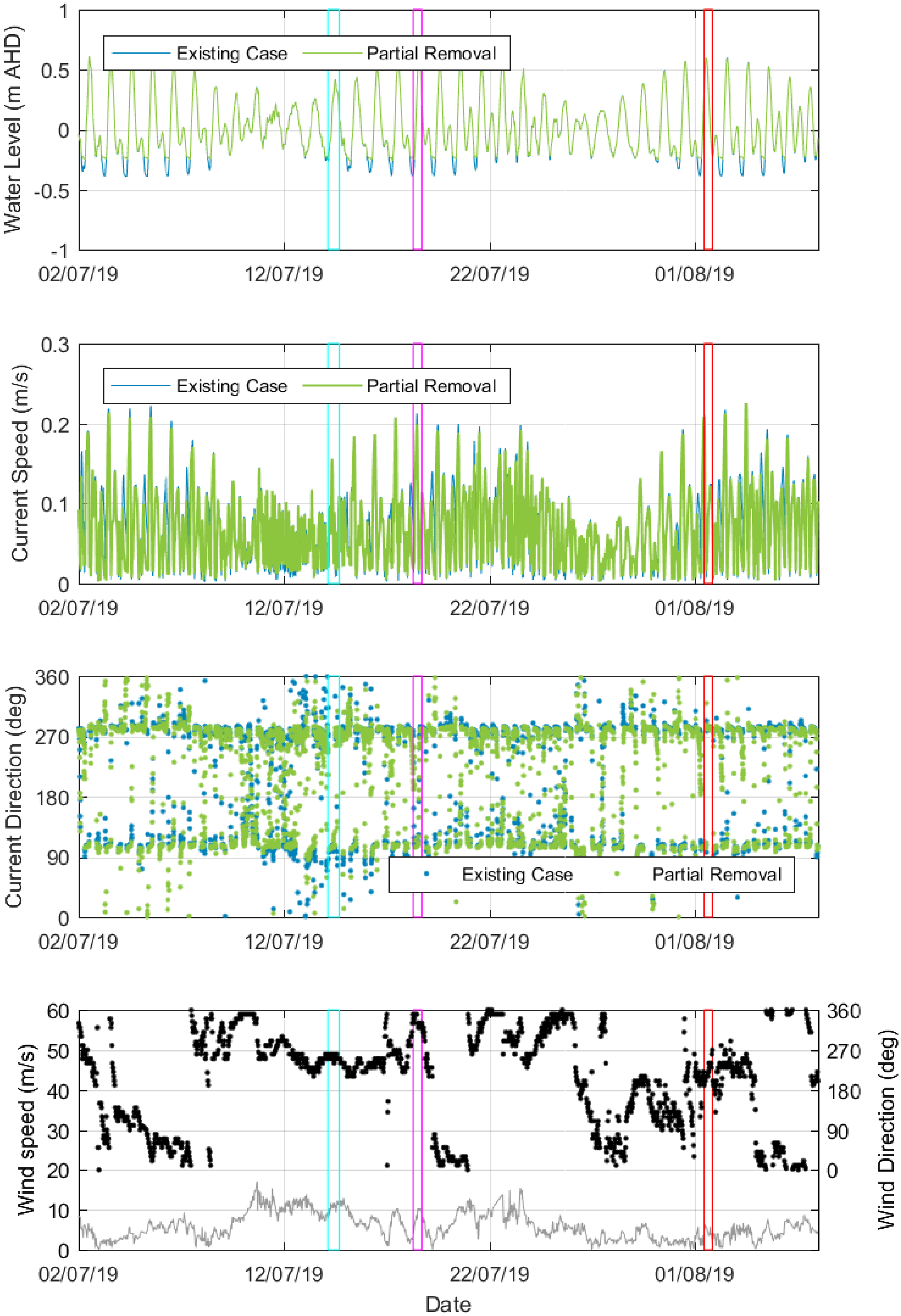


Figure 4. Timeseries of modelled tidal levels and flows in Maria Creek (30 m east of MC) for the Existing Case and Partial Removal Concept design.

PORT & COASTAL SOLUTIONS

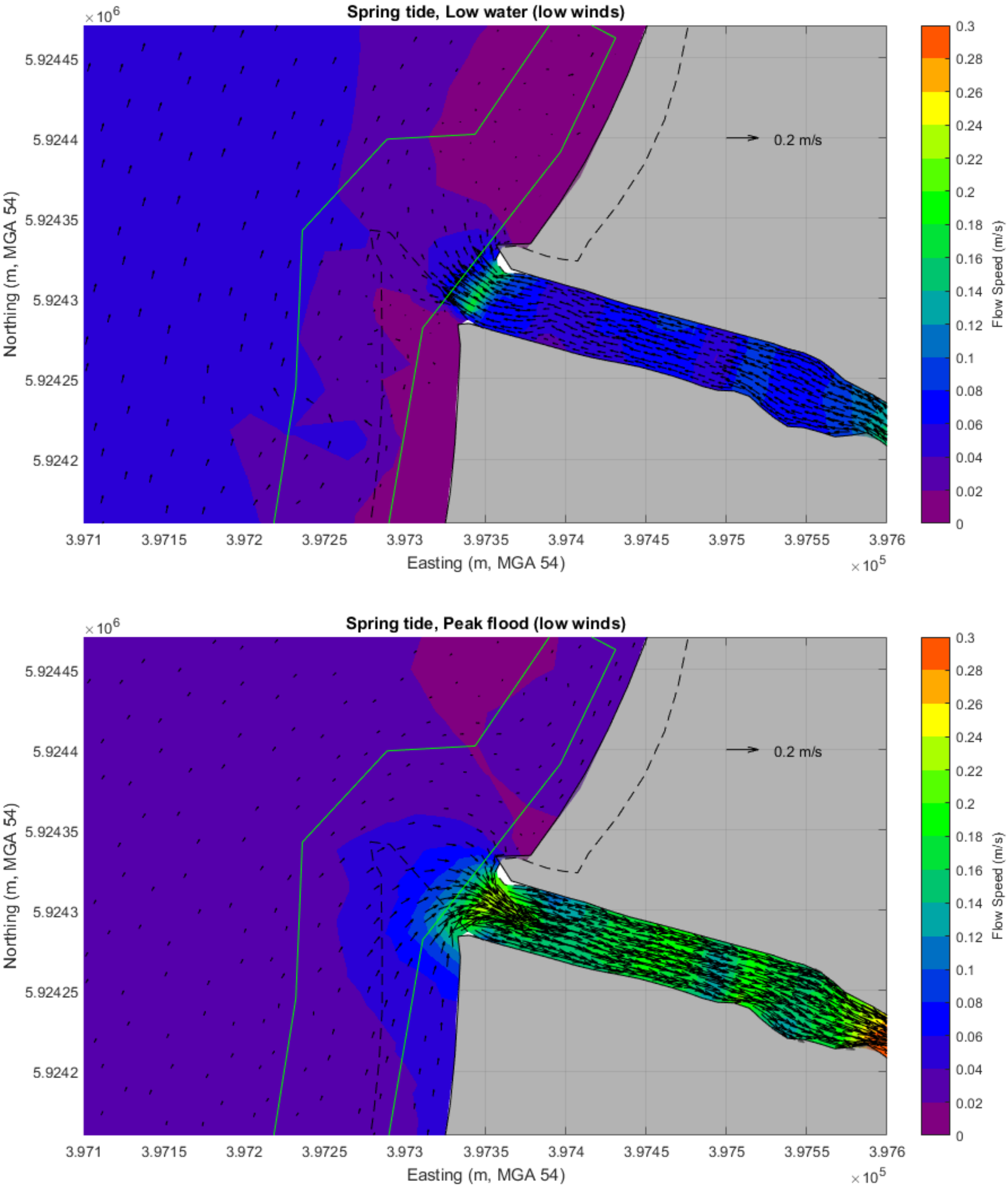


Figure 5. **Modelled tidal current speeds around Maria Creek at low water (top) and peak flood (bottom) for a spring tide with low winds for the Partial Removal Concept.**

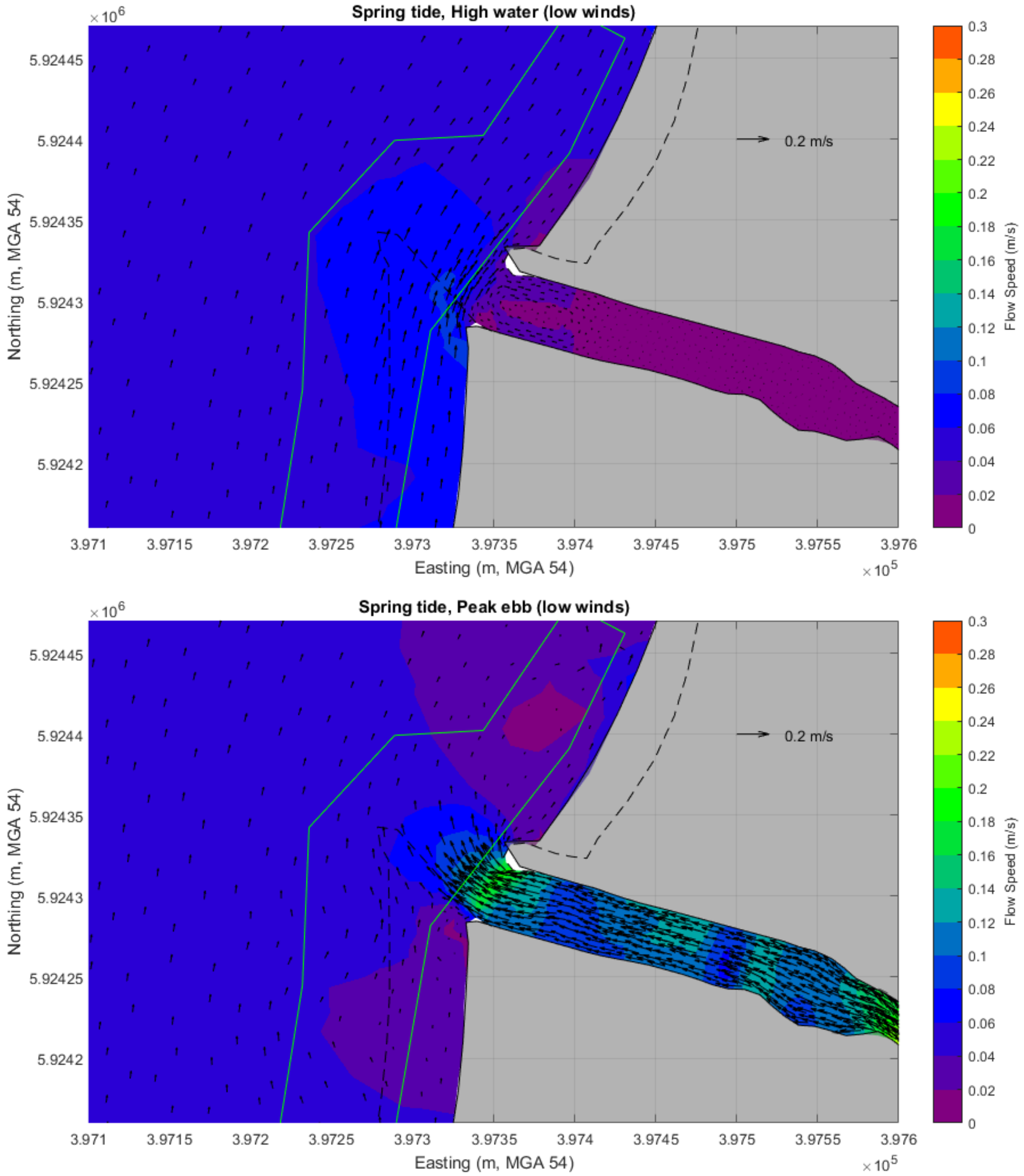


Figure 6. Modelled tidal current speeds around Maria Creek at high water (top) and peak ebb (bottom) for a spring tide with low winds for the Partial Removal Concept.

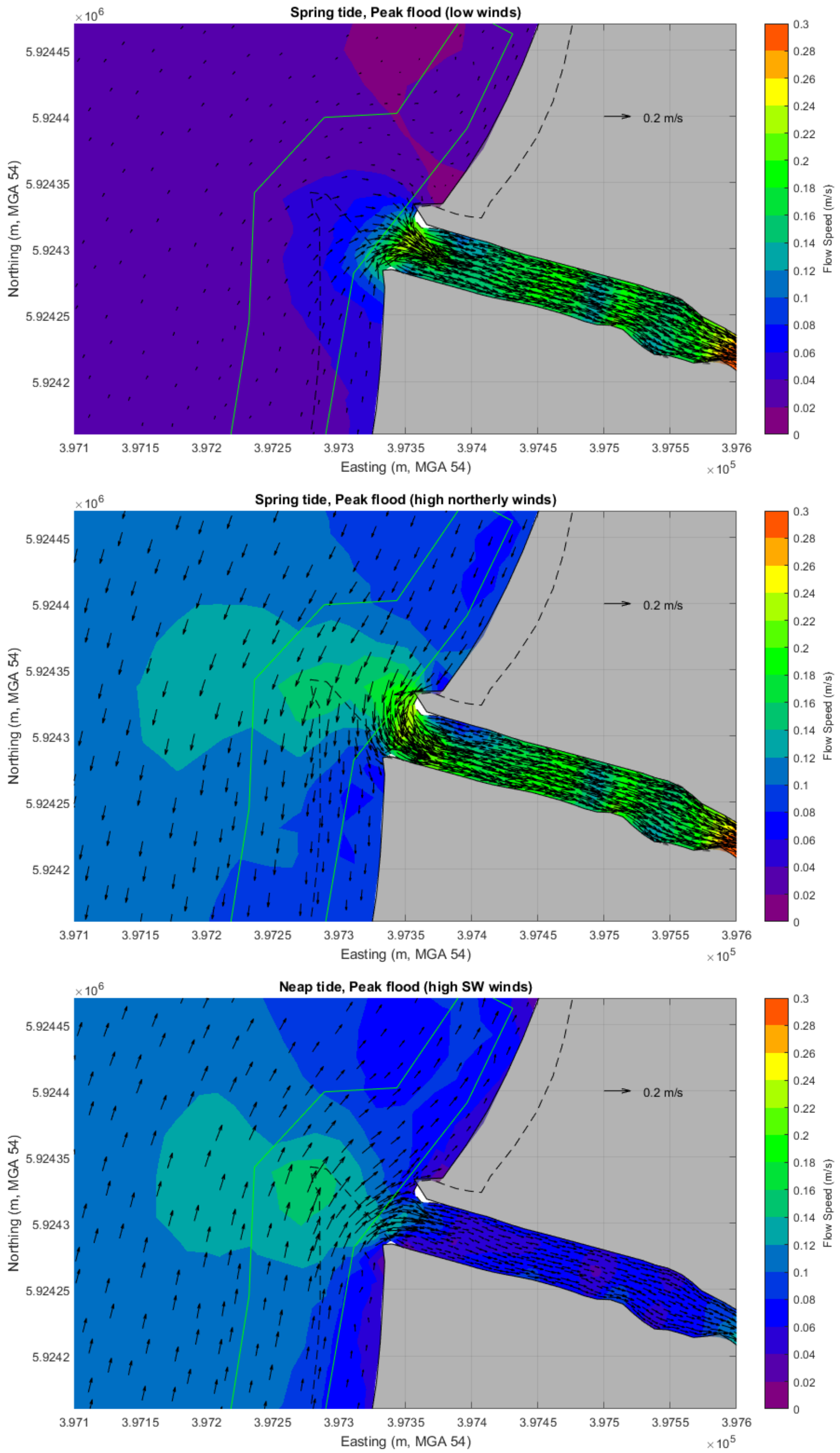
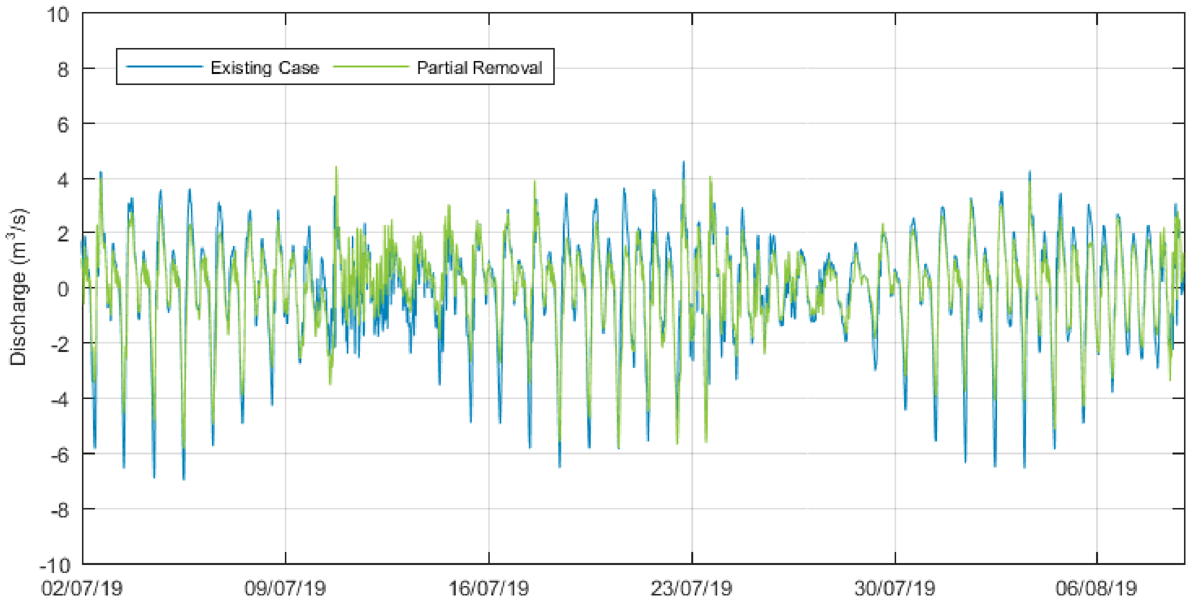


Figure 7. **Modelled tidal flows around Maria Creek at peak flood for a spring tide with low winds (top), a spring tide with high northerly winds (middle) and a neap tide with high south westerly winds (bottom) for the Partial Removal Concept.**



Note: Positive values denote discharge out of Marina Creek and negative values discharge into the Creek.

Figure 8. Modelled discharge through Maria Creek for the Partial Removal Concept.

3.2. Effect on Waves

To show how the partial removal of the southern breakwater affects the wave conditions around Maria Creek, vector plots are presented in Figure 9 to Figure 11. These plots show the typical wave conditions for the Partial Removal Concept for the following conditions:

- a north-westerly wave event (H_s is 0.44 m[1], less than a 10 in 1 year wave event – Figure 9);
- a westerly wave event (H_s is 0.94 m[1], between a 1 in 1 year and 1 in 5 year wave event – Figure 10); and
- a south-westerly storm (H_s is 0.89 m[1], equivalent to a 1 in 1 year – Figure 11).

The wave events were defined by consideration of the directions of waves at the offshore Cape de Couedic Wave Rider Buoy (since the angle of incidence for waves approaching the coast at Maria Creek covers a relatively narrow band due to the effects of wave refraction across the relatively wide shallow region of Lacepede Bay). Waves from the northwest tend to be duration limited (i.e. the size of waves is limited by the duration for which winds from this direction occur) and therefore resultant waves at Maria Creek are typically small when considered in relation to wave events from other more persistent directional sectors.

Wave conditions are shown for the Partial Removal Concept and the existing case to show how the partial breakwater removal affects the wave conditions, particularly within the Creek entrance where reduced wave sheltering will occur.

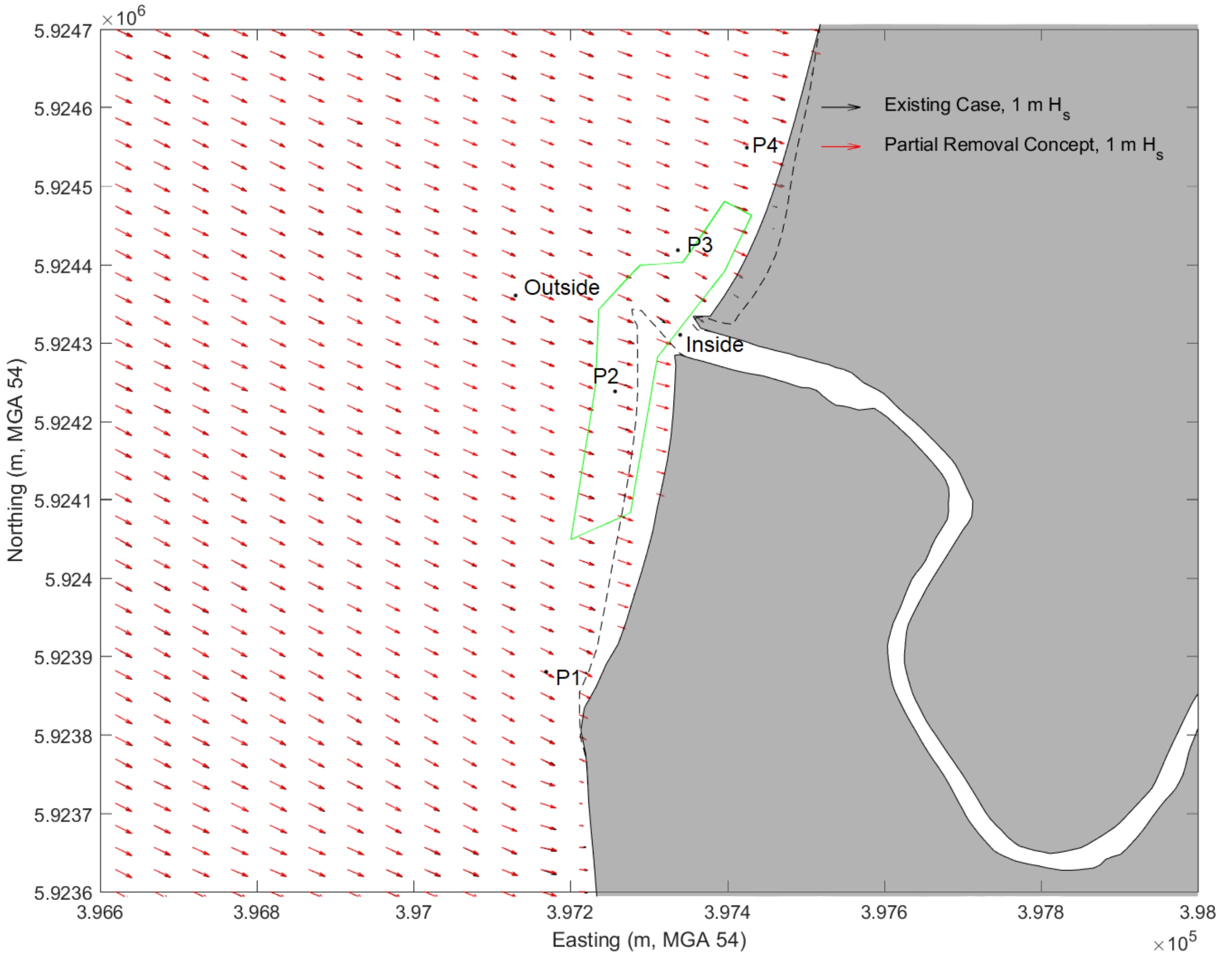
The Partial Removal Concept results in a number of small changes to the wave conditions relative to the existing case:

- a shift in wave direction at the entrance to Maria Creek so that the incoming wave direction remains orientated with the wider wave field, rather than being locally reorientated by the breakwater structure;
- a reduction in the refraction of waves directly to the north of the Creek following the partial breakwater removal so that waves approach the reorientated shoreline closer to shore normal;

[1] Based on modelled wave height at Maria Creek at the 'Outside' extraction point (see Figure 1).

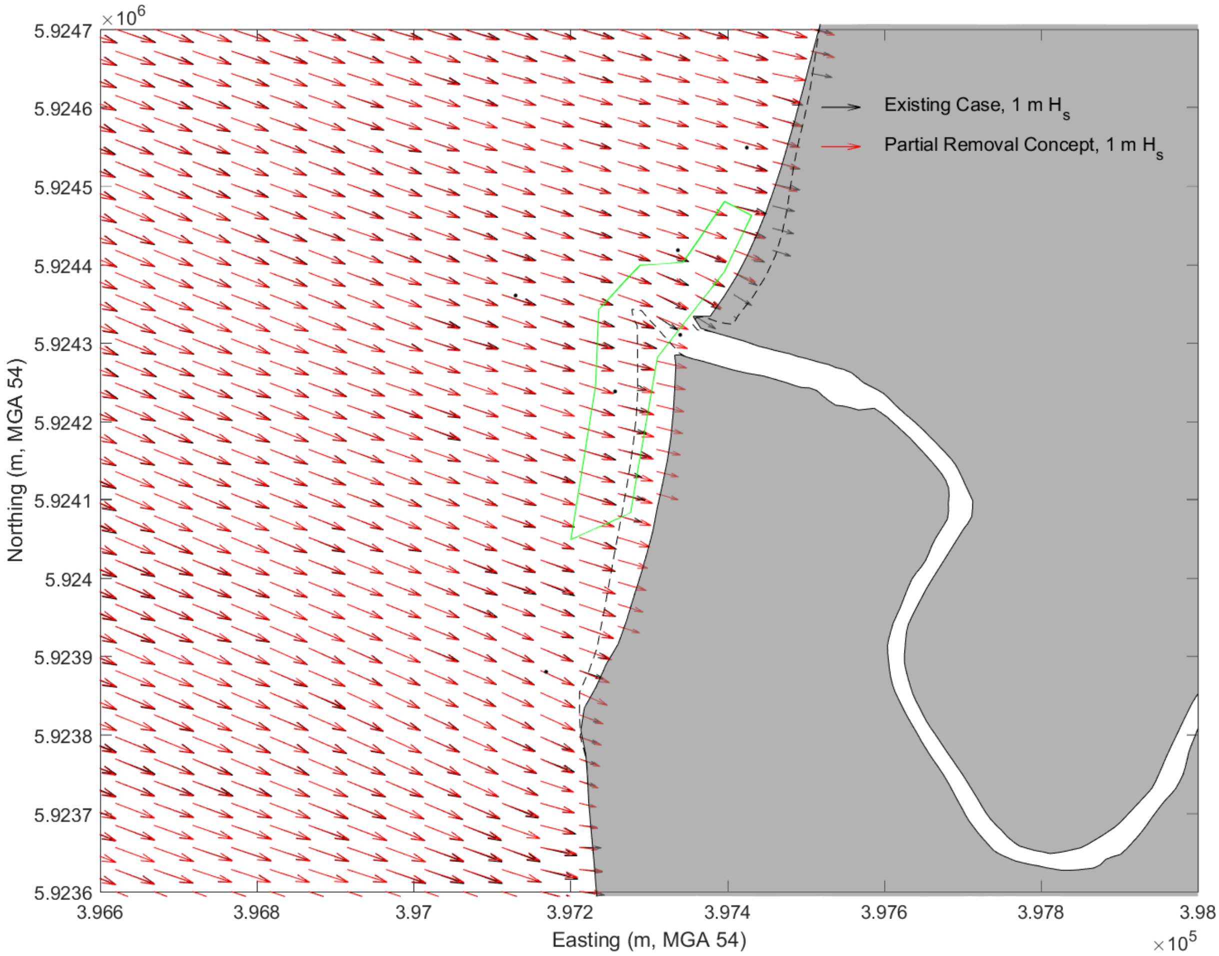
- a reduction in the refraction of waves to the south of the Creek following the partial breakwater removal so that waves approach the reorientated shoreline at a more oblique angle; and
- an increase in wave heights in the entrance of Maria Creek following the partial removal of the southern breakwater due to the reduced sheltering from the dominant wave directions.

To further assess the effect of the breakwater extension on the propagation of waves into the Creek a time series of wave conditions within the Creek entrance ('Inside' extraction point – see Figure 9 for location) is shown in Figure 12. A comparison of conditions between the Partial Removal Concept and the existing case indicates that the partial removal of the breakwater increases wave heights within the Creek by around 70% and the wave energy by a factor of 2.5 (from around 950 million Joules (J) per year to 2,400 million J per year). Comparisons of waves further offshore ('Outside' extraction point) indicate negligible differences between wave conditions for the existing case and Partial Removal Concept as would be expected as this point is located offshore of any changes resulting from the concept (Figure 13).



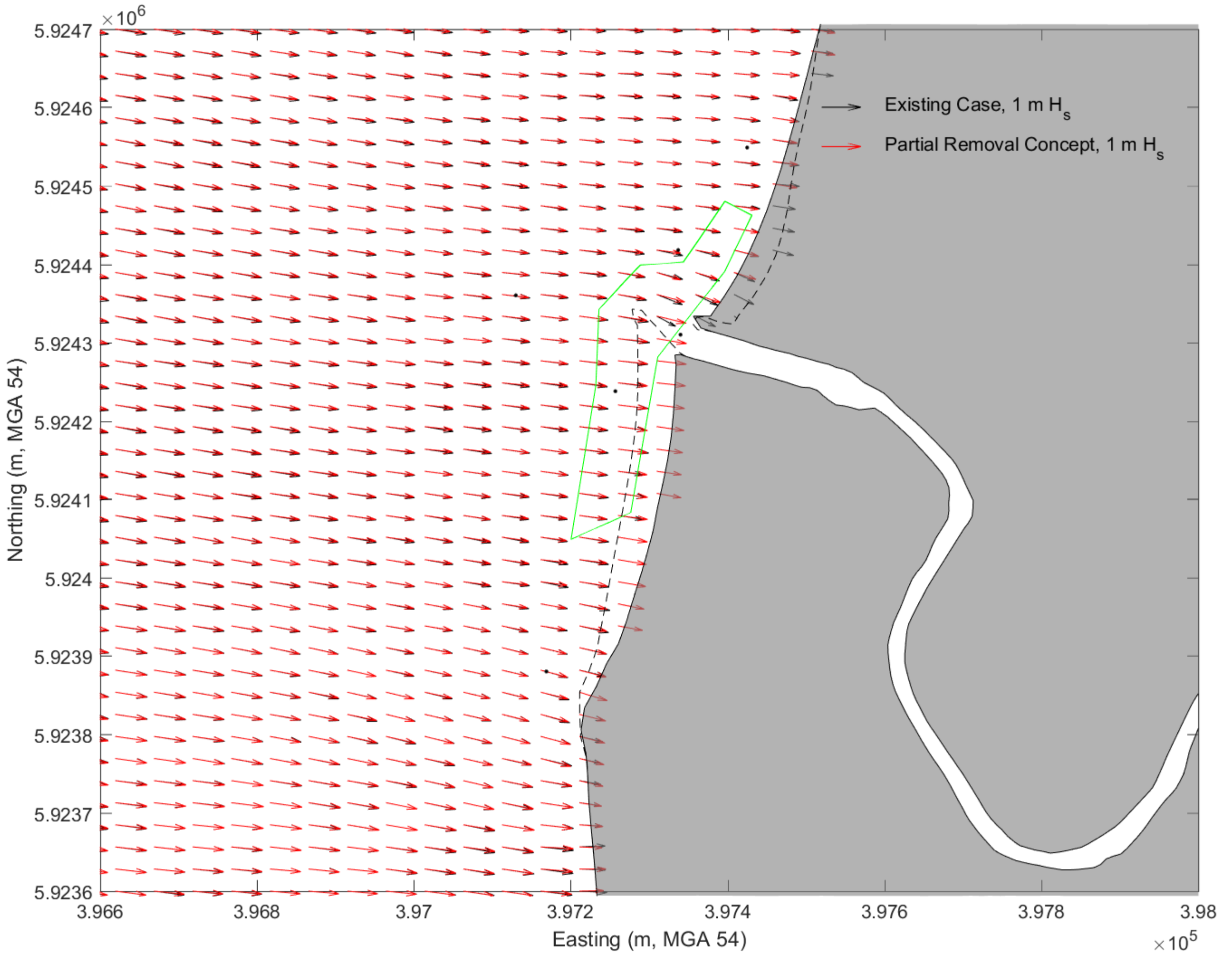
Note: The dashed line shows the location of the coastline for the Existing Case.

Figure 9. Modelled wave vectors for waves from the north-west for the Existing Case and the Partial Removal Concept design.



Note: The dashed line shows the location of the coastline for the existing case.

Figure 10. Modelled wave vectors for waves from the west for the existing case and the Partial Removal Concept design.



Note: The dashed line shows the location of the coastline for the existing case.

Figure 11. Modelled wave vectors for waves from the south-west for the existing case and the Partial Removal Concept design.

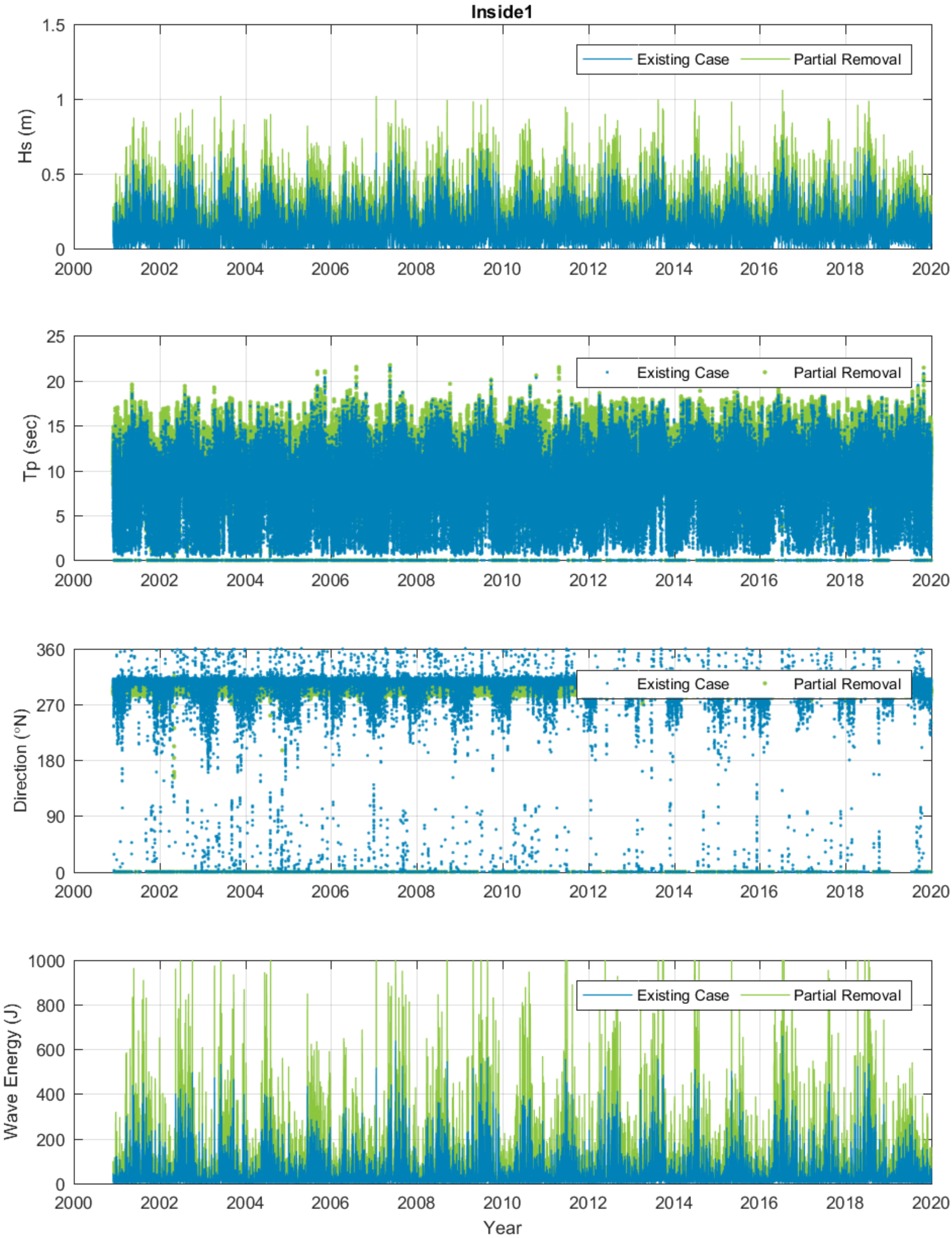


Figure 12. Timeseries of modelled wave conditions in the Creek Entrance (at 'Inside') for the existing case and Partial Removal Concept designs.

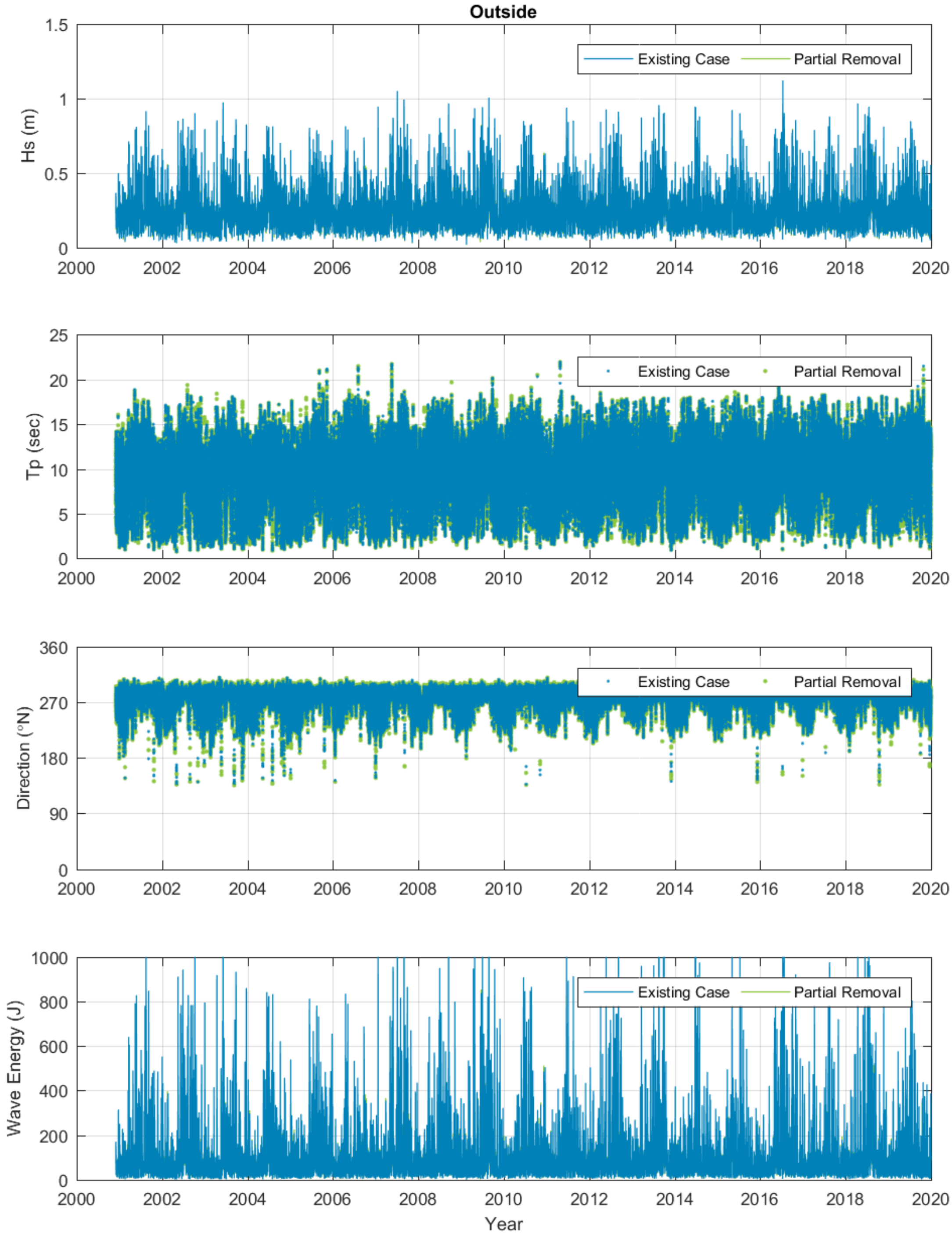


Figure 13. Timeseries of modelled wave conditions Outside the Creek Entrance (at 'Outside') for the existing case and Partial Removal Concept designs.

To provide further insight into the wave conditions at the creek entrance and the effect of the partial removal on the existing case wave conditions, Joint Probability Tables of wave direction and wave height within the Creek Entrance are provided in Table 1 and Table 2 for the Partial Removal Concept and existing case respectively. Consistent with the results shown in the time series and in the map plots, the partial removal of the southern breakwater results in a slight increase and a reorientation of waves into the Creek. Joint Probability Tables are also shown offshore of Maria Creek in Table 3 and Table 4 and indicate negligible changes to the wave climate offshore[2].

[2] The difference in wave condition at the offshore site is likely to be largely a result of slight differences in the model mesh causing minor numerical differences in the wave conditions as opposed to differences resulting from the concept as the concept does not extend to the offshore point.

PORT & COASTAL SOLUTIONS

Table 1. Joint Probability Table of wave direction and wave height in the Creek Entrance (at 'Inside') for the Partial Removal Concept.

	Significant Wave Height Range (m)										Percent Total
	<0.1	0.1 - 0.2	0.2 - 0.3	0.3 - 0.4	0.4 - 0.5	0.5 - 0.6	0.6 - 0.7	0.7 - 0.8	0.8 - 0.9	0.9 - 1.0	
North	1.7	-	-	-	-	-	-	-	-	-	**1.7**
NNE	-	-	-	-	-	-	-	-	-	-	**-**
North East	-	-	-	-	-	-	-	-	-	-	**-**
ENE	-	-	-	-	-	-	-	-	-	-	**-**
East	-	-	-	-	-	-	-	-	-	-	**-**
ESE	-	-	-	-	-	-	-	-	-	-	**-**
South East	-	-	-	-	-	-	-	-	-	-	**-**
SSE	-	-	-	-	-	-	-	-	-	-	**-**
South	-	-	-	-	-	-	-	-	-	-	**-**
SSW	-	-	-	-	-	-	-	-	-	-	**-**
South West	-	-	-	-	-	-	-	-	-	-	**-**
WSW	-	-	-	-	-	-	-	-	-	-	**-**
West	0.1	0.1	0	-	-	-	-	-	-	-	**0.2**
WNW	14.4	42.4	22.1	10.4	4.8	2.4	1.0	0.4	0.1	0	**98.0**
North West	-	-	-	-	-	-	-	-	-	-	**-**
NNW	-	-	-	-	-	-	-	-	-	-	**-**
% Total	**16.2**	**42.5**	**22.2**	**10.4**	**4.8**	**2.4**	**1.0**	**0.4**	**0.1**	**0**	**100**
% Exceed	**83.8**	**41.2**	**19.1**	**8.7**	**3.9**	**1.5**	**0.5**	**0**	**0**	**0**	

Table 2. Joint Probability Table of wave direction and wave height in the Creek Entrance (at 'Inside') for the existing case.

	Significant Wave Height Range (m)										Percent Total
	<0.1	0.1 - 0.2	0.2 - 0.3	0.3 - 0.4	0.4 - 0.5	0.5 - 0.6	0.6 - 0.7	0.7 - 0.8	0.8 - 0.9	0.9 - 1.0	
North	4.4	-	-	-	-	-	-	-	-	-	**4.4**
NNE	0.1	-	-	-	-	-	-	-	-	-	**0.1**
North East	0.0	-	-	-	-	-	-	-	-	-	**0**
ENE	0.0	-	-	-	-	-	-	-	-	-	**0**
East	0.0	-	-	-	-	-	-	-	-	-	**0**
ESE	0.0	-	-	-	-	-	-	-	-	-	**0**
South East	-	-	-	-	-	-	-	-	-	-	**-**
SSE	0.0	-	-	-	-	-	-	-	-	-	**0**
South	0.0	-	-	-	-	-	-	-	-	-	**0**
SSW	0.1	-	-	-	-	-	-	-	-	-	**0.1**
South West	0.1	-	-	-	-	-	-	-	-	-	**0.1**
WSW	0.4	-	-	-	-	-	-	-	-	-	**0.4**
West	1.1	-	-	-	-	-	-	-	-	-	**1.1**
WNW	7.9	3.7	1.0	0.5	0.3	0.1	0	-	-	-	**13.6**
North West	34.6	30.7	10.2	3.5	1.0	0.1	0	-	-	-	**80.1**
NNW	0.1	-	-	-	-	-	-	-	-	-	**0.1**
% Total	**48.8**	**34.4**	**11.2**	**4.0**	**1.3**	**0.3**	**0.1**	**-**	**-**	**-**	**100**
% Exceed	**51.2**	**16.8**	**5.6**	**1.6**	**0.3**	**0**	**0**	**0**	**0**	**0**	

Table 3. Joint Probability Table of wave direction and wave height offshore of Maria Creek (at 'Outside') for the Partial Removal Concept.

	Significant Wave Height Range (m)										Percent Total
	<0.1	0.1 - 0.2	0.2 - 0.3	0.3 - 0.4	0.4 - 0.5	0.5 - 0.6	0.6 - 0.7	0.7 - 0.8	0.8 - 0.9	0.9 - 1.0	
North	-	-	-	-	-	-	-	-	-	-	-
NNE	-	-	-	-	-	-	-	-	-	-	-
North East	-	-	-	-	-	-	-	-	-	-	-
ENE	-	-	-	-	-	-	-	-	-	-	-
East	-	-	-	-	-	-	-	-	-	-	-
ESE	-	-	-	-	-	-	-	-	-	-	-
South East	-	-	-	-	-	-	-	-	-	-	-
SSE	0	-	-	-	-	-	-	-	-	-	0
South	0	-	-	-	-	-	-	-	-	-	0
SSW	0.1	0.1	0	-	-	-	-	-	-	-	0.2
South West	0.1	1.0	1.5	0.1	-	-	-	-	-	-	2.7
WSW	0.3	3.1	3.0	0.4	0	-	-	-	-	-	6.9
West	4.3	36.9	17.8	6.6	3.0	1.3	0.6	0.2	0.1	0	70.8
WNW	0.1	3.8	6.4	5.0	2.3	1.1	0.4	0.1	0	-	19.3
North West	-	0	0	-	-	-	-	-	-	-	0
NNW	-	-	-	-	-	-	-	-	-	-	-
% Total	**5.0**	**45.0**	**28.8**	**12.1**	**5.4**	**2.4**	**1.0**	**0.3**	**0.1**	**0**	
% Exceed	**95.0**	**50.1**	**21.3**	**9.1**	**3.8**	**1.4**	**0.4**	**0.1**	**0**	**0**	

Table 4. Joint Probability Table of wave direction and wave height offshore of Maria Creek (at 'Outside') for the existing case.

	Significant Wave Height Range (m)										Percent Total
	<0.1	0.1 - 0.2	0.2 - 0.3	0.3 - 0.4	0.4 - 0.5	0.5 - 0.6	0.6 - 0.7	0.7 - 0.8	0.8 - 0.9	0.9 - 1.0	
North	-	-	-	-	-	-	-	-	-	-	-
NNE	-	-	-	-	-	-	-	-	-	-	-
North East	-	-	-	-	-	-	-	-	-	-	-
ENE	-	-	-	-	-	-	-	-	-	-	-
East	-	-	-	-	-	-	-	-	-	-	-
ESE	-	-	-	-	-	-	-	-	-	-	-
South East	-	-	-	-	-	-	-	-	-	-	-
SSE	0	-	-	-	-	-	-	-	-	-	0
South	0	-	-	-	-	-	-	-	-	-	0
SSW	0.1	0.1	0	-	-	-	-	-	-	-	0.2
South West	0.1	0.8	1.1	0.1	-	-	-	-	-	-	2.1
WSW	0.3	3.0	2.9	0.3	0	-	-	-	-	-	6.6
West	3.8	36.1	18.6	7.0	3.2	1.4	0.7	0.2	0.1	0	71.1
WNW	0.1	4.1	6.5	5.1	2.4	1.2	0.5	0.2	0.1	0	20.0
North West	-	0	-	-	-	-	-	-	-	-	0
NNW	-	-	-	-	-	-	-	-	-	-	-
% Total	**4.5**	**44.2**	**29.1**	**12.4**	**5.6**	**2.6**	**1.1**	**0.4**	**0.1**	**0**	
% Exceed	**95.5**	**51.4**	**22.3**	**9.8**	**4.3**	**1.7**	**0.6**	**0.1**	**0**	**0**	

3.3. Effect on Longshore Transport

To assess the effect of the partial breakwater removal on the longshore drift (especially in the area of reduced wave shadow) and the potential for reduced trapping of sand to the north of the Creek, the annual wave driven longshore transport rates for the Partial Removal Concept are plotted in Figure 14. Net transport rates are tabulated in Table 5, with results for the existing case also included to allow an assessment of the effect of the partial breakwater removal.

The comparison of wave driven annual net longshore sediment transport rates shows the following:

- an increase in northly transport (by around 25%) at the most southerly profile (P1) due to the shoreline retreat and reorientation at this location;
- a similar increase in northerly transport just south of the existing breakwater location (at P2) due to the shoreline retreat;
- an increase in northerly transport to the north of Maria Creek at P3 (by around 20%) as a result of the reduced wave shadowing effect following the partial removal of the southern breakwater;
- a small reduction in longshore transport at P4 in response to the shoreline reorientation and reduced angle of wave incidence; and
- more uniform transport rates along the coast adjacent to Maria Creek indicating a more stable shoreline position and a reduced potential for trapping of sand to the north of the Creek.

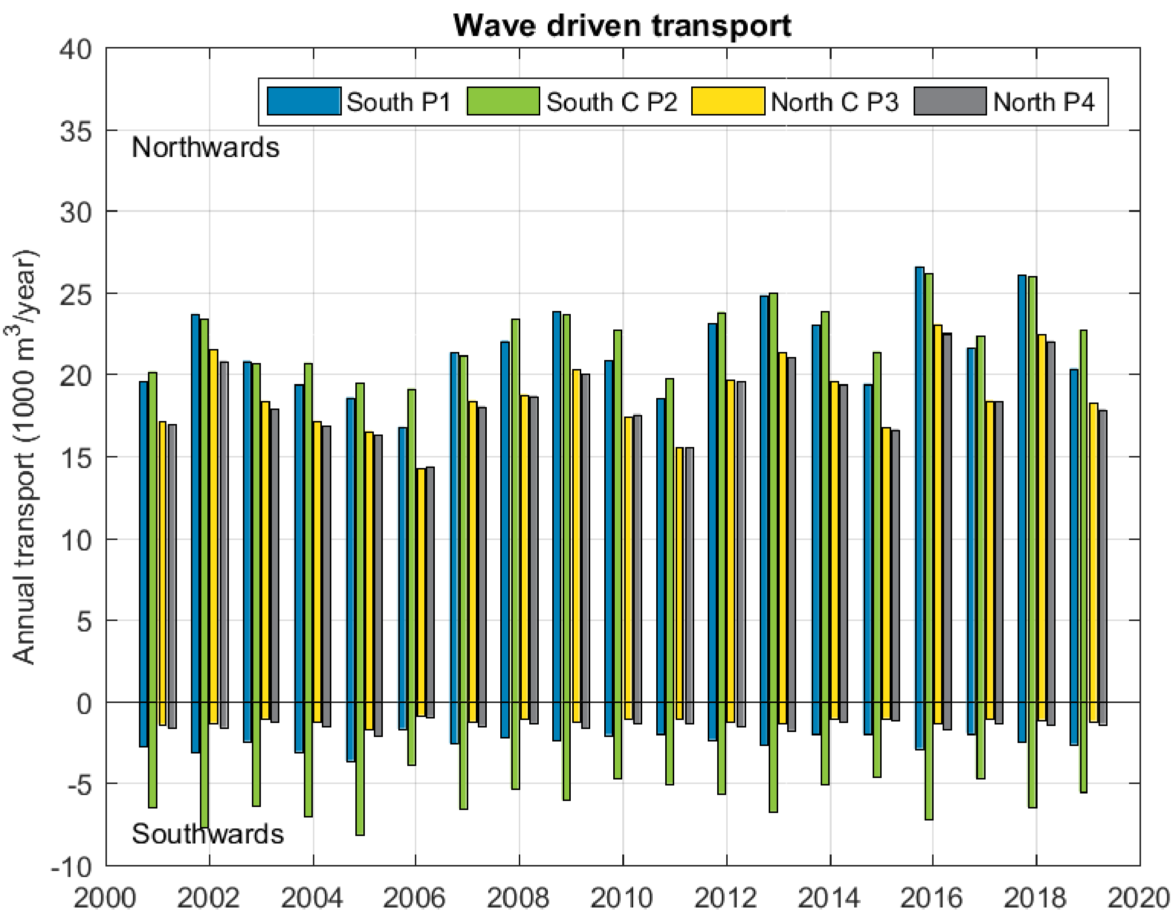


Figure 14. **Predicted wave driven annual longshore sediment transport for the Partial Removal Concept.**

PORT & COASTAL SOLUTIONS

Table 5. Predicted wave driven annual net longshore sediment transport rates for the Partial Removal Concept and the existing case.

Year	Wave Driven Net Transport (1,000 m^3/year), Kamphuis (1991)							
	P1		P2		P3		P4	
	Existing	Partial Removal	Existing	Partial Removal	Existing	Partial Removal	Existing	Partial Removal
2001	13.1	16.8	10.6	13.7	12.9	15.7	16.3	15.3
2002	15.6	20.6	11.5	15.7	16.2	20.2	20.5	19.2
2003	14	18.4	10.8	14.3	14.1	17.3	17.6	16.6
2004	12.8	16.3	11	13.7	12.8	15.9	16.4	15.3
2005	11.7	15	9.1	11.3	11.5	14.8	15.3	14.2
2006	12.2	15.1	12.7	15.3	11.4	13.4	14.2	13.4
2007	14.8	18.7	11.3	14.5	13.9	17.2	17.5	16.5
2008	16	19.8	14.7	18	14.9	17.7	18.3	17.4
2009	17.1	21.4	13.8	17.6	16	19	19.4	18.4
2010	15.4	18.8	14.9	18	14	16.3	17.1	16.2
2011	13.4	16.6	12.3	14.7	12.1	14.5	15	14.2
2012	16.7	20.8	14.6	18.2	15.7	18.4	19	18
2013	17.7	22.1	14.2	18.2	16.6	20	20.4	19.3
2014	16.9	21	15	18.8	15.8	18.6	19.1	18.1
2015	13.9	17.4	13.7	16.8	13.3	15.7	16.3	15.5
2016	18.6	23.7	14.4	19	17.8	21.7	21.9	20.8
2017	15.9	19.6	14	17.7	14.7	17.3	18	17
2018	18.7	23.6	15.2	19.5	17.8	21.4	21.7	20.6
2019	14.2	17.7	14.1	17.2	14.1	17.1	17.5	16.5

4. Summary

This technical note has presented an assessment of the effects of a 'Partial Removal Concept' design on flows and waves in and around Maria Creek. The assessment has compared the results from the concept against results for the existing case, the results of which were reported by PCS (2020a). The results from the modelling indicate:

- while current speeds within the creek are predicted to be similar for the Partial Removal Concept to the existing case, higher current speeds are predicted to occur immediately south of the entrance to Maria Creek when the offshore tidal currents are in a northerly direction. This is because removal of the offshore end of the southern training wall allows northerly currents to flow directly from the end of the southern training wall into the mouth of the creek, when they were previously diverted around the end of the training wall;
- as with the existing case, for the Partial Removal Concept the currents within Maria Creek are predicted to remain as being flood dominant, meaning that the Creek is likely to be a net importer (of wrack and sediment);
- the removal of the offshore end of the southern training wall has been shown to increase the wave exposure at the entrance to Maria Creek, with significant wave heights at the mouth increasing by around 70%; and
- the reduced sheltering of the shoreline directly to the north of the northern training wall resulting from the partial removal of the southern breakwater is likely to result in a more stable shoreline with comparable longshore transport rates occurring along the coast to the north and south of the Creek (i.e. it is unlikely that there would be a large build-up of sediment in this location).

5. References

Kamphuis., J.W., 1991. Alongshore sediment transport rate. Journal of Waterway, Port, Coastal and Ocean Engineering, Vol. 117, 624-640.

PCS, 2020a. Maria Creek Concept and Design Study, Numerical Modelling Report, May 2020.

PCS, 2020b. Maria Creek Concept and Design Study, Hybrid Concept Technical Note, November 2020.

PORT & COASTAL SOLUTIONS

APPENDICES

Appendix A – Additional Plots for the Partial Removal Concept Design

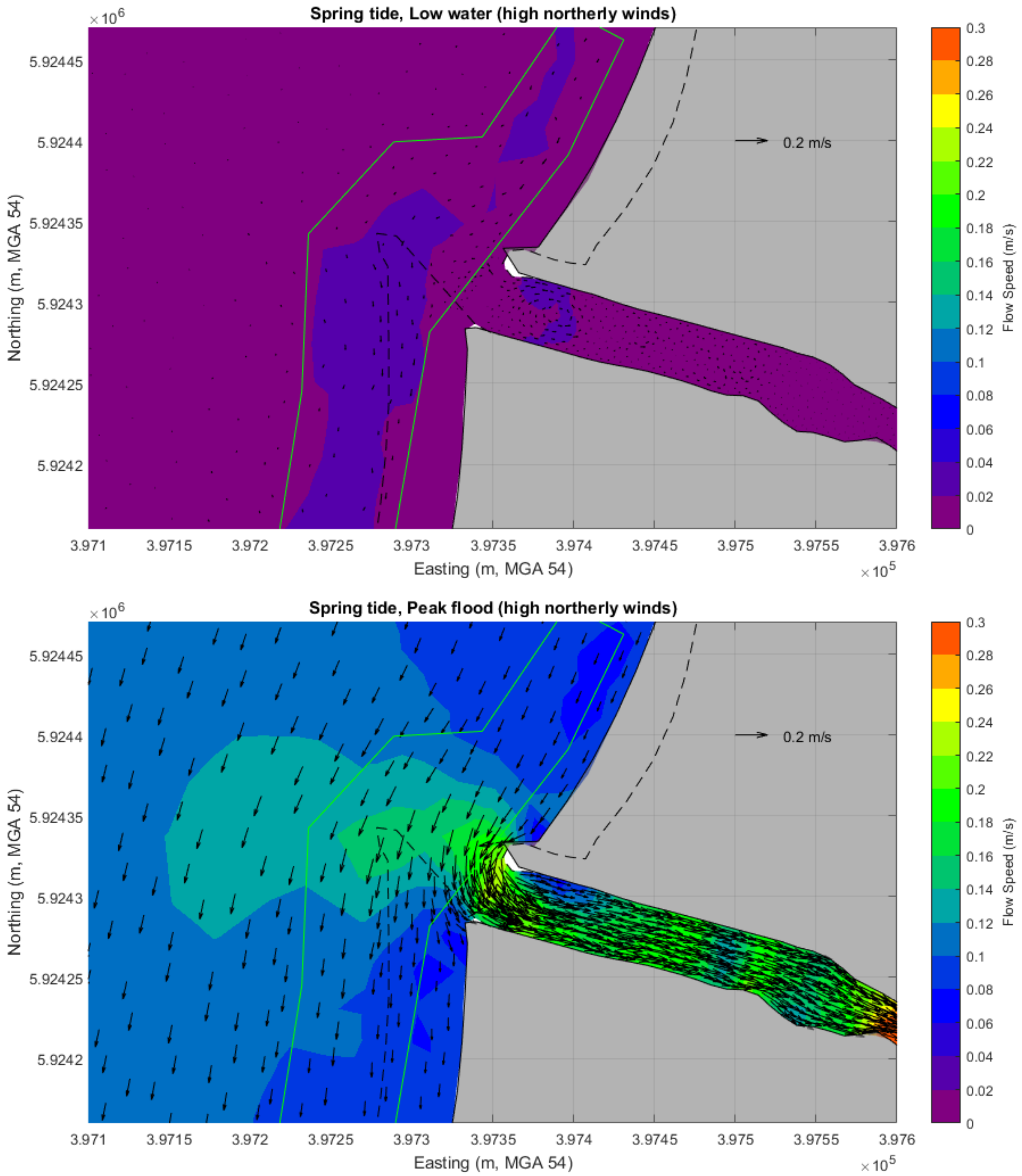


Figure A1. Modelled tidal current speeds around Maria Creek at low water (top) and peak flood (bottom) for a spring tide with high northerly winds for the Partial Removal Concept.

PORT & COASTAL
SOLUTIONS

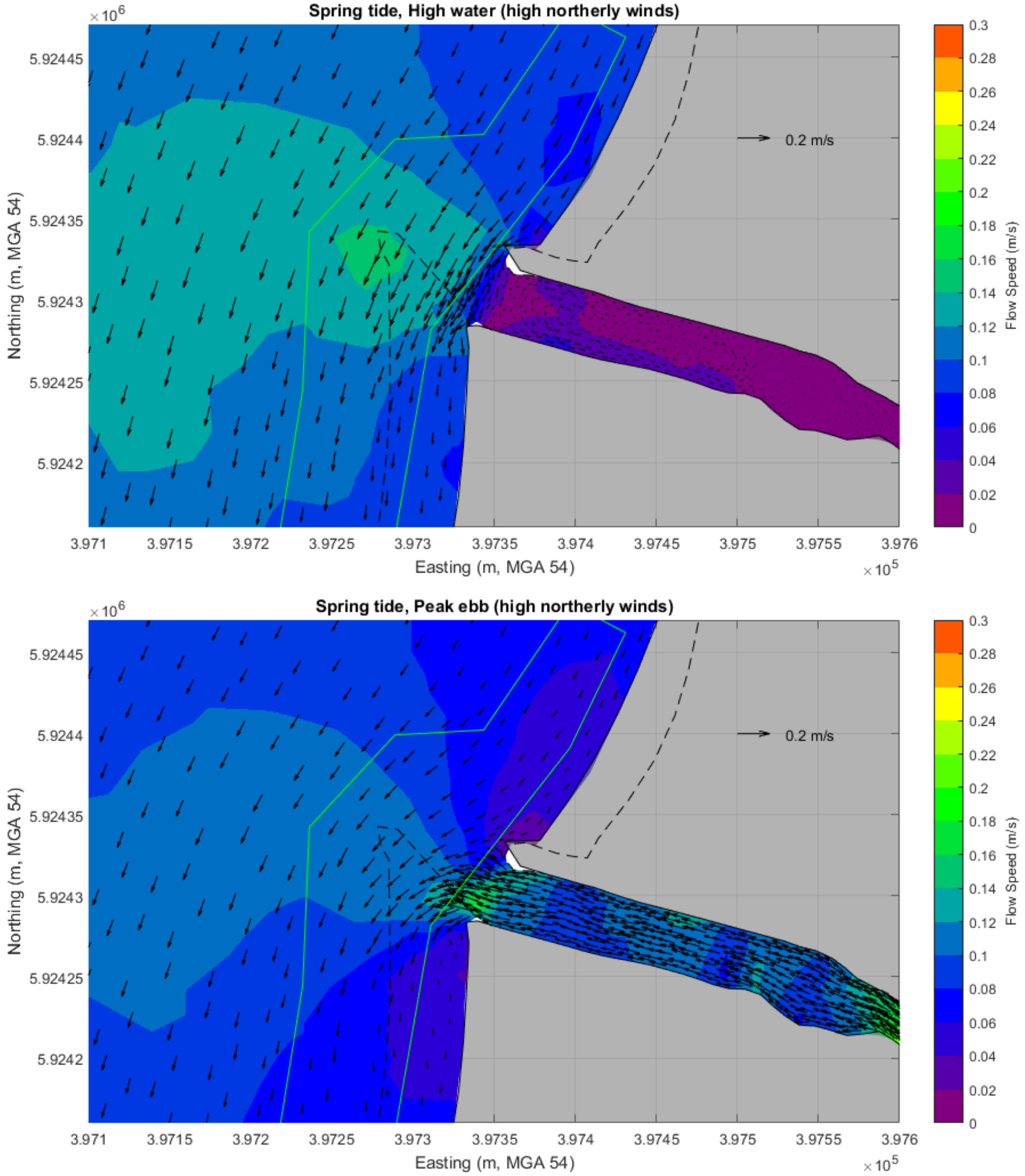


Figure A2. Modelled tidal current speeds around Maria Creek at high water (top) and peak ebb (bottom) for a spring tide with high northerly winds for the Partial Removal Concept.

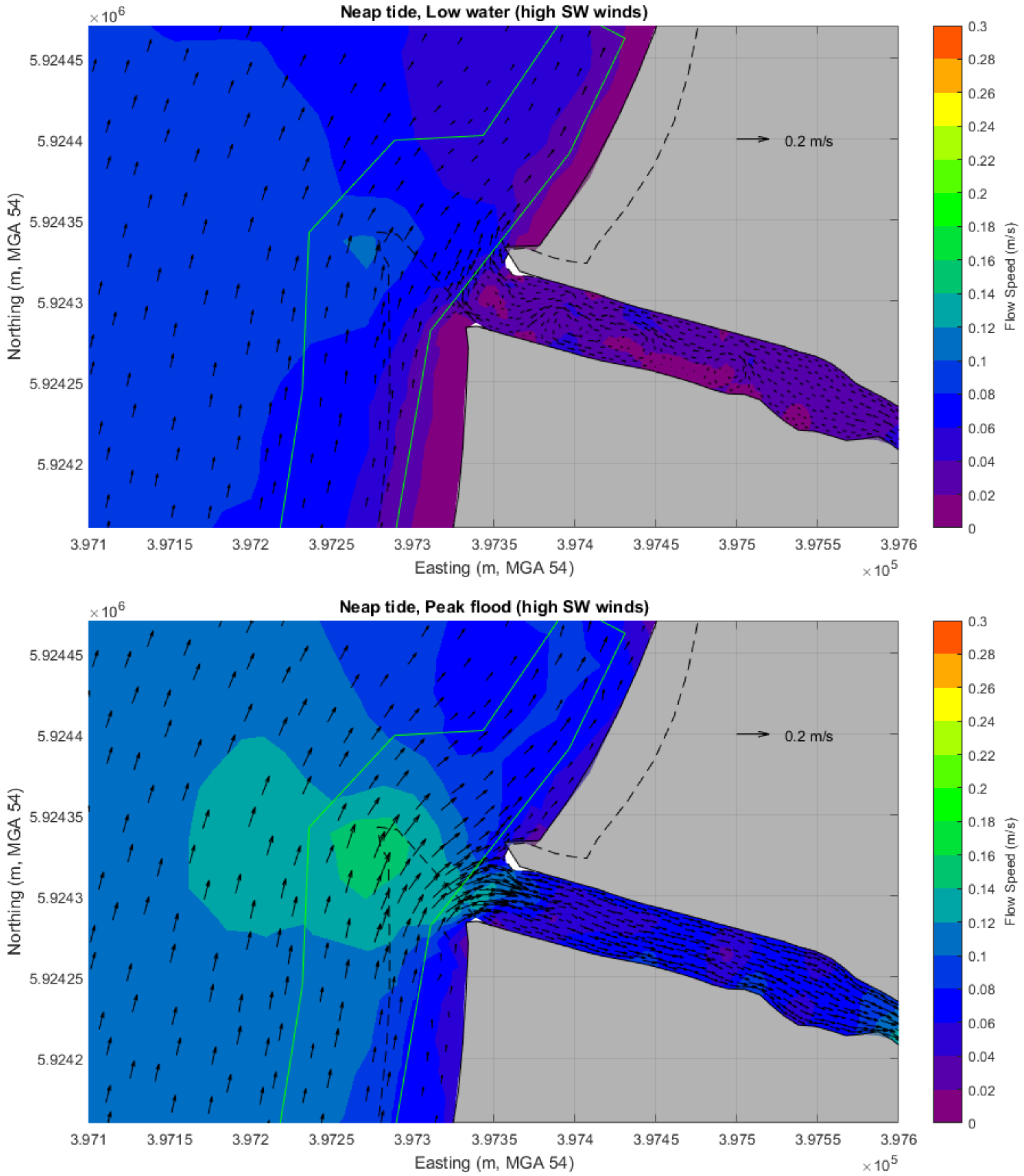


Figure A3. Modelled tidal current speeds around Maria Creek at low water (top) and peak flood (bottom) for a neap tide with high south-westerly winds for the Partial Removal Concept.

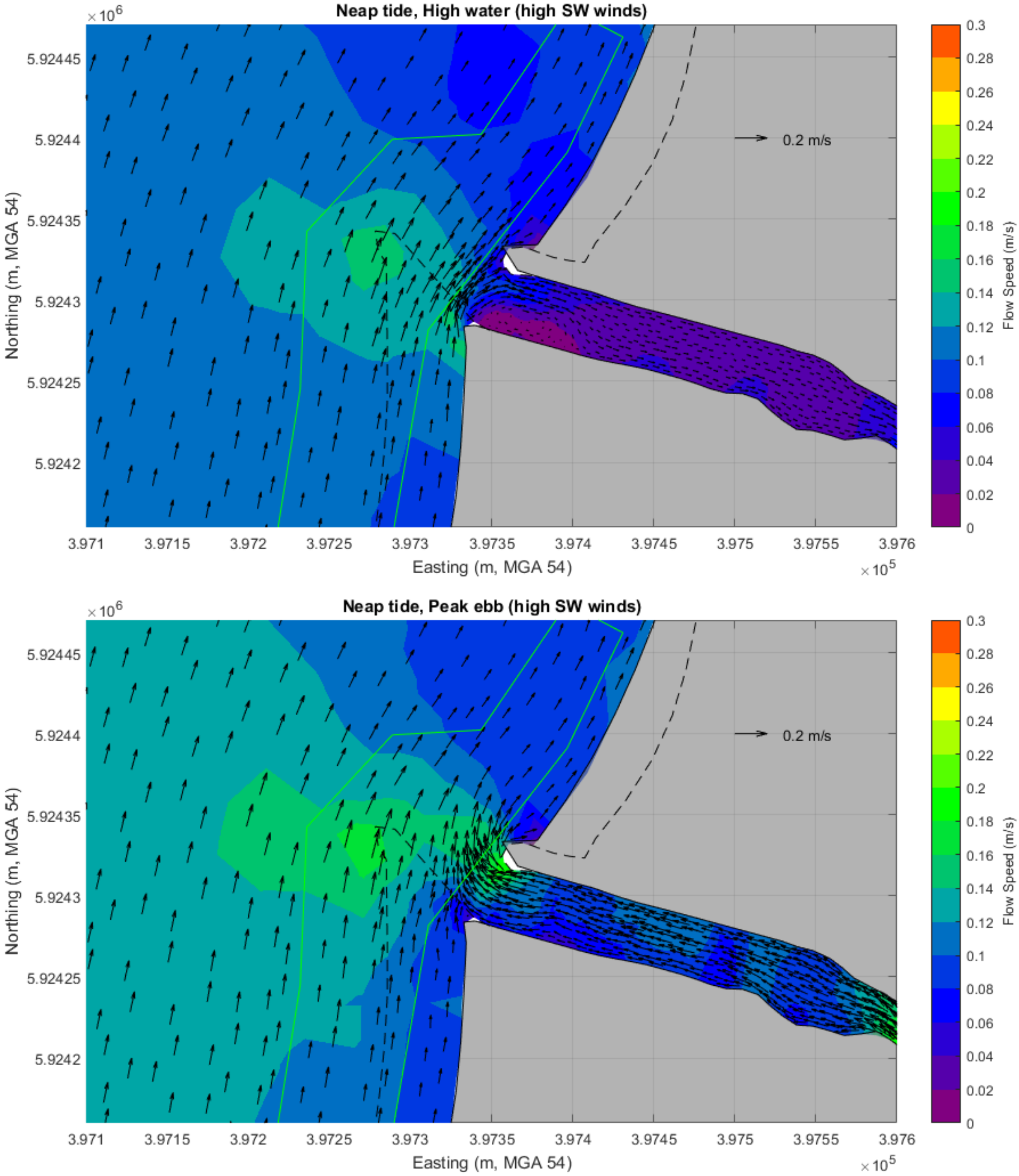


Figure A4. **Modelled tidal current speeds around Maria Creek at high water (top) and peak ebb (bottom) for a neap tide with high south-westerly winds for the Partial Removal Concept.**

PORT & COASTAL SOLUTIONS

Appendix B – Plots for the Existing Case

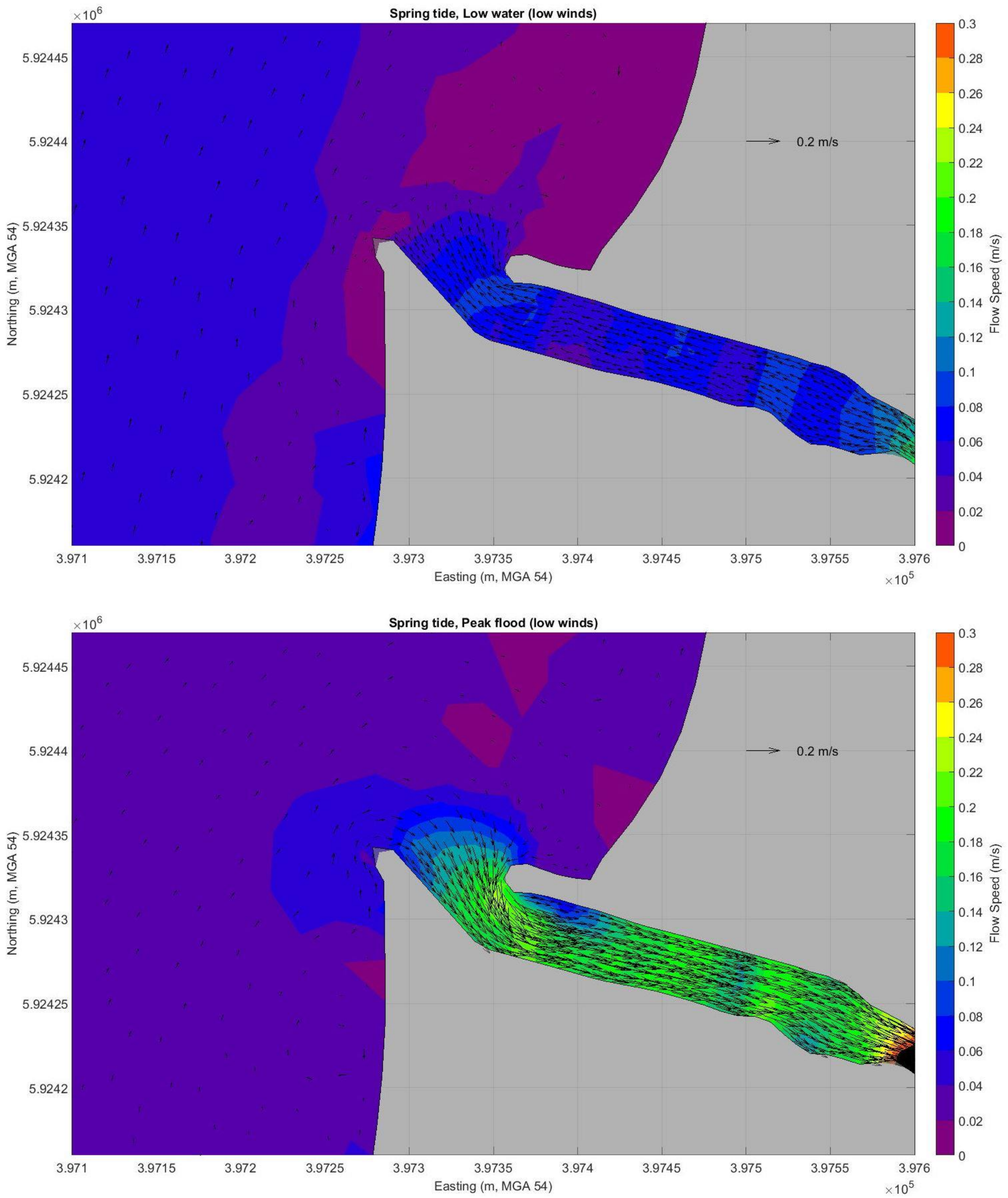
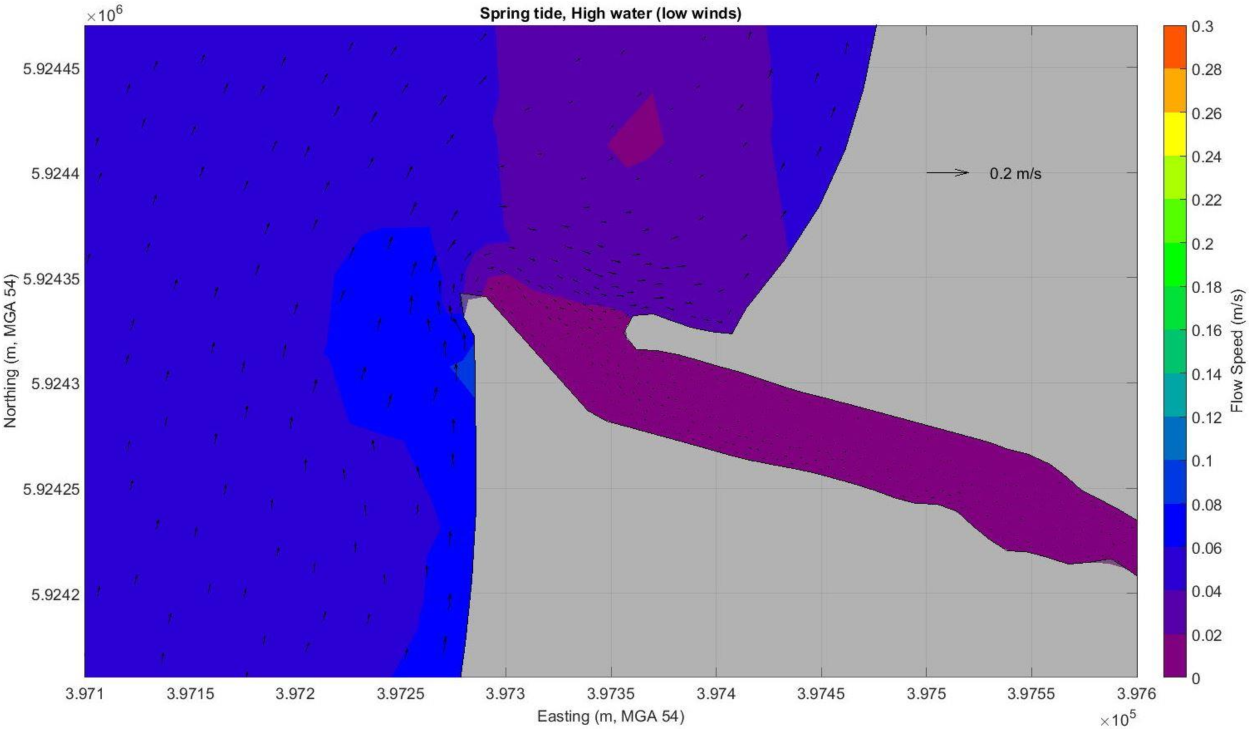


Figure B1. Modelled tidal current speeds around Maria Creek at low water (top) and peak flood (bottom) for a spring tide with low winds for the existing case.



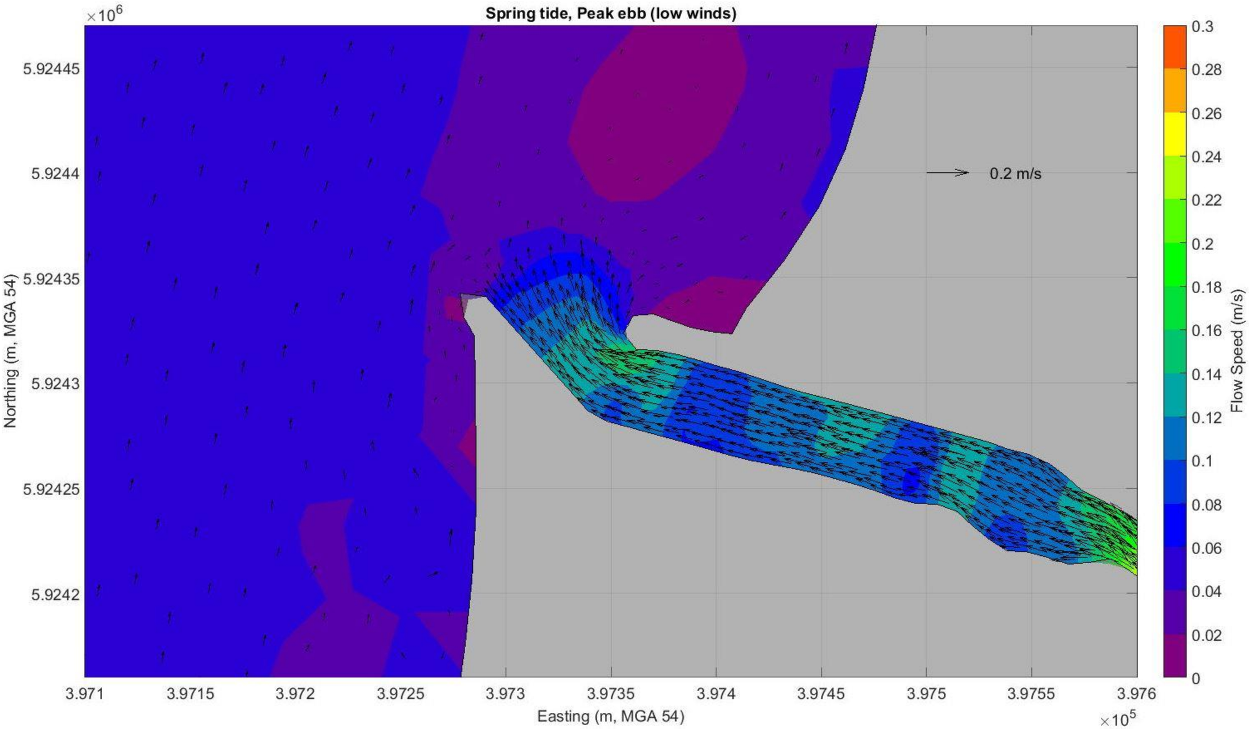


Figure B2. Modelled tidal current speeds around Maria Creek at high water (top) and peak ebb (bottom) for a spring tide with low winds for the existing case.

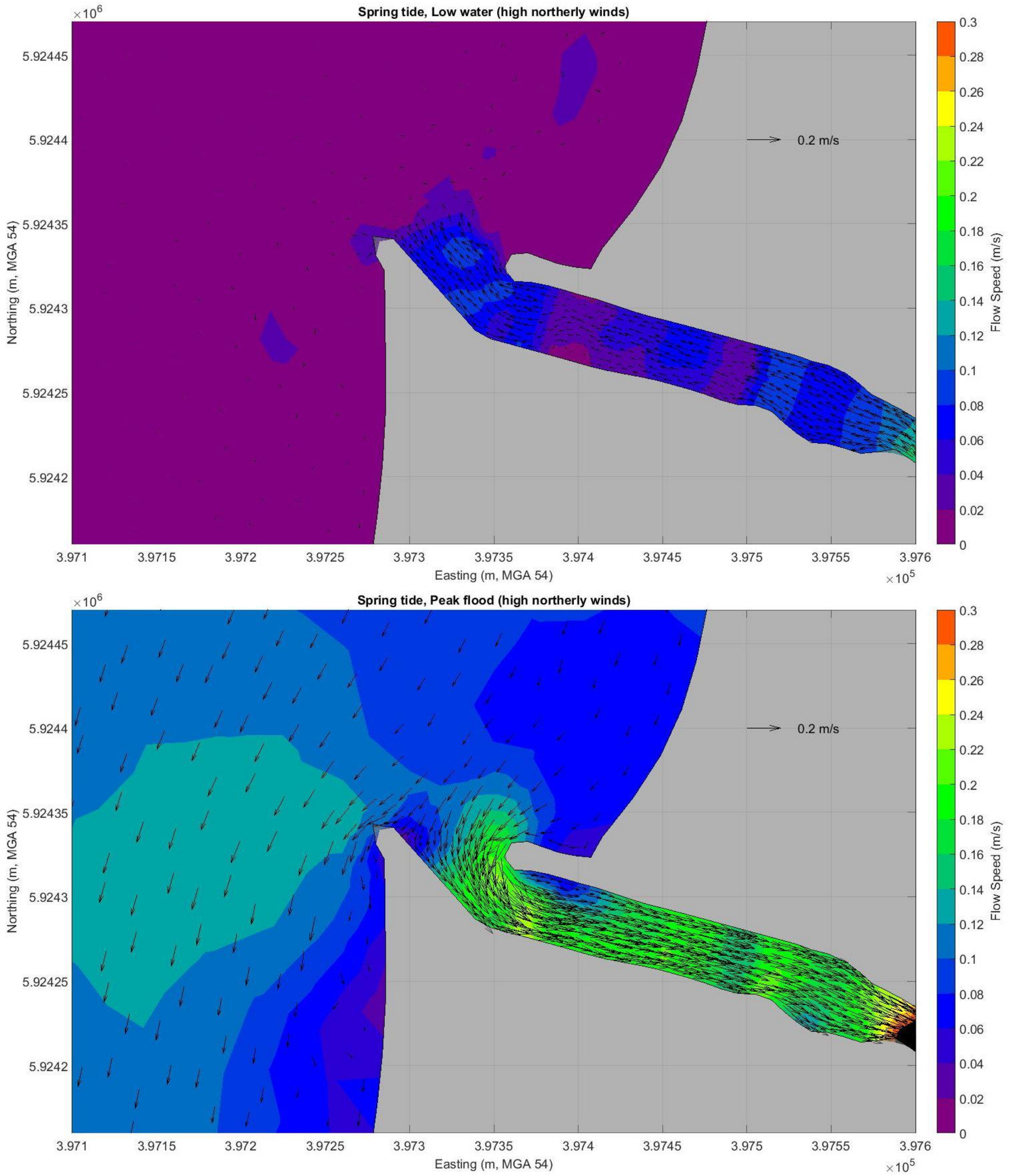


Figure B3. **Modelled tidal current speeds around Maria Creek at low water (top) and peak flood (bottom) for a spring tide with high northerly winds for the existing case.**

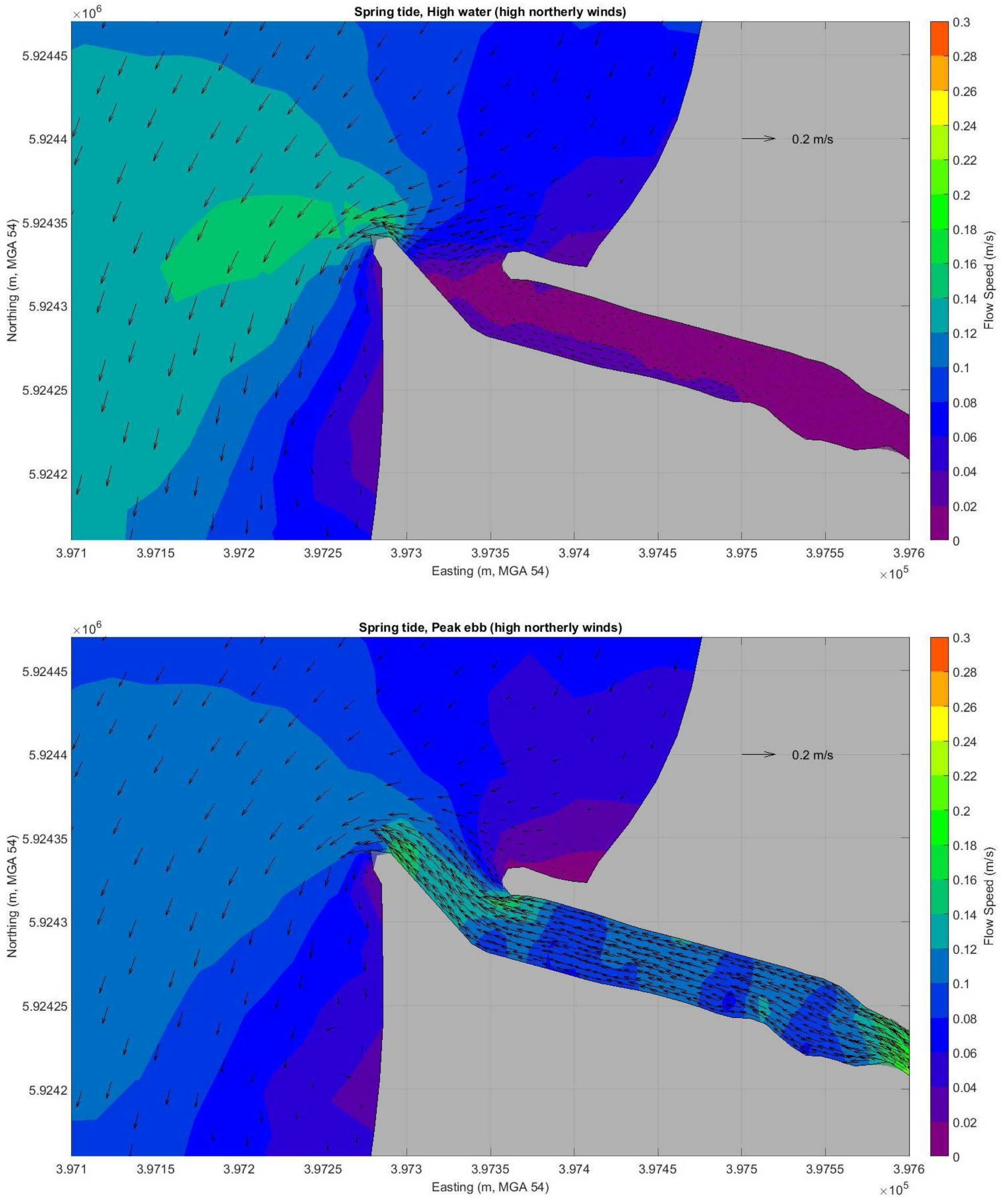


Figure B4. **Modelled tidal current speeds around Maria Creek at high water (top) and peak ebb (bottom) for a spring tide with high northerly winds for the existing case.**

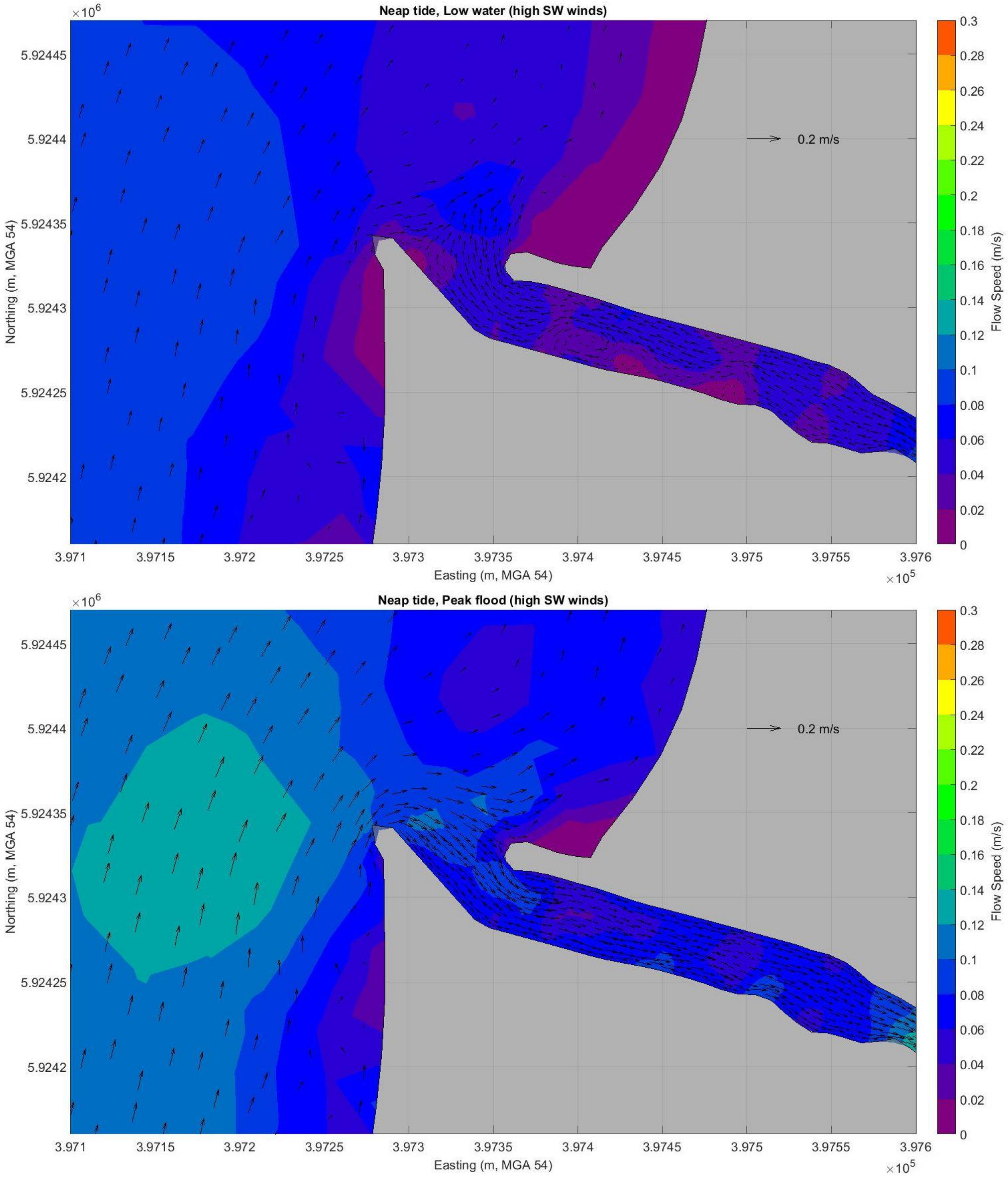


Figure B5. **Modelled tidal current speeds around Maria Creek at low water (top) and peak flood (bottom) for a neap tide with high south-westerly winds for the existing case.**

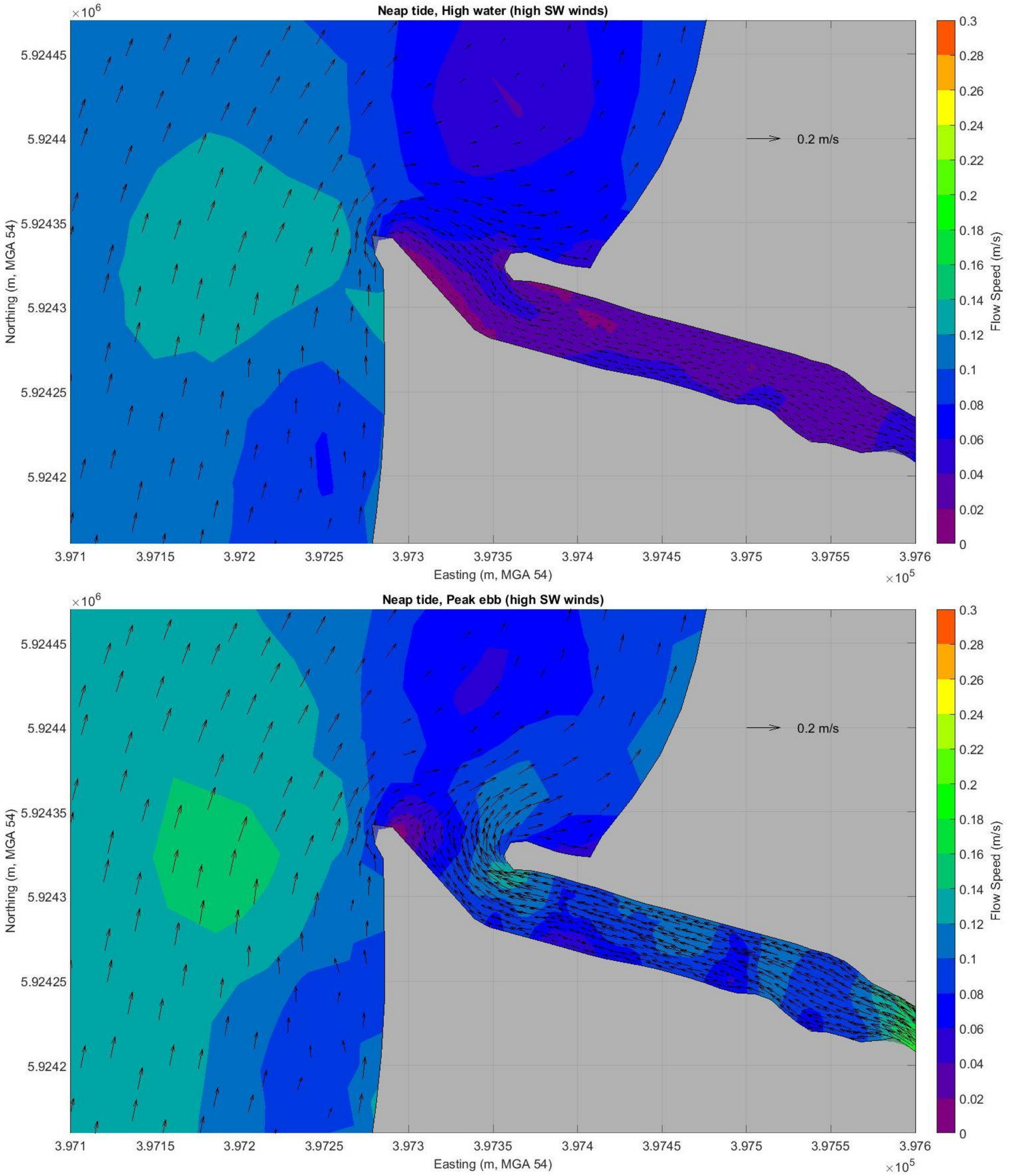


Figure B6. Modelled tidal current speeds around Maria Creek at high water (top) and peak ebb (bottom) for a neap tide with high south-westerly winds for the existing case.

Appendix B Partial Removal Concept capital cost and NPV results

Item No.	Description	Unit	Quantity	Rate, $	Amount, $
1	**Preliminaries**	Item			$ 85,860
2	**Removal Works (80m)**				
2.1	Remove Armour, stockpile at Maria Creek & sort	t	9,135	$ 40	$ 365,400
2.2	Remove Core, stockpile at Maria Creek & sort	m^3	4,950	$ 40	$ 198,000
2.3	Transport surplus armour within 5km	t	8,033	$ 10	$ 80,325
2.4	Transport armour within 5km	m^3	4,950	$ 10	$ 49,500
	Sub-total				*$ 693,225*
3	**Reconstruct breakwater head**				
3.1	Supply 6t armour (remaining not available in stockpile)	t	1,103	$ 60	$ 66,150
3.2	Place 6t armour	t	1,654	$ 60	$ 99,225
	Sub-total				*$ 165,375*
	Sub-total (exc preliminaries)				$ 858,600
	Construction Total (inc preliminaries)				$ 944,460
	Contingency	%		20%	$ 188,892
	Approvals				$ 100,000
	Management	%		5%	$ 47,223
	Project Total (exc GST)				**$ 1,280,575**

Partial Removal of Breakwaters NPV

Discount Rate 5

Years from Present	Discount Factor	Item	Nominal Cash Flow		Net Present Value	
			Capital	Sand & Wrack	Capital	Sand & Wrack
0	1.00000	Partial Removal of breakwaters	$ 1,280,575	$ 67,500	$ 1,280,575	$ 67,500
1	0.95238			$ 67,500	$ -	$ 64,286
2	0.90703			$ 67,500	$ -	$ 61,224
3	0.86384			$ 67,500	$ -	$ 58,309
4	0.82270			$ 67,500	$ -	$ 55,532
5	0.78353			$ 67,500	$ -	$ 52,888
6	0.74622			$ 67,500	$ -	$ 50,370
7	0.71068			$ 67,500	$ -	$ 47,971
8	0.67684			$ 67,500	$ -	$ 45,687
9	0.64461			$ 67,500	$ -	$ 43,511
10	0.61391			$ 67,500	$ -	$ 41,439
11	0.58468			$ 67,500	$ -	$ 39,466
12	0.55684			$ 67,500	$ -	$ 37,587
13	0.53032			$ 67,500	$ -	$ 35,797
14	0.50507			$ 67,500	$ -	$ 34,092
15	0.48102			$ 67,500	$ -	$ 32,469
16	0.45811			$ 67,500	$ -	$ 30,923
17	0.43630			$ 67,500	$ -	$ 29,450
18	0.41552			$ 67,500	$ -	$ 28,048
19	0.39573			$ 67,500	$ -	$ 26,712
20	0.37689			$ 67,500	$ -	$ 25,440
21	0.35894			$ 67,500	$ -	$ 24,229
22	0.34185			$ 67,500	$ -	$ 23,075
23	0.32557			$ 67,500	$ -	$ 21,976
24	0.31007			$ 67,500	$ -	$ 20,930
25	0.29530			$ 67,500	$ -	$ 19,933
			$ 1,280,575	**$ 1,755,000**	**$ 1,280,575**	**$ 1,018,841**
					$ 2,299,416	