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R1319 Rev 2

June 2020

City of Joondalup

Joondalup Coastal Monitoring 2019/2020 Data Report

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1. Introduction

The City of Joondalup (City) has established a coastal monitoring program for the shoreline within its boundaries. The City's shoreline extends from Marmion in the south, to Burns Beach in the north. The extent and key locations are presented in Figure 1.1.

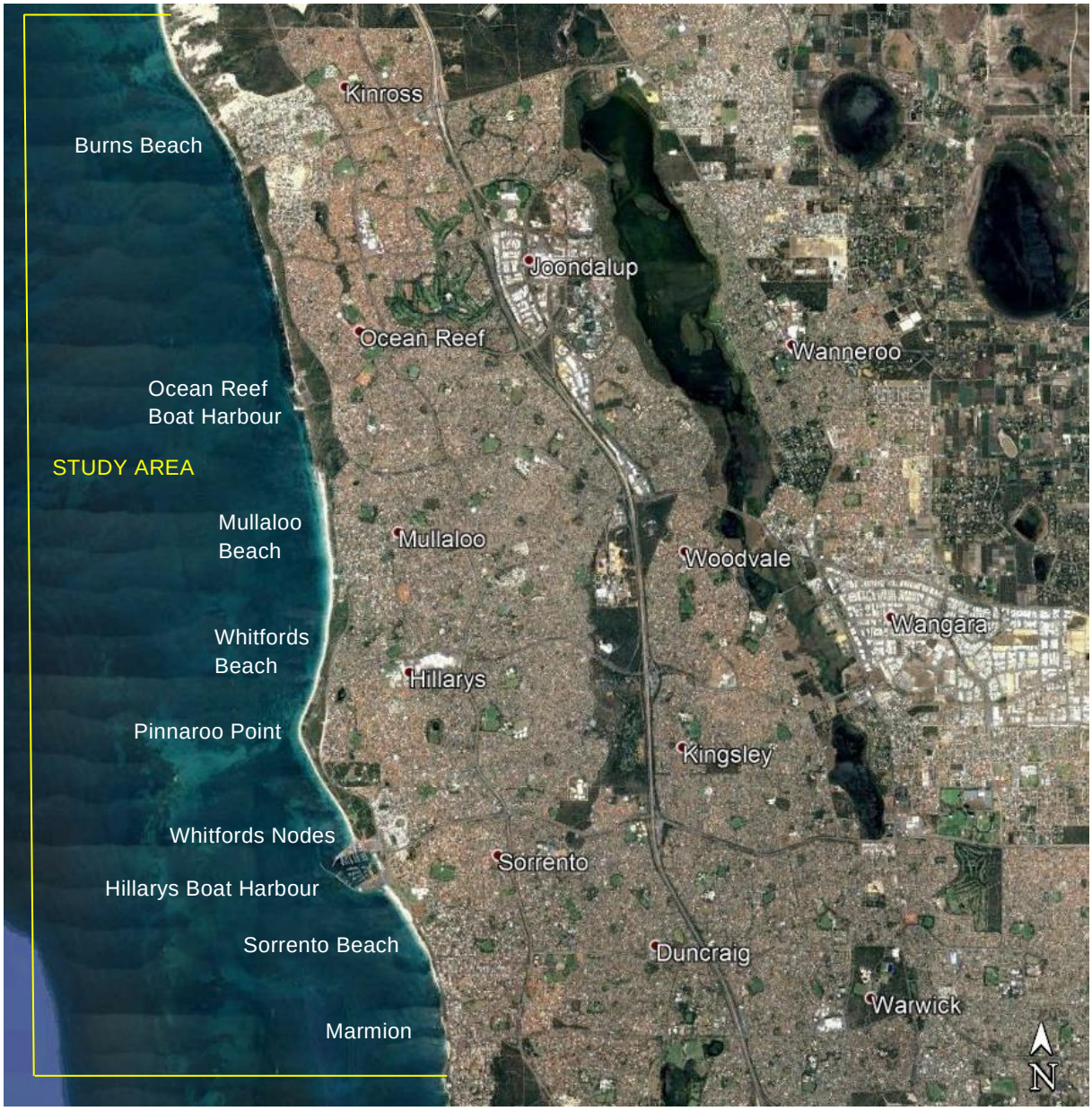

Figure 1.1 Joondalup Coastal Monitoring Study Area

The Joondalup coastal monitoring program has been set up to monitor changes to the shoreline within the study area, and to assist the City in managing their coastal assets. The monitoring program was established under a Coastal Adaptation and Protection grant from the Department of Transport (DoT) in 2015 and includes the following elements.

- Beach and hydrographic surveys conducted every 2 years, from behind the primary dune to several hundred metres offshore. 22 profiles are completed over approximately 15 km.
- Inspections and photographic monitoring of the beaches within the study area every six months.
- Mapping of the shoreline from aerial photographs taken every year.
- Analysis of the monitoring surveys by experienced and professional coastal engineers, identifying areas of accretion or erosion.
- Implementation of a fixed monitoring camera which captures daily photographs of the shoreline in Marmion.
- A report on the monitoring results and analysis each year, highlighting notable variations in shoreline movements and estimating the sediment movement within the study area.

The data and assessment are used to identify areas of concern and inform decision making for development and maintenance of coastal assets.

The City has engaged M P Rogers & Associates Pty Ltd (MRA) to complete the coastal monitoring of the shoreline within the study area.

This report presents the analysis and summary of the monitoring results from October 2019 to March 2020. Comparative analyses with the monitoring data collected in previous years have also been completed and are discussed in the following sections.

The coastal management works completed within the period are outlined and recommendations for future monitoring and management works are provided.

2. Monitoring Activities

The Joondalup coastal monitoring program includes the following monitoring activities:

- Beach profiles (survey).
- Shoreline mapping (coastal vegetation line mapped from aerial photographs).
- Photographic monitoring (seasonal).
- Fixed camera monitoring at Marmion.

The results of the monitoring will be presented in Coastal Monitoring Data reports. Table 2.1 presents the recently completed and future planned monitoring activities.

Table 2.1 Proposed Monitoring Frequency

Activity	Frequency	2017/18 FY		2018/19 FY		2019/20 FY	
		October 2017	March 2018	October 2018	March 2019	October 2019	March 2020
Beach profiles survey	Biennial	✓				✓	
Shoreline mapping	Annual	✓		✓		✓	
Photographic monitoring	6 monthly	✓	✓	✓	✓	✓	✓
Fixed camera monitoring	Continuous (daily)	✓	✓	✓	✓	✓	✓

Notes: 1. Program established in 2015
2. Completed works have been highlighted in green
3. FY – Financial year

The surveyed beach profiles will notionally be completed in October every 2 years, following winter. It is important that they are completed at the same time each period (following winter) to minimise the impact of seasonal changes on the shoreline data.

The shoreline mapping will be completed by mapping the position of the coastal vegetation line from ortho-rectified aerial photography. The shoreline mapping will be used to assess shoreline movement and monitor large scale trends in movement. The mapping should be completed annually and use aerial photographs from consistent times of the year to remove any seasonal variations from the record.

Photographic monitoring will be completed at 21 fixed sites notionally in March (end of summer) and October (end of winter) each year. Fixed camera monitoring is also being undertaken at the new carpark north of the Mullaloo Angling and Aquatic Club (MAAC). The photographic monitoring and fixed camera monitoring will assist in highlighting seasonal movements on the

shoreline and visually show any changes to beaches, as well as providing a long term reference of shoreline condition.

The monitoring activities carried out in the October 2019 to March 2020 monitoring period will be discussed in the coming sections, including comparisons with the 2015/16 baseline dataset and the previous year's (2018/19) dataset. This will help to highlight areas of change and to inform future monitoring and management requirements.

The Ocean Reef Marina is currently undergoing design for redevelopment. The specific coastal monitoring requirements for the Ocean Reef Marina will be developed during the detailed design stage. The City's coastal monitoring program could be modified to reflect this in the future.

2.1 Recommendations of Previous Monitoring

The previous 2018/19 coastal monitoring report (MRA 2019) assessed the changes to the shoreline and made several recommendations to the City. These are outlined below:

- Make allowances to actively manage the continued erosion at Whitfords Nodes and Pinnaroo Point, which may require removal or relocation of dune fencing following storm events and regrading of beach access ways.
- Continue bypassing the sand that is accumulating at Sorrento Beach to the northern side of Hillarys Boat Harbour, to address the shoreline erosion from Whitfords Nodes to Pinnaroo Point.
- Continue coastal monitoring with a specific focus on changes to the shoreline from Whitfords Nodes to Pinnaroo Point and along Burns Beach.

These recommendations have been considered in relation to the October 2019 to March 2020 monitoring data captured.

3. Shoreline Movement

3.1 Mapping

The movement of a shoreline can be estimated through mapping the position of the coastal vegetation line from aerial photography. The vegetation line is a good indicator of the shoreline position, as it generally represents the limit of coastal processes and is less susceptible to short term fluctuations than other markers such as the waterline. By mapping the historical position of the vegetation line, changes to the shoreline can therefore be estimated.

For the Joondalup coastal monitoring program, mapping of the coastal vegetation line provides a continuous estimate of the shoreline position for the study area. This expands upon the beach survey profiles used to represent the various shoreline sectors.

A shoreline movement plan covering the study area was previously prepared and presented in the baseline monitoring data report (MRA 2016). A detailed description of the source of the aerial images used for shoreline mapping has been presented in MRA (2016).

In each subsequent monitoring period, the shoreline movement plan has been updated to include vegetation line mapping from the most recently available ortho-rectified aerial imagery provided by the City (MRA 2017, MRA 2018b, MRA 2019). The vegetation line mapping has been completed based on DoT (2009) and has an estimated accuracy within the order of ±5 m, depending on the resolution of the aerial photographs and the rectification process.

The shoreline movement plan has been updated with the August 2019 vegetation line and is presented in Appendix A.

Using the updated shoreline movement plan, the relative movements of the mapped coastal vegetation lines were estimated at 100 m intervals along the shoreline. These chainages are presented in Figure 3.1.

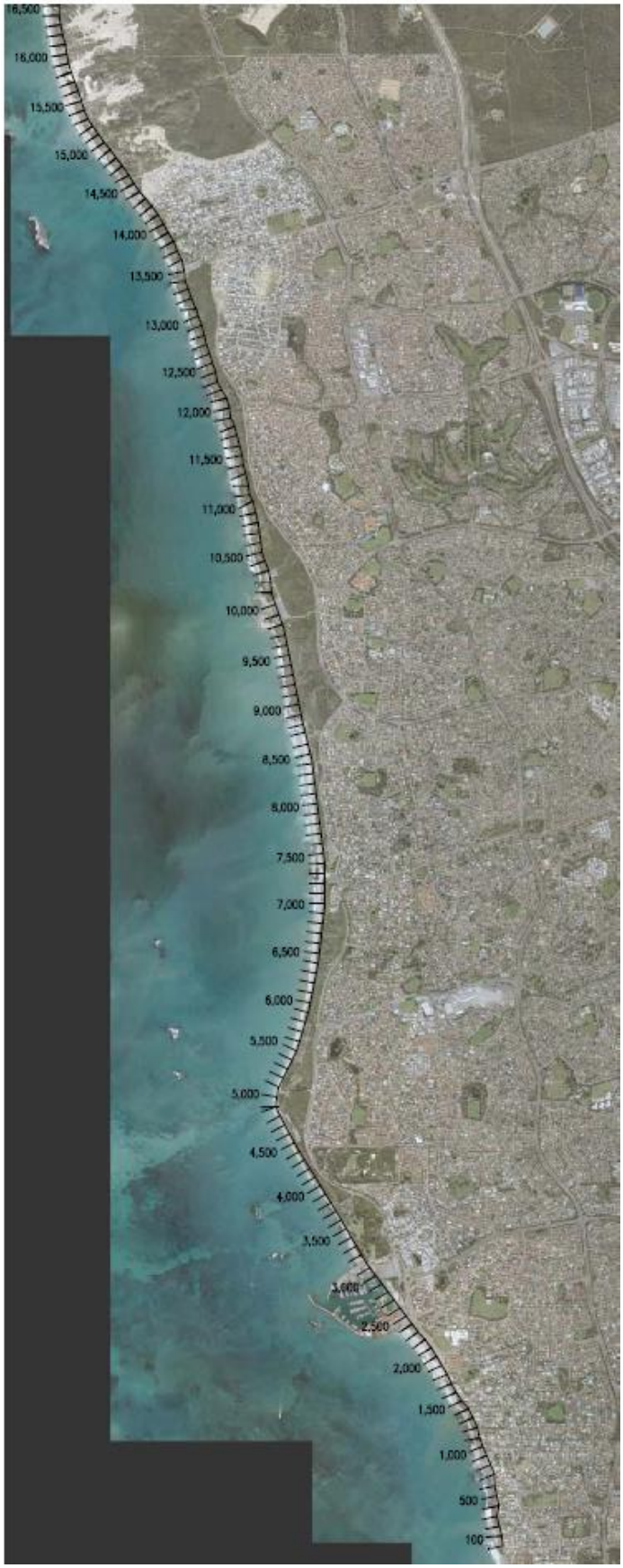

Figure 3.1 Shoreline Movement Chainage Plan

3.2 Shoreline Movement Analysis

The shoreline movements recorded last year (August 2018 to August 2019) and between 2015 and 2019 have been generally assessed from the shoreline movement plans.

The net movements were in some cases made up of varying inter-annual changes. The following annual movements were noted in the assessment of shoreline movement.

- There were generally only minor (<2 m of recession and up to 4 m of accretion) changes to the shoreline position between August 2018 and August 2019.
- The overall change to shoreline position between 2015 and 2019 is generally less than 5 m. The only exceptions are the following previously identified sites:
    - Whitfords Nodes.
    - Pinnaroo Point.
    - The northern end of Burns Beach.

  These locations are highlighted in Figure 3.3.

The movement in the shoreline positions is presented in the following figure. While historical vegetation lines date back to 1942, significant changes to the sediment movement dynamics in the area were caused by the following developments:

- Construction of Ocean Reef Boat Harbour.
- Construction of Hillarys Boat Harbour (HBH).
- Construction of the Sorrento groyne field.

The first available vegetation lines after these developments (1987 and 1996) are therefore used as the baseline for analysis in Figure 3.2. This has been discussed in detail in previous monitoring reports and assessments for the City (MRA 2016, MRA 2017, MRA 2018b and MRA 2019)).

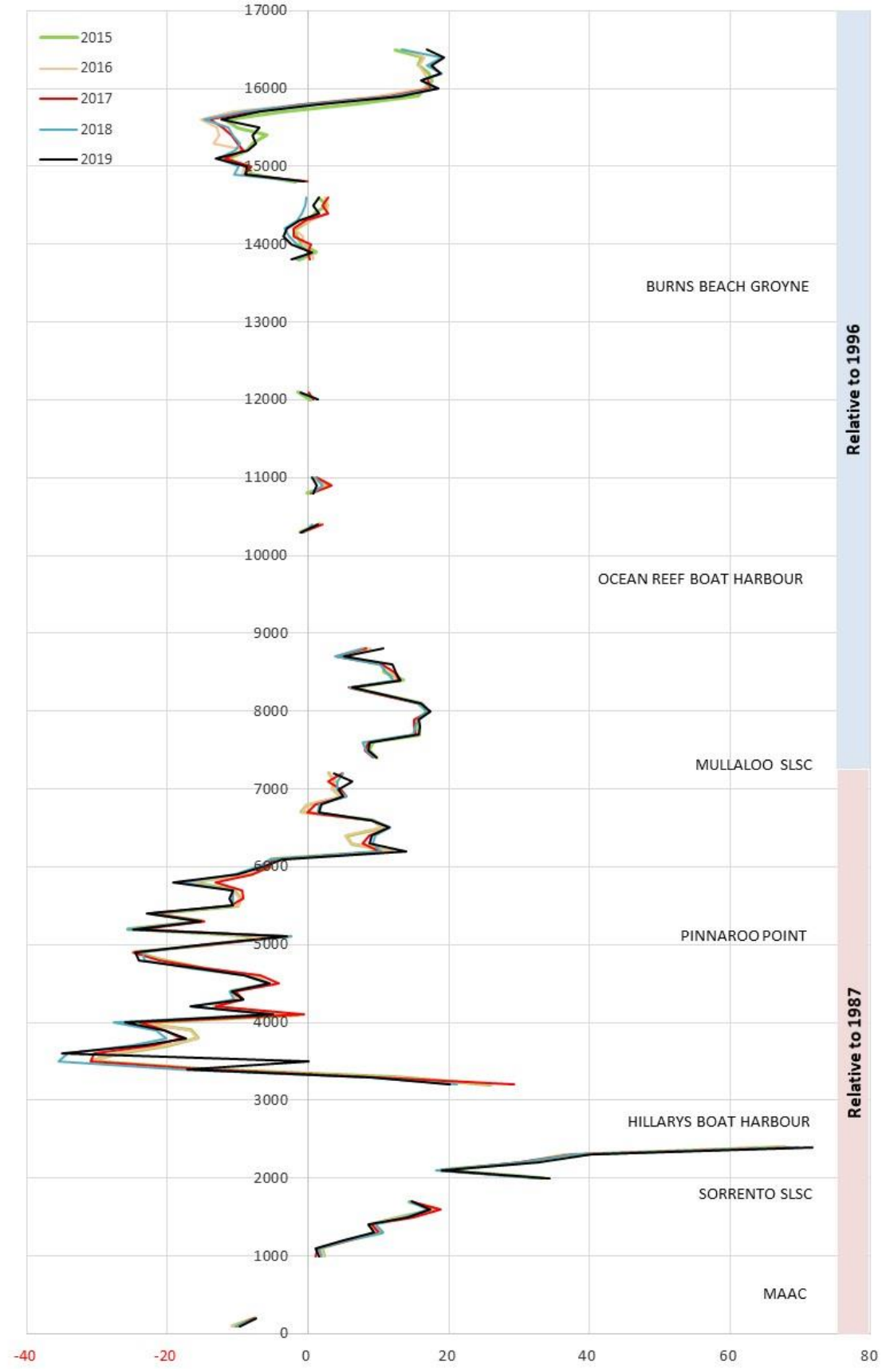

Figure 3.2 Shoreline Movement to 2019

Figure 3.3 Previously Identified Sites for Further Investigation

The shoreline movement for each of the areas in Figure 3.3 that were previously identified as requiring specific monitoring (Whitfords Nodes, Pinnaroo Point and Burns Beach) have been assessed in more detail with the updated shoreline movement data. Extracts showing the vegetation lines between 2015 and 2019 for each of these locations are provided below and discussed thereafter.

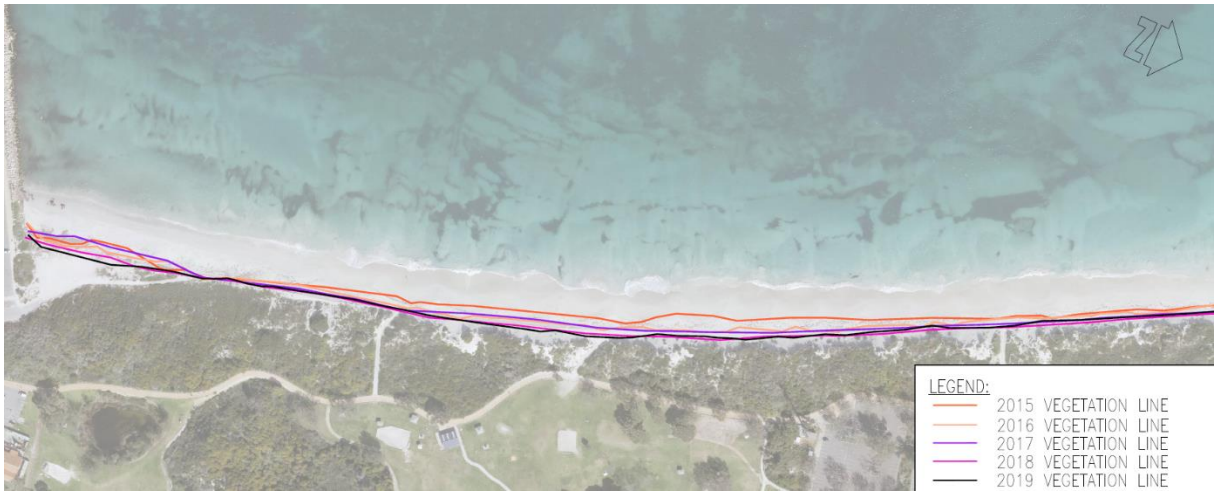

Figure 3.4 Recent Shoreline Movement at Whitfords Nodes

The shoreline along Whitfords Nodes, north of Hillarys Boat Harbour, experienced some additional recession of up to 2 m between August 2018 and August 2019. This was recognised as the continuation of a previously identified erosion trend. However, the recession recorded between August 2018 and August 2019 is less than in previous years (MRA 2019).

MRA recently completed a metocean analysis for Fremantle Ports, which included analysing the wave, water level and wind data over the relevant period covered in this report. The findings of this metocean analysis are outlined in MRA (2020) and found that:

- There was a significantly higher number of winter storm days (classified by a significant wave height greater than 3 m and less than 6 m, and wind speeds of around 40 km/h) in 2019 when compared to the long term average.
- There was a slightly lower number of severe storm days (classified by significant wave heights greater than 6 m and wind speeds of around 60 km/h) in 2019 when compared to the average.
- There was a slightly lower number of swell days (classified by significant wave heights greater than 2 m at periods greater than 8 s) in 2019 when compared to the average.
- There was a significantly higher number of seabreeze days (classified by and the land / sea breeze cycle of wind direction changing between east in the morning and south to west in the afternoon) in 2019 when compared to the average.

The significantly higher number of seabreeze days in 2019 when compared to the averages may have contributed to the erosion observed along the Whitfords Nodes shoreline, given their potential to cause northerly longshore sediment transport.

Conversely, coastal management in the form of sand bypassing completed between August 2018 and August 2019 may have somewhat alleviated the erosion of the Whitfords Nodes shoreline. This is discussed in more detail in Section 6 of this report.

Figure 3.5 Recent Shoreline Movement at Pinnaroo Point

The shoreline at Pinnaroo Point has generally remained relatively stable in the last year. The vegetation line within 500 m either side of Pinnaroo Point experienced changes of up to 1 m between August 2018 and August 2019. This is notably less than the 3 m of recession identified in places in MRA (2019).

Similar to Whitfords Nodes, the metocean conditions experienced in 2019 and the sand bypassing works are likely to have influenced the Pinnaroo Point shoreline. This is discussed in more detail in Section 6 of this report.

Figure 3.6 Recent Shoreline Movement at Northern End of Burns Beach

The shoreline along Burns Beach, including the northern end shown above, generally accreted between August 2018 and August 2019, resulting in little net change over the 2015 to 2019 period.

4. Beach Survey Profiles

A beach monitoring program has been established to monitor the shoreline within the City's boundaries. Beach and hydrographic surveys are collected and analysed to allow long-term changes in shoreline position and coastal processes to be monitored.

The beach monitoring program consists of 22 profiles across the full extent of the City's coastline, approximately 15 km. The locations of the profiles are shown in Figure 4.1.

Figure 4.1 Location of Beach Monitoring Survey Profiles

The locations of the profiles are also provided in more detail in Appendix B. The beach survey profiles are provided in Appendix C.

All of the surveyed profiles extend from behind the coastal dune to approximately 1 km offshore to capture the extent of sediment movement and accurately assess the shoreline changes and coastal processes.

4.1 Investigation Triggers

The trigger values for investigation of shoreline recession in the area were set at:

- 5 m recession of the Mean Sea Level (MSL), approximated as the 0 mAHD contour.
- 5 m recession of vegetation line, approximated as the +3.5 mAHD contour.

These are referenced to the baseline position (2015).

The MSL contour or waterline is a short-term indicator of shoreline change, but is susceptible to fluctuations and short-term movements. The vegetation line is a commonly used indicator of longer term change and trends. Discussion of these triggers is presented in MRA (2016).

4.2 Movement of MSL Contour (0 mAHD)

Table 4.1 presents the positions of the shoreline at the end of winter (October). Profiles where the MSL contour has receded by more than the trigger value are highlighted grey in the table. Figure 4.2 presents the change to the MSL since 2015 graphically.

It is noted that there is no information presented for Profile 8 as this profile runs directly over the Ocean Reef Boat Harbour breakwaters. Other historical survey positions have also been omitted where the profile data wasn't able to be captured at high resolution due to safety reasons (Profiles 6 and 7).

Table 4.1 Position of the MSL

Survey Profile	Nov 2015	Oct 2017	Oct 2019	Oct 2021	Change from 2017 to 2019 (m)	Change from Baseline (2015) (m)
16	66.9	73.7	70.7		-3.0	3.8
15	46.9	58.3	48.3		-10.0	1.4
14	56.5	56.9	54.9		-2.0	-1.6
13	34.2	32.2	31.4		-0.8	-2.8
12	75.2	71.8	73.1		1.3	-2.1
11	55.1	53.3	54.9		1.6	-0.2
10	183.7	184.6	181.0		-3.6	-2.7
9	146.9	147.2	148.4		1.2	1.5
8	OCEAN REEF BOAT HARBOUR					
7	N/A	N/A	233.3		N/A	N/A
6	201.8	N/A	195.1		N/A	-6.7
5	141.3	127.5	139.9		12.4	-1.4
4	187.4	192.5	192.8		0.3	5.4
3	170.3	163.3	162.7		-0.6	-7.6
2	108.8	100.1	101.4		1.3	-7.4
1	142.2	137.4	138.9		1.5	-3.3
21	80.6	80.0	85.8		5.8	5.2
20	93.6	100.5	97.8		-2.7	4.2
19	44.8	43.2	45.8		2.6	1.0
18A	N/A	25.5	27.5		2.0	N/A
18	33.2	33.0	33.6		0.6	0.4
17	38.0	36.3	37.2		0.9	-0.8

Notes: 1. Values in table are position in metres, relative to a nominal baseline.
2. Positive values indicate accretion, negative values (in red) indicate recession
3. The MSL is approximated by the 0 mAHD contour.
4. Changes that have exceeded the trigger value have been highlighted in grey.

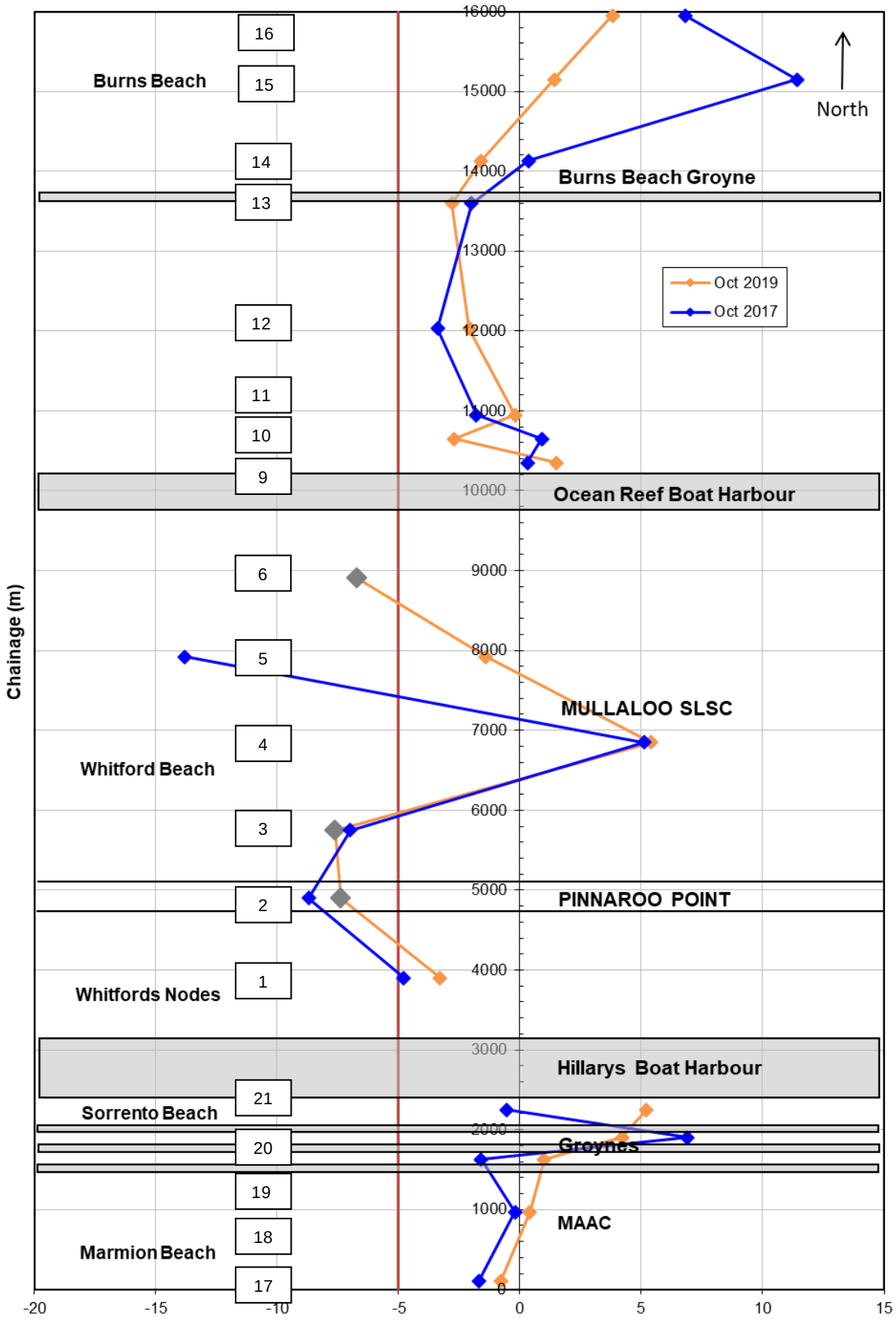

Figure 4.2 Position of 0 mAHD Relative to 2015 Baseline

The following observations are noted over the surveyed period.

- Profiles 2 and 3 at Pinnaroo Point appear to have stabilised somewhat at the MSL since the recession trigger values were originally exceeded (MRA 2018b).
- Profile 5 at Mullaloo SLSC appears to have recovered at the MSL between 2017 and 2019, following the previous erosion identified.
- There has been erosion at Burns Beach (Profile 15) between 2017 and 2019 that has returned the MSL almost back to its 2015 position.
- There has been erosion of the MSL at the northern end of Mullaloo (Profile 6) between 2015 and 2019.

These shoreline changes will be discussed in more detail later in the report.

4.3 Movement of the Approximated Vegetation Line (+3.5 mAHD)

Table 4.2 presents the position of the vegetation line contour at the end of winter (October). The +3.5 mAHD contour is used as a representation of the coastal vegetation line from the surveys.

Figure 4.3 presents the change to the vegetation line since 2015 graphically. Note that there is no information presented for Profile 8, as this profile runs directly over the Ocean Reef Boat Harbour breakwaters, or Profile 20 as the rear of the beach in this area consists of a limestone block retaining wall. No assessment of change at these contours can be made.

Table 4.2 Position of the Approximated Vegetation Line Contour

Survey Profile	Nov 2015	Oct 2017	Oct 2019	Oct 2021	Change from 2017 to 2019 (m)	Change from Baseline (2015) (m)
16	28.6	28.1	28.0		-0.1	-0.6
15	15.0	16.0	15.7		-0.3	0.7
14	22.0	21.8	20.5		-1.3	-1.5
13	7.4	8.0	6.1		-1.9	-1.3
12	49.3	49.8	47.9		-1.9	-1.4
11	35.2	36.5	35.3		-1.2	0.1
10	165.0	165.5	165.9		0.4	0.9
9	122.8	122.6	122.2		-0.4	-0.6
8	OCEAN REEF BOAT HARBOUR					
7	140.3	140.2	141.5		1.3	1.2
6	187.8	187.9	188.1		0.2	0.3
5	90.8	91.3	92.5		1.2	1.7
4	159.5	162.8	164.2		1.4	4.7
3	135.8	135.9	132.6		-3.3	-3.2
2	71.5	71.3	70.1		-1.2	-1.4
1	121.0	116.0	116.1		0.1	-4.9
21	6.7	16.2	16.8		0.6	10.1
20	SORRENTO SLSC					
19	16.0	17.8	18.2		0.4	2.2
18A	N/A	7.0	7.3		0.3	N/A
18	7.6	8.6	8.7		0.1	1.1
17	16.5	17.1	17.3		0.3	0.8

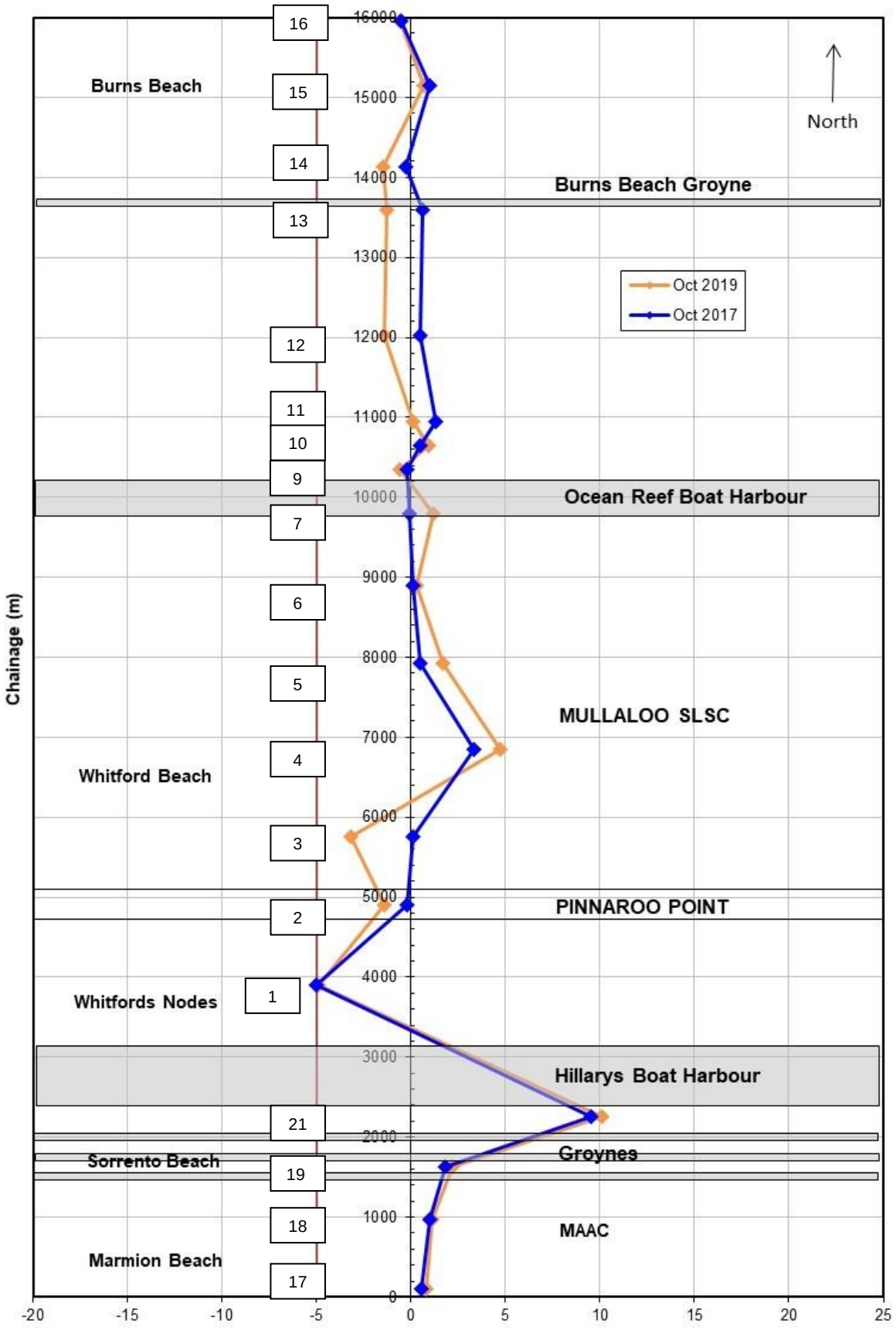

Figure 4.3 Position of Vegetation Line Relative to 2015 Baseline

As expected, changes to the 3.5 mAHD (approximate vegetation line) contour are not as large as the MSL, as it is a longer-term indicator of shoreline change and less susceptible to fluctuation and short-term changes. Changes in the position of the vegetation line were both positive and negative. All profiles fall below the trigger value for erosion, although Profile 1 (Whitfords Nodes) has experienced 4.9 m erosion from the baseline.

5. Photographic Monitoring

5.1 Periodic Photographic Monitoring

The coastal monitoring program includes seasonal (March and October) photographic monitoring of specific locations within the study area. Through the use of a specific field of view (FOV), photographic monitoring programs can be used to obtain visual estimates of the changes occurring on the coast. Erosion and accretion trends can be observed, while photos taken at more frequent intervals can capture seasonal movements or the changes due to storm events. Figure 5.1 presents the location and orientation for all the points used in the photographic monitoring program.

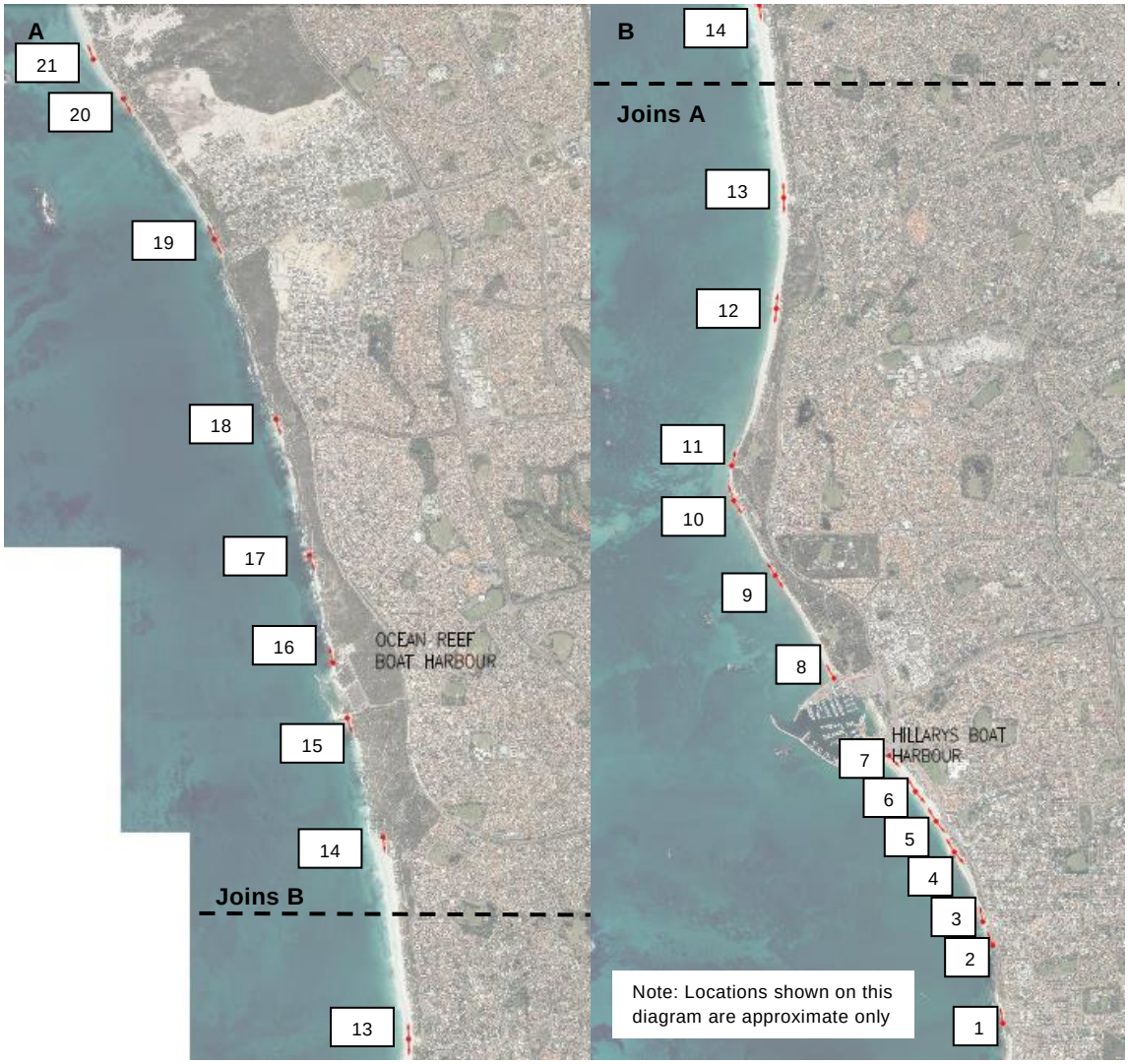

Figure 5.1 Photographic Monitoring Locations

A drawing presenting the photographic monitoring locations, with the survey profile locations, is included in Appendix B.

A summary of the photos taken at each monitoring location are included as Appendix D.

The photographs collected from the 21 photographic monitoring locations were inspected and compared to the photographs from previous monitoring periods. These show seasonal and

inter-annual changes to the beach at a number of locations, however no noticeable ongoing change or trends.

There were no significant areas of change identified from the monitoring photographs. They will continue to be inspected for trends in movement and changes in key areas.

5.2 Fixed Camera Monitoring

In addition to periodic photographic monitoring at fixed points, a fixed time lapse camera is installed at the carpark north of the MAAC. The fixed camera was installed in February 2016 to assist with the following.

- Monitoring the bank in front of the new carpark and the protection offered to the carpark.
- Providing qualitative and quantitative information on seasonal/storm changes in shoreline position.

Photographs are taken daily at 9 am and 3 pm and stored by MRA.

Some example photographs taken between October 2019 and March 2020 are shown in Figures 5.2 and 5.3.

The photographs indicate that there are some seasonal fluctuations of the beach level and width. The photographs indicate that there is now substantial vegetation growing over the bank in front of the car park (see Figures 5.2 and 5.3). The vegetation growth is an indication that there has been very little recent movement of the dune and potential accretion at this location.

Overall, there does not appear to be any significant change to the shoreline position between October 2019 and March 2020.

Figure 5.2 October 2019 Fixed Monitoring Camera Photograph

Figure 5.3 March 2020 Fixed Monitoring Camera Photograph

6. Coastal Management Works Completed

The City undertakes active coastal management works as part of their routine operations. This includes items such as the following:

- Management of sand accumulation and wind-blown sand.
- Management of dune and beach fencing.
- Management of beach access ways, including following storm events.

The following sections outline the larger scale coastal management works completed within the City over the past 2 years. Coastal management activities can have a significant influence on coastal dynamics and movements and need to be considered in assessing the monitoring data.

6.1 Sand Bypassing

MRA (2018b) recommended that sand bypassing be completed around Hillarys Boat Harbour to assist with the following:

- Reducing the continued erosion trend observed north of Hillarys, including at Whitfords Nodes and Pinnaroo Point.
- Reduce sand accumulation issues at the accreting Sorrento Beach.

The City subsequently completed sand bypassing works in December 2018. Sand was excavated from the northern section of Sorrento Beach and trucked to Whitfords Nodes where it was placed at the back of the beach. Photographs showing these works are presented in the following figures.

Figure 6.1 L) Extraction Area Looking South; R) Disposal Area Looking North (18/12/18)

Figure 6.2 L) Disposal Area Looking South; R) Disposal Area Looking North (18/12/18)

Determining the effectiveness of the 2018 sand bypassing project was one of the aims of the 2019/20 monitoring program and is discussed in Section 7 of this report.

MRA (2019) again recommended that sand bypassing be completed over the 2019/20 summer. This was undertaken recently in March/April 2020 and photographs taken during the works are provided below.

Figure 6.3 L) Extraction Area Looking South (26/3/20); R) Disposal Area Access Way (2/4/20)

Figure 6.4 L) Disposal Area Looking North; R) Disposal Area Looking South (2/4/20)

Pre- and post-works surveys were completed by JBA Surveys and are provided in Appendix E. These survey plans show the pre- and post-works contours as well as the areas, depths and volume differences determined between the two surveys.

Based on these surveys, the bypassed volume was estimated and is summarised in the following Table 6.1. The estimate volumes bypassed in 2018 are also provided for information.

Table 6.1 Estimated Sand Bypassing Volumes

Date	Approximate Sand Bypassing Volume (m^3)
December 2018	8,400
March/April 2020	8,700[1]

Notes: 1. Volume based on survey difference in extraction area as discussed below.

MRA visited the site once during the works and liaised with the City who managed the works. MRA also reviewed the survey information provided by JBA Surveys in detail. A summary of the bypassing works and potential impacts are outlined below.

- A large quantity of material appears to have been placed outside the disposal area. As such, the 5,612 m^3 volume determined in the disposal area is likely underestimated.
- The extraction volume of 8,731 m^3 is likely a more accurate representation of what was bypassed and, as such, is the volume documented in Table 6.1.
- It is important to note that the extraction volume determined captures the volume change of the in-situ material. The material placed in the disposal area was quite loose and ungraded and may even be an overestimate of what was actually placed in that area.
- The vast majority of material was extracted from the upper beach at Sorrento, where cuts of over 1 m in depth are evident. As per the Drawings and Specification for the works (MRA 2018a) it was intended for the cut depths to be limited to 0.5 m in that area. As a

result of this area being targeted for extraction, the beach south of Hillarys is likely to continue to widen at a lower elevation, rather than building up.

- Some material was extracted from the waterline, however this is limited to a small area adjacent to Hillarys. This was the area which was intended to preferentially be excavated, as shown on the Drawings and Specification (MRA 2018a).

- In the disposal area, material has been piled much higher than the +2 mAHD level specified and is generally between +2.5 and 3 mAHD along the back of the beach. The placement width is also quite narrow and doesn't generally extend past the pre-works waterline. As a result of this disposal placement, it may take longer for the sand material to move north and feed the beaches which have been eroding.

- The grading of the disposal area appears to be much steeper than the 1V:5H specified. It is unclear if it was graded at all and appears to have just been dumped and is loose in stockpiles. It was noted that further grading may have been completed following the post-works survey capture. As a result of the disposal placement mentioned above, as well as the likely steeper than 1V:5H grading, steeper scarps may form and there will likely be less usable beach width once erosive pressures are experienced. This has the potential to make the area potentially unsafe at the bottom of the scarps if they are approximately 2 to 3 m high.

The effectiveness of this recent sand bypassing will continue to be monitored as part of the coastal monitoring program and will be assessed in future annual reports.

The effectiveness of the December 2018 sand bypassing is discussed in Section 7 in relation to monitoring data captured in 2019/20.

6.2 Dredging at Ocean Reef Boat Harbour

The Department of Transport (DoT) manages the Ocean Reef Boat Harbour and periodically dredges sand from the entrance of the harbour. The dredge spoil is generally disposed of on the southern side of the harbour in winter, to encourage transport to the south over winter months.

MRA (2014) has considered this dredging in previous estimates of the sediment budget. The DoT provided the following details of the dredging and disposal of sediment from recent years. "Dredged" material refers to the material dredged or excavated from the entrance and harbour, while "bypassed" material refers to the material placed back into the active zone on the southern side of the harbour.

Table 6.2 Dredging at Ocean Reef Boat Harbour

Year	Volume Dredged (m^3)	Volume Bypassed (m^3)
1982 to 2010	76,985	Nil
2011	3,542	1,087
2012	-	2,645
2013	6,031	3,030
2014	3,000	3,350
2015	5,660	5,960
2016	-	5,200
2017	-	-
2018	6,000	-
2019	4,350	4,350

The table shows that since 2011 approximately 3,600 m^3 has been removed from the entrance channel and harbour each year and approximately the same amount has been deposited off the southern breakwater. Historically not all material dredged has been bypassed. The DoT advised that in future years dredging and bypassing operations are likely to be completed concurrently.

These works have the potential to influence coastal movements, particularly around Ocean Reef Boat Harbour and should be considered in estimates of shoreline movements and sediment budgets.

7. Summary & Discussion

Based on the review and analysis results presented in previous sections, the key observations are summarised and discussed below:

- There were generally only minor changes (<2 m of recession and up to 4 m of accretion) to the vegetation line over the last year seen in the shoreline mapping. The areas identified as requiring specific monitoring are discussed below.

- The vegetation line at Whitfords Nodes receded by up to 2 m over the last year. This was recognised as a continuation of the previously identified trend, however was significantly less than the 5 m recorded in MRA (2019). The metocean conditions experienced during this period, including a significantly higher number of seabreeze days compared to the averages, may have contributed to the erosion observed along this shoreline. However, the previously identified trend may have been partially alleviated over the recent period by the sand bypassing completed in December 2018.

- The vegetation line at Pinnaroo Point remained relatively stable (changes < 1 m) over the last year. Similar to Whitfords Nodes, the recession previously identified in places at Pinnaroo Point (MRA 2019) may have been improved by the sand bypassing completed in December 2018.

- The vegetation line at Burns Beach generally accreted over the last year, resulting in little net change over the 2015 to 2019 period.

- Beach survey Profiles 2 and 3 at Pinnaroo Point appear to have stabilised somewhat at the MSL since the recession trigger values were originally exceeded. Beach survey Profile 5 at Mullaloo SLSC appears to have recovered at the MSL following previous erosion. There appears to have been erosion at Burns Beach (beach survey Profile 15) over the last 2 years that has returned the MSL almost back to its 2015 position. It is noted that fluctuations of the MSL are expected between years, based on the metocean conditions experienced.

- There has been erosion of the MSL at the northern end of Mullaloo Beach (beach survey Profile 6) between 2015 and 2019. The MSL contour was not adequately picked up in the 2017 surveys, however based on a review of photographic monitoring (location 14) it appears that the shoreline receded between 2015 and 2017 and has since recovered somewhat.

- There were minimal changes to the +3.5 mAHD (approximate vegetation line) contour, with no profiles exceeding the 5 m trigger value for erosion. The greatest recession of the 3.5 mAHD contour identified between 2015 and 2019 was 4.9 m at Whitfords Nodes (beach survey Profile 1). This recession appears to have stabilised somewhat in the last 2 years which may have been helped by the sand bypassing completed in December 2018.

- There were no significant areas of change identified from the photographic monitoring or fixed camera analysis.

- Approximately 8,700 m^3 of sand was extracted from Sorrento Beach, bypassed around Hillarys Boat Harbour and disposed on the beaches to the north in March / April 2020. The

effectiveness of this round of bypassing will be assessed in conjunction with monitoring data collected in future monitoring campaigns.

Based on the monitoring data collected in 2019/20, the majority of which came from October 2019, the key areas previously identified for specific monitoring have typically shown reduced change in the last period. The movement experienced in the past year at Whitfords Nodes and Pinnaroo Point has reduced compared to previous years. This provides a strong indication that the sand bypassing completed in late 2018 was effective.

Over the past year, the shoreline at Burns Beach appears to have accreted somewhat. The profile surveys indicate there are still some changes at the waterline, although the photo monitoring indicates this may have been experienced in 2017 to 2018 and the changes in the past year are likely reduced. It is recommended that this area continue to be specifically monitored. At the moment there is a significant buffer to infrastructure and assets at Burns Beach, but the monitoring should be continued to ensure that it does not accelerate and that an adequate buffer remains.

8. Conclusion & Recommendations

This report presents the monitoring data collected in October 2019 and March 2020, the fifth year of the Joondalup coastal monitoring program, and the changes that have occurred since the baseline monitoring data was collected in 2015/16. The monitoring data collected in October 2019 and March 2020 includes:

- Shoreline mapping and monitoring.
- Photographic monitoring (seasonal).
- Fixed camera monitoring at Marmion.
- Beach survey profiles.

Based on the key observations discussed in Section 7 of this report, it is recommended that the City:

- Continue to monitor and actively manage (if required) erosion between and including Whitfords Nodes and Pinnaroo Point.
- Continue to complete annual sand bypassing around Hillarys Boat Harbour (around 10,000 to 15,000 m^3, depending on budget) to address the windblown sand issues at Sorrento Beach and the recession identified at Whitfords Nodes and Pinnaroo Point. Future monitoring data analysis should specifically analyse the effect of the sand bypassing operations completed to date, including in March and April 2020.
- Continue to specifically monitor the shoreline movement at Burns Beach.

9. References

Department of Transport 2009. *Coastal Demarcation Lines for Administrative & Engineering Purposes. Delineation Methodology & Specification*. Government of Western Australia, Perth.

Department of Transport, 2012. *How to photo monitor beaches*. Coastal Infrastructure Department, Government of Western Australia, Perth.

MRA 2014. *Ocean Reef Marina Coastal Processes Assessment, R519 Rev 3*. Prepared for City of Joondalup.

MRA 2016. *Joondalup Coastal Monitoring – Baseline Monitoring Report, R733 Rev 1*. Prepared for City of Joondalup.

MRA 2017. *Joondalup Coastal Monitoring – Data Report, R893 Rev 1*. Prepared for City of Joondalup.

MRA 2018a. *Hillarys Sand Bypassing Technical Specification, R1037 Rev 1*. Prepared for City of Joondalup.

MRA 2018b. *Joondalup Coastal Monitoring – 2017/18 Data Report, R1003 Rev 3*. Prepared for City of Joondalup.

MRA 2019. *Joondalup Coastal Monitoring – 2018/19 Data Report, R1092 Rev 1*. Prepared for City of Joondalup.

MRA 2020. *Climate Change Risk Monitoring Program Baseline 2019/20 Report, R1374 Rev 0*. Prepared for Fremantle Ports.

Appendices