

**Review of Sea-grass Wrack
Management Trial
Port Geographe – October 2018**

**RD Gee BSc (Hons), PhD and
RC McDavitt Assoc WAIT, FIE Aust, MIET**

**A report to the Busselton City Council, Department
of Transport and residents of Port Geographe by the
Port Geographe Landowners Association Inc**

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Figure 1

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Figure 3

Seaward advances of Western Beach with new Western Groyne

Table 1

1. Background

The beaches and infrastructures of Geographe Bay are susceptible to inconvenient accumulations of sea-grass wrack, especially after winter storms. This is an inevitable natural phenomenon because of the immediate proximity to one of the largest shallow sea-grass meadows in Western Australia. Winter accumulations are omnipresent on all beaches, but are particularly larger against natural and artificial discontinuity features of the beach-line. Accumulations mostly disperse naturally by December each year.

After the initial development of Port Geographe in 1997 there were major seasonal wrack accumulations particularly against the western groyne because of its orthogonal orientation and the anti-clockwise littoral circulation. Accumulations of the magnitude $115,000\text{m}^3$ to $150,000\text{m}^3$ were recorded against the western groyne in the period 2011 - 2013. The study by Oldham *et al* (2010) estimated that 97% of all beach wrack was accumulated against the western groyne.

This situation was aggravated year upon year by the well intentioned but ill-advised removal of all the accreted material, resulting partly from the cost-plus type earthworks contract. The end result was a bigger trap for the next seasons wrack. Natural by-passing was impossible. This un-natural accumulation was of sufficient nuisance value to warrant intense debate on re-configuring the groynes, which ultimately became effective in December 2014. Naturally all involved parties have taken a close interest in the performance of the re-configured groynes.

Bi-annual reviews are made in accordance with the Port Geographe Coastal Structures Environmental Monitoring and Management Plan 2016-2020 (CMMP) jointly adopted by Department of Transport (DoT) and Busselton City Council (BCC). The CMMP covers the coastal stretch from Morgan St in the west, past the Port Geographe development, to Baudin Reserve at the eastern part of Wonnerup Beach. This is the Port Geographe Coastal Management Area (PGCMA), for which the Special Area Rate (SAR)-paying landowners of Port Geographe have a legal liability to contribute funds, at the discretion of Deed between BCC and DoT.

The objective of the CMMP is to “*maintain natural beachfront wrack dynamics by ensuring less than $60,000\text{ m}^3$ of wrack is on the Western Beach by December each year*”. It also provides that wrack management activities may be implemented when volumes exceed $30,000\text{m}^3$.

DoT provides periodic updates on performance of the re-configured groynes. No volumetric figures were given for the winter of 2015 immediately following the reconfiguration. However the winter's-end accumulations for 2016 and 2017 were given as $15,000\text{m}^3$ and $12,000\text{m}^3$ respectively. No quantitative figures were released for post-winter 2018 immediately prior to the trial program reviewed in this paper, although the DoT update stated volumes were “less than half the peak winter values” of the years prior to re-configuration. Therefore a conclusion can be drawn that these volumes are significantly less than quantities prior to re-configuration.

In the period 11-15 October 2018, BCC and DoT chose not to wait for the scheduled December review, and jointly undertook a limited mechanical-intervention program on the wrack along the Western Beach of Port Geographe. The stated objective was to “*achieve a greater volume of*

sand closer to the Western Breakwater so there is improved opportunity for winter wrack accumulations to be shed more quickly” and to “improve the management of the Western Beach by December each year”.

It is clear this early intervention was partly in response to a community action group with residential frontages on the Western Beach, whose concern was what one may interpret as a short term view towards their beach amenity.

As no formal review is likely from BCC or DoT, PGLOA has used its scientific and engineering expertise to conduct its own review.

PGLOA has taken the view that no mechanical interventions on the Western Beach should be contemplated until natural processes have allowed the new shore-line to come to equilibrium. Whilst recognizing there are societal, environmental and image concerns, the principle concern is that **nothing should be done that will retard the natural buildup of material against the western groyne**. The key question is, how long will this natural process take, and will it be effective. This position paper addresses this question from a technical rather than emotional perspective.

2. Datasets available

The Coastal Department of DoT have kindly provided before-and-after images of Western Beach. These have been registered into MapInfo GIS software for the purpose calculating volumes of wrack. In addition, ancestral coast lines going back to 1941 have been captured from the Slip website www.transport.wa.gov.au/portgeographe. Also DoT has kindly provided geo-referenced aerial photo mosaics of the coastal strip, some as old as 1941. Time-series satellite imagery back to 1985 is available through Google Earth Pro.

3. Nature of the trial program

Before-and-after drone images are shown in **Figure 1**. The total area of wrack on the Western Beach, as of 10 October 2018 has been measured by us as 59,840m². Thicknesses ranged between 0.25m to 1.0m with some localised heights immediately adjacent to the western groyne exceeding 2 metres. Taking an average thickness of 0.75m, gives a volume of 44,880 m³, which is less than the 60,000m³ trigger volume.

It is evident in comparing Nov 2017 satellite imagery with Oct 2018 drone imagery that the Oct-2018 wrack contains some residual material from the previous year. This may account for the two-metre scarps immediately adjacent to the western groyne wall.

The mechanical intervention program of October 2018 involved cutting bulldozer slots through the wrack, and levelling the compacted seaward face of the wrack. Altogether there were seven bulldozer slots through the wrack perpendicular to the beach, between Morgan Street in the west and Lesueur Close in the east – a distance of 900m. It is notable that all slots correspond to

established foot-tracks through the dunes to the beach. In this respect beach amenity was restored for local residents.

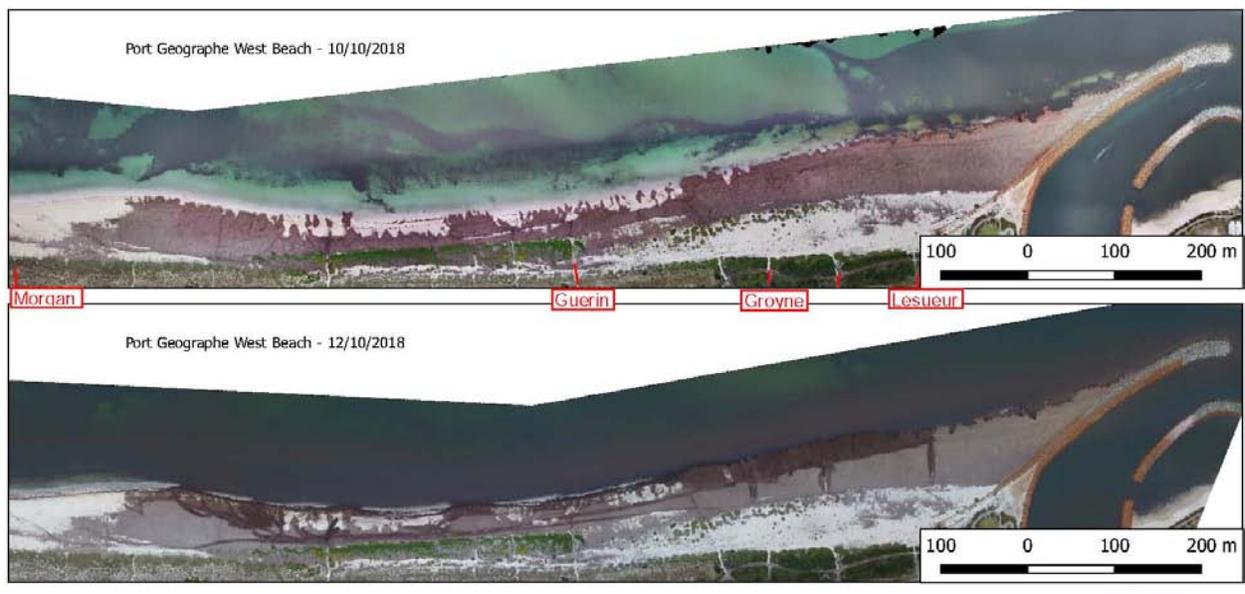


Figure 1: Drone images of Western Beach before (upper 10/10/2018) and after (lower 12/10/2018) mechanical intervention: Tracks from street terminations shown in red. Wrack is medium grey. Bulldozed slots and flattened scarp appear as dark grey in lower image

By a combination of compaction and etching by waves, the seaward edge of the wrack had developed a steep face varying from 0.4m to 1.7m in height over most of its length. This face was mechanically flattened by raised-blade traverses over 900 metres of wrack in a swath 20m wide.

No material was removed from the beach, nor was there any beach clearing. This is consistent with written advice from the CEO of BCC that no future removal of wrack would happen, after the controversial removal program in 2017.

The operation is reported to have cost some \$14,000 and was paid for by DoT. Whether DoT may invoice BCC has not been revealed, however PGLOA is advised by Mayor Henley that contributions will not come from the Port Geographe Waterways Management Reserve Fund, or the Port Geographe Development Fund.

4. Morphology of the Western Beach

For the purpose of this review, the Western Beach is taken to be that stretch of sandy beach between the two shoreline protuberances (here called *nodes*) of the Western Groyne and Russell Street. The Western Groyne Node (WGR) acts as an artificial node that influences sediment transport. The Russell Street Node (RSN) is a gentle natural seaward bulge of the beach-line, which similarly influences sedimentation. It owes its existence to the close proximity of a major

off-shore sand bar. Historic aerial photos show the node and sand bar have been in existence for at least 75 years, and neither has moved laterally.

In equilibrium, the beach morphology will be determined by these two nodes. The shore line in plan will take the form of a shallow catenary-shaped curved embayment between the two nodes. It will not be a straight line. Because of the prevailing littoral southwest-to-northeast drift, the curve will be slightly asymmetrical, with the deeper embayment closer to the RSN and a sediment build-up closer to the WGR. Presently the deepest part of present curve, taken from a straight line between RSN and WGR, is 90 metres near Guerin Street. This should not be taken as erosion, but a natural curve.

5. Mechanics of wrack movement

The mechanics of seagrass accumulation and removal is well understood following the study of Oldham *et al* (2010). Seagrass leaves are continually shed into the off-shore meadow. During winter storms the litter is moved along the seabed as myriads of individual particles, which become stranded at the high watermark of the associated storm surge. At this point the entangled mass is non-buoyant but after drying over a period of days or weeks, its density drops and providing it is does not become heavily impregnated with sand, becomes buoyant. The mass of particles can then float off at the next suitable high-water weather event. Particles are transported in the prevailing northeast directed wind-driven currents in the immediate littoral zone. During this secondary transport process, which normally removes the material from the system, some material may linger and accumulate as wrack on the up-stream face of natural or artificial features.

It is well established from the Oldham (2010) studies that lingering wrack becomes heavily impregnated and partially buried with sand. Two-year old wrack is observed to become covered with summer wind-blown dune sand and show incipient vegetation. In a non-equilibrium situation, as at present-day Western Beach, wrack plays a beneficial role in accelerating the attainment of a natural beach shape and profile. It is therefore important that lingering wrack should **not** be removed from the Western Beach whilst the filling stage is going on.

6. Mechanics of sand movement

The mechanics of sand movement are less well enunciated in consultants' reports, but is a combination two factors. In the swash zone individual sand grains are driven obliquely up the beach face by oblique wind-generated waves, and then run orthogonally down the beach face. The prevailing wind (both summer sea breezes and winter storms) is from the west and southwest, which migrates the sand northeasterly along this part of the coast.

The second mechanism involves movement of suspended sand grains in the rill channels that characterize this part of the shoreline. These occur near to shore, between the submerged beach face and near-shore sand bars. They show as dark sinuous channels on **Figure 3**, some 50 metres offshore. Currents of 0.3m/s are required to move sand grains in suspension which are easily generated in these channels by fresh-to-strong westerly and southwesterly winds.

These two processes do not cause accretion of sand on the natural shore line. Accretion occurs when sand is lost from the total sand flux by being blown onto the beach and sequestered against the fore-dune. Losses from the sand flux are more than adequately replenished by sand ingress which has been scoured from the deeper seabed of Geographe Bay during storm events. Source material for the sand flux is **not** coming from erosion at the head of Geographe Bay.

Damara (2010, 2011) estimates the total equilibrium littoral sand flux along the beach line is in the range of 25,000 – 35,000m³. This has been measured by growth rates of accretionary-prisms against fabricated structures. However it is noted that in the early years of the initial development of Port Geographe, build-up rates were of the order of 60,000 – 70,000m³ per year (Pattiaratchi and Wijeratne, 2011). In summary, there is a lot of sand movement in the system.

7. Shore-line accretion

The part of the coastline between RSN, through Port Geographe to Wonnerup lagoons, shows some of the strongest accreting rates in the whole of Geographe Bay. For example RSN has grown 90 metres seaward (but not moved laterally) in the last 75 years, giving an accretion rate of 1.2m/y. Similarly at Wonnerup Vasse River Bridge, the coast has accreted 105m in 75 years, equating to 1.4m/y. The accretion curves are non-linear generally but progressive not cyclic, as seen in **Figure 2**.

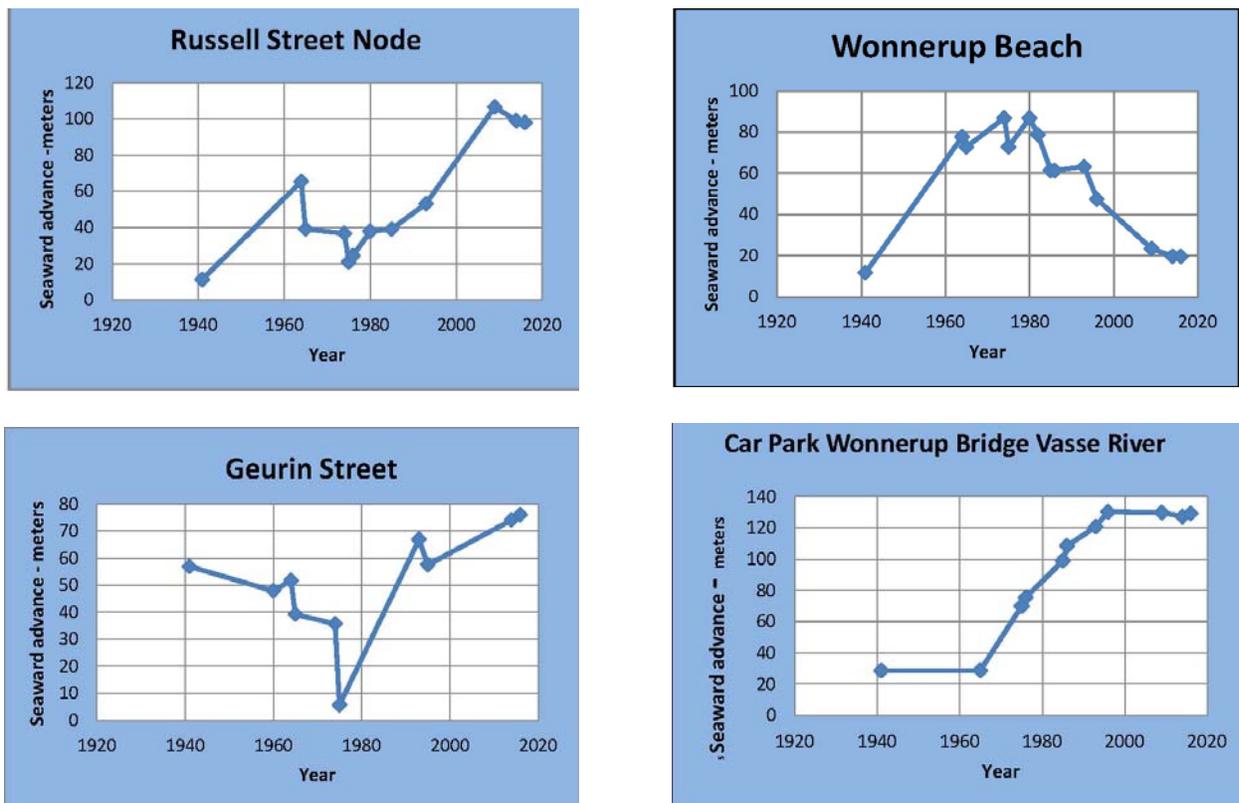


Figure 2: 80-year accretionary curves.

The dip sharp dip in Russell St and Guerin St growth curves is attributed to Cyclone Alby in 1978. The pronounced downturn in the growth curve for Wonnerup Beach (measured 60m east of the revetment of Port Geographe is attributed to starvation of sand that is not naturally by-passing at the present time. This gives some justification for localized beach-nourishing programs at Wonnerup Beach. It is noted that even in its depleted state **the beach has nevertheless advanced from its 1941 position.**

8. Dynamics of the Western Beach

The progression of Western Beach has been examined over the period from the time just before dismantling of the first western groyne (Jan 2014) to the present time (Nov 2018). The beach-line is the interface between the sand and water, which closely conforms to AHD 0m. Any deviation from this by tide situation is insignificant in this analysis.

The beach-lines for Jan 2014 (green) and Nov 2018 (blue) are plotted on **Figure 3**. The 1941 beach line (red) is also plotted for reference. It is important to note the actual 1941 beach is now occupied by sand dunes, and the top of the 1941 beach, as recorded by the vegetation line on historic photos, is 45-50 meters further inland and laps against present-day Geographe Bay Road. **Table 1** shows the progression distances for different segments of Western Beach during this four-year period.

Transect	Metres	Rate m/y
Leseuer	70	17
Reidle	62	15
Groyne	52	13
Guerin	26	12
Morgan	25	6
Russell	10	<2

Table1: Seaward advances of the Western Beach since installation of the new Western Groyne

The segment between WGN and Guerin St can be considered an accreting prism, with a narrow accreting band that stretches westward from Guerin St to RSN. As expected, highest rates occur in the “elbow” of the current embayment close to the WGN. These rates of progression are ten times higher than the undisturbed part of the coast, and clearly show there is rapid filling of the elbow. There is some evidence from recent satellite imagery that the rate of lateral accretions (in terms of area) is slowing, but this is to be expected as the accreting wedge moves in deepening water.

The area of accretionary sand growth in the full section between RSN and WGN, since the time of groyne re-configuration, is 55,450m². Most of this occurs in the elbow as noted above. This equates roughly to 13,800m² /year. Taking the average thickness of the mobile sand slab (actually a trapezoid) at 2 metres, this equates to trapping of 27,725m³ /y. This is comfortably within the range of 25,000 – 35,000m³ for the sand flux along the beach-line estimated by Damara (2010, 2011). We can therefore infer that virtually all the sand entering Western Beach

by long-shore littoral drift is being trapped against the Western Groyne. This is the desirable situation for the short to intermediate term.

To date, the leveling of the seaward scarp of the wrack has not resulted in any natural removal of wrack from the beach. However it has exposed the surf zone of the beach profile which re-activates littoral sand movement. This is not the desired action at present. Fortunately the remnant scarps close to the WGN continue to cover sand that would otherwise be the active surf zone. These undisturbed scarps are assisting the natural build-up of sand.



Figure 3: Western Beach between Russell Node and Western Groyne showing historic shorelines and 2018 wrack

9. The ideal shoreline

The ideal final shore-line curve has been superimposed on **Figure 3** to represent the final curvature of the Western Beach. This final curve extends from the tip of the WGN to just beyond Groyne Road. Only a small area of 9,000m² remains to completely fill the elbow to a form smooth dynamic shape. Considering its progression into deepening water, this may require a slab of up to five metres, equating to 45,000m³ of sand. At present rates of accretion this may be achieved in one season – or more likely the beginning of the 2020 winter.

The natural filling will produce a catenary-style beach shape, returning it to its natural embayment of about 90 metres. In this case the bulge of the artificial WGN will be no more prominent than the natural RSN, which does not have a lingering wrack problem.

It is significant that all the historic waterlines prior to the first groyne construction for Port Geographe in 1997, show a long-lived protruding sand node that lies precisely under the present marina area. Whether by accident or design, the “final curve” presented in **Figure 3** closely mimics the 1941 and subsequent shorelines, although it is translated seaward by 90 metres due to natural accretion.

10. Conclusions

1. The build-up of seagrass against the western groyne of Port Geographe (both original and re-configured) has been, and continues to be, the cause of abnormal build-up of wrack on the Western Beach.
2. However the Western Beach lies within a segment of coastline that displays the highest sand accreting rates in Geographe Bay.
3. Based on quantitative volumetric estimates of sand accreting rates on the Western Beach, and known sand flux rates, the beach should reach an equilibrium shape by the summer of 2020.
4. The ideal beach shape will be a catenary-style gentle embayment between the tip of the Western Groyne and the Russell Street Node, and its shape will mimic the shape of previous natural beach lines going back to 1941.
5. The equilibrium profile will still be subject to normal wrack accumulation and dispersal processes as they occur elsewhere around Geographe Bay on a seasonal basis.
6. The accumulation of wrack plays an important role in assisting the build-up of sand into the elbow of the beach-groyne interface.
7. The mechanical intervention in October 2018, intended as a wrack management trial, has neither enhanced nor impeded the build-up of sand in the Western Beach; however it is acknowledged it has improved the beach amenity of local residents.
8. As a general principle mechanical intervention that removes wrack from the Western Beach should **not** be contemplated.
9. There is no necessity for any artificial sand nourishment program to accelerate the attainment of equilibrium of the Western Beach – it will happen naturally.

11. References

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