MEMO

To:	South Australian Department for Environment and Water
Att.:	James Guy
Cc:	Murray Townsend, Jason Quinn
From:	Méven Huiban
DHI ref.:	43803780
Date:	10 February 2021
Subject:	2021 revision of West Beach Sediment cell sand volume estimation

1 Introduction

In 2017, DHI was engaged by the Department for Environment and Water (DEW) to undertake an investigation of the West Beach sediment cell, to identify the causes of long term and ongoing recession of the shoreline, and to evaluate a range of management options for this sediment cell.

During this project, a detailed analysis of bathymetry data, coastal profiles and historical nourishment volumes led to the development of a conceptual model of the coastal processes causing erosion at West Beach. The understanding of the coastal processes allowed the establishment and calibration of a coastal sediment transport model of the West Beach sediment cell.

The results of this assessment were documented in a detailed technical report (Ref. /1/).

Since the completion of the 2017 study, DEW has continued the collection of detailed profile surveys in January each year. In August 2020, the data for three additional years (2018 to 2020) have been analysed and used to inform the evolution of the sand volumes in the West Beach sediment cell. The results of this assessment were documented in a technical memo (Ref. /2/).

A new survey campaign was conducted in December 2020 and this technical note presents the update of the computed volume of sand in the West Beach sediment cell, incorporating the newly collected dataset.

2 Profile analysis update

2.1 Methodology

To allow direct comparison with the previous results (Ref. /1/ and Ref. /2/), the same methodology has been applied to the recently collected survey. As a reminder, the littoral volume analysis is based on the following principles:

- For each profile, the volume of sand per metre is integrated from the back of the dune system out to -5 m AHD, which is the estimated depth of closure. The beach volume per metre of beach length has been calculated for all available profiles. In case a measured profile does not extend below -5 m this profile was not included in the analysis. Profiles not extending above 0 m were also excluded.

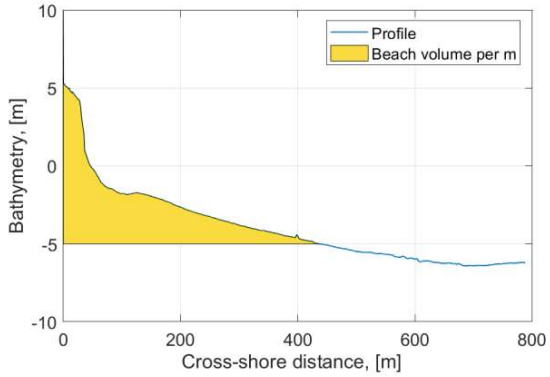

Figure 1 Computation of the volume of sand per metre in the surveyed profiles.

- To reconcile the different timings of the surveys throughout the years, the volumes at each profile were interpolated in time, by linear interpolation, to provide an estimated volume on Jan 1st for each year at each profile and facilitate subsequent analysis over the entire cell.

- The total littoral volume is calculated by trapezoidal integration per metre between each surveyed profile, as schematically illustrated in the figure below, where the total volume of sand (in yellow) is integrated from the discrete volume per metre in each profile (in blue).

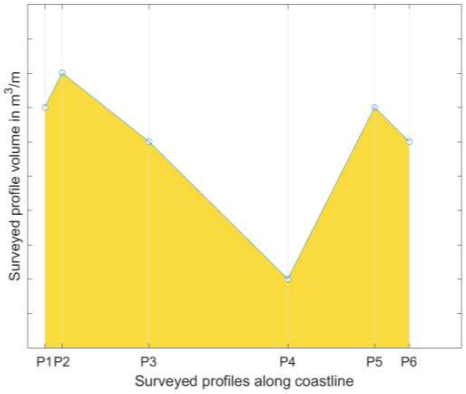

Figure 2 Integration of the volume of sand per metre to compute the total littoral volume in the sediment cell.

For the assessment of the West Beach sediment cell, the analysis is based on the five profiles indicated in Figure 3.

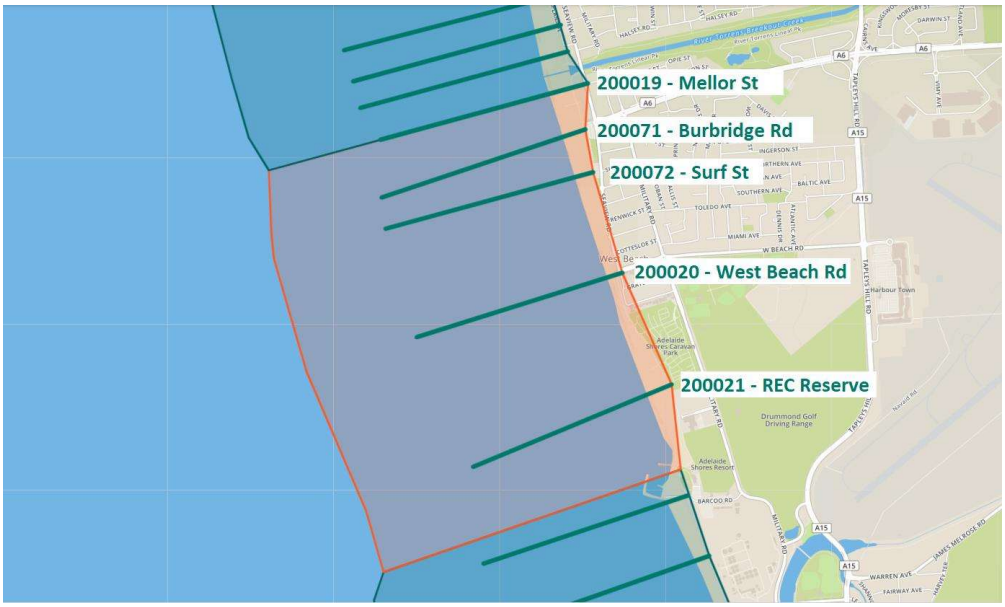

Figure 3 Overview of profiles located within the West Beach sediment cell.

2.2 West Beach Road profile

DEW indicated that the seawall along the West Beach SLCS has been reshaped in 2020. The figure below illustrates the presence of sheet piles protecting the construction site at the location of the West Beach Rd profile.

Figure 4 Aerial image from the 22 February 2020 showing the extent of the construction work carried out along West Beach SLSC in 2020 (Source: Google Earth). The location of the surveyed profile is indicated in yellow.

Figure 5 presents the two latest profiles taken at West Beach Rd (profile 200020). As it can be seen, the profile from December 2020 had to be linearly interpolated from cross-shore distance x=26 m to x=62 m as no data point could be taken due to the presence of the new seawall.

Therefore, for the computation of the evolution of the volume of sand, the "loss" between these two chainages (highlighted in blue in the figure below) has not been considered, as this volume has been manually removed for the construction of the new seawall and is not due to natural processes.

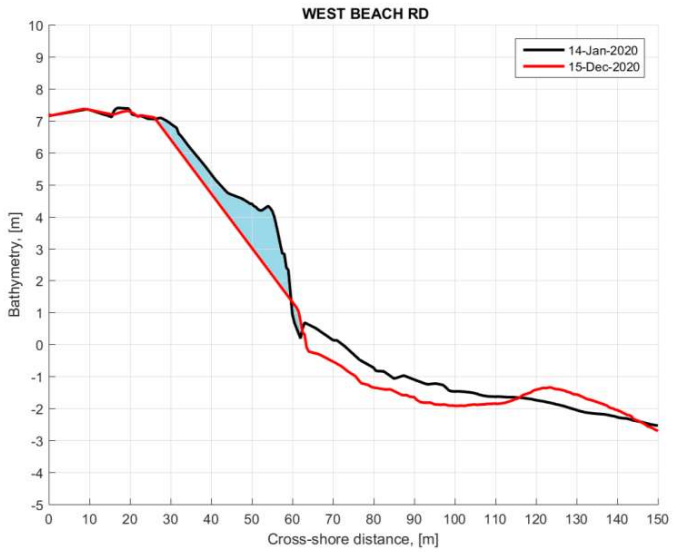

Figure 5 Comparison between profiles as surveyed in January 2020 and December 2020. The area highlighted in blue is not considered in the volume calculation.

2.3 REC Reserve profile

As identified during the previous volume calculation update (see Ref /2/), the profile survey line 200021 (REC Reserve) is adjacent to an outlet pipeline and it was deemed not representative of the section of the coast for years 2019 and 2020. To compute the evolution of the volume of sand, a synthetic profile using neighbouring profiles was used for these two years.

Figure 6 is a picture taken at the REC Reserve location during the December 2020 survey. As it can be seen, the gully identified in the data from 2019 and January 2020 is not observed in the most recent dataset.

This is confirmed by the cross-shore profiles presented in Figure 7. On this figure, the original is compared to the synthetic profile computed based on the methodology described in Ref. /2/. As it can be seen, both profiles are very similar.

Therefore, the original profile at REC Reserve has been used for the December 2020 volume calculations.

Figure 6 Picture taken at the REC Reserve profile location (200021).

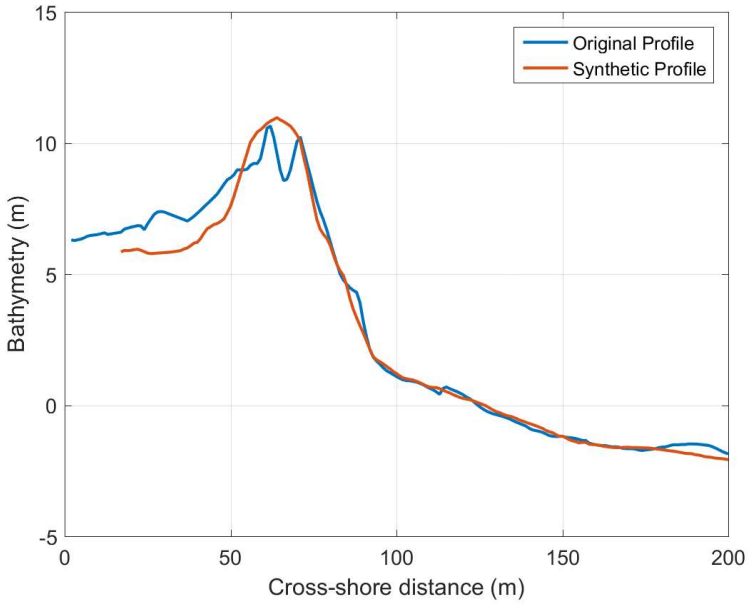

Figure 7 Comparison between the original profile and the synthetic profile computed using the same methodology as in Ref. /2/.

3 Updated volume evolution

Figure 8 presents the results of the analysis in terms of volume of sand in the cell. The updated volume of sand in the West Beach sediment cell is based on:

- from 1994 to 2018: Original surveys for each of the five locations.
- For 2019 and January 2020: Synthetic profile at REC Reserve, Original profiles at the other four locations
- December 2020: Adjusted volume at West Beach Rd to take into consideration the reshaping of the seawall (See section 2.2), Original profiles for the other four locations

The figure below indicates that the computed volume of sand in the West Beach Sediment cell has significantly decreased from January 2020 to December 2020. The estimated volume decrease in the sediment cell is approximately -65,000 m^3 over that period.

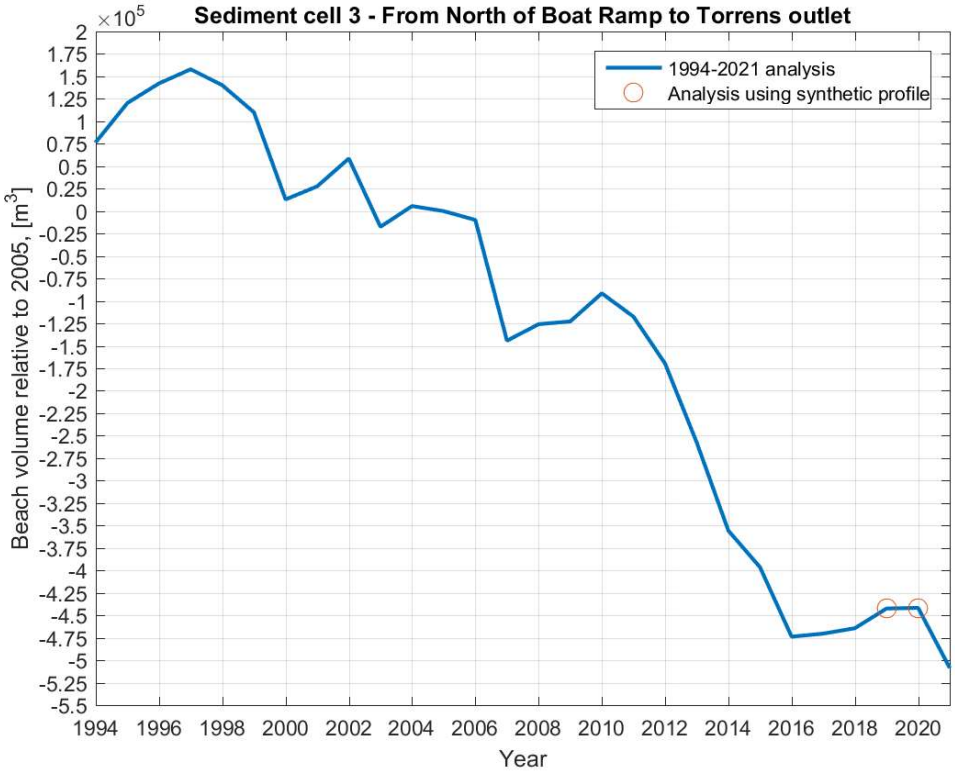

Figure 8 Change in West Beach sediment cell volumes relative to the 2005 volume, including December 2020 surveys.

4 Comments, limitations, and recommendations

The update of the analysis based on the recently measured beach profiles leads to the following comments:

- DEW indicated that 46,000 m^3 of sand have been imported to West Beach during 2020 (26,000 m^3 in March and 20,000 m^3 in October/November). The computed loss of

65,000 m^3 which suggests that the total littoral transport out of the West Beach cell in 2020 of approximately 111,000 m^3.

As indicated in Ref. /1/, the estimated average littoral drift is ~100,000 m^3/yr, with a high variability (+/- 50%). Based on the volume calculations, 2020 is slightly above an average year in terms of littoral transport along West Beach sediment cell.

- The vertical steel sheet piling in front of the SLSC associated with the reconstruction of the seawall (see Section 2.2) was in place for most of 2020 and has caused reflection which led to observable nearshore deepening, as illustrated in Figure 5.

  This profile is the only representative of the stretch of coast between Surf St. and REC Reserve profiles, which is approximately 1400 m long. However, it should be considered representative of only a short stretch of the coast in front of the seawall.

- The point above highlights a limitation of the methodology applied to compute the total littoral volume. Five profiles unevenly distributed in the sediment cell are used to compute the total littoral sand volume in the area and interpolation is applied in between these five profiles. Therefore, potential features "hidden" between the surveyed profiles are not captured.

  Another consequence of this methodology is the fact that a small variation of the computed volume per metre at one profile may have a significant impact on the total estimated volume, especially if the distance with the two neighbouring profiles is large, as schematically illustrated in Figure 9.

  In the West Beach context, with the distance between Surf St. (Profile 200072), West Beach Rd. (Profile 200020) and REC Reserve (Profile 200021), a variation of 10 m^3/m in the middle profile would lead to a variation of 7,000 m^3 in terms of integrated volume.

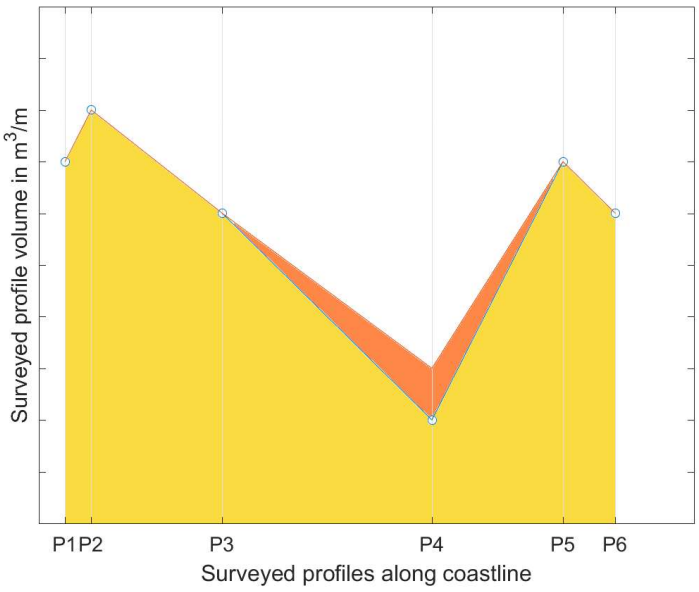

Figure 9 Schematic illustration of the impact of a small variation of the volume per metre in one surveyed profile on the computed total littoral volume.

The littoral sand volume computation as it stands provides some insights on the variation of the sand volume in the sediment cell. However, due to the limitations highlighted in this section, this analysis would certainly benefit from additional datasets such as:

- Additional and evenly spaced profiles between Surf St. and RED Reserve profiles to capture better the sand features along that stretch of coast where human intervention is happening (seawall, nourishment).
- Additional 2D bathymetry derived from satellite imagery, aerial drone, lidar… These datasets could be used to increase the resolution of the sand volume assessment both spatially and temporally.

5 References

/1/ DHI, August 2018, *West Beach Coastal Modelling Processes, Assessment of Coastal Management Options.* Technical report prepared for DEW.

/2/ DHI, August 2020, *Analysis of the 2018 to 2020 profiles along West Beach.* Technical memo prepared for DEW.