Department for Environment and Water

Sand pumping system feasibility assessment

Executive Summary

Purpose

The South Australian Department for Environment and Water (DEW) is undertaking a review of the '*Securing the Future of Our Coastline Sand Pumping System Projec*t' (SOC SPS).

DEW engaged Hatch to:

1. Review the existing design of the SOC Sand Pumping System, identify information and assumptions that underpinned the design, and confirm the status of the design and development approval.

2. Review relevant new information, in particular data from more recent sand source investigations and coastal process monitoring, to verify sand characteristics and sustainable extraction volumes in the vicinity of proposed sand collection units.

3. Assess the feasibility of the designed SOC sand pumping system to achieve ABMR Panel Recommendation 2 (recycle 90,000 m^3 per annum to West Beach from northern beaches) and outline any changes required to achieve this.

4. Consider implications of any changes on regulatory and operational feasibility, and outline timeframes and additional costs incurred to deliver a revised Sand Pumping System.

Design Status

The design objective of the original SOC SPS was to transport an average of 100,000 m^3 of sand per annum, with a peak annual volume of 150,000 cubic metres (m^3) per year.

The Sand Pumping System comprised two portions with 100% design documentation completed for:
- Portion A - From existing sand transfer system at West Beach to Semaphore South Breakwater.
- Portion B - Semaphore South breakwater to just north of Largs Bay Jetty (Everard St).

The design assumed the following extraction volumes per annum from four Sand Collection Units (SCUs):
- Portion A: 50,000m^3 from Semaphore Breakwater SCU (Semaphore South) and Terminus St SCU (Grange).
- Portion B: 50,000m^3 from Hall St SCU (Semaphore) and Everard St SCU (Largs Bay).

Technical feasibility

The feasibility of the SOC SPS design to achieve ABMR Panel Recommendation 2 (recycle 90,000 m^3 per annum to West Beach from northern beaches) was assessed.

Sand Suitability

In 2024, DEW commissioned Bluecoast Consulting Engineers to develop *draft Suitability Criteria for Sand Sources to Nourish West Beach* (Sand Suitability Criteria).

Existing data (2022) was reviewed against the new draft Sand Suitability Criteria to verify the suitability of the sand at each of the designed SCU sites: -
- The particle size distribution (D50) of sand sampled in the vicinity of designed SCUs met the Sand Suitability Criteria for 'beneficial reuse'.
- Carbonate content of sand sampled in the vicinity of designed SCUs was acceptable.

In line with EPA Dredging Guidelines and to support the approval process, sampling at these locations have been undertaken (JBS&G, April 2025) to confirm contaminants, results found no exceedances against relevant criteria.

Sustainable extraction rate

Sustainable annual extraction rates for each of the SCU sites were calculated using the latest data. The following extraction rates would maintain a stable beach (i.e. no recession of current shoreline position) and limit impact to downdrift shorelines:

- Portion A - Semaphore Breakwater SCU: 40,000m^3/year.
- Portion B - Hall St SCU: 5,000m^3/year plus Everard St SCU: 15,000m^3/year.
  - → Annual sand volume for sustainable extraction = 60,000m^3/year.

Options to increase extraction volumes

The target volume of 90,000m^3/year could be achieved by:

- Reinstating the existing pipeline (Cell 3) - Torrens Outlet SCU: 15,000m^3/year
- Accepting some recession of the coastline at any of the SCU locations
  - The Adelaide Living Beaches Strategy's sand buffer requirement (80m^3 per linear meter above +1m AHD contour) could be applied to each of the proposed SCU locations to determine the limits of extraction.
  - The scale of the likely loss of beach and dune resulting from extraction of higher volumes at any of the designed SCU sites could be modelled to inform decision-making on sensible extraction rates.
  - Impacts to the shoreline should be carefully monitored to inform future management decisions on volumes available for extraction.
- Extending the pipeline to Largs North:
  - Portion C: Seafield St SCU: 15,000m^3/year

Regulatory feasibility

Development Approval

Portion A of the Sand Pumping System was assessed and approved as a Crown development application. Should the pipeline alignment be altered, approval to vary the development application would be required.

Portion B requires development approval prior to construction. It may be possible to seek a variation to the Portion A development application. Alternatively, Portion B may require a Crown development or Impact Assessed Development application.

Portion C proposed herein requires full design, including geotechnical investigations, ecological assessments, and community consultation, prior to seeking development approval via the Crown development or Impact Assessed Development pathway.

Operational feasibility

The operational program to backpass 90,000m^3 of sand to West Beach per annum was estimated from the production rate of the operational Southern (Cell 1) Sand Pumping System. This included consideration of downtime due to mobilisation and demobilisation between SCU locations and allowance for circumstantial downtime (e.g. inclement weather, mechanical breakdown).

- Assuming the same operating window (8.5 hours on weekdays only and no public holiday or school holiday operations), the program would need to run for 8-9 months.

Indicative Timeframes and Costs

The estimated costs and timeframes required to design, obtain approvals, construct and operate a fit-for-purpose Sand Pumping System capable of backpassing 90,000m^3 per annum to West Beach are summarised below.

	Design, Planning & Approvals		**Construction**		**Time to functioning SPS**	**Indicative Cost**
	Timeframe	*Cost*	*Timeframe*	*Cost*		
Cell 3	8 months	$1M	-	-	**3.5 – 4 years***	**$71 M**
Portion A	8 months	$440K	18 months	$45.5 M		
Portion B	18 months – 2 years	$800K– $1.1M		$9 M		
Portion C	18 months – 2 years	$1.4M– $1.8M		$12 M		

Operation & Maintenance	
Timeframe	**Cost**
20-year program	$70 M – $77 M

**Note – Timeframes required for procurement, internal governance, government decision-making, or contingency for unforeseen circumstances are not included.*

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1. Introduction

1.1 Background

The independent Adelaide Beach Management Review (ABMR or 'the Review') was an election commitment to review sand management practices employed on Adelaide's beaches by the incoming South Australian Government in 2022. The Department for Environment and Water (DEW) were tasked with administering the Review.

An Independent Advisory Panel (the Panel) was appointed to oversee a process for the identification of sustainable sand management approaches on Adelaide's beaches that could achieve the following three goals: maintain sandy beaches, minimise community disruption, and avoid environmental harm.

The process involved a desktop scientific review of Adelaide beach management by independent firm Bluecoast Consulting Engineers, and a program of community consultation facilitated by independent engagement specialists URPS.

The Panel considered the outcomes of this work and made two recommendations, documented in the ***ABMR Independent Advisory Panel Report***:

1. **Restore West Beach with external sand within 5 years**
2. **Recycle sand between northern beaches and West Beach**

For Recommendation 2, the Panel recommended that the Government:

> *"Investigate the feasibility of dredging nearshore or nearby sand deposits as a long-term, sustainable method to deliver sand recycling. This should include verifying the availability of suitable sand in the littoral zone, as well as the operational viability and constraints for environmental approvals.*
> - *If viable, assess against the sand recycling pipeline option to determine the best long-term, sustainable sand recycling option.*
> - *If not viable, seek relevant approvals to implement the sand recycling pipeline."*

DEW was tasked with implementing the recommended actions, including reviewing the design of the previously approved sand pumping pipeline and assessing the feasibility of the design in the context of the Panel's recommendation for long-term recycling of sand within the system to maintain a sustainable sand buffer.

1.2 Objectives and approach

DEW is reviewing the '*Securing the Future of Our Coastline Sand Pumping System Project*' (Sand Pumping System) as a sand management option along Adelaide's metropolitan coastline.

The approved Sand Pumping System (Application ID: 252/V156/21, Approved date: 17 February 2022) comprises an underground sand pumping system and associated infrastructure along the Adelaide beachfront, from Semaphore South to West Beach.

DEW engaged Hatch to: -

1. Review the existing design of the Sand Pumping System, identify information and assumptions that underpinned the design, and confirm the status of the design and development approval.

2. Review relevant new information, in particular data from more recent sand source investigations and coastal process monitoring, to verify sand characteristics and sustainable extraction volumes in the vicinity of proposed sand collection units.

3. Assess the capability of the designed sand pumping system to achieve ABMR Panel Recommendation 2 (recycle 90,000 m^3 per annum to West Beach from northern beaches) and outline any changes required to achieve this.

4. Consider implications of any changes on regulatory and operational feasibility, and outline timeframes and additional costs that may be incurred.

To support the Sand Pumping System feasibility assessment, HATCH undertook: -

- A review of all available design reports, drawings and supporting documentation that was able to be provided by DEW.

- Interviews and data collation from key stakeholders:
    - McConnell Dowell (MCD) - Sand Pumping System contractor and current operator of the southern Sand Pumping System (Cell 1: Kingston Park–Glenelg)
    - Tonkin - Sand Pumping System design engineers
    - JBS&G - supported Sand Pumping System approvals and specialist investigations
    - DEW Coast Unit - existing and former staff where possible

- Review of sediment sampling data, sediment budgets and transport rates.

2. Sand Pumping System Design

2.1 Overview

The approved Sand Pumping System was from Semaphore South to West Beach. The design of the Sand Pumping System, however, included an extended northern section from Largs Bay to Semaphore South.

For the purpose of this feasibility assessment, the design of both portions of the pipeline will be considered. The Sand Pumping System design was separated into two portions (Portion A and B):

Portion A (approved portion) - sand transfer pipeline from Semaphore South breakwater located adjacent Bower Road to the existing transfer system at West Beach dunes (Cell 3). This includes all associated infrastructure (pumping stations, sand collection units, sand discharge outlets, seawater intakes and control system integration between the existing Cell 3 and the new proposed system).

Portion B - sand transfer pipeline and associated pumping system to extend the approved Semaphore South breakwater collection location pipeline (Portion A) to the north, with two additional sand collection locations north of Semaphore jetty (Hall St) and Largs Bay jetty (Everard St).

Figure 1 shows the extent of Portion A, B and the existing pipeline at West Beach (Cell 3), the proposed sand collection units, pumping stations, discharge locations and water intake locations. For both Portion A and B, 100% detailed design documentation including instrumentation was prepared, with supporting references for the design summarised in Appendix A.

Figure 1: Location of Sand Pumping Pipeline (Portion A + B) and the existing pipeline (Cell 3)

2.2 Design assumptions

The following assumptions were built into the original Sand Pumping System design and operation philosophy:

2.2.1 Capacity

The design specification for the Sand Pumping System between Semaphore South Breakwater and Torrens Outlet (Portion A) included capability to operate continuously for up to 5 months per annum with the following volume capacities:

- **Average Annual Volume** 100,000 m^3/year
- **Peak Annual Volume** 150,000 m^3/year
- **Peak Monthly Volume** 30,000 m^3/year

The peak monthly volume of 30,000 m^3 equates to a sand throughput rate of 200 m^3/hour based on a 5 day working week and 8 hours of operation per day, with a small allowance for lower productivity.

2.2.2 Alignment

The proposed alignment of Portion A and B is described in Section 2 of the 100% Design Report (20C539-DP00-00-GEN-DER-0002) and shown in Figure 1.

When the Sand Pumping System was approved, the 1.3km section of the pipeline between Third Avenue, Semaphore Park and Wara Wayingga-Tennyson Dunes Conservation Reserve was intended to be constructed under the then-proposed Stage 1 Coast Park Path. Stage 1 of the Coast Park Path has now been constructed, providing an opportunity for the alignment of this section of pipeline to be reconsidered. Considerations including works, costs and timeframes required to resolve the alignment is outlined in Section 4.3.

2.2.3 Sand parameters

The Sand Pumping System will need to transport both in-situ sand from collection locations and imported sand sourced from various land-based quarries. The design assumed an average D50 range of 0.25–0.5mm, though the system was designed for to accommodate a broader range of grain sizes (see DEW 2019 - Sand Suitability Investigation Findings Report).

2.2.4 Sea level rise (SLR)

In accordance with SA Coast Protection Board Policy, sea level rise equating to +0.5m to 2070 was to be incorporated in the design of the SOC SPS.

2.2.5 Asset design life

Asset life-cycle requirements were adopted from the Principal's Project Requirements as follows:

Concrete structure (in ground)	50 years
Underground pipework	25 years
Electrical reticulation	25 years
Above Ground Structures	50 years
Instrumentation and Control	10 years
Mechanical Pipework (PU lined steel)	50 years
Slurry pipeline (HDPE)	25 years
Mechanical Equipment	25 years
Rotating and wearing parts	10 years

2.2.6 Sand collection

2.2.6.1 Method

In-situ sand shall be collected from the beach into stockpiles using a land plane and subsequently transferred to the mobile sand collection unit (SCU). This method is consistent with the existing operating techniques employed for the southern pipeline (Cell 1) sand collection operations (Kingston Park–Glenelg).

Sand collected from the beach is mixed with seawater to create a sand slurry. Seawater is also used to assist with flushing the pipeline.

The sand harvesting area is operationally limited to approximately 300m either side of each sand collection site, to optimise sand pumping efficiencies.

Two SCUs may be run concurrently on the provision that they are independent, i.e. sections of the pipeline are isolated. For example, it would be possible to have an SCU at Semaphore Breakwater discharging at Torrens Outlet at the same time as an SCU at Torrens Outlet discharging at West Beach; it is not possible to discharge from two SCUs to one common section of the pipeline.

2.2.6.2 Volumes and SCU locations

The following volumes of sand to be transferred through each section of the SOC SPS were provided to the pipeline designers:

- Largs Bay to Semaphore - 30,000m^3
- Semaphore to Bower Rd Breakwater - 20,000m^3
- Bower Rd Breakwater to Grange - 50,000m^3

While two sand collection points were included in the design of *Portion A,* only one sand collection unit at Semaphore Breakwater remained in the development approved design (the Terminus St collection point was removed).

Two sand collection points are proposed in *Portion B* - one north of Semaphore jetty and one north of Largs Bay jetty.

2.2.6.4 Sand buffer consideration

The Adelaide Living Beaches (ALB) Strategy outlines the requirement to maintain a sand buffer of up to 80m^3 of sand per lineal metre of beach above the +1.0m AHD contour – the equivalent of approximately two 1-in-100-year Average Recurrence Interval (ARI) storm events.

The volume of the sand buffer is measured seaward from the edge of roads, carparks or other public infrastructure, or seaward from the property boundary where private properties are at the coast.

An assessment of the erosion buffer volume available for the pipeline alignment was undertaken and is detailed in a technical memo (Ref: 20C539-DP01-00-PIP-MEM-0003). Where the pipeline has been located within the beach to avoid Tennyson Dunes, DEW advised that the depth of cover should be equivalent to -1m below the lowest recorded beach level as shown in the beach profile survey data.

2.2.7 Sand discharge

Design of sand discharge was required to meet the following objectives:

- Minimise scour of adjacent dune buffer
- Maximise even dispersion, i.e. maintain a wide distribution of sand across the beach
- Minimise turbidity in the receiving water
- Maintain public safety, in conjunction with an operational management plan.

Sand discharge locations are:

- Mirani Court, West Lakes
- Moredun St, Tennyson
- Terminus St, Grange
- Adjacent toilet blocks, Henley Beach South
- Lexington Rd, Henley Beach
- Rockingham Dune, West Beach proposed within the existing pipeline.

2.2.8 Pump stations

Design of pump stations was required to meet the following objectives:

- Pumps must be able to pump seawater to flush sand from the pipeline.
- Pump stations must be accessible for operation and maintenance activities, including removal of pumps and fittings offsite for regular maintenance, overhaul or replacement.
- Pump stations must be watertight to prevent ingress of groundwater or stormwater.
- All pump stations (main and booster) shall be permanent structures and should be designed to minimise impact on visual amenity.
- Each pump station must be equipped with a drainage sump and two sump pumps in case of flooding.

Locations of pump stations are:

- Bower Rd, Semaphore
- Mirani Court, West Lakes
- Moredun St, Tennyson
- Terminus St, Grange
- Adjacent toilet blocks, Henley Beach South.

2.2.9 Electrical and Water Supply Requirements

Each of the pump stations requires connection to the SA Power Networks (SAPN) high voltage transmission network.

One permanent underground seawater supply pipeline and associated pumping infrastructure to deliver water to SCUs is required. One water intake was included in the design, located upstream of the West Lakes control gates at Trimmer Parade.

2.2.10 Pipeline material

The pipeline material is proposed to be High-Density-Polyethylene (HDPE). This is the most commonly used pipe material in slurry-based applications due to its durability in harsh environments and high pressure applications. It is acknowledged that HDPE does experience erosion in slurry applications due to friction between the pipe wall and the passing sand particles. To quantify the potential discharge of pipeline particles into the marine environment, an assessment was undertaken (Doc ref: 0C539-DP01-00-PIP-MEM-0002). The assessment found an estimated 9.2cm^3 of HDPE eroded per 1 m^3 of sand pumped, or 0.00092% of HDPE by volume of sand pumped.

2.2.11 Other factors

Further detail on other requirements and considerations (e.g. work health and safety requirements, safety in design, coastal vegetation and corrosion control requirements) are captured in the Basis of Design and Design Reports (20C539-DP00-00-GEN-DBR-0001 and 20C539-DP00-00-GEN-DER-0002).

2.3 Existing pipeline: Cell 3 (West Beach)

The Sand Pumping System is required to be connected to the existing sand pumping pipeline (Cell 3) at Burbridge Rd, West Beach. The discharge location and sand collection zone are shown in Figure 2.

Construction of this 2.2km section of the sand pumping pipeline was completed around January 2013. The pipeline was operational between 2013 and 2016, typically from May–September, and backpassed volumes between 30,000m^3 – 70,000m^3. Works required for this section of pipeline is to be reinstated are summarised in Section 0.

The Cell 3 pipe infrastructure is halfway through its functional design life, and components such as Instrumentation and Control have reached the end of their functional design life (as per Section 0).

Figure 2: Existing sand pumping pipeline - Cell 3 (West Beach)

2.4 Development application (Portion A)

The approved Sand Pumping System (Portion A) was described as 'essential infrastructure' and lodged, assessed and approved as a Crown development under the provisions of Section 131 of the *Planning, Development and Infrastructure Act 2016* (PDI Act).

An extension to the Development Approval (DA) was sought and granted in February 2024. The approved extension requires commencement of pipeline construction by 17 February 2026 and completion by 17 February 2028.

As outlined in Section 0.2, a 1.3 km portion of the pipeline is located under the now constructed Stage 1 Coast Park Path. Subsequently, if the alignment of this section of the pipeline was to shift (either landward into the dunes or seaward towards the beach), a variation to the existing DA would be required. This would entail additional environmental assessments and community consultation (see Section 4.2). If Stage 1 Coast Park Path was to be removed and reinstated once the pipeline was installed, a variation of the DA is unlikely to be required.

3. Sand source suitability

The assessment of sand source suitability involves consideration of two key components:

1. **Sand characterisation** (i.e. composition and properties of the sand) at the proposed SCU locations is consistent with Bluecoast's (2024) *Draft Suitability Criteria for Sand Sources to Nourish West Beach* (see Table 7, Appendix B).

2. **Sand volumes** are sufficient at the SCU locations to enable sustainable annual extraction for a 20-year asset lifecycle. This requires consideration of operational constraints (e.g., sand collection is limited to 300m either side of the SCU) and recovery rates (e.g., sediment transport processes specific to collection areas).

3.1 Sand characterisation

The following datasets were reviewed to assess the suitability of the sand in the vicinity of the proposed SCU locations:

- *Sand suitability investigations: Semaphore and Largs Bay. May 2019. Prepared by DEW.*
- *Metro coastal sand sampling. March 2022. Prepared for DEW by Environmental Projects.*

The characterisation of sand further north of Largs Jetty (Portion B) has also been considered given the recommendation from the *Impact Assessment of Moving Sand from Adelaide's Northern Beaches* (Salients and Coastal Environment, July 2021) to extend the pipeline beyond Largs Jetty, as far north as possible.

Table 8 and Figure 3 (Appendix B) provide a summary of the March 2022 sampling results against the Sand Suitability Criteria. The 2019 results are summarised here: Sand_suitability_investigation - Semaphore-Largs_Bay_findings_report.

Both the 2019 and 2022 sand sampling programs focused on the analysis of D50 and carbonate content only. The results show the sand in the vicinity of the proposed SCUs and north of Largs jetty is suitable under the beneficial reuse criteria for D50 and carbonate content (i.e. suitable for placement at West Beach). The results also show the sand samples adjacent to and northward of Strathfield Tce (Largs North/Taperoo) have a higher carbonate content and subsequently do not meet the criteria for beneficial reuse.

In line with EPA Dredging Guidelines and to support the approval process, sampling at these locations have been undertaken (JBS&G, April 2025) to confirm contaminants, results found no exceedances against relevant criteria.

3.2 Sand volumes

For the consideration of sand volumes, historical cross-shore beach survey profiles (provided by DEW) have been used to analyse sand volumes and assess trends in response to historical sand extraction and nourishment records. The following analysis has been undertaken to understand sand volumes available at the proposed SCU locations:

1. Based on the design assumption (outlined in Section 0) that a sand buffer is required to be maintained up to 80m^3 per lineal metre of beach above the +1.0m AHD contour, available sand volumes within 300m either side (600m total) of the proposed SCUs has been calculated.
    - This does not account for downdrift impacts and assumes the beach could recede (i.e. accept the beach does not remain stable, accept potential for loss of dune and vegetation), and does not consider how the beach would recover. This calculation was undertaken to understand the availability of sand, irrespective of the beach's ability to recover.

2. Estimates for **sustainable extraction volumes** in the vicinity of the proposed SCUs represent the amount of sand that could be removed without leading to long-term erosion, calculated by examining impacts from historical sand extraction records (where available) against cross-shore profile data from areas near the SCUs.

Existing volumes and sustainable extraction volumes for the proposed SCUs are presented in Table 1.

Estimated sustainable extraction volumes have been defined for the purpose of this investigation as the volume that can be taken annually for the beach to remain stable. Further detail on the method, results and limitations of the analysis are presented in Appendix C.

Whilst the Terminus St (Grange) SCU in Portion A was removed from the original pipeline design, estimates of available sand and sustainable extraction rates have been included for completeness.

Similarly, whilst the existing pipeline in Cell 3 is not currently operational, analysis of available sand and sustainable extraction rates has been included for the SCU located at Torrens Outlet. It is noted that any extraction of sand within Cell 3 would need to consider broader management requirements for the Torrens Outlet.

Finally, given the recommendation from Salients and Coastal Environment (2021) to extend the pipeline as far north as possible beyond Largs Bay jetty, an extension to just south of Strathfield Tce (referred to as 'Portion C' - Seafield St SCU) has been added to enable assessment of available sand and potential sustainable extraction rates.

Table 1: Existing and estimated annual extraction volumes at proposed SCU locations

	SCU Location	Existing volume* (m^3)	Estimated sustainable annual extraction (m^3)
Portion A	**Semaphore Breakwater**	120,000	40,000
	Terminus St	150,000	5,000
Portion B	**Everard St**	150,000	15,000
	Hall St	140,000	5,000
Portion C	**Seafield St**	215,000	15,000**
Cell 3	**Torrens Outlet**	130,000	15,000**

** Within 600m (300 m either side) from 1m AHD to 80m^3/m buffer from nearest asset, calculated from Dec '23-Jan '24 survey.*
***Up to 30,000m^3 of sand could be extracted (accepting some recession in these areas)*

4. SOC SPS feasibility assessment

4.1 Technical feasibility

Review of the Sand Pumping System design, design assumptions, existing approvals and sand source suitability has informed the following statements regarding the technical feasibility of the designed (Portion A+B) and DA-approved (Portion A only) Sand Pumping System: -

- The original design objective of the Sand Pumping System was to transport an average of 100,000m^3 per annum (150,000m^3 per annum peak) of sand via the pipeline to West Beach.

- 100% design documentation was undertaken for two portions:
  - Portion A – Existing Cell 3 (West Beach dunes) to Semaphore South breakwater.
  - Portion B – Semaphore South Breakwater to just north of Largs Bay Jetty.

- The original design philosophy assumed the following extraction rates across four locations:
  - Portion A: 50,000m^3/year from SCUs at Semaphore Breakwater and at Terminus St, Grange.
  - Portion B: 50,000m^3/year from SCUs at Hall St, Semaphore and Everard St, Largs Bay.

- Development approval applies to the design of Portion A only. Note - the Terminus St SCU was not included in the approved design.

- Review of 2022 data on particle size distribution (D50) and carbonate content of sand in the vicinity of the SCUs meets the draft Sand Suitability Criteria for beneficial reuse.

- In line with EPA Dredging Guidelines and to support the approval process, sampling was undertaken (JBS&G, April 2025) to confirm potential contaminants, results found no exceedances against relevant criteria.

- Assuming a stable shoreline position and no downdrift impacts, the volume of sand available for sustainable extraction is calculated to be 60,000m^3 per year, comprising:
  - Portion A: 40,000m^3 from Semaphore Breakwater
  - Portion B: 5,000m^3 from Hall St, Semaphore plus 15,000m^3 from Everard St, Largs Bay

- The ABMR Panel Recommendation 2 advocates 90,000m^3/year is backpassed to West Beach. Therefore, it is not technically feasible to sustainably backpass this volume with Portion A and Portion B of the 100% designed Sand Pumping System.

- To reach the required maintenance volume for West Beach by backpassing of 90,000m^3/year:

  a) The existing pipeline at Cell 3 would need to be reinstated (Torrens Outlet SCU).
     → For Cell 3, extraction of 15,000m^3/y is sustainable and up to 30,000 m^3/y may be possible.

  b) The pipeline would need to be extended (Portion C: Seafield St, Largs North).
     → For Portion C, extraction of 15,000 m^3/y is sustainable and up to 30,000 m^3/y may be possible if some recession of the shoreline in this area was considered acceptable.

4.2 Regulatory feasibility

Given Portion A of the Sand Pumping System was assessed and approved as a Crown development application, based on current information, Portion B and C could follow the same approval pathway with a new Crown development application prepared and submitted under the provisions of Section 131 of the PDI Act. This approval pathway would allow commencement of construction of Portion A whilst the design, consultation and development application processes for Portions B and C are underway.

Portion B and C may be classified or declared as 'Impact Assessed Development' under Section 108 (1)(b) and(c) of the PDI Act. This would require the preparation of an Environmental Impact Statement (EIS), subsequently increasing the time and cost required to obtain required approvals prior to construction.

4.3 Additional work

4.3.1 Planning and approvals

This section summarises additional work required in terms of planning and approvals (e.g. further investigations, design, engagement, and/or approvals) for a fit-for-purpose sand pumping system to be ready for construction. Where possible, opportunities for efficiencies have been identified.
Table 2 provides a high-level summary of the tasks, timing and costs for each portion of the pipeline to be ready for construction. Note - Construction timeframes are outlined in Section 4.3.2.

Table 2: Summary of tasks, estimated timeframes and costs

	Tasks	Time per Task	Total Timeframe*	Cost
Cell 3	Maintenance & repair of existing infrastructure	8 months	8 months	$1M
Portion A	Design: Confirm alignment; *if changed:* *- Ecological Assessment; Engagement* *- DA variation* Contractor repricing	4 months 4 months 2 months 2 months	10 months	$440K
Portion B	Design: Reissue documentation Contractor repricing DA – Crown or Impact Assessed	10 months 2 months 12 or 18 months	18 months – 2 years	$800K - $1.1M
Portion C	Design Contractor pricing DA – Crown or Impact Assessed	10 months 2 months 12 or 18 months	18 months – 2 years	$1.4M - $1.8M
Portions A+B	Design Contractor repricing DA – Crown or Impact Assessed	10 months 2 months 12 or 18 months	18 months – 2 years	$1.1M - $1.4M
Portions A+B+C	Design Contractor pricing DA – Crown or Impact Assessed	12 months 2 months 12 or 18 months	2 – 3 years	$1.8M - $2.4M

**Takes into consideration dependencies of tasks as advised by MCD/Tonkins/JBS&G.*

4.3.1.1 Existing Pipeline (Cell 3)

MCD advised the following works are required for the existing Cell 3 pipeline to become operational, i.e. to enable the SCU to receive sand and the pipeline to discharge sand to West Beach: -

1. Resolve integrity issues at Discharge Station 1 due to seawall subsidence – either remove seawall or repair and reinstate. Costs assumes removal of seawall and repair would incur additional cost.

2. Excavate the SCU connection points. Note - the area has had Hooded Plovers nesting.

3. Dredge the Seawater Pump Station intake zone to remove decayed wrack and silt and allow pump operation.

4. Pump Station Instrumentation and Control assets have reached expected service life (>10 yrs) – consider replacement.

It is estimated that the above works would take **8 months** and would cost in the order of **$1M.**

4.3.1.2 Portion A

Table 3 provides a summary of tasks and an estimate of time and costs for Portion A of the pipeline to be ready for construction.

Accounting for dependant tasks and where tasks can be undertaken in parallel, the total planning and approvals time for this portion of the pipeline to be ready for construction is estimated to be **10 months** and would cost approximately **$440K.**

The following assumptions and exclusions apply:

- It is assumed that a variation to the existing DA will be required due to a change in the alignment of the pipeline. Should the pipeline alignment remain, and the Coast Park Path be removed and reinstated after pipeline installation, no DA variation is required.
- It is assumed that the Terminus St (Grange) SCU will not be reinstated.
- Resources required by the South Australian Government for project management and contract management (i.e. internal costs).
- Timeframes associated with internal processes including procurement have not been factored in.

Table 3: Summary of planning and approvals tasks (Portion A)

Scope	Description
Confirm alignment under Coast Park Path Stage 1 **Timing:** 4 months **Cost**: $100K	• Site visit to consider alternative alignment options • Modelling to confirm alignment (if substantial vertical alignment change) • Options analysis outlining impacts to hydraulics, constructability • Develop concept plans showing Options (under path, in dunes, on beach) with trade-offs (e.g. digging up new path, removing dune vegetation) • Procure survey for alternative alignment (only if in-dune alignment required) • Update Design and Modelling Reports • Detailed design drawings (70/100/IFA/IFC)
Coast Park Path Stage 2 **Timing:** 3 months **Cost**: $100K	• Liaise with Coast Park Path Stage 2 project team • Update pipeline configuration and pump station, update drawings • Detailed design of Coast Park Path Stage 2 (30/IFA/IFC) • Detailed Design drawings of pipeline/pump station (IFA/IFC)
If alignment is changed*	
Ecological assessment **Timing:** 1 month **Cost**: $20K	• Assess impact to flora and fauna for 1.3 km section through Tennyson Dunes
Engagement **Timing:** 3 months **Cost**: $40K	• Fact sheet, letterbox distribution, community engagement, report to accompany DA
Contractor reprice **Timing:** 2 months **Cost**: $120K	• Reprice pipeline construction costs based on current market rates
DA variation **Timing:** 2 months **Cost**: $60K	• Amend DA with ecological impact assessment and updated impact zones • Submit DA to PlanSA, respond to Request for Information (RFIs) and submissions, SCAP hearing (if required)

4.3.1.3 Portion B

Table 4 shows the time and cost for planning and approvals of this portion of the pipeline, and is dependent on the specific approvals pathway. Both approvals pathways are presented.

The following cost exclusions apply:

- For the Impact Assessed Development approvals pathway, the fees associated with lodgement, assessment, public notification of the EIS and any publication fees of the EIS documentation are excluded.
- Resources required by the South Australian Government for project management and contract management (i.e. internal costs).
- Timeframes associated with internal processes including procurement have not been factored in.

Table 4: Summary of planning and approvals tasks (Portion B)

Scope	Description
Design: Reissue documentation **Timing:** 1 month **Cost**: $100K	• Reissue documentation for variation of discharge location (D18). • Detailed design 100/IFC
Contractor reprice **Timing:** 2 months **Cost**: $120K	• Reprice pipeline construction costs based on current market rates

Approvals Pathway Option 1: Crown Development Application
Timing: 12 months
Cost: $580K
	• Commission specialist assessments for:
	  ○ Marine Ecology
	  ○ EPBC self-assessment
	  ○ Terrestrial ecology
	  ○ Arborist report
	  ○ Nosie and vibration
	  ○ Traffic
	  ○ Aboriginal and European heritage
	  ○ Landscape concept design
	  ○ Downdrift impacts and volumetric analysis
	• Undertake communication and engagement
	• Prepare Environment and Heritage Impact Assessment Report
	• Prepare and submit Development Application
	• Respond to RFIs, submissions, SCAP hearing (if required)

Approvals Pathway Option 2: Impact Assessed Development
Timing: 18 months
Cost: $880K
	• Apply for Impact Assessed Development (gazettal letter, DA12)
	• EPBC Act Self Assessment, EPBC Act Referral if required
	• Preliminary site investigation
	• Commission specialist assessments for:
	  ○ Terrestrial Ecology
	  ○ Arborist Report
	  ○ Landscape Concept Design
	• Prepare and submit Environmental Impact Statement
	• Respond to regulator feedback (if required)

4.3.1.4 Portion C

Table 5 shows that the time and cost for planning and approvals of this portion of the pipeline is dependent on the specific approvals pathway. Both approvals pathways are presented.

The following cost exclusions apply:

- For the Impact Assessed Development approvals pathway, fees associated with lodgement, assessment, public notification of EIS and publication fees are excluded.
- Resources required by the South Australian Government for project management and contract management (i.e. internal costs)
- Timeframes associated with internal processes including procurement have not been factored in.

Table 5: Summary of planning and approvals tasks (Portion C)

Scope	Description
Design for construction **Timing:** 10 months **Cost**: $770K	• Site visit to understand potential alignments and pump station siting • Physical investigations (survey and geotechnical) • Concept design of Pipeline (including modelling), Pump stations, SCU compound and services, Water Intake (including modelling) • Community engagement • Detailed design of approved concept (including IDC) • Concept design plans • Detailed design packages - 30/70/100/IFA/IFC
Contractor pricing **Timing:** 2 months **Cost**: $120K	• Price pipeline construction costs based on current market rates

Approvals Pathway Option 1: Crown Development Application
Timing: 12 months
Cost: $450K
	• Commission specialist assessments for:
	  ○ Marine Ecology
	  ○ EPBC self-assessment
	  ○ Terrestrial ecology
	  ○ Arborist report
	  ○ Nosie and vibration
	  ○ Traffic
	  ○ Aboriginal and European heritage
	  ○ Landscape concept design
	  ○ Downdrift impacts and volumetric analysis
	• Undertake communication and engagement
	• Prepare Environment and Heritage Impact Assessment Report
	• Prepare and submit Development Application
	• Respond to RFIs, submissions, SCAP hearing (if required)

Approvals Pathway Option 2: Impact Assessed Development
Timing: 18 months
Cost: $880K
	• Application of impact assessed development (gazettal letter; DA12)
	• EPBC Act Self Assessment, EPBC Act Referral if required
	• Commission specialist assessments for:
	  ○ Marine Ecology
	  ○ Terrestrial ecology
	  ○ Arborist report
	  ○ Nosie and vibration
	  ○ Traffic
	  ○ Aboriginal and European Heritage
	  ○ Landscape Concept Design
	  ○ Downdrift impacts and volumetric analysis
	• Prepare and submit Environmental Impact Statement
	• Respond to regulator feedback (if required)

4.3.2 Construction and operational costs

This section outlines estimated costs and timeframes required for construction of a fit-for-purpose sand pumping system, as well as operational costs and work program timeframes once functioning. Opportunities for efficiencies – such as construction of multiple portions concurrently and purchase of multiple SCUs – have also been identified.

Indicative construction and operational costs are summarised in Table 6.

Table 6: Indicative costs for construction and annual operation & maintenance

	Construction	Maintain/Repair	Operation
Cell 3	-	$1M	$2.6M* to $2.9M**
Portion A	$45.5M	-	
Portion B	$9M	-	
Portion C	$12M	-	
TOTAL COST	**$67.5M**	**$1M**	**$70M to $77M**
Indicative capital + operational cost of backpassing 90,000m^3 per annum via pipeline for 20 years = $137.6M - $144.9M			

**$29/m^3 for handling and disposal of standard sand screenings*
***$32/m^3 for hazardous waste (e.g. asbestos)*

Note - Operational costs represent a 20-year program of backpassing a volume of 90,000m^3, accounting for a rate of 3% inflation; the costs of further design, investigations and consultation required for planning and approvals are additional.

Construction costs have been based on the following information and assumptions: -

- The construction cost estimates for Portion A and B present the revised scope and escalated construction costs prepared by Rider Levett Bucknall in October 2024 against the base 2021 cost prepared by the contractor.
- Should the government elect to construct a pipeline (whichever portion/s), the contractor will need to re-price and this will be subject to market rates at the time of construction contract negotiations.
- The costs in Table 6 represent construction costs only – the costs of investigations and consultation required to support planning or approval are set out in Section 4.3.1.
- The cost for construction of Portion A assumes the original design alignment, therefore requiring Coast Path Park (Stage 1) to be removed and reinstated. As such, the cost of removing and reinstating Coast Park is included.
- The cost of a re-designed extended pipeline is difficult to estimate. MCD have provided a high-level estimate for Portion C, where the following assumptions apply:
  - Ground conditions (e.g. geotechnical, groundwater) are similar to Portion B.
  - One single pump station is included within the extension (Portion C).
  - An additional water intake structure (equivalent to the Trimmer Parade pump station) is required. The location of this is assumed to be North Haven.
  - All pipework is located in the road reserve, except for the section adjacent to the water intake.
  - A provisional sum for SAPN works is based on previous experience and requires further validation.
- Additional work crews could be engaged to reduce construction timeframes, at additional cost.

Indicative operational costs have been provided by MCD based on current disposal and management costs for the southern pipeline (Cell 1):

- $29 per m^3 – standard handling and disposal of sand screenings
- $32 per m^3 – hazardous waste handling and disposal of sand screenings

MCD noted the high potential for contaminated waste material requiring disposal, such as asbestos.

4.3.3 Construction timeframes

MCD have provided the following timeframes as estimates for construction:

- Portion A only - 12 months
- Portion B only - 8 months
- Portions A+B - 12 months with additional work crews (at additional cost)
- Portions A+B+C - 12 months with additional work crews (at additional cost)
- Portions A+B+C - 18 months without additional work crews, assuming construction of Portion C pump station commences on completion of Portion A pump station

4.3.4 Operational timeframes

An operational program of **8-9 months** is required to transport **90,000m^3** to West Beach per annum. This has been calculated based on:

- An operational window of 8.5 hours on weekdays, with no operations on public holidays, weekends or during school holidays, as per the existing southern pipeline operational program.
- The current production rate of the existing southern pipeline.
- Provisional allowance of:
  - Four weeks to transfer between SCU locations (two weeks per mobilisation + demobilisation)
  - Two weeks downtime per year due to unforeseen circumstances (e.g. inclement weather or mechanical breakdown).

The length of the operational program could be reduced by extending operating hours (longer work days, working over weekends, public holidays and school holidays), and purchasing multiple SCUs to reduce mobilisation and demobilisation downtimes (at an additional cost of approx. $2M per unit).

4.4 Risks, considerations and limitations

Several risks, considerations and limitations have been identified during the feasibility assessment, including: -

Risks

- Urgent engagement with SAPN regarding Portion B and Portion C is recommended to identify any changes required to the grid, and given the long lead time required for transformer procurement.

- Consultation with Planning and Land Services (PLUS) should be progressed as soon as possible to confirm the approval pathway and assessment process. DEW, as the proponent, should seek endorsement of a preferred pathway and commence early consultation with relevant referral bodies.

- As the market currently stands, there is only one locally skilled contractor to operate and maintain the existing and potential future sand pumping systems (MCD). Reliance on a single skilled contractor to presents an operational risk; with potential impacts on maintenance continuity, response time and trained labour required.

Considerations

- Careful consideration should be given to the tolerable setback distance for the sand harvesting areas, where the ALB sand buffer requirement of 80m^3 per linear meter above the +1m AHD contour is reviewed. Appropriate 'triggers' should be defined in consultation with key stakeholders, enabling adaptive management of extraction volumes in these areas.

- The pipeline material, HDPE, is subject to erosion due to friction between the pipe wall and sand slurry. MCD's assessment of the rate of erosion estimated that 9.2cm^3 of HDPE is eroded per 1 m^3 of sand pumped, or 0.00092% of HDPE by volume of sand pumped (Doc ref: 0C539-DP01-00-PIP-MEM-0002). An alternative pipeline construction material could be considered. Elsewhere in Australia, steel has been used for this application. It is assumed that steel would be substantially more expensive due to raw material price, welding requirements, and revised construction methods.

Limitations

- The estimation of sand availability and extraction volume potential was limited by the data available (see Appendix C).
  - Refinement of the sand availability and extraction volume analyses is recommended to improve confidence in the estimates provided here. The following studies would be valuable:
    - Morphodynamic modelling to investigate downdrift effects of sand extraction.
    - 3D bathymetric survey capture and change analyses to assess volumetric changes beyond the extent of the DEW cross-shore profiles.
    - Evaluation of potential sea level rise impacts on sand buffers and sustainable extraction rates.

- For the storage of plant-based equipment associated with the SCU for Portion C of the proposed pipe line the required land to store the equipment and the associated cost has not been captured.

- Two SCUs cannot simultaneously discharge to one portion of the pipeline, but they can operate concurrently if pipeline portions are operating in isolation (e.g. one SCU is discharging at a point north of the other operating SCU).
  - If operating two SCUs concurrently in isolation is desired:
    - Additional water supply infrastructure would be required;
    - The Control philosophy and design would need to be revisited;
    - An additional SCU would need to be procured.
  - The timeframe and cost implications associated with multiple SCUs operating concurrently has not been captured within this feasibility report.

5. References

Bluecoast Consulting Engineers - *Draft Suitability Criteria for Sand Sources to Nourish West Beach*. Prepared for DEW, August 2024.

DEW - *Sand Suitability Investigation – Semaphore and Largs Bay*, May 2019.

Environmental Projects - *Metro coastal sand sampling*. Prepared for DEW, March 2022.

JBS&G - *Sand Pumping System approval options, scope, cost estimates and timing*. Prepared for DEW, March 2025.

Salients and Coastal Environments - *Impact Assessment: Phase 2 of Moving Sand from Adelaide's Northern Beaches*. Prepared for DEW, July 2021.

Tonkins - *Sand Pumping Project Memorandum – Pipe wear volume calculation*. Prepared for Department of Infrastructure and Transport, July 2021.

Tonkins - *Sand Pumping System from Largs Bay to West Beach: Design Basis Report.* Prepared for Department of Infrastructure and Transport, February 2022.

Tonkins - *Sand Pumping System Design Report.* Prepared for Department of Infrastructure and Transport, July 2022.

Appendix A. – Supporting references

Document Number	Rev.	Document Title
20C539-DP00-00-GEN-DBR-0001	A	Design Basis Report
20C539-DP00-00-MCH-SPC-0001	B	Functional Description
ADL2021-0138AC	O	Geotechnical Report
20C539-DP00-00-GEN-REP-0001	C	Climate Change Assessment
20C539-DP01-00-PIP-MEM-0003	A	Coastal Erosion Assessment – Sand Buffer Calculation
20C539-DP01-00-PIP-DER-0001	C	Slurry Pipeline Erosion Report
20C539-DP01-00-PIP-DER-0002	C	Slurry Pipeline Hydraulics Report
20C539-DP01-00-PIP-MEM-0001	C	Hydraulic Transient Analysis
5819-001	-	Sand Transfer Infrastructure – Ventilation Report
200864R003 (20C539-DP00-00-GEN-DER-0001-A)	-	A ECI Stage 1 Concept Design Report
-	-	Summary of Project Delivery Requirements – Securing the Future of Our Coastline Sand Pumping System
20C539-DP04-00-MCH-MEM-0001	C	Sand Collection Unit – Option Study
20C539-DP03-00-GEN-MEM-0001	A	West Lakes Memo
20C539-DP03-00-PIP-MEM-0001 B	B	Water Intake Hydraulics Report
20C539-DP00-00-GEN-RCR-0001	-	IDC Review Comment Register
20C539-DP00-00-GEN-RCR-0002	-	City of Charles Sturt Review Comment Register
20C539-DP00-00-GEN-RCR-0003	-	Port Adelaide Enfield Council Comment Register
20C539-DP00-00-GEN-RCR-0004	-	DIT/DIT Marine Assets Review Comment Register
20C539-DP00-00-GEN-RCR-0005	-	DEW Review Comment Register
20C539-DP03-00-STR-REP-0001	A	A West Lakes Intake Chamber Inspection Report
20C539-DP02-06-ELE-CAL-0001	A	Electrical Demand Calculation Reports

Appendix B. – Sand Suitability Criteria

From Bluecoast Consulting Engineers - Draft Suitability Criteria for Sand Sources to Nourish West Beach. Prepared for DEW, August 2024 (filename P24462_AdelaideBeachNourishmentFeasibility_R1.0).

The criteria for physical sand characterisation outlined below were applied to the assessment of onshore (beach) harvest areas in the existing pipeline (Cell 3), the current design (Portion A+B), and the proposed extension (Portion C) of the sand pumping system.

Table 7: Sand suitability criteria for nourishment of West Beach

Acceptability item	Beach nourishment (ideal)	Beneficial reuse
Median grain size (D50)	D50 = 0.18 to 0.22mm	D50 = 0.14 to 0.30mm
Uniformity coefficient (Cu = D60/D10)	Less than 2.4	Less than 3.0
Fines content (silt and clay)	• **Nearshore placement:** <10% (desirable) • Onshore placement: <5%	Less than 10%
Gravel content	Less than 2%	Less than 5%
Mineralogy	Quartz sand with a carbonate content of less than 25%	
Colour	Only a significant issue if placing onshore	
Contamination	**Nearshore placement:** the 95% upper confidence limit of the mean concentration of all contaminants must be below the screening levels in the 2009 National Assessment Guidelines for Dredging (NAGD).	

Table 8: Sand characterisation against criteria

(Source: Metro coastal sand sampling, Environmental Projects, March 2022)

Parameter		Median grain size D50 (mm)		Fines content (% particles < 0.075 mm)		Gravel content (% particles > 2 mm)		Mineralogy		Uniformity Cu = D60/D10	
Criteria		0.14 < D50 < 0.30		< 10%		< 5%		Quartz sand Carbonate content < 25 %		< 3	
Profile	Sample ID	Value	Criteria met	Value	Criteria met	Value	Criteria met	Value	Criteria met	Value	Criteria met
200001	SB12	0.16	yes	2	yes	0	yes	29	no	2.0	yes
	SB13	0.19	yes	3	yes	4	yes	46	no	2.7	yes
	SB28	0.16	yes	4	yes	1	yes	22	yes	2.2	yes
200002	SB14	0.18	yes	10	yes	0	yes	20	yes	2.7	yes
	SB15	0.27	yes	1	yes	1	yes	11	yes	1.6	yes
	SB16	0.16	yes	1	yes	1	yes	32	no	2.0	yes
200129	SB17	0.21	yes	1	yes	0	yes	12	yes	2.0	yes
	SB18	0.20	yes	3	yes	1	yes	23	yes	2.3	yes
	SB30	0.20	yes	1	yes	3	yes	17	yes	2.1	yes
300m south of 200003	SB11A	0.20	yes	3	yes	0	yes	15	yes	2.0	yes
	SB23	0.22	yes	5	yes	1	yes	10	yes	2.4	yes
	SB24	0.20	yes	4	yes	2	yes	12	yes	2.4	yes
200004	SB09	0.20	yes	8	yes	0	yes	15	yes	2.5	yes
	SB10	0.20	yes	10	yes	1	yes	22	yes	2.8	yes
	SB22	0.19	yes	5	yes	4	yes	19	yes	2.5	yes
200006	SB07	0.21	yes	2	yes	1	yes	23	yes	2.2	yes
	SB08	0.19	yes	7	yes	0	yes	16	yes	2.3	yes
	SB21	0.22	yes	3	yes	1	yes	12	yes	2.5	yes
200007	SB06	0.26	yes	1	yes	0	yes	8.5	yes	1.7	yes
	SB19	0.27	yes	1	yes	2	yes	11	yes	1.9	yes
	SB20	0.20	yes	1	yes	1	yes	12	yes	1.8	yes
200008	SB04	0.25	yes	1	yes	0	yes	8.1	yes	1.6	yes
	SB05	0.27	yes	1	yes	0	yes	7.2	yes	1.7	yes
	SB39	0.24	yes	1	yes	0	yes	6.8	yes	1.7	yes

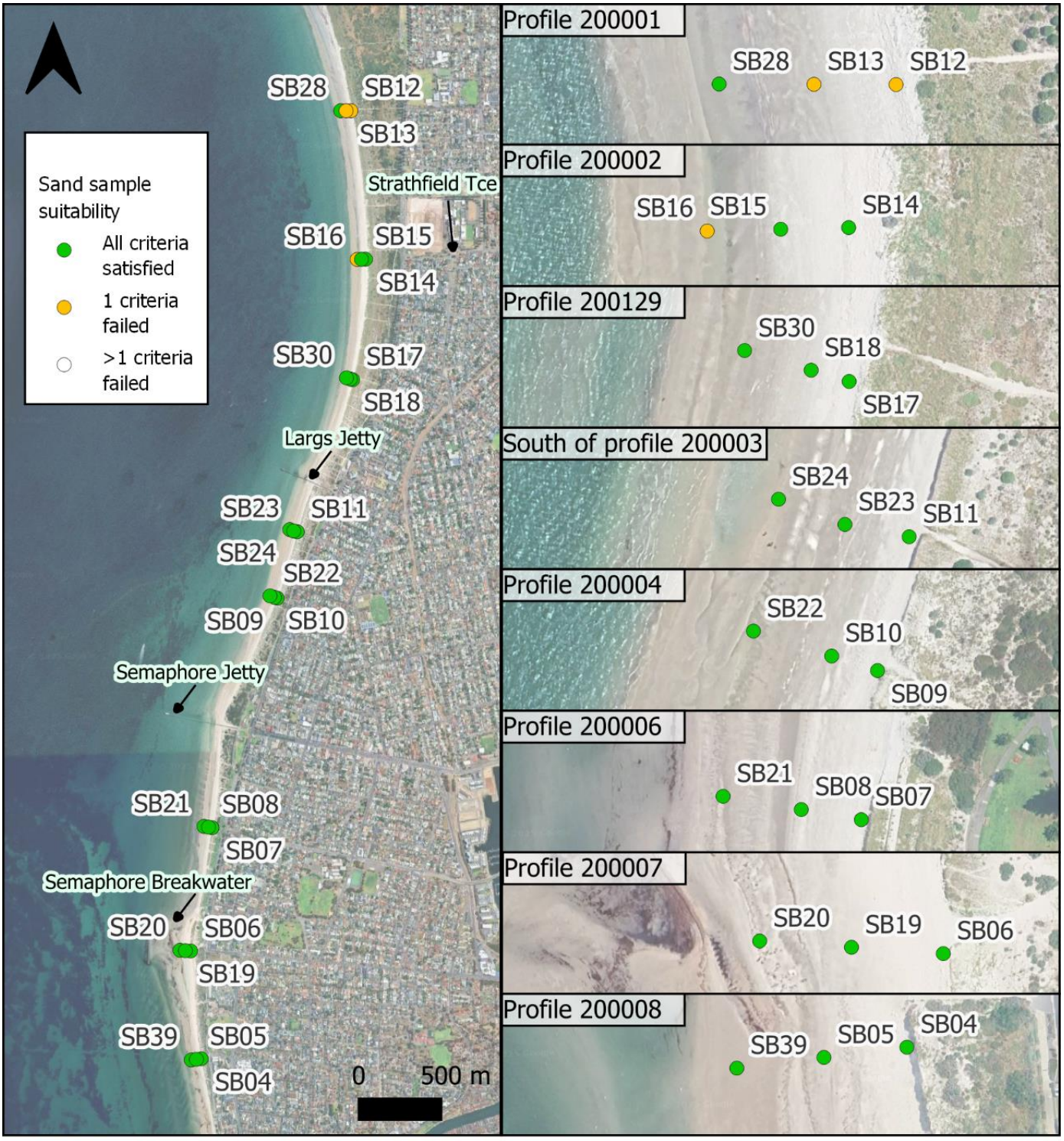

Figure 3: Map of suitable sand based on *Metro coast sediment sampling report* (Environmental Projects 2022)

Appendix C. – Volumetric analysis of beach profiles

C.1 Method considerations

C.1.1 Available sand volumes

To quantify available sand volumes above the +1m AHD contour exceeding 80m³ per lineal m of beach, the following approach was taken:

- Analysing the most recent survey at each cross-shore profile (see list of profiles analysed below).
    - Note that profile 200129 did not have a full landward survey extent in the most recent survey, so it was blended with the previous survey landward of the +2.8m AHD contour.
- The coastal edge of the profile (e.g., the back of the dune) was defined within each profile to ensure that non-sandy survey points were excluded.
- A trapezoidal area calculation was applied to small elevation segments to compute cross-sectional dune areas.
- Available sand volume estimates for extraction locations have been inferred from the associated profiles (listed below).
    - In some cases, this is calculated as the average volume from representative profiles, while in others, judgement has been used to alter this (e.g., at Semaphore Breakwater where it is assumed that sand would not be extracted from the downdrift side).

C.1.2 Sustainable extraction estimates

The estimated sustainable extraction volume at each location represents the amount of sand that can be removed without leading to long-term erosion rates. This estimate was determined through:

- An evaluation of historical extraction impacts on sand volume changes, performed on annual summer survey records dating back to 2008.
- An analysis of accretion/erosion trends within profiles over time.
- A review of satellite-derived shoreline behaviour, identifying broader spatial trends in sand movement.

It is important to note that these estimates are high-level approximations (~±50%), and further studies would be required to refine them and improve accuracy.

C.1.3 Profiles analysed

The following cross-shore profiles were assessed across key locations (see Figure 4):

- Strathfield Tce: Profile 200002
- Everard St: Profile 200003 (extends across Largs Jetty accessway, potentially underestimating available volume), Profile 200129
- Hall St: Profile 200004, Profile 200005
- Semaphore BW: Profile 200006, Profile 200007, Profile 200008
- Terminus St: Profile 200013, Profile 200014, Profile 200015
- Torrens Outlet: Profile 200018, Profile 200019

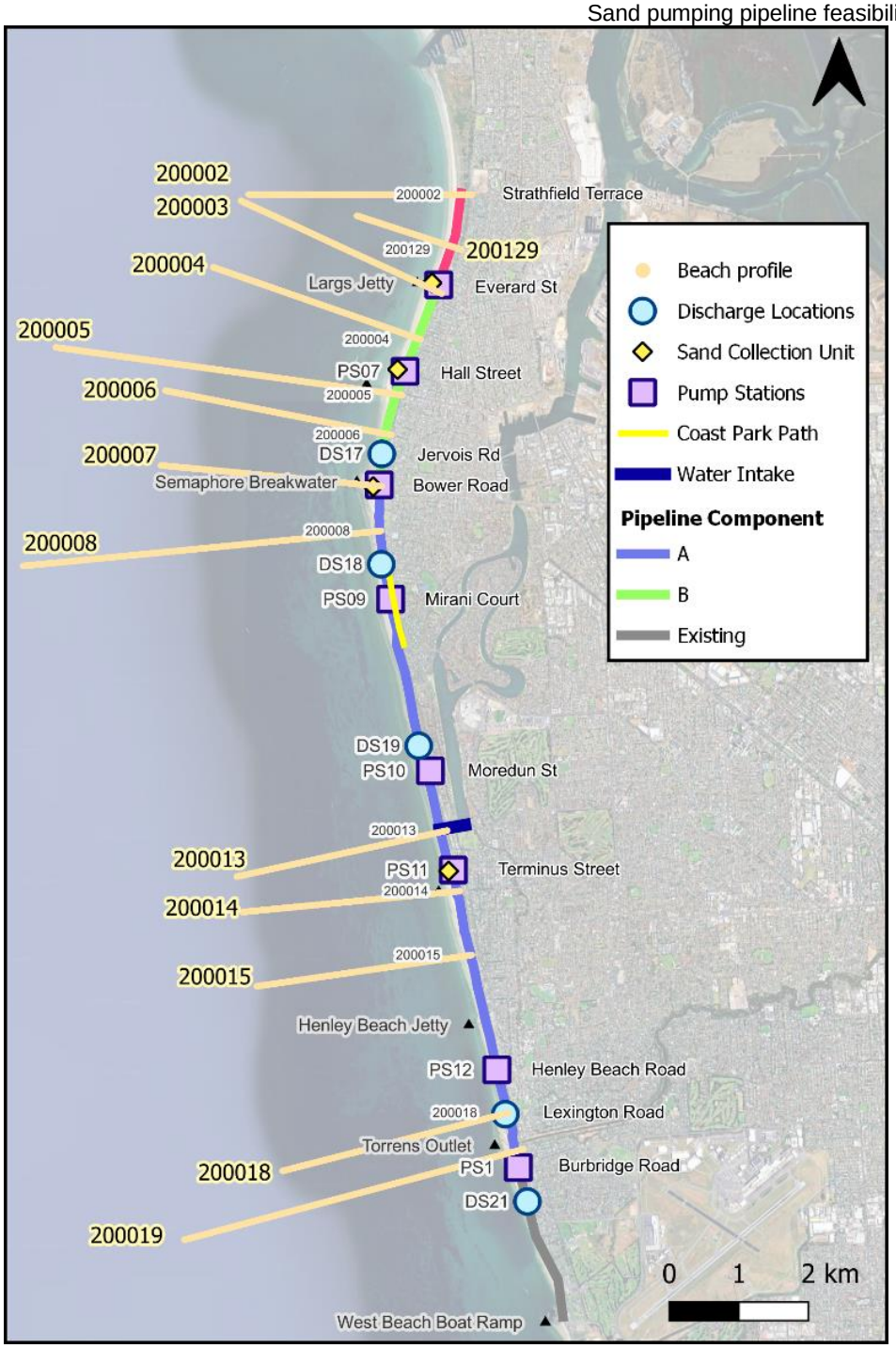

Figure 4: Pipeline layout and cross-shore beach profiles used in volumetric analysis

C.2 Assumptions, limitations and recommended further works

The analyses were intended to provide an initial assessment of sand availability and extraction potential. Several limitations must be acknowledged:

- Cross-shore profiles are assumed to be representative of the entire extraction area's longshore sediment availability. This introduces some uncertainty, as sediment distribution varies spatially.
- The analysis does not account for downdrift impacts of extraction. Removal of sand from one area may disrupt natural sediment transport patterns, potentially leading to unintended erosion in adjacent areas.
- Post-extraction shoreline adjustments have not been considered. Natural redistribution of sand following extraction may alter the volume estimates over time.
- Sea level rise impacts are not factored into the analysis. Rising sea levels are expected to reduce the availability of surplus sand and alter sustainable extraction thresholds.
- Shoreline recession from sand extraction may affect sediment transport rates and beach orientation, influencing long-term sustainability of extraction.
- Annual variations in longshore sediment transport will impact estimated extraction rates.
- To improve confidence in these sand extraction estimates, the following additional studies could be considered:
    - Morphodynamic modelling to improve understanding of downdrift effects of sand extraction.
    - Analysis of bathymetric changes over time using 3D survey to assess volumetric changes beyond cross-shore profiles.
    - Evaluation of sea level rise impacts on sand buffers above 80 m^3/m and sustainable extraction rates.

C.3 Results of volumetric analysis of cross-shore beach profiles for estimation of harvest area volumes and sustainable annual extraction volumes

Volumetric analysis plots for each profile assessed are presented below (Figure 5 – Figure 17).

Table 9 summarises the estimated harvest area volumes and sustainable annual extraction volumes for the proposed SCU locations, based on the results of volumetric analysis of nearby cross-shore beach profiles.

Table 9: Estimated harvest area volumes and sustainable annual extraction volumes

Proposed SCU Location	DEW Beach Profile/s	Existing surplus area (m^2)***	Estimated volume at Profile (m^3)	Estimated volume at SCU Location (m^3)	Estimated sustainable extraction volume (at profile - m^3/yr)	Estimated sustainable extraction volume (at SCU - m^3/yr)
Strathfield Tce (Portion C)	200002	363	217800	215000	15000	**15000**
Everard St (Portion B)	200129	365	219000	150000	15000	**15000**
	200003*	159	95400		**	
Hall St (Portion B)	200004	225	135000	140000	5000	**5000**
	200005	241	144600		0	
Semaphore Breakwater (Portion A)	200006	92	55200	120000	**	**40000**
	200007	312	187200		40000	
	200008	177	106200		40000	
Terminus St (Portion A)	200013	413	247800	150000	10000	**5000**
	200014	250	150000		5000	
	200015	153	91800		10000	
Torrens Outlet (Existing - Cell 3)	200018	45	27000	130000	0	**15000**
	200019	413	247800		30000	

**Profile 200003 extends across Largs Bay Jetty access, likely providing an underestimated sand volume.*
***Profile 200003 not suitable for sustainable extraction assessment.*
****Existing surplus is the cross-sectional area of the profile between the 1m contour and edge of coastal extent (e.g. road) above the 80m^3/lineal m threshold.*

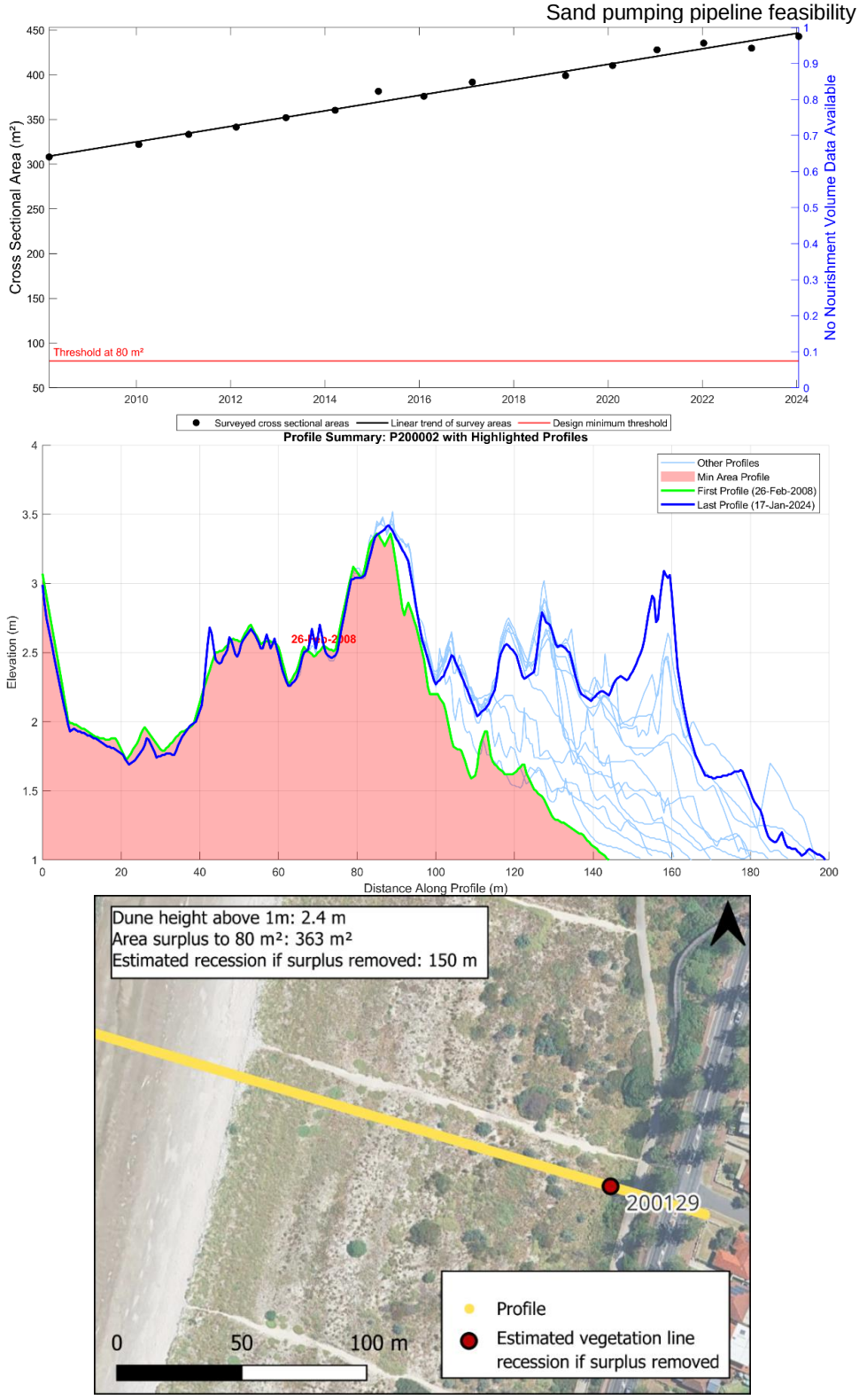

Figure 5: Profile 200002 - No historic extraction considered

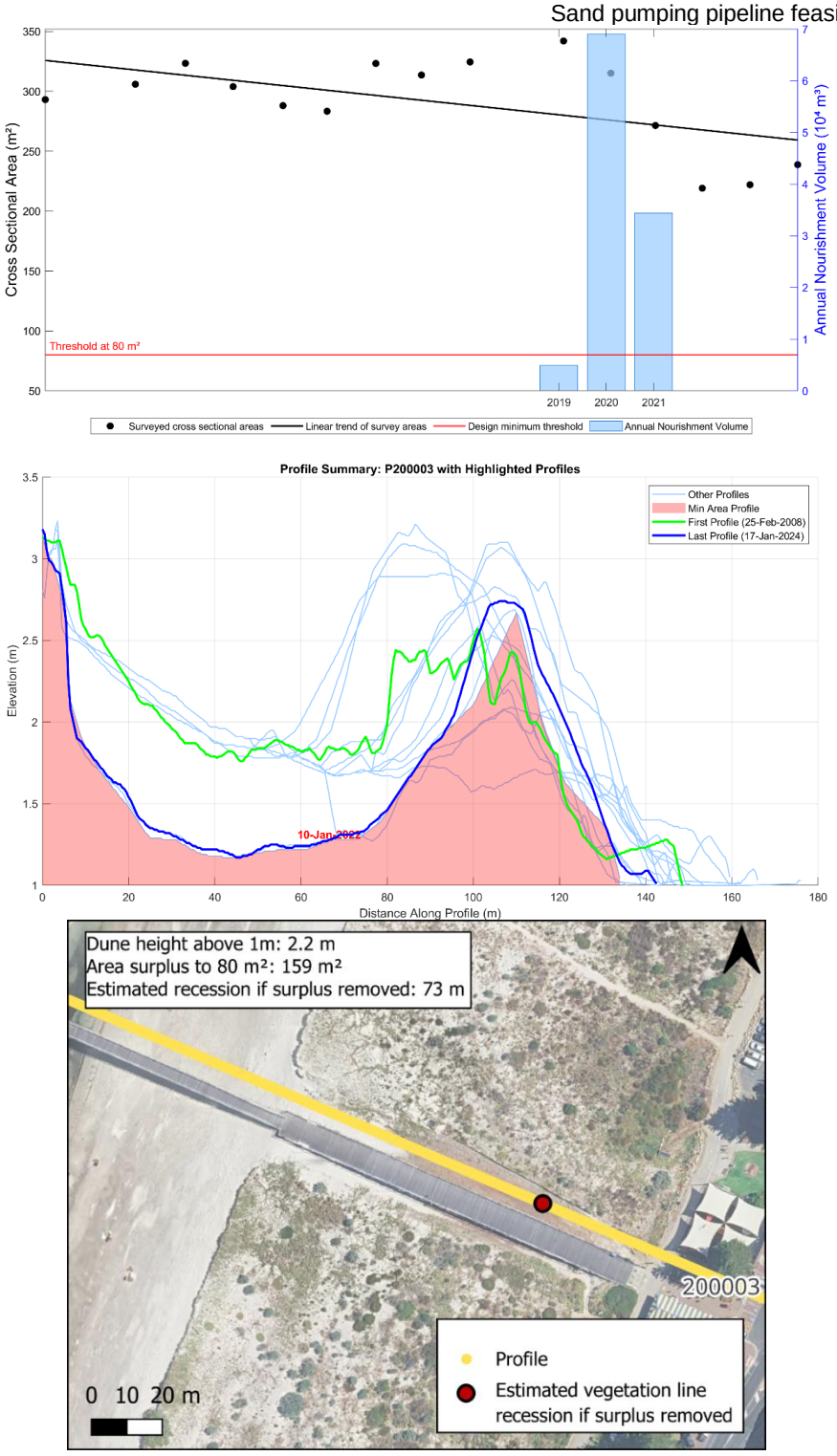

Figure 6: Profile 200003 – Consideration of historic extraction volumes from 'Largs' and 'Between jetties'

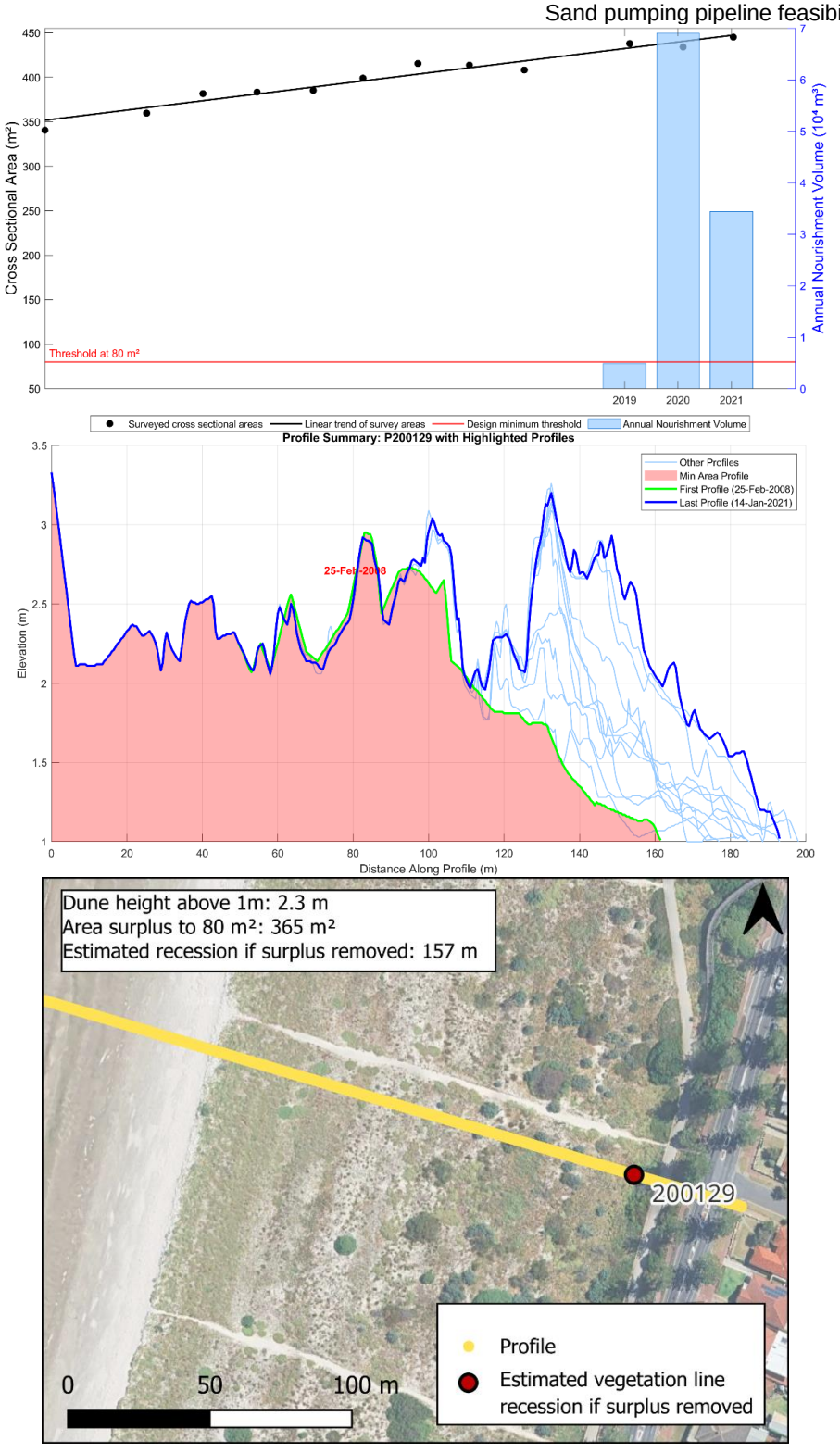

Figure 7: Profile 200129 – Consideration of historic extraction volumes from 'Largs' and 'Between jetties'

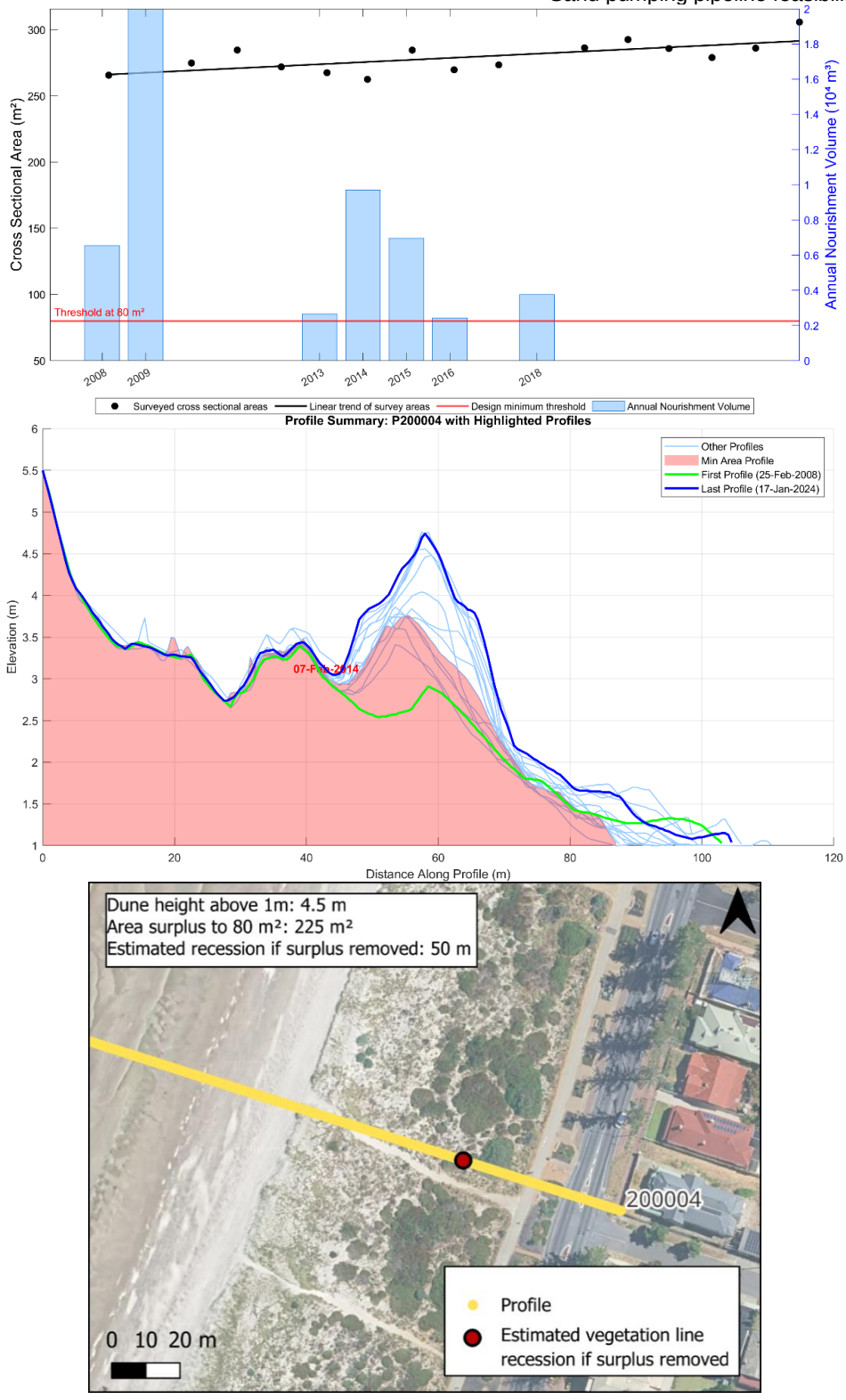

Figure 8: Profile 200004 – Consideration of historic extraction volumes from 'Semaphore Jetty'

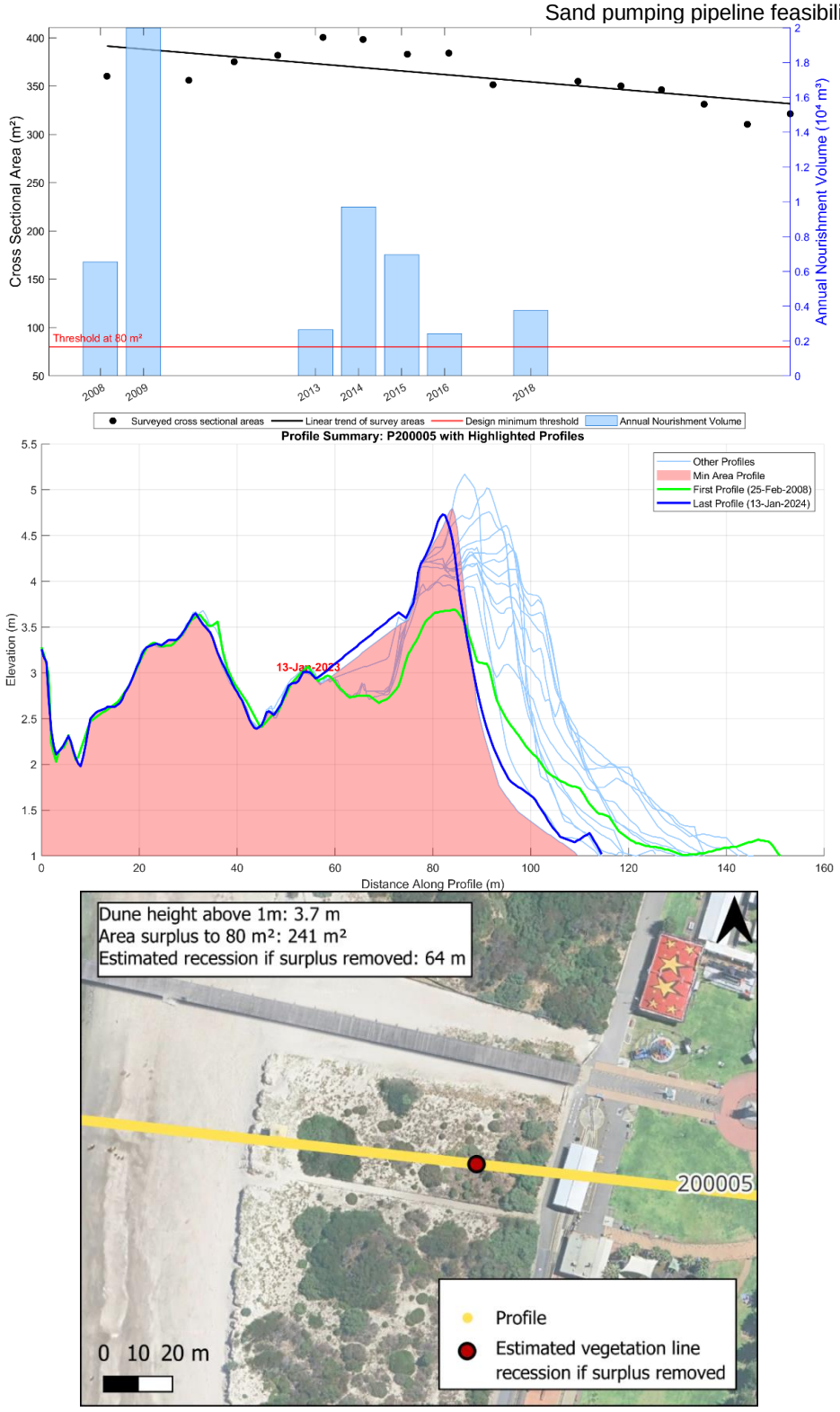

Figure 9: Profile 200005 – Consideration of historic extraction volumes from 'Semaphore Jetty'

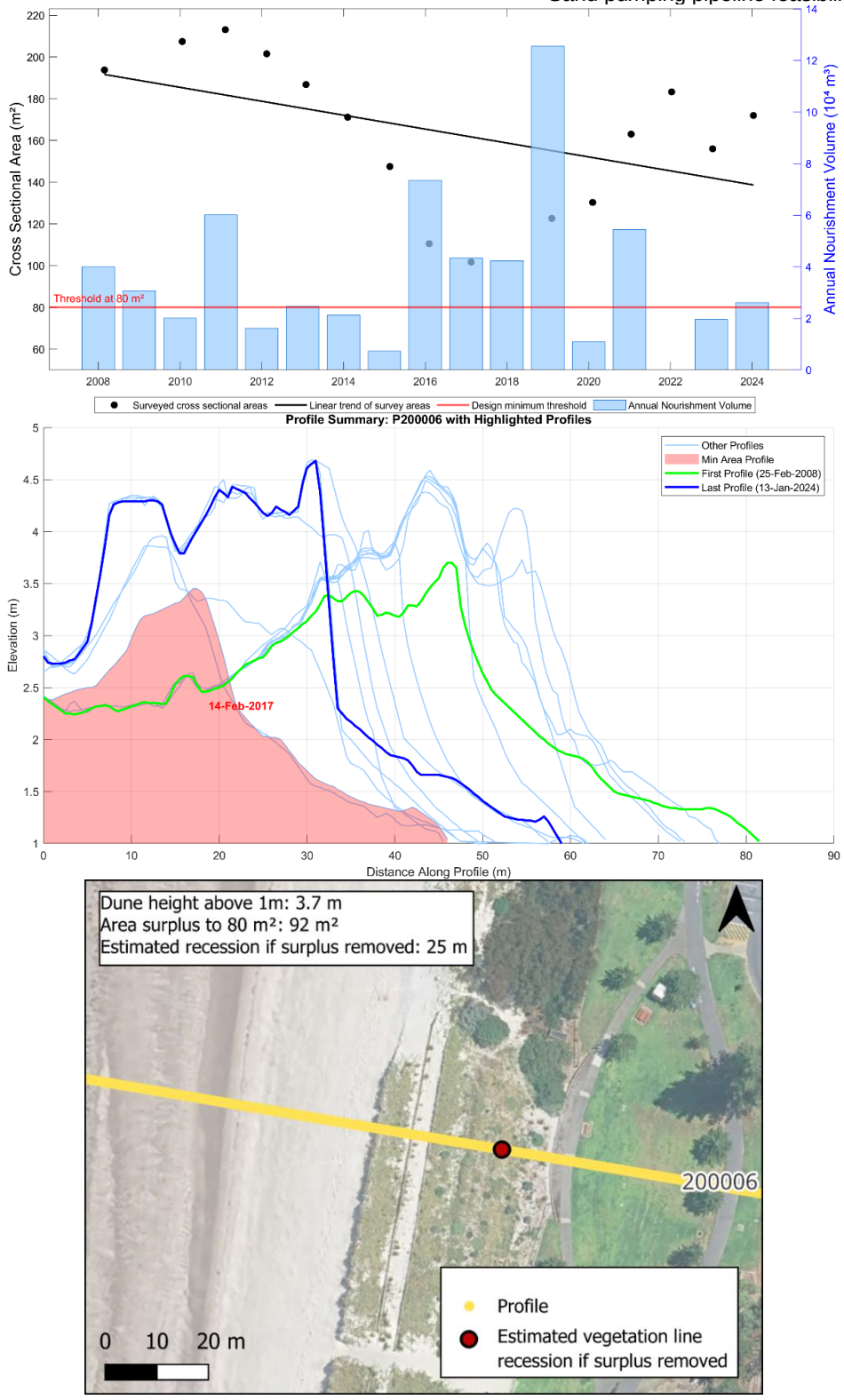

Figure 10: Profile 200006 – Consideration of historic nourishment volumes from 'Semaphore Jetty' and 'Point Malcolm'

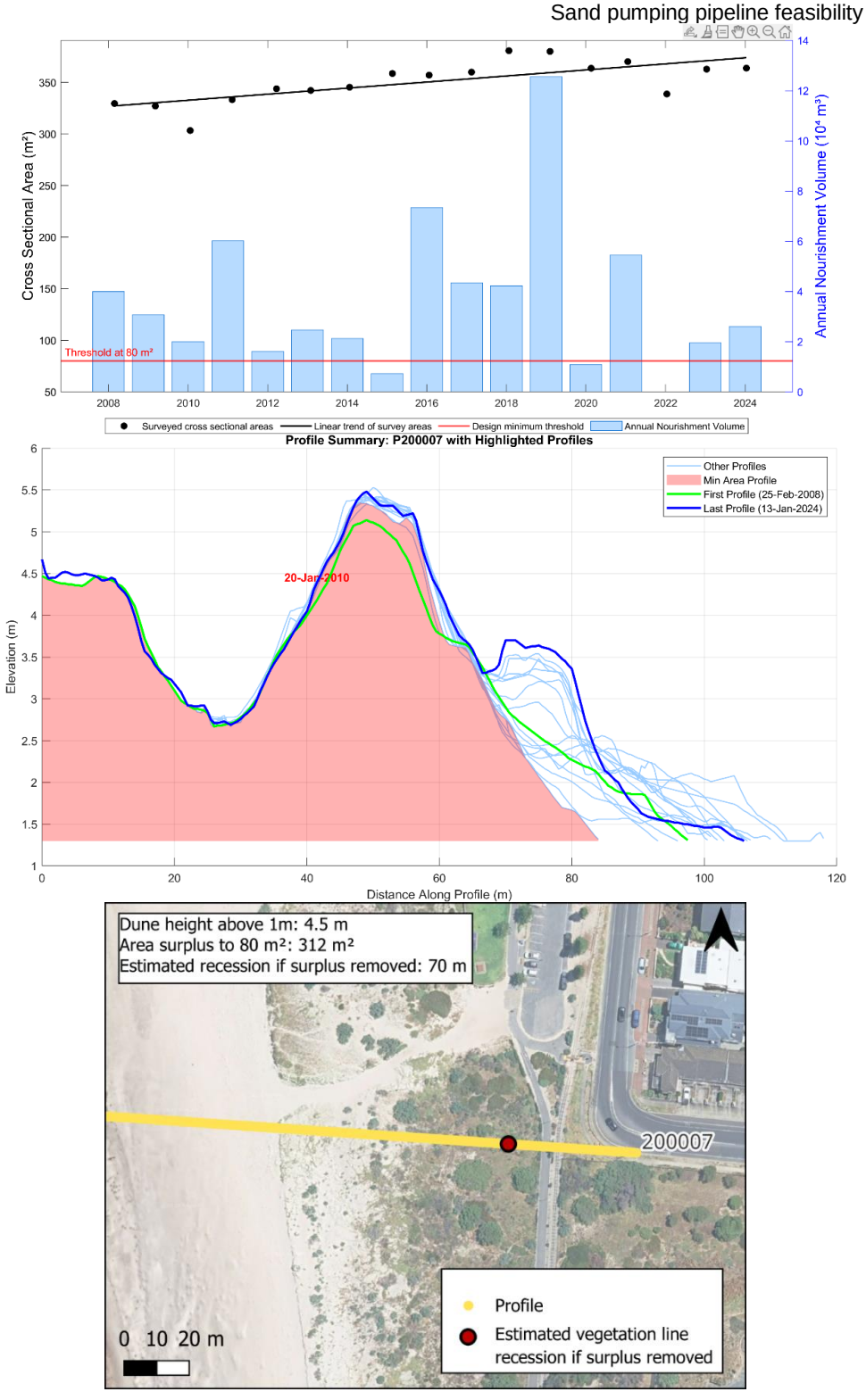

Figure 11: Profile 200007 – Consideration of historic nourishment volumes from 'Semaphore Jetty' and 'Point Malcolm'

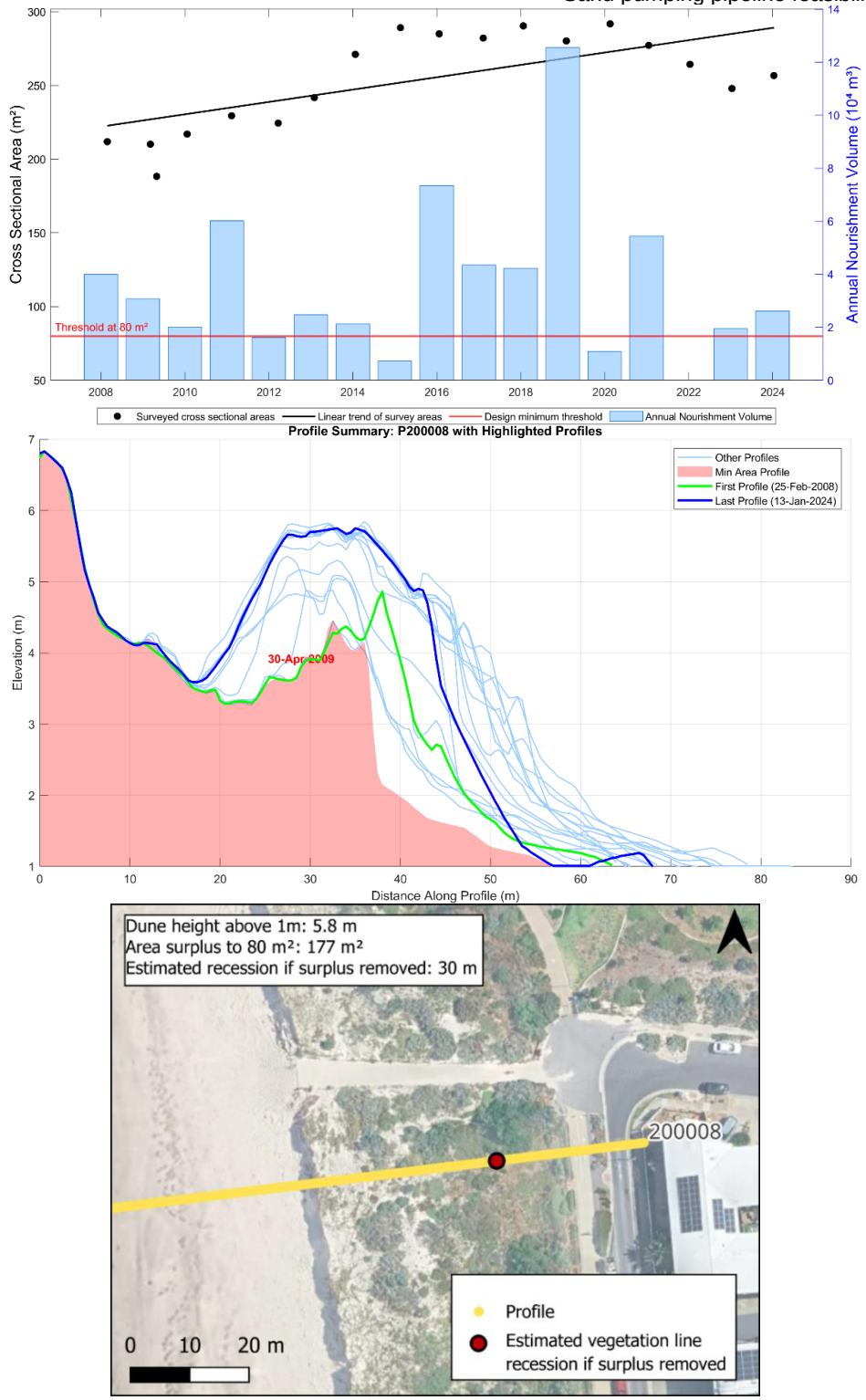

Figure 12: Profile 200008 – Consideration of historic nourishment volumes from 'Semaphore Jetty' and 'Point Malcolm'

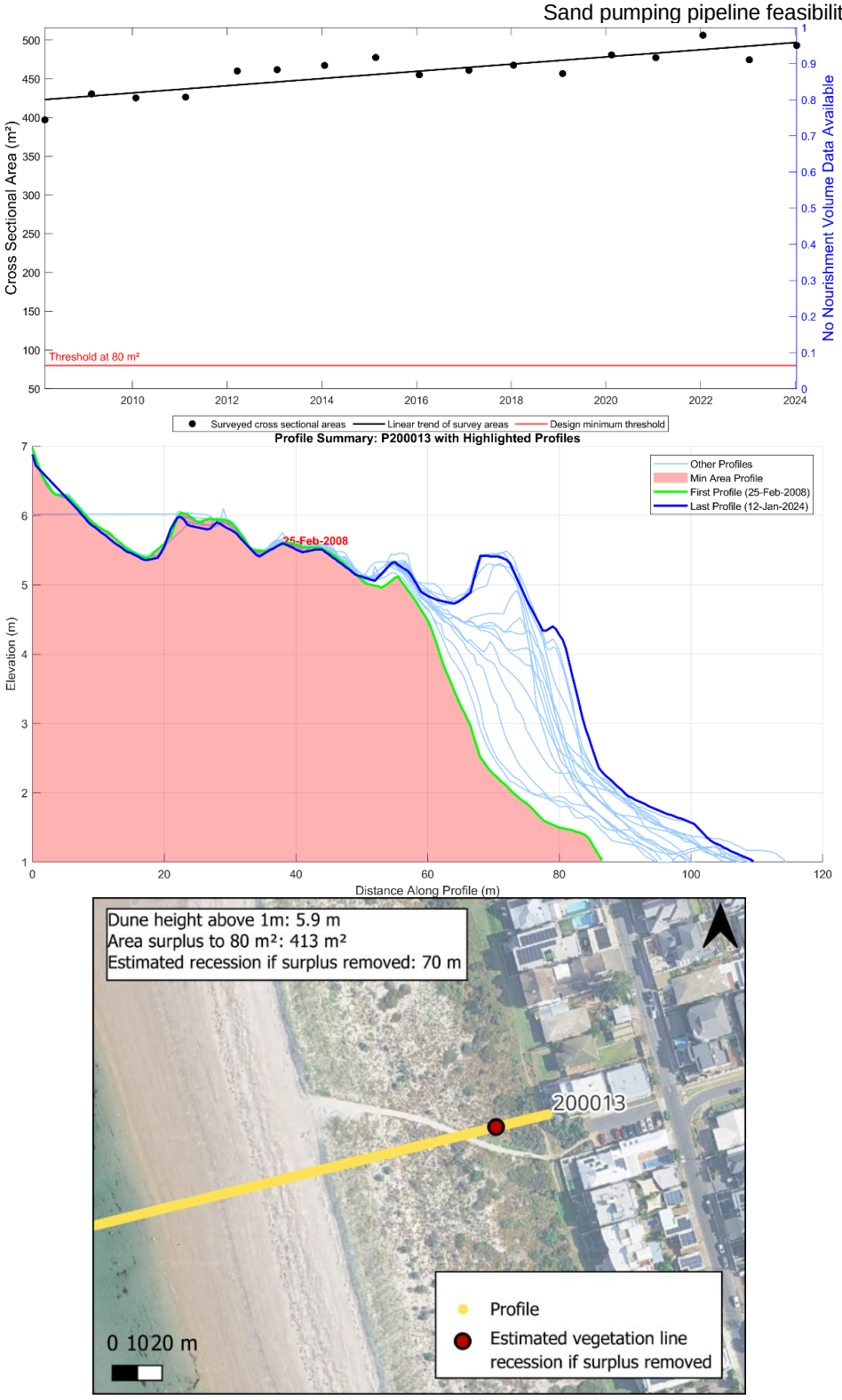

Figure 13: Profile 200013 - No historic extraction considered

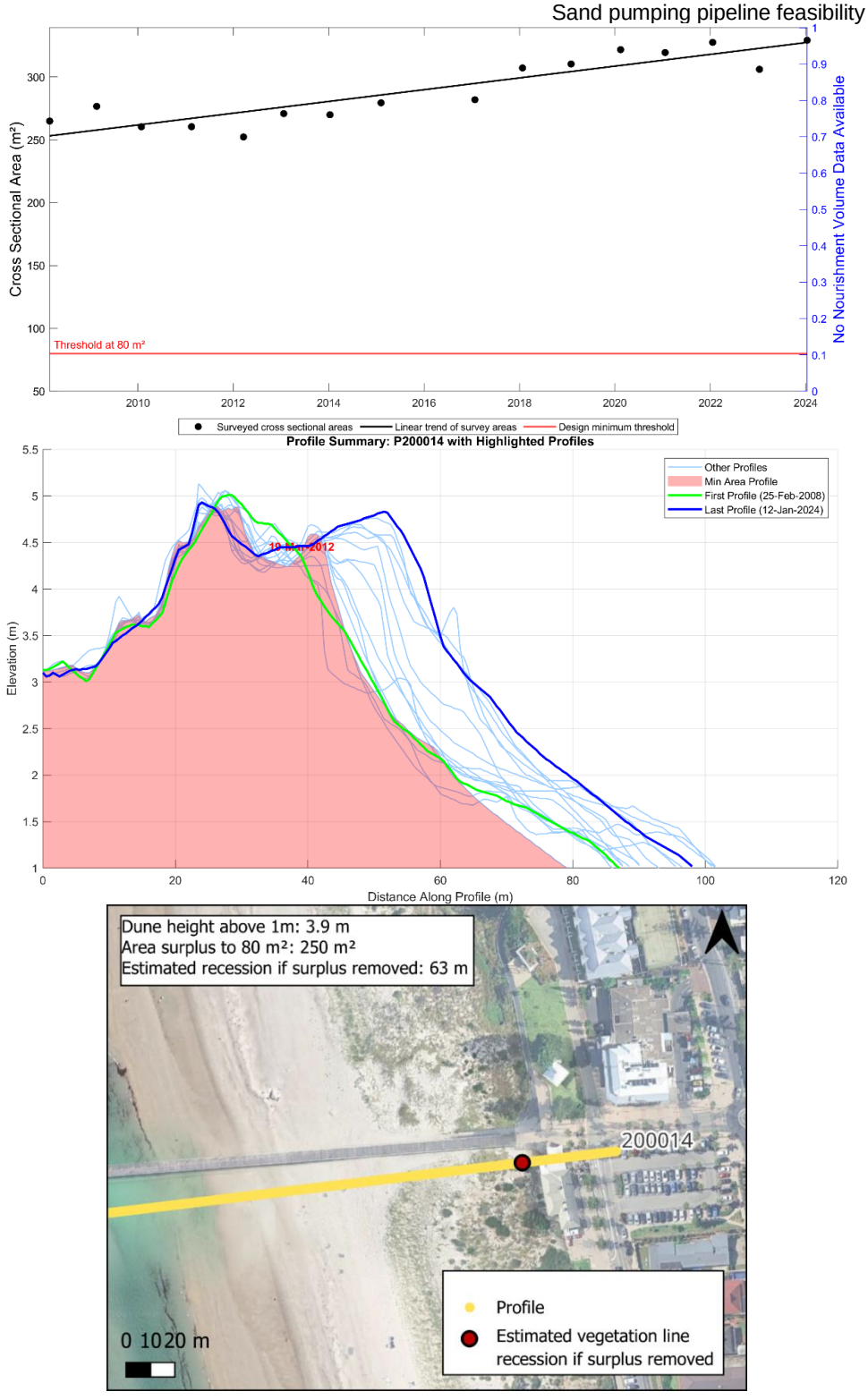

Figure 14: Profile 200014 - No historic extraction considered

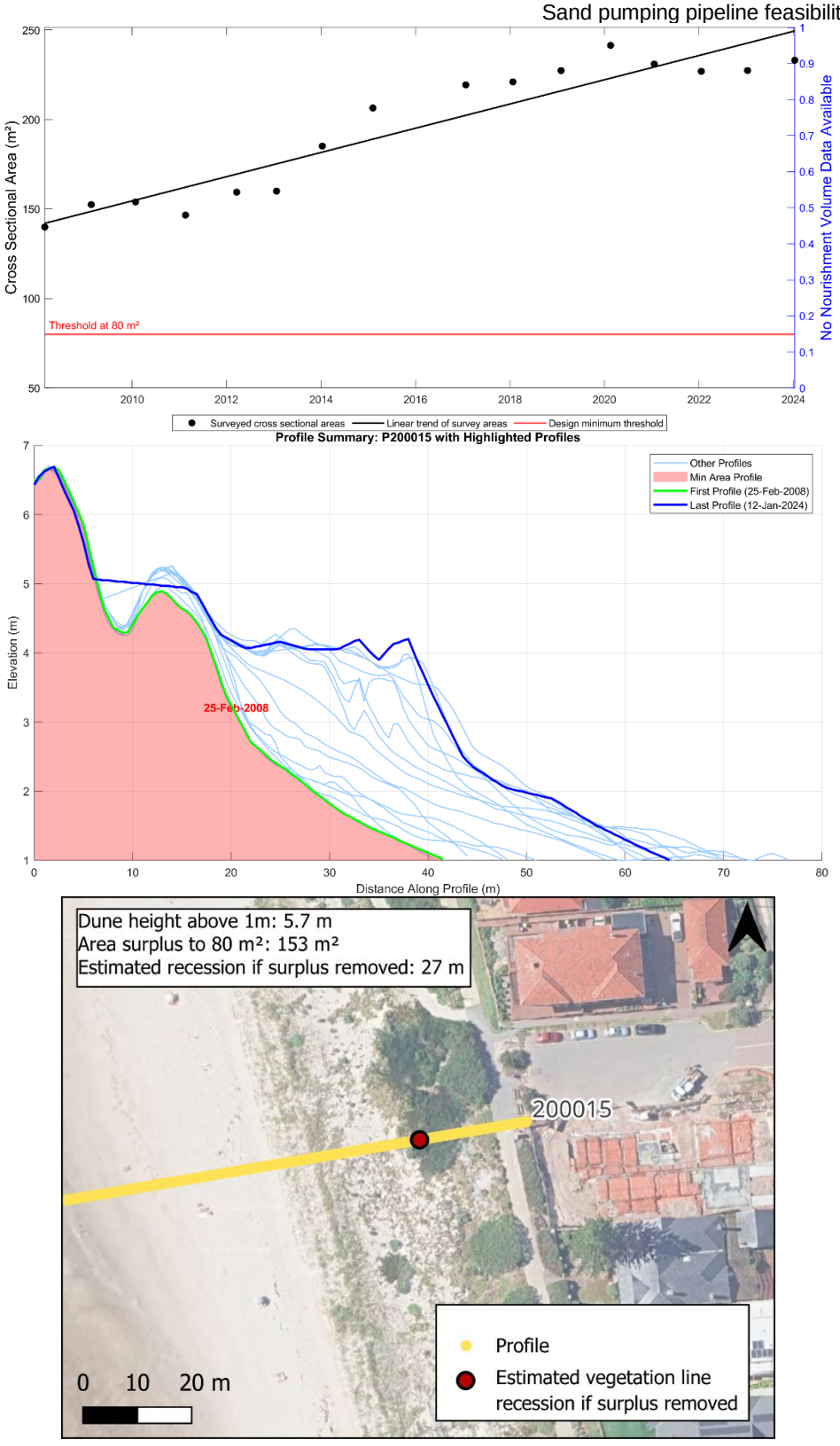

Figure 15: Profile 200015 - No historic extraction considered

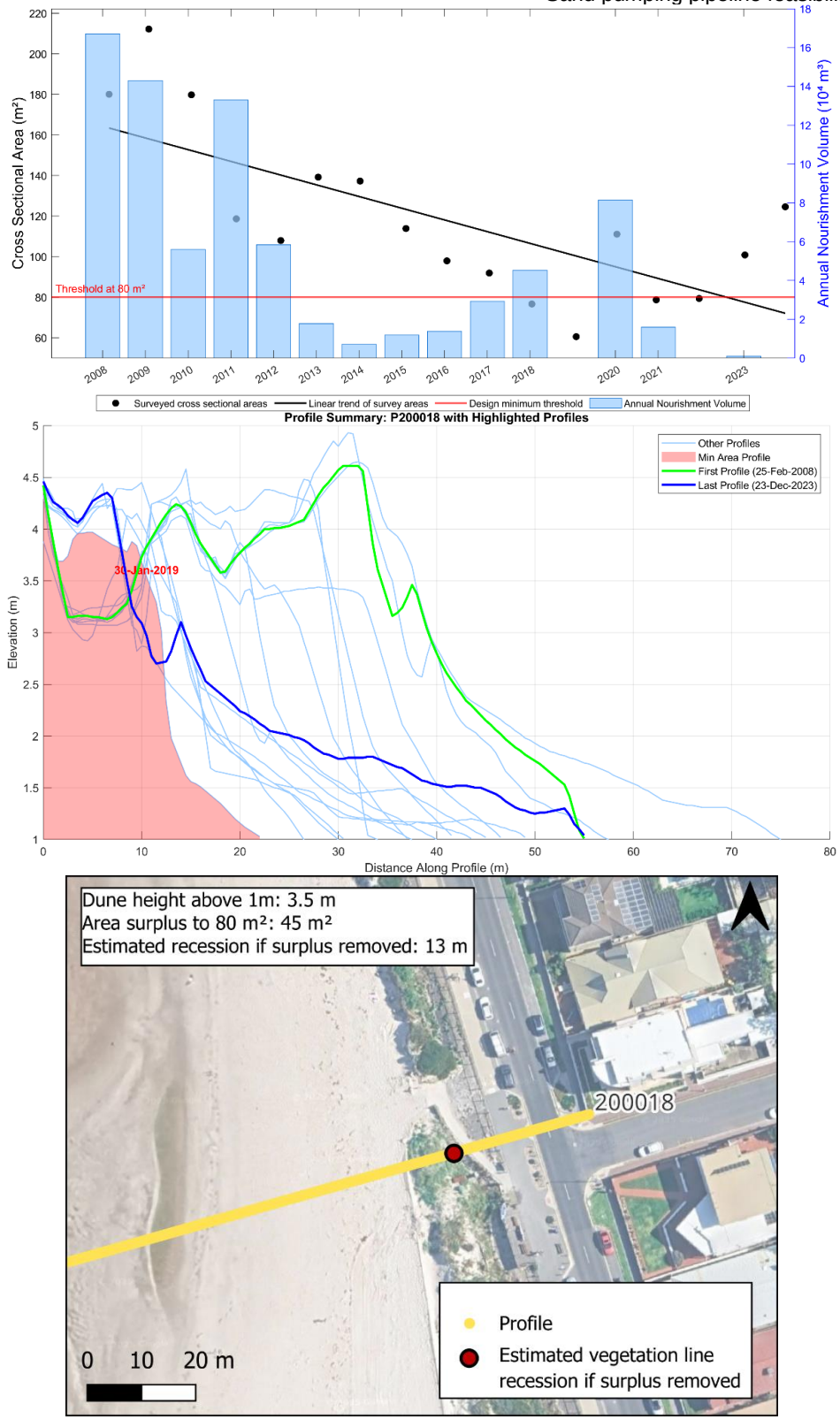

Figure 16: Profile 200018 - Consideration of historic nourishment volumes from 'Torrens Outlet'

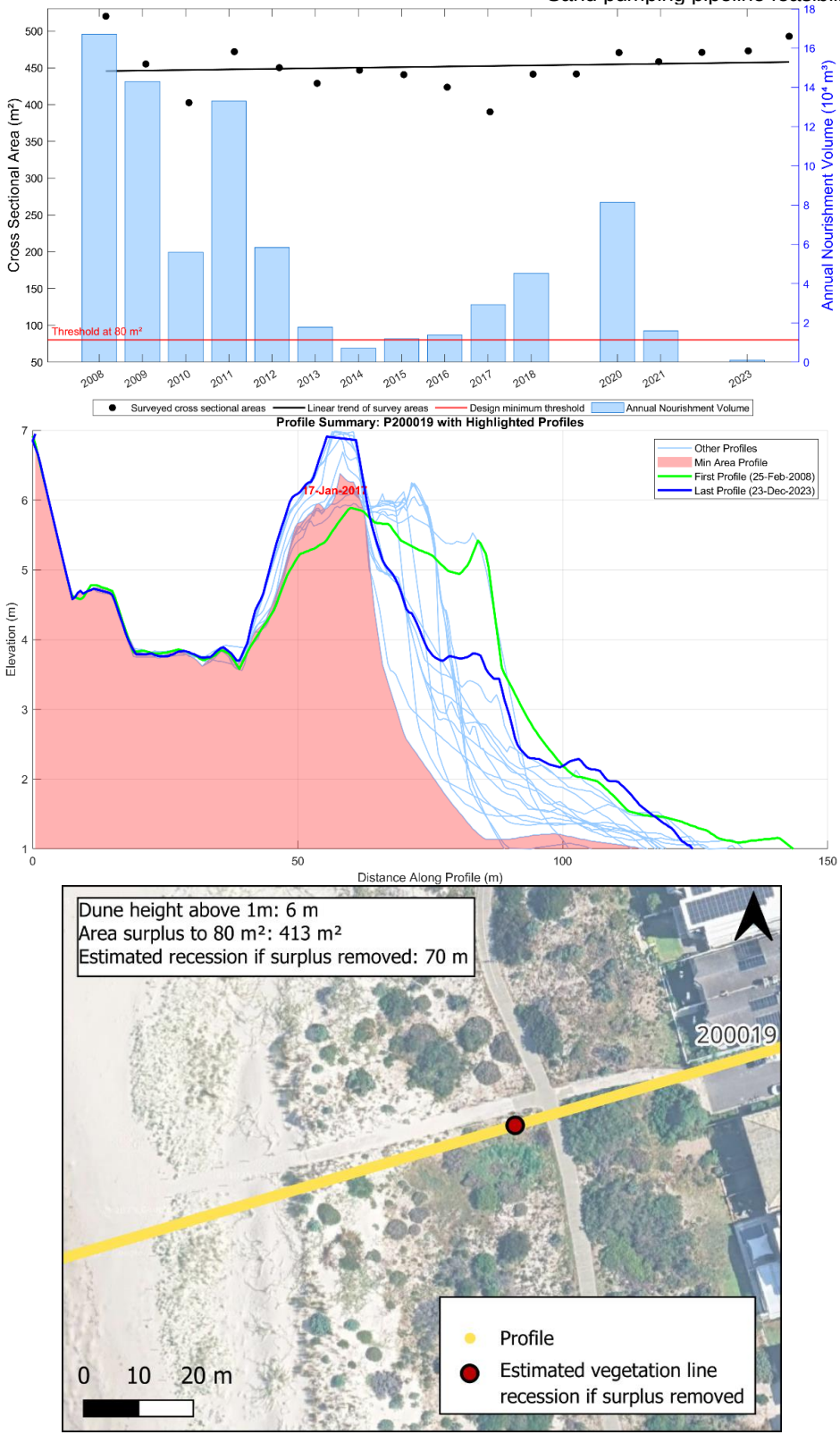

Figure 17: Profile 200019