Sediment Management in Metropolitan Adelaide

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ABSTRACT

Extensive seagrass meadows occur in Gulf St Vincent covering 5,000 km^2. They provide a natural habitat and food source for many marine species and stabilise the underlying sediments. Over the last half century, around one third of seagrass along the Adelaide metropolitan coast has been lost and this has been one of the most visible and significant coastal impacts. While natural events such as storms can cause large-scale loss, the main cause of the initial seagrass loss was poor water quality. This is particularly related to increased turbidity and nutrients in stormwater run-off discharged to the Gulf from watercourses and drains.

Infrastructure has been installed that uses physical processes to trap solid waste such as litter and coarse sediment. Sediment basins and gross pollution traps were established in Metropolitan Adelaide in the Patawalonga and River Torrens catchments, which Green Adelaide now operate and maintain. They own three sediment basins located in the Patawalonga catchment, which has been an identified sediment source, and they help protect a key area of Adelaide's coastline by preventing sediment from being transported out to the marine environment. The most productive basin is situated at the confluence of the Brown Hill and Keswick Creeks in Netley.

2,000-3,500 tonnes of sediment per annum have typically been removed from the Netley sediment basin over the last three years. The amount varies according to the rainfall in the preceding season and upstream catchment conditions such as land use, soil type and vegetation cover.

According to research, the seagrass decline is slowly being reversed. Removal of sediment from stormwater runoff is not the only solution and other management actions being utilised include seagrass meadow restoration, which provide opportunities to improve blue carbon storage.

Key words: Gulf St Vincent, sediment management, stormwater, seagrass, blue carbon storage.

1. STORMWATER IMPACTS ON ADELAIDE'S COASTAL WATERS

Traditional urban residential and industrial development has altered landscapes from permeable vegetated surfaces to a series of impervious interconnected surfaces. This has resulted in large quantities of stormwater runoff from these impervious surfaces (roofs, roads, paving etc) which carry gross pollutants, nutrients and sediments to the receiving coastal and marine environments. In Adelaide, these ecosystems include saltmarshes, mangroves, seagrasses, tidal flats and rocky reefs (Fernandes, 2008) and sediment has had an impact on all of these.

Issues of poor water quality, loss of seagrass, declining reef health and sediment instability were noticed by the Adelaide community, environmental managers, and researchers as early as 60 years ago (EPA, 2013). Over one third of the seagrass meadows have been lost from Adelaide's coastline in the last 50 years with the main cause of the initial loss being the result of drain discharge, stormwater runoff and effluent disposal. Historically, the main impacts were observed from Glenelg and Port Adelaide sludge outfalls, Bolivar wastewater treatment plant and the Penrice Soda Ash plant, which ceased operation in 2013. Wastewater related sediments tended to have higher nutrients attached to the sediment which have resulted in considerable impacts (EPA, 2008).

According to Wiltshire (2023), the nutrient inputs from stormwater in the Gulf St Vincent adversely affect seagrass through promotion of epiphytic growth and may encourage the growth of introduced or other nuisance algae or toxic phytoplankton. The sediment impacts seagrass through light reduction due to turbidity. Organisms living in the waters off the Adelaide metropolitan coast are directly impacted by a range of stormwater pollutants including heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs) and organic contaminants. Bryars (2013) also highlights that under certain conditions the local reef and seagrass systems can be highly sensitive to even slight increases in nutrients and sediments.

The Adelaide Coastal Water Quality Improvement Plan or ACWQIP, (EPA, 2013) provided strategies and actions for water quality improvements to Adelaide's coastal waters over a 20 to 40-year timeframe. The study established that nitrogen and sediment inputs were the main contributors to issues impacting on Adelaide's coastal water quality and seagrass health. Central to the ACWQIP, the Adelaide Coastal Waters Study (ACWS) recommended a reduction in sediment loads of 50% from 2003 levels to allow sufficient light levels for seagrass to grow.

This paper discusses the work the Green Adelaide Landscape Board continues to carry out in support of reducing land-based impacts of stormwater entering the coastal environment and measures that have been established to contribute to the ACWQIP sediment reduction targets.

2. URBAN WATER QUALITY MANAGEMENT

The Green Adelaide Landscape Region and Board were established under the *Landscape South Australia Act 2019* (Government of South Australia, 2019), with the key aims to educate, inspire, influence, and enable a cooler, greener, wilder, and climate-resilient Adelaide. The 5-year Regional Landscape Plan (Green Adelaide, 2021) provides strategic direction to delivering practical outcomes across key priorities. The Board owns water management assets including gross pollutant traps, which capture gross pollutants and sediment basins which capture finer sediments. The sites are legacy assets which were formerly owned by the Adelaide and Mount Lofty Ranges Natural Resource Management Board and its predecessors. The majority of which were installed in a 10-year period from 1995-2005. They were then transferred to Green Adelaide when the *Landscape South Australia Act 2019* came into effect. The primary focus of establishing these sites at the time, was to improve water quality in Adelaide and its surroundings and the coastal environments.

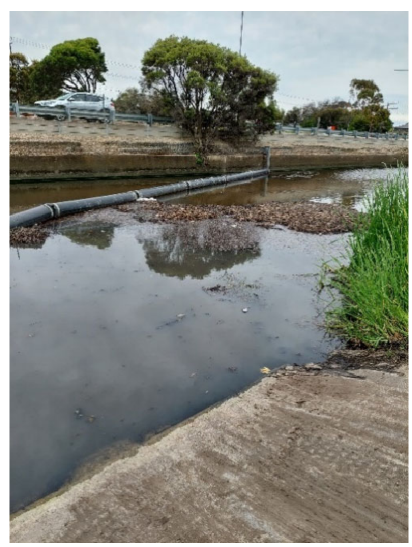
The assets are located in the River Torrens and Patawalonga catchments and are predominantly situated in the metropolitan areas of Adelaide. The Board is responsible for the operation, maintenance and ongoing management of these assets. This work aligns with two of the seven priorities of Green Adelaide as detailed in the Regional Landscape Plan (Green Adelaide, 2021): coastal management; and water resources and wetlands. One of the main objectives of the asset management program is the reduction of land-based impacts from stormwater entering the coastal environment by reducing the quantity of sediment and gross pollutants discharged. The continued maintenance and cleaning of the water management assets has and will continue to assist in providing opportunities for urban waterways and coastal native ecology to maintain healthy ecosystems.

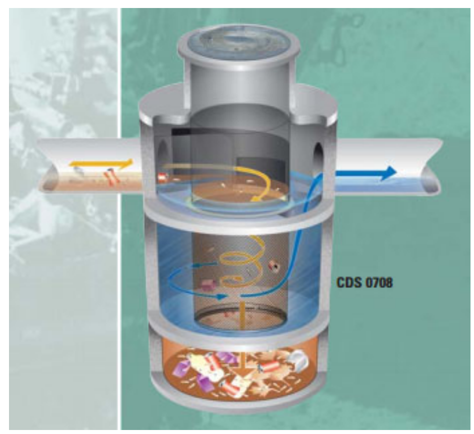
The recently published *Urban Water Direction* Statement by the Department for Environment and Water (DEW, 2022) provides additional strategic alignment to integrated urban water management in Metropolitan Adelaide, including improving water quality and the environment for urban waterways and the coast. The water management assets are one of the ways this objective can be achieved.

3. GREEN ADELAIDE'S STORMWATER MANAGEMENT ASSETS

Commonly, gross pollutant traps (GPTs) have been used as one of the measures to improve the water quality in urban watercourses. GPTs are structures that use physical processes to trap solid waste such as litter and coarse sediment. They are often used as the primary treatment because they mostly remove large amounts of organic matter and some rubbish via physical screening, rapid sedimentation or separation processes. All gross pollutants, sediment and other debris removed during the cleaning are transported and disposed of at a licensed waste facility, with the mass (tonnage) of wet material removed from each site recorded. Green Adelaide is responsible for twelve GPTs (net-style traps, floating booms and a CDS) devices, three sediment basins and one debris screen on a flood control dam (Table 1):

Table 1. Green Adelaide Water Management Assets

Gross pollutant traps		
Net-style traps	Series of individual nets inserted along a steel frame. Typically made from galvanised steel structures with nets made form high-strength netting, mounted on a concrete base. The racks are installed perpendicular to the direction of flow and are designed to capture both floating and suspended gross pollutants. Gross pollutants and sediment are captured in the nets and in the immediate area upstream of the rack.	
Floating booms	Floating booms consist of a series of polyethylene pipe sections coupled together to provide the required length to span between anchor points on both sides of the watercourse. They operate by floating on the water surface and trapping floating gross pollutants behind them. Typically installed at an angle to the direction of water flow and with complementary net-style traps at the downstream end to aid collection of gross pollutants within a more contained area. The skirt that hangs below the boom reduces the risk of gross pollutants being pushed under the boom during high flow periods. The floating booms have the capacity to move up and down that allows them to move with the water level.	

Sediment basins	Located upstream of net-style traps or floating booms at strategic locations. Operate by slowing water flow and allowing sediment particles to settle out of suspension and be captured within the basin. Require periodic cleaning to maintain their performance. Typically hold water for most of the year and require dewatering to enable cleaning. A concrete hardstand is required for machinery to enter the basin for cleaning.	
Continuous separation devices (CDS)	CDS units are designed to capture and retain gross pollutants, litter, grit, sediments and associated oils, utilising patented CDS indirect screening technology. Gross pollutants and coarse sediment are directed to the base of the CDS unit. In some instances, there may be a removable collection basket installed in the capture chamber to facilitate cleaning. They are typically situated in constrained environments where net-style systems are not suitable.	
Debris screen	Typically consists of vertical or mesh steel bars designed to trap floating and suspended gross pollutants. The Sturt River Flood Control Dam trash cage is located on the upstream side of the dam wall in the Sturt Gorge, Flagstaff Hill. Whilst this site is predominantly for flood control purposes, it does provide a water quality and sediment control function. Installed as part of the project which provided a permanent sediment basin at the dam. A permanent pool of water approximately 10m deep at the dam wall is maintained behind the dam wall by an elevated inlet pipe.	

4. SEDIMENT MANAGEMENT

Sediment basins are one of the primary measures which Green Adelaide use for sediment management in the watercourses flowing through Metropolitan Adelaide. Green Adelaide is the asset owner of three sediment basins surrounding Adelaide Airport. Large annual desiltation cleans are undertaken annually or biannually at two of the sediment basins because of the large sediment build up at these locations. Smaller, regular cleans are also undertaken as part of routine maintenance. Secondary drivers for undertaking these large cleans include social impacts such as odour and aesthetic appeal as the basins are adjacent to residential and recreational areas.

Desilting usually occurs around February-March when minimal water is in the system for ease of access and site operation. Sediment sampling and analysis is conducted prior to the desiltation to enable classification of the waste in accordance with relevant South Australian EPA guidelines. The site is then dewatered to access the sediment and material deposited in the basin with machinery. Typically, classification of the material has allowed for disposal to licensed composting facilities. The contractor mixes the sediment with green waste to add bulk which is an innovative solution to reduce the moisture in the material and to facilitate transportation off-site.

Between 2,000 and 3,500 tonnes of sediment have been removed annually from the sedimentation basin located in Netley in the period 2018–24, with most of this resulting from the large annual clean. 3,500 tonnes are equivalent to the weight of almost 1800 medium-sized cars. This sediment removal is one of several measures which contributes to the ACWQIP target of a 50% reduction in sediment load from 2003 levels to improve seagrass meadow health. This site is the most productive of the three sediment basins and is located at the confluence of the Brown Hill and Keswick Creeks. Only data from this site has been reported due to its priority location for capturing sediment and because it is located upstream of important infrastructure at the Patawalonga Lake System. The amount removed from the basin has been steadily increasing in recent years (Figure 1) and there is evidence of considerable sediment accumulation in Keswick Creek both immediately upstream and downstream of the basin. As annual rainfall increases, the amount of sediment accumulating typically increases too. 2023-24 experienced 435mm of rainfall which was 200mm lower than 2022-23 but several large rainfall events occurred in late 2023 and early 2024 resulting in sediment accumulation in the basin.

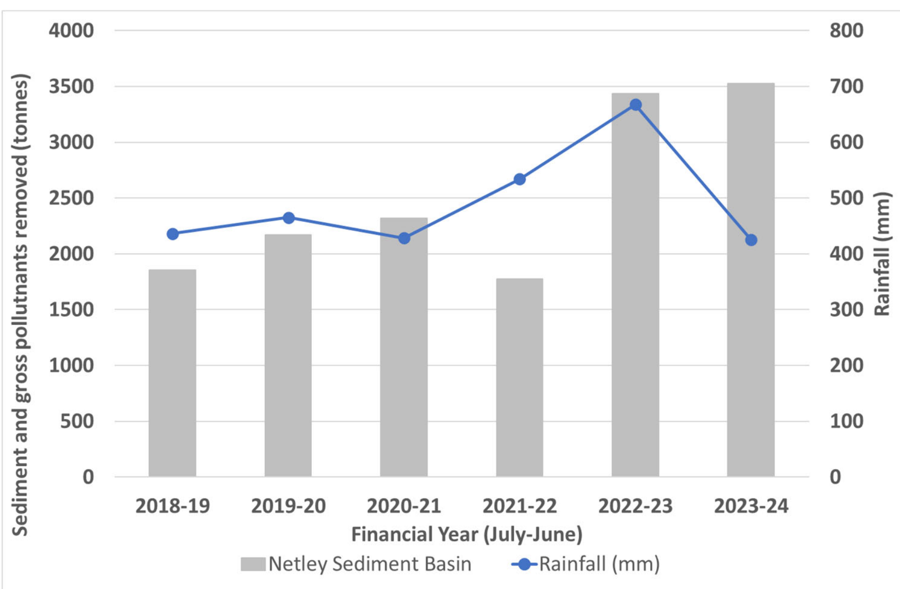


Figure 1. Sediment and gross pollutants removed from the Netley sediment basin and annual rainfall

These systems also require ongoing maintenance to ensure flow conveyance and adequate capacity is maintained. This will result in the reduction of localised flooding impacts in the vicinity of Adelaide Airport and sedimentation problems further downstream in the Patawalonga Lake System. There is a need to manage sediment sources in upstream catchments. This management in provides benefit to downstream ecosystems such as the seagrass meadows and reef systems. The following sections discuss the work being undertaken to reverse the seagrass meadow disappearance because of stormwater impacts and the benefits this restoration brings.

5. SEAGRASS MEADOW RESTORATION

According to the Blue Carbon initiative (Conservation International, 2019), coastal ecosystems provide numerous benefits and services that are essential for climate change adaptation along coasts globally. This includes protection from storms and sea level rise, prevention of shoreline erosion, regulation of coastal water quality, provision of habitat and food security for biota and people.

In addition to the above-mentioned sediment removal, considerable work is also being undertaken to restore seagrass meadows in the coastal waters of South Australia, funded by the South Australian Research Development Institute (SARDI) in partnership with the Department for Environment and Water. Since 2021 Green Adelaide has also supported ($160,000 over 2021-24) community lead restoration of Adelaide seagrass meadows. The previous NRM Board funded these seagrass restoration trials by SARDI Aquatic Sciences for over a decade ($649,579 from 2008-19).

The ‘Seeds for Snapper’ seagrass restoration project is run by OzFish and involves the collection of Posidonia seagrass fruit by volunteers which wash up on the beach. The fruit are then processed on shore in tanks and the resulting seeds sewn into hessian bags which are placed back in the ocean at key locations to regrow. Over 40,000 seeds have been dispersed since the program commenced, with 15,000 replanted in 2022 alone. This has equated to almost 6,500 volunteer hours delivered in total. 5-7 years are typically required to assess trends, but initial surveys of deployed bags have indicated good germination rates for the seed. More recently the deployment of bags has been ramped up with over 50,000 bags being distributed over ten 1-hectare areas off the Adelaide coast (Tanner J. E., 2023). Over the last two decades there has also been a major focus on the use of unseeded hessian sandbags on the seabed to facilitate the recruitment of seagrass (*Amphibolis spps.*) (Tanner et al 2023).

6. CLIMATE CHANGE AND BLUE CARBON STORAGE

Additionally, these coastal ecosystems sequester and store significant amounts of blue carbon from the atmosphere and ocean in plants and sediments and are now recognised for their role in mitigating climate change.

Over the last decade, further work has been undertaken to conserve and restore these coastal habitats. Green Adelaide partners with various organisations to investigate carbon values of certain habitats and create demonstration projects such as the Dry Creek Salt Field tidal restoration project. Funding to support the implementation of the Blue Carbon Strategy for South Australia 2020-25 (Government of South Australia, 2020) is available through Green Adelaide’s Blue Carbon Futures Grants Program. The restoration of environments which can sequester blue carbon is a key focus of this program. In 2023-24, funding of up to $300,000 is available. To date, $965,932 has been invested by the previous NRM and Green Adelaide Boards in Blue Carbon Futures projects, ($723,978 by Green Adelaide) with a combined project value of $2,312,866 leveraged over the first four years.

7. SUMMARY

This paper has documented the impacts of stormwater on Adelaide's coastal environment, including the decline in water quality and increased sediment loads from the contributing catchments. One of the most significant impacts which has been observed is the decline in seagrass meadows (Bryars, 2013) (Wiltshire, 2023). The ACWQIP was established to tackle these detrimental impacts on Adelaide's coastal waters and provided strategies and action to reverse these trends (EPA, 2013). The Green Adelaide Landscape Board continues to undertake work to reduce the impacts of stormwater which have included the installation of physical infrastructure to stop gross pollutants and sediment from damaging downstream ecosystems. The success of these assets is measured through documenting the weight of material removed. Further research is required to look at upstream catchment conditions (such as land use and soil), point source pollution and climate impacts to undertake proactive sediment management prior to transportation downstream.

Seagrass restoration is also being undertaken by SARDI, Green Adelaide and other partner organisations and successes have been observed at a variety of scales and locations. Trials and demonstration sites have been established (Government of South Australia, 2020) but research has highlighted that there are still many knowledge gaps to fill (Tan, 2020). Seagrass condition monitoring results have shown a gradual reversal of the seagrass decline (Tanner, 2020) and it has been reported that Port Adelaide seagrass cover increased from 56% to 64%. A collaborative approach is required between natural resource management organisations, local and state government, private landholders, and developers to further reduce the impacts of stormwater on valuable coastal ecosystems such as seagrass meadows.

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