Marine and Coastal
National Environmental Science Program

RESEARCH REPORT

July 2023

# National Outfall Database: Outfall ranking based on 2020/2021 nutrient loads discharge

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Milestone number: 6

Research Plan number: RP 2022

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## Preferred citation

Rohmana, Q. A., Fischer, A. and Gemmill, J. (2023). *National Outfall Database: Outfall ranking based on 2020/2021 nutrient loads discharge*. Report to the National Environmental Science Program. Clean Ocean Foundation and University of Tasmania.

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## Acknowledgement

This work was undertaken for the Marine and Coastal Hub, a collaborative partnership supported through funding from the Australian Government's National Environmental Science Program (NESP). The outfall data used in this report based on or contains data provided by the State of Queensland (Department of Environment and Science) 2022, Ballina Shire Council (NSW), Bega Valley Shire Council (NSW), Central Coast Council (NSW), Sydney Water, Clarence Valley Council (NSW), Coffs Harbour City Council (NSW), Eurobodalla Shire Council (NSW), Hunter Water (NSW), Kempsey Shire Council (NSW), MidCoast Council (NSW), Port Macquarie-Hastings Council (NSW), Shoalhaven Water (NSW), South Australian Water (SA), TasWater (TAS), EPA Tasmania, Barwon Water (VIC), Greater Western Water (VIC), Gippsland Water (VIC), Melbourne Water, South East Water (VIC), South Gippsland Water (VIC), Wannon Water (VIC), Westernport Water (VIC), and Water Corporation (WA).

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# Executive Summary

This report provides an analysis of the Australian coastal outfalls and ranks them according to the total flow volume and nutrients (nitrogen and phosphorus) load to prioritise the potential degree of impact of each source to the environment and human health.

Wastewater quality data was collected from 42 out of 43 water authorities (WTAs) with 178 out of 192 outfall sites (93%) around Australia by either downloading the water quality data reports directly from WTA websites or by formally requesting the data through email.

The pollutant contribution index, based on nitrogen and phosphorus loads, was calculated for each outfall. Nitrogen and phosphorus loads were calculated according to the Load Calculation Protocol of New South Wales Department of Environment and Climate Change. Outfalls were ordered from lowest to highest index value to rank them according to their relative pollutant contribution to the coastal and marine environment. The index is based on a total nutrient load discharge using the variables of flow, nitrogen and phosphorus.

The results show that the outfalls released 1,453 gigalitres of effluent into the marine environment between July 2020 to June 2021. The total nutrient load from individual outfall sites around Australia ranged from 7 to 4,669,238 kg with a mean of 103,552 kg. The ranked loads throughout Australia were mapped by quartiles. The outfalls in the top 25% quartile were more prevalent in regional areas and discharge less nitrogen and phosphorus loads into the coastal and marine environment. The bottom 25% quartile, on the other hand, with higher nutrient loads, principally occur around the major cities. The phosphorus concentrations contribute less to the overall outfall nutrient load and vary less between outfall sites. Nitrogen, on the other hand has a higher median contribution and high variability across the sites.

In general, the outfalls contributing higher nitrogen and phosphorus loads varied more than those discharging lower loads. There may be many reasons for this, but it could be related to treatment plant capacity, population growth, and licensing requirements, resulting in increased discharge at metropolitan outfall sites. There are some exceptions to this pattern where rural/regional sites contributed higher nutrient loads than urban areas (e.g., Warrnambool, VIC). The reasons may vary; however, the main contributor is the level of technology employed to remove nutrients. This ranking of nutrient loads from Australian outfalls by site at a national scale can therefore be useful in prioritising treatment upgrade resources to manage biodiversity impacts and human health concerns.

# 1. Introduction

The discharge of treated wastewater has the potential to be a major contributor of marine environment pollution, which occurs globally. High concentrations of nutrients, pathogens, microplastics, organic and inorganic pollutants from wastewater discharge can threaten coastal ecology, biodiversity and affect the health of marine environment users, depending on the sensitivity of the receiving environment. (Wear et al., 2021, Boehm et al., 2017, Chahal et al., 2016, Ziajahromi et al., 2016). High loadings of nutrients may cause increased water eutrophication leading to hypoxic events that promote the mortality of marine organisms, including coral reefs (Altieri et al., 2017, Cheng et al., 2019, Whitehead et al., 2015). Harmful algal blooms (HABs) due to excess nutrient can be a major pose to human health by direct contact with water, consuming contaminated seafood and inhalation of the aerosolised algal toxins (Lim et al., 2023, Berdalet et al., 2023). In addition, eutrophication and HABs may also lead to economic losses for the local businesses that rely on the marine environment (Berdalet et al., 2023, Lemée et al., 2012).

To manage and safeguard aquatic and marine environments around Australia from the impacts of wastewater effluent, state/territory governments have each established Environment Protection Authorities (EPA). Each EPA acts as an independent environmental protection regulator to prevent and control pollutant impacts to human health and the environment. For example, in Victoria the EPA was established under section 5(1) of the Environment Protection Act of 1970. In New South Wales, the Protection of the Environment Administration Act (1991) (POEA Act) served as the mechanism to establish the environmental protection regulator. With regards to wastewater effluent each state or territory EPA has a role in regulating wastewater treatment plant (WWTP) discharges. For example, in New South Wales, the EPA regulates water pollution through the establishment of conditions in environmental protection licences. These licences take into account several factors, such as the community value of a waterway, the community's uses of a waterway and practical measures to prevent deterioration of waterway values and uses (EPA NSW, 2013). Any activity that may produce a discharge of waste that by reason of volume, location or composition adversely affects the quality of any segment of the environment will require a licence from the Authority (DECC NSW, 2009). The basic requirement of the licence consists of an explanation of the activity, pollutant loads and discharge limits. The actual load of a pollutant is the mass (in kilograms) of the pollutant (e.g., nitrogen, phosphorus, total suspended solids, oil and grease) released into the environment from the potential emission sources. Throughout each state and territory, emission sources are required to monitor their discharges and to comply with conditions set out in their licences. Each WWTP is required to conduct monitoring within the vicinity of their outfalls, analyse the samples and report the results to the EPA (DECC NSW, 2009, EPA VIC, 2009).

The National Outfall Database (NOD), developed by the Clean Ocean Foundation in collaboration with state and territory governments, provides policy makers with a guide to help prioritise outfall reform and identify public and private sector opportunities for wastewater recycling (Marine Biodiversity Hub, 2015). In collaboration with the National Environmental Science Program, the NOD also provides Australian water authorities and the public an accessible database to help identify pollutant loads and assess any potential health and environmental impact risks of wastewater outfalls on the marine environment and surrounding communities.  The NOD provides an unprecedented national collection of water quality data, collected by water authorities and local governments according to guidelines set out in Environment Protection Authority (EPA) licences.  Given the NOD's centralised collection of national scale water quality data, the opportunity to examine the comprehensive impacts of wastewater outfalls at regional scales becomes possible.

The aim of this report is to present a collection of discharge monitoring data between July 2020 and June 2021 from outfalls across Australian coastal regions.  This report also ranks each outfall according to the total flow volume and nutrients load to prioritise the potential degree of impact of each source to the environment.  Nutrient load based on treatment levels are also investigated to understand the differences nutrient discharged between each level. In general, the results of this analysis will provide stakeholders and the general community a better understanding of the relative pressures of outfalls to their coastal waterways and provide policy makers and managers evidence to prioritise outfall infrastructure reform and wastewater recycling initiatives.

# 2. Methods

## 2.3 Data collection

Wastewater quality data were collected from 43 water treatment authorities (WTAs) around Australia (Figure 1) by either downloading the water quality data reports directly from WTA websites or by formally requesting the data through email. To standardise data collection, the NOD prepared a document outlining a predefined format in which the data was to be delivered. Through this process, the NOD collected, verified, and published data from 43 WTAs up until 2020/2021 financial year. This report analysed wastewater quality data between 1st of July 2020 to 30th June 2021 inclusive. WTA monitoring requirements varied depending on EPA licence requirements. Therefore, the type of pollutant data monitored varied across all outfall locations. In this report, we assess only nitrogen, phosphorus and flow volume (Table 1), for nutrient loads calculation purposes.

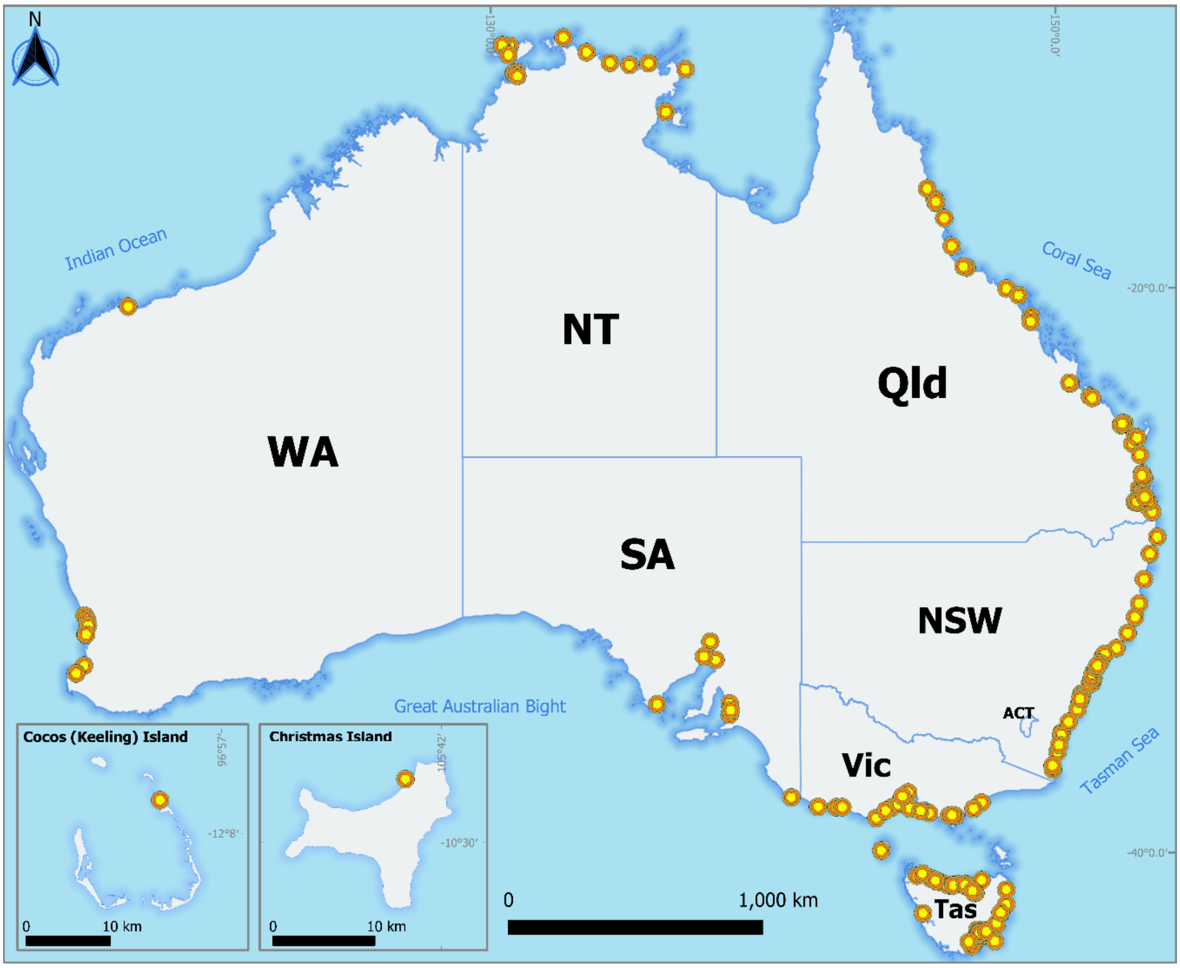


Figure 1. The location of 192 outfall sites managed by 43 water authorities.

Table 1. Number of WWTPs monitored each parameter for 2020/2021 financial year data. In bold, flow volume, total phosphorus and total nitrogen are assessed in this report.

| Parameter | Unit | Number of WWTPs |
|---|---|---|
| **Flow volume** | **ML** | **160** |
| pH | pH | 138 |
| Total dissolved solids | mg/L | 32 |
| Total suspended solids | mg/L | 151 |
| **Total phosphorus** | **mg/L** | **152** |
| **Total nitrogen** | **mg/L** | **152** |
| Oil and grease | mg/L | 84 |
| Surfactants (MBAS) | mg/L | 2 |
| *E. coli* | cfu/100mL | 56 |
| Enterococci | cfu/100mL | 85 |
| Faecal coliforms | cfu/100mL | 73 |
| Turbidity | NTU | 13 |
| Colour | Pt.Co. Units | 7 |
| Algal blooms | cells/mL | 4 |
| Blue green algal bloom | cells/mL | 4 |

Treatment level data were collected from the NOD website (www.outfalls.info) (NOD, 2023b). All analysed sites were then coded into three groups, primary (1), secondary (2) and tertiary (3). The population data of each outfall catchment were also gathered from the Australian Bureau of Statistics (2021).

## 2.4 Data Analysis

The pollutant contribution index, based on nitrogen and phosphorus loads, was calculated for each outfall (Figure 1). Outfalls were ordered from lowest to highest index value to rank them according to their relative pollutant contribution to the coastal and marine environment. The index is based on a total nutrient load discharge (see below) using the variables of flow, and nitrogen and phosphorus concentrations.

Nitrogen and phosphorus (nutrient) load was calculated based on the Load Calculation Protocol (DECC NSW, 2009) using

$$N_l = \sum \frac{(Tf * n) + (Tf * p)}{1000}$$

where, $N_l$ is the total nutrient load in tonnes, calculated for nitrogen ($n$) and phosphorus ($p$) concentrations individually, $Tf$ is the total daily flow from each outfall in megalitres (ML). Nitrogen and phosphorus loads were summed to provide the total nutrient load. Values were sorted and ranked for each outfall location and grouped into four quartiles, top 25% quartile (least nutrient load released), 50% quartile, 75% quartile and bottom quartile (most nutrient load released). The last 10 bottom quartile outfalls were further calculated by population to examine the amount of nutrient load per person. All quartiles were then classed by treatment levels, primary, secondary and tertiary. Those sites with only nitrogen or only phosphorus monitored for 2020/2021 financial year were not considered in the final nutrient load ranking.

# 3. Results

NOD has been consistently collecting data from the WTAs since 2015. As for 2020/2021 financial year, wastewater quality data were collected from 42 out of 43 WTAs with 178 out of 192 outfall sites (93%). Across the last eight years, Queensland, South Australia, Tasmania and Western Australia were able to maintain reliability in providing wastewater quality data (Table 2). Despite the complexity having various individual WTAs in Victoria and New South Wales, the NOD has successfully collected wastewater quality data for the 2020/2021 financial year. Due to various circumstances, the Northern Territory experienced difficulties in providing the requested information.

Table 2. Outfalls wastewater quality data collected for 2020/2021 financial year.

| States/Territory | Number of outfalls | Data collected (%) |
|---|---|---|
| New South Wales | 34 | 100 |
| Northern Territory | 14 | 0 |
| Queensland | 55 | 100 |
| South Australia | 10 | 100 |
| Tasmania | 47 | 100 |
| Victoria | 19 | 100 |
| Western Australia | 12 | 100 |

There were 149 out of 192 outfall sites analysed in this report. This is due to 14 sites were not provided to the NOD and 29 sites have incomplete data. Top (38) and bottom (37) quartiles of the outfall rankings are presented in Table 3. The 2020/2021 financial year data shows that 1,453 gigalitres effluent were released transporting a total nutrient load of 15,429 tonnes, almost five percent less than 2019/2020 financial year data (Rohmana et al., 2021). Total nutrient load from individual outfall sites ranged from 7 to 4,669,238 kg with a mean of 103,552 kg. Compared to Rohmana et al. (2021), New South Wales has improved from four to 14 outfall sites in the current top quartile, while Tasmania slightly declined to 12 outfall sites. Western Australia, Victoria and Queensland each had five, four and two outfall sites, respectively. Only one South Australian outfall recorded in the top quartile. The bottom quartile (highest nutrient load) was represented by 11 outfall sites from Queensland. Tasmania and Victoria each had eight and six sites, respectively. New South Wales, South Australia and Western Australia each had four outfall sites in the bottom quartile.

Table 3. Top 25% (green) and bottom 25% (red) quartiles of outfall ranking for 2020/2021 financial year data. REMS = reclaimed water management scheme, BMS = Boneo, Mt Martha and Somers, ETP = Eastern Treatment Plant.

| Rank | State | Outfall | Total nutrient load (kg) |
|---|---|---|---|
| 1 | New South Wales | Iluka | 7 |
| 2 | Tasmania | Beaconsfield | 21 |
| 3 | Western Australia | Wickham | 97 |
| 4 | New South Wales | Bermagui | 109 |
| 5 | New South Wales | Crescent Head | 125 |
| 6 | Tasmania | Swansea | 164 |
| 7 | Western Australia | Home Island (Cocos Keeling) | 172 |
| 8 | Western Australia | Christmas Island | 206 |
| 9 | Tasmania | Sisters Beach | 248 |
| 10 | New South Wales | Penguin Head (REMS) | 271 |
| 11 | New South Wales | Merimbula | 273 |
| 12 | Western Australia | Busselton (North Wetlands) | 277 |
| 13 | South Australia | Christies Beach - Southern | 311 |
| 14 | New South Wales | Long Nose (Tomakin) | 328 |
| 15 | Tasmania | Cambridge | 366 |
| 16 | Tasmania | Boat Harbour | 386 |
| 17 | New South Wales | Camden Haven | 418 |
| 18 | Victoria | Toora | 422 |
| 19 | New South Wales | Yamba | 491 |
| 20 | New South Wales | Narooma | 504 |
| 21 | Victoria | Port Welshpool | 531 |
| 22 | New South Wales | Ulladulla | 563 |
| 23 | New South Wales | Batemans Bay | 631 |
| 24 | New South Wales | Skennars Head (Lennox Head) | 706 |
| 25 | Tasmania | Triabunna | 817 |
| 26 | Tasmania | Rokeby | 831 |
| 27 | Tasmania | St Helens | 843 |

| Rank | State | Outfall | Total nutrient load (kg) |
|---|---|---|---|
| 28 | New South Wales | Forster | 870 |
| 29 | Tasmania | Dover | 886 |
| 30 | Queensland | Karana Downs | 1,018 |
| 31 | Tasmania | Bicheno | 1,183 |
| 32 | Victoria | Lorne | 1,378 |
| 33 | Western Australia | Busselton (South Wetlands) | 1,390 |
| 34 | Queensland | Bowen | 1,420 |
| 35 | New South Wales | Bombo | 1,490 |
| 36 | Victoria | Apollo Bay | 1,532 |
| 37 | Tasmania | Stanley | 1,734 |
| 38 | Tasmania | Geeveston | 2,083 |
| 113 | New South Wales | Potter Point (Cronulla) | 44,198 |
| 114 | Queensland | Merrimac | 45,930 |
| 115 | Tasmania | Rosny | 47,331 |
| 116 | Tasmania | Newnham | 48,989 |
| 117 | South Australia | Glenelg | 50,076 |
| 118 | Queensland | North Rockhampton | 56,804 |
| 119 | Tasmania | Smithton | 56,870 |
| 120 | Queensland | Elanora | 57,066 |
| 121 | Tasmania | Cameron Bay | 62,161 |
| 122 | Queensland | Wynnum | 68,005 |
| 123 | Queensland | Coombabah | 68,044 |
| 124 | South Australia | Bolivar High Salinity | 70,562 |
| 125 | South Australia | Christies Beach - Northern | 72,320 |
| 126 | Queensland | Gibson Island | 83,354 |
| 127 | Queensland | Loganholme | 85,103 |
| 128 | Tasmania | Prince of Wales Bay | 100,255 |
| 129 | Victoria | Delray Beach | 107,289 |
| 130 | Victoria | Boags Rock (BSM) | 146,310 |
| 131 | Queensland | Oxley | 151,799 |

| Rank | State | Outfall | Total nutrient load (kg) |
|---|---|---|---|
| 132 | New South Wales | Bondi | 156,790 |
| 133 | Tasmania | Ti-tree Bend | 163,687 |
| 134 | Tasmania | Macquarie Point | 166,568 |
| 135 | Victoria | Black Rock | 168,821 |
| 136 | Tasmania | Pardoe | 173,879 |
| 137 | Western Australia | Subiaco | 217,466 |
| 138 | Western Australia | Point Peron (industrial only) | 232,392 |
| 139 | Victoria | Altona | 235,723 |
| 140 | Victoria | Warrnambool | 271,383 |
| 141 | Western Australia | Beenyup | 336,292 |
| 142 | South Australia | Bolivar WWTP | 392,547 |
| 143 | Queensland | Kawana | 396,982 |
| 144 | Queensland | Luggage Point | 403,285 |
| 145 | Western Australia | Woodman Point | 492,031 |
| 146 | New South Wales | North Head | 542,807 |
| 147 | New South Wales | Malabar | 689,587 |
| 148 | Victoria | Boags Rock (ETP) | 3,242,411 |
| 149 | Victoria | Werribee (WTP) | 4,669,238 |

Rank 140 to 149 were further calculated by the population serviced, estimated from the ABS population data (2021) (Table 4 and Figure 2). The ten highest nutrient loads were represented by five states, Victoria (3), Queensland (2), New South Wales (2), Western Australia (2) and South Australia (1). Within this list, Werribee (Western Treatment Plant) released the highest nutrient load of 4,669,238 kg with 1,946 g nutrient load per capita. However, Warrnambool, with the lowest nutrient discharged (271,383 kg), had the highest total nutrient load per capita of 7,637 g.

Table 4. Total nutrient load per capita discharged by ten highest nutrient load producers from the bottom 25% quartile (2020/2021 FY).

| Rank | Outfall | Nitrogen load (kg) | Phosphorus load (kg) | Total nutrient load (kg) | Population (ABS 2021) | Nutrient load/capita (g/C) |
|---|---|---|---|---|---|---|
| 140 | VIC - Warrnambool | 165,107 | 106,276 | 271,383 | 35,533 | 7,637 |
| 141 | WA - Beenyup | 236,486 | 99,806 | 336,292 | 660,000 | 510 |
| 142 | SA - Bolivar WWTP | 323,925 | 68,622 | 392,547 | 470,000 | 835 |
| 143 | QLD - Kawana | 333,526 | 63,456 | 396,982 | 157,169 | 2,526 |
| 144 | QLD - Luggage Point | 296,781 | 106,505 | 403,285 | 807,000 | 500 |
| 145 | WA - Woodman Point | 422,798 | 69,233 | 492,031 | 760,000 | 647 |
| 146 | NSW - North Head | 483,215 | 59,591 | 542,807 | 1,358,440 | 400 |
| 147 | NSW - Malabar | 616,096 | 73,491 | 689,587 | 1,700,000 | 406 |
| 148 | VIC - Boags Rock (ETP) | 2,401,876 | 840,535 | 3,242,411 | 1,900,000 | 1,707 |
| 149 | VIC - Werribee (WTP) | 3,372,907 | 1,296,331 | 4,669,238 | 2,400,000 | 1,946 |

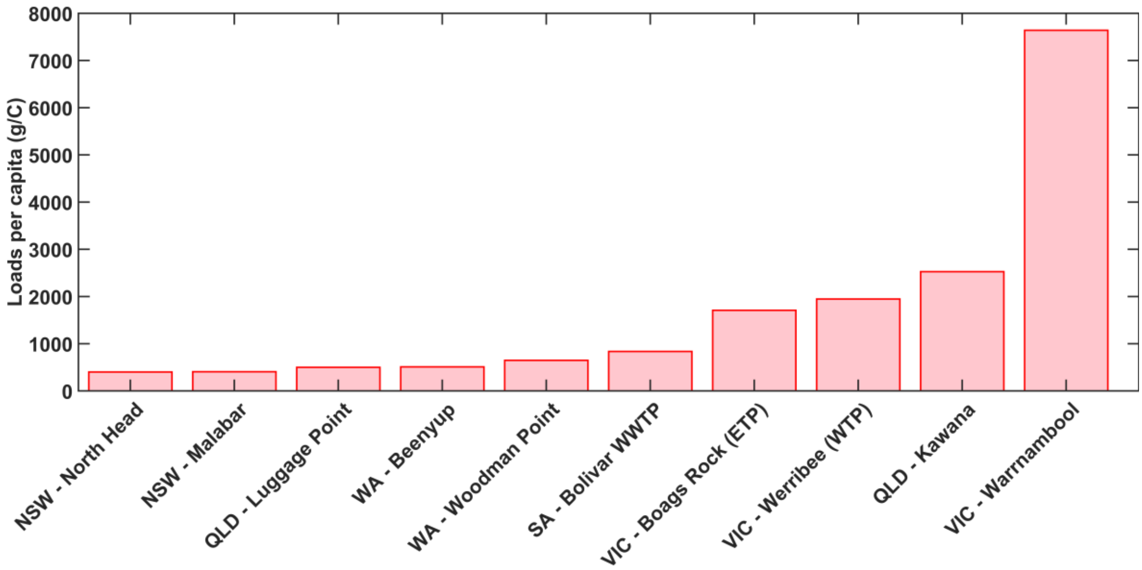


Figure 2. Total nutrient load per capita discharged by ten highest nutrient load producers from the bottom 25% quartile sorted from low (left) to high (right).

The total nutrient loads from each outfall site were grouped by treatment levels (primary, secondary and tertiary) (Table 4; Figure 3). Although primary treatment has the lowest number of outfall sites (6), the discharged load has a median value of 203,136 kg, which is 37 times more than tertiary treatment (5,360 kg) with 61 outfall sites. Secondary treatment is utilised by 82 outfall sites and produces second highest nutrient load (4,039 kg) with the median value of 12,177 kg.

Table 5. A summary and mean of nutrient loads between primary, secondary and tertiary in 2020/2021 financial year data.

| Treatment level | Total nutrient load (kg) | Median nutrient load (kg) | Outfall sites |
|---|---:|---:|---:|
| Primary | 1,815,564 | 203,136 | 6 |
| Secondary | 4,038,994 | 12,177 | 82 |
| Tertiary | 9,574,692 | 5,360 | 61 |

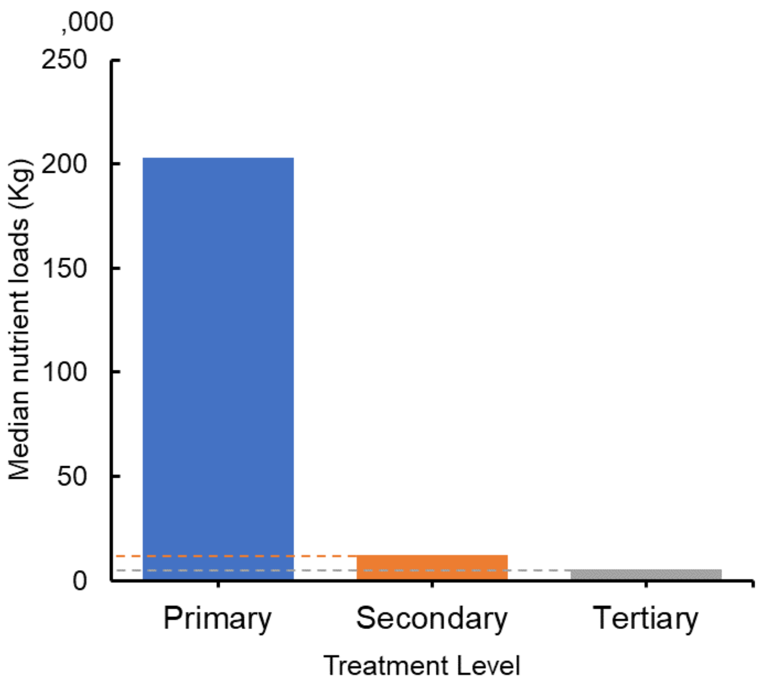


Figure 3. A comparison of average of nutrient loads between primary, secondary and tertiary treatment level in 2020/2021 financial year data.

The boxplot (Figure 4) illustrates the difference between the median contributions of nitrogen and phosphorus in the total nutrient loads across 149 sites. The outliers were removed to show clearer figure. Phosphorus concentrations consistently contribute less to the overall outfall nutrient load and vary less between outfall sites. Meanwhile, nitrogen has a higher median contribution and high variability across all sites. The outfalls contributing higher nitrogen and phosphorus loads vary more than those delivering lower loads.

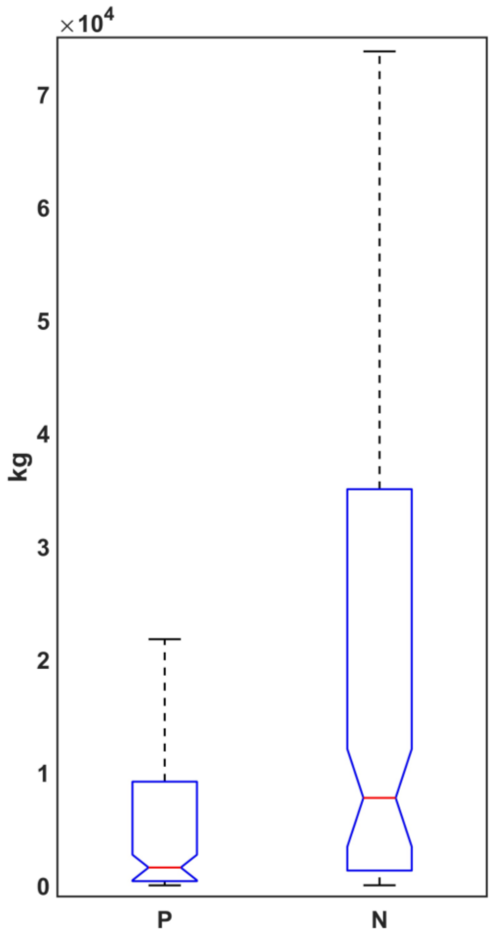


Figure 4. A boxplot of nitrogen (N) and phosphorus (P) loads in kg for each outfall reported data (n = 149).

Figure 5 shows the map of ranked outfalls distribution throughout Australia grouped by quartiles. The top quartile (lowest nutrient load) outfalls are spread dominantly in regional areas which mostly utilise tertiary treatment and discharge less nutrient into the coastal and marine environment. Discharges in the top quartile ranged between 7 to 2,083 kg (Table 3). The 50th and 75th quartiles consist of the outfalls that are mixed of metro and regional areas across six states, which majority operate secondary treatment for their effluent. The bottom quartile with higher nutrient loads appears to occur around the major cities. The total load discharged by this quartile ranged between 44,198 to 4,669,238 kg. Each quartile consisted of 37 outfalls, except the top quartile has 38 sites. The rankings for all outfalls are presented in Appendix A.

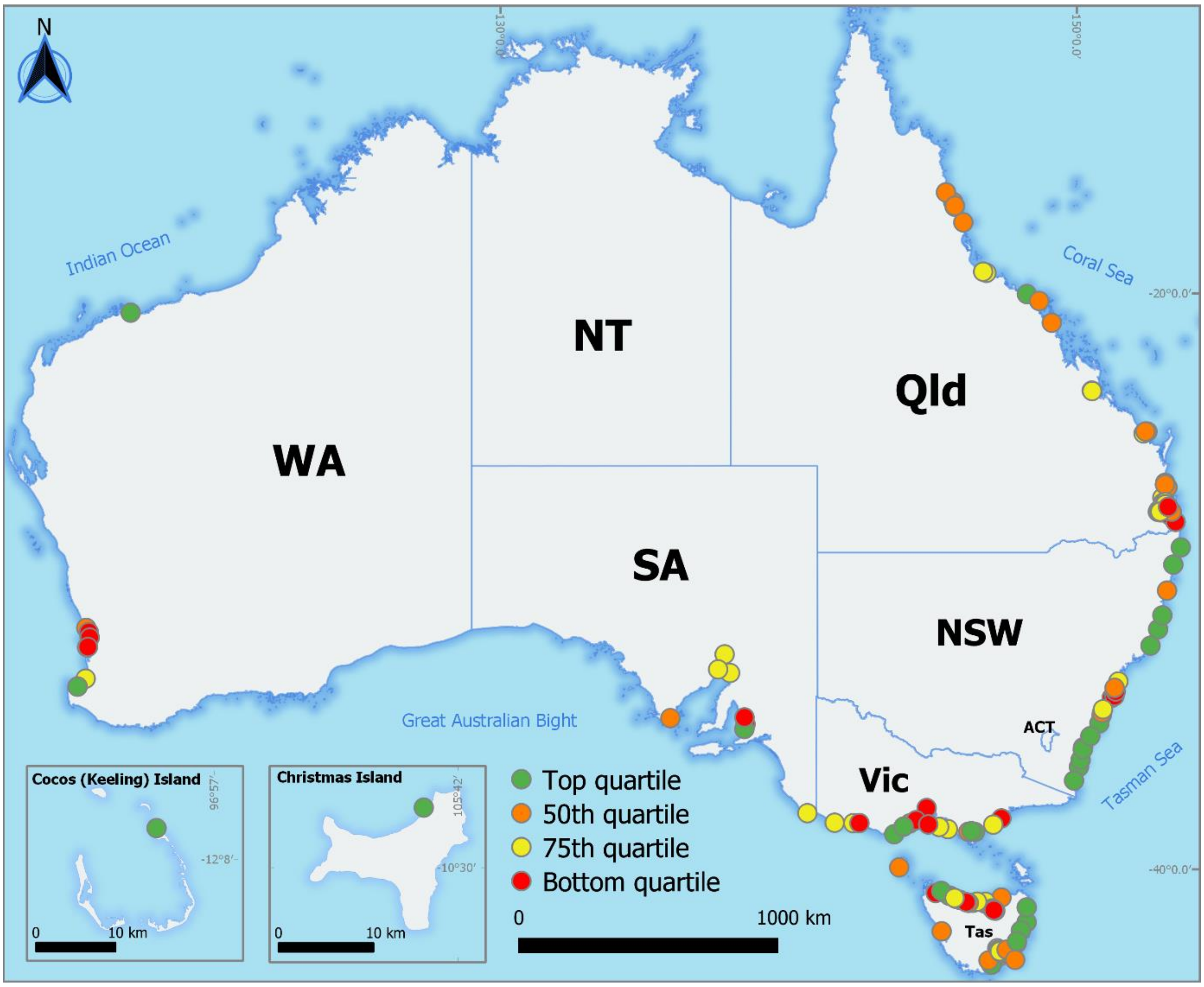


Figure 5. Australian coastal and estuarine/riverine outfalls ranked by quartiles for 2020/2021 financial year data. Cocos (Keeling) and Christmas islands are not in position.

# 4. Discussion

Nitrogen, phosphorus, and flow volume data were collected from 149 (77%) coastal outfall sites across six states, Queensland, New South Wales, Western Australia, South Australia, Victoria and Tasmania. These outfalls were ranked according to their total nutrient load (nitrogen and phosphorus). General patterns show that the highest nutrient loads tend to occur through those outfalls serving metropolitan and surrounding areas. Lower nutrient loads outfalls seem to occur in regional areas, however, the loads varied across individual outfalls. Sites with higher discharge load of nitrogen exhibited greater variability in discharge, compared to sites with lower discharge. This trend is most likely due to high population levels in urban areas which cause increasing in general discharge at metropolitan outfall sites. In addition, higher nutrient loading could be related to high levels of industrial influent to WWTPs within service areas, such as in Pardoe, Tasmania; Warrnambool, Victoria; and Point Peron, Western Australia.

Licence conditions are determined by a variety of factors, including the conditions of the waterway being discharged to, and the community uses of the waterway (EPA NSW, 2013, EPA VIC, 2017). For instance, although it is required to monitor, Pardoe does not have a concentration limit condition for nitrogen and phosphorus, compared to Macquarie Point, TAS that has the concentration limit of 38 mg/L and 8 mg/L for nitrogen and phosphorus, respectively (EPA Tasmania, 1998, EPA Tasmania, 2013). In addition to existing conditions and the uses of waterways, available resources for treatment plant upgrades and community pressure may also contribute to WWTP loading. For example, Boags Rock outfall, serving ETP and BMS, were under significant community pressure in the past and upgraded to tertiary treatment in 2012 (Melbourne Water, 2022). Another example related to the community pressure is the VCAT order for Warrnambool WWTP to upgrade the current wastewater treatment by 31 December 2025 (VCAT, 2021).

Several outfall sites that ranked in the bottom quartile do not have concentration limits for nitrogen and phosphorus in their licence conditions. Despite having no concentration limits, these sites are not considered to be breaching their licences regardless the amount of nitrogen and phosphorus loading into the marine and coastal environments. For example, the Eastern Treatment Plant in Victoria has no nitrogen concentration limit restriction listed in its license (EPA VIC, 2023). This, however, is a tertiary treatment plant which tends to be more efficient at the removal of bacteria and the further reduction of organics, turbidity, nitrogen and phosphorus (Roberts et al., 2010, EPA VIC, 2002, ANZECC and ARMCANZ, 1997). In addition, this plant has been consistently listed in the bottom quartile in the last four years, including current 2020/2021 financial year data, due to high flow volume (Rohmana et al., 2019, Rohmana et al., 2020a, Rohmana et al., 2021).

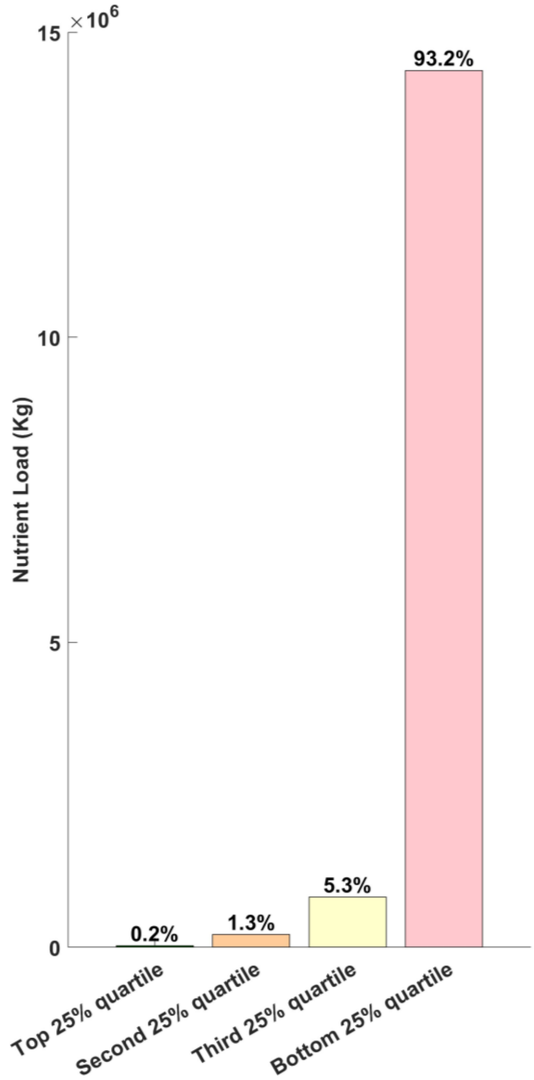


Figure 6. Total nutrient load comparison based on quartile group.

As illustrated here, this ranking and the identification of nutrient loads by site can therefore be useful in prioritising treatment upgrade resources. In addition, the discrepancies in treatment level and license conditions, as well as wastewater reuse policies, warrant further examination at a national scale. The top quartile (38 outfalls) contributes only 0.2% nutrient load, compared to 37 outfalls in the bottom quartile. These contribute over 90% of the overall nutrients loads (Figure 6). This may indicate that bottom quartile outfalls should be the primary target for an upgrade feasibility assessment in order to achieve the greatest benefit per cost in upgrade investment (Blackwell and Gemmill, 2019, Blackwell and Gemmill, 2020, Rohmana et al., 2020b). In addition, some sites (e.g., Richmond in Tasmania and Lucinda in Queensland) reported zero discharge (NOD, 2023c, NOD, 2023a). These sites are already fully recycling and diverting their wastewater to agricultural use, highlighting the success of a program that could be implemented in other areas.

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# Appendix A – Outfall ranking

Table 6. Outfall rankings based on the total nutrients (Kg) for the 2020/2021 financial year data.

| Rank | State | Location | Treatment Level | Total nutrient (Kg) |
|---|---|---|---|---|
| 1 | New South Wales | Iluka | Tertiary | 7 |
| 2 | Tasmania | Beaconsfield | Secondary | 21 |
| 3 | Western Australia | Wickham | Tertiary | 97 |
| 4 | New South Wales | Bermagui | Tertiary | 109 |
| 5 | New South Wales | Crescent Head | Secondary | 125 |
| 6 | Tasmania | Swansea | Secondary | 164 |
| 7 | Western Australia | Home Island | Secondary | 172 |
| 8 | Western Australia | Christmas Island | Secondary | 206 |
| 9 | Tasmania | Sisters Beach | Tertiary | 248 |
| 10 | New South Wales | REMS | Tertiary | 271 |
| 11 | New South Wales | Merimbula | Tertiary | 273 |
| 12 | Western Australia | North Wetlands | Secondary | 277 |
| 13 | South Australia | Southern outfall | Tertiary | 311 |
| 14 | New South Wales | Tomakin | Tertiary | 328 |
| 15 | Tasmania | Cambridge | Tertiary | 366 |
| 16 | Tasmania | Boat Harbour | Tertiary | 386 |
| 17 | New South Wales | Camden Head | Tertiary | 418 |
| 18 | Victoria | Toora | Secondary | 422 |
| 19 | New South Wales | Yamba | Tertiary | 491 |
| 20 | New South Wales | Narooma | Tertiary | 504 |
| 21 | Victoria | Port Welshpool | Secondary | 531 |
| 22 | New South Wales | Ulladulla | Tertiary | 563 |
| 23 | New South Wales | Batemans Bay | Tertiary | 631 |
| 24 | New South Wales | Skennars Head | Tertiary | 706 |
| 25 | Tasmania | Triabunna | Secondary | 817 |
| 26 | Tasmania | Rokeby | Tertiary | 831 |
| 27 | Tasmania | St Helens | Tertiary | 843 |
| 28 | New South Wales | Forster | Tertiary | 870 |
| 29 | Tasmania | Dover | Secondary | 886 |
| 30 | Queensland | Karana Downs | Secondary | 1,018 |

| Rank | State | Location | Treatment Level | Total nutrient (Kg) |
|---|---|---|---|---|
| 31 | Tasmania | Bicheno | Secondary | 1,183 |
| 32 | Victoria | Lorne | Tertiary | 1,378 |
| 33 | Western Australia | South Wetlands | Secondary | 1,390 |
| 34 | Queensland | Bowen | Secondary | 1,420 |
| 35 | New South Wales | Bombo | Secondary | 1,490 |
| 36 | Victoria | Apollo Bay | Tertiary | 1,532 |
| 37 | Tasmania | Stanley | Secondary | 1,734 |
| 38 | Tasmania | Geeveston | Secondary | 2,083 |
| 39 | Tasmania | Cygnet | Secondary | 2,425 |
| 40 | Queensland | Port Douglas | Tertiary | 2,474 |
| 41 | Tasmania | Orford | Secondary | 2,602 |
| 42 | Victoria | Anglesea | Tertiary | 2,649 |
| 43 | Tasmania | Sorell | Secondary | 2,663 |
| 44 | Tasmania | Currie | Secondary | 3,261 |
| 45 | Tasmania | Risdon | Secondary | 3,692 |
| 46 | New South Wales | Coffs Harbour | Tertiary | 3,697 |
| 47 | Queensland | Landsborough | Secondary | 3,780 |
| 48 | Tasmania | Strahan | Secondary | 3,917 |
| 49 | Tasmania | Beauty Point | Secondary | 4,114 |
| 50 | Queensland | Fairfield | Secondary | 4,171 |
| 51 | Queensland | Cannonvale | Tertiary | 4,181 |
| 52 | Queensland | Thorneside | Tertiary | 4,604 |
| 53 | Queensland | Capalaba | Tertiary | 4,699 |
| 54 | Queensland | Bargara | Tertiary | 4,711 |
| 55 | Queensland | Edmonton | Tertiary | 4,737 |
| 56 | Victoria | Foster | Secondary | 4,935 |
| 57 | Queensland | Victoria Point | Tertiary | 5,076 |
| 58 | Queensland | Innisfail | Tertiary | 5,360 |
| 59 | Queensland | Nambour | Secondary | 5,381 |
| 60 | Tasmania | Bridport | Secondary | 5,716 |
| 61 | Western Australia | Alkimos | Secondary | 5,736 |
| 62 | New South Wales | Shellharbour | Secondary | 6,190 |
| 63 | Tasmania | Somerset | Secondary | 6,361 |
| 64 | Queensland | Woree | Tertiary | 6,682 |

| Rank | State | Location | Treatment Level | Total nutrient (Kg) |
| --- | --- | --- | --- | --- |
| 65 | Queensland | Rubyanna | Tertiary | 6,907 |
| 66 | Tasmania | Turners Beach | Secondary | 7,115 |
| 67 | Western Australia | East Rockingham | Secondary | 7,122 |
| 68 | Queensland | Marlin Coast | Tertiary | 7,393 |
| 69 | New South Wales | Warriewood | Secondary | 7,464 |
| 70 | Tasmania | Port Arthur | Secondary | 7,970 |
| 71 | Tasmania | Legana | Secondary | 8,931 |
| 72 | Queensland | Mackay North | Tertiary | 9,754 |
| 73 | Queensland | Coolum | Secondary | 10,047 |
| 74 | South Australia | Port Lincoln | Secondary | 10,375 |
| 75 | Tasmania | George Town | Secondary | 10,439 |
| 76 | Queensland | Mt St John | Tertiary | 10,552 |
| 77 | Queensland | Millbank | Tertiary | 11,098 |
| 78 | Queensland | Wacol | Secondary | 11,738 |
| 79 | Queensland | Maroochydore | Secondary | 12,617 |
| 80 | South Australia | Whyalla | Secondary | 14,344 |
| 81 | Queensland | Burpengary East | Secondary | 14,908 |
| 82 | Queensland | Beenleigh | Tertiary | 15,113 |
| 83 | Tasmania | Burnie | Tertiary | 15,527 |
| 84 | South Australia | Port Augusta | Secondary | 15,759 |
| 85 | Victoria | Portland | Secondary | 16,095 |
| 86 | Tasmania | Selfs Point | Tertiary | 16,280 |
| 87 | Tasmania | Hoblers Bridge | Secondary | 16,862 |
| 88 | Queensland | Carole Park | Secondary | 17,635 |
| 89 | New South Wales | Kincumber | Secondary | 17,811 |
| 90 | Tasmania | Bridgewater | Secondary | 18,374 |
| 91 | Queensland | Sandgate | Secondary | 18,508 |
| 92 | Queensland | Luggage Point Advanced | Tertiary | 19,863 |
| 93 | Tasmania | Port Sorell | Secondary | 19,896 |
| 94 | Victoria | McGaurans | Primary | 20,109 |
| 95 | Queensland | Goodna | Secondary | 21,227 |
| 96 | Tasmania | Blackmans Bay | Secondary | 21,434 |
| 97 | South Australia | Port Pirie | Secondary | 21,813 |
| 98 | Queensland | Redcliffe | Secondary | 22,147 |

| Rank | State | Location | Treatment Level | Total nutrient (Kg) |
|---|---|---|---|---|
| 99 | Queensland | Murrumba Downs | Secondary | 22,206 |
| 100 | Queensland | South Rockhampton | Tertiary | 24,424 |
| 101 | Victoria | Cowes | Tertiary | 24,643 |
| 102 | Victoria | Port Fairy | Tertiary | 27,400 |
| 103 | Western Australia | Bunbury | Secondary | 27,537 |
| 104 | Queensland | Bundamba | Secondary | 28,126 |
| 105 | Tasmania | Riverside | Secondary | 30,007 |
| 106 | Queensland | Caboolture South | Secondary | 30,899 |
| 107 | New South Wales | Coniston Beach (Wollongong) | Tertiary | 32,799 |
| 108 | Tasmania | Wynyard | Secondary | 33,644 |
| 109 | South Australia | Finger Point | Secondary | 34,117 |
| 110 | Victoria | Baxters Beach | Secondary | 34,425 |
| 111 | Queensland | Cleveland Bay | Tertiary | 40,650 |
| 112 | Tasmania | Ulverstone | Secondary | 41,876 |
| 113 | New South Wales | Cronulla | Tertiary | 44,198 |
| 114 | Queensland | Merrimac | Tertiary | 45,930 |
| 115 | Tasmania | Rosny | Secondary | 47,331 |
| 116 | Tasmania | Newnham | Secondary | 48,989 |
| 117 | South Australia | Glenelg | Tertiary | 50,076 |
| 118 | Queensland | North Rockhampton | Tertiary | 56,804 |
| 119 | Tasmania | Smithton | Secondary | 56,870 |
| 120 | Queensland | Elanora | Tertiary | 57,066 |
| 121 | Tasmania | Cameron Bay | Secondary | 62,161 |
| 122 | Queensland | Wynnum | Secondary | 68,005 |
| 123 | Queensland | Coombabah | Tertiary | 68,044 |
| 124 | South Australia | Bolivar | Tertiary | 70,562 |
| 125 | South Australia | Northern outfall | Tertiary | 72,320 |
| 126 | Queensland | Gibson Island | Secondary | 83,354 |
| 127 | Queensland | Loganholme | Secondary | 85,103 |
| 128 | Tasmania | Prince of Wales Bay | Secondary | 100,255 |
| 129 | Victoria | Delray Beach | Tertiary | 107,289 |
| 130 | Victoria | BMS | Tertiary | 146,310 |
| 131 | Queensland | Oxley | Secondary | 151,799 |
| 132 | New South Wales | Bondi | Primary | 156,790 |

| Rank | State | Location | Treatment Level | Total nutrient (Kg) |
|---|---|---|---|---|
| 133 | Tasmania | Ti-tree Bend | Secondary | 163,687 |
| 134 | Tasmania | Macquarie Point | Secondary | 166,568 |
| 135 | Victoria | Black Rock | Tertiary | 168,821 |
| 136 | Tasmania | Pardoe | Primary | 173,879 |
| 137 | Western Australia | Subiaco | Tertiary | 217,466 |
| 138 | Western Australia | Point Peron | Primary | 232,392 |
| 139 | Victoria | Altona | Tertiary | 235,723 |
| 140 | Victoria | Warrnambool | Secondary | 271,383 |
| 141 | Western Australia | Beenyup | Secondary | 336,292 |
| 142 | South Australia | Bolivar WWTP | Secondary | 392,547 |
| 143 | Queensland | Kawana | Secondary | 396,982 |
| 144 | Queensland | Luggage Point | Secondary | 403,285 |
| 145 | Western Australia | Woodman Point | Secondary | 492,031 |
| 146 | New South Wales | North Head | Primary | 542,807 |
| 147 | New South Wales | Malabar | Primary | 689,587 |
| 148 | Victoria | Boags Rock (ETP) | Tertiary | 3,242,411 |
| 149 | Victoria | Werribee (WTP) | Tertiary | 4,669,238 |
| **Total** | | | | **15,429,250** |

Note:

= Top quartile

= 50th quartile

= 75th quartile

= Bottom quartile

# Appendix B - Outfalls histogram

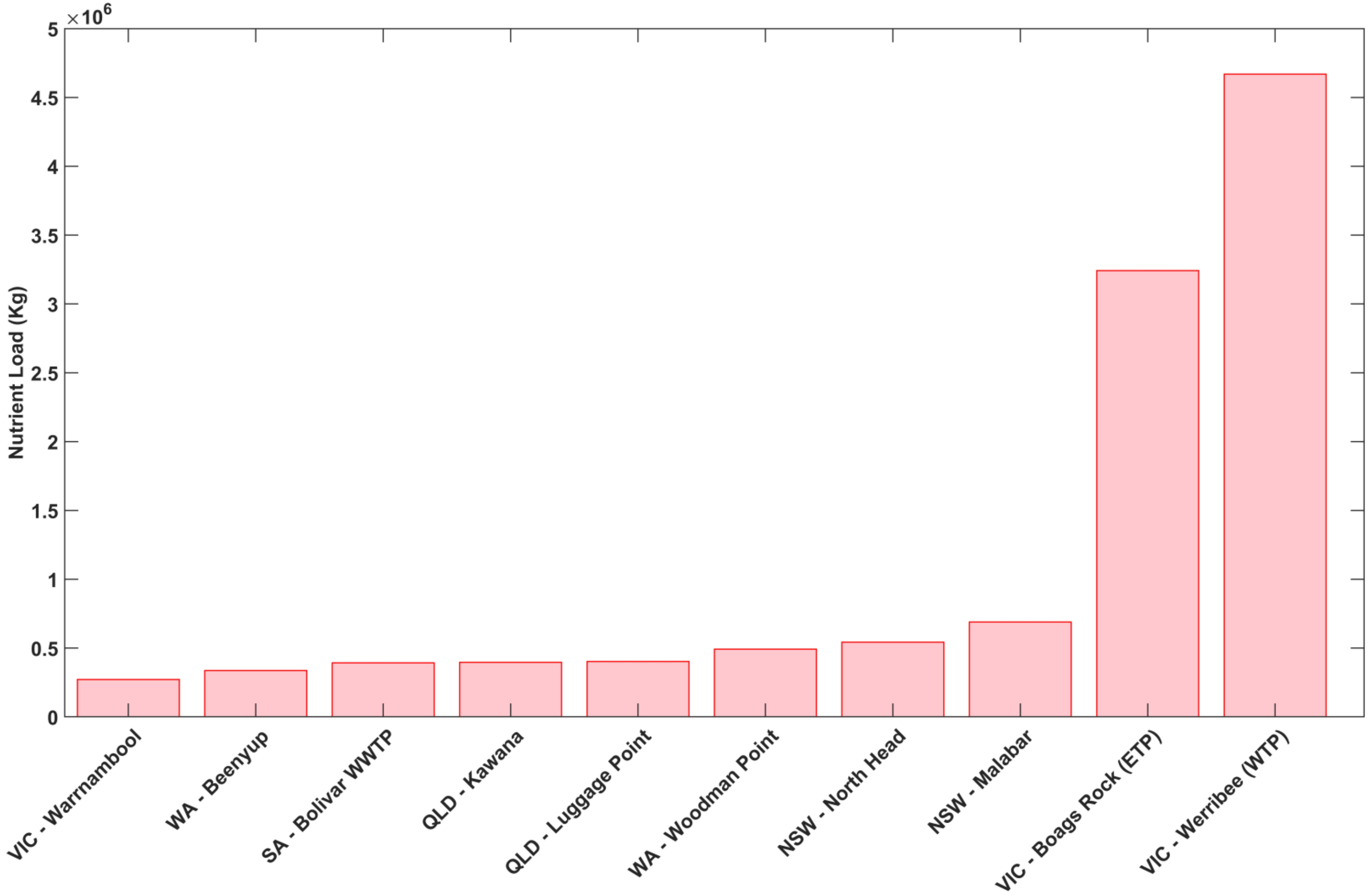


Figure 7. Ten outfalls with highest nutrient load discharged from the bottom 25% quartile.

# Appendix C – Distribution list

| | |
|---|---|
| Clean Ocean Foundation | John Gemmill |
| University of Tasmania | Andrew Fischer |
| | |
| **Federal** | |
| Minister for Environment and Water | The Hon. Tanya Plibersek MP |
| Assistant Minister for Waste Reduction and Environmental Management | The Hon. Trevor Evans MP |
| Minister for Agriculture, Fisheries and Forestry and Emergency Management | Senator the Hon. Murray Watt |
| Minister for Infrastructure, Transport, Regional Development and Local Government | The Hon. Catherine King MP |
| Minister for Health and Aged Care | The Hon. Mark Butler MP |
| Senator for Victoria | Senator Linda White |
| | |
| **Victoria** | |
| Minister for Environment | Ingrid Stitt MLC |
| Minister for Water | The Hon. Harriet Shing MLC |
| EPA Victoria | Lee Miezis |
| EPA Victoria - Victoria's Chief Environmental Scientist | Prof. Mark Patrick Taylor |
| Barwon Water | Luke Christie |
| Greater Western Water (Previously City West Water) | Joshua Mah |
| Gippsland Water | Boon Huang Goo |
| Melbourne Water | Marcus Mulcare |
| South East Water | Ben Spedding |
| South Gippsland Water | Bree Wiggins |

| | |
|---|---|
| Wannon Water | Jimena Harrington |
| Westernport Water | Johanna Randall |
| | |
| **New South Wales** | |
| Minister for Environment | The Hon. Penny Sharpe, MLC |
| Minister for Water | The Honourable Rose Jackson MLC |
| EPA New South Wales – Chief Executive Officer | Tony Chappel |
| Bega Valley Shire Council | Ken McLeod |
| Ballina Shire | Thomas Lees |
| Clarence Valley | Greg Mashiah |
| Coffs Harbour | Sam Pinnuck |
| Kempsey | Bobbie Brenton |
| Port Macquarie-Hastings Shire | Belinda Green |
| Midcoast City Council | Craig Dowler |
| Hunter Water | Darren Cleary |
| Sydney Water | Sharmila Lakshmanaa |
| Shoalhaven City Council | Daniel Page |
| Eurobodalla Shire Council | Brett Corven |
| Central Coast Council | Stephen Shinners |
| | |
| **Queensland** | |
| Minister for the Environment and the Great Barrier Reef | The Hon. Meaghan Scanlon MP |
| Minister for Water | The Hon. Glenn Butcher MP |
| Department of Environment and Science (WaTERs) | Dr Vaitea Pambrun |
| | |

| | |
|---|---|
| **Northern Territory** | |
| Minister for Environment, Climate Change and Water Security | The Hon. Lauren Moss ML |
| EPA Northern Territory | Dr Paul Vogel AM |
| Power and Water Corporation | Ms Djuna Pollard |
| | |
| **Western Australia** | |
| Minister for Environment | The Hon. Reece Whitby MLA |
| Minister for Water | The Hon. Simone McGurk MLA |
| EPA Western Australia - Director General of the DWER | Ms Michelle Andrews |
| EPA Western Australia | Prof. Matthew Tonts |
| Water Corporation | Gillian Griffin |
| | |
| **South Australia** | |
| Minister for Climate, Environment and Water | The Hon. Susan Close MP |
| EPA South Australia | Keith Baldry |
| SA Water – Chief Executive Officer | David Ryan |
| SA Water | Julia De Cicco |
| | |
| **Tasmania** | |
| Minister for Environment and Climate Change | The Hon. Roger Jaensch MP |
| Minister for Primary Industries and Water | The Hon. Jo Palmer MLC |
| EPA Tasmania | Jason De Weys |
| TasWater | Kate Westgate |

| | |
|---|---|
| **Other Bodies** | |

| | |
|---|---|
| Australia Institute | Richard Dennis |
| Australia New Zealand Society for Ecological Economics | Dr Boyd Blackwell |
| Australian Conservation Foundation | Liana Downey |
| Environment Victoria | Tyler Rotche |
| Friends of the Earth | Cam Walker |
| Ocean Decade Australia | Jas Chambers |
| ORCV | Tim Boucat |
| SO Shire | Sarah-Jo Lobwein |
| Surfrider Australia | Damien Cole |
| Water Services Association Australia | Adam Lovell |
| Western Sydney University | Assoc Professor Ian Wright |

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This project is supported with funding
from the Australian Government under the
National Environmental Science Program.