Marine Biodiversity Hub

National Environmental Science Programme

National Outfall Database Ranking Report 2017-2018

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Important Disclaimer

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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 load to prioritise the potential degree of impact of each source to the environment and human health. Water quality data were collected from 42 Water Treatment Authorities (WTAs) 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 phosphorous loads, was calculated for each outfall. Nitrogen and phosphorous 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 phosphorous.

The results showed that total nutrient load from individual outfalls sites around Australia ranged from 90.4 to 14,324,559.1 kg with a mean of 420,398.19 kg. The ranked loads throughout Australia were mapped by quartiles. The top quartile (lowest nutrient load) of outfalls seem to be more prevalent in regional areas and discharge less nitrogen and phosphorus loads into the coastal and marine environment. The bottom quartile, on the other hand, with higher nutrient loads appear to occur around the major cities. The phosphorous concentrations contribute less to the overall outfall nutrient load and vary less between outfall site. Nitrogen, on the other hand has a higher median contribution and high variability across the sites.

In general, the outfalls contributing higher nitrogen and phosphorous loads vary more than those delivering lower loads. There may be many reasons for this, but it could be related to the capacities of the treatment plants and storm water management in urban areas, resulting in increased in discharge at metropolitan outfall sites. There are some exceptions to this pattern with rural/regional sites contributing higher nutrient loads than urban areas. The reasons for them may vary, however, they may primarily be due to the conditions set out in their licenses. This ranking of nutrient loads from Australian outfalls by site at a national scale can therefore be useful in prioritizing treatment upgrade resources to manage biodiversity impacts and human health concerns.

1. INTRODUCTION

Wastewater disposal into the marine environment is one of the main factors leading to the deterioration of coastal water quality. Poorly managed disposal can lead to increased concentrations of nutrients, organic and inorganic pollutants, as well as alter levels of turbidity, pH and bacteria ((Beck and Birch, 2012, Carey and Migliaccio, 2009, Cheung et al., 2015). An increase in the level of pollutants can have an impact on coastal ecology and biodiversity and affect the health of recreational users (Schwarzenbach et al., 2010, Boehm et al., 2017, Burd et al., 2012, Eugenia et al., 2016).

In order 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 environments. For example, in Victoria the EPA was established under section 5(1) of the Environmental Protection Act of 1970. In New South Wales, the Protection of the Environment Administration Act (1991) (POEA Act) served as the mechanisms 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 licenses. These licenses 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, phosphorous, 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 be in compliance with the conditions set out in their licenses. 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 States and Territories Government, 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 Programme – Marine Biodiversity Hub, 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 sewerage 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 Environmental Protection Authority (EPA) licenses. Given the NOD's centralized collection of national scale water quality data the opportunity to examine the comprehensive impacts of sewerage outfalls at regional scales becomes possible.

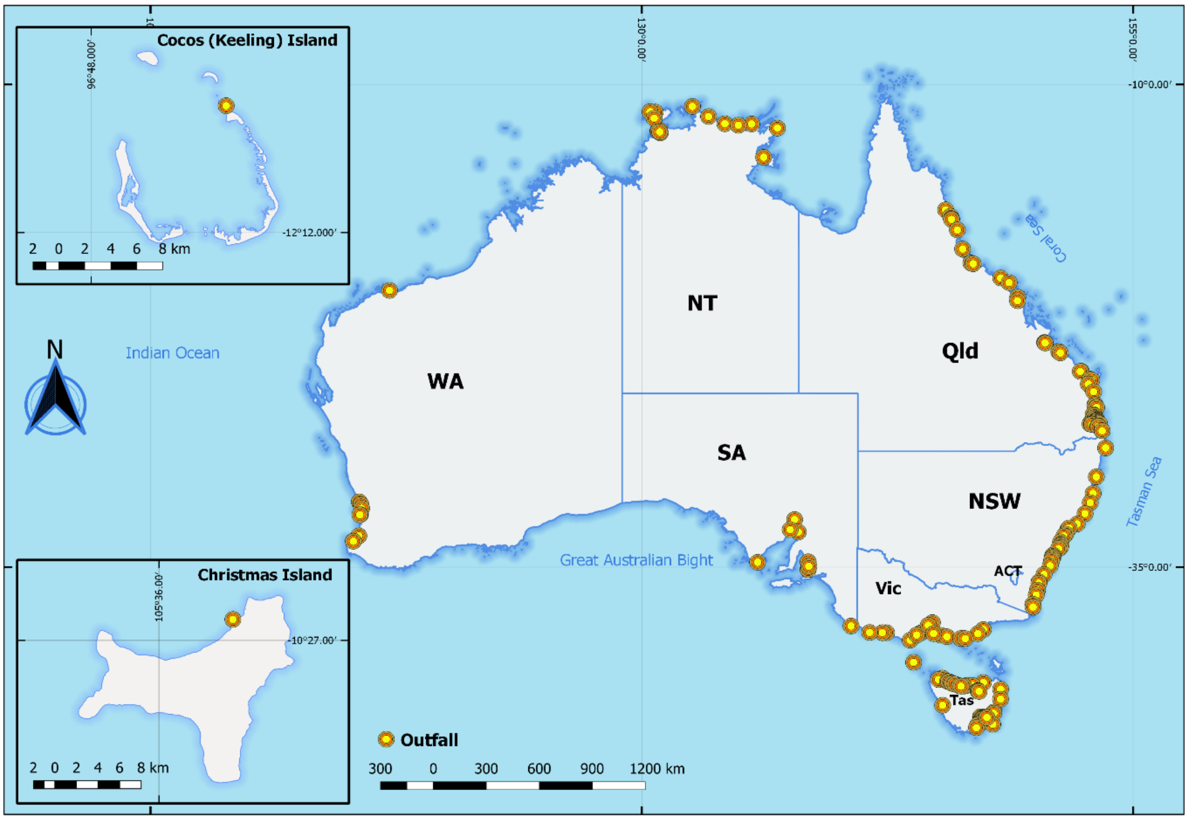
The aim of this report is to present a comprehensive collection of discharge monitoring data between 2017 and 2018 from outfalls across Australian coastal regions. This report also ranks each outfall according to the total flow volume and nutrients load to prioritise the potential degree of impact of each source to the environment and human health. In general, the results of this analysis will be able to provide stakeholders and the general community a better understanding of the relative impacts of outfalls to their coastal waterways and provide policy makers and managers evidence to prioritise outfall infrastructure reform and wastewater recycling initiatives.

2. METHODS

2.1 Data collection

Water quality data were collected from 42 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 standardize 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 42 WTAs for the 2015 to 2018 calendar years. Only 2017 and 2018 are provided in this report, as 2015 and 2016 were reported in Rohmana et al. (2018). WTA monitoring requirements varied depending on EPA license requirements. Therefore, the type of pollutant data monitored varied across all outfall locations. In this report, we only asses only nitrogen, phosphorus and flow volume (Table 1), as these three indicators were commonly measured across all WTAs. To determine the total flow volume per capita of discharge from the WWTP, the total discharge volume was divided by the approximate population within each outfall service areas, based on data provided by the Australian Bureau of Statistics (Australian Bureau of Statistics, 2017). These estimates derive population numbers from the total number of houses, commercial and industrial properties service by a local WTA.

Figure 1.The location of 181 wastewater discharge points managed by 42 water treatment authorities around Australia.



2.2 Data Analysis

The pollutant contribution index, based on nitrogen and phosphorous 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 phosphorous concentrations.

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

$$N_l = \sum_{n,p} \frac{Tf * N_a}{1000}. (1)$$

where, N_l is the total nutrient load in tonnes, calculated for nitrogen and phosphorous individually, Tf is the total annual flow from each outfall in megalitres (ML) and N_a is the annual average nutrient concentration in mg/L. Nitrogen and phosphorous loads were summed to provide the total nutrient load. Values were sorted and ranked for each outfall location for 140 outfall locations and grouped into quartiles. Those sites with incomplete data for 2017-2018 were not considered in the final ranking.

3. RESULTS

Top and bottom quartiles of the outfall rankings are presented in Table 1. Total nutrient load from individual outfalls sites ranged from 90.4 to 14,324,559.1 kg with a mean of 420,398.19 kg. Tasmania had 15 outfall sites in the top quartile (lowest nutrient load). South Australia and the Northern Territory each had only one and zero outfalls in the top quartile. New South Wales, Victoria and Queensland each had five and Western Australia had four. The bottom quartile (highest nutrient load) was represented by eight outfalls from New South Wales, six each from Tasmania and Queensland, and five, four, three and three from Victoria, Western Australia, the Northern Territory and South Australia, respectively. The mean nutrient load from the top quartile was 2618 kg and 1,615,801 kg

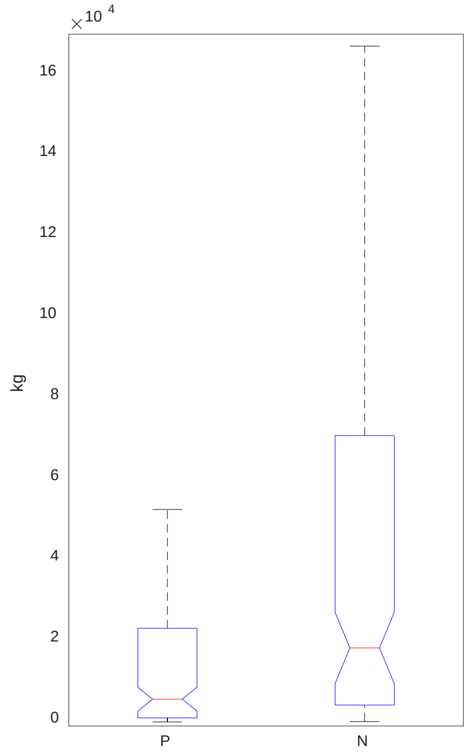
Table 1. Top (green) and bottom (red) quartiles of outfall ranking.

Outfall	Nutrients Load (kg)	State	Rank
Iluka	90	New South Wales	1
Christies Beach-Southern	287	South Australia	2
Home Island	359	Western Australia	3
Port Welshpool	414	Victoria	4
Sisters Beach	476	Tasmania	5
Boat Harbour	490	Tasmania	6
Busselton (North)	567	Western Australia	7
Bicheno	646	Tasmania	8
St Helens	729	Tasmania	9
Busselton (South)	1339	Western Australia	10
Dover	1349	Tasmania	11
Crescent Head	1357	New South Wales	12
Christmas Island	1691	Western Australia	13
Bermagui	1900	New South Wales	14
Cambridge/airport	2041	Tasmania	15
Orford	2051	Tasmania	16
Anglesea	2234	Victoria	17
Port Arthur	2287	Tasmania	18
Apollo Bay	2379	Victoria	19
Stanley	2393	Tasmania	20
Karana Downs	2748	Queensland	21
Lorne WRP	2872	Victoria	22
Camden Haven	2901	New South Wales	23
Risdon (east)	3449	Tasmania	24
Electrona	3858	Tasmania	25
Cygnet	4139	Tasmania	26
Port Douglas	4258	Queensland	27
Currie	4805	Tasmania	28
East Strahan	4830	Tasmania	29
Cannonvale	4881	Queensland	30

Outfall	Nutrients Load (kg)	State	Rank
Bridgewater	5008	Tasmania	31
Landsborough	5376	Queensland	32
Victoria Point	5598	Queensland	33
Foster	5624	Victoria	34
Merimbula	6219	New South Wales	35
North Rockhampton	104646	Queensland	106
Gibson Island	108970	Queensland	107
Loganholme	113088	Queensland	108
Smithton	122576	Tasmania	109
Coombabah	132233	Queensland	110
Blackmans Bay	137078	Tasmania	111
Boags Rock (Boneo)	151645	Victoria	112
Ti-tree Bend	178405	Tasmania	113
Prince of Wales Bay	180990	Tasmania	114
Oxley	193897	Queensland	115
Macquarie Point	238933	Tasmania	116
Shellharbour	240151	New South Wales	117
Palmerston	242436	Northern Territory	118
Black Rock	245826	Victoria	119
Leanyer Sanderson	252787	Northern Territory	120
Winney Bay (Kincumber)	261452	New South Wales	121
Ludmilla	267783	Northern Territory	122
Pardoe	305653	Tasmania	123
Warrnambool WRP	307302	Victoria	124
Glenelg	383036	South Australia	125
Warriewood	429849	New South Wales	126
Subiaco	573772	Western Australia	127
Bolivar High Salinity	604478	South Australia	128
Bolivar WWTP	685004	South Australia	129
Point Peron	692652	Western Australia	130
Potter Point (Cronulla)	911183	New South Wales	131
Luggage Point	925360	Queensland	132
Coniston Beach (Wollongong)	1186472	New South Wales	133
Beenyup	1514724	Western Australia	134
Woodman Point	2345688	Western Australia	135
Boags Rock (ETP)	3669779	Victoria	136
Bondi	4527083	New South Wales	137
Port Phillip Bay (WTP)	7988464	Victoria	138
North Head	12005094	New South Wales	139
Malabar	14324559	New South Wales	140

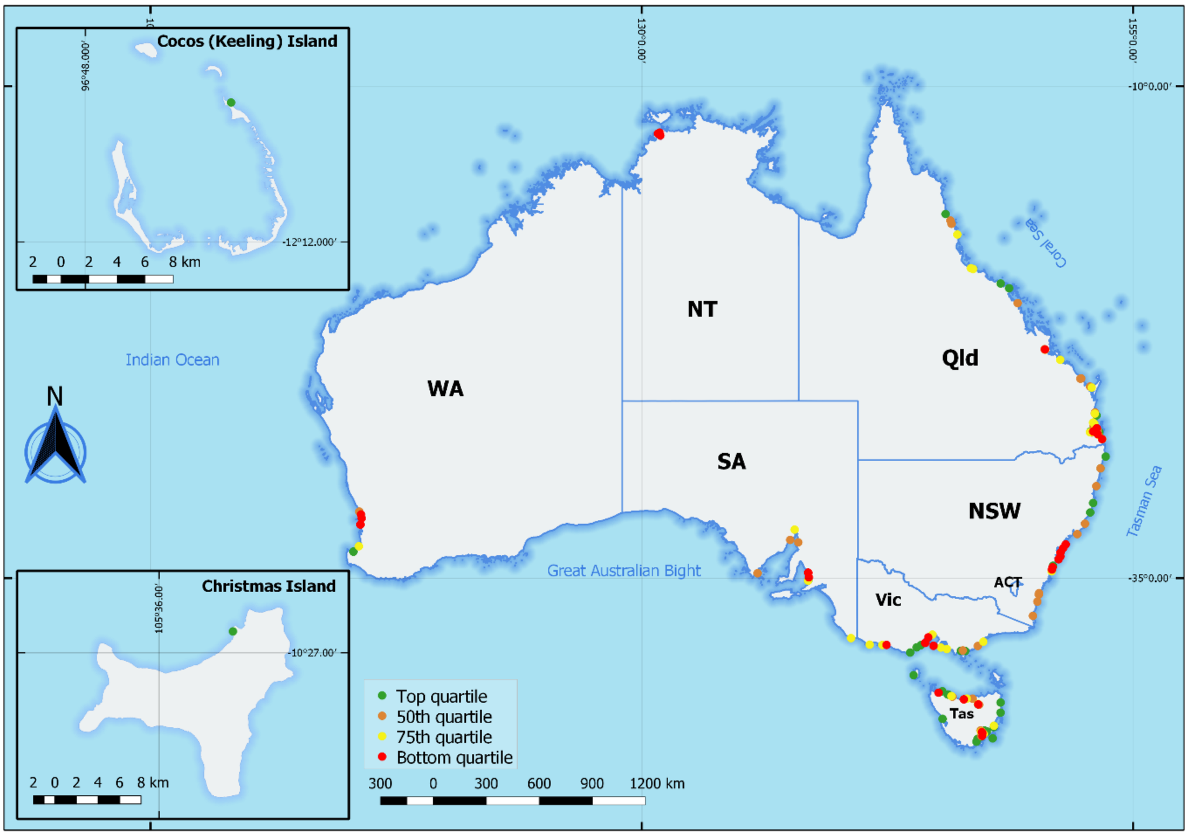
The boxplot (Figure 2), with outliers removed, shows the difference between the median contributions of nitrogen and phosphorous in the total nutrient load. Phosphorous concentrations contribute less to the overall outfall nutrient load and vary less between outfall site. Nitrogen, on the other hand has a higher median contribution and high variability across the sites. The outfalls contributing higher nitrogen and phosphorous loads vary more than those delivering lower loads.

Figure 2. A boxplot of nitrogen (N) and phosphorous (P) loads (kg) for each outfall's reported data (n=140).



The map in Figure 3 shows the distribution ranked outfalls throughout Australia outfalls grouped by quartiles. The top quartile (lowest nutrient load) of outfalls seem to be more prevalent in regional areas and discharge less nitrogen and phosphorus loads into the coastal and marine environment. Discharges in the top quartile ranged between 90 to 6,219 kg (Table 1). The bottom quartile, on the other hand, with higher nutrient loads appear to occur around the major cities. The total load discharged by this quartile ranged between 104,646 to 14,324,559 kg. Each quartile consisted of 35 outfalls. The rankings for all the outfalls appear in Appendix A.

Figure 3. Australian coastal and river/estuary outfalls ranked by quartiles.



4. DISCUSSION

Nutrient concentrations and discharge flow data was collected from 171 outfalls around Australia. These outfalls were ranked according to their combined nutrient load (nitrogen and phosphorous). General patterns show that the highest nutrient loads tend to occur through those outfalls serving metropolitan and surrounding areas. Outfalls with lower nutrient loads seem to occur in regional areas, however, the loads varied across individual outfalls. The nitrogen and phosphorous loads seemed vary more across sites with higher nutrient loads. This may simply be related to the high population levels in urban areas and the resulting increase in general discharge at metropolitan and outfall sites. There are some exceptions to this pattern, with rural/regional sites contributing higher nutrient loads than urban areas. These include places such as Smithton in Tasmania, Rockhampton in Queensland and Warrnambool, Victoria. The reasons for them may vary, however, they may primarily be due to the condition set out in the licenses. License conditions are determined by a variety of factors, including the conditions of the waterway being discharged to, and the communities uses of the waterway (EPA NSW, 2013, EPA VIC, 2017). For example, Warrnambool has a nitrogen concentrations limit of 30 mg/L, compared to the combined Boag's Rock and Boneo (Table 1) outfalls that have a combined concentration limit of 25 mg/L. In addition, to existing conditions and the uses of waterways, available resources for treatment plant upgrades and community pressure may also contribute to WWTP load. Both Boag's Rock and Boneo outfalls, which are run by the Eastern Treatment Plant have come under significant community pressure in the past and upgraded to tertiary treatment in 2012 (Melbourne Water, 2017). Therefore, Warrnambool, which is a secondary treatment plant ranks in the bottom quartile with the outfalls that service the Melbourne metropolitan area.

Several sites, that ranked toward the bottom of the highest quartile, were sites that do not have nitrogen and phosphorous concentration limits as conditions in their licenses. This essentially means that they will not be in breach of their license regardless of the amount of nitrogen and phosphorous discharged. These include, Malabar, Bondi and North Head, three treatment pants that service the Sydney Metropolitan area and discharge effluent after the primary treatment (Sydney Water, 2015). The Werribee treatment plant in Victoria also has no nitrogen concentration limit restrictions in its license. This however, this 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 phosphorous.

As illustrated here, this ranking and the identification of nutrient loads by site can therefore be useful in prioritizing treatment upgrade resources. In addition, these discrepancies in treatment level and license conditions warrant further examination of water quality guidelines at a national scale, as well as wastewater reuse policies. The top quartile (lowest nutrient load) of wastewater treatment plants contribute only 0.2% of the overall nutrient load to the coastal and marine environment, while the bottom quartile contributes about 96%. Perhaps treatment plants in the bottom quartile should be the target of an upgrade feasibility assessment in order to achieve the greatest benefit per cost in upgrade investment. In addition, some sites (e.g. Richmond and Rokeby in Tasmania) reported zero discharge. 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 RANKINGS

Table 2. Australian coastal outfalls ranking by quartiles.

Rank	Outfall	State	Total nutrients load (kg)
1	Iluka	New South Wales	90
2	Christies Beach-Southern	South Australia	287
3	Home Island	Western Australia	359
4	Port Welshpool	Victoria	414
5	Sisters Beach	Tasmania	476
6	Boat Harbour	Tasmania	490
7	Busselton (North)	Western Australia	567
8	Bicheno	Tasmania	646
9	St Helens	Tasmania	729
10	Busselton (South)	Western Australia	1339
11	Dover	Tasmania	1349
12	Crescent Head	New South Wales	1357
13	Christmas Island	Western Australia	1691
14	Bermagui	New South Wales	1900
15	Cambridge/airport	Tasmania	2041
16	Orford	Tasmania	2051
17	Anglesea	Victoria	2234
18	Port Arthur	Tasmania	2287
19	Apollo Bay	Victoria	2379
20	Stanley	Tasmania	2393
21	Karana Downs	Queensland	2748
22	Lorne WRP	Victoria	2872
23	Camden Haven	New South Wales	2901
24	Risdon (east)	Tasmania	3449
25	Electrona	Tasmania	3858
26	Cygnet	Tasmania	4139
27	Port Douglas	Queensland	4258
28	Currie	Tasmania	4805
29	East Strahan	Tasmania	4830
30	Cannonvale	Queensland	4881
31	Bridgewater	Tasmania	5008
32	Landsborough	Queensland	5376
33	Victoria Point	Queensland	5598
34	Foster	Victoria	5624
35	Merimbula	New South Wales	6219
36	Bowen	Queensland	6232
37	Somerset	Tasmania	6677
38	Edmonton	Queensland	6989

39	Capalaba	Queensland	7193
40	Bridport	Tasmania	7368
41	Long Nose (Tomakin)	New South Wales	7377
42	Thorneside	Queensland	7451
43	Forster	New South Wales	8710
44	Nambour	Queensland	8714
45	Yamba	New South Wales	8763
46	Whyalla	South Australia	9253
47	Berrimah	Northern Territory	9438
48	Marlin Coast	Queensland	9773
49	Turners Beach	Tasmania	10348
50	Mackay North (Bucasia)	Queensland	10382
51	Fairfield	Queensland	10916
52	Narooma	New South Wales	11378
53	Millbank	Queensland	11628
54	Coolum	Queensland	11659
55	McGaurans Beach	Victoria	12342
56	Port Lincoln	South Australia	13924
57	Skennars Head (Lennox Head)	New South Wales	14263
58	Carole Park	Queensland	14311
59	Margate	Tasmania	14917
60	East Rockingham	Western Australia	15277
61	George Town	Tasmania	16777
62	Batemans Bay	New South Wales	17424
63	West Rockhampton	Queensland	18567
64	Goodna	Queensland	19250
65	Wynnum	Queensland	20071
66	Alkimos	Western Australia	20791
67	Coffs Harbour	New South Wales	23049
68	Hoblers Bridge	Tasmania	23548
69	Murrumba Downs	Queensland	23993
70	Port Pirie	South Australia	24216
71	Port Sorell	Tasmania	24353
72	Burpengary East	Queensland	24591
73	Sandgate	Queensland	25147
74	Port Augusta East	South Australia	26560
75	Bombo	New South Wales	29186
76	Caboolture South	Queensland	29846
77	Mt St John	Queensland	32813
78	Southern WWTP (Woree)	Queensland	33058
79	Round Hill	Tasmania	33308
80	Baxter's Beach	Victoria	33588
81	Selfs Point	Tasmania	33918
82	Beenleigh	Queensland	36244

83	Riverside	Tasmania	36266
84	Wacol	Queensland	37907
85	Delray Beach	Victoria	44140
86	Bundamba	Queensland	45715
87	Phillip Island	Victoria	46353
88	Innisfail	Queensland	50837
89	Wynyard	Tasmania	51210
90	Ulverstone	Tasmania	51259
91	South Rockhampton	Queensland	51701
92	Finger Point	South Australia	53315
93	Rosny	Tasmania	53888
94	Portland	Victoria	54942
95	Redcliffe	Queensland	56528
96	Altona	Victoria	57375
97	Merrimac	Queensland	60557
98	Cameron Bay	Tasmania	61899
99	Cleveland Bay	Queensland	64672
100	Newnham	Tasmania	67192
101	Maroochydore	Queensland	76814
102	Christies Beach-Northern	South Australia	81176
103	Elanora	Queensland	82509
104	Bunbury	Western Australia	95601
105	Port Fairy Domestic	Victoria	103619
106	North Rockhampton	Queensland	104646
107	Gibson Island	Queensland	108970
108	Loganholme	Queensland	113088
109	Smithton	Tasmania	122576
110	Coombabah	Queensland	132233
111	Blackmans Bay	Tasmania	137078
112	Boags Rock (Boneo)	Victoria	151645
113	Ti-tree Bend	Tasmania	178405
114	Prince of Wales Bay	Tasmania	180990
115	Oxley	Queensland	193897
116	Macquarie Point	Tasmania	238933
117	Shellharbour	New South Wales	240151
118	Palmerston	Northern Territory	242436
119	Black Rock	Victoria	245826
120	Leanyer Sanderson	Northern Territory	252787
121	Winney Bay	New South Wales	261452
122	Ludmilla	Northern Territory	267783
123	Pardoe	Tasmania	305653
124	Warrnambool WRP	Victoria	307302
125	Glenelg	South Australia	383036
126	Warriewood	New South Wales	429849

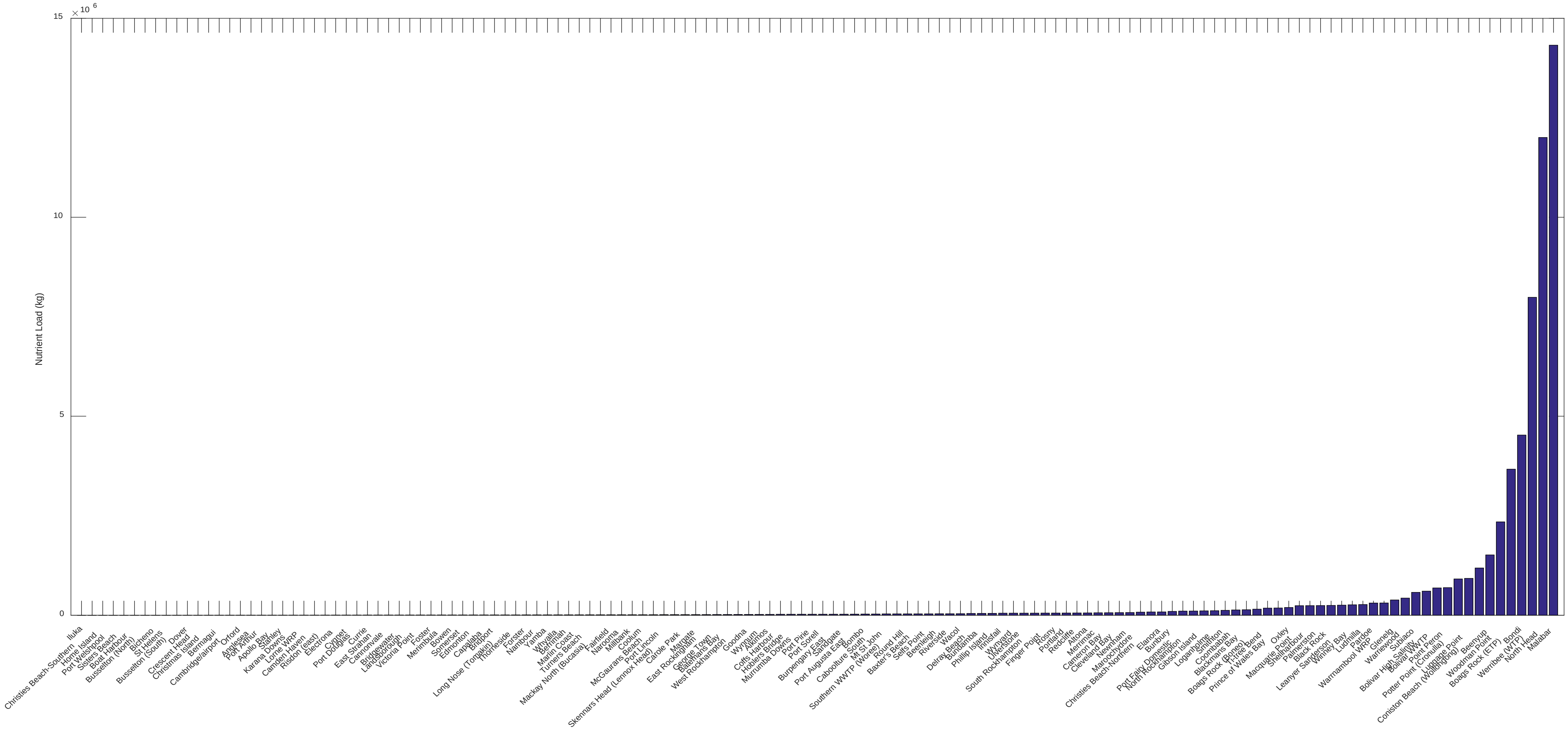
127	Subiaco	Western Australia	573772
128	Bolivar High Salinity	South Australia	604478
129	Bolivar WWTP	South Australia	685004
130	Point Peron	Western Australia	692652
131	Potter Point (Cronulla)	New South Wales	911183
132	Luggage Point	Queensland	925360
133	Coniston Beach (Wollongong)	New South Wales	1186472
134	Beenyup	Western Australia	1514724
135	Woodman Point	Western Australia	2345688
136	Boags Rock (ETP)	Victoria	3669779
137	Bondi	New South Wales	4527083
138	Werribee (WTP)	Victoria	7988464
139	North Head	New South Wales	12005094
140	Malabar	New South Wales	14324559

Note:

(green)	= Top quartile
(orange)	= 50th quartile
(yellow)	= 75th quartile
(pink)	= Bottom quartile

APPENDIX B – OUTFALLS HISTOGRAM

Figure 4. A histogram of total nutrient load (kg) for each outfall sites.



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