Annual Nutrient Survey
for Local Government Authorities

2023 RESULTS

An initiative of the South East Regional Centre for Urban Landcare's Phosphorus Awareness Project

ALGAE BUSTER PHOSPHORUS AWARENESS PROJECT

SERCUL South East Regional Centre for Urban Landcare

GOVERNMENT OF WESTERN AUSTRALIA

Department of Biodiversity, Conservation and Attractions

PARKS AND WILDLIFE SERVICE

DISCLAIMER

This report is written by SERCULs Phosphorus Awareness Project based on responses received from Local Government participants in the Annual Nutrient Survey.

The information contained in this report is based on the results from the survey and is believed to be reliable. While every care has been taken in the preparation of this report, SERCUL gives no warranty that the said base sources are correct and accepts no responsibility for any resultant errors contained herein and any damage or loss, howsoever caused, suffered by any individual or corporation.

SERCUL South East Regional Centre for Urban Landcare

ALGAE BUSTER PHOSPHORUS AWARENESS PROJECT

For further information, contact:

Natasha Bowden
Education and Promotion Manager
South East Regional Centre for Urban Landcare
E I natashabowden@sercul.org.au
1 Horley Road
Beckenham WA 6107
P I (08) 9458 5664
W I www.sercul.org.au/fertilisewise

CONTENTS

THE PHOSPHORUS AWARENESS PROJECT
ANNUAL NUTRIENT SURVEY 2023

The Phosphorus Awareness Project (PAP), supported by the Rivers and Estuaries Branch of the Department of Biodiversity, Conservation and Attractions (DBCA) and managed by the South East Regional Centre for Urban Landcare (SERCUL), aims to raise awareness about:

- **the sources of nutrients to the environment,**
- **the need to minimise their input, and**
- **how a reduction in nutrients to the Swan Canning River System and wetlands can be achieved.**

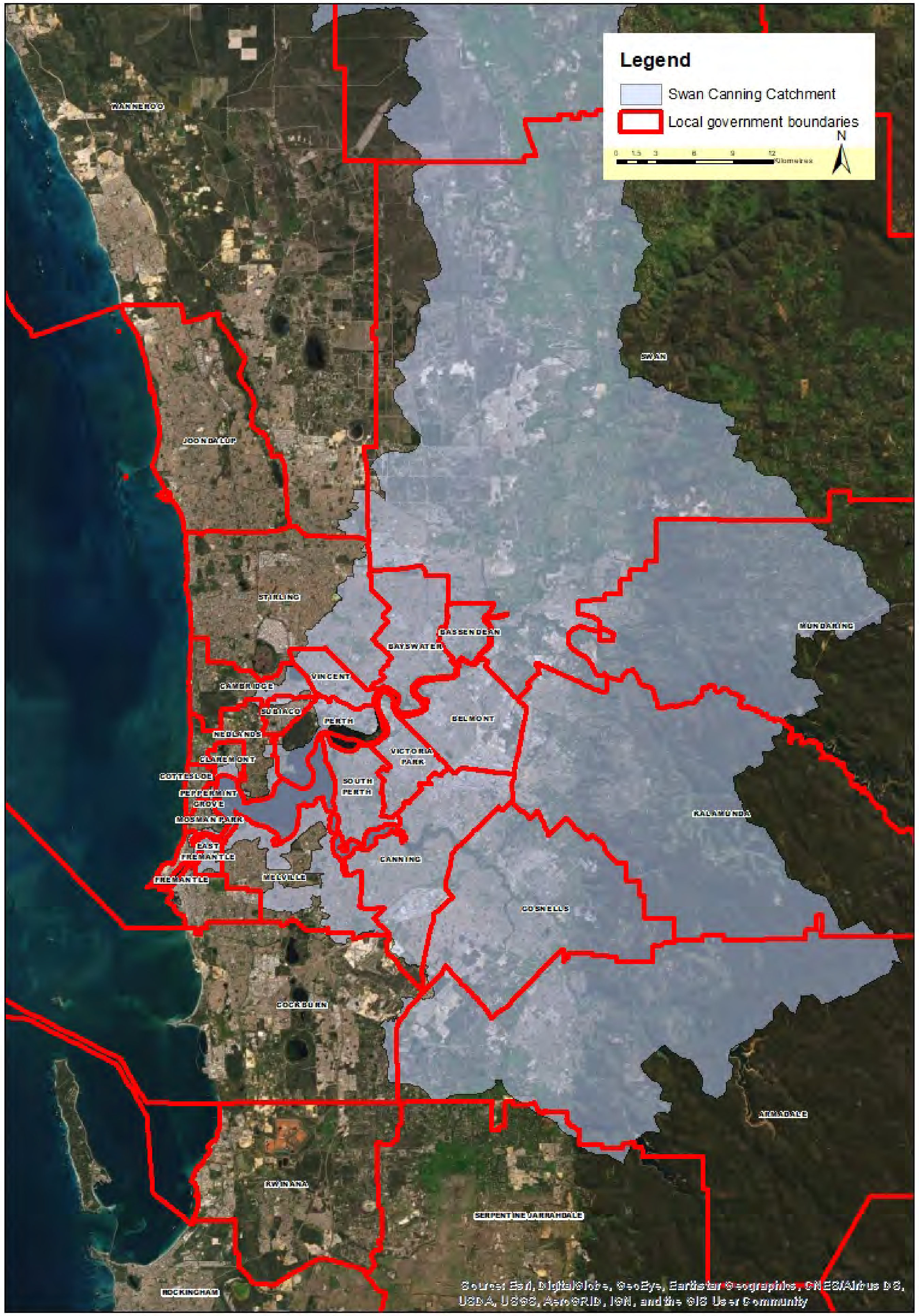
Local Government Authorities (LGAs) are responsible for large areas of turf and gardens, waterways, drainage systems, and planning decisions and can lead the community by setting examples in nutrient best practice. The Annual Nutrient Survey for LGAs was designed to determine LGA practice with respect to nutrient use, monitoring, management, regulation, and education, and to inform the local community.

Each year the thirty LGAs of the Perth metropolitan region are given the opportunity to take part in the Annual Nutrient Survey. Of the thirty LGAs invited to take part in this survey, twenty-seven touch upon the boundaries of the Swan Canning Catchment (refer to Map 1 over page). This was the twenty-second survey to target all the LGAs of the Perth Region and the twenty-fourth survey of the LGAs of the Canning Catchment. Twenty-six LGAs responded to the survey this year. Those who chose not to participate were the Cities of Joondalup and Kalamunda, Shire of Peppermint Grove and Town of Mosman Park. It is important that ***all*** LGAs take the opportunity to participate in this survey every year as a way of monitoring their management practices over time, educating their employees about nutrient Best Management Practices (BMPs) and assessing the impact their organisation's practices may be having on the catchment. As a region, it allows us to gain an understanding of the amount of nutrients potentially entering the Swan Canning River System and wetlands.

The results of this year's survey are not directly comparable to those of previous years due to the addition of new questions and participation of different LGAs each year. The results are based on responses received from LGA employees to a survey provided to them at the completion of the 2022/23 financial year. Overall, the LGAs have excelled in implementing BMPs in the areas of nutrient monitoring, nutrient management and nutrient education, achieved an above average result in fertiliser applications to foreshore areas and development control, and an average result in water quality monitoring. The Cities of Bayswater and Swan should be commended for once again implementing all the assessed BMPs.

In 2022/23, those LGAs that provided data that have some or all their area within the Swan Canning Catchment (so excluding Kwinana and Rockingham) used over 149 tonnes of total nitrogen and 18 tonnes of total phosphorus on 2327 ha of turf. The maximum acceptable load to the Swan and Canning Rivers is 130 tonnes per year of total nitrogen and 14 tonnes per year of total phosphorus (Swan River Trust, 2009). Not all these nutrients would have been applied to areas within the catchment or reached the Swan Canning River System. However, given that three LGAs within the catchment didn't respond to the survey, amounts applied to areas within the catchment but located outside the Perth metropolitan area were not considered, and the nutrient loads from other sources were not included, the level of nutrients originating solely from the application of fertiliser by the surveyed LGAs may be of concern.

It is strongly recommended that all employees of LGAs that are involved with turf management, natural area management, irrigation, drainage, development, planning and community engagement, such as those in the Parks and Gardens, Environment, Planning, and Infrastructure Departments, read the BMP Recommendations in each section of this report and provided as a separate document at www.sercul.org.au/fertilisewise/. The recommendations outline the strategies that need to be implemented to achieve a high level of BMP for all areas of nutrient use and management. LGAs are encouraged to compare their practices to the recommendations provided and implement those they do not currently undertake. Score Cards will be provided to all LGAs that responded to this year's survey that clearly show where and how improvements can be made for each area. Score Cards, BMP Recommendations and this report can be found at www.sercul.org.au/fertilisewise/.



MAP 1: SWAN CANNING CATCHMENT (GREY) OVERLAID WITH LGA BOUNDARIES (RED)

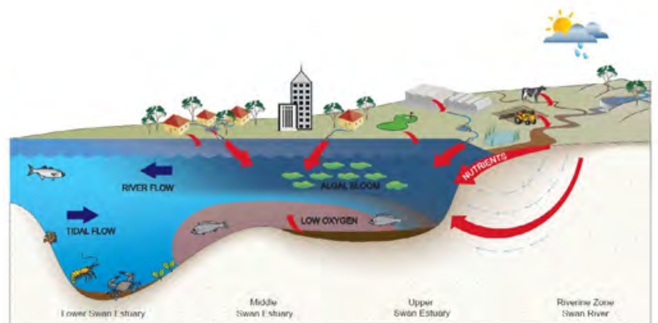
THE IMPACT OF NUTRIENTS AND ALGAE ON THE **SWAN CANNING RIVER SYSTEM**

The Swan River and its major tributary, the Canning River, flow through the heart of Perth and greatly contribute to the city's recreational, economic and ecological attributes. Since European settlement, however, the positive attributes of these river systems, and many wetlands, have been damaged by the occurrence of regular algal blooms. These blooms occur due to the excessive input of nutrients, particularly phosphorus and nitrogen, combined with low water flows and warm temperatures.

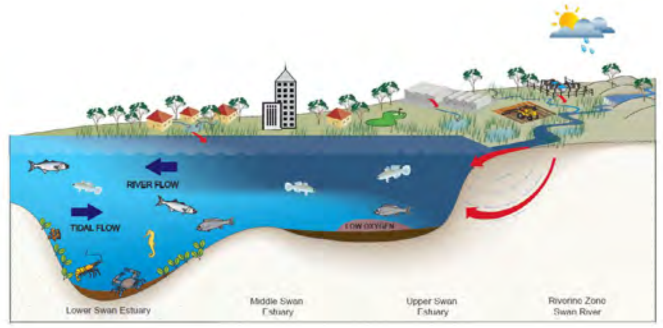
Algal blooms are undesirable as they reduce the amount of sunlight reaching aquatic plants and cause dissolved oxygen levels to decrease when they decompose, resulting in the death of aquatic plants and animals. They are also unsightly, foul smelling and can be toxic to humans and animals. In 2019 and 2020 two large blooms of ***Alexandrium*** microalgae occurred in the Swan and Canning Rivers. More recently in 2023, an ***Alexandrium*** microalgae bloom was spotted in the Swan Canning estuary near Riverside Drive and a ***Dilichospermum circinale*** bloom shut down parts of the freshwater section of the Canning River. ***Alexandrium*** microalgae can produce Paralytic Shellfish Toxins (PSTs) that can impact mussels and crabs and be poisonous to humans if consumed (DBCA, 2023) and ***Dilichospermum*** (formerly ***Anabaena***) can produce PSTs and also produces a toxin that can cause respiratory arrest, liver and gastrointestinal damage and is possibly a carcinogen (Chambers et. al, 2005). Other non-toxic algal blooms also regularly occur in the rivers and wetlands in warmer months.

Caution sign near Canning River (left) and algal bloom in a residential compensation basin (right).

Nutrients enter the Swan Canning River System and wetlands via runoff, stormwater drains and through groundwater. The soils and waters of the Swan Canning Catchment naturally contain low levels of nitrogen and phosphorus and the native flora and fauna are adapted to surviving and flourishing in these conditions. European settlement has drastically changed the landscape and brought with it the introduction of exotic plant species that require large inputs of nutrients, by way of fertiliser, and return large amounts of nutrients to the environment when they decompose. Introduced deciduous trees drop all their leaves just prior to the first flush of winter rains and as they are 'soft' they decompose at a rate faster than aquatic macro-fauna can process (Water and Rivers Commission, 2002). Introduced fauna, such as farm animals like sheep and cattle and domesticated animals like dogs and cats, also contribute large amounts of nutrients in their droppings. Even human excreta can contribute to nutrient loads in rivers and wetlands through its movement through the groundwater from septic systems. The figure, shown below left, illustrates the current state of the Swan Canning River System, with excessive nutrient inputs resulting in algal blooms, low oxygen conditions and a reduced number of aquatic plants and animals.



Current State of the Swan Canning River System



Desired State of the Swan Canning River System

Source: Healthy Rivers Action Plan (www.dpaw.wa.gov.au)

As LGAs are responsible for nutrient use on turfed and garden areas, the management of drainage systems and for local planning decisions, they can lead the community by setting examples in nutrient best practice. The following report outlines how the LGAs that responded to this year's Annual Nutrient Survey performed and provides some understanding of how and why all LGAs should improve their practices to help achieve the desired state of the Swan Canning River System, shown above right.

FERTILISING PRACTICES

The leaching of nitrogen and phosphorus containing fertilisers from the Swan Canning Catchment greatly contributes to the eutrophication of the river system and wetlands and has a detrimental impact on their environmental, economic and recreational attributes. LGAs are largely responsible for the estimated 5000 – 7000 hectares of irrigated turf in parks and public open space in the Perth metropolitan area (Ruscoe, Johnston & McKenzie, 2004). As representatives of their ratepayers, they have an obligation to practice responsible fertiliser use to avoid wasting time, money and resources and having a negative impact on the environment through the overuse of fertilisers and irrigation systems.

NUTRIENT MONITORING

Monitoring the level of nutrients in soil and leaf tissue allows turf managers and gardeners to determine whether nutrients are required and if required, the application rate and types of nutrients and fertiliser needed. Soil testing provides a guide to the availability of nutrients in the turf root zone and the soil pH and salinity, whilst leaf tissue analysis identifies the specific nutrient requirements of the plant. Different turf types have different efficiencies at extracting nutrients from the soil, which means that in the same soil one turf type can be nutrient deficient whilst another is healthy (Ruscoe, Johnston & McKenzie, 2004).

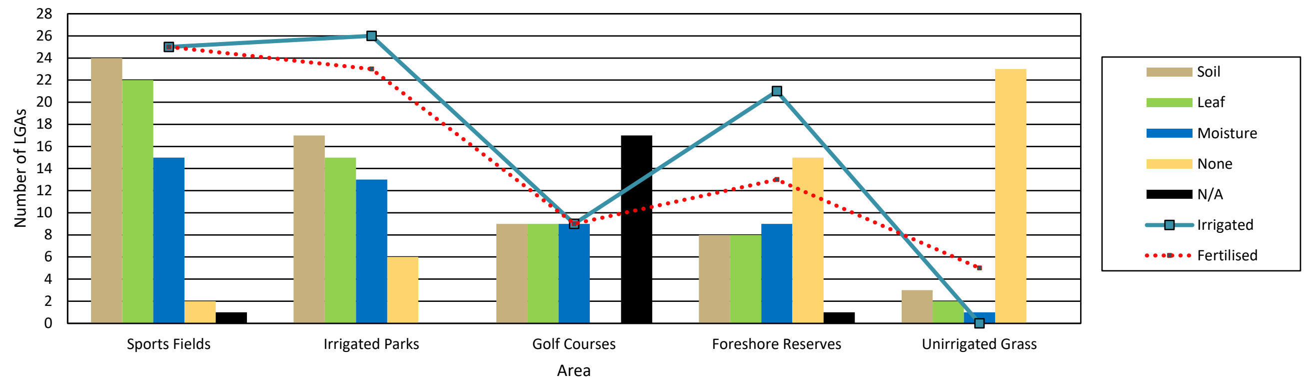
The soil testing method employed should be suited to the unique characteristics of soil types found on the Swan Coastal Plain. The standard method used in Western Australia for testing plant available phosphorus is the Colwell Test, however other methods such as Olsen, Bray and Mehlich 3 are also used. Results can vary depending on the test used so it is important to know which test your laboratory employs. Another test used to determine the rates of fertiliser applied to Western Australian soils is the Phosphorus Retention Index (PRI). The PRI test measures the capacity of a soil to hold on to phosphorus. The PRI of a soil can change if the soil is fertilised and contains excessive amounts of phosphorus. Other testing that should be performed is the soil pH which will indicate the availability of certain nutrients and soil moisture which allows adjustments to be made to irrigation regimes and reduces the possibility of nutrients leaching into waterbodies (Ruscoe, Johnston & McKenzie, 2004).

RESULTS OF THE SURVEY

Overall, the LGAs who responded to the survey excelled in implementing the BMPs for nutrient monitoring. All 26 LGAs applied fertiliser to at least one grassed/turfed area during the 2022/23 financial year. Of the 26 LGAs, 25 (96%) conducted regular soil tests and/or leaf tissue analysis for nutrients in at least one grassed area during 2022/23. Unfortunately, the LGA that didn't perform any type of testing has a riverside locality. The most tested areas were sports fields, followed by irrigated parks, golf courses, foreshore reserves and unirrigated grass areas (Figure 1). The only area in which all the LGAs that fertilised and irrigated performed all three types of testing and analysis (soil, leaf and moisture) was golf courses. Unirrigated grass areas were the least fertilised area with five LGAs applying fertiliser, and only two of those undertaking any nutrient monitoring. Irrigated parks were fertilised by 23 LGAs, of which seven did not perform any nutrient monitoring in these areas. Of the 13 LGAs that fertilised foreshore areas, seven did not perform any nutrient monitoring. Some LGAs performed nutrient monitoring of areas which were not fertilised, presumedly as testing indicated that it wasn't required.

All the 25 LGAs that conducted soil tests and/or leaf tissue analysis had their testing performed by an Australian Soil and Plant Analysis Council (ASPAC) affiliated laboratory and determined the rates of phosphorus using soil testing and PRI results. Fourteen LGAs measured plant available phosphorus using only the Colwell method , seven relied solely on Minimum Level Sustainable Nutrition (MLSN) requirements using the Mehlich 3 method, two used both methods and two did not specify what method was employed, if any.

FIGURE 1: FERTILISING, IRRIGATION AND TYPES OF TESTING PERFORMED IN EACH AREA



DISCUSSION AND RECOMMENDATIONS

It is strongly recommended that all LGAs regularly conduct soil tests and leaf tissue analysis before applying fertiliser using a laboratory affiliated with the ASPAC. ASPAC laboratories are independent, run by experienced staff, offer quality assurance, and use standard procedures. Rates of phosphorus should be determined according to the results obtained using an appropriate soil testing method (such as the Colwell method) to determine the level of available phosphorus in the soil, PRI test results and leaf tissue analysis. Leaf tissue analysis will allow a determination to be made as to whether phosphorus is even required by the turf. The amount of phosphorus that can be applied prior to leaching will be determined by the soil test to determine plant available phosphorus and the PRI. As a minimum, these tests should be conducted every second year and more often in high use areas. Moisture testing of irrigated areas will ensure overwatering and leaching of nutrients is less likely to occur.

If the Colwell method of testing is employed, Table 1 should be used to determine if phosphorus applications are necessary and if so, how much should be applied. If MLSN guidelines are used to determine the levels of nutrients to be applied, it is recommended that the guidelines be compared to test results obtained using the Mehlich 3 method. If you have Mehlich 3 soil test data, you can directly compare your test results (in ppm) to the MLSN guideline levels. Other tests can be converted to their expected values in Mehlich 3 – or the MLSN guidelines converted to expected values in the other extractant – however this introduces an unknown amount of error into the calculation. If your soil nutrient level is above the MLSN guideline when measured using the Mehlich method, which for phosphorus is 21 ppm, then you don't need to add any nutrient at this time (Woods, 2018). The PRI of the soil should also be taken into consideration when following MLSN guidelines.

TABLE 1: PHOSPHORUS RECOMMENDATIONS USING PRI AND P SOIL TEST RESULTS

Phosphorus Recommendations		
PRI (Allen & Jeffery method)	**Soil Test P (Colwell test)**	**Recommendations**
O or negative		Do not apply P
0.1- 0.5	< 5 ppm > 5 ppm	Apply up to 5 kg P/ha Do not apply P
0.5- 2	< 7 ppm > 7 ppm	Apply up to 5 kg P/ha Do not apply P
3- 5	< 10 ppm > 10 ppm	Apply up to 10 kg P/ha Do not apply P
> 5	< 10 ppm	Apply up to 20 kg P/ha

Source: Ruscoe, Johnston & McKenzie 2004, Turf Sustain – A Guide to Turf Management in Western Australia. Sports Turf Technology, WA.

With respect to the leaf tissue nutrient levels, the nitrogen content should be maintained between 1.5- 2% for passive turf and 2- 3% for sports fields while the leaf tissue phosphorus content should be maintained between 0.2- 0.4% (Ruscoe, Johnston & McKenzie, 2004). Parks and Gardens Officers can attend the Fertilise Wise Fertiliser Training courses that are hosted by the Phosphorus Awareness Project each year to gain an understanding of the results of the testing conducted in their LGAs area.

It is recommended that all LGAs conduct regular soil testing, leaf tissue analysis and moisture content tests on sports fields as they are high use areas requiring good quality turf where over fertilising and overwatering could occur if not monitored appropriately. Irrigated parks should be regularly tested, with moisture testing being essential so that irrigation schedules can be adjusted accordingly to avoid the leaching of nutrients and wasting of water. It is concerning that these areas were fertilised by most LGAs, however not always tested for nutrient and moisture levels. Phosphorus and nitrogen should not be applied within the buffer zone of foreshore reserves. Areas beyond the buffer zone should be tested before fertiliser is added due to the close proximity of the waterbody (Swan River Trust, 2014). Golf courses are another area where inappropriate fertilising and watering could result in the leaching of nutrients, particularly given the large number of golf courses located near natural and man-made waterbodies. It is pleasing to see that all the LGAs who stated they had golf courses under their control conducted all forms of testing. Low levels of testing were conducted in unirrigated grass areas that were fertilised. It is recommended that regular testing occur before nutrients are applied to these areas to determine if it is required and to ensure they don't leach into the groundwater in the wetter months.

It is encouraging that all but one of the LGAs that responded conducted soil tests and/or leaf tissue analysis in at least one of the areas they were responsible for managing. This indicates that in those areas they have scientific information to know exactly how much and what type of nutrient needs to be applied and as such over fertilising is less likely to occur. Ideally, soil testing and leaf tissue analysis should be conducted prior to fertiliser being applied to any area and the fertilising regime should be based on this testing. It is disappointing that moisture testing was not conducted by all LGAs in irrigated areas. If areas are overwatered, then it is highly likely that nutrients in the soil will be washed past the root zones of turf and plants and enter the groundwater system. Thus, it is recommended that all areas that are irrigated are regularly moisture tested to ensure that leaching does not occur.

TURF TYPES AND FERTILISER APPLICATIONS

The Mediterranean climate of the Perth area means that it is characterised by hot, dry summers and mild, wet winters and as such a wide range of turf grass species, both warm and cold season types, can be grown. Warm season grasses, such as Kikuyu (*Pennisetum clandestinum*), Couch (*Cynodon dactylon*) and Buffalo (*Stenotaphrum secundatum*) grow best during the warmer parts of the year, having an optimum temperature range of 25-35°C, and are semi-dormant during the cooler winter months. Cool season grasses, such as Bentgrass (*Agrostis stolonifera*), grow best in the cool, moist conditions of spring and autumn when temperatures are between 15-25°C. Their growth slows when subjected to the high temperatures of summer and cold conditions of winter. In Perth it is preferential to grow warm season grasses as cool season grasses require more fertiliser and water than warm season grasses (Ruscoe, Johnston & McKenzie, 2004).

RESULTS OF THE SURVEY

All the LGAs surveyed grew the warm season grass, Kikuyu, with some also growing Couch and/or Buffalo. Only one LGA listed the cool season grass, Bentgrass, and this was grown on a golf course (Figure 2).

All 26 LGAs that responded to the Annual Nutrient Survey provided details on the amounts of fertiliser applied to active turf, such as sports fields; passive turf, such as parks; and foreshore areas (Table 2). Four LGAs that reported applying fertiliser to foreshore areas, did not provide values for the fertiliser applied to those areas. It is assumed this is because they had buffer zones in which they did not apply fertiliser and so included the amounts applied outside those areas in their passive or active turf values. Only three of the LGAs who stated that they fertilised foreshore areas didn't have a buffer zone in which fertiliser was not applied.

FIGURE 2: TYPES OF TURF GROWN

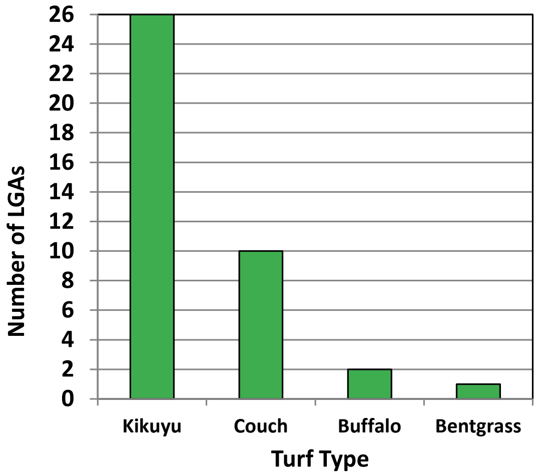


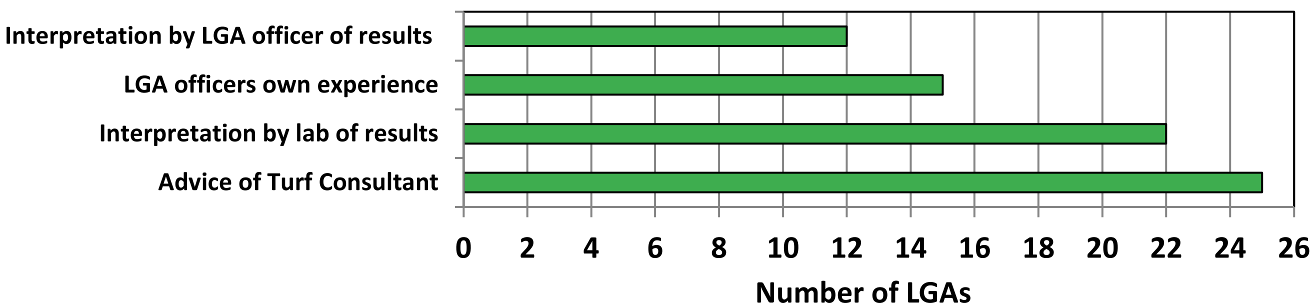
TABLE 2: SUMMARY OF THE ANALYSED RESPONSES FROM 26 LGA'S TO FERTILISER QUESTIONS FOR EACH APPLICATION AREA

Units of Measurement	Average Nutrient Application Rate (kg/ha)		% of LGAs who Applied Fertiliser per Season				Average Annual Nutrient Application Rate (kg/ha/yr)		Total Nutrient Applied (kg/yr)	
	Nitrogen	Phosphorus	Winter	Spring	Summer	Autumn	Nitrogen	Phosphorus	Nitrogen	Phosphorus
Applications to active turf (e.g. Sporting ovals) *Area of active turf that is fertilised: 1752.78 ha; Cumulative area to which fertilisers applied: 2662.46 ha*										
Kilograms (kg)	31.68	4.35	69	96	69	92	55.67	8.51	129 296	18 014
Applications to passive turf (e.g. Parks) *Area of passive turf that is fertilised: 1005.97 ha; Cumulative area to which fertilisers applied: 1018.61 ha*										
Kilograms (kg)	28.43	1.70	8	58	35	35	49.98	3.12	49 131	2351
Applications to foreshore turf *Area of foreshore turf that is fertilised: 55.51 ha; Cumulative area to which fertilisers applied: 61.03 ha*										
Kilograms (kg)	31.61	0.68	12	31	15	19	55.27	0.91	3692	114
Total area that is fertilised: 2814.26 ha *Cumulative area to which fertilisers applied: 3742.10 ha*									**182 119**	**20 479**

Note: the nutrient values for liquid fertiliser were assumed to have been supplied as percentage weight by volume. The cumulative area to which fertiliser is applied is provided as the same area may have had more than one type of fertiliser applied to it and in previous year's reports this is how we have represented the area (ie. assumed each fertiliser was applied to a separate area due to a lack of more detailed information). The area of turf fertilised is the actual area fertilised, regardless of how many different types of fertiliser were applied within that area.

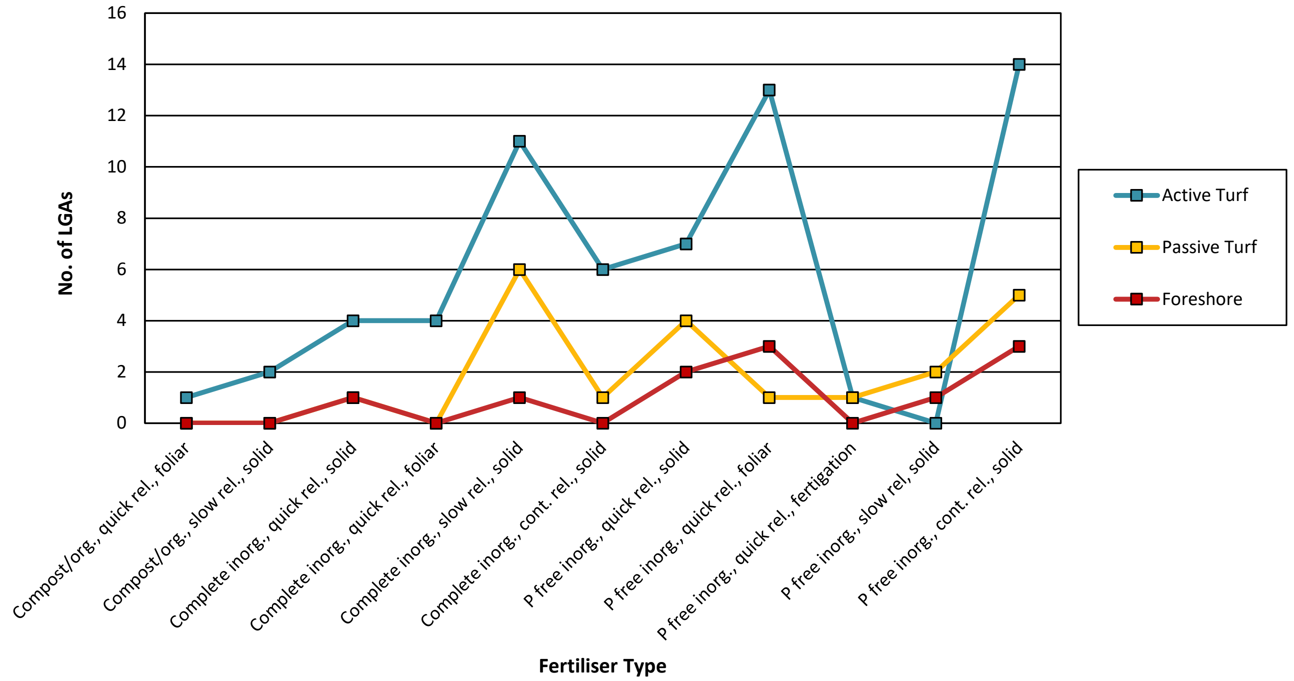
The majority of LGAs based their fertiliser regimes on the advice of a turf consultant, with many combining that knowledge with their own or the laboratories interpretation of results and/or experience (Figure 3).

FIGURE 3: WHAT DETERMINES FERTILISER APPLICATIONS?



The fertilisers applied by the LGAs to each area were defined according to whether they were an organic/compost, complete inorganic (containing phosphorus) or a phosphorus free inorganic fertiliser. They were further categorised by their release rate (quick, slow or controlled) and application state (solid, foliar or fertigation). The results shown in Figure 4 illustrate the types of fertiliser used in each turf area.

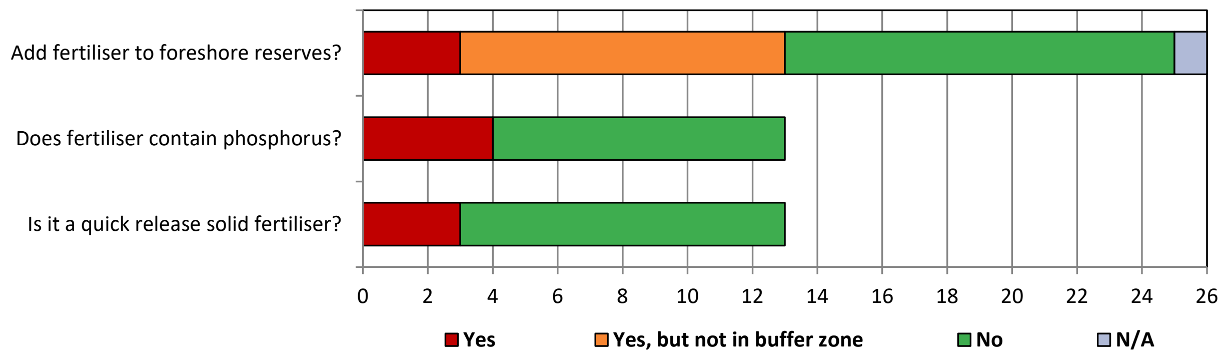
FIGURE 4: FERTILISER TYPES USED BY LGAS IN EACH AREA



Overall, the LGAs who responded to the survey performed above average in implementing the BMPs for fertiliser applications to foreshore areas. All but one of the LGAs surveyed have foreshore reserves and parks (which includes grassed/turfed areas around rivers and wetlands), to which 12 (48%) did not add any fertiliser. Of the 13 LGAs that did fertilise these areas, only four used a fertiliser that contained phosphorus. Three of those used a slow release solid fertiliser, irrigated the area and had a buffer zone, but did not complete any testing or analysis. The remaining LGA used a quick release solid fertiliser, irrigated the area and had no buffer zone, but completed all testing and analysis. The majority of LGAs had a buffer zone in place in which they did not fertilise. As discussed previously, over half of the LGAs who fertilised foreshore areas did not conduct any nutrient monitoring.

All of the LGAs surveyed have native gardens, of which 13 (50%) fertilise them using a variety of fertilisers, some of which contain phosphorus. All the LGAs surveyed have non-native gardens and 16 (62%) fertilise them using a variety of fertilisers, most of which contain phosphorus.

FIGURE 5: FORESHORE AREAS THAT ARE FERTILISED



DISCUSSION AND RECOMMENDATIONS

Turf type:

It is recommended that LGAs continue to use Kikuyu as their first choice for turfed areas due to its low fertiliser requirements, medium water usage, drought and wear tolerance and long growing season. The use of Kikuyu results in less nutrients and water having to be applied to turfed areas, and therefore less chance of nutrients leaching, when compared to other turf types. Turf managers should, however, ensure that care is taken to avoid Kikuyu spreading to bushland or garden areas as it can be difficult to eradicate. Fertiliser should not be applied to warm season grasses, such as Couch and to a lesser extent Kikuyu and Buffalo, in the winter months as they could be dormant and thus would not take up nutrients. Analysis of the raw data revealed that eighteen of the LGAs reported applying fertiliser in winter.

Season in which to fertilise:

The months of spring followed by those of autumn are when the majority of LGAs applied fertiliser. There were, however, many LGAs also applying fertiliser to turf areas during summer and winter. An analysis of the raw data revealed that some LGAs were applying fertiliser using multiple applications over the year rather than one large application per year. It is recommended that all LGAs adopt the practice of fertilising using smaller amounts, multiple times during spring and autumn.

Spring and autumn are when turf and plants are actively growing. The application of fertiliser in the winter months should be avoided as heavy rain can cause nutrients to be leached from the soil. Warm season grasses like couch and to a lesser extent Kikuyu and Buffalo, are dormant or semi-dormant during the winter months and thus any nutrients applied may not be taken up at this time. Planting trees in the winter months is highly recommended so they can establish themselves before the dry summer months, and as such this is the only instance when applying fertiliser during winter is acceptable. Applying fertiliser during extended periods of high temperatures in summer is not recommended as many turf types will not take up nutrients from fertiliser under these conditions. Fertiliser application in summer also encourages excessive growth and the overuse of water.

How to determine fertiliser regimes:

It is recommended that LGAs use a range of opinions, such as those expressed by the laboratories generating testing results, turf consultants and their own, to determine application rates of fertiliser rather than a single source. Utilising advice from turf consultants who are specifically trained in turf management and usually have many years of on ground experience is highly recommended to determine appropriate fertiliser regimes. It is also strongly recommended that Parks and Gardens Officers attend the Fertilise Wise Fertiliser Training course hosted by the Phosphorus Awareness Project and presented by Turf Consultant John Forrest in 2024 to obtain a greater understanding of appropriate fertiliser and nutrient applications.

Fertilising turf:

In turf areas it is recommended that LGAs apply fertilisers according to the conditions of the area as determined by location, soil type, soil testing and leaf tissue analysis, irrigation levels and how the area is used i.e. active vs passive use. Heavily trafficked active areas are subjected to more wear and tear than passive areas and as such may require fertilisers that release certain nutrients rapidly to enable faster growth and rejuvenation.

Complete inorganic fertilisers can contain high levels of phosphorus and nitrogen and should only be applied if soil testing and leaf tissue analysis reveal these nutrients are required as both nutrients can cause problems in wetlands and rivers. They can come in quick, slow or controlled release forms. Where testing or analysis indicates phosphorus is not required, phosphorus free inorganic fertilisers should be used. Organic fertilisers can also contain high levels of both nitrogen and phosphorus and undergo microbial breakdown to release nutrients, which is influenced by environmental factors such as moisture and heat and, as such, their rate of nutrient release can be unpredictable. Mature composts are generally considered to be slow release and could also have the added benefit of improving the soil however, before application, it is important to know the nutrient analysis of the compost, especially the soluble nitrogen and phosphorus (Swan River Trust, 2014).

Quick release fertilisers are water soluble and readily available for plants to take up and can come in solid or liquid form. Slow-release fertilisers generally release many of their nutrients, particularly nitrogen, slowly over a period according to a number of variables (soil moisture, temperature, pH etc) and plants and turf have an extended opportunity to take up all the nutrients released. The rate, pattern and duration of nutrient release, however, is not well controlled and can occasionally be released very quickly when excessive moisture and high temperatures occur simultaneously. Nutrients in controlled release fertilisers are released according to soil temperature, meaning they are released faster in the warmer months during peak growth times. They maximise nutrient use efficiency and minimise environmental concerns (Liu et. al., 2021).

Solid fertilisers can be quick, slow or controlled release. Liquid fertiliser applied to the foliage of turf and other plants allows nutrients to be taken up into the leaves, and if applied correctly only minimal amounts will enter the soil where it can be leached to groundwater and waterbodies. It would be beneficial for more LGAs to consider applying their fertiliser using foliar applications. Fertigation is the process of applying fertiliser via an irrigation system and is used to apply low rates of fertiliser on a frequent basis and to minimise potential nutrient losses. This method of application requires a high level of supervision to ensure equipment is operated correctly and fertiliser application is accurate (Ruscoe, Johnston & McKenzie, 2004).

As stated previously, soil testing, leaf tissue analysis and moisture testing should be conducted before any nutrients are applied to reduce the risk of nutrients leaching to groundwater and waterbodies.

Fertilising foreshore areas:

Foreshore reserves and parks are potentially high-risk areas where nutrients can enter waterbodies. Buffer zones should be put in place around waterbodies in which no fertiliser is applied. The width of buffer zones will vary depending on their function and factors relating to the sites condition (Swan River Trust, 2014), however, for natural waterways a width of 30 - 50 metres is recommended (DWER, 2022). LGAs can refer to ***'Fertiliser Application on Pasture or Turf near Sensitive Water Resources'*** (2010) available from the Department of Water and Environmental Regulation for further information.

The application of fertiliser to areas outside the buffer zone of foreshore areas should only be considered if the areas are used frequently, expected by the public to be presented to a high standard and soil and moisture testing and leaf tissue analysis has been undertaken and has determined that fertiliser is required. Any fertiliser that is applied should be phosphorus free and a controlled release, low water soluble fertiliser if in solid form or applied to foliage and left to dry if a liquid. This is one of the areas in which some LGAs did not perform very well in meeting the nutrient BMPs. It is disappointing that a number of LGAs used fertiliser containing phosphorus in foreshore areas and that some fertilisers contained nitrogen and phosphorus in a quick release, solid form. Some LGAs used foliar applications which release nutrients quickly, but these are preferred over solid, quick release fertilisers as they have less chance of leaching into waterways if applied correctly, namely to the leaves and left to dry.

Fertiliser should not be applied in the winter months to foreshore areas as grasses may be dormant and heavy rainfall can wash nutrients into the waterway. Irrigation needs to be carefully monitored at all times so that overwatering does not occur. Analysis of the raw data shows that three LGAs reported applying fertiliser to foreshore areas in winter, however they were all liquid and phosphorus free. Liquid fertilisers are preferable to solid applications, however care would need to be taken to apply them during dry conditions to ensure nutrients didn't get washed off the leaves into soil. In general fertilising during winter, particularly in foreshore areas, is not recommended. Four LGAs applied fertiliser to foreshore areas during summer, with only one of these being a liquid. Fertilising with solid fertilisers during summer should be avoided as without enough water the fertiliser can burn grass, but with water the risk of runoff causing fertiliser to enter waterbodies is increased. The low water levels and still conditions in waterways during summer, combined with the warm temperatures, favour the growth of algae.

Application of nitrogen:

The maximum recommended rate for a single application of nitrogen to turfed areas containing Couch and Kikuyu is 40 kg/ha (Ruscoe, Johnston & McKenzie, 2004), though 30 kg/ha is usually sufficient. Higher rates can be used if the fertiliser has a higher proportion of controlled release nitrogen (Ruscoe, Johnston & McKenzie, 2004). The values reported (Table 2) show that the average application rate was not above 40 kg/ha in any of the turfed areas. An analysis of the raw data, however, showed that eleven LGAs were applying nitrogen at levels exceeding the maximum recommended single application rate in one or more turfed area. Some of these LGAs, however, were using controlled release or slow release fertiliser at these levels, which may mean that the rates of quick release nitrogen were below this value. One of the LGAs that was monitoring nutrients did, however, apply urea, which is a quick release solid fertiliser, to active turf at nearly three times the maximum recommended rate for a single application and applied it in summer. If LGAs are applying fertiliser according to the results of soil testing and leaf tissue analysis, they may need to consider applying them at less than the maximum recommended rate on multiple occasions instead of in one application. It is recommended that all LGAs test for nitrogen levels in soil and leaf tissue and base their applications on the results, the maximum recommended rate for a single application of nitrogen and the intended use of the turf.

The recommended annual application rate of nitrogen is 100-200 kg/ha/yr for high use active turf, 50 – 100 kg/ha/yr for low use active and premium passive turf , 0-50 kg/ha/yr for minor passive turf and 0 kg/ha/yr for grass buffers (Swan River Trust, 2014). Table 2 shows the average annual rate applied to active turf for all LGAs was below the recommended annual application rate for high use active turf and within the range for low use active turf. The value for passive turf was below the range recommended for premium passive turf but within those recommended for minor passive turf. Grass buffers within foreshore areas should not have any nitrogen applied. Analysis of the raw data showed that of the three LGAs that applied fertiliser in foreshore areas and didn't have buffer zones, all of them applied fertiliser in excess of the recommended rate of 0 kg/ha/yr for grass buffers and two of them applied it in excess of the 0-50 kg/ha/yr rate recommended for minor passive turf. Overall, the results for foreshore areas are hard to confirm as four LGAs stated in the survey that they fertilised foreshore areas though not in buffer zones, but didn't provide values for the amounts they applied and presumedly included them in the values for active or passive turf. Going by the information we did receive that is presented in Table 2, however, we can see that the value for foreshore areas is greater than the average annual rate applied to the passive turf of LGAs and it is within the ranges recommended for low use active and premium passive turf but above those recommended for minor passive turf. Turf outside buffer zones but within foreshore areas should only be fertilised at a rate corresponding to its use (passive or active) and the standard of upkeep required (minor or premium). Separation distances (buffers) vary according to their function and factors relating to site conditions (Swan River Trust, 2014), but as mentioned previously, if possible, a 30- 50 metre buffer zone should be established between fertilised areas and natural waterbodies (DWER, 2022). It is recommended that all LGAs keep a logbook of their nitrogen applications over the year for all application areas to ensure that recommended rates are not exceeded.

It is also recommended that LGAs ensure nitrogen applied to gardens is done following manufacturers recommendations, as excessive applications to these areas can also contribute to nitrogen leaching to waterbodies.

Application of phosphorus:

The maximum water-soluble phosphorus single application rate in a low PRI soil is 5 kgs/ha (J. Forrest, pers. comm, 2021). When the PRI (Allen and Jeffery) and the soil (Colwell method) is tested the amount of fertiliser to be applied is as recommended in Table 1, assuming the leaf tissue analysis indicates that phosphorus is needed. The averages for total phosphorus applied by the LGAs who reported their results (Table 2) were below 5 kgs/ha in all turf areas. An analysis of the raw data showed that twelve LGAs were applying phosphorus to some turfed areas at levels higher than the 5 kg/ha rate, although this was the total phosphorus rather than water-soluble phosphorus. The rate can also be higher if it is being applied to a higher PRI soil as confirmed by testing. Of the twelve, all but three LGAs were using fertiliser containing some proportion of slow or controlled release nutrients. Only one LGA did not test soil in the areas to which they were applying amounts exceeding the maximum water-soluble single application rate of phosphorus in a low PRI soil. Despite stating that they tested soil, three LGAs were applying phosphorus to active turf areas at rates above that recommended for a single application to a high PRI soil (20 kg/ha), although two of these fertilisers were slow release and may have contained less water-soluble phosphorus. Without PRI, soil and moisture tests and calculations of the amount of water soluble phosphorus fertilisers contain, LGAs cannot be confident that the phosphorus they have applied is not leaching into groundwater. It is recommended that all LGAs determine the PRI of the soil and the phosphorus levels in soil and leaf tissue and base their applications of fertiliser to turf on these results and the intended use of the turf.

Some LGAs appear to have added fertilisers containing phosphorus to native gardens. Many native species do not respond well to high levels of this nutrient. It is recommended that LGAs ensure phosphorus applied to gardens is done following manufacturers recommendations and according to the phosphorus requirements of the plants present, as excessive applications to these areas can also contribute to phosphorus leaching to waterbodies.

Total nutrient applied by LGAs:

Table 2 reveals that overall 182,119 kg/yr (182 tonnes/yr) of nitrogen and 20,479 kg/yr (20 tonnes/yr) of phosphorus was applied by 26 LGAs to an area of 2814.26 ha. The Swan Canning Water Quality Improvement Plan states that the maximum acceptable load to the Swan and Canning Rivers is 130 tonnes per year of total nitrogen and 14 tonnes per year of total phosphorus (Swan River Trust, 2009). Of the 30 LGAs asked to participate in this survey each year, only Joondalup, Kwinana and Rockingham don't have any part of their LGA within the Swan Canning Catchment (refer to Map 1). Excluding the data supplied by Kwinana and Rockingham (as Joondalup didn't participate), this means that up to 149,283 kg/year (149 tonnes) of nitrogen and 18,477 kg/year (18 tonnes) of phosphorus was applied by the LGAs within the Swan Canning Catchment to 2326.54 ha of turf. If all these nutrients were to reach waterbodies, it would have exceeded the maximum accepted load of total nitrogen and total phosphorus. It should be kept in mind however that the total area covered by each LGA does not always reside within the Swan Canning Catchment (see Map 1) so not all these nutrients have the potential to reach the waterbodies of this catchment either directly, through leaching to groundwater, or via runoff onto hard surfaces and into stormwater drains. However, given that three LGAs within the catchment didn't respond to the survey, amounts applied to areas within the catchment but located outside the Perth metropolitan area were not considered, and nutrient loads from other sources were not included, the level of nutrients originating solely from the application of fertiliser by the surveyed LGAs may be of concern.

It is recommended that LGAs implement the BMPs for fertiliser applications recommended in this report and separately in the 2023 Recommendations available at www.sercul.org.au/fertilisewise/ to ensure that nutrients applied do not enter the river system and wetlands.

SUMMARY OF RECOMMENDATIONS

It is difficult to assess the overall level of BMPs for fertiliser applications to all turfed areas by the LGAs that responded due to differences in LGA areas including (but not limited to): soil type, turf type, passive vs active turf, standard of turf expected, age of turf, location of turf, percentage of nutrients in fertiliser and whether nutrient monitoring of turf occurred. It is recommended that LGAs implement the following strategies to ensure management practices relating to fertiliser use approach a high level:

- Determine the rate of each nutrient of the fertiliser they intend to apply before application to ensure that over application of phosphorus and nitrogen does not occur. The formula to determine the rate of nutrient is to multiply the amount of fertiliser to be applied per hectare by the percentage of that nutrient (either N% or P%) in the fertiliser, divided by 100.
- The maximum nitrogen rate for a single application is 40 kg nitrogen/hectare, though 30 kg nitrogen/hectare is usually sufficient. Higher rates can be used if the fertiliser has a higher proportion of controlled release nitrogen (Ruscoe, Johnston & McKenzie, 2004).
- The maximum water-soluble phosphorus single application rate in a low PRI soil is 5 kgs/ha (J. Forrest, pers. comm, 2021). Where testing of turfed areas occurs using the Colwell method and PRI it should be applied according to Table 1.
- Applications of nitrogen should not exceed 100-200 kg/ha/yr for high use active turf, 50-100 kg/ha/yr for low use active and premium passive turf, 0-50 kg/ha/yr for minor passive turf and 0 kg/ha/yr for grass buffers around waterbodies (areas within approximately 30- 50 m of natural waterbodies).
- Fertiliser applied to gardens should follow manufacturers recommendations, as excessive applications to these areas can also contribute to nutrients leaching to waterbodies. Fertilisers specific to native plants should be used on native gardens.
- Keep a log book to record details of fertiliser and nutrient applications over the year for each application area including details such as weather conditions and monitoring information.
- If fertiliser is required, apply in spring and/or early autumn (September, October, November, March and April) when rapid growth occurs. Apply the fertiliser in small amounts and often over these months instead of a single application. This will ensure all nutrients can be utilised by the turf.
- Do not fertilise in summer or winter (with the exception of native trees that are planted in winter). Summer fertilising encourages the overuse of water and turf may grow excessively, while fertiliser applied during winter can be washed into stormwater drains or leached into groundwater.
- Do not apply fertiliser too close to hard surfaces such as roads. Fertiliser on hard surfaces will be washed into stormwater drains and end up in waterbodies. Also, do not apply fertiliser in the buffer zones of wetlands and rivers where it can be washed directly into these waterbodies.
- Avoid applying fertiliser before heavy rainfall and do not over water turf as both actions could result in the leaching of nutrients to groundwater and waterbodies.
- LGA Parks and Gardens Officers should attend the Fertilise Wise Fertiliser Training, which is hosted by the Phosphorus Awareness Project, in 2024 to learn fertiliser BMPs specific to the Perth Metropolitan Area.
- LGAs should refer to the following publications (see Reference section for full publication details) to obtain more information on fertiliser and irrigation BMPs:

  ** Turf Sustain – A Guide to Turf Management in Western Australia*
  ** Western Australian Environmental Guidelines for the Establishment and Maintenance of Turf Grass Areas*
  ** Stormwater Management Manual for Western Australia.*

NUTRIENT MANAGEMENT

Whilst fertilisers applied to turf and gardens are the largest and most easily quantified sources of nutrients from LGAs to wetlands and rivers, there are other sources, such as those from lawn clippings, deciduous leaves, and sediment, that need appropriate levels of management to avoid contributing to the nutrient load of the Swan Canning River System and wetlands.

Overall, the LGAs who responded to the survey excelled in meeting the BMPs for nutrient management. However, they performed much better in having structural and non-structural measures in place to prevent grass clippings, deciduous tree leaves and sediment from reaching waterbodies than they did in having Nutrient and Irrigation Management Plans (NIMPs) and Local Plants Policies in place.

STRUCTURAL AND NON-STRUCTURAL MEASURES

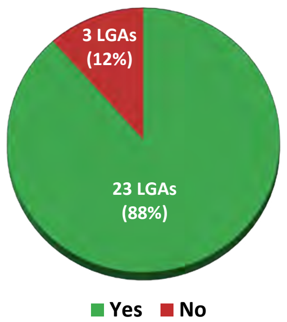
It is important for LGAs to have structural and non-structural BMPs in place to minimise the impact of nutrients on water quality. Structural BMPs are defined as engineered and constructed systems that allow in-situ water quality improvement. Non-structural BMPs comprise institutional and pollution prevention strategies to preclude or minimise the transport of pollutants in stormwater runoff and/or reduce the volume of runoff generated. The most effective stormwater quality management programs use non-structural BMPs to complement the selected structural BMPs (Department of Water and Environmental Regulation (DWER), 2022).

RESULTS OF THE SURVEY

Overall, the LGAs that responded to the survey excelled in implementing structural and non-structural BMPs measures. LGAs were asked whether they had structural measures in place to reduce nutrients making their way into waterbodies (Figure 6). Twenty-three LGAs (88%) had at least one type of structural BMP in place.

The LGAs that indicated that they did have structural BMPs in place were then asked to define the type of structural BMPs they had (Figure 7). Infiltration systems include pervious pavement, infiltration trenches, 'dry' sumps (those that do not intersect the maximum groundwater table) and infiltration basins. Conveyance systems include swales and buffer strips, bioretention systems and living streams. Detention systems include dry/ephemeral detention areas and constructed wetlands.

FIGURE 6: LGAS WITH STRUCTURAL BMPS



LGAs were also asked about non-structural measures they had in place to prevent nutrients from grass clippings, deciduous leaves, and sediment from entering the river system via stormwater drains or directly (Figure 8 and Table 3).

FIGURE 7: TYPES OF STRUCTURAL BMPS

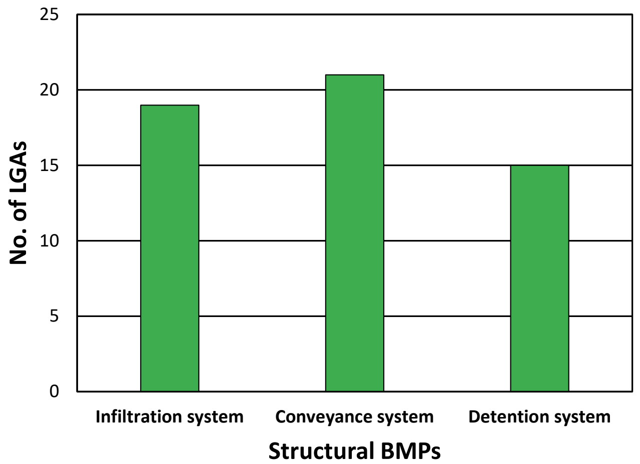


FIGURE 8: LGAS WITH NON-STRUCTURAL BMPS

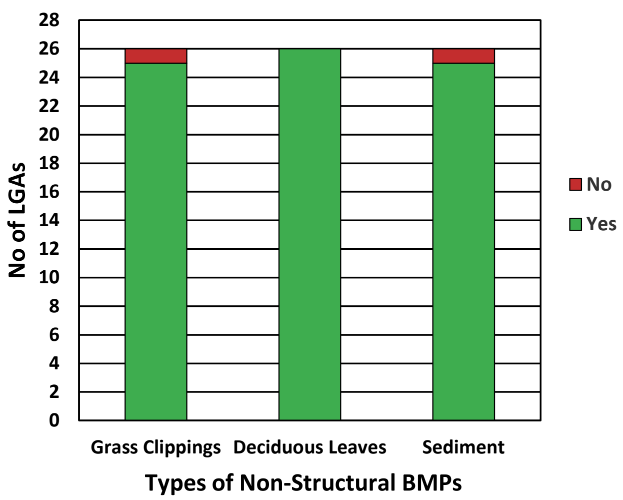


TABLE 3: MEASURES TAKEN BY LGAS TO PREVENT NUTRIENTS FROM GRASS CLIPPINGS, DECIDUOUS LEAVES AND SEDIMENT ENTERING RIVER SYSTEM VIA STORMWATER DRAINS.

Measure relating to	# of LGAs Using Measure
Grass Clippings	
Regular mowing to reduce excess clippings	25
Street/path sweeping	24
Direct debris from mowing away from road/path/waterbody	23
Drains e-ducted or cleaned regularly	23
All clippings left on lawn to act as natural fertiliser (in areas away from water bodies and roads)	23
Informing staff of correct procedures ie. at toolbox meetings	21
Cleaning sumps and soakwells regularly	18
Turf machinery cleaned down after use and debris/runoff directed away from drains/waterbodies	18
Cleaning Gross Pollutant Traps (GPTs) regularly	14
Application of growth retardant	13
Landscaping of GPTs	10
Clippings collected and removed from site	10
Timing mowing to occur just before street sweeping	9
Catchers used on mowers	8
Deciduous Leaves	
Road/park/path sweeper used regularly	26
Road/park/path sweeper used in leaf drop 'hot spots'	25
Stormwater drainage system regularly inspected and maintained/cleaned	23
Drains e-ducted or cleaned regularly	22
Cleaning sumps and soakwells regularly	20
Road/park/path sweeper used prior to first flush runoff events	18
Cleaning GPTs regularly	17
Landscaping of GPTs	9
Leaf drop mowed and caught in catcher	7
Not planting deciduous trees on verges or near waterbodies	7
Other (option added by a LGA)	
Additional green waste collection for residents during leaf drop season	1
Sediment	
Road sweeper used regularly	24
Maintaining vegetation buffers, swales and rain gardens	22
Stormwater drainage system regularly inspected and maintained/cleaned	20
Drains e-ducted regularly	20
Road sweeper used in sediment 'hot spots' such as around construction sites	19
Structures designed to trap sediments, such as GPTs, stormwater infiltration units, drain inserts, soakwells, detention basins, side entry pits and diversion drains, are cleaned regularly	17
Road sweeper used prior to 'first flush' rainfall runoff events	15
Sandbagging or hydromulching to prevent erosion	11
Covering soil and imported sand piles	8
Sediment control fences installed and maintained where necessary	6

DISCUSSION AND RECOMMENDATIONS

Structural measures designed to prevent nutrients making their way into the river system and wetlands are important to have as they are permanently in place and when combined with non-structural measures can assist in improving the water quality of a receiving waterbody. It is encouraging that 88% of LGAs had structural measures in place, with many of those having more than one type. All LGAs had non-structural measures in place to prevent nutrients from deciduous tree leaves entering the river system and wetlands directly or via stormwater drains. Structural measures to prevent nutrients from sediment and grass clippings reaching waterbodies were put in place by all but one LGA for each category.

Grass clippings and deciduous leaves are high in nitrogen and phosphorus and break down quickly. They can be washed into stormwater drains and/or directly into receiving water bodies. Prior to European settlement of Perth, deciduous trees and the species of grass commonly used for turf did not form part of the landscape. These species require an input of nutrients that do not naturally occur in our nutrient poor soils. When deciduous trees lose leaves in autumn they decompose quickly (unlike those from evergreen native species which are lost gradually and decompose much slower) and when washed into stormwater drains or directly into the river system with the first flush of winter rain, deciduous trees can deliver a large amount of nutrients in a short period of time. Unless there are measures in place to prevent grass clippings and deciduous leaves entering stormwater drains or to remove them before they decompose they will release excess phosphorus and nitrogen into local rivers and wetlands.

Sediment is the loose sand, clay, silt and other soil particles that settle at the bottom of a waterbody. Nutrients present in sediment come from natural sources, such as plants and animal decomposition, or as a result of human activity, such as the application of fertiliser, and can enter waterbodies via runoff or the stormwater system. Unless there are measures in place to prevent or contain erosion, stop sediment entering stormwater drains or to remove it once there, it will release excess phosphorus and nitrogen into the river system and wetlands.

It is recommended that LGAs have both structural and non-structural measures in place to prevent nutrients entering the river systems via stormwater drains. As indicated by Table 3 many of the measures adopted by LGAs can prevent nutrients from all three sources (grass clippings, deciduous leaves, and sediment) entering the river system and these should be implemented in the first instance. Such measures include street sweeping, cleaning, or e-ducting drains regularly, and having GPTs, sumps and soakwells in place ***and*** cleaning them regularly. Other measures specific to each nutrient source can then be implemented.

SUMMARY OF RECOMMENDATIONS

It is recommended that LGAs take the following measures to prevent nutrients entering the river system and wetlands directly and/or via stormwater drains:

- Use a combination of structural and non-structural BMPs to form a treatment train that will be most effective at reducing the nutrient load to the river system and wetlands from sources such as grass clippings, deciduous leaves, and sediment.
- Maintain and clean structural systems regularly.
- Do not plant deciduous trees on verges or in foreshore areas. Structural measures and non-structural measures should be in place to prevent nutrients from the leaves of historical plantings of deciduous trees from ending up in the river system.
- Grass clippings, leaves and sediment should never be blown, hosed, or swept onto hard surfaces such as roads or driveways as they can be washed or blown into stormwater drains and into the river system and wetlands.
- Grass clippings, leaves and sediment that end up on hard surfaces such as roads and driveways should be swept up and removed (either manually or with a street sweeper) or in the case of grass clippings and sediment blown off the hard surface back onto the area from which they originated.
- When mowing, clippings should be thrown away from hard surfaces.
- When mowing median strips and small areas near hard surfaces or waterbodies, a catcher should be used.
- In most turfed areas, where testing determines that nutrients are lacking, LGAs should leave grass clippings on the mowed turf as this will return the nutrients contained in the clippings back to the soil thus reducing fertiliser requirements. Clippings left in piles should be removed to disperse clippings. If testing reveals that nutrients are required in turfed foreshore areas outside the buffer zone, this practice should be adopted in favour of adding fertiliser or to reduce fertiliser requirements. If nutrients are not required, clippings should be removed from foreshore areas.
- Clippings and leaves that are removed should be composted and then utilised as a soil amendment.
- Mowing equipment should be cleaned down before going to the next location.
- When hosing down mowing equipment ensure that this water does not enter stormwater drains.
- Use sandbagging, hydromulching, covers or sediment control fences to prevent erosion from soil or imported sand piles.

Further information can be obtained from the Department of Water and Environmental Regulation's ***'Stormwater Management Manual for Western Australia'*** and the Swan River Trust's (Fertiliser Partnership Urban Users Working Group) ***'Western Australian Environmental Guidelines for the Establishment and Maintenance of Turf Grass Areas'.***

NUTRIENT AND IRRIGATION MANAGEMENT PLANS AND LOCAL PLANTS POLICY

Public (LGA controlled) and private (developer controlled) areas within a LGA can be landscaped using turf and garden areas. Streetscapes comprising median strips, roundabouts, entry statements, car park landscaping and road verges constitute large areas within LGAs. If streetscapes are landscaped with turf and introduced species of plants, they can require larger applications, both initially and once established, of nutrients and water than native plants, which may require no further applications once they are established.

RESULTS OF THE SURVEY

Overall, the LGAs who responded to the survey have achieved an average result in implementing the BMPs for Nutrient and Irrigation Management Plans (NIMP) and Local Plants policies. LGAs were asked whether they have a Nutrient and Irrigation Management Plan for their streetscapes (Figure 9) and a policy to use local native plants as the first choice in public (LGA) and private (developer) landscaping (Figure 10).

DISCUSSION AND RECOMMENDATIONS

It is disappointing that less than a third of all LGAs surveyed had a NIMP for their streetscapes. It is recommended that a NIMP be implemented by all LGAs for their streetscapes as they are large areas within a LGA where nutrients and water usage should be controlled more appropriately. The use of local native species within streetscapes would reduce the need to water and fertilise in these areas.

Information about NIMPs is available from the Department of Water and Environmental Regulation's website where the following documents can be located:

- *Water Quality Protection Note 33 (June 2010) Nutrient and Irrigation Management Plans*
- *Water Quality Information Sheet 04 (August 2010) Nutrient and Irrigation Management Plan Checklist.*

Turf consultants can also assist with the preparation of a NIMP.

It is recommended that all LGAs adopt a preferential policy for the use of local native plants in all their landscaped areas. These plants generally require the application of less water and fewer nutrients than introduced species, meaning there is a reduced chance of nutrients leaching from these areas into the river system and wetlands. Whilst it is acknowledged that there are various sound reasons why LGAs use a mixture of native and deciduous trees for street verges, it must be recognised that deciduous tree leaves pose a substantially greater nutrient enrichment risk for waterways than leaves from native trees. A Local Plants Policy would see less deciduous trees being used on verges and in foreshore areas.

Information on native plant policies and the use of local native species is available in the Eastern Metropolitan Regional Council's Landscaping with Local Plants Policy and Guidelines section of their ***'Local Government Natural Resources Management Policy Manual'.*** LGAs can also access the Which Plant Where website at www.whichplantwhere.com.au which offers a free plant database where you can view the climate suitability of species at post code level. SERCULs Phosphorus Awareness Project produces ***'Grow Local Plants'*** leaflets for the five main soil types in Perth. The leaflets are available on our website or in hard copy from SERCUL and contain species lists of local plants that are found on each soil type, from groundcovers and climbers through to trees.

FIGURE 9: LGAS WITH A NIMP FOR STREETSCAPES

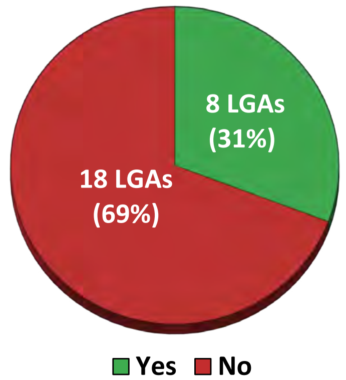
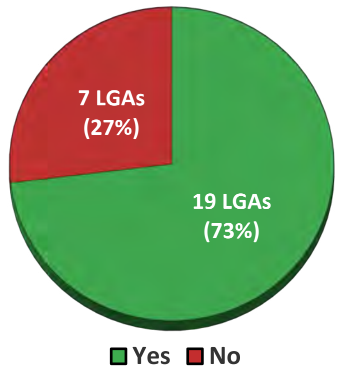


FIGURE 10: LGAS WITH A LOCAL PLANTS POLICY



WATER QUALITY MONITORING

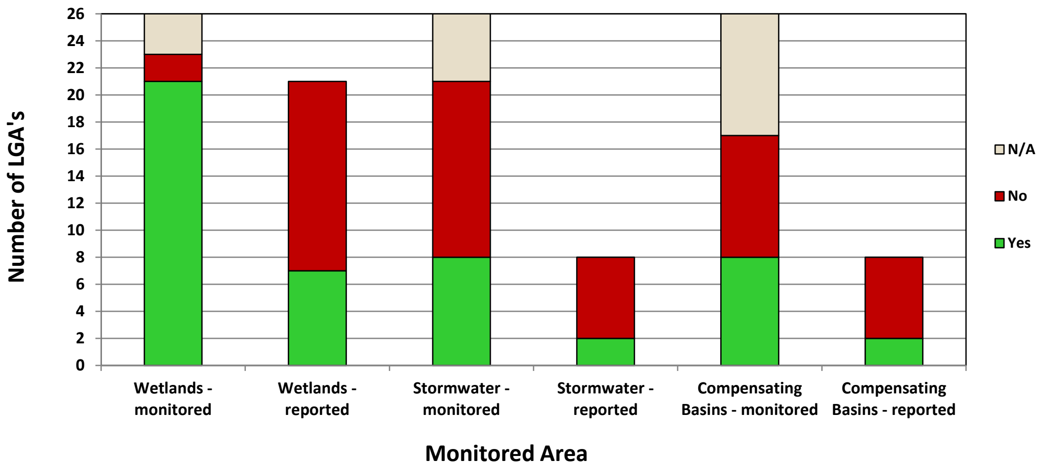


Stormwater drains, compensating basins and wetlands are adversely affected by nutrients from their surrounding catchments. Monitoring water quality in these areas allows LGAs to determine the nutrient levels in these locations and the impacts they may be having on the health of the ecosystem.

RESULTS OF THE SURVEY

The results for water quality monitoring are disappointing with the LGAs who responded receiving an average BMP score overall. LGAs were asked whether they regularly monitor wetlands, stormwater drains and compensating basins under their control for nutrient levels and if they did, whether they reported these results to the local community (Figure 11). Analysis of the raw results shows that only nine LGAs conducted water quality monitoring in all locations applicable to their area, with another three LGAs not having any areas requiring water quality monitoring. Only two of these nine LGAs reported the results of all their monitoring to the community. Another four LGAs reported on those areas they did monitor. Where LGAs did not have wetlands or compensating basins under their control, or had dry sumps and soakwells that didn't interact with the maximum groundwater table as stormwater drains, this question was marked as being not applicable to that LGA.

FIGURE 11: WATER QUALITY MONITORING



DISCUSSION AND RECOMMENDATIONS

Stormwater drains, unlined compensating basins and wetlands are connected to the river either directly or through ground water, and nutrients and other pollutants can have impacts in each of these areas, including causing algal blooms. It is recommended that all LGAs monitor the wetlands, stormwater drains and compensating basins in their area as they are all influenced by nutrient and other pollution inputs from surrounding areas and monitoring them could help pinpoint the sources from which pollution is entering waterbodies. SERCUL has an Environmental Monitoring team that can assist LGAs in undertaking water quality monitoring in these areas.

Reporting of the results of this monitoring to the public is recommended. It would reflect the LGAs commitment to the environment and provide important information to community catchment and environment groups. These groups could use this information to determine where the rehabilitation of waterbodies and education of general community members needs to occur.

DEVELOPMENT CONTROL

Many new developments, especially subdivisions, are major sources of nutrients to waterbodies. Levels of nutrients from these developments could be reduced by imposing relevant environmental conditions on developments, monitoring them for compliance and prosecuting developers who don't comply. This would not only deter developers from not complying on future projects but would provide funds to remediate the damage caused.

RESULTS OF THE SURVEY

Overall the LGAs who responded to the survey performed above average in implementing the BMPs for development control. LGAs were asked if they had provisions in the Town Planning Scheme or Planning Policies to enforce environmental conditions on development and if those conditions on development include NIMPs. They were then asked whether the developments were monitored for compliance with NIMP conditions and if they were, if any were found to be non-compliant and the developers prosecuted (Figure 12). Twenty-four LGAs (92%) had environmental conditions on development, but only 13 had NIMPs, with 12 of those monitoring them for compliance.

FIGURE 12: DEVELOPMENT CONTROL

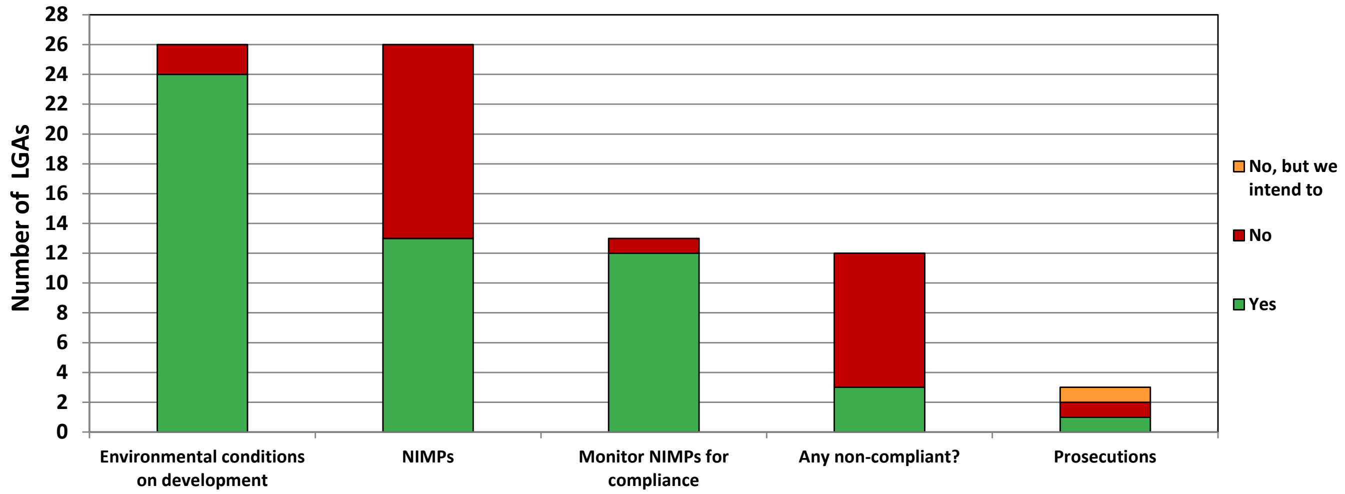
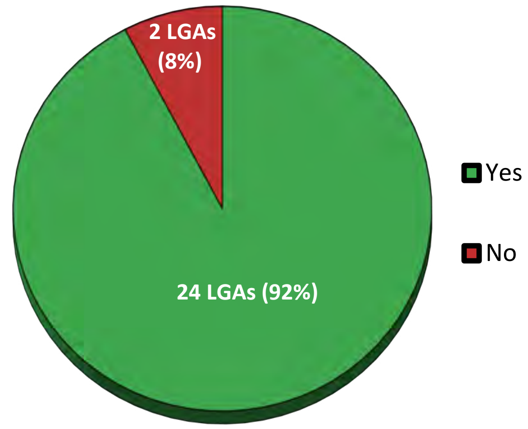


FIGURE 13: SEDIMENT MANAGEMENT REGULATIONS



LGAs were asked whether they had any mechanisms in place to regulate sediment management to prevent sediment runoff from subdivisions and during public works, and from residential, commercial, and industrial building sites (Figure 13). They were then asked what mechanisms were used to regulate sediment management (Table 4). Analysis of the raw data showed that 23 of the 24 LGAs who had sediment management regulations in place utilised more than one mechanism.

TABLE 4: MECHANISMS USED BY LGAS TO REGULATE SEDIMENT MANAGEMENT

Sediment Management Mechanism	Number of LGAs Using Mechanism
Permits (e.g. verge permit)	**16**
Requirement for a Site Management Plan or an Erosion and Sediment Control Plan to be submitted during approval	**15**
Bonds	**15**
Conditions on subdivision approvals that relate to the management of sediment runoff	**14**
Local law	**12**
Advice notes (e.g. information for land developers and builders on how to control on-site erosion and sediment loss)	**11**
Erosion and/or sediment control guidelines for residential building (builders and sub-contractors)	**10**
Erosion and/or sediment control guidelines for subdivision (land developers)	**9**
Erosion and/or sediment control policies	**8**
Local Government Officers completing DWERs Authorised Officers training so they can issue infringement notices under Unauthorised Discharges Regulations 2004	**5**
Other (Option added by a LGA)	
Reference in the Guidelines to the Unauthorised Discharges Regulations 2004	**1**

DISCUSSION AND RECOMMENDATIONS

Environmental conditions placed on developments helps to ensure that developers implement BMPs. It is pleasing that the majority of LGAs had provisions in the Town Planning Scheme or Planning Policies to enforce conditions on development, but disappointing that only a little over half of those LGAs imposed NIMPs as one of those conditions. NIMPs provide detailed guidelines for minimising water wastage and fertiliser losses in landscaped areas, provide economic benefits as they promote cost saving through the efficient use of water and fertiliser, and if implemented correctly prevent the leaching of nutrients to the river system and wetlands (DoW, 2010). It is possible that these conditions are being imposed but are included in Urban Water Management Plans and are not clearly defined as a NIMP. It is recommended that all LGAs impose environmental conditions on development including NIMPs, monitor compliance to these conditions and prosecute for non-compliance. Many new developments, especially subdivisions, are major sources of nutrients to waterbodies and this could be reduced by monitoring for compliance and prosecuting developers for their lack of compliance, not only to recoup costs for environmental damage but to deter the developers from not complying on future projects.

Soil erosion and runoff from building, subdivision and construction sites are major sources of stormwater pollution in local government areas. They transport nutrients from urban areas that may have previously been used for agriculture, horticulture and/or industry to the river system and wetlands. As well as causing an influx of nutrients to these waterbodies, sedimentation can cause other environmental and infrastructure damage, which LGAs are often responsible for fixing. The raw data indicated that many of the respondents to this question were initially unsure of whether their LGA had sediment management regulations in place, only to realise they did when presented with the options of what was considered a regulation. It is important for all LGA employees working in areas relevant to nutrient management to be aware of these regulations and it is recommended that all LGAs have mechanisms in place to regulate sediment management. Those that currently have none should seek to implement those measures outlined in Table 4. Further information about sediment management for LGAs can be found on Perth NRMs website (https://www.perthnrm.com/resource/sediment-management/).

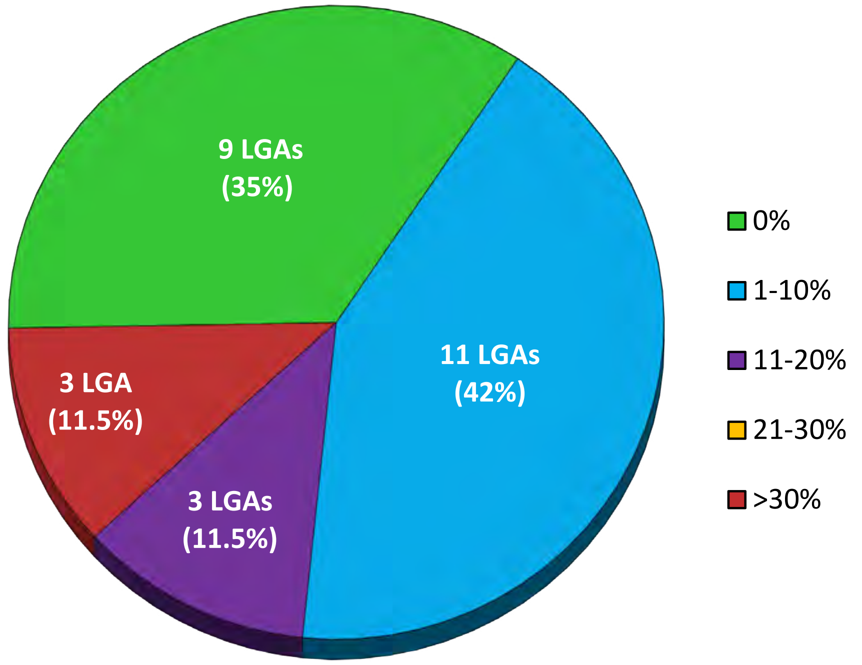
WASTEWATER SYSTEMS

A large majority of the Perth urban area was connected to sewerage as part of the State Governments Infill Sewerage Program, which commenced in 1994. Those properties not connected today were not considered to be in high priority areas and were generally on larger blocks away from water resources. Septic tanks can pose a threat to the river system by releasing nutrients if they are not well maintained.

RESULTS OF THE SURVEY

LGAs were asked what percentage of properties (for subdivisions less than 1 ha) in their urban zone are either unsewered or if sewered are not connected to the sewer (Figure 14). Of the six LGAs that had more than 10% of their properties not connected to the sewer, four of these localities are either in, or in the foothills of, the Darling Range, where the soil can contain large amounts of clay and rock and the properties are bigger and more spaced apart, making it more difficult and expensive to install sewerage. The remaining two LGAs are riverside localities and it is not clear why more of their properties have not been connected to sewerage.

FIGURE 14: PERCENTAGE OF PROPERTIES WITHIN LGAS NOT CONNECTED TO SEWER



DISCUSSION AND RECOMMENDATIONS

The majority of LGAs who responded had 10% or less of properties that were not connected to the sewerage system. It is recommended that where possible LGAs encourage those householders that remain unconnected to connect to the main sewerage line or, at the very least, ensure that their septic tanks are well maintained, as leaking septic tanks can contribute nutrients to river systems and wetlands via groundwater.

NUTRIENT EDUCATION

Every effort can be made by LGA employees to implement BMPs when it comes to fertiliser application, nutrient sources, water quality monitoring, development control and wastewater systems, however, unless ratepayers (including residents, industries and businesses) are educated about nutrients and the role they play in their management, nutrients will still be entering rivers and wetlands in large quantities. Raising community awareness of the sources of nutrients, their pathways into waterbodies and the impact resultant algal blooms can have on the recreational, economic, and environmental values of the river system and wetlands are vital to protecting them from harm.

Residents should be educated on the contribution of dog faeces, bread fed to water birds and other nutrient sources to nutrient loads, how to implement best practice in fertiliser management according to soil type and how nutrients from all sources, including grass clippings, leaves, sediment and detergents, make their way into waterbodies, via stormwater drains, groundwater or runoff. Businesses and industries that are located within a local government area should be educated on the potential for nutrients from their activities to enter waterbodies and how to prevent this occurring. Much of the Perth Metropolitan Area is located on an extensive infertile sand plain covered in sedimentary material. The undisturbed and unamended sand plain soils are characterised by extremely low fertility, poor nutrient retention and low water holding capacity (ChemCentre, 2019). As such, under the right conditions, nutrients are able to easily move through these sand plain soils into waterbodies. Some of the soil duplexes present in the Darling Range, or to a lesser extent on the Swan Coastal Plain, that contain loam or clay retain more nutrients (Department of Primary Industries and Regional Development, 2023) meaning less is released into waterbodies through groundwater than from the sand plain soils.

Achieving a garden with healthy plants and soils requires choosing a plant for the soil or amending the soil to suit the plant (ChemCentre, 2019). Responsible fertiliser use is part of keeping our soils and waterbodies healthy, as is responsible behaviour when it comes to animals. A portion of the phosphorus load in residential areas can be attributed to pet faeces and bread fed to waterbirds. Bread can make waterbirds sick as they aren't able to digest it readily and can become reliant on it as a food source, suffer malnutrition and as a result are more susceptible to diseases. Bread also contains large amounts of phosphorus that can contribute directly or through the faeces of waterbirds to the nutrient enrichment of waterbodies. Many residents feed ducks as a recreational activity and as a way of 'helping' the birds without realising the negative consequences their actions can have on the health of waterbirds and the rivers and wetlands on which they live. The general public should also be educated on the linkages between what goes into the stormwater or septic system or on the ground and its movement into waterbodies via that system, groundwater or runoff.

RESULTS OF THE SURVEY

Overall, the LGAs that participated in the survey excelled in implementing nutrient education BMPs. LGAs were asked whether information and/or resources are provided to residents regarding dog faeces, bread fed to waterbirds and best practice in fertiliser management according to soil type. They were also asked whether residents, businesses and schools are educated about the sources of nutrients found in waterways and the ways in which they move into, and impact upon, these environments (Figure 15).

The LGAs that responded yes to the questions regarding education were then asked how they provide this education (Table 5).

FIGURE 15: NUTRIENT EDUCATION AND RESOURCES

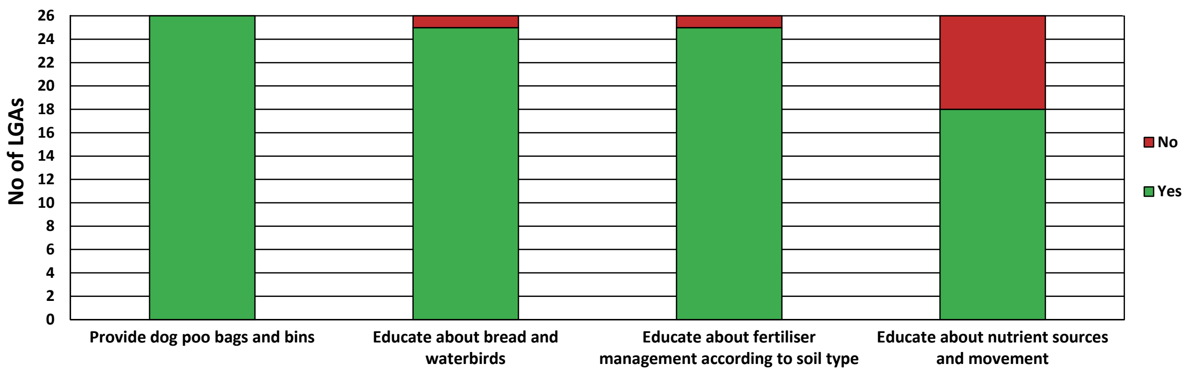


TABLE 5: EDUCATION MEASURES TAKEN BY LGAS

Measures relating to education about	No. of LGAs Using Measure
Bread fed to waterbirds	
Information signage	**24**
Information on LGA website	**15**
Signage regarding laws prohibiting the feeding of wildlife	**15**
Media ie. newsletters, social media, print media	**14**
Information distributed by staff ie. Rangers, Environmental Officers, staff at Reception	**12**
Information distributed at community events	**11**
Ranger enforcement	**11**
Workshops	**5**
Best practice in fertiliser management	
Native plants to residents programs/subsidies	**20**
Information at community events	**15**
Verbal/email advice	**14**
Information on LGA website	**12**
Workshops	**12**
SERCUL Fertilise Wise brochure distributed	**10**
A link to SERCUL Fertilise Wise information on LGA website	**8**
Social media	**8**
SERCUL Grow Local Plant Guides distributed	**5**
LGA produced pamphlets	**4**
Other (option added by a LGA)	
Adopt a Verge program and rebate	**1**
City of Bayswater Local Native Plants Guide	**1**
Nutrient sources, their movement through the landscape and their impact on waterways	
Information on LGA website	**11**
Information distributed by staff ie. Rangers, Env. Officers, Env. Health Officers, staff at reception	**9**
Information distributed at community events	**8**
Media ie. newsletters, social media, print media	**8**
Link on LGA website to relevant information on SERCUL or other organisations website	**7**
Workshops targeting particular groups ie. residents or businesses, and either provided by LGA directly or through funding to an external provider such as SERCULs Phosphorus Awareness Project	**6**
School events or incursions, either provided by the City directly or through funding to an external provider such as SERCULs Phosphorus Awareness Project	**6**
Follow up on reports of stormwater contamination by speaking directly to the suspected perpetrators (where possible)	**4**
Other (option added by a LGA)	
Sediment Task Force – on website	**1**

DISCUSSION AND RECOMMENDATIONS

All LGAs surveyed were conducting nutrient BMP by providing dog poo bags and bins for residents to use and it is recommended that this continue. The LGAs currently not educating the public about not feeding bread to waterbirds and fertilising according to soil type should adopt some of the measures listed in Table 5. Those LGAs who only listed verbal or email advice provided by staff should implement additional measures as this tends to be a reactive rather than a proactive approach which is only provided in response to a request for information. The question regarding educating ratepayers about nutrient sources, their impact on waterways and how they move through the landscape was new to this years survey. Fewer LGAs were providing education around this topic.

The use of interpretative signage in educating people about the issues relating to feeding bread to waterbirds is effective as it means information is being provided at the site at which it is occurring. The use of enforcement is also recommended to deter persistent bird feeders. At a minimum, it is strongly recommended that all LGAs erect signage in parks and freshwater and ocean foreshore reserves that educates the public about the effects of bread on waterbodies (eg. increased phosphorus levels and algal blooms) and waterbirds (eg. malnutrition, botulism, and aggressive behaviour). SERCULs Phosphorus Awareness Project has a brochure which outlines this issue that could be used as the basis for signage.

The focus of the information provided to ratepayers about their fertilising practices should be based around the fertilising of lawns. With few exceptions, ratepayer's lawns form the largest turfed area in a LGA and householders generally have limited knowledge of best practice fertiliser management. It is recommended that LGAs provide advice to ratepayers on fertiliser practices. This will help to reduce the high levels of nutrients from fertilisers that leach through the sandy soils of the Swan Coastal Plain and into groundwater and waterbodies.

The Phosphorus Awareness Project (PAP) has a ***'Fertilise Wise'*** leaflet about establishing, maintaining and fertilising lawn according to the soil type. This leaflet contains information on fertiliser BMPs, is targeted at homeowners and is available for LGAs to distribute to their ratepayers for free. SERCULs website also contains Fertilise Wise and other gardening information specific to the Perth region (www.sercul.org.au/fertilisewise). LGAs are encouraged to link this website to their own. SERCULs PAP also has a series of ***'Grow Local Plants'*** brochures for each of the five major soil types in Perth. Providing them with the relevant brochure and native plant subsidies is a great way to get ratepayers to use native plants in their gardens, thereby reducing the use of fertiliser and water. LGAs could also host a ***'WaterWise'*** or ***'Our Gardens with Josh Byrne'*** workshop to educate ratepayers on fertiliser and water management and other garden issues. Workshops can be organised by contacting The Forever Project or Josh Byrne & Associates (contact details provided at the end of this report).

Educating ratepayers about other nutrient sources, such as grass clippings, leaves, sediment, septic tanks and detergents, and the way in which all nutrient sources move through the landscape is important as a lack of understanding can lead to unnecessary inputs of nutrients into waterways. Nutrient education is provided by the Phosphorus Awareness Project, which has been run by SERCUL since 1998 and has for many years been largely funded by the Department of Biodiversity, Conservation and Attractions (DBCA). PAP aims to educate the general community about the impact of too many nutrients on the Swan and Canning river systems and how to reduce those levels. LGAs can utilise PAPs education program, including the resources available on its website (www.sercul.org.au), or direct school or community groups to it.

Information about sediment management, which represents a major nutrient source in many LGA areas, has been produced by the Sediment Task Force (STF), which is facilitated by Perth NRM. They have recently released information sheets for all audiences and more specifically residents, builders, developers and local government. Those targeting residents are titled:

- *STF Infosheet: Residents #1 – What You Need to Know About Sediment Control*
- *STF Infosheet: Residents #2 – We Can All Stop Sediment Runoff from Our Home*
- *STF Infosheet: Residents #3 – Waterwise Gardens are also Sediment Wise*

These can be found at www.perthnrm.com/resource/sediment-management/ and it is suggested that a link to these resources is provided on each LGAs website.

ADDITIONAL INFORMATION, REFERENCES & CONTACTS

ADDITIONAL INFORMATION

LGAs were asked whether they had implemented any other strategies in relation to nutrient management that they felt were not adequately captured in the survey. Five of the LGAs provided additional information relating to various approaches to nutrient management that they have in place. Some of the strategies included:

- providing residents with a Local Native Plants Guide specific to our area,
- verge enhancement grants for residents,
- using liquid fertilisers and wetting agents,
- putting Minimum Level of Sustainable Nutrition (MLSN) programs in place,
- locking irrigation programs when rainfall events occur to reduce overwatering and leaching of nutrients,
- having high-profile gardens that are thematically planned around using WA natives and endemic riverine species and preferencing the use of endemic WA species in Verge Transformation Guidelines,
- development and council adoption of Watercourse Hierarchy strategy,
- blowing leaves off verges in front of street sweepers.

The information specific to those LGAs will be summarised on their scorecard.

REFERENCES AND CONTACTS FOR FURTHER INFORMATION

ChemCentre (2019) ***WA Soil Analysis Results Fact Sheet ChemCentre Open Day***. Available from www.chemcentre.wa.gov.au/soil-interpretation-guide-open-day-2019

Chambers, J; Hosja, W; Begum, A; Mykytiuk, C; Hale, J; Latchford, J (2005) ***Scum Book! A Guide to Common Algae and Aquatic Plants in Wetlands and Estuaries of South-Western Australia***, Murdoch University and Department of Environment, Western Australia.

Department of Biodiversity, Conservation and Attractions, www.dbca.wa.gov.au/management/swan-canning-riverpark/alexandrium-algal-blooms-swan-and-canning-rivers, accessed 2023.

Department of Primary Industries and Regional Development (2023) ***My Soil Diagnostic Tool***. Available from www.agric.wa.gov.au/managing-soils/mysoil

Department of Water and Environmental Regulation (DWER) (2022) ***Stormwater Management Manual for Western Australia.*** Available from the Department of Water and Environmental Regulation, www.wa.gov.au/government/document-collections/stormwater-management-manual-of-western-australia

Department of Water (DoW) (2010) ***Water Quality Protection Note 33: Nutrient and Irrigation Management Plans & Water Quality Information Sheet 04: Nutrient and Irrigation Management Plan Checklist***. Available from the Department of Water and Environmental Regulation – www.water.wa.gov.au

Department of Water (DoW) (2010) ***Fertiliser Application on Pasture or Turf near Sensitive Water Resources***. Available from the Department of Water and Environmental Regulation- www.water.wa.gov.au

Fertilise Wise Fertiliser Training, Fertilise Wise guides, Fertilise Wise website, Grow Local Plants leaflets, Feeding Water Bird brochures and the Phosphorus Awareness Project (PAP) educational program. Available from the Phosphorus Awareness Project, South East Regional Centre for Urban Landcare (SERCUL) – www.sercul.org.au

Landscaping with Local Plants Policy and Guidelines - Local Government Natural Resources Management Policy Manual. Available from the Eastern Metropolitan Regional Council by phoning 9424 2222.

Liu G., Zotarelli L., Li Y., Dinkins D., Wang Q., Ozores-Hampton M (2021) ***Controlled-Release and Slow-Release Fertilizers as Nutrient Management Tools***, https://edis.ifas.ufl.edu/publication/HS1255

Our Gardens with Josh Byrne Workshops. Available from Josh Byrne & Associates- www.joshbyrne.com.au or by phoning 9433 3721.

Ruscoe, Johnston & McKenzie (First Published 2004, Reprinted 2014) ***Turf Sustain – A Guide to turf management in Western Australia.*** Sports Turf Technology, Como, WA. Available from Sports Turf Technology – www.sportsturf.net.au or by phoning 9367 1600.

Sediment Task Force, STF Infosheet: Local Government #1 – 4 and Residents 1-4, Available from Perth NRM at https://www.perthnrm.com/resource/sediment-management

Swan River Trust (2007) ***Healthy Rivers Action Plan,*** Swan River Trust, East Perth, WA. Available from the Department of Biodiversity, Conservation and Attractions- www.dpaw.wa.gov.au or by phoning 9219 9000.

Swan River Trust (2009) ***Swan Canning Water Quality Improvement Plan,*** Swan River Trust, East Perth, WA. Available from the Department of Biodiversity, Conservation and Attractions- www.dpaw.wa.gov.au or by phoning 9219 9000.

Swan River Trust (2014) ***Western Australian environmental guidelines for the establishment and maintenance of turf grass areas.*** Swan River Trust with support from organisations represented on the Fertiliser Partnership Urban Users Working Group, Kensington, WA. Available from the Department of Biodiversity, Conservation and Attractions- www.dpaw.wa.gov.au or by phoning 9219 9000.

Waters and River Commission (2002) ***Water Notes 25 The Effects and Management of Deciduous Trees on Waterways.*** Available at https://www.water.wa.gov.au/__data/assets/pdf_file/0018/3357/12685.pdf

WaterWise Workshops. Available from The Forever Project – www.theforeverproject.com.au or by phoning 0409 662 704.

Which Plant Where website – www.whichplantwhere.com.au

Woods, M (2018) ***MLSN Cheat Sheet***. Available from Asian Turfgrass Centre- https://files.asianturfgrass.com/mlsn_cheat_sheet_us.pdf

SERCUL
South East Regional Centre for Urban Landcare

ALGAE BUSTER
PHOSPHORUS AWARENESS PROJECT

This report has been prepared by the Phosphorus Awareness Project, South East Regional Centre for Urban Landcare, 2023.

For further information please contact:
Natasha Bowden
P | 9458 5664
E | natashabowden@sercul.org.au
W | www.sercul.org.au/fertilisewise

Printed on 100% recycled paper.