Nutrient Management Report

28/08/2017

SCOTCH COLLEGE | 76 SHENTON ROAD SWANBOURNE

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Soil, Tissue and
water report April 2(

Soil , Tissue and Water Report 2017

1 INTRODUCTION

Scotch College is a privately-owned site operating as an educational facility with large areas of playing field, passive lawn and garden areas. Scotch college are always seeking the best managment practices to protect the environment and resources. The purpose of this report is to ensure the present and future management of the site assists in meeting the water and nutrient quality objectives of the Lake Claremont Protection Committee and its Lake Management plan. It has also been developed to ensure that Scotch College's own irrigation and fertiliser management practices do not contribute to an oversupply of fertiliser application or an over utilisation of the sites irrigation system and that best practice is always applied.

The primary objective of our nutrient management plan is to minimise the export of nutrients, especially phosphorus and nitrogen. Other outcomes expected of this plan are to:

- Outline a program to monitor nutrient levels within the school site that have no effect downstream of the properties boundary.
- Identify management actions
- To further improve fertiliser management by
    1. Limiting irrigation after applying fertiliser.
    2. Maintain lower application rates
    3. Avoid fertilising near the existing natural vegetation areas.
    4. Maintain more accurate records of when fertilising was undertaken including weather conditions and frequency of application.

1.1 Site Description

The land area of the College is 42 hectares. Of this, 12.5 hectares are playing fields with trees scattered around the boundaries and a small stand of trees located in the middle between two ovals, approximately 16 hectares of gardens and passive grassed areas and 14.5 hectares of buildings, car parking and paving

2 SOIL

2.1 Spearwood Dunes Sand

Scotch college's soil structure consists of mostly the Spearwood dune system.
The Spearwood dune sand can be described of the following coloured sands.

- Red / Brown
- Yellow
- Pale Yellow / Grey

All of these sands are coated with iron and aluminium oxides. It is the amount of iron oxide that coats the sand that determines the colour. The more iron coating the sand, the darker the colour.
The sand found on the site is the red / brown sand and this is better known as Cottesloe sand. The Cottesloe sands generally retain moisture and are more supportive of plant generation.

3 DRAINAGE

3.1 Drainage Controls

Currently the profile is high in organics which creates a low drainage capability.
To combat this aeration measures are used, regular verti-draining during the wet season helps improve water surface drainage whilst also allowing oxygen into the soil. The verti drain punches holes that allow water to move freely into the profile instead of sitting at the surface.
Regular dusting between verti-draining is required to help improve soil structure allowing for better drainage in the future.

3.2 Subsoil Drainage

The older sections of the playing fields are the only areas with subsoil drainage installed. The method of construction carried out was to lay 150mm slotted earthenware into trenches, totally encased in a continuous blue metal filling. Branches were formed and 100mm earthenware takeoffs were run out in trenches. The pipe works have been connected into a main pipe which delivers water to the drainage sumps in the middle of the ovals and from there it is discharged into the drainage swale on the eastern boundary.

4 NUTRIENT EXPORT PATHWAYS

The aim of the report is to identify areas where nutrient export can or will occur. Following that assessment the following pathways for export of nutrients from the College grounds to the environment have been identified:

1. Transport of nutrients from the site in ground water and surface water.
2. Inefficient use of chemical fertilisers to maintain or increase turf production. This may occur by:
   a. The selection of inappropriate fertilisers, such as those containing high concentrations of water-soluble nutrients that are not limiting productivity.
   b. Excessive application rates, especially on soils with very low adsorption capacity.
   c. The correct processing of chemicals containing nitrogen or phosphorus compounds.

3. Fertiliser applications are applied with low drift nozzles to reduce risk of nutrients drifting into water resources.
4. Low rates of nutrient are applied per application reducing chances of leeching.

In addition Scotch College playing fields offer an attractive venue to the neighbours and residents of the area. The size of this proliferation is significant enough for issues with dog waste to be identified as a contributor to waste entering the soil system and the probable leaching into the environment.

Another significant contributor to contaminating the College grounds is the amount of rainwater runoff that enters the property from outside of the boundaries. This runoff has been identified as containing hydrocarbons. A drainage swale has been designed to help filter water collected from heavy downpours.

Attached to the maintenance facility is an underground storage facility for diesel and petrol which has the potential to leak hydrocarbons into the ground. The college manages this by conducting 2 yearly inspections / testing of the tank and the surrounding soil to determine whether leaks and contamination has occurred. Test results are attached for reference form and form part of this plan

5 LAND USE AND NUTRIENT APPLICATION DETAILS

1. Selection of appropriate fertilisers and application rates will be based on the results attained from soil testing.
2. Fertilisers are only applied in response to issues identified in the soil analysis tests.

The table below shows all of the types of Fertilisers / Pesticides / Herbicides employed at the school and their application rates.

Fertiliser				
Product	Product Rate	Intervals	Composition	Storage Location
Sulphate of ammonia Ferrous Sulphate Manganese Sulphate Magnesium Sulphate	50Kgs 25Kgs 7Kgs 25Kgs	Every 6 - 8 weeks September - March Every 8 Weeks April – August	Nitrogen 21% Sulphur 24% Ferrous 19.5% Sulphur 11.0% Manganese 31.8% Magnesium 9.8% Sulphur 13%	25kg Bags Bunded chemical store
Calcium	40L / Ha	4 times a year September November December March	Calcium 6% Potassium 2.0% Magnesium 0.35% Sulphur 0.30%	1000L shuttle chemical store
NPK Slow release granular	66kg / Ha	4 times a year September November December March	Nitrogen 15% Phosphorus 1.7% Potassium 12.5%	20kg Bags stored on shelves inside workshop
Broadwet	300mls / Ha	Every night September – March	Wetting agent	1000L shuttle stored on shelves inside workshop
Kelp	10L / Ha	4 times a year September November December March	Nitrogen 0.2% Phosphorous 0.02% Potassium 3.7%	1000L shuttle chemical store
Chemicals				
Product	Product Rate	Intervals	Composition	Storage Location
Primo	500mls / Ha	4 times a year September November December March	Primo	5L Bunded chemical store
Kerb	1.2L / Ha	Septmeber if Poa Annua present	Propyzamide	5L Bunded chemical store
Steere	1.1Kg / Ha	Autumn / Situatonal	Quinclorac	2Kgs Bunded chemical store
Eraze 510 Biaquatic	1.5L / Ha	Weed control during winter	Glyphosate	20L Bunded chemical store
Thumper	1 – 2L / Ha	If couch mite present	Abamectin	5L Bunded chemical store
All Chemicals are sprayed at label rates. Chemicals are only applied if a problem arises, chemicals are the last alternative if cultural practices are not succesfull.				

5.1 Other Nutrient Sources

The College will ensure that the sewerage system on the site is maintained to ensure that there is no leaching of contaminated water in to the ground water system.
The existing waste water system that pumps ground water from collection tanks in the playing fields area discharges into that swale where multiple species of native flora have been planted to assist in the absorption of nutrients inside the water.

6 NATIVE VEGETATION

Revegitation of the tree line that backs onto the Claremont lake is being considered using the recommended native plants from the Town Of Claremonts Flora appendix .
Currently applications of glyphosate are used to control weeds in the native tree line with cultural controls used for larger sized weeds. Nutrient requirements of native vegetation are significantly lower than those of grasses, however revegetation by native plants may be accelerated by application of low rates of fertilisers.

7 MONITORING

7.1 Water Quality Monitoring

Regular monitoring will be required to demonstrate that the grounds maintenance operations do not adversely affect groundwater and surface water quality. The testing frequency is twice a year at the start of the growing season and the end , water tests will be carried out by a reputable testing organisation.
Copies of the most recent water analysis of bores and ground water pits are included in the irrigation management plan.

7.2 Soil Quality Monitoring

The Grounds Supervisor will be responsible for ensuring soil samples are taken from areas where the application of fertiliser is being considered. The soil samples will be analysed to determine whether fertiliser or other soil amendments are required and if so, the suitable application rates.
Soil testing will also be taken twice a year, once in Septmeber the second in March (start of the growing season and the end). Copies of the most recent soil analysis are included as an appendix in this document.

8 RECORDS, REVIEW AND REPORTING

The Grounds Supervisor is responsible for recording the results of water and nutrient monitoring conducted on site.

The following records will need to be maintained for the following activities:

1. Laboratory soil test reports.
2. Reports provided to substantiate the fertiliser application rates chosen.
3. The types and quantities of any fertilisers or soil conditioners applied.

The Grounds Supervisor is also responsible for:

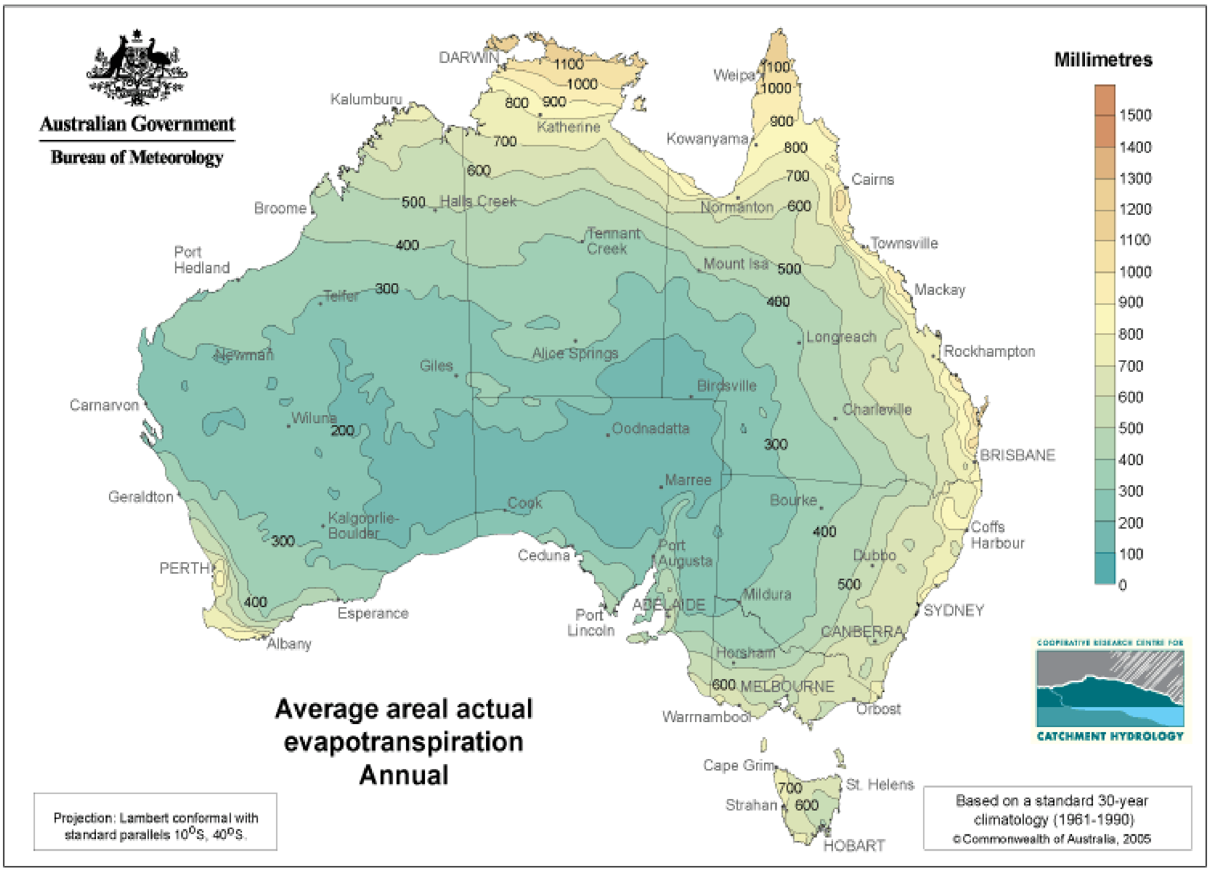
1. Ensuring that the nutrient management plan is reviewed annually and amended if necessary to ensure that it remains relevant, practical and effective.
2. Ensuring that all results for soil and groundwater monitoring undertaken in the year are included in an annual environmental report.
3. Ensuring soil testing is undertaken prior to revegetation of areas using native plant species.
4. Ensuring soil samples are taken for areas to be revegetated to lawn, prior to any revegetation works taking place. The soil samples are required to be tested for a range of nutrients and other contaminants.
5. Ensuring that regular water samples are collected from the existing groundwater collection pit on the playing field

9 CLIMATE

Yearly climate averages for the Swanbourne area, the closest recording station to the site, are presented in the Tables below. Also included is a map of the continent showing evapotranspiration rates. Evapotranspiration is used to determine our water budget for the year, the previous five years of evapotranspiration are averaged out to help determine the amount of water required for that month.

Average Evapotranspiration 2016								
Jan	Feb	Mar	Apr	May	Sept	Oct	Nov	Dec
9.5mm	8.5mm	6.9mm	4.8mm	3.4mm	4.4mm	5.9mm	7mm	8.6mm

Perth Weather Data Gathered from the WA Bureau of Meteorology Website



Statistics gathered from the Swanbourne Bureau of Meteorology station are utilised to set the strategy with the systems run times. Monitoring of expected rainfall through satellite sites on the web are also used as part of the management strategy.

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years		Plot	Map
Temperature																	
Mean maximum temperature (°C)	29.9	30.6	28.9	25.4	22.2	19.5	18.4	18.9	19.9	22.3	25.4	27.9	24.1	24	1993 2017		
Mean minimum temperature (°C)	18.3	18.7	17.4	15.2	12.6	10.6	9.6	10.1	11.0	12.4	14.7	16.5	13.9	24	1993 2017		
Rainfall																	
Mean rainfall (mm)	15.5	12.6	21.9	39.7	91.6	122.2	149.4	116.2	82.6	43.4	24.1	11.8	726.5	21	1993 2017		
Decile 5 (median) rainfall (mm)	1.8	2.1	15.4	31.4	90.2	126.2	153.8	120.0	80.8	41.0	21.7	5.8	744.6	24	1993 2017		
Mean number of days of rain ≥ 1 mm	1.3	1.0	2.5	4.7	9.2	12.2	15.2	13.2	11.0	5.8	3.8	1.9	81.8	24	1993 2017		
Other daily elements																	
Mean daily sunshine (hours)																	
Mean number of clear days																	
Mean number of cloudy days																	
9 am conditions																	
Mean 9am temperature (°C)	23.8	23.9	22.1	19.5	16.4	13.7	12.9	13.6	15.6	17.8	20.8	22.7	18.6	17	1993 2010		
Mean 9am relative humidity (%)	53	55	58	65	72	77	78	76	69	62	57	53	65	16	1993 2010		
Mean 9am wind speed (km/h)	19.5	19.7	19.3	17.3	18.0	19.6	20.0	18.5	19.5	19.1	19.5	19.8	19.2	17	1993 2010		
9am wind speed vs direction plot																	
3 pm conditions																	
Mean 3pm temperature (°C)	26.3	27.2	26.3	23.3	20.8	18.0	17.0	17.3	18.1	19.9	22.4	24.9	21.8	17	1993 2010		
Mean 3pm relative humidity (%)	55	54	52	57	59	62	63	63	62	59	58	54	58	16	1993 2010		
Mean 3pm wind speed (km/h)	27.7	25.8	23.0	19.9	18.4	19.3	20.2	20.8	23.0	24.9	26.1	27.2	23.0	17	1993 2010		
3pm wind speed vs direction plot																	

PerthWeather Data Gathered from the WA Bureau of Meteorology Website

10 IRRIGATION

Scotch College has an annual allocation of 114750kL across the 2 Campuses and works within that allocation.

As previously indicated the strategy employed in this plan was to provide initial settings for the irrigation system. The system however will require ongoing adaptations to adjust for conditions that may become apparent over time.

The schedule needs to take into account variations in climate and in use patterns. The principle aim is to minimise the amount of water applied, both to reduce leaching and to conserve the resource.

Monthly adjustment is made to the scheduling of the irrigations control system. It is done by altering the time for which water is applied, and also the frequency of irrigation. The cumulative volume of water pumped by the irrigation system is to be recorded on a monthly basis by reading the water meter on the reticulation system at the bore or mains water.

The operator is also required to keep a log book showing the irrigation schedule settings.

Soil moisture monitoring devices are also being considered as part of a system upgrade to measure moisture content. A log book record of the findings will also be kept to assess the success of the current watering program and to give a baseline for comparison into the future.

10.1 Irrigation System

The college's irrigation system:

- 6 SD Controllers
- Variable Speed Drives
- Gear drive and pop up sprinklers
- Storage tank (160,000 liters)
- 3 Licensed Bores
- Pressure pumps
- Drip system to garden beds
- Fertigation system for wetting agents

10.2 Irrigation Management
Our irrigation management focus includes the following.

a. Sodium and water quality affecting turf and soil structure.
b. Investigate sustainable ways to reduce the amounts of water being drawn from the groundwater system at a time when there are greater demands through urban land use.
c. Assess future watering requirements and work towards achieving a significant reduction on the present-day allocations
d. Ensure that irrigation applied to the soil cover does not result in excessive subsurface infiltration and contribute to any acceleration of leaching of nutrients into the ground water system.
e. Communicate to stakeholders that the College is aware of its responsibility to the environment and has a good working knowledge of where the water comes from, its composition and the effects on the environment that its application could have downstream.

The plan includes and addresses the following specific items:

- Water balance
- Subsurface drainage
- Overall irrigation strategy

The long-term goal is to

a. Achieve high water use efficiencies both through design and through management initiatives.
b. Maintain existing standards in the turf area while considering the minimum application of watering necessary.
c. Achieve environmental excellence

10.3 Irrigation Rate

The appropriate irrigation rate for Scotch College is a balance between supporting plant growth and minimising the infiltration to the sub surface and then into the ground water catchment.

Irrigation rates are calculated to suit the plants water requirements.
With kikuyu being a warm season grass we work with a crop factor range of 50% - 60%.
Frequency is set for plant water replacement based on daily evapotranspiration.
Run times are measured

$$\text{Run Time} = \frac{\text{Irrigation Depth (mm)} \times 60 \text{ min}}{\text{Precipitation rate (mm/h)}}$$

Run times are dependent on the sprinkler model purchased, Currently hunter i25 sprinklers are used around the school. Full rotation sprinklers are set at 20 minutes, whilst half rotation sprinklers are set at 10 minutes. Our run times are not altered as our system is adjusted through a percentage option that allows us to adjust to the correct crop factor. For example if we needed to apply 5mm for that days watering we would alter the percentage to 50% if we needed to apply 3mm we would change it to 30% currently we do not go above 60% (6mm) as we are focused on staying within our water budget.

The watering requirements of active areas of turf such as the Scotch College Playing Fields are generally greater than those of passive lawn areas due to the additional growth required to take into account the activity of that area. Irrigation cycles are altered daily due to evapotranspiration, this is to make sure we replace the correct amount each day to meet our crop factor target.

10. 4 Infiltarion Of Soil
The amounts of infiltration through a soil profile can be defined as

<u>Rainfall + Irrigation</u>
Runoff + Evaporation / Transpiration.

Water that passes through the Soil / Loam layer will infiltrate into the subsoil and potentially cause minor amounts of leaching of nutrients and soil contaminants. Clearly the effect that rainfall as well as irrigation has on this potential must be considered when controlling the rate of this leaching.

Consideration must be given to the ability of the existing soil types to reduce the amount of infiltration that meets the subsoil layer. The volume of water that infiltrates and recharges the deeper soil profile has been previously calculated for the soil type in use at the College.

The Western Australian Bureau of Meteorology assumes that Perth will have an average rainfall of 800mm per year, and by doing the calculations the total infiltration rate for the sandy type soils throughout the College would be 11.5 cm/year or 14% of all rainfall.

10.5 Irrigation Reporting
A report detailing the management of the irrigated area is to be prepared following a three year monitoring

The following items are to be included in this report:

- Monthly irrigated volumes
- Monthly evaporation data from closest climate station
- Subsurface soil moisture levels
- Total fertiliser applied to site
- Results of topsoil pH testing
- A general description of any excessive wear, erosion or any other loss of soil from the site.

The need for any additional soil monitoring would be required if excessive subsurface drainage containing contaminants is identified as entering Lake Claremont.

11 WATER QUALITY TESTING

Bore sites and ground water collection pits are tested for composition. Recent analysis indicated that the water quality at Scotch College varied between the bore water and sump water which had, as expected, higher concentrations.

11.1 Bore Water – Main Oval Test Results

Location	Main Grounds Bore			
Sample Date	April 2017			
Water Analysis	Concentration	Low	Medium	High
Nitrate (mg/L)	< 0.10			
Ammonium (mg/L)	5.42			
Bi-Carbonate (mg/L)	471.63			Very High
Sulphur (mg/L)	48.38			
Phosphorus (mg/L)	0.05			
Potassium (mg/L)	21.89			
Sodium (mg/L)	262.3			
Calcium (mg/L)	159.7			
Magnesium (mg/L)	39.64			
Copper (mg/L)	< 0.05			
Zinc (mg/L)	< 0.05			
Manganese (mg/L)	< 0.05			
Iron (mg/L)	4.51			
Boron (mg/L)	0.15			
Chloride (mg/L)	418.15			
pH	6.8	Acidic	neutral	Alkaline
EC (dS/m)	2.38			
TDS(ppm)	1523.2			

Increase from last year (red) Decrease from last year (green)

11.2 Bore Water - Junior School Test Results

Location	**Junior School Bore**			
Sample Date	**April 2017**			
Water Analysis	**Concentration**	**Low**	**Medium**	**High**
Nitrate (mg/L)	< 0.10			
Ammonium (mg/L)	0.91			
Bi-Carbonate (mg/L)	368.29			
Sulphur (mg/L)	40.53			
Phosphorus (mg/L)	0.06			
Potassium (mg/L)	17.12			
Sodium (mg/L)	266.4			
Calcium (mg/L)	144.9			
Magnesium (mg/L)	43.41			
Copper (mg/L)	< 0.05			
Zinc (mg/L)	< 0.05			
Manganese (mg/L)	< 0.05			
Iron (mg/L)	4.92			
Boron (mg/L)	0.12			
Chloride (mg/L)	485.35			
pH	7.1	Acidic	Slightly Acidic	Alkaline
EC (dS/m)	2.32			
TDS(ppm)	1484.8			

Increase from last year Decrease from last year

11.3 Bore Water – Senior School Test Results

Location	Senior School Bore			
Sample Date	April 2017			
Water Analysis	Concentration	Low	Medium	High
Nitrate (mg/L)	< 0.10			
Ammonium (mg/L)	< 0.10			
Bi-Carbonate (mg/L)	275.47			Very High
Sulphur (mg/L)	24.08			
Phosphorus (mg/L)	< 0.05			
Potassium (mg/L)	7.67			
Sodium (mg/L)	162.4			
Calcium (mg/L)	113.5			
Magnesium (mg/L)	22.34			
Copper (mg/L)	< 0.05			
Zinc (mg/L)	< 0.05			
Manganese (mg/L)	< 0.05			
Iron (mg/L)	2.49			
Boron (mg/L)	0.06			
Chloride (mg/L)	287.5			
pH	7.1	Acidic	Slightly Acidic	Alkaline
EC (dS/m)	1.518			
TDS(ppm)	971.52			

Increase from last year | Decrease from last year

11.4 Details of existing bores

Bore	Depth Metres BGL	SWL Metres BGL	Approx Flow Rate Litres/sec
Senior School	42	24m	8 litres
Junior School	30	3m	12 litres
Main Oval	20	1m	12 litres