

School as a Catchment

Integrated Water System Report

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Environment • Design • Communication

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SCHOOL AS A CATCHMENT

INTEGRATED WATER SYSTEM REPORT

prepared by
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prepared for
**VICTORIAN ASSOCIATION FOR ENVIRONMENTAL EDUCATION (VAEE),
DEER PARK NORTH PRIMARY SCHOOL (DPNPS)
& THE VICTORIAN GOVERNMENT**

project
SCHOOL AS A CATCHMENT

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1 INTRODUCTION

The purpose of this report is to develop an integrated water management scheme for the Deer Park North Primary School (DPNPS) to help rejuvenate key areas on the school campus. The document is also designed for use by other schools as a methodology for implementing integrated water management outcomes. It forms part of the 'School as a Catchment' project which will see systems designed and installed on site, student and community engagement through workshops and a host of project partners committed to disseminating the broader potential of this demonstration exemplar.

The principal objective is to increase the 'liveability' of the school through a holistic and integrated approach to the management of water on the school site. For example it is anticipated that substantial greening of the school can be achieved without any increase in overall water consumption. Other aspirations include the development of a productive school kitchen garden, and a more diverse and interesting use of the existing open space (often hard surfaced areas) through better management of water and increased shading, microclimates, and habitat through appropriate vegetation.

1.1 Target audience

This report is aimed at school principals and those staff involved in water and landscape management, local government staff, engineers and consultants and educational institutions more broadly. Having said that, the language is intended to be user-friendly and engaging, with the intent that it can be accessible to the general public and interested individuals.

1.2 Deer Park North Primary School (DPNPS)

Deer Park North Primary School is located on Mawson Avenue in the City of Brimbank in Melbourne's western suburbs. The school occupies approximately 2ha and currently has some 400 students and 35 staff. The two principal sports ovals have recently been resurfaced with artificial turf which in conjunction with a large expanse of asphalt basketball courts has resulted in a relatively impervious school campus with limited natural shade or soft landscape surfaces. All stormwater currently drains to the eastern boundary and ultimately enters the Kororoit Creek catchment system. The local soil consists of relatively thin loamy topsoil overlying a heavy, impermeable clay which in turn limits the scope for the onsite infiltration of stormwater.

The school has already implemented some excellent water efficiency measures including participating in the Victorian SWEP program, installing timers for automated urinal flushing in the two toilet blocks, and four separate rainwater tank systems totaling over 60,000 litres in storage capacity for rainwater capture and reuse. The school principal is keen to ensure the school continues its progress down the path of best practice water management and to share its experience with the local community and other schools in the state.

2 METHODOLOGY

Where to start? This is the first question confronting anyone attempting to tackle their 'water' situation so we have developed a methodology to help structure this process. Clearly every site is unique with its own different set of issues and objectives, but nevertheless the strategy for considering each site is similar and we have tried to capture this process here.

We have broken-down this approach into the following key components and describe them in this document:

- What are the opportunities?
- What are the objectives?
- Key considerations
- Design solutions
- Quantitative performance

2.1 What are the opportunities?

The first thing we need to understand when considering an integrated water approach is to identify the opportunities for improvement and the principal water elements for investigation:

- Water efficiency
- Rainwater
- Stormwater
- Groundwater
- Wastewater (e.g. greywater)

Water efficiency is always the first key consideration as being efficient with water use in all its forms represents the 'lowest hanging fruit'. It is always the quickest, easiest and most cost effective item and therefore needs to be addressed first.

Once water efficiency has been tackled it is a matter of considering both the quantity and quality of other available water sources, typically rainwater, stormwater, groundwater and wastewater. The principle behind this logic is to ask the question of whether water of lower quality can be used to achieve the same outcome. For example, can rainwater be used to flush toilets, can wastewater be used to irrigate garden beds?

This then leads to the second consideration which is that of attempting to close the water cycle, commonly referred to as 'closing the loop' for each water source.

An example of this would be attempting to capture, treat and use on site, all rainwater that falls on the site. This could include a mix of rainwater tanks for indoor use and perhaps irrigation, maintaining a wetland / raingarden, infiltration into the soil, and then allowing only heavy rainfall events to flow off site. The secondary outcome of this approach is that it allows the nutrient cycle to be taken into account and maximises the opportunity for closing the nutrient loop too. One example of this is where greywater is reused for irrigation supplying both water and nutrients to the garden for maximum plant growth, providing habitat, shade, general amenity benefits and reducing sewer loads.

2.2 What are the objectives?

Once we have established what the available opportunities are on the site it is necessary to decide upon some achievable objectives to utilise these opportunities. There are innumerable objectives that can be achieved however some of the most common objectives are provided below:

- Environmental
 - Reduce demand on mains water supply
 - Remove pollutants and nutrients from stormwater
 - Improved infiltration of groundwater
 - Improve flora and fauna biodiversity
- Financial
 - Reduce water costs
 - Reduce maintenance
 - Reduce costs associated with storm damage
- Social
 - Improved amenity
 - Improved health and security
 - Improved microclimate and shade
 - Create spaces for social interaction and cohesion
 - Increase availability of water for productive gardens
- Educational
 - Demonstrate environmental leadership, responsibility and resourcefulness
 - Opportunities for local food production and engaging with nature

These objectives should be considered as a guide and are clearly not exhaustive.

2.3 Things to consider

There are many issues that need consideration, some site-specific or more important according to the situation and aspirations. Some common questions to consider are:

- What are the current costs, and what cost savings are possible?
- How to consider and value other benefits and externalities such as habitat, amenity, treated stormwater, ecological values.
- Who are the 'stakeholders' and what are their needs?
- How do we measure performance?
- Who will maintain it/them?

Next comes the process which is the 'doing' stage where information (data) about the site and its systems is collated, input from the school and its community received, calculations on size and cost done, and a plan for implementation developed.

2.3.1 Assess the site

The first step is to gather as much information about the school before arriving on site – commonly called the desktop phase. Typical questions that can be answered include:

- What are the water sources?
- Where are the water meters and how many are there?
- How much water does the school use?
- Are there plans of the school, its buildings, gardens, drainage, services and any irrigation systems?
- Where does stormwater drain to?
- What is the surface area of the site?
- What is the geography, soil type, surrounding water bodies, water issues etc.
- What is the climate?

There is a wide range of information sources you can access to help answer these questions and include your local council (drainage), your water provider/utility (water meter readings, bills and locations), Bureau of Meteorology website (climate statistics) and other web tools such as google maps.

The next step is to walk the site. Use this opportunity to sketch or markup any plans you may have, identify any new features and confirm the information gleaned from your desktop phase (e.g. are the water meters where you thought they were and maybe take some meter readings while you are there). It may be informative to visit the site when it is raining if possible to see exactly how and where water flows. This can reveal blocked drains, overland flow paths both intentional and unintentional and areas of localised flooding.

2.3.2 Develop an 'all water flows' concept drawing/sketch

This is a useful way to put everything down on one page and consists of a diagram illustrating the movement of water through buildings, around the site and potentially where water is ultimately leaving the site. It can also highlight possible synergies as well as conflicts. Depending upon the level of discussion and feedback sought it can provide the ideal vehicle for this though it may be need some enhancement, even professional drafting, depending upon the likely audience.

2.3.3 Gather input from the community

There are many and various ways to gather input from your community, ranging from group presentations to workshops to surveys amongst others. The important thing is that the opportunity is made available at some stage for the community to provide input otherwise they may feel alienated and potentially hostile to any changes that are implemented. Regular project updates via newsletters or online media may also be valuable.

2.3.4 Consider water-related opportunities and other desirable benefits

This the time to consider what opportunities exist for an integrated water systems approach. For example what space is currently under-utilised and could it benefit from a raingarden or garden bed, or be a potential rainwater tank site? Is there erosion occurring on site that could be

remedied with some attention to stormwater runoff? What opportunities are there to increase soft landscapes, plant new shade trees, increase plant and wildlife habitat.

2.3.5 Crunch the numbers (quality, quantity, cost)

It is important to realistically assess the numbers. This includes the volumes of water (and quality of the water where this is applicable), and the likely costs to implement possible options. Of course, this either then informs the budget or is limited by the budget. Simple Payback is often used to assess and then prioritise the benefits of any intervention. For example where water efficiency measures are proposed (e.g. upgrading shower heads to water efficient models) this is commonly used to determine the 'payback period' which may range from months to years. The shorter the payback period the more sense it makes to implement the recommendation.

2.3.6 Develop a design, costs, implementation plan

The level of detail here should be appropriate to the scope and scale of the project. For a large institution where substantial costs are proposed this may require a business plan to be approved by the board whereas for a small organisation planning a smaller outlay then several quotes for work may be sufficient.

2.3.7 Maintenance

It is critically important to consider the maintenance requirements associated with all new measures. It is typically the least exciting part of any project and for this very reason is often overlooked. Indeed it is well worth considering the likely maintenance requirements, costs and human resource needs in detail prior to making any final decisions. Specifically, who will be charged with maintaining the systems?

2.3.8 Monitor performance

Once a project is complete it is important to monitor performance. It is therefore important to consider this during the planning part of the project. This is made substantially easier these days due to technologies such as data loggers, web-based dashboards and auto-alert functions, but there is invariably a need for human interaction! This can be part of the maintenance program e.g. a checklist and/or annual reporting. Monitoring performance allows trends to be identified, for example why has our water consumption increased in the last six months, and issues like leaks, to be picked up sooner rather than later. These have direct cost implications if nothing else.

2.4 Quantitative performance

While qualitative assessments of such projects are readily made, it is considered highly desirable that a range of quantitative measures be derived where feasible, in order to be able to track the performance of the various initiatives. As a result the following table has been developed which illustrates potential metrics and targets for the school to strive towards. This table can form the basis for performance monitoring and annual reporting and can readily incorporate new indicators as required. These metrics can be developed by the school and have been left as preliminary indicators for information only at this stage.

Table 1 - Quantitative performance indicators

ITEM	INDICATOR	METRIC	TARGET	PRE - PROJECT	YEAR 1	YEAR 2
1	Mains water consumption	(kL/yr; L/student/school day)				
2	Rainwater consumption	(kL/year)				
3	Sewage discharged	(kL/year)				
4	Campus canopy cover	(% of campus, m ²)				
5	Impervious surface	(% of campus, m ²)				
6	Pervious surface reinstated	(% of campus, m ²)				
7	Productive garden bed area	(m ²)				
8	Amount of vegetables produced	(kg/year)				
9	Stormwater treated (estimate)	kL/year				
10	Biodiversity/Habitat available	No. of species, m ²				
11	Thermal cooling per site	Degrees C/site				

Table 2 - Deer Park North Primary School – Integrated Water System Matrix

OPPORTUNITY	OBJECTIVES	THINGS TO CONSIDER	DESIGN SOLUTIONS	OUTCOMES
WATER MANAGEMENT	Understand water usage and opportunities for further savings	School has two main water meters with SWEP data loggers installed. Needs further understanding of major water uses. High unexplained usage after hours.	Recommend a water audit. Delegate responsibility for water management.	Repair any water leaks found. Identify potential water savings. Prioritise implementation of water saving devices.
WATER EFFICIENCY	Reduce average per day consumption of 20.8L/student.	Consider water management data and audit to look for high usage areas. Consider alternative water sources.	Install water saving devices on hand washing facilities and in kitchen areas. Service existing rainwater systems servicing toilet flushing.	Reduce water usage in amenities and kitchens.
RAINWATER	Reduce water use by servicing two existing rainwater harvesting systems providing toilet flushing water.	Investigate issues with existing rainwater systems and pumps.	Test and service pumps and improve pre-filtration of rainwater to prevent maintenance issues. Install sub meters.	Water savings and improve monitoring and maintenance.
	Increase yield of existing water tank near library to supply water for irrigating new school garden and to top up proposed wetland feature.	Look for additional roof catchment areas. Pump in need of repair and has no mains water backup.	Capture roof runoff from adjoining building to North of existing catchment and plumb into existing tank. Service pumps and install mains water backup valve and sub meters.	Capture more water for small constructed wetland: improve amenity, microclimate, biodiversity and provide educational benefits. Provide year round irrigation water source for new productive school garden, creating opportunities for environmental education, local food production and community cohesion.
	Find new short term use for unused rainwater servicing toilet flushing in Recreation Centre.	What other potential water use is in close proximity that requires a short term water supply.	Install new drip irrigation for short term establishment of native landscaping. Install sub meter.	Use water to establish new native landscape with shade trees to shelter exposed western elevation of the Recreation Centre and improve amenity.
STORMWATER	Capture a portion of stormwater leaving the site and utilise in landscape to improve amenity, microclimate and biodiversity.	Develop site wide plan of stormwater flows. Look for suitable locations.	Install small constructed wetland to capture and treat a portion of storm water flows. Install raingarden to infiltrate and store water in new landscaped area. Install new tree pits and reduce impervious surfaces.	Reduce stormwater discharged from site. New areas of high impact landscaping areas and a constructed wetland entry feature. Improved water treatment, infiltration, liveability, amenity, microclimate and biodiversity. Extensive network of shade trees.
WASTEWATER	Utilise wastewater to reduce mains water usage and provide cost savings.	Consider wastewater reuse options from hand basins and cost effectiveness.	Potential to consider greywater reuse from hand basins in future.	Continue to discharge to sewer and reduce water usage through water efficiency in the short term.
URBAN GREENING	Increase urban greening and liveability of school. Create areas of social cohesion. Minimise maintenance and maximise success during establishment phase.	Consider locations for new shade trees and landscaped areas throughout the school. Understand arrangement of existing site elements and services.	Include new shade trees and vegetation in high use areas and around buildings to improve shading and reduce heat loads. Install water efficient irrigation based on hydrozoning principles. Appropriate tree and plant selection. Utilise productive trees in the landscape, where possible.	Improve liveability, amenity and biodiversity, throughout the school. Reduce energy loads required to heat buildings. Improved success during establishment with reduced ongoing maintenance.

3 WATER SYSTEM AND DESIGN SOLUTIONS

Here we consider the possible solutions and technologies that can be employed / retrofitted to achieve the objectives.

3.1 Water management

Understanding how water is used at your site is essential for good management and understanding where the opportunities for improvement lie. Effective water management is not a one off event - it is an ongoing process and requires someone to be responsible for this.

3.1.1 School Water Efficiency Program (SWEP)

The Schools Water Efficiency Program (SWEP) is a voluntary program that upon request will provide data loggers connected to the mains water meter for all Victorian schools to continue the education and demonstration of water efficiency in practice. Access to the up to date water consumption data collected, is available on an interactive online tool that allows for custom reporting, high level leak detection and benchmark comparison with other participating schools. The program also provides access to a tailored curriculum program for students.

SWEP is funded by the Department of Environment and Primary Industries and the Department of Education and Early Childhood Development. Refer to the section on resources for details on how to register your school.

The SWEP program provides real-time overall site usage from the mains water meter. In addition, installation of isolation valves and/or sub-meters on major water uses can provide a clearer picture of where, how and when water is being consumed within the site and allows individual areas to be isolated if repairs are required or leaks suspected. The outcomes of water saving initiatives can then be accurately assessed.

3.1.2 Water auditing

Engaging a trained water auditor to conduct a water audit and identify opportunities for water savings is valuable. Water auditors can provide technical assistance with understanding your water usage and help identify water saving opportunities. City West Water can provide assistance with this and please refer to the section on resources for further details. Many other jurisdictions have similar programs and information can be sought from the local water utility or council.

3.1.3 Water leaks

Water leaks are a clear example of water being wasted and these leaks can account for large volumes of unaccounted for water. Some leaks are easily found through regular inspection of water devices whilst other may be concealed and will require more comprehensive leak detection processes.

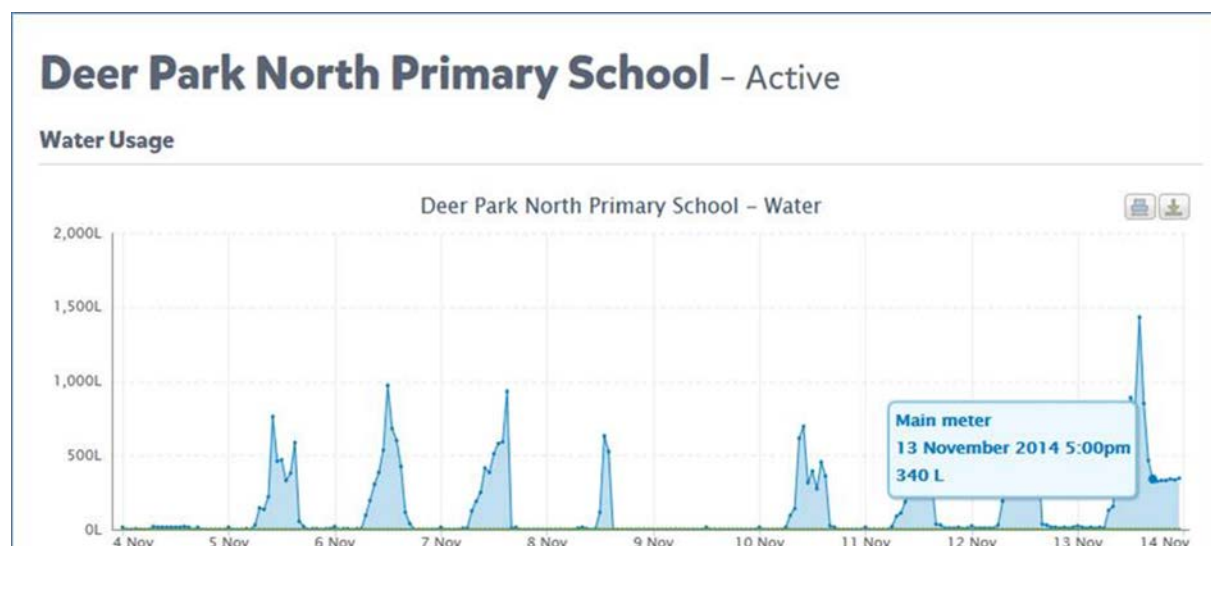
As part of your water management process and maintenance schedule it is recommended to test for unaccounted water loss. Water leaks can be continuous where under constant pressure or temporary in nature e.g. irrigation systems. It is relatively easy to test for continuous water leaks by recording the difference in water meter readings during long unoccupied or low occupancy periods or by reading your SWEP data logger. Continuous water use in periods of minimal use should be investigated.

3.1.4 General maintenance

A proactive approach to maintenance of your water system should be favoured over a reactive one and will help avoid water leaks and inefficiencies which can waste hundreds of dollars in water and energy costs.

Water management example – Deer Park North Primary School

Deer Park North Primary School has signed up to the SWEP program and has already received some interesting, and concerning, feedback as a result of the SWEP-provided data logger attached to the school's main water meter. The graph below shows one of the several alerts that the school has received which shows a persistent water demand of about 340L/hour starting around 5pm and continuing until after midnight. So far the cause, perhaps a jammed toilet cistern or running tap, hasn't been identified and investigations are underway. The good news is that there are no signs of a constant low-level demand – a sure sign of a leak.



3.2 Water efficiency

Once you have a clear understanding of your site, improving water efficiency is the simplest way of saving water, and energy where hot water or pumps are used. Water efficiency aims to reduce the volume of water used to perform a specific task without effecting quality of the service.

The benefits of improving water efficiency include:

- Helping to secure the water supply for future generations
- Reducing water and energy bills
- Carbon footprint reduction
- Public accountability
- Education / behaviour change opportunities

The Water Efficiency Labelling Scheme (WELS, for a link to this source refer to the resources section) helps you choose water efficient products and also sets minimum performance standards for water using devices including taps, showers, toilets, urinals and flow controllers. For new construction and refurbishments projects the selection of higher WELS rated devices is nearly always justified.

Improving water efficiency can save water, money and energy. Your water bill includes separate charges for water usage, sewage disposal and any trade waste disposal. Installing water efficient devices will reduce the volume of water used and disposed of, and provide savings on these costs. For water devices supplied with hot water it can also save significant amounts of energy and money, an example of this is water used for showers and hand basins.

Prioritising the installation of water saving technologies is important if you wish to get the best return on investment and maximise your savings. Calculating water savings is based on a number of factors, and a water auditor can assist with prioritising the most cost effective changes for your school. In addition to this South East Water has an online investment payback calculator that allows for easy analysis of water efficiency improvements including return on investment based on water and energy savings (for a link to this source refer to the resources section).

City West Water has put together some Best Practice Guidelines for Water Efficiency to help to identify water and resource saving opportunities (for a link to this source refer to the resources section). The guidelines include information about suitable water saving equipment, suggested process and procedural change, maintenance, benchmarking and a selection of case studies. The guideline covers the below major water uses;

- Amenities
- Kitchens
- Cleaning
- Cooling towers
- Fire protection systems
- Landscapes
- Swimming pools and spas

3.3 Rainwater

Here we consider the opportunities that are available from harvesting rainwater. We make the distinction between rainwater and stormwater due to the difference in water quality as follows: Rainwater is water which comes off roofs only (sometimes referred to as roof water) while stormwater is rainwater from all other surfaces e.g. footpaths, carparks etc.

Some of the potential uses of rainwater include for toilet flushing and irrigation/watering of gardens. It is of course possible to use rainwater for drinking after treatment but we don't consider this option further here as it is a costly exercise. A key benefit of using rainwater is the potential to displace mains water which is therefore a direct cost saving.

Key considerations surrounding rainwater harvesting include:

- Site characteristics
- Existing roof arrangements & plumbing elements
- Quality of roof catchment material i.e. not asbestos or lead-based paint
- Location of storage and proximity to water use
- Is the location low maintenance i.e. overhanging trees clogging gutters
- Annual rainfall and frequency i.e. is there sufficient regular rainfall to effectively meet demand
- Who will be responsible maintenance? Costs associated with maintenance
- Budget estimate of costs and available budget
- Water quality e.g. Pre-filtration, leaf gutter rain heads, first flush diverters

The local climate in the western Melbourne region illustrates the relatively consistent average monthly rainfall and mild temperature profile as shown in the following table of climate data for Melbourne Airport some 15 kilometres to the north. The mean daily evaporation is also important to understand as it provides a means by which to estimate the likely plant evapotranspiration (evaporation multiplied by a crop factor) in any given month and therefore an indication of the irrigation demand. Landscape designers will consider all these factors plus average daily maximum and minimum temperatures to select suitable plant species and irrigation designs.

Table 3 - Climate statistics for Melbourne Airport (Period 1981-2010)

STATISTIC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
RAINFALL (mm)	39.8	37.3	38.5	38.1	35.6	38.8	38.9	43.5	44.4	51.2	62.1	51.4	518.9
MEAN DAILY EVAPORATION (mm)	8.1	7.2	5.9	3.9	2.4	1.9	2.0	2.8	4.1	5.2	6.0	7.3	
MEAN MAX. DAILY TEMP. (°C)	26.3	26.5	24.1	20.4	16.6	13.7	13.0	14.5	16.6	19.3	22.1	24.3	
MEAN MIN DAILY TEMP. (°C)	13.6	14.1	12.7	10.1	8.4	6.3	5.5	6.0	7.1	8.5	10.4	12.0	

Source: Australian Bureau of Meteorology

While this represents the total theoretical volume that could be harvested in an average year, it is the term known as 'yield' that is more useful to calculate. Yield is a function of the catchment area, demand and the tank size. For example in the above example, if the tank was only 5,000L capacity – depending on the type of demand e.g. irrigation, toilet flushing etc. – the tank may very well overflow at certain times of the year e.g. school holidays, and so the yield is typically somewhat less (typically 20-50%) than the theoretical maximum volume possible. It is possible to calculate different tank sizes for a given catchment area to optimise the rainwater harvesting system for any given situation. A simple spreadsheet model can be set up to do this to varying levels of sophistication as we have done here in Table 4 or alternatively there are some free on-line models available on the web that will do it for you (refer to the resources section).

Rainwater harvesting: it is possible to estimate the likely amount of rainfall that can be collected from a roof in any given month with the following ready reckoner which employs the data from above and the measured roof surface to calculate volume collected.

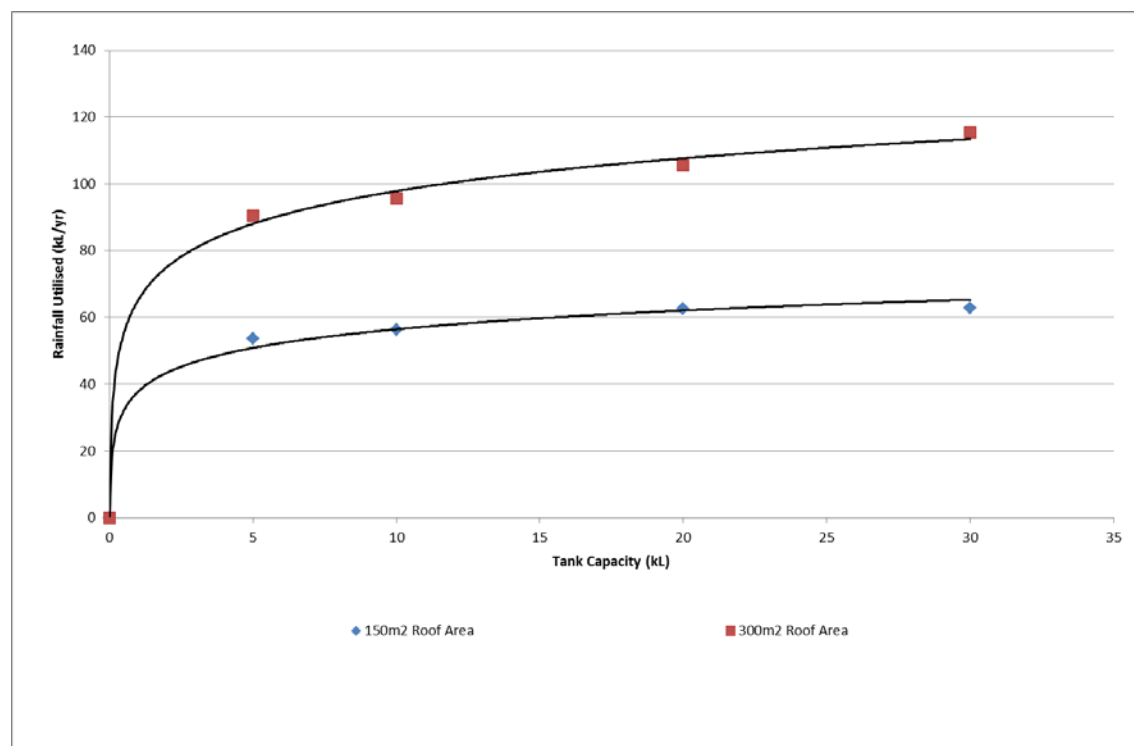
Table 4 - Rainwater harvesting calculator

ASSUMPTION #1	Assume a runoff coefficient of 0.9 for a typical steel roof i.e it assumes 90% of all rain can be collected with only 10% lost to evaporation and infiltration.
ASSUMPTION #2	Assume 100% of the roof catchment is connected to downpipes which all enter the same rainwater tank(s) then for every 1mm of rain which falls on 1m ² of roof it is theoretically possible to collect 0.9L of rainwater.

The available catchment from the Deer Park North Primary School library roof (sloping north) is approximately 130m² however currently less than half of this is connected to the 20,000L rainwater tank. There is also an additional 300m² of potential contributing catchment on the south side of Block B. This means that it is theoretically possible to connect in excess of 430m² of roof catchment via a wet system to the rainwater tank. In order to investigate what potential yield is achievable we have modelled two potential scenarios – 150m² and 300m² of additional roof catchment with a range of rainwater tank sizes in order to demonstrate what effect this has.

We have estimated a total irrigation demand for the new school garden of 147kL/yr based on 117kL/yr for reticulated irrigation (subsurface dripline) and an allowance of a further 25% or 30kL/yr for handwatering, washing down tools and the like. This also allows an estimate of the volume of mains water top-up water that will be needed according to the tank capacity and roof catchment area.

This calculation indicates that a total catchment of 300m² connected to the existing 20kL tank can contribute over 100kL per annum in an average year. Alternatively a catchment of 150m² is only able to achieve roughly half this amount. The graph shows these relationships and demonstrates that the priority lies with connecting additional roof runoff if the maximum yield from the existing tank is to be achieved.



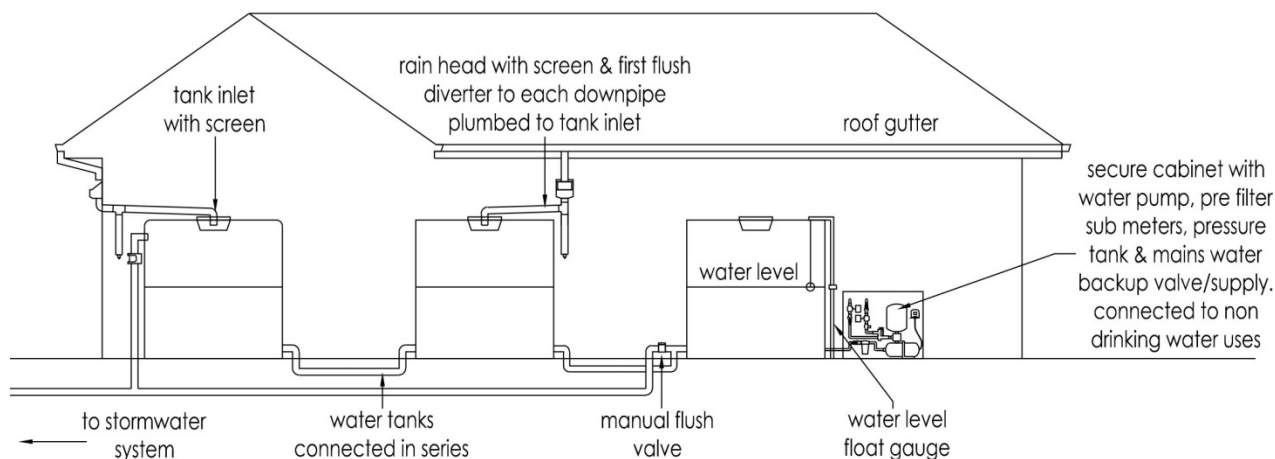


Figure 1. Rainwater harvesting typical detail – Dry system

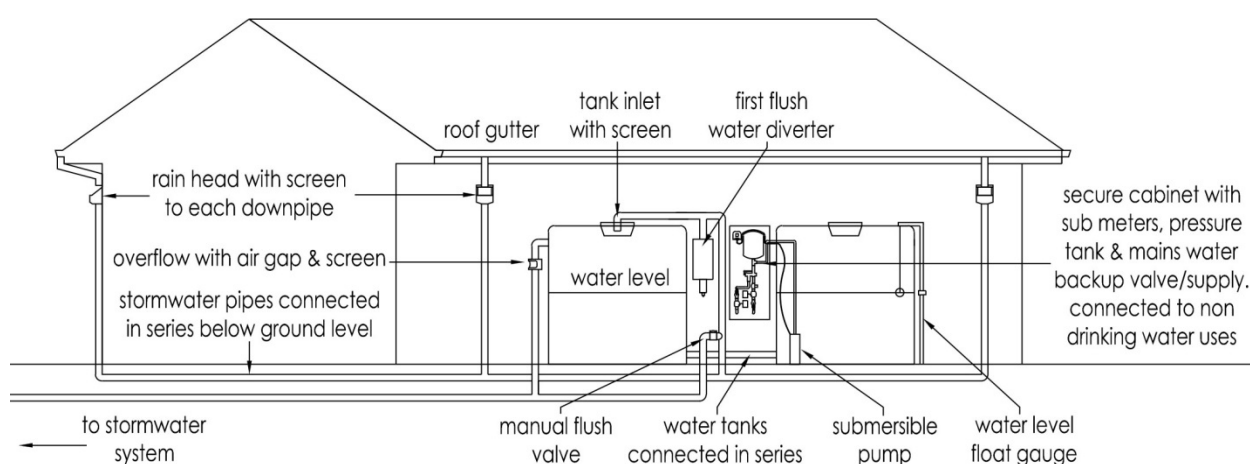


Figure 2. Rainwater harvesting typical detail – Wet system

Rainwater example – Deer Park North Primary School

The rainwater harvesting systems at Deer Park primary school are great initiatives which unfortunately are not performing at their optimum and we aware that this is a fairly common situation. Three of the systems are plumbed into the buildings for toilet flushing purposes while the fourth is a free standing (un-plumbed) arrangement for garden watering purposes only. All four systems have pumps mounted externally to the tanks and the three used for toilet flushing have mains water back-up connections. When we conducted our site visit it was apparent that all the tanks were full, or nearly full, despite their having been no significant, recent rainfall.

This aroused our suspicions that all was not well and indeed a subsequent inspection by the school plumber confirmed that the systems were not working. There are several possible reasons for this which include design, technical and maintenance factors and should be considered prior to undertaking any repairs or retrofitting.

Maintenance

Systems that use externally mounted pumps will have an in-line filter/s which require regular inspection and cleaning. Once the filter/s becomes blocked the pump will either trip out or even potentially burn out. The amount of sediment and leaf litter entering the tanks - which in turn causes the clogging of the filters - is dependent on the type of first flush device and leaf diverter systems, plus overhanging trees.

Rainwater example – Deer Park North Primary School (Continued)

Technical

There are several technical issues which can cause the system to function poorly which we have attempted to describe here.

- **Filter sizing** - Standard in-line filters are often quite small e.g. one inch screen filter. We would recommend that these be upsized to at least two inch.
- **Pressure flag** - It is possible to install a pressure-activated visual 'flag' that is activated when back pressure from a clogging filter reaches a certain level. This provides a readily seen indicator that the filter requires cleaning.
- **Mains water pressure** - If the local mains water pressure is particularly high it is possible that the pressure differential between the rain water pump pressure and main water pressure is too great for the pressure switch to operate. This is able to occur as most mains water back-up switch devices require a small amount of mains water to flow first, and only then does it switch over to rainwater. If there is a pressure issue it can be dealt with by installing a pressure reducing valve in the mains water line, or discussing the issue with the pump manufacturer to determine the pump's factory set operating pressure to see if it can be adjusted.
- **Pressure tank** - Pressure tanks come in a range of sizes and are easily installed or retrofitted. They allow for a volume of water to be pressurised and ready to meet demand without the need for the pump to 'kick in'. This is an important consideration with respect to energy efficiency and in many ways should be considered an essential component in any plumbed rainwater harvesting system. It also reduces the number of cycles the pump does in a day and therefore increases the pump's life expectancy.

Design

Three key design considerations which impact the overall system are discussed here. Firstly the type of mains water back-up valve is an important consideration. These are typically automatic and may be either via automatic controllers or hydraulic switches and both types should be considered on their own merits. The second consideration is whether to have an externally mounted pump or an in-tank submersible pump and again both types should be considered on their own merits. Thirdly there exist two principal general arrangements of the overall system referred to as Dry or Wet systems. We have illustrated these two types here in Figures 1 and 2 and again there exist pros and cons for both configurations. In general terms it is typically easier and more feasible to collect all of a roof's runoff with a Wet system (some pipework below ground that always holds water).

3.4 Stormwater

Stormwater is the water draining off a site from rain that falls on the roof and land, and everything it carries with it. This includes the soil, organic matter, litter, fertilisers from gardens and oil residues from driveways it carries which can pollute downstream waterways.

Rainwater, as described previously refers only to the rain that falls on roofs and which is usually much cleaner than stormwater, however stormwater can still be a valuable resource depending upon how polluted it is, what treatment it receives and what the intended end use is.

Water Sensitive Urban Design (WSUD) is about integrating water cycle management into urban planning and design. WSUD looks to manage the impacts of stormwater on site with the aim of protecting and improving waterway health by mimicking the natural water cycle as closely as possible. It also provides benefits in relation to providing an alternate water supply to reduce mains water demand and provide opportunities to improve amenity, liveability and biodiversity.

We can see from the local climate data above that there is a relatively consistent rainfall average across all months of the year in this region. This is ideal for harvesting stormwater regularly for potential irrigation purposes and managing stormwater where possible through Water Sensitive Urban Design (WSUD) elements, such as raingardens and constructed wetland features.

Designing for stormwater and flood events is moderately complex and is principally covered by the publication Australian Rainfall and Runoff (Institution of Engineers, 1987). Where there is the potential for impact on people or structures, or required by local or state government authorities,

then a qualified engineer should be engaged to oversee the design calculations in line with this document.

Below are the key WSUD principles identified for managing stormwater on a typical school site;

- **Stormwater harvesting** – Harvesting stormwater in below ground tanks as an alternative water source for irrigation purposes, reducing demand for mains water.
- **Water treatment** – Capture and treat stormwater on site to improve water quality, amenity, biodiversity and enhance liveability.
- **Water infiltration** – Infiltrate excess stormwater on site to reduce volume and frequency of stormwater leaving the site. Instead focusing on infiltrating in the landscape where it can support vegetation, improving amenity, microclimate and enhance liveability.

When considering utilising stormwater it is helpful to think about the quality and the quantity of water and if it will be fit for purpose. If the quality is unsuitable to meet one objective or the volume is too great then the overflow can be utilised to meet a subsequent objective before requiring to be discharged to the stormwater drainage network. The diagram in Figure 3 shows the relationship between these different objectives.

There are a number of valuable resources that can be utilised when investigating WSUD on your site and include the Water Sensitive Urban Design section of Melbourne Waters website and the technical Urban Stormwater Best-Practice Environmental Management Guidelines available from CSIRO Publishing (refer resources section).

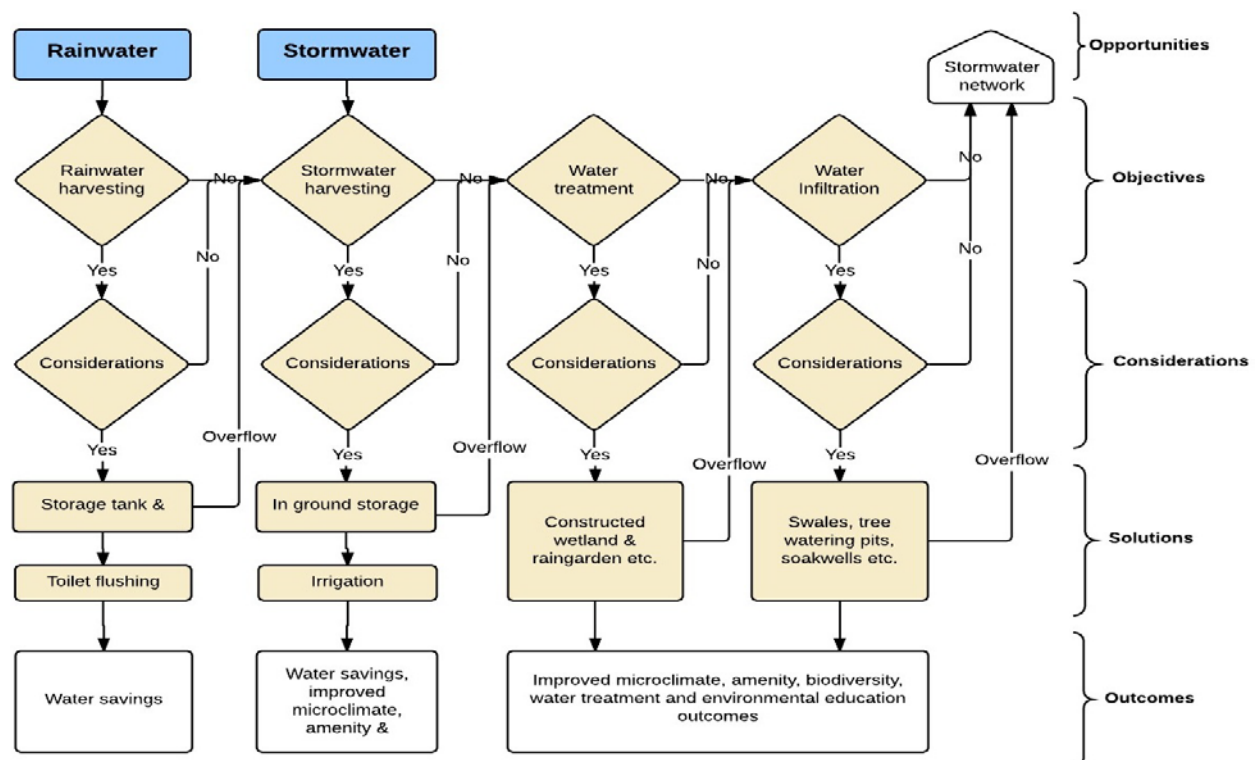


Figure 3. Stormwater decision making tool

3.4.1 Stormwater harvesting

Harvesting stormwater for irrigation purposes can be feasible in some circumstances where a large catchment area like a playing surface, drain to a suitable location in the landscape where a subterranean reservoir or dam can be located. Stormwater harvesting involves collection, pre-filtration, storage, and distribution. Treatment of this water may also be required to ensure the water quality is fit for purpose and does not pose a risk to public health.

Generally stormwater harvesting will require the water collected to pass through a trap to remove gross pollutants, including litter and coarse sediments. The collected water is then usually stored in a constructed dam or in subterranean tank. The irrigation and pump hardware to distribute the water will need to be suitable for utilising the stormwater. The stormwater harvesting system will

require regular testing and maintenance to ensure water quality and performance is maintained at acceptable levels.

The storage body needs to be suitably sized to ensure sufficient water is available for irrigation year round. A mains water backup valve should also be connected and may be required to ensure a continuous supply during dry periods of weather.

3.4.2 Water treatment

The primary objective of the treatment of stormwater is to capture and treat stormwater on site to improve water quality, amenity, biodiversity and enhance liveability. Water treatment systems can assist with reducing loads on drainage infrastructure as they have a limited storage capacity, however they will typically require an outlet to overflow into the drainage network.

The best water treatment outcomes are achieved through design solutions that incorporate a sequence of treatment measures as opposed to a single solution, maximising water treatment potential. An example of a treatment 'train' is a constructed stormwater wetland which typically includes a sediment ponds basin and a wetland with a series of permanent pools and marshes.

Some typical water treatment solutions that can be used in schools include constructed wetlands and bioretention systems typically called raingardens.

3.4.2.1 Raingardens

Bioretention systems or raingardens are specially designed vegetated areas that collect stormwater runoff and then treat the water through biological process and retain contaminants. They are flexible in design arrangement and compact in size, which makes them perfect for school sites. Raingardens are designed to reduce gross pollutants, coarse sediments, nutrients and heavy metals. They consist of a series of layers including an open water peak volume detention layer, mulch, low nutrient filter media, transition layer and in some cases a drainage layer.

Water can be collected through surface runoff or can utilise water from the school's stormwater drainage plumbing. They typically include an overflow back into the stormwater drainage network to limit the water level in peak flow events.

Raingardens are most effective when densely planted with suitable plants and include a lined saturated zone that stores water permanently below ground level. This saturated zone supports the plant water requirements and removes or limits requirements for irrigation.

Bioretention systems incorporating trees are an example of a small type of raingarden that is typically designed to take overland flows from hardstand surfaces and support significant streets tree in the landscape, providing shade and improving amenity and liveability. Below is an example of one type of raingarden design.

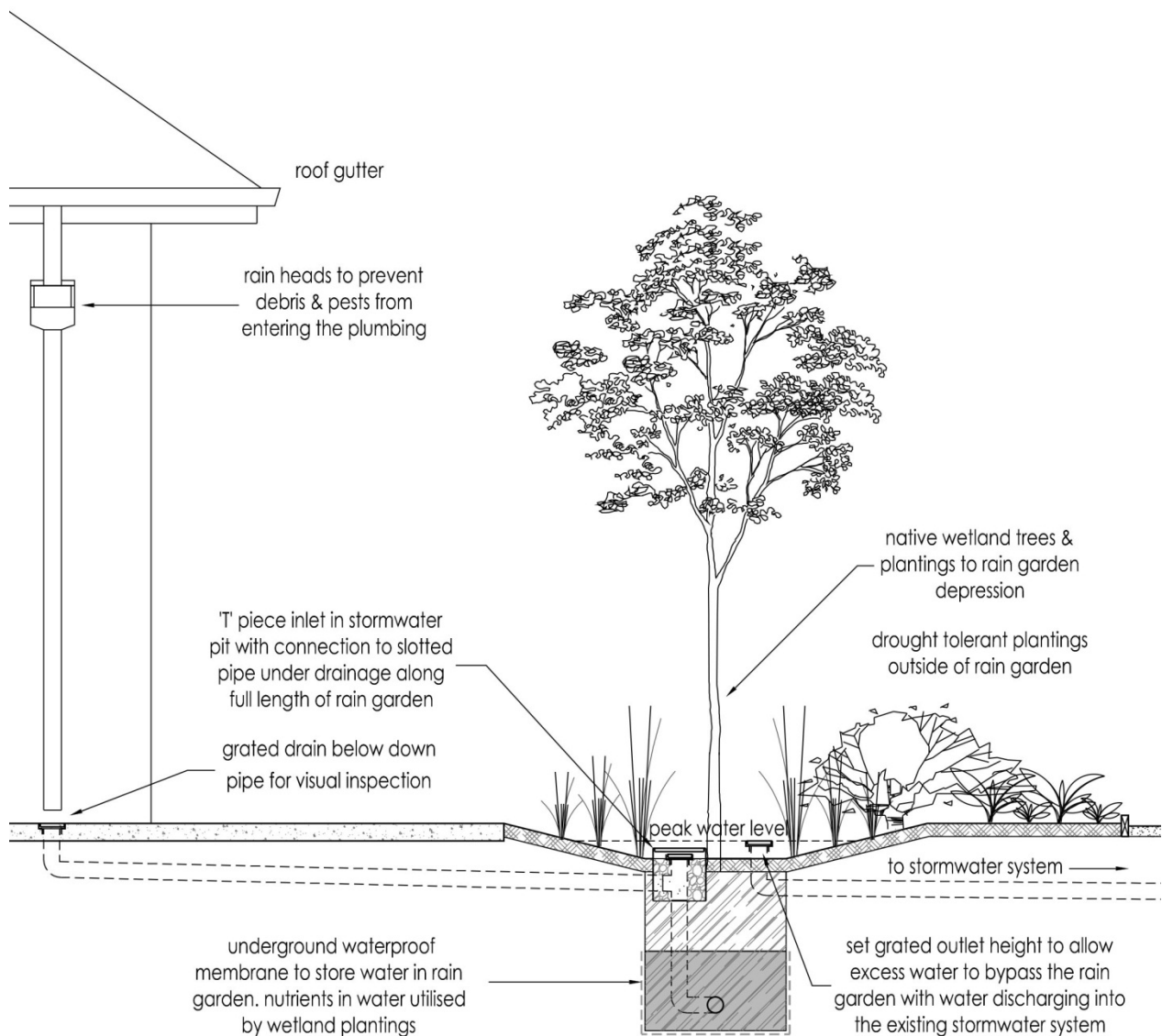


Figure 4. Raingarden typical detail

In situations where the water is already of a high quality, for instance where it is collected from roof catchments, there will be limited need for treatment. In this situation the raingarden can vary the requirements for a low nutrient filter media and separate transition layers and focus on storing water to support plant health. Below is a diagram of a raingarden that will be utilising a high quality water source.

3.4.2.2 Constructed wetlands

Constructed wetlands are typically a series of shallow, intensively planted water bodies that reduce water velocity and treat water through sedimentation, filtration and biological processes as water flows through the system. They provide opportunities for a high level of storage and treatment and can also improve microclimate, amenity and support biodiversity. Generally wetlands will require a larger area than a rain garden and will need to be designed to ensure limited access to any open water bodies to improve safety.

The school's existing stormwater drainage network conveys the bulk of any stormwater off site and in such situations it is possible to incorporate a wetland to intercept and treat a percentage of overland flow before discharging back into the drainage system.

Constructed wetlands typically include the following zones;

- Inlet zone – Stormwater is directed to an inlet zone typically called a sedimentation basin, to remove coarse sediments including rubbish. The sedimentation zone needs to be separate from the macrophyte zone and accessible for occasional maintenance.

- Macrophyte zone – Water then flows through a series of vegetated marshes of varying depths.
- Outlet zone – This is generally section of open water that detains water allowing for settling and sunlight to kill bacteria. It also supports aquatic life and predators that will assist with controlling mosquitoes.

The above typical sequence of treatment can be varied in larger wetland systems. The inclusion of a bypass drain to discharge water around a wetland in high flow events should also be considered. Below is an example of a typical constructed wetland design.

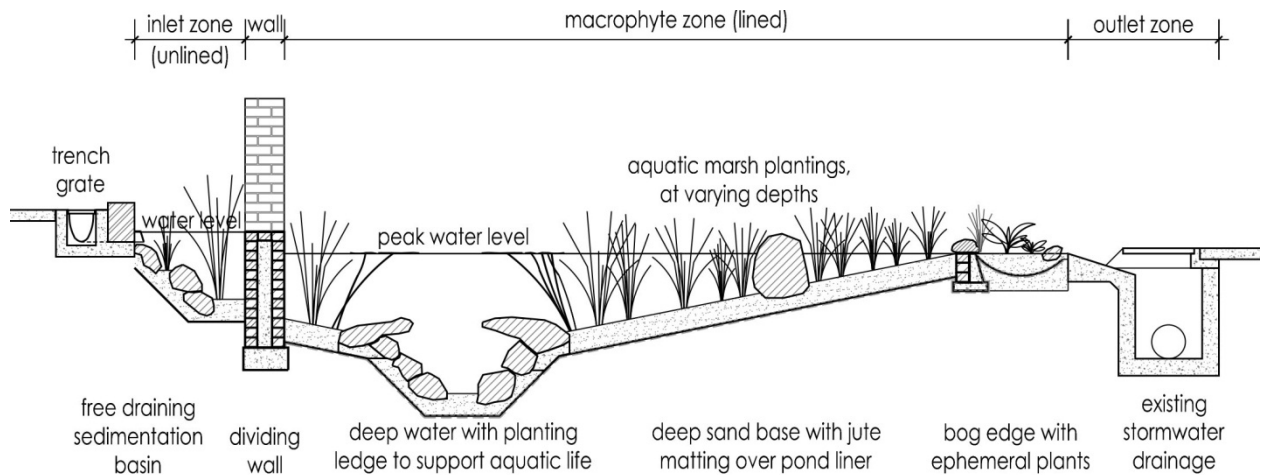


Figure 5. Constructed wetland typical cross-section detail

3.4.3 Water infiltration

This is the final opportunity to manage stormwater and involves infiltrating excess stormwater on site to reduce volume and frequency of stormwater entering the main stormwater drainage network. Water infiltration can partially be achieved through the water treatment methods detailed above, for example in raingardens which include a saturated zone designed to detain water to a specific water level with any remaining water collected infiltrated into the surrounding landscape. However the more typical method for infiltrating excess stormwater may be through vegetated swales, infiltration trenches and soakwells.

Swales are a landscape and engineering solution that detains and conveys water in a linear depression along a site contour. The primary principle is to infiltrate water on site and reduce / delay stormwater run-off. It also provides water treatment benefits and can support the establishment of additional landscaping.

Infiltration trenches are a depression in the landscape that has been excavated and filled with coarse free draining medium to store and infiltrate water into the soil.

Stormwater example – Deer Park North Primary School

DPNPS is located in the Kororoit Creek catchment system. Stormwater runs toward the eastern boundary, most noticeably from paved area through the concreted area between the library and the canteen. The northern part of the library roof drains to the rainwater tank, the southern part of the roof flows to the paved area and out to Gould Street.

The primary objective for managing stormwater on site was to capture a portion of stormwater from site to establish new areas of urban greening in the landscape throughout the school. With the aim of providing local shade and cooling the microclimate, supporting biodiversity, providing green spaces for social interaction and environmental education.

To achieve this, a site visit was arranged with school and VAAE staff to discuss the opportunities. The large volume of stormwater runoff from the playing surfaces that currently flows towards Gould St was identified as a resource for establishing a small constructed wetland at the Eastern entry of the school. The wetland will remove a small section of old carpark and be located centrally between the proposed school hub located to the south and the school garden to the North, creating a green precinct along the East of the school. As well as the surface flows it will receive, it is also in close proximity to the library water tank and the overflow from this can easily be directed to the wetland as well as provide a top up water source in dryer periods.

An opportunity to establish a raingarden utilising rainwater harvested from roof catchments between two classrooms. The space is currently cleared and underutilised. The roof catchment area is limited but

3.5 Wastewater

Options for wastewater are principally treatment and reuse, and wastewater minimisation.

Wastewater reuse covers a wide range and scale of commercially available onsite wastewater treatment systems which are capable of treating wastewater to a level suitable for above ground sprinkler irrigation. In urban areas where deep sewerage is available they are unlikely to be cost effective, however in unsewered areas they can provide a realistic alternative to septic tanks and leachfields and provide a much improved environmental outcome.

Greywater reuse is also an option particularly where regular high volumes of greywater are generated, for example showers or laundries. Treating the greywater to a level fit for toilet flushing is possible but expensive, whereas greywater diversion direct to subsurface irrigation is very cost effective.

Reducing the amount of wastewater produced by reducing the amount of mains water consumed through water efficiency measures can provide an ongoing cost saving via a reduced sewage disposal charge. The sewage charge is simply the volume of water consumed multiplied by the rate multiplied by discharge factor (DF). For most schools and DPNPS the DF is 0.9.

For DPNPS the options for wastewater or greywater reuse are limited and therefore the most appropriate opportunity initially would be to maximise mains water efficiencies thereby reducing the sewage disposal charge accordingly.

There may be merit in investigating the potential for greywater reuse from the toilet block handbasins for garden irrigation in future stages.

3.6 Urban greening

Developing an integrated water management scheme provides the opportunity for schools to support environmental sustainability and community health. The management of urban water and increased community green spaces are two topical issues in Australia. Gardens and water are inherently linked - community green spaces are well recognised to play a major beneficial role in the control and improvement of urban water impacts and quality, via the improvement of stormwater runoff reduction, flood mitigation, minimisation of soil erosion and contaminant minimisation.

A wealth of research has demonstrated the benefits of community greening, most recognisably the environmental, water and air quality improvements but also valuable social improvements such as improved aesthetics, vehicular safety, mental wellbeing and physical health. Likewise there are a number of strong arguments for improved workplace and community productivity.

Water and vegetation are both also recognised in reducing the urban heat island effect, which is where hard surfaces such as buildings, roads and concrete absorb heat causing them to be much warmer than surrounding vegetated areas. Deer Park North Primary School is located within the City of Brimbank where research has shown there is a very low amount of tree coverage and a high amount of bare ground. Integrating water management and the development of green spaces can be a highly beneficial step in addressing issues such as the urban heat island effect.

More information to provide ideas for urban green spaces and playgrounds can be found in the resources section.

4 SUMMARY

This document is attempting to provide a holistic strategy for greening a local primary school by addressing its existing water systems in an integrated manner. It makes recommendations for retrofitting certain areas of the school in order to increase liveability. These include the development of a productive school kitchen garden, and a more diverse and interesting use of the existing space (often hard surfaced areas) through better management of water and increased shading, microclimates, and habitat through appropriate vegetation.

It is hoped that the concepts and methods outlined in this report can be readily taken up and applied by school principals and staff involved in water and landscape management, local government staff, engineers and consultants and educational institutions more broadly.

5 RESOURCE LIST

Climate Data

Bureau of Meteorology website (climate statistics): <http://www.bom.gov.au/climate/data/>

Victorian SWEP Program

<http://www.myswep.com.au/>

Water Auditing

City West Water:

http://www.citywestwater.com.au/business/free_water_energy_audits.aspx

Water Efficiency

City West Water:

http://www.citywestwater.com.au/documents/best_practice_guidelines.pdf

South East Water (Victoria):

<http://ipc.sew.com.au/login>

Water Efficiency Labelling Scheme (WELS)

<http://www.waterrating.gov.au/>

Water Sensitive Urban Design (WSUD)

Melbourne Water:

<http://www.melbournewater.com.au/raingardens>.

<http://www.melbournewater.com.au/Planning-and-building/Stormwater-management/Water-Sensitive-Urban-Design/Pages/wsud.aspx>

CSIRO:
<http://www.publish.csiro.au/pid/2190.htm>

Rainwater Harvesting

Alternative technology association:
Tankulator (<http://tankulator.ata.org.au/>)

Urban Greening

2020 Vision:
<http://2020vision.com.au/>

Burden, D. (2006). Urban street trees: 22 benefits, specific applications. Glatting Jackson and Walkable Communities, Inc.

Ely, M. & Pitman, S. (2012). Green Infrastructure Life support for human habitats: The compelling evidence for incorporating nature into urban environments. Botanic Gardens of Adelaide, Department of Environment, Water and Natural Resources.

Jacobs, B., Mikhailovich, N., and Delaney, C. (2014). Benchmarking Australia's Urban Tree Canopy: An i-Tree Assessment. Institute for Sustainable Futures, University of Technology Sydney.

6 APPENDICES

6.1 Deer Park North Primary School – School as a Catchment Master Plan