STORM_CONSULTING

Water Management Plan

Final Report Prepared for:
University of Wollongong

Project No. 993

Prepared by:
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EXECUTIVE SUMMARY

STORM_CONSULTING was engaged by the University of Wollongong (UOW) to investigate and prepare a Water Management Plan for the main Wollongong campus. The Plan defines an Action Implementation Plan for the period 2010-2012 to minimise UOW's reliance on potable water.

In preparing this Water Management Plan, STORM undertook the following major tasks:

- Collation and review of background information including WSAP, as built drawings of the University, Stormwater Management Study, etc.
- Analysis of the smart water metering data that is available for the campus
- Three separate inspections of the University - two of these were accompanied tours with UOW staff.
- Ongoing liaison with UOW staff
- A workshop with UOW staff to discuss the Water Management Plan and issues and opportunities that ought to inform it
- Additional investigations, analysis and design as required to develop preliminarily feasible recommendations within the Water Management Plan.

The University of Wollongong is committed to optimising its potable water savings and has set an aspirational target of achieving 100% self-sustainability for campus water supply. The University has already implemented numerous projects and initiatives to reduce potable water consumption on campus. In some respect, previous water saving activities undertaken to date have proceeded as projects in isolation. There is now a need to provide an overarching strategy to guide future water management initiatives so that they work toward achieving a specific water potable water reduction target.

The Water Management Plan outlines a strategy that will enable UOW to achieve significant potable water savings by 2012. The strategy comprises a series of components which are described. Note that these strategy components represent the "low-hanging fruit" options. In other words, they are logical and relatively easy and cost-effective to achieve – while also providing significant benefits over the Plan implementation timeframe to 2012.

The strategy shall be achieved through the Action Implementation Plan.

This Water Management Plan has through option analysis and investigation devised a 3-year program of works (2010-2012) that will provide substantial progress toward the University of Wollongong achieving 100% self-sustainability in water supply.

The works are across several projects within seven strategy components as follows:

- Strategy component No. 1: Refine existing harvesting arrangements to optimise benefits
- Strategy component No. 2: Install a stormwater harvesting scheme in the Admin precinct
- Strategy component No. 3: Add roof water storages to existing buildings
- Strategy component No. 4: Water smart design for new buildings
- Strategy component No. 5: Sports Precinct scheme
- Strategy component No. 6: Continued and expanded metering and monitoring
- Strategy component No. 7: Continue to audit for and identify water saving measures

The projects combined will require a total investment of $790,000 which will result in water savings of up to 46 ML, or 40-50% of total campus demand (compared to baseline water consumption).

In going beyond this Plan and looking to medium and long term potable water consumption levels insights are provided that compare expanded roofwater+stormwater versus expanded stormwater harvesting options. This will facilitate future decision making.

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1. INTRODUCTION

STORM_CONSULTING was engaged by the University of Wollongong (UOW) to investigate and prepare a Water Management Plan for the main Wollongong campus. The Plan defines an Action Implementation Plan for the period 2010-2012 to minimise UOW's reliance on potable water.

1.1 Background and context

In 2009 there were an estimated 15,768 effective full-time equivalent students (EFTSU) and 1600 staff at the Wollongong campus. Student numbers are expected to increase through 2010 and beyond as the University is embarking on a growth phase. What and how that growth will be incorporated into the planning of the University is yet to be determined.

Potable water consumption has decreased over time at the university from a high in 1999 of 240,698 kL per year to 147,552 kL in 2008 (refer Figure 1: note the 2009 total consumption was 155, 697 kL, slightly up on the 2008 total).

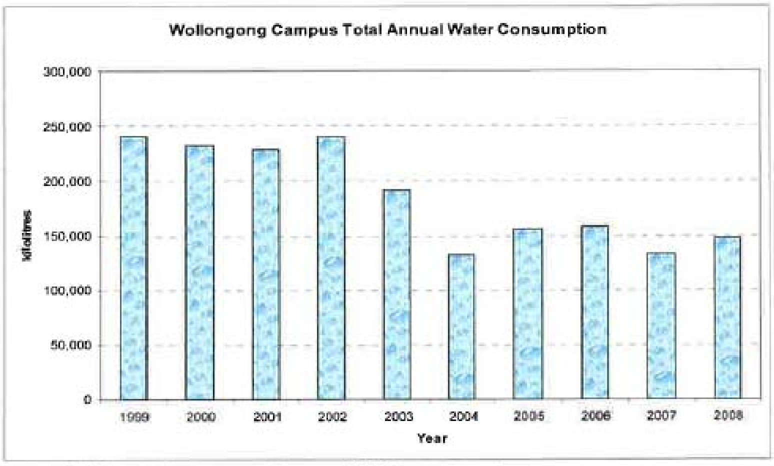


Figure 1. Annual Water Consumption at Wollongong Campus

In 2006, UOW prepared its first Water Savings Action Plan (WSAP), a legislative requirement of the NSW State Government. The WSAP measures water consumption improvements against 2005 as a "baseline" year. The WSAP categorised the consumption down to buildings, irrigation, swimming pool and unaccounted flow (refer Figure 2). In this audit, unaccounted flow made up 33% of the water use.

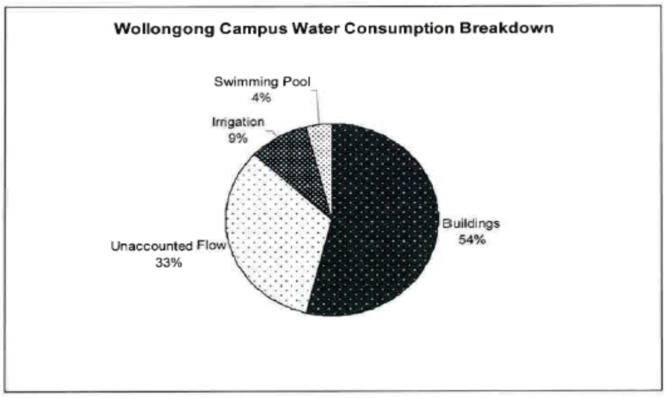


Figure 2 Water Consumption Breakdown

To address this issue, a Smart metering program was implemented to capture more precise information of water use across campus. The metering system is due to be complete at the end of 2009.

The WSAP identified a range of initiatives to be implemented over a number of years. The initiatives implemented to date or in progress include:

- establishment of a leak detection program;
- increase cooling tower cycles of concentration to 1,000 ppm saving 1,898 kL per annum;
- the "DIY" Sydney Water retrofit of showerheads and taps with water efficient devices and flow restrictors, saving 7,045 kL per annum;¡
- installation of Pressure Reduction Valves saving 6,205 kL per annum;.
- replace water-cooled woks with air-cooled woks in the restaurants saving 4,015 kL per annum
- installation of a 25 kL rainwater tank at the Graduate School of Medicine in 2006;
- installation of a 20 kL rainwater tank at the Ecological Research Centre in December 2008;
- installation of a 39 kL rainwater tank at Central Square/ White Cedar Court;
- installation of a 360 kL rainwater tank at Oval 1 Redevelopment;
- installation of a 500 kL rainwater tank at URAC Sports Hub/Ovals; and
- installation of 360kL of rainwater storage at Oval 1.

These initiatives have reduced water consumption at the Wollongong campus. The initial savings in potable water use from 2006 to 2007 were over 25,000 kL (equating to $14,607). However, this has been eroded a little in 2008-09 with increased consumption. The largest decrease in water consumption from the above initiatives, compared to the 2005 baseline year, will be realised in 2010 once the large rainwater tanks are commissioned over the summer irrigation period.

In some respects, the activities undertaken to date have proceeded as projects in isolation. There is now a need to provide an overarching strategy to guide future water management initiatives so that they work toward achieving a specific water potable water reduction target.

1.2 Scope of work

In its Brief, UOW identified the following scope of work to be undertaken:

1. Inspect the building and landscape assets of the UOW to establish the starting point for the Water Management Plan;
2. Conduct a workshop with relevant UOW staff and academics to identify a list of ideas;
3. Review and firm up the list of ideas to implement on the campus which are worthy of feasibility analysis to create an outline Plan;
4. Provide location-relevant BOM rainfall data to allow the accurate and reliable evaluation of competing systems and responses through simulation and other estimation calculations;
5. Prepare a Plan to undertake a feasibility analysis of those ideas and of the outline Plan as a whole, including the potential for outside funding support and for academic, research and promotional collateral benefits from such investments;
6. Prepare an outline cost budget for the work proposed in that Plan with sufficient detail to allow the UOW to informedly modify that scope and timing of work to suit its budgetary requirements;
7. Provide a cost benefit analysis of the various water capture and storage options;
8. Provide advice on health risks and constraints on water use from various options; and
9. Provide advice on any adverse environmental impact.

1.3 Key issues to be examined

Listed in Table 1 are some key areas of consideration in the preparation of the Water Management Plan.

Table 1: Issues for consideration from Council's Brief

Leakage Detection system	The University has developed a water metering system in an effort to, not only better manage our water consumption across the campus but also to detect leakages where they occur. Figure 2 identifies that 33% of water consumption is unaccounted for flow, a proportion of this may be leakages. The University requires advice on the most effective leak detection program that incorporates: - Active leak detection and repair; - Reductions in pipe pressures; - Any additional metering; - Optimal response times; and - Optimal pipe replacement and maintenance regimes.
Stormwater Reuse	Significant stormwater is transported down Robson's Rd and Northfields Ave this may be captured and stored on-site (with or without treatment) for reuse.
On Site Rainwater Tanks	The University currently has 944,000 litres of rainwater tank storage. This could be expanded and strategically developed further both from the demand side but also from a demonstration view point.
Existing Pond System as Water Storage/Treatment	The Wollongong campus has extensive, shallow ponds that could be enhanced for storage or used as part or all of a treatment process. The ponds are artificially topped up with potable water.
Potable Water Reuse	There are a number of mini recycling plants on the market that will treat "grey" water to A grade water for reuse in certain applications.
Sewer Mining	While the sewage system passing the campus is closed for sewer mining due to the Wollongong Treatment Plant recycling facility, the capture and treatment of the University sewage is an option for appropriate end uses.
Funding opportunities	The UOW seeks to effect a Plan with a minimum of expenditure and a maximum of benefit to the University, its students (current and future) and its industrial partners and tenants. Accordingly, co-funding and contributions in kind as well as key synergies within its research and teaching programs are to be identified to recommend the best combination to incorporate in its Water Management Plan. These possibilities should include: - Commonwealth subsidies and program supports; - NSW subsidies and program supports; - Illawarra subsidies and program supports; - Industry partnerships and other supports (e.g., philanthropy); - Teaching synergies; - Research synergies including IP creation and ARC grant attraction; and - Public relations, tourism and attraction/retention of students and staff.

2. METHODOLOGY

In preparing this Water Management Plan, STORM undertook the following major tasks:

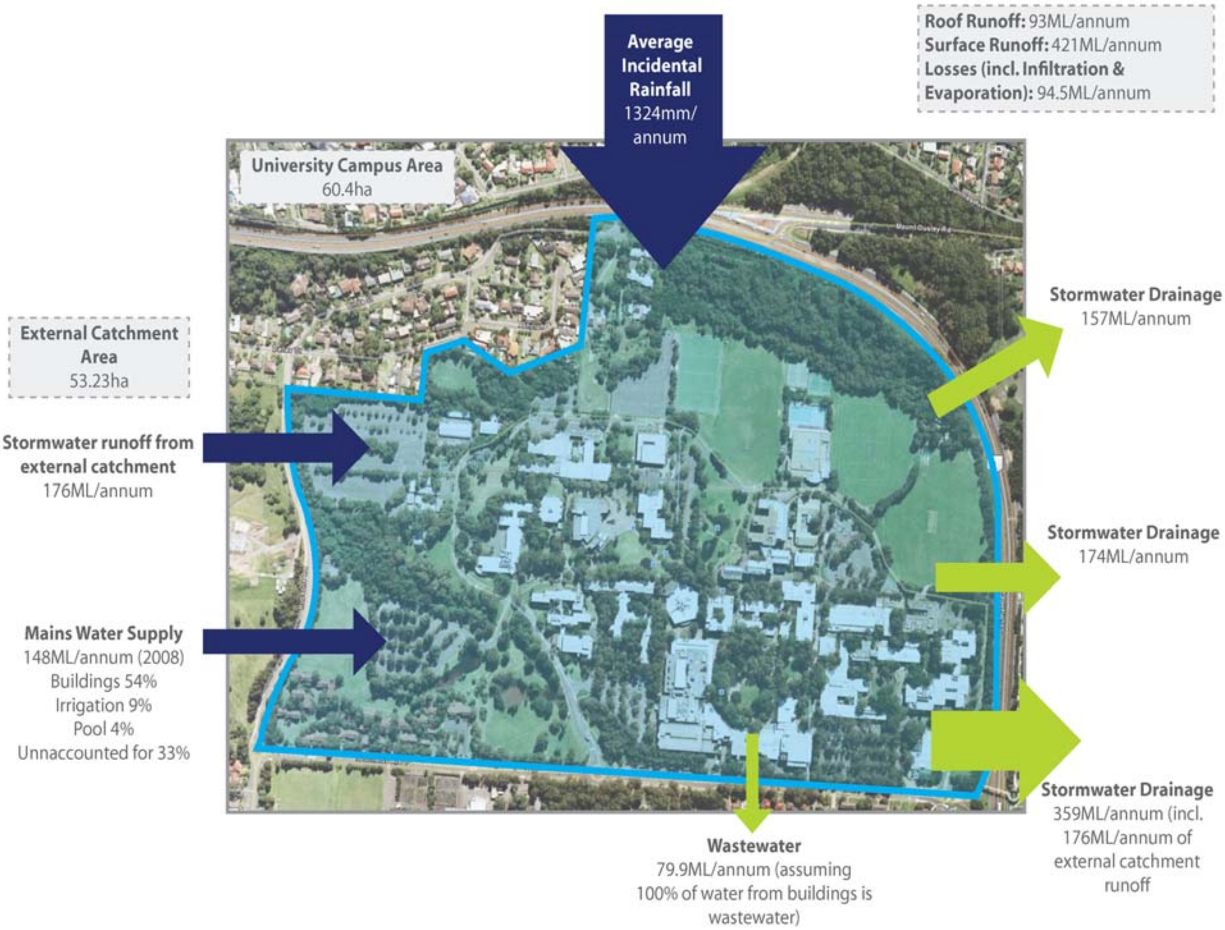
- Collation and review of background information including WSAP, as built drawings of the University, Stormwater Management Study, etc.
- Analysis of the smart water metering data that is available for the campus
- Three separate inspections of the University - two of these were accompanied tours with UOW staff.
- Ongoing liaison with UOW staff
- A workshop with UOW staff to discuss the Water Management Plan and issues and opportunities that ought to inform it
- Additional investigations, analysis and design as required to develop preliminarily feasible recommendations within the Water Management Plan.

During STORM's commission, it became evident that a parallel project to prepare a Landscape Master Plan for the Administration Precinct required some water engineering inputs, and this specific analysis was added to STORM's investigations. STORM attended three meetings with UOW and its consultant to coordinate STORM's input to the Landscape Master Plan.

3. BACKGROUND INFORMATION SUMMARY

3.1 Campus Water Budget

Figure 3.1 shows the water budget for the UOW campus, which provides an excellent snapshot of water flows and use on campus.



3.2 Environmental Management Plan

In January 2009, and new unit called the Environment and Sustainability Initiatives (ESI) was formed This Unit reports to an Environmental Advisory Committee and has prepared a Draft Environmental Management Plan (EMP) for the campus. The EMP was finalised in 2010, and was developed to provide a strategic direction for sustainability and environmental action for the University over a period of 3 years.

UOW's EMP is based on ISO14001. The Plan will contain Key Performance Indicators (KPIs) to assist the University in evaluating how successful they are at meeting their environmental objectives and goals, laid down in the EMP. UOW has set an aspirational goal of being self-sufficient in water, this Water Management Plan's findings will inform the setting of EMP objectives and targets. Therefore those objectives and targets shown in Table 1 (LH column) will be determined and adopted.

The Unit is also responsible for aiding environmental education through the provision of material on sustainable water activity within the campus, and fostering environmental awareness across campus.

Table 3.1: EMP Environmental Objectives, Targets, Strategies and Performance indicators for water

Objectives and targets	Strategies and Actions	Performance indicator	Reported via	Reported via
Reduce potable water consumption by 5% per EFTSU and FTE Staff each year until 2013	Continue to implement the Water Savings Action Plans (Ongoing)	Water Savings Actions implemented. Reductions in potable water consumption per EFTSU per year compared to 2005.	Water Savings Action Plan Annual Reports	Sustainability Engineer Environment and Sustainability Initiatives Unit
	Ensure all new water-related equipment and fixtures are minimum 4 star efficiency rated (ongoing)	Proportion of 4 star rated equipment and fixtures compared to total	Building and Engineering Information and Maintenance System (BEIMS)	Manager Construction Manager Maintenance and Energy Facility Managers
	Develop and implement water conservation awareness programs for staff and students by December 2011	Number of programs conducted Survey results of staff and students to measure awareness changes	Environmental Advisory Committee	Environmental Education and Compliance Officer
	Ensure all Deans, Heads of Schools and facility managers at Wollongong Campus have water consumption information monthly by June 2011	Reports available to Deans, Heads of School and Facilities Managers monthly	Performance Indicator Project (PIP)	Performance Indicator Unit
	Investigate and seek grant funding for water consumption reduction projects (ongoing)	Grant funding received as $	Environmental Advisory Committee	Sustainability Engineer Environment and Sustainability Initiatives Unit
	Monitor water usage at Wollongong Campus via PIPs System by December 2011	PIPs used to monitor water usage at Wollongong Campus Reductions in potable water consumption per EFTSU and FTE Staff per year compared to 2005.	Performance Indicator Project (PIP)	Performance Indicator Unit Environment and Sustainability Initiatives Unit
	Ensure that savings that are made on consumption reductions are reinvested into water savings actions (i.e. capital improvements and staff engagement activities	Revolving fund established	Buildings and Grounds Financial Report	Sustainability Engineer
		Water consumption reduction projects funded by savings made on consumption reductions	Water Savings Action Plan Annual Reports	Environment and Sustainability Initiatives Unit
Also relates to pollution prevention and risk management: other health risks from stormwater/ rainwater reuse				

3.3 Water Savings Action Plan

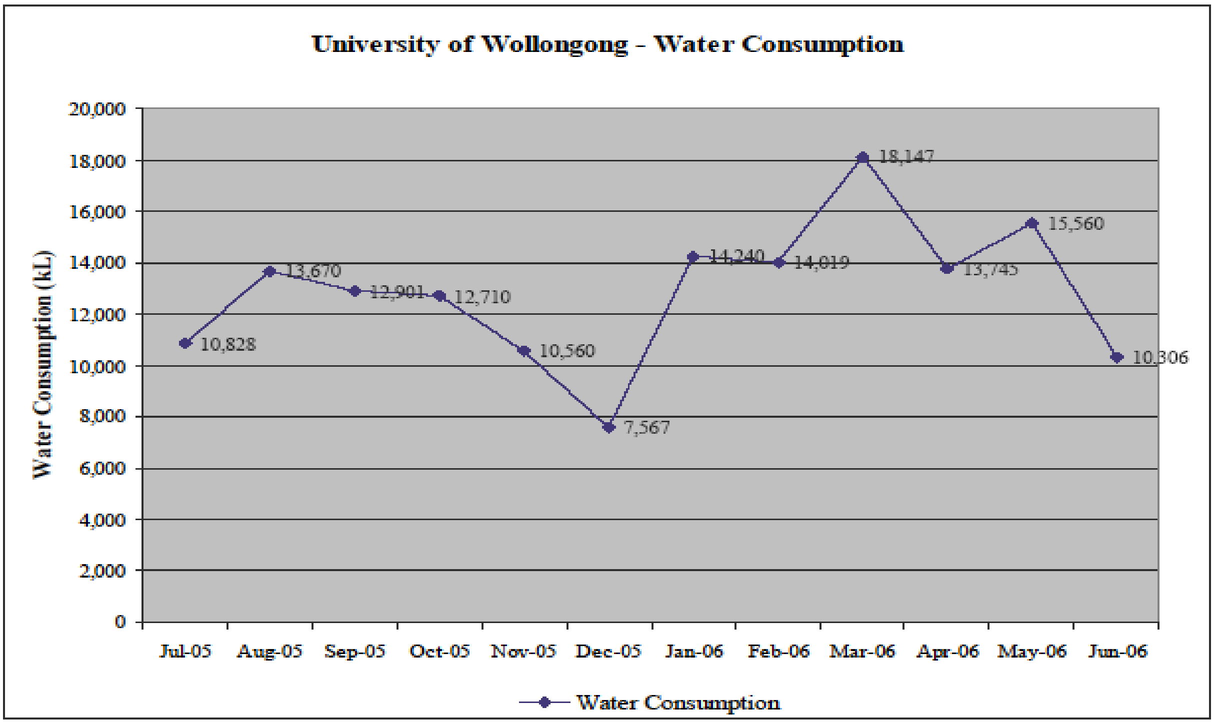
UOW prepared a WSAP in August 2006 with the following key findings:

Baseline water use

Baseline water use - uses 2005 as benchmark year	154,253 kL
Baseline Key Performance Indicator (KPI) units	kL/effective full-time students (EFTSU)
KPI from WSAP (baseline 2005)	11.6kL/EFTSU

Variability in monthly water use (2005)

The graph below refers to the baseline water consumption in 2005.

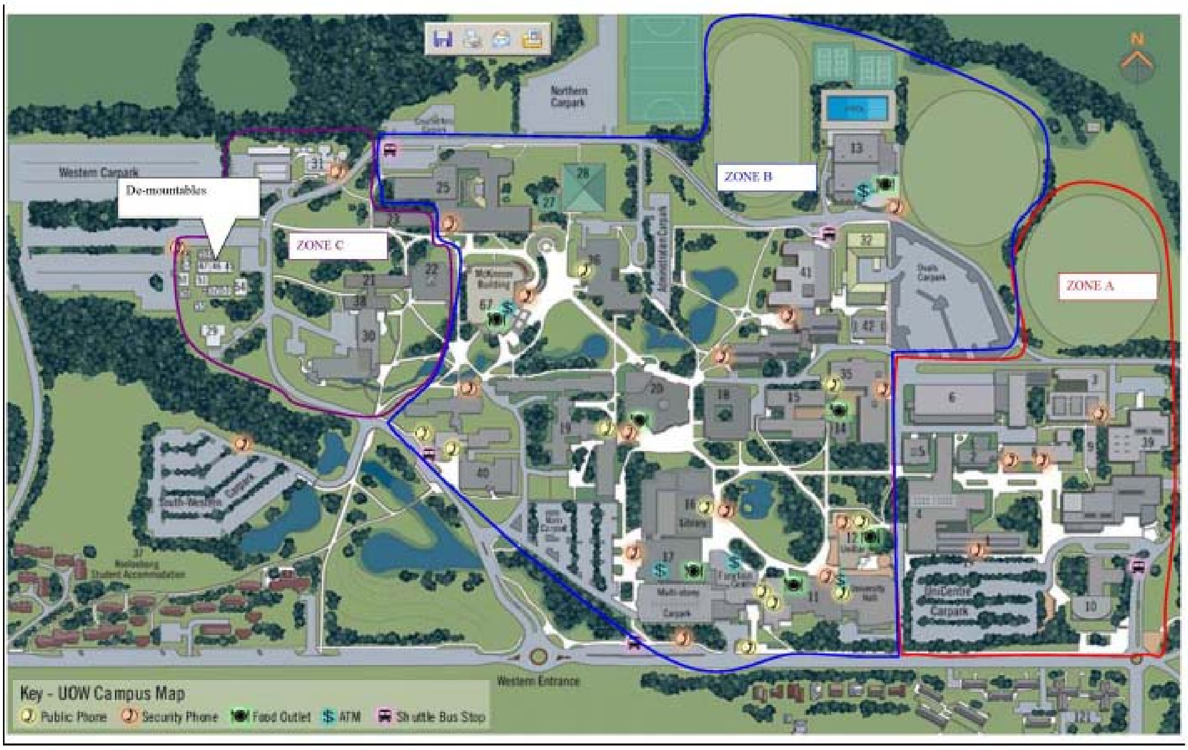


Key water infrastructure

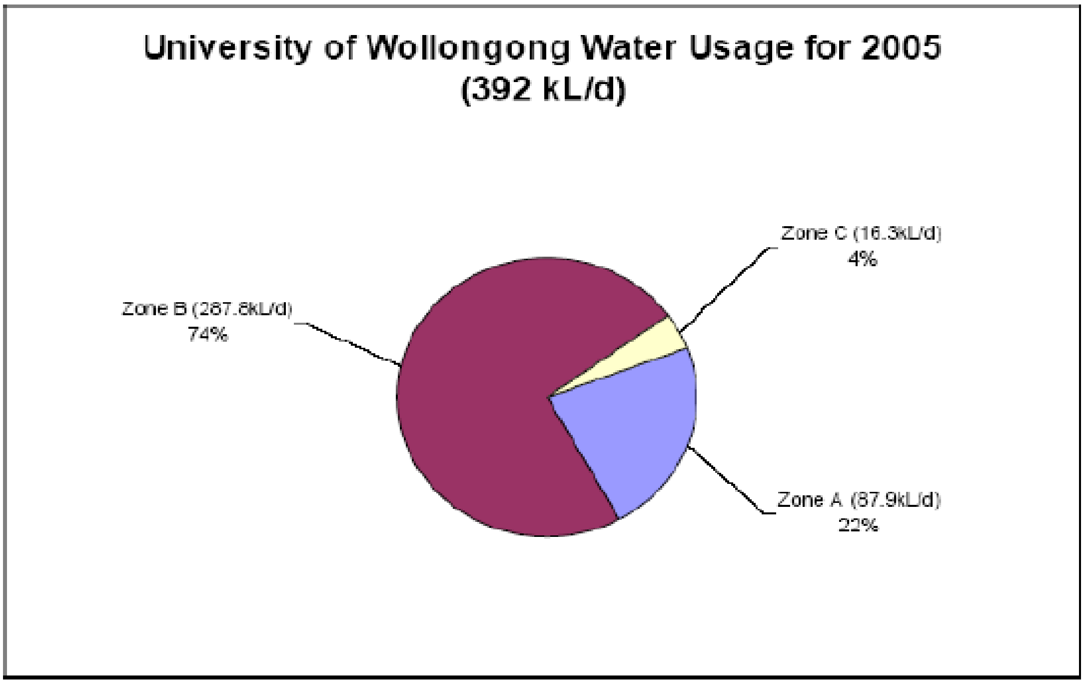
Main water meters	Sub meters
1 x 80mm meter in Northfields Ave (HDTA0004). 1 x 80mm meter in Irvine St (HDTA0021). 1 x 50mm meter in Western Carpark (GDUF0004).	51 sub-meters are installed, including thirty-two (32) new meters, which were installed as part of the water audit. The sub-meters are installed at the following locations: ▪ Buildings 1, 2, 5, 6, 8, 10A, 10B, 11, 12, 15, 16, 16A, 16B, 18, 19A, 19B, 19C, 20A, 20B, 23, 25, 32, 35A, 35B, 38, 39, 40, 41, 42, 67 and 67A. ▪ Oval 1, 2 and 3 ▪ Irrigation 1 and 2 ▪ Pond 1

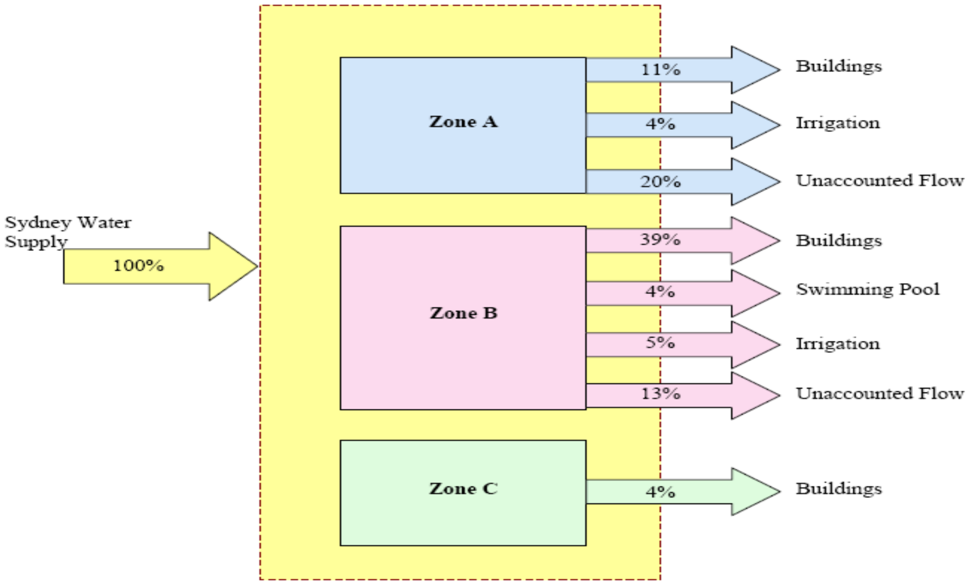
Water supply zones

Zones A (red), B (blue) and C (purple), are shown in the Figure below.



Water use by zone





Some key points to note:

- Building internal use makes up 54% of current demand. The split between potable and non-potable use is unknown at the time or writing, though UOW is obtaining this data to inform future decisions.
- Irrigation makes up only 9% of current demand across the campus
- 33% of consumption is currently unaccounted for. It is not expected that leakage will form a significant part of this total
- The Swimming Pool makes up 4% of total consumption.

Water saving measures

Project No.	Measure Description	Responsibility	Cost to Implement	Savings Water (ML or kL pa)	Total Cost Water + Energy + Chemical + other ($pa)	Internal Rate of Return/ Payback	Completion Date	Action status (Implemented (I); Pending (P); Rescheduled (R); Cancelled (C); New (N).
Cost Effective Opportunities								
1	Install of Pressure Reduction Valves	Chris Hewitt	$13,000	6,205 kL	$13,200	102%	1-Feb-09	I
2	Install Water Efficient Showerheads	Chris Hewitt	$2,500	2,117 kL	$4,500	180%	31-Jan-08	I
3	Install Flow Restrictors to Additional Bathroom Taps	Chris Hewitt	$11,950	4,928 kL	$10,500	88%	31-Jan-08	I
Totals for implemented CE actions only			**$14,450**	**7,045 kL**	**$15,000**			
Potential Cost Effective Opportunities								
4	Replace Existing Water-Cooled Woks with Air-Cooled Woks	Chris Hewitt	$16,000	4,015 kL	$8,500	53%	31-Jan-07	I
5	Installation of Stop Valves	Chris Hewitt	$20,000	N/A	N/A		31-Jul-08	I
6	Increase Cooling Tower Cycles of Concentration to 1,000 ppm.	Chris Hewitt	$5,000	1,898 kL	$4,000	80%	31-Mar-08	I
7	Utility Measuring and Measurement System	Chris Hewitt	$400,000	N/A	N/A		1-Sep-10	P
8	Implement Non-Potable Water Systems	Chris Hewitt	$770,000	15,000 kL	$26,100	3.30%	31-Dec-09	I
Totals for implemented PCE actions only			**$770,000**	**15,000kL**	**$26,100**			
Totals for all implemented actions			**$825,450**	**27,958 kL**	**$48,647**			

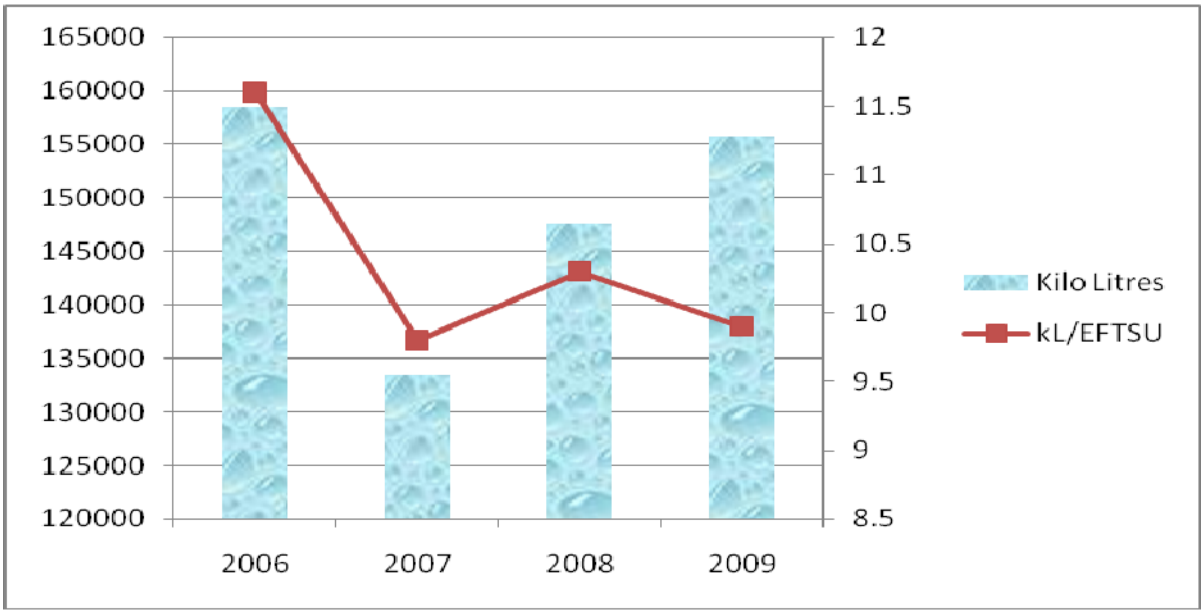
Suggested non-potable source substitution

The following table was taken from the WSAP (2006) and provides options for non-potable source substitution.

	Pool Backwash	Rain water	Bore water
Non-potable water available on site	42,000L over 2wk period Allowing 30% to sewer Via 1st flush	230,000L based on a rain event every 2wks Based on 16L\s	max 2L\s
Non-potable water storage facilities required	Pool backwash 2 x 100,000ltr based on collection rainwater from western end of building 16L\s Mains water make up to main tanks 1l\s	Rainwater 10,000L 2 x 5,000L tanks	Main tanks 2 x 350,000L
Potential applications for non-potable water	Main fields 60l\s for 4hrs 864,000L\s	Recreation Centre toilet flushing 480L\day	

3.4 Implementation and reporting of WSAP

For the two years after the baseline water consumption data was prepared, UOW has reported on the implementation of the WSAP. The following provides a summary of progress and initiatives.



This graph shows fluctuating consumption patterns with a dip in both total consumption and per capita consumption in 2007, followed by an increase in 2008, and a growth in total consumption and a fall in per capita consumption in 2009.

Project No.	Measure Description	Responsibility	Cost to Implement	Savings Water (ML or kL pa)	Total Cost Savings Water + Energy + Chemical + other ($pa)	Internal Rate of Return/ Payback	Completion Date	Action status (Implemented (I); Pending (P); Rescheduled (R); Cancelled (C); New (N).
Cost Effective Opportunities								
1	Install of Pressure Reduction Valves	Chris Hewitt	$13,000	6,205 kL	$13,200	102%	1-Feb-09	P
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3	Install Flow Restrictors to Additional Bathroom Taps	Chris Hewitt	$11,950	4,928 kL	$10,500	88%	31-Jan-08	I
Totals for implemented CE actions only			$14,450	7,045 kL	$15,000			
Potential Cost Effective Opportunities								
4	Replace Existing Water-Cooled Woks with Air-Cooled Woks	Chris Hewitt	$16,000	4,015 kL	$8,500	53%	31-Jan-07	I
5	Installation of Stop Valves	Chris Hewitt	$20,000	N/A	N/A		31-Jul-08	I
6	Increase Cooling Tower Cycles of Concentration to 1,000 ppm.	Chris Hewitt	$5,000	1,898 kL	$4,000	80%	31-Mar-08	I
7	Utility Measuring and Measurement System	Chris Hewitt	$400,000	N/A	N/A		1-Sep-09	P
8	Implement Non-Potable Water Systems	Chris Hewitt	$178,000	41,472 kL	$54,905	31%	31-Dec-09	P
Totals for implemented PCE actions only			$41,000	5,913 kL	$12,500			
Totals for all implemented actions			$55,450	12,958 kL	$27,500			

Implementation status table as at 2009.

Summary of water storages created as non-potable source substitution.

PROJECTS	Water storgae capacity (KL)	Capture area (m2)	Caputure Method	Uses	Features	No of Pans connected	No of Urinals connected	Installation cost (exc GST)	Completion date	Funding Source
SMART Infrastructure Facility	120	4000	Roof	Toilet flushing	Fresh water suplement	36 pans @ 4.5L/3L dual flush	8 urinals @ 0.8 to 1.8L flush	$100K	Dec-10	Federal Gov
Illawarra Health + Medical Research Centre	30	1100	Roof	Toilet flushing, minor irrigation	Fresh water suplement	19 pans @ 4.5L/3L dual flush	3 urinals @ 0.8 to 1.8L flush	$90K	Feb-10	State Gov & UOW
Central Square / White Cedar	39	320	Roof	Irrigation only	Nil			$50K	Jan-09	UOW
Graduate School of Medicine	25	650	Roof	Irrigation only	Nil			$50K	Sep-06	UOW
Ecological Research Centre	20	820	Roof	Irrigation only	Nil			$40K	Dec-08	UOW
URAC Sports Hub	500	4150	Roof	Toilet flushing and irrigation	Fresh water suplement	18 pans @ 4.5L/3L dual flush	10 urinals @ 0.8 to 1.8L flush	$75K	Apr-09	Federal Gov & UOW
Oval 1 Change Rooms	16	220	Roof	Toilet flushing and irrigation	Fresh water suplement	9 pans @ 4.5L/3L dual flush	1 urinals @ 0.8 to 1.8L flush	$20K	Jul-09	Federal Gov
Ovals 1 Redevelopment	360	14500	Through ground	Irrigation	Water capture is through oval ground			$625K	Mar-09	Federal Gov
Bldg 31 Block C	10	120	Roof	Irrigation only	Nil			$5K	Beginning of time	UOW
Landscape shed	15	60	Roof	Irrigation				5K	Beginning of time	UOW
Totals	1135	25940								

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3.5 Existing and future water savings from source substitution

The following provides broad-brush calculations to estimate existing and future alternative water sources.

A	Existing (Roofs, including those under construction) Roof Catchment = 11,440 m^2 Rainfall Depth = 1.3 m/annum Rainfall Volume = 14.9 ML/annum *Harvestable Volume = 0.5*14.9 = 7.5 ML/annum (assumes 50% of volume is harvestable)*
B	Existing Water Savings Measures From the WSAP Implementation Table status (Section 3.3) *Volume saved = 13 ML*
C	Existing (Ovals 1+2) Oval Catchment = 14,500 m^2 Rainfall Depth = 1.3 m/annum Rainfall Volume = 18.9 ML/annum *Harvestable Volume = 0.5*18.9 = 9.5 ML/annum (assumes 50% of volume is harvestable)*
D	Future (Roofs) Roof Catchment = 71,717 m^2 (total roof area – existing roof area captured) Potential Harvestable Roof Catchment (assume 25%) = 17,929 m^2 Rainfall Depth = 1.3 m/annum, Rainfall Volume = 23.3 ML/annum *Harvestable Volume = 0.5*23.3 = 11.6 ML/annum (assumes 50% of volume is harvestable)*
E	Future Water Savings – Pressure Reduction valves From the WSAP Implementation Table status (Section 3.3) *Volume saved = 6.2 ML*
F	Future Stormwater Harvesting (central flow catchment through campus) Catchment = 6 Ha (Oval 3) + 5 Ha (Admin Precinct upper subcatchment) Rainfall depth = 1.3 m/annum Runoff volume = 107 ML (assumes losses of 25%) *Harvestable volume = 21 ML (assumes 20% is harvestable)*

Note therefore that the **total amount of water estimated to be provided compared to the 2005 baseline demand is A+B+C = 30ML/Annum.** This represents **about 19% of total consumption.**

When the harvesting of future roofs and stormwater plus the installation of Pressure Reduction Valves are factored into the estimates, a **total of 38.8 ML/annum savings will result**, i.e. D+E+F. Using 2005 baseline consumption figures, this represents **about 25%** of **total consumption**.

Therefore, implementation of a full range of measures on top of existing measures will result in nearly 44% reduction of potable demand across the campus.

Note that despite the fact that these estimates are considered broad-brush, they indicate that the various measures proposed across the campus make substantial progress toward achieving the aspirational target of 100% source substitution of potable water.

3.6 Building roof area and consumption data

The Table in Appendix B lists the buildings at University of Wollongong, their roof areas and water demands (where known).

The campus has numerous buildings which all vary in relation to height, construction method and materials, building form and configuration, roof area, roof drainage and potable and non-potable water demands. For example, many buildings have downpipes constructed within building columns and with numerous downpipes distributed around building perimeters making centralised collection impractical and costly. In addition, there are services and infrastructure issues to consider in relation to building surrounds. A further complication is that the proportion of potable versus non-potable water use within buildings is not known at this stage.

This combination of issues and unknowns makes it very difficult to design feasible systems. There is also a question mark over the creation of multiple systems for buildings which will all require individual maintenance, thereby creating a management burden for the University.

On top of all this, most buildings have water demands of less than 1-2% of total campus demand which makes implementation of harvesting and reuse systems unfeasible on economic grounds in relation to their limited benefit.

3.7 Effects of climate change

The CSIRO has predicted the effects of climate change and reported these in "*Climate Change in the Southern Rivers Catchment*". The projected climate change is as shown in Table 3.2.

Table 3.2: Climate change predictions for the southern rivers catchment

Climate Factor	By 2030	By 2070
Annual Average Rainfall	-13 - +7%	-40 - +20%
Extreme rainfall (1 in 40 yr 1 day event)	+7%	+5%
Evaporation	+1 - +13%	+2 - +40%
No. droughts per decade (ave monthly drought frequencies based on BOM's criteria for serious rainfall deficiency - currently 3)	1-5	1-9

These predictions have implications for water harvesting-based approaches to potable water source substitution.

Increased evaporation will caused increased demand for irrigation. However, irrigation represents only 9% of current total consumption. This impact is considered negligible.

Potential decreased rainfall will mean less water is available for harvesting, while increased rainfall intensities will mean that less water can be harvested because storages will fill, and overflow, more quickly. One way to mitigate this impact is to allow for increased storage sizes, e.g. 10-20% by volume.

3.8 Buildings & Grounds Division Strategic Plan

A Buildings & Grounds Division (B&G) Strategic Plan for the period 2008-2010, was prepared by UOW in September 2008. The B&G Division Strategic Plan aligns with and complements the UOW Strategic Plan 2008-2010.

As outlined in the plan, one of B&G's strategic directions is that of Asset Management, of which they take primary responsibility for the majority of the Wollongong Campus.

B&G provides facility management advice to all University entities coordinates essential services certification and organises a condition audit each five years. This audit measures the University's backlog maintenance and directs maintenance, replacement and refurbishment planning. It is proposed to conduct the next condition audit at the end of 2009.

B&G also prepare Capital Management Plans which are a 5-year rolling plan of works approved at the start of each year.

B&G will review the training and skills required to assist with implementation of the EMS and in the development of appropriate reporting mechanisms.

3.9 Stormwater Management Study

UOW commissioned a study into drainage to identify key risks, i.e. flooding and to assess for compliance against Council's codes and policies.

The Study is useful as it provides information on detention basins and flow paths within the campus.

The study also alludes to the harvesting of roof or stormwater to substitute potable water.

3.10 Administration Precinct Landscape Master Plan

Landscape Architects and Urban Designers McGregor Coxall have been engaged by UOW to develop a Landscape Master Plan for the Administration Precinct.

The timing of their engagement fits perfectly with the preparation of this Water Management Plan as it enables integration of alternative water sources into works that will soon de designed and constructed.

3.11 TEFMA Benchmark

Tertiary Facilties around Australia utilise the annual TEFMA benchmarking survey to compare the performance and cost data of their facilities with others around the country. According to the survey UOW ranks 6th when compared with other Universities in terms of water efficiency, consuming 9.9 kL per EFTSU.

Table 3.3: TEFMA Survey Results for Water Efficiency

University	kL/year	kL/EFTSU	Rank
J	92,994	10.5	7
C	116,200	5	1
H	135,761	6.7	3
M	147,206	6.3	2
UOW	155,697	9.9	6
D	168,351	14.3	11
E	285,255	11.7	9
I	338,903	9.6	5
A	342510	26.8	14
G	367,422	9.2	4
F	380,788	10.6	8
B	380,963	27.3	15
K	428,185	13.1	10
N	475,695	18.7	13
L	565,060	17.6	12

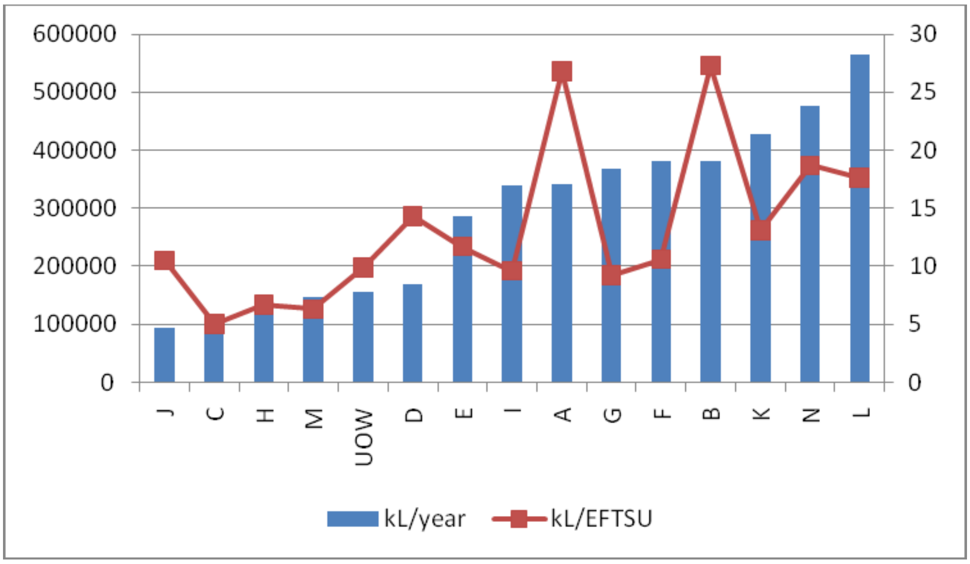


Figure 3.1: TEFMA Survey Results for Water Efficiency

4. OPTIONS ASSESSMENT

4.1 Multi-criteria assessment

As part of the investigations process for this project, an Options Assessment Matrix was prepared, the full table is included in Appendix A. The Matrix assesses six alternative water sources according to a range of criteria. The six options are:

- Roof Water Harvesting
- Stormwater Harvesting
- Blackwater Treatment and Reuse
- Greywater Treatment and Reuse
- Groundwater
- Desalination (sea water)

The criteria these options were assessed against include:

- Quantities and Reliability of supply
- Water Quality and fit-for-purpose use
- Costs – Capital and Operation and Maintenance
- Risk
- Planning requirements

Based on the results of the Matrix assessment, the options that are considered worthy of retaining for expansion of alternative water sources are:

- Roof Water Harvesting; and
- Stormwater Harvesting

The rationale for this is that both are relatively clean sources of water requiring little treatment (with associated energy inputs) by comparison with wastewaters, sea water and local groundwater. In addition, the campus is in an area of relatively high and reliable rainfall which reinforces the attractiveness of these options.

4.2 Achieving the aspirational target

For UOW to make significant progress toward their aspirational vision of achieving 100% self-sufficiency in water, it is obvious that alternative water sources will need to contribute vast amounts of water to satisfy demands and this will need to occur from the outset in a staged approach.

In section 3.5 it was estimated that roof water harvesting applied to its fullest extent across the campus could deliver only about 19ML of demand annually, and this represents about 12% of baseline water demand. Therefore, roof water harvesting would need to be supplemented with another water source – harvested stormwater.

By comparison, stormwater harvesting has potential to supply nearly all of existing demand. The campus has the luxury of having available four flow paths with several points that offer potential as offtake locations (Figure 4.1). Multiple offtakes on the same flow path allow for the optimising of harvestable quantities because any given offtake will only be able to harvest a small proportion of the flow.

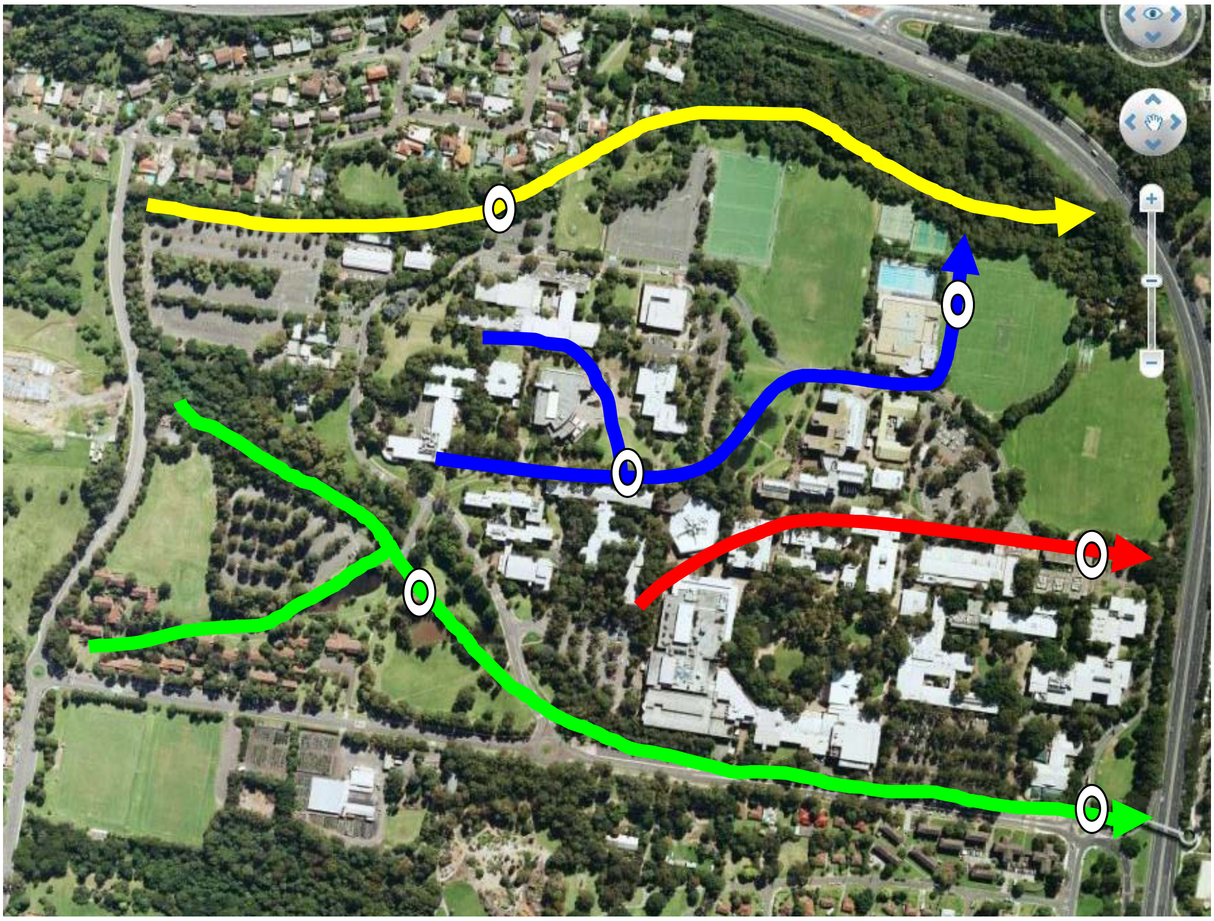


Figure 4.1: Stormwater flow paths and potential offtake locations for harvesting (Source: Google Earth)

As an exercise in comparative feasibility, it is worthwhile to contrast stormwater harvesting with combined roof and stormwater in relation to costs and benefits in delivering the aspirational vision of water self-sufficiency (Table 4.1). Note that for both roof water and stormwater, direct potable use is proposed, i.e. substituting for all sources of water.

This information will be of use in assisting decisions by UOW staff in going beyond the savings recommended in this Plan that are scheduled for implementation between 2010-12. As such, it represents mid to long term options for consideration.

Table 4.1: Comparison of stormwater harvesting versus combined roof and stormwater harvesting

Factors	Rainwater and roof water harvesting	Stormwater harvesting
Harvesting requirements	New rooves – harvesting can feature as part of the design of new buildings with harvested water readily plumbed into buildings Existing rooves – Multiple roof collection points and complex pipe systems required. Multiple tanks even when several rooves are combined into tanks. Multiple storage tanks, with possible need for linkages between certain tanks. Up to 3 harvesting offtakes – comprising weirs in creeks or modifications to stormwater pipes or outlets.	Up to 5 harvesting offtakes – comprising weirs in creeks or modifications to stormwater pipes or outlets.

Factors	Rainwater and roof water harvesting	Stormwater harvesting
Treatment requirements	**For roof water** – UV disinfection associated with each supply (multiple systems) **For stormwater** (repeated from RHS column) – Primary, Secondary and tertiary treatment (e.g. Gross Pollutant Trap, settlement pond/tank; automated sand filtration, UV disinfection.	For stormwater – Primary, Secondary and Tertiary treatment (e.g. Gross Pollutant Trap, settlement pond/tank, automated sand filtration, UV disinfection. It is possible to configure the system such that the sand filtration and UV disinfection are centralised to serve each harvesting system.
Supply requirements	**For roof water** – multiple pumps and pipework and fittings required. **For stormwater** (repeated from RHS column) Centralised header tank at point where Sydney Water Main enters the campus – all tanks to feed into this one. Pump from each storage to centralised header tank. Simple reconfiguration of main supply to provide mains top-up to centralised tank. No major or extensive plumbing required. Simple pump arrangement required – main and standby pump. Backflow prevention required for Sydney Water main	Centralised header tank at point where Sydney Water Main enters the campus – all tanks to feed into this one. Pump from each storage to centralised header tank. Simple reconfiguration of main supply to provide mains top-up to centralised tank. No major or extensive plumbing required. Simple pump arrangement required – main and standby pump. Backflow prevention required for Sydney Water main
Cost	**For new building rooves** – approx $20,000 per building for 10 buildings = $200,000 **For existing rooves** – approx $50,000 for each scheme for 5 schemes = $250,000 **For stormwater** – approx $500,000 for each of up to 3 systems = $1.5 million	Approximately $500,000 for each of up to 5 systems = $2.5 million
Acceptability	The issue here is one of the acceptability of direct potable reuse of treated stormwater. Given that both options rely on treated stormwater, the issue is relevant to both. There will need to be consultation with stakeholders and it is certain that Department of Health, Sydney Water and possibly others will want to be involved	
Constructability	**For new buildings** – relatively easy **For existing buildings** – often very complicated design and construction taking into account existing services and infrastructure **For stormwater** – relatively easy as it should be possible to avoid services and infrastructure clashes	Relatively easy as it should be possible to avoid services and infrastructure clashes
Staging	**For new buildings** – as they are constructed **For existing buildings** – requires major retrofits and so only undertaken when major refurbishments fall due – over the next 30 years. **For stormwater** – as per RHS column	Given that it is proposed to integrate several harvesting systems with centralised treatment and distribution systems, the latter will need to be installed initially meaning a high up front cost. It may be possible to adopt a modular approach to these centralised facilities whereby they can be scaled up – this could reduce up front costs. Once the centralised infrastructure is in place, harvesting schemes can be staged to suit.

Factors	Rainwater and roof water harvesting	Stormwater harvesting
Operability	Multiple systems to manage Differences posed by roof water and stormwater harvesting systems Often complex system configurations required that will be difficult to understand Impossible to automate entire system	Five systems to manage but all configured in a similar manner Centralised components offer simplicity Possible to automate entire system
Maintenance	Multiple systems to maintain Differences posed by roof and stormwater systems Each UV treatment on roof harvesting systems will require routine maintenance up to 4x/annum	Five systems to maintain but all configured in a similar manner Centralised Sand Filter and UV disinfection will require routine maintenance up to 4X/annum
Risks	For stormwater harvesting, spillages (accidental or intentional) of toxic materials in catchments is by far the biggest risk. Note that on-line monitoring systems would be installed that could automatically shut down parts of the scheme. The University would need to ban or heavily restrict use of all herbicides, pesticides and other toxins for outdoor use. All chemical storages will need to fully comply with best practice for spill prevention and management For roof systems - UV system failure could lead to ingestion of pathogens from bird or other fauna droppings For roof systems - atmospheric fallout of pollutants will not be detected	
Health considerations	Having multiple systems will increase the chance of a failure, however, the affected population exposed in any failure will only be a small proportion of the total population	Having a centralised system will decrease the chance of a failure, but if one does occur, then the whole campus population is at risk
Planning considerations	For stormwater harvesting, DECCW's Office of Water will want to ensure that the requirements of the Water Management Act are achieved in relation to harvestable rights While IPART's requirements under the Water Industry Competition Act (WICA) may not apply, UOW will want to ensure that the risk management processes conform to their standards and principles. Financial, technical and organisational capacity will need to be demonstrated to own and operate a water treatment plant and supply. Department of Health requirements will need to be complied with.	

5. WATER MANAGEMENT STRATEGY

By distilling all the information in the document thus far, it is possible to define a strategy that will enable UOW to achieve significant potable water savings by 2012. The strategy comprises a series of components which are described. Note that these strategy components represent the "low-hanging fruit" options. In other words, they are logical and relatively easy and cost-effective to achieve – while also providing significant benefits over the Plan implementation timeframe to 2012.

The strategy shall be achieved through the Action Implementation Plan as shown in Section 6.

Strategy component No. 1: Refine existing harvesting arrangements to optimise benefits

- Provide linkages between storages to derive the most effective efficiencies for capture and reuse, while also considering fit-for-purpose
- Identify additional building demands that existing storages can be supplied to

Rationale and Background

Because of the *ad hoc* nature in which the initial campus rain tanks were proposed, there could be circumstances where a particular tank is under- or oversized. In addition, the connections between storages may need some alteration. Therefore, water efficiency may be optimised in some instances by linking storages, i.e. the overflow from one tank tops up another one, or by augmenting storage.

To apply the fit-for-purpose principle, roof water storages may be connected to any other storage, but stormwater storages should not be connected to rain water storages.

Projects for Plan period

The University has already installed roof water harvesting systems as shown in the following table. Proposed refinements or additions to the system of storages are shown in the bottom row.

Building	6	9, The Hub	13 URAC	14-15	32	70	31 workshop
Roof water storage	120 KL	500 KL	16 KL	3 x 13 KL	30 KL	20 KL	10 KL
Projects for implementation/ consideration	Also supply from same storage to one or more of Bldgs 2, 5, 8, & 35	Storage to be retained, refer to Sports Precinct Strategy	Storage needs to be increased in this location, refer to Sports Precinct Strategy	Currently used for irrigation. Consider linking, increasing storage (if required) and plumbing into one or more of Bldgs 15 & 35	Consider upgrading storage volume and supply to Bldgs 41 & 42	Currently used for irrigation. Consider plumbing into either or both of Bldgs 70 & 71	Retain for irrigation use.

In addition, the stormwater storage on Oval No. 1 has overflow directed by pump to the twin tanks associated with Building No. 9. This connection needs to be removed. Refer to the Sports Precinct Strategy for details. It may be possible to reuse the existing pumping arrangement that has been installed to drive this connection.

Other refinements to the various systems may be identified into the future based on metering data or other investigations.

Strategy component No. 2: Install a stormwater harvesting scheme in the Admin precinct

The Administrative Precinct is shown as part of the Blue subcatchment flow line on Figure 4.1. This subcatchment is fully contained within the campus and receives little or no flow from car parks and road drainage. Therefore, we predict that it produces relatively unpolluted runoff making it ideal for harvesting and reuse for non-potable demands in this Precinct.

It was fortunate that the Landscape Master Planning process for the Administration Precinct was occurring at the same time as the preparation of this Plan. Stormwater harvesting was able to be integrated with the other works proposed for the Precinct with the harvested stormwater to supply the following demands:

- top-up water for the cascade water feature adjacent to the McKinnon Building
- toilet flushing in surrounding buildings
- irrigation of high use lawns, e.g. McKinnon Lawn

Appendix C contains details of the analysis and calculations for this stormwater harvesting scheme. A minimum 500KL underground tank is proposed as the storage.

Strategy component No. 3: Add roof water storages to existing buildings

- Retrofit rainwater harvesting schemes on Buildings based on yield analysis. Refer to Appendix C for a typical example of a yield analysis undertaken for Buildings 31 (Building and Grounds) and 36 (Administration) (see Appendix C for analysis and calculations). A lack of non-potable demand data inhibited further detailed yield analysis for other buildings although basic yield analyses were undertaken which assumed demand data, the results of which are summarised in Appendix B.
- Plumb rainwater supply to all fixtures in the building as substitute for current mains potable water supply
- Rainwater supply to include appropriate treatment system/s (e.g. sediment and carbon filtration and UV disinfection) to ensure water is fit for purpose
- Consider installation of additional treatment at dedicated drinking water taps/stations as an additional risk management measure

Background and rationale

Buildings 31 and 36 have been included as an alternative water case study in Appendix C of this report and the results indicate that rainwater harvesting is anticipated to meet about 80% of the current demands for each building.

Buildings with demands in excess of 1% of the total campus usage where analysed in respect of their ability to meet the individual buildings current demand and the results are reported in Appendix B. The results show that, in general, only up to about 40% of current demands for these buildings can be met with rainwater supply assuming 100% of the roof area is plumbed to the tank. For Building 18 (Chemistry) this figure is a low as 15%. The low yields can generally be attributed to reasonably high daily demands compared to contributing roof catchments.

In Section 3.5 of this plan we established the highly constrained nature of retrofitting existing buildings with roof water storages. Because of these issues relating to individual project feasibility, we have not proposed any additional projects of this nature.

Tool for future projects

In analysing the feasibility of roof water harvesting on buildings across the campus, STORM developed a spreadsheet tool (supplied separately to UOW) which provides background to support the future design of schemes on campus.

Strategy component No. 4: Water smart design for new buildings

Ensure:

- Dual plumbing for all new buildings
- Collect roof water for Potable uses – endeavour to collect 100% of roof drainage
- Connect harvested stormwater for non-potable uses – with stormwater provided from Admin Precinct or Sports Precinct schemes

Strategy component No. 5: Sports Precinct scheme

- Existing storage capacity on Building 13 (16KL) to be increased (to minimum 100KL) to improve capture efficiency and used as a collection storage for transfer of water to existing 500KL storage behind Building 9.
- Existing 500KL storage tanks behind Building 9 to become centralised potable water supply for Building 9 and Building 13 (including Pool) and Hockey Field (potable supply recommended for wetting down of artificial playing surface due to potential health issues associated with stormwater).
- Implement stormwater harvesting scheme to capture stormwater runoff from existing drainage system immediately south of Oval 3 to supply irrigation for Oval 3, top-up of current recycling system on Oval 1 (which also supplies Oval 2), and non-potable uses within Buildings 6, 9, 13 and 32.

Rationale and Background

The sports precinct comprising Buildings 9 and 13, Ovals 1, 2 and 3, the Swimming Pool and the Hockey Field account for approximately 25% of the current campus demand (about 30ML/year).

The precinct currently has sufficient rainwater storage capacity by way of the existing 500KL storage tanks behind Building 9, but the roof catchment of Building 9 alone is not sufficient to meet current demands. By connecting the roof catchment from Building 13, the quantum of available rain water supply will increase from about 4.6ML/yr to about 6.6ML/yr. 6.6ML represents approximately 20% of the precinct demand and in the absence of sufficient data to enable the current split between potable and non-potable demands to be determined one could suggest that 20% would be a reasonable estimate.

Implementation of dual reticulation to Building 13 only would be required as Building 9 already has a dual water reticulation system with rainwater currently being supplied for toilets flushing.

Non-potable demands in the precinct could be largely met by harvesting stormwater from the existing stormwater drainage system immediately south of Oval 3 and storage in a stormwater tank with a minimum desirable storage of 300KL. Buildings 6 and 32 which are currently under construction are being constructed with dual reticulation and are therefore highly receptive to a non-potable supply source (provided mains quality supply is not required by the laboratory equipment and process plant connected to the non-potable system).

Strategy component No. 6: Continued and expanded metering and monitoring

- Continue to implement water metering and sub-metering to build a picture of detailed water consumption
- Where necessary, ensure sub-metering of potable and non-potable supplies.
- Analysis required by a water savings expert to identify areas of further potential water savings.
- Implement leakage reduction actions where leakage is identified

Background and rationale

The need for monitoring is best summed up in the adage "if you can't measure it, you can't manage it". At present, 30% of the water consumption across the campus is unaccounted for. While it is difficult to imagine there are significant losses from the system, it is nonetheless important to quantify this and to account for all flows.

With all the data that will be provided by sub-metering, it will be important to maintain ongoing detailed analysis. This may be undertaken by UOW, but ought to also be reviewed by a water savings expert to identify areas of further potential water savings.

If ongoing metering and monitoring identifies significant losses in the system, it is likely that the losses will be attributable to leakage. In such a case, a leakage identification and reduction program will be required.

Notes:

Submetering - it is generally considered good water management practice in large facilities to do this for any individual stream of use that accounts for over 10% of flows. In the case of UOW this would best be done *via* a system of wireless sender units on each submeter feeding back to a central interface. It would be recommended that a person be nominated to receive alert messages and regularly check smart meter data, as well as short term high flow leakage incidents being automatically sent to a relevant tradesperson. To take this submetering exercise one step further, it is possible to interface the smart meter with a shutoff valve, that will automatically close the water supply if a preset flow rate is exceeded, say, due to a burst pipe. Historically, it is burst pipes that are noticeable and the response time to fix them is relatively short, but on the flipside there are the base flow leakages that can go for months or years without being noticed.

Leakage Detection: By analysing smart water metering data, conclusions can be made regarding what parts of the flow rate curve can be attributed to particular uses i.e. cooling towers and irrigation for instance have a very distinct 'fingerprint'. Similarly, any point where the flow rate does not return to zero and that no water use should be occurring indicates leakage, which can emanate from a number of sources including sprinkler or flusherette valves not closing properly, taps left on or excessive cooling tower bleed to name a few. Acoustic leak detection is the most practical way to detect sources of leakage.

Strategy component No. 7: Continue to audit for and identify water saving measures

- Install Pressure reduction valves
- Implement/install measures as they are identified with priority given to those with lower payback periods. This would include a range of typical measures, including the following as examples:
    1. Aerated taps
    2. Water efficient shower roses
    3. AAAA rated appliances
    4. Installation of waterless urinals

6. STRATEGY IMPLEMENTATION PLAN

In the previous Section, a Strategy was outlined comprising seven different Strategy Components. Table 6.1 details how to implement these Strategy Components in an Action Implementation Plan with estimated benefits and costs, timings, etc.

Table 6.1 shows that for a capital investment of approximately $790,000, this will result in up to 46 ML of potable water savings, equating to 30% of campus demand (compared to the 2005 baseline demand). This is in addition to the 30ML of potable water savings from existing initiatives (as outlined in Section 3.5). Therefore, if all the Actions from Table 6.1 are implemented by 2012, total water savings will be 76ML or 49%. This is comparable to the estimate of 44% calculated in Section 3.5, although care should be taken to read too much into the comparison as they were calculated using different methods and assumptions.

In relation to payback period for UOW's capital investment of $790,000, the works will pay for themselves after 12 years (based on potable water costs estimated at $1.50/KL over that period).

6.1 Funding options

A list of some funding options is provided and described in Appendix D. They are summarised as follows.

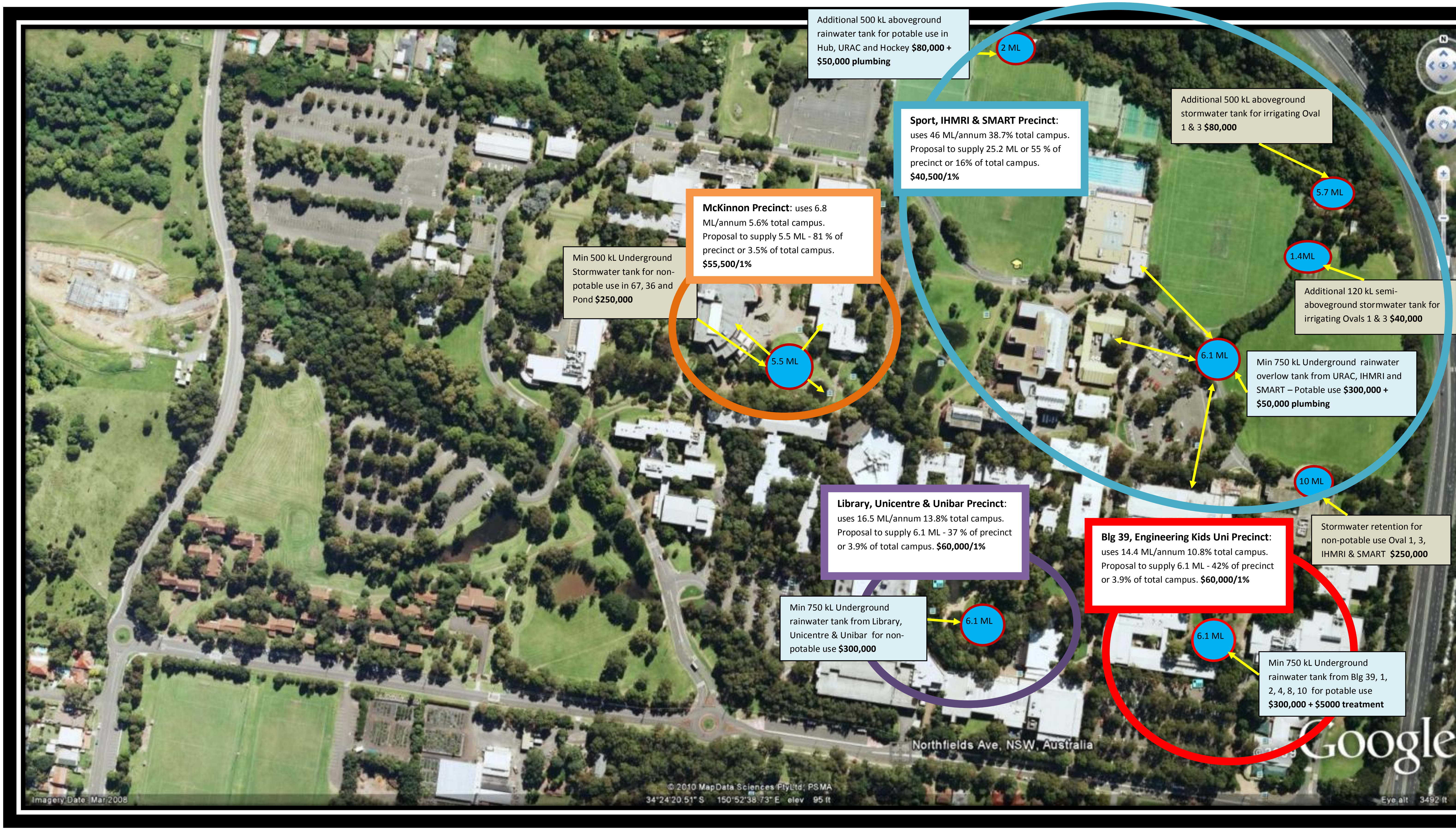
- Commonwealth subsidies and program supports – despite that large focus on alternative water project funding through the National Water Initiative, there do not appear to be any opportunities for UOW's projects to attract funding at present
- NSW subsidies and program supports – potential opportunities exist from the following: NSW Climate Change Fund; NSW Green Business program
- Illawarra subsidies and program supports – most of the Illawarra regional grants and subsidies target employment generating activities;
- Industry partnerships – existing synergies with BlueScope Steel could be explored
- Philanthropy – the University may tap into networks that are already established
- Teachíng synergies – one idea for a water saving project that would be perfect from a University educational standpoint, but which at this stage has not been recommended, is to recycle the pool backflush water from the filters. The Engineering and Science faculties could investigate the feasibility of this project idea, specifically to see whether it could be achieved using low-cost "appropriate" technology such as solar to separate salts from the backflush water. This would continue the University's low-cost solar desalination efforts and there may be commercial opportunities that result.
- Research synergies including IP creation and ARC grant attraction – the Australian Centre for Cultural Environmental Research (AUSCCER) is jointly funded by UOW and ARC. Its Director is Prof Lesley Head (an Australian Laureate Fellow 2009-2014). Topics for potential research would be into the perceptions and behaviours associated with water savings from a user and system management perspective.
- Public relations, tourism and attraction/retention of students and staff - Sustainability Advantage (DECCW NSW) is a professional network that may open up funding opportunities, and which may assist UOW to manage and report on its sustainability success to stakeholders and the community.

Table 6.1: Action Implementation Plan for University of Wollongong's Water Management Strategy

Strategy component	Projects / components	Constraints or issues to resolve	Benefit	Costs: Capital ($)	Costs: O & M ($)	Life Cycle Cost $/kL	Payback	Timing
No. 1: Refine existing harvesting arrangements to optimise benefits	Building 6	Storage locations and configuration	Up to 2 ML/annum, or 1.3% of campus demand	30,000	1500	$0.41/kL	>25 Years	2012
	Building 14-15	Services clashes		15,000	750			2012
	Building 32	Quantification of potable vs. non-potable use		40,000	1500			2012
	Building 70	Detailed design		5,000	500			2012
	Building 9	Quantification of potable vs. non-potable use		50,000				
No. 2: Refine existing harvesting arrangements to maximise volume	Building 9 add 500 kL			80,000	1500			2012
	Oval 1 & 3 add 120 kL concrete and 500 kL above ground			40,000	750			2012
	Building 70 add 40 kL			23,500	1500			2012
	Building 13, 32, 6 add 750 kL underground			300,000	500			2012
No. 3: Install a stormwater harvesting scheme in the McKinnon Landscape Precinct	Min 500KL underground storage Pump Connections to Pond and Building 67 and 36 non-potable uses	Risk analysis - Determine if treatment system required for alternative end uses	5,500 kL (3.5%) or 71% of precinct	250,000 Costs reduced because other major works occurring concurrently	7,500	-$2.08/kL	20 years	2010-11
No. 4: Add roof water storages to existing	Building 31	Storage locations and configuration		23,500	1,500	-$0.3/kL	>25 Years	2011

buildings		Services clashes Quantification of potable vs. non-potable use	Up to 468kL/annum, or 0.3% of campus demand					
	Building 36	Detailed design	593kL/annum	23,500	1,500	-$0.3/kL	>25 Years	2011
	Building 16, 11 and 12 add underground rainwater storage (Duck Pond Lawn)		6,100 kL (3.9%) or 37% of precinct	300,000	2500	-$2.89/kL	17 years	
No. 5: Water smart design for new buildings	Dual plumbing for all new buildings Collect roof water for Potable uses Connect harvested stormwater for non-potable uses Install treatment system Pumping of non-potable supply required	Projected water demands for new buildings Breakdown of potable vs non-potable demand Detailed design Review existing hydraulic design standards Include building performance targets	Unquantified (note that these projects also represent new demands on the system)	150,000 per building Additional costs of system above that of a traditionally plumbed building (Cost not included in total below)	5,000 per building (Cost not included in total below)			As buildings are proposed, designed and constructed
No. 6: Sports Precinct scheme	Existing storage capacity on Bldg 13 to be increased (to minimum 100KL) to be used as a collection storage for transfer of water to existing storage behind Building 9.	Pumping required (consider reusing redundant transfer pump on Oval 1) System detailed design Services clashes		75,000	2,500			2010-11

	Existing 500KL storage tanks behind Building 9 to become centralised potable water supply for Building 9 and Building 13 (including Pool) and Hockey Field.	Treatment system and pumping required Plumbing		50,000	10,000			2010-11
	Stormwater harvesting scheme to capture stormwater runoff from existing drainage system immediately south of Oval 3 to supply irrigation for Oval 3, top-up of current recycling system on Oval 1, and non-potable uses within Buildings 6, 9, 13 and 32.	Concept and detailed design required Risk Analysis	Up to 11ML/annum, or 7.1% of campus demand	250,000	12,000	-$3.26/kL	11 years	2010-11
No. 7: Continued and expanded metering and monitoring	Implement water metering and sub-metering to build a picture of detailed water consumption Where necessary, ensure sub-metering of potable and non-potable supplies	Detailed analysis required by a water savings expert to identify areas of further potential water savings. Implement leakage reduction actions where leakage is identified	Up to 15ML to 2012, or 9.7% of campus demand	Already covered in annual budget	N/A			Ongoing
No. 8: Continue to audit for and identify water saving measures	Pressure reduction valves Aerated taps Water efficient shower roses AAAA rated appliances Waterless urinals	Implement/install measures as they are identified with priority given to those with lower payback periods.	Up to 11ML to 2012, or 7.1% of campus demand	13,000 (pressure reduction valves) + 5,000/annum	N/A	-$4.76/kL	0 years	PRVs 2010 Remainder ongoing
		TOTALS	46ML or 30% of demand	790,000	39,250			



Additional 500 kL aboveground rainwater tank for potable use in Hub, URAC and Hockey $80,000 + $50,000 plumbing
2 ML
Sport, IHMRI & SMART Precinct: uses 46 ML/annum 38.7% total campus. Proposal to supply 25.2 ML or 55 % of precinct or 16% of total campus. $40,500/1%
Additional 500 kL aboveground stormwater tank for irrigating Oval 1 & 3 $80,000
5.7 ML
1.4ML
Additional 120 kL semi-aboveground stormwater tank for irrigating Ovals 1 & 3 $40,000
6.1 ML
Min 750 kL Underground rainwater overlow tank from URAC, IHMRI and SMART – Potable use $300,000 + $50,000 plumbing
10 ML
Stormwater retention for non-potable use Oval 1, 3, IHMRI & SMART $250,000
McKinnon Precinct: uses 6.8 ML/annum 5.6% total campus. Proposal to supply 5.5 ML - 81 % of precinct or 3.5% of total campus. $55,500/1%
Min 500 kL Underground Stormwater tank for non-potable use in 67, 36 and Pond $250,000
5.5 ML
Library, Unicentre & Unibar Precinct: uses 16.5 ML/annum 13.8% total campus. Proposal to supply 6.1 ML - 37 % of precinct or 3.9% of total campus. $60,000/1%
Min 750 kL Underground rainwater tank from Library, Unicentre & Unibar for non-potable use $300,000
6.1 ML
Blg 39, Engineering Kids Uni Precinct: uses 14.4 ML/annum 10.8% total campus. Proposal to supply 6.1 ML - 42% of precinct or 3.9% of total campus. $60,000/1%
6.1 ML
Min 750 kL Underground rainwater tank from Blg 39, 1, 2, 4, 8, 10 for potable use $300,000 + $5000 treatment
Northfields Ave, NSW, Australia
Google
© 2010 MapData Sciences Pty Ltd, PSMA
Imagery Date: Mar 2008
34°24'20.51" S 150°52'38.73" E elev 95 ft
Eye alt 3492 ft

6.2 Cost Benefit Analysis & Payback Period

As a means to assist in the economic appraisal of the strategic components listed in the Action Implementation Plan (Table 6.1) a Cost Benefit Analysis was undertaken to determine a levelised life cycle cost for the potential projects. By analysing the costs of a project over its life cycle, capital costs as well as ongoing costs can be accounted for thus providing a better forecast of the expected economic burden/benefit of a project.

The following assumptions were incorporated into the modelling;

- Discount Rate: 7%
- Inflation Rate: 3.1% (From CBA); Cash Rate: 4.50% (from CBA)
- Life Cycle: 25 Years
- Economic Benefits: Potable-water supply savings, and associated wastewater savings
  - Potable Water Supply Savings: The last IPART determination for 5 years to be repeated every 5 years into the future (i.e supply charges per kL to increase at a rate of 30% every 5 years).
  - Wastewater Savings: Sydney Water assumes that the Total Wastewater Volume discharged is based on a percentage (assumed to be 60%based on service bills) of the potable supply volume delivered. Hence a reduction in potable water usage can translate into a reduction in wastewater discharge costs. Discharge costs to rise 5% a year based on the previous years charge, with base year charge set at $1.11/kL (based on service bills).
- Levelised life cycle cost = Life Cycle Cost / Volume of water supplied over lifetime
- When a Levelised life cycle cost is negative it represents an economic saving over it's lifetime.

6.3 Further analysis

There are many assumptions that have been factored into the numbers in Table 6.1 and so they should be considered ballpark, or indicative. In each project, it is recommended that further analysis and design take place to confirm specific project feasibility.

Further and targeted metering and analysis of water consumptions is fundamental to ongoing design, as is definition of contributing catchment areas and an in-depth understanding of water and drainage networks both within buildings and in the surrounding grounds.

6.4 Social & Environmental Impacts

In relation to the implementation of strategy components, there will be impacts arising mainly from construction. These include:

- Disruption to access and normal campus operations
- Disruption to services
- Noise, exhaust and dust emissions
- Erosion and sedimentation

Most of these impacts will be localised and are considered to be relatively minor and able to be effectively managed by the implementation and monitoring of Construction Environmental Management Plans that ought to be a requirement of each tender for construction works.

During the operation of the various schemes and projects, social impacts may arise if the quality of water supplied causes any health or environmental risks. Risk assessment should be a requirement of the detailed design process of any projects.

7.0 CONCLUSIONS & RECOMMENDATIONS

The University of Wollongong has already implemented numerous projects and initiatives to reduce potable water consumption on campus. The University is committed to optimising its potable water savings and has set an aspirational target of achieving 100% self-sustainability for campus water supply.

This Water Management Plan has through option analysis and investigation devised a 3-year program of works (2010-2012) that will provide substantial progress toward the University of Wollongong achieving 100% self-sustainability in water supply.

The works are across several projects within seven strategy components as follows:

- Strategy component No. 1: Refine existing harvesting arrangements to optimise benefits
- Strategy component No. 2: Install a stormwater harvesting scheme in the Admin precinct
- Strategy component No. 3: Add roof water storages to existing buildings
- Strategy component No. 4: Water smart design for new buildings
- Strategy component No. 5: Sports Precinct scheme
- Strategy component No. 6: Continued and expanded metering and monitoring
- Strategy component No. 7: Continue to audit for and identify water saving measures

The projects combined will require a total investment of $790,000 which will result in water savings of up to 46 ML, or 40-50% of total campus demand (compared to baseline water consumption).

An Action Implementation Plan has been prepared that costs and schedules projects over the timeframe of this Plan, i.e. to 2012.

In going beyond this Plan and looking to medium and long term potable water consumption levels, insights are provided that compare expanded roofwater+stormwater *versus* expanded stormwater harvesting options. This will facilitate future decision making.

APPENDIX A

Options assessment matrix

	Roofwater	Stormwater	Black water	Groundwater	Desalination	Grey water
Description	Harvest Roofwater from available roof catchments Total Roof Area = 8.3 Ha, harvestable roof catchments to be confirmed.	* Main waterway runs along southern boundary, significant catchment. History of flooding. Potential for storage * Minor waterway along northern boundary * Significant car park areas (north west and south west carparks), room available for treatment systems ***On site** – account for existing capture/use ***Off site** – catchments analysis – yield, catchment mgt, WQ (all sewered areas?) , permissions / licensing e.g. DWE	Mine sewage from the main that services the University only and treat *in situ* . We have presumed that a treatment plant would be required (and this is carried forward), but treatment could also be provided passively in a wetland system as per Macquarie University) (Sydney Water mains can not be harvested)	Pumping groundwater from a depth of 6-8m	Because of proximity to coast, a source of water exists that is reliant on desalination technology	Grey water is described as water that would normally enter the sewerage system, but not water from toilet flushing. In other words, grey water is waterfrom showers and basins, etc. Therefore, grey water represents a proportion of black water.
Quantities	R**ough estimate based on basic water balance and available information on roof catchments. Roof water supply 254.8kL/d - assume 50% of this is readily harvestable (127kL/d).** **Full water balance required for more accurate data.**	***Rough estimate based on basic water balance, 482.2kL/d of harvestable stormwater, assuming intial loss of 20mm, external catchment area = 53ha, 20% impervious catchment**	**226.8kL/day - value based on mains water demands for uni bldgs (excl. irrigation, pool, and unaccounted for demand).**	Unkown	The amount of water available is constrained only by the size and rate of a desalination system	Unknown, although it may represent up to 20% of the black water volume (20% of 226.8kL/day = 45 kL/day). One would expect most grey water to be generated where there are multiple showers, i.e. accommodation buildings, the pool and URAC.
Reliability	Relatively reliable coastal rainfall. Existing tanks may be capable of supplying approx. 10% of total demand (12-14ML of 147ML total). Full Water Balance required to determine storage sizes.	Large catchment areas available and rainfall is coastal with relatively high reliability. Full Water Balance Required to determine storage sizes.	Fluctautes with Uni population, i.e. high during semeter, lower during holidays and breaks	Only limited by Sustainable Yield of the aquifer - investigations required to determine this. A license application required from DECCW which would establish operating rules including extraction limits.	Highly reliable	Fluctautes with Uni population, i.e. high during semeter, lower during holidays and breaks
Quality	* No asbestos roofs. Generally concrete slab or galvanised. * Potential for contamination due to air quality. Sydney Water has undertaken an investigation of roof water quality. UoW to provide? * Cooling tower contents discharged to roofs currently during cleaning * Potential air contamination (leading to rainwater contamination) from labs and industrial activities. * **Roofwater may require Filtration & UV Treatment**	Stormwater quality varies considerably and is highly dependent on the catchment characteristics and the behaviour of people within the catchment which can lead to pollution. The University grounds would provide relatively clean stormwater because there are no pets in the catchment (pathogens), there is no major development, the grounds are stable (no erosion). Additionally, the campus population does not cause any significant pollution and grounds staff clean the campus up. For reuse, stormwater requires filtration & possibly UV disinfection.	Typically sewage is high in BOD, TOC, pathogen counts, nutrients and salts. Note that all labs would discharge chemical wastes to sewer.	Questionable water quality – high EC, iron. Quality also subject to change from urban pollution and ingress of saline water. Permian sediments underliew the area and these are prone to be saline.	Requires Reverse Osmosis fully controlled treatment process	Quality can be highly variable depending on what goes down the drain. Typically there would be hair/grit, oils and grease associated with skin, oils and grease from food preparation, soaps and other surfactants (cleaning products).
Fit for purpose	Non- Potable Uses: Irrigation, Toilet, Bathroom (cold & hot)	Non- Potable Uses: Irrigation, Toilet	Non- Potable Uses: Irrigation, Toilet	Non-potable uses: Irrigation, toilet	Can be treated to any required level	Non-potable uses: irrigation, toilet

Infrastructure Requirements	*Storage Tanks (Above/Below Ground), Concrete Pad (footing) *Pump & Pump Housing *Reticulation Pipes, Valves, & Fittings, *Mains Back Up, *Pre Treatment (UV)/ Vermin Control, *Stormwater Pipes & Fittings	Offtake, Treatment, Storage, Pipes & Fittings Pump, Pump Housing, & Control System Reticulation Pipes, Valves, & Fittings, Mains Back Up, *Post Storage Treatment, e.g. UV disinfection,	* Pump station for sewer extratction, * Transfer pipes to STP *Storage Tanks (Above/Below Ground), Concrete Pad (footing) *STP *Pump for effluent (to storage, & waste line) *Piping to Storage *Sewer Connection and Waste Line *Reticulation Pipes, Valves, & Fittings,	*Bore Wells *Pump, Pump Housing, & control system, with possible dosing for Iron removal *Storage Tanks (Above/Below Ground), Concrete Pad (footing) *Pre Treatment (UV)/ Vermin Control *Reticulation Pipes, Valves, & Fittings,	Pumping infastucure including an offtake in the ocean, rising main, pump station. Treatment Plant and further pumping to end use. Balance tanks. Brine disposal pipe to sewer.	Plumbing to separate grey water from black water. This is probably the biggest constraint in most buildings, i.e. how to separate the two with the constraints of plumbing which integrates the two. Plumbing to collect the grey water. Treatment plant required including filtration and either a biological or mechanical process. Pipes and pumping to deliver treated grey water to end use
Spatial Footprint	Medium - scattered infrastructure	Medium to high in a few locations	Low	Low	Low	With pipework included - High
Cost	Capital: < $50,000 per system	Capital: < $350,000 per system	< $5 Million	$100,000 - $150,000 per system	> $ 5 Million	< $ 1 Million
	Operation & Maintenance: <$1,000 per system per annum	Operation & Maintenance: <$10,000 per system per annum (mainly removal and disposal of pollutants.	Operation & Maintenance: > $100,000 per annum	Operation & Maintenance: <$5,000 per annum	Operation & Maintenance: >250,000 per annum	Operation & Maintenance: >50,000 per annum
Legislative and Planning Requirements	***These development controls may not apply to the University, further investigation required.*** ***Above Ground Tanks-*** DCP No. 99/2 permits the installation of 1x RW Tank/dwelling with a max. capacity of 10,000L in urban areas (max height 2m), and 2x RW Tanks/dwelling with a max. capacity of 17,000L in non-urban areas (max. height 2.4m) without the necessity for development consents, subject to satisfying certain criteria. ***Underground Tanks –*** Development consent is required for all installations of UG tanks. All tanks above 30,000kL must be underground. (WCC, 2008)	*water license from DWE not required for carparks. If no significant ecosystems downstream not likely to be relevant ?	IPART / Licensing (still Council DA and s68 approval until IPART gets organised)	License required from DECCW and likely to be based on a sustainable yield study	An EIS likley required with extensive consultation	IPART / Licensing (still Council DA and s68 approval until IPART gets organised)
Risk - Environmental, Social, Economic	If only non-potable uses supplied - LOW RISK	If only non-potable uses supplied - LOW RISK	* potential for contamination of plant – e.g. chemistry, labs, medical labs, commercial kitchen / greasy waste etc. Also requires consideration of TRADE WASTE DISCHARGES, and sludge disposal	Risk to turf quality and any fixtures/fittings from saline water	High risk of not obtaining approval	* potential for contamination of plant – e.g. chemistry, labs, medical labs, commercial kitchen / greasy waste etc. Also requires consideration of TRADE WASTE DISCHARGES, and sludge disposal
Environmental & Social Impacts	Negligible - positive	Positive	Moderate - ongoing energy and materials input, embodied energy in treatment plant. Noise and odour issues	Negligible	High - ongoing energy and materials input, embodied energy in treatment plant. Noise issues	Low-Moderate - ongoing energy and materials input, embodied energy in treatment plant. Noise issues. Lots of disruption to retrofit pipework required.

Constraints & Issues	Mainly spatial and service clash issues of locating storages. Rainfall reliability. Climate change impacts. Aesthetics of above-ground tanks.	Mainly spatial issues of locating storages	* Possible only to harvest from downstream most locations, as flows critical higher up. * minimum volumes to maintain sewer pipe flows/flushing etc *Flow variability also affects design of treatment plant. *High level of O&M expertise required	Tha main issues appear to be water quality related, and sustainable yields from an unconfined aquifer.	Increasing cost of energy; disposal of brine; additional trained employees required or otherwise expensive outsourcing; ongoing compliance reporting.	* Possible only to harvest from downstream most locations, as flows critical higher up. * minimum volumes to maintain sewer pipe flows/flushing etc *Flow variability also affects design of treatment plant *moderate level of O&M expertise required
Opportunities	Rationalisation of existing tanks that have been installed to drive efficiency	*Opportunity for Grant Funding * Existing central pond/riffle system could be converted to stormwater treatment system (currently offline – topped up with potable water)	Monitor the success of the Macquarie University system and consider replicating at UoW. Reductions in sewer charges	N/A	N/A	Possible to target specific buildings with high grey water generation such as the pool and URAC. Could possibly combine with a pool backflush treatment system and may generate up to 50 kL/day for non-potable use.
Discussion & Recommendations	Further and ongoing roof water harvesting is seen as a low cost and low risk option providing high quality water for a range of uses, including potable if the Uni so desires in the future.	Worth considering on a precinct by precinct basis. Would normally consider after exhausting roof water harvesting options. Would only consider harvesting from the two main drainage lines at the Uni	Monitor the success of the Macquarie University wetland treatment system and consider replicating at UoW. Note that the benefits would relate to Ecological Footprint as opposed to meaningful substitution of potable demand, because this can be achieved more cost-effectively with roof and stormwater harvesting. Do not proceed further at this time	Do not proceed further with investigations	Do not proceed further with investigations	Do not proceed further with investigations

APPENDIX B

Table of Building/Facility roof areas, demands and storage yields

Bld No	Building Name	Roof Area sq m	Water Demand KL/day)	Water Demand as % Campus Usage	Demand met by Rainwater (%)	Demand met by Rainwater (KL/day)
0		0	0			
1	Bld 1 Materials Engineering	1256	10.3	3.1%	40%	4.1
2	Bld 2 Engineering Extension	683	1.7	0.5%		0.0
3	Bld 3 Informatics	1752	1.5	0.5%		0.0
4	Bld 4 Engineering	3049	1.5	0.5%		0.0
5	Bld 5 Biological	549	1.1	0.3%		0.0
6	Bld 6 SMART Infrastructure	3881	20	6.1%	40%	8.0
8	Bld 8 Mechanical Engineering	1355	2.1	0.6%		0.0
9	Bld 9 URAC Sports Hub	4287	15	4.6%	45%	6.8
10	Bld 10 KidsUni	1364	9	2.7%	30%	2.7
11	Bld 11 UniCentre	9483	29.7	9.0%	30%	8.9
12	Bld 12 UniBar	806	3.6	1.1%	50%	1.8
13	Bld 13 URAC (including Swimmming Pool)	3231	25.7	7.8%	30%	7.7
14	Bld 14 Central Lecture Theatre	400	0	0.0%		0.0
15	Bld 15 Austin Keane Building	1355	5.9	1.8%	40%	2.4
16	Bld 16 Library	4895	12	3.7%	40%	4.8
17	Bld 17 IT Resource Centre	1650	3	0.9%	40%	1.2
18	Bld 18 The Halpern Chemistry Bld	1429	22	6.7%	15%	3.3
19	Bld 19 Arts	3095	11.3	3.4%	40%	4.5
20	Bld 20 Communications Centre	2673	5	1.5%	60%	3.0
21	Bld 21 Education: Laboratories	557	0.3	0.1%		0.0
22	Bld 22 Education & Clinic Bld.	1060	0.4	0.1%		0.0
23	Bld 23 Education Building	530	9.9	3.0%	15%	1.5
25	Bld 25 Creative Arts	4223	3.1	0.9%		0.0
26	Bld 26 Hockey Dugout	43.2		0.0%		0.0
27	Bld 27 Movement Laboratory	283	0	0.0%		0.0
28	Bld 28 Grad School of Medicine	1630	10	3.0%	40%	4.0
29	Bld 29 Centre for Health Service Development	308	0.7	0.2%		0.0
30	Bld 30 Wollongong College Australia	1316	2	0.6%		0.0
31	Bld 31 Bld & Grounds	1288	1.5	0.5%	80%	1.2
32	Bld 32 Illawarra Health MRI	1566	10	3.0%	25%	2.5
32A	Bld 32A Distribution Centre	563	0.1	0.0%		0.0
33	Bld 33 Entry Booth East (Gate 1)	13.5		0.0%		0.0
34	Bld 34 Entry Booth West (Gate 2)	13.5		0.0%		0.0
35	Bld 35 Biology/Informatics	2177	8	2.4%	50%	4.0
36	Bld 36 Administration	1914	2	0.6%	80%	1.6
37	Bld 37 Kooloobong	2809		0.0%		0.0
38	Bld 38 Sydney Business School	387	1	0.3%		0.0
39	Bld 39 Illawarra Technology Corporation	4811	15	4.6%	40%	6.0
40	Bld 40 Commerce/Hope Theatre	3282	10.8	3.3%	40%	4.3
41	Bld 41 The Sciences Building.	4090	15.6	4.8%	40%	6.2
42	Bld 42 The Science Annexe	520	2.7	0.8%		0.0
43	Bld 43 Gas Store	21		0.0%		0.0
45	Bld 45 Demountable Store	50		0.0%		0.0
46	Bld 46 Demountable Store	149		0.0%		0.0
47	Bld 47 Demountable Store	100		0.0%		0.0
48	Bld 48 Demountable Centre for Health Service Development	65		0.0%		0.0
49	Bld 49 Demountable Centre for Health Service Development	65		0.0%		0.0
50	Bld 50 MSA Demountable	111		0.0%		0.0
51	Bld 51 Demountable Classroom	75		0.0%		0.0
52	Bld 52 Demountable Classroom	75		0.0%		0.0
53	Bld 53 Demountable Classroom	75		0.0%		0.0
54	Bld 54 Demountable Office	130		0.0%		0.0
55	Bld 55 Demountable Centre for Health Service Development	65		0.0%		0.0
56	Bld 56 Demountable Classroom	65		0.0%		0.0
57	Bld 57 Demountable Classroom	65		0.0%		0.0
58	Bld 58 Demountable Classroom	65		0.0%		0.0
59	Bld 59 Demountable Classroom	65		0.0%		0.0
60	Bld 60 Demountable Classroom	65		0.0%		0.0
61	Bld 61 Animal Housing Facility	12		0.0%		0.0
63	Bld 63 Visitor's Lodge	363		0.0%		0.0
65	Bld 65 Landscape Store	94		0.0%		0.0
66	Bld 66 Substation 6	84		0.0%		0.0
67	Bld 67 The McKinnon Building	2407	14.5	4.4%	30%	4.4
70	Bld 70 Ecological Research Centre	613		0.0%		0.0
104	Bld 104 No. 12 Madoline Street	110		0.0%		0.0
113	Bld 113 Northfields Ave (45)	100		0.0%		0.0
121	Bld 121 Graduate House	1564		0.0%		0.0
Oval 1		12500	15	4.6%		0.0
Oval 2		5500	7.1	2.2%		0.0
Oval 3		12500	15	4.6%		0.0
Hockey			3.3	1.0%		0.0
	TOTAL:	83157	328.4	100.0%	29%	94.9

Notes:

Building 67 - Demand adjusted down from 27.6KL/d (from WSAP) to 14.5KL/d based on meter readings 4 months to end March 2010

Building 13 - Demand based on meter readings for 6/11/09 - 08/03/09

Building 9 - in absence of data similar consumption as building 13 adopted

Building 6 - Demand estimate from Building 18 which is similar size and assumed similar use (lab building)

Building 28 - Mid Range Estimate

Building 32 - Mid Range Estimate

Building 28a – Estimate

Red demand values estimated due to lack of available data

Water Balance Assumptions:

- Modelling assumed that Demand is 100% of the reported potable consumption for the respective buildings, due lack of specific non-potable consumption data
- Initial loss is 1mm

APPENDIX C

Alternative Water Project analysis, Buildings 31, 36 and Admin Precinct

C1. Roof water harvesting for Buildings 31 and 36

The proposal for Buildings 31 and 36 is to retrofit each building with a rainwater harvesting system, the intention of which is to substitute the existing potable supply for those buildings, hence reducing the reliance on mains water. It is envisaged the system will incorporate a UV disinfection unit after storage, and that the treated rainwater will be plumbed to all fixtures within the building. Designated drinking taps in the building will require filter attachments to provide added protection and suitable water quality.

Water balance modelling

A detailed water balance was undertaken to guide the proposed concept design development and to assess the volumes of water that could be saved by the proposal. A sensitivity analysis assessing varying roof catchment sizes was also undertaken to highlight possible savings that can be achieved with varying system arrangements.

Daily fluctuations of stored water were modelled taking into account rainfall-runoff after initial losses and building demands.

It was assumed that excess roof water would spill into a nearby existing stormwater pit.

The model was used to then calculate the yields and reliability of the proposed harvesting systems.

Rainfall and Evaporation

Historical daily rainfall was obtained from the Australian Bureau of Meteorology (BoM) weather station at University of Wollongong (68188) located at the study site.

Daily rainfall data from 1972-2000 was used to simulate the water balance. The annual average depth of rainfall was found to be 1385.8mm/annum.

Modelled Water Demands

The daily building demands were estimated using figures sourced from Version 1 of the University's Water Savings Action Plan (WSAP, 2006) which documented the results of a campus-wide water consumption audit. As the proposal is to substitute the entire existing potable supply system with a rainwater harvesting system, it was deemed acceptable to use the 'average daily water usages' documented in the WSAP for the respective buildings.

Table C.1: WSAP Audit results for Buildings 31 and 36.

Area of Usage	Water Usage During Audit	
	kL/d	% of Total Consumption
Building 31	1.5	0.4%
Building 36	2	0.5%

Source: Tables 4.3-2 and 4.3-3 Water Distribution for 2005 Daily Water Usage (WSAP, 2006).

Contributing Catchments and Losses

Roof areas for all campus buildings were provided by University of Wollongong, and were 1288m^2 and 1914m^2 for Buildings 31 and 36 respectively. It is assumed that roof water would be collected by the gutter system and drained to an adjacent storage tank.

A sensitivity analysis assessing varying roof catchment sizes was undertaken to highlight possible savings that can be achieved with varying system arrangements.

The roof catchments for both buildings were deemed to be 100% impervious, for modelling purposes.

We accounted for initial losses of 2mm, from the catchment areas.

Results

Yield Analysis

In order determine absolute minimum and optimal rainwater tank volumes, a yield analysis was undertaken.

Results from the analysis are documented below:

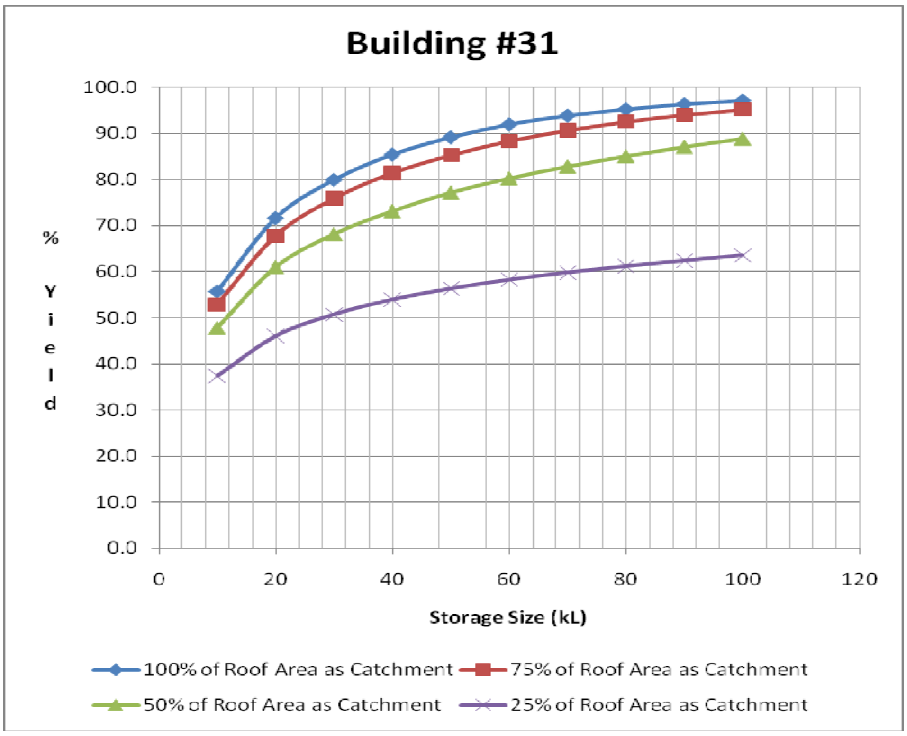


Figure C.2: Yield Analysis Results (Building 31)

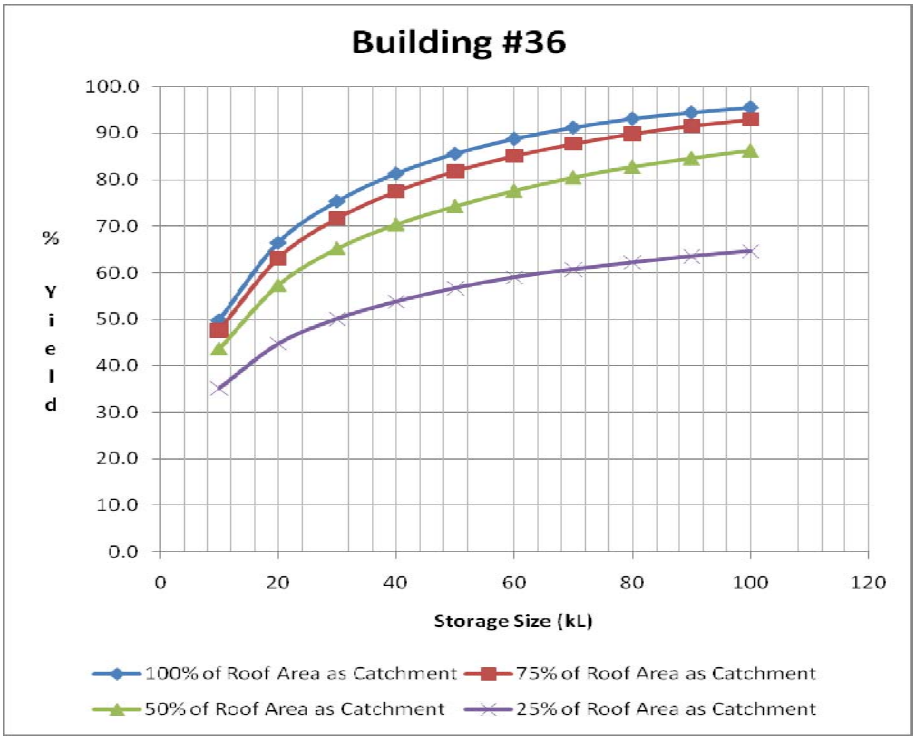


Figure C.3: Yield Analysis Results (Building 36)

The optimal tank size is represented by the point where an increase in tank size delivers a diminishing return in tank yield. For both buildings this point is about 40KL, when utilising 100% of available roof area as catchment.

A sensitivity analysis was undertaken to gauge the sensitivity of tank yield to percentage of roof catchment draining to the tank. The graphs show that a reduction in percentage of roof area draining to the tank from 100% down to 25% results in a reduction in yield of 31.5% for Building 31 and 27.5% for Building 36.

Table C.2: Roofwater Storage - predicted yields for Building 31

Roofwater Storage Results - Bldg 31	
Total Runoff (kL/yr)	1516.7
Total Demands (kL/yr)	547.5
Rainwater supplied (kL/yr)	467.8
Total Tank Top Up (kL/yr)	79.7
% Total Water Demand met	85.4
No. of spills/yr	38.4
Spill Volume (kL/yr)	1048.7
# top-ups/yr (days)	56.7

Table C.3: Roofwater Storage - predicted yields for Building 36

Roofwater Storage Results - Bldg 36	
Total Runoff (kL/yr)	2253.8
Total Demands (kL/yr)	730.0
Rainwater supplied (kL/yr)	593.4
Total Tank Top Up (kL/yr)	136.6
% Total Water Demand met	81.3
No. of spills/yr	42.8
Spill Volume (kL/yr)	1660.3
# top-ups/yr (days)	72.7

Tables C.2 and C.3 show that significant water can be harvested and stored in tanks, and used to meet 85% and 81% of demand for Buildings 31 and 36 respectively. A mains bypass device would need to be installed as part of the system to secure a constant water supply when the tanks empty.

Roofwater once disinfected by UV will be fit for drinking, thus requiring only a single set of water supply pipes to be present within the building.

Preliminary Cost Estimates

Preliminary cost estimates for installation of rain water harvesting schemes on each of the buildings is provided in Table C.4,

Table C.4: Preliminary Cost Estimate – Buildings 31 and 36

Item	Description	Cost
1	Tank Supply (40KL Poly)	$5,000
2	Tank Installation Allowance	$2,000
3	Supply and Install Pump, Pressure Vessel and Enclosure	$2,000
4	Three Way Mains Control Device (i.e. Davey Rainbank)	$1,200
5	Rain Heads/First Flush Devices	$1,500
6	UV System comprising sediment filter, carbon filter and UV disinfection	$1,500
7	Allowance for modification/connection to existing mains reticulation in building	$1,000
8	Allowance for modification of Downpipes to maximise roof capture	$5,000
9	Project Management Costs (10%)	$1,800
	Contingency	$2,500
	Total	**$23,500**

C.2 Administrative Precinct Landscape Master Plan

As part of the proposed works, stormwater will be harvested from the Precinct subcatchment and stored in an underground tank near the McKinnon Building. Some treatment will be provided in proposed bioretention systems (Figure 6.4). The demands for the water are the existing cascade water feature (which is currently topped up using mains water) and the proposed turf areas within the Precinct.

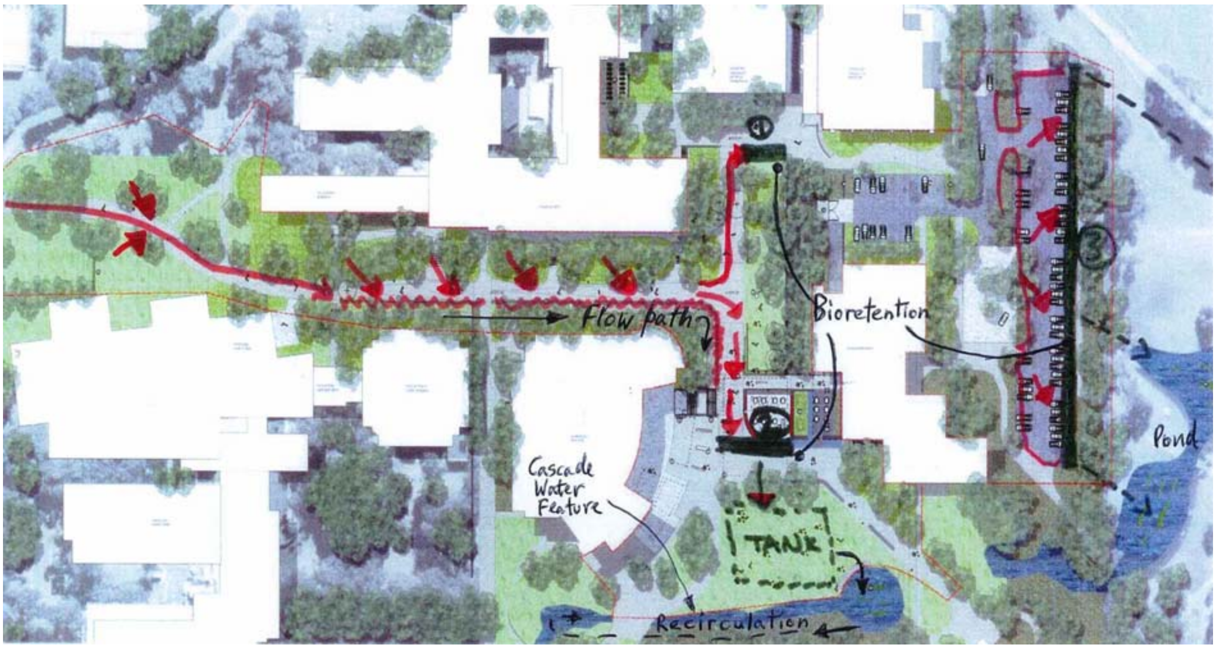


Figure 6.4: Administration Precinct sketch showing water flow and harvesting

There is a total demand of approximately 7.8 ML/annum (1.6 ML Ponds, 6.2 ML Lawns – noting that the 6.2 ML for lawns in NEW demand on the system, as these lawns are not currently irrigated).

As indicated in Figure 6.5, a tank size of around 500-1000 kL seems appropriate. This would supply approx. 5.5-6.5 ML/yr (a yield of 71-84%). A 500kL tank would need a maximum surface area of approx. 450m^2 (assuming 1.2m deep). It is possible to go deeper to reduce the surface area, however this increases the pumping and excavation requirements. By way of example, a 2m deep tank would only need approximately 275m^2 of surface area). Alternatively, a 1000 kL tank would need a maximum surface area of 850m^2, or 550m^2 for a 2m deep tank.

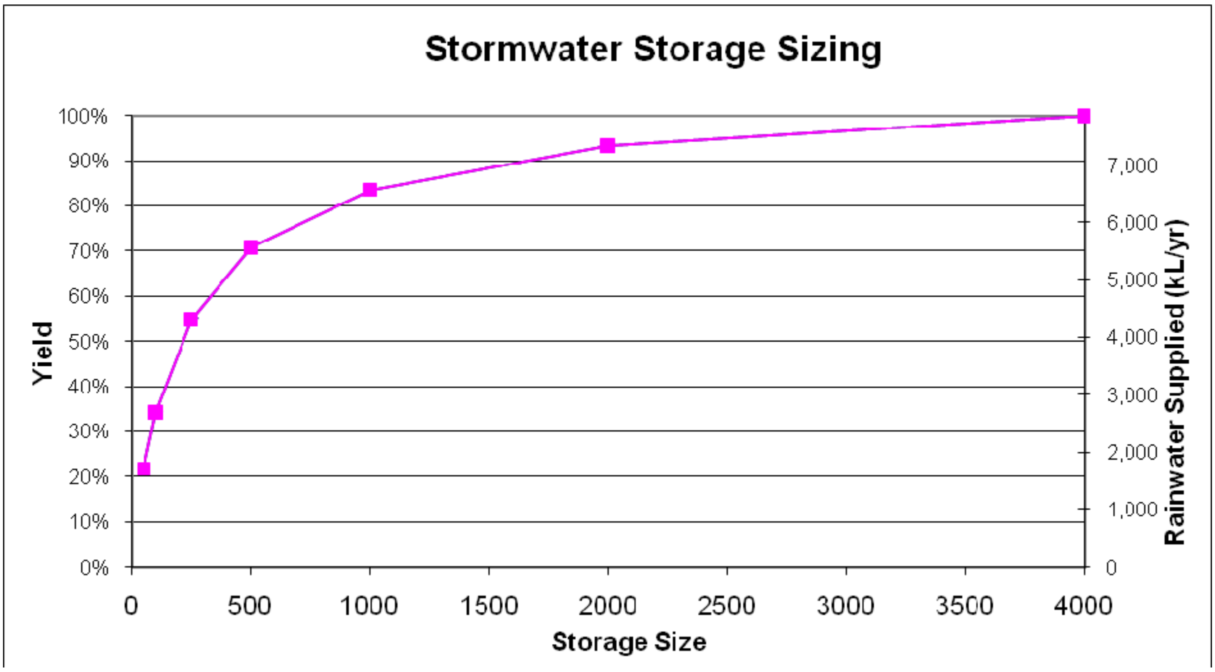


Figure 6.5: Yield vs Storage size for the Administrative Precinct stormwater harvesting scheme

APPENDIX D
Funding options

DECCW Sustain-ability Advantage Program	DECCW invites you to partner with us to boost your environmental performance. Over 380 organisations are currently working with the **Sustainability Advantage** program to: Manage environmental risk and ensure compliance Use resources more efficiently Integrate environmental strategies with business planning Measure their carbon footprint and manage their emissions Enhance customer, supplier and community relationships, and Engage and train staff to become an employer of choice. **Sustainability Advantage** makes sense of all the noise about sustainability, pinpoints how your business can benefit and provides a clear path for action. Rather than creating extra work, we can help you focus your efforts to deliver the best results for your company and for the environment. When you sign up to **Sustainability Advantage** you can choose to take part in an exciting new initiative - the Sustainability Advantage **Energy Saver**. Energy Saver subsidises audits of energy use;and helps you reduce electricity costs. A feature of **Sustainability Advantage** is that it brings together groups of businesses into clusters that share regional, industry or supply chain interests. Cluster meetings held 3-4 times a year provide an opportunity to draw on the ideas and experiences of like minded organisations. An initial management diagnostic helps you evaluate your current environmental performance and ranks possible initiatives. Over 18 months, or longer if you choose, you work on tailored, flexible projects selected from **Sustainability Advantage** modules: • Vision, Commitment and Planning - develop a sustainability road map, including goals and the plans to deliver them - develop a sustainability road map, including goals and the plans to deliver them • Environmental Risk and Responsibility - undertake risk assessment, education and training to help ensure compliance with environmental law • Resource Efficiency - reduce waste and use less raw materials, energy and water to improve your bottom line • Supply Chain Management - work with key suppliers and customers to get the best environmental results from products and services • Staff Engagement - engage and train your staff to implement your sustainability plans • External Stakeholder Engagement - build stronger relationships with your community, government, shareholders, suppliers and customers • Climate Change - identify risks and opportunities, and develop a greenhouse gas inventory Participating organisations commit to an 18 month involvement and a modest financial contribution. While results will depend on a company's own efforts, **Sustainability Advantage** provides expertise, training, tools and a network of organisations working with you towards sustainability. Case studies describe how **Sustainability Advantage** has helped participating companies improve their environmental and business performance. The **Sustainability Advantage** recognition scheme also promotes its partners' work towards environmental performance and advocacy. For more information on the **Sustainability Advantage** program, read the Sustainability Advantage brochure (PDF, 879kb) To pursue the **Sustainability Advantage** for your organisation and contribute to the health of our environment and communities, please contact Business Partnerships on (02) 8837 6000 or sustainbus@environment.nsw.gov.au

NSW Environ-mental Trust	It appears that the projects recommended for UOW do not fit into any of the categories of Environmental Trust grants. Nevertheless, the scheme is outlines as follows: The Environmental Trust is an independent statutory body established by the NSW government to support exceptional environmental projects that do not receive funds from the usual government sources. The Trust's main responsibility is to make and supervise the expenditure of grants. The Trust is administered by the Department of Environment, Climate Change and Water (DECCW). The Trust is chaired by the Minister for Climate Change and the Environment. Members are the Director-General of DECCW and representatives from the Local Government and Shires Associations, the Nature Conservation Council and NSW Treasury. The objectives of the Environmental Trust are: • to encourage and support restoration and rehabilitation projects • to promote research into environmental problems of any kind • to promote environmental education in both the public and private sectors • to fund the acquisition of land for the national parks estate • to fund the declaration of areas for marine parks and for related purposes • to promote waste avoidance, resource recovery and waste management (including funding enforcement and regulation and local government programs) • to fund environmental community groups and • to fund the purchase of water entitlements for the purpose of increasing environmental flows for the State's rivers and restoring or rehabilitating major wetlands. The Trust also reimburses NSW Treasury for approved forestry restructuring payments under the Forestry Restructuring and Nature Conservation Act 1995.				
NSW Climate Change Fund: The Public Facilities Program	Assists water / energy savings in public / community facilities in NSW. The program showcases technologies to encourage uptake by the wider community.	$30 million over five years of project	Demonstration stream - funding for projects which demonstrate how water / energy savings work in practice in public or educational facilities which are open to the public. No set limit. Contributions from applicants are encouraged to maximise the cost effectiveness of projects	Universities eligible	Environment Line on 1300 361 967 or email ccf@environment.nsw.gov.au
NSW Green Business Program	Save water / energy in business operations	$30 million over five years of project	Eligible activities (not limited to) - projects which improve the efficiency of buildings, appliances and industrial processes - projects which reduce the demand for water supplied from water supply networks.	Example: University of Technology, Sydney - Sewer Mining for Cooling Tower Make Up Water	http://www.environment.nsw.gov.au/grants/ccfgbp.htm