Rainwater Harvesting Report

Hearing Hub Development

Macquarie University

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1 INTRODUCTION

1.1 Background

Macquarie University (the Client), have commissioned SPP Group Pty Ltd (the Hydraulic & Wet Fire Consultant) to prepare a Rainwater Harvesting Report for the proposed Hearing Hub development on the Macquarie University campus site.

1.2 Aims

The aim of this report is to provide an outline of the rainwater harvesting design initiative that has been adopted for the project with regard to hydraulic and wet fire services.

1.3 Location & Development Description

The overall Hearing Hub development site is located within the existing Macquarie University campus at Ryde. This proposed construction site is bounded by Macquarie Drive to the north-south secondary road to the east, University Avenue to the south, and Western Road to the west.

Total Gross Floor Area for the Hearing Hub development will be in the order of 22,767m^2.

1.4 Building Population

Based upon a total net letable area of 19,408m^2, the Hearing Hub development population has been estimated at of 1,940 people (10m^2 per person). We have based feasibility options presented within this report on these figures.

1.5 Briefing Documents

The engineering elements considered in this report have based or taken into consideration the following documents:

- Preliminary architectural drawings prepared by Perumal Pedavoli Architects Pty Ltd.

2 BASE WATER DEMAND

2.1 Indoor Water Requirements

In a typical office building, on average each employee uses between 15 and 30 litres of potable water per working day. The water demand depends on the type of fittings used and the behaviour of the occupants. For the Hearing Hub development, the base case indoor water demand has been modelled using the Potable Water Calculator from Green Star Commercial Building Rating Tool V3. Specifically the base model has been developed upon following information:

- Total gross floor area 24,000m^2.
- Total net letable floor area 19,520m^2.
- Standard hours of operation.
- Dual flush 4.5/3 litre toilets, having an average volume per flush of 3.5 litres.
- Standard single stall urinals, 5 star WELS rated, having an average volume per flush of 1 litre.
- WELS 6 star rated tapware, having a flow rate of 4.5 litres per minute.
- WELS 3 star rated showers, having a flow rate of 9.0 litres per minute.
- Assuming 3 credit points for the Tra-3 option

The indoor potable water demand with these fittings is estimated to be 0.63 litres/m^2/day. Assuming a 5 day working week, the total indoor potable water consumption for the development will be 75.600kL per week throughout the development.

2.2 Outdoor Water Requirements

Water consumption within each landscape irrigation system varies depending upon the nature of the irrigation system, species of planting, and the prevailing climate. For the Hearing Hub development the base case outdoor water demand has been developed using following information:

- Irrigation area of approximately 2,750m^2
- Irrigation requiring 20mm/m^2/twice a week
- Available roof collection area 3,866m^2
- Coefficient of run-off is 0.95
- Mean annual rainfall is 1140.2mm

The gross outdoor water demand with these parameters is estimated to be 110.000kL per week throughout the development. Net outdoor water demand however takes account of reductions in demand due to rainfall on the catchment and has been modelled within the rainwater tank sizing calculations on a monthly basis to actual average rainfall.

2.3 Fire Services Water Requirements

Water consumption within each fire services system varies depending upon the type of fire services system incorporated. For the Hearing Hub development the base case fire services water demand has been developed using the following information:

- Fire Services Test Water Recycled
- Fire Services Drain Down Water Recycled

The fire services water demand with these parameters is estimated to be 0.1kL per week throughout the development.

2.4 Mechanical Services Water Requirements

Water consumption within each mechanical system varies depending upon the location of the building, the type of building construction, and the type of mechanical services systems incorporated. For the Hearing

Hub development the base case mechanical water demand has been developed using the following information;

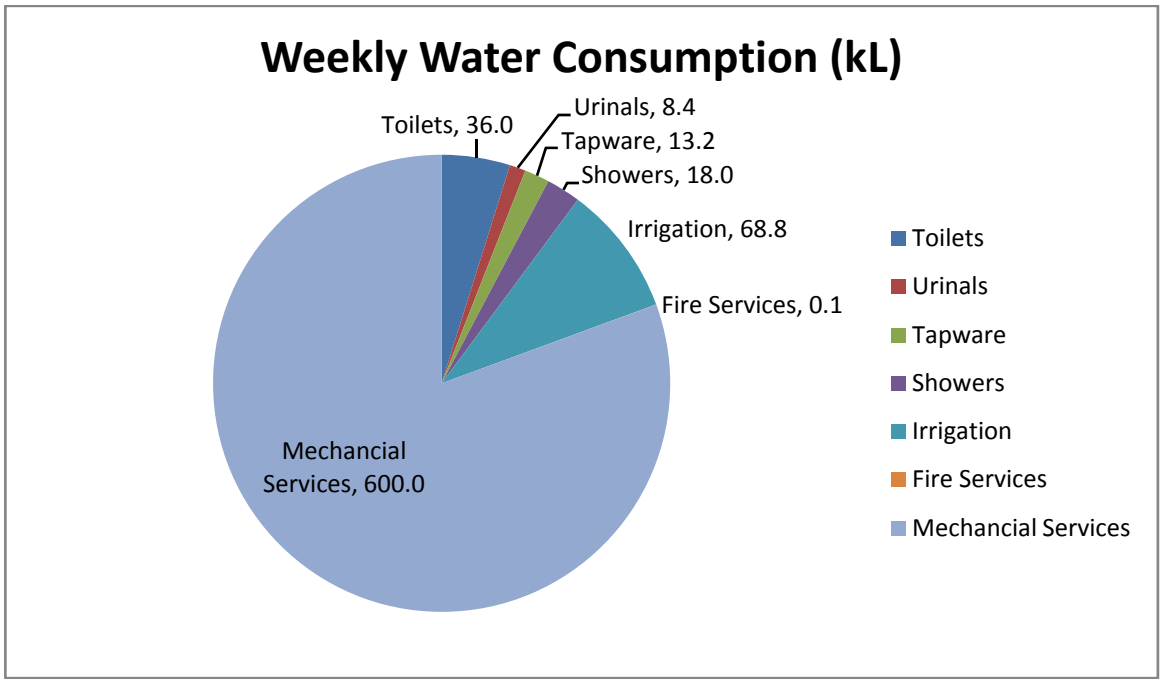
- Average Cooling Tower Water Supply 5L/day/m^2

The mechanical water demand with these parameters is estimated to be 600.000kL per week throughout the development.

2.5 Total Base Case Water Consumption

Based on the estimated indoor water requirements of 75.600kL per week, the estimated outdoor water requirements of 68.750kL per week, the estimated fire services water requirements of 0.100kL per week and the estimated mechanical services water requirements of 600.000kL per week, the total base water consumption for this development will be 744.45kL per week.

These base water consumption estimates will be adopted throughout this report as the bench-mark to enable the water consumption reduction options to be compared. The breakdown of weekly water consumption throughout the development is shown below;



Base Case Water Consumption for the Hearing Hub

3 Water Supply

3.1 Water Quality

Not all of the processes generating water consumption throughout the development require a water supply of potable quality (suitable for drinking). A summary of the water quality requirements for the various building uses detailed within this report is provided below;

Building Use	Water Quality	Additional Requirements
Toilet Flushing	Non-Potable	Class A
Urinal Flushing	Non-Potable	Class A
Tapware	Potable	
Showers	Potable	
Irrigation	Non-Potable	Class A
Fire Services	Non-Potable	Class A
Mechanical Services	Non-Potable	Class A Low Salinity

3.2 Stormwater Harvesting

Stormwater harvesting refers to the collection of stormwater from the developments internal stormwater drainage system. Stormwater from the stormwater drainage system can be classified as either rainwater where the flow is from roof areas only, or stormwater where the flow is from all areas of the development.

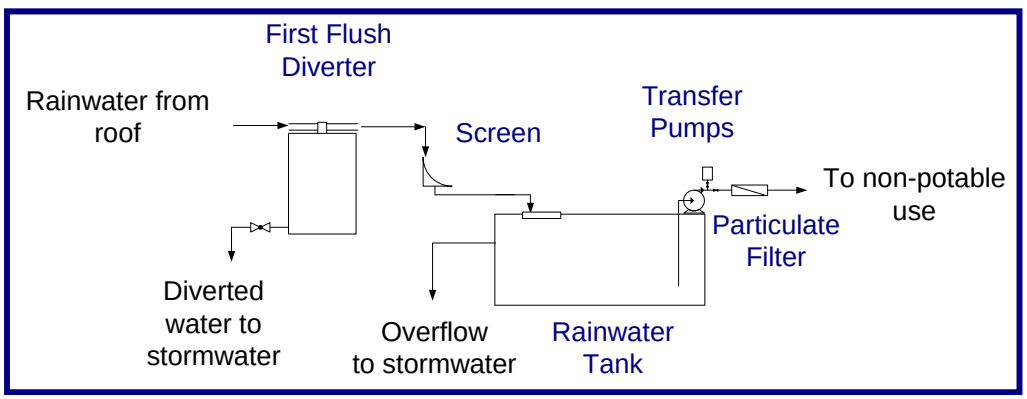
For the purposes of this development, we refer to a rainwater harvesting system, where the following benefits can be achieved over a stormwater harvesting system;

- Rainwater collected from roof areas is generally less polluted than general stormwater drainage.

In general terms the rainwater harvesting system will be an in-line tank for the collection and storage of rainwater. At times when the rainwater storage tank is full rainwater can pass through the tank and continue to be discharged via gravity into the stormwater drainage system. Rainwater from the storage tank will be pumped for distribution throughout the development in a dedicated non-potable water reticulation system.

The collected rainwater is not classified in terms of water quality, but the use of rainwater for cooling tower make up water supply, toilet flushing and spray irrigation systems is recommended as safe practice by all Australian Health Departments. Rainwater falling on roofs is soft, clear and generally low in microbial and chemical contamination. Any contamination of rainwater generally occurs during collection and storage.

The use of simple and cost effective rainwater collection and treatment systems ensures reliable operation and water quality for non-potable use. An example of rainwater treatment technology is shown below.



A Rainwater Collection And Treatment System

The objective of rainwater treatment is to maintain a high quality of water in the rainwater storage tank. Rainwater treatment diverts or removes the following contaminants:

- Dust
- Leaves
- Grit and particles

The first 1-5 mm of rainfall falling on roof surfaces wash the majority of contaminants from the roof surface. A first-flush diverter is a collection tank that automatically diverts this contaminated water to the stormwater collection system. The remaining rainfall is directed to the rainwater tank for storage.

Screens are used to stop leaves and debris entering the rainwater tank. Finer screens are used to ensure that insects and animals do not enter the water storage. Depending on the application a tertiary filter may be used to remove grit and fine particles so these do not block irrigation nozzles or toilet inlet valves.

The use of rainwater harvesting reduces potable water demand within the development, and the amount of stormwater runoff generated by the development. By collecting the rainwater run-off from roof areas, rainwater tanks provide a valuable water source suitable for flushing toilets and landscape irrigation.

Rainwater harvesting systems can be considered to have the following advantages;

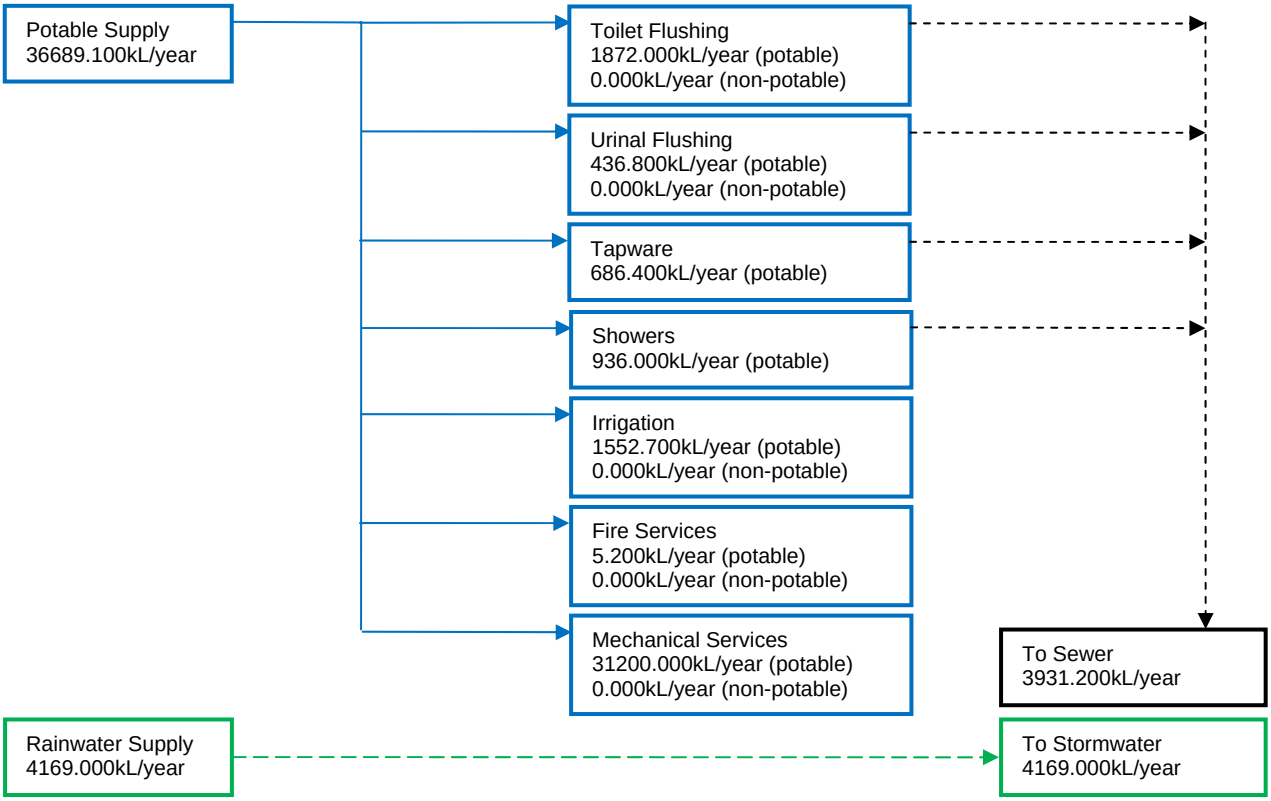
- Collected rainwater is of high quality allowing for uses including toilet flushing, cooling tower make up and un-controlled irrigation.
- Rainwater harvesting can provide a large reduction in potable water consumption.
- Rainwater harvesting is well suited to buildings where the available roof footprint is large for collection of the rainwater.
- Rainwater harvesting systems have a relatively low capital cost.
- Rainwater harvesting systems do not require specialized maintenance.

Rainwater harvesting systems can be considered to have the following dis-advantages;

- Rainwater harvesting systems rely upon favorable climatic conditions.
- Rainwater harvesting systems are relatively inflexible as they rely on gravity discharge from the storage tank.
- Rainwater harvesting systems are relatively inefficient in terms of their spatial requirements due to the need to store larger volumes of rainwater allowing for periods of little or no rainfall.
- Rainwater harvesting systems require a potable cold water supply make up facility for periods when the storage has been exhausted.

4 Base Case Evaluation

4.1 Water Supply Schematic Diagram



4.2 Overview

- Potable water from the Authority mains is supplied for potable consumption.
- 0% harvested rainwater is supplied for toilet flushing & urinal flushing.
- 0% harvested rainwater is supplied for irrigation.
- Potable water from the Authority main is supplied for all fire services consumption.
- Potable water from the Authority main is supplied for all mechanical services consumption.
- No rainwater storage tank is provided.
- Overflow from the rainwater storage tank is discharged to the stormwater main.
- 4 Star WELS rated toilets have been included.
- 5 Star WELS rated urinals have been included.
- 6 Star WELS rated tapware has been included.
- 3 Star WELS rated showers have been included.
- Water meter sub-meters are installed.
- Fire services water is recycled.

4.3 Green Star Assessment

WAT – 1 (Potable Water Consumption)	3 Points From 5 Available
WAT – 2 (Water Meters)	1 Points From 1 Available
WAT – 3 (Landscape Irrigation)	0 Points From 1 Available
WAT – 4 (Heat Rejection Water)	0 Points From 4 Available
WAT – 5 (Fire Services Water Consumption)	1 Points From 1 Available
Totals	**5 Points From 12 Available**

4.4 Environmental Assessment

Potable Water Consumption	36,689.100kL/year
Wastewater Discharge	3931.200kL/year
Stormwater Discharge	4169.000kL/year

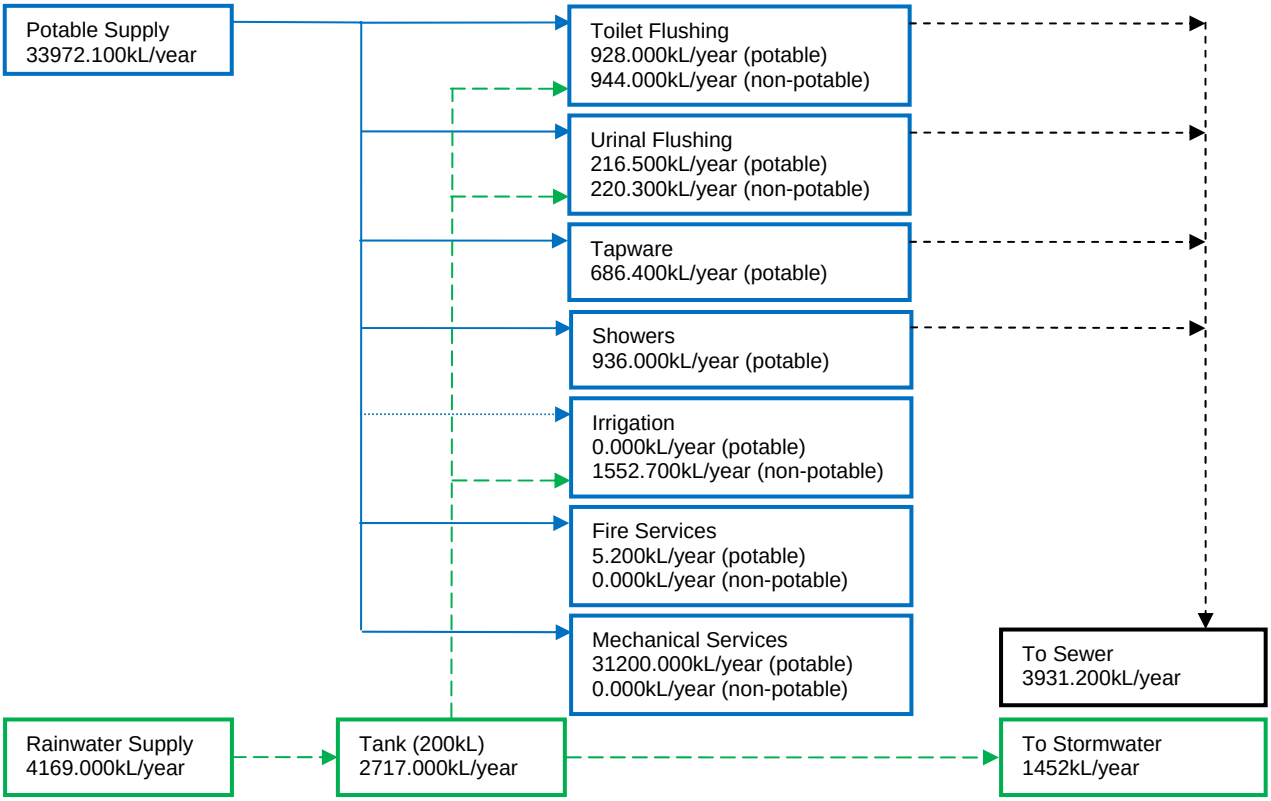
4.5 Financial Assessment

ESD Option	**Cost**
Rainwater Harvesting System	$0
Wastewater Recycling System	$0
Non-Potable Water Service	$0
4 Star WELS Rated Toilets	Standard Inclusion
5 Star WELS Rated Urinals	Standard Inclusion
6 Star WELS Rated Tapware	Standard Inclusion
3 Star WELS Rated Showers	Standard Inclusion
Water Sub-Meters	$15,000
Fire Services Water Recycling	$25,000
Total Additional Cost	**$40,000**

Authority Tariffs	**Base Consumption**	**Rate**	**Annual Cost**
Potable Water Consumption	36,689.100kL/year	$1.87/kL	$68,608.62
Wastewater Discharge In Excess Of 1.37kL/day	3,431.150kL/year	$1.423/kL	$4,882.53
Total Cost			**$73,491.15**

5 Rainwater Harvesting Evaluation

5.1 Water Supply Schematic Diagram



5.2 Overview

- Potable water from the Authority mains is supplied for potable consumption.
- 50.4% harvested rainwater is supplied for toilet flushing & urinal flushing.
- 100% harvested rainwater is supplied for irrigation.
- Potable water from the Authority main is supplied for all fire services consumption.
- Potable water from the Authority main is supplied for all mechanical services consumption.
- A 200kl rainwater storage tank is provided.
- Overflow from the rainwater storage tank is discharged to the stormwater main.
- 4 Star WELS rated toilets have been included.
- 5 Star WELS rate urinals have been included.
- 6 Star WELS rated tapware has been included.
- 3 Star WELS rated showers have been included.
- Water meter sub-meters are installed.
- Fire services water is recycled.

5.3 Environmental Assessment

Potable Water Consumption	33972.100kL/year Saving 2717.000kL/year 7.4% of base case mode
Rainwater Water Consumption	2717.000kL/year 65.1% of available supply
Wastewater Discharge	3931.200kL/year Saving 0.000kL/year 0.0% of base case model
Stormwater Discharge	1452.000kL/year Saving 2717.000kL/year 65.1% of base case model

5.4 Green Star Assessment

WAT – 1 (Potable Water Consumption)	4 Point From 5 Available
WAT – 2 (Water Meters)	1 Point From 1 Available
WAT – 3 (Landscape Irrigation)	1 Points From 1 Available
WAT – 4 (Heat Rejection Water)	0 Points From 4 Available
WAT – 5 (Fire Services Water Consumption)	1 Point From 1 Available
Totals	**7 Points From 12 Available**

5.5 Financial Assessment

ESD Option	**Cost**
Rainwater Harvesting System	$60,000
Wastewater Recycling System	$0,000
Non-Potable Water Service	$79,500
4 Star WELS Rated Toilets	Standard Inclusion
5 Star WELS rated Urinals	Standard Inclusion
5 Star WELS Rated Tapware	Standard Inclusion
3 Star WELS Rated Showers	Standard Inclusion
Water Sub-Meters	$15,000
Fire Services Water Recycling	$25,000
Total Additional Cost	**$179,500**

Authority Tariffs	**Consumption Reduction**	**Rate**	**Annual Saving**
Potable Water Consumption	2717.000kL/year	$1.87/kL	$5,080.79
Wastewater Discharge In Excess Of 1.37kL/day	0.000kL/year	$1.423/kL	$0.00
Total Savings			**$3,715.69**

6 Summary

6.1 ESD Options Summary Table

ESD Option	Green Star Points (Water Categories)	Cost
Base Case	5	$0
Rainwater Harvesting Option	7	$179,500

The assessment has revealed that simple options of more water efficient toilets, urinals, tapware and showers when combined with a rainwater harvesting system can provide 7 Green Star points in the WAT categories for the cost of $179,500 as detailed in Rainwater Harvesting Option. We believe that this option will be sufficient to achieve an overall 5 Star Green Star rating for the development. Our experience indicates that this option is in accordance with market expectations for an “A Grade” commercial office development.

We recommend that the Rainwater Harvesting Option be included within the design, as the most cost effective method to meet the clients current stated objectives of achieving an “A Grade” commercial office development, with a 5 Star Green Star design rating.

7 Appendix A – Rainwater Calculations

Project:	**Hearing Hub**
Project Number:	**SY100027**
Date:	**26/03/2010**
Engineer:	**Brett Lipscombe**

Irrigation Data

Irrigation Area (m2)	2750
Irrigation Rate (mm/m2)	20
Applications Per Week	2

Actual Water Consumption	**kL/week**
Indoor Water Consumption (kL)	75.600
Irrigation Water Consumption (kL)	110.000
Total Water Consumption	**185.600**

Rainfall Data	**Average mm**	**Weeks**
January	114.2	4.4
February	148.1	4
March	133.4	4.4
April	107.6	4.3
May	86.9	4.4
June	114.4	4.3
July	51.7	4.4
August	57.6	4.4
September	59.3	4.3
October	85.9	4.4
November	92.1	4.3
December	83.8	4.4
Annual	**1140.2**	**52**

Catchment Data

Total Catchment Area (m2)	3866
Harvestable Catchment (%)	100%
Run-Off Coefficient	0.95

Modelling Options

Option 1 Rainwater Contribution	35.0%
Option 2 Rainwater Contirbution	40.0%
Option 3 Rainwater Contribution	45.0%
Option 4 Rainwater Contribution	50.0%

Minimum Tank Sizes	**Opiotn 1**	**Option 2**	**Option 3**	**Option 4**
Tankl Size (L)	30	110	200	290
Annual Collection (kL)	4,169	4,169	4,169	4,169
Annual Contribution (kL)	1,987	2,347	2,717	3,026
Annual Overflow (kL)	2,181	1,821	1,452	1,143

Project:	**Hearing Hub**
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Date:	**26/03/2010**
Engineer:	**Brett Lipscombe**

Monthly Water Balance	**Rainfall Collection**	**Indoor Consumption**	**Gross Outdoor Consumption**	**Net Outdoor Consumption**
January	419.422	332.640	484.000	64.578
February	543.927	302.400	440.000	0.000
March	489.938	332.640	484.000	0.000
April	395.183	325.080	473.000	77.817
May	319.158	332.640	484.000	164.842
June	420.157	325.080	473.000	52.843
July	189.879	332.640	484.000	294.121
August	211.548	332.640	484.000	272.452
September	217.791	325.080	473.000	255.209
October	315.485	332.640	484.000	168.515
November	338.256	325.080	473.000	134.744
December	307.772	332.640	484.000	176.228
Totals	**4168.515**	**3931.200**	**5720.000**	**1661.351**

Project: Hearing Hub
Project Number: SY100027
Date: 26/03/2010
Engineer: Brett Lipscombe

Option 1 - **35.0% Rainfall Contribution**

Modelled Catchment (m2) 3866
Tank Size (m3) 30

Month	Average Rainfall	Monthly Collection	Monthly Consumption	Monthly Balance	Tank Storage	Tank Overflow
January	114.2	419.422	139.026	280.396	30.000	250
February	148.1	543.927	105.840	438.087	30.000	438
March	133.4	489.938	116.424	373.514	30.000	374
April	107.6	395.183	141.014	254.168	30.000	254
May	86.9	319.158	174.119	145.039	30.000	145
June	114.4	420.157	132.273	287.884	30.000	288
July	51.7	189.879	219.366	-29.488	0.512	0
August	57.6	211.548	211.782	-0.235	0.277	0
September	59.3	217.791	203.101	14.690	14.967	0
October	85.9	315.485	175.404	140.081	30.000	125
November	92.1	338.256	160.939	177.317	30.000	177
December	83.8	307.772	178.104	129.669	30.000	130
Totals		**4168.515**	**1957.393**			**2181**

Project: Hearing Hub
Project Number: SY100027
Date: 26/03/2010
Engineer: Brett Lipscombe

Option 2 - **40.0% Rainfall Contribution**

Modelled Catchment (m2) 3866
Tank Size (m3) 110

Month	Average Rainfall	Monthly Collection	Monthly Consumption	Monthly Balance	Tank Storage	Tank Overflow
January	114.2	419.422	158.887	260.535	110.000	151
February	148.1	543.927	120.960	422.967	110.000	423
March	133.4	489.938	133.056	356.882	110.000	357
April	107.6	395.183	161.159	234.024	110.000	234
May	86.9	319.158	198.993	120.165	110.000	120
June	114.4	420.157	151.169	268.988	110.000	269
July	51.7	189.879	250.705	-60.826	49.174	0
August	57.6	211.548	242.037	-30.489	18.685	0
September	59.3	217.791	232.116	-14.324	4.360	0
October	85.9	315.485	200.462	115.023	110.000	9
November	92.1	338.256	183.930	154.326	110.000	154
December	83.8	307.772	203.547	104.225	110.000	104
Totals		**4168.515**	**2237.020**			**1821**

Project: Hearing Hub
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Date: 26/03/2010
Engineer: Brett Lipscombe

Option 3 - **45.0% Rainfall Contribution**

Modelled Catchment (m2) 3866
Tank Size (m3) 200

Month	Average Rainfall	Monthly Collection	Monthly Consumption	Monthly Balance	Tank Storage	Tank Overflow
January	114.2	419.422	178.748	240.674	200.000	41
February	148.1	543.927	136.080	407.847	200.000	408
March	133.4	489.938	149.688	340.250	200.000	340
April	107.6	395.183	181.304	213.879	200.000	214
May	86.9	319.158	223.867	95.291	200.000	95
June	114.4	420.157	170.065	250.091	200.000	250
July	51.7	189.879	282.043	-92.164	107.836	0
August	57.6	211.548	272.292	-60.744	47.092	0
September	59.3	217.791	261.130	-43.339	3.753	0
October	85.9	315.485	225.520	89.965	93.718	0
November	92.1	338.256	206.921	131.335	200.000	25
December	83.8	307.772	228.990	78.782	200.000	79
Totals		**4168.515**	**2516.648**			**1452**

Project: Hearing Hub
Project Number: SY100027
Date: 26/03/2010
Engineer: Brett Lipscombe

Option 4 - **50.0% Rainfall Contribution**

Modelled Catchment (m2) 3866
Tank Size (m3) 290

Month	Average Rainfall	Monthly Collection	Monthly Consumption	Monthly Balance	Tank Storage	Tank Overflow
January	114.2	419.422	198.609	220.814	220.814	0
February	148.1	543.927	151.200	392.727	290.000	324
March	133.4	489.938	166.320	323.618	290.000	324
April	107.6	395.183	201.449	193.734	290.000	194
May	86.9	319.158	248.741	70.416	290.000	70
June	114.4	420.157	188.962	231.195	290.000	231
July	51.7	189.879	313.381	-123.502	166.498	0
August	57.6	211.548	302.546	-90.999	75.499	0
September	59.3	217.791	290.144	-72.353	3.146	0
October	85.9	315.485	250.578	64.907	68.053	0
November	92.1	338.256	229.912	108.344	176.397	0
December	83.8	307.772	254.434	53.338	229.735	0
Totals		**4168.515**	**2796.275**			**1143**