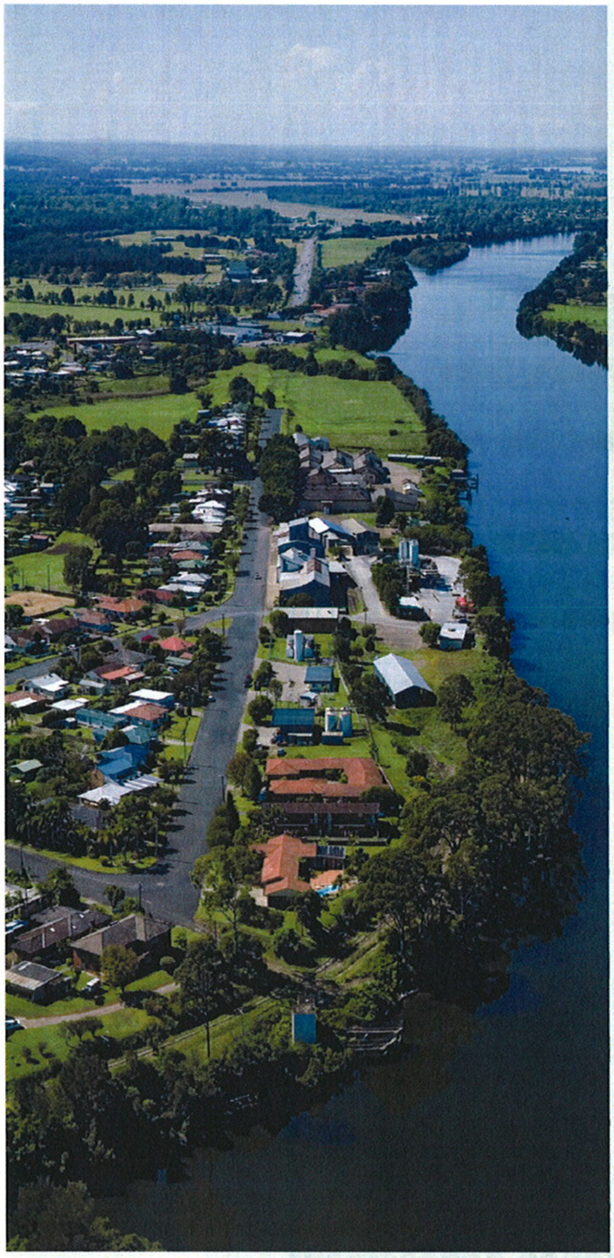

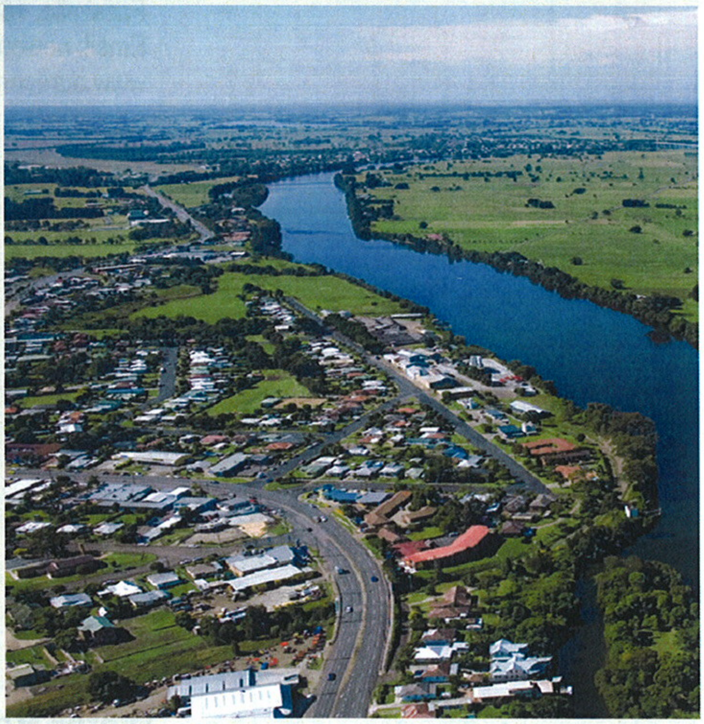

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Figtrees on the Manning

Water Balance Assessment

Project No. 32402-002

Prepared for
Greater Taree City Council

May 2009

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Water Balance Assessment
Figtrees on the Manning
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Contents

1. Introduction

The city of Taree is situated on the NSW mid north coast approximately 300 km north of Sydney. The city is spread along the northern bank of the Manning River and includes the satellite suburbs of Chatham and Cundletown to the east of the city centre.

The Figtrees on the Manning Master Plan has been presented to the Greater Taree City Council (GTCC) and the community of Taree as a unique opportunity to create a high quality mixed-use development of regional importance. The proposed configuration of the development would create five distinct precincts along Pitt Street and its extension to connect to Bligh Street:

- Gateway Residential (residential)
- Figtree Commercial (commercial/mixed use)
- Dairy Heritage (commercial/residential)
- Riverpark Village Complex (residential)
- Marina Commercial Complex (commercial/mixed use)

Each precinct will have an individual character and purpose, providing a range of development outcomes including commercial and retail outlets, residential units, modern reuse of the historical old dairy buildings and a commercial marina (refer Figure 1-1). The landuse will impact directly on the water demand and wastewater production.

Aurecon has been engaged as part of the multi disciplinary consulting team assembled by GTCC in the development of the master plan. The current component of the planning process as represented by this report encompasses a preliminary water balance study.

The preliminary water balance study provides the following:

- An assessment of the local annual rainfall patterns for the area
- A review of available soil profiles for the site
- A stormwater runoff analysis for the existing catchment
- A review of the proposed urbanisation for the project
- An assessment of opportunities to apply water reuse initiatives
- A water balance assessment for the proposed development

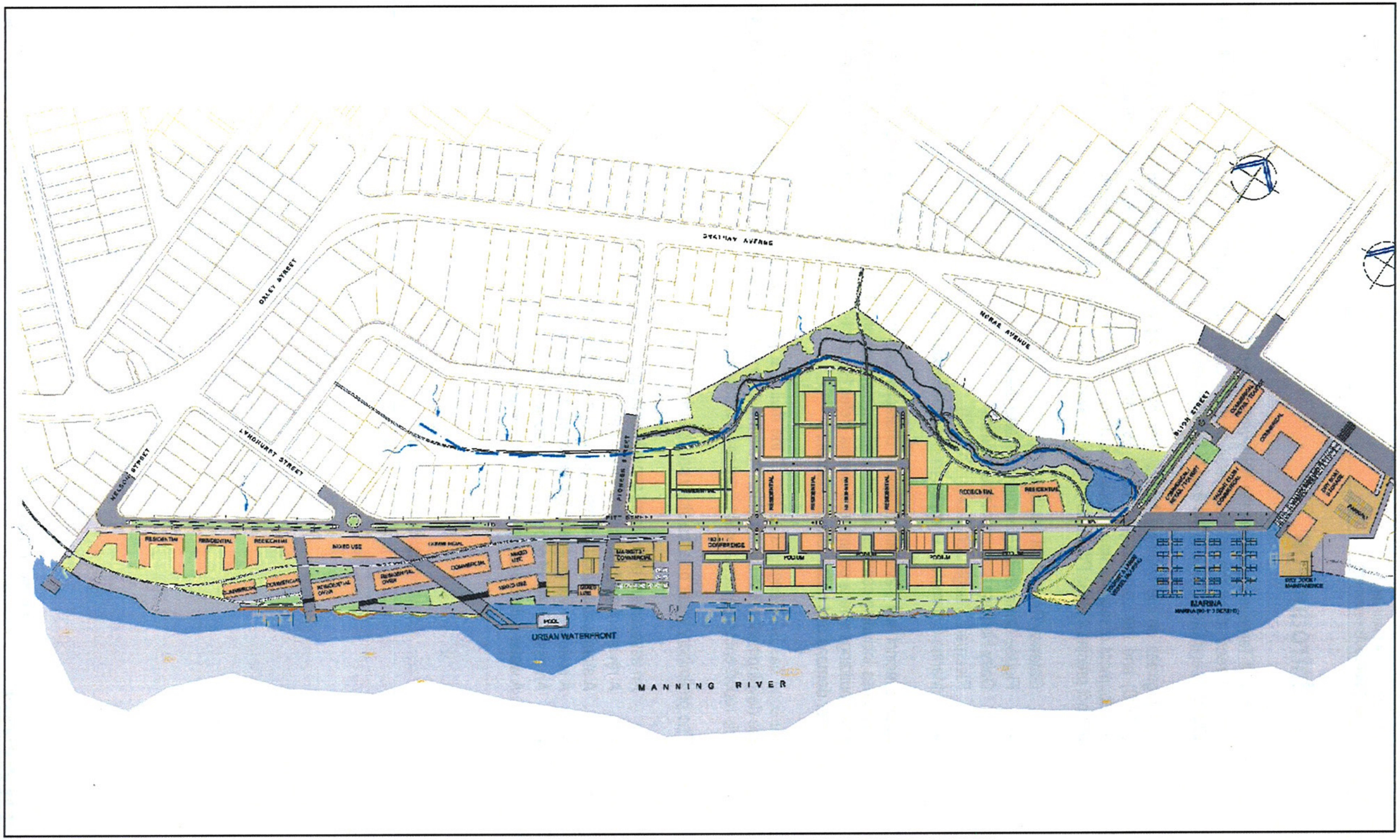

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FIGURE 1-1 Location Plan

2. Site Description

The development site is located between the north arm of the Manning River and the Old Pacific Highway, now incorporating parts of Oxley Street and Chatham Avenue in Chatham, and renamed Manning River Drive between Chatham and Cundletown. The site is bordered to the north by residential areas around Pitt Street, Pioneer Street and Chatham Avenue. The regional Botanical Gardens are located beyond Browns Creek to the west of the site. To the east of the site is the Taree Entertainment Centre on Manning River Drive and the Taree Airport at Cundletown.

The surrounding area has been urbanised by a mixture of low and medium density residential, commercial, and light industrial buildings.

The majority of the site consists of flood prone land extending approximately 2 km along the northern arm of the Manning River.

2.1 Existing land use

The site includes a narrow western flank (approximately 100 m wide, 600 m long) between Pitt Street and the Manning River. This portion includes the former dairy processing facility and a range of associated heritage buildings with some existing utilities and infrastructure.

The site also includes a large tract (approximately 6 ha) of partially cleared land at the eastern end of Pitt Street, with a creek / open drain meandering though the area and a large parcel of land (approximately 3 ha) on the eastern extremity of the site with frontage to both Manning River Drive and the river. These two parcels of land have no current utilities. Each of the three parts of the development site is in separate ownerships.

2.2 Soil profiles

The 1:250,000 geological sheets for the Taree area indicate that the geology of the area comprises residual clays overlying lithic sandstone, siltstone, tuff, shale and limestone. Previous geotechnical reports indicate that the residual clay layer in the vicinity of the site is up to 30 to 40 m thick. In the vicinity of the Manning River and along drainage lines the Geology primarily consists of Quaternary sediments of alluvial mud, silt, sand and gravel deposits (Greater Taree City Council 2000).

The Greater Taree Draft Local Environmental Plan (LEP) classifies land within the Local Government Area into five classes according to whether development consent is required due to the risk posed by the presence or potential presence of Acid Sulfate Soils (ASS).

Areas of the proposal immediately adjacent to the Manning River are Class 1 areas which require development consent for any works undertaken. Areas along the creek line which forms the northern boundary on the Riverport Village precinct and along the river frontage of the Riverport Village precinct are Class 3 soils. Class 3 soils require development consent for works occurring more than 1 m below the natural ground surface or works which lower the water table more than1 m below the natural ground surface.

Class 5 soils make up the remainder of the site and require development consent if the proposed works are within 500 m of other Acid Sulfate Soil risk classes and involve disturbance of the soil below 5 m AHD. Under the Draft LEP development consent may only be granted if either an ASS Management Plan has been prepared or a preliminary ASS investigation has been undertaken which shows an ASS management plan is not required (GTCC 2008).

The Australian Natural Resources Atlas classifies the majority of the site as massive black and grey coastal clays, while a thin portion of the site to the south west of Pitt Street is classified as yellow and red texture contract soils (DEWHA 2007).

The NSW Soil and Land Information System has recorded soil profiles from two boreholes drilled in 1994 in the vicinity of the Study Area. One borehole was located approximately 1 km north of the eastern extent of the Study Area, immediately to the east of Taree Park and was classified under the Australian Soil Classification system as an Acidic Sulfidic Oxyaquic Hydrosol. This soil profile exhibited slight active streambank erosion and a slowly permeable profile which had a poorly drained free water depth of 0.7 m below the surface. The other borehole was located approximately 0.5 km to the south east of the Study Area on Dumaresq Island and was classified under the Australian Soil Classification system as a Kurosolic Redoxic Hydrosol with a moderately permeable profile (NSW NR Atlas 2008).

It should be noted that information available through the Australian and NSW Natural Resources Atlases is inherently broad scale and is therefore not suited to small scale land developments. Review of site specific geotechnical information should be undertaken and further investigation undertaken as required to confirm any limiting soil factors which may exist within the Study Area.

From the review of soil profiles a low to moderate permeability rate should be adopted for infiltration rates during a detailed assessment of stormwater.

2.3 Proposed Development

For the purpose of this report, the development has been assessed on a precinct basis. Appendix B of the Figtrees on the Manning Master Plan Engineering Assessment (Connell Wagner, 2008) was used to estimate the number of premises and equivalent tenements (ETs) as shown in Table 2-1. The number of ETs was calculated with reference to MidCoast Water's Equivalent Tenement Policy (2006).

Table 2-1 Predicted Number of Premises and ETs per Precinct

Precinct	Residential		Commercial/Mixed Use		Total ETs
	Premises	ETs	Premises	ETs	
Gateway Residential	104	83.2	10	10	93.2
Figtree Commercial	0	0	101	64.5	64.5
Dairy Heritage	30	24	23	23	47
Riverpark Village Complex	475	380	0	0	380
Marina Commercial Complex	0	0	138	138	138

The following assumptions were made to predict the number of premises:

- A typical apartment/unit is 120m²
- A typical townhouse is 180m²
- An average commercial or mixed use premise is 250 m² (typically 200-300m²)
- Where a proposed use is not identified in the Equivalent Tenement Policy, a similar use will be substituted, otherwise 1Et/unit will be applied as a conservative estimation

Note: It is recommended that a more detailed calculation of equivalent tenements be undertaken when additional information about the development becomes available.

3. Rainfall

The following data is from the Taree (Robertson Street) Bureau of Meteorology (BOM) Climatic Station which has been collecting rainfall data since 1881. Table 3-1 shows the long term monthly rainfall averages from 1881 to 2008 as well as maximum and minimum rainfalls for the period (BOM 2008).

Table 3-1 Long-term Monthly Rainfall Patterns 1881-2008

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Monthly (mm)	120	138	151	117	96.5	97.3	73.9	61.2	60.2	75.6	86.3	100
Highest Monthly (mm)	768	78990	710	489	4067	469	334	653	272	331	303	471
Year of Highest Monthly	1895	1929	1963	1931	1913	1950	1922	1899	1914	1914	1996	1897
Lowest Monthly (mm)	0.0	1.5	2.7	1.1	5.2	2.2	0.0	0.0	0.0	4.7	1.8	9.4
Year of Lowest Monthly	2007	1939	1884	1996	2004	2004	1946	1946	2003	1957	1926	1986
Highest daily (mm)	246	187	236	280	182	163	203	159	173	161	149	172
Mean No. Rain Days per Month	10.6	11	12.3	10.3	9.3	8.8	7.4	7.6	7.3	9.1	9.6	10.2
Mean No. Days Rainfall >= 10 mm	3.3	3.3	3.7	2.8	2.4	2.4	1.9	1.5	1.5	2	2.4	2.9

Table 3-1 shows rainfall in the Taree area is summer dominant with the passage of tropical or subtropical low pressure systems moving inland from their origins in the Pacific Ocean being the chief source of summer rainfall (Soil Conservation Service of NSW 1985).

Table 3-2 shows the Annual Average Rainfall for the Taree area from 1881 to 2008.

Table 3-2 Long Term Annual Average Rainfall Patterns 1881-2008

Rainfall Scenario	Value
Average Annual Rainfall	1177 mm
Highest Annual Rainfall	2410 mm
Lowest Annual Rainfall	555 mm
Mean number of rainy days	113.5 days

4. Stormwater runoff

4.1.1 Existing

The proposed Figtrees on the Manning Development is located within the Taree Urban Catchment Area which is located on the floodplain of the lower Manning River. Slope of the Taree Urban catchment generally varies between 0.5% and 13%.

The majority of the stormwater system in the Taree Urban Catchment consists of piped or natural channels and wetlands (GTCC 2000).

The proposal is located in sub catchment T6 as defined in the Greater Taree Urban Stormwater Management Plan (2000). This sub catchment flows partially into Manning River and partially into Browns Creek which is a minor tributary of Manning River.

There are three main stormwater discharge points in this sub catchment in the vicinity of the proposed development along the minor creek traversing the study area associated with the residential areas to the north of the proposed development.

A major stormwater discharge point also exists in the south western corner of the study area that falls directly into the Manning River. This collects stormwater runoff from the residential area bound by Lyndhurst Street, Pitt Street and Chatham Avenue.

The associated infrastructure and estimated discharge flows are given in Table 4-1 below.

Table 4-1 Summary of Stormwater Outlets within Catchment T6

Outlet	Pipe Diameter	Catchment Area (ha)	Flow (l/s)	Fraction Impervious %
T6.7	450	0.46	57	80
T6.8	1350	45.6	4264	60
T6.9	450	2.94	294	60
T6.10	450	3.47	348	60

4.1.2 Proposed

The proposed development has the potential to increase the stormwater runoff for sub catchment T6, depending on the extent of rainwater harvesting and greywater reuse applied across the site.

An preliminary assessment based on regional contours of the area indicates that new stormwater outlets would be required at the minor creek traversing the development and direct discharge into the Manning River.

The existing stormwater drainage would be separated from the Proposal, requiring a site specific stormwater management plan to be prepared for this development. A detailed stormwater analysis would be required based on the accepted rainwater harvesting and greywater reuse strategy adopted by GTCC for this development.

5. Potable Water Demand

5.1 Average Annual Demand per ET

Table 5-1 shows the historic water usage per ET for different land uses in the Greater Taree/Great Lakes area (provided by Chris Copp, Midcoast Water, unpublished).

Table 5-1 Average Annual Water Usage per ET in the Greater Taree Great Lakes Area

Land use	kL/ET/Year July 2007-June 2008 (kL)
Residential	170*
Commercial	814
Industrial	3185
Institutional	367
Public Use	377

*Average residential water usage was quoted as 175kL/ET/year, however more accurate data from MCW indicates the value is 170kL/ET/year

5.2 Residential Water Consumption Breakdown

Residential water consumption can be further divided, as shown in Table 5-2 (MidCoast Water, unpublished). Medium to high density developments typically uses less outdoor water. For the purpose of this report it is assumed that the reduced outdoor demand will be offset against non-residential applications such as parks, marina boat washing facilities etc.

Table 5-2 Residential Water Usage Distribution in the Greater Taree Great Lakes Area

Use	Percentage of overall consumption	Quantity (kL/ET/Year)	Potential to be supplied with rainwater	Potential Greywater Yield
Bathroom	39%	66	N	Y
Kitchen	7%	12	N	Y
Toilet	14%	23	Y	N
Laundry	26%	43	Y	Y
Outdoor	14%	23	Y	N
Total	**100%**	**170**	**54%**	**72%**

From the above table it can be seen that 54% of the demand could potentially be met using harvested rainwater, rather than potable town water. Up to 72% of wastewater could potentially be recycled, both reducing potable demand and wastewater disposal (Refer Section 6 for a detailed discussion).

5.3 Commercial Water Consumption Breakdown

A breakdown of typical commercial water consumption was sourced from Sydney Water audits of commercial buildings (Department of Environment and Heritage, 2006) as shown in Table 5-3. These figures have been altered assuming that a new building built to appropriate standards would have a low leakage rate (6% rather than 26% reported).

Table 5-3 Commercial Water Usage Distribution

Use	Percentage of overall consumption	Quantity (kL/ET/Year)	Potential to be supplied with rainwater	Potential Greywater Yield
Amenities (kitchen/shower/toilet)	44%	358	Y (30%)*	Y (30%)*
Cooling towers/Air-conditioning	37%	301	Y (15%)#	N
Irrigation	6%	49	Y	N
Leakage	6%	49	N	N
Other	8%	57	N	N
Total	**100%**	**814**	**51%**	**30%**

*Estimate assuming toilet and kitchen use each account for a third of amenities usage

#Depending on the cooling system used. Seek professional advice prior to purchase.

5.4 Total Estimated Potable Water Demand for Proposed Development

The total estimated potable water demand for each precinct was calculated based on the number of ETs listed in Table 2-1 and are shown in Table 5-4 below.

Table 5-4 Water Demand

Precinct	Residential Demand (kL/Year)	Commercial Demand (kL/Year)	Total Demand (kL/year)
Gateway Residential	14144	8140	22284
Figtree Commercial	0	52503	52503
Dairy Heritage	4080	18722	22802
Riverpark Village Complex	64600	0	64600
Marina Commercial Complex	0	112332	112332

6. Potential Water Sources

The identified potential water sources available to supply the demand of the proposed development are town water, rainwater, stormwater, greywater and recycled water.

6.1 Town Water

MidCoast Water is the authority responsible for reticulated water supply and sewerage systems in the proposed project area and the Taree area in general. The main water supply is provided by the Manning scheme involving pumping water from the Manning River into Bootawa Dam.

It is assumed that all residences and commercial and other premises will be connected to town water. The application of water sensitive urban design schemes to the project will aim to reduce the amount of town water imported into the proposed development. The use of water efficient fixtures, including AAA showerheads and water efficient toilets, can also reduce demand on town water supply.

6.2 Rainwater Harvesting

Clean rainwater can be collected from building rooftops and stored in tanks for later reuse. Rainwater can be used to supply water for toilets, laundry, irrigation and outdoor taps.

The roof surface areas in the proposed development could be utilised to capture and direct rainwater into several large tanks located adjacent to the buildings. Alternatively, to reduce visual impacts a series of smaller underground tanks could be installed beneath a garden or pathway.

6.2.1 Potential Rainwater Tank Yield

Rainwater would be harvested by directing roof water from buildings into communal rainwater tanks. The volume that could potentially be harvested was calculated based on the assumption that runoff from 50% of the total roof area (www.savewater.com.au) is collected for potential reuse, with maximum potential annual yields as shown in Table 6-1.

Table 6-1 Potential Water Harvesting

Precinct	Total Roof Area (m^2)	Harvest Potential (kL/year)
Gateway Residential	4240	2496
Figtree Commercial	6727	3960
Dairy Heritage	6593	2968
Riverpark Village	20180	11662
Marina Commercial	8854	5211

Note: The volumes shown in Table 6-1 are indicative of the maximum expected annual volume of water that could potentially be collected from roof areas and is based on average annual rainfall figures. The available supply for reuse will depend on the monthly and daily distribution of rainfall as well as the available tank sizes. The detailed analysis of rainfall distribution and the calculation of tank sizes fall outside the scope of this report.

6.3 Greywater Reuse

Greywater is defined as wastewater from washing machines, laundry tubs, showers, hand basins and baths (NSW Department of Water & Energy, 2008). Greywater can be treated, stored and reused for garden and outdoor applications.

Wastewater from a kitchen, toilet, urinal or bidet is classified as blackwater and cannot be treated by greywater devices, although it can be recycled by other means.

There are two main categories of greywater treatment recycling schemes. A primary system diverts greywater by means of diversion device and filter system to an underground storage tank prior to distributing greywater through an underground drip irrigation network throughout a garden or outdoor area.

The secondary system is more complex, requiring additional internal building plumbing, and provides treatment via a filter system. Treated effluent may be pumped back to the house for laundry use and flushing of toilets or directed to garden sprinkler system. Both systems can direct overflows from the storage tank to the reticulated sewage system along with effluent from the toilets and kitchen areas.

6.3.1 Potential Greywater Yield

Greywater has very limited use without treatment and generally to be used effectively requires similar treatment to sewage. MidCoast Water has addressed the use of recycled water comprehensively in its Sustainable Water Cycle Management Plan.

Residential buildings have the potential to recycle 72% of the wastewater generated (Table 5-2) while commercial premises can recycle 30% of wastewater (Table 5-3). By adopting these values, the potential volume of available greywater was calculated, as shown in Table 6-2.

Table 6-2 Greywater Generation

Precinct	Potential Greywater Produced (kL/year)		
	Residential	Commercial	Total
Gateway Residential	10184	2442	12626
Figtree Commercial	0	15751	15751
Dairy Heritage	2938	5617	8555
Riverpark Village	46512	0	46512
Marina Commercial	0	33700	33700

7. Water Management Strategies

Figtrees on the Manning presents an opportunity to implement water management strategies that will reduce the demand on potable water sources. The objectives of implementing such strategies include:

- Reducing the demand on town water supplies
- Reducing the discharge of wastewater to the sewerage system
- Mitigating increased runoff caused by further urbanisation
- Minimising the impact on the surrounding environment

A number of strategies could be implemented within the proposed development to achieve the desired objectives. Potential measures include:

- Installation of AAA rated water fittings and appliances
- Landscaping using indigenous low water using plant species
- Installation of rainwater tanks
- Stormwater capture, treatment and re-use
- Greywater reclamation and re-use
- Blackwater treatment and re-use

The first two measures are relatively inexpensive and may yield consistent savings over the time period for which they are maintained. Larger savings can be made by implementing the remaining options provided that appropriate requirements are integrated into the design and construction of Figtrees on the Manning.

Harvesting rainwater was identified as a stormwater management measure in the MasterPlan Engineering Assessment. Both rainwater harvesting and greywater reuse (with or without treatment) are further considered in this report as means of supplying water for irrigation, toilets and washing clothes. Neither stormwater capture nor blackwater treatment were considered appropriate measures for Figtrees on the Manning due to the potential impact on natural flows of the former and the expense and infrastructure requirements of the latter.

Note: Rainwater harvesting and greywater reuse are separate systems. Greywater is also a competing source with water harvesting. Consequently, the use of greywater for outdoor applications should be supplemented with harvested rainwater or be implemented to reduce the discharge of waste water to the reticulated sewerage system.

7.1 Water Harvesting & Re-use Options

To identify the potential viability of such water sensitive urban design schemes, the demand for water must first be calculated for the base case (i.e. use of potable water to supply all demands). Four potential scenarios were identified for comparison purposes, namely:

1) Potable Water Only (base Case)
2) Combination of Potable & Rainwater Tanks (indoor uses only)
3) Combination of Potable & Rainwater Tanks (indoor & outdoor uses)
4) Combination of Potable, Rainwater Tanks (indoor & outdoor) & Greywater (outdoor only)

These options were developed to conform with MidCoast Water's Sustainable Water Cycle Management Strategy 2008.

7.1.1 Option 1 – Base Case

Option 1 assumes all water demand will be met with town water.

Table 7-1 Option 1 - Water Demand Distribution

Precinct	Water Demand (kL/year)			
	Town Water	Tank Water	Greywater	Total
Gateway Residential	22284	0	0	22284
Figtree Commercial	52503	0	0	52503
Dairy Heritage	22802	0	0	22802
Riverpark Village Complex	64600	0	0	64600
Marina Commercial Complex	112332	0	0	112332

7.1.2 Option 2 – Rainwater for Outdoor Demands

For this option, rainwater will be used to supply outdoor demands only. Outdoor demands constitute 14% of total demand for residential developments and 6% of total demand for commercial developments. The balance of the demands will be supplied with potable town water.

Table 7-2 Option 2 - Water Demand Distribution

Precinct	Water Demand (kL/year)			
	Town Water	Tank Water	Greywater	Total
Gateway Residential	19814	2470	0	22284
Figtree Commercial	49353	3150	0	52503
Dairy Heritage	21107	1695	0	22802
Riverpark Village Complex	55556	9044	0	64600
Marina Commercial Complex	107121	5211	0	112332

Note: The potential rainwater yield for the Marina Complex (5211kL) is less than potential tank water demand shown (6740kL)by approximately 1500kL. This number was adjusted accordingly, however the excess of rainwater captured in the neighbouring Riverpark Village complex (2600kL excess) could potentially be made available to meet this demand.

7.1.3 Option 3 – Rainwater for Indoor & Outdoor Demands

This option uses rainwater to supply indoor & outdoor demands. Indoor & outdoor demands constitute 54% of total demand for residential developments (toilet, laundry & gardens) and 51% of total demand for commercial developments (toilets, heating/cooling & irrigation). The balance of the demands will be supplied with potable town water.

Table 7-3 Option 3 - Water Demand Distribution

Precinct	Water Demand (kL/year)			
	Town Water	Tank Water	Greywater	Total
Gateway Residential	19788	2496	0	22284
Figtree Commercial	48543	3960	0	52503
Dairy Heritage	19654	2968	0	22802
Riverpark Village Complex	52938	11662	0	64600
Marina Commercial Complex	107121	5211	0	112332

In all precincts, the potential rainwater yield (Table 6-1) was the limiting constraint on the tank water demand. Carefully considered planning and design could potentially increase the rainwater yield, however it falls outside the scope of this report.

7.1.4 Option 4 - Rainwater for Indoor & Rainwater/Greywater for Outdoor Demands

For this option, rainwater will be used to supply indoor demands, as in Options 2 and 3. Outdoor demands will be supplied primarily with greywater, using rainwater augment this supply. The balance of the demands will be supplied with potable town water.

Table 7-4 Option 4 - Water Demand Distribution

Precinct	Water Demand (kL/year)			
	Town Water	Tank Water	Greywater	Total
Gateway Residential	10495	2470	9319	22284
Figtree Commercial	32792	3960	15751	52503
Dairy Heritage	11279	2968	8555	22802
Riverpark Village Complex	29716	9044	25840	64600
Marina Commercial Complex	73421	5211	33700	112332

Pending a detailed investigation, the above results suggest that there is a potential to reuse all recycled greywater and captured rainwater.

In residential precincts there may be an opportunity for captured rainwater and recycled greywater to provide more than half of the overall water demand. Sufficient tank storage would need to be provided for both rainwater and greywater systems; however the calculation of tank sizes falls outside the scope of this report.

7.1.5 Summary of Options

A summary of the imported town water demand is shown in Table 7-5.

Table 7-5 Reduced Potable Water Demand

Precinct	Potable Water Demand (kL/year)			
	Option 1	Option 2	Option 3	Option 4
Gateway Residential	22284	19814	19788	10495
Figtree Commercial	52503	49353	48543	32792
Dairy Heritage	22802	21107	19654	11279
Riverpark Village Complex	64600	55556	52938	29716
Marina Commercial Complex	112332	107121	107121	73421

Option 2 would achieve a slight decrease in town water demand (compared to Option 1) attributable to the use of tank water. Water savings are slightly higher in Option 3; however the yield of rainwater is a significant limiting factor in both options. Both Option 2 and Option 3 would result in only minor reduction in town water required for the Marina Commercial Complex, which is responsible for around 40% of predicted water demand for Figtrees on the Manning.

Option 4 demonstrates a large reduction in town water demand by incorporating a third water source – greywater. Overall, town water reliance is decreased by 40% and significant water savings would be achieved in all precincts.

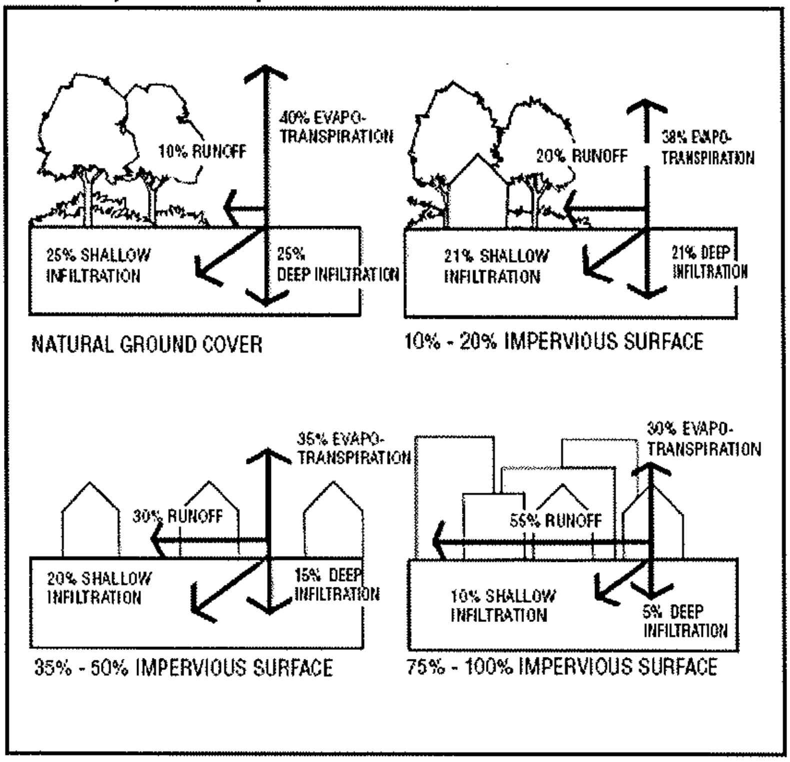
8. Water Balance

8.1 Methodology

As discussed above, the development has been assessed on a precinct basis. With the exception of the Riverpark Village Complex, all precincts would drain directly to the Manning River unless runoff is intercepted by stormwater devices. The northern section of Riverpark Village Complex would drain to a minor creek while the remainder of the Complex drains south to the Manning River. Consequently, this precinct was assessed as two components for the following water balance.

The rainfall fate was for all land uses interpolated from Tourbier and Westmacott (1981), refer Figure 8-1. This figure shows the likely increase in runoff that occurs with increased urbanisation.

Figure 8-1 Relationship between impervious cover and rainfall fate



Note that the following water balances are high level investigations and more detailed analyses are recommended.

8.2 Pre-Developed Conditions

A water balance was conducted for the pre-developed case as a point of comparison. Aerial photography was used to estimate the percentage of impervious surfaces in the existing precincts. It was assumed that minimal rainwater harvesting occurs at the premises within the project area. The average annual rainfall scenario (Table 3-1) was applied to calculate the volume of annual rainfall occurring in the project area. Results for the water balance are shown in Table 8-1.

Table 8-2 Predeveloped Conditions - Water Balance for Figtrees

Precinct	% Impervious	Total Annual Rainfall (ML)	Water Harvested (ML)	Infiltration (ML)	Evaporation (ML)	Runoff (ML)
Gateway Residential	40%	22.7	0.0	8.7	8.2	5.8
Figtree Commercial	75%	26.0	0.0	3.9	7.8	14.3
Dairy Heritage	50%	21.9	0.0	7.7	7.7	6.5
Riverpark Village excl. Wetland Park	20%	89.2	0.0	37.5	33.9	17.8
Wetland Park	0%	44.9	0.0	17.4	18.0	9.5
Marina Commercial	50%	30.9	0.0	10.8	10.8	9.3

It is likely that shallow infiltration in the Wetland Park is contributing to the creek.

8.3 Developed Case

The impervious and pervious areas were calculated for each precinct. The harvested water values in Section 7 were applied and the roof area contributing to harvested tank water was not included in the calculation of percentage impervious as it would not further contribute to the water balance.

The Precinct areas analysed for the water balance are shown in Figure 8-2.

Table 8-1 Impervious and Pervious Areas within each Precinct

Precinct	Total Area (m^2)	Impervious Area (m^2)		Pervious Area (m^2)	% Impervious Applied
		Roof	Other		
Gateway Residential	19285	4240	6075	8970	48
Figtree Commercial	22096	6727	13503	1866	90
Dairy Heritage	18591	6593	11058	940	94
Riverpark Village excl. Wetland Park	75812	20180	38408	17224	74
Wetland Park	38164	0	0	38164	0
Marina Commercial	26229	8854	16975	400	98

Applying the average annual rainfall scenario (Table 3-1), a water balance was performed for Option 1 and Option 4. The results are summarised in Tables 8-2 and 8-3 respectively. Due to the close proximity of the water table to the surface, shallow and deep infiltration were combined in the water balance.

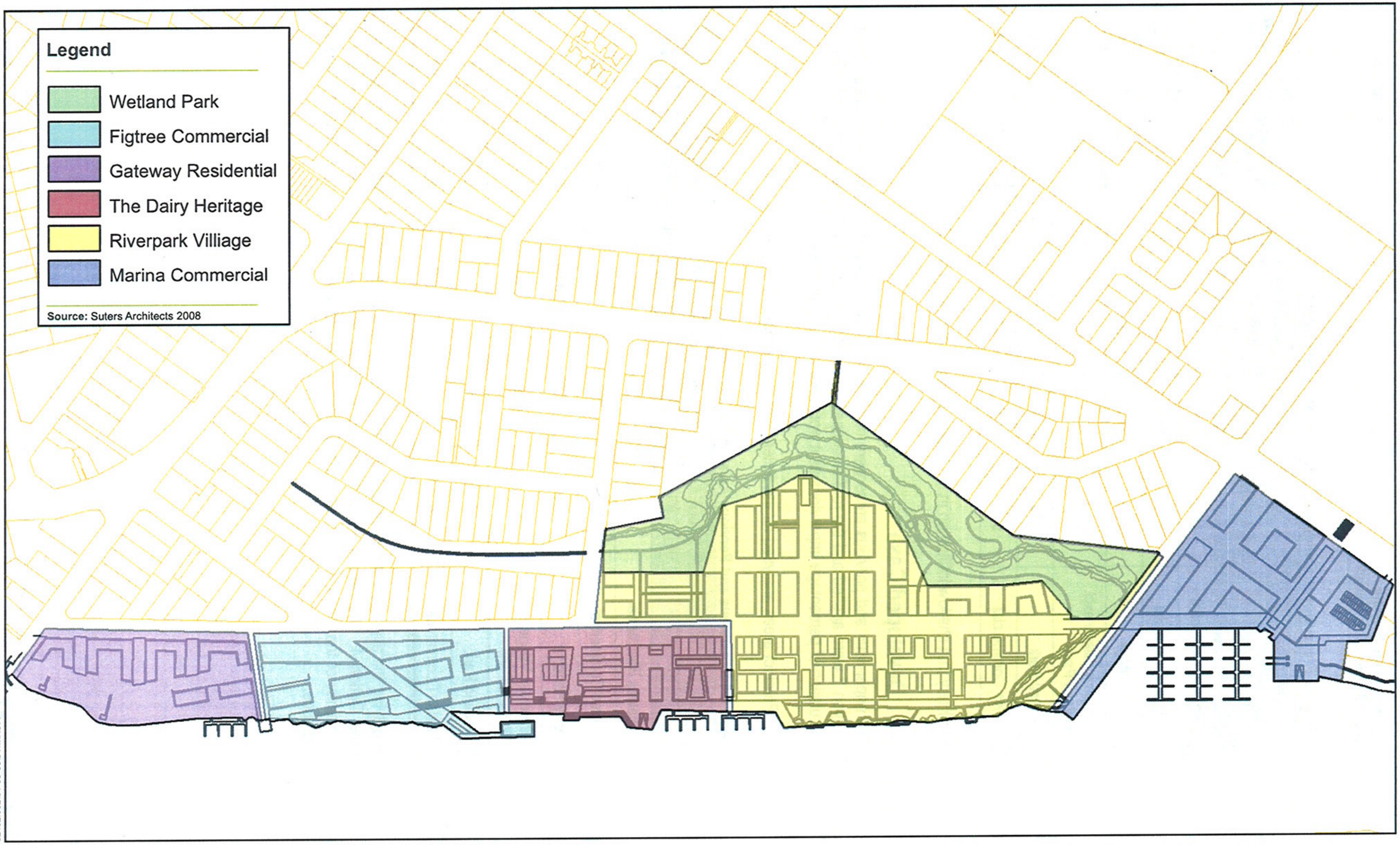


FIGURE 8-2 Project Precincts

Table 8-2 Option 1 - Water Balance for Figtrees

Precinct	Total Annual Rainfall (ML)	Water Harvested (ML)	Infiltration (ML)	Evaporation (ML)	Runoff (ML)
Gateway Residential	22.7	0.0	7.0	8.2	7.5
Figtree Commercial	26.0	0.0	3.9	7.8	14.3
Dairy Heritage	21.9	0.0	3.3	6.6	12.0
Riverpark Village excl. Wetland Park	89.2	0.0	13.4	26.7	49.1
Wetland Park	44.9	0.0	17.4	18.0	9.5
Marina Commercial	30.9	0.0	4.6	9.3	17.0

Most of the rainfall falling on the catchment will become runoff, with a considerable amount of evaporation potential. Urbanisation of the study area contributes to additional runoff that would have infiltrated or evaporated in pre-developed conditions, particularly in the Riverpark Village Complex.

Table 8-2 Option 4 - Water Balance for Figtrees

Precinct	Total Annual Rainfall (ML)	Water Harvested (ML)	Infiltration (ML)	Evaporation (ML)	Runoff (ML)
Gateway Residential	22.7	2.5	6.3	7.3	6.5
Figtree Commercial	26.0	4.0	3.3	6.6	12.1
Dairy Heritage	21.9	3.0	2.8	5.7	10.4
Riverpark Village excl. Wetland Park	89.2	9.0	12.0	24.1	44.1
Wetland Park	44.9	0.0	17.4	18.0	9.5
Marina Commercial	30.9	5.2	3.9	7.7	14.1

The water balance for the application of Option 4 indicates that only 10-20% of rainfall will be harvested based on the applied assumptions. There is potential to harvest greater volumes of water if careful design of a community water harvesting system is applied.

Harvesting rainwater decreases the volume of runoff by about 15% compared to Option 1, bringing the likely runoff volumes closer to pre-developed conditions. All volumes are still greater than or similar to pre-developed conditions, hence additional harvesting would be encouraged.

9. Conclusions & Recommendations

The proposed Figtrees on the Manning development has an opportunity to reduce potable water demand using water sensitive urban design elements. This report provides an overall strategy that proposes measures to maximise this opportunity and assesses the potential outcomes for each precinct.

A preliminary assessment of the site aspects, potential water sources and predicted water demand was conducted to determine potential water management strategies that could be applied to the development to reduce potable water demand, site runoff and discharge to the reticulated sewerage system. Due to the concentration of residential and commercial premises proposed, there are significant water demands and a scheme that maximises the use of harvested or recycled water would be desirable.

Water harvesting could easily be established on site due to the large roof areas with the additional benefit of decreasing the volume of stormwater runoff. Underground rainwater tanks and greywater systems could be installed beneath public space and garden areas resulting in minimal changes to the proposed aesthetics of the development.

Four options were overviewed in this assessment, considering combinations of town water, tank water and greywater as potential water sources. Preliminary calculations suggest that there is potential to reduce potable water use by more than 40% by utilising tank water for appropriate indoor uses, greywater (supplemented by tank water) for outdoor uses and town water for the balance. Significantly lower water savings were indicated for options that do not incorporate greywater.

The assessment also predicted the likely volumes of harvested water, infiltration, evaporation and runoff resulting from average annual rainfall over the study area. The water balance indicated that the increased urbanisation associated with the development would result in the production of larger volumes of runoff. These impacts could be partially mitigated by harvesting rainwater and recycling greywater for outdoor applications.

Based in the preliminary findings of this investigation, we recommend more detailed analysis be conducted as follows:

- Develop a daily urban water balance model over a period of one year or longer to reflect seasonality of rainfall
- Periods of high and low annual rainfall to be modelled to assess the effectiveness of rainwater harvesting and identify the ideal tank volumes
- If available, apply more accurate detail in regards to the likely developments
- Use the model to assess scenarios in more detail in regards to key outcomes such as imported water requirements and wastewater discharge

10. References

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SKM

Client Feedback

Process Control Checklist PM63 Rev JAN 09

Client:	Defence	Feedback from:	Dominic Schimizzi	Date:	5/5/09
Project:	RAAF Richmond	Project No.:	NB10936	PM:	Scott Liddell

RCM: Present ☐ Recorded by ☐ PD: Present ☐ Recorded by ☐

General Comments

Client Satisfaction Drivers (from Project Kick off)

Satisfaction Driver	Client feedback
Apply client policies	Very good
Within budget	So far so good
Pro-active mgmt	More than very good

Current Client Rankings

Client Issues	Ranking (1-10)	Comments
On-time delivery / Project Schedule	9	On track no delays
Manage Client's expectations	8	
Keep your commitments	8	
Management of Project Costs	8	
Management of Project Scope	9/10	Very impressed - difficult project -
Communication	8	Report as required Risk Workshops
Value for money	7	A little bit
Delivery of Product Quality	9	kept scope
Client happy with project team?	8	
No surprises	7	Hourly basis of PD tight.

Milestones (from proposal or variations)

Milestone	Due date	Actual Date	Client Comment
	All achieved to date		

Communication (from Project Kick off)

Planned Communication	Is it happening?	Last Communication	Client Comments
Project Status Reports	Reports	forwarded as	required

Agreed Actions

Issue	Agreed Action	Who	When	Done? / Follow-up
	No actions			

Upcoming Issues / Opportunities	Comment / Discussion / Action taken
	N/A

Other Comments / Feedback: Recommend SKM for another opportunity particularly where there are complexities

FORM/CHECKLIST STATUS		
Mandatory............ ☐	Intent On File........ ☑	Guideline............... ☐