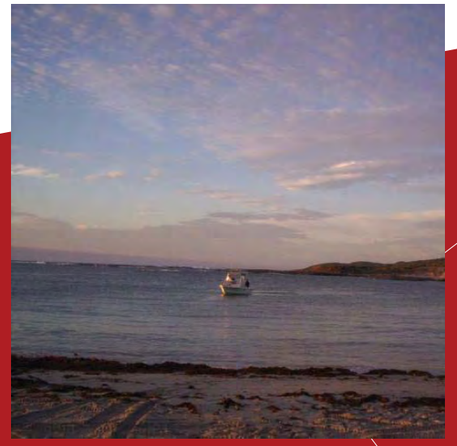
Thompson McRobert Edgeloe Group

DRAFT

Peaceful Bay

Pre-Feasibility Servicing Report



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May 2010

Attachment 8.1.5

Project Management Planning Geotechnical Environmental Engineering

DOCUMENT QUALITY CONTROL

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REVISION TABLE

No.	REVISION	DATE
A	Draft for Council Consideration	07.05.2010

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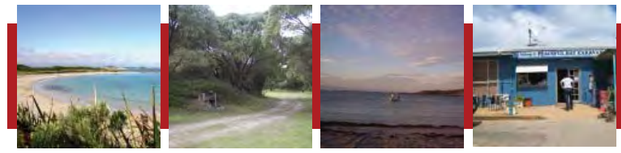


CONTENTS

FIGURES AND TABLES

APPENDIX 1- Water Sensitve Design Practices

APPENDIX 2 - Rainwater Systems

EXECUTIVE SUMMARY

The isolation and seasonal nature of household occupancy at Peaceful Bay presents unique challenges for the provision of adequate services.

This servicing report has been prepared to provide a practical servicing outcome which has a reasonable prospect of implementation and fulfilling the servicing requirements of the growth identified in the Peaceful Bay Local Structure Plan.

The plan provides for roads to be upgraded to a contemporary standard while still being sympathetic to the local environment, and drainage upgrading to utilise water sensitive urban design principles.

The provision of power and upgrading power supply head works is likely to present a significant barrier to future development at Peaceful Bay unless a fair, staged contributory scheme can be established or Government assistance obtained.

The recommended power supply scheme utilises current "green power" options provided by Western Power and also encourages use of home based photo voltaic cells to further off-set local power demands.

Controlled subsoil drainage will need to be introduced in places to manage the water table.

A state of the art integrated water supply and effluent disposal system is proposed for Peaceful Bay which incorporates the following:

- Rainwater tanks to each lot to provide potable supply
- Water efficient devices used in each home
- Sewer effluent from each lot collected and conveyed to a treatment plant
- Effluent treated to "Fit for Use" (class A+) standard
- Effluent returned to each lot for non potable uses such as toilet flushing and garden watering
- An operator will need to be identified to be the licensed operator of sewer and non potable systems
- Existing plantation to be cleared from site prior to development

One of the key advantages enjoyed by Peaceful Bay is the ability to overcome upfront head works costs by freeholding existing leasehold lots in a manner which is sympathetic to existing leaseholders. The existing sewerage load that will be generated by these houses is also an advantage in establishing the waste water treatment plant facility.

Implementation of the recommendations of this report is a complex exercise and we strongly encourage Council to consider appointment of a dedicated project manager to progress the various studies and implementation strategies.

Below is the collective list of recommendations from this report:

Recommendations:

1. *Preparation of a detailed road hierarchy and traffic assessment should be prepared as part of a full servicing report prior to further subdivision occurring at Peaceful Bay.*
2. *It is recommended that Groundwater monitoring be initiated in order that readings can be taken over the next two winters and reliable data acquired for the preparation of an District/Local Water Management Strategy and detailed design of drainage systems in accordance with Water Sensitive Urban Design principles.*
3. *That Peaceful Bay adopt Water Sensitive Urban Design Practices in future stormwater design as outlined in Appendix 1 - Water Sensitive Design Practices.*
4. *That an integrated sustainable power supply be pursued.*
5. *That the Western Power network and Infrastructure be upgraded to contemporary standards.*
6. *Require the power purchased from the grid to be "Green Power".such as "Natural Power" or "Earth Friendly". The natural power scheme ensures all energy is sourced from renewable sources whereas earth friendly also provides for power supplies to be carbon neutral.*
7. *Utilisation of house based photo voltaic cells to provide a portion of local requirements with any excess power generated fed back into the grid.*
8. *To undertake more detailed investigations into Western Power head works upgrade requirements and develop a mechanism to share these costs equitably across the settlement.*

9. *That rainwater collection and onsite storage is the preferred option for potable water supply for Peaceful Bay.*

10. *That reclaimed (recycled) water from a ERA licensed comprehensive integrated effluent collection, treatment and distribution scheme is the preferred non potable water supply.*

11. *That Council regulation is modified to provide for appropriately sized water tanks.*

12. *That Council endorse the principle of an integrated effluent disposal/non potable water supply system for Peaceful Bay which allows collected rainwater to be used for potable purposes and all effluent being collected from each lot, taken off site for treatment and then returned to each lot to meet non-potable water demands. The system is to have a single licensed operator which could be the Shire of Denmark or a private Operator in which case assets may be held by a third party and leased to the operator.*

13. *That the Waste Water Treatment Plant Site nominated in the Peaceful Bay Local Structure Plan is retained and the buffer requirements reassessed when the facility is designed to a point where risks and odour can be assessed further.*

14. *That Council monitor current discussions and negotiations occurring in respect to Gracetown and Witchcliffe, each of which is currently pursuing establishment of a sewerage and third pipe water re-use scheme similar to that described for Peaceful Bay.*

15. *Council should engage the services of a Project Manager to prepare a project delivery plan and indicative project budget for the delivery of infrastructure services at Peaceful Bay. The scope of project services should encompass but not necessarily be limited to:*

    - *determining a fair process for privatising leasehold lots;*
    - *entering into negotiations to deliver an integrated waste water collection, treatment and distribution system in a manner consistent with the recommendations of this report;*
    - *Investigate the level of government's assistance which may be available to assist in the project;*
    - *progress the necessary statutory rezoning and subdivisions needed to facilitate implementation of the Peaceful Bay Structure Plan and the recommendations of this Servicing Report;*
    - *prepare a full feasibility analysis for the project and identify staging which will allow the project to occur in a economically and environmentally responsible manner; and,*
    - *to establish the extent of cost share items which all subdividers and developers will need to contribute to and report on a mechanism which will allow this to occur.*

1.0 INTRODUCTION

Peaceful Bay is a seaside settlement situated in the Shire of Denmark approximately mid way between Denmark and Walpole as shown in *Figure 1*. It is occupied by several full time residents but is primarily populated for short periods during seasonal holidays

Historically the Town has been developed with a combination of leasehold and private tenure. Approximately 205 leasehold lots, including a 130 site caravan and camping area, and 49 freehold lots have been created. The tenure of the leasehold lots consists of Reserve 24510 being vested in the Shire of Denmark with the power to lease and subsequent leases being issued by the Shire for a term of 21 years. Renewal of these leases is due in July 2010, it is understood that these leases will be issued for a further 21 years by the Shire.

Servicing of the existing settlement currently consists of a potable water supply provided by roof top catchment and supplemented by a limited non potable reticulated supply which is operated, and licensed to the Shire of Denmark by the Economic Regulatory Authority (ERA).

Effluent disposal is by way of septic tanks which are in places of questionable suitability given high water tables. Power is provided by Western Power but has little expansion capability according to Western Power. Roads and drainage of various standards are provided by the Local Government and while these provide a unique character, they are not at a suitable standard if permanent occupation of the settlement to be pursued.

In recent years there have been proposals to expand the size of the settlement which have culminated in approval of the Peaceful Bay Local Structure Plan by Council in August 2000 and the West Australian Planning Commission in June 2001 (subject to amendments).

The approved Structure Plan specifically states that further zoning, subdivision and development of the settlement needs to be linked to the provision and upgrading of adequate urban services. Section 21.0 Implementation of the Peaceful Bay Local Structure Plan reads *'As a condition of subdivision or strata titling full provision of services will be required'.*

The isolation of Peaceful Bay and the limited size of the settlement pose particular servicing issues which need to be addressed in a creative, innovative way. This study therefore attempts to explore opportunities for servicing at Peaceful Bay which are: responsive to local needs; sensitive to the special character that Peaceful Bay; and, enjoys and economic to pursue.

2.0 TOWNSITE DESCRIPTION

Located approximate 50km west of the Denmark townsite (refer *Figure 1 - Location Plan)* Peaceful Bay consists of land generally bound by the Walpole-Nornalup National Park to the west, Ficifolia Road to the North, Peaceful Bay Road to the east and the Southern Ocean coastline to the South.

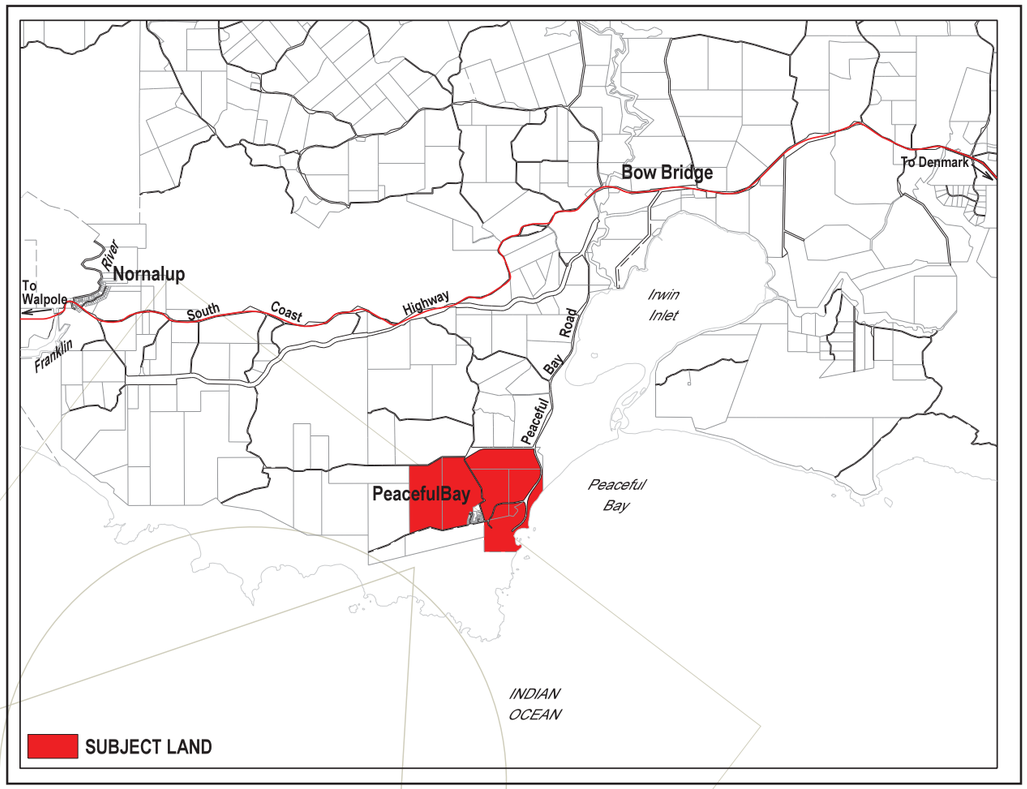


Figure 1 - Location Plan

Soils and Landform

The Soil and Landform information collected as part of the Peaceful Bay Local Structure Plan indicates that the study area is comprised of two landform units with corresponding soils. These landforms are characteristic of coastal processes and are dominated by dune systems with various soil profiles. They are derived from coastal aeolin (dune) or fluvial (stream) sediments and can be widely identified in this region of the south coast, particularly from Albany through to Northcliffe and as such are not restricted. *Figure 2 – Soil and Landform Units identifies the two landform units present over the Peaceful Bay Structure Plan area.*

Coastal Dune System

This system is known as the Meerup System and comprises a complex of parabolic dunes extending inland from the coast. They derive from windblown coastal sands and contain siliceous and calcareous soils.

The landform is characterised by dunes with moderate slopes and interdunal swales which are sometimes expressed as damp lands or wetlands. The dunes have suitable potential for residential development. Proposed residential development should be restricted to areas with moderate elevation and hence satisfactory clearance to groundwater.

The Meerup coastal dune system is well represented along the South Coast.

Coastal Swampy Terrain

This land type is known as the Blackwater system and is generally seen in the lower lying northerly portions of the subject land. It represents a more eroded, older and less defined landform. This unit comprises a flat to undulating plain with poor, diffuse drainage patterns, with some wetlands and linear dunes. The elevation ranges from 12-30metres AHD, rising in the north-west. These sub-coastal linear dunes are sparsely to moderately vegetated while the lower lying soils can have denser wetland vegetation types varying from sedge lands to woodlands. The Blackwater system is well represented in this region of the south coast.

Vegetation

The remnant vegetation within the Structure Plan is generally reflects the landform units above and is also widely spread along the southern coast. The vegetation is heavily represented within the National Parks and reserves along this portion of the south coast including the adjacent areas.

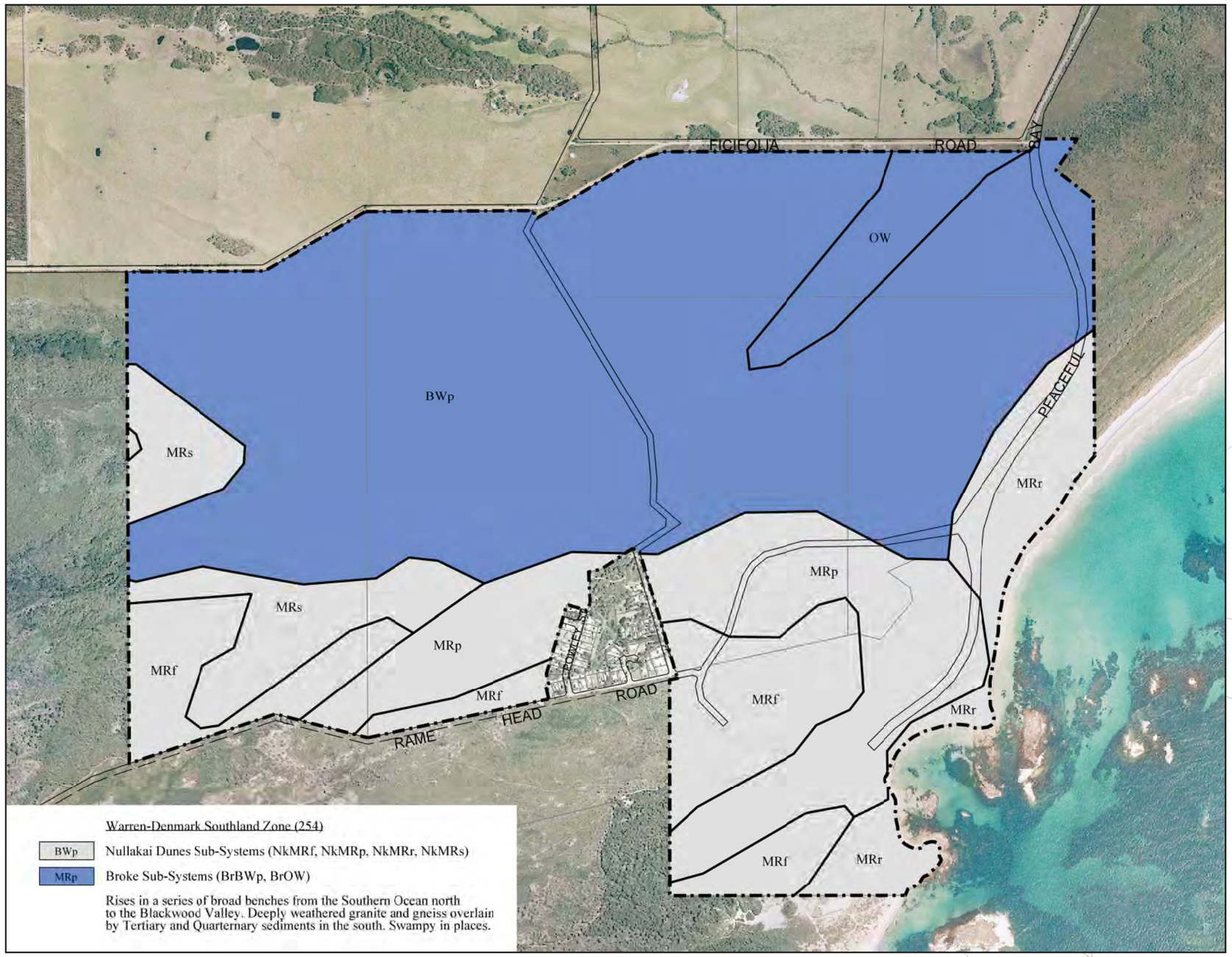


Figure 2 - Soils and Landform

The structure plan area contains a large amount of remnant vegetation. The condition of the vegetation varies depending on the landuse associated with the present and historic use of land. The camping and recreation reserve 24510 comprises largely undisturbed vegetation in the northern portion, notwithstanding the landfill site in the north-east corner. Lot 1425 comprises blue gum plantations on the northern portion and remnant vegetation in the southern portion which has suffered impacts in the past due to grazing. Vegetation on lot 301 comprises portions of cleared land, improved pasture, in the north and south edges, with grazed remnant vegetation on the balance of the land.

The physical and flora characteristics of the subject land provide development and conservation options which are reflected in the Structure Plan. There is potential during development to retain stands of remnant vegetation for aesthetic and planning purposes. It should be noted that while these associations may be significant remnant vegetation, they do not necessarily have a high conservation status.

Existing Development

The existing development within the Peaceful Bay precinct consists of approximately 49 freehold lots (of which approximately 2/3 are developed) and 205 leasehold sites and a 130 site caravan park site. The settlement also contains several community purpose buildings. The majority of the leasehold buildings were developed in the 1950's and 60's and only a few dwellings have been constructed since this time. The townsite consists of a small number of permanent residents with most of the developed area being short-stay holiday accommodation.

The Shire of Denmark Town Planning Scheme No. 3 depicted in *Figure 4* includes several zoning classifications, these being; "Parks and Recreation" (lots 1422, 1423 and 1424), "Residential" (central triangle) and "Rural" (lots 301 and 1425).

The area of land zoned for residential development is largely developed, with very limited area identified for future expansion.

Future Development Opportunities

Future development opportunities for the Peaceful Bay area are mostly dependant on the availability and upgrading of services, access to the area and approvals to clear some of the land. The Peaceful Bay Local Structure Plan indicates that approximately 430 additional lots could be created. The density of development proposed resonds top the extent of remnant vegetation. The less vegetated areas are proposed for village settlement with the more vegetated areas being identified for rural residential, landscape protection area and conservation lots.

Future development is proposed within the 'Rural' zoned lots with the balance of the land identified for conservation and National Park reservation.

Table 1 indicates the lot yield of existing and proposed development identified in the Peaceful Bay Structure Plan

	Leasehold Lots	Freehold Lots	Caravan Park Sites	**Total Development**
Existing	205	49	130	
Proposed		435		
Total	205	484	130	**819**

Table 1 - Peaceful Bay Lot Yield

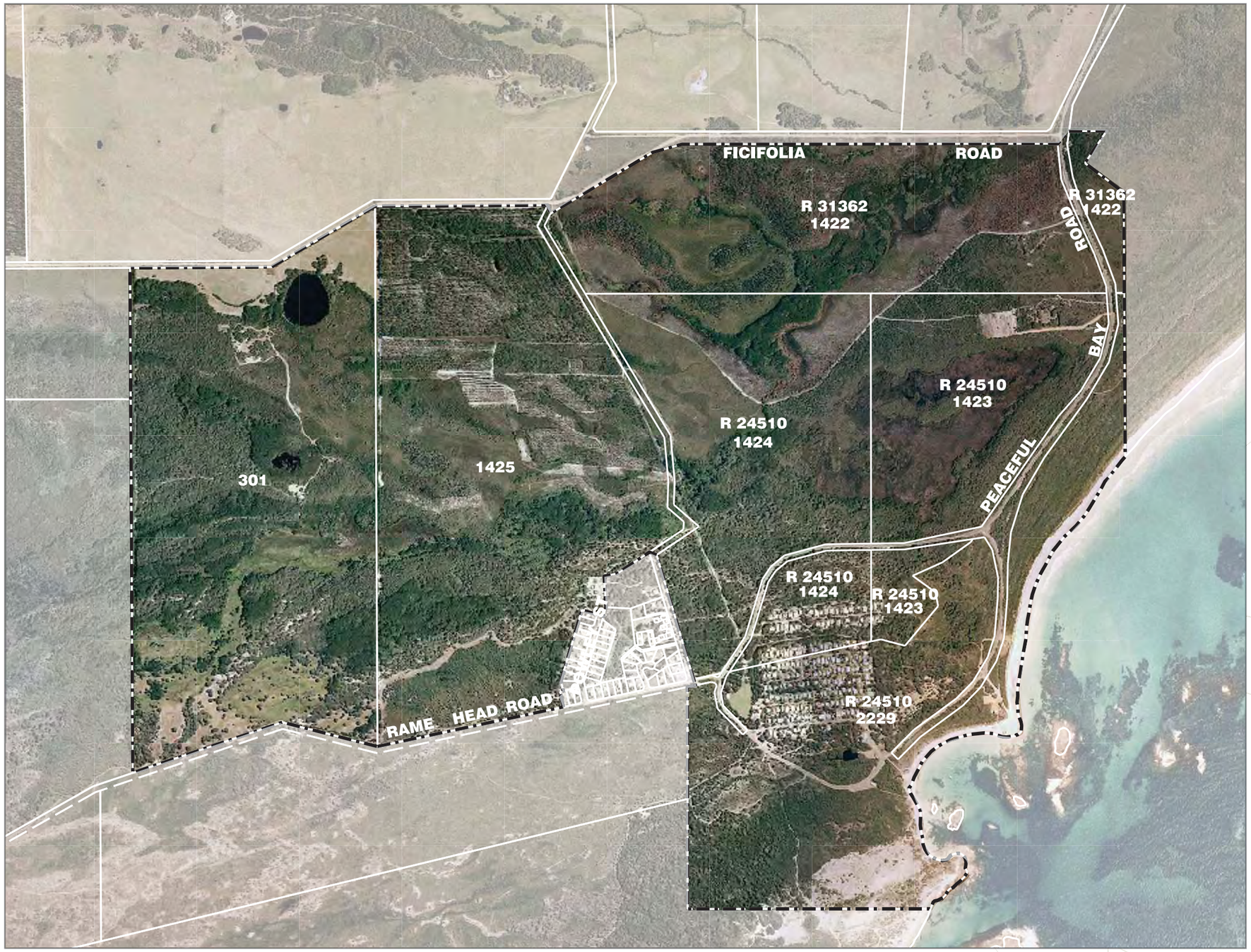
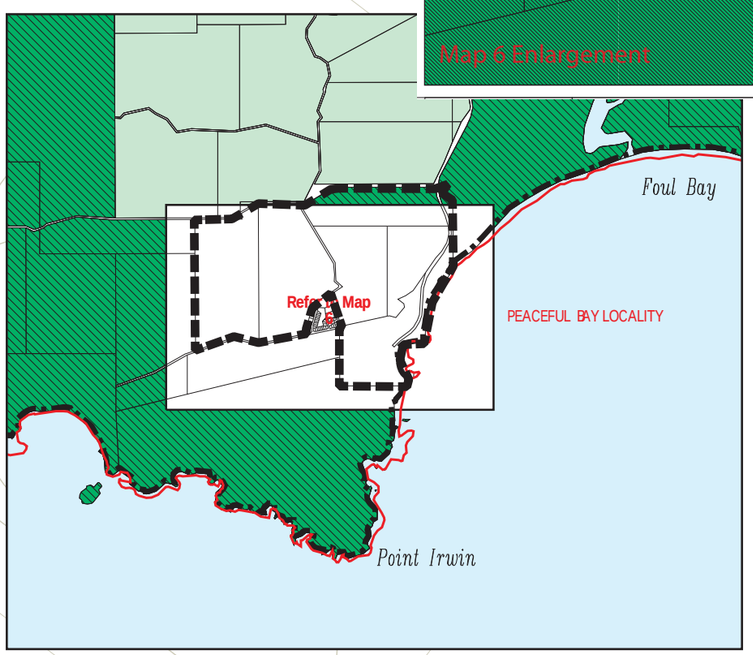


Figure 3 - Aerial Photograph



Subject Land

LEGEND

LOCAL SCHEME RESERVES

- DRAINAGE AND WATERBODIES
- PARKS AND RECREATION
- PUBLIC USE
- PUBLIC USE DENOTED AS FOLLOWS:
  - AL AERIAL LANDING GROUND
  - AP AGED PERSONS HOME
  - AR AGRICULTURAL RESEARCH STATION
  - E EDUCATIONAL PURPOSES
  - F FOREST
  - FF FLORA AND FAUNA
  - FS FIRE STATION
  - G GRAVEL
  - H HOSPITAL SITE
  - PS PRIMARY SCHOOL
  - S SCHOOL SITE
  - T TIMBER
  - W WATER SUPPLY
  - WB WILLIAM BAY NATIONAL PARK
  - WEF WIND ENERGY FACILITY
- PUBLIC USE DENOTED AS FOLLOWS: WW WASTE WATER TREATMENT WORKS

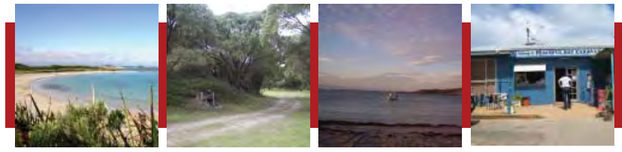
ZONES

- RESIDENTIAL
- SPECIAL RESIDENTIAL
- COMMERCIAL
- PROFESSIONAL OFFICE
- TOURIST
- INDUSTRIAL
- LANDSCAPE PROTECTION
- RURAL
- RURAL MULTIPLE OCCUPANCY
- SPECIAL RURAL

OTHER

- R20 R CODES
- A1 ADDITIONAL USES
- SCHEME BOUNDARY
- LOCAL GOVERNMENT BOUNDARY
- TOWNSITE – LAND ACT
- R2 RURAL MULTIPLE OCCUPANCY ZONE (SEE SCHEME TEXT)
- SR9 SPECIAL RURAL AREAS (SEE SCHEME TEXT)
- H19 DISTRICT HERITAGE BOUNDARY (SEE SCHEME TEXT)
- SRes 6 SPECIAL RESIDENTIAL AREA (SEE SCHEME TEXT)
- LPI LANDSCAPE PROTECTION AREA (SEE SCHEME TEXT)
- T6 TOURIST AREA (SEE SCHEME TEXT)
- PLACE OF HERITAGE VALUE (SEE SCHEME TEXT)
- NO ZONE

Figure 4 - Shire of Denmark Town Planning Scheme No. 3



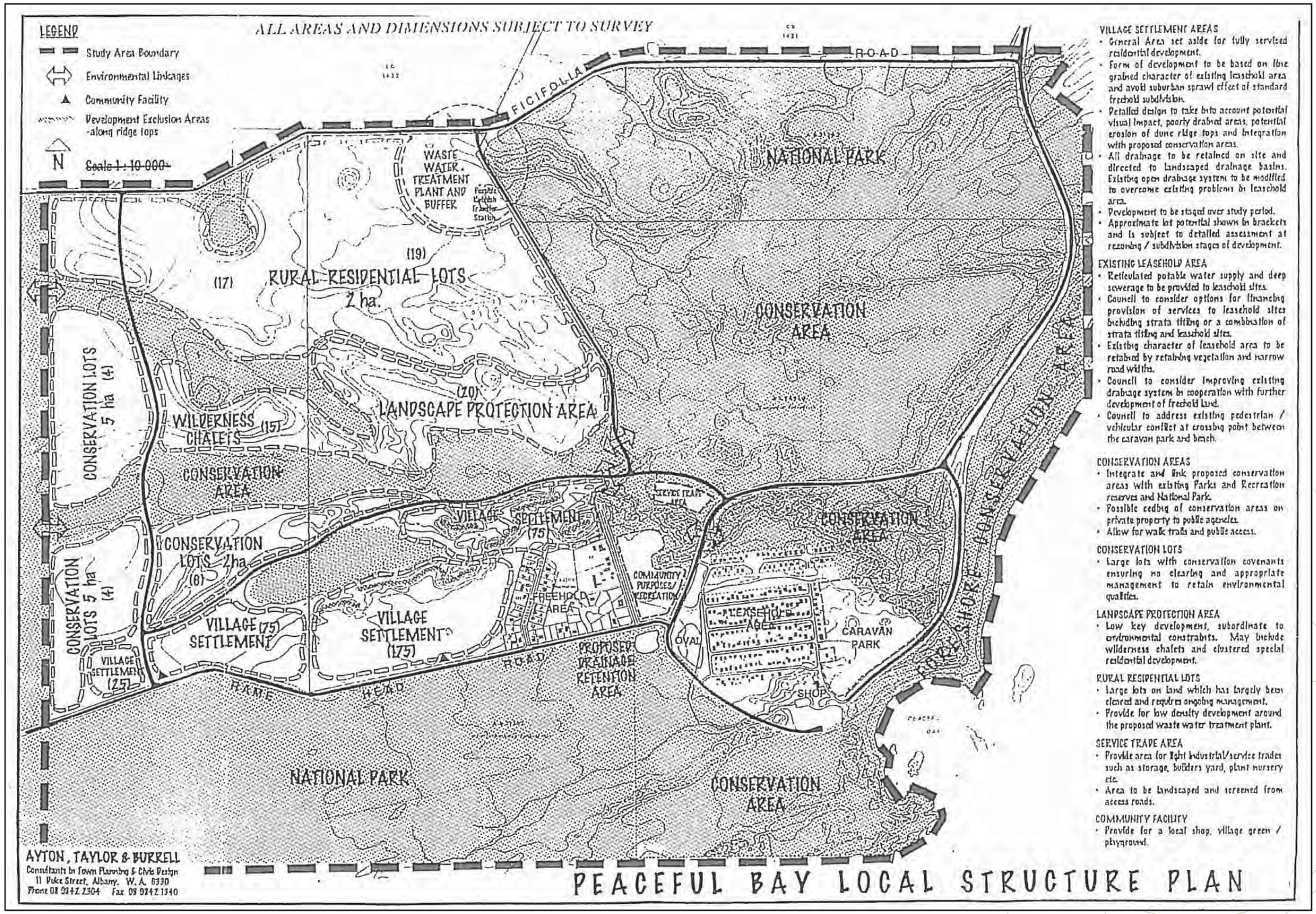


Figure 5 - Peaceful Bay Local Structure Plan

3.0 ROADS

Figure 6 – Road Status highlights the key considerations with respect to roads within the study area.

Roads generally fall within the following classifications:-

- ROAD TYPE A - Roads which have been constructed to a suitable standard and are located within appropriate reserves. No further upgrading works are expected to be required on these roads.
- ROAD TYPE B - Roads which are located within appropriate reserves which require upgrading in terms of pavement or drainage as part of future development of Peaceful Bay. Funding of the upgrading of these roads is likely to be the subject of a contributory scheme levied on each new lot as it is created.
- ROAD TYPE C - Informal roads within the existing lease area which will require upgrading of pavements and drainage and the creation of appropriate reserves. It is expected that funding of these works will be provided from an income stream generated by a tenure rationalisation of the lease area which will allow existing leases to be changed to freehold and sold.
- ROAD TYPE D - Existing and proposed roads within or adjacent to freehold land identified within the Peaceful Bay Structure Plan which will be constructed and funded by landowners at the time of subdivision proceeding.

Principals of Road Construction

All future roads and road upgrading will be designed to serve the following functions:-

1. Provide legal access to each lot;
2. Provide emergency service access;
3. Provide a network of linkages within the settlement;
4. To provide a 100 year over-land flow path for storm water in major events;
5. To be responsive to the unique character of Peaceful Bay;
6. Achieve water sensitive urban design principals;
7. Enhance landscape improvement opportunities along road verges;
8. Aid in the collection of stormwater for treatment to supplement the water supply;

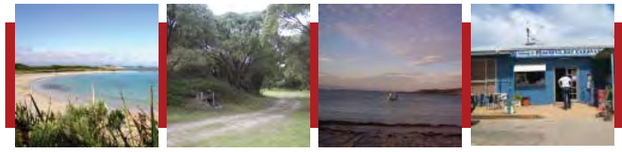
The width of road pavements is generally anticipated to be 6 meters or less, sealed with either flush or mountable kerbs. *Figure 7 – Road Forms* below depicts road forms which are considered suitable for Peaceful Bay.

Road Drainage will need to adopt water sensitive urban design principles. Flush or channel kerbed roads are preferred with swales or bio retention gardens as shown in *Figure 8 - Road Drainage Treatment*.

Where swales are used they should incorporate native plants and rock mulch in order that supplementary watering is not required.

Recommendation:

1. *Preparation of a detailed road hierarchy and traffic assessment should be prepared as part of a full servicing report prior to further subdivision occurring at Peaceful Bay.*



ROAD TYPE A

ROAD TYPE B

ROAD TYPE C

ROAD TYPE D

ROAD TYPE A - Roads which have been constructed to a suitable standard and are located within appropriate reserves. No further upgrading works are expected to be required on these roads.

ROAD TYPE B - Roads which are located within appropriate reserves which require upgrading in terms of pavement or drainage as part of future development of Peaceful Bay. Funding of the upgrading of these roads is likely to be the subject of a contributory scheme levied on each new lot as it is created.

ROAD TYPE C - Informal roads within the existing lease area which will require upgrading of pavements and drainage and the creation of appropriate reserves. It is expected that funding of these works will be provided from an income stream generated by a tenure rationalisation of the lease area which will allow existing leases to be changed to freehold and sold.

ROAD TYPE D - Existing and proposed roads within or adjacent to freehold land identified within the Peaceful Bay Structure Plan which will be constructed and funded by landowners at the time of subdivision proceeding.

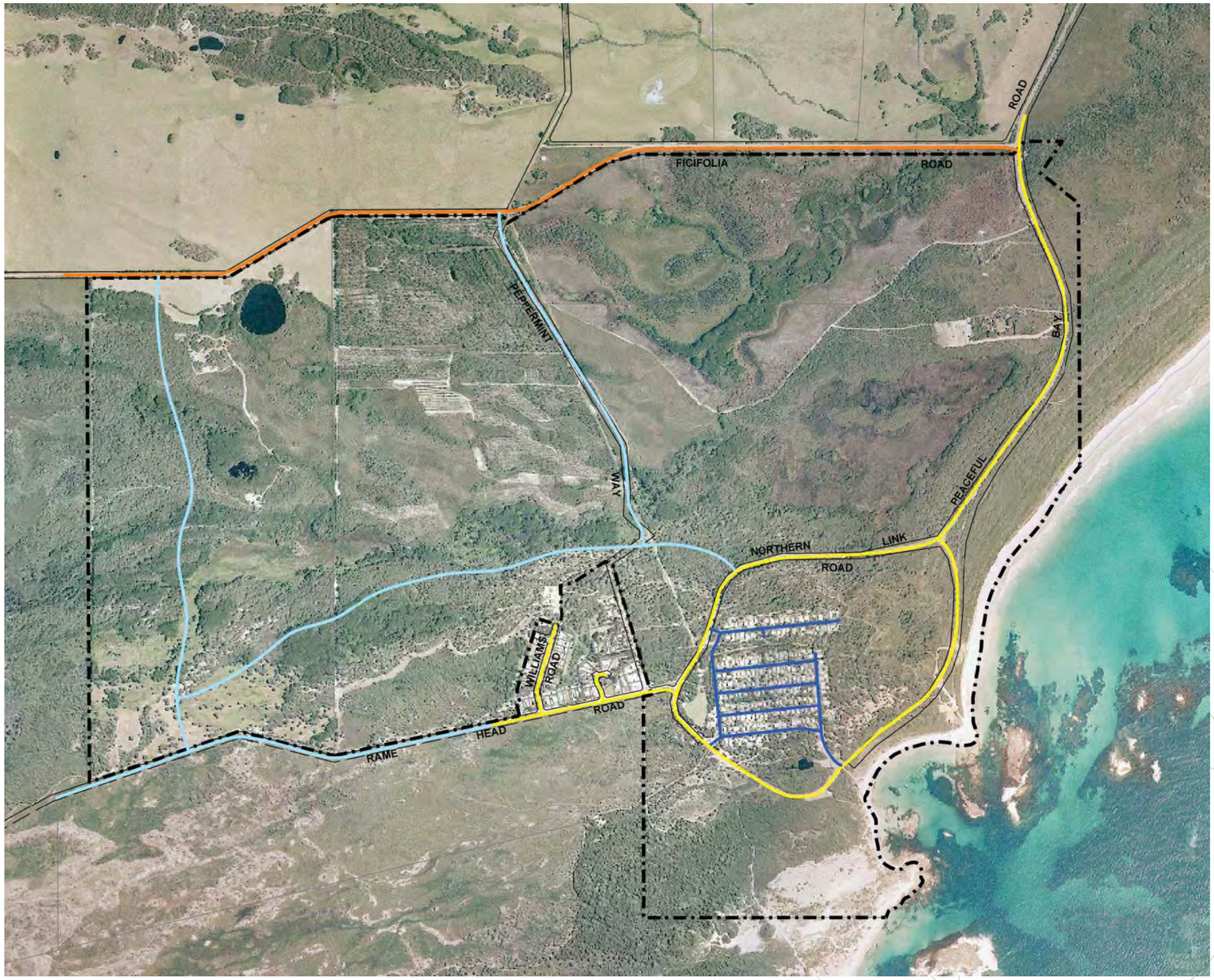


Figure 6 - Road Status

Figure 7 – Desirable Road Forms

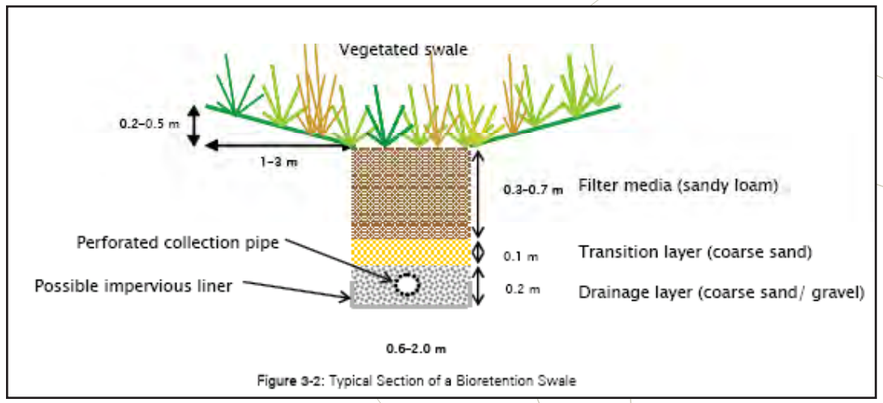


Figure 3-2: Typical Section of a Bioretention Swale

Figure 8 - Road Drainage Treatment

4.0 DRAINAGE AND GROUNDWATER

Figure 9 – Existing Drainage depicts an indicative drainage catchment network for the study area and where major inflows are expected.

Drainage at Peaceful Bay is further complicated by a high water table and there is evidence that septic tanks are at times inundated by the water table generating a potential health risk.

The ability to provide further advice in respect to drainage and groundwater is limited by the absence of long term, reliable monitoring of groundwater levels which could eventually be used to prepare a District/Local Water Management Strategy. This would support rezoning of the land.

In addition, an Urban Water Management Plan would be required for each landholding at subdivision stage.

Recommendation:

2. *It is recommended that Groundwater monitoring be initiated in order that readings can be taken over the next two winters and reliable data acquired for the preparation of an District/Local Water Management Strategy and detailed design of drainage systems in accordance with Water Sensitive Urban Design principles.*

Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is an internationally recognised concept that offers an alternative to traditional development practices. WSUD is a holistic approach to the planning and design of urban development that aims to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems. It promotes the integration of stormwater, water supply and sewage management at a broad scale.

WSUD represents a fundamental change in the way urban development is conceived, planned, designed and built. Rather than using traditional approaches to impose a single form of urban development across all locations, WSUD considers ways in which urban infrastructure and the built form can be integrated with a site's natural features. In addition, WSUD seeks to optimise the use of water as a resource.

The key principles of WSUD are to:

- Protect existing natural features and ecological processes.
- Maintain the natural hydrological behaviour of catchments.
- Protect water quality of surface and ground waters.
- Minimise demand on the reticulated water supply system.
- Minimise sewage discharges to the natural environment.
- Integrate water into the landscape to enhance visual, social, cultural and ecological values.

WSUD has evolved over recent years and many advances have been made in the field. WSUD is now well established in developments and guidelines are available from the Department of Water.

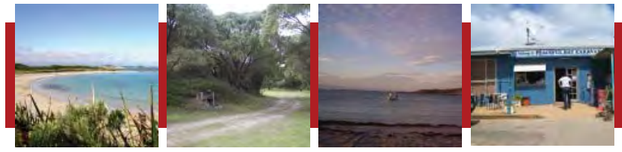
In order to understand the fundamental differences between the traditional approach to drainage and WSUD the following comparison is provided.

Traditional Drainage Design

Traditionally developments have been created and stormwater systems developed such that:

- Almost all native vegetation on site is cleared;
- Major earthworks are undertaken such that cut is taken from hill tops to fill low lying land (usually wetlands);
- Large areas of impervious surfaces are created;
- Large pipe and channel systems are built to rapidly convey stormwater to outlet;
- Large sumps or wetlands are constructed at the at bottom end of systems; and,
- Little respect for natural systems and processes.

These are demonstrated in *Figures 10 and 11* (Monk *et al* (2006)) where very harsh, engineered systems have been installed as part of the stormwater system



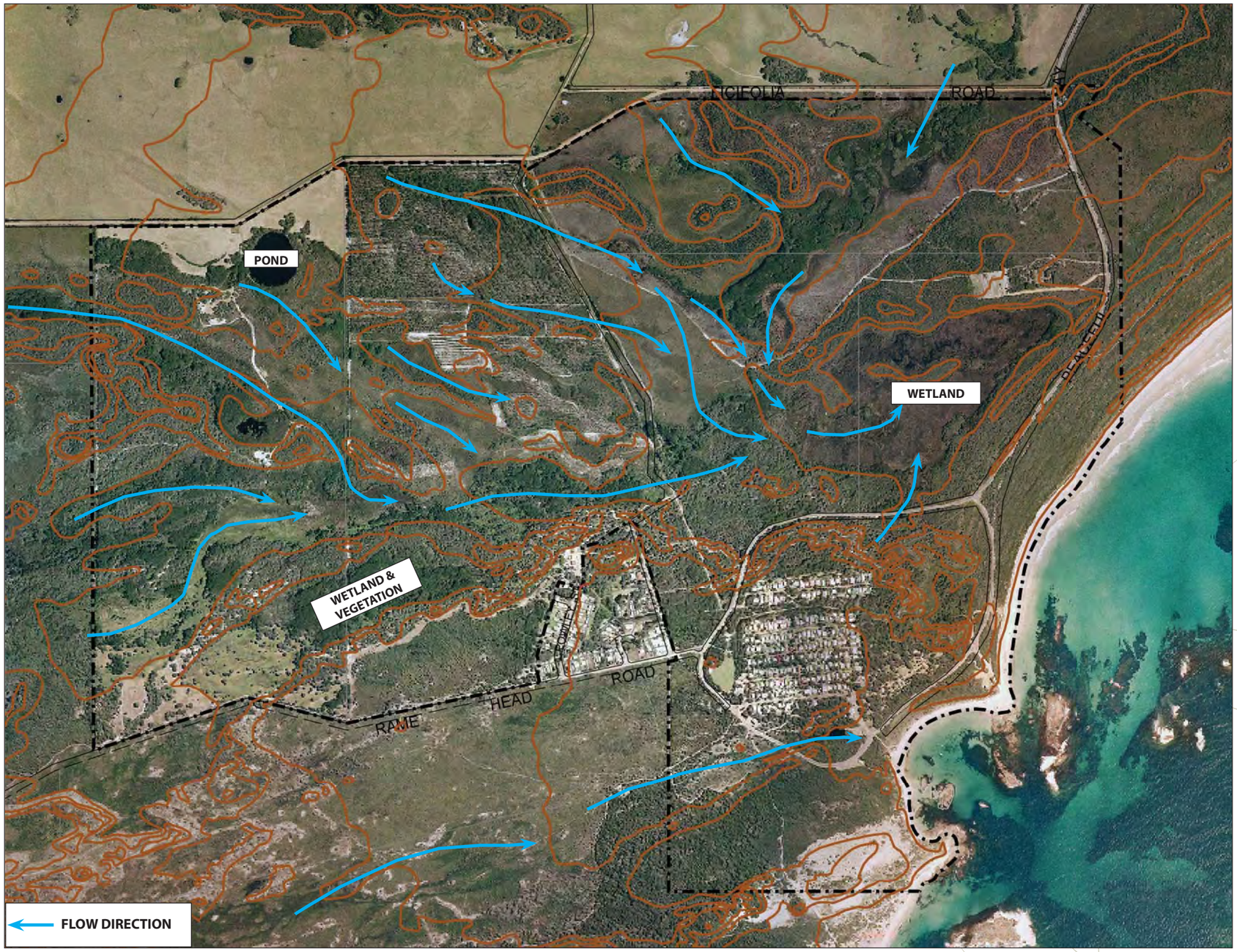


Figure 9 - Existing Drainage

Figure 10 - Trapezoidal drain, Bayswater, WA. Monk et al (2006)

Figure 11 - Pipes entering lake Monger, Wembley, WA. Monk et al (2006)

These systems cause significant changes to catchment hydrology and characteristics of the stormwater. They were generally developed to efficiently convey and dispose of stormwater for flood protection with little consideration given to the treatment of stormwater. They were also generally designed to control or lower groundwater levels to allow development to proceed.

This traditional approach is an environmentally insensitive solution which leads to hard engineering solutions and is not considered desirable.

Water Sensitive Approach

The Water Sensitive Approach to drainage design as described by Monk et al (2006) includes:

- Mimicking natural processes;
- Managing stormwater quality;
- Predevelopment peak flows to match post development peaks;
- Retention of natural vegetation;
- Sustainable solutions;
- Maximising onsite retention/ detention of stormwater;
- Recognising that designing a system for 1 year events that can cater for in excess of 99% of all storm events; and
- Designing for 1 in 1 year peak storm for water quality treatment

The management of the various stormwater events using WSUD is depicted in *Figure 12 - Management of 0 to 100 year ARI Events*.

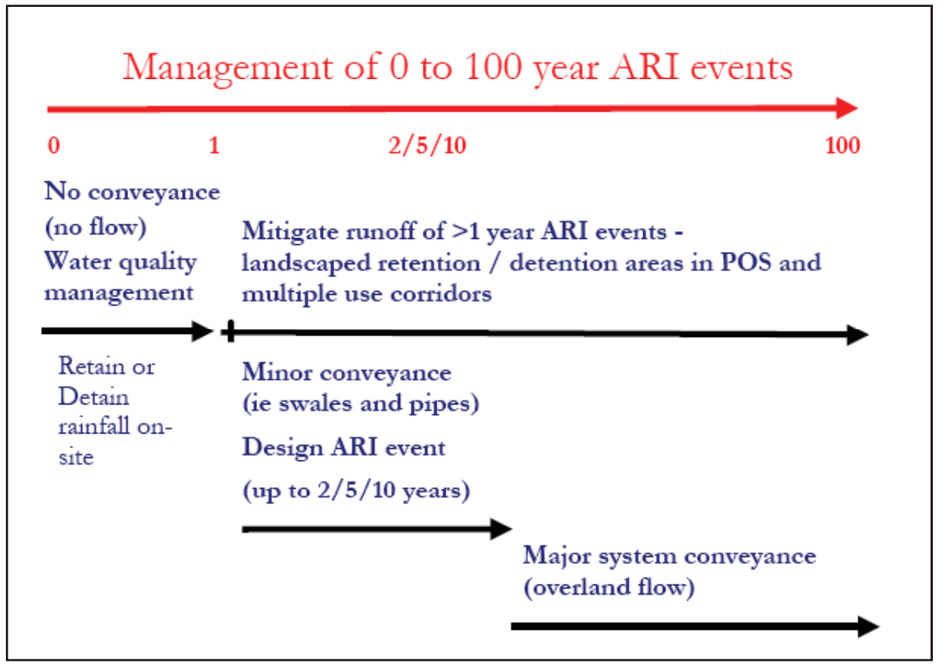


Figure 12 - Management of ARI (Average Recurrence Interval) rainfall events, Monk (2006)

These principles are firmly embedded in Department of Water, DOE Policy (2005) and the approval process for Stormwater management in WA.

Principles for up to 1 Year ARI Events

For the small events up to and including the 1 in 1 year ARI event, the guidelines state, DOE (2005):

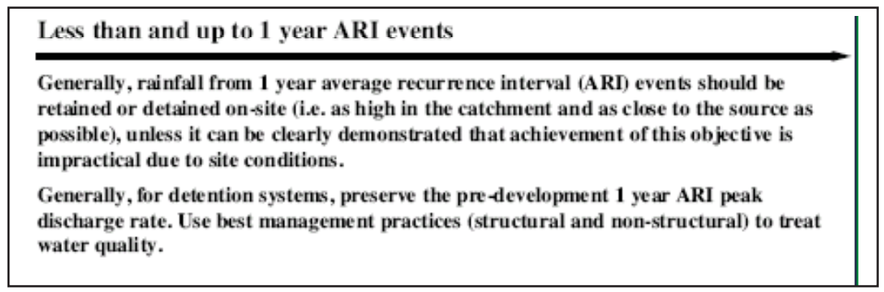


Figure 13 - Process for less than and up to 1 in 1 year ARI events, DOE (2005)

The key principle is to retain the 1 in 1 year event on site if conditions permit. Where soils are clay based, and this is not readily possible then the guiding principle is to keep the 1 in 1 year storm flow peak the same pre and post development. The stated objective is to maintain the pre development hydrologic regime and to meet the ecological water requirements of the receiving environment. The key principle in this approach is that if the 1 in 1 year ARI event is targeted for stormwater treatment then approximately 99.5% of all stormwater events are captured as shown in *Figure 15*. The intent of this is maximise infiltration of drainage at source.

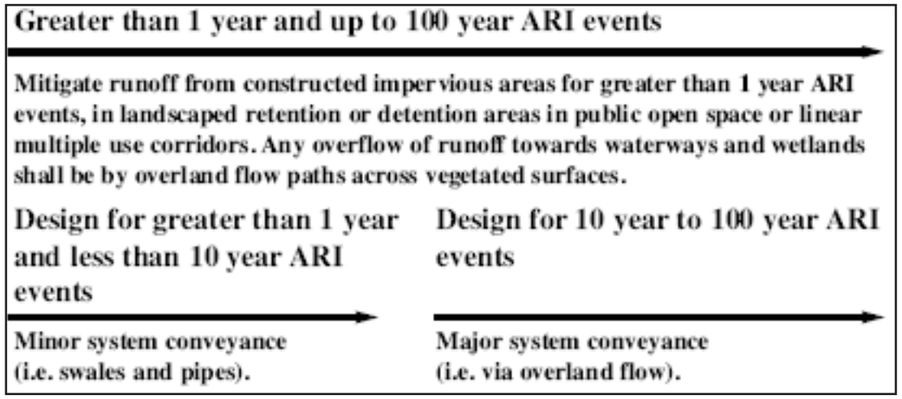


Figure 14 - Process for greater than 1 in 1 year and up to 100 year ARI events, DOE (2005)

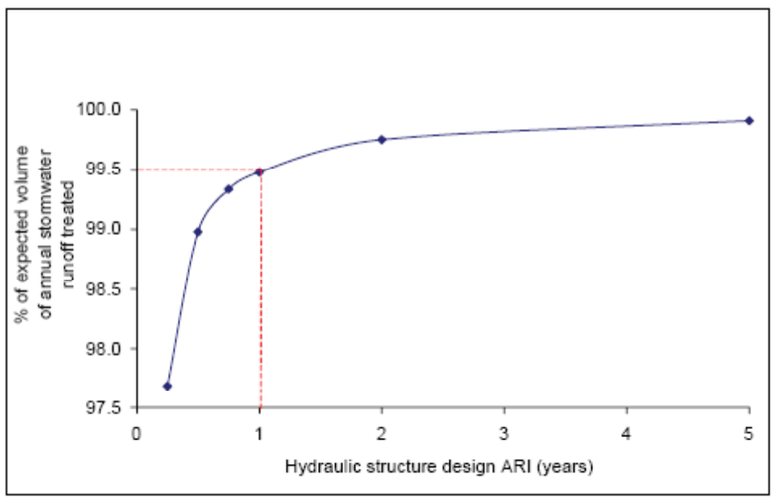


Figure 15 - Treatment efficiency for hydraulic structures in Perth, (Wong et al 1999)

Principles for Greater than 1 in 100 yaer ARI Events

The larger events then only need to be considered for conveyance, scour and flood protection requirements.

Various tools and guidelines are available to assist in the planning, design and construction of WSUD elements. Further guidance in respect to Water Sensitive Urban Design is provided in *Appendix 1 – Water Sensitive Design Practices.*

Proposed Water Sensitive Urban Design Strategy for Peaceful Bay

Water Sensitive Urban Design Principles provide a range of solutions which can be adapted for Peaceful Bay. It will be necessary for an District/Local Water Management Strategy to be prepared to support future rezonings.

It is expected that the Strategy will encompass the following principles.

Stormwater will be collected and treated as close to the source as possible utilising conveyance networks that incorporate treatment and infiltration swales, buffer strips and bio retention basins.

These systems will be designed for the 1 in 100 year ARI event.

Excess flows up to the 1 in 5 year event will be conveyed to dedicated open space areas where suitable treatment would occur, including gross pollutant traps and sedimentation basins, prior to final discharge into a suitable outfall only after conveyance through the proposed treatment drain.

It is also likely that parts of Peaceful Bay will require subsoil drainage and property drainage collection system to respond to soil conditions and groundwater levels. It is possible that these flows could be collected and treated prior to storage and reused for irrigation of open space areas.

Recommendation:

3. *That Peaceful Bay adopt Water Sensitive Urban Design Practices in future stormwater design as outlined in Appendix 1 – Water Sensitive Design Practices.*

6.0 POWER

Power is currently conveyed to Peaceful Bay by a 3 phase 22kv power line utilising the alignment of Pioneer Road from the Coastal Highway intersection with Peaceful Bay Road. This supply services the Peaceful Bay town site and tourist area. A single phase power line runs from the Pioneer Road/Ficifolia Road intersection to a farm residence situated 900 metres to the West along Ficifolia Road.

Western Power advise that the current power supply has the capacity to supply an estimated additional 55 dwellings in increments of 15 dwellings before upgrading is required.

In order to supply the planned expansion of Peaceful Bay, as outlined in the Peaceful Bay Structure Plan, it is likely that an increase in supply head works consisting of 8 drop out fuse connections, 37 transformers plus earthing and cables will be required. This would be at an approximate cost of $1,540,000.

The cables and pillars to serve the lots is estimated at $4,500 per lot resulting in an estimated cost to the development of about $1,876.500.

Additional power supplies at Peaceful Bay will be classified as edge of grid by Western Power, and therefore will be at the full cost of subdividers. Indicative research suggests that these costs could be in the order of $2,316,000 dollars and therefore represent a significant barrier to future development.

In the absence of a Government contribution to the provision of the necessary power head works, the most practical approach is to develop a mechanism which will allow proportional contributions to head works to be made by each of the developers at Peaceful Bay.

Options for the Provision of Alternative Power

Recent investigations into alternative power schemes for Gracetown have evaluated wind, solar, wave and local diesel generators. Detailed evaluation of these options has not occurred for Peaceful Bay however the following conclusions and observations are relevant.

The use of photo voltaic cells has been found to be particularly appropriate in holiday settlements where houses may be empty for extended periods of time. In these instances, almost all of a homes needs can be generated by photo voltaic cells, but these need to be connected to a wider supply grid so that generated power can be utilised in off peak times. In addition it needs to be recognised that as latitude increases the efficiency of solar cells decreases. There is a question about the efficiency of solar cells as far south as Peaceful Bay.

Wave power generation has been seriously considered as part of the Gracetown project and it appears that the technology is well developed but more suited to larger settlements. There is no Western Australian proven wave generation technology suitable for Peaceful Bay.

Wind power generation technology is well developed and used throughout the State. Research shows that turbine generation is most efficient when turbines are located where wind regimes are reliable over an extended period. It is also true that wind power generation needs to be part of a wider power network to cover those times when turbines are not generating. The solution at both Gracetown and Witchcliffe is to purchase Green Power from Western Power. There is the possibility to put in a turbine to offset the power used by a local reclaimed water treatment facility as a token to local sustainability however the current most sustainable power supply is the purchase of Green Power from Western Power to allow renewable energy to be generated in the most efficient locations.

Recommendations:

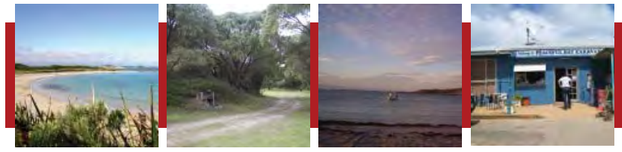
4. *That an integrated sustainable power supply be pursued.*

5. *That the Western Power network and Infrastructure be upgraded to contemporary standards.*

6. *Require the power purchased from the grid to be "Green Power".such as "Natural Power" or "Earth Friendly". The natural power scheme ensures all energy is sourced from renewable sources whereas earth friendly also provides for power supplies to be carbon neutral.*

7. *Utilisation of house based photo voltaic cells to provide a portion of local requirements with any excess power generated fed back into the grid.*

8. *To undertake more detailed investigations into Western Power head works upgrade requirements and develop a mechanism to share these costs equitably across the settlement.*



7.0 WATER SUPPLY

Existing Water Supply

The existing water supply for Peaceful Bay consists of roof top catchment for potable purposes and either roof top catchment, groundwater extraction and/or access to a licenced non-potable water supply scheme operated by the Shire.

Roof top catchment and storage is utilised on all properties for potable purposes although not all sites utilise water tanks with a capacity of 92,000 litres which is the generally accepted standard in the South West of the state.

A non-potable water supply scheme is connected to the 203 lease sites and the caravan park. This non potable supply is operated by and licensed to the Shire of Denmark by the Economic Regulatory Authority. The Scheme is sourced from a pond situated adjacent to the general store. The pond is topped up from a bore located within the Walpole-Nornalup National Park approximately 7km's from the settlement. Water from the pond is pumped into two 54kilolitre holding tanks located on an elevated position behind the General Store and then gravity fed to both the leasehold lots and the Caravan Park.

Water supplied to the caravan park undergoes disinfection (chlorination) via an automated process prior to being pumped into the designated storage tank for caravan park use only. The water for use within the leasehold lots does not undergo any form of treatment and is not intended for human consumption. It is deemed a non potable supply. It is a condition of leases that each dwelling construct and maintain a potable storage tank which has a capacity of at least 4,640 litres of groundwater. It is intended and assumed that rainwater is used to fill these tanks and be used as the potable source for the leasehold dwellings.

Potable Water Supply Context

In W.A. there are 3 main suppliers of drinking water. These are:

- Licensed public drinking water suppliers such as the Water Corporation, Aqwest or Busselton Water Board.
- Privately owned small water systems supplying the public e.g. roadhouses and caravan parks
- Private domestic water supplies.

The source of potable water for each of these suppliers is varied and includes:

- Surface water dams, rivers and soaks
- Groundwater from bores and springs
- Rainwater
- Desalinated seawater or brackish water

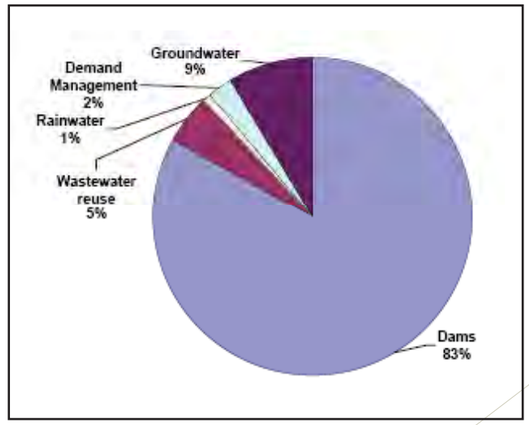


Figure 16 - Sources of Urban Water (2004/2005 water year) (Coombes et al (2007))

On an Australian wide basis it can be seen in *Figure 16 – Sources of Urban Water (2004/2005 water year)* that the majority of the potable water supplies are sourced from dams and ground water and that alternate supplies are still very low. This is also the case in Western Australia.

Approximately 90% of Western Australians are supplied from licensed and regulated water supply schemes. (Department of Health, 2001). In other states however the provision of water from self controlled supplies is more varied.

In Western Australia the Department of Health controls drinking water in public supplies and applies the recommendations of the Australian National Drinking Water Guidelines. All public water suppliers in Western Australia are also required to be licensed by the Economic Regulatory Authority (ERA). Individual households with their own rainwater tanks, dams or bores are not required to be licensed.

Water Supply Options for Peaceful Bay

It is an objective of this report to explore alternative water supplies for Peaceful Bay and not rely on conventional methods.

The range of possible supplies is shown in *Figure 17 –Water Supply Source Options.*

Water Supply

Water	Source	Quality	Treatment Required
Potable mains water	Water Corporation Supply	High	None
Roof Runoff	Roof water stored in tanks	Reasonable	First flush diversion and UV treatment
Stormwater runoff	Stormwater from the site possibly stored in dam or individual tanks	Moderate	Treatment required so can be used for non potable uses
Light Grey Water	From showers, baths, bathroom basins	Cleanest wastewater- low pathogens and low organic content	Treatment required to remove pathogens and organic content
Grey Water	Light Grey water, laundry water, including basin and washing machine	Low quality, high organic loading and highly variable depending on source	High Level of treatment required
Blackwater	Kitchen and toilet water	Lowest quality- high level of pathogens and organics	Advanced treatment and disinfection required
Bore Water	Possible shallow bores- subject to confirmation	Reasonable	Sufficient for non potable, may need treatment for potable use

Figure 17 - Water Supply Source Options

The most conventional option would be to extend or create a Water Corporation supply similar to the options discussed in the Nilson Projects 2003 study commissioned by the Water Corporation titled "Peaceful Bay Desktop Study into Water and Wastewater Services". This report explored several contemporary supply options most of which are prohibitively expensive and do nothing to develop a local sustainable water supply for Peaceful Bay.

The second option is to utilise the roof runoff generated on each lot and to use this water for in-house potable water demands such as:

- Drinking water
- Kitchen use
- Laundry use
- Showering and washing

This option is partly in place now and is the preferred option from a sustainable perspective. This option is further detailed later in this report.

Stormwater can also be a possible water supply source but not currently for potable water demands. Its use for non potable water is acceptable providing treatment occurs to the correct levels.

The remaining water supply options utilise the waste water stream consisting of:

- Light grey water
- Grey water
- Black water

Each of these sources requires varying levels of treatment but cannot be used as a source of potable or drinking water.

Finally, is the possibility of utilising groundwater as a potable source. The Nilson Projects 2003 report suggests that there is a sustainable groundwater supply but the preferred location of bores is within an established National Park and environmental issues may make obtaining approvals difficult.

Potable and Non Potable Water Demand

The average Australian family uses between 250,000 and 300,000 litres of water per year.

This water is used inside and outside the household with approximately 54% of water in Western Australia being used for watering outside the household. This is shown in *Figure 18 – Single Residential Household Usage. Loh and Coghlan (2003).*

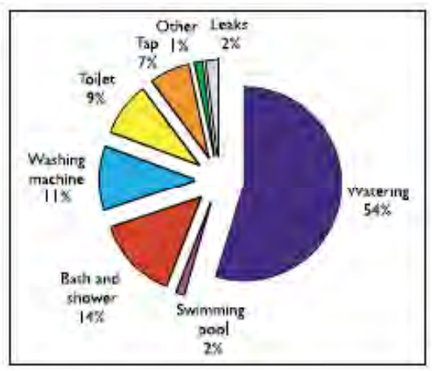


Figure 18 - Single Residential Water Usage, (Loh and Coghlan (2003))

Adding the 9% toilet usage to the 54% garden usage, approximately 63% of water usage is in areas where a non potable supply would suffice. The balance of 37% of the supply then only need be to a potable supply standard.

We therefore propose that the Peaceful Bay potable supply be obtained by rooftop catchment of rainwater and utilisation of storage tanks on each residence.

The design options and standards for rainwater collection and storage systems are provided in *Appendix 2 – Rainwater Systems*

Potable Water Supply Regulatory Framework

It is proposed that each lot provide its own potable water supply via rainwater capture and storage systems. These systems will be fully owned by each landowner and thus the operation and maintenance of these will be fully the landowner's responsibility. As long as the roof areas that feed the system are not shared between different owners, then the responsibilities are relatively straight forward.

The Shire currently require a minimum of 92,000 litres of storage where rain tanks are used except in the leasehold area where 4,640 litre tanks are a lease requirement and the supply is supplemented by reticulated non potable supply.

There may be a need from Council to reduce the 92,000 litre standard if water reuse is part of the ultimate reuse system, although larger tanks do provide a higher level of security to cover abnormal demands on low rainfall years.

No specific regulations apply to rain tanks other than the requirement for a building license from the Local Authority at construction stage.

Recommendations

9. *That rainwater collection and onsite storage is the preferred option for potable water supply for Peaceful Bay.*

10. *That reclaimed (recycled) water from a ERA licensed comprehensive integrated effluent disposal collection, treatment and distribution scheme is the preferred non potable water supply.*

11. *That Council regulation is modified to provide for appropriately sized water tanks.*

8.0 SEWER/NON-POTABLE WATER SUPPLY

Existing Effluent Systems

At present all existing houses at Peaceful Bay have their own onsite effluent disposal systems. There is anecdotal evidence that the high water table in some areas leads to the potential for contamination of the groundwater.

In addition, there is no operational sewerage scheme within the vicinity and therefore any comprehensive sewerage collection and treatment system will need to be stand alone and locally based. Peaceful Bay is not currently within a Economic Regulatory Authority (ERA) Licensed Sewerage scheme area.

More importantly, there is a local desire for an alternative servicing scheme which is more environmentally sound and sustainable.

Effluent Disposal Options

There is a range of possible effluent collection and disposal options for Peaceful Bay.

The simplest system to manage is to collect all effluent from each lot and convey it to a sewer treatment plant within the vicinity of Peaceful Bay. This plant and associated collection system would need a licensed operator that meets the requirements of the Economic Regulatory Authority.

The second option is to collect the effluent and treat it on each individual lot. This option is difficult to implement given the inability of soils at Peaceful Bay to adequately treat effluent and the high groundwater levels which are encountered.

A further option is to collect and re-use the grey water generated by each site and then export the excess grey water and black water off site. In this solution each lot owner is required to maintain a suitable treatment mechanism for grey water. This option has major constraints associated with health and maintenance issues and there is still a requirement for a licensed provider to operate the off site collection and disposal system.

Preferred Peaceful Bay Effluent Disposal System

The preferred system for Peaceful Bay is for all effluent to be collected from each lot, taken off site for treatment and then returned to each lot to meet non-potable water demands. This solution provides for a single licensed operator and allows collected rainwater to be initially used for potable purposes, subsequently treated and returned to each household for non-potable uses.

The re-use of water means that the volume of water necessary to be held at each house is substantially reduced. In addition, issues of ongoing maintenance of onsite disposal systems and responding to high groundwater levels are overcome. The catchment area of roofs will need to be determined through an assessment of rainfall statistics and trends to ensure adequate water is collected for a range of occupancies and climate conditions.

The non-potable water supply would be treated to "Fit for Purpose" standards (previously known as class A+) based on the National Guidelines for Water Recycling which were developed by the Natural Resource Management Ministerial Council and the Environment Protection and Heritage Council (2006).

It is expected that the treated water at Peaceful Bay would be utilised for:-

- Toilet flushing;
- Garden watering;
- Fire fighting;
- Unrestricted Irrigation of open space areas.

Treated water is suitable for use in washing machines but it is possible there could be an initial public resistance to this and so it should not be planned in the initial instance. As the public becomes more knowledgeable about the use of recycled non-potable water, and associated risks, the option to have houses plumbed to allow for treated water to be used in washing machines could be explored further.

The Peaceful Bay treatment system would be expected to be owned and operated by a single licensed service provider. This provider would own and operate:-

- The sewer collection system;
- The sewer treatment plant;
- The non-potable water distribution system.

The provider would charge each lot owner an appropriate annual fee and consumption charges for sewer collection and non-potable water supply.

This Report does not make a recommendation as to who is an appropriate service provider. Providers could be:-

- Shire of Denmark;
- Water Corporation;
- A private Operator in which case assets may be held by a third party and leased to the operator.

The collection, treatment and recycling of non-potable water has been subject to extensive investigations. A schematic of the proposed system for Peaceful Bay is shown in *Figure 19*. This is based on the system planned to be implemented at Witchcliffe.

Regulatory Framework for Non Potable Water

At present there are only a limited number of licensed schemes in Western Australia that provide a non potable supply.

The Shire of Denmark currently operates the existing non potable supply scheme for Peaceful Bay and with assistance of a private operator could possibly own and operate the proposed new scheme. This is a similar model to the Witchcliffe scheme where the Shire of Augusta Margaret River will operate the non potable scheme in conjunction with private operator United Utilities Australia.

Other Shires such as in Kalgoorlie also provide non potable supplies from treated effluent but only to Golf Courses and similar uses, not to residences.

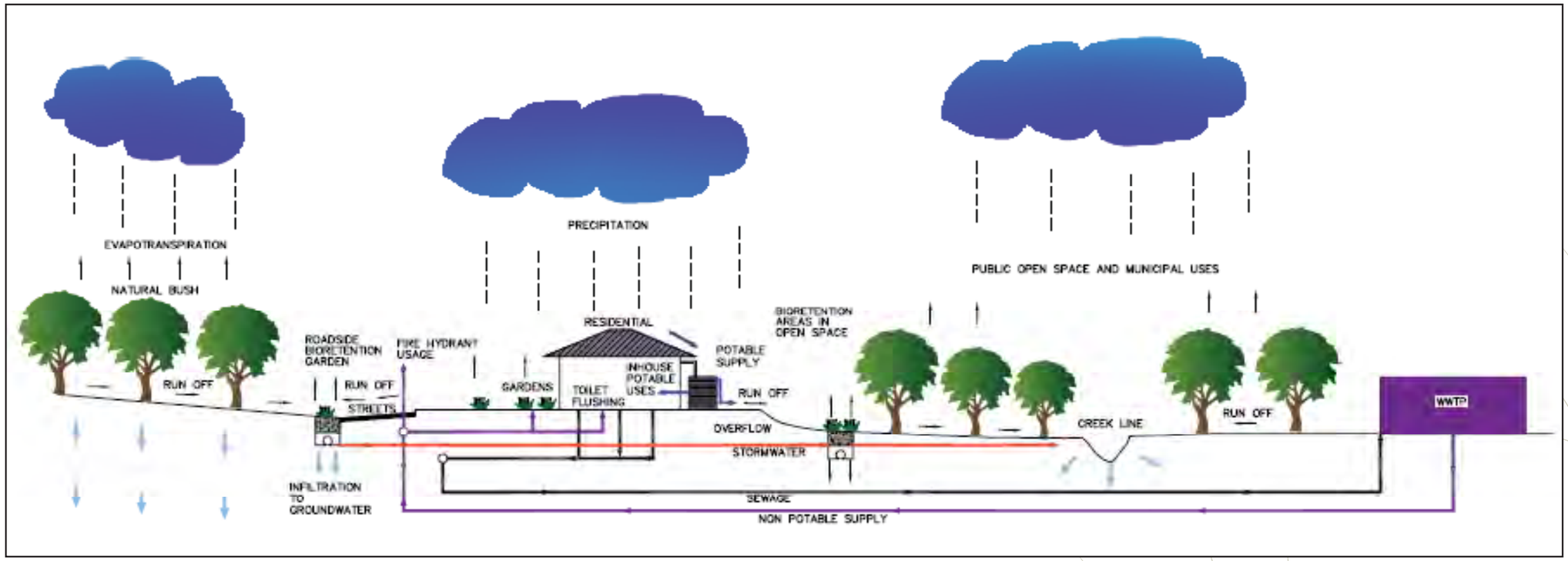


Figure 19 - System Schematic

The proposed non potable scheme at Peaceful Bay will be similar to that proposed at Witchcliffe and Gracetown and would be one of the first schemes constructed in Western Australia that provide 'Fit for Purpose' (Class A+) treated effluent as a non potable supply.

Because of this it is considered that the main challenge for this project will be the gaining of the required institutional approvals for the scheme rather than the technical issues of the scheme.

The *Water Services Act* requires that a licensed service provider licensed by the Economic Regulatory Authority (ERA) must operate the non potable water scheme.

A licensed provider is also required to run the sewer collection and treatment scheme and in this instance it is proposed to be the same operator.

The service provider will need to meet all requirements of the ERA before a license is granted. The ERA is also likely to seek the advice of the Department of Health as part of this process.

The construction and operation of the WWTP to deliver the 'Fit For Purpose' (class A+) non potable water supply will require approval from the Department of Health (DoH) and a license from the Department of Environment and Conservation (DEC).

A works approval will be required from the DEC and this will address all construction aspects of the WWTP. Subsequently a Part 5 License (to operate) would be issued by the DEC.

The construction and operation of the plant may also require an approval from the Environmental Protection Authority (EPA).

Waste Water Treatment Plant Site

The endorsed Peaceful Bay Local Structure Plan nominates a waste water treatment plant site and buffer. The location of this site is supported although it may be necessary to reconsider the treatment plan buffer requirements at such time as the treatment plant is designed and odour and risk impacts can be assessed in more detail.

Recommendations

12. *That Council endorse the principle of a preferred effluent disposal/non potable water supply system for Peaceful Bay which allows collected rainwater to be initially used for potable purposes and all effluent being collected from each lot, taken off site for treatment and then returned to each lot to meet non-potable water demands. The system is to have a single licensed operator which could be; the Shire of Denmark; Water Corporation; a private Operator in which case assets may be held by a third party and leased to the operator.*

13. *That the Waste Water Treatment Plant Site nominated in the Peaceful Bay Local Structure Plan is retained and the buffer requirements reassessed when the facility is designed to a point where risks and odour can be assessed further.*

14. *That Council monitor current discussions and negotiations occurring in respect to Gracetown and Witchcliffe, each of which is currently pursuing establishment of a sewerage and third pipe water re-use scheme similar to that recommended for Peaceful Bay.*

9.0 IMPLEMENTATION STRATEGY

The proposed Servicing Strategy recommended in this report is innovative and at the cutting edge of current technology. This implies a higher order of management as many of the operational models currently used for subdivision and development will not apply.

Greenfield sites suffer from the disadvantage of significant upfront costs to establish and upgrade infrastructure such as water treatment plants, roads, drainage treatment trains and major power infrastructure. The need to fund this upfront infrastructure very often makes projects difficult to fund and therefore initiate.

Peaceful Bay enjoys the position that leasehold lots already exist on the site and there is a potential for these lots to be sold in a manner which is respectful of the existing leaseholders and generate considerable funds to help in the establishment of the head works upgrades.

Private Developers will also need to make a proportional contribution to the establishment of head works, although it needs to be recognised that these developers do not enjoy the captured market of the existing leaseholders and therefore are unlikely to enjoy the same sales rates as could be expected in the leasehold area.

The development of Peaceful Bay in accordance with the Peaceful Bay Local Structure Plan ultimately consists of 689 lots plus a caravan park site. Even the developed areas of Peaceful Bay will require considerable upgrading in terms of servicing infrastructure. This scale of development implies a high level of management and fiscal responsibility. We believe that Council should be engaging external management to coordinate these works in a responsible manner. This management may be provided through a government instrumentality, such as LandCorp, or from the private sector. Council may also seek to employ a full time Project Manager with suitable experience.

Recommendation

15. *Council should engage the services of a Project Manager to prepare a project delivery plan and indicative project budget for the delivery of infrastructure services at Peaceful Bay. The scope of project services should encompass but not necessarily be limited to:*

    - *determining a fair process for privatising leasehold lots;*
    - *entering into negotiations to deliver an integrated waste water collection, treatment and distribution system in a manner consistent with the recommendations of this report;*
    - *Investigate the level of government's assistance which may be available to assist in the project;*
    - *progress the necessary statutory rezoning and subdivisions needed to facilitate implementation of the Peaceful Bay Structure Plan and the recommendations of this Servicing Report;*
    - *prepare a full feasibility analysis for the project and identify staging which will allow the project to occur in a economically and environmentally responsible manner; and,*
    - *to establish the extent of cost share items which all subdividers and developers will need to contribute to and report on a mechanism which will allow this to occur.*

APPENDIX 1 –

WATER SENSITIVE DESIGN

1.0 WSUD METHODS

The range of WSUD methods that are available for application to this site include

- Gross Pollutant Traps
- Swales and Buffer Strips
- Bioretention Swales and Basins
- Sedimentation Basins
- Constructed Wetlands
- Infiltration Measures
- Sand Filters
- Aquifer Storage and Recovery

These methods are all effective for various flows and particle sizes as shown in *Figure 1* and are briefly described in sections 1.1 to 1.9 of this report.

Only simple concepts are given to aid in understanding of the strategy presented this report.

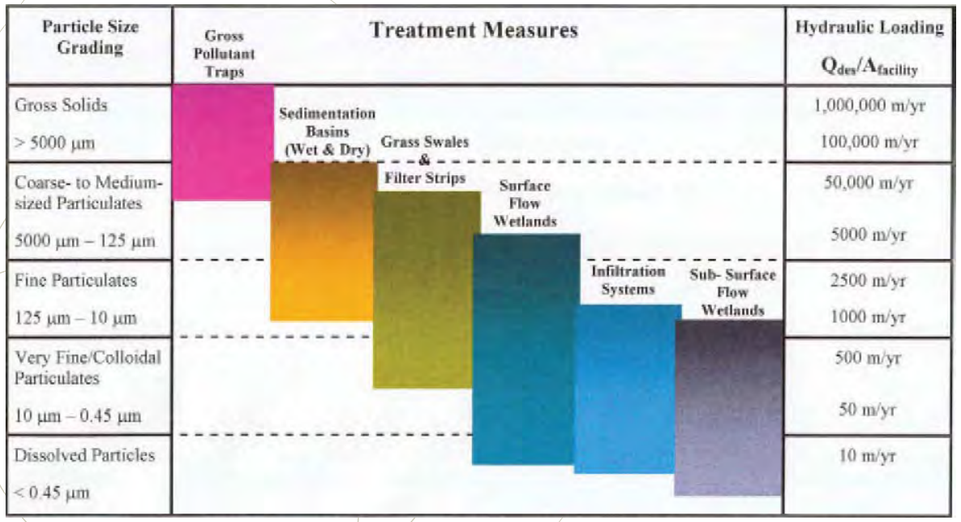


Figure 1 - Pollutant size ranges for various stormwater treatment measures. Ecological Engineering (2003)

Figure 1 demonstrates that each method is applicable over a limited range of particle sizes and hydraulic loadings and that a careful combination of methods is required to ensure effective WSUD on a site.

In the preparation of a WSUD strategy for a site, a set of targets is normally set to guide pollutant and nutrient removal effectiveness.

For this site the general targets that will be adopted include minimums of:

- 80% reduction in total suspended solids
- 60% reduction in total phosphorus load
- 45% reduction of total nitrogen load
- 70% reduction in gross pollutant load

These will be assessed against the design charts provided in DOE (2004) for various removal efficiencies for each type of WSUD method and are consistent with current DOW recommended pollutant removal targets in the draft Urban Water Management Framework for the Swan Coastal Plain, EES (2007).

1.1 GROSS POLLUTANT TRAPS

The general principles of Gross Pollutant Traps are:

- Capture large sediments and gross pollutants, removing these from stormwater at the start of treatment trains and preventing clogging of later elements such as infiltration systems
- Generally capture particles greater than 5mm
- Are normally located at the entry point of stormwater into the system
- Need a high maintenance as regular cleaning required to remove collected trash and sediment
- Reduce litter, debris and coarse sediment from entering system
- Are proprietary (off the shelf) designs with a wide choice available

Key design considerations include:

- Location - need to be accessible and not too visible
- Treatment Objectives - clearly target particle sizes to be removed
- Design Flows - generally only design for 1 in 1 year flows to capture 99.5% of all storms

- Flood capacity - need to allow for impact of large flows
- Trapped Pollutant Storage will determine frequency of cleaning
- Maintenance needs to fit with shire capacity to maintain

Examples of GPT's are shown in *Figures 2 to 4*.

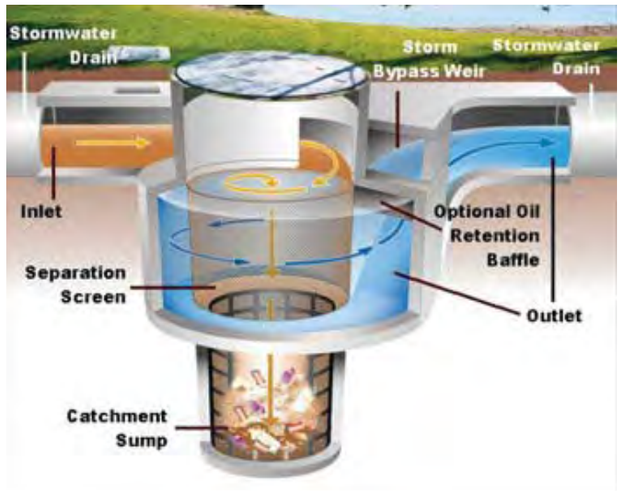


Figure 2 - Gross Pollutant Traps- CDS Pit

Figure 3 - Gross Pollutant Trap being cleaned

Figure 4 - Grated lid on entry to pipe system acting as partial GPT by trapping large litter and leaf material. Lynbrook, Vic.

As seen in *Figure 4* some normal elements of a stormwater system can also have a dual function. The grated lid on the entry to the subsoil pipe system here below the central swale, is also acting as a GPT by trapping large litter and leaf matter and preventing it entering the system. Sediment in this system is trapped by vegetation in the base of the swale system.

It is proposed to utilise a similar system of trapping sediments and litter in the system for Peaceful Bay.

1.2 SWALES AND BUFFER STRIPS

The general principles of Swales and Buffer Strips are:

- Swales convey stormwater in overland flow rather than piped systems;
- Commonly combined with buffer strips to maximise removal of fine particle sizes;
- Slopes generally less than 4% as steeper slopes create scour and reduce pollutant removal efficiencies;
- Means of disconnecting impervious areas form waterways;
- Vegetation traps sediment and aids in reducing total suspended solids and attached pollutants; and
- Particularly good at coarse sediment trapping as first step in a treatment train.

The key design considerations are:

- Landscape Design, very effective method to use that can be integrated with landscape treatments;
- Hydraulic Design, capacity needs to allow for appropriate design flows;
- Vegetation Types need to be selected to cater for flows and wetting regimes;
- Driveway Crossings need to be incorporated into the design to ensure new residences don't fill the swales and lower their effectiveness;
- Traffic Controls may be required in areas to keep vehicles out of the swales;
- Roof Water Discharge can be directed into the base of the swales to further reduce the need for piped systems; and
- Services need careful integration with the swale design to ensure adequate access and cover is maintained.

Various examples of swale systems are shown in *Figures 5 to 8* and various combinations of the elements of each of these can be integrated into a final design for a site.

Figure 5 - Grassed Swale

Figure 6 - Grassed and Rock Swale

Figure 7 - Rock Swale

Figure 8 - Narrow vegetated swale

Special design details such as shown in *Figure 8* can aid in the operational effectiveness of swale systems. Appropriate kerb profiles can prevent build-up of sediment adjacent the kerb line that can subsequently prevent free flow of water into the swale system.

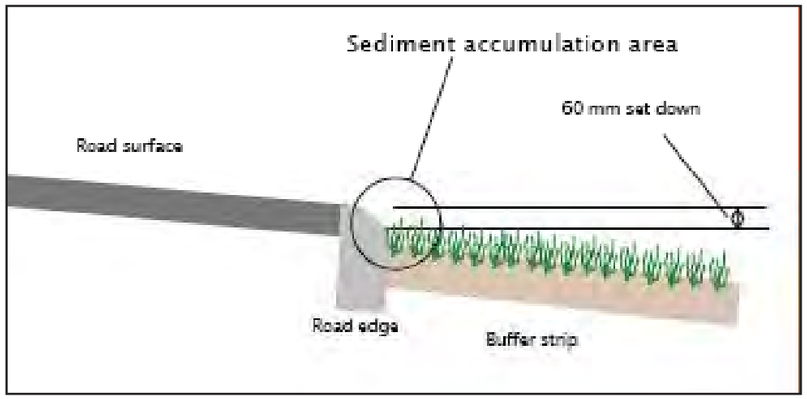


Figure 9 - Kerb Treatment for Swale Systems, (Brisbane City Council (2006))

It is proposed that the system for Peaceful Bay will contain swales in select locations as described in Section 1.6 of this report.

Low water use native plants and rock mulch will be incorporated into the swale designs to remove the need for supplementary watering of the swale areas.

1.3 BIORETENTION SWALES AND BASINS

The general principles of Bioretention Swales and Basins are to:

- Provide both conveyance and treatment functions and reduce reliance on pipe systems;
- Remove coarse sediments;
- Filter runoff through surface vegetation and through percolation through soils;
- Soils and vegetation also allow biological uptake;
- Disconnect impervious areas from waterways;
- Reduces flow velocities and peaks; and
- Desirable maximum grade 4%.

The general principles of a bioretention system combined with a vegetated swale are shown in *Figure 10*.

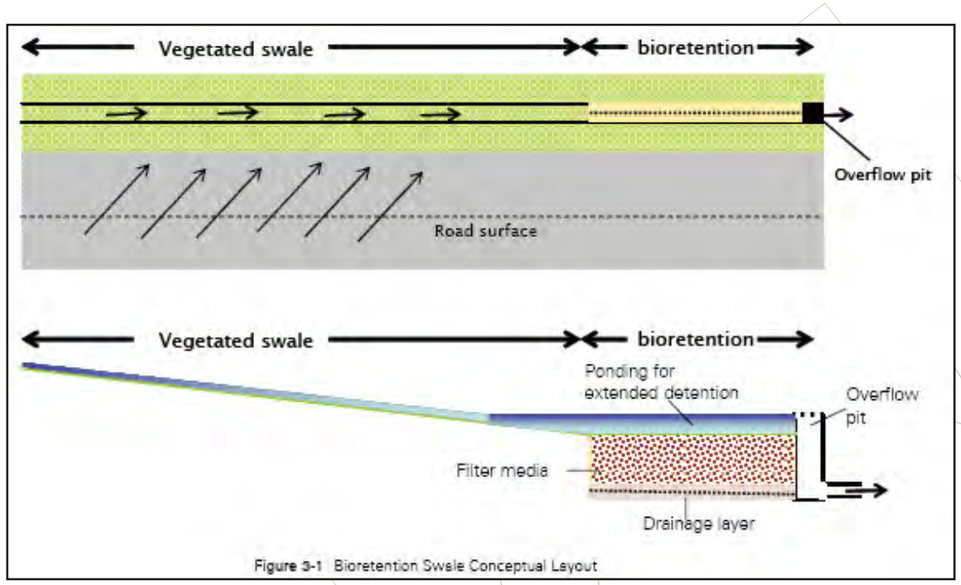


Figure 10 - Bioretention Swale Conceptual Layout

Key Design Considerations include:

- Landscape Design, very effective method that can be integrated with landscape treatments
- Hydraulic Design, capacity needs to allow for appropriate design flows
- Vegetation Types need to be selected to cater for flows and wetting regimes
- Exfiltration from Insitu Soils needs to be assessed and appropriate filter layers provided
- Bioretention Filter Media needs to be carefully selected to enhance performance of the system
- Driveway Crossings need to be incorporated into the design to ensure new residences don't fill the bioretention areas and lower their effectiveness
- Traffic Controls may be required in areas to keep vehicles out of the swales.
- Roof Water Discharge can be directed into the base of the swales to further reduce the need for piped systems
- Services need careful integration with the swale design to ensure adequate access and cover is maintained.

A typical section of bioretention systems are shown in *Figures 11 and 12.*

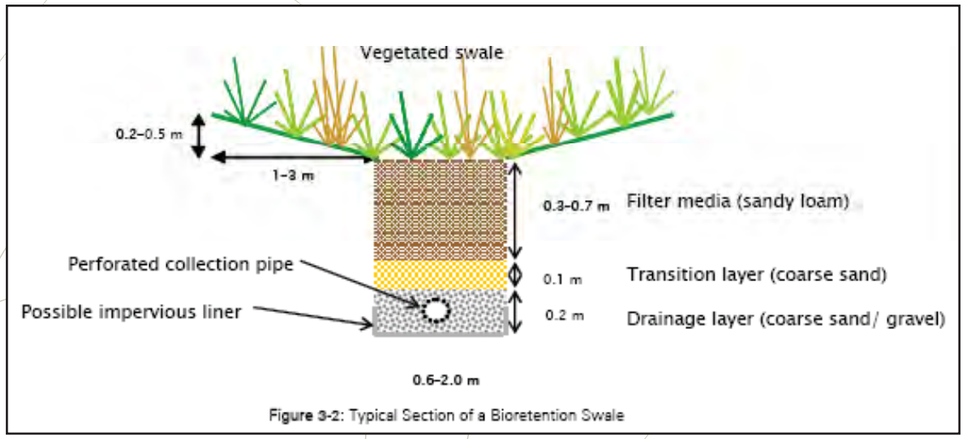


Figure 11 - Bioretention Swale Typical Section (Brisbane City Council (2006))

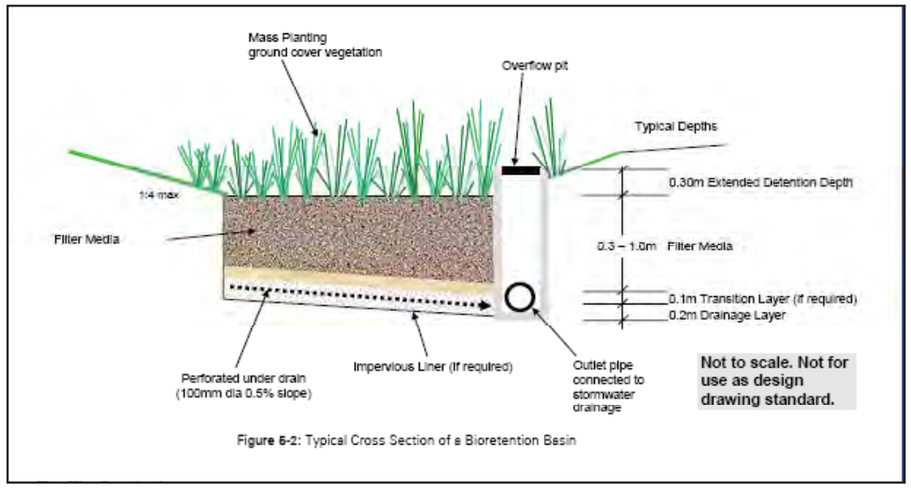


Figure 12 - Bioretention Basin Typical Section (Brisbane City Council (2006))

Examples of constructed Bioretention systems are shown in *Figures 13 and 14.*

Figure 13 - Bioretention Basin, Treendale , Australind, (TME)

Figure 14 - Bioretention Swale at Lynbrook, Victoria.

Bioretention systems feature extensively in the WSUD system proposed for Peaceful Bay. The main form of the bioretention systems to be used includes road side Bioretention gardens or Biopods as shown in *Figure 15*.

These are planned to be constructed at the end of each residential cell and enable ready capture and treatment of stormwater in discrete and easily maintainable locations.

Low water use native plants and rock mulch will be incorporated into the bioretention swale and basin designs to remove the need for supplementary watering of the bioretention areas.

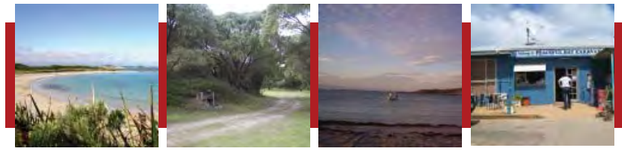


Figure 15 - Roadside Bioretention Garden, Wells Road, Chelsea Heights, Melbourne, (Kingston City Council (2007))

1.4 SEDIMENTATION BASINS

The general principles of Bioretention Swales and Basins are:

- They remove coarse and medium sized sediments by settling them from the water column
- Can be permanent or temporary systems used in early construction phases
- Reduce flow peaks and volumes by their detention properties
- Form part of an integrated WSUD treatment train

Key Design Considerations include:

- Role in Treatment Train and appropriate siting
- Sizing of Sedimentation Basin to ensure adequate storage volume for particles collected
- Sediment Storage needs to be adequate size and accessibility
- Outlet Design must match required outflow rates
- Must be integrated into the Landscape Design
- Vegetation needs to be carefully specified
- Maintenance aspects need to be incorporated into the design.

A schematic of a permanent sedimentation basin is shown in *Figure 16* and key design features in *Figure 17*.

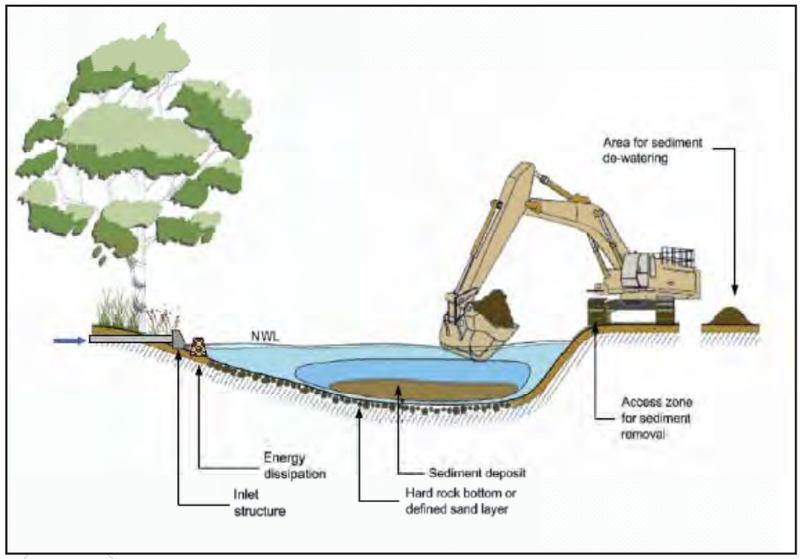


Figure 16 - Sedimentation Basin Conceptual Layout (Brisbane City Council (2006))

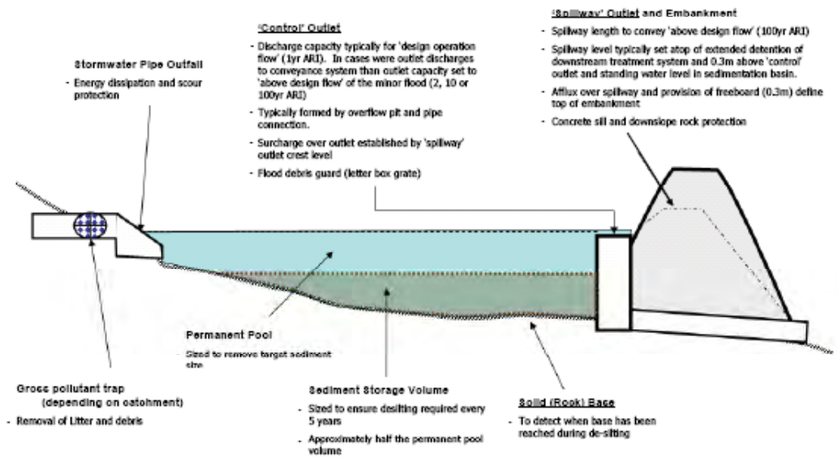


Figure 17 - Sedimentation Basin Key Elements (Brisbane City Council (2006))

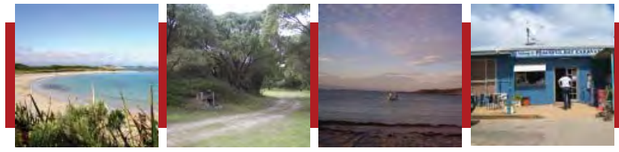
Sedimentation basins are planned to be integrated into early phases of development while sediment loads are high but would be removed once the land form stabilises and the sediment load reduces.

An example of a temporary sediment basin is shown in *Figure 38* from a development in Edenbrook Estate, Queensland.

Figure 18 - Temporary Sedimentation Basin, Edenbrook Estate, Queensland

In this example the temporary basin is constructed adjacent the main creek line through the centre of the site and captures all sediment from the stormwater system. Once the site is established this system will be backfilled and landscaped.

The same concept will be used at Peaceful Bay after initial clearing of the site and also in the early development phases.



1.5 CONSTRUCTED WETLANDS

The general principles of Constructed Wetlands are:

- Shallow extensively vegetated water bodies
- Use enhanced sedimentation, fine filtration and biological uptake to remove pollutants from stormwater
- Reduce flow peaks by detention storage in the wetland
- Provide habitat for local fauna
- Can be designed as a landscape feature
- Provide opportunities for passive recreation
- Use large land areas compared to other methods

Key Design Considerations include:

- Integration into overall landscape design is essential
- Detention Time and Hydrologic Effectiveness need to be set to suit pollutant levels and flow regimes
- Hydrodynamic Design needs to match flow regimes
- Inlet Zone needs careful design to allow for sedimentation and flow attenuation
- Macrophyte Zone needs to be designed to ensure it will function adequately and will be sustainable
- Vegetation Types need careful selection
- Design features need to be incorporated to avoid mosquitoes
- Design required for maintenance access

Diagrammatic representations of the various zones within a wetland and their interrelationship are shown in *Figures 19 and 20*.

These show the various zones that make up a wetland including:

- Inlet zone
- High flow bypass
- Shallow marsh
- Marsh
- Deep marsh
- Ephemeral zone
- Pool
- Outlet zone

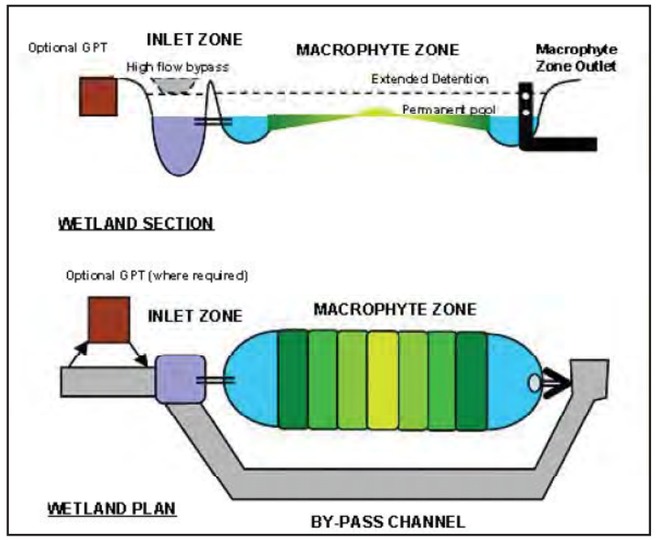


Figure 19 - Wetland Design Features, (Brisbane City Council (2006))

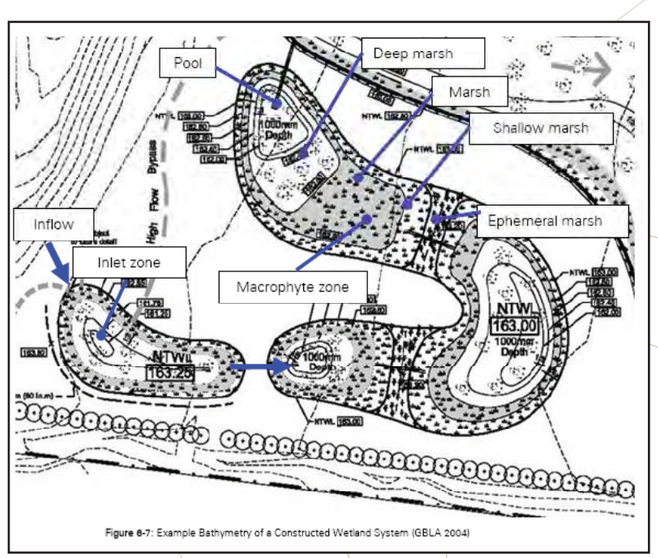


Figure 20 - Example Bathymetry of a Wetland System, (Brisbane City Council (2006))

It is not intended to include any constructed wetlands within the Peaceful Bay WSUD strategy although adjacent land owners may elect to incorporate these features on their land if conditions permit.

1.6 INFILTRATION MEASURES

The general principles of Infiltration measures are:

- Capture stormwater and encourage infiltration near to source
- Reduce runoff peak flows and volumes in small rainfall events
- Reduce downstream flooding
- Improve groundwater discharge
- Reduce pipe system sizes for smaller events
- Not a treatment system other than trapping coarse sediments and associated insoluble pollutants

Key Design Considerations include:

- Design Objectives of infiltration of 1 in 1 year near source
- Selecting Type of Infiltration System to match particle sizes of materials in the development
- Design (Sizing) Methods to match storage size with infiltration capacities
- Pre-treatment of Stormwater may be required to ensure no clogging of the system
- Site Terrain may restrict applicability of these methods
- In-Situ Soils need to be of sufficient infiltration capacity
- Groundwater levels must be low enough not to influence infiltration capacity
- Building Setbacks (clearances) may be required from infiltration devices
- Flow Management of larger events required (> 1 in 1 year ARI)

Infiltration systems are particularly effective where sites consist of deep sandy soils. A range of systems are available as shown in *Figure 21*.

Where there is only shallow sand layers over clayey soils, such as at Witchcliffe then modified systems are required.

Such a system was used by TME at Boronia Ridge in Walpole and is featured in the Chapter 9 of the Stormwater management manual for Western Australia, DOE (2004) and is shown in *Figure 22*.

In this system the surface sandy soils are relatively shallow and so infiltration into the surface profile only was encouraged.

Storage and infiltration was designed for the 1 in 1 year ARI events and larger flows were then overflowed into a classic pipe system.

This enabled larger flows (greater than 1 in 1 year ARI) to be conveyed to the outlet dissipater at the bottom end of the system.

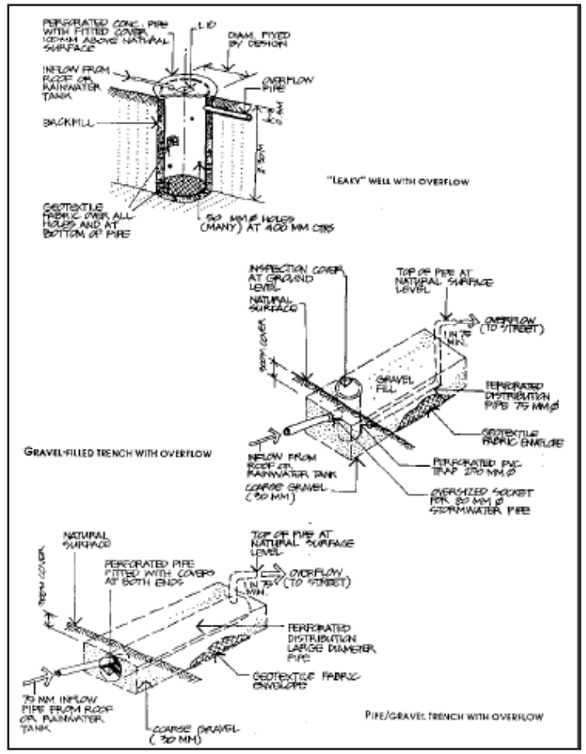


Figure 21 - Infiltration Systems, (Engineers Australia (2006))

It is proposed at the areas of the Peaceful Bay site where sandy soils are present in sufficient depth that these systems be integrated into the final design solution.

It is an effective means of encouraging infiltration where the soils permit and reducing down-stream flows and pipe sizes and requirements.

Figure 3. Side entry pit and bubble-up located within mulched detention area. (Photograph: TME 2003.)

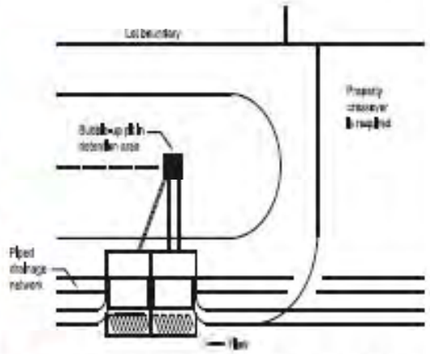


Figure 4. Plan view of the pipe network with bubble-up connection to the piped system. (Source: TME 2003.)

Figure 5. Soakwell construction. (Photograph: TME 2003.)

Figure 6. Construction of side entry pits to capture road runoff and divert it into soakwells that have bubble-up lids and are located within a detention area. (Photograph: TME 2003.)

Figure 22 - Boronia Ridge Stormwater Infiltration System, DOE (2004) Chapter 9 released in 2007.

1.7 SAND FILTERS

The general principles of Sand Filters are:

- Similar to Bioretention systems
- Passes through media that has no vegetation on surface
- Reduced performance compared to Bioretention systems
- More maintenance and can clog easier
- Not used much in WA

An indicative layout is shown in *Figure 23*. These systems are not planned to be used at Peaceful Bay.

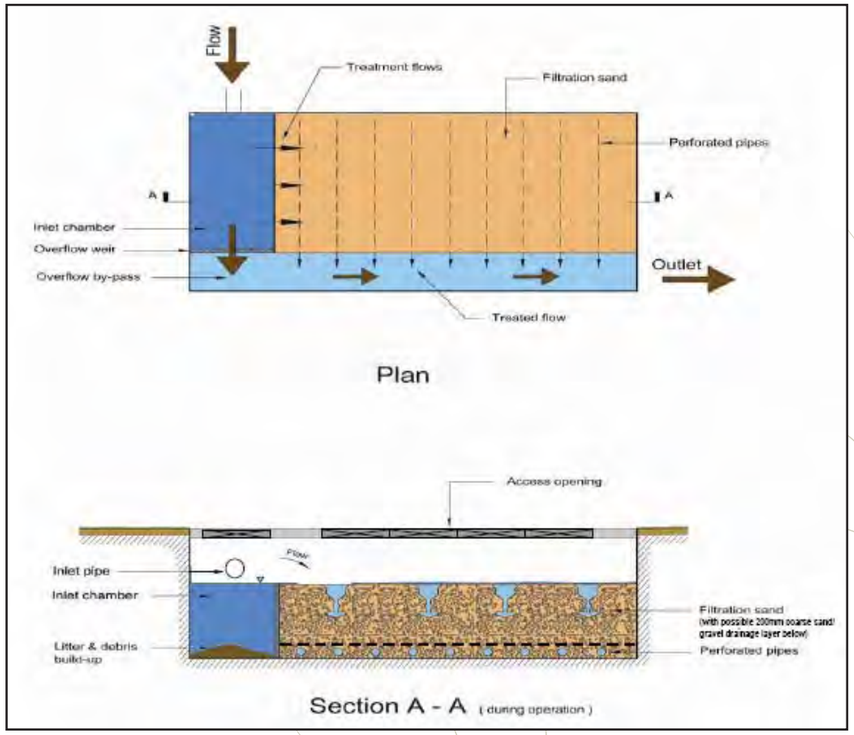


Figure 23 - Sand Filter Schematic, (Brisbane City Council (2006))

1.8 AQUIFER STORAGE AND RECOVERY (ASR)

The general principles of Aquifer Storage and Recovery are:

- Introducing recycled water into underground aquifers
- Via direct injection or gravity flow
- Can be low cost water storage compared to surface storage
- Can reduce losses
- Need to ensure don't reduce quality of the aquifer
- Store excess flows in wet period for reuse in dry periods
- Used extensively in South Australia

These systems are used extensively in South Australia and require suitable aquifer properties to allow ready injection and recovery of the treated stormwater.

The aquifer at Peaceful Bay is not considered suitable for this method and also it is anticipated the groundwater rise on the site would prevent such methods being used effectively. A schematic of an ASR scheme is shown ion *Figure 24*.

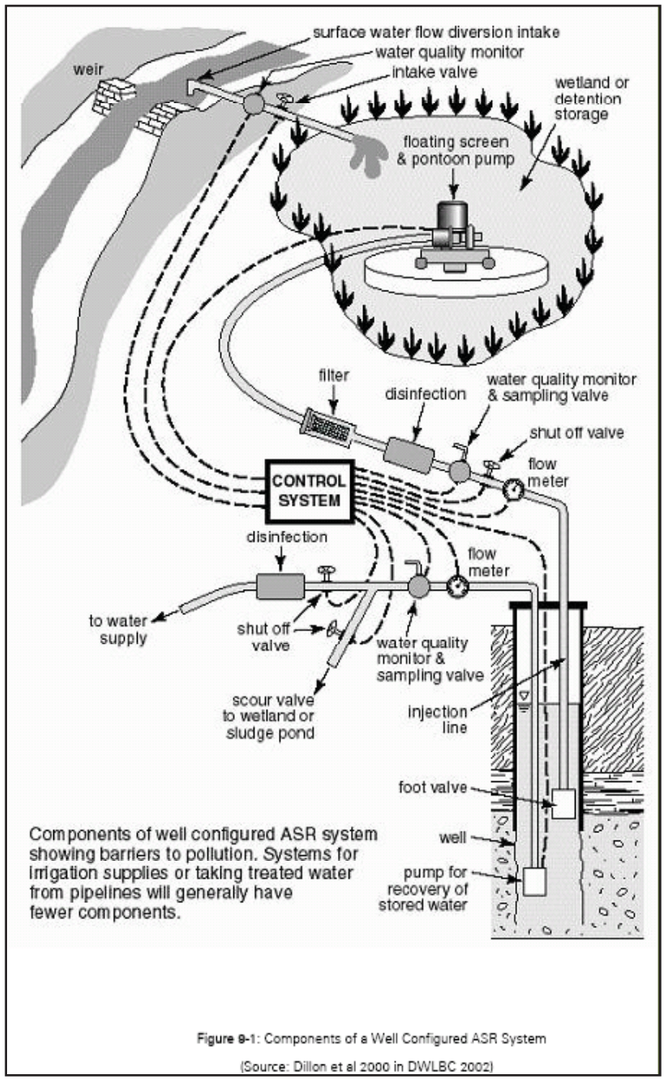


Figure 24 - Components of a Well Configured ASR System (Brisbane City Council (2006))

1.9 COMPARISON OF METHODS

In selection of the appropriate methods for use at the Peaceful Bay site a balance between a number criteria needs to be considered including:

- Soil conditions
- Climate
- Hydrology
- Integration with landscaping
- Capital cost
- Maintenance cost
- Public acceptability
- Environmental benefits

Each of the various methods also has varying land requirements as shown in *Figure 25* with generally the infiltration and bioretention systems having the smallest required footprints.

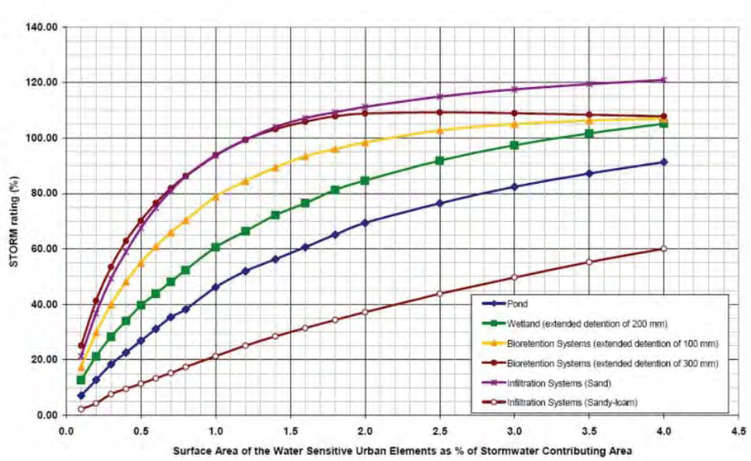


Figure 25 - Comparison of surface areas required for each type of WSUD method. (Wong)

APPENDIX 2 -

RAINWATER SYSTEMS

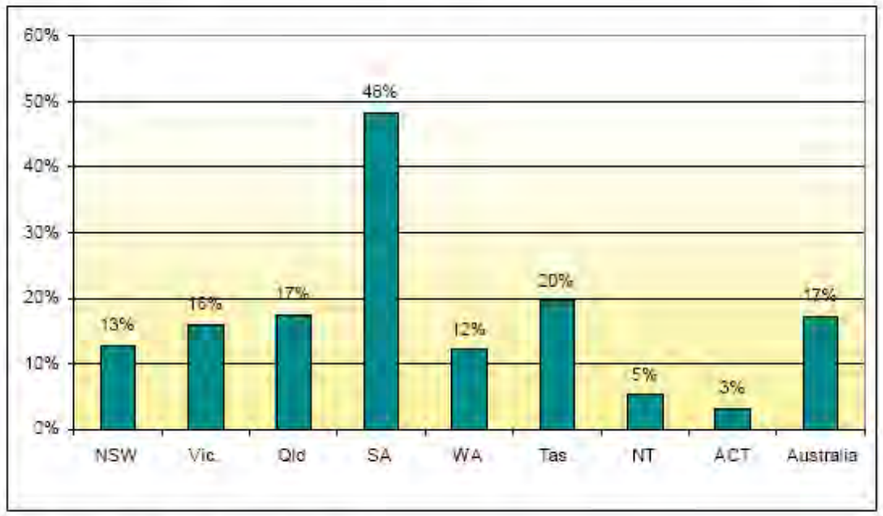
1.0 RAINWATER SYSTEMS

Rainwater tanks are currently installed in around 17% of Australian households but still only provide a small portion of potable supplies.

In some states such as South Australia the proportion of rainwater tanks is very high at 48% but it is thought this is largely due to the historically poor taste of the tap water. More recently this has improved and the take up rate of rain tanks has declined. Marsden Jacob Assoc (2007)

This high proportion of tanks in South Australia is shown in *Figure 1*.

Figure 5: Proportion of households with a rainwater tank (March 2004)



Source: ABS Water Account Australia 2004-05

Figure 1 - Proportions of Households with a Rainwater Tank, Marsden Jacob Assoc (2007)

"Roof run-off or rainwater generally provides a supply of clear, very soft and low salinity water" Department of Agriculture, 2004.

Providing systems are installed correctly with all recommended practices adopted then rain water systems present very safe means of supply.

Rain tank systems should be installed in accordance with established guides such as produced by the Department of Health.

Rain tank systems can be either above ground or below ground systems as shown in *Figures 2 and 3.* Above ground systems are much cheaper however and are favoured where land is readily available for the required footprint of the tank.

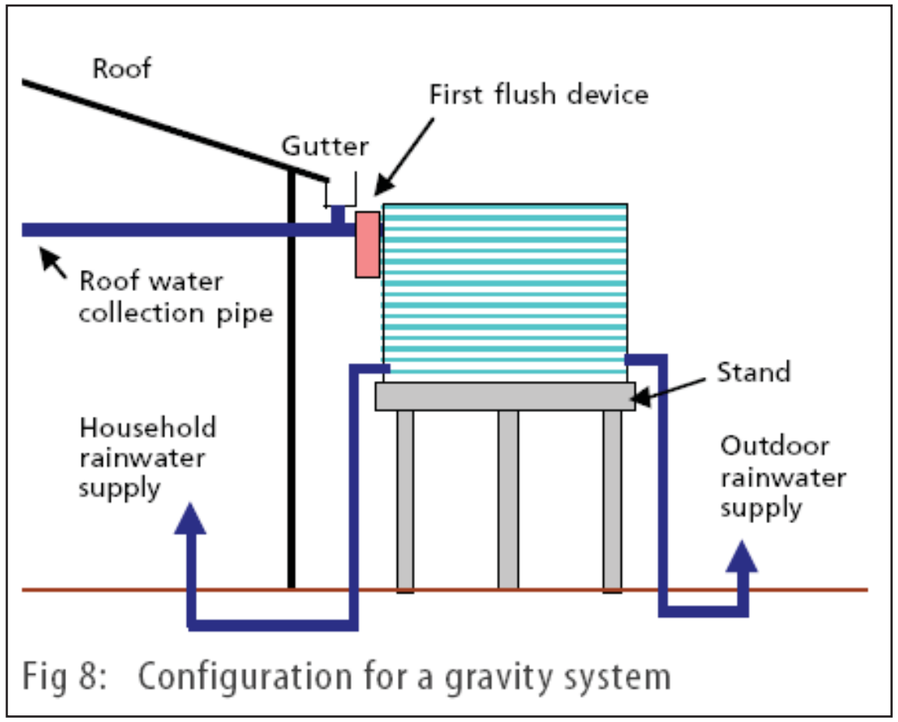
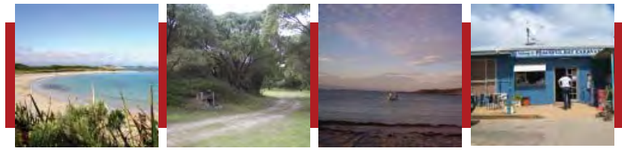


Figure 2 -Configuration of Above Ground System, LHCCREMS, 2002



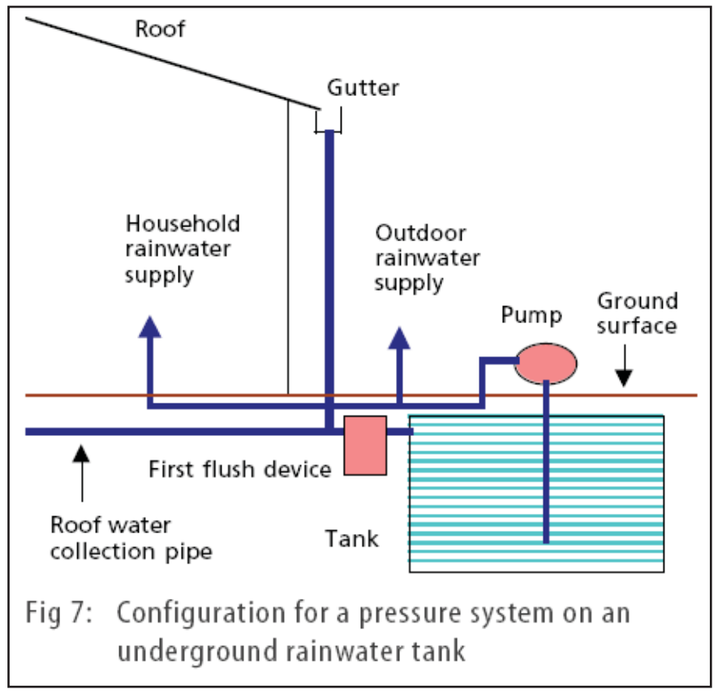


Fig 7: Configuration for a pressure system on an underground rainwater tank

Figure 3 - Configuration of Pressure System on Below Ground System, LHCCREMS, 2002

Various types and sizes of tanks available on the market and their size will depend on roof area and reliability required. Each tank is proposed to be owned and maintained by the individual lot owners.

Examples of various tanks are shown in *Figures 4 and 5*.

Figure 4 - Above Ground Rain Tanks

Watercell™ - Rainwater reuse system

Figure 5 - Below Ground Rain Tank

1.1 FIRST FLUSH DIVERTERS

Effective water quality treatment in the rain tank system will require the correct use of first flush diverters.

These devices allow for a proportion of first flush into rain tanks to be diverted automatically to remove litter and sediment load. This increases water quality , reduces tank maintenance and protects pumps by removing the sediments and pollutants generally associated with the first flush events.

They are used generally in conjunction with litter traps on gutters and entry to tanks.

Examples of a first flush diverter are shown in *Figures 6 and 7*.

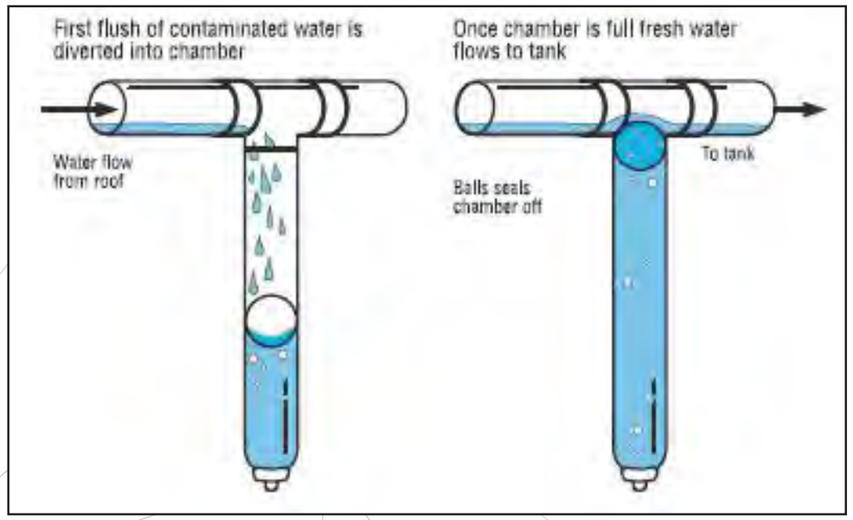


Figure 6 - First Flush Diverter Operating Principles, (Rain Harvesting (2007))

Figure 7 - First Flush Diverter

1.2 LITTER GUARDS

Litter guards are used on rainwater tank systems to prevent leaf litter going into the rain tank. They are an integral part of correct operation and maintenance of the tank system. An example is shown in *Figure 8*.

Figure 8 - Litter Trap

1.3 UV DISINFECTION

To provide a secure and safe water supply free of bacteria and other pathogens it is also recommended that a UV lamp be used to disinfect water prior to flow inside the house for potable use.

UV light systems require relatively low maintenance and have the advantage of not requiring chemicals. These systems should also include a sensor that clearly indicates when the lamp is not operational. enHealth, 2004.

An example of a system is shown in *Figure 9*.

Figure 9 - UV Disinfection System

1.4 RAINWATER TANK MAINTENANCE

Correct and safe operation of rain tank systems requires a simple and effective maintenance protocol. Numerous guides are available for maintenance of rain tank systems in including Department of Health, 2005

General principles of tank maintenance and operation include:

- Keep gutters and roofs clean and in good repair
- Use first flush diverters
- Use a litter trap on the inlet to the system
- Screen the inlet and overflow for insects/ animals
- Cover and seal the tank to prevent the entry of sunlight, dust, animals, mosquitoes and other insects
- Install a properly fitting manhole cover for access and cleaning
- Use materials compliant with Australian Standards for drinking water purposes
- Only clean tank when sediment levels become unacceptably deep
- Draw water from the tank from above the anaerobic/ sediment layer

1.5 WATER USE REDUCTION

To aid in minimising the amount of rainwater required to service each house it is also recommended that water use reduction methods be undertaken or encouraged for each householder.

This includes promoting:

- Use water efficient devices
- Reduce garden usage
- Water conservation within household
- Ongoing education

The largest incentive for households will be the awareness of their own supplies and the capacity of these supplies to serve throughout a summer period. This is unlike houses that have a piped supply where no limitations on supply are even considered by the householder except possibly for garden watering in times of restrictions.

Figure 10 - Water Saving Appliances