Policy 11: Land Development Guidelines

Section 13 Water Sensitive Urban Design (WSUD) Guidelines

13.2 WSUD – Conceptual Design

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13.2.1 Background

The purpose of this section is to provide guidance on the development of a Conceptual Stormwater Management Plan (CSWMP). The application of WSUD requires significant input from a range of professions and it is essential that a logical process is followed which considers not only the implementation of WSUD practices, but integrates these within the overall urban design framework.

This section addresses the recommended planning and design process, site planning concepts and practices that should be incorporated into the design of Greenfield and infill development. The practices presented are central to effective site planning and design of stormwater management facilities and the protection of receiving waters throughout the Gold Coast. The main focus of these Guidelines is the consideration of stormwater management in the initial layout and design of a development rather than as an ad-hoc development requirement or one that is left until all other elements (such as lot layouts, street design, hydraulics, etc) have been completed.

13.2.1.1 How to Use this Section

This section is provided to assist developers, surveyors, planners, landscape architects, engineers and all other professionals involved in the initial assessment and layout of a development. It presents basic overviews of the process, and where necessary, refers the user to documents that contain greater detail or other processes which may need to be followed to successfully implement WSUD.

The procedure outlined in this section should be reviewed before any detailed site planning is undertaken to ensure that WSUD can be integrated within the overall development easily, rather than taking a simple 'end-of-pipe' approach.

Where relevant, this document refers to other Council policies and guidelines and external documents, for example:

- **Gold Coast City Council Planning Scheme**;
- **Land Development Guidelines – Standard Specifications and Drawings**;
- **Land Development Guidelines** – Other chapters in **Section 13.0**, **Section 3.0**;
- **Stormwater Management Guidelines**;
- **MUSIC Modelling Guidelines**;
- **Gold Coast City Landscape Strategy**;
- **Australian Runoff Quality**.

13.2.1.2 WSUD Planning Process

To achieve the most optimal outcome in the application of WSUD principles and measures within a development, integration of detailed planning, engineering, landscaping and ecology is an absolute necessity. For this to occur, a process which addresses the relevant tasks in a logical manner is required.

The process set out below highlights key steps in the overall conceptual design process and identifies which professionals are required for input. In the majority of cases, the WSUD professional will lead a team through the required tasks, or at least seek to facilitate the team through it. This process cannot be conducted separately to other processes such as the overall urban, engineering or landscape design and may require several iterations through the overall urban development project.

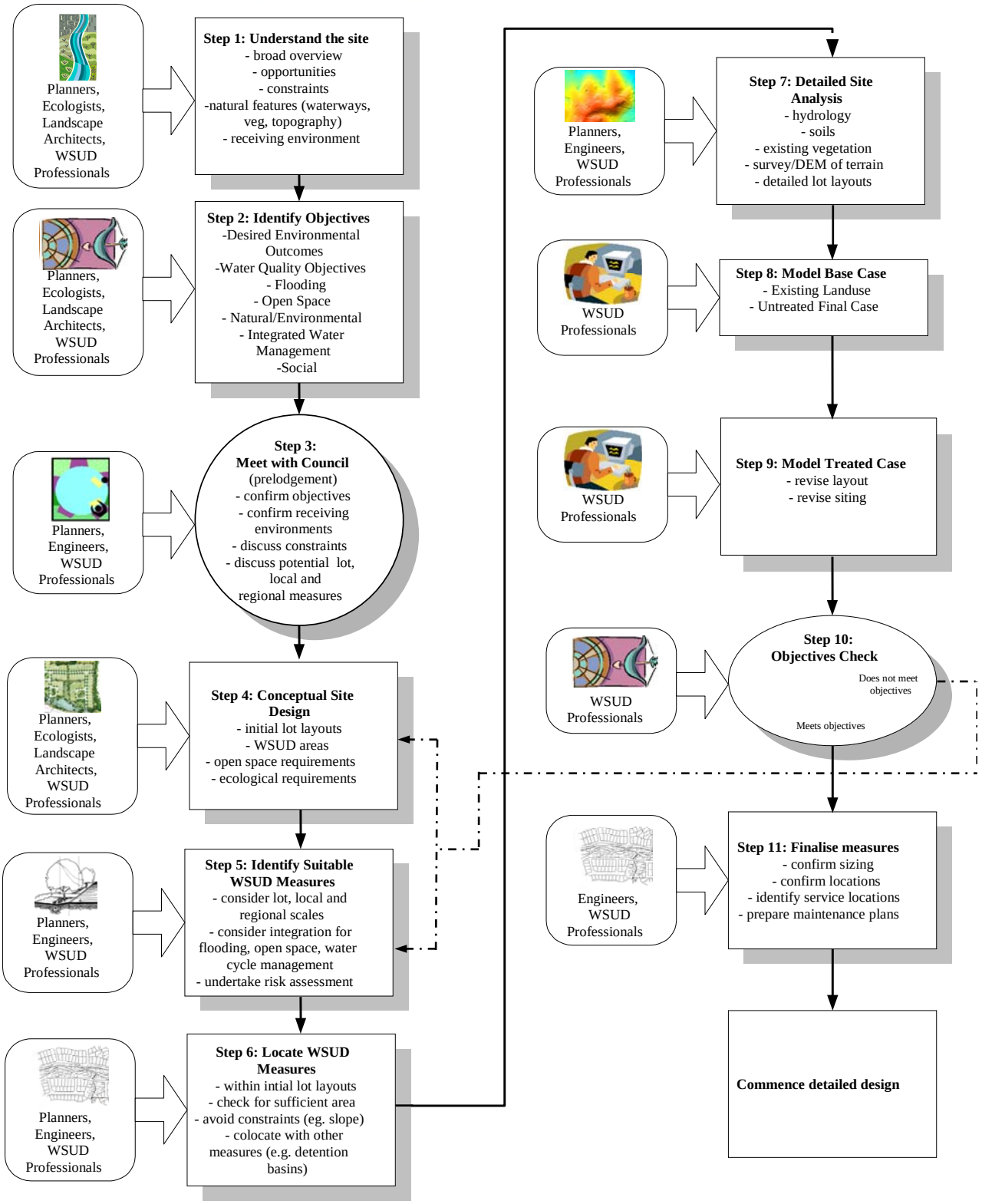


Figure 13.2-A: WSUD Planning Process

13.2.2 Step 1: Understand the Site

Understand the location where WSUD is to be applied is fundamental to the overall success of implementation. This task is about gathering a broad overview of the subject site and identifying those issues that may assist or hamper the overall delivery of WSUD practices.

This task should involve initial data collection such as land use zonings, terrain information, aerial imagery and previous studies and reviewing them in conjunction with planning scheme maps. A site visit will also be of benefit. The following items will need to be identified and considered:

- terrain – areas of high and low gradients, flatter areas which may allow larger WSUD measures such as wetlands, level areas which may present difficulties in terms of hydraulic head and high groundwater table;
- catchment boundaries – internal to the site and catchment areas external to the site;
- natural features – especially creek lines, permanent water bodies, existing vegetation;
- planning constraints – environmental corridors, waterway corridors, flood lines, open space or recreational nodes;
- receiving environment – identify those waterways or drainage lines where discharge off site is likely to occur;
- strategic catchment planning – identify catchment or sub-catchment plans (in GCCC this will include catchment management plans, stormwater management plans and master drainage strategies) to identify any regional or catchment-scale strategies applicable to the site.

From this, a list of opportunities and constraints as they apply to WSUD at the subject site should be prepared to assist in the remaining tasks.

Useful Documents and Information Sources:

The following information and documents will assist in this task:

- **Council Catchment and Stormwater Management Plans**;
- **Gold Coast City Planning Scheme Overlay Maps**, as follows:
  - 11 Natural Wetland and Waterway Areas
  - 13 Building Setback Line from Canals and Waterways
  - 14 Acid Sulfate Soil Hazard Areas
  - 16 Areas of Unstable Soils and Areas of Potential Land Slip Hazard
  - 17 Natural Hazard (Flood) Management Areas
  - 18 Stormwater Drainage Study Areas
  - 20 Conservation Strategy Plan
  - 21 Public Open Space Management
  - 24 Vegetation Protection Order
  - 25 Future Water Innovations
- aerial imagery;
- contour information and survey data;
- **GCCC Maps** – refer to **Mapping Products Schedule of Fees and Order Form** at:
  http://www.goldcoast.qld.gov.au/t_standard.aspx?PID=5179 ;
- **Gold Coast Property Enquirer** at:
  http://www.goldcoast.qld.gov.au/t_standard2.aspx?pid=1095 ;
- plumbing and drainage information at:
  http://www.goldcoast.qld.gov.au/t_standard.aspx?PID=3635 .

13.2.3 Step 2: Identify Objectives

The implementation of WSUD in a development seeks to achieve a range of outcomes relating to water quality, hydrology, conservation and amenity as shown in **Figure 13.2-B**.

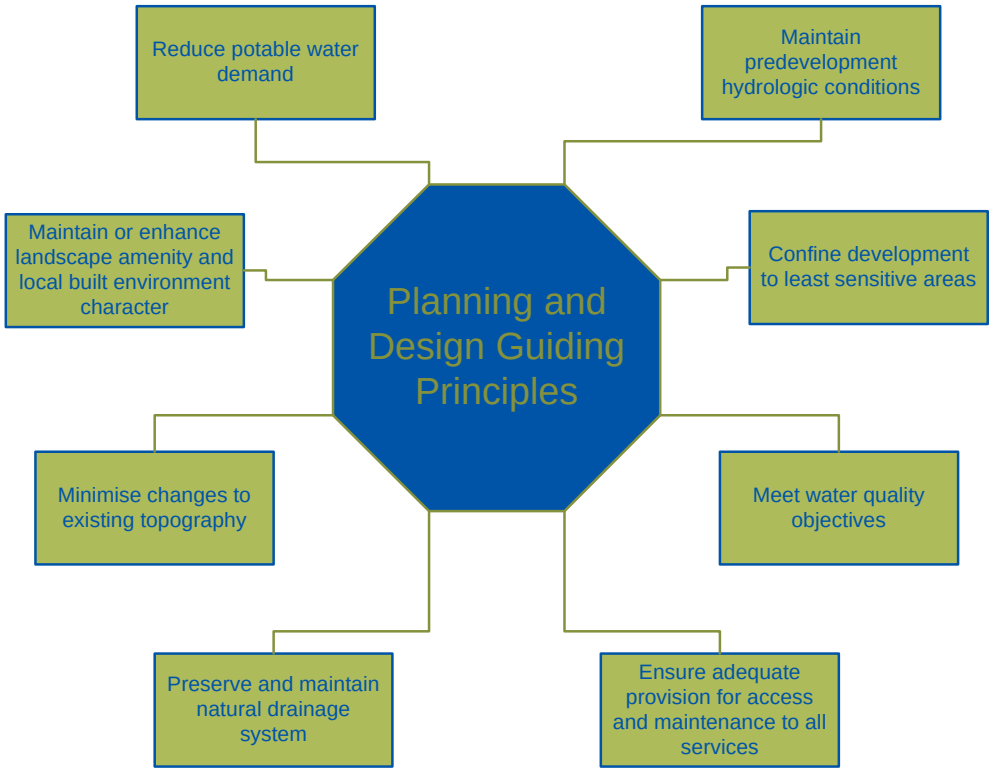


Figure 13.2-B: WSUD Conceptual Design Outcomes

Each of these outcomes is met by ensuring development complies with the appropriate objectives identified for the site. Before any other activities are undertaken with respect to site planning, the objectives must be clearly established using the information provided in the sections below.

In most cases, site-specific objectives will be available and need to be identified clearly so that they can be referred to during remaining tasks in the concept design process.

13.2.3.1 Water Quality Objectives

One of the primary roles of WSUD is to reduce the impacts of urban development on receiving water quality. As part of the design process, relevant environmental values and water quality objectives of receiving waters or other water quality targets relevant to the site must be identified and documented. These may include:

- concentration based water quality objectives for receiving waters;
- concentration-based discharge standard from a site;
- load based criteria (mass per unit of time) or reduction in load.

The relevant water quality objectives should be used as primary performance criteria on which a development is assessed for its ability to ensure protection of receiving water quality. **Pages 12-14** of Council's **Stormwater Management Guidelines** identify appropriate water quality objectives and where they will apply. The targets provided in the **Stormwater Management Guidelines** are load-based targets based on current knowledge of the performance of best practice WSUD. Information on other environmental values and concentration-based objectives from other sources should also be sought out and included in documentation of the stormwater planning process.

Useful Documents:

The following documents will assist in identifying Environmental Values and Water Quality Objectives and should be used in the following order (ie. use the most locally specific document first):

- **Council Catchment and Stormwater Management Plans**;
- Council's **Stormwater Management Guidelines**;
- **Queensland Water Quality Guidelines (EPA 2006)**;
- **Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC 2000)**.

13.2.3.2 Water Quantity Objectives

Another key principal of WSUD is to reduce the impact of urban development on the natural hydrologic conditions of a site. The **Works for Infrastructure Code** in Council's **Planning Scheme** clearly outlines the requirements of all development:

- predicted peak flows are not increased for all Average Recurrence Intervals from 2 year to 100 year;
- predicted peak volumes for 3-month and 2 year Average Recurrence Intervals are maintained; and;
- frequency of bank-full flows compared to pre-developed scenario is maintained to the post development scenario.

Other water quantity objectives may also be relevant. Inundation times should be considered as part of the setting of water quantity objectives. This will be particularly relevant where inundation times may be increased for downstream properties.

Further discussions should be held with Council development assessment officers during **Step 3** to ensure appropriate quantity targets have been identified.

It should be recognised that WSUD elements in isolation will not be sufficient to address all flooding/ hydraulic requirements but may be integrated within the overall hydraulic design of the development.

Useful Documents:

- **Council's Works for Infrastructure Code**;
- **Council Flood Studies**;
- **Council Stormwater Management Plans** and **Master Drainage Strategies**.

13.2.3.3 Integrated Water Cycle Management Objectives

One of the major benefits of WSUD is the ability to incorporate measures that can benefit all parts of the water cycle. Council has invested significantly in Integrated Water Management planning across the Gold Coast region and specific objectives may be defined for the subject site. WSUD elements such as rainwater tanks, aquifer storage and recovery, wetlands and ponds can all be useful elements in an overall Integrated Water Management Plan.

Useful Documents:

- **Pimpama-Coomera Waterfuture Master Plan**;
- **Gold Coast Waterfuture Strategy Report**.

13.2.3.4 Landscape and Amenity Objectives

While deterministic objectives may not be available, broad objectives for the integration of landscape elements into WSUD may include the following:

- ensure the integration of landscapes, recreational amenity and WSUD functionality facilitates creative expression and solutions, meets standards of service for recreation and landscape amenity, can be comprehended by the community and is sensitive to the environment and the local setting;
- provide appropriate buffers to open space areas or environmental corridors;
- the functionality of open space areas should not be compromised by the WSUD elements in most circumstances;
- provide a desirable community amenity and integrate WSUD into the overall design of the urban framework;
- ensure the sustainability of landscape amenity through design which accounts for longevity of the system considering maintenance and community use aspects (eg. vandalism, litter protection);
- provide 'green' elements and visual breaks in the urban landscape.

The landscape and amenity objectives of a site must be established using the **Gold Coast City Landscape Strategy** (**2000**) (**Planning Scheme Policies 12** and **13**). **Part 1** of the **Strategy** should be used to establish landscape objectives by:

- identifying the broad character area in which the site is located;
- identifying major elements in the City Image maps that may be impacted on by the proposal;
- using the visual diaries to identify the landscape character elements that are important for the site.

Landscape objectives for WSUD should identify specific features within and surrounding the site to ensure:

- consistency with the current character of the area;
- the qualities of the existing or built environment landscape are retained;
- retention of existing landscape and heritage features;
- social and recreational opportunities are provided;
- important view and vistas are retained.

Part 2 of the **Strategy** should be used as a guide to the requirements for landscape planning and the detailed requirements for development applications.

Useful Documents:

- **Gold Coast City Landscape Strategy Part 1 Landscape Character: Guiding the Image of the City** (**Planning Scheme Policy 12**) (**GCCC 2000**);
- **Gold Coast City Landscape Strategy Part 2 Landscape Works Documentation Manual** (**Planning Scheme Policy 13**);
- **Gold Coast Planning Scheme**.

13.2.3.5 Vegetation and Natural Features

The objectives of WSUD relating to vegetation and natural features include:

- protection and enhancement of waterways, wetlands and their buffers;
- ensuring appropriate development setback from waterways and wetlands;
- protection of remnant vegetation communities;
- retention and reinstatement of native vegetation;
- natural channel design responses for natural gullies and waterways.

Each of these objectives should be developed in conjunction with **Step 7** to ensure natural features of the site are identified and their protection/ enhancement, specific to the identified feature, is listed as an objective for that development.

Useful Documents and Information Sources:

- aerial photography;
- Gold Coast City **Nature Conservation Mapping** available at: http://www.goldcoast.qld.gov.au/t_standard.aspx?pid=5951;
- **Overlay Map 24: Vegetation Protection Order**;
- **Planning Scheme Policy 8: Guidelines for Ecological Assessments**.

13.2.3.6 Social Outcomes

Increasingly, developers are recognising the benefits of incorporating social design into the delivery of new urban areas. Objectives relating to public safety, community enhancement, and recreational opportunities may be identified through other processes, however it is important that they are considered as a specific outcome.

13.2.4 Step 3: Meet with Council

In the majority of applications, it will be beneficial to the overall development application process to meet with Council officers to discuss the existing site, proposed development and likely Council requirements. Typically, this would form part of a 'pre-lodgement' meeting which allows informal discussions between the developer (and their consultants) and Council.

A draft concept design of the proposed development (including potential WSUD locations) should be prepared and form the basis of discussion at the pre-lodgement meeting. Further guidance on this is provided in **Step 4**.

In relation to delivery of WSUD on the site, the primary objective of this meeting will be to establish that the objectives identified in the **Step 1** are the most appropriate and current for the area in question. Given the pace of change in guidance documents, it will also be useful at this stage to confirm which guidelines or policies are the most relevant and current. This meeting will also allow proponents to discuss the opportunities and constraints identified in **Step 1** to determine whether any compromise may be necessary in the objectives to address the issues noted.

This meeting should also be used to discuss the implications, if any, of Council catchment and stormwater management plans, particularly in relation to the opportunity or requirement for larger catchment scale detention or water quality treatment devices that account for upstream catchment areas.

13.2.5 Step 4: Conceptual Site Design

Based on the outcomes of **Steps 1** and **2**, an initial conceptual site design based on broad development outcomes should be undertaken.

This may simply be a sketch using intended land uses (eg. residential areas, local open space, regional open space, protected zones), and should identify areas for possible implementation of lot, local and regional scale WSUD measures. The objectives identified previously may provide guidance, however key to this conceptual design will be the opportunities and constraints identified in **Step 1** and addressing those in a 'whole-of-development' context. This conceptual site design becomes the overall vision for more detailed design in later steps.

Useful Documents:

- **Gold Coast Planning Scheme**;
- **Australian Runoff Quality – Chapter 4 Water Sensitive Urban Design (Engineers Australia 2006)**;
- **Urban Stormwater Best Practice Environmental Management Guidelines (Victoria Stormwater Committee 1999)**.

13.2.6 Step 5: Identify Suitable WSUD Measures

13.2.6.1 Identify Possible WSUD Measures for the Site

WSUD best management practices (BMP) are best provided as a series of 'fit for purpose' treatment measures placed sequentially to form a 'treatment train'. One individual measure will generally not adequately address the full range of pollutants generated from a typical urban development and therefore an appropriate collection of individual treatment measures in series within a treatment train must be developed. This shall consider the optimal operating environment for each treatment measure taking into account:

- contributing catchment area;
- hydraulic and pollutant loading;
- the treatment processes employed;
- soil type and groundwater;
- maintenance and public health and safety issues.

The treatment train should provide a treatment train suitable for the site that includes a graduated level of treatment from primary through to tertiary treatment with a specific aim of treating stormwater for the target pollutants.

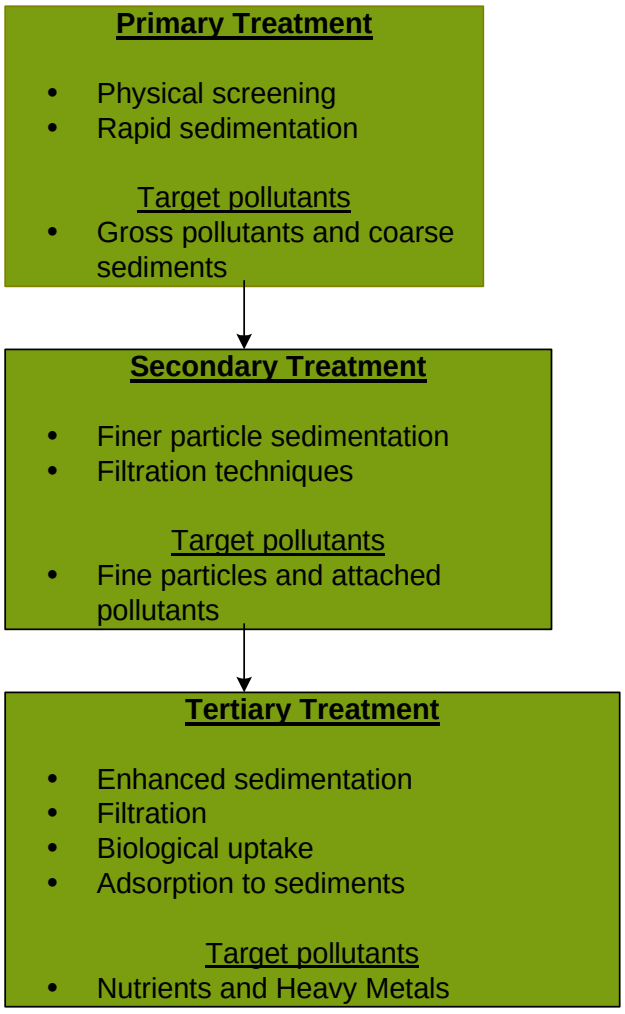


Figure 13.2-C: Stormwater Treatment Train Categories

Figures 2.3 and **2.4** of the **Stormwater Management Guidelines (GCCC 2006)** show generalised relationship between stormwater pollutant characteristics (defined by particle size) and effective treatment processes. It can be seen from these figures that a stormwater treatment train needs to comprise a range of treatment measures in order to address the full range of pollutants likely to be found in urban stormwater runoff. **Figures 2.3** and **2.4** of the **Stormwater Management Guidelines** should be used to determine a shortlist of suitable WSUD devices available for implementation at the site. Other 'screening tools' useful for selecting possible WSUD devices can also be found in the **Useful Documents** list below.

Useful Documents:

- **Australian Runoff Quality** (**Engineers Australia 2006**);
- **Urban Stormwater Best Practice Environmental Management Guidelines (Victoria Stormwater Committee 1999)**;
- **Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (Chapter 1)**;
- **Managing Urban Stormwater: Treatment Techniques (Screening Tools) (NSW EPA 1997)**.

13.2.6.2 Selecting Optimal WSUD Measures

The list of possible WSUD devices should then be used to develop a series of potential treatment trains for the proposed development based on the interpreted site conditions and site opportunities and constraints. Other issues that should also be taken into consideration in selecting appropriate treatment measures include:

- cost:benefit ratio of the number of treatment devices (capital and maintenance costs) against the water quality achieved;
- workplace health and safety issues (for maintenance crews);
- general public amenity and safety;
- whether a distributed or 'bottom-of-catchment' approach will be utilised;
- integration with urban design including road and lot layouts;
- life cycle costs and ongoing maintenance requirements and resources.

A number of factors must be considered in the selection of the final treatment train for the site. These factors should be considered alongside the opportunities and constraints identified at the site and the opportunities to layout the development to respond to WSUD requirements (refer **Section 13.2.7**).

The following factors should be considered in the selection of the treatment train:

Maintenance

- the devices selected should represent a reasonable maintenance burden, particularly where the asset will be handed over to Council at some time in the future;
- the maintenance requirements must be within Council's capacity in terms of skills, resources and equipment;
- there should be enough resources to undertake maintenance at the required frequency;
- the treatment devices should be safe to maintain and should not require direct contact by maintenance staff with pollutants and other trapped materials;
- maintenance procedures should be simple without the requirement for specialised equipment;
- disposal of waste (eg. gross pollutants, vegetation, etc) should be considered.

Life Cycle Costs

- a life cycle cost assessment may be undertaken in the process of selecting optimal devices (eg. many smaller devices versus larger treatment devices). Refer to **Section 13.2.10.2** for further guidance on life cycle costs.

Location

- the device must be able to integrate with the local character and built environment and be suitably located to treat the maximum amount of runoff from the site.

Public Safety

- the safety of the general public adjacent to the WSUD device. Consideration should be given to the risks associated with open water bodies, ponded water, etc. and should be appropriately managed through selection of devices and subsequent detailed design;
- stormwater infrastructure is to be designed in accordance with Council's report '**Stormwater Inlet/ Outlet Screens ER295/249/46/02**'.

Establishment

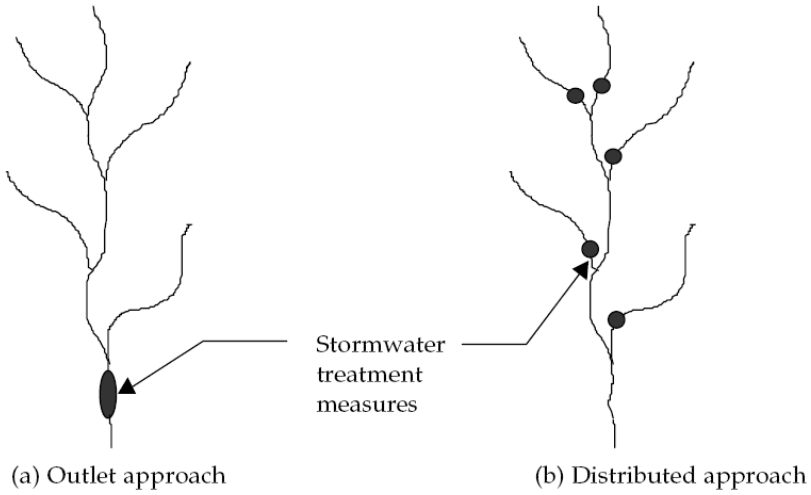
- the establishment period will be dictated by the period required for the measure to become fully functional. With vegetated systems, this may take two or three growing seasons.

Access

- the devices and their locations must be accessible for ongoing maintenance. Maintenance access must be ensured for all equipment required for ongoing maintenance (including any heavy machinery).

13.2.7 Step 6: Locate WSUD Measures

When determining the optimal WSUD measures for a site, some consideration should be given to the site analysis and the opportunities available and the 'natural' or obvious areas for WSUD devices (eg. overland flow paths). The site analysis may provide information on whether a 'bottom of catchment' approach or a distributed approach to WSUD is optimal for the site. These two options are shown in **Figure 13.2-D**.



Source: NSW EPA 1997

Figure 13.2-D: Location of Stormwater Treatment Measures

The potential advantages and disadvantages of each approach are provided in **Table 13.2-A**.

Table 13.2-A: Advantages and Disadvantages of Outlet and Distributed Approaches to Locating WSUD Devices

	Advantages	Disadvantages
Distributed Approach	▪ Water quality protection distributed over greater length of waterway ▪ Specific treatments can target high risk pollutants at specific locations ▪ Lower risk of system failure as failure of a single treatment will not significantly impact on overall treatment train performance ▪ Improved removal efficiencies as lower flow velocities and volumes at smaller catchment scale ▪ Allows for staged implementation as development is staged	▪ Higher capital and maintenance costs for larger number of devices
Outlet Approach	▪ More efficient maintenance	▪ Treating high volumes and velocities of stormwater ▪ High risk of failure if this one device fails

Source: NSW EPA (1997) and Victorian Stormwater Committee (2002)

In selecting the number and location of WSUD measures, designers must also consider the cost of ongoing maintenance and management of the devices. The number of devices should not create a substantially increased burden where one device could be used to effectively achieve the same outcome. That is, where one, or a smaller number of devices can be used, this is preferential to several devices to achieve the same outcome, particularly in terms of the ongoing maintenance burden.

Development staging may also be considered in locating WSUD devices throughout the development. Where a development is to be staged, treatment devices may be located to treat each stage of the development.

13.2.7.1 Development Type

WSUD principles are most effective and economical when integrated into development design at the concept design stage. Subdivision patterns for different development types may vary significantly and present different WSUD opportunities. Different development types and suitable WSUD can include:

1. Low density subdivisions (eg. park residential). These developments generally have larger allotments and may incorporate a large range of WSUD initiatives. These sites may have sufficient space to incorporate significant landscape WSUD elements such as swales & buffer strips in road reserves, wetlands in natural depressions, etc.
2. Low to Medium density subdivisions generally contain a range of low rise dwelling types on smaller allotments and afford less opportunity for landscape WSUD elements. In this instance detention devices may be incorporated into street design or through more effective lot layout design.
3. High-density development contains several dwellings in strata or community title. Private open space will generally be hard paved with limited pervious area. Open space areas will be generally multi-function areas acting as treatment measures and recreational areas. WSUD opportunities may include common open space areas, courtyards and roof areas.

In considering and optimising the WSUD Devices, the designer must consider the context of WSUD in the overall development and consider options for providing a treatment train within the urban layout, and also providing an urban layout that accommodates and responds to WSUD. All developments must comply with the requirements of the Reconfiguring a Lot Code in the Gold Coast **Planning Scheme**, however some consideration should be given to three key elements of development layout that provide opportunity for integration of WSUD:

- Public Open Space layout;
- road layout;
- lot layout.

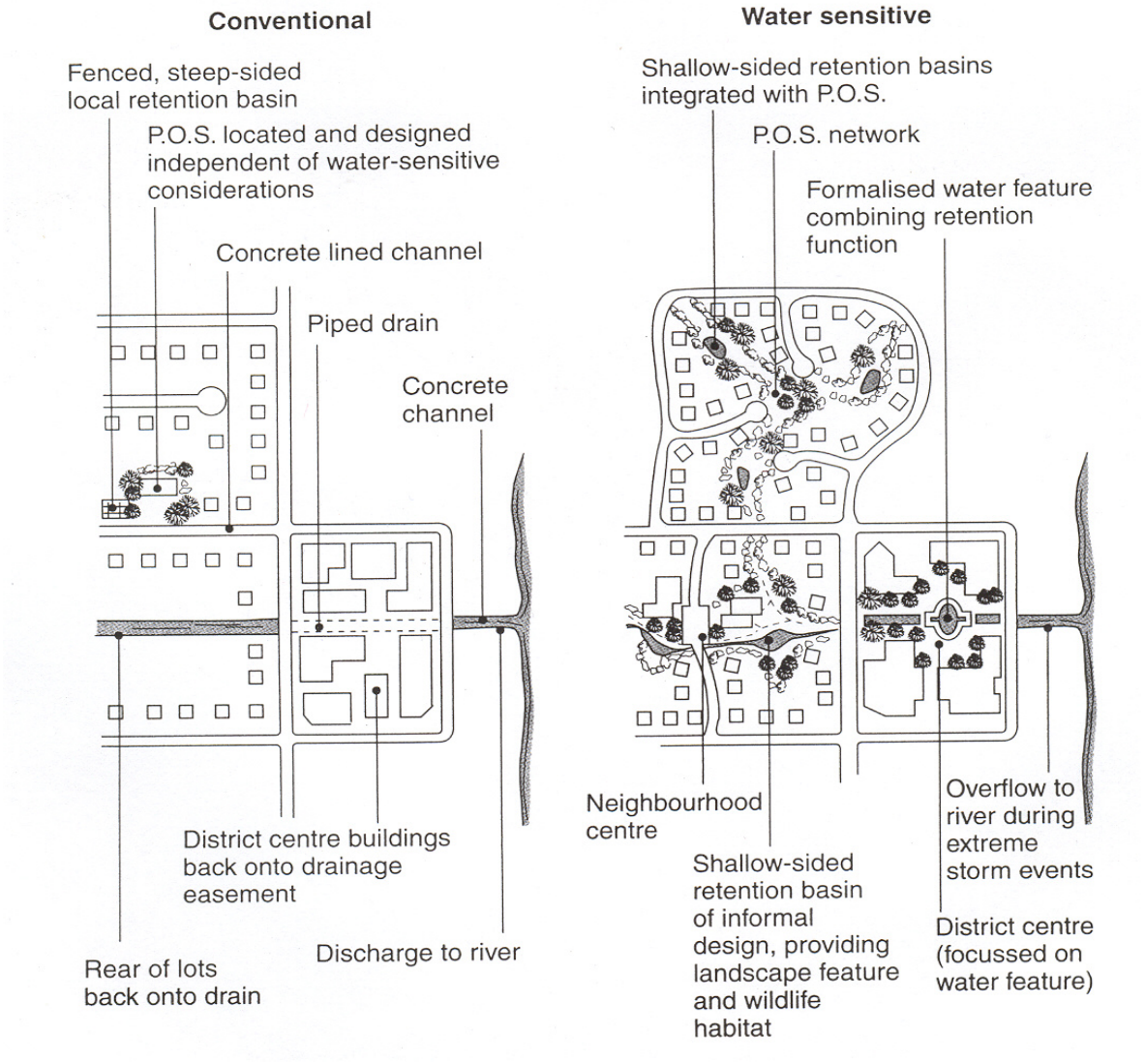
a) Public Open Space Layout

Integration of Public Open Space (POS) with conservation corridors, stormwater management systems and recreational facilities is a fundamental objective of WSUD. POS areas can potentially incorporate stormwater conveyance and treatment systems as landscape features within a multiple use corridor (where the corridor is not recognised as an ecological corridor). This can provide a recreation focus (such as a linear park with bike path or an urban forest) as well as enhancing community understanding and regard of stormwater as a valuable resource. Where stormwater treatment devices are proposed in

Key principles to be considered in locating POS are:

- align POS along natural drainage lines;
- protect/ enhance areas containing natural water features (such as creeks and wetlands) and other environmental values by locating them within POS;
- utilise POS to provide links between public and private areas and community activity nodes.

Figure 13.2-E compares examples of POS provision within a conventional urban design layout and a WSUD layout. It shows how stormwater conveyance and treatments systems can become visual focus points of developments.



Source: Whelans et al in Engineers Australia (2006)

Figure 13.2-E: Conventional Urban Layout Versus WSUD Urban Layout (showing POS provision)

The open space system should be developed with the aim of establishing a network of natural features and compatible land uses that will be act as a green network throughout the development. The integration of stormwater management initiatives as components of the open space system contributes to open space outcomes by increasing the physical area of general open space and green elements within a community, enhancing terrestrial and aquatic habitat diversity and enhancing recreational and educational opportunities. The following are examples of techniques which can be used to integrate stormwater management and the open space network:

- incorporation of waterways and wetlands within parks as ecological and/or recreational features;
- integration of playfields within the basin of a dry detention basins;
- design of subsurface storage and/or infiltration systems beneath playfields within parks or school yards;
- development of gardens within open space areas as bioretention systems.

b) Road Configuration and Layout

Most impervious hard surfaces in urban developments are roads. Road designs can change the way water is transported through a development. Roads also generate water-borne stormwater contaminants including fine sediments, metals and hydrocarbons. Road alignments and streetscapes should be carefully planned to incorporate some degree of treatment. Appropriate WSUD drainage elements include:

- bioretention system;
- bioretention swales;
- buffer strips;
- vegetated swale.

These devices collect, attenuate, convey and treat run-off before discharge to receiving waterways.

Opportunities exist for incorporating stormwater elements in roadways by diverting flow paths to a treatment system. Traditional road features (medians, roundabouts, street trees and car parking nodes) can be configured to collect and treat runoff as part of a stormwater conveyance system.

Road layouts can be utilised to effect WSUD outcomes by:

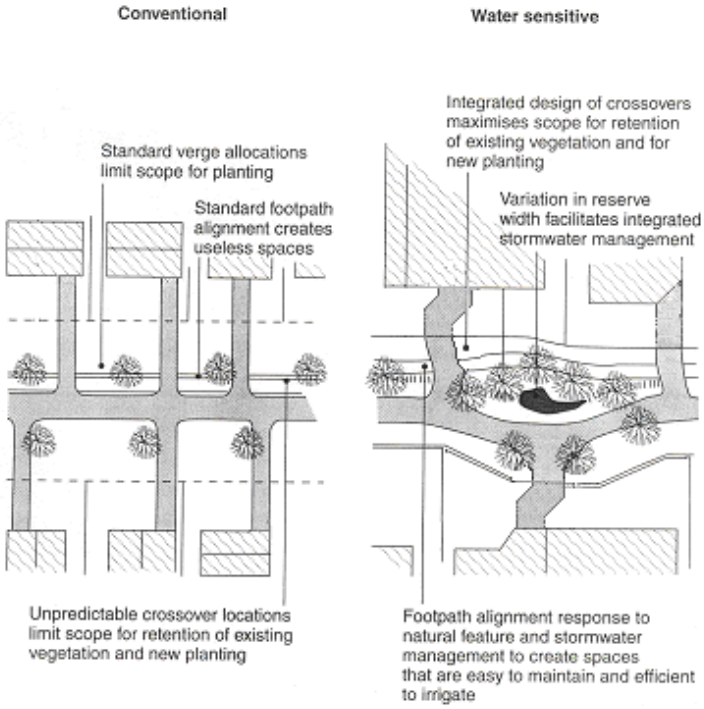
- reducing the overall road network coverage and reducing the total impervious area of a site (however not at the expense of pedestrian and vehicle connectivity);
- incorporating WSUD features into the road network by replacing piped networks with swales/ bioretention swales;
- using porous pavement surfaces where appropriate;
- designing the road network to minimise site disturbance and maximise use of natural flow paths.

No single street layout will be appropriate for all development and it is largely dependent on topography, density of development and traffic volume. Areas of low traffic volume (ie. local access streets) may have the greatest flexibility in design alternatives.

Designers should look for street layout alternatives that will allow for:

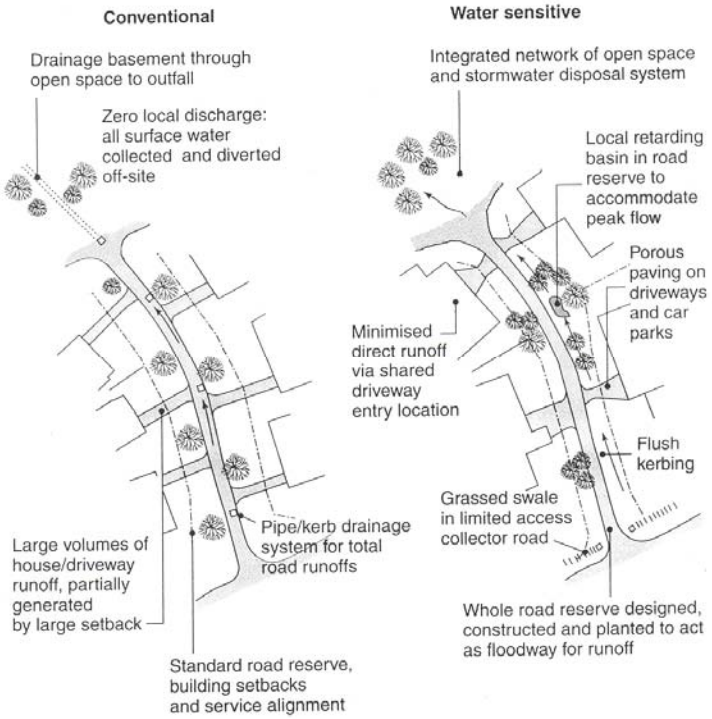
- reduced lot frontages to reduce overall road length (but within the requirements of the Reconfiguring a Lot code in the **Gold Coast Planning Scheme**);
- lengthen street blocks to reduce the number of cross streets and reduce the overall amount of road per dwelling;
- reduce road widths within the allowable constraints and requirements of the **Gold Coast Planning Scheme** and the **Land Development Guidelines**;
- flexibility in verge design to incorporate WSUD features (in line with the requirements of the **Land Development Guidelines**);
- reduced number of stream crossings.

Figure 13.2-F and **Figure 13.2-G** show examples of a conventional versus water-sensitive road layout. **Figure 13.2-H** shows an example of alternative verge design and incorporation of WSUD features.



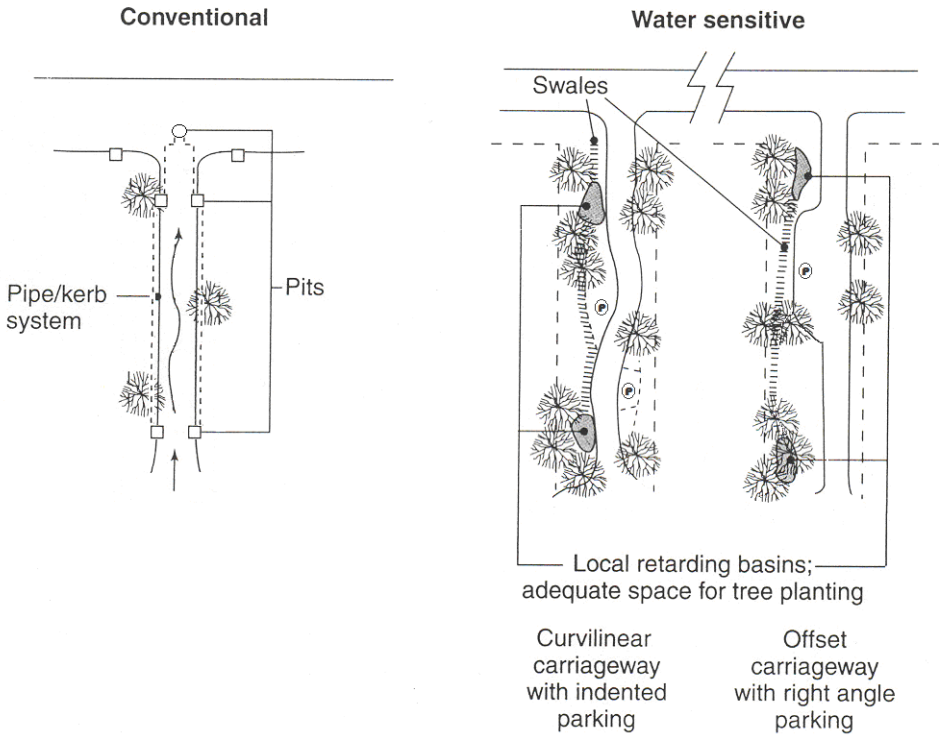
Source: Adapted from Victorian Stormwater Committee (1999)

Figure 13.2-F: Conventional Versus Water Sensitive Road Layout



Source: Adapted from Victorian Stormwater Committee (1999)

Figure 13.2-G: Streetscape Layout



Source: Adapted from Victorian Stormwater Committee (1999)
Please note that the conveyance of stormwater in accordance with QUDM is to be independent of any swales and shall provide for the piping of the minor flow within the roadway and the allowance for the conveyance of the major flow overland contained within the road reserve.

Figure 13.2-H: Verge Design and Management

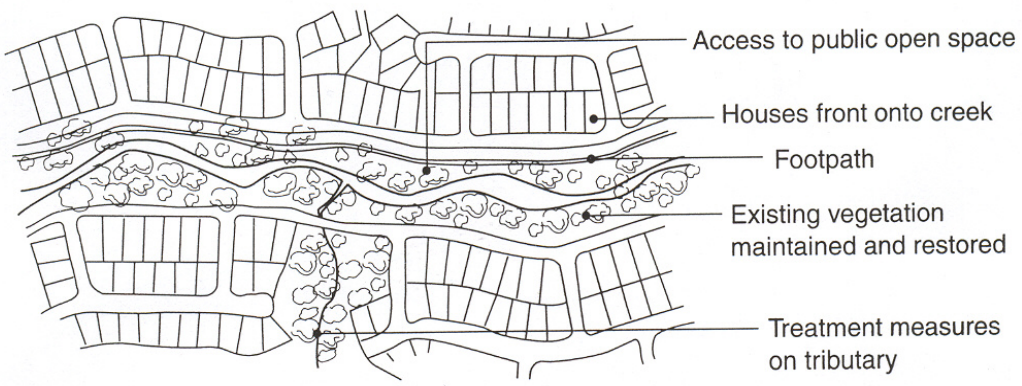
c) Lot Layout Considerations

The requirements of the Reconfiguring a Lot code in the **Planning Scheme** will be the key document to be used in overall lot layout, however some general principles that can be followed in lot layout to maximise WSUD opportunities and reduce stormwater impacts are:

- minimise site disturbance;
- locate lots in a way that stormwater can be discharged via open space (and not concentrated in one location);
- maximise opportunities for on-lot treatment or for conveyance via WSUD devices.

Lot layout options that may be considered:

- clustering of houses to use central stormwater treatment measures;
- use open space and existing vegetation as buffers;
- reduce impervious area per lot (eg. driveway length and width).



Source: Whelans et al in Engineers Australia (2006)

Figure 13.2-I: Integration of Housing with Waterway Corridor

13.2.8 Step 7: Detailed Site Analysis

This is a critical step in determining the ability of the land to sustain the proposed use without significant impacts to receiving waters and other environmental factors. New developments should be designed so as to ensure that buildings and other development on the site would work within the natural and existing drainage systems.

Planning Scheme Policy 17 – Site Analysis provides guidance on Council's requirements regarding site analysis. The aim of this section is to provide supporting information to **Planning Scheme Policy 17** by providing guidance on the type of information relevant to the layout and design of WSUD.

A detailed site analysis will include consideration of the following:

- existing hydrological patterns and features;
- topography and slope stability;
- geology and soil characteristics;
- existing water quality;
- waterways, wetlands and floodplains;
- minor drainage features;
- existing known stormwater or drainage 'problem' areas;
- vegetation;
- erosion prone areas;
- groundwater and recharge areas;
- existing infrastructure and services (pot holing to obtain levels is considered a mandatory requirement in most cases);
- planned infrastructure and services;
- existing easements and drainage reserves on the site and the possible need to secure additional areas at downstream locations.

The site analysis will generally focus on the existing site characteristics, however as the site analysis is undertaken some amount of looking forward to the development type and scale will be required.

Where possible, GIS systems such as MapInfo or Arc/ Info should be used to spatially represent the data captured. Where this information is not possible, hand drawn maps or information sheets may be sufficient. It is important to establish the levels of existing services as these may represent considerable constraints when identified. Liaison with relevant service providers may be required in this regard.

Useful Documents:

- **Planning Scheme Policy 17: Site Analysis**.

13.2.8.1 Hydrology

A site's hydrologic characteristics are essential in the selection and design of WSUD systems. To gain a clear picture of a site's hydrology, the site assessment should include consideration of hydrologic processes and physical features that would affect these (eg. soil type, slope, etc).

This component of the site assessment should include:

- identification of prominent hydrologic features such as waterways and wetlands;
- identify and map the extent of the floodplain for the 100 year ARI;
- identify and map minor hydrologic features such as natural drainage lines, depressions and overland flow paths (using contour data for the site);
- identify and map groundwater resources and the groundwater table;
- identify and map required buffers to waterways and wetlands;
- identify and map significant signs of waterway damage, erosion or deposition.

While some of this may have been identified through the objective setting in **Step 2**, further assessment and documentation of this is required, especially through mapping of key components such as flooding lines and corridors.

Some characterisation of the natural hydrology and an assessment of the peak flow rates and volumes for the pre-development condition must be undertaken for the full range of Average Recurrence Intervals from 2 year to 100 year. Preliminary assessments can be made using simple catchment calculations using the rational method for smaller catchments. For larger catchments characterisation of the site hydrology may require use of hydrologic models (eg. RAFTS-XP, RORB, URBS, etc) to adequately represent the hydrologic conditions of the site. These pre-development conditions will be used as the reference point for which the WSUD strategy should aim. Note that this will usually be conducted through an overall hydraulic assessment of the site to address flood management requirements.

Readers are referred to the **Queensland Urban Drainage Manual** and **Section 3.5** of the **Land Development Guidelines** for further guidance on hydrologic assessments.

Useful Documents:

- **Land Development Guidelines (Section 3.5)**;
- **Queensland Urban Drainage Manual**.

13.2.8.2 Slope

Using contour information for the site, the site analysis should provide a description, and where possible, map or characterise the site based on slope and topography. The analysis of slope should include:

- contour information (where possible to 1 or 0.5m intervals);
- analysis of slope, specifically identifying natural depressions, flat areas (<1%), low slopes (1-5%), moderate slopes (5-10%) and steep (10-20% and very steep (>20%) slopes;
- identification of natural features such as escarpments, rock outcrops, etc;
- orientation of the site (slopes facing north/ south, etc).

Some description of proposed land shape should also be made in this early stage. For example, areas that will potentially undergo significant changes through cut and fill to create flat house pads, etc. should also be identified.

13.2.8.3 Vegetation

An ecological assessment of the site should be undertaken to:

- identify and map all vegetated areas of the site, identifying:
  - areas of conservation significance (either for floristic integrity or habitat potential);
  - existing and potential regional or local habitat linkages;
- identify and map significant habitat trees or features;
- identify and map aquatic habitat features in waterways and wetland areas;
- identify and map areas required for rehabilitation.

13.2.8.4 Geology and Soils

Planning and integration of WSUD into a development requires an understanding of the soil and geological characteristics on site. Understanding soil types help to assess the potential or suitability of the site or parts of the site for infiltration.

In the overall planning of a subdivision, the soil analysis should aim to provide the following information:

- description of geology and soil types/ soil landscape;
- depth of topsoil and subsoil;
- soil pH;
- current soil conditions and impacts of existing uses;
- erosion issues;
- contaminated sites;
- acid sulfate soils.

To enhance the soil information, some strategically placed test pits may be undertaken as part of initial soil testing of the site. Pit locations should be determined by:

- topography;
- expected soil type;
- hydrologic characteristics;
- other site features as appropriate.

Test pits may be used to:

- determine the likely infiltration capacity of the soil;
- confirm the assumed soil types;
- identify changing soil types across the site.

13.2.8.5 Existing and Future Infrastructure and Services

Objectives for incorporation of WSUD into developments relating to services include:

- minimise the occurrence of co-location of services;
- ensure adequate provision of space for all services and WSUD features;
- ensure no loss of service functionality due to proximity to WSUD devices;
- ensure no loss of access to existing or future services when locating and designing WSUD;
- maintain the width of existing service corridor allocations in accordance with the **Land Development Guidelines**.

The site analysis should identify any existing infrastructure and services within and adjacent to the site which will affect or potentially affect the location of WSUD devices. The site analysis should also include information on any planned infrastructure and services that need to be accommodated in the future site design.

The infrastructure and services to be included in a site analysis include existing infrastructure and those outlined in existing infrastructure planning documents and will include:

- roads;
- water supply infrastructure;
- wastewater infrastructure;
- stormwater infrastructure;
- telecommunications;
- electricity;
- gas.

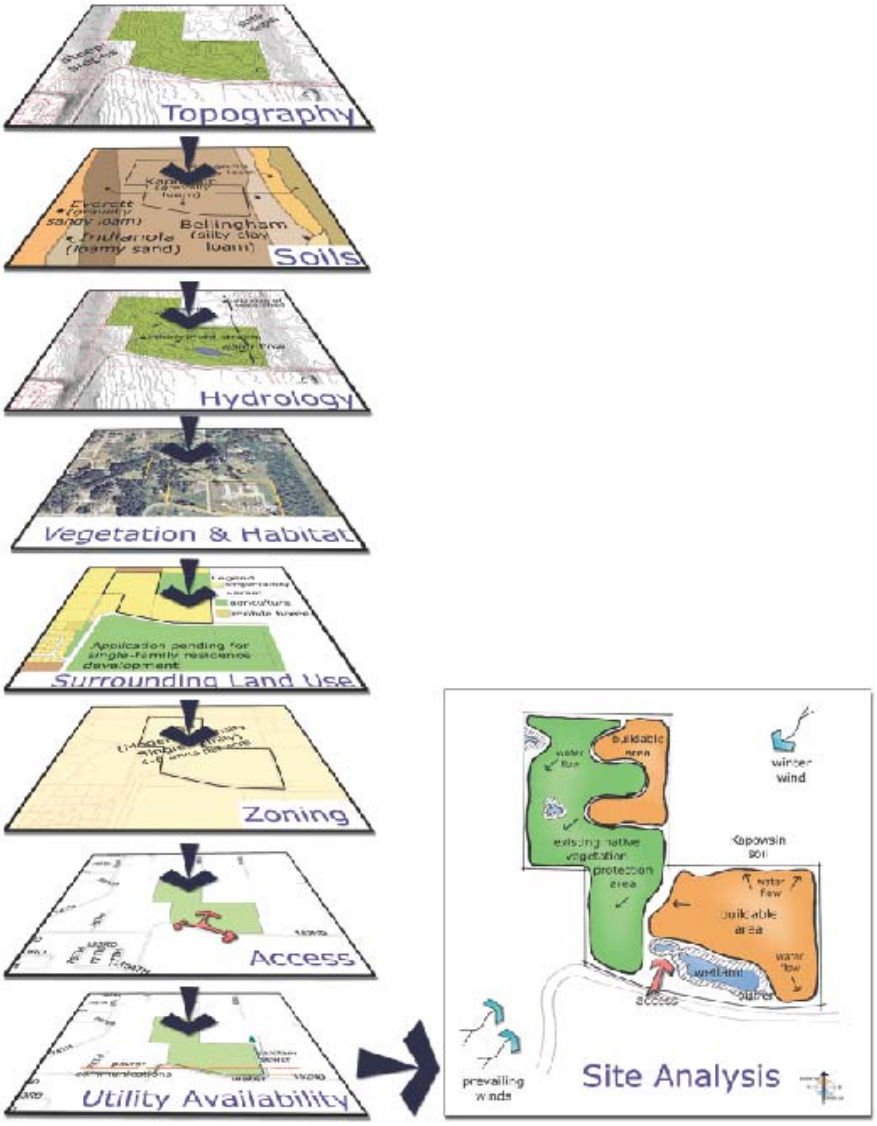
Some consideration of future infrastructure will also need to be undertaken, such as where roads will likely be located.

13.2.8.6 Opportunities and Constraints

The information layers compiled during the resource mapping then need to be overlayed to provide a composite site analysis that:

- identifies the developable area of the site;
- shows the relationship between constraints and opportunities at the site;
- guides lot and road layout;
- identifies the areas best used for stormwater treatment, storage and conveyance.

Figure 13.2-J shows the process of layering site constraint information to determine the development area within the site constraints.



Source: Puget Sound Action Team (2005)

Figure 13.2-J: Site Analysis Process

13.2.9 Step 8: Model Base Case

At this stage, sufficient information would have been collected to allow modelling of both the existing site and the 'untreated' developed site that would form the 'base case' with which to compare future modelling of the WSUD development.

In the majority of developments, water quality modelling should focus on total suspended solids, total nitrogen, total phosphorus and gross pollutants as the key pollutants of interest, in addition to the hydraulic outcomes. Further guidance on water quality modelling is provided in Council's **MUSIC Modelling Guidelines** (**2005**).

Hydrologic and hydraulic modelling should be undertaken in accordance with **Section 3.5** of the **Land Development Guidelines** and the **Queensland Urban Drainage Manual (QUDM)**.

Useful Documents:

- **MUSIC Modelling Guidelines** (**GCCC 2005**);
- **Land Development Guidelines** (**GCCC 2005**);
- **Queensland Urban Drainage Manual** (**DPI, BCC & IMEA 1992**).

13.2.10 Step 9: Model Treated Case

13.2.10.1 Water Quality and Quantity Performance

Evaluation and assessment of alternative stormwater strategies are based on predictions made by forecasting tools. Modelling tools such as MUSIC and hydrologic models such as RAFTS-XP, URBS, etc. should be used to demonstrate that the proposed strategy:

- achieves the load reduction targets adopted by Council;
- results in no change to the hydrology of the site as per Council's water quantity objectives.

Other tools may include water balance modelling and flooding or hydraulic modelling where this is appropriate to the site. Council's **Stormwater Management Guidelines** (**GCCC 2006**) and the **MUSIC Modelling Guidelines** (**GCCC 2005**) for further guidance on the use of MUSIC to assess stormwater treatment trains. **Section 3.5** of these Guidelines and the **Queensland Urban Drainage Manual** should be referred to for hydrologic and hydraulic assessments.

13.2.10.2 Life Cycle Costing

The life cycle costing of a WSUD practice or treatment train is a process to determine the sum of all expenses associated with a product or project, including acquisition, installation, operation, maintenance, refurbishment, discarding and disposal costs. It aims to calculate a single dollar value which can be used in the overall decision making process. The particular cost elements which are incorporated into life cycle costing are shown in **Figure 13.2-K** below.

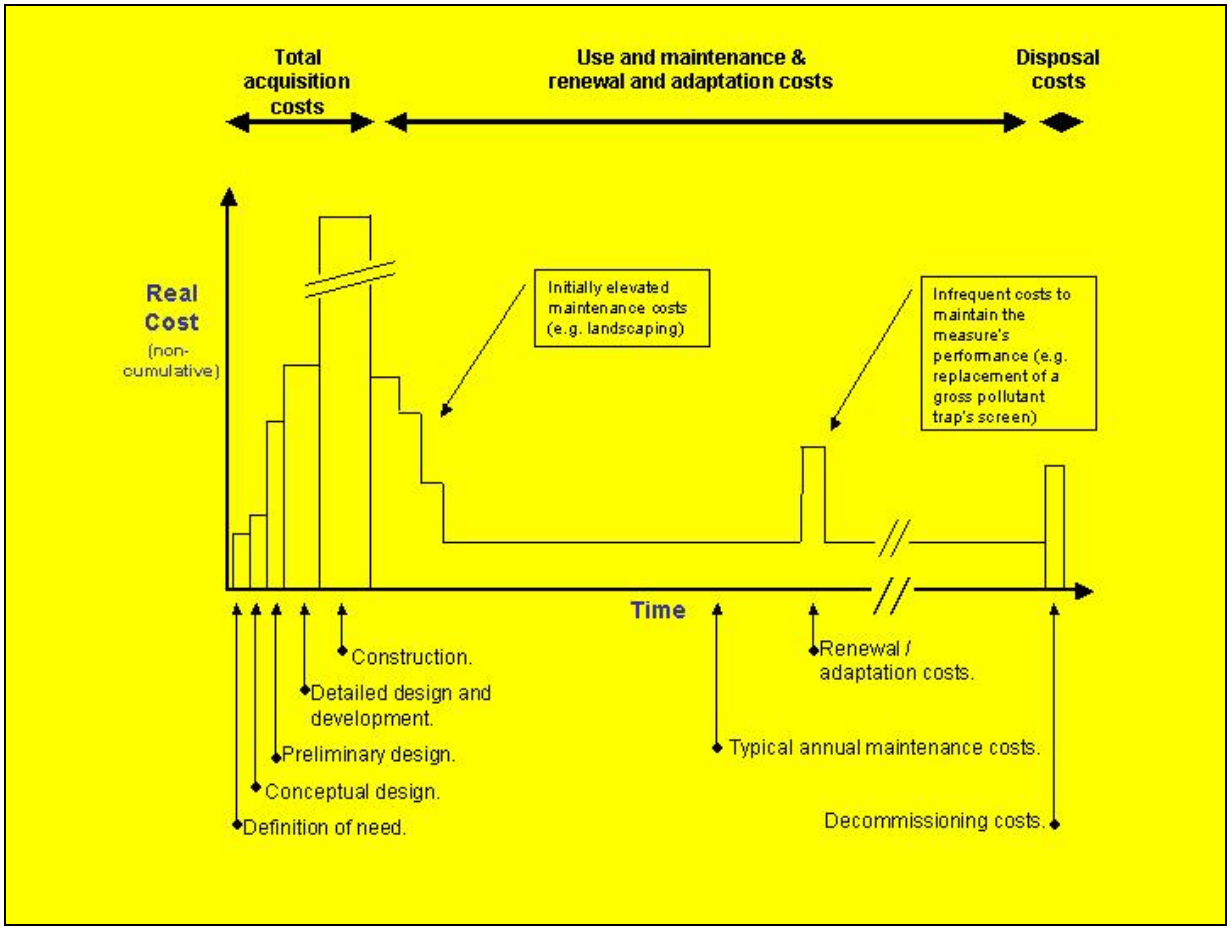


Figure 13.2-K: Life Cycle Costing Elements

The MUSIC software includes a life cycle costing module which should be used to calculate the overall life cycle cost of the WSUD treatment train. Guidance on the life cycle costing module is provided in the MUSIC User Guide and modellers will need to be familiar with the caveats within that document with regards to using the module.

13.2.11 Step 10: Objectives Check

At this stage, several iterations may be required to ensure that the majority of objectives set out in **Step 2** are achieved. Note that it may not be possible that all objectives will be met and it may require that compromise is needed in some areas to achieve the most optimal outcome.

Where necessary, if particular objectives are essential, then it may be appropriate to revisit the conceptual site design and/or the type of WSUD practices used.

13.2.12 Step 11: Finalise Measures

Once the final WSUD conceptual design has been confirmed, it will be necessary to confirm sizing and locations of measures prior to entering the detailed design process. Of key importance at this stage will be identifying services and completed design elements (eg. roads, open space areas, final lot layouts, hydraulic design) within which WSUD elements may need to be integrated.

A conceptual design should be developed that shows:

a) The location of the WSUD device/ devices within the development (refer **Figure 13.2-L** for an example).

b) The proposed layout of the device in its specific location (also showing key features such as roads and other services). An example is provided in **Figure 13.2-M**. The proposed layout should also provide detail around proposed access to the WSUD device for maintenance and monitoring, and where relevant, any associated recreational infrastructure around the device. This is to ensure that adequate consideration has been given to ongoing maintenance and does not result in future impacts on the functionality of open space or other recreational space.

c) The conceptual design should also be undertaken in consideration of the **Design Considerations** in **Chapters 13.3** to **13.12** of this Guideline. Designers may also use the **Design Assessment Checklist** in each chapter during the concept design to check that no key issues will arise in the detailed design.

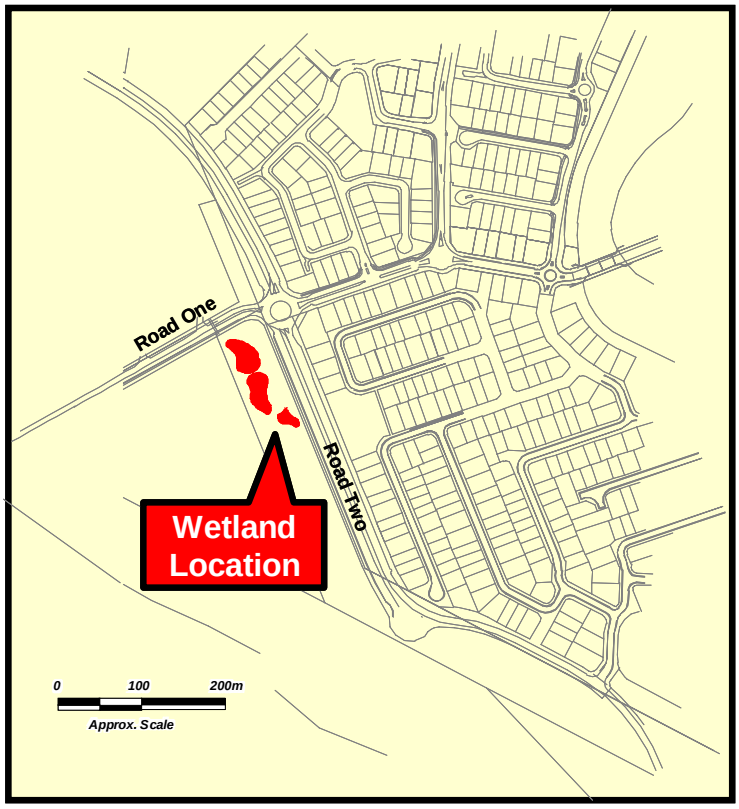


Figure 13.2-L: Example Wetland Location Map for Conceptual WSUD Design

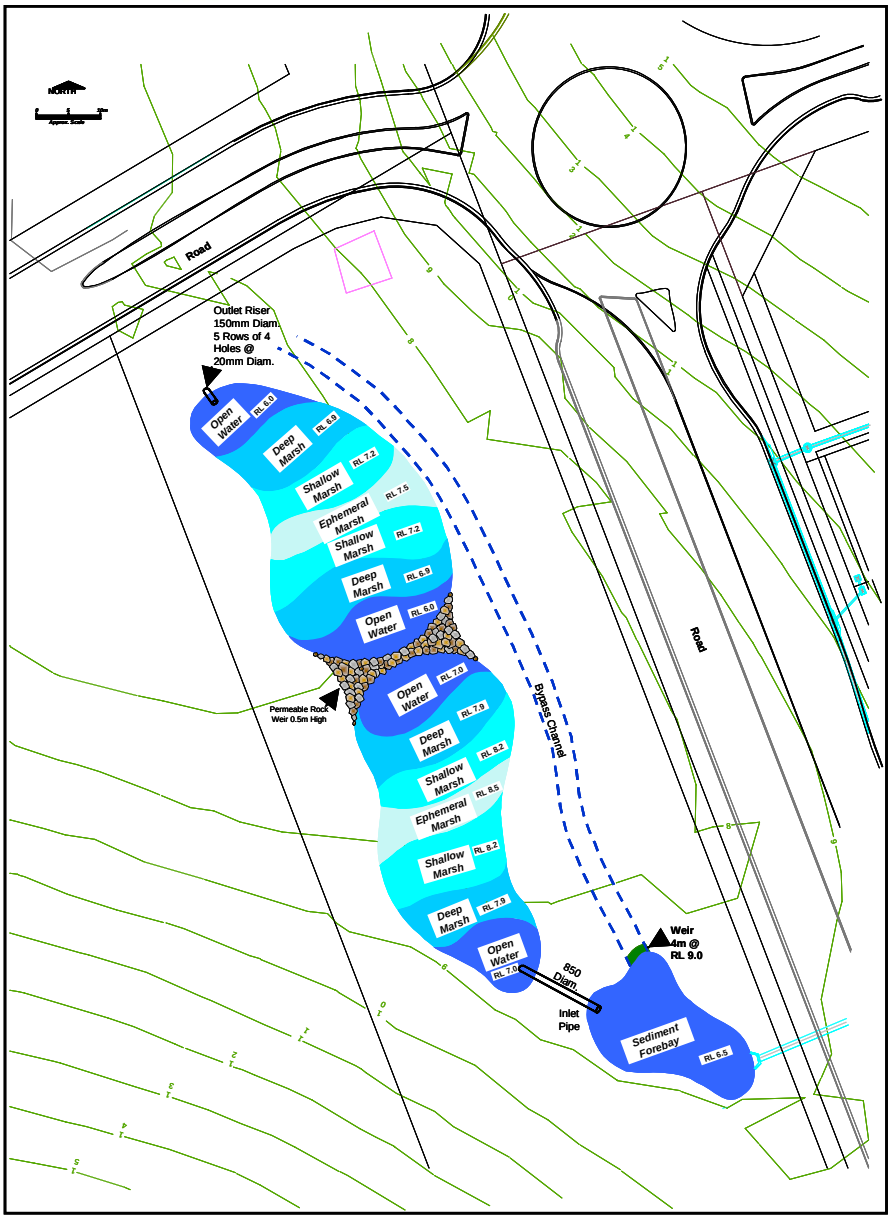


Figure 13.2-M: Example Layout of WSUD (Wetland) Concept Design

At this stage, it will also be appropriate to document operation and maintenance plans including all ongoing requirements of the treatment train should be developed.

An implementation plan should also be developed for the WSUD devices, particularly where they will be used as interim erosion and sediment control measures, and when the final setting of the system will take place some time after initial functional installation of the device.

The plan should identify:

- when structural elements of the device are to be constructed in relation to development staging and sub divisional works;
- if devices are to be used as temporary sediment basins, and for what period;
- how the final setting of the WSUD device is to be undertaken.

Where it is envisaged that the final setting of the WSUD device will take place some time after the functional installation of the device (eg. after the building phase of the contributing catchment area has been completed), discussions should be held with Council to determine the process by which the WSUD device will be completed. Options are to either provide a contribution to Council to complete the WSUD asset(s) or for the developer to return and complete the asset as designed at a later time. These options should be discussed at the pre-lodgement meeting with Council outlined in **Step 3**.

Further guidance can be found in the 'Construction and Establishment' sections of the technical design guideline chapters.

13.2.13 Step 12: Undertake Detailed Design

Following approval of the development and the conceptual stormwater management plan, the detailed design should be undertaken in accordance with **Sections 13.2.3** to **13.2.13** of these Guidelines.

13.2.14 WSUD Conceptual Design Checklist

The checklist provided on the following page should be used to ensure the conceptual design process has been followed and that all appropriate information has been collated and considered.

Item	Checked/ Considered		Comments
	Y	N	
Step 1: Understand the Site			
Land use and planning information obtained?			
Slope and terrain information obtained?			
Information on natural features obtained (waterways, wetlands, vegetation, etc)?			
Information on planning constraints obtained (waterway buffers, open space, flood lines, general land use planning information)?			
Receiving waters identified?			
Step 2: Identify Objectives			
Water quality objectives identified?			
Water quantity objectives identified?			
Integrated water cycle objectives identified?			
Landscape objectives identified using **Gold Coast City Landscape Strategy**?			
Vegetation and natural features objectives identified?			
Social objectives identified?			
Step 3: Meet with Council			
Pre-lodgement meeting held with Council?			
Objectives and constraints discussed?			
Step 4: Conceptual Site Design			
Sketch of conceptual site design undertaken?			
Step 5: Detailed Site Analysis			
Hydrologic patterns and features identified?			
Slope/ site shape characterised?			
Ecological assessment undertaken and significant vegetation/ habitat/ trees identified?			
Soil/ geology description and analysis undertaken?			
Existing and planned infrastructure identified?			
Opportunities and constraints summarised?			

Step 6: Model Base Case			
Water quality of base case modelled?			
Hydrology/ hydraulics of base case modelled?			
Step 7: Identify Suitable WSUD Measures			
Range of suitable WSUD devices identified?			
Optimal range of WSUD devices identified based on site-specific constraints and opportunities, maintenance requirements and costs?			
Step 8: Locate WSUD Measures			
WSUD locations identified?			
WSUD incorporated into development design giving consideration to space and infrastructure requirements?			
Open space, lot layout and street configuration considered and appropriately managed?			
Step 9: Model Treated Case			
Water quality of treated case modelled?			
Hydrology/ hydraulics of treated case modelled?			
Life cycle costs presented?			
Step 10: Objectives Check			
Water quality objectives achieved?			
Water quantity objectives achieved?			
Integrated water cycle objectives achieved?			
Landscape objectives achieved?			
Vegetation and natural features objectives achieved?			
Social objectives achieved?			
Step 11: Finalise Measures			
Size and location of WSUD devices confirmed?			
WSUD devices shown to fit within development layout without impacting on open space, road function or service functioning?			

13.2.15 References

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000, **Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Paper No. 4, National Water Quality Management Strategy**.

DPI, IMEA & BCC (Department of Primary Industries – Water Resources, Institute of Municipal Engineers Australia – Qld Division & Brisbane City Council) 1992, **Queensland Urban Drainage Manual** (**QUDM**), prepared by Neville Jones & Associates and Australian Water Engineering for DPI, IMEA & BCC, Brisbane.

Engineers Australia 2006, **Australian Runoff Quality**.

GCCC 2000, **Gold Coast City Landscape Strategy Part 1 Landscape Character: Guiding the Image of the City**.

GCCC 2003, **Gold Coast City Landscape Strategy Part 2 Landscape Works Documentation Manual**.

GCCC 2003, **Gold Coast Planning Scheme**.

GCCC 2004, **Pimpama Coomera Waterfuture Master Plan March 2004**.

GCCC 2005, **Nature Conservation Mapping Review Stage 2 Significance Mapping**, prepared by Chenoweth Environmental Planning and Architecture Pty Ltd, Gold Coast.

GCCC 2005, **MUSIC Modelling Guidelines**.

GCCC 2006, **Gold Coast Waterfuture Strategy 2006-2056**.

New South Wales Environmental Protection Authority 1997, **Managing Urban Stormwater: Treatment Techniques Draft**.

Queensland EPA 2006, **Queensland Water Quality Guidelines**.

Victorian Stormwater Committee 1999, **Urban Stormwater Best Practice Environmental Management Guidelines**.