Chapter 2 Hydrologic Design Regions

2.1 Introduction

This chapter outlines a methodology for sizing stormwater treatment systems, or WSUD elements, across Tasmania.

The following process has been developed through extensive stormwater modelling using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) developed by eWater. For a higher level of accuracy, it is suggested that site-specific modelling using MUSIC be performed.

Simulation of the performance of WSUD systems were completed using pluviographic rainfall data for 48 Bureau of Meteorology (BOM) rainfall stations distributed throughout Tasmania. Results of these simulations were used to develop eight Hydrologic Regions (see figure 3.1). The Hydrologic Regions allow the WSUD designer to determine the size of a WSUD element for a given pollutant removal objective, with the only rainfall data required being the mean annual rainfall (MAR) of a site.

This report is adapted for Tasmania from Melbourne Water's WSUD Engineering Procedures: Stormwater and builds upon previous work (described in Hydrologic regions for Sizing Stormwater Treatment in Victoria, October 2003. The methods described in this section are intended for use as a simple design procedure that can be used for small development projects (e.g. single or a small clustered allotment development type) and can serve as a preliminary design procedure. In addition, it could be used as a simple design checking tool. It is not intended for the design of large or complex projects.

2.2 Development of Hydrologic Regions

Constructed wetlands, ponds, bioretention systems and vegetated swales were modelled at 48 locations distributed right across Tasmania. The locations modelled were chosen based on the availability of BOM pluviographic rainfall data. The data used was six-minute time step rainfall data from 1980 onwards. Of the stations used, the duration of data sets ranged from 1-24 years. No pre-1980 data was used due to a shift in rainfall patterns.

Each WSUD element was modelled to determine the size of system required at each location to provide a 45% reduction in total nitrogen (TN). TN was used because it is commonly the limiting parameter in meeting best practice stormwater quality objectives. 45% was chosen as an arbitrary, although realistic, performance objective.

The 48 sites were modelled individually to determine the difference in system size needed to meet the required performance objective compared to one reference site. These differences were used to develop 'adjustment factors' so that sizing information from a reference site could easily be adapted for anywhere in Tasmania.

Specific, more-detailed modelling was performed at one site (see Figure 2.1) to provide a reference site from which the size of WSUD elements could be calculated wherever in Tasmania.

More detail on the methodology used to develop the Hydrological Region Process is provided in Appendix A: Tasmanian Hydrological Regions.

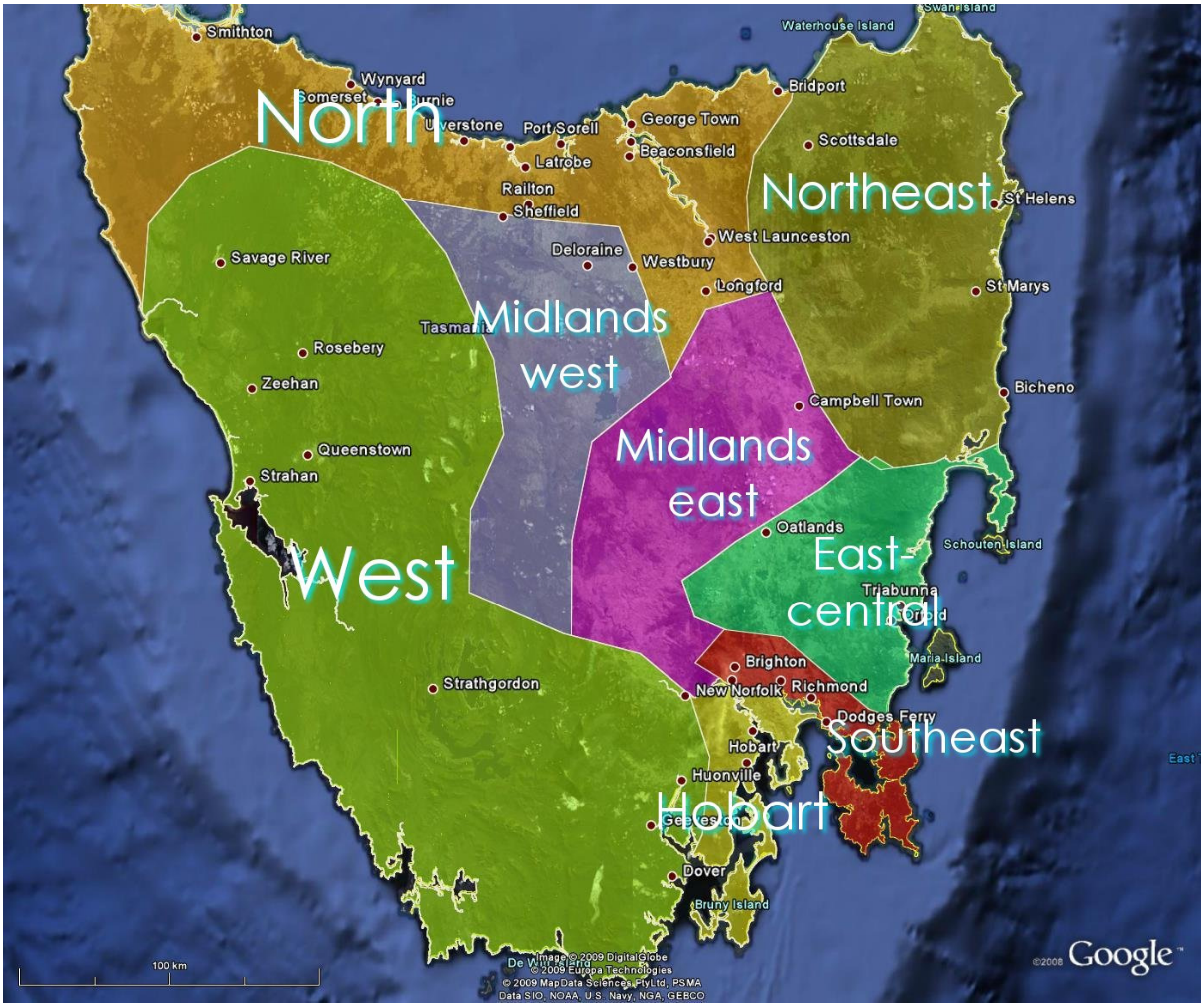

Figure 2.1. Map showing the eight hydrologic regions for Tasmania

2.3 Sizing WSUD elements

Chapters 4, 5, 7, 8 & 9 contain WSUD element sizing graphs for the reference site. Three sizing graphs are provided showing the required size of a treatment system to meet a desired pollutant reduction. The graphs represent sizing information to meet objectives of three pollutants, total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) (see figure 3.2).

Figure 2.2 demonstrates how to determine the required size of a wetland, at the reference site, designed to provide a 45% reduction in TN, 45% reduction in TP and an 80% reduction in TSS. A horizontal line is drawn from the desired % reductions on the y-axis to meet the pollutant curve. In this case, 3 pollutant removal objectives have been set so the size of wetland chosen must meet all the targets. In this example, the TN objective requires the largest wetland, therefore, a wetland equivalent in surface area to 3% of the contributing impervious catchment is needed to provide greater than or equal to the required objective for all pollutants.

To determine the size of a wetland that will meet pollutant removal objectives, the required size at the reference site is first calculated using the above methodology. An adjustment factor is then applied to that size to determine the size wetland required in the area of interest.

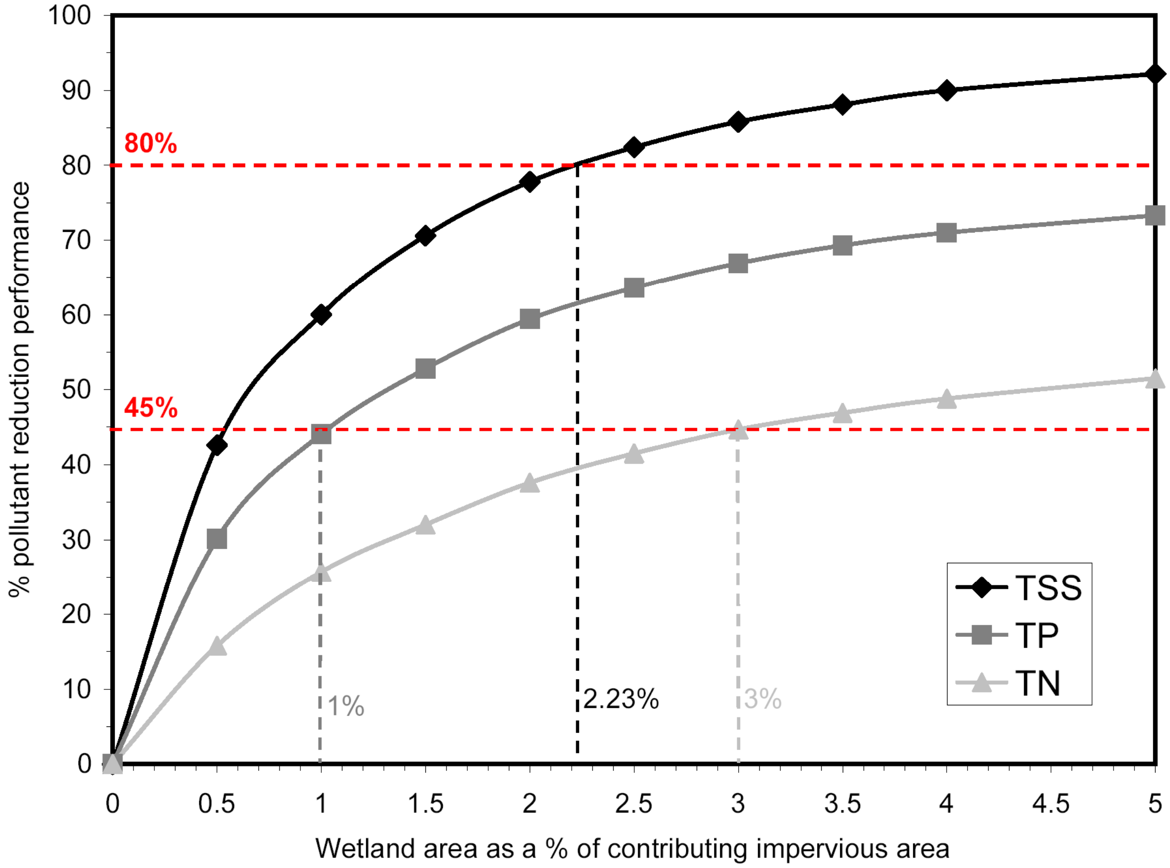

Figure 2.2. Size of wetland required to meet desired pollutant reduction in Hobart

2.4 Calculating adjustment factors

To calculate an adjustment factor (A_f) for anywhere in Tasmania, the only site specific data required is mean annual rainfall (MAR) for the site.

Different adjustment factors are used for each WSUD element (wetlands, bioretention, swales and ponds).

To account for uncertainty in the relationship between mean annual rainfall and the variation in size of treatment systems across the state, a safety factor of 10% is included in the adjustment factor relationships. To avoid this requirement, site-specific modelling should be completed.

Table 2-1. Adjustment factor equations

	Bioretention	Pond	Swale	Wetland
East-central	0.0053(MAR)-1.2818	0.0031(MAR)-0.5156	0.0004(MAR)+0.8559	0.0024(MAR)-0.1239
Hobart	0.0041(MAR)-0.9728	0.0044(MAR)-1.3281	0.0002(MAR)+0.9274	0.0017(MAR)+0.1123
Midlands-east	-0.0038(MAR)+2.835	0.0046(MAR)-1.3754	-0.0071(MAR)+4.5261	-0.0016(MAR)+1.6456
Midlands-west	-0.0072(MAR)+9.4801	0.0027(MAR)+0.0379	-0.0007(MAR)+1.8961	-0.001(MAR)+2.5053
North	0.0016(MAR)+0.3281	0.0033(MAR)-0.7432	0.0005(MAR)+0.794	0.0006(MAR)+0.5906
Northeast	0.0034(MAR)-0.8879	0.003(MAR)-0.4068	0.0005(MAR)+0.9196	0.0012(MAR)+0.5645
Southeast	0.0025(MAR)-0.1253	0.003(MAR)-0.562	0.00003(MAR)+1.0481	0.0012(MAR)+0.3184
West	0.0009(MAR)+0.4632	0.0029(MAR)-0.4404	0.0005(MAR)+0.6041	0.0007(MAR)+0.5005

2.5 Using the adjustment factor methodology

Step 1 – determine treatment objectives

The first step should be to check with the local authority to see if performance objectives for stormwater treatment are required. It is recommended that the stormwater management targets set in State Stormwater Strategy (2010) be used. The Strategy sets an 80% reduction in TSS, 45% reduction in TP and 45% reduction in TN. These targets should provide an adequate level of treatment for the protection of receiving waters throughout Tasmania.

Step 2 – calculate the size of system required at the reference site

Follow the methodology detailed in 2.3 Sizing WSUD elements to calculate the required size of the planned WSUD element in Hobart, the reference site using the sizing graphs provided in the detailed design chapter for that WSUD element.

Step 3 – calculate the appropriate adjustment factor

Determine the Hydrologic Region in which the WSUD element is to be built from figure 2.1. Find out the mean annual rainfall (MAR) at the site (MAR of the site may be obtained from the Bureau of Meteorology if not already known). Apply the adjustment factor equation (from table 2.1) with the MAR of the proposed site to determine the adjustment factor. (NOTE: **MAR** SHOULD BE EXPRESSED IN MILLIMETRES)

Step 4 – calculate the required size of WSUD element

Multiply the size of treatment system calculated in step 2 by the adjustment factor calculated in step 3 to determine the actual size of system required at the location of interest.

2.6 Worked example

A large ecotourism development in Bicheno plans to install a constructed wetland within its 12 Ha development site. The project proponents would like to achieve the State Stormwater Strategy (2010) stormwater management targets – a 45% reduction in TN, 45% reduction in TP and an 80% reduction in TSS for stormwater leaving the site so that they may assure visitors that the site will not adversely affect local receiving waters. Bicheno has a mean annual rainfall (MAR) of 675.8 mm. The project designers have calculated that the site will have impervious surfaces making up 45% of the total site area.

Calculations for sizing the wetland are as follows:

1. From Figure 2.2, a wetland at the reference site needs a surface area equal to 3% of the contributing impervious area to meet objectives,

   i.e. contributing impervious area = (45/100) x (12 x 10,000) = 54,000 m^2

   reference wetland area = 0.03 x 54,000 = 1,620 m^2.

2. From figure 2.1, it is apparent that Bicheno lies within the NORTHEAST hydrologic region.
3. The *Adjustment Factor* for the NORTHEAST region is computed using the wetland adjustment equation for the NORTHEAST region in Table 2-1:

   Adjustment Factor = 0.0012 (MAR) + 0.5645

   =0.0012 (0.6758) + 0.5645 = 0.5653

4. The required wetland area is 0.5653 x 1,620 = **916m^2**.

Thus, a wetland treating a 12 Ha catchment in Bicheno (with 675.8mm annual rainfall) is required to be 916 m^2 to give the same level of treatment as a 1,620 m^2 wetland at the Hobart reference site.