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SURFACE WATER RESOURCE CAPACITY ESTIMATES FOR THE WESTERN MOUNT LOFTY RANGES PRESCRIBED WATER RESOURCES AREA

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INTRODUCTION

This technical note summarises the methods and results of investigations undertaken to estimate the capacity of surface water resources in the Western Mount Lofty Ranges Prescribed Water Resources Area of South Australia. It contains:

- the objectives and background information of the investigation;
- the concept of management zones;
- the methodology used for the derivation of rainfall-runoff relationships for each river system catchment;
- the definition of Resource Capacity and the methodology used to estimate it for management zones and prescribed watercourses;
- background information on Threshold Flow Rates and methodology used for their derivation; and
- background information on Sustainable Extraction Limits and the methodology used for their derivation.

The methodology to estimate Resource Capacities and Sustainable Extraction Limits, and the resulting data form part of the *Draft Water Allocation Plan for the Western Mount Lofty Ranges, 2010*.

BACKGROUND

Surface and groundwater resources in the Western Mount Lofty Ranges (WMLR) were prescribed on 20 October 2005 under the *Natural Resources Management Act 2004* (the *Act*) by the Minister for Environment and Conservation. Under the *Act,* the Adelaide and Mount Lofty Ranges Natural Resources Management Board (the Board) is required to undertake the development of a Water Allocation Plan (WAP) for the Prescribed Area (WMLR PWRA).

The Science, Monitoring and Information Division of the Department for Water (DFW), in partnership with the Board, undertook scientific investigations to determine the surface and groundwater resources in the WMLR. The surface water resources data provided in this report forms the scientific basis used to formulate the policy and rules relating to the allocation of water for existing users, new users and the environment (as environmental flow provisions) in a sustainable manner.

THE AREA

The Western Mount Lofty Ranges Prescribed Water Resources Area covers an area of about 2750 km^2. It spans from the Gawler River system in the north of Adelaide to the southern coast of the Fleurieu Peninsula (Figure 1). For the purpose of this investigation, the area is defined by surface water drainage boundaries and is broadly grouped into six main river catchments, namely:

- South Para River;
- Little Para River;
- Upper River Torrens;
- Onkaparinga River;
- Willunga Basin; and
- The Southern Fleurieu Peninsula including Myponga, the Inman and the Hindmarsh Rivers.

The water resources of each of these catchments has been assessed separately, based on information from existing technical reports that were written individually for these catchments over the past eight years.

Each catchment is subdivided into a number of major sub-catchments, which in turn are further subdivided into management zones. The latter is the catchment unit where allocation limits for the surface water is provided in the WAP.

In addition to this, there are three prescribed watercourses, namely the Lower Gawler River (downstream of Gawler Junction), Lower Torrens River (downstream of Gorge Weir) and the Onkaparinga River (downstream of Clarendon Weir), all draining to the Gulf St Vincent.

Figure 1. Location Map - Western Mount Lofty Ranges Prescribed Water Resources Area

SURFACE WATER MANAGEMENT ZONE

For the purpose of the WMLR WAP, the smallest geographical unit for management of the surface water resources in the Prescribed Catchment Areas is the Surface Water Management Zone (SWMZ).

The SWMZ is the catchment area providing runoff into an identified individual stream reach. The reaches may be of different types and lengths depending on their nature and their position within the catchment. Typical reaches are identified as headwater reaches or reaches formed by upper, middle and lower pool riffle channels (refer Vanlaarhoven J and Van Der Wielen M. 2009 for further details). The aim of managing surface water resources within each SWMZ is to ensure that adequate water (and flow regime) can be provided to maintain a healthy ecosystem at an acceptable level of risk at the outlet of each SWMZ that represents a particular reach type, yet leaving a reasonable amount of water for social, economic and agricultural development.

A SWMZ is generally smaller in area than a major sub-catchment and constitutes a catchment area of a lower order stream with a major sub-catchment. Catchment areas of Kersbrook Creek and Mt Pleasant in the Torrens River catchment are examples of major sub-catchments. At the scale of individual reaches identified for the WAP, the majority of SWMZs range in area from less than 1 km^2 to about 25 km^2, but with the majority having catchment areas of the order 3-8 km^2.

In the WAP, the SWMZs are categorised as either “Headwater SWMZs” or “Receiving SWMZs”. The former are located in the uppermost headwaters and thus cannot receive any runoff from catchments further upstream. The latter, being the remainder of the SWMZs, receive runoff from all upstream SWMZs in addition to the runoff from their own catchments.

Since the majority of SWMZs are relatively small in comparison to the size of the main river catchments, they are also generally relatively homogeneous in terms of their topography, rainfall distribution, vegetation, geology and soil types, etc. On occasions, where markedly different land uses exist, eg, townships, farm dam development intensities, etc., and these straddle the SWMZ topographical boundaries, the SWMZs have been restructured to avoid this situation by either enlargement or further sub-division. It should be noted that the concept of SWMZs discussed in this section does not apply to the SWMZ in the Prescribed Major Watercourses, as their environmental water requirements are different from those of the Prescribed Water Resources Areas.

Maps of the SWMZs of the WMLR PWRA are included in Appendix VI.

ADJUSTED RUNOFF AND RESOURCE CAPACITY

Definitions

“Adjusted runoff”: **NRM Act, 2004**

The median annual runoff from a catchment with the impact of development (farm dams) removed.

Proposed Definition:

“Resource Capacity” **- The long-term mean annual runoff from a catchment or a Surface Water Management Zone with the impact of farm dams and plantation forestry removed.**

With reference to the definition for Resource Capacity, the mean annual runoff for any area should be derived from records over a recent period of at least 30 years and with land uses typical of the same period, except that the runoff must be adjusted to remove the impact of the recent rapid growth in farm

dams and plantation forestry. The Resource Capacity thus defined does not take into account any effects of possible future climate change.

Any earlier uses of the terms resource capacity, adjusted runoff or adjusted flow would have been refering to flow estimates with only the removal of the effects of farm dams from the historical flow observations and modelling. In particular, the earlier investigations into adjusted runoff or resource capacity did not take the effects of forestry into account. To assist in clarity of description of the investigations undertaken, the original estimations of resource capacity that did not take forestry into account are here-in referred to as **adjusted runoff, or adjusted flow**. Adjusted runoff therefore takes only the effects of farm dams into account. Resource Capacity takes both the effects of farm dams and forestry into account.

For the purposes of the WAP, the estimation of the Resource Capacity is required for each SWMZ within the Prescribed Areas and for the three major Prescribed Watercourses within the WMLR. The estimation of resource capacity for the SWMZs has been undertaken via incorporation of the following steps through data collation, analysis and modelling:

1. Collation of data on rainfall and flow measured at many sample locations within the catchments draining the WMLR from about the 1970s and later. Collation of data on surveys of farm dams and areas of forestry;
2. The analysis of the rainfall and runoff data, along with other data affecting the hydrology of the catchments upstream of the flow measurement locations, leading to the ability to establish rainfall to runoff models and techniques capable of providing estimates of flow from rainfall records (and other catchment data), including estimates of flow over the majority of catchment areas where the flow has not been measured;
3. The use of the models to predict what the measured flow may have been (and is likely to be in the future) under 'benchmark/standardised' conditions of rainfall and land use (specifically the typical existing WMLR land use, but with flows estimated under a hypothetical 'no farm dams and no forestry' situation, both of which have significantly reduced the observed flows over recent years); and
4. Extrapolation of the estimated 'benchmark/standardised' flows, as predicted at the flow gauge locations, to each individual SWMZ to provide the quantification of its resource capacity.

The majority of SWMZs do not contain any forestry, thus for these, the Adjusted Flow is then the same as the Resource Capacity. The final step in estimating the Resource Capacity is described after the Section below.

ESTIMATION OF ADJUSTED RUNOFF

STEP 1. BASIC HYDROLOGICAL DATA USED IN ESTIMATIONS OF ADJUSTED RUNOFF

The basic sources of data for estimation of both the Adjusted Runoff and Resource Capacity of the SWMZs are the records of runoff, typically measured over the past 15-35 years, at various locations on catchments distributed across the WMLR.

The majority of catchments for which flows have been measured are cleared for mixed farming and have vegetation and topography typical of the Mt Lofty Ranges. The catchments upstream of the locations where the flows have been measured range from about 1 to greater than 1000 km2.

Over the past 30 years there has been a rapid growth in the number and size of farm dams. While forestry has existed earlier the areas of forest have also increased recently. Data on these activities has been collated from ground and map surveys.

STEP 2. ANALYSIS OF CATCHMENT DATA AND ESTABLISHMENT OF RAINFALL TO RUNOFF MODELS

Analysis of the flows has determined that within any particular catchment, the measured flows are dependant on many variables, but particularly on the catchment area, the rainfall over the catchment and the intensity of farm dams and forestry plantations within the catchment.

Rainfall-runoff models consist of a series of equations with up to 10 or more variables, which calculate runoff from rainfall records and specifically take into account the catchment area and farm dam capacity. The rate of rainfall on the catchment surface is generally estimated by tracking recorded daily rainfalls through a conceptualisation of the catchment as a series of three vertically layered storages and pathways; a vegetated, upper soil storage draining to a lower unsaturated soil storage which in turn drains to a saturated groundwater store. The models assumed a take of 50% of dam capacity from all licensed dams (identified at the stage of analysis) and 30% of dam capacity from all other dams. Evaporation takes place from each store according to estimates of daily evaporation and only when the stores are full does surface runoff take place from that store. The vast majority of rainfall is lost by evaporation from the stores.

The records of daily rainfall are thus translated into estimates of daily flow. These are then accumulated in estimates of monthly, annual and long-term average flows.

The values of the variables within the equations contained in the model (which dictate the rates of movement through these storages and thus the rates of surface flow generation) are found by trial and error fitting of the runoff as calculated by the model to the runoff as measured at the gauged locations. This process of fitting is termed calibration.

The models used have equations which specifically predict the amounts of flow that are estimated to be diverted into farm dams.

The rainfall to runoff modelling for the six major catchment areas making up the WMLR prescribed area commenced in 2003 and has been progressively extended since then by different hydrologists using different methods and models. The following reports provide descriptions of the modelling undertaken for each of the six major catchment areas:

- The Impact of Farm Dam Development on the Surface Water Resources of the South Para River Catchment, 2003/19 (Teoh, 2003);
- Estimating the Impact of Current Farm Dam Development on the Surface Water Resources of the Onkaparinga River Catchment, 2002/22 (Teoh, 2002);
- Surface Water Assessment of the Upper River Torrens Catchments, 2003/18 (Heneker, 2004);
- Draft Surface Water Assessment of the Little Para River (Williams, 2007);
- The Environmental Water Needs of the Watercourses of the Willunga Basin (AMLR INRMB, 2006); and
- Surface Water Assessment for the Southern Fleurieu Region (Clark, et al 2007).

STEP 3. EXTRAPOLATION AND STANDARDISATION OF FLOW ESTIMATIONS USING TANH CURVES

Each of the six models referenced above were constructed to specifically include, and thus take into account, the water diverted from the stream courses into the farm dams that existed over the period of flow measurement and modelling. Once calibrated to the flow data, with the location and size of the farm dams (which existed within the catchment over the period of measurement) included in the model, the model could then be re-run with the farm dams removed. Since the effect of the farm dams, when included in the model, was to remove flow from the catchment, removal of the farm dams will increase the flow. This increased flow was termed the ‘adjusted runoff or flow’.

For the purposes of the WAP, a simple and consistent method of estimation of the newly defined Resource Capacity is now needed. As noted, for the majority of catchments where forestry does not exist, the Resource Capacity will be the same as the Adjusted Runoff. The Tanh Curve method has been chosen for this as in most cases the reports listed above either used this method directly in the determination of the Adjusted Runoff or produced Tanh curves as an outcome of the modelling undertaken. Moreover, the Tanh method can also be used to modify estimates of Adjusted Runoff to give the Resource Capacity.

The derivation of the Tanh curve is described in Appendix I. The method distills the rainfall to runoff relations derived from modelling into a single curve that can be defined by two parameters L and F. The first defines the minimum annual rainfall required, in an average year, to initiate any runoff at all. The second value, F defines the rate at which runoff increases as rainfall increases above the threshold value.

Using the rainfall to runoff models previously established, Tanh curves have been derived for all gauged catchments under both the 'with' and 'without farm dams' situations.

STEP 4. EXTRAPOLATION OF THE TANH CURVES TO EACH SWMZ TO GIVE THEIR ADJUSTED RUNOFF

The Tanh curves previously produced for the major catchments have been reviewed and minor modifications made in order to confirm their adequate consistency for the purposes of the WAP. Table 1 gives a summary of the basic information used in the derivation of the original Tanh curves derived in the listed reports. The next section reviews the methods and describes any modifications required.

In order to extrapolate the L and F values derived for the major catchments to the individual SWMZs it has been assumed that the SWMZs will share the same L and F values that have been found for the major catchment in which the SWMZ is located. On occasions it may be the L and F values for the nearest gauged catchment where this catchment has similar hydrology to that of the SWMZ.

Having determined the L and F values for each SWMZ by this method of extrapolation (using the Tanh curves fitted to adjusted runoff), the Adjusted Runoff for that SWMZ can be calculated from the Tanh equation by insertion of the L and F values and the records of annual rainfall for that SWMZ.

Note that an annual runoff value can be calculated using the Tanh equation for any value of annual rainfall. However, being non-linear, the equation cannot be used accurately to predict an annual average runoff from a single value of estimated average annual rainfall. In most cases therefore the average runoff (or Adjusted Runoff or Resouce Capacity) for any area is derived as the average of (say) 30 estimates of annual runoff calculated from a set of 30 annual rainfalls recorded for the catchment (the average of which will be taken as the average rainfall for the area).

The next Section describes the process of final modification to achieve consistency where L and F values have been derived using 'non-standard' rainfall record, period of calculation or different methods.

ESTIMATION OF RESOURCE CAPACITY FOR SWMZ

STEP 1. STANDARDISATION OF TANH PARAMETERS.

Table 1. Summary of information used for derivation of Tanh curve

Catchment & Reports	Modelled area km^2	Period of runoff calibration	Hydrologic model	Time steps	Remarks
South Para	324.1	1969-98	WC-1	Daily	L and F values updated with adjusted BoM rainfall
Little Para	1968	2003	WC-1	Daily	L and F value taken as from the draft report

Upper Torrens	350	1971-2000	AWBM	Daily	L and F values updated with adjusted BoM rainfall
Onkaparinga	558	1968-97	WC-1	Daily	L and F values updated with adjusted BoM rainfall
Willunga Basin	222.1	1968-97	WC-1	Daily	L and F values were not provided in the report, so they were derived from the WaterCress model provided and rainfall has not been adjusted to BoM rainfall
Southern Fleurieu	1196	1971-2000	Tanh curve and Farm dam impact	Annual	As provided in the draft reported. Rainfall used in the draft report to derived L and F values has been adjusted to BoM rainfall

Table 1 provides information on the different methods and periods of analysis governing the production of past Tanh parameters. These differences are described below.

- Different sets and periods of rainfall data used. For most catchment modelling, the point rainfall station dataset were used as input for the model simulations. For Resource Capacity calculations it was decided to use the gridded rainfall isohyet dataset produced recently by the Bureau of Meteorology. These two data sets will give different values of mean annual rainfall for some SWMZs and thus also different calculated runoff.
- Different period of flow simulations used to estimate catchment runoff. The surface runoff reported in the technical reports are calculated over different periods. Where possible, the Resource Capacity has been recalculated for the standard period 1971-2000 with rainfalls compatible to the BoM gridded rainfall data set.
- Different methodologies. The catchment runoff has been calculated using different rainfall to runoff models (WC-1 or AWBM). The Southern Fleurieu catchment model only used the Tanh method but incorporated modifications to allow for soils and catchment slope.
- Different catchment areas. Recent updating of GIS data has lead to changes to some catchment boundaries and thus calculated areas. These changes will affect the calculation of runoff.

These considerations have been taken into account in the review and (where necessary) modification of the results obtained previously, as given in the listed reports and as described below.

Onkaparinga - The original Tanh curves used a different form of equation in which additional variables ‘a’ and ‘b’ were incorporated. The curves were also derived using the previous (now non-standardised) rainfall isohyets to determine the annual rainfall. The daily rainfall to runoff model was therefore re-run with rainfall factors adjusted to reflect the standard BoM isohyets and the annual rainfall and runoff results plotted and the L and F factors determined by fitting the Tanh relationship to the results.

Upper Torrens - The original Tanh curves were adopted with only minor changes.

South Para - As above, with slightly greater changes since the original Tanh curves were derived using the extended period 1884-1998.

Willunga Basin - The modelling was undertaken on behalf of the NRM Board as part of an assessment of the impact of changed land use on the flows within the basin. The models were complicated by attempting to account for apparent large losses on the plains tributaries. The report did not provide any Tanh curves, so the original models were obtained and re-run to obtain annual rainfall and runoff values. Minor changes

were incorporated to certain catchment boundaries and areas and rainfall factors modified to reflect the BoM standardised isohyets.

Little Para - The L and F values for the Tanh equation equation were obtained from the report. No evaluation or update of the L and F values could be carried out since the model was not available at the time of reassessment.

Southern Fleurieu - The modelling avoided the need to use daily rainfall to runoff modelling by adopting the Tanh method only. The method calibrated the Tanh parameters directly to observed annual rainfall and runoff data and sought to relate these to soil types, slopes and farm dam intensities. The investigation utilised the gridded BoM rainfall data set and Tanh curves were produced for no dams situation. As a result, no update of L and F values were necessary. A full description of the methodology can be found in the Southern Fleurieu Report (Clark, et al 2007).

A summary of updated L and F values derived using the Tanh curve method for each major sub-catchment is provided in Appendix III.

The flows calculated for the SWMZs using the revised Tanh curves, when aggregated for each of the major sub-catchments, show some (generally minor) differences to the runoff reported in the technical reports. However, differences of up to 30% are found in the case of the Little Para River and Willunga Basin catchments. These have identified large river channel losses and in some cases the Resource Capacities for individual SWMZs should strictly be assigned a negative value in order to preserve the correct aggregated flow at the catchment outlet.

STEP 2. RESOURCE CAPACITY - ADJUSTMENT TO THE MEAN ANNUAL RUNOFF TO ACCOUNT FOR THE IMPACTS OF PLANTATION FORESTRY

This section describes the method used to redistribute water deemed to be used by plantation forestry across the landscape at a major sub-catchment level.

At the time of development of the daily streamflow models, the effects of forestry were not incorporated into the models. Through the process of developing the Water Allocation Plan, it became evident that the impacts on surface-water resources due to plantation forestry were large in some areas and needed to be quantified. What follows is a description of the simple water balance method used to account for that impact. The impacts of plantation forestry are accounted for via the adoption of a simple additional adjustment to the mean annual runoff from each catchment (over and above the adjustment made for farm dams). No attempt has been made to represent this overall single additional adjustment in a temporally varying fashion.

Key Assumptions

1. Plantation Forestry is responsible for an 85% reduction in available surface water resources over the planted areas.
2. This use is incorporated on an area weighted basis to define a finally adjusted “capacity” of the surface water resource – that is the total water that is available before applying any limits or restrictions, but after adjusting for the effects of farm dams, watercourse diversions and forestry.

The use of an 85% reduction figure is consistent with the State Policy Framework which states:

- “*Plantation forests, regardless of species, can be assumed to reduce runoff (including groundwater recharge) by 85%.”*
- *“…maximum water use should be used to estimate the amount of water used by plantation forests over the lifecycle of the forest*” (SA Government, 2009 p15-16).

This assumption has been applied to all plantation forestry areas as defined by the South Australian Land Use data set (DEH, 2008) regardless of age or level of canopy closure. It also assumes steady state coverage

over the assessment period, which is generally between 1971 and 2006. In general it is a conservative assumption of the impacts of forestry on surface water runoff.

The following land use classifications were used to define areas of plantation forestry (Bureau of Rural Sciences, 2006):

- 3.1.0 Plantation Forestry
- 3.1.1 Plantation Forestry, Softwood Production e.g. Pine Plantations
- 3.1.2 Plantation Forestry, Hardwood Production e.g. Blue Gum Plantations

Scale of Application

Major sub-catchments in the WMLR PWRA are generally in the order of tens of square kilometres. This is the scale of calibration of most hydrological models as streamflow data is generally available only at this scale.

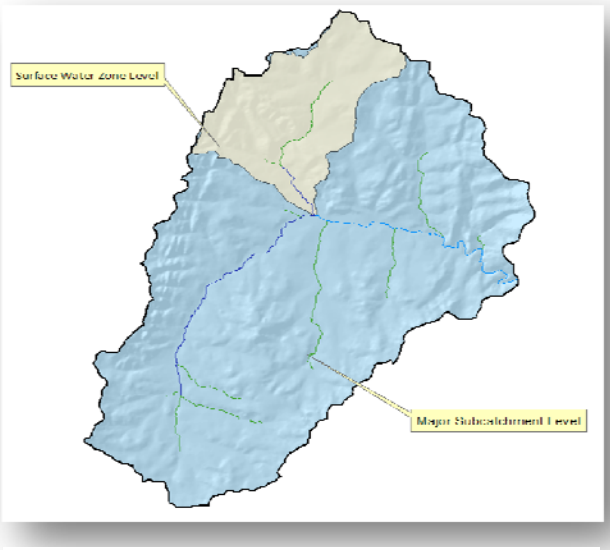


Figure 2. Sub-catchment and Management Zone Scale

Water use from commercial forestry is not currently explicitly modelled as part of DFW's hydrological assessments. This is due mostly to a lack of streamflow data at the scale required to validate any assumptions about forest water use. This leads to the impacts of assumed forestry water use being spread across the entire sub-catchment instead of it being accounted to only the forested areas. This results in overestimation of the Resource Capacity in forested areas or SWMZs within a sub-catchment and under-estimation of it in other non-forested SMWZs within the same sub-catchment (Figure 2). Hence, it is necessary to redistribute the assumed forest water use back across the landscape at the appropriate scale.

Method for redistributing assumed plantation forest water use

The calculation of the impacts of plantation forestry is carried out using the following steps:

1. Calculate the predicted Resource Capacity assuming that forested areas would reduce the runoff from their proportional zone area by 85%.

$$RC_{Z2} = (RC_{Z1} \times P_1 \times 0.15) + (RC_{Z1} \times (1-P_1)$$ Equation 1

Where:

RC_{Z2} = the resource capacity adjusted for decreased runoff from forested areas

RC_{z1} = the resource capacity adjusted, previously, for farm dams only

P_1 = Proportion of total area of the SWMZ that is forested

This step ensures that the impact of forestry is considered to be proportional to the level of runoff within the catchment. In other words, the higher the runoff, the higher the assumed impact.

2. In order to validate the assumption that the original modelling made no account for the spatial distribution in forestry across the sub-catchment, it is necessary to adjust the runoff in each SWMZ by the proportional increase for the whole sub-catchment:

$$RC_{adj(i)} = RC_{z2} \times \frac{\sum_1^n RC_{z1}}{\sum_i^n RC_{z2}} \qquad \textbf{Equation 2}$$

Where:

$RC_{adj(i)}$ *= SWMZ resource capacity adjusted for forest water use and farm dams (ML)*

RC_{z2} *= Initial estimate of SWMZ resource capacity adjusted down for forest water use (Eq. 1)*

$\sum_1^n RC_{z1}$ *= Sum of the original resource capacities for each SWMZ in the major sub-catchment unit*

$\sum_1^n RC_{z2}$ *= Sum of the resource capacities after adjustment for forest water use for each SWMZ in the major sub-catchment unit*

This step provides what is termed "adjusted runoff". That is what runoff there would be in each zone were the impacts of farm dams and commercial forestry were removed.

3. Given the "adjusted runoff" from step 2 above, it is still necessary to account for the existing impact due to the effects of commercial forestry for the purposes of water allocation and water accounting. To calculate the assumed forest water use for use in determining the existing level of development (in addition to existing demands from farm dams on the resource), take the product of the adjusted resource capacity, the reduction factor (0.85) and the proportion of the area is covered by commercial forestry, as below.

$$Forest\ Water\ Use = RCadj(i) \times P1 \times 0.85 \qquad \textbf{Equation 3}$$

Where:

$RCadj(i)$ is the fully redistributed runoff for zone i from Equation 2

$P1$ is the proportion of zone i covered by commercial forestry

To demonstrate the methodology described above, an example is worked out in Appendix II.

RESULTS AND DISCUSSION

The final estimates of the surface water Resource Capacity for the SWMZs in the WMLR PWRA are provided in the tables in Appendix V. The resource capacity is either expressed as a measure of volume in megalitres (ML) or a as a measure of runoff depth across the catchment area in millimetres (mm) per SWMZ.

Resource Capacity has been termed in various earlier reports and documents as 'the adjusted runoff' or 'pre-development flows' or sometimes termed as 'natural flow'. However, it should not be interpreted as pre-European settlement "natural" flow, since the runoff estimated uses current land use condition (other than plantation forestry).

The use of this method to redefine the concept of "Resource Capacity" to include the impacts of plantation forestry should be limited to the Mount Lofty Ranges, due to the reliance on the key assumption regarding the impact of forestry on surface water runoff and stream flow. The assumption of an 85% reduction in runoff was derived from a catchment study in the middle of the MLR with medium-high rainfall, therefore its applicability to other areas of the State needs to be verified.

The expected effect of using this method is that, where there is plantation forestry present in a particular catchment, an increase in the total adjusted runoff available should be available under the definition of "Resource Capacity". There is no further assumption implicit in this method as to how the "additional" available water could or should be applied. If the forests were removed and replaced with a comparable

mix of pasture and native vegetation, more water would be available. This condition is often also sometimes termed the “natural” flow, but care should be taken to avoid comparisons with pre-European conditions which would naturally have seen a greater proportion of native vegetation. This method, and indeed the original modelling, does not explicitly take into account differing land uses or cover.

RESOURCE CAPACITY OF PRESCRIBED MAJOR WATERCOURSES

The prescribed major watercourses assessed in the WMLR prescribed area are the Gawler River (downstream of Gawler Junction), Lower Torrens River (downstream of Gorge Weir) and the Onkaparinga River (downstream of Clarendon), all draining to Gulf St Vincent.

LOWER TORRENS PRESCRIBED WATERCOURSE

Since there are no significant forest areas in the catchment of the Lower Torrens River, the Resource Capacities of its reaches have been taken as the Annual Adjusted Flows as reported in the draft Lower Torrens Report (Teoh 2008).

The flows are generated partly from the higher rainfall undeveloped hillsface zone forming the eastern margin of Adelaide, but mostly from the urbanised catchments making up its eastern suburbs and central CBD area.

The majority of flows generated in the Upper Torrens catchment are diverted for water supply to Adelaide from the Gorge Weir. Only infrequent high flows spill over the Weir and enter the Lower Torrens watercourse. When averaged over the long term these spills are estimated at 11,000 ML/y, but because of their infrequency these flows are not included in the estimation of Resource Capacity.

Figure 3 shows the watercourse divided into four reaches, identified as Lower Torrens Prescribed Water Zones (LTPWZ1 to LTPWZ4). The five5 locations forming the ends of the four4 reaches (preceding downstream from Zone 1 to Zone 4) are the Gorge Weir; just upstream of the junction with Third Creek; just downstream of Second Creek; the Torrens Lake City Weir; and the Outlet Weir at the coast. The catchments’ inflow to these reaches are shown, but it should be noted that the catchments are not part of the WLMR Prescribed Area and thus the control of water extractions only applies to the main watercourse itself.

The Annual Adjusted Flow contributions from the catchments and the cumulated flows within the Zones are shown in Columns 3 and 4 of Table 2.

Table 2. Adjusted runoff and flow for Lower Torrens Prescribed Watercourse

1	2	3	4	5	6	7
Lower Torrens Prescribed Watercourse Zones	Catchment area (Ha)	Annual no-dams runoff (ML)	Annual no-dams flow (ML)	Allocation limit to Farm Dams (ML)	Sustainable Watercourse Extraction Limit (ML)*	Minimum TFR (L/s)**
LTPWZ1	7155	12482	12482	3121	2362	650
LTPWZ2	4460	6646	19128	1661	10669	850
LTPWZ3	3002	3982	23111	363	15014	1000
LTPWZ4	1426	2196	25307	0	17211	1350
Total GW to SVG	16043	25307	25307	5145	17211	
GW - Gorge Weir, SVG - St Vincent Gulf Spills from the Gorge Weir have not been included in these figures						

*Sustainable watercourse extraction limit = Annual no-dams flow – (Allocation to farm dams + Environmental Water Provisions)

**TFR – Threshold Flow Rate (in litres per second) is the flow rate above which water can be diverted/extracted from the watercourse

Columns 6 and 7 give the Sustainable Watercourse Extraction Limits and Minimum Threshold Flow Rates for the Zones. Environmental Water Provision (EWP) for the Lower Torrens Prescribed Watercourse is the flow rate (a) that is required for fish passage through the entire watercourse and (b) below which water must not be extracted or diverted from the watercourse (*VanLaarhoven J, 2010*). The EWP flow rate, or the Threshold Flow Rate (TFR), was calculated based on 20 cm of water depth required for fish passage across the entire watercourse (*Vanlaarhoven JM and Van der Wielen M, 2009*). The steps involved in calculating the TFR and EWP flow volumes involved: (i) surveys undertaken across various sections of the watercourse, (ii) estimation of flow rates (using Manning's formula) required for a water depth of 20cm at the widest section in the zones, (iii) calculation of the number of days those flow rates exceeded, using flow duration curves developed from measured/modelled flows and (iv) calculation the total volume of flows from (ii) and (iii).

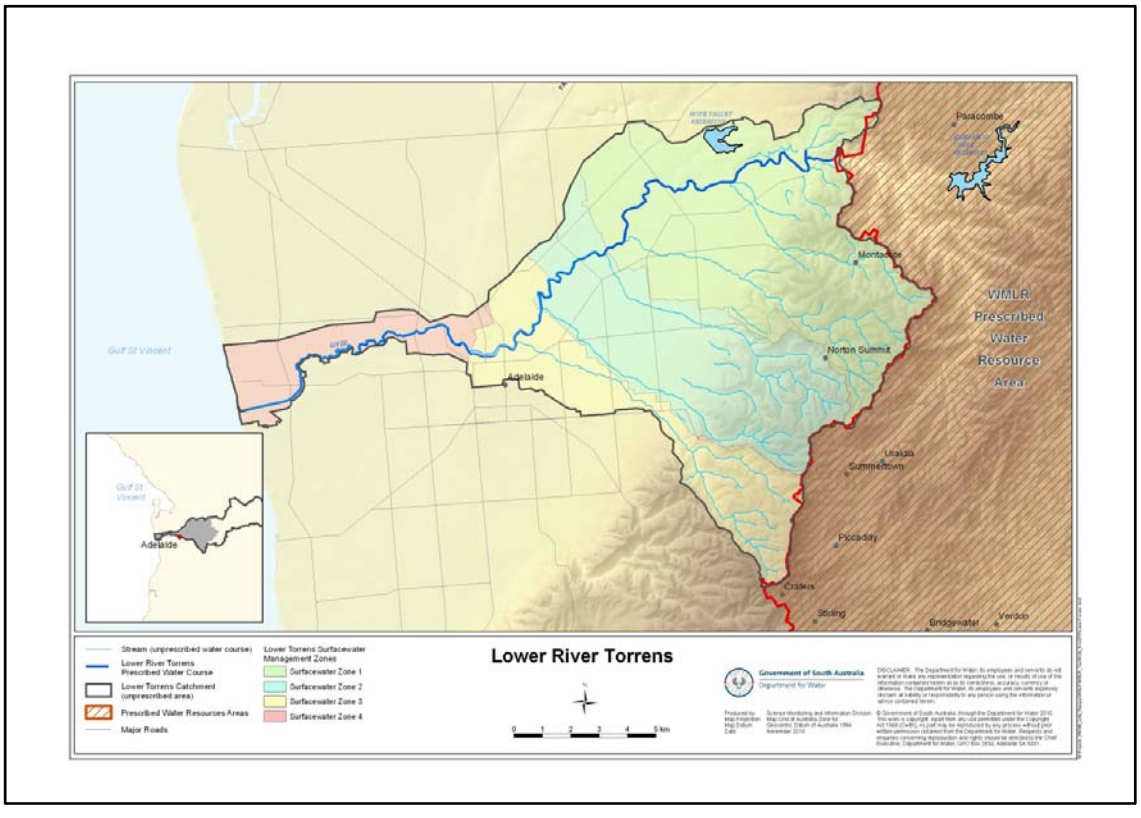


Figure 3. Lower Torrens River Prescribed Watercourse

ONKAPARINGA RIVER PRESCRIBED WATERCOURSE

The Onkaparinga River Prescribed Watercourse is taken as the reach from downstream of Clarendon Weir to Saint Vincent Gulf. All the catchments along the southern side of the river contributing to the flow are prescribed in the WAP, while those on the northern side are not.

The majority of upstream flows are captured in the Mt Bold Dam, which are then released at controlled flow rates to Clarendon Dam for diversion to Adelaide water supplies. The estimates of Resource Capacity given in Table 3 are taken from Teoh, 2008 after adjustment for farm dams. The flows from the urban areas within Noarlunga are not included in the table and are estimated to add an additional 1,385 ML/y.

The catchments have been subdivided into SWMZs as shown in Table 3 below and in Figure 4. The Resource Capacity (or adjusted runoff) from each SWMZ contributing to the adjusted flow is also given in the table.

Excluding the spill from Clarendon Weir, the table shows that at a location immediately downstream of SWMZ O_OM08, the watercourse has adjusted flow of 1,309 ML, at downstream of O_OM08a, it is 6,308 ML and at the end of the river draining to St Vincent Gulf (SVG), the adjusted flow is 8,198 ML. These are the estimated flows excluding the stormwater component from the urban areas. Assuming the runoff coefficient from the urban catchments is 0.23 (Teoh 2008), then with the additional stormwater flows, the adjusted flow to SVG is approximately 9,582 ML.

The WAP has determined that the flows in the watercourse are below levels required for environmental requirements and thus no additional diversions will be allowed. Thus the Sustainable Extraction Limits and minimum Threshold Flow Rates are redundant and do not apply.

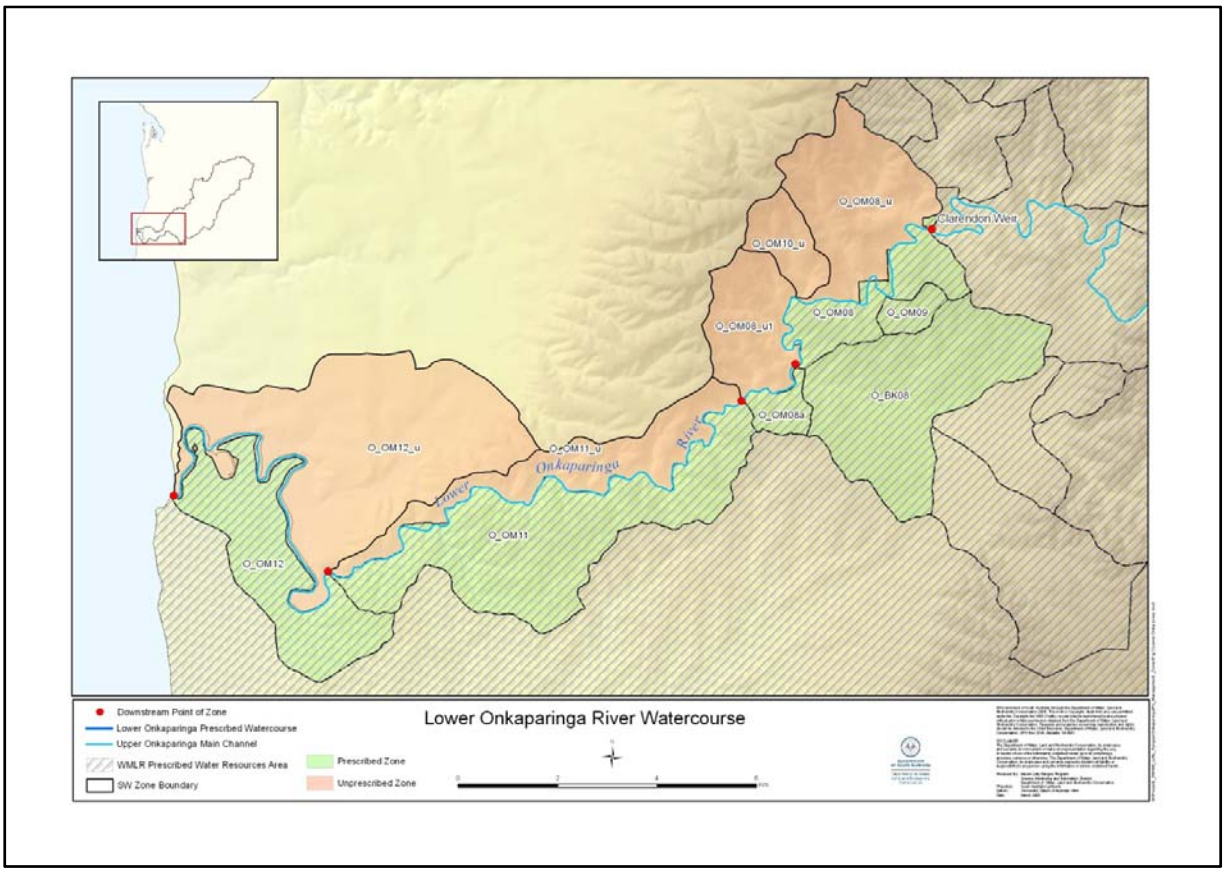


Figure 4. Lower Onkaparinga River Prescibed Watercourse

Table 3. Adjusted runoff and flow for the Onkaparing River Prescibed Watercourse

Management Zones	Management Zone catchment area (ha)	Annual adjusted runoff (ML)	Annual adjusted flow (ML)	Allocation limit to farm dams
O_OM08_u**	729	725	-	0
O_OM09	89	79	-	0
O_OM10_u**	208	211	-	0
O_OM08	380	336	1351	0
Flow from Bakers Gully	4834	5042	-	0
O_OM08_u1**	427	382	-	0
O_OM08a	109	88	6863	0
O_OM11_u**	575	338	-	0
O_OM11	1331	725	7926	0
O_OM12_u**	1803	645	-	0
O_OM12	779	250	8821	0
Total CW to GSV	11264	8821	8821	0

**Zones that contribute flow to the watercourse but are outside of the prescribed boundary.

Data in the table above excludes urban runoff equal to 1,385 ML

No allocation for watercourse extraction

MZ's Inclusive of Urban Runoff

Management Zones MZs	MZs Catch Area (ha)	Annual adjusted runoff (ML)	Annual adjusted flow (ML)	Allocation limit to farm dams
O_OM12_u**	1803	1851	-	0
O_OM12	779	428	10206	0
Total CW to GSV	11264	10206	10206	0

GAWLER RIVER PRESCRIBED WATERCOURSE

The resource capacity for the Gawler River Prescribed Watercourse at Gawler Junction is estimated to be 16,000 ML in a year (note: this is the current flow scenario with no adjustment for the impact of farm dams). The estimated environmental water provision is 4,500 ML and the transmission losses including recharge to groundwater are 1,500 ML. Hence, the limit of available water for sustainable extraction is 10,000 ML. To enable low flows to pass along the watercourse before extraction can occur, the threshold flow rate to be in place at or just downstream of Gawler Junction (Figure 5, station A5050505) is 690 L/s (0.69 cumec) and 500 L/s (0.5 cumec) at the old Virginia gauging station (Figure 5, station A5050510)..

The values stated above are an estimate and surveys of river-hydraulics are required to develop a water level to flow relationship. This will enable determination of water levels required for Environmental Water Provisions at various sections of the river. It should be noted that the catchment areas contributing to the flow in the river are only partly prescribed and therefore the control of taking water can only be partially regulated.

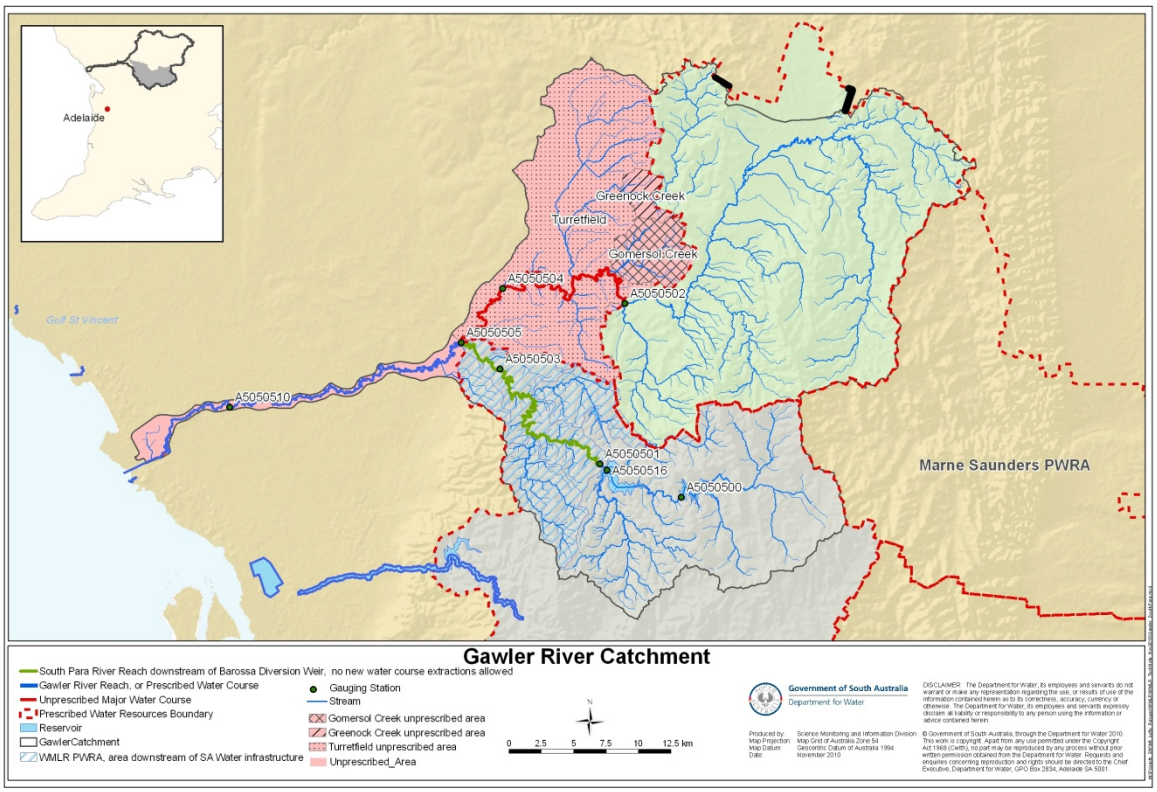


Figure 5. Gawler River Prescibed Watercourse

THRESHOLD FLOW RATES

Threshold Flow Rates (TFR) are defined as the mimimum flow that must be allowed to pass any location before any capture or diversion or extrcation from that flow can be made (*VanLaarhoven, 2010*). This rate has been determined as the minimum flow that is required to maintain the health of the watercourse. The environmental water provision at the end of a SWMZ is based on the criterion that the 20th percentile non-zero daily flows should always be allowed to pass through the following before surface water can be captured, diverted or extracted:

(i) all existing dams greater than 5 ML in capacity;

(ii) all existing licensed dams of any size; and

(iii) all existing watercourse extractions and diversions.

This "20th percentile exceedence non-zero daily flow" is referred to as the Threshold Flow Rate (TFR) and is expressed in litres per second (L/s).

The Unit Threshold Flow Rate (UTFR) is the TFR per unit catchment area. UTFR is calculated by dividing the TFR by the catchment area above the point of capture, diversion or extraction and is expressed as litres per second per square kilometre of contributing catchment area (L/s/km^2).

To this effect, a generalised unit threshold flow rate (UTFR, L/s/km^2) for all SWMZs was developed for the MLR catchments (Appendix IV, Figure 8)). This is essentially a generalised relationship (curve) derived from the actual 20th percentile non-zero flows recorded from thirty one gauging streams spanning the entire

Mount Lofty Ranges and the corresponding rainfall. Hence for a SWMZ, given known annual rainfall (obtained from BoM rainfall isohyet map) and its catchment area, the TFR can be calculated. Similarly, for an extraction point along a watercourse, the TFR can be calculated when the upstream catchment area and the area weighted annual mean rainfall are known.

SUSTAINABLE EXTRACTION LIMITS

Calculation of the Sustainable Extraction Limits is the final step after the Resource Capacities and Threshold Flow Rates have been determined. The Sustainable Extraction Limits for the WMLR WAP were based on the hypothesis presented in VanLaarhoven, JM and Van der Wielen, M. 2009. The results presented here are the outcome of flow modelling of the environmental water requirement hypothesis.

Definitions

Sustainable Extraction Limit calculations were based on the following definition:

The maximum annual volume of surface water and watercourse water that can be taken from a Surface Water Management Zone (but not from a Prescribed Major Watercourse e.g. Torrens River downstream of Gorge Weir), with flows under the Threshold Flow Rate bypassed (not captured, diverted or extracted) by all existing licensed farm dams, all existing farm dams greater than 5 ML in capacity and all existing watercourse diversions and extractions.

This maximum annual volume was derived to be 25% of the Resource Capacity* at a Surface Water Management scale, when water taken from dams does not exceed (i) 50% of the dam capacity for licensed dams and 30% of the dam capacity for all other dams; and (ii) the modelled runoff available at the point of capture.

***- *'Resource Capacity' as defined previously in Section* ADJUSTED RUNOFF AND RESOURCE CAPACITY**

Sustainable Extraction Limit, for the purposes of this WAP, applies at two different scales within a catchment. The first is at the scale of a catchment area within a SWMZ and termed "Surface Water Extraction Limit". The second is at a watercourse scale and is termed "Main Watercourse Extraction Limit". The two terms and their application is explained below.

(i) Surface Water Extraction Limit – refers to the maximum total surface water (runoff) that can be extracted from (a) anywhere within Headwater SWMZs and (b) anywhere other than from Defined Major Watercourse/s in Receiving SWMZs.

(ii) Main Watercourse Extraction Limit – refers to the maximum total surface water (runoff from the SWMZ being referred to, and flow from all upstream SWMZ/s) that can be extracted from the Main Watercourse in a Receiving SWMZ. This limit does not apply to Headwater SWMZs.

RESULTS

The results of this investigation, namely the Resource Capacity estimates, the Sustainable Extraction Limits and the Threshold Flow Rates for each Surface Water Management Zone in the Western Mount Lofty Ranges Prescribed Water Resources Area are provided in tables in Appendix VI.

APPENDIX I - TANH CURVE

For the purpose of estimating the resource capacity of a SWMZ, a rainfall runoff relationship called Tanh curve is used. Tanh curve is expressed as shown below:

$$Runoff\ Q = (P \quad L) \quad F \times Tanh\frac{(P \quad L)}{F}$$ (Grayson et al 1996)

where Q is the runoff in mm generated from a catchment

P is the annual rainfall received in the catchment (mm)

L notional intial loss (mm)

F notional continuing loss (mm)

The L and F values are constants that represent the hydrologic characteristic of a catchment, which is unique to each catchment. They are derived from the best-fitted trend line of Tanh curve plotted against the chart of annual runoff (in mm as Y axis) generated from a catchment versus the corresponding annual rainfall (in mm as X axis) it receives over a long period of time.

It is important to note that the rainfall-runoff relationship is a non-linear function, with the higher the annual rainfall a catchment receives, the more efficient is the runoff. This is different from the runoff coefficient of a catchment, which is sometimes being used to estimate the runoff. The Tanh curve function used to estimate a catchment runoff has the advantage that for a higher rainfall catchment, the runoff being generated is more, and that for a lower rainfall catchment the runoff is reduced.

Once the Tanh curve of a catchment is established, one can estimate the runoff of the catchment if the annual rainfall it receives is known.

For L and F values of each major sub-catchment, see Appendix III.

APPENDIX II - REDISTIBUTION OF ASSUMED WATER USE BY PLANTATION FOREST – EXAMPLE CALCULATION

Consider Figure 6 which describes, by its full outline, a major sub-catchment, with eight sub-zones (Z1 to Z8).

Figure 6. Runoff distributions when calibrated at point A.

For simplicity, all Sub-zone areas are equal. Sub-zone 4 is the only zone with any forested area. That zone has 50% of its area occupied by forest.

Therefore:

P_1 = 0.5 x 1

P_1 = 0.5 (50%)

RC_{z1} at SWMZ 4 = 100 ML

P1 (Proportional area of sub-catchment forested) = 50%

Applying Equation 1:

$$RC_{z2} = (RC_{z1} \times P_1) \times 0.15 + RC_{z1} \times (1 - P_1)$$

RC_{z2} = (100 x 0.5) x 0.15 + 100 x (1 – 0.5)

RC_{z2} = 57.5 ML

Applying Equation 2 to each sub-zone:

Zone 1

RCz1 = 200 ML

$$RC_{zone1} = 200 \times \frac{800\ ML}{757.5\ ML}$$

$$RC_{zone1} = 211.2\ ML$$

$$RC_{zone4} = 57.5 \times \frac{800\ ML}{757.5\ ML}$$

$$RC_{zone4} = 60.7 ML$$

And so on for all eight zones.

$$RC_{zone8} = 26.4\ ML$$

The fully adjusted Resource Capacity will now appear as in Figure 7 below.

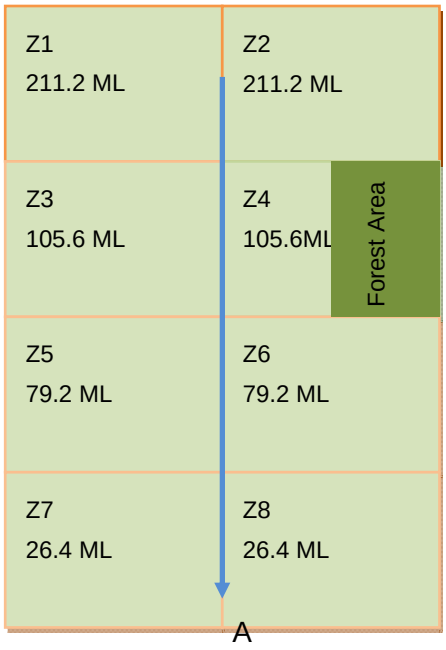


Figure 7. Final allocations by sub-zone after redistribution of forest water use.

Replace the Resource Capacity adjusted for forest water use into sub-zone 4. Final figures and calculations can be seen in Table and Figure 7.

Table 4. Calculations for redistributing forest water use

Sub-Zone	Area (km^2)	Forested Area (km^2)	Forested Proportion - P_1	RC_1 (ML)	RC_{z2} (ML)	$RC_{adjusted}$ (ML)	Forest Water Use (ML)
Z1	1	0	0	200	200	211.2	0
Z2	1	0	0	200	200	211.2	0
Z3	1	0	0	100	100	105.6	0
Z4	1	0.5	0.5	100	57.5	105.6	44.9
Z5	1	0	0	75	75	79.2	0
Z6	1	0	0	75	75	79.2	0
Z7	1	0	0	25	25	26.4	0
Z8	1	0	0	25	25	26.4	0
Totals	8	0.5	-	800	757.5	***844.9***	44.9

APPENDIX III – TANH FUNCTION L AND F VALUES

River system	Major sub-catchment	L	F
Little Para River	Gould Creek	150	600
	Lower Little Para	100	800
	Little Para Reservoir	140	700
	Upper Little Para	150	520
South Para River	Upper catchment	0	900
	Middle catchment	0	910
	Lower catchment	0	1125
Onkaparinga River	Aldgate Creek	0	802
	Angels Gully	0	1053
	Baker Gully	0	1260
	Balhannah	0	1140
	Biggs Flat	0	1275
	Charleston	0	1060
	Cox Creek	0	880
	Echunga Creek	0	1175
	Hahndorf	0	920
	Inverbrackie Creek	0	1055
	Lenswood Creek	0	800
	Mitchell Creek	0	1120
	Onkaparinga Main Channel_1	0	1045
	Onkaparinga Main Channel_2	0	1065
	Onkaparinga Main Channel_4	0	1195
	Scott Creek	0	1150
	Upper Onkaparinga	0	965
	Western Branch	0	975
Upper River Torrens	Angas Creek	100	780
	Birdwood	100	620
	Cudlee Creek	100	860
	Footes Creek	100	670
	Gumeracha_Total	100	640
	Hannaford Creek	100	675
	Kangaroo Ck Total	100	760
	Kenton Creek	100	700
	Kersbrook_Total	100	690
	McCormick Creek	100	705
	Millers Creek	100	710
	Mount Pleasant	100	730
	Sixth Creek	100	810

River system	Major sub-catchment	L	F
Willunga Basin	Ingleburn Creek	90	1450
	Pedler Creek	100	1300
	Sellicks Creek	100	1750
	Silver Sands	60	1450
	Willunga Creek	75	1400
Southern Fleurieu	Aaron & Tent Rock	0	1460
	Anacotilla & Congeratinga Rivers	0	1397
	Ballaparudda Creek	0	1102
	Balquhidder	0	1035
	Bare Rock	0	1052
	Blowhole Creek	0	1108
	Boat Harbor Creek	0	1326
	Boat Harbor Hill	0	1031
	Brown Hill	0	1103
	Bungala River	0	1277
	Callawonga Creek	0	1206
	Cape Jervis	0	1120
	Carrickalinga Creek	0	1271
	Carrickalinga Head	0	1055
	Cooalinga Creek	0	1233
	Coolawang Creek	0	1201
	Dump Beach	0	904
	First Creek	0	1244
	Fishery Creek	0	1142
	Goolwa	0	1100
	Hindmarsh River d/s	0	1252
	Hindmarsh River u/s	0	1188
	Inman River d/s	0	1181
	Inman River u/s	0	1369
	Lady Bay	0	1031
	Little Gorge	0	1107
	Middleton	0	1086
	Myponga River d/s	0	1236
	Myponga River u/s	0	1232
	Naiko Inlet	0	1024
	Newland Head - The Bluff	0	1211
	Normanville	0	1145
	Parananacooka River	0	1190
	Parsons Beach	0	1264
	Port Elliot	0	1117
	Rapid Bay	0	981
	Rapid Head	0	1103
	Salt Creek	0	1166

River system	Major sub-catchment	L	F
	Starfish Hill	0	1019
	Talisker	0	1068
	Tapanappa	0	1495
	The Deep Creek d/s	0	1352
	The Deep Creek u/s	0	1503
	The Links	0	1077
	Tunk Head	0	1020
	Tunkalilla Beach	0	1106
	Tunkalilla Creek	0	1228
	Victor Harbor	0	1263
	Victoria Wreck	0	1039
	Waitpinga Creek	0	1175
	Wirrina Cove	0	1200
	Yankalilla River d/s	0	1333
	Yankalilla River u/s	0	1379
	Yattagolinga River	0	1403
	Yohoe Creek	0	1162

APPENDIX IV – THRESHOLD FLOW RATES

The environmental water provision at the end of a SWMZ is based on the criterion that 20th percentile non-zero flows should be allowed to pass through all the time, at the point of consideration. The same requirement applies to water extraction at a watercourse. This translates to a low flow bypass rate, expressed as litres per second, calculated from the catchment area upstream of the extraction point and the unit threshold flow rate (UTFR, L/s/km^2) determined for that catchment area.

To this effect, a generalised unit Threshold Flow Rate (UTFR, L/s/km^2) for all SWMZs was developed for the MLR catchments. This is essentially a generalised Tanh Curve derived from the actual 20th percentile non-zero flows recorded from 31 gauging streams spanning the Mount Lofty Ranges. The rainfall-flow relationship thus developed has the L and F values of 325 and 3150 respectively. The Tanh curve is shown in Figure 8 below:

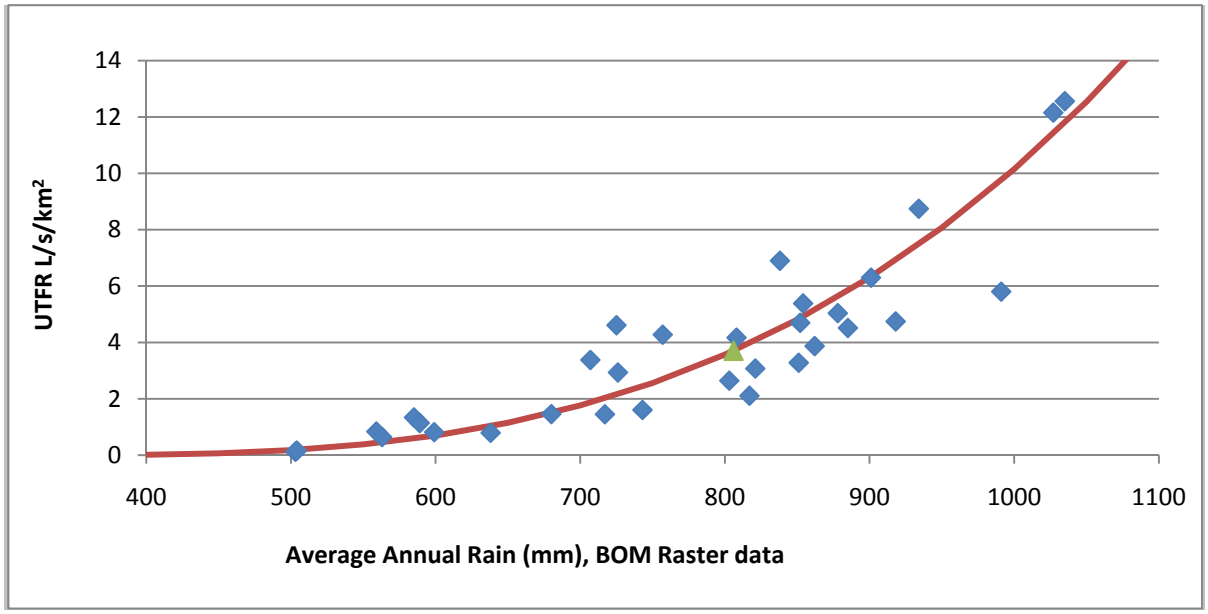


Figure 8. Unit Threshold Flow Rates derived using gauged flow data

Hence for a SWMZ, given known mean annual rainfall (obtained from BoM rainfall isohyet map) and catchment area, the unit threshold flow rate required for low flow bypass can be calculated. Similarly, for an extraction point along a watercourse, with the upstream catchment area and the area weighted annual mean rainfall known, the unit threshold flow rate can also be calculated. (Table 5)

Table 5. Average annual rainfall and corresponding Unit Threshold Flow Rates

Average Annual Rainfall (mm)	Unit Threshold Flow Rate (L/s/km^2)
400-450	0.04
450-500	0.12
500-550	0.28
550-600	0.54
600-650	0.92
650-700	1.45
700-750	2.16

750-800	3.06
800-850	4.19
850-900	5.56
900-950	7.19
950-1000	9.11
1000-1050	11.34

APPENDIX V - RESOURCE CAPACITY AND EXTRACTION LIMITS OF CATCHMENTS

SOUTH PARA RIVER CATCHMENT

South Para River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR ($L/s/km^2$)	Minimum UTFR ($L/s/km^2$)	Maximum UTFR ($L/s/km^2$)
S_LC01	4.13	250	61	62	-	125	1.02	-	-
S_LC02	2.43	120	50	30	93	60	0.64	0.87	1.02
S_LC03	3.28	145	44	36	129	73	0.49	0.73	0.87
S_LC04	4.92	220	45	55	-	110	0.50	-	-
S_LC05	3.56	145	41	36	-	73	0.40	-	-
S_LC06	4.53	170	38	43	263	85	0.32	0.40	0.73
S_LC07	1.05	81	78	20	-	41	1.74	-	-
S_LC08	4.09	340	83	85	-	170	1.98	-	-
S_LC09	7.66	470	61	117	223	235	1.05	1.36	1.98
S_LC10	9.79	618	63	154	-	309	1.12	-	-
S_LC11	1.39	62	44	16	-	31	0.50	-	-
S_LC12	9.49	479	50	120	512	239	0.67	0.50	1.36
S_LC13	1.04	48	46	12	-	24	0.54	-	-
S_LC14	4.26	239	56	60	-	120	0.86	-	-
S_LC15	5.73	319	56	80	-	159	0.84	-	-
S_LC16	1.50	64	43	16	-	32	0.45	-	-
S_LC17	1.16	55	47	14	-	27	0.57	-	-
S_LC18	1.46	66	45	17	-	33	0.52	-	-
S_LC19	2.32	97	42	24	222	49	0.43	0.45	0.86
S_LC20	1.23	52	43	13	-	26	0.45	-	-
S_LC21	0.96	35	36	9	-	17	0.30	-	-
S_LC22	6.04	229	38	57	805	115	0.33	0.45	1.03
S_LC23	0.90	33	36	8	-	16	0.29	-	-
S_LC24	7.79	241	31	60	1145	121	0.19	0.29	0.81
S_LC25	8.18	267	33	67	-	133	0.22	-	-
S_LC26	13.88	381	27	95	1307	191	0.13	0.22	0.65
S_MC01	1.31	195	149	49	-	98	2.50	-	-
S_MC02	1.69	249	147	62	-	124	2.43	-	-
S_MC03	3.29	469	142	117	-	234	2.28	-	-
S_MC04	9.87	1369	139	342	570	684	2.16	2.24	2.50
S_MC05	1.99	262	132	65	-	131	1.94	-	-
S_MC06	4.62	534	116	133	769	267	1.47	1.94	2.24
S_MC07	5.23	727	139	182	-	364	2.17	-	-
S_MC08	2.80	425	152	106	-	213	2.61	-	-
S_MC09	4.95	754	153	189	-	377	2.63	-	-
S_MC10	1.75	266	152	66	-	133	2.62	-	-
S_MC11	3.53	521	147	130	-	261	2.45	-	-
S_MC12	3.78	526	139	132	-	263	2.17	-	-
S_MC13	7.59	1061	140	265	593	530	2.20	2.17	2.62
S_MC14	6.86	990	144	248	-	495	2.35	-	-
S_MC15	8.30	1137	137	284	-	568	2.10	-	-

SOUTH PARA RIVER CATCHMENT - Continued

South Para River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
S_MC16	4.18	540	129	135	430	270	1.86	2.33	2.63
S_MC17	0.51	65	127	16	-	32	1.80	-	-
S_MC18	1.98	256	129	64	-	128	1.86	-	-
S_MC19	1.05	126	120	32	112	63	1.59	1.77	1.86
S_MC20	4.56	545	120	136	1803	273	1.58	1.77	2.35
S_MC21	1.24	147	119	37	-	74	1.55	-	-
S_MC22	3.55	442	125	110	-	221	1.72	-	-
S_MC23	21.38	2470	116	617	8833	1235	1.47	1.55	2.17
S_MC24	7.22	678	94	170	-	339	0.92	-	-
S_UC01	9.39	1815	193	454	-	908	2.40	-	-
S_UC02	19.79	3437	174	859	1313	1718	1.92	2.06	2.40
S_UC03	16.63	2855	172	714	-	1428	1.87	-	-
S_UC04	25.37	4079	161	1020	1734	2040	1.63	1.72	1.87
S_UC05	27.76	5339	192	1335	-	2670	2.37	-	-
S_UC06	19.75	3732	189	933	5314	1866	2.29	1.72	2.37

LITTLE PARA RIVER CATCHMENT

Little Para River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
L_GC01	10.35	1211	117	303	-	606	1.80	-	-
L_GC02	8.85	768	87	192	495	384	1.06	1.43	1.80
L_GC03	4.22	299	71	75	570	150	0.73	1.28	1.43
L_LLP01	3.88	179	46	45	-	90	0.46	-	-
L_LLP02	1.17	51	43	13	57	25	0.40	*	*
L_LPR01	7.99	419	52	105	674	209	0.60	1.08	1.28
L_LPR02	7.78	359	46	90	2349	180	0.47	1.08	1.87
L_ULP01	8.43	1480	176	370	-	740	2.58	-	-
L_ULP02	3.92	669	171	167	-	334	2.45	-	-
L_ULP03	1.59	240	151	60	-	120	1.95	-	-
L_ULP04	4.35	630	145	157	755	315	1.81	1.95	2.58
L_ULP05	2.67	430	161	107	-	215	2.21	-	-
L_ULP06	1.57	235	150	59	921	118	1.92	2.21	2.30
L_ULP07	1.33	238	179	60	-	119	2.66	-	-
L_ULP08	0.84	148	176	37	97	74	2.59	2.63	2.66
L_ULP09	2.23	394	177	99	-	197	2.61	-	-
L_ULP10	0.92	133	144	33	228	66	1.80	2.46	2.63
L_ULP11	1.70	255	150	64	-	128	1.94	-	-
L_ULP12	1.04	163	157	41	-	81	2.10	-	-
L_ULP13	0.93	128	137	32	136	64	1.63	1.90	2.10
L_ULP14	10.31	1089	106	272	1585	544	1.01	1.41	2.46
L_ULP15	0.87	110	126	27	-	55	1.41	-	-

* SWMZ L_LLP02 does not have a Main Watercourse Unit Threshold Flow Rate range, but has a threshold flow rate of 55 L/s.

RIVER TORRENS CATCHMENT

Torrens River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
T_Ang01	11.99	1460	122	365	-	730	2.66	-	-
T_Ang02	15.18	1700	112	425	790	850	2.29	2.44	2.66
T_Bir01	10.40	1348	130	337	990	674	1.53	1.50	1.51
T_Bir02	5.53	793	143	198	-	396	1.86	-	-
T_Bir03	6.13	808	132	202	1390	404	1.58	1.51	1.86
T_Bir04	5.17	732	142	183	-	366	1.81	-	-
T_Bir05	10.82	1556	144	389	1962	778	1.87	1.55	1.81
T_Bir06	7.72	1205	156	301	-	603	2.19	-	-
T_Bir07	5.22	764	146	191	2983	382	1.94	1.62	2.30
T_Cud01	1.52	234	154	59	-	117	3.89	-	-
T_Cud02	2.54	423	166	106	-	211	4.41	-	-
T_Cud03	4.49	759	169	190	-	380	4.52	-	-
T_Cud04	1.57	234	149	58	223	117	3.65	3.89	4.41
T_Cud05	3.19	610	191	153	-	305	5.55	-	-
T_Cud06	1.91	387	202	97	-	193	6.11	-	-
T_Cud07	2.75	437	159	109	359	219	4.08	5.13	6.11
T_Cud08	2.10	287	136	72	843	143	3.14	4.05	5.13
T_Foo01	5.50	925	168	231	-	463	3.23	-	-
T_Foo02	4.00	601	150	150	382	301	2.63	2.97	3.23
T_Gum01	11.03	1918	174	480	4959	959	2.40	1.79	2.97
T_Gum02	2.29	429	187	107	6393	214	2.76	2.05	3.36
T_Gum03	7.55	1460	193	365	6758	730	2.93	2.21	2.23
T_Gum04	7.45	1504	202	376	7134	752	3.18	2.23	2.26
T_Han01	8.74	1191	136	298	-	596	2.21	-	-
T_Han02	6.45	923	143	231	529	461	2.42	2.21	2.30
T_Kan01	4.63	813	176	203	-	407	4.35	-	-
T_Kan02	17.82	2393	134	598	9018	1197	2.71	2.26	5.01
T_Kan03	5.02	955	190	239	-	477	5.01	-	-
T_Kan04	4.50	554	123	138	-	277	2.32	-	-
T_Kan05	0.81	87	108	22	-	44	1.82	-	-
T_Kan06	5.54	606	109	151	2450	303	1.87	1.82	6.23
T_Ken01	12.84	2091	163	523	-	1046	3.36	-	-
T_Ker01	7.26	1143	157	286	-	572	2.58	-	-
T_Ker02	2.94	471	160	118	-	235	2.66	-	-
T_Ker03	8.27	1331	161	333	736	666	2.69	2.58	2.66
T_Ker04	3.13	519	166	130	-	260	2.85	-	-
T_Ker05	12.61	2048	162	512	1478	1024	2.73	2.63	2.85
T_Ker06	2.51	399	159	100	-	200	2.63	-	-
T_McC01	4.03	605	150	151	-	302	2.97	-	-
T_McC02	1.85	249	135	62	-	125	2.44	-	-
T_McC03	3.51	449	128	112	326	224	2.22	2.44	2.97

RIVER TORRENS CATCMENT – Continued

Torrens River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
T_Mil01	1.56	222	142	55	-	111	2.70	-	-
T_Mil02	2.08	294	141	74	-	147	2.68	-	-
T_Mil03	11.81	1654	140	413	543	827	2.63	2.64	2.70
T_Mil04	2.13	307	144	77	-	154	2.77	-	-
T_Mil05	5.24	739	141	185	804	369	2.66	2.64	2.77
T_MP01	10.99	1081	98	270	-	540	1.45	-	-
T_MP02	4.75	513	108	128	-	257	1.73	-	-
T_MP03	10.39	1018	98	254	653	509	1.44	1.45	1.73
T_Six01	5.25	1261	240	315	-	630	9.21	-	-
T_Six02	2.56	566	221	142	457	283	7.98	8.79	9.21
T_Six03	5.83	1547	265	387	-	774	10.89	-	-
T_Six04	1.50	369	246	92	-	184	9.57	-	-
T_Six05	2.74	609	222	152	631	305	8.06	9.57	10.89
T_Six06	13.77	2271	165	568	1721	1135	4.87	6.49	9.87
T_Six07	1.33	260	195	65	-	130	6.49	-	-
T_Six08	7.50	1210	161	303	-	605	4.69	-	-
T_Six09	3.84	461	120	115	2139	231	2.82	4.69	7.16

ONKAPARINGA RIVER CATCHMENT

Onkaparinga River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
O_AG01	8.19	2776	339	694	-	1388	11.33	-	-
O_AG02	4.73	1370	289	342	1037	685	8.31	10.15	11.33
O_AG03	6.60	1626	246	406	1443	813	6.04	8.61	10.15
O_AN01	3.71	543	146	136	-	271	4.70	-	-
O_AN02	3.91	531	136	133	-	266	4.10	-	-
O_AN03	1.96	247	126	62	-	124	3.55	-	-
O_AN04	4.57	564	123	141	471	282	3.41	3.55	4.70
O_BF01	5.36	533	100	133	186	267	4.22	4.11	4.19
O_BF02	2.16	212	98	53	-	106	4.11	-	-
O_BF03	4.83	467	97	117	-	233	3.98	-	-
O_BF04	3.35	324	97	81	384	162	4.01	3.98	4.19
O_BF05	5.93	560	95	140	-	280	3.84	-	-
O_BF06	1.91	178	93	44	568	89	3.71	3.84	4.08
O_BH01	9.85	1121	114	280	-	560	3.79	-	-
O_BK01	6.27	733	117	183	-	366	4.49	-	-
O_BK02	2.48	282	114	71	-	141	4.28	-	-
O_BK03	4.30	494	115	123	-	247	4.36	-	-
O_BK04	8.88	997	112	249	626	499	4.19	4.28	4.49
O_BK05	1.53	160	105	40	-	80	3.67	-	-
O_BK06	3.81	362	95	90	757	181	3.07	3.67	4.32
O_BK07	9.86	1056	107	264	-	528	3.84	-	-
O_BK08	11.21	959	86	240	1261	479	2.52	3.63	4.09
O_CH01	9.23	1089	118	272	-	545	3.25	-	-
O_CH02	3.91	465	119	116	-	233	3.31	-	-
O_CH03	7.12	909	128	227	-	455	3.77	-	-
O_CH04	3.55	405	114	101	490	202	3.03	3.21	3.31
O_CH05	4.43	543	122	136	-	271	3.48	-	-
O_CH06	3.37	383	114	96	949	192	3.03	3.21	3.77
O_CH07	4.63	535	116	134	-	267	3.12	-	-
O_CH08	9.23	1087	118	272	1354	544	3.23	3.12	3.35
O_CH09	6.21	696	112	174	1528	348	2.94	3.26	3.30
O_CX01	5.52	1711	310	428	-	855	11.82	-	-
O_CX02	3.93	1230	313	307	-	615	12.06	-	-
O_CX03	6.72	1974	294	493	1580	987	10.70	10.74	12.06
O_CX04	2.55	774	304	194	-	387	11.43	-	-
O_CX05	2.14	631	294	158	-	316	10.74	-	-
O_CX06	1.48	392	265	98	-	196	8.79	-	-
O_CX07	7.70	1720	223	430	2108	860	6.34	8.79	11.34
O_EC01	1.56	193	123	48	-	96	4.23	-	-
O_EC02	8.00	940	118	235	-	470	3.87	-	-
O_EC03	8.54	1028	120	257	540	514	4.05	3.87	4.23

ONKAPARINGA CATCHMENT - Continued

Onkaparinga River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
O_EC04	4.36	508	117	127	-	254	3.82	-	-
O_EC05	8.30	1003	121	251	-	501	4.07	-	-
O_EC06	3.38	384	114	96	1014	192	3.64	3.82	4.07
O_EC07	1.31	159	121	40	-	79	4.10	-	-
O_EC08	3.62	424	117	106	146	212	3.85	3.92	4.10
O_HD01	4.25	720	170	180	-	360	4.26	-	-
O_HD02	2.62	440	168	110	-	220	4.20	-	-
O_HD03	3.37	569	169	142	-	285	4.21	-	-
O_HD04	4.56	734	161	184	616	367	3.85	4.11	4.26
O_IV01	11.72	1514	129	379	-	757	3.72	-	-
O_IV02	4.84	588	121	147	-	294	3.30	-	-
O_IV03	6.63	748	113	187	808	374	2.86	3.07	3.72
O_IV04	3.28	383	117	96	-	192	3.07	-	-
O_LW01	6.50	1772	272	443	-	886	7.14	-	-
O_LW02	4.92	1390	283	348	629	695	7.70	8.01	8.43
O_LW03	3.80	1124	296	281	-	562	8.43	-	-
O_LW04	1.70	487	286	122	-	244	7.85	-	-
O_LW05	2.32	581	251	145	1217	291	6.05	7.14	8.01
O_LW06	9.15	2175	238	544	1882	1088	5.44	6.76	7.85
O_MT01	5.08	543	107	136	-	271	3.19	-	-
O_MT02	2.49	272	109	68	-	136	3.34	-	-
O_MT03	6.60	682	103	171	374	341	3.00	3.13	3.34
O_OM01	1.76	251	142	63	-	126	4.20	-	-
O_OM02	6.10	836	137	209	11289	418	3.90	4.11	9.75
O_OM03	2.03	274	135	68	-	137	3.80	-	-
O_OM04	13.95	2144	154	536	13905	1072	4.85	3.80	8.61
O_OM05	2.17	348	160	87	-	174	5.54	-	-
O_OM06	33.76	4348	129	1087	17774	2174	3.68	3.84	5.64
O_OM07	2.21	241	109	60	-	120	3.84	-	-
O_OM08	3.80	336	88	84	338	168	2.59	*	*
O_OM08a	1.09	88	81	22	1716	44	2.17	*	*
O_OM09	0.89	79	89	20	-	40	2.61	-	-
O_OM11	13.31	725	55	181	1981	363	0.96	*	*
O_OM12	7.79	250	32	63	2205	125	0.26	*	*
O_SC01	10.68	1716	161	429	-	858	7.33	-	-
O_SC02	4.11	584	142	146	-	292	5.89	-	-
O_SC03	14.02	1715	122	429	1004	858	4.48	5.64	7.33
O_UP01	3.36	441	131	110	2821	221	2.94	3.13	3.34
O_UP02	3.00	422	141	105	-	211	3.38	-	-
O_UP03	4.56	631	139	158	6572	316	3.28	3.25	6.76
O_UP04	6.63	1193	180	298	-	597	5.43	-	-

* SWMZs O_OM08, O_OM08a, O_OM11 and O_OM12 do not have a Main Watercourse Unit Threshold Flow Rate Range. The Theshold Flow Rate for O_OM08 is 200 L/s and for the other 3 zones it is 215 L/s.

ONKAPARINGA CATCHMENT - Continued

Onkaparinga River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
O_UP05	4.22	1041	247	260	-	521	9.75	-	-
O_UP06	2.77	709	256	177	-	355	10.45	-	-
O_UP07	5.53	1008	182	252	689	504	5.57	7.84	10.45
O_UP08	6.18	1250	202	312	-	625	6.76	-	-
O_UP09	10.96	1687	154	422	8294	844	4.03	3.98	7.84
O_WB01	6.10	998	164	249	-	499	4.68	-	-
O_WB02	5.02	885	176	221	-	443	5.41	-	-
O_WB03	1.74	318	182	79	-	159	5.73	-	-
O_WB04	2.04	352	173	88	-	176	5.21	-	-
O_WB05	5.17	758	147	190	828	379	3.80	4.68	5.73
O_WB06	4.27	730	171	183	-	365	5.09	-	-
O_WB07	4.49	699	156	175	-	350	4.27	-	-
O_WB08	4.16	558	134	140	1325	279	3.19	4.27	5.09

WILLUNGA BASIN

Willunga Basin Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
W_Blac01	2.93	170	58	43	-	85	2.22	-	-
W_Blac02	1.69	73	44	18	-	37	1.47	-	-
W_Blac03	4.57	169	37	42	-	85	1.12	-	-
W_Blan01	4.99	85	17	21	-	42	0.26	-	-
W_Ingl01	4.59	232	51	58	-	116	3.07	-	-
W_Ingl02	4.03	181	45	45	-	91	2.47	-	-
W_Ingl03	2.02	108	53	27	-	54	3.35	-	-
W_Ingl04	2.30	125	54	31	-	62	3.40	-	-
W_Ingl05	5.70	128	22	32	34	64	0.76	1.54	3.07
W_Ingl06	5.31	117	22	29	99	58	0.69	1.80	3.40
W_Ingl07	9.64	150	16	38	119	75	0.37	1.17	1.80
W_Pedl01	8.86	378	43	94	-	189	1.83	-	-
W_Pedl02	9.65	509	53	127	-	255	2.58	-	-
W_Pedl03	9.27	646	70	161	-	323	4.04	-	-
W_Pedl04	8.60	501	58	125	-	250	2.95	-	-
W_Pedl05	4.14	261	63	65	-	131	3.40	-	-
W_Pedl06	4.38	136	31	34	230	68	1.07	1.83	2.58
W_Pedl07	5.14	140	27	35	66	70	0.86	1.72	3.40
W_Pedl08	7.91	287	36	72	113	143	1.38	2.59	4.04
W_Pedl09	4.98	125	25	31	341	63	0.73	1.94	2.59
W_Pedl10	4.42	131	30	33	78	66	0.97	2.12	2.95
W_Pedl11	15.69	428	27	107	-	214	0.83	-	-
W_Pedl12	3.67	77	21	19	477	39	0.52	1.72	2.12
W_Pedl13	16.01	310	19	78	610	155	0.44	0.83	1.86
W_Pedl14	6.95	131	19	33	-	66	0.33	-	-
W_Robs01	11.25	169	15	42	631	85	0.22	1.20	1.38
W_Sell01	4.15	238	57	60	-	119	2.29	-	-
W_Sell02	2.27	67	29	17	51	33	0.72	1.60	2.29
W_Sell03	4.01	264	66	66	-	132	2.83	-	-
W_Sell04	3.81	217	57	54	-	109	2.16	-	-
W_Sell05	0.89	21	24	5	-	11	0.50	-	-
W_Silv01	5.56	256	46	64	-	128	2.40	-	-
W_Silv02	4.88	211	43	53	-	105	2.09	-	-
W_Silv03	2.99	127	42	32	-	63	2.03	-	-
W_Silv04	3.34	75	22	19	71	37	0.63	1.56	2.40
W_Silv05	1.78	35	19	9	51	17	0.47	1.50	2.09
W_Silv06	2.54	55	22	14	33	28	0.59	1.22	2.03
W_Silv07	9.11	142	16	35	142	71	0.29	0.92	1.56
W_Silv08	6.26	100	16	25	183	50	0.31	0.82	1.22
W_Silv09	11.55	162	14	40	-	81	0.23	-	-

WILLUNGA BASIN - Continued

Willunga Basin Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR ($L/s/ km^2$)	Minimum UTFR ($L/s/ km^2$)	Maximum UTFR ($L/s/ km^2$)
W_Will01	4.21	254	60	64	-	127	2.53	-	-
W_Will02	3.87	270	70	68	-	135	3.33	-	-
W_Will03	4.19	256	61	64	-	128	2.62	-	-
W_Will05	3.65	104	28	26	138	52	0.68	1.98	3.33
W_Will06	7.20	172	24	43	71	86	0.50	1.02	2.62
W_Will07	5.49	116	21	29	224	58	0.37	1.02	1.98
W_Will08	1.63	28	17	7	224	14	0.24	1.09	1.17

MYPONGA RIVER CATCHMENT

Myponga River Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
F_Mypo01	24.77	3208	130	802	-	1604	4.59	-	-
F_Mypo02	2.61	319	122	80	-	160	4.11	-	-
F_Mypo03	7.06	821	116	205	1087	411	3.73	4.11	4.59
F_Mypo04	4.78	552	115	138	-	276	3.68	-	-
F_Mypo05	8.39	1142	136	286	-	571	5.05	-	-
F_Mypo06	4.52	665	147	166	-	332	5.83	-	-
F_Mypo07	7.79	1025	132	256	423	513	4.73	5.12	5.83
F_Mypo08	2.73	295	108	74	1021	147	3.23	4.16	5.12
F_Mypo09	7.78	957	123	239	-	479	4.16	-	-
F_Mypo10	2.90	297	102	74	2321	148	2.91	3.68	4.67
F_Mypo11	1.06	109	103	27	-	55	2.95	-	-
F_Mypo12	3.14	306	98	77	2424	153	2.55	2.95	4.38
F_Mypo13	8.04	1058	132	265	-	529	4.59	-	-
F_Mypo14	3.48	420	121	105	-	210	3.90	-	-
F_Mypo15	6.35	660	104	165	535	330	2.90	3.80	4.59
F_Mypo16	2.92	337	115	84	-	169	3.56	-	-
F_Mypo17	4.97	632	127	158	-	316	4.29	-	-
F_Mypo18	4.10	437	106	109	-	218	3.04	-	-
F_Mypo19	2.18	223	102	56	-	112	2.81	-	-
F_Mypo20	0.54	54	100	13	-	27	2.68	-	-
F_Mypo21	1.93	200	104	50	-	100	2.88	-	-
F_Mypo22	0.28	25	88	6	-	13	2.08	-	-
F_Mypo23	7.04	490	70	123	-	245	1.24	-	-
F_Mypo24	19.16	1412	74	353	3789	706	1.41	2.08	4.29

HINDMARSH AND INMAN RIVER CATCHMENTS

Hindmarsh and Inman River Catchments									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR ($L/s/ km^2$)	Minimum UTFR ($L/s/ km^2$)	Maximum UTFR ($L/s/ km^2$)
F_Brow01	15.23	884	58	221	-	442	0.60	-	-
F_Dump01	1.32	75	57	19	-	37	0.21	-	-
F_Gool01	26.65	1003	38	251	-	501	0.17	-	-
F_Hind01	5.54	802	145	200	-	401	4.99	-	-
F_Hind02	15.65	2247	144	562	-	1124	4.97	-	-
F_Hind03	2.57	367	143	92	654	183	4.95	4.96	4.97
F_Hind04	2.93	415	142	104	-	207	4.92	-	-
F_Hind05	4.91	654	133	164	921	327	4.75	4.92	4.96
F_Hind06	7.55	919	122	230	1351	459	4.50	4.85	4.99
F_Hind07	3.11	422	135	105	-	211	4.79	-	-
F_Hind08	2.43	331	136	83	-	165	4.81	-	-
F_Hind09	1.99	253	127	63	-	127	4.62	-	-
F_Hind10	2.52	286	113	72	218	143	4.33	4.58	4.81
F_Hind11	4.40	593	135	148	-	297	4.78	-	-
F_Hind12	5.51	396	72	99	1921	198	3.57	4.58	4.85
F_Hind13	8.57	751	88	188	232	375	3.94	3.79	3.90
F_Hind14	2.20	179	81	45	-	89	3.79	-	-
F_Hind15	6.21	449	72	112	-	225	3.58	-	-
F_Hind16	4.48	257	57	64	-	129	3.23	-	-
F_Hind17	5.95	486	82	121	-	243	3.80	-	-
F_Hind18	2.51	192	77	48	-	96	3.68	-	-
F_Hind19	5.26	392	75	98	268	196	3.64	3.68	3.80
F_Hind20	17.69	778	44	194	2792	389	2.90	3.23	4.67
F_Inman01	9.16	987	108	247	-	494	2.68	-	-
F_Inman02	3.77	383	101	96	-	191	2.52	-	-
F_Inman03	3.76	304	81	76	-	152	2.01	-	-
F_Inman04	1.09	77	70	19	-	38	1.77	-	-
F_Inman05	1.76	135	77	34	471	68	1.92	1.77	2.68
F_Inman06	5.51	508	92	127	-	254	2.28	-	-
F_Inman07	9.46	601	64	150	1240	301	1.61	1.64	2.37
F_Inman08	6.43	455	71	114	-	228	1.77	-	-
F_Inman09	3.81	261	68	65	-	130	1.72	-	-
F_Inman10	0.95	64	67	16	-	32	1.70	-	-
F_Inman11	1.78	122	69	31	-	61	1.72	-	-
F_Inman12	2.41	167	69	42	123	84	1.74	1.70	1.72
F_Inman13	1.97	137	70	34	-	69	1.75	-	-
F_Inman14	5.30	358	68	90	277	179	1.70	1.72	1.75
F_Inman15	2.02	137	68	34	-	69	1.71	-	-
F_Inman16	1.66	109	66	27	-	55	1.66	-	-
F_Inman17	2.38	154	65	38	-	77	1.64	-	-

HINDMARSH AND INMAN RIVER CATCHMENTS - Continued

Hindmarsh and Inman River Catchments									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
F_Inman18	3.38	205	61	51	-	103	1.55	-	-
F_Inman19	6.78	606	89	151	-	303	2.21	-	-
F_Inman20	8.99	795	88	199	-	397	2.19	-	-
F_Inman21	5.77	305	53	76	330	152	1.38	1.60	2.19
F_Inman22	3.49	220	63	55	-	110	1.60	-	-
F_Inman23	13.27	771	58	193	1635	386	1.50	1.55	2.21
F_Inman24	1.47	112	77	28	-	56	1.91	-	-
F_Inman25	1.11	91	82	23	-	46	2.04	-	-
F_Inman26	1.21	98	81	25	-	49	2.00	-	-
F_Inman27	1.71	124	72	31	106	62	1.81	1.91	2.04
F_Inman28	1.94	139	72	35	-	70	1.79	-	-
F_Inman29	6.53	448	69	112	492	224	1.73	1.79	1.93
F_Inman30	1.72	132	76	33	-	66	1.90	-	-
F_Inman31	3.93	292	74	73	106	146	1.85	1.87	1.90
F_Inman32	5.30	408	77	102	132	204	1.92	1.93	1.97
F_Inman33	1.54	122	79	30	-	61	1.97	-	-
F_Inman34	6.63	451	68	113	-	225	1.71	-	-
F_Inman35	2.63	190	72	48	-	95	1.81	-	-
F_Inman36	10.42	607	58	152	832	304	1.50	1.67	1.85
F_Inman37	1.73	115	66	29	-	57	1.67	-	-
F_Inman38	11.50	551	48	138	2935	275	1.28	1.74	1.86
F_Inman39	12.33	938	76	235	-	469	1.53	-	-
F_Inman40	9.73	604	62	151	3321	302	1.30	1.53	1.77
F_Inman41	5.48	236	43	59	3380	118	0.99	1.70	1.72
F_Midd01	16.28	1185	73	296	-	592	1.00	-	-
F_PortE01	7.61	314	41	79	-	157	0.25	-	-
F_VicH01	3.45	131	38	33	-	65	0.37	-	-

FLEURIEU COASTAL CATCHMENTS

Fleurieu Coastal Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
F_AarT01	3.30	158	48	39	-	79	1.27	-	-
F_AarT02	2.51	81	32	20	-	41	0.51	-	-
F_AarT03	1.93	67	35	17	-	34	0.61	-	-
F_AarT04	4.64	275	59	69	-	138	2.02	-	-
F_AarT05	1.73	80	46	20	-	40	1.19	-	-
F_AarT06	2.50	92	37	23	-	46	0.70	-	-
F_AnaC01	5.13	621	121	155	-	311	3.99	-	-
F_AnaC02	2.57	274	107	69	-	137	3.15	-	-
F_AnaC03	2.62	300	115	75	-	150	3.60	-	-
F_AnaC04	4.30	441	103	110	-	221	2.91	-	-
F_AnaC05	3.35	302	90	76	306	151	2.25	3.31	3.99
F_AnaC06	1.17	89	75	22	201	44	1.54	2.74	3.15
F_AnaC07	3.95	382	97	95	-	191	2.58	-	-
F_AnaC08	3.03	304	100	76	-	152	2.78	-	-
F_AnaC09	1.91	124	65	31	-	62	1.12	-	-
F_AnaC10	2.17	97	45	24	227	49	0.45	1.12	2.78
F_AnaC11	8.10	401	50	100	607	201	0.58	2.05	3.31
F_Ball01	5.37	921	171	230	-	460	4.10	-	-
F_Ball02	2.21	386	175	96	-	193	4.25	-	-
F_Ball03	1.03	147	142	37	133	73	2.82	3.75	4.25
F_Ball04	3.96	380	96	95	458	190	1.20	2.86	4.10
F_Balq01	1.35	111	82	28	-	56	1.10	-	-
F_Bare01	1.84	133	73	33	-	67	0.87	-	-
F_Blow01	2.43	303	125	76	-	152	3.40	-	-
F_Blow02	2.45	282	115	71	-	141	2.91	-	-
F_Blow03	7.20	645	90	161	308	322	1.71	2.22	3.40
F_BoHC01	4.28	456	107	114	-	228	4.45	-	-
F_BoHC02	1.40	144	103	36	-	72	4.16	-	-
F_BoHC03	8.62	834	97	208	359	417	3.68	3.95	4.45
F_BoHC04	5.45	384	70	96	455	192	1.96	3.31	3.95
F_BoHH01	0.89	41	45	10	-	20	0.22	-	-
F_Bung01	6.95	529	76	132	-	264	2.04	-	-
F_Bung02	3.53	243	69	61	-	121	1.65	-	-
F_Bung03	2.82	187	66	47	-	93	1.52	-	-
F_Bung04	5.11	312	61	78	-	156	1.28	-	-
F_Bung05	3.15	174	55	44	283	87	1.02	1.52	2.04
F_Bung06	2.41	139	58	35	-	70	1.12	-	-
F_Bung07	3.31	160	48	40	118	80	0.74	1.05	1.28
F_Bung08	8.94	354	40	89	525	177	0.45	1.05	1.64

FLEURIEU COASTAL CATCHMENTS - Continued

Fleurieu Coastal Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
F_Bung09	12.65	557	44	139	-	278	0.58	-	-
F_Call01	2.13	290	136	72	-	145	4.89	-	-
F_Call02	4.74	640	135	160	232	320	4.84	4.86	4.89
F_Call03	5.45	714	131	178	-	357	4.56	-	-
F_Call04	7.14	682	95	171	581	341	2.44	3.77	4.86
F_CapJ01	2.59	118	46	30	-	59	0.32	-	-
F_CapJ02	7.09	386	54	96	-	193	0.53	-	-
F_CapJ03	7.60	301	40	75	-	150	0.21	-	-
F_CarC01	3.10	265	86	66	-	132	2.53	-	-
F_CarC02	1.87	139	74	35	-	70	1.90	-	-
F_CarC03	3.89	433	111	108	-	216	4.24	-	-
F_CarC04	4.88	467	96	117	225	233	3.16	3.61	4.24
F_CarC05	3.17	256	81	64	-	128	2.25	-	-
F_CarC06	6.22	402	65	100	490	201	1.40	1.90	3.61
F_CarC07	2.57	168	65	42	-	84	1.43	-	-
F_CarC08	3.77	266	71	67	-	133	1.70	-	-
F_CarC09	5.13	316	62	79	187	158	1.26	1.43	1.70
F_CarC10	3.53	218	62	55	-	109	1.28	-	-
F_CarC11	3.56	200	56	50	-	100	1.03	-	-
F_CarC12	14.26	682	48	170	953	341	0.70	1.03	2.43
F_CarH01	1.53	69	45	17	-	35	0.24	-	-
F_CarH02	4.98	333	67	83	-	166	0.71	-	-
F_CarH03	3.85	240	62	60	-	120	0.59	-	-
F_CarH04	0.83	41	49	10	-	20	0.31	-	-
F_CarH05	1.40	77	55	19	-	38	0.42	-	-
F_CarH06	3.99	214	54	53	-	107	0.39	-	-
F_Cooa01	3.51	257	73	64	-	129	1.67	-	-
F_Cool01	3.88	427	110	107	-	214	3.50	-	-
F_Cool02	3.12	361	116	90	-	181	3.88	-	-
F_Cool03	2.08	253	122	63	-	126	4.26	-	-
F_Cool04	1.53	199	130	50	-	100	4.87	-	-
F_Cool05	3.90	465	119	116	229	233	4.11	4.26	4.87
F_Cool06	6.22	653	105	163	590	327	3.19	3.50	4.30
F_Cool07	4.29	389	91	97	-	194	2.38	-	-
F_Cool08	2.76	318	115	79	-	159	3.82	-	-
F_Cool09	2.97	283	95	71	150	142	2.64	3.17	3.82
F_Cool10	2.77	211	76	53	-	105	1.65	-	-
F_Cool11	3.72	288	77	72	-	144	1.70	-	-
F_Cool12	3.71	247	67	62	951	123	1.22	1.65	3.74
F_Deep01	7.91	836	106	209	-	418	4.06	-	-
F_Deep02	0.88	85	96	21	-	42	3.39	-	-

FLEURIEU COASTAL CATCHMENTS - Continued

Fleurieu Coastal Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
F_Deep03	2.36	218	93	55	285	109	3.17	3.39	4.06
F_Deep04	6.73	625	93	156	-	313	3.53	-	-
F_Deep05	1.41	130	92	33	-	65	3.49	-	-
F_Deep06	2.54	220	87	55	244	110	3.08	3.41	3.53
F_Deep07	2.69	228	85	57	683	114	2.95	3.41	3.81
F_Deep08	4.21	389	93	97	-	195	3.50	-	-
F_Deep09	4.06	353	87	88	-	176	3.09	-	-
F_Deep10	8.73	586	67	147	918	293	1.84	3.07	3.53
F_First01	1.97	198	100	50	-	99	3.29	-	-
F_First02	2.86	205	71	51	101	102	1.64	2.22	3.29
F_Fish01	8.53	584	69	146	-	292	1.06	-	-
F_Lady01	1.29	63	49	16	-	32	0.28	-	-
F_Link01	2.94	121	41	30	-	61	0.20	-	-
F_Link02	0.38	15	39	4	-	7	0.17	-	-
F_Litt01	7.82	624	80	156	-	312	1.32	-	-
F_Naik01	1.85	115	62	29	-	58	0.52	-	-
F_NewH01	1.70	87	51	22	-	43	0.67	-	-
F_NewH02	17.83	971	54	243	324	486	0.78	0.67	1.12
F_NewH03	3.75	238	64	60	-	119	1.12	-	-
F_Norm01	1.88	69	36	17	-	34	0.20	-	-
F_Para01	7.76	603	78	151	-	301	1.37	-	-
F_Para02	5.21	247	47	62	213	124	0.41	0.89	1.37
F_Pars01	6.24	306	49	77	-	153	0.74	-	-
F_RapB01	1.22	67	55	17	-	34	0.29	-	-
F_RapH01	3.81	174	46	43	-	87	0.31	-	-
F_RapH02	1.62	87	54	22	-	43	0.49	-	-
F_RapH03	0.47	20	41	5	-	10	0.23	-	-
F_Salt01	1.78	143	80	36	-	71	1.59	-	-
F_Salt02	3.15	281	89	70	-	141	2.02	-	-
F_Salt03	1.63	108	66	27	133	54	1.04	1.59	2.02
F_Salt04	2.89	215	74	54	-	108	1.36	-	-
F_Salt05	5.52	292	53	73	260	146	0.6	1.13	1.63
F_Salt06	0.88	41	47	10	-	20	0.43	-	-
F_Star01	1.25	69	55	17	-	34	0.36	-	-
F_Tali01	2.64	148	56	37	-	74	0.48	-	-
F_Tali02	1.62	112	69	28	-	56	0.82	-	-
F_Tapa01	2.38	154	65	39	-	77	2.64	-	-
F_Tapa02	2.18	100	46	25	64	50	1.3	1.92	2.64
F_Tapa03	2.24	80	36	20	-	40	0.72	-	-
F_Tapa04	2.61	117	45	29	-	59	1.22	-	-
F_TunB01	0.94	116	123	29	-	58	3.32	-	-
F_TunB02	4.23	397	94	99	128	199	1.9	2.12	3.32

FLEURIEU COASTAL CATCHMENTS - Continued

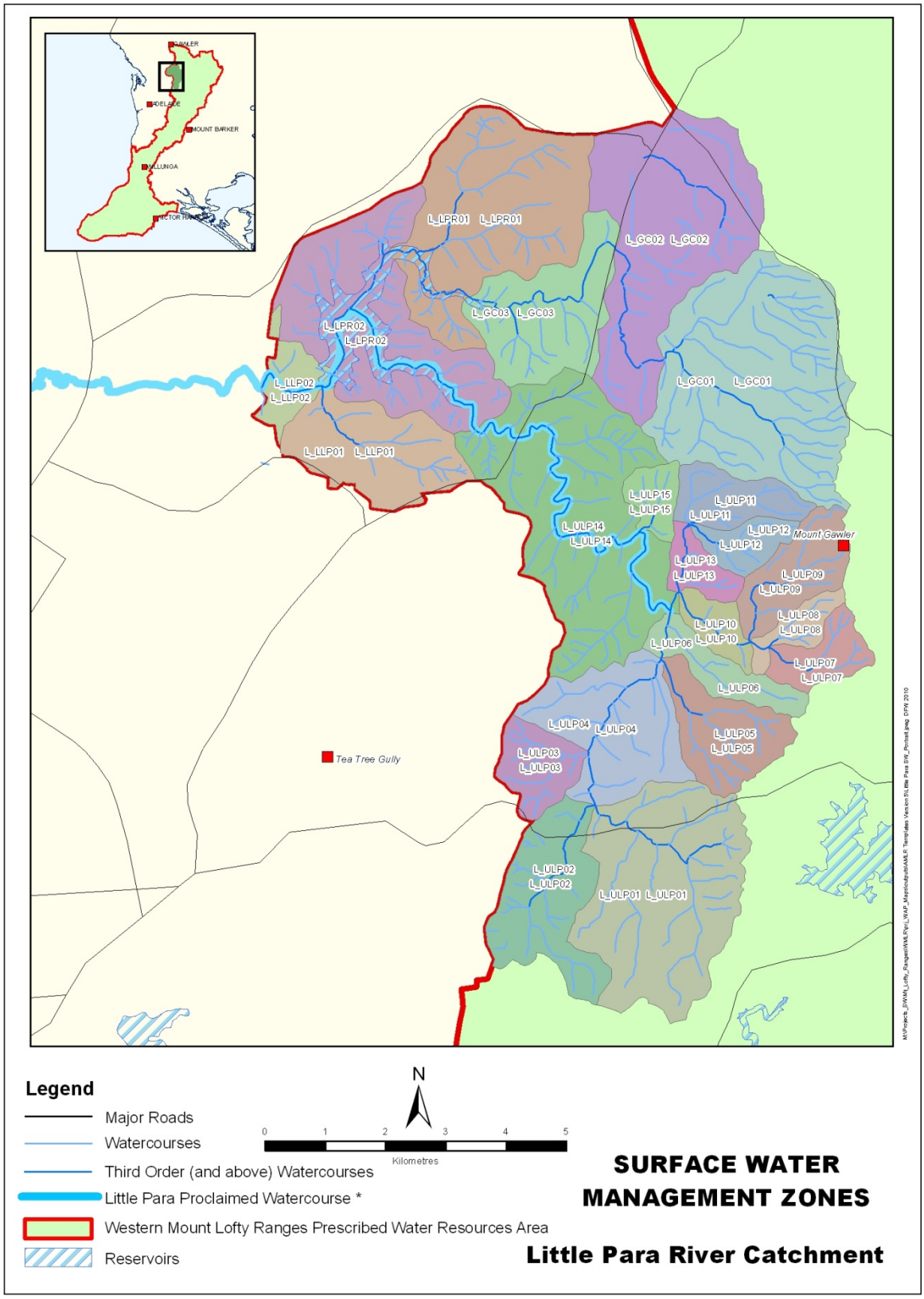
Fleurieu Coastal Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
F_TunB03	2.31	163	70	41	-	81	0.99	-	-
F_TunC01	2.11	291	138	73	-	146	5.32	-	-
F_TunC02	0.82	113	139	28	-	56	5.35	-	-
F_TunC03	1.38	178	129	44	145	89	4.65	5.1	5.35
F_TunC04	3.67	448	122	112	257	224	4.21	4.68	5.1
F_TunC05	3.72	478	129	119	-	239	4.65	-	-
F_TunC06	3.40	423	124	106	225	211	4.35	4.51	4.65
F_TunC07	5.38	509	95	127	744	255	2.55	2.44	4.68
F_TunC08	2.34	242	104	61	95	121	3.05	3.2	3.48
F_TunC09	1.24	137	111	34	-	69	3.48	-	-
F_TunC10	1.71	159	93	40	-	79	2.44	-	-
F_TunC11	0.70	49	71	12	-	25	1.36	-	-
F_Tunk01	1.08	92	84	23	-	46	1.1	-	-
F_Tunk02	1.67	147	88	37	-	73	1.2	-	-
F_Tunk03	1.37	122	89	31	-	61	1.25	-	-
F_Tunk04	0.48	36	75	9	-	18	0.83	-	-
F_VicW01	1.70	128	75	32	-	64	0.89	-	-
F_Wait01	10.29	966	94	241	-	483	2.33	-	-
F_Wait02	9.58	841	88	210	-	421	2.03	-	-
F_Wait03	28.80	2262	79	566	-	1131	1.6	-	-
F_Wait04	8.51	561	66	140	1158	280	1.07	1.6	2.33
F_Wirr01	2.47	101	41	25	-	50	0.36	-	-
F_Yank01	3.18	305	96	76	-	152	4.51	-	-
F_Yank02	1.48	123	83	31	-	61	3.68	-	-
F_Yank03	2.19	210	96	53	-	105	4.54	-	-
F_Yank04	0.53	43	82	11	140	22	3.61	4.43	4.54
F_Yank05	1.14	90	79	23	-	45	3.45	-	-
F_Yank06	2.00	169	84	42	-	85	3.76	-	-
F_Yank07	1.75	130	74	32	268	65	3.16	3.45	4.43
F_Yank08	1.17	84	72	21	-	42	3.06	-	-
F_Yank09	1.70	155	91	39	75	78	4.2	4.4	4.64
F_Yank10	1.47	143	98	36	-	72	4.64	-	-
F_Yank11	1.64	150	91	37	-	75	4.21	-	-
F_Yank12	3.77	281	74	70	182	140	3.16	3.77	4.4
F_Yank13	3.38	212	63	53	524	106	2.55	3.06	3.93
F_Yank14	8.03	618	77	155	-	309	3.32	-	-
F_Yank15	3.70	199	54	50	728	99	2.1	3.32	3.62
F_Yank16	2.18	218	100	54	-	109	4.8	-	-
F_Yank17	3.56	275	77	69	123	138	3.34	3.83	4.8
F_Yank18	7.18	772	107	193	-	386	5.37	-	-
F_Yank19	4.54	384	85	96	289	192	3.77	4.69	5.37

FLEURIEU COASTAL CATCHMENTS - Continued

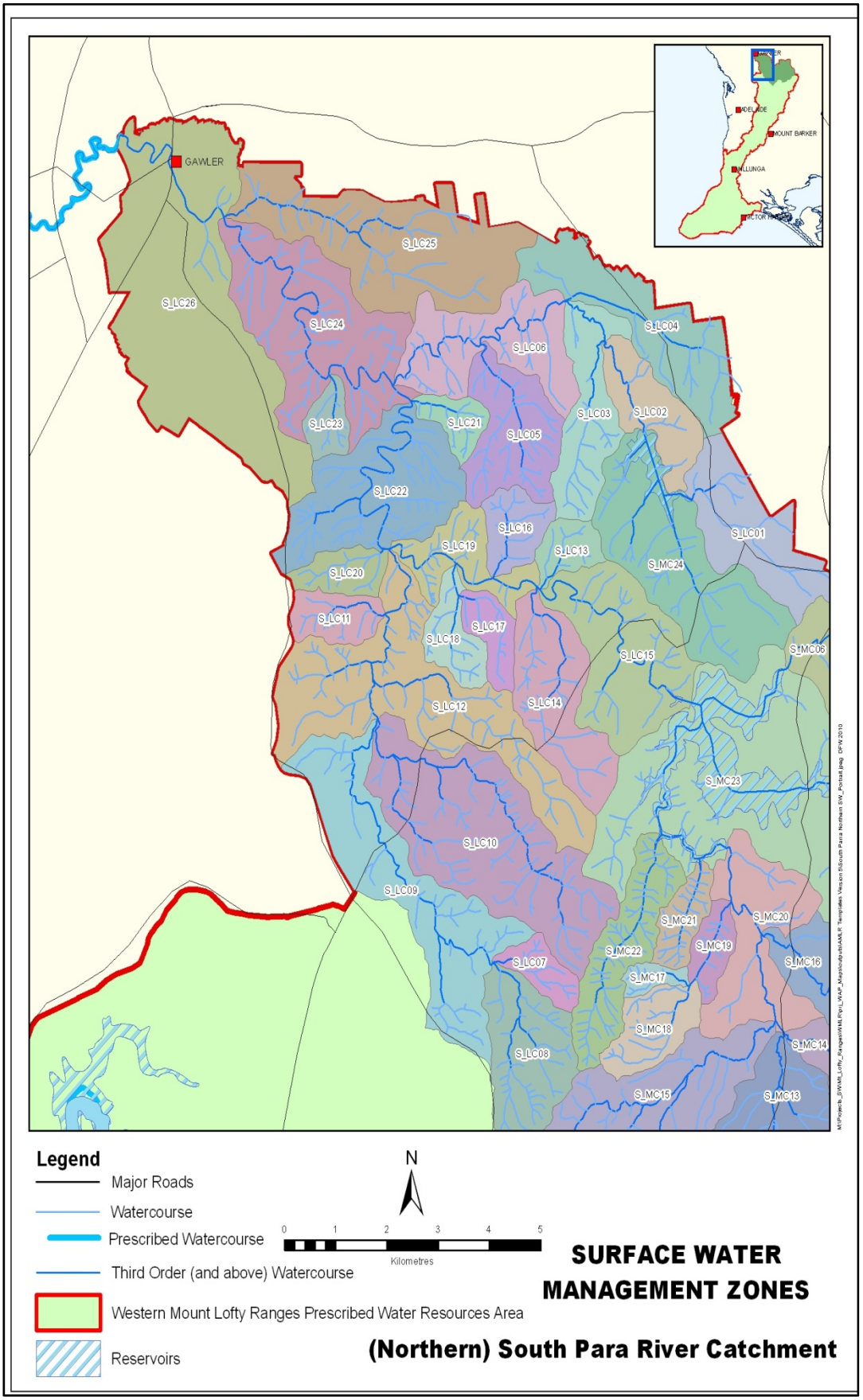
Fleurieu Coastal Catchment									
Catchment Summary				**Extraction Limits**		**Diversion Limit**	**Unit Threshold Flow Rate**	**Main Watercourse Unit Threshold Flow Rate Range**	
SWMZ	Area (km^2)	Surface Water Resource Capacity (ML)	Annual Adjusted Runoff (mm)	Surface Water Extraction Limit (ML)	Main Watercourse Extraction Limit (ML)	Diversion Limit (ML)	SWMZ UTFR (L/s/ km^2)	Minimum UTFR (L/s/ km^2)	Maximum UTFR (L/s/ km^2)
F_Yank20	3.36	214	64	53	466	107	2.59	3.83	4.69
F_Yank21	3.69	199	54	50	1244	100	2.12	3.36	4.03
F_Yank22	2.05	128	62	32	-	64	2.52	-	-
F_Yank23	2.71	290	107	73	-	145	5.11	-	-
F_Yank24	1.79	187	105	47	-	94	4.93	-	-
F_Yank25	13.96	740	53	185	1589	370	2	1.49	5.11
F_Yank27	0.88	36	41	9	-	18	1.49	-	-
F_Yatt01	15.72	1274	81	319	-	637	1.87	-	-
F_Yatt02	2.96	215	73	54	-	107	1.48	-	-
F_Yatt03	1.83	113	62	28	-	56	1.03	-	-
F_Yatt04	0.56	28	49	7	106	14	0.59	0.81	1.48
F_Yatt05	1.23	68	56	17	-	34	0.81	-	-
F_Yatt06	1.39	64	46	16	122	32	0.52	0.99	1.12
F_Yatt07	1.07	41	39	10	451	21	0.31	0.99	1.87
F_Yoho01	3.43	364	106	91	-	182	2.64	-	-
F_Yoho02	3.34	374	112	93	-	187	2.96	-	-
F_Yoho03	1.68	195	116	49	-	97	3.17	-	-
F_Yoho04	1.53	150	98	38	180	75	2.27	2.84	3.17
F_Yoho05	1.15	96	83	24	295	48	1.58	2.63	2.84
F_Yoho06	1.52	125	82	31	-	62	1.55	-	-
F_Yoho07	5.62	353	63	88	414	177	0.83	1.55	2.63

APPENDIX VI - SURFACE WATER MANGEMENT ZONES IN THE WESTERN MOUNT LOFTY RANGES PRESCRIBED WATER RESOURCES AREA

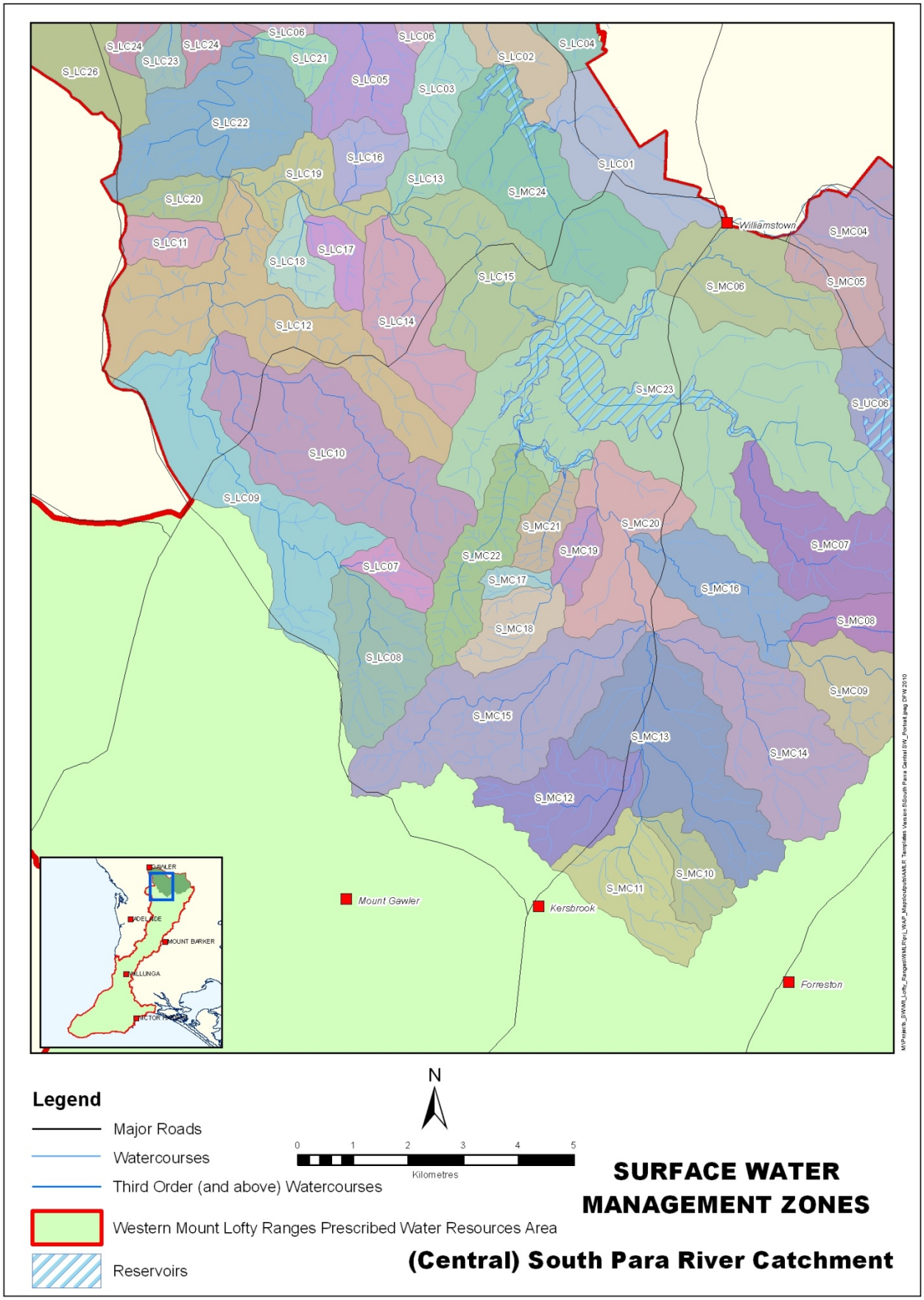
LITTLE PARA RIVER CATCHMENT



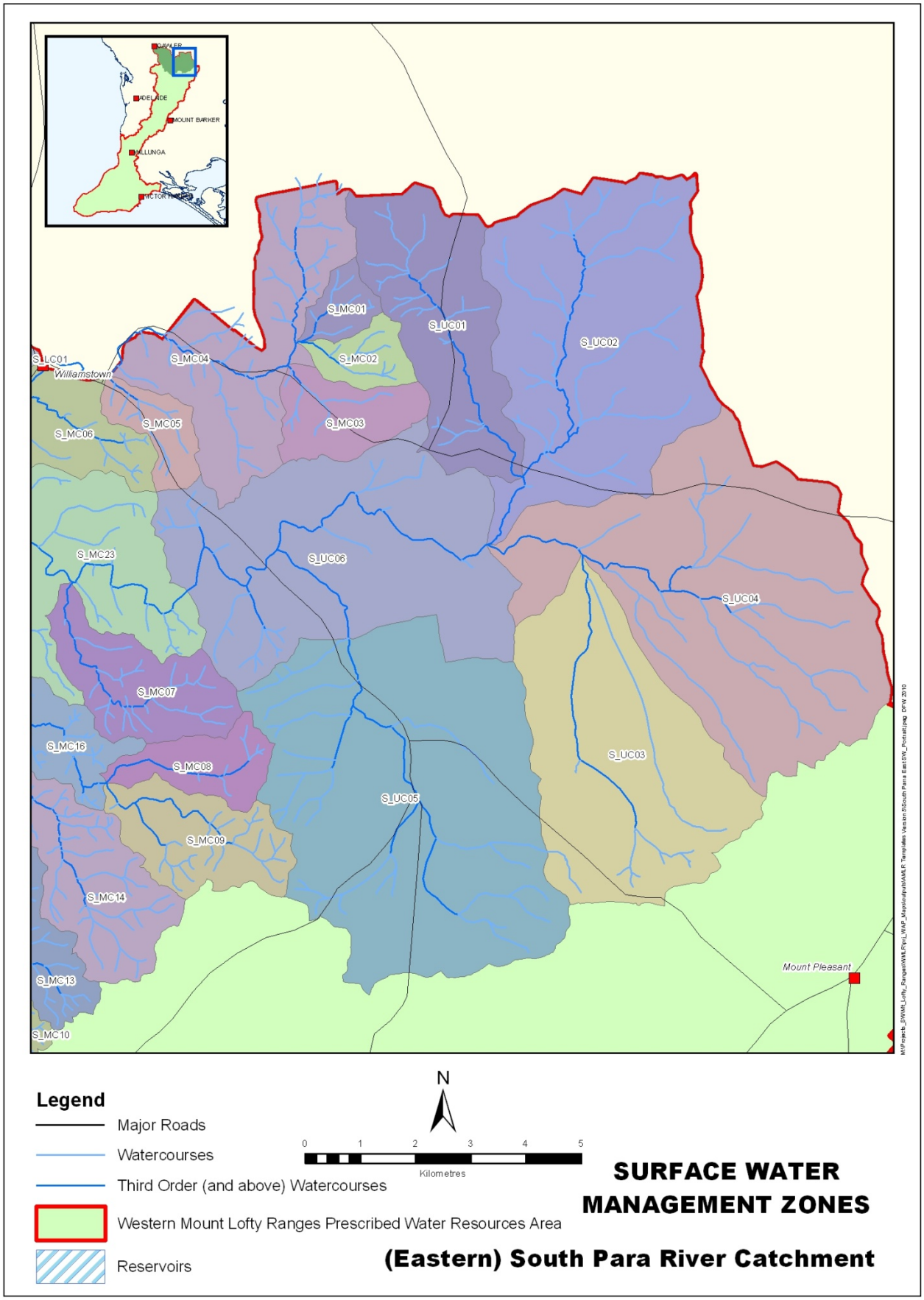
(NORTHERN) SOUTH PARA RIVER CATCHMENT



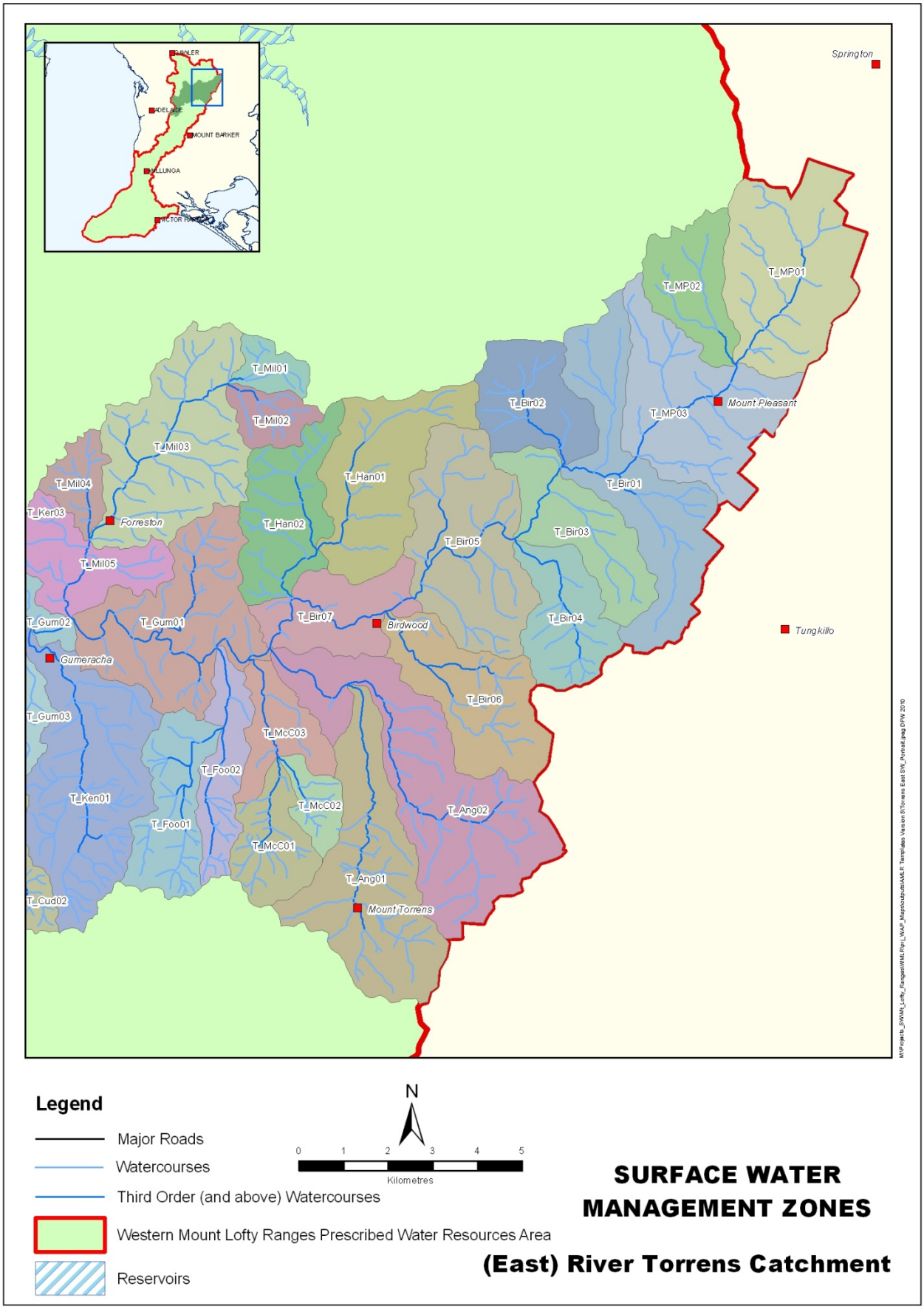
(CENTRAL) SOUTH PARA RIVER CATCHMENT



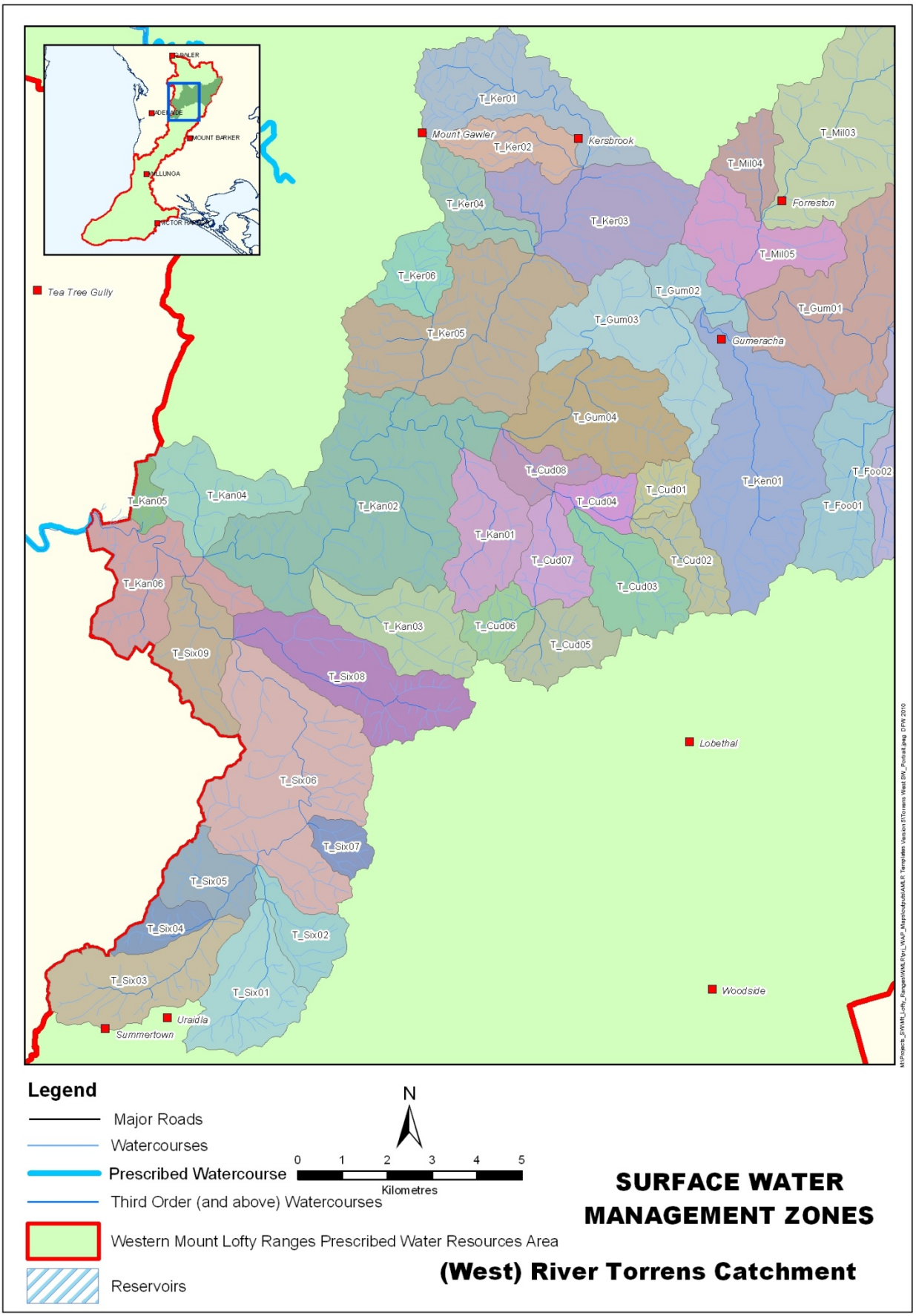
(EASTERN) SOUTH PARA RIVER CATCHMENT



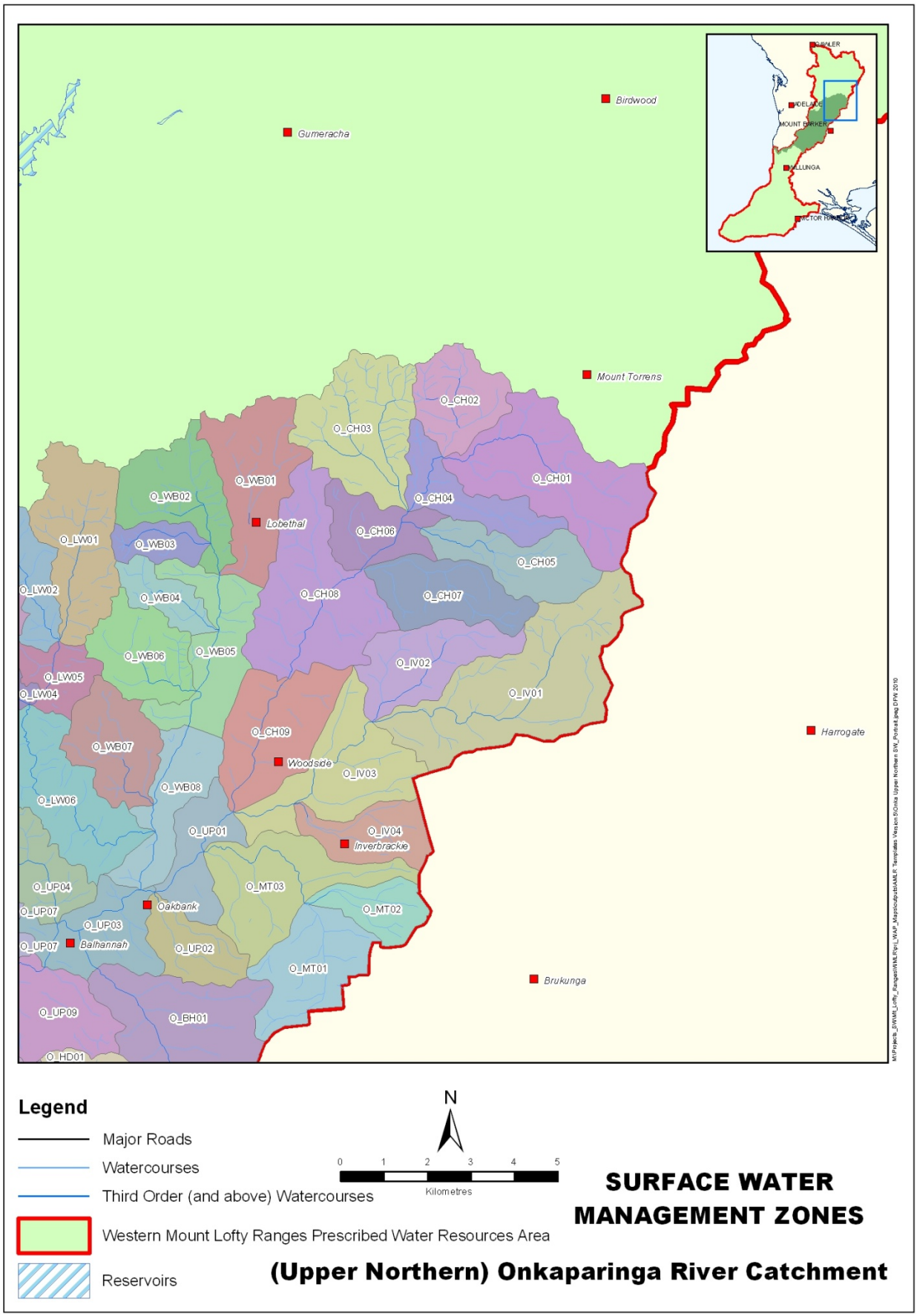
(EASTERN) RIVER TORRENS CATCHMENT



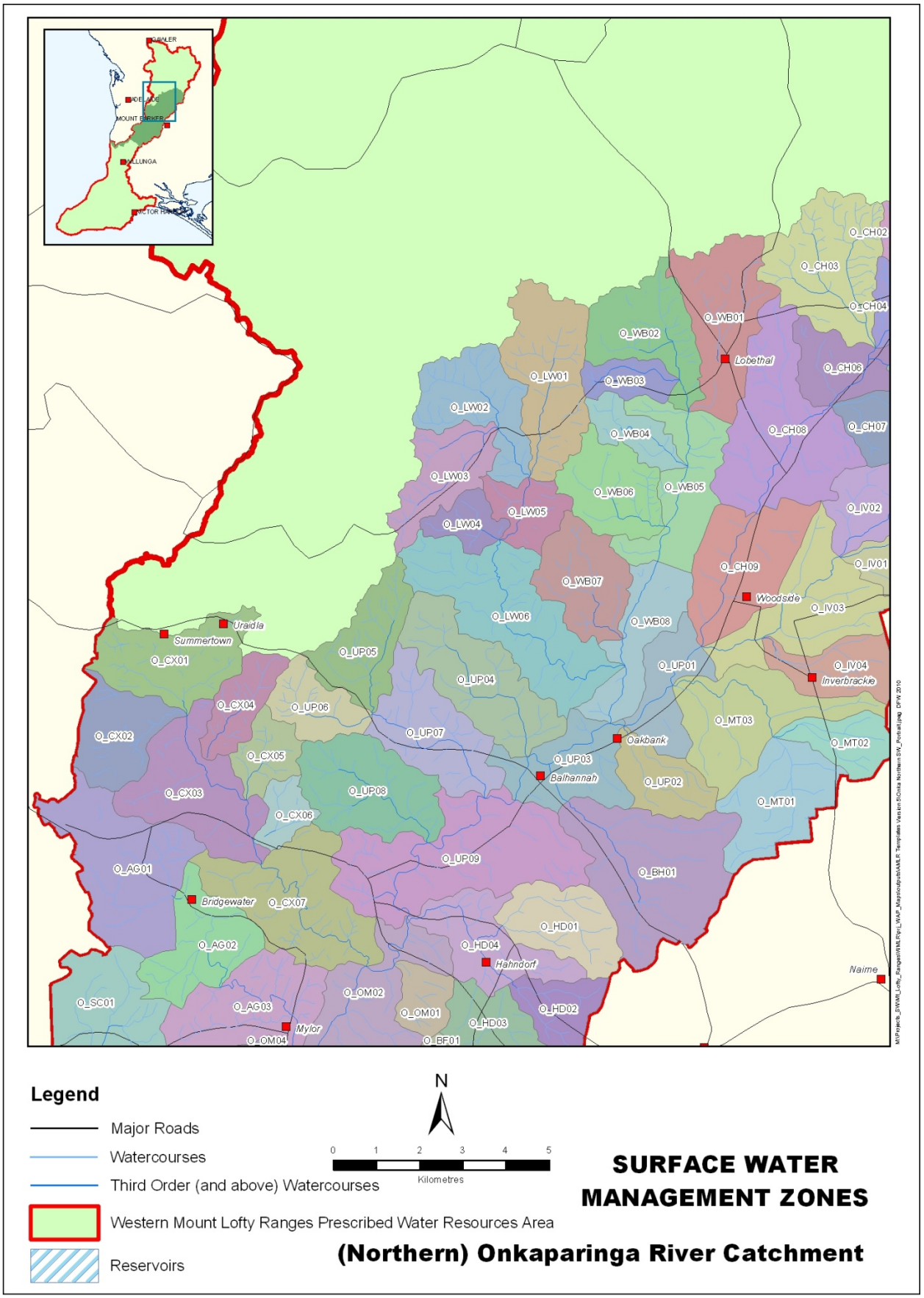
(WESTERN) RIVER TORRENS CATCHMENT



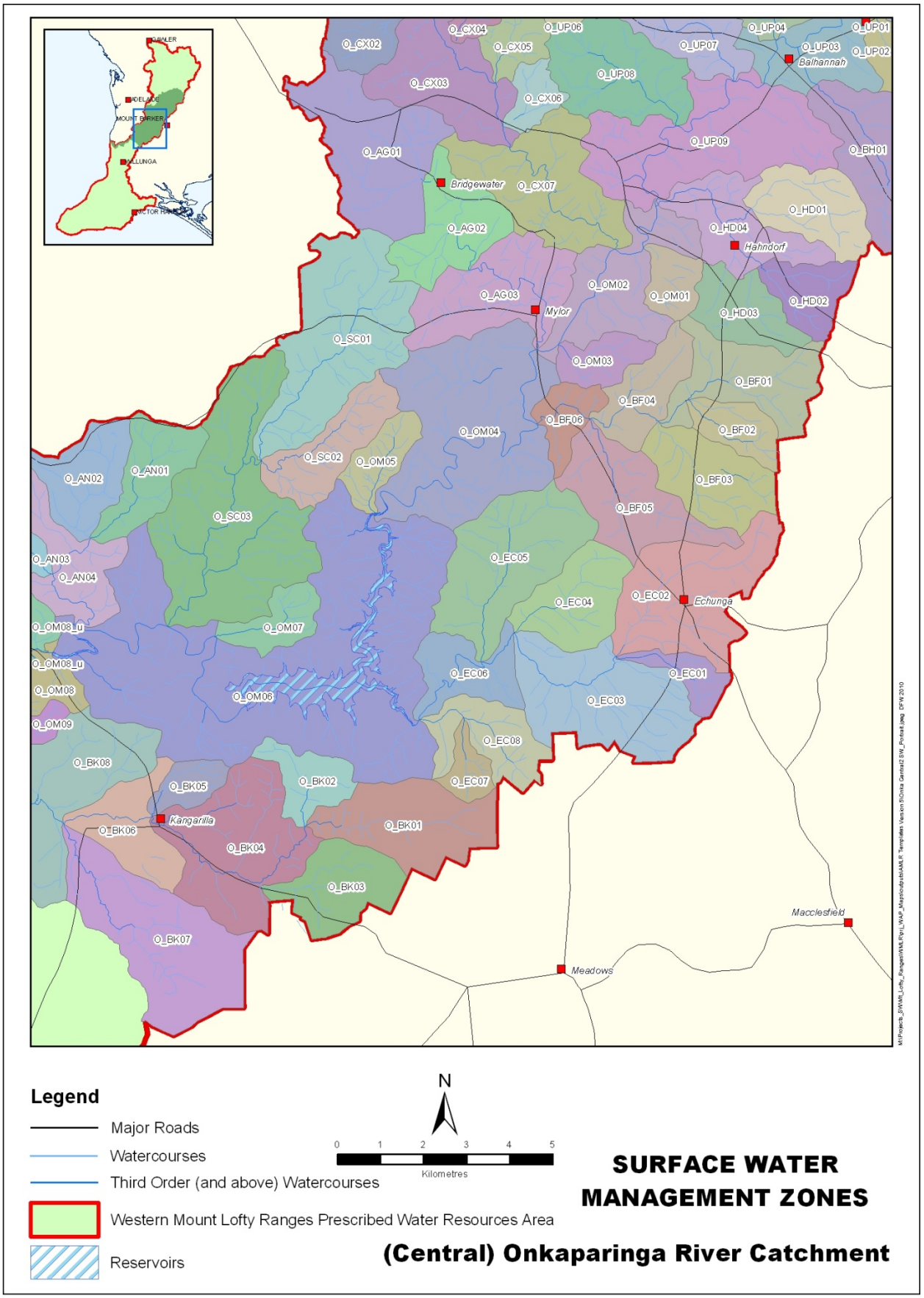
(UPPER NORTHERN) ONKAPARINGA RIVER CATCHMENT



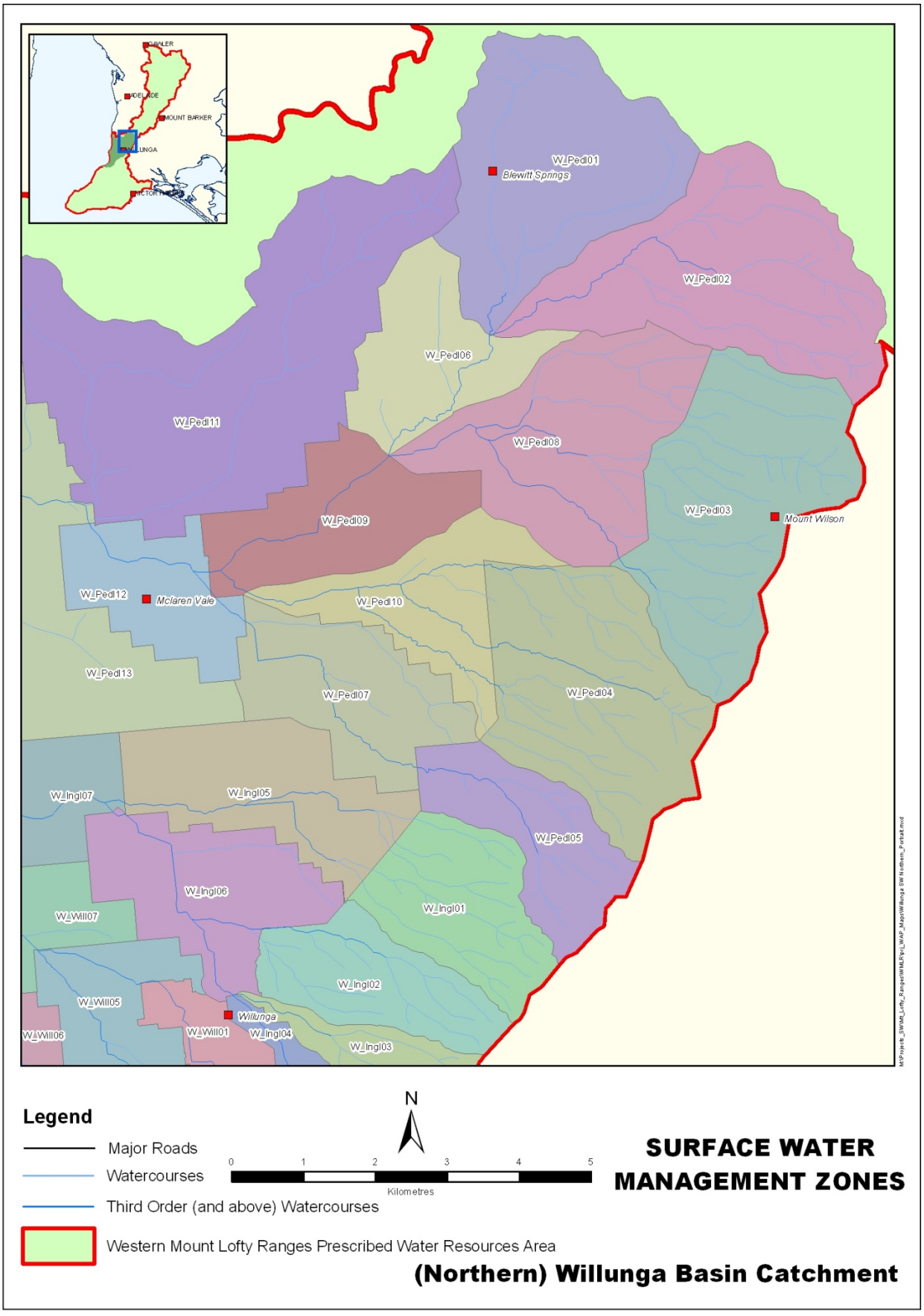
(NORTHERN) ONKAPARINGA RIVER CATCHMENT



(CENTRAL) ONKAPARINGA RIVER CATCHMENT



(NORTHERN) WILLUNGA BASIN



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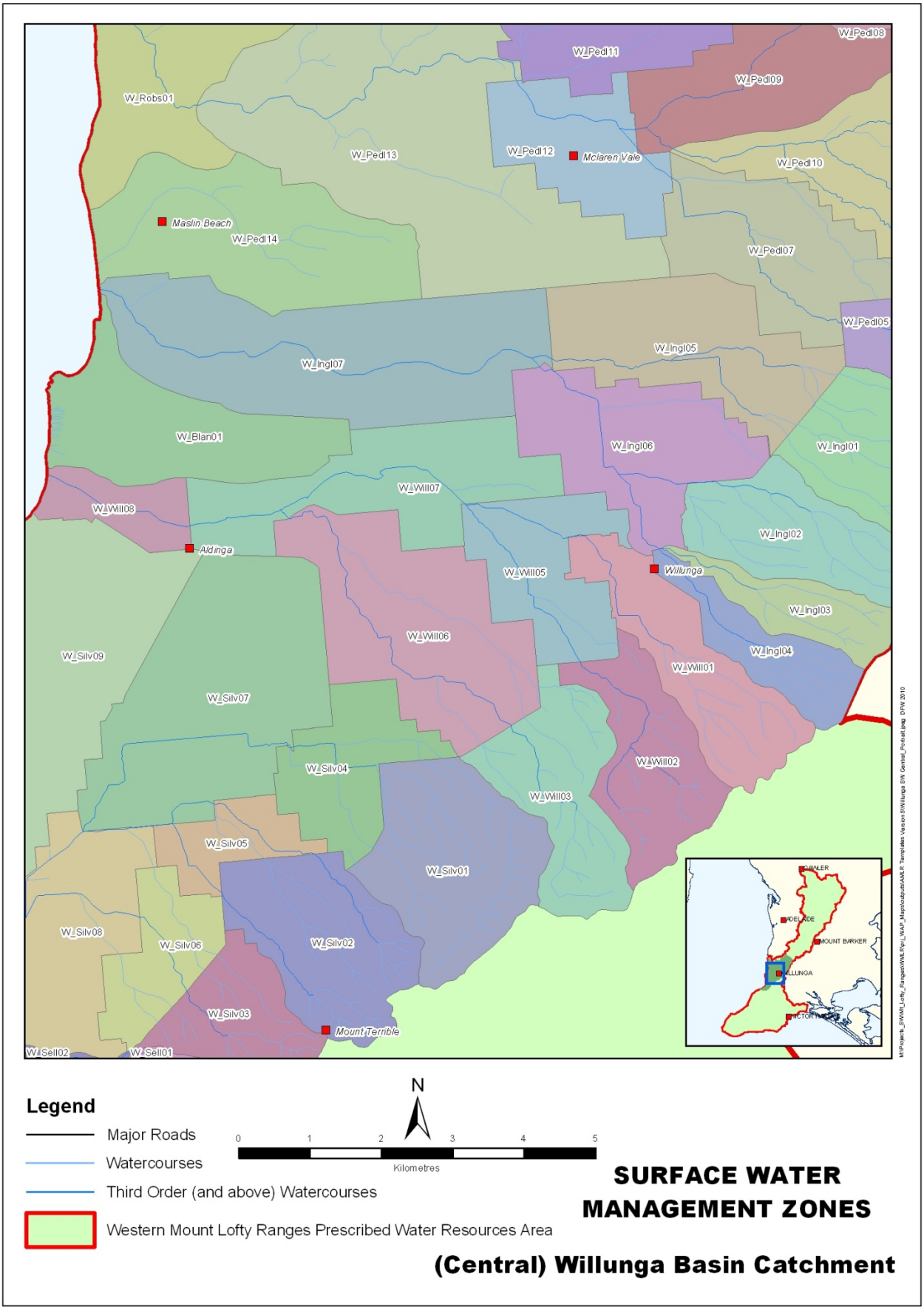
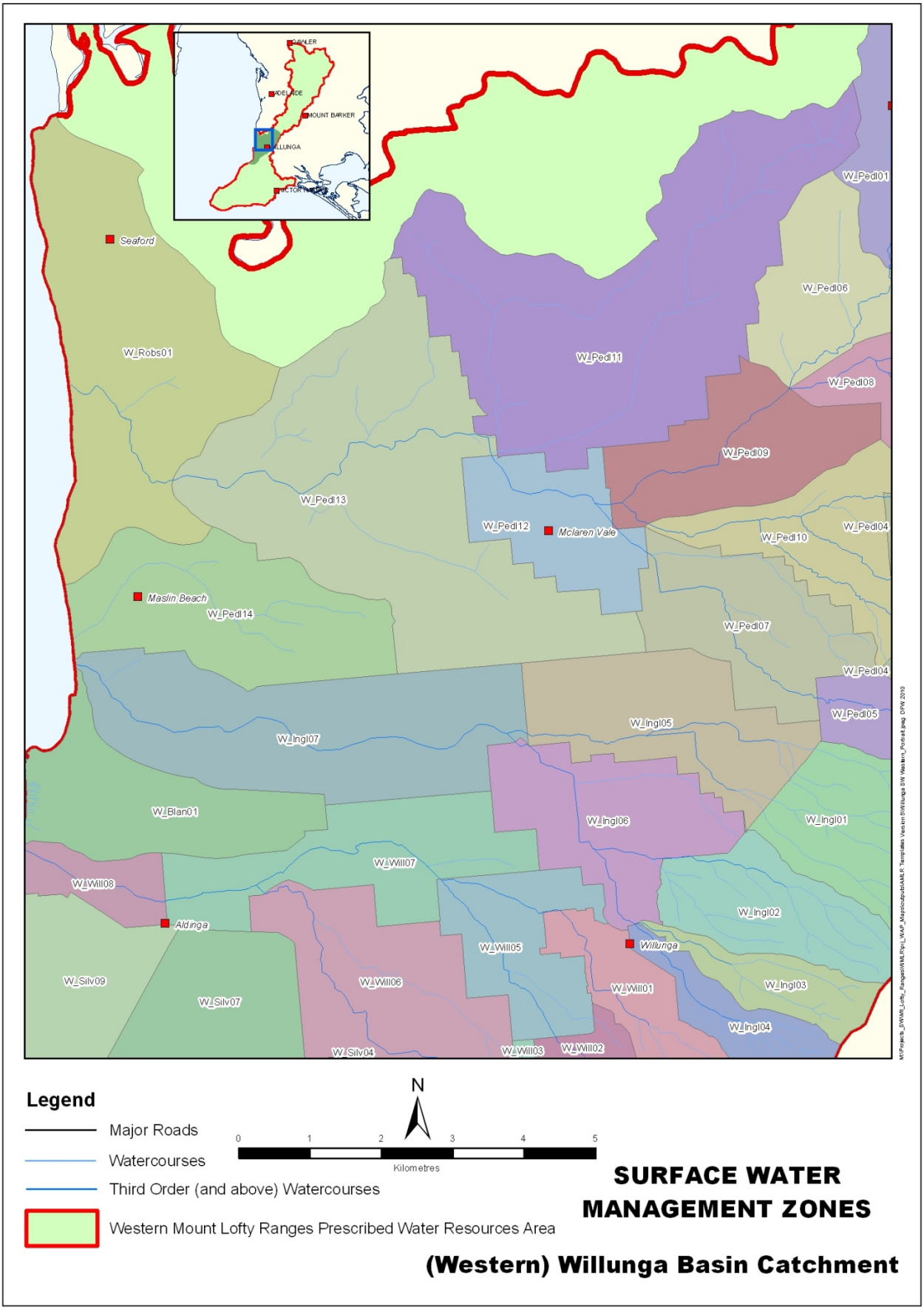
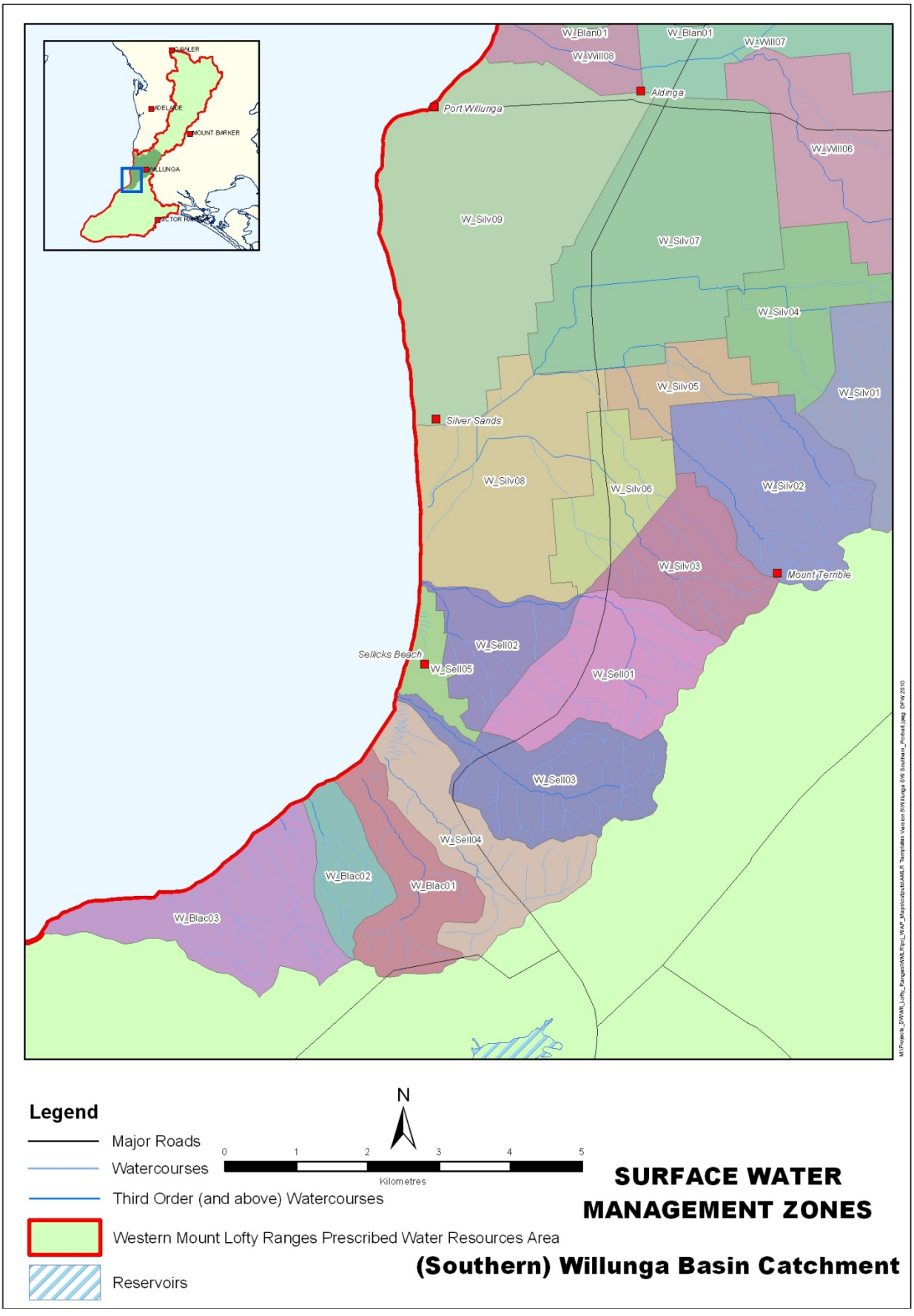


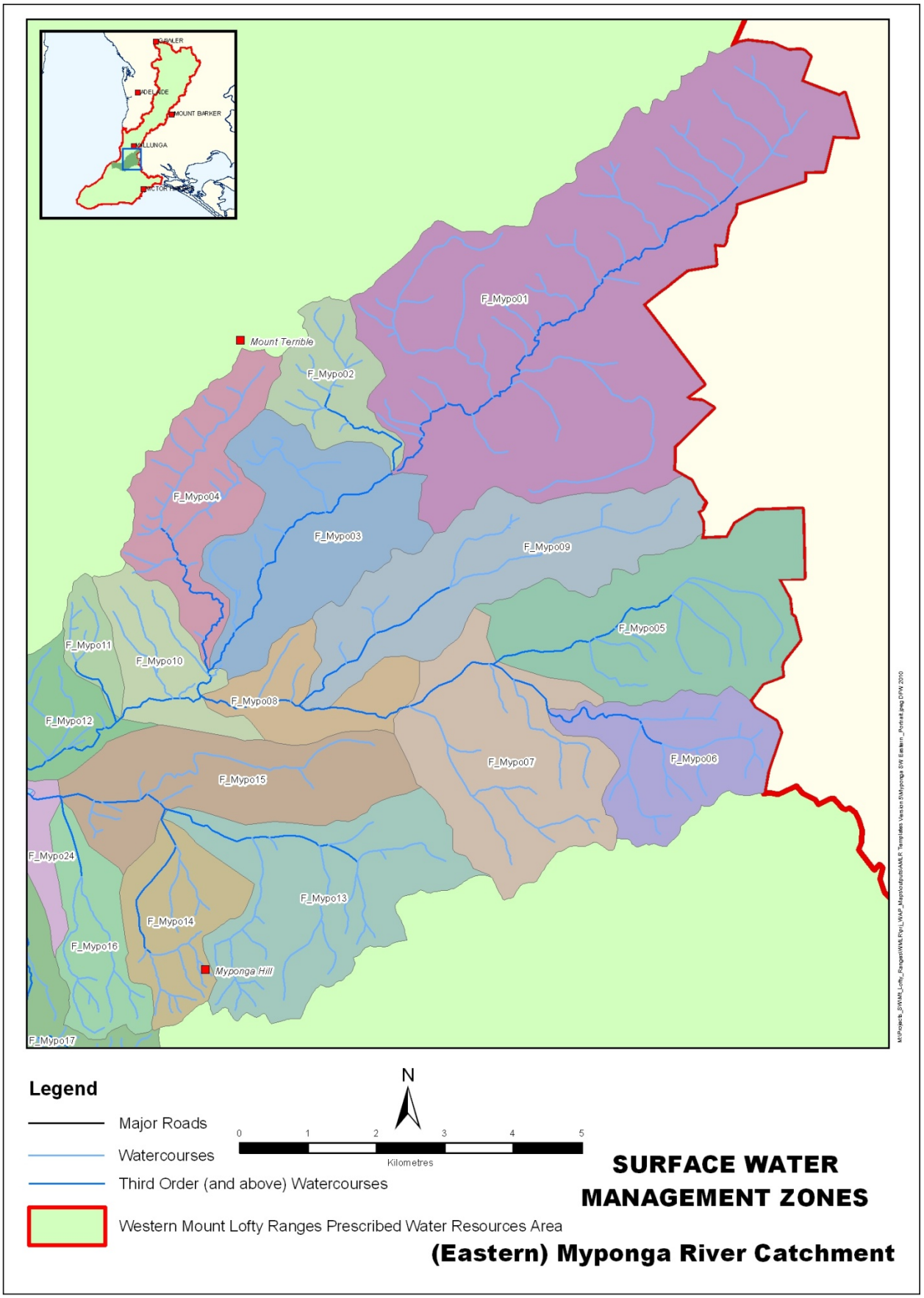
(WESTERN) WILLUNGA BASIN



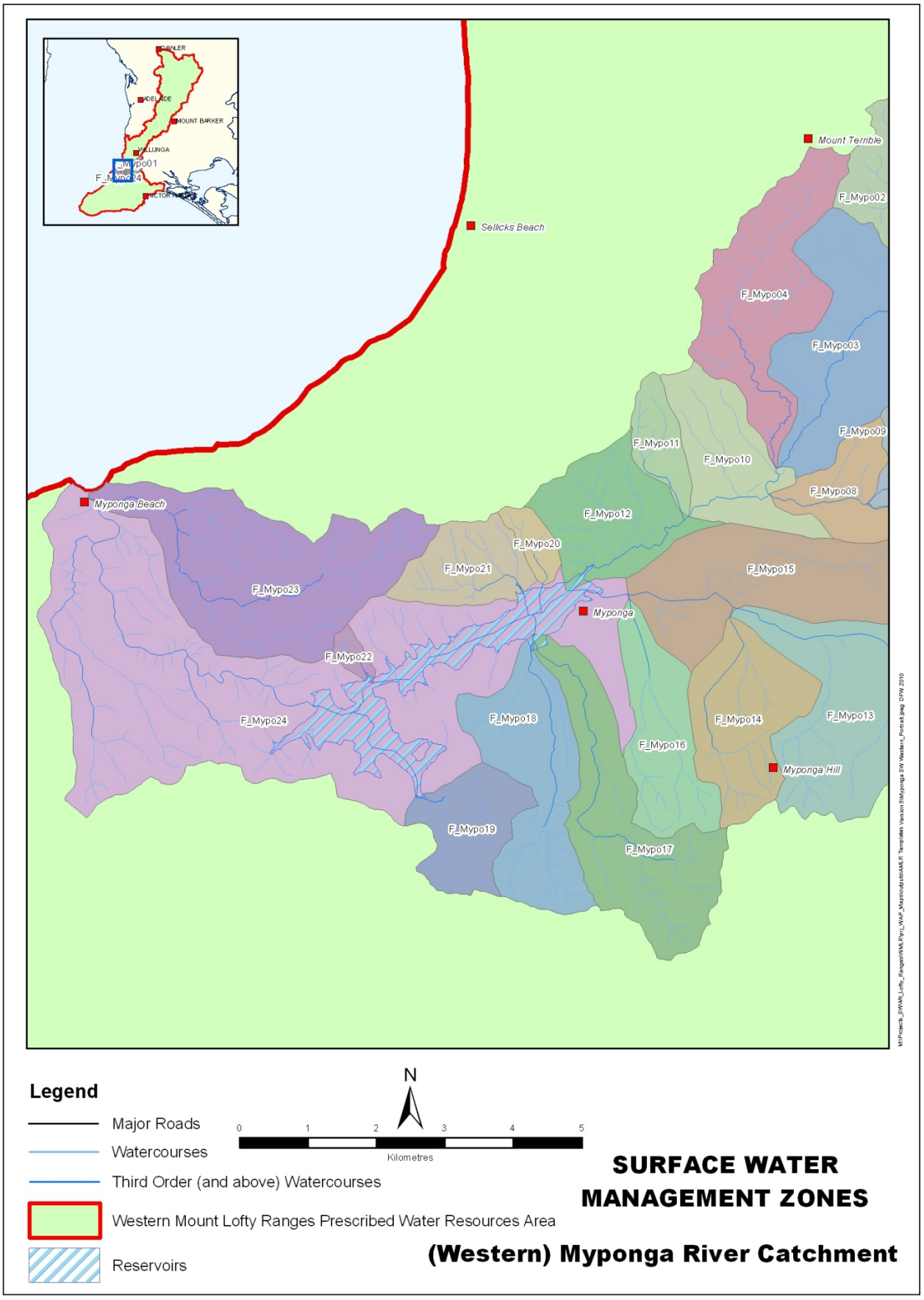
(SOUTHERN) WILLUNGA BASIN



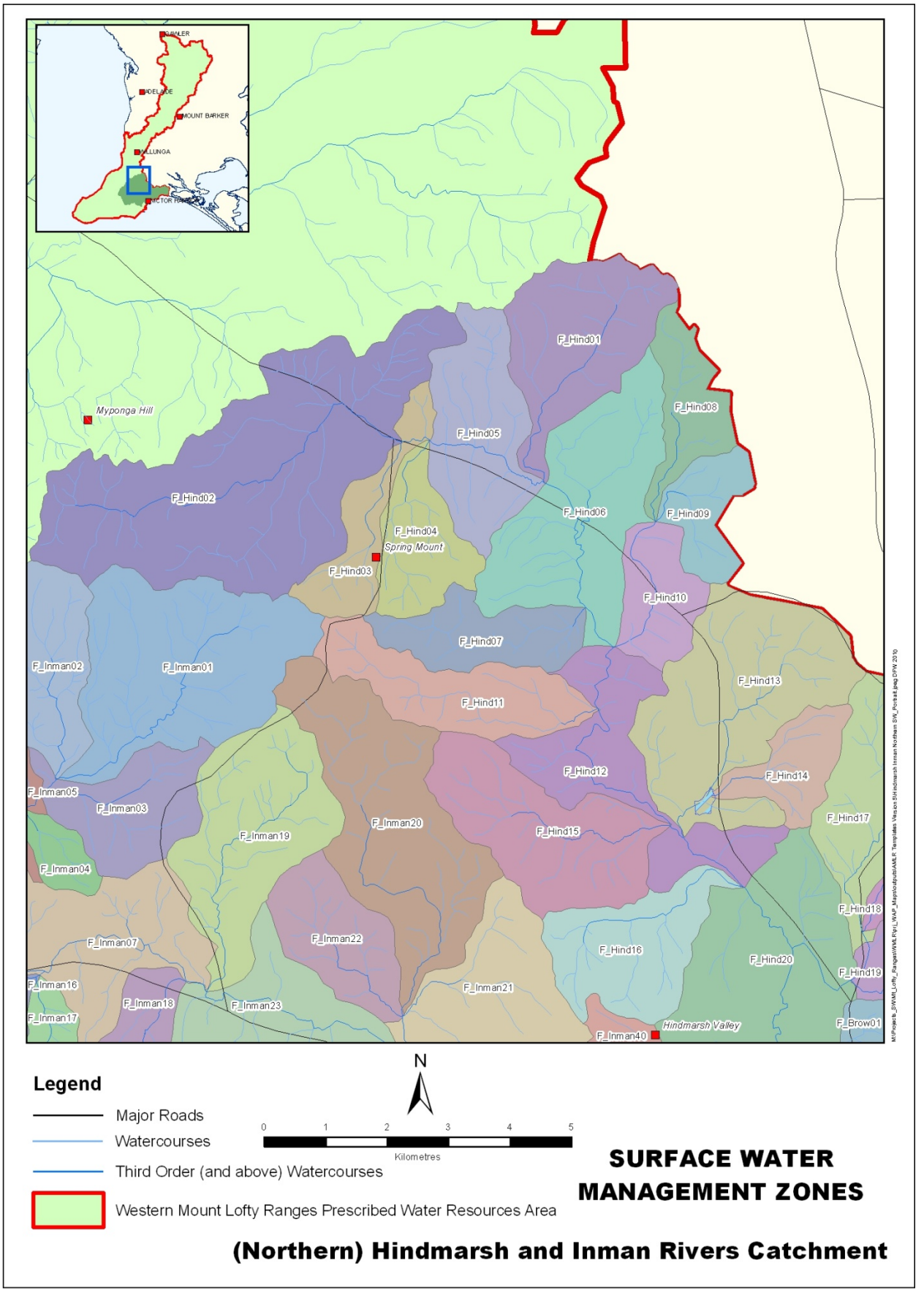
(EASTERN) MYPONGA RIVER CATCHMENT



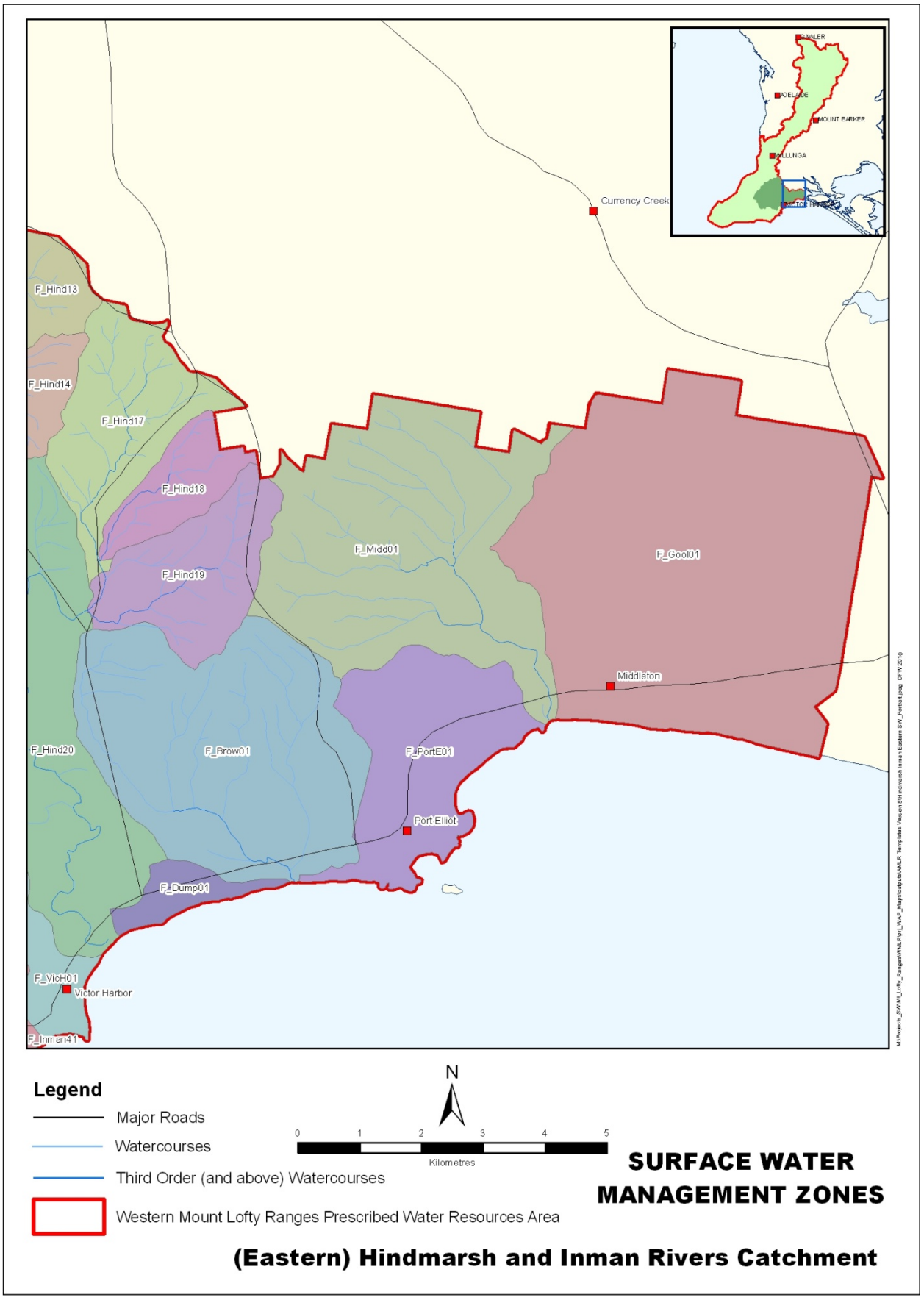
(WESTERN) MYPONGA RIVER CATCHMENT



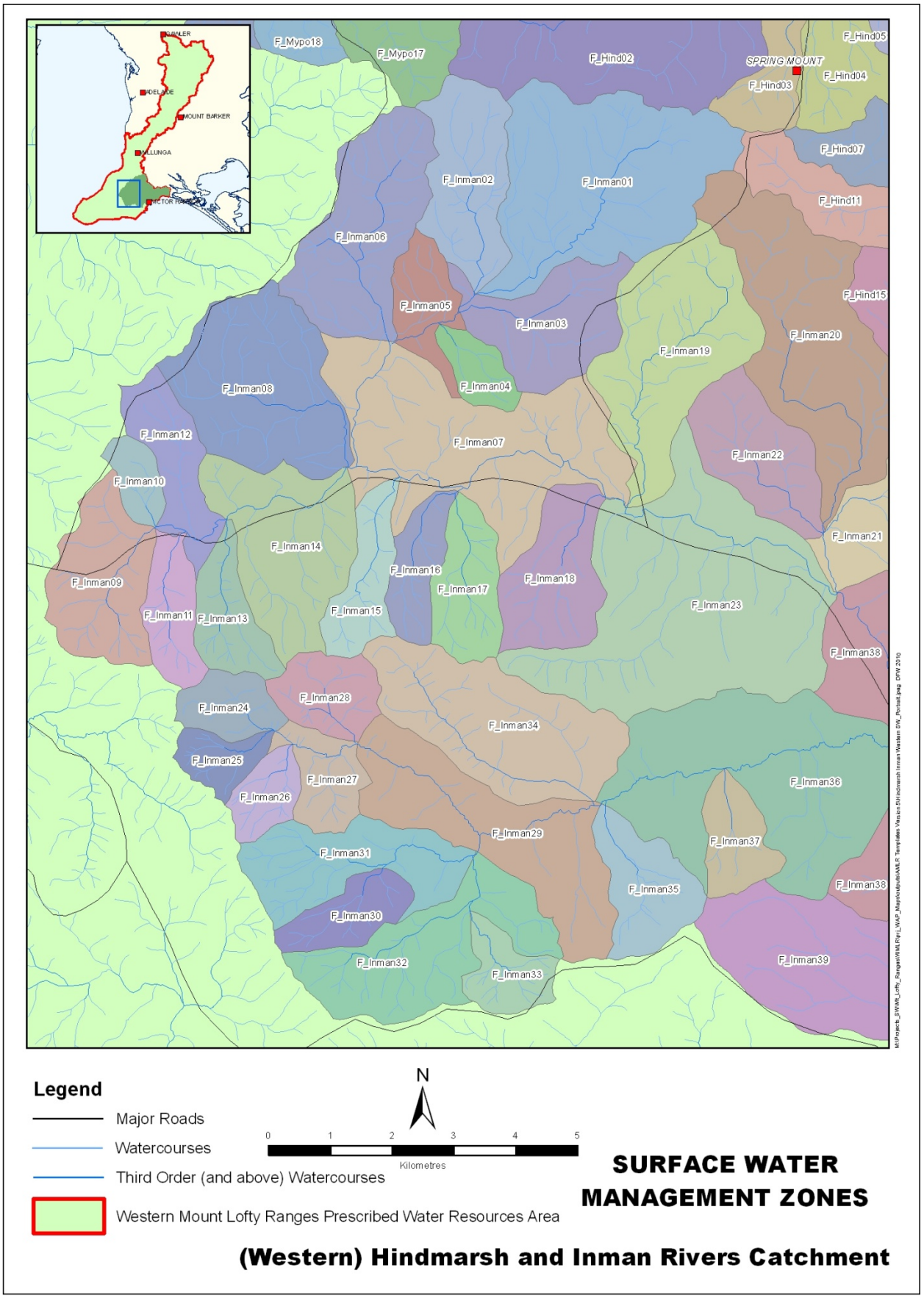
(NORTHERN) HINDMARSH AND INMAN RIVER CATCHMENTS



(EASTERN) HINDMARSH AND INMAN RIVER CATCHMENTS



(WESTERN) HINDMARSH AND INMAN RIVER CATCHMENTS



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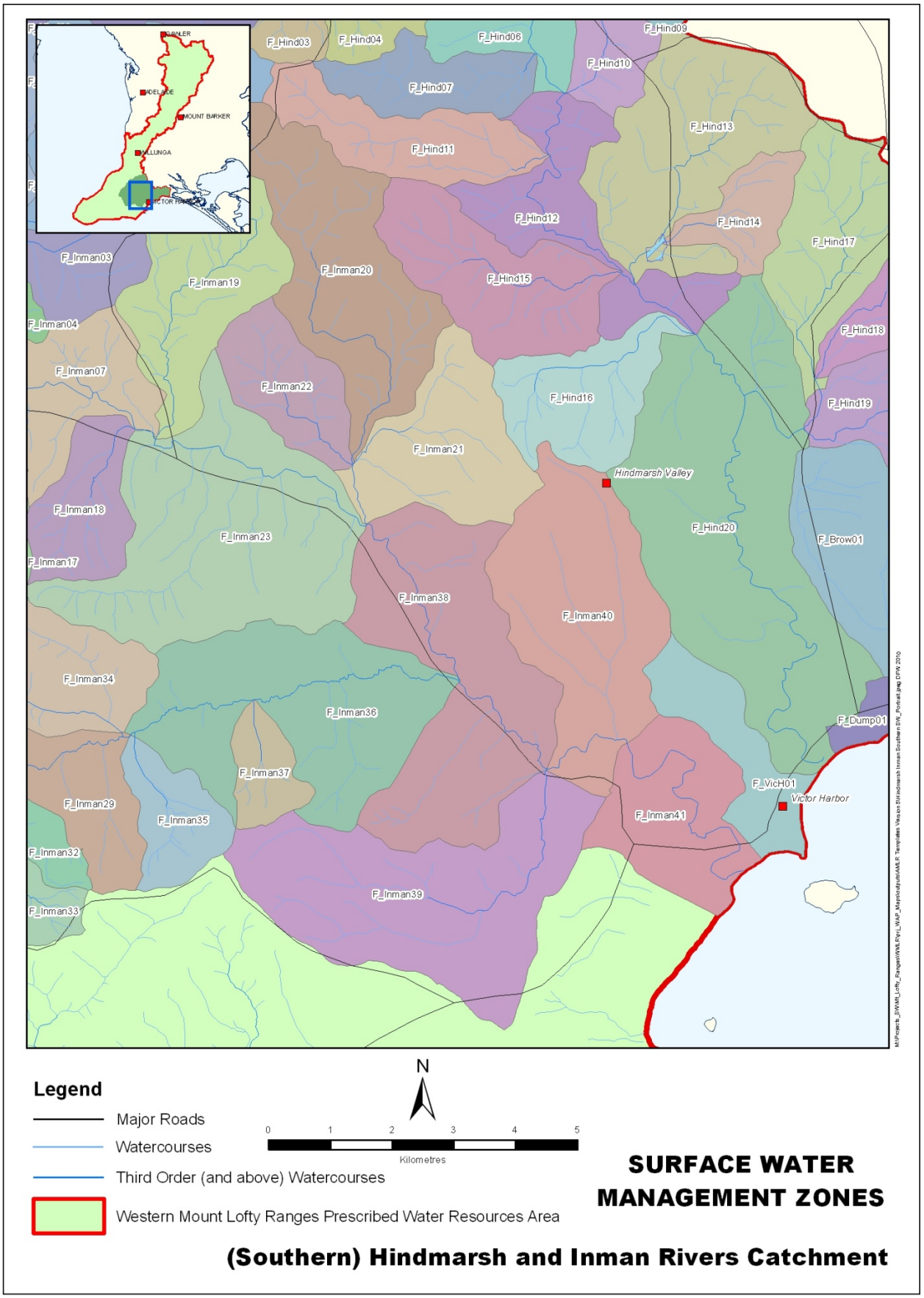
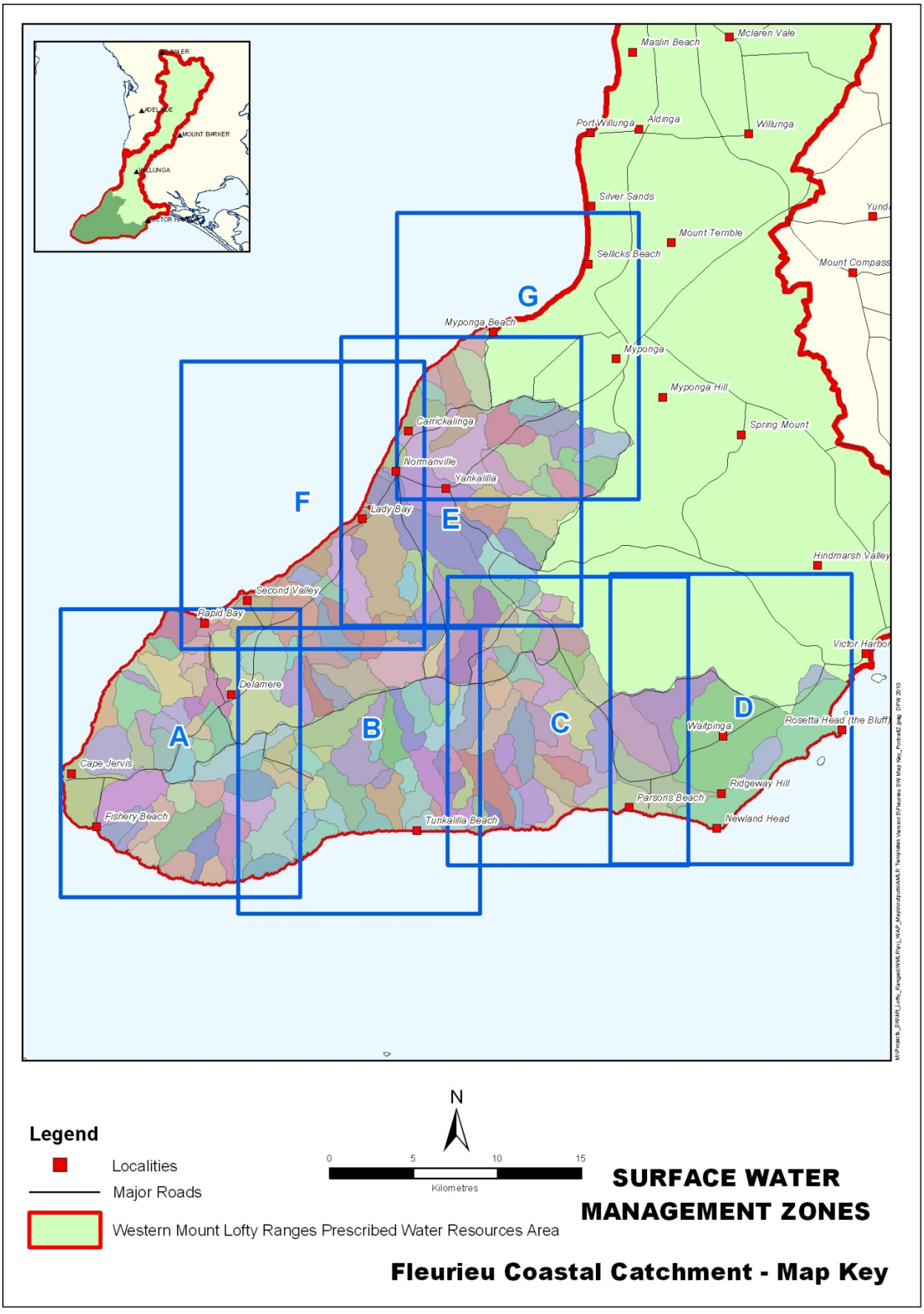
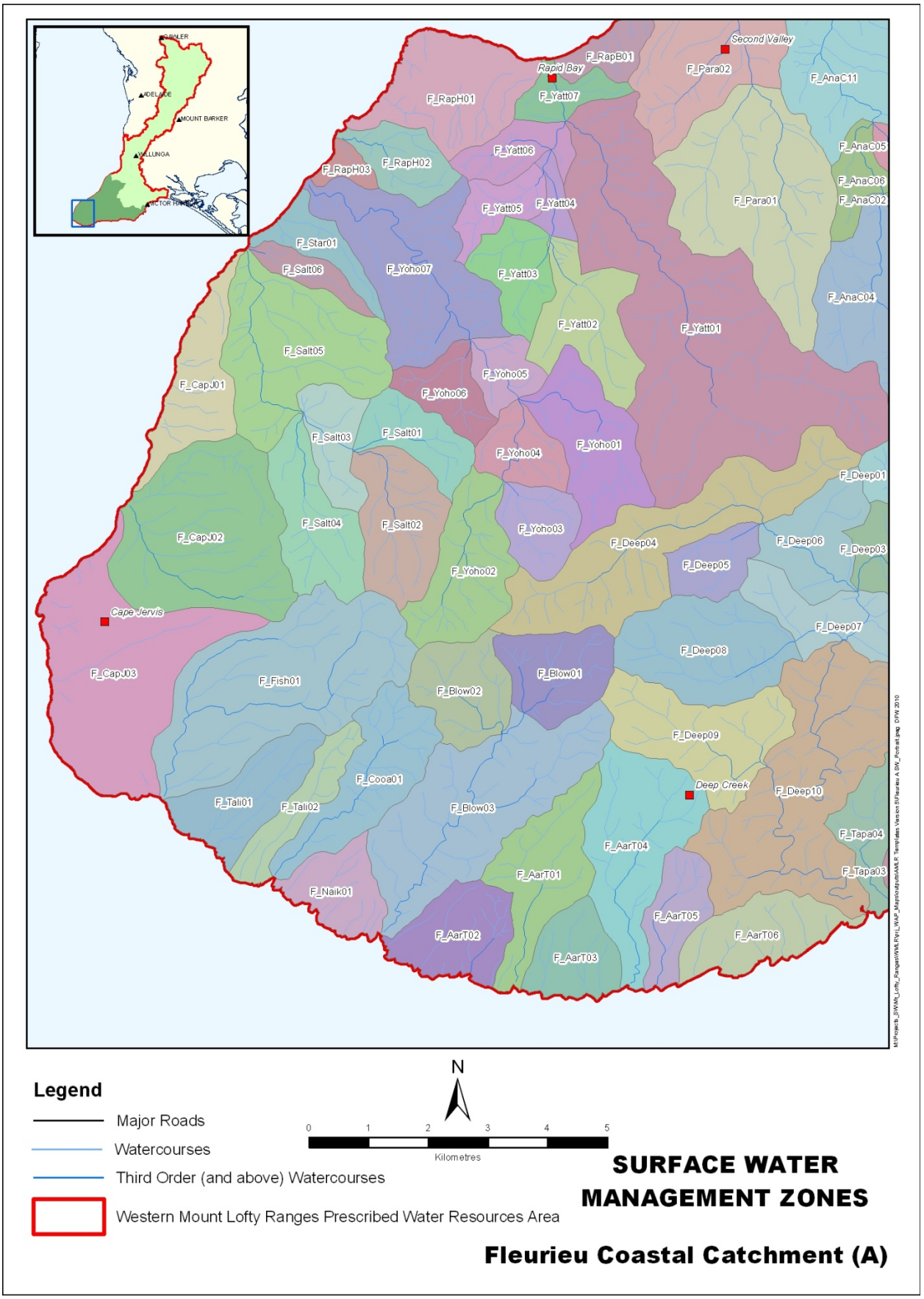


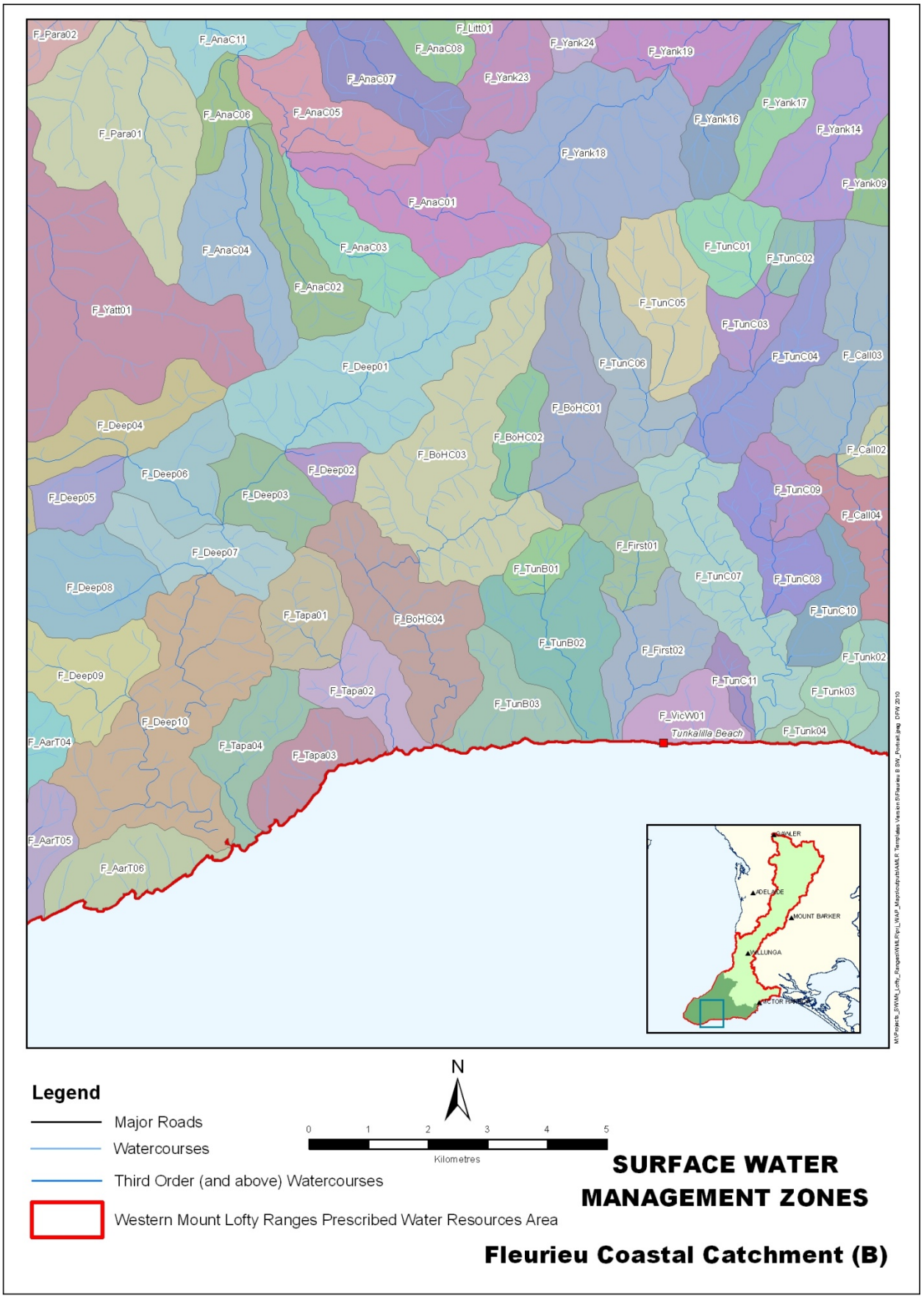
FLEURIEU COASTAL CATCHMENTS – MAP KEY



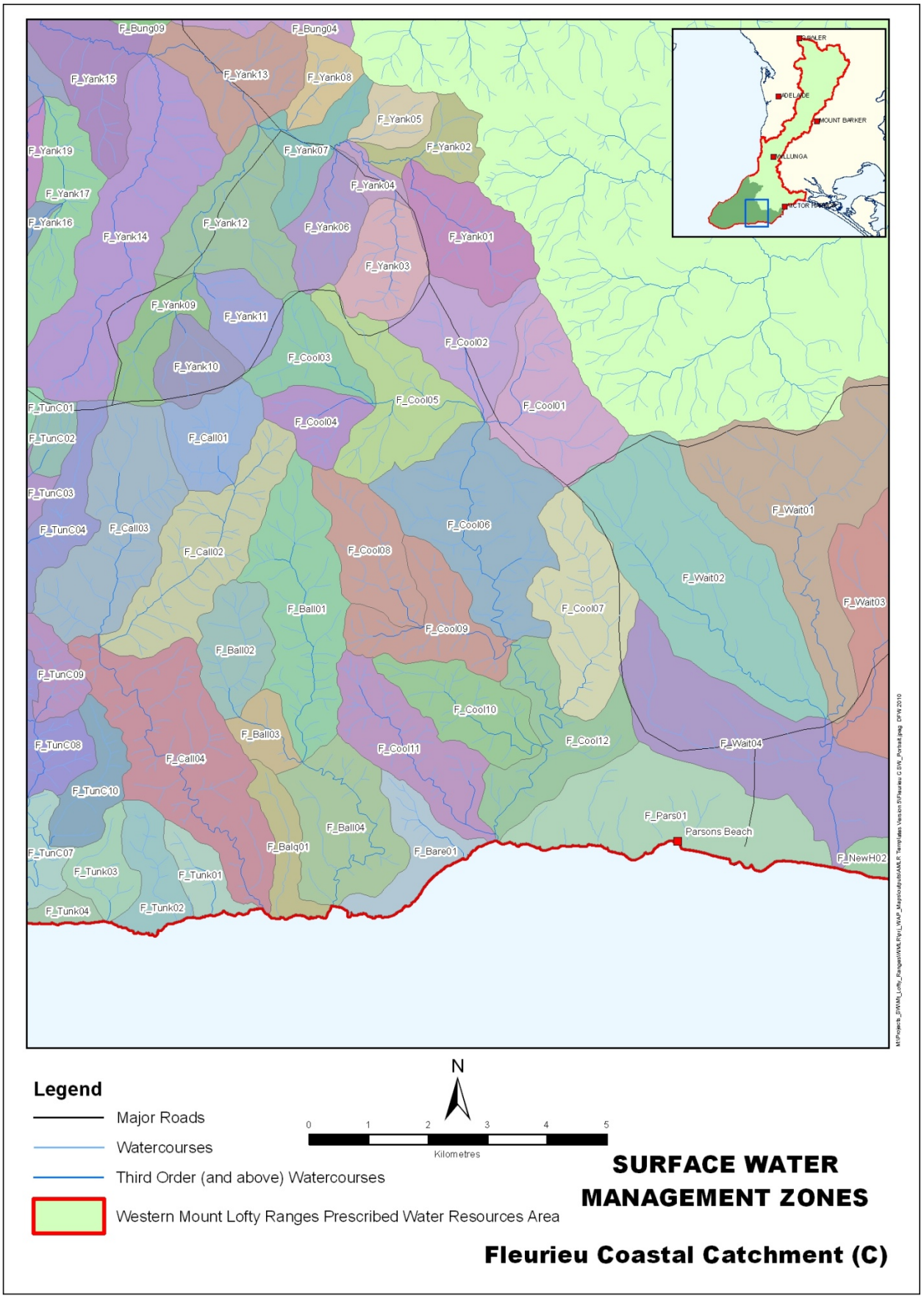
FLEURIEU COASTAL CATCHMENTS (A)



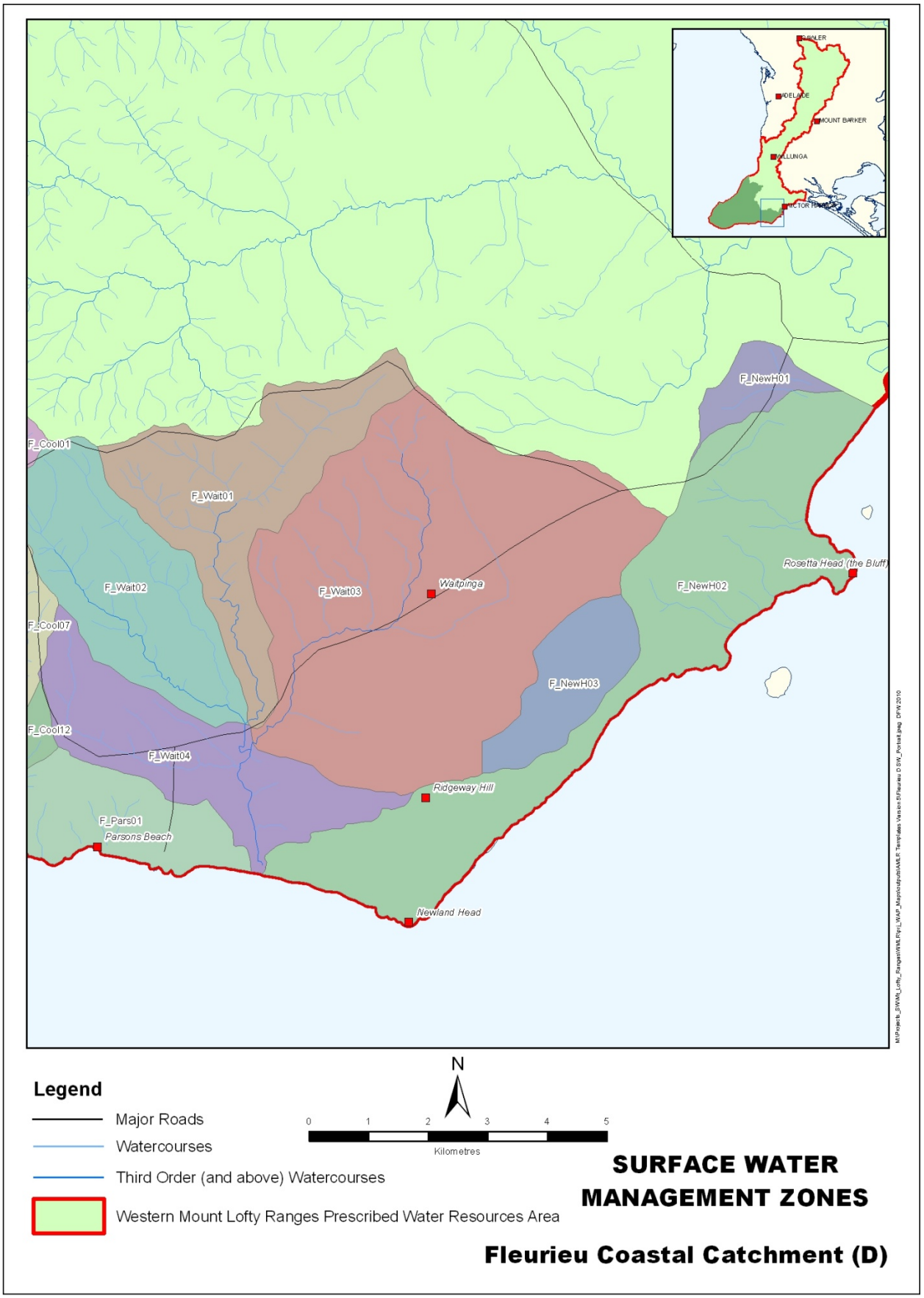
FLEURIEU COASTAL CATCHMENTS (B)



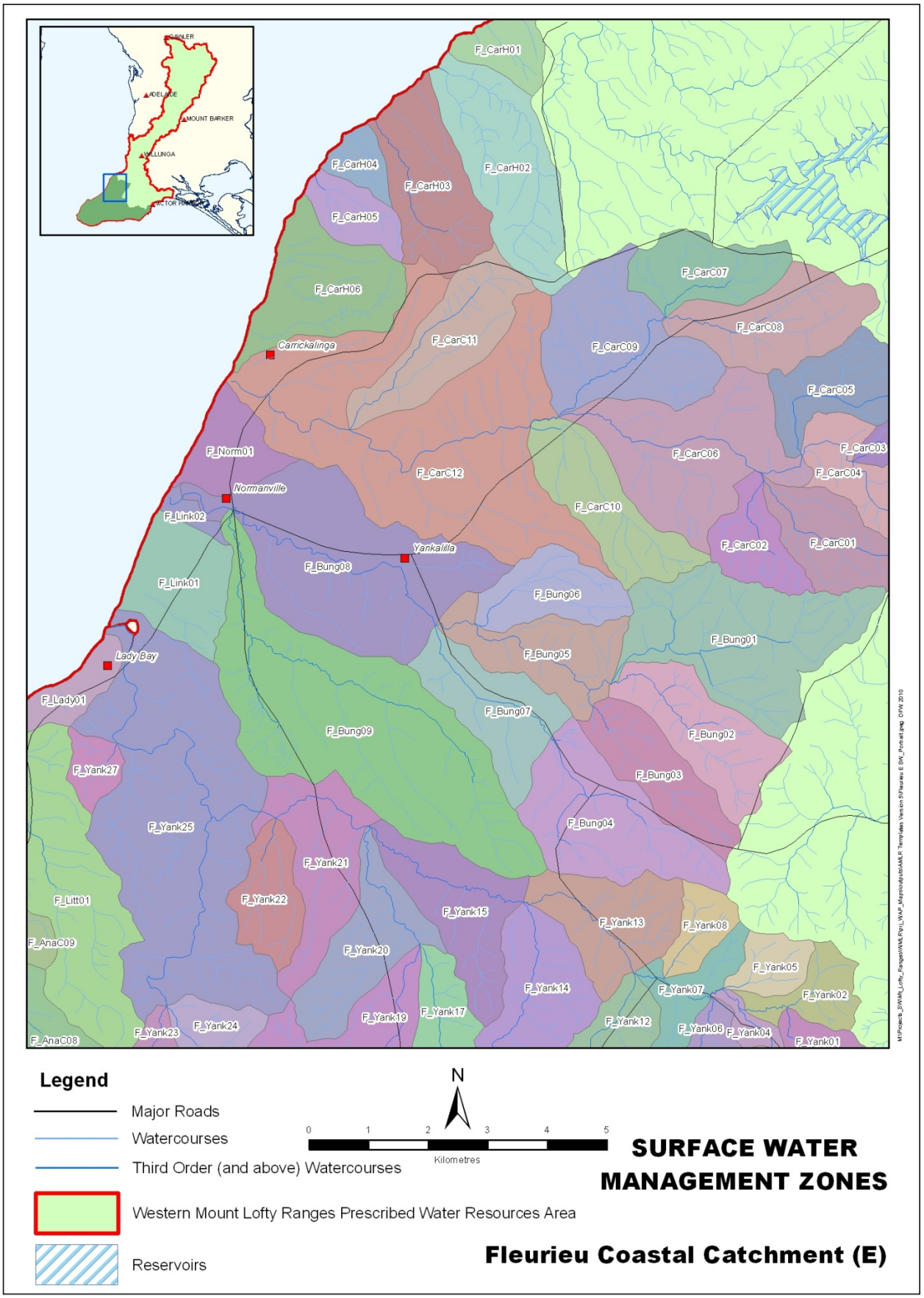
FLEURIEU COASTAL CATCHMENTS (C)



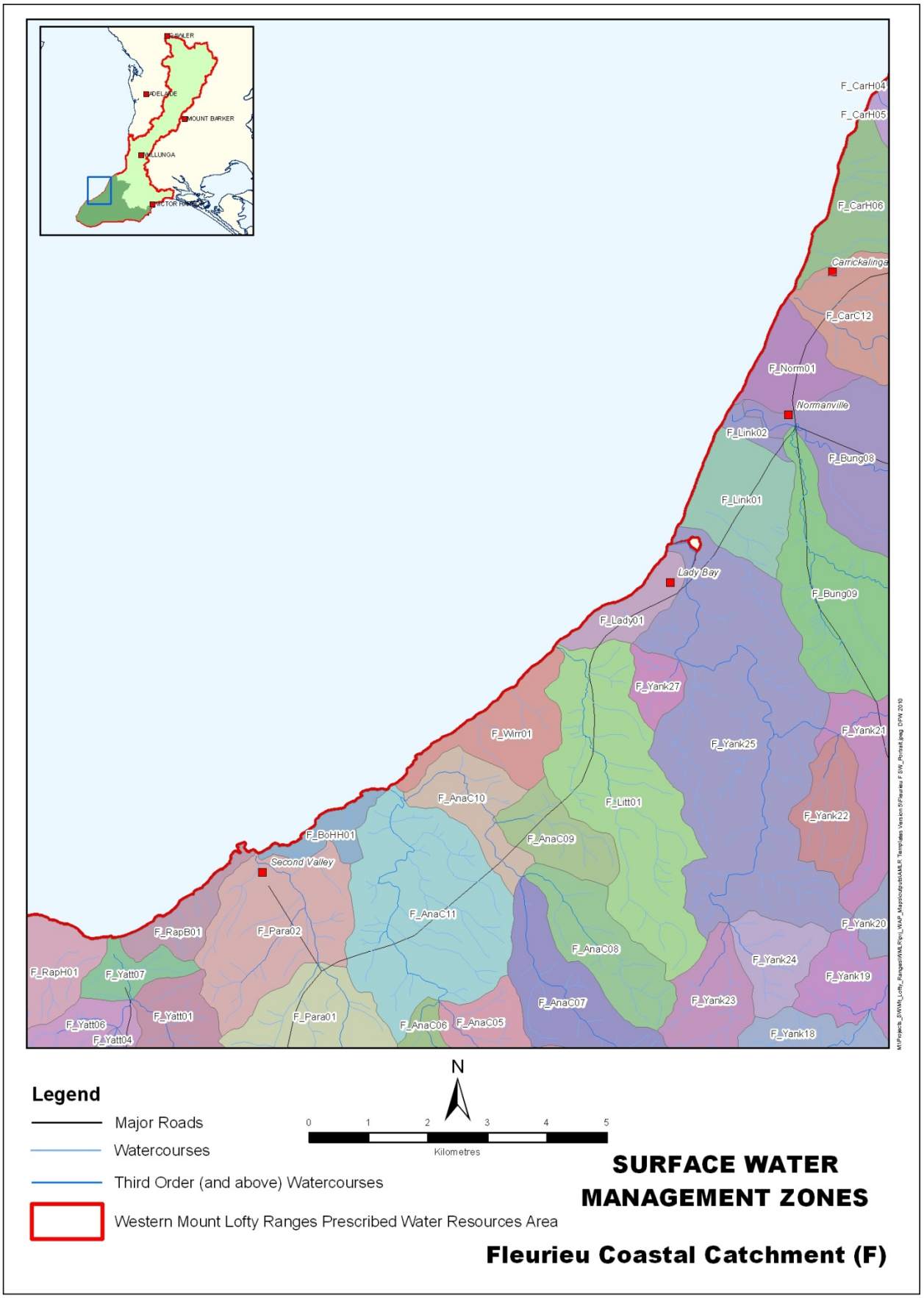
FLEURIEU COASTAL CATCHMENTS (D)



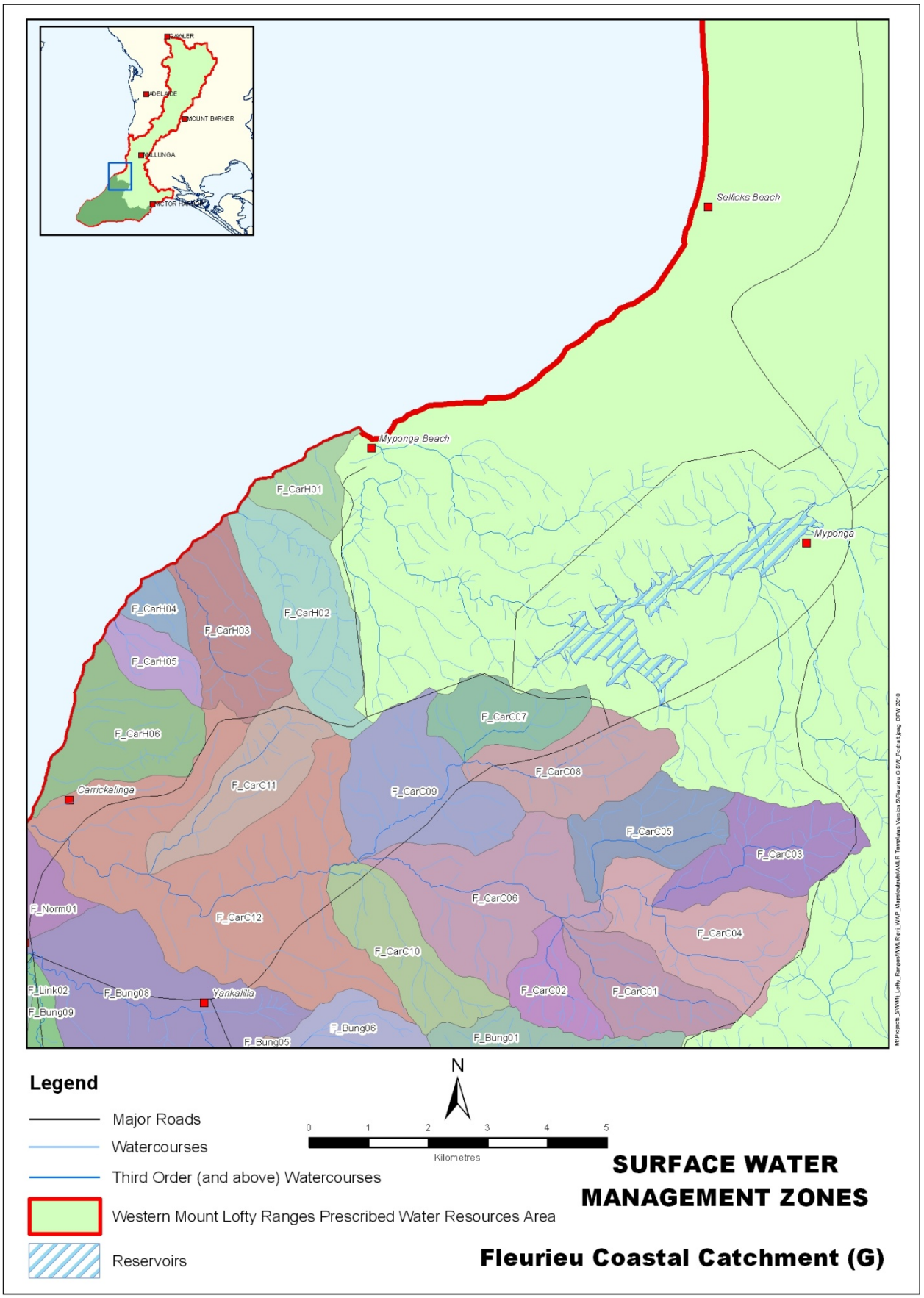
FLEURIEU COASTAL CATCHMENTS (E)



FLEURIEU COASTAL CATCHMENTS (F)



FLEURIEU COASTAL CATCHMENTS (G)



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