

A large, thick, olive green curved shape that starts from the top left, curves around the top and right, and ends at the bottom right, framing the text.

# Central Coast Council

## Stormwater System Management Plan

June 2020

Document Endorsement	
Responsibility:	<p>It is the responsibility of the Director Infrastructure Services to implement this Plan and review its content with Council.</p> <p>It is the responsibility of the Engineering Group to maintain this document in the corporate document framework.</p>
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## 1. EXECUTIVE SUMMARY

Within the Central Coast municipal area there are seven locations that can be considered “Urban Areas” for the purposes of the *Urban Drainage Act 2013* (the Act).

Under this legislation the Council has an obligation to provide and manage appropriate stormwater reticulation and to manage potential risks associated with stormwater.

The Council has established operational and asset management systems in place to effectively operate the reticulation. There are, however, opportunities to continue to mitigate community risk, improve system operation and support improved environmental outcomes, associated with stormwater.

From a global urban area perspective there are a range of risks that require some form of management or awareness in respect to the natural environment including climate change, sea level rise, landslip, impacts on waterway environments.

There are measures, systems and processes in place to consider and provide for such risks.

Of more significance to our local community are risks that can have a direct impact on residents, their property or business and community infrastructure. Such risks can be assessed on a specific catchment basis and generally relate to:

- . Localised flooding impacting on persons, property and infrastructure.
- . Overland flows.
- . Stream flooding.
- . Riverine flooding.

The purpose of this Stormwater System Management Plan (SSMP) is to provide a high level of understanding of how the Council manages its existing stormwater reticulation, opportunities to improve system management and planning for the future, document risks associated with stormwater and our plans to addresses potential risks to the community.

The SSMP is framed around the Council’s stormwater management objectives.

- . Document infrastructure performance requirements and standards for stormwater assets and communicate to key stakeholders.
- . Fund the maintenance and operation of the stormwater reticulation in accordance with the Council’s stormwater service level documents.
- . Develop the reticulation within the urban areas, to meet user needs for appropriate and safe stormwater disposal.
- . To understand the systems deficiencies and flooding (localised and broader catchment) risks, and possible mitigation measures.
- . Identify priorities for improvement and mitigation activities.

- . Develop a plan to progressively improve waterway environment and water quality in the natural systems impacted by stormwater systems.
- . Communicate the SSMP to stakeholders.

The SSMP has been developed through a review of existing Council records and reports, Officer knowledge of the systems operation, reference to contemporary stormwater management practices and legislation, and flood studies previously carried out.

The outcome is an Action Plan that sets stormwater system management priorities over the next four years.

Key objectives are:

- . Create a “Flood Hazard Layer” on the Council’s Graphical Information System (GIS), to assist in the management of priorities and planning assessments.
- . Where appropriate develop a “Retention/Detention Basin” strategy to assist in the management of the stormwater system and planning assessments.
- . Liaise with the Bureau of Meteorology (BOM) and any other relevant state entities to install two rainfall recording/stream gauging stations on the Leven River.
- . Liaise with the State Government and any other relevant entities regarding flood modelling of the Leven River system.
- . Develop management plans for an integrated approach for the common use of “open space” natural waterways as a joint drainage flow path and natural riverine system.
- . Liaise with the State Government regarding flood modelling of Penguin Creek and Sulphur Creek.
- . Specific systems and process improvement.
- . Review and adjust forward works programs.

Implementation of the actions will require adequate resources to be allocated.

## 2. BACKGROUND

### 2.1 GENERAL

The Central Coast Council manages an extensive urban stormwater reticulation network system, within the towns of Ulverstone, Penguin and Turners Beach, and the townships of Forth, Sulphur Creek, Leith, Preservation Bay and Heybridge.

This system comprises:

- . Open waterways (forming part of the urban stormwater system and where utilised within the Urban Drainage Area).
- . Piped systems.
- . Pits and inspection chambers for the capture and conveyance of stormwater.
- . Outfalls.
- . Retention/Detention systems.
- . Gross pollution traps and other such devices.

Outside of the urban area, the Council's role in stormwater management relates primarily to roadside drainage and providing a passage for natural stream and overland flows, where roads intercept.

### 2.2 WHAT IS STORMWATER?

What is stormwater and why is it important to manage?

The Act, defines stormwater:

***"stormwater means run-off water that has been concentrated by means of a drain, surface channel, subsoil drain or formed surface;"***

The broad reasons why a council has an interest in stormwater management relate to:

- . The Council facilitates and plans the development of communities. Development can have impacts on the normal water cycle: water courses are diverted, ground water recharge areas are paved over, the quantity and speed of flows to waterways can increase or reduce and the receiving environment can be impacted. Appropriate management of stormwater can assist in mitigating some of these negative impacts on the natural systems.
- . Infrastructure concentrates and collects rain and overland flows to discharge points. This concentration, if not managed, can present a risk through localised and a broader flooding risk, resulting in damage to public or private property and injury to persons. Understanding the nature and performance of stormwater infrastructure, ensuring consistent approaches to design, construction and maintenance, identifying risks and establishing plans to address risks aids in protecting community infrastructure and the residents of the community.

Pollutants (oils, litter, chemicals) and the like accumulate in the urban environment and are washed into stormwater systems. Works in the catchments can result in silt and sediment mobilisation. Ultimately these materials find their way into receiving waters. These materials impact on water quality and the eco system. Opportunities exist to mitigate the impacts of such materials.

In urban environments stormwater systems have developed over time in response to community needs.

The current legislative framework for urban stormwater management is the Act.

Under the Act, the Council is a ***stormwater service provider*** (a council or an agent engaged to act on behalf of the council that operates and maintains the public stormwater system within a municipal area). As such the Council has responsibility for meeting its obligations under the Act.

The Objectives are noted below and reflect the discussion above as to why a council has an interest in managing stormwater:

- a to protect people and property by ensuring that stormwater services, infrastructure and planning are provided so as to minimise the risk of urban flooding due to stormwater flows; and
- b to provide for the safe, environmentally responsible, efficient and sustainable provision of stormwater services in accordance with the objectives of the resource management and planning system of Tasmania.

## 2.3 REQUIREMENTS OF THE URBAN DRAINAGE ACT 2013.

A specific requirement of the Act is for a council to develop a SSMP.

### ***“10. Stormwater system management plans***

*(1) A council must develop a stormwater system management plan for the urban area of its municipal area within 6 years after the day on which this Act commences.*

*(2) A stormwater system management plan is to specify –*

*(a) plans for the management of any assets used for the delivery of a stormwater service; and*

*(b) the level of risk from flooding for each urban stormwater catchment in the public stormwater system; and*

*(c) any other matters prescribed in the regulations or that the council considers appropriate.”*

In meeting this obligation, best practise urban stormwater management in Tasmania should aim to develop catchment based SSMPs with consideration given to the following core principles:

- 1 Understand the level of risk in its public stormwater system within the urban area.

- 2 Apply a risk management framework for flood mitigation and stormwater renewal works based on analysis of defined flood events.
- 3 Ensure stormwater systems are planned, designed and built with appropriate consideration of stormwater management principles by making better use of the statutory development and planning system.
- 4 Build resilience and consider climate change impacts to address future demands on the urban stormwater system.
- 5 Integrate stormwater management into the urban water cycle to achieve the goals of social, environmental and economic sustainability.
- 6 Enhance community awareness of, and participation in, the appropriate management of stormwater.

To provide guidance on the framework a SSMP statewide working group, convened by the Local Government Association of Tasmania (LGAT), developed a template “Stormwater System Management Planning– A Guide for Local Government in Tasmania”.

The approach taken by the Council generally follows the approach suggested in the stormwater framework. It is noted that this is the first iteration of the Central Coast Council SSMP and is developed as a starting point for future improvement.

The Central Coast Council SSMP will consider primarily the management of stormwater and how the Council is addressing the various risks associated with stormwater. While environmental matters are touched upon in the SSMP, the setting of specific environmental improvement targets and actions to address the targets are not areas able to be resourced at this point of time. However, they would be the focus of future iterations of the SSMP.

In many respects the SSMP is an aggregation of a range of current Council practices, plans, policies and the like, reflecting the current management arrangements.

### **3. OVERVIEW OF PLAN CONTENT**

The purpose of developing the framework was to support councils in meeting the general requirements of the Act, at a core level.

The framework identifies key elements of a SSMP:

- . An **identification of objectives and outcomes** for management of stormwater in the designated Urban Area/s.
- . A **description of the catchment** to which the SSMP applies, including a definition of the Urban Area.
- . A **description of the existing public stormwater system**, including identification of current condition and ownership of assets where known.
- . An **identification of stormwater management problems and opportunities** for achieving outcomes for public and environmental benefit in the Urban Areas/s.



- . An **identification of strategies** to meet specified management objectives for the Urban Area/s.
- . **Determination of capital and maintenance (including recurring) costs** associated with identified management strategies.
- . An **assessment of the benefits to be derived by implementation** of proposed management strategies.
- . **Prioritisation** of the strategies and a **timeframe** for implementation.
- . **Assignment of responsibilities** for implementing the strategies and meeting any costs.
- . A **communication/consultation strategy** for the SSMP.

This SSMP prepared by the Council addresses the key elements. It is acknowledged that in some areas, particularly in the water quality space, further attention and development is required and will be resourced at a later date.

It is important to note that the development of the framework considered the content of relevant legislation, including:

- . *Urban Drainage Act 2013;*
- . *Local Government Act 1993;*
- . *Local Government By-Laws;*
- . *Local Government (Building and Miscellaneous Provisions) Act 1993;*
- . *Environmental Management & Pollution Control Act 1994;*
- . *Building Act 2016;*
- . *State Policy on Water Quality Management (1997);*
- . *State Stormwater Strategy (2010); and*
- . *Plumbing Regulations 2014 and Building Regulations 2014.*

#### **4. STORMWATER MANAGEMENT OBJECTIVES**

In Section 2 of the SSMP the objectives of the Act are reproduced. The objectives are very broad.

Reviewing the nature of the Central Coast Council's current stormwater management practices and current level of development in the provision and management of stormwater infrastructure, specific objectives (which are our current focus) have been identified, being:

- . Document infrastructure performance requirements and standards for stormwater assets and communicate to key stakeholder.
- . Fund the maintenance and operation of the stormwater reticulation in accordance with the Council's stormwater service level documents.

- . Develop the reticulation within the urban areas, to meet user needs for appropriate and safe stormwater disposal.
- . To understand the systems deficiencies and flooding (localised and broader catchment) risks, and possible mitigation measures.
- . Identify priorities for improvement and mitigation activities.
- . Develop a plan to progressively improve waterway environment and water quality in the natural systems impacted by stormwater system
- . Communicate the SSMP.

Achieving these objectives will be a journey that will take some time to complete and it is important that a clear strategy is developed and implemented to guide that journey.

## 5. DESCRIPTION OF URBAN AREA

The Act specifies that each council must develop a SSMP for the urban areas of its municipal area.

There is no definition of “urban” specified within the Act. The SSMP framework provides some guidance as to potential matters to consider in the establishment of the “Urban Area.”

For the Central Coast, the stormwater infrastructure is included on layers on the GIS. This defines all underground stormwater (lines, pits etc.) and the associated urban drainage catchments. There is a “Council map” complying with Section 12 of the Act, this is available to public.

The catchment areas have been modified over time to reflect those properties that have the potential to access a stormwater system maintained by the Council.

Attached as **Appendix A** are a series of plans which detail the urban areas within the municipal area, and for the purposes of the Act, these are the Urban Areas.

To support urban stormwater planning, urban catchments have been identified. Attached as **Appendix B** are a series of plans identifying the major urban catchments. Some of these catchments have been used for system modeling purposes (Ulverstone East – Buttons Creek and Sulphur Creek – East), where flood studies have been prepared previously (2007 and 2003 respectively), and these studies require updating.

Of the major and moderate rural catchments in the municipal area, only the Forth River has been modelled for flood mitigation purposes.

The urban catchments reflect the downstream “residential” components of the major, moderate and minor stream systems in the urban areas.

The Council does not have a specific management role in respect to the major river systems (Blythe, Leven and Forth) or the moderate riverine systems (Penguin Creek and Claytons Rivulet) or the other minor systems (Heybridge Rivulet, Sulphur Creek, Buttons Creek and local systems). Management rests with the State Government and relevant agencies.

## 6. DESCRIPTION OF EXISTING STORMWATER ASSETS

There is a record of the Council's stormwater assets managed in the urban areas and the same can be found in the Council's GIS.

In summary the assets are:

**Table 6.1 Current Drainage Assets**

ASSET CATEGORY	ITEMS
Underground stormwater pipes – various sizes	5627kms
Stormwater inspection chambers	3011
Stormwater pits	2241
Stormwater headwalls incl. outfalls	269
Miscellaneous items	9
<b>TOTAL ASSET REPLACEMENT VALUE – \$47,435,849.21</b>	

The stormwater asset information is recorded in the Councils asset management register.

Work is required to improve the register, to account for in-stream structures such as ponds and dams.

The *Urban Drainage Act* requires that:

***“12. Council to maintain maps***

*A council that provides stormwater services must maintain and make publicly available maps showing all public stormwater systems within the urban area of its municipal area, including those portions of waterways that have a primary role in transporting stormwater.”*

This information is recorded on the Council map, which is available to the public for viewing.

Underpinning the Asset Management Plan are various reference and supporting documents including:

- . Central Coast Council Asset Management Policy.
- . Central Coast Council Strategic Asset Management Plan
- . Central Coast Council Drainage Asset Management Plan
- . Relevant industry standards, guidelines and publications.
- . Australian Rainfall and Runoff.

## **7. IDENTIFICATION OF RISK, ISSUES AND OPPORTUNITIES**

This section of the SSMP aims to document matters that are relevant to the Central Coast in the management of the stormwater system in respect to:

- . Risk to the community: current and future impacts.
- . System assets and systems management.
- . Environment and environmental influences.

Which consequently assists in identifying strategies and actions to consider, with the aim being to more effectively manage risk, address issues or explore opportunities.

As this is a strategy document it is not the intent to undertake a detailed exploration of the matters raised nor is the aim to undertake definitive risk assessments, this will occur as the need arises in respect to specific projects, rather the intent it is to ensure that known and potential future issues are acknowledged, current understanding of such matters is documented and the implications of issues in respect to community safety and level of service are considered.

The exploration will be carried out at two levels:

- . System as a whole; and
- . Catchment specific.

### **7.2 LEVEL OF SERVICE**

The Council has not developed specific measurable technical or community levels of service for stormwater services at this point of time. Broad community levels of service are noted in the Council's stormwater asset management plan, as follows:

- . There is an ability to connect their property to the stormwater system.
- . The stormwater system is safe and does not damage the environment.
- . The community's exposure to flooding is minimised and where there is a resident risk, this is communicated.

A Service Level Document details our approach to operational maintenance and management of stormwater infrastructure.

The Council's Subdivision Guidelines, based on the Tasmanian Subdivision Guidelines, identifies specific design standards based upon the function of the stormwater system element. The Planning Scheme only includes relevant planning criteria.

From a technical perspective our aim is to work towards achieving the 1% Annual Exceedance Probability (AEP), flood protection for vulnerable uses, e.g. residences and other key infrastructure, which is equivalent to the older term of 1 in 100-year Annual Recurrence Interval (ARI). Furthermore, for strategic infrastructure such as emergency and community service infrastructure, 0.2% AEP (1 in 500-year ARI), is used on the basis that the additional protection of people is a key consideration.

Minimising impact on commercial and industrial areas and non-critical infrastructure, is also the aim of the Council, however, mitigating strategies need first to be targeted to community safety.

The technical standards applied by the Council in managing the stormwater systems are noted elsewhere in this document.

## **7.2 THE OVERALL STORMWATER SYSTEM**

There are a variety of risks, issues and opportunities that are common across all of the catchments within the urban areas under the Council's management. These relate to the responsibilities of the Council associated with the management of stormwater and the potential impact of uncontrolled stormwaters on other assets, agencies, the environment and community.

**Table 7.2** identifies known matters and provides an overview of how such matters are being managed using existing systems, processes, statutory controls and the like, and indicates potential improvement action and strategies for consideration.

The actions and strategies are further explored in **Section 8**.

**Table 7.2 Risks, Issues and Opportunities with Mitigation Options and Improvements**

<b>Risk, issue or opportunity</b>	<b>Discussion</b>	<b>Risk concerns</b>	<b>Responsible party</b>	<b>Mitigation Options</b>	<b>Potential Improvements</b>
Design Standards	<ul style="list-style-type: none"> <li>· Maintain or improve design standards.</li> <li>· Pipe capacities (AEP).</li> <li>· Communicate design standards and their basis to the community.</li> <li>· Address requirements for retention and/or detention systems.</li> <li>· While accepted industry design standards and methodologies are used by Council there appears to be some latitude in ensuring their compliance with subdivisions.</li> </ul>	<ul style="list-style-type: none"> <li>· Changes in design standards e.g. ARR.</li> <li>· Lack of compliance with established design standards, both internally and externally.</li> <li>· Methodologies or standards presented by external parties that may not provide Council and the community with an optimal outcome.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>· Follow established best practice design standards.</li> <li>· Maintain ongoing professional development.</li> <li>· Regular peer reviews for consistent application of standards and audit all external designs.</li> </ul>	<ul style="list-style-type: none"> <li>· Regular review of industry and subdivision standards by Council.</li> </ul>
Subdivision or Development Guidelines	<ul style="list-style-type: none"> <li>· The Tasmanian Subdivision Guidelines for stormwater are very brief, allowing enormous latitude for external design consultants.</li> <li>· AusSpec documents are used as standard design and construction specifications.</li> </ul>	<ul style="list-style-type: none"> <li>· Submission of documentation for development applications incl. engineering drawings that require excessive checking by council not effective use of officer's time.</li> <li>· Lack of preparedness for council to challenge or take 'punitive / litigative' action against external parties does not encourage external professional checking before submission to Council.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>· Review current design standards and ensure compliance with current engineering and industry standards.</li> <li>· Consider adopting other Council Guidelines, even in part, for Subdivisions (even reviewing interstate guidelines).</li> </ul>	<ul style="list-style-type: none"> <li>· Consistent application of standards in assessment of development applications to create community confidence in council and improve standard of submitted documentation.</li> </ul>
Resources to Manage Infrastructure Assets	Meeting expected performance standards needs appropriate resources (time, money and personnel) committed to achieve those standards and intervene/remediate in a timely manner.	Gaps in resources and funding results in reduced service life and less than optimal system performance.	CCC	<ul style="list-style-type: none"> <li>· Asset management plan.</li> <li>· Service Levels.</li> <li>· Regular inspection and reporting on existing asset condition.</li> <li>· Protocol to update stormwater systems onto the GIS system.</li> <li>· Allocation of appropriate staffing levels (Stormwater Engineer).</li> </ul>	<ul style="list-style-type: none"> <li>· Establish relevant service level.</li> <li>· Establish regular inspection and reporting on existing asset condition.</li> <li>· Establish protocol to upload stormwater assets onto GIS.</li> </ul>

Risk, issue or opportunity	Discussion	Risk concerns	Responsible party	Mitigation Options	Potential Improvements
Climate Change	<ul style="list-style-type: none"> <li>Changes to rainfall patterns, intensities and storm frequencies are noticeable.</li> <li>Storm tide/surge and predicted sea level rise impacts require assessment and mitigation measures.</li> </ul>	<ul style="list-style-type: none"> <li>Current design standards do not reflect prevailing weather patterns.</li> <li>Existing older systems unable to cope.</li> <li>New system performance does not meet desired standard.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Apply agreed industry design standards and methodologies.</li> <li>Adapt promptly to new and innovative design concepts.</li> <li>Peer reviews.</li> <li>Monitor catchment response for localised issues.</li> </ul>	<ul style="list-style-type: none"> <li>Promptly document system performance and update systems and plans as required.</li> <li>Prioritise improvement work.</li> <li>Review current design AEP's against rainfall patterns and determine any changes to existing AEP's.</li> </ul>
Development within Catchments	<ul style="list-style-type: none"> <li>Added development increases system flows.</li> <li>Development may occur on land where streams, riverine flooding and overland flows pre-exist.</li> </ul>	<ul style="list-style-type: none"> <li>Existing system performance may be impacted or compromised.</li> <li>Localised flooding could result.</li> <li>Exposing new residents, property and infrastructure to unnecessary flood risk.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Individual catchment modelling required to understand impacts of the added development from site on surrounding (upstream and downstream) amenity.</li> <li>Thorough review of submitted designs to meet design criteria.</li> <li>Manage the development approval process.</li> </ul>	<ul style="list-style-type: none"> <li>Develop relevant policy documents.</li> <li>Review and establish the how, when and why detention and/or retention facilities are required.</li> <li>Include inundation / flood mapping in planning schemes.</li> <li>Develop appropriate inundation development controls.</li> </ul>
Water Sensitive Urban Design (WSUD)	<ul style="list-style-type: none"> <li>New development increases the risk of pollutant discharge.</li> <li>Necessary to maintain or improve the quality of receiving waters.</li> </ul>	<ul style="list-style-type: none"> <li>Pollutant discharge has an impact on the environment, aquatic life and health and safety.</li> </ul>	State Government and CCC	<ul style="list-style-type: none"> <li>Require pollutant assessments and WSUD measures in development approvals.</li> <li>Adopt or use the Tasmanian Water Sensitive Urban Design guidelines.</li> </ul>	<ul style="list-style-type: none"> <li>Set targets for water quality improvements in waterways and reduce the growth or 'unwanted' vegetation.</li> </ul>
Sea Level Rise	<ul style="list-style-type: none"> <li>This is linked to Climate Change.</li> <li>The impacts of sea level rise must be 'accommodated' in new developments, especially outfall structures, treatment structures etc.</li> </ul>	<ul style="list-style-type: none"> <li>Catchment hydraulics impacted.</li> <li>Outfall infrastructure performance impacted.</li> <li>Stormwater assets impacted.</li> </ul>	State Government and CCC	<ul style="list-style-type: none"> <li>Sea level rise is an external influence not controlled by Council.</li> <li>Tasmanian Planning Schemes do include relevant "coastal inundation" and other hazard overlays to guide assessment of potential risks.</li> <li>Hydraulic assessment modelling requires the</li> </ul>	<ul style="list-style-type: none"> <li>Continued awareness of this issue.</li> <li>Acceptance of the relevance and impact of sea level rise.</li> </ul>

Risk, issue or opportunity	Discussion	Risk concerns	Responsible party	Mitigation Options	Potential Improvements
				<ul style="list-style-type: none"> <li>inclusion of sea level rise impacts.</li> <li>To be reviewed as part of planned stormwater improvement works.</li> </ul>	
Riverine Flooding	<ul style="list-style-type: none"> <li>Councils have no management responsibility for River management.</li> <li>For the "Urban Area" primary areas of concern are the Leven River, Forth River, Penguin Creek, Sulphur Creek and Claytons Rivulet.</li> </ul>	Riverine flooding impacts on the function and operation of the municipality, especially areas abutting watercourses.	State Government	<ul style="list-style-type: none"> <li>Seek funding for flood modelling of the major waterways in the municipal area initially focussing on the Leven and Forth Rivers.</li> </ul>	<ul style="list-style-type: none"> <li>Continue engagement with State Government to better understand the flooding implications for the Leven River.</li> <li>Investigate flooding implications for Penguin Creek along with investigations of Sulphur Creek and Claytons Rivulet.</li> </ul>
Management of Natural Waterways	<ul style="list-style-type: none"> <li>Open waterways form the majority of major flow paths through Urban Areas.</li> <li>Require improvements and regular maintenance of waterways.</li> </ul>	<ul style="list-style-type: none"> <li>Blockages or impediments to flow from build-up of vegetation.</li> <li>Conflict between waterway hydraulics and enhancing natural waterway values.</li> <li>Degraded waterways.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Develop inspection plans to inspect operations and functions of waterways.</li> <li>Planning scheme protects waterways and requires permits for works (other than maintenance) in waterways.</li> <li>Review of natural values atlas to identify the areas of important natural values that requires protection.</li> </ul>	<ul style="list-style-type: none"> <li>Develop management plans and natural values for all waterways within the scope of Council's responsibilities.</li> </ul>
Landslide	<ul style="list-style-type: none"> <li>Some urban areas near Howth; Preservation Bay-Penguin; and Penguin-West Ulverstone are areas of known recent landslide activity.</li> <li>Other urban areas near Sulphur Creek; Penguin, Ulverstone; and Leith-Forth are areas have geotechnical susceptibility (potential for landslide).</li> </ul>	<ul style="list-style-type: none"> <li>Stormwater system become blocked as a result of landslide.</li> <li>Use of onsite 'wastewater' treatment systems can aggravate sub-surface geotechnical stability.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>The Central Coast Planning Scheme includes landslide hazard mapping showing areas of 'risk' requiring management in all phases of development, including stormwater management.</li> <li>Application of relevant planning controls required to mitigate impacts on stormwater.</li> <li>Identify the areas where stormwater infrastructure is missing.</li> </ul>	<ul style="list-style-type: none"> <li>Investigate the potential for landslide impacting on stormwater infrastructure.</li> </ul>



Risk, issue or opportunity	Discussion	Risk concerns	Responsible party	Mitigation Options	Potential Improvements
Infrastructure Gaps	<ul style="list-style-type: none"> <li>Need to determine if 'gaps' in the systems exist and how they should be managed.</li> </ul>	<ul style="list-style-type: none"> <li>Inter-allotment surface flows create potential inter-neighbour disagreements requiring Council to resolve.</li> <li>Surcharge flows in extreme events have the potential to cause property damage.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Identify infrastructure gaps and surcharge paths where concentrated or overland flows impacting downstream.</li> <li>Plumbing controls for new works.</li> </ul>	<ul style="list-style-type: none"> <li>Develop systems or protocol to address or resolve 'gap' issues.</li> </ul>
Connection to Stormwater Systems	<ul style="list-style-type: none"> <li>Can all the properties get connected to public Stormwater infrastructure.</li> </ul>	<ul style="list-style-type: none"> <li>Overland stormwater flows between neighbouring properties.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Consistently implement the '30 metre connection criteria', consider increasing the distance to 50m or 100m.</li> </ul>	<ul style="list-style-type: none"> <li>Develop a system or protocol to address or manage properties not connected to public infrastructure.</li> <li>Identify the properties that cannot connect to the network.</li> </ul>
Cross Connection of Infrastructure Types	<ul style="list-style-type: none"> <li>It is possible that the interconnection between stormwater and sewer exists.</li> </ul>	<ul style="list-style-type: none"> <li>Likely impact on the performance of the reticulated sewer network and sewer treatment plants.</li> <li>Health risks as a result of potential sewer spills.</li> </ul>	CCC/TasWater	<ul style="list-style-type: none"> <li>Work in collaboration with TasWater to reduce the number of illegal connections.</li> </ul>	<ul style="list-style-type: none"> <li>Prepare list or table of known 'illegal' connections and forward to TasWater.</li> </ul>
Condition of Existing System	<ul style="list-style-type: none"> <li>Asset performance is managed by having appropriate inspection/monitoring programs in place to optimise life cycle and replacement costs.</li> </ul>	<ul style="list-style-type: none"> <li>Asset life is not achieved.</li> <li>Cost to the community of replacing or upgrading infrastructure due to failure or reduced life.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Condition assessment is critical as system is 'out of sight' and CCTV assessment OR a percentage random annual inspection system is required to diagnose potential unknown issues.</li> <li>The Drainage AMP should detail management and condition inspection programs.</li> </ul>	<ul style="list-style-type: none"> <li>Establish a nominal budget for the regular monitoring and inspection of the stormwater system. Where possible modern and non-invasive methods should be utilised.</li> <li>Regular monitoring and inspection program (to include all stormwater assets)</li> </ul>
Urban Area Flood Mapping	<ul style="list-style-type: none"> <li>Flood mapping has only occurred for the Forth River system.</li> <li>Other riverine systems (Leven R; Penguin Ck; Sulphur Ck; Claytons Rivulet) would benefit from flood or hydraulic assessments.</li> </ul>	<ul style="list-style-type: none"> <li>Risk to life, property and community assets not known with the lack of modelling (reliant on anecdotal evidence or when an extreme event occurs).</li> <li>Known urban areas in Ulverstone, Turners Beach, Penguin and Sulphur Creek</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Known flood information included in the GIS system.</li> <li>A GIS 'layer' under Drainage for known or new 'hot spots' that cause disruption and inconvenience to the community would be a benefit.</li> </ul>	<ul style="list-style-type: none"> <li>Fund a high order flood modelling assessment of the Leven River.</li> <li>Fund lower order hydraulic assessments of Penguin Ck; Sulphur Ck and Claytons Rivulet.</li> <li>Establish a GIS 'layer' in Drainage for known and</li> </ul>

Risk, issue or opportunity	Discussion	Risk concerns	Responsible party	Mitigation Options	Potential Improvements
	<ul style="list-style-type: none"> <li>1% AEP envelope on GIS does not match the 2014 Entura Forth River results.</li> <li>2007 flood study of Buttons Creek not on GIS.</li> <li>Anomaly between 1% and 0.5% AEP flood mapping in Turners Beach.</li> </ul>	susceptible to inundation in extreme events e.g. 2011 and 2016 floods.		<ul style="list-style-type: none"> <li>Modelled flood results can be used as development controls to achieve optimal outcomes and prevent unnecessary risk to the residential, commercial and industrial community (people, property and assets).</li> </ul>	<ul style="list-style-type: none"> <li>new 'hot spots' for community benefit and for a council investigation and rectification program.</li> <li>Use flood modelling results to develop a set of development controls for future developments.</li> <li>Address anomaly in the flood mapping results in Turners Beach.</li> </ul>
Asset Service Areas	<ul style="list-style-type: none"> <li>There is no designated stormwater serviced land area as there is for water and sewer, only drainage catchments.</li> </ul>	There is no apparent alignment between drainage catchments and the possible/likely 'urban area'. This causes inconsistencies and possible community and/or developer confusion.	CCC	<ul style="list-style-type: none"> <li>Review land zonings and drainage catchments to create certainty and consistency.</li> <li>Consider the concept of a stormwater serviced area (similar to water and sewer).</li> <li>Update GIS after the above review of zonings and catchments.</li> <li>Some drainage catchments are missing from the GIS.</li> </ul>	<ul style="list-style-type: none"> <li>Update GIS after the review of zonings and drainage catchments.</li> <li>Include the missing drainage catchments on the GIS.</li> <li>Consider a stormwater service area policy.</li> </ul>
Water Quality	<ul style="list-style-type: none"> <li>The trunk drainage system consists of underground pipe networks, existing natural waterways and constructed open drains. This system conveys stormwater to the Bass Strait.</li> <li>Natural waterways change as part of the geomorphological process and development modifications.</li> <li>Remnant vegetation remains and other vegetation infestations grow as the result of pollutant runoff (silt, sediment, irrigation systems and fertilising residential land and public open spaces).</li> </ul>	<p>Poor or reduced water quality impacts natural systems, and the supporting flora and fauna is often lost.</p> <p>Impacts on aquatic life and human health.</p> <p>Also impacts on the passive use of natural waterway systems for recreation, increasing the need for irrigation.</p> <p>Degraded systems more likely to catch or retain litter and contaminants.</p>	CCC and State Government	<ul style="list-style-type: none"> <li>Any previous work to restore degraded sections of natural waterways?</li> <li>Some GPTs installed at outlets of known litter and contaminant trails.</li> <li>GPTs are not as effective at reducing suspended contaminant as previously expected.</li> <li>Flood studies use the natural topographical conditions in their analysis and are generally focussed on 'structural' or 'non-structural' solutions for flow or discharge management, rather than environmental benefit.</li> </ul>	<ul style="list-style-type: none"> <li>Develop a regular audit program of natural waterways to understand their conditions and to program necessary improvements.</li> <li>Consider the establishment of a water quality monitoring program, initially on a trial basis, with a commitment to a formal regular monitoring, assessment and water quality improvement program.</li> <li>Develop a stabilisation and improvement program for natural waterways, while</li> </ul>

Risk, issue or opportunity	Discussion	Risk concerns	Responsible party	Mitigation Options	Potential Improvements
	<ul style="list-style-type: none"> <li>Natural systems are also degraded as the result of constructed infrastructure.</li> </ul>			<ul style="list-style-type: none"> <li>The State Stormwater Strategy focuses on water quality and councils need to align their vision, mission and strategies to address water quality improvements as a priority.</li> </ul>	<ul style="list-style-type: none"> <li>concurrently maintaining the desired stormwater management and discharge function of these waterways.</li> <li>Investigate the impacts of where natural waterways crossroads and streets and improve the hydraulic efficiency of drainage structures.</li> <li>Adopt WSUD guidelines and ultimately prepare a Council specific guideline.</li> </ul>
Urban Area	<ul style="list-style-type: none"> <li>There is no real delineated/designated urban area/footprint in the municipality.</li> <li>No definition of 'urban area' in CCC Planning Scheme as it relates to the Act.</li> <li>A designated area will benefit growth projections, allow the development of relevant planning controls and create community spirit in the smaller coastal communities.</li> </ul>	<ul style="list-style-type: none"> <li>Urban development proposals outside of current 'preferred' urban areas creates unnecessary costs for infrastructure by Council.</li> <li>Inappropriate development sets precedents that could be difficult to defend.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Limit conventional residential development to current zoned areas or areas that are close to existing serviced infrastructure where the developer funds infrastructure connection.</li> </ul>	<ul style="list-style-type: none"> <li>Investigate the correlation between 'Urban Area' as defined under the Act compared with 'General Residential Zone' under the planning scheme.</li> </ul>
Network Hydraulic Model	<ul style="list-style-type: none"> <li>Development of an overall network hydraulic model assists in future planning and supports the decision-making process for future new developments or changes to existing development.</li> </ul>	<ul style="list-style-type: none"> <li>Current lack of base data flood information available in the review and assessment of development applications.</li> <li>Some development designs do not adequately address the flooding impacts beyond the development both upstream and downstream.</li> </ul>	State Government and CCC	<ul style="list-style-type: none"> <li>Older flood modelling or hydraulic assessment has occurred for some waterway systems.</li> <li>Further flood or hydraulic assessments need completing to understand the impacts and risk from flooding.</li> </ul>	<ul style="list-style-type: none"> <li>Existing residential areas are protected in the event of an extreme event.</li> <li>Appropriate planning assessments can be completed with a higher confidence to mitigate risk.</li> </ul>
Retention and/or Detention Code or Policy	<ul style="list-style-type: none"> <li>Development generally increases the volume of runoff from a site due to an increased impervious area.</li> <li>The volume of flow in an extreme event cannot be</li> </ul>	<ul style="list-style-type: none"> <li>Increases the risk of flooding to abutting downstream and upstream properties.</li> <li>Limited guidance for developers or consultants.</li> </ul>	CCC	<ul style="list-style-type: none"> <li>Prepare a council specific retention / detention code or policy or guideline.</li> </ul>	<ul style="list-style-type: none"> <li>Initially adopt an approach based on limiting stormwater discharge to the equivalent rate based on either the allowable impervious area under</li> </ul>

Risk, issue or opportunity	Discussion	Risk concerns	Responsible party	Mitigation Options	Potential Improvements
	<p>contained within the underground system.</p> <p>Either onsite, or outside of site, capacity must be provided to temporarily store the excess volume of runoff.</p>				<p>the planning scheme or impervious area assumed in the stormwater network, whichever is the lesser discharge rate.</p> <p>Regular review of Retention / Detention guidelines.</p>

### 7.3 CATCHMENTS

Within the urban area there are a number of discrete catchments that can be identified from a stormwater management perspective.

In essence each of the catchments are self-contained stormwater systems, that can be defined by geographic features, generally ridge lines and valleys, as noted in *Section 5* and illustrated on the plans attached as *Appendix B*.

In this section we discuss more fully how the risk of flooding is managed, or proposed to be managed in each of the catchments, and actions required to be progressed to mitigate flood risk. *Table 7.3* below details the various urban catchments and their issues, limitations and potential improvements.

Flood in the context of the catchment will consider:

- . Stream flooding: individual catchments.
- . Overland flows.
- . Localised flooding.

**Table 7.3 Urban Catchments and their Flood Issues, Infrastructure Limitations and Potential Improvements.**

<b>Catchment</b>	<b>Description</b>	<b>Flood Study or Hydraulic Assessment</b>	<b>Flooding issues</b>	<b>Infrastructure and Infrastructure Limitations</b>	<b>Potential Improvements</b>
Turners Beach North (TBN A to F)	Catchment 0.60km <sup>2</sup> . Fully piped network. Claytons Rivulet to the west.	No flood study completed. No present need for study. Outfalls to Forth River, Bass Strait and Claytons Rivulet.	Localised flooding at western end and in the central to eastern end.	West end – impacts from Claytons Rivulet. East end – impacts from Forth River. Existing detention system at the western end of Turners Avenue.	Documentation of known issues. Identify Service Levels.
Turners Beach South (TBS G to M)	Catchment 0.77km <sup>2</sup> . Fully piped network. Claytons Rivulet to the west.	No flood study completed. No present need for study. Outlets to Claytons Rivulet and Forth River floodplain.	Claytons Rivulet overtops Westella Dr and Bass Hwy in extreme events. Inundation into floodplain on west side of Forth River.	TasWater sewer treatment ponds at risk of inundation. Investigation into Claytons rivulet crossing of Westella Dr and Bass Hwy warranted.	Overtopping requires documentation. Investigate the option for detention storage upstream of Bass Highway. Identify Service Levels.
Leith (LE A to C)	Catchment 0.34 km <sup>2</sup> . Some piped network.	No flood study completed. No present need for study. Outlets to Forth River.	No specific flooding issues identified in this small catchment.	No known infrastructure issues in catchment.	Maintenance of outfall near Allport street West. Identify Service Levels.
Forth East (FO E)	Catchment 0.19 km <sup>2</sup> . Small pipe network.	Forth River flood study 2014. Outfalls to Forth River.	Inundation into floodplain on the eastern side of the river. Considerable commercial impacts.	Existing levee systems are estimated to be overtopped in the 1% AEP event on both sides of river.	Consider whether some of the 2014 report recommendations have economic benefit and can be justified through a BCR process. Identify Service Levels.
Forth West (FO W)	Catchment 0.22 km <sup>2</sup> . More extensive piped network than east side.	Forth River flood study 2014. Outfalls to Forth River.	Inundation into floodplain on the western side of the river. Some residential impact and extensive commercial impacts on this side.	Existing levee systems are estimated to be overtopped in the 1% AEP event on both sides of river.	Consider whether some of the 2014 report recommendations have economic benefit and can be justified through a BCR process. Identify Service Levels.
Ulverstone East - Buttons Creek (ULV I to N, Q, R and ULV MM)	Catchment 3.33km <sup>2</sup> . Fully piped network. Buttons Creek waterway.	2007 HECRAS assessment of Buttons Creek. Needs updating. Outfalls to Bass Strait	Isolated flooding issues. Fairway Park and outfall through park to Bass Strait.	Some inundation into the end of Smith Street; the open area off McCulloch Street (and the impacts on 14 Cornelia St); impacting 26 & 28 Parsons Street; surcharge issues along Beach Road north of the industrial area; possible vegetation blockages at Alexander Rd crossing of Buttons Ck.	Review of 2007 HECRAS assessment to confirm the impacts from the 1% AEP event. Identify Service Levels.
Ulverstone Central – Leven/Gawler Rivers. (ULV H, O, P, S, new U, new W, X)	Catchment 3.26km <sup>2</sup> . Fully piped network. Leven and Gawler Rivers and Masons Creek waterway.	No flood study completed. Outfalls to Leven and Gawler Rivers.	Localised flooding issues. In Shropshire Park and south end of Ulverstone High School.	No specific issues noted, but hydraulic assessment will provide level of confidence and establish community guidance and development flood controls.	Documentation of known issues. Flood study strongly recommended for Leven and Gawler River system. Installation of two rainfall and river gauging stations recommended on Leven River. Identify Service Levels.

Catchment	Description	Flood Study or Hydraulic Assessment	Flooding issues	Infrastructure and Infrastructure Limitations	Potential Improvements
Ulverstone West – Leven River. (ULV A to E, AA, BB and ULV DD)	Catchment 3.62km <sup>2</sup> . Fully piped network. Unnamed waterways. Leven River.	No flood study completed. Outfalls to Leven River and Bass Strait.	Localised flooding issues along Josephine Street; perceived issues south off Westland Drive; and some outfalls block regularly.	Outfalls from Maud and Bertha Streets suffer from consistent blockage at outlet causing localised flooding issues upstream. Outfall from Amy and Josephine Streets are also an issue.	Regular inspection and maintenance of Maud and Bertha Street outfalls. Flood study strongly recommended for Leven and Gawler River system. Installation of two rainfall and river gauging stations recommended on Leven River. Possibly extend Bertha Street outfall to prevent sand and silt blockage. Identify Service Levels.
Penguin South – Myrtle Creek. (PEN G to M)	Catchment 3.63km <sup>2</sup> . Some piped network. Myrtle Creek waterway.	No flood study completed. Outfalls to east into the Leven River.	Localised flooding through Golf Course and U/S of the Dial Rd culvert.	No specific issues noted.	Documentation of known issues. Hydraulic assessment recommended for Penguin Creek. Check the capacity for the culvert. Identify Service Levels.
Penguin North – Penguin Creek, Deviation Creek (PEN A to F)	Catchment 2.41km <sup>2</sup> . Piped network. Penguin Creek waterway.	No flood study completed. Outfalls to Bass Strait.	Extensive flooding of properties – Crescent St; Hayward St; Killara Ave; Carroo Ct; Howe Lane. Coroneagh Park Aged Person Facility at risk of inundation.	Playground facilities and carpark in Hiscott Park inundated. Sections of Hayward St; Killara Ave; Carroo Ct and Howe Lane inundated. Culvert under Main Road.	Documentation of known issues. Hydraulic assessment recommended for Penguin Creek. Investigation of possible detention storage upstream (just south of Bass Hwy or upstream of Bass Hwy). Investigation of culvert capacity under Main Road warranted, and possible vegetation blockage in waterway may need clearing. Identify Service Levels.
Preservation Bay (PB 1)	Catchment 0.05km <sup>2</sup> . Small piped network. Small unnamed waterways.	No flood study completed. No present need for study. Outlets to Bass Strait.	No specific flooding issues identified in this catchment.	No specific issues noted.	Documentation of known issues. Identify Service Levels.
Sulphur Creek East – Sulphur Creek (SC G to K)	Catchment 0.43km <sup>2</sup> . Piped network. Sulphur Creek waterway.	Flood study completed in 2003 as a part of a development application. Outfalls to Bass Strait.	System discharging just west of Sulphur Creek Point an issue. No apparent evidence of inundation in 2011 and 2016 on properties both sides of Sulphur Creek. Needs to be 'modelled' to have no or low risk to property to support known or anecdotal evidence. Need to confirm no flood risk	No known infrastructure issues in catchment.	Documentation of known issues. Vegetation clearing of waterway may be warranted (between Preservation Dr and Bass Hwy). Investigation of possible detention storage upstream of Bass Hwy warranted. Concern about the restricted waterway channel to cater for the 1% AEP event. Further hydraulic assessment recommended for Sulphur Creek.

Catchment	Description	Flood Study or Hydraulic Assessment	Flooding issues	Infrastructure and Infrastructure Limitations	Potential Improvements
			to properties at 250 and 254 Preservation Drive.		Identify Service Levels.
Sulphur Creek West – Ellis Creek (SC A to F)	Catchment 0.33km <sup>2</sup> . Piped network. Ellis Creek waterway.	No flood study completed. No present need for study. Outlets to Bass Strait.	No specific flooding issues identified in this catchment.	No specific issues noted.	Identify Service Levels.
Heybridge East – Lings Creek (HB F to H)	Catchment 0.23km <sup>2</sup> . Small piped networks. Lings Creek waterway.	No flood study completed. No present need for study. Outlets to Bass Strait.	No specific flooding issues identified in this catchment.	No specific issues noted.	Identify Service Levels.
Heybridge West – Cuprona Rd (HB A to E)	Catchment 0.31km <sup>2</sup> . Piped network. Unnamed small waterways.	No flood study completed. No present need for study. Outlets to Blythe River.	Localised surcharge issues in Cuprona Rd. No other specific flooding issues identified in this catchment.	No specific flooding issues identified in this catchment.	Documentation of known issues. Identify Service Levels.



## **7.4 RISK ASSESSMENT**

The preceding sections have provided an understanding of what we know about the Central Coast stormwater systems, identified potential actions and undertakings to address community risk, improve system performance and support improved environmental outcomes.

Broadly actions identified can be grouped under the following headings:

- . Operational management and management improvements.
- . Flooding including hotspot management.
- . Development impacts.
- . Environmental management.

A focus of the SSMP is risk management and understanding the relative risk of the issues and impact of the implementation of the proposed action/s will aid in prioritising actions and projects.

A basic risk assessment applying Council's risk management framework was undertaken and is included as **Table 7.4** below.

The framework notes seven risk categories. For the purpose of this exercise there is a focus on the assets and infrastructure, and public safety categories but this is not to suggest that the other risk categories are less important or relevant. Generally, there will be alignment across many of the risk categories in respect to risk scoring. The risk assessment has been applied to the matters raised above, which would have apparent risk implications if not managed.

The output from the risk assessment will be included in the corporate risk register, and the risk rating used to assign a priority to projects listed in the action plan.

**Table 7.4 Risk Assessment**

Risk Assessment											
Risk Category	Responsible Officer	Risk Issue	Consequence	Inherent Assessment			Treatment	Residual Risk after Treatment			Notes
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk	
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Management and design processes do not reflect current practice.	Service level expectations not met. Required infrastructure capacity for new and upgrade work not to an appropriate standard.	Possible	Minor	Moderate	Staff training, periodic review of design process and policies.	Unlikely	Minor	Low	Service levels for stormwater need to be more comprehensive than based on community surveys only.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Development impacts on existing system performance.	System capacity issues. New incidences of local flooding. Damage to infrastructure.	Possible	Minor	Moderate	Develop a policy to guide system management for new subdivisions, e.g. detention/retention, augmentation, upgrades etc. and the impact on the capacity on downstream smaller systems.	Unlikely	Minor	Low	System capacity issues occur in existing systems designed/built to older standards OR when new upstream systems are designed/built to current standards and connect to a smaller sized downstream system.
Public Safety / Assets and Infrastructure	Director Infrastructure Services and Director Community Services	Development within areas of inundation.	Flood impact on new properties. Insurance claims and possible claims against Council.	Possible	Moderate	Moderate	Development controls and associated flood hazard maps in scheme that provide accurate and specific guidelines on encroachment into known or likely inundation areas.	Unlikely	Minor	Low	Current 1% and 0.5% AEP (1 in 100 year and 1 in 200-year ARI) layers on the GIS do not reflect the outcomes of the 2014 Entura Forth River Flood Report. Older flood assessment reports for Buttons Creek (August 2007) and Sulphur Creek (April 2003) have not been added to the GIS to cover potential development in those areas.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Waterway / flora and fauna health impacts due to use as drainage systems	Eco system is damaged. Poor water quality. Likely community complaint about the aesthetic of the waterways. Potential impact on use of recreational waters.	Likely	Moderate	High	Develop waterway management plans that recognise the integrated nature or balance of drainage systems and natural waterway ecology.	Unlikely to Possible	Minor	Low to Moderate	Environmental issues need to take a higher priority when a joint use as a drainage flow path and natural waterway occurs.

Public Safety / Assets and Infrastructure	Director Infrastructure Services	Cross connections between sewer and stormwater create public health issues	Stormwater impacts on operation of the sewerage. Sewage enters waterways and impact on water quality	Likely	Minor	Moderate	Work with TasWater. Provide details of past investigations to support TasWater. Infill drainage works as per gap analysis.	Possible	Minor	Moderate	Future works programs could address this over time. Where these connections occur illegally, Council should pursue to disconnection themselves after advice to the owner.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Service area maps do not reflect infrastructure provision	Not all the properties are provided with Stormwater connection	Possible	Minor	Moderate	Create a Service area map	Unlikely	Minor	Low	Central Coast does not have stormwater service areas, although a Drainage Catchment Area layer is included on the GIS under 'Waterways'.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Hot spot management and identification	Inattention to hotspots will result in localised flooding and potential damage to infrastructure	Possible	Minor to Moderate	Moderate	Identify and document hot spot flooding areas. Establish maintenance regimes to monitor and upgrade as required to maintain low or no flood risk.	Unlikely	Minor	Low	Monitor 'hot spot' list, update and provide report to Director Infrastructure Services annually.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Forth River flooding	Properties and commercial operations along Forth River are inundated. Consequential loss and damage, social and environmental impacts. Some council infrastructure at risk of inundation. Probable health and safety issues and consequences.	Possible	Major	High	GIS layers are not consistent with the results of the 2014 Entura Forth River flood Study. Update 1% and 0.5% AEP (1 in 100 year and 1 in 200-year ARI) layers for Forth River on the GIS. Reconsider some of the recommendations of the 2014 Entura Forth River Flood Study.	Unlikely	Moderate	Moderate	Latest flood extents provide council, consultants, developers and the community the most accurate information available.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Leven River flooding	Properties in West Ulverstone may be at risk of flooding. Probable consequential loss and damage	Possible	Minor to Moderate	Moderate	Seek funding from State Government for a flood study on the Leven River. Engage consultants to complete the flood study and consider the recommendations for implementation.	Unlikely	Minor	Low	This study will provide good development controls for new development or re-development abutting the river and provide guidance to developers and consultants. Risk not likely to reduce until flood report received and recommendations can be considered. The risk and likelihood shown in the adjacent columns represent the predictions after any recommendations are implemented.

Public Safety / Assets and Infrastructure	Director Infrastructure Services	Penguin Creek flooding	Properties and commercial operations abutting Penguin Creek (Bass Highway to coast) are inundated. Consequential loss and damage, social and environmental impacts. Some council playground infrastructure at risk of inundation.	Possible	Moderate to Major	Moderate to High	Seek advice from State Government on flood study for Penguin Creek. Engage consultants to complete the flood study and consider the recommendations for implementation.	Unlikely	Minor to Moderate	Low to Moderate	2D modelling software required.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Claytons Rivulet flooding	Properties and council infrastructure are inundated. Consequential loss and damage, social and environmental impacts.	Possible	Moderate	Moderate	Implement a flood study for Claytons Rivulet catchment using current IFD and rainfall data and current modelling methods.	Unlikely	Minor	Low	Risk not likely to reduce until flood report received and recommendations can be considered. The risk and likelihood shown in the adjacent columns represent the predictions after any recommendations are implemented.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Sulphur Creek flooding	Potential impacts on properties abutting Sulphur Creek. Probable risk of loss and damage. Known instances of flooding due to surcharge flows.	Possible	Minor to Moderate	Moderate	Implement a flood study for Sulphur Creek catchment using current IFD and rainfall data and current modelling methods.	Unlikely	Minor	Low	An August 2003 Sulphur Creek Subdivision Hydraulic Report by Pitt & Sherry using HECRAS generated Flood Study limits (SUB2002.31). Risk not likely to reduce until flood report received and recommendations can be considered. The risk and likelihood shown in the adjacent columns represent the predictions after any recommendations are implemented.
Public Safety / Assets and Infrastructure	Director Infrastructure Services	Buttons Creek flooding	Potential impacts on some properties.	Possible	Minor	Moderate	Update the 2007 study using current IFD and rainfall data and modelling methods.	Unlikely	Minor	Low	A May 2007 Flood Hazard Report by Pitt & Sherry produced flood limits using a HECRAS analysis (D9524/D06225d2003). Upload the 2007 study flood limits onto the GIS as an interim flood layer, pending a future flooding review.

Public Safety / Assets and Infrastructure	Director Community Services	Lack of environmental protection to natural waterway systems	Crown land or riparian buffers are not established along waterways to allow for the natural geomorphological movement of river systems.	Almost certain	Moderate to Major	High to Very High	Ensure the requirements of E10 Water and Waterways Code is achieved in both intentional and practical terms. The use of "stormwater reserves" where natural freshwater waterways pass through a development footprint, or where a development abuts a natural waterway, should be given strong consideration, with a lawful point of access from both ends of the "reserve". Optionally, "easements" in the rear of lots where they abut waterways (freshwater or saline) could be considered with appropriate easement documents and lawful access rights for Council to enter and maintain waterways, as necessary. These "easements" would be designated 'non-developable' zones on the lot.	Possible	Minor	Moderate	Central Coast Interim Planning Scheme in the Water and Waterways Code Section E10.2 and E10.6 specifies the application and development standards for development use abutting a waterway. There appear to be anecdotal evidence that (1) this 'use free' zone is sometimes not provided by developers and (2) if it is, there is no lawful point of access provided to such a "buffer". The importance of crown land or "residential free use land" abutting waterways is critical to the natural riverine process and to provide appropriate environmental and erosion buffers. Where developed land lots immediately abut the waterway, often landowners 'denude' the riverine vegetation which puts the bank at risk of erosion and impacts the balance of aquatic life.
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## 8. IDENTIFICATION OF STRATEGIES AND OUTCOMES

Within the Council there is a mature understanding of stormwater asset management, design, construction and operational management. This is supported by appropriate operational resources and funding.

The Council in recent years have been focused on understanding the source of a number of flood incidents that have occurred and identifying opportunities to mitigate the extent and impact of flooding.

This is evidenced in the flood mitigation works identified for implementation and those already completed.

As noted in the preceding sections, further work is required in this space.

Through the discussion and risk assessments in *Section 7* above, various specific actions were identified related to works implementation, flood studies and the like, with a more strategic focus.

Matters related to improvements to internal processes, information capture and communication were also noted, and in most instances existing administrative arrangements will allow these matters to be addressed over time, as noted in the discussion section.

An Action Plan has been prepared to capture those specific tasks that will require focus and resource.

It is suggested that overall priorities for management of the urban stormwater systems are (in order of importance).

- 1 Quantifying flood risk in all urban catchments.
- 2 Identifying and implementing flood mitigations strategies.
- 3 Communicating / educating the community.
- 4 Systems and process improvements and knowledge capture management regimes.
- 5 Waterway environment and water quality.

It is acknowledged that others may consider that waterway environment and water quality are important matters for the Council to consider and on which to focus its efforts. However, from a broad community perspective protection of people and property from flood risk, which has the potential to be managed or mitigated, is the priority focus area for the Council at this point in time.

Future iterations of the SSMP will focus on waterway environment and water quality improvements.

### 8.1 ACTION PLAN

The Action Plan noted below in *Table 8.1* documents the key matters which the Council wishes to address within the life of this plan.

**Table 8.1 Action Plan**

Action/Strategy	Scope	Benefit	Priority	Cost	Funding Source	Timeline	Responsibility
Modelling of Urban Catchments.	Importation of drainage network data including some survey of existing infrastructure where required.	Knowledge of the pipe network, capacity issues and hotspot areas	High	Staff time only	CCC	2020-2021 FY	CCC
Add the results of the Buttons Creek Flood Hazard Report 2007 and the Sulphur Creek Flood Study 2003 to the Flood layer in GIS.	Add the flood extents for Buttons Creek and Sulphur Creek to the GIS as interim flood extents.	Improved understanding of flood risk in both creek systems. Part of a total flood map for the municipal area.	High	Staff time only	CCC	2020-2021 FY	CCC
Update 1% AEP (1 in 100-year ARI) layers on the GIS.	Replace existing flood extents on GIS with updated information from the 2020 Entura study.	Accurate and current information Community knowledge.	Low	Staff time only	CCC	2020-2021 FY	CCC
Flood study of Claytons Rivulet.	Identify extent of flooding, properties at risk and mitigation strategies.	Understand the extent of flooding in Turners Beach west Part of a total flood map for the municipal area.	High	Estimated \$60,000 (External) Some staff time	CCC	2021-2022 FY	CCC – primary role
Develop a retention/detention service level.	Work to develop or adopt a retention and detention basin policy for use by internal and external parties.	Guidance for developers and consultants where these infrastructure assets are required.	High	By adopting the ARRB "Guide to Road Design Part 5A" in the interim. Significant staff time.	CCC	2021-2022 FY	CCC
Develop a Water Sensitive Urban Design (WSUD) guideline.	Work to develop or adopt a water sensitive urban design policy for use by internal and external parties.	Guidance for developers and consultants where these infrastructure assets are required. Protection of natural waterways and water bodies against pollutant load discharge.	High	By adopting the Tasmanian WSUD document in the interim cost is minimal. Preparing a specific CCC document estimated at \$15,000.	CCC	2021-2022 FY	CCC
Develop management plans for an integrated approach for the common use of 'open space' land as both a drainage system and a natural waterway.	Work to develop a policy for 'open space' areas were joint use as a drainage path and natural waterway system occurs.	Guidance for Council staff, the community and developers. Provides environmental protection for natural waterway systems.	Medium	Some staff time	CCC	2022-2023 FY	CCC

Action/Strategy	Scope	Benefit	Priority	Cost	Funding Source	Timeline	Responsibility
Establish annual monitoring and updating of 'hot spot' log and report to Director Infrastructure Services annually.	Include known 'hot spots' in a monitor log and add new sites and issues as they are found. Report to Director.	For use in prioritising improvement works to reduce risk to community.	Medium	Some staff time	CCC	Ongoing	CCC
Installation of two rainfall recording/river gauging stations in the Leven River catchment.	<ul style="list-style-type: none"> <li>Install two rainfall recording/river gauging stations on the Leven River.</li> <li>May work in collaboration with BOM and State Government.</li> </ul>	Used for reporting rainfall in catchment and provide alerts to downstream urban areas in an extreme event.	Medium	Estimated \$30,000	CCC and DSG and BOM	2022-2023 FY	CCC in partnership with BOM and State Government.
Comprehensive flood study of the Leven River catchment (including all tributaries).	<ul style="list-style-type: none"> <li>Understand the extent and impacts of flooding in the Leven River.</li> <li>May work in collaboration with BOM and State Government.</li> </ul>	Community preparedness. Warning of potential flooding Part of a total flood map for the municipal area.	Medium	Estimated \$100,000 (External) Significant staff time.	CCC and DSG	2022-2023 FY	CCC in partnership with State Government
Flood study of Penguin Creek.	<ul style="list-style-type: none"> <li>Understand the extent and impacts of flooding in Penguin Creek.</li> <li>May work in collaboration with BOM and State Government.</li> </ul>	Community preparedness. Warning of potential flooding Part of a total flood map for the municipal area. Develop mitigation strategies for impacted areas.	Medium	Estimated \$60,000 (External) Some staff time.	CCC with possible DSG assistance	2022-2023 FY	CCC – primary role (consider Government grant)
Flood study of Sulphur Creek.	Identify extent of flooding, properties at risk and mitigation strategies. <ul style="list-style-type: none"> <li>May work in collaboration with BOM and State Government.</li> </ul>	Understand the extent of flooding in Sulphur Creek. Part of a total flood map for the municipal area.	Medium	Estimated \$40,000 (External) Some staff time	CCC	2022-2023 FY	CCC – primary role (consider Government grant)
Consistently use the provisions of E10 Water and Waterways Code, supported by changes to include/adopt "reserves" and/or "easements", and require the provision of lawful points of access to these 'buffer' zones.	Work to apply consistency in assessing developments abutting waterways and provide accessible 'buffer' areas of public benefit and for environmental protection.	Protect the banks and riverine areas abutting waterways against erosion and vegetation clearing.	Medium	Staff time only.	CCC	2022-2023 FY	CCC
Need to develop a Levels of Service for Stormwater/Drainage infrastructure within Central Coast.	Work to improve and clarify the standard for providing an effective and efficient stormwater network.	Identify parts of the network system requiring replacement or augmentation.	Low	Staff time only	CCC	2023-2024 FY	CCC
Establish a protocol or policy to condition a contribution from upstream developers where their development will have a hydraulic impact on	Work to establish a protocol and contribution system where development sites could cause flooding on upstream and downstream properties/land.	Guidance to developers and consultants. Protection to existing residential amenity.	Low	Staff time only	CCC	2023-2024 FY	CCC



Action/Strategy	Scope	Benefit	Priority	Cost	Funding Source	Timeline	Responsibility
the existing downstream system.		Reduces imposition on Council to fund or install stormwater systems to resolve post development issues.					
Regular annual update of 'Drainage Line' and 'Drainage Catchment Area' layers on GIS.	Add new stormwater systems to the GIS annually.	Up to date and accurate stormwater network in Council records.	Low	Staff time only	CCC	Ongoing	CCC
Flood study of Buttons Creek.	Identify extent of flooding, properties at risk and mitigation strategies.	Understand the extent of flooding in Buttons Creek. Part of a total flood map for the municipal area.	Low	Estimated at \$40,000 (External) Some staff time	CCC	2023-2024 FY	CCC – primary role (consider Government grant)
Establish a log of "illegal" connections and update Council and TasWater as CCC is notified.	Collate and report on "illegal" connections to Council and TasWater.	Reduce contamination in the stormwater network. Reduce water load in sewage treatment plant.	Very low	Staff time only	CCC	Ongoing	CCC in partnership with TasWater

## 8.2 Specific System and Process Improvements

Specific system and process improvements noted for action are shown in **Table 8.2** below:

**Table 8.2 Specific System and Process Improvements**

Specific system and process improvements noted for action are:

Systems and Processes	Benefits	Responsibility	Timeline
Review ARI/AEP set for storm events against the catchment responses and climate change impacts. Determine if new design criteria are required and if so adopt.	Design of new systems and existing system upgrades cater for expected storm flows. Mitigate over time instances of localised flooding associated with higher intensity storm events.	Infrastructure Services	2020-2021 FY
Ensure consistency and currency of information on council systems	Useful reference for staff. Useful reference for developers and community	Infrastructure Services incl. GIS	2020-2021 FY Ongoing
Consolidate flood information in one location/map.	Knowledge is available across Council. Support the development of planning scheme hazard maps. Useful for development applications	Infrastructure Services incl. GIS	2020-2021 FY Ongoing
Develop a Stormwater detention/retention policy	Provide clear guidance on the use of such infrastructure, design, construction, and maintenance criteria and responsibilities.	Infrastructure Services	2021-2022 FY
Develop a Water Sensitive Urban Design (WSUD) document	Provides guidance on the purpose, need, design, construction and maintenance responsibilities.	Infrastructure Services	2021-2022 FY
Develop a Stormwater Service Area map series. Review current stormwater catchment layer on GIS and align with the current and future capacity to service.	Provide a clear connection between existing stormwater network and expansion capability. Could provide a basis to establish a stormwater change regime.	Infrastructure Services	2021-2022 FY Ongoing
Develop a Level of Service document for Stormwater Infrastructure	Sets a standard for council to achieve. Sets a benchmark for the community to understand	Infrastructure Services	2023-2024 FY
Develop and maintain a register of flooding hot spots and add new sites/issues as they become obvious.	Manage known localised flooding risk areas. Identify issues where assessment is required and inclusion in future works programs. Data to be included in a GIS flood layer. Useful reference for staff and information for community.	Infrastructure Services	Ongoing

<b>Systems and Processes</b>	<b>Benefits</b>	<b>Responsibility</b>	<b>Timeline</b>
Ensure appropriate management processes are in place to guide work in waterways, and to limit impact on the natural environment.	Preserve the integrity and amenity in existing natural waterways. Will provide guidance, education and training for staff, developers and contractors working in waterways.	Infrastructure Services	Ongoing
"Gaps" in stormwater network are noted for capture and rectification in forward works programs.	Improvement works are identified, costed and prioritised for future works. Progressively resolves areas where no current ability to connect to the stormwater network.	Infrastructure Services	Ongoing
Maintain a "Council Map" for stormwater	Comply with Section 208 of the Local Government Act 1993 and Section 12 of the Urban Drainage Act 2013.	Infrastructure Services	Ongoing
Review 'buffer' zones abutting natural waterways. Consistently apply established distances. Consider increasing width of 'buffer' zones to protect banks and property.	Maintain accessible public natural habitat zones along waterways. Protection against bank erosion. Minimise erosion of private property.	Infrastructure Services and Community Services (Planning)	Ongoing
Consider the use of and requirement for either 'easements' or 'reserves' containing natural waterways ('reserves' preferred).	Provides accessible 'public' or 'crown' areas to allow maintenance and improvements to waterways. Prevents/restricts private ownership abutting natural waterways	Infrastructure Services and Community Services (Planning)	Ongoing

## **9. COSTS, BENEFITS AND FUNDING ARRANGEMENTS**

The Action Plan has broadly identified cost, benefit and funding opportunities to address those projects and strategies. Such an approach assists in broadly identify priorities.

For the majority of project's and strategies there is a need to source funding, either via the Council's capital works program or externally through grants or other agencies.

In seeking such funding there is generally a need for a more detailed assessment of "Cost and Benefit" to enable a projects viability to be proved up.

The more detailed assessment may include

- . Preliminary design and project costing.
- . Cost benefit analysis.
- . Risk assessment.

## **10. PRIORITIES AND TIMEFRAMES**

Project priorities are noted on the action plan. The priority has been assigned generally through consideration of Risk exposure either to Council or more directly to the community, at a local or broader level.

Timeframes will adjust over time depending upon budget allocations and review of project priorities and in response to unforeseen circumstances.

## **11. RESPONSIBILITIES**

The Council has primary responsibility for managing stormwater in the urban area.

The river environments and coastal beach strip are managed by the State Government. Works in those environments, related to stormwater assets, requires approval from the respective Government Agencies.

Understanding the impacts of riverine flooding is a joint responsibility of the State Government and Council, however, the role for the Council is understanding the extent of risk and working with stakeholders to mitigate the risk or ensuring persons at risk are aware of the potential for inundation.

### **11.1 COMMUNICATION AND CONSULTATION**

The purpose of this plan is to provide the community and Council staff with an understanding of the Urban stormwater system, how it is managed, current issues and risks which may need to be addressed and a plan of action to address such issues and risks, on a priority basis.

The plan informs decisions in regard to the allocation of resources within Council and supports potential applications for external funding to address identified issues.

Planned communication and consultation actions include:

**Table 11.1 Communication Strategy**

<b>Action</b>	<b>Responsibility</b>	<b>Timeline</b>
Where appropriate make available information on the extent of flood impacts, advice on flood preparedness and plan mitigation actions.	Infrastructure Services	Ongoing
Develop a page on the Council website to provide information on stormwater, stormwater management, flooding and flood preparedness and water quality issues.  Include a link to the Interim Planning Scheme hazard and flood mapping.	Infrastructure Services	Adoption of SSMP
Publish the Stormwater System Management Plan on Council's website.	Infrastructure Services	Adoption of SSMP

## **12. REVIEW OF THE STORMWATER SYSTEM MANAGEMENT PLANS**

This initial Stormwater System Management plan is the first iteration of such a document.

The plan is underpinned by a range of other documents as noted throughout this document.

To implement the actions noted within the plan will require a number of budget cycles.

The planned review cycle for this plan is 3 years.

## APPENDIX A – URBAN AREAS

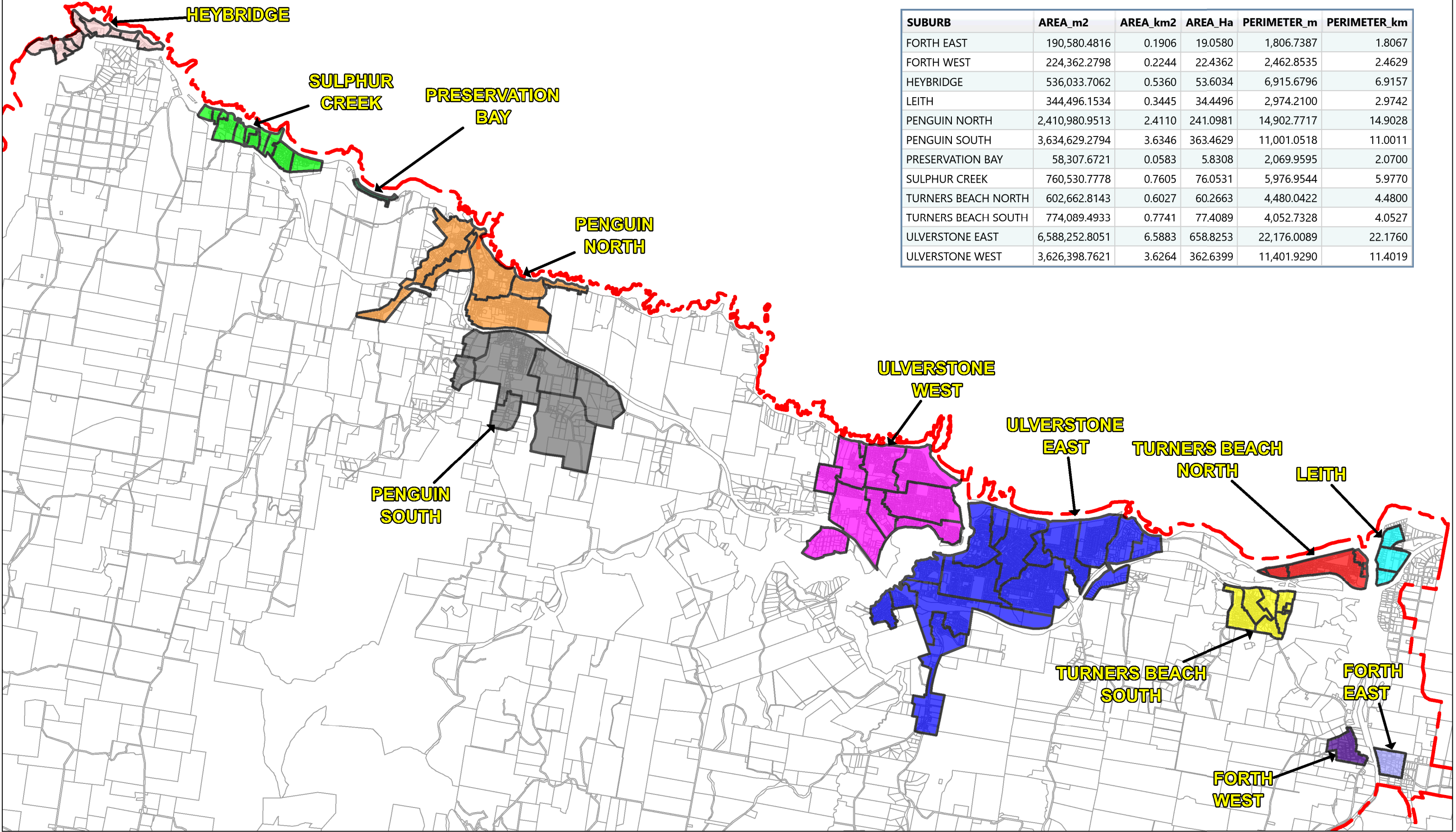
Attach the several individual Urban Area maps

- . Ulverstone
- . Penguin
- . Turners Beach and Leith (with Forth as a possible insert)
- . Sulphur Creek (with Preservation Bay as an insert)
- . Heybridge

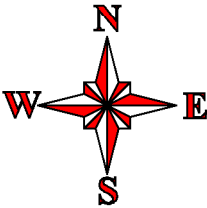
## APPENDIX B – URBAN CATCHMENTS

Attach the several individual Urban Catchment maps

- . Ulverstone (East, Central and West)
- . Penguin (East, South, and West)
- . Turners Beach (North and South) and Leith
- . Forth (East and West)
- . Sulphur Creek (East and West) – with Preservation Bay as an insert
- . Heybridge (East and West)

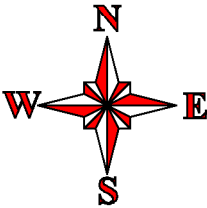
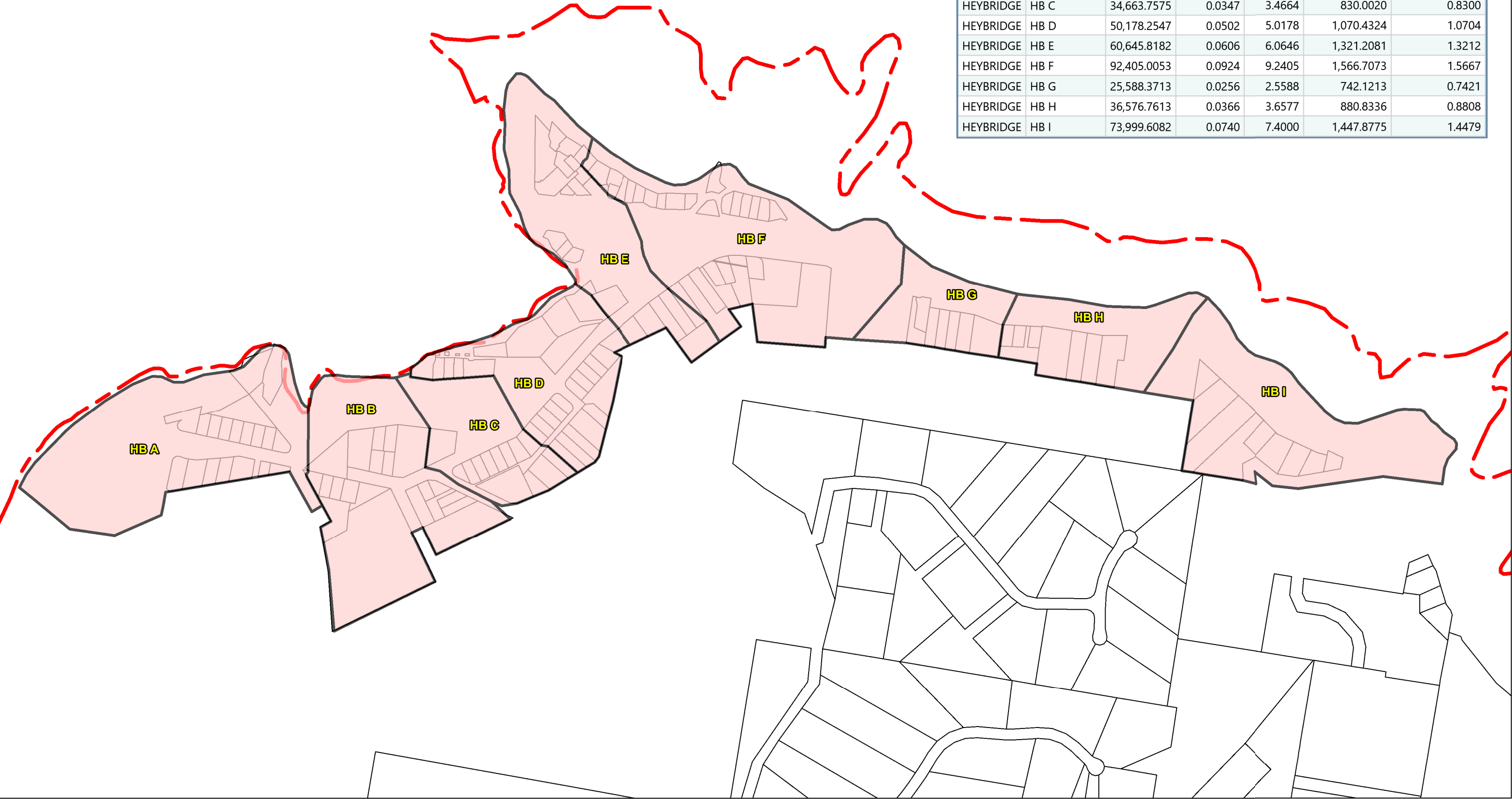


SUBURB	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
FORTH EAST	190,580.4816	0.1906	19.0580	1,806.7387	1.8067
FORTH WEST	224,362.2798	0.2244	22.4362	2,462.8535	2.4629
HEYBRIDGE	536,033.7062	0.5360	53.6034	6,915.6796	6.9157
LEITH	344,496.1534	0.3445	34.4496	2,974.2100	2.9742
PENGUIN NORTH	2,410,980.9513	2.4110	241.0981	14,902.7717	14.9028
PENGUIN SOUTH	3,634,629.2794	3.6346	363.4629	11,001.0518	11.0011
PRESERVATION BAY	58,307.6721	0.0583	5.8308	2,069.9595	2.0700
SULPHUR CREEK	760,530.7778	0.7605	76.0531	5,976.9544	5.9770
TURNERS BEACH NORTH	602,662.8143	0.6027	60.2663	4,480.0422	4.4800
TURNERS BEACH SOUTH	774,089.4933	0.7741	77.4089	4,052.7328	4.0527
ULVERSTONE EAST	6,588,252.8051	6.5883	658.8253	22,176.0089	22.1760
ULVERSTONE WEST	3,626,398.7621	3.6264	362.6399	11,401.9290	11.4019

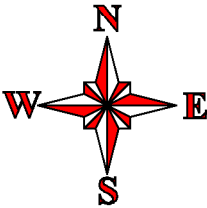
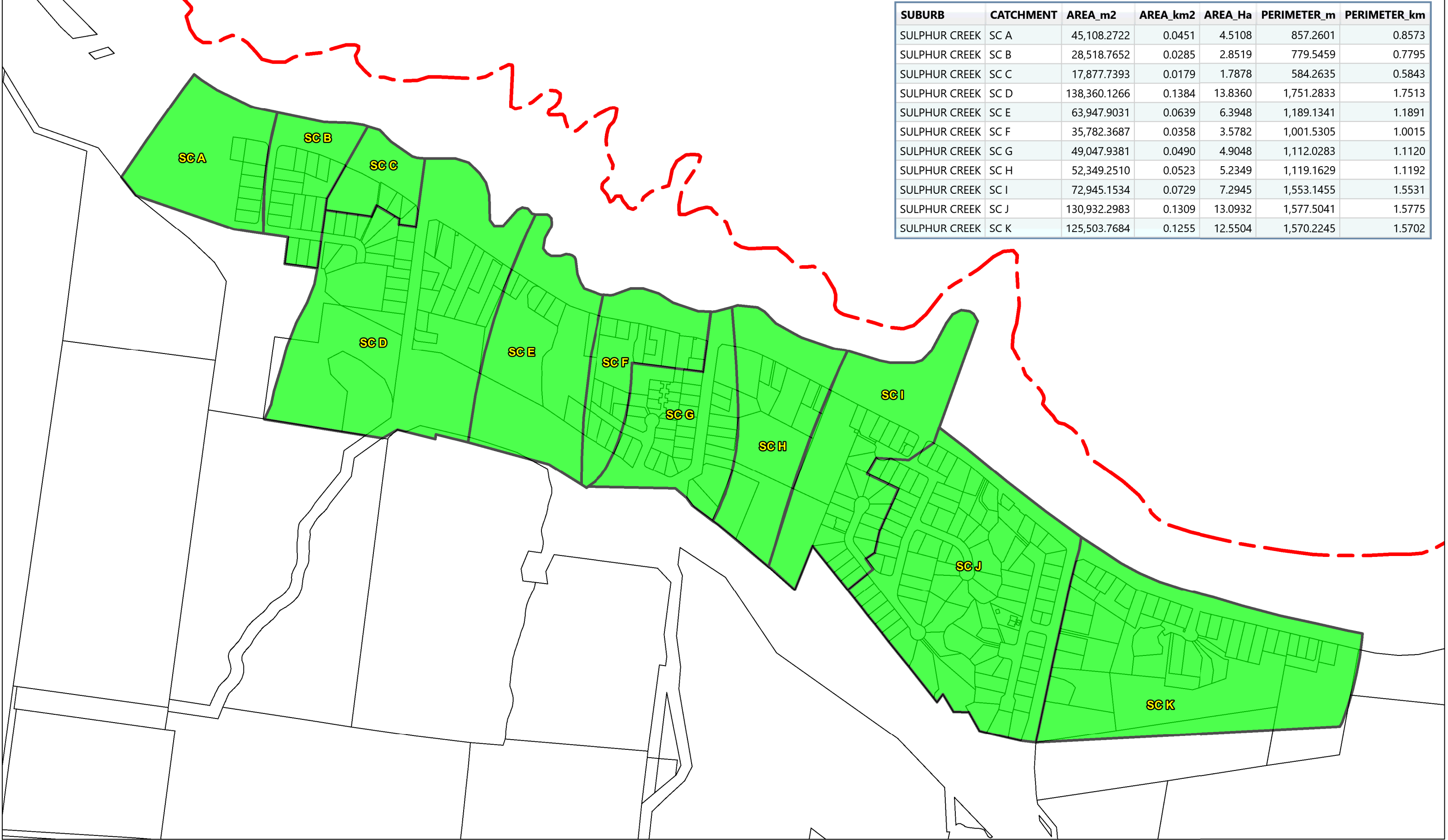




SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
HEYBRIDGE	HB A	85,515.1501	0.0855	8.5515	1,411.7076	1.4117
HEYBRIDGE	HB B	76,449.4517	0.0764	7.6449	1,379.4334	1.3794
HEYBRIDGE	HB C	34,663.7575	0.0347	3.4664	830.0020	0.8300
HEYBRIDGE	HB D	50,178.2547	0.0502	5.0178	1,070.4324	1.0704
HEYBRIDGE	HB E	60,645.8182	0.0606	6.0646	1,321.2081	1.3212
HEYBRIDGE	HB F	92,405.0053	0.0924	9.2405	1,566.7073	1.5667
HEYBRIDGE	HB G	25,588.3713	0.0256	2.5588	742.1213	0.7421
HEYBRIDGE	HB H	36,576.7613	0.0366	3.6577	880.8336	0.8808
HEYBRIDGE	HB I	73,999.6082	0.0740	7.4000	1,447.8775	1.4479

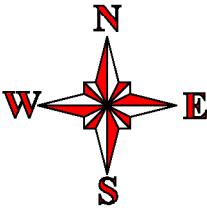


SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
SULPHUR CREEK	SC A	45,108.2722	0.0451	4.5108	857.2601	0.8573
SULPHUR CREEK	SC B	28,518.7652	0.0285	2.8519	779.5459	0.7795
SULPHUR CREEK	SC C	17,877.7393	0.0179	1.7878	584.2635	0.5843
SULPHUR CREEK	SC D	138,360.1266	0.1384	13.8360	1,751.2833	1.7513
SULPHUR CREEK	SC E	63,947.9031	0.0639	6.3948	1,189.1341	1.1891
SULPHUR CREEK	SC F	35,782.3687	0.0358	3.5782	1,001.5305	1.0015
SULPHUR CREEK	SC G	49,047.9381	0.0490	4.9048	1,112.0283	1.1120
SULPHUR CREEK	SC H	52,349.2510	0.0523	5.2349	1,119.1629	1.1192
SULPHUR CREEK	SC I	72,945.1534	0.0729	7.2945	1,553.1455	1.5531
SULPHUR CREEK	SC J	130,932.2983	0.1309	13.0932	1,577.5041	1.5775
SULPHUR CREEK	SC K	125,503.7684	0.1255	12.5504	1,570.2245	1.5702

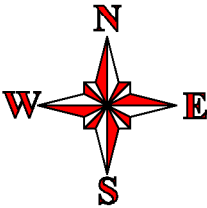
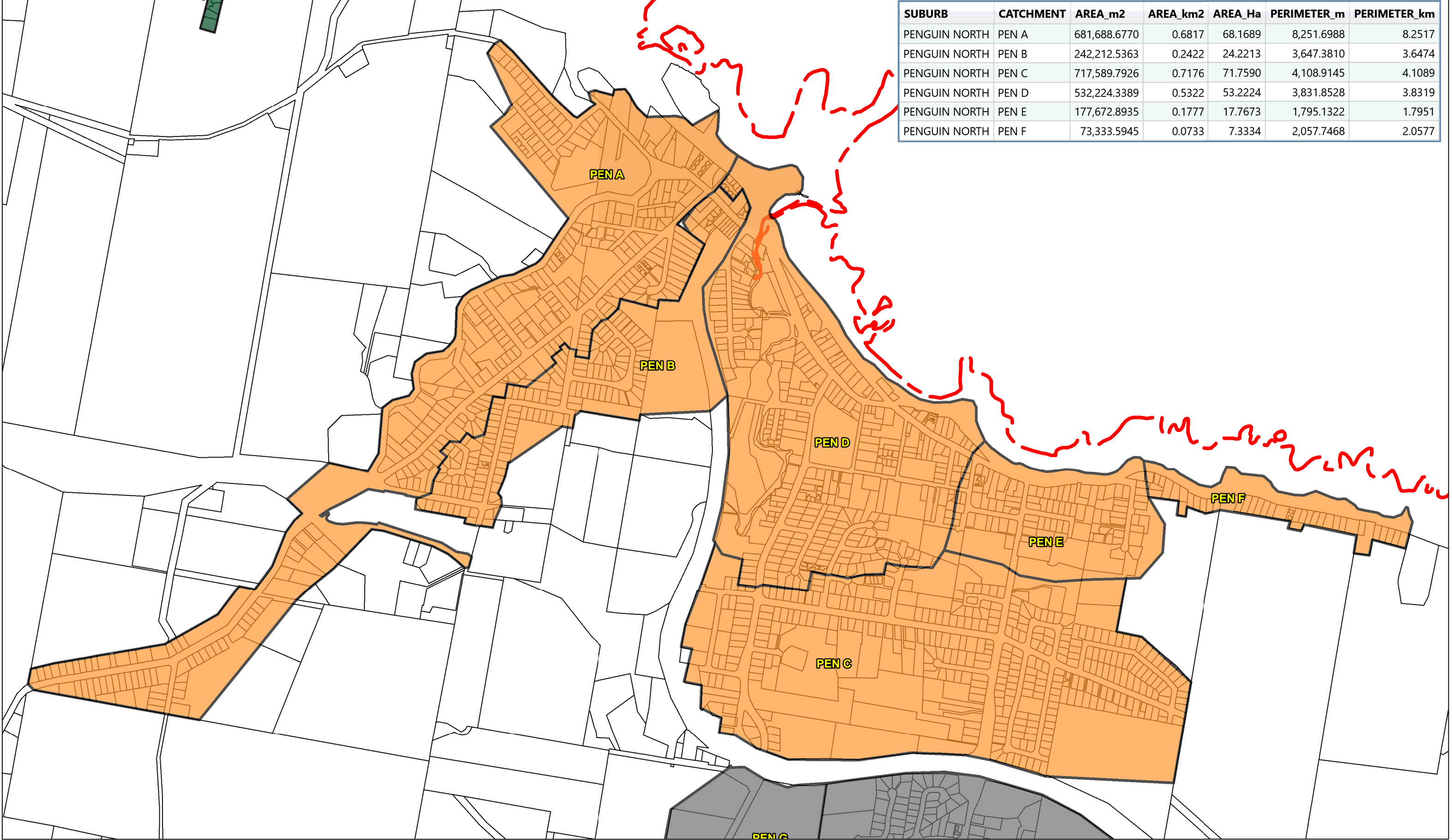


## SULPHUR CREEK DRAINAGE CATCHMENTS

SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
PRESERVATION BAY	PB A	58,307.6721	0.0583	5.8308	2,069.9595	2.0700

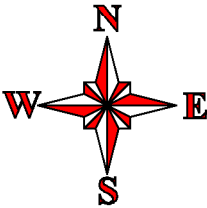
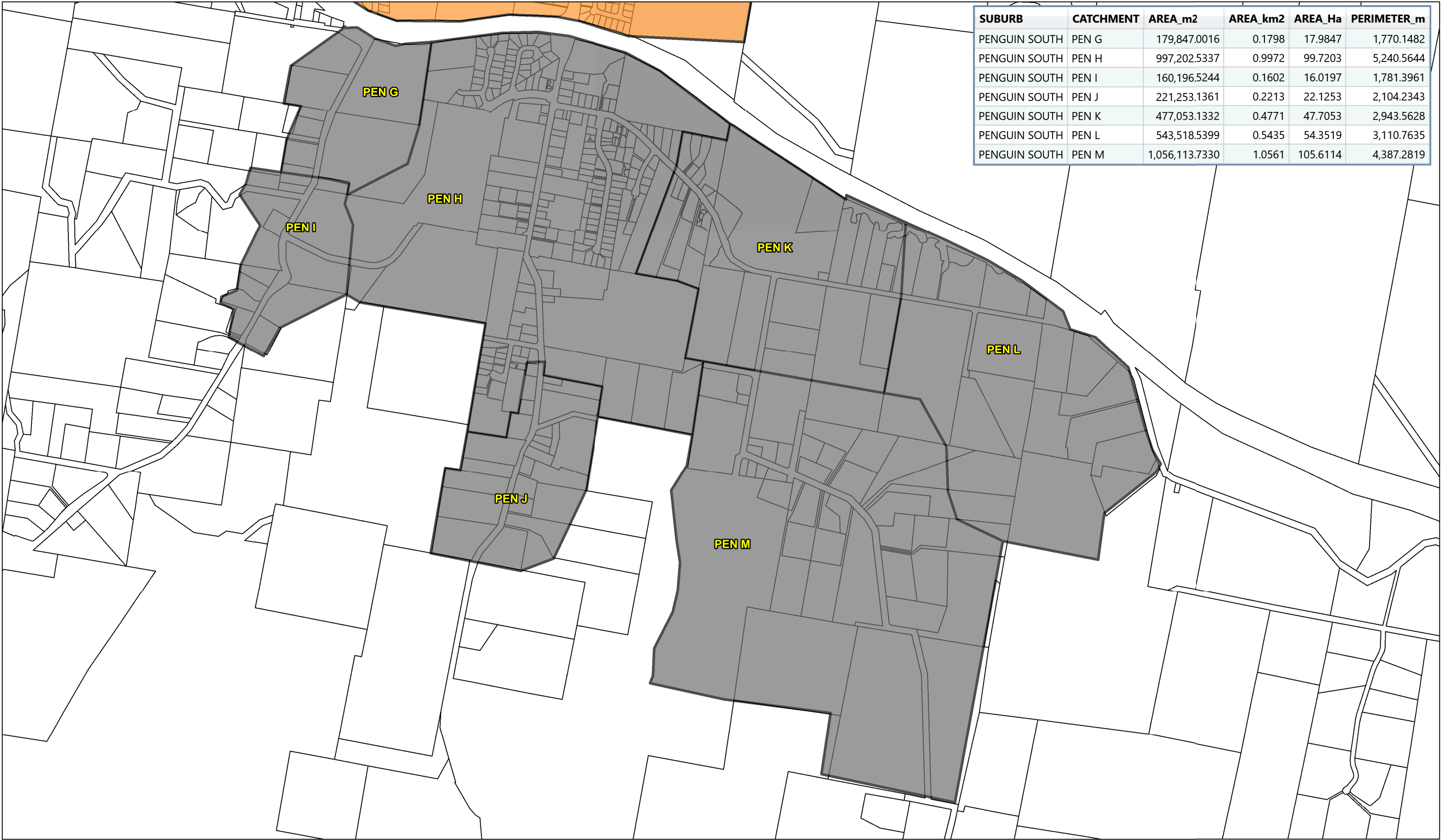


SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
PENGUIN NORTH	PEN A	681,688.6770	0.6817	68.1689	8,251.6988	8.2517
PENGUIN NORTH	PEN B	242,212.5363	0.2422	24.2213	3,647.3810	3.6474
PENGUIN NORTH	PEN C	717,589.7926	0.7176	71.7590	4,108.9145	4.1089
PENGUIN NORTH	PEN D	532,224.3389	0.5322	53.2224	3,831.8528	3.8319
PENGUIN NORTH	PEN E	177,672.8935	0.1777	17.7673	1,795.1322	1.7951
PENGUIN NORTH	PEN F	73,333.5945	0.0733	7.3334	2,057.7468	2.0577

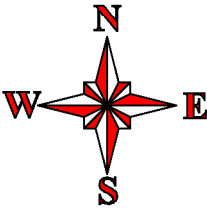
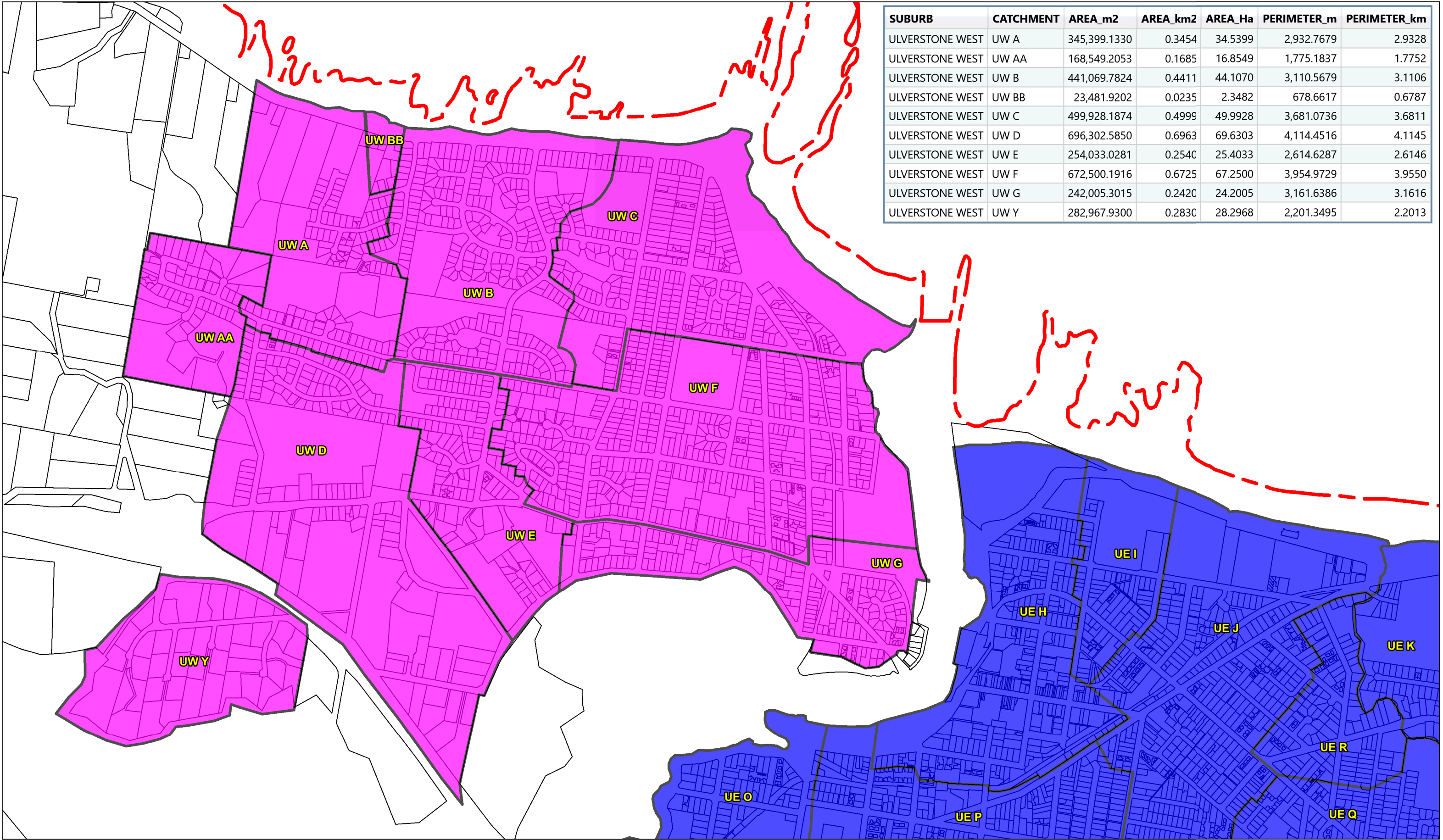




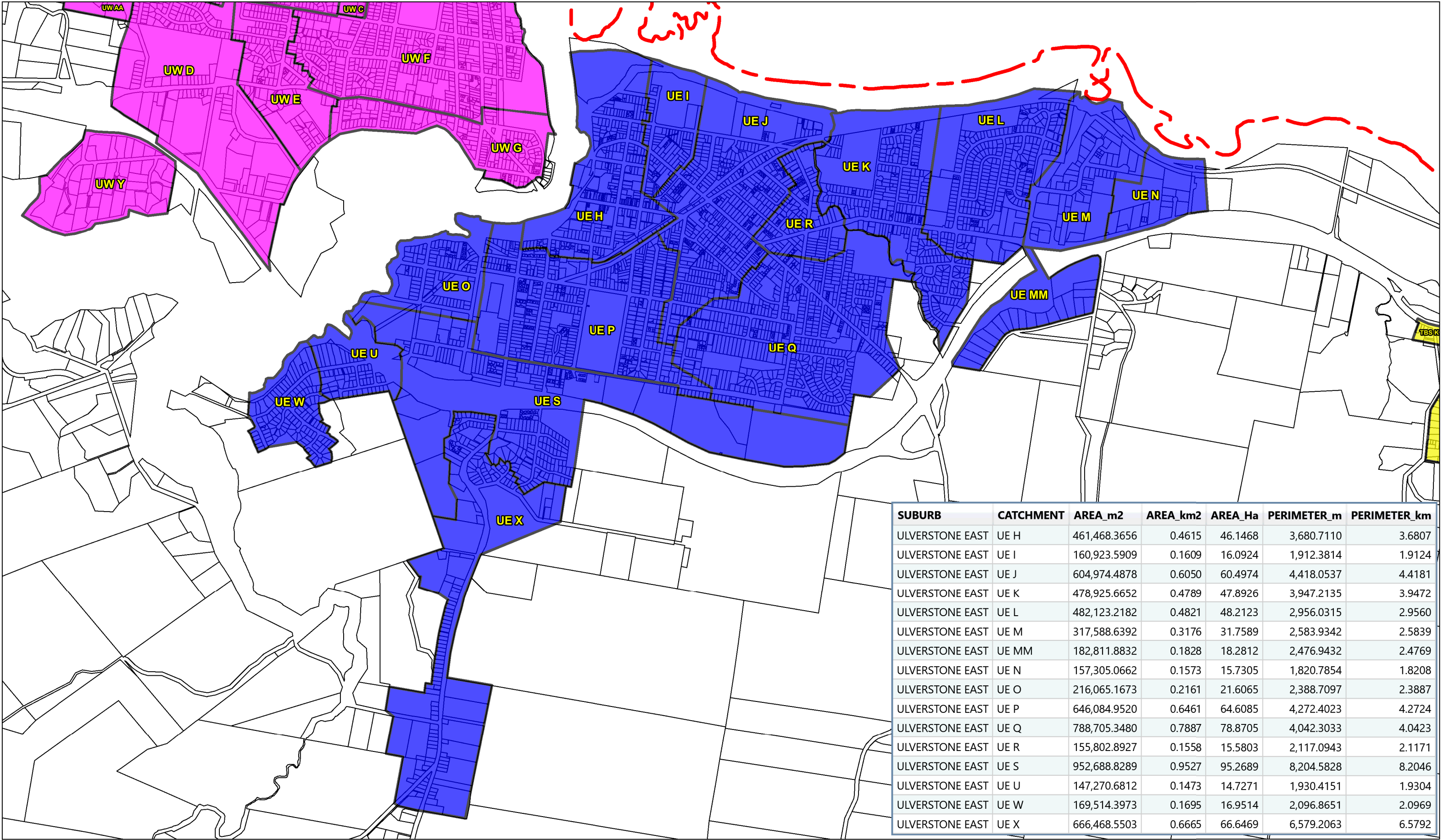
SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m
PENGUIN SOUTH	PEN G	179,847.0016	0.1798	17.9847	1,770.1482
PENGUIN SOUTH	PEN H	997,202.5337	0.9972	99.7203	5,240.5644
PENGUIN SOUTH	PEN I	160,196.5244	0.1602	16.0197	1,781.3961
PENGUIN SOUTH	PEN J	221,253.1361	0.2213	22.1253	2,104.2343
PENGUIN SOUTH	PEN K	477,053.1332	0.4771	47.7053	2,943.5628
PENGUIN SOUTH	PEN L	543,518.5399	0.5435	54.3519	3,110.7635
PENGUIN SOUTH	PEN M	1,056,113.7330	1.0561	105.6114	4,387.2819



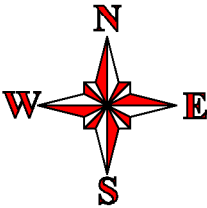
SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
ULVERSTONE WEST	UW A	345,399.1330	0.3454	34.5399	2,932.7679	2.9328
ULVERSTONE WEST	UW AA	168,549.2053	0.1685	16.8549	1,775.1837	1.7752
ULVERSTONE WEST	UW B	441,069.7824	0.4411	44.1070	3,110.5679	3.1106
ULVERSTONE WEST	UW BB	23,481.9202	0.0235	2.3482	678.6617	0.6787
ULVERSTONE WEST	UW C	499,928.1874	0.4999	49.9928	3,681.0736	3.6811
ULVERSTONE WEST	UW D	696,302.5850	0.6963	69.6303	4,114.4516	4.1145
ULVERSTONE WEST	UW E	254,033.0281	0.2540	25.4033	2,614.6287	2.6146
ULVERSTONE WEST	UW F	672,500.1916	0.6725	67.2500	3,954.9729	3.9550
ULVERSTONE WEST	UW G	242,005.3015	0.2420	24.2005	3,161.6386	3.1616
ULVERSTONE WEST	UW Y	282,967.9300	0.2830	28.2968	2,201.3495	2.2013



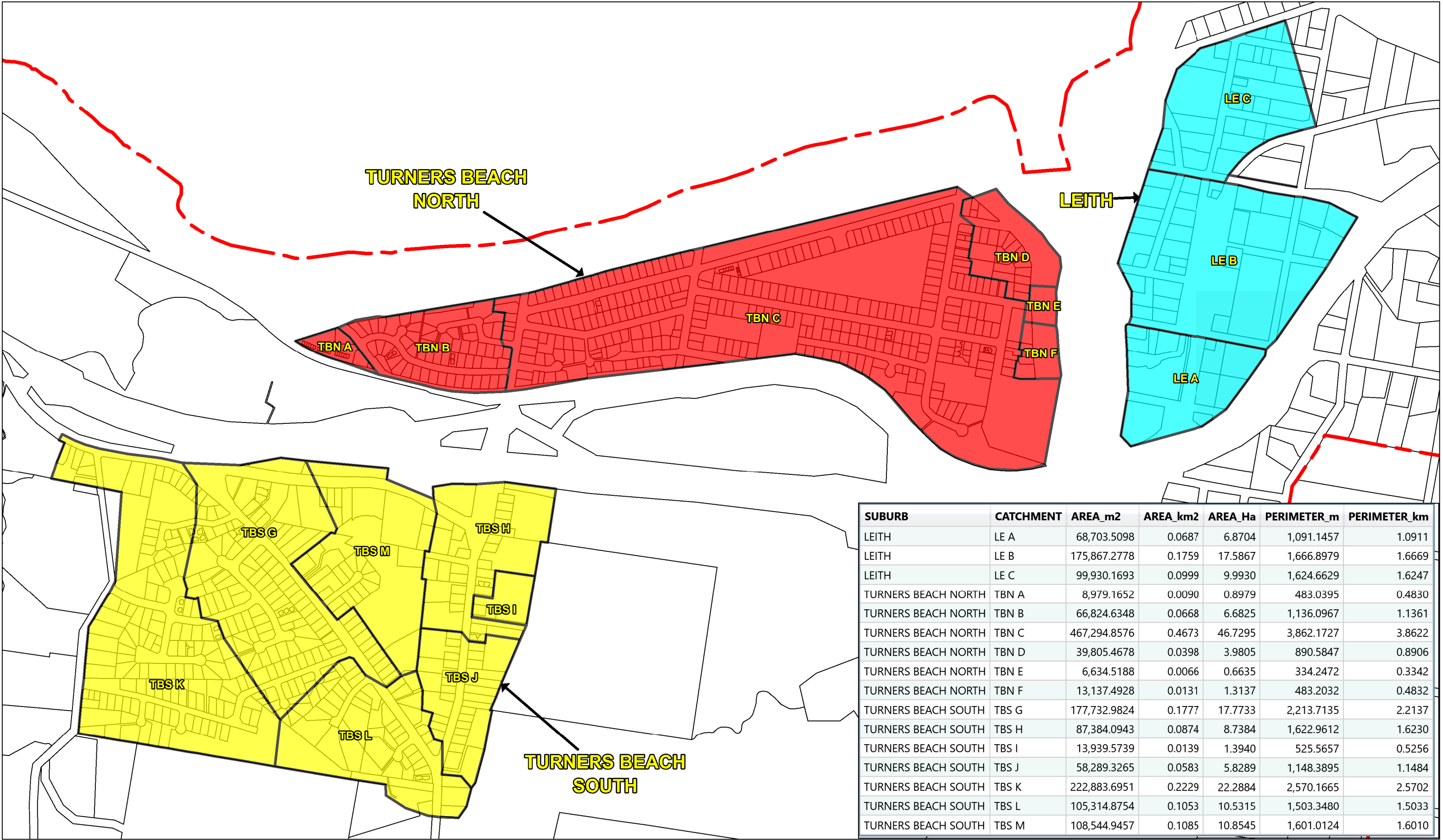




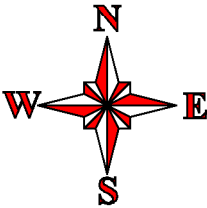
SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
ULVERSTONE EAST	UE H	461,468.3656	0.4615	46.1468	3,680.7110	3.6807
ULVERSTONE EAST	UE I	160,923.5909	0.1609	16.0924	1,912.3814	1.9124
ULVERSTONE EAST	UE J	604,974.4878	0.6050	60.4974	4,418.0537	4.4181
ULVERSTONE EAST	UE K	478,925.6652	0.4789	47.8926	3,947.2135	3.9472
ULVERSTONE EAST	UE L	482,123.2182	0.4821	48.2123	2,956.0315	2.9560
ULVERSTONE EAST	UE M	317,588.6392	0.3176	31.7589	2,583.9342	2.5839
ULVERSTONE EAST	UE MM	182,811.8832	0.1828	18.2812	2,476.9432	2.4769
ULVERSTONE EAST	UE N	157,305.0662	0.1573	15.7305	1,820.7854	1.8208
ULVERSTONE EAST	UE O	216,065.1673	0.2161	21.6065	2,388.7097	2.3887
ULVERSTONE EAST	UE P	646,084.9520	0.6461	64.6085	4,272.4023	4.2724
ULVERSTONE EAST	UE Q	788,705.3480	0.7887	78.8705	4,042.3033	4.0423
ULVERSTONE EAST	UE R	155,802.8927	0.1558	15.5803	2,117.0943	2.1171
ULVERSTONE EAST	UE S	952,688.8289	0.9527	95.2689	8,204.5828	8.2046
ULVERSTONE EAST	UE U	147,270.6812	0.1473	14.7271	1,930.4151	1.9304
ULVERSTONE EAST	UE W	169,514.3973	0.1695	16.9514	2,096.8651	2.0969
ULVERSTONE EAST	UE X	666,468.5503	0.6665	66.6469	6,579.2063	6.5792



## ULVERSTONE EAST DRAINAGE CATCHMENTS



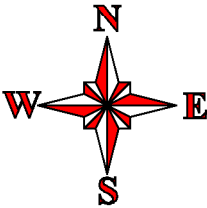
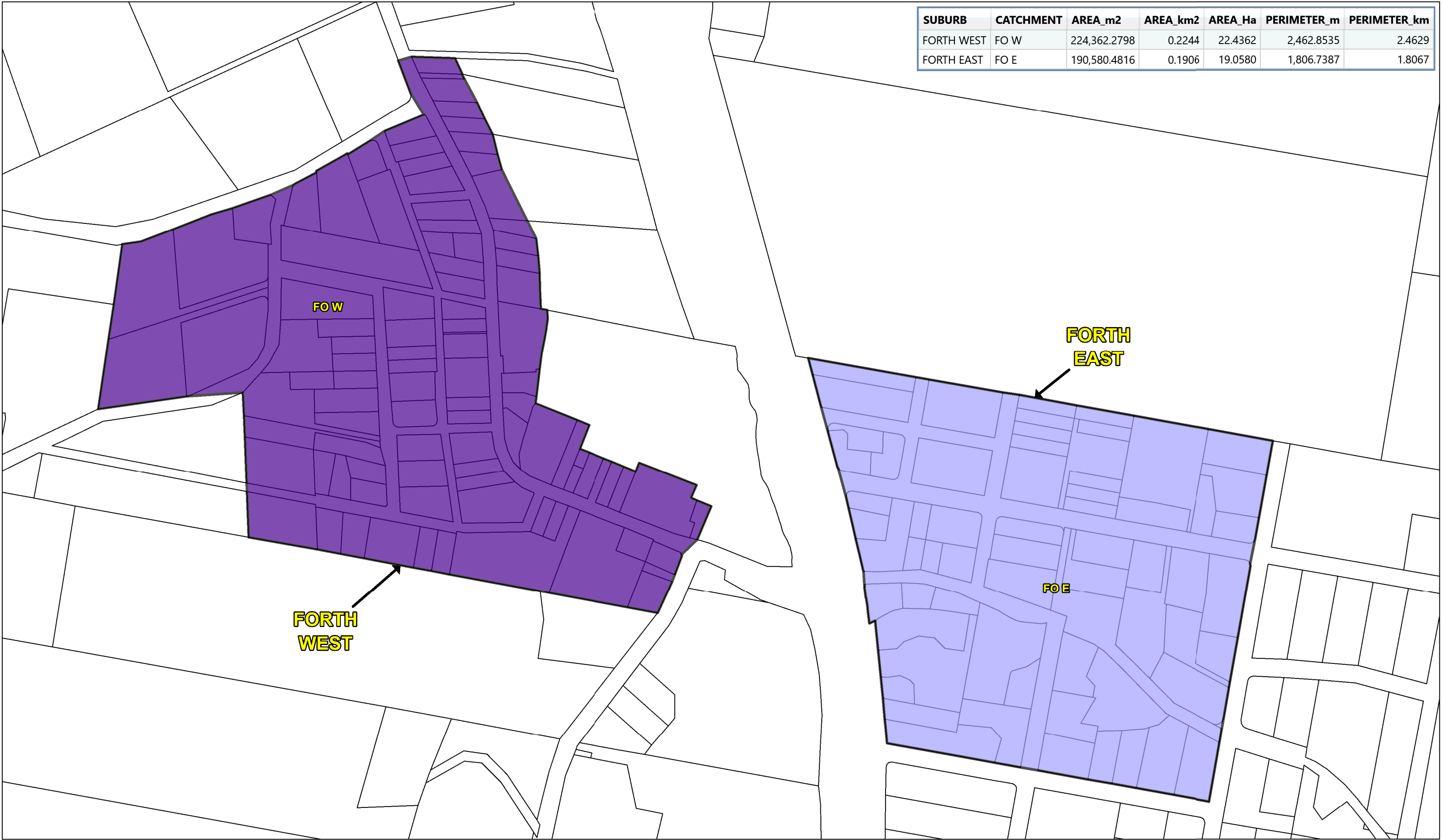
SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
LEITH	LE A	68,703.5098	0.0687	6.8704	1,091.1457	1.0911
LEITH	LE B	175,867.2778	0.1759	17.5867	1,666.8979	1.6669
LEITH	LE C	99,930.1693	0.0999	9.9930	1,624.6629	1.6247
TURNERS BEACH NORTH	TBN A	8,979.1652	0.0090	0.8979	483.0395	0.4830
TURNERS BEACH NORTH	TBN B	66,824.6348	0.0668	6.6825	1,136.0967	1.1361
TURNERS BEACH NORTH	TBN C	467,294.8576	0.4673	46.7295	3,862.1727	3.8622
TURNERS BEACH NORTH	TBN D	39,805.4678	0.0398	3.9805	890.5847	0.8906
TURNERS BEACH NORTH	TBN E	6,634.5188	0.0066	0.6635	334.2472	0.3342
TURNERS BEACH NORTH	TBN F	13,137.4928	0.0131	1.3137	483.2032	0.4832
TURNERS BEACH SOUTH	TBS G	177,732.9824	0.1777	17.7733	2,213.7135	2.2137
TURNERS BEACH SOUTH	TBS H	87,384.0943	0.0874	8.7384	1,622.9612	1.6230
TURNERS BEACH SOUTH	TBS I	13,939.5739	0.0139	1.3940	525.5657	0.5256
TURNERS BEACH SOUTH	TBS J	58,289.3265	0.0583	5.8289	1,148.3895	1.1484
TURNERS BEACH SOUTH	TBS K	222,883.6951	0.2229	22.2884	2,570.1665	2.5702
TURNERS BEACH SOUTH	TBS L	105,314.8754	0.1053	10.5315	1,503.3480	1.5033
TURNERS BEACH SOUTH	TBS M	108,544.9457	0.1085	10.8545	1,601.0124	1.6010



# TURNERS BEACH & LEITH DRAINAGE CATCHMENTS



SUBURB	CATCHMENT	AREA_m2	AREA_km2	AREA_Ha	PERIMETER_m	PERIMETER_km
FORTH WEST	FO W	224,362.2798	0.2244	22.4362	2,462.8535	2.4629
FORTH EAST	FO E	190,580.4816	0.1906	19.0580	1,806.7387	1.8067



# FORTH DRAINAGE CATCHMENTS