GROUNDWATER SUSTAINABLE YIELD ASSESSMENT: METHODOLOGY REPORT

Part 8: Sustainable Yield synthesis paper – Mapping, Boundaries, and Naming Conventions for Confined Aquifer UAs (DEECA)

VICTORIA State Government | Energy, Environment and Climate Action

Acknowledgements

The Sustainable Yield Assessment for Victoria was undertaken by DEECA in collaboration with Southern Rural Water, Goulburn–Murray Water, Grampians Wimmera Mallee Water and Lower Murray Water corporations.

A technical advisory panel provided specialist advice in the development of the assessment method. The panel comprised specialists from Deakin University (Prof. Wendy Timms), Jacobs (Dr Richard Evans) and HydroGeoLogic (Mr Hugh Middlemis).

The assessment was completed with contributions from external industry specialists, who developed the technical details of the methodology and carried out assessments of groundwater resources. These included Jacobs Pty Ltd, GHD Pty Ltd, CDM Smith Pty Ltd, HARC Pty Ltd and Monash University (Dr Tim Peterson).

Authors

Groundwater Assessment and Modelling team, Water Resources Strategy, Department of Energy, Environment and Climate Action. 8 Nicolson Street, East Melbourne 3002.

Editor

Scientel Pty Ltd, 8 Latrobe Street, Melbourne 3000

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.

ISBN 978-1-76176-767-8 (Pdf/Online/MS Word)

Disclaimer

This publication may be of assistance to you but the State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

Accessibility

To receive this document in an alternative format, phone the Customer Service Centre on 136 186, email customer.service@delwp.vic.gov.au, or contact National Relay Service on 133 677. Available at DEECA website (www.deeca.vic.gov.au), https://www.water.vic.gov.au/water-sources/groundwater/groundwater-management-2030/sustainable-yield-assessment/?a=777719.

Contents

List of Figures

List of Tables

About this report

This report outlines the technical approach and methodology of the Sustainable Yield (SY) project. The Victorian Department of Energy, Environment, and Climate Action (DEECA) developed the methodology in partnership with:

Contractors Jacobs, GHD Pty Ltd and CDM Smith, who were responsible for developing the technical aspects of the methodology and conducting assessments of groundwater resources.

Representatives from Southern Rural Water Corporation, Goulburn-Murray Rural Water Corporation, Grampians Wimmera Mallee Rural Water Corporation, and the DEECA Environmental Waterways and Water Licensing Policy teams, who possessed extensive experience and expertise in water and groundwater resource management and policy, and offered advice on technical, management and policy aspects of the project.

A technical review panel, consisting of 3 subject matter experts in groundwater assessment and modelling, who provided expert peer review of the methodologies.

The methodology was developed in stages so that assessments could be undertaken in parallel with the methodology refinement. This enabled DEECA to meet the project completion date of June 2024. The methodology is described and reported in 8 parts:

Part 1: Methodology overview (DEECA)

Part 2: Confined aquifers – throughflow method (report by (Jacobs, 2024))

Part 3: Confined aquifers – drawdown-use method (report by (GHD Pty Ltd, 2024))

Part 4: Unconfined aquifers – recharge estimation and drawdown-use methods (report by (CDM Smith, 2025)

Part 5: Sustainable Yield synthesis paper – confined aquifers synthesis approach (DEECA)

Part 6: Sustainable Yield synthesis paper – semi-confined aquifers mapping approach (DEECA)

Part 7: Sustainable Yield synthesis paper – semi-confined aquifers synthesis approach (DEECA)

Part 8: Sustainable Yield synthesis paper – Mapping, Boundaries, and Naming Conventions for Confined Aquifer UAs (this report)

Part 1, the methodology overview provides context for the project by discussing its drivers, current resources and understanding, expected outcomes, objectives, outputs, scope, and principles for the proposed approach to the methodology.

Parts 2 to 8 of the methodology provide additional details of the methods. Parts 2 to 4 were developed and reported on by the contractors, and parts 5 to 8 were developed by DEECA.

This paper presents Part 8 of the Methodology Report.

1. Purpose

The purpose of this paper is to map confined aquifer unincorporated areas (UAs) and define boundaries for them.

2. Background

DEECA undertook a statewide assessment of confined aquifers to determine groundwater sustainable yield for these aquifers as part of the SY assessment. To date the unit of management for groundwater resources in Victoria (as part of the groundwater management framework) are Groundwater Management Units (GMU), areas with groundwater development or the potential to be developed. There are other parts that are outside of the GMUs and are classified as UAs. These areas are generally considered to be low yielding or high salinity groundwater. The SY assessment aimed to estimate sustainable yields for all aquifers in the state, including UAs.

The following sections describe how the confined aquifers were mapped across the state and the UA boundaries are defined for the purpose of the SY assessment. These boundaries are not management boundaries and whether the boundaries are appropriate for management will be considered as part of GM2030.

3. Method

Unlike surface water catchments, aquifer extents are not easily delineated. They are interpreted by field and other information, so there can be some uncertainty. Coupled with this is that groundwater characteristics may vary (yield and quality) and have divergent flow paths. These may represent different ‘common pools’ which can be unlike the catchment context that applies to surface water. Consequently, determining boundaries for groundwater assessments and management generally results from consideration of many factors, rather than catchment divide for surface water. In the case of the SY assessment the following principles were applied for determining boundaries:

- Existing GMU boundaries to remain unchanged and new areas/boundaries to be established for the SY assessment
- The SY assessment proposes a sustainable yield volume for ‘common pool’ resources. That is groundwater resources that are connected and similar groundwater characteristics and perhaps development potential (e.g., land use).
- All Tertiary confined aquifers are mapped. Pre-Tertiary aquifers are not mapped.

The following tertiary aquifers have the potential for mapping:

- Upper Tertiary Aquifer (fluvial) (UTAF – 105)
- Upper Mid-Tertiary Aquifer (UMTA – 107)
- Lower Mid-Tertiary Aquifer (LMTA – 109)
- Lower Tertiary Aquifer (LTA – 111)

An approach to determining the boundaries of confined aquifers is as follows:

- Identify confined aquifer extents
- Determine the areas/boundaries of UAs
- Name the areas

The task was undertaken using GIS. Assessment and determination are based on the following key data sources:

- Victorian Aquifer Framework (VAF) layers (GHD Pty Ltd, 2012)
- flow-tube boundaries (Jacobs, 2024)
- GMU boundaries
- Land use (Victorian Land Use Information System (VLUIS) 2016/17) (DEECA, 2018)

4. Results

Identify confined aquifer extents:

Aquitard layer extents were overlaid on the aquifers to determine where an aquifer of interest is overlain by an aquitard layer. Aquitard layers are grouped and merged based on the aquifer of interest. **Table 1** shows the presence of aquitard layers across the major sedimentary basins. The "confined extent" is obtained by overlaying different "confinement" layers over the extent of the aquifer. The “confinement” layer is generated through grouping and merging aquitard layers based on the aquifer of interest (LTA, LMTA, UMTA, UTAF). **Table 2** shows which aquitard layers are used to generate the “confinement” layer based on the aquifer of interest.

Table 1. Statewide aquitard presence across the major sedimentary basins

Aquitard	Otway Basin	Central Coast Basin	Gippsland Basin	Murray Basin - NW	Murray Basin - NE
Upper Tertiary/Quaternary (UTQD - 103)	Absent	Absent	Present	Present	Absent
Upper Tertiary (UTD - 106)	Absent	Absent	Present	Present	Absent
Upper-Mid Tertiary (UMTD - 108)	Present	Present	Present	Present	Absent
Lower-Mid Tertiary (LMTD - 110)	Present	Present	Present	Present	Absent

Table 2. Aquitard layers for mapping aquifer of interest

Aquifer of interest	Aquitard layer
Lower Tertiary Aquifer (LTA – 111)	110, 108, 106, 103
Lower Mid-Tertiary Aquifer (LMTA – 109)	108, 106, 103
Upper Mid-Tertiary Aquifer (UMTA – 107)	106, 103
Upper Tertiary Aquifer (fluvial) (UTAF – 105)	103

The SAFE project (DSE, 2012) distinguished aquifers as groundwater systems (being fractured rock / highlands, volcanics, upland sedimentary valleys, sedimentary plains, and deep confined aquifers systems). The SAFE method assumed that confined aquifers were approximately areas that were 10-15km from the confining aquitard layer boundary. This 10-15km “buffer zone” was excluded for this paper as it would require a much more detailed analysis of the aquifer layers. Aquifer thickness was also excluded as the thickness required to create confined effects is highly variable and not always consistent.

Table 2 shows, as an example, aquitard layers 110, 108, 106, and 103 are used for mapping the LTA aquifer. To map the LMTA aquifer, aquitard layers 108, 106, and 103 are used. UMTA aquifer is mapped using aquitard layers 106, and 103. Aquitard layer 103 is used for mapping the UTAF aquifer. **Figure 1**, as an example, shows the grouped and merged aquitard layers 110, 108, 106, and 103 for mapping the LTA aquifer.

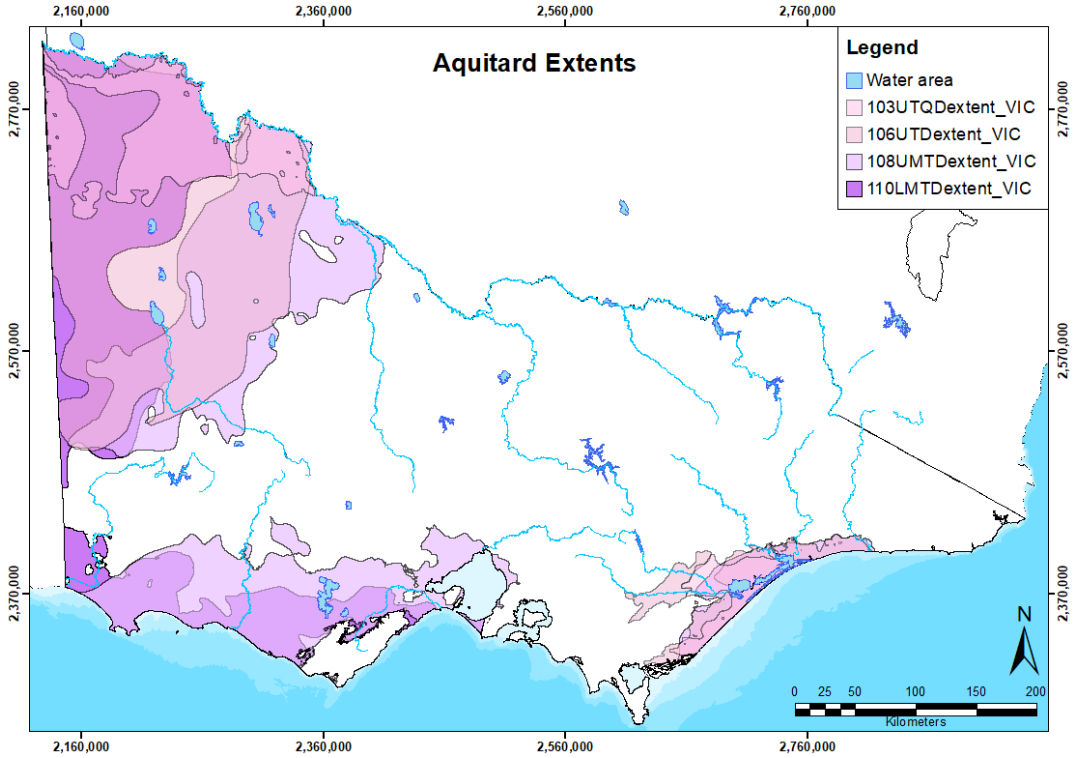

Figure 1. Grouped and merged Aquitard layers 110, 108, 106, and 103

The "confined extent" is obtained by overlaying different "*confinement*" layers over the extent of the aquifer of interest. **Figure 2** shows the LTA aquifer was overlain by a confinement layer consisting of aquitard layers 110, 108, 106 and 103. **Figure 3** shows the confined extent of the LTA aquifer. This step is applied for all aquifers of interest including LMTA, UMTA, and UTAF.

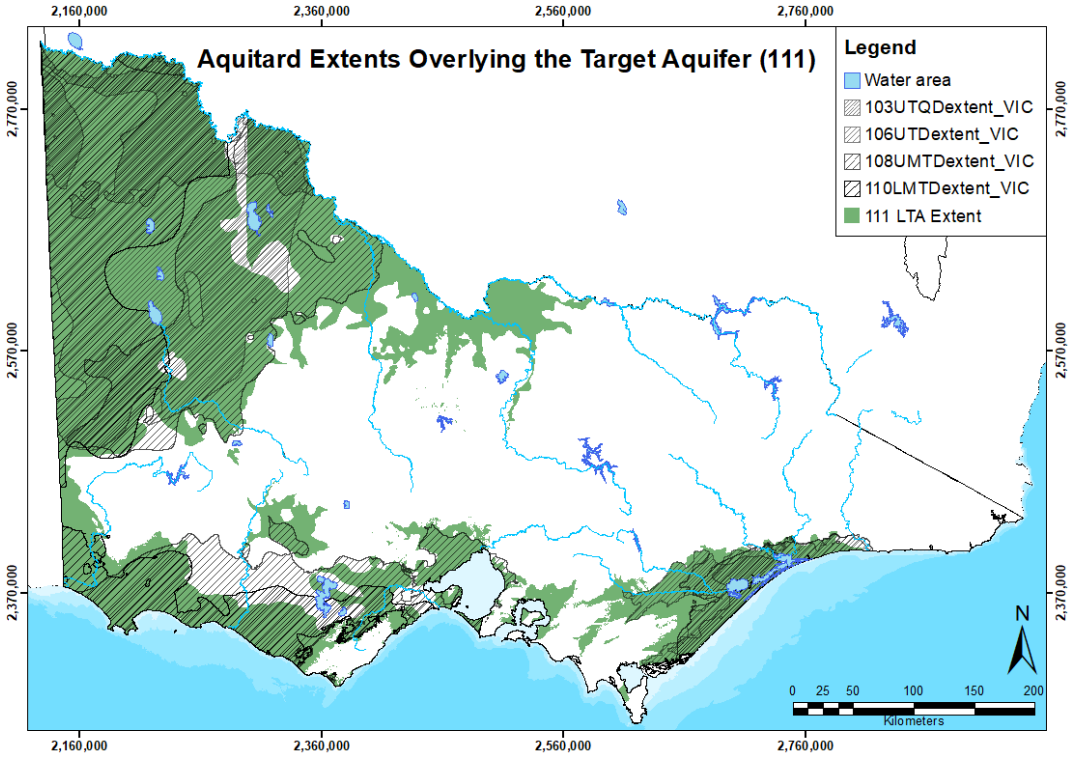

Figure 2. Overlaying the LTA aquifer by a confinement layer consisting of aquitard layers 110, 108, 106 and 103

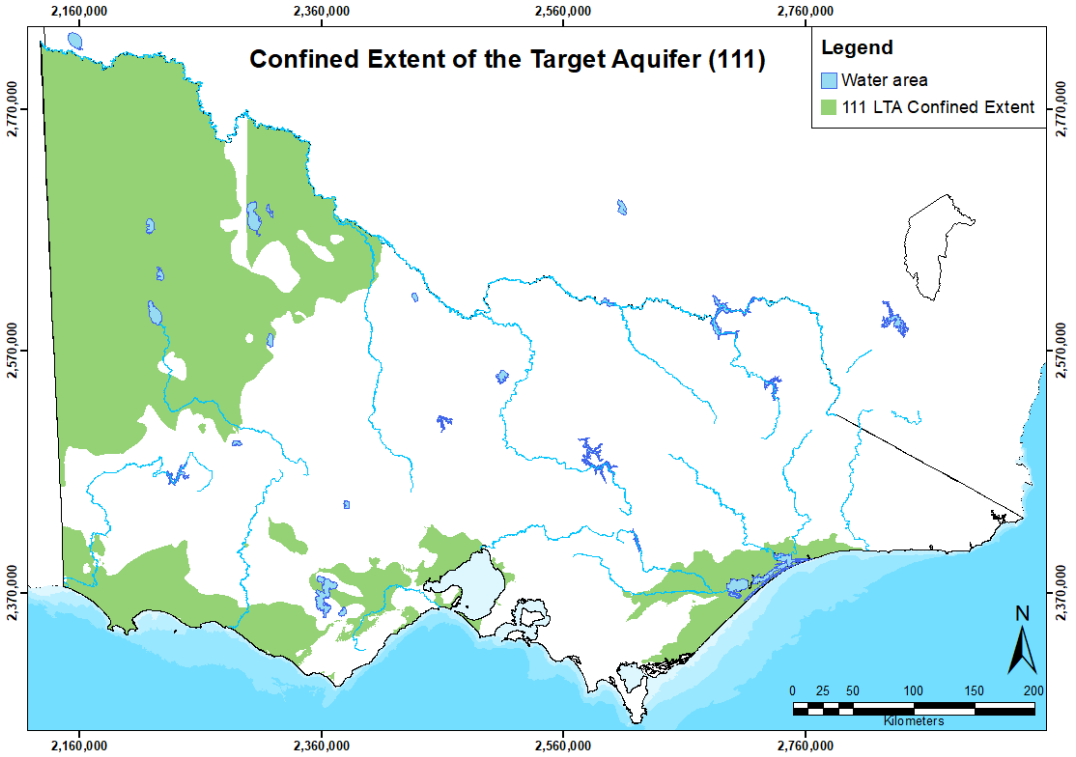

Figure 3. The confined extent of the LTA aquifer based on aquitard layers 110, 108, 106 and 103

Determine the areas/boundaries of UAs

The confined extent of all aquifers of interest (LTA, LMTA, UMTA, UTAF) were trimmed where they were covered by GMUs. This applies where the GMU depth criteria align with at least part of the aquifer depth range. This process was repeated for each of the aquifers of interest with reference to the depth boundaries for each GMU that might be relevant to that layer. **Figure 4** shows the confined extent of the LTA aquifer covered by GMUs. Other portions of the LTA aquifer not covered by GMUs are classified as confined UAs (**Figure 5**).

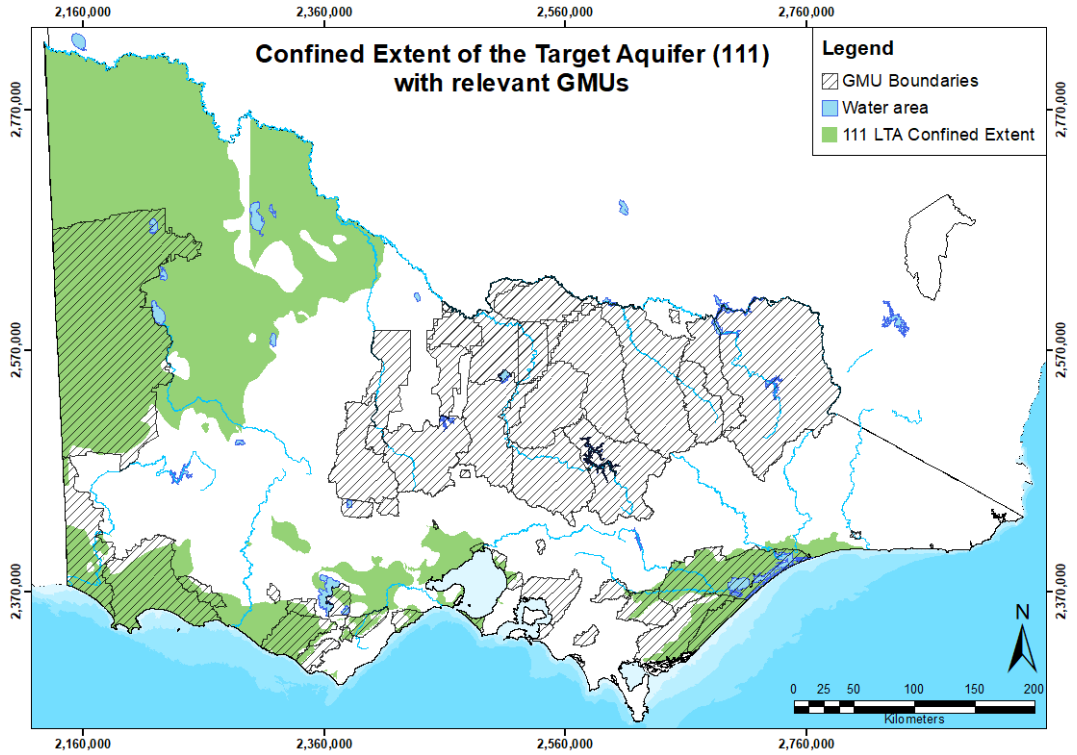

Figure 4. Overlaying GMUs on the confined extent of the LTA aquifer

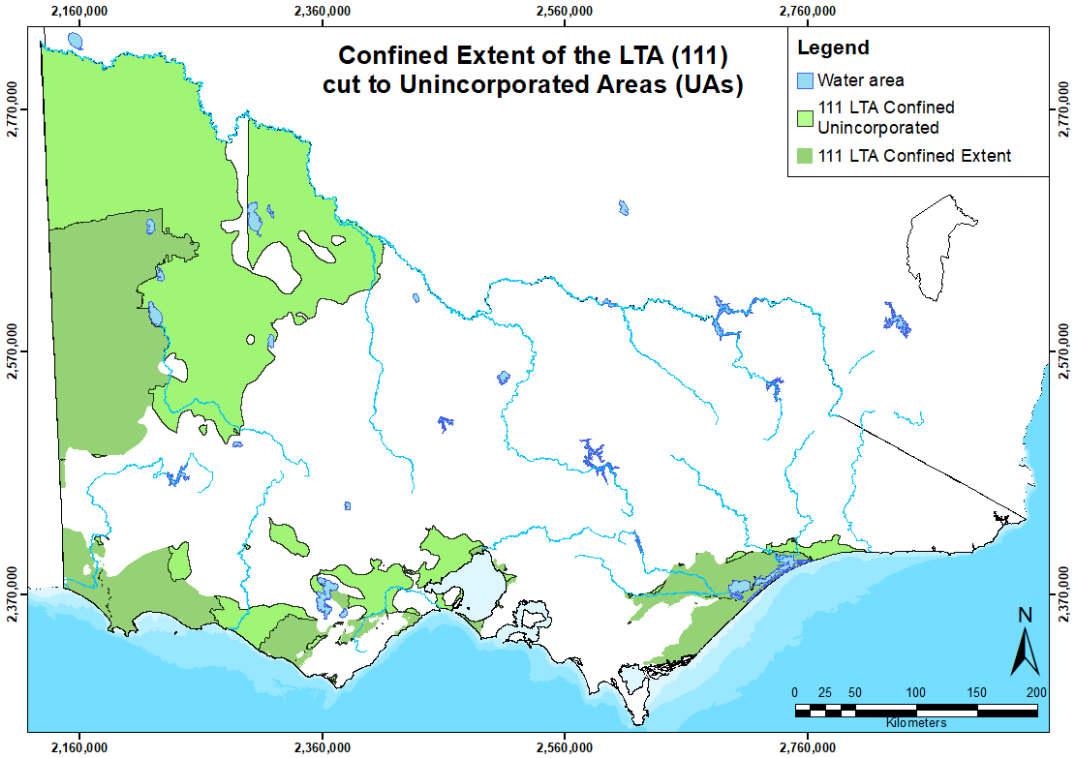

Figure 5. The UA extent of the LTA confined aquifer

The confined extent of all aquifers of interest (LTA, LMTA, UMTA, UTAF) were trimmed where they were covered by GMUs. This step is applied to all aquifers of interest including LMTA (109), UMTA (107), and UTAF (105). Followings are the UA confined extents for all aquifers of interest.

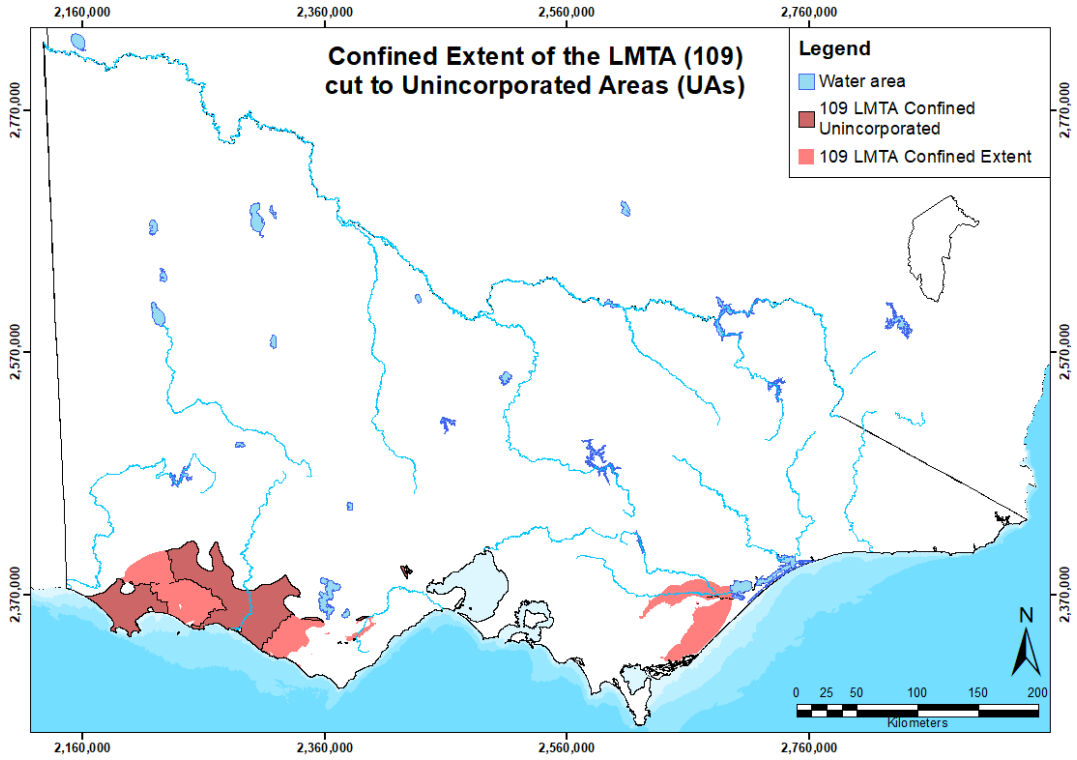

Figure 6. The UA extent of the LMTA confined aquifer

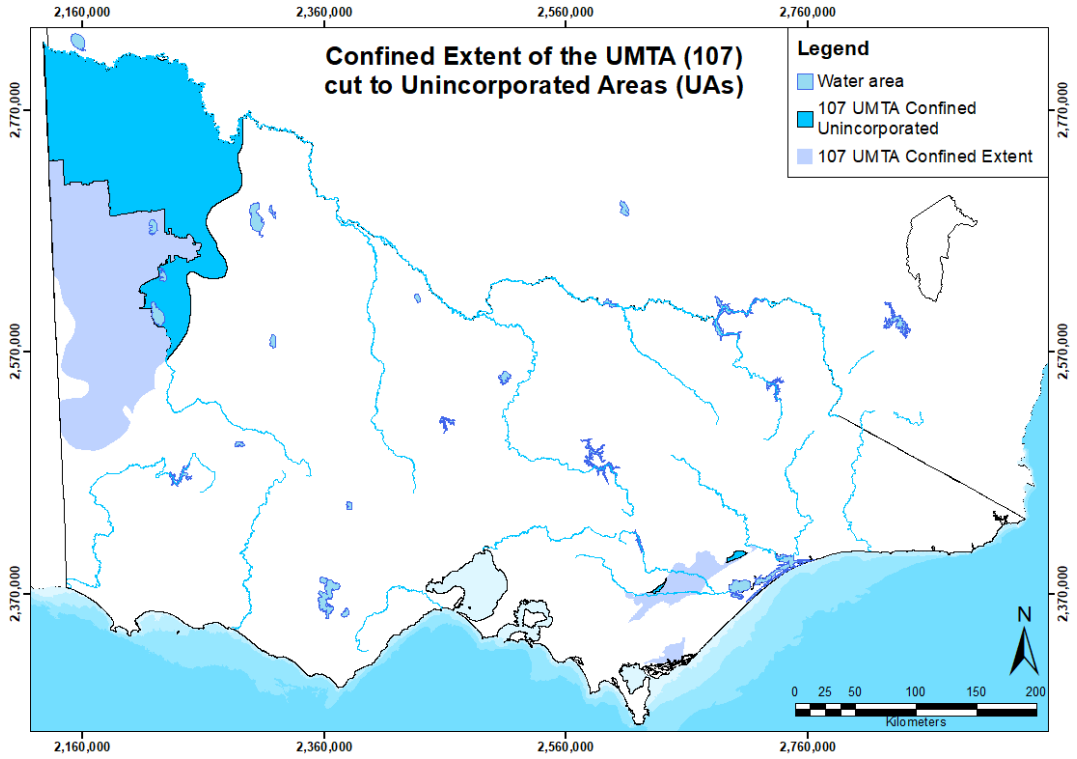

Figure 7. The UA extent of the UMTA confined aquifer

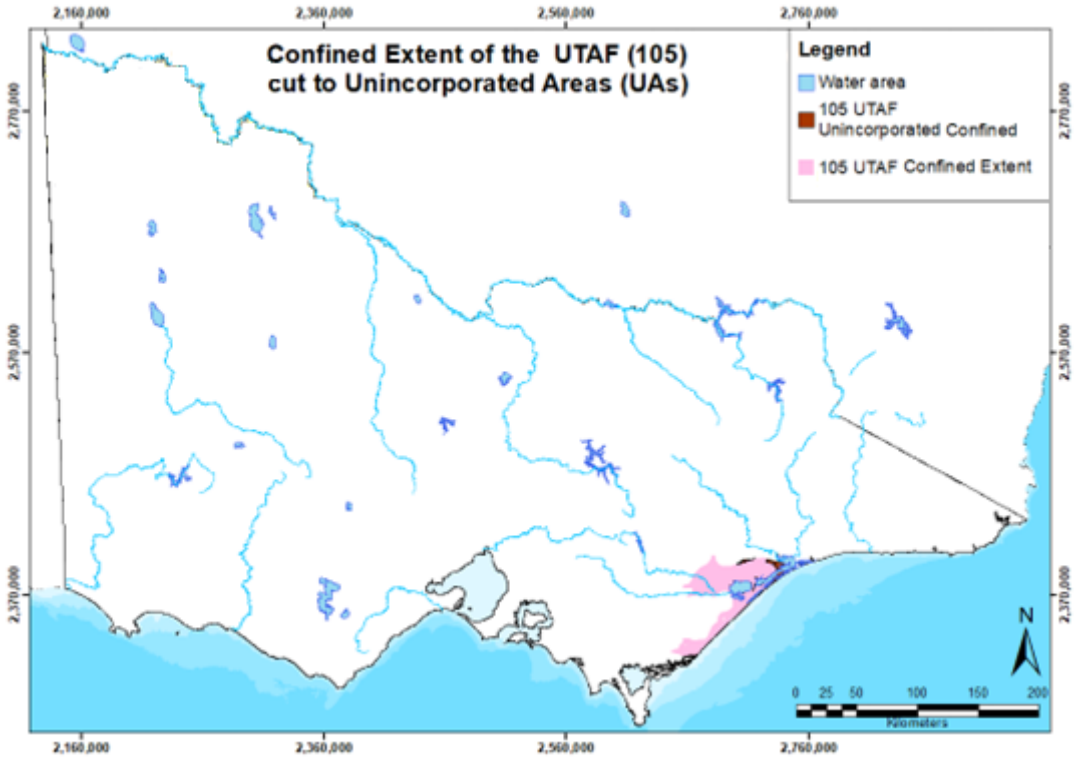

Figure 8. The UA extent of the UTAF confined aquifer

Subdivide based on natural/artificial features

The confined UA zones are defined based on the boundaries of different features including geographical regions, national parks, water quality, rivers, and Jacobs throughflow flowtube boundaries. **Figure 9** shows the confined UA zones for the LTA aquifer for northwest of the State.

- NW1, area north of Murray Sunset National Park
- NW2, main section of Murray Sunset National Park
- NW3, Area south of Murray Sunset National Park
- NW4, south of narrowest point of West Wimmera-edge of aquifer extent (roads are used to divide NW3 and NW4)
- NW5, area east of flow tubes 23 and 24 boundary (rivers and roads are used to divide NW4 and NW5)

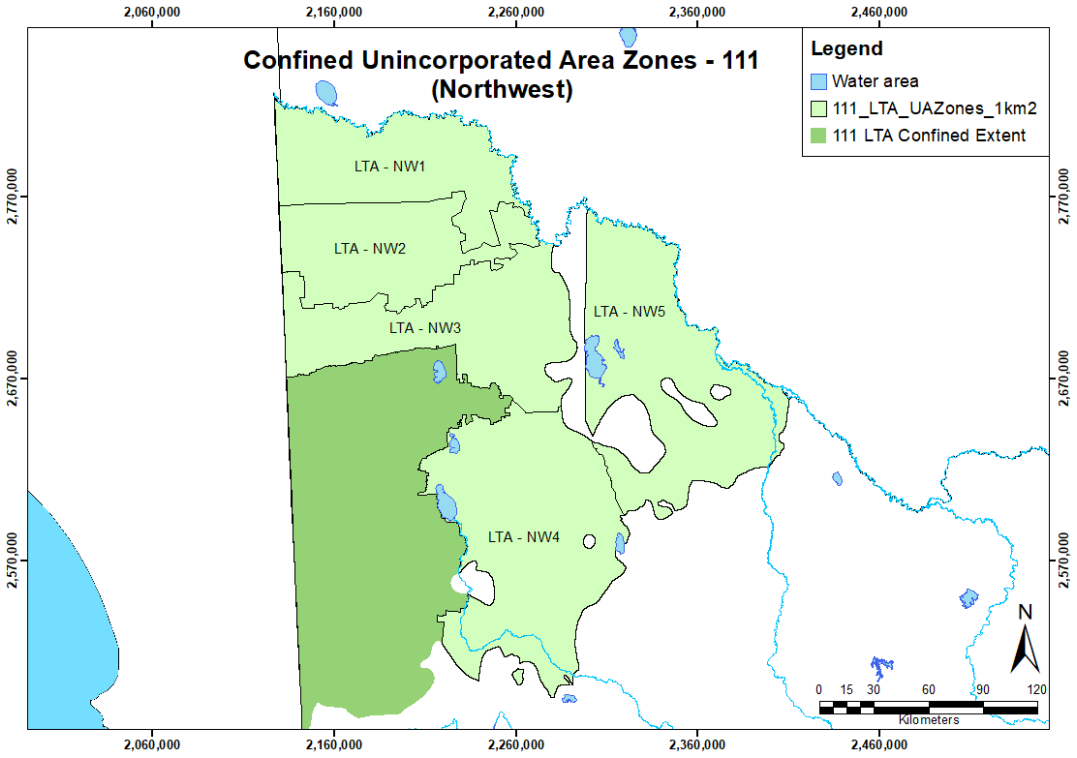

Figure 9. The confined UA zones of the LTA aquifer – northwest of the State

Figure 10 shows the LTA confined aquifer UA zones for the for southwest and Port Philip parts of the State. SW2 and SW3 are separated using Hopkins River as an approximation of groundwater salinity profiles from east to west.

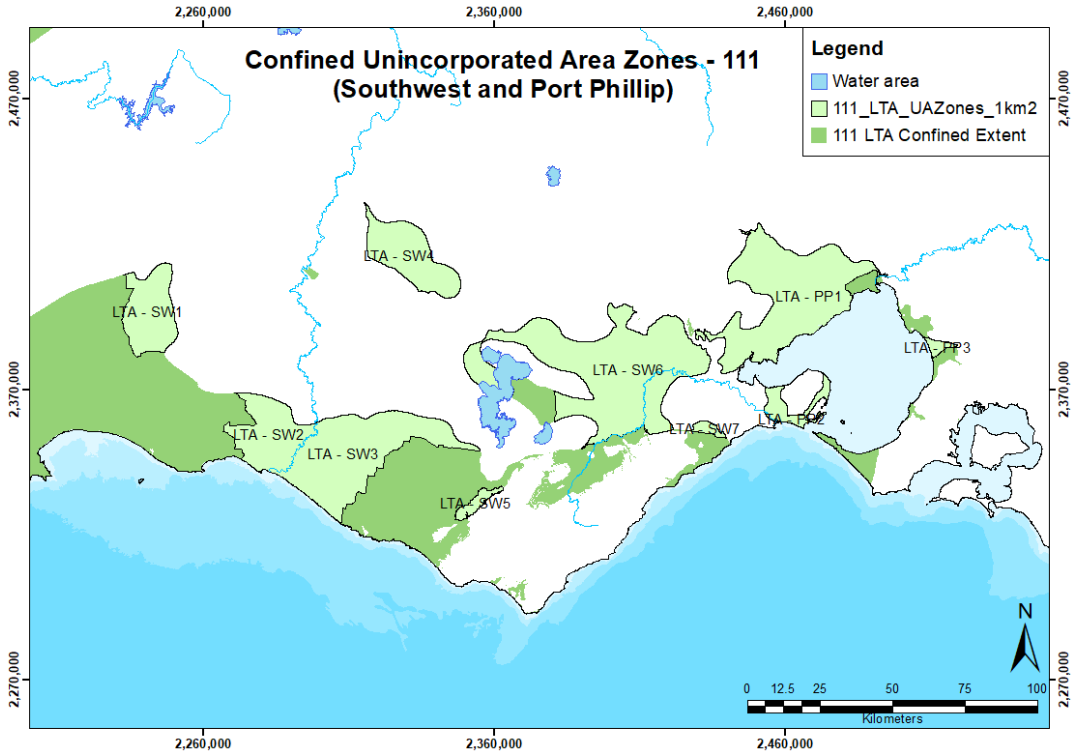

Figure 10. The confined UA zones of the LTA aquifer – southwest and Port Philip of the State

Figure 11 shows the LTA confined aquifer UA zones for southeast areas of the State.

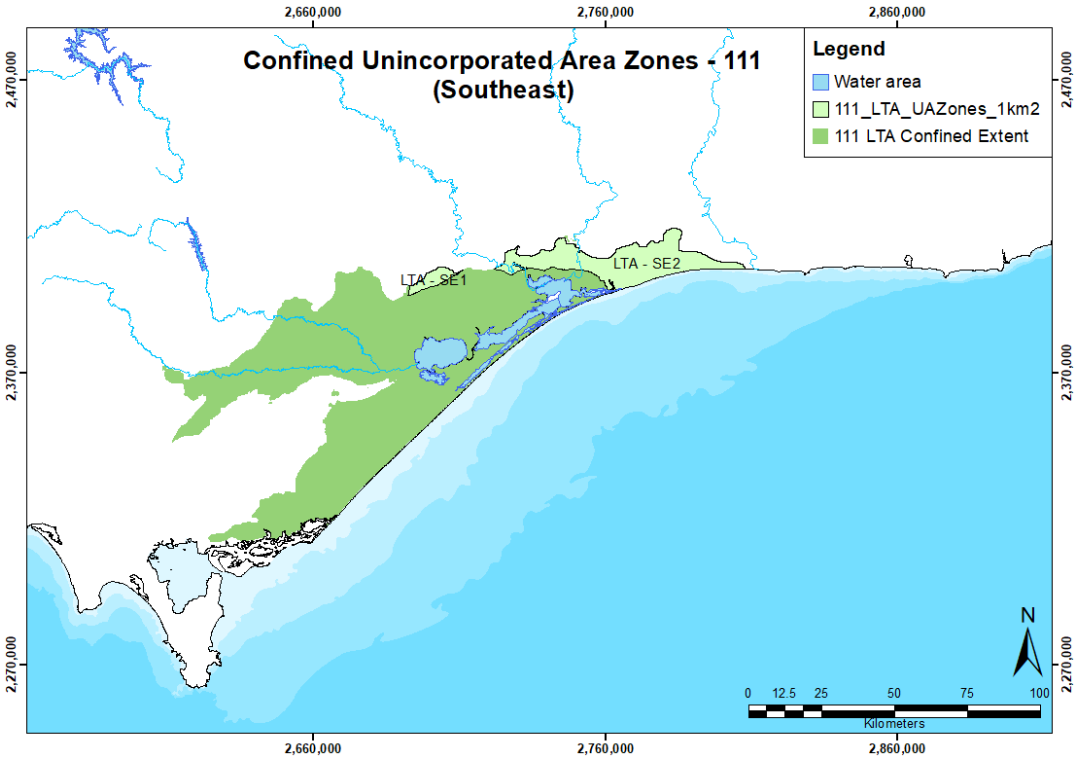

Figure 11. The confined UA zones of the LTA aquifer – southeast of the State

Figure 12 shows the confined UA zones for the LMTA aquifer. The Hopkins River serves as a boundary for indicating a change in salinity gradient. Therefore, it is used to split zones SW2 and SW3.

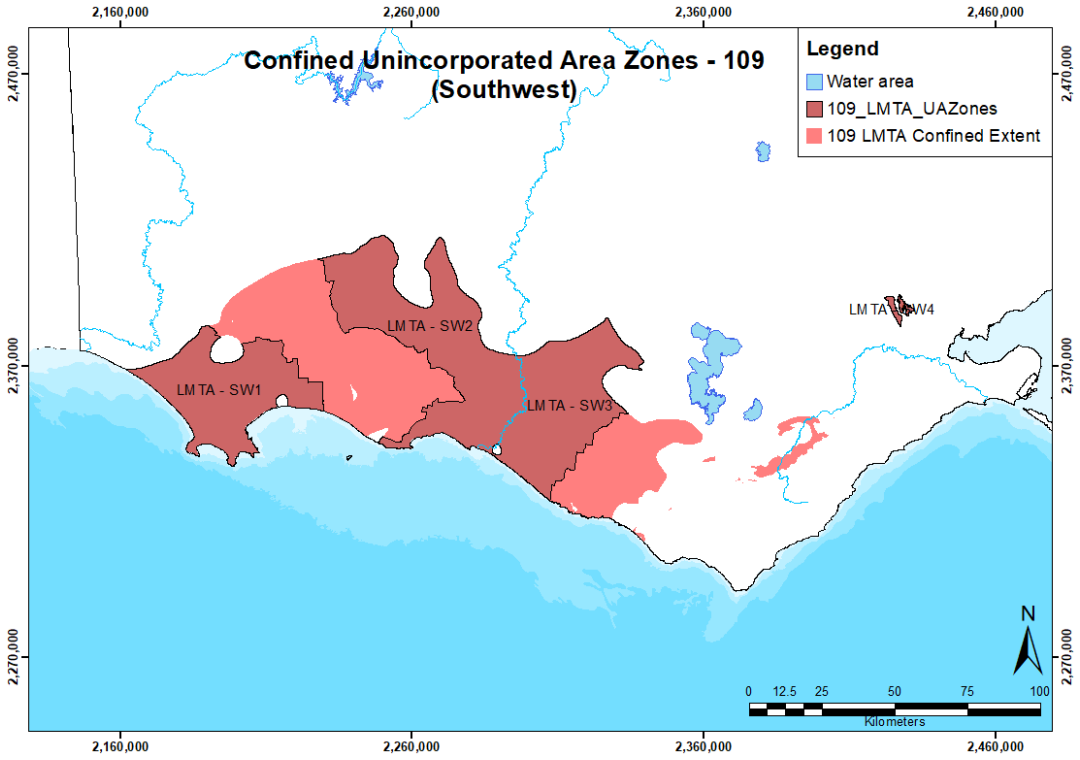

Figure 12. The confined UA zones of the LMTA aquifer

Figure 13 shows the confined UA zones for the UMTA aquifer. The Sunset National Park boundary is used to create zone 2.

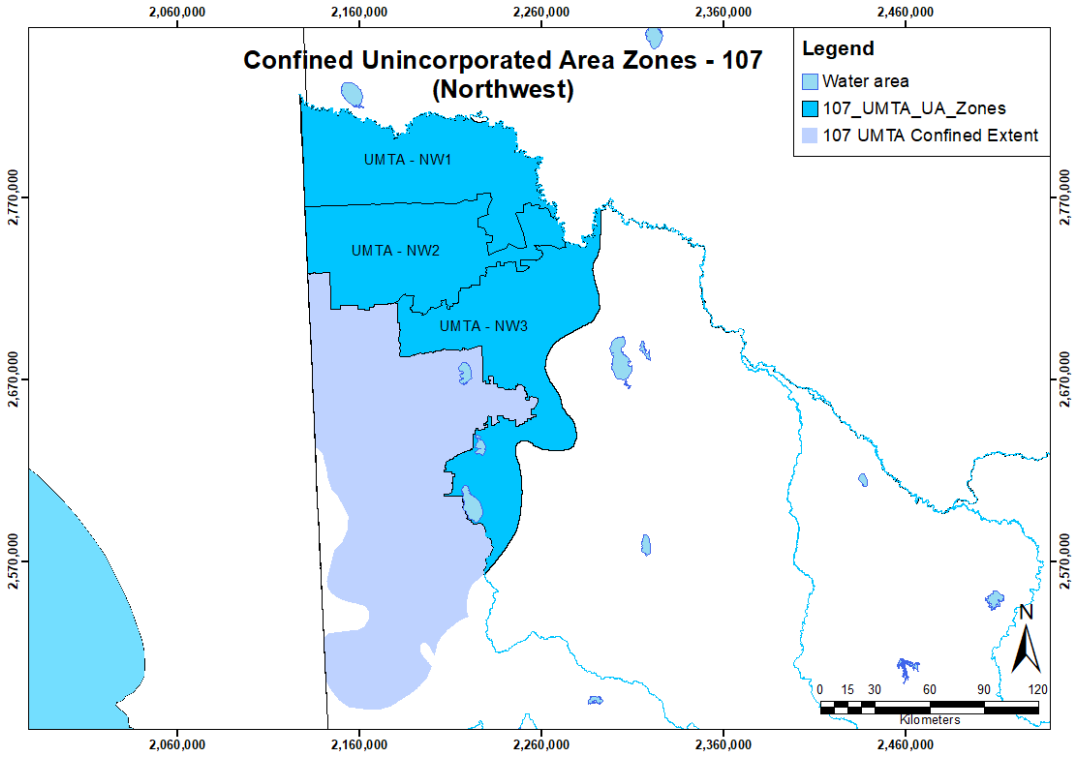

Figure 13. The confined UA zones of the UMTA aquifer

Figure 14 shows the confined UA zones for the UTAF aquifer.

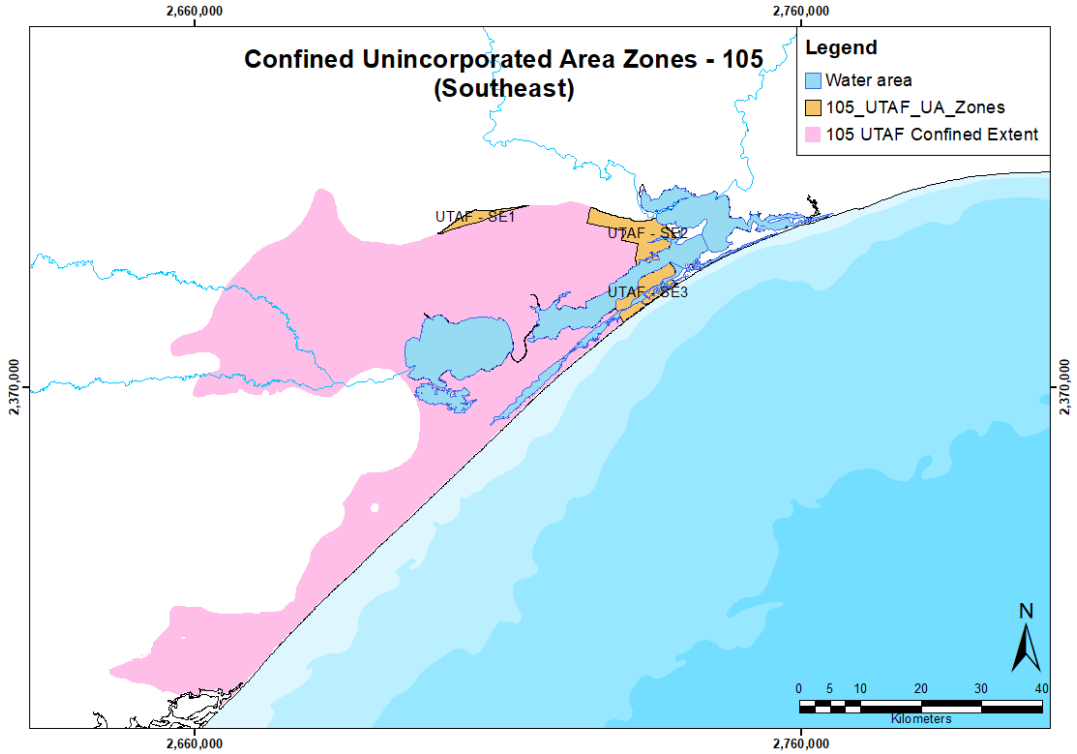

Figure 14. The confined UA zones of the UTAF aquifer

List of all confined UA areas

Table 3 and **Figure 15** show the confined UA areas across the state.

Table 3. List of all confined UA zones across the State

Unincorporated Area	Aquifer
Wimmera–Mallee	
UTAF-NE1	UTAF
UMTA-NW1	UMTA
UMTA-NW2	UMTA
UMTA-NW3	UMTA
LTA-NW1	LTA
LTA-NW2	LTA
LTA-NW3	LTA
LTA-NW4	LTA
LTA-NW5	LTA
Goulburn–Murray	
UTAF – NE2	UTAF
LTA – NE1	LTA
Otway–Torquay	
LMTA-SW1	LMTA
LMTA-SW2-A	LMTA
LMTA-SW2-B	LMTA
LMTA-SW3	LMTA
LMTA-SW4	LMTA
LTA-SW1	LTA
LTA-SW2	LTA
LTA-SW3	LTA
LTA-SW4	LTA
LTA-SW5	LTA
LTA-SW6	LTA
LTA-SW7	LTA
Central	
UTAF-PP2	UTAF
UTAF-PP1	UTAF
LTA-PP1	LTA
LTA-PP2	LTA
LTA-PP3	LTA
Gippsland	

Unincorporated Area	Aquifer
UTAF – SE1	UTAF
UTAF – SE2	UTAF
UTAF – SE3	UTAF
LTA – SE1	LTA
LTA – SE2	LTA

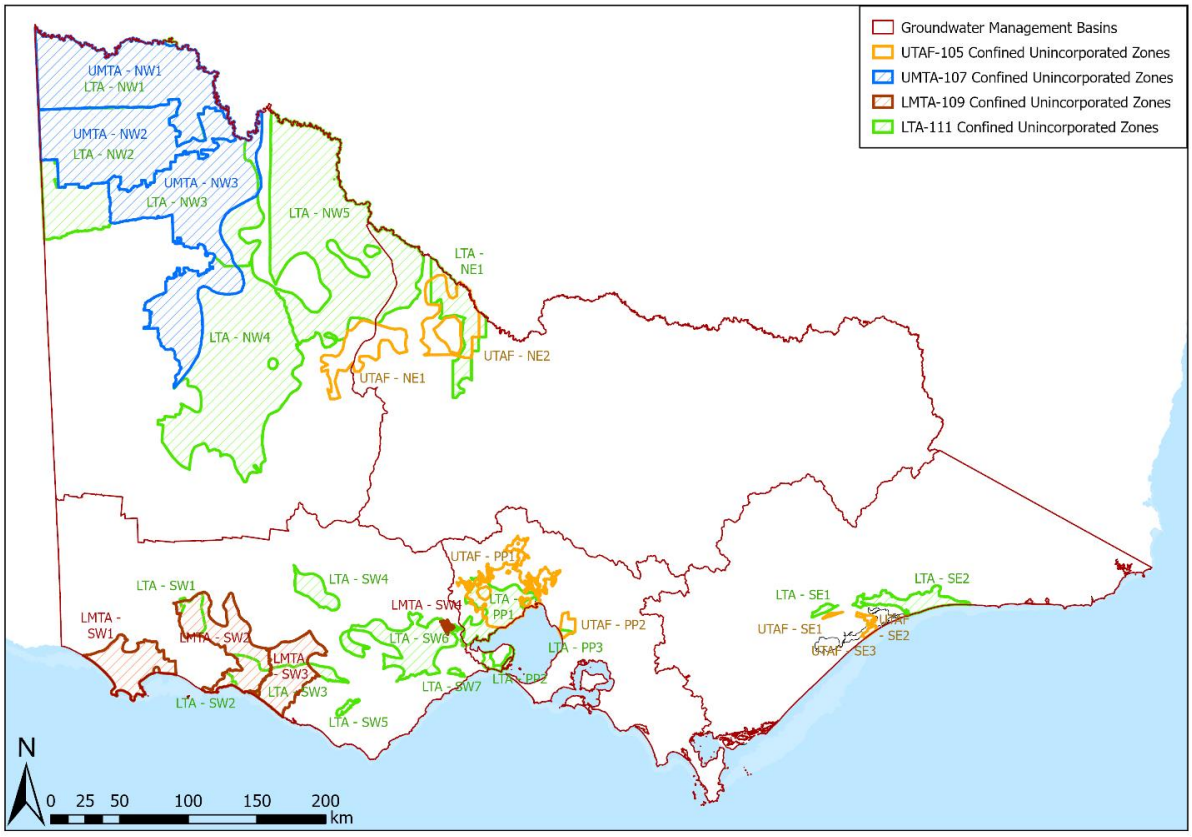

Figure 15. Location of all confined UA zones across the state

Naming conventions

The UA area names are determined by:

Which VAF unit they refer to,

Which region of the state they are in (Northwest, Southwest, Northeast, Southeast, or Port Phillip),

Sequenced from West to East according to the edge of the polygon area.

References

CDM Smith. (2025). *Review Of Groundwater Sustainable Yield: Unconfined and Semi-confined Aquifers.* Melbourne: CDM Smith.

DEECA. (2018). *Victorian Land Use Information System 2016-2017*. Retrieved from Datavic: https://data.gov.au/data/dataset/cbece4e0-7cbd-49c3-bc3a-76f41709fbdb

DSE. (2012). *Groundwater SAFE (Secure Allocations, Future Entitlements).* Melbourne: Department of Sustainability and Environment.

GHD Pty Ltd. (2012). *Victorian Aquifer Framework - Updates for Seamless Mapping of Aquifer Surfaces.* Melbourne: DSE.

GHD Pty Ltd. (2024). *Technical Assessment of State Wide Groundwater Sustainable Yields Confined Aquifers :Stage 2 (Statewide) report.* Melbourne: GHD Ltd Pty.

Jacobs. (2024). *Confined Aquifer Throughflow Assessment - Updated Method and Phase B State-wide Rollout.* Melbourne: Department of Energy, Environment and Climate Action.

Jacobs. (2024). *Confined Aquifer Throughflow Assessment - Updated Methof and Phase B State-wide Rollout.* Melbourne: Jacobs.