Western Sydney Aerotropolis (Initial Precincts)

Riparian Corridors Assessment

Acknowledgement of Country

Sydney Water respects the traditional 'Caring for Country' restorative approaches practiced over tens of thousands of years by Aboriginal people and play our part to improve the health of the landscape by recognising and nurturing all values of water in our environment.

In doing so, we acknowledge the traditional custodians and their ancestors of the lands and waters in Western Sydney where we are working and learning: the Dharawal and Dharug nations, as well as their neighbours the Gundungurra. Their lore, traditions and customs nurtured and continue to nurture the sweet waters in this area, creating wellbeing for all. We also pay our respects to Elders, past and present.

Executive summary

The waterways of the Wianamatta-South Creek catchment are unique and highly vulnerable to the impacts of urbanisation. The creeks, floodplains and landscapes of Wianamatta-South Creek are valuable natural assets that underpin the future amenity and liveability of the Aerotropolis and broader Western Parkland City. The protection, restoration and maintenance of waterways, riparian corridors, and water dependent ecosystems is essential in achieving the cultural, social and biodiversity aspirations, as well as tree canopy targets of the Western Parkland City. Therefore, the management of water in the Aerotropolis is therefore a critical component of precinct planning.

CTENVIRONMENTAL was engaged by Sydney Water to undertake a Riparian Corridors Assessment within the Western Sydney Aerotropolis (WSA) Initial Precincts on behalf of the Western Sydney Planning Partnership Office (PPO). This report presents the results of extensive field assessment and analyses of waterways within the Badgerys Creek, Aerotropolis Core, Agribusiness, Northern Gateway and Wianamatta Precincts.

A desktop review of aerial photography and spatial datasets was undertaken to identify mapped waterways, farm dams, key fish habitat, High Ecological Value Ecosystems (HEV) and Groundwater Dependent Ecosystems (GDE) across the precincts, in addition to aiding in the development of a Riparian Revegetation Strategy (RRS). Field assessments were conducted to validate waterways and top of bank mapping, identify key fish habitat, conduct assessments of the ecological value of farm dams, weed extent and bank erosion. A Riparian Revegetation Strategy (RRS), which outlines a strategy for the enhancement, protection and maintenance of waterways, riparian corridors and water dependent ecosystems that promotes the cultural, social and biodiversity objectives of the Aerotropolis region, was also developed and potential biodiversity credit generation of management zones within the precincts calculated.

This report was developed to be used to inform strategic planning and rezoning which is consistent with the Western Parkland City vision within the Agribusiness, Aerotropolis Core, Badgerys Creek and Northern Gateway precincts. The Wianamatta-South Creek corridor has been considered primarily where it is adjacent to the four initial precincts.

This report details results of the assessment which includes;

- Validation of the presence of mapped waterways, including creeks and wetlands,
- Top of bank delineation for validated waterways,
- Assessment of the ecological value of farm dams,
- Development of a high-level Riparian Revegetation Strategy (RRS).

Recommendation: Development within the WSA is to ensure waterways, riparian corridors, selected farm dams, open water bodies and other water dependent ecosystems are protected, restored and maintained. Vegetated riparian zones (VRZ) adjacent to creeks and other water bodies mapped must be protected, restored and maintained. Opportunities to revegetate beyond standard VRZs should be explored to maximize biodiversity outcomes and achieve urban canopy targets, particularly within the Wianamatta Precinct. The ongoing ownership and management of these assets must ensure adequate and sustainable funding for maintenance is available.

Field validated waterways with no top of bank

A total of 64 waterways that were identified for field validation were found to lack a defined top of bank (ToB). However, for the majority of these sites, overland flow paths were present and many exhibited signs of significant channel/flow path modification.

Recommendation: It is recommended that these flow paths are designed to consider future flows and have suitable vegetated riparian zones. If the alteration of these flow pathways is required, such as realignment/reconstruction/stabilisation in developable areas, it should be guided by the Riparian Revegetation Strategy (RRS) and site-based Vegetation Management Plans (VMP).

Field validated waterways and top of bank mapping

Based on desktop reviews and field validation of top of bank across the study precincts, approximately 134 km of waterways were identified as having a defined top of bank and must be retained in the landscape (Figure i).

Recommendation: It is recommended that a total of 33.1 km of 1st order, 38.27 km of 2nd order, 21.73 km of 3rd order, 19.72 km of 4th order and 20.77 km of 5th order waterways with defined top of bank be retained in the landscape unless minimal realignment of these waterways can be justified (Figure i). Creeks to be retained and their associated vegetated riparian zones should have an appropriate zoning and management response that promotes waterway function, enhances urban biodiversity and provides green space for community to find connection to natural places. It is also recommended that first order streams with upper catchments of 15 ha or greater should be retained in the landscape as daylighted creek channels. Alteration of these waterways will be required to consider future flows and have suitable vegetated riparian zones. The management of all retained waterways should be guided by the Riparian Revegetation Strategy (RRS) and site-based Vegetation Management Plans (VMP).

Ecological Assessment of Farm Dams

A total of 539 farm dams were identified across the study precincts, with 80 identified for ecological assessment and 64 field validated as meeting the criteria of farm dams for assessment. Across the precincts, 13 farm dams received scores that reflected the ‘Protect’ category, 18 were listed as suitable to ‘Restore’ and 33 sites were of Least Priority.

Recommendation: Farm dams to retain in the landscape are primarily based on those assessed as having high ecological value and classified by the assessment process as ‘protect’. These dams should also have appropriate zoning that promotes function of a wetland or open water body, enhances urban biodiversity and provides green space for the community to find connection to natural places. To do this it is recommended that these dams are managed and maintained to protect and restore their ecological values.

Riparian Revegetation Strategy

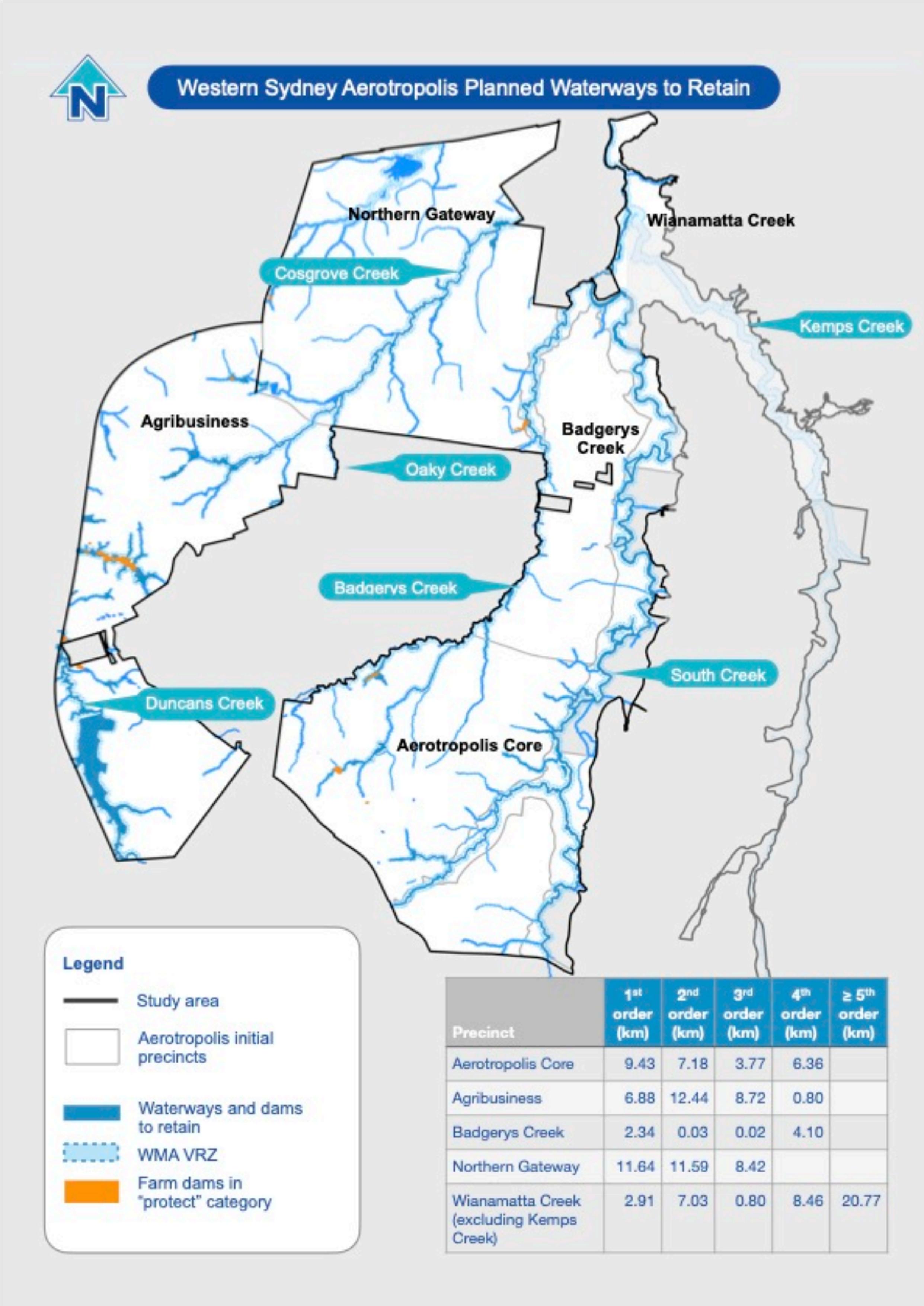
The Riparian Revegetation Strategy (RRS) for the Aerotropolis Initial Precincts seeks to identify strategies for the enhancement, protection and maintenance of waterways, riparian corridors and water dependent ecosystems. It aims to stabilise waterways, enhance and protect native riparian and floodplain ecology and create VRZs that support waterway health and social objectives. It incorporates factors such as hydraulic roughness, weed density, extent of creek channel erosion and extent of native vegetation and included desktop analysis and field assessments using rapid Riparian Assessments (RRA) and biometric vegetation assessments (BAM 2017). To effectively manage revegetation of riparian and floodplain vegetation across the Western Sydney Aerotropolis, management zones were identified (MZ1, MZ2, MZ3, MZ4 and MZ4a; Figure ii). The total cost estimate for vegetation management was calculated at $138,970,124 and the estimated cost for bed and bank stabilisation for all management zones was $297,942,000. The total cost which was estimated for the RRS vegetation management and creek stabilisation works was calculated as $436,911,952.

Recommendation: The RRS should advise strategic and ongoing management of waterway and floodplain areas of the WSA, particularly the Wianamatta-South Creek Precinct. Suitable funding sources and governance for ongoing management will be required through an appropriate ‘waterway manager’. It is important that new waterway health objectives and targets for development developed by the NSW Government under Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions be achieved in order to minimise bed and bank stabilisation costs. An assessment of riparian vegetation and bed and bank stabilisation should be undertaken for Kemps Creek, in addition to top of bank mapping. This will enable more accurate creek revegetation and stabilisation costings for future planning of the area.

Ecosystem credits

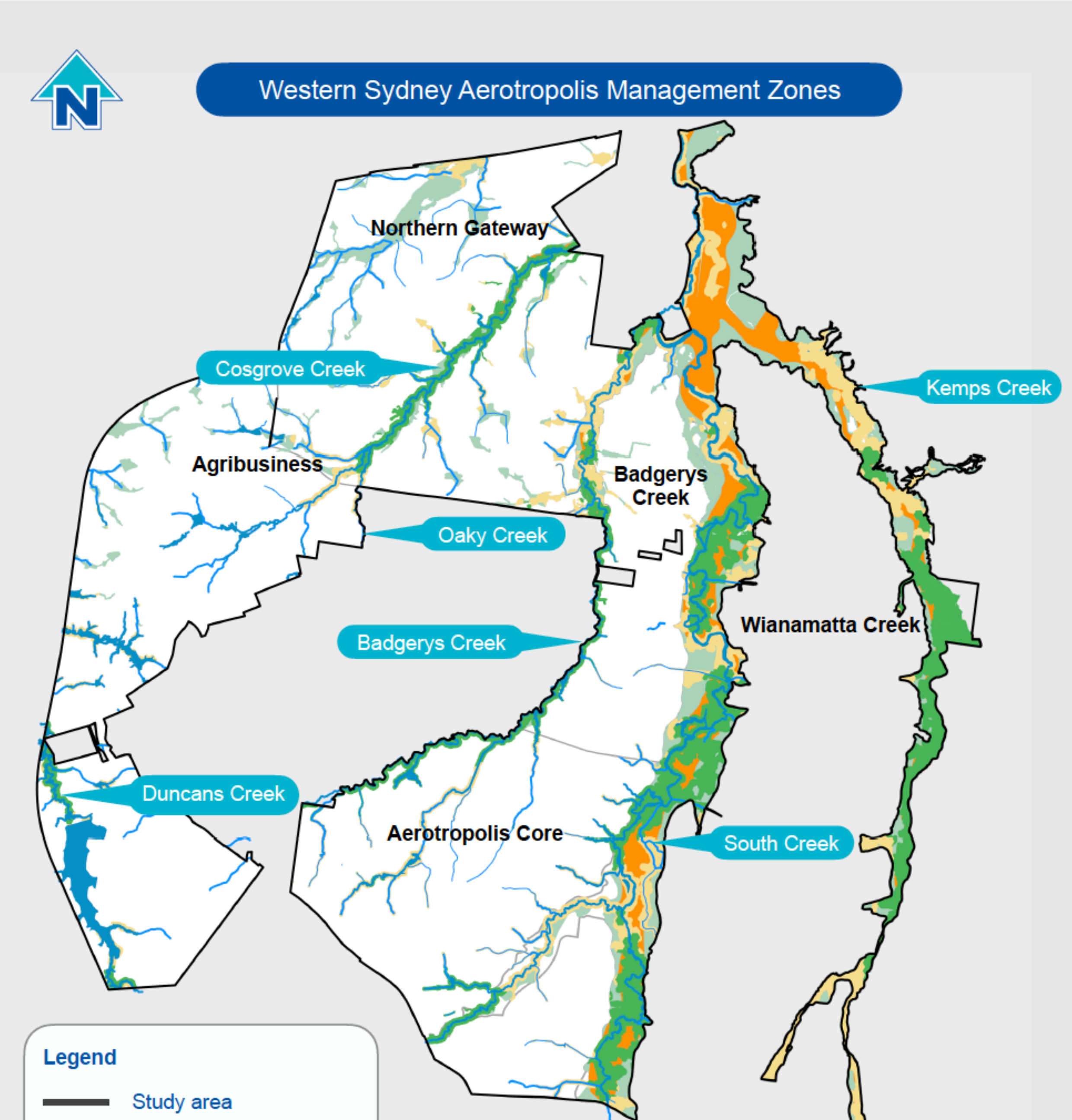
Potential ecosystem credit generation for the area covered by the RRS was undertaken using the OEH BAM Calculator (OEH 2020), which utilises calculations-based comparison of current state vegetation biometrics with Plant Community Type specific condition benchmarks (based on PCT 835 – Cumberland River Flat forest within the Sydney Basin IBRA region). Potential ecosystem credit generation was calculated for the management zones identified in the RRS (MZ1, MZ2, MZ3, MZ4 and MZ4a).

Recommendation: The total potential ecosystems generated across all management zones was calculated as 2388, with the highest credit generation for MZ1 HEV Protect. Potential ecosystem credit generation was based on all available land within the area covered by the RRS. The average price per credit over the last two years for PCT 835 is estimated at $16,145.26. However, the number of potential credits generated are estimates based on the desktop review and do not take into consideration current or planned future offsets.



Precinct	1st order (km)	2nd order (km)	3rd order (km)	4th order (km)	≥ 5th order (km)
Aerotropolis Core	9.43	7.18	3.77	6.36	
Agribusiness	6.88	12.44	8.72	0.80	
Badgerys Creek	2.34	0.03	0.02	4.10	
Northern Gateway	11.64	11.59	8.42		
Wianamatta Creek (excluding Kemps Creek)	2.91	7.03	0.80	8.46	20.77

Figure i Waterways recommended to be retained across Western Sydney Aerotropolis study precincts including creeks and farm dams



Precinct	Protect MZ 1 (ha)	Improve MZ 2 (ha)	Re-vegetate Reveg MZ 3 (ha)	Re-vegetate Reveg MZ 4 (ha)	Re-vegetate Reveg MZ 4A (ha)
Aerotropolis core	40.2	42.8	2.0	13.5	0.1
Agribusiness	14.4	22.8	0.0	88.5	20.5
Badgerys Creek	20.7	6.9	7.7	2.0	21.3
Northern Gateway	60.2	59.3	10.4	66.8	62.9
Wianamatta Creek	378.5	305.0	453.6	32.8	268.9

Figure ii RRS management zones across the Western Sydney Aerotropolis. Parts of South Creek and Kemps Creek south of Elizabeth Drive is not within an initial precinct but may be considered as part of the Riparian Revegetation Strategy

Table of contents

Figures

Tables

1 Introduction

In September 2020, the Minister for Planning and Public Spaces approved *State Environmental Planning Policy (Western Sydney Aerotropolis) 2020* (*Aerotropolis SEPP*) to enable the rezoning of lands surrounding the proposed Western Sydney Airport, known as the Western Sydney Aerotropolis (Aerotropolis). The rezoning is for a mix of employment, residential and community uses.

The Aerotropolis lies mostly within the Wianamatta-South Creek catchment. Wianamatta is the Dharug name for South Creek and means 'mother's place' or 'mother's creek.' Wianamatta is highly significant to First Nations people who have cared for Country, including the waters of Wianamatta for thousands of years.

The waterways of the Wianamatta-South Creek catchment are unique and highly vulnerable to the impacts of urbanisation. The creeks, floodplains and landscapes of Wianamatta-South Creek are valuable natural assets which underpin the future amenity and liveability of the Aerotropolis and broader Western Parkland City. The management of water in the Aerotropolis is therefore a critical component of precinct planning.

1.1 Strategic Context

The *Aerotropolis SEPP* includes the following two aims:

1. to protect, maintain and enhance, and to minimise the impact of development on, trees and vegetation, soil quality and the health of waterways and to contribute to the conservation of biodiversity,
2. to recognise and protect the ecological and cultural value of Wianamatta–South Creek.

The *Aerotropolis SEPP* also states the objectives of the Environment and Recreation Zone (which encompasses much of the Wianamatta flood plain) as being:

- To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values.
- To protect the ecological, scenic and recreation values of waterways, including Wianamatta–South Creek and its tributaries.
- To provide a range of recreational settings and activities and compatible land uses.
- To protect and conserve the environment, including threatened and other species of native fauna and flora and their habitats, areas of high biodiversity significance and ecological communities.

This Riparian Corridors Assessment (the study) responds to the scope defined by the Western Sydney Planning Partnership (WSPP). The study identifies waterways and their riparian zones that must be protected. It also identifies existing waterway values and makes recommendations for how they should be enhanced in order to achieve regulatory compliance as well as the vision, aims and objectives outlined in the SEPP and other government strategies for Western Sydney.

1.2 Public consultation

The Draft Stormwater and Water Cycle Management Study Interim Report was publicly exhibited in November 2020. This interim report included mapping, commentary and recommendations on the riparian corridor assessment work that was underway at that time. This version of the Riparian Corridors Assessment is a stand alone study and report but closely relates to the Stormwater and water cycle management study (Sydney Water 2021). The interrelationships and roadmap for completing both these pieces of work are summarised in Figure 1-1 on the next page.

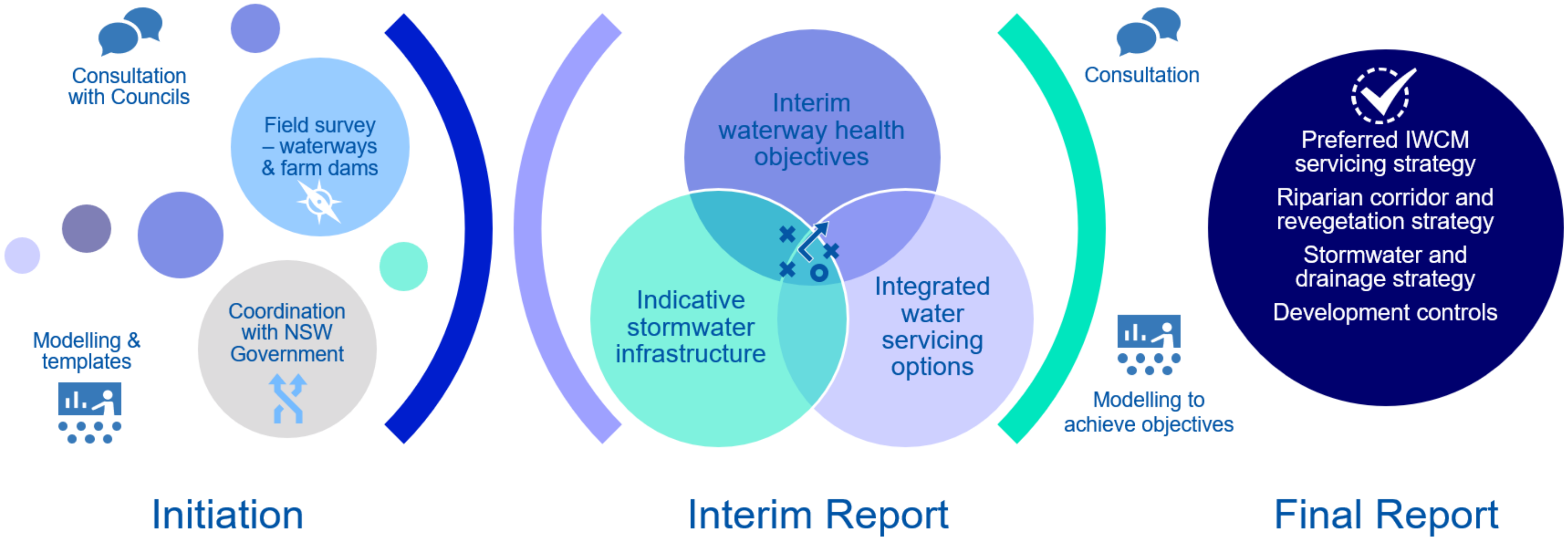


Figure 1-1 Study road map

1.3 Initial Precincts

Five precincts surrounding the proposed Western Sydney Airport in the Aerotropolis have been planned for initial release/rezoning (shown in Figure 1-2):

- Badgerys Creek
- Aerotropolis Core
- Agribusiness
- Northern Gateway
- Wianamatta-South Creek (where it adjoins the precincts above)

Several creeks intersect the initial precincts including:

- Badgerys Creek
- South Creek
- Thompsons Creek
- Science Creek
- Cosgroves Creek
- Duncans Creek

This report has been prepared based on the boundaries in the Draft Western Sydney Aerotropolis Precinct Plan, which was exhibited on the Department of Planning, Industry and Environment's webpage between December 2020 and March 2021. Waterway reporting has also included the portion of the Wianamatta-South Creek Precinct, which is in a non-initial precinct of the Aerotropolis. This is due to the reporting synergies across this precinct.

Badgerys Creek

This precinct is a low-lying area between the well-vegetated Wianamatta-South Creek and Badgerys Creek corridors. The land use consists of small agricultural plots with frequent farm buildings and road infrastructure. A strip of 'Environmentally Sensitive Land' runs through the centre of this zone and significant Cumberland Plain vegetation is focussed along the creek corridors.

Aerotropolis Core

Badgerys Creek follows the northern boundary of this precinct and Thompsons Creek and Wianamatta-South Creek form the southern boundary. The precinct is largely low-lying with higher terrain located along the western boundary. Well-vegetated, small agricultural plots with frequent farm buildings and road infrastructure dominate the area. Significant Cumberland Plain vegetation is found towards the west of the zone and includes primarily Grey box woodland.

Agribusiness

This precinct is largely dominated by an open rural landscape with sparse buildings and roads and interspersed with pockets of forested vegetation and agricultural dams. The rural village of Luddenham is located within this precinct and the adjacent land is generally higher than surrounding precincts providing long distance views towards the Blue Mountains to the northwest. Duncans Creek follows the western boundary of this precinct and there are significant areas of existing vegetation and existing dams associated with this corridor. Key vegetation types include Forest Red Gum and Grey Box woodland.

Northern Gateway

This precinct borders a residential estate associated with the Twin Creeks Golf and Country Club and is predominantly a flat, rural landscape with large agricultural lots. The Cosgroves Creek corridor dissects the precinct from southwest to northeast and a second creek runs along the northern boundary of the precinct and contains a number of small existing farm dams. The highest terrain is located in the southwestern corner of the precinct and a large segment of this precinct is also designed as 'Environmentally Sensitive Land' and follows the Cosgroves Creek corridor and the southern boundary of the precinct. Existing blocks of Cumberland Plain vegetation are scattered across the area and consist primarily of Broad-leaved Iron Bark and Grey Box woodland.

Wianamatta-South Creek

This precinct follows the riparian corridors of Wianamatta-South Creek and Kemps Creek and is dominated by significant areas of Forest Red Gum woodlands and associated grasslands. The plots of woodland become smaller and more sparsely located as the two creeks join in the north of the precinct. Agricultural plots and infrastructure towards the edges of the precinct generally border the vegetated corridors.

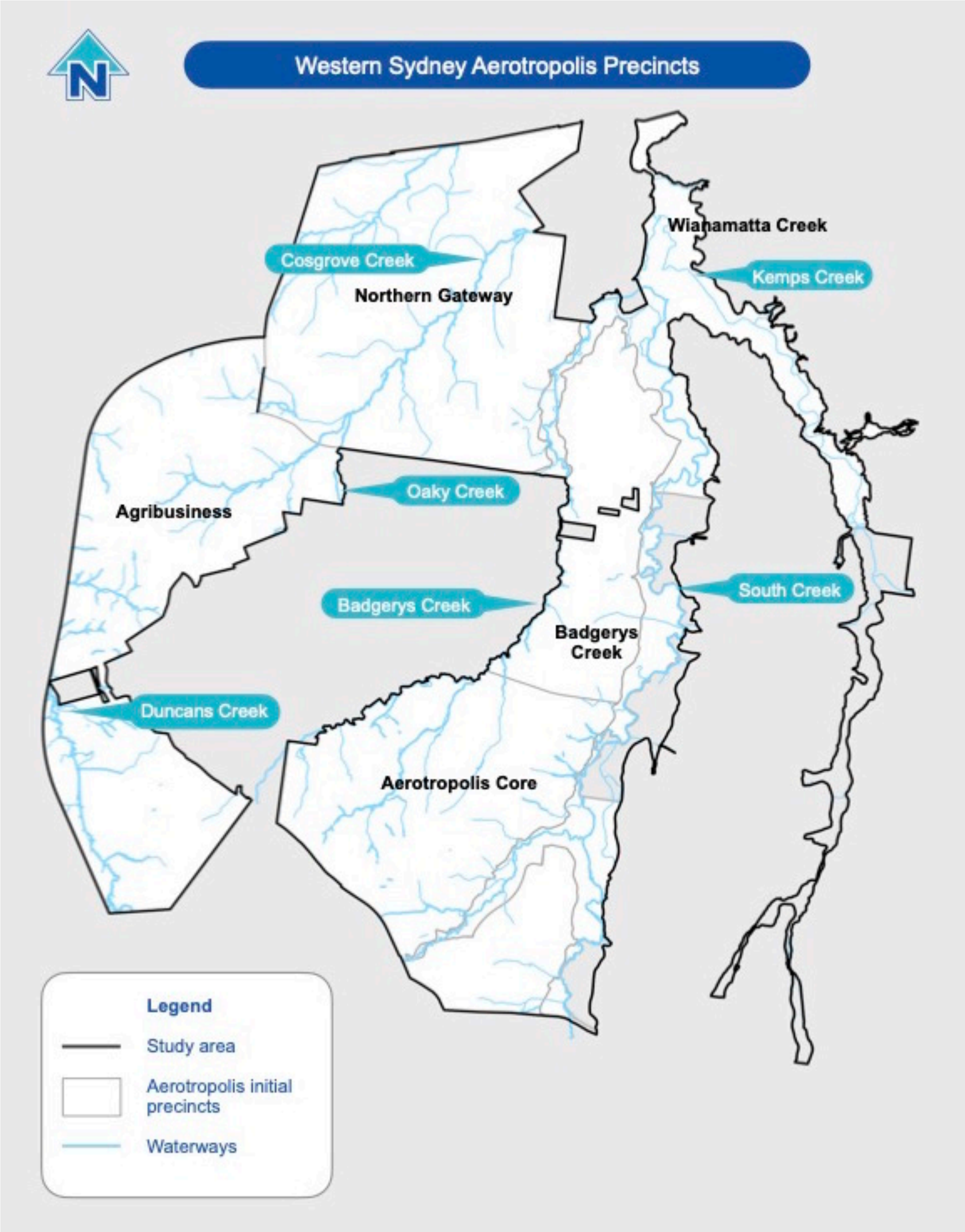


Figure 1-2 Aerotropolis creeks and associated tributaries.

1.4 Study objectives

The objectives of this *Riparian Corridors Assessment* (the study) are to outline and present the results of extensive field investigations including waterway validations, farm dam ecological assessments, weed extent, bank erosion mapping and the development of a high-level Riparian Revegetation Strategy (RRS). The study has been conducted as part of and in conjunction with the precinct planning process and will inform and support the rezoning of the Aerotropolis Initial Precincts.

The three key objectives of this study are outlined below.

- **Objective 1:** Waterway Validation and Top of Bank Mapping
    - Determine the presence of mapped and potential unmapped waterways across the four Precincts using spatial data reviews, validate and map top of bank and provide recommendations for future zoning.
- **Objective 2: Ecological Assessment of Farm Dams**
    - Undertake desktop and field ecological assessments of farm dams across the four precincts and provide recommendations as to which dams to integrate into future rezoning.
- **Objective 3:** Development of Riparian Revegetation Strategy (RRS)
    - Develop a Riparian Revegetation Strategy (RRS) for the four precincts that provides high-level guidance on the cost of riparian management actions and potential biodiversity credit generation.

2 Methods

2.1 Desktop review

A desktop review of aerial photography and spatial datasets was conducted for components relating to mapped waterways, farm dams and for the Riparian Revegetation Strategy. Spatial data sets used included:

- NSW Waterways Strahler Stream Ordering – data: Shapefile – Source: Planning Partnership Office (PPO) (2019). Accessed: Provided by PPO.
- 1:25,000 NSW Topographic maps for Outer Sydney Region – Shapefile – Source: NSW Department of Lands and Property Information (2006). Accessed: https://maps.six.nsw.gov.au/clipnship.html (2019).
- DPIE High Ecological Value and Water Dependent Ecosystem (HEV) for Liverpool, Penrith and Camden LGA's – Shapefile – Value Ecosystem (HEV) mapping for South Creek catchment – Source: NSW Department of Planning Industry and Environment (DPIE) (2020). Accessed - https://datasets.seed.nsw.gov.au (2020).
- Remnant Vegetation of the Western Cumberland Subregion 2013 update VIS_ID-4207 – Shapefile – Source: NSW Department of Planning Industry and Environment (DPIE) (2013). Accessed - https://datasets.seed.nsw.gov.au/dataset/remnant-vegetation-of-the-western-cumberland-subregion-2013-update-vis_id-4207fd1f4 (2020).
- Key Fish Habitat (KFH) Mapping of LGA's in the Sydney Area and Threatened Species Habitat Mapping – data: PDF – Source: NSW Department of Primary Industries (2007). Accessed https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/634354/Sydney_updated.pdf (2020).
- NSW Department of Primary Industries (2013) Native Vegetation of the Cumberland Plain.
- DPIE Fisheries Key Fish Habitat (KFH) and Threatened Species Habitat Mapping.
- DPIE Fisheries Policy and guidelines for fish habitat conservation and management (update 2013).
- Australian Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems (GDE) – data: Shapefile – Source: Australian Bureau of Meteorology Groundwater Dependent Ecosystem Atlas. Accessed http://www.bom.gov.au/water/groundwater/gde/map.shtml (2020).
- Western Sydney Aerotropolis Precinct Boundaries – data: Shapefile – Planning Partnership Office (PPO) (2019). Accessed: Provided by PPO.
- Modelled flood extent data: Shapefile – Planning Partnership Office (PPO) (2019). Accessed: Provided by PPO.

2.1.1 Determination of stream order and Vegetated Riparian Zone Buffer Widths

Stream order was determined based on NSW Waterways Strahler Stream Ordering data (PPO 2019). The *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (NRAR 2018) provides guidance to establish Vegetated Riparian Zones (VRZ) along watercourses which are based on the Strahler stream ordering system (Figure 2-1).

The VRZ is measured from the top of the creek bank and also includes the creek channel. The minimum required VRZ width for a first order stream is 10 m either side of the creek (measured from top of bank) plus the width of the creek channel. The maximum required VRZ is 40 m either side of the creek (measured from top of bank) plus the channel width and this is applied to 4th order and greater streams, wetlands, estuaries, and tidal influenced waters (Table 2-1).

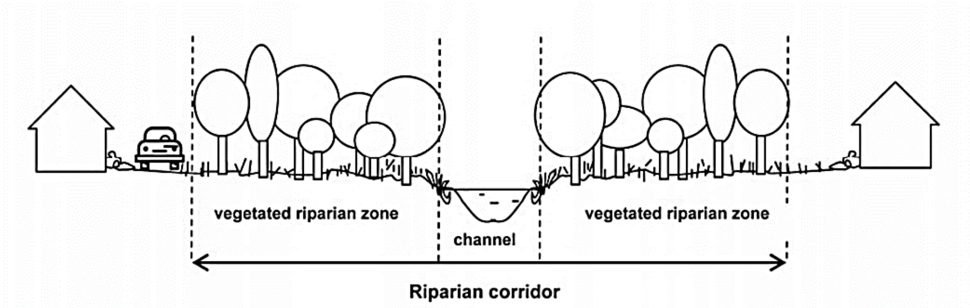


Figure 2-1 Vegetated Riparian Zone (VRZ)

Table 2-1 Required riparian corridor widths according to Strahler stream order (NRAR 2018)

Strahler Stream Order	VRZ Width (m)	Total Riparian Corridor Width (m)
	(each side of watercourse)	
1st order	10 m	20 m + channel width
2nd order	20 m	40 m + channel width
3rd order	30 m	60 m + channel width
4th order and greater, wetlands, estuaries, and tidal influenced watercourse	40 m	80 m + channel width

2.1.2 Identification of Key Fish Habitat

Key Fish Habitat (KFH) was identified using datasets including, KFH Mapping of LGA's in the Sydney Area and Threatened Species Habitat Mapping datasets (NSW Department of Primary Industries 2007), the DPIE Fisheries Key Fish Habitat (KFH) and Threatened Species Habitat Mapping and the DPIE Fisheries Policy and guidelines for fish habitat conservation and management (update 2013).

2.1.3 Identification of Groundwater Dependent Ecosystems

Groundwater Dependent Ecosystems (GDE) were identified using the Australian Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems (GDE) dataset (Australian Bureau of Meteorology 2020).

2.1.4 Identification of High Ecological Value Ecosystems

High Ecological Value Ecosystems (HEV) were identified using datasets including the DPIE High Ecological Value and Water Dependent Ecosystem (HEV) for Liverpool, Penrith and Camden LGA's, HEV mapping for South Creek catchment (NSW Department of Planning Industry and Environment 2020), the Remnant Vegetation of the Western Cumberland Subregion 2013 update VIS_ID-4207 (NSW Department of Planning Industry and Environment 2013), and the NSW Department of Primary Industries (2013) Native Vegetation of the Cumberland Plain.

2.1.5 Identification of Waterways for Field Validation, Top of Bank Mapping and Allocation of Vegetated Riparian Zone (VRZ).

To identify waterways for field validation and top of bank mapping a multi-criteria selection process was developed. Spatial data was interrogated, and waterways which fell into one or more of the flowing criteria were selected for field validation.

- Waterways identified as part of the desktop review and located within Badgerys Creek, Aerotropolis Core, Agribusiness and Northern Gateway Precincts that are considered as High Ecological Value Water Dependent Ecosystems (HEV).
- Waterways with Stream Order of 3 or greater within the Badgerys Creek, Aerotropolis Core, Agribusiness and Northern Gateway Precincts.
- Waterways within Wianamatta-South Creek Precinct.

An assumption was applied that waterways with Stream Order of 1 and 2 located within the Badgerys Creek, Aerotropolis Core, Agribusiness and Northern Gateway Precincts that fell outside areas identified as HEV were likely to be realigned or piped by future development and were therefore not considered for validation.

An exception to this was those waterways of First Order with upper catchments of > 15 Hectares. These waterways were not assessed but were considered as remaining in the landscape under future development scenarios.

2.1.6 Identification of farm dams for ecological assessment

Farm dams as they currently exist in the Wianamatta-South Creek catchment primarily provide water for stock and domestic uses in agricultural areas, and as a secondary consequence, provide aesthetic and ecological habitat functions. They have typically been constructed as private works to store supplementary water for use on properties. This storage function results in significant areas of water in the landscape, which can be highly beneficial for the Aerotropolis.

To facilitate this, the location, size and operation of existing farm dams need to be considered and where possible, dams should be retained and enhanced to provide water in the landscape functions for the future urbanised landscape. Critical to the success of retaining farm dams is to understand how they can best operate in a future urban environment.

Key benefits of retained farm dams include:

- Storage and evaporation of stormwater runoff;
- Control of the release of stormwater to minimise hydrologic impacts;
- Retain/provide key ecological habitat features (e.g. chain of ponds, open water bodies and wetting of native vegetation communities);
- Provision of alternative sources of water for reuse opportunities and irrigation;
- Water quality treatment (if properly configured);
- Aesthetic features of water in the landscape;
- Recreational opportunities (walking trails etc.);
- Reduction in urban heat island impacts due to water presence in the landscape enhancing evaporative cooling.

In 2020, Alluvium and CTENVIRONMENTAL developed a decision framework applied to farm dams across Wianamatta-South Creek catchment to determine whether the water body could be retained in the landscape or removed. This framework considers the following metrics:

- Size (surface area and likely depth), including a water balance of typical farm dams to determine appropriate sizing;
- Contributing catchment area;
- Ecological condition or if the farm dam provides ecological services;
- Amenity provisions;
- Land use and zoning, such as development areas, EECs, riparian zones.

Application of the framework provides an informed approach to the decision-making process regarding future management of farm dams across the catchment.

To assess the ecological condition of farm dams across the precincts, a combination of desktop and field assessment were undertaken, the results of which were fed into the decision framework as a component of the “waterway retain or remove” process.

Desktop assessment to identify eligible dams for assessment.

Spatial data sets and aerial photography were used to determine which farm dams would be considered for field assessment.

Criteria applied included:

- Dam surface area of 0.2 – 3% of the upstream catchment;
- Located on a 1st, 2nd, or 3rd order stream;
- Located within the DPIE HEV mapped areas.

Development of rapid ecological assessment method for farm dams

A rapid assessment method was developed to enable a rapid qualitative assessment of the ecological value of farm dams. This method was based on the framework described in Wetland Assessment Techniques Manual for Australian Wetlands (Price et al 2007). This method was applied as it was previously used by Hull (2016) to assess farm dam ecology across the South Creek catchment and was therefore considered as a suitable method to apply to this study.

Metrics considered included;

- Distance of dam to native vegetation;
- Connectivity to creek;
- Presence/extent of native macrophytes;

- Presence of native water dependent fauna (mapped on BIONET and observed);
- On or adjacent to mapped Key Aquatic Habitat;
- Presence/extent of fringing wetland ecosystem.

A ranking system was developed which scores farm dams according to their ecological value, which was then applied during the field assessment stage.

2.2 Field assessment

2.2.1 Assessment of Key Fish Habitat

Field validation to verify Key Fish Habitat (KFH) were conducted across waterways that were identified as mapped Key Fish Habitat by the desktop review. The field validations sought to:

- Identify existing aquatic habitat occurring across the precincts;
- Identifying any species, populations or ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the NSW *Biodiversity Conservation Act 2016 Act* or the *Fisheries Management Act 1994*;
- Identify any requirements for further work under the relevant legislation;
- Identify any noxious aquatic weed species listed under the Biosecurity Act 2015;
- Ground-truth and validate habitats and identify threatened species (aquatic and groundwater dependent) through field surveys.

This information was then used to develop precinct mapping and inform revegetation strategies.

Field assessments of KFH were carried out following the framework outlined by DPIE Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (update 2013).

The presence/absence of significant in-stream habitat, such as rocks, woody debris, and snag were assessed which enabled the KFH Type and Class to be assigned in accordance with DPIE Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (update 2013).

Kemps Creek was not field assessed as it is outside the scope of the project.

2.2.2 Assessment of Groundwater Dependent Ecosystems

Field validations also encompassed assessment of groundwater dependent ecosystems (GDE) within the Initial Precincts. The field validations sought to:

- Identify existing GDE occurring in the precinct;
- Identify any noxious aquatic weed species listed under the Biosecurity Act 2015

2.2.3 Field validated waterways and top of bank mapping

To validate waterways across the Precincts, spatial data compiled during the desktop analysis were loaded into a GIS field app (iGIS) and displayed on field iPads. Validation and top of bank mapping were conducted based on waterways identified during the desktop review. Features such as wetlands, anabranches and gullies that did not feature in the desktop survey were validated and where appropriate mapped, or alternatively validated as not meeting requirements of a waterway as per the WM Act and WM Regulation.

In the case where creek bed and bank were present, top of bank mapping was undertaken using a Trimble DGPS by walking along the route of the high point on the creek bank and recording X, Y, Z coordinates at an approximate spatial distribution of 5 m.

Where access was not possible, visual inspection was undertaken using a MAVIC Pro 2 drone with 4k camera to determine if bed and bank were present. If this was the case, top of bank was manually digitised using LiDAR.

This method does not result in the same accuracy as application of DGPS but enables an estimate of top of bank upon which Vegetated Riparian Zones (VRZ) can be applied.

It was necessary to assess Science Creek and tributaries which are located in the Northern Gateway Precinct using this approach as access to the properties contain these waterways was denied at the time field survey was undertaken.

Following field assessment VRZ's were assigned to waterways according to those required by NSW Water Management Act 2000 (Table 2.1).

Vegetated Riparian Zones were delineated from field validated top of bank mapping. In the case where waterways were found to have no top of bank, but were considered as a waterway, a representative channel width of 5 m was assumed. First and second order waterways within HEV mapped areas with no defined bed or bank have an ad-hoc VRZ of 22.5 m each side of the mapped creek centre line (an additional 5 m has been included as an estimate of channel width). The intention of this is to provide guidance on delineating flow paths to accommodate a 2 yr ARI flow.

First order streams outside HEV areas with catchments less than 15 ha have been removed under the assumption these will be piped in the development stages.

2.2.4 Ecological assessment of farm dams

Field assessment to assess ecological value of farm dams

Farm dams identified for assessment during the desktop review were then analysed using the ecological assessment method for farm dams that was developed. Each dam was visited on foot, or where access was restricted or time constrained, a drone fly over was used to capture up close aerial photos or satellite images (from Google Maps or Nearmaps) was used and the assessment performed remotely. Assessment data was then consolidated with farm dams ranked according to the method applied and a shapefile generated for mapping of results.

Mapping of assessment results and recommendation for retention or removal based on ecological value

Following collation of field assessments, results were mapped by precinct and recommendations for retention or removal based on ecological data made. Farm dams were grouped based on results into three categories, Protect (overall scores greater than the 80th percentile), Restore (overall scores between the 50th and 80th percentile) and Least Priority (less than the 50th percentile).

It is noted that the dams are unlikely to provide any meaningful retardation of flows, as it would be valid to assume that the dams would be full at the start of a storm event. This is even more likely if the dams are required for visual appeal.

Regarding dam safety, the majority of farm dams are privately constructed with no regulation of the construction material and techniques, and no ongoing monitoring; therefore, the geotechnical stability of the dam embankment walls is unknown. If identified for retention, the potential impact in case of failure will need to be assessed through hydraulic modelling in accordance with Dams Safety NSW requirements. Since these dams will be located in an urban environment, it is likely some of the retained dams would create a safety hazard if they failed. This may influence their viability where potential risks posed to future development are not acceptable. If assessed as having failure consequences, the dams would need to be registered with Dams Safety NSW, remediated structurally, and require ongoing asset management and reporting. Dams to be retained will need to be integrated with the urban fabric and public safety will need to be ensured.

3 Results

The following section provides results of desktop review and field validation surveys for the following;

- Key Fish Habitat (KFH)
- Groundwater Dependent Ecosystems (GDE)
- High Ecological Value Water Dependent Ecosystems (HEV)
- Stream order and waterways for assessment
- Waterways validated with no top of bank present
- Waterways validated with top of bank present and mapped
- Farm dam ecological assessment

3.1 Key Fish Habitat

Key Fish Habitat (KFH) was determined based on review of KFH Mapping of LGA's in the Sydney Area, Threatened Species Habitat Mapping datasets (NSW Department of Primary Industries 2007), DPIE Fisheries KFH and Threatened Species Habitat Mapping, and the DPIE Fisheries Policy and guidelines for fish habitat conservation and management (update 2013) and field assessment.

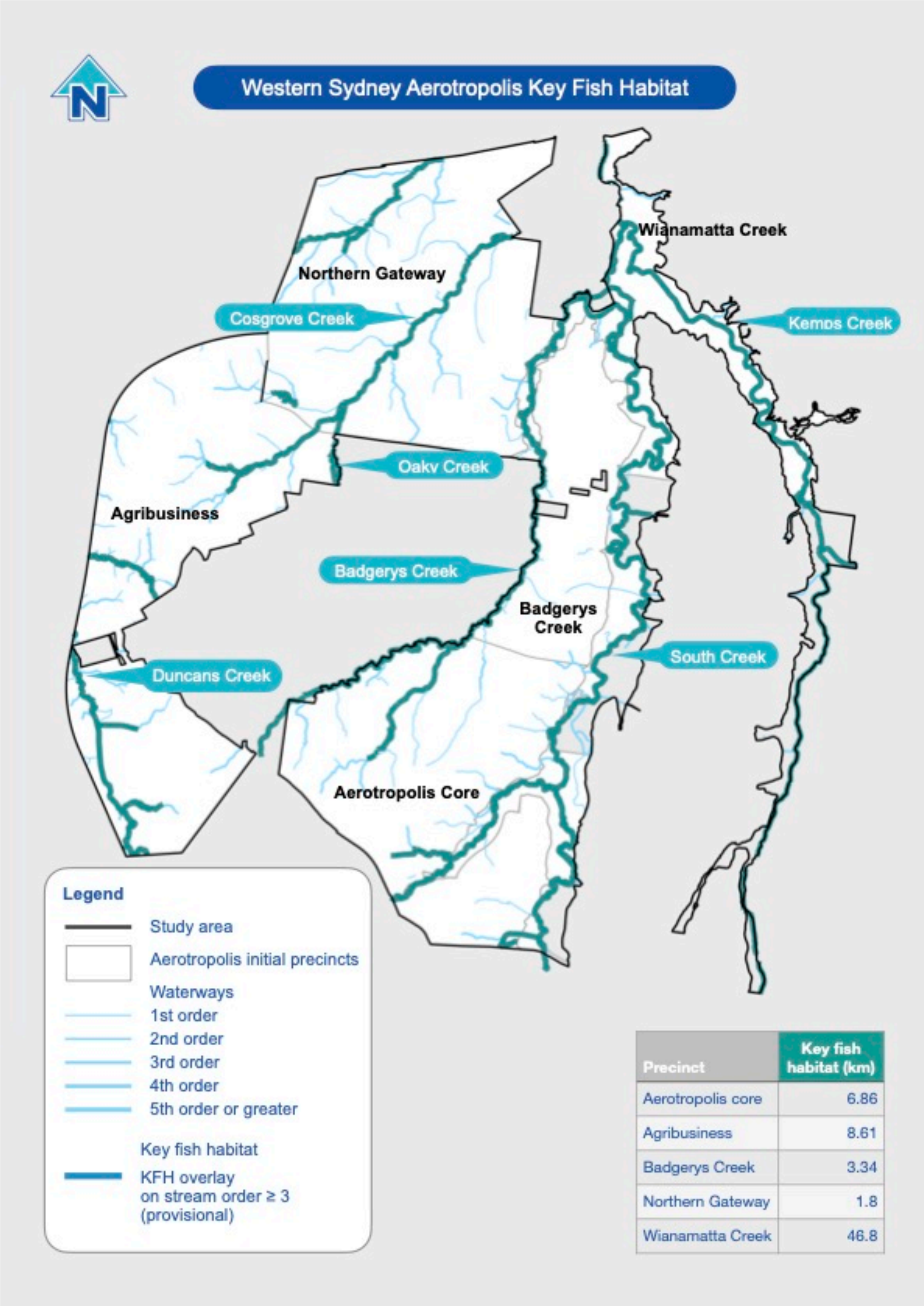
KFH Type and Class was determined in the field and included qualitative visual assessment of key characteristics of fish habitat, including in-stream rocks and gravel beds, large woody debris, perennial and ephemeral flow, presence of macrophytes as described by DPIE Fisheries Policy and guidelines for fish habitat conservation and management (update 2013).

Review of KFH mapping (DPIE 2007) shows the major creeks across the study are considered KFH which includes Wianamatta-South Creek, Badgerys Creek, Science Creek, Cosgroves Creek, Thompsons Creek and Duncans Creek (Figure 3-1).

A breakdown of the total length of mapped KFH by precinct is listed below shown and in Figure 3-2:

- Aerotropolis Core: 6.86 km
- Agribusiness: 8.61 km
- Badgerys Creek: 3.34 km
- Northern Gateway: 1.8 km
- Wianamatta-South Creek: 46.8 km

Figure 3-1 Example of mapped Key Fish Habitat (KFH) – Wianamatta-South Creek Precinct



Precinct	Key fish habitat (km)
Aerotropolis core	6.86
Agribusiness	8.61
Badgerys Creek	3.34
Northern Gateway	1.8
Wianamatta Creek	46.8

Figure 3-2 Aerotropolis Key Fish Habitat (KFH) mapping as per DPI 2007.

Field assessment to determine KFH Type and Class was undertaken at 104 sites across the study precincts (Figure 3-3; Figure 3-4).

A breakdown of the total length of KFH Type across the study is listed below shown and in Table 3-1 and Figure 3-4:

- Type 1 – Highly Sensitive KFH: 23.18 km
- Type 2 – Moderately Sensitive KFH: 119.6 km
- Type 3 – Minimally Sensitive KFH: 181.17 km

A breakdown of the total length of KFH Class across the study is listed below shown and in Table 3-1 and Figure 3-5:

- Class 1 – Major KFH: 13.47 km
- Class 2 – Moderate KFH: 89.76 km
- Class 3 – Minimal KFH: 41.18 km
- Class 4 – Unlikely KFH: 32.53 km

Thirty-five sites in Badgerys Creek were assessed for KFH Type and Class (Table 3-1) with results indicating two sites were assessed as Type 1, Class 2 KFH and considered highly sensitive freshwater habitat due the presence of semi-permanent to permanent pools with in-stream rocks, large woody debris and native macrophytes.

The majority of Badgerys Creek sites (n = 14) were assessed as Type 2, Class 2 KFH and considered as moderate key fish habitat, with defined banks, aquatic vegetation, rocks and woody debris present. These sites were located from the mid to downstream reaches.

Three sites assessed as Type 2, Class 3 KFH. These sites had minimal habitat features which included minimal woody debris and native aquatic vegetation.

One site was identified as Type 3, Class 2 KFH. This site had defined banks but large woody debris and macrophytes were absent.

Five sites were assessed Type 3, Class 3 KFH and considered as minimal habitat as features such as vegetation, large woody debris and rocks were absent.

Seven sites, predominantly in the upstream areas of Badgerys Creek, were identified as Type 3, Class 4 KFH. These sites lacked a defined channel and aquatic vegetation and are considered as unlikely key fish habitat.

Cosgroves Creek was mapped as KFH and 21 sites were assessed within the study precincts (Table 3-1

One site at the most downstream section of Cosgroves Creek was assessed as Type 1, Class 2 KFH and considered highly sensitive key fish habitat due to the presence of aquatic vegetation and habitat features which included large woody debris.

Two sites in the mid-section of Cosgroves Creek were assessed as Type 2, Class 2 KFH and considered moderate key fish habitat due to the presence of large woody debris and aquatic vegetation.

The majority of sites (n = 8) were identified as being Type 2, Class 3 KFH and considered minimal key fish habitat as large woody debris and aquatic vegetation was sparse.

One site was assessed as Type 3, Class 3 KFH and considered minimal the site was ephemeral and lacked aquatic vegetation.

Nine sites, with the majority located in the upstream, agricultural region of Cosgroves Creek, were assessed as Type 3, Class 4 KFH and considered as unlikely key fish habitat due to an absence of a defined channel, aquatic vegetation an ephemeral flow regime.

South Creek was mapped as KFH and 51 sites were assessed across the study precincts (Table 3-1). Seven sites were assessed as Type 1, Class 1 KFH (Figure 3-3) and considered as highly sensitive freshwater habitat, with permanent flows, a high degree of woody debris, large, in stream rocks, and the presence of native aquatic plants. These sites were scattered through the upper, mid, and lower sections of South Creek.

Six sites were assessed as Type 1, Class 2 KFH (predominantly in the downstream section of the precinct) and considered as sensitive freshwater habitat with in-stream rocks, large woody debris and native aquatic plants present.

Four sites were assessed as Type 2, Class 1 KFH and considered major fish habitat, however, these sites were found to have fewer habitat features (such as rocks and snags) when compared to the sites assessed as Type 1.

The majority of South Creek sites assessed within the study precincts (n = 22) were assessed as Type 2, Class 2 KFH and considered as moderate key fish habitat.

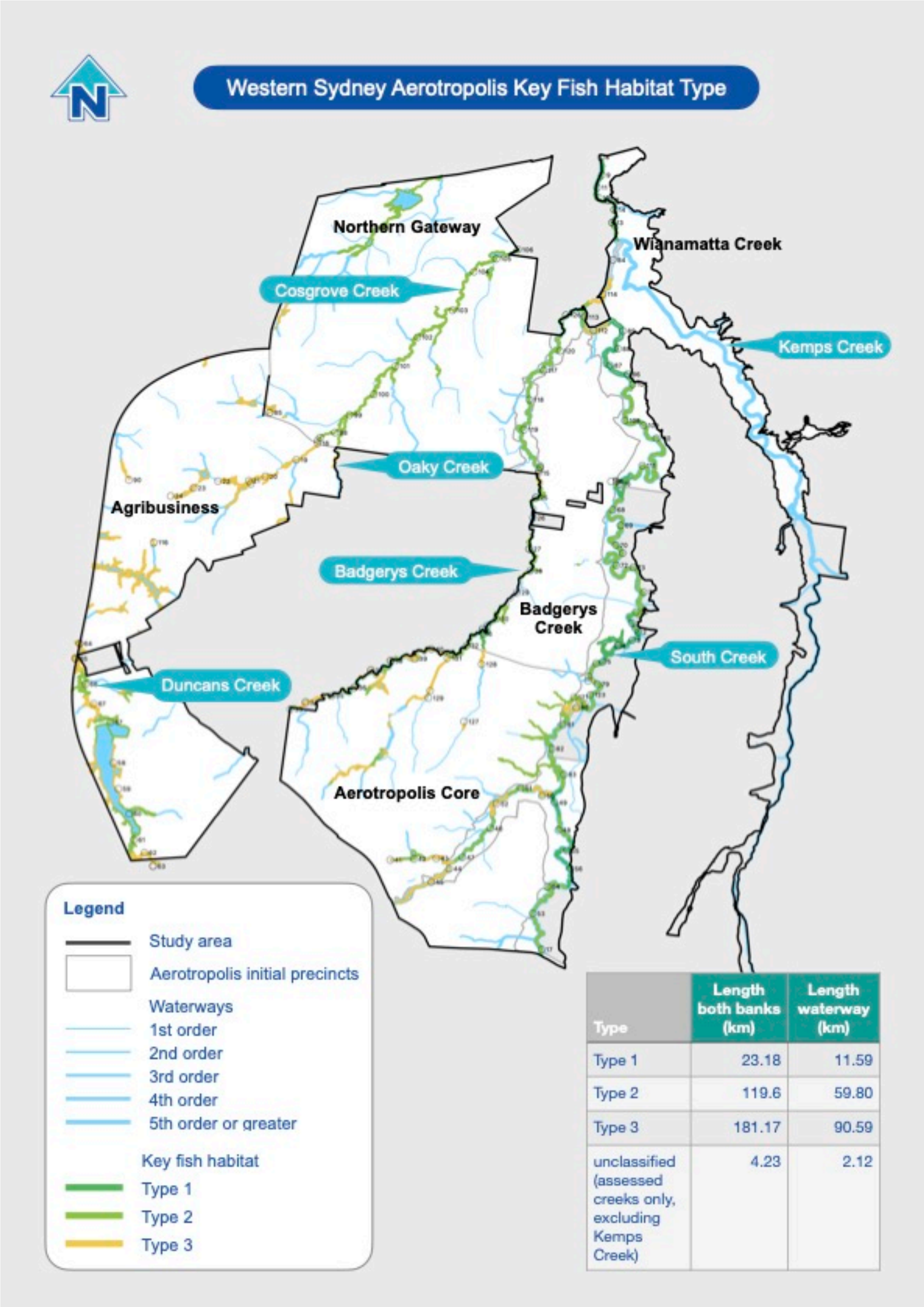
These sites were located in the middle reach of the creek and typically were found to have defined banks, aquatic vegetation, some rocks, and large woody debris.

Two sites were assessed as Type 2, Class 3 KFH, as they had minimal habitat features and four sites were assessed as Type 3, Class 3 KFH, as these sites were ephemeral and lacked aquatic vegetation and habitat features.

Six sites were assessed as Type 3, Class 4 KFH which included ephemeral waterways and tributaries of South Creek that typically lacked aquatic vegetation, defined banks and low-quality habitat features. provides a summary of KFH assessment results and Figure 3-2, Figure 3-4 and Figure 3-5 show mapped KFH, field assessed KFH Type and field assessed KFH Class respectively.

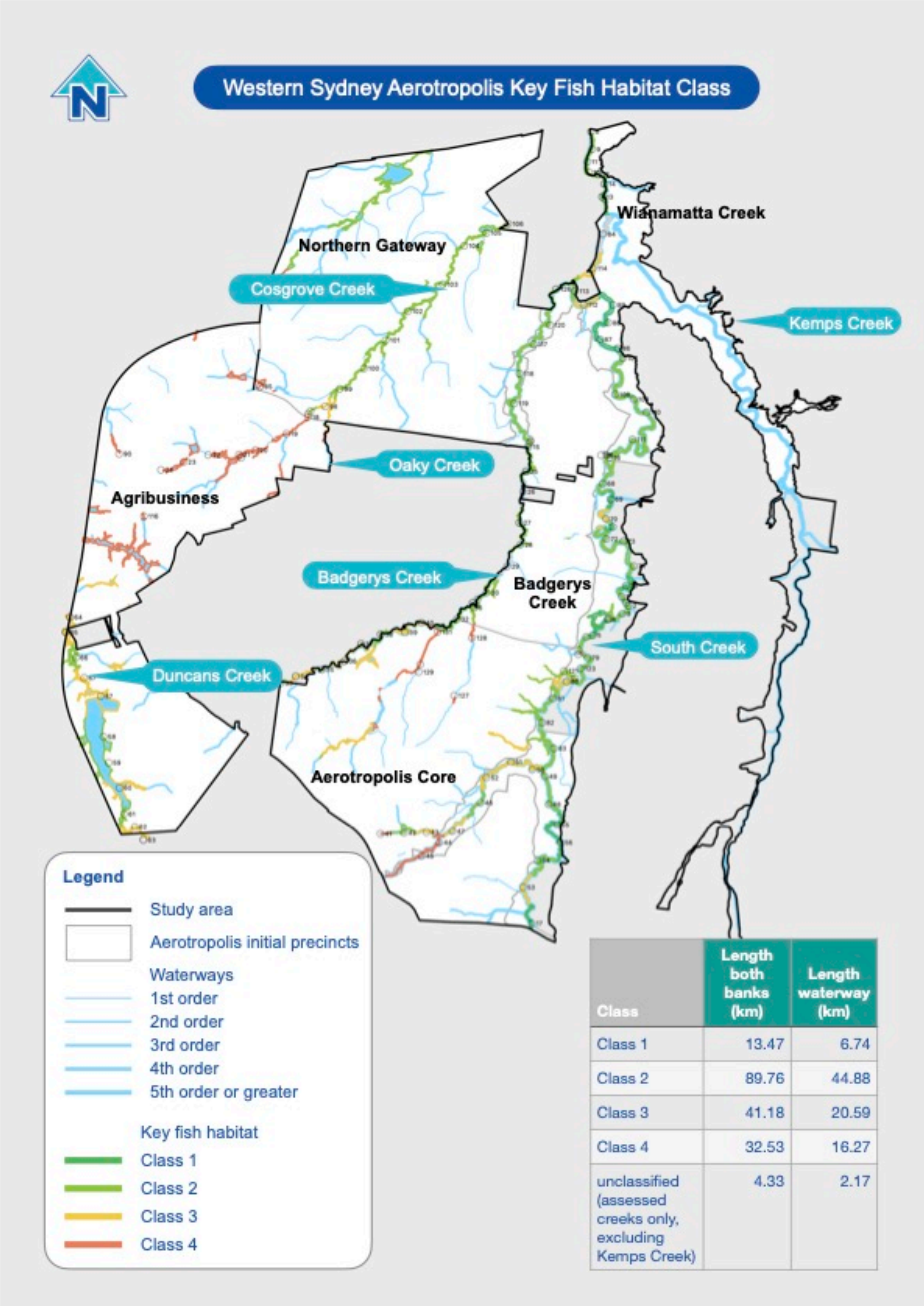
Recommended vegetated riparian zones (VRZ) as per DPIE Fisheries (2013) are shown in Table 3-1. Note these are recommendations only and not a legislative requirement as is the case with VRZ's required under the *NSW Water Management Act* 2000.

Figure 3-3 Type 1; Class 1 Key Fish Habitat (KFH) – Wianamatta-South Creek, Aerotropolis.



Type	Length both banks (km)	Length waterway (km)
Type 1	23.18	11.59
Type 2	119.6	59.80
Type 3	181.17	90.59
unclassified (assessed creeks only, excluding Kemps Creek)	4.23	2.12

Figure 3-4 Field Assessed Key Fish Habitat (KFH) Type across the Aerotropolis Initial Precincts. Grey numbering represents assessment site



Class	Length both banks (km)	Length waterway (km)
Class 1	13.47	6.74
Class 2	89.76	44.88
Class 3	41.18	20.59
Class 4	32.53	16.27
unclassified (assessed creeks only, excluding Kemps Creek)	4.33	2.17

Figure 3-5 Field Assessed Key Fish Habitat (KFH) Class across the Aerotropolis Initial Precincts. Grey numbering represents assessment site.

Table 3-1 Summary of Key Fish Habitat (KFH) findings for the Aerotropolis precincts.

Creek Name	Sites	Type	Characteristics for Type	Class	Characteristics for Class	Recommended VRZ (m)
Badgerys Creek	18, 20	Type 1	Type 1 sites highly sensitive freshwater habitat with in-stream rocks, large woody debris, and native aquatic plants.	Class 2	Class 2 waterways are semi-permanent to permanent with clearly defined banks and had aquatic vegetation present. These sites provide moderate key fish habitat.	100
Badgerys Creek	2, 12,15, 17, 21, 23-24, 26, 28-29, 32- 35	Type 2	Type 2 sites refers to all waterways not defined in Type 1.	Class 2	Class 2 waterways are semi-permanent to permanent with clearly defined banks and had aquatic vegetation present. These sites provide moderate key fish habitat.	50
Badgerys Creek	9, 30- 31	Type 2	Type 2 sites refers to all waterways not defined in Type 1.	Class 3	Class 3 waterways provide minimal key fish habitat and intermittent flows.	50
Badgerys Creek	27	Type 3	Type 3 sites are ephemeral waterways that do not support native vegetation.	Class 2	Class 2 waterways are semi-permanent to permanent with clearly defined banks and had aquatic vegetation present. These sites provide moderate key fish habitat.	50
Badgerys Creek	5, 7, 10, 14, 16	Type 3	Type 3 sites are ephemeral waterways that do not support native vegetation.	Class 3	Class 3 waterways provide minimal key fish habitat and intermittent flows.	50
Badgerys Creek	1, 3-4, 6, 8, 11, 13	Type 3	Type 3 sites are ephemeral waterways that do not support native vegetation.	Class 4	Class 4 waterways refer to sites with little or no defined channel, intermittent flow (mainly after rainfall) that provide unlikely key fish habitat.	50
Cosgroves Creek	21	Type 1	Type 1 sites highly sensitive freshwater habitat with in-stream rocks, large woody debris, and native aquatic plants.	Class 2	Class 2 waterways are semi-permanent to permanent with clearly defined banks and had aquatic vegetation present. These sites provide moderate key fish habitat.	100
Cosgroves Creek	10, 12	Type 2	Type 2 sites refers to all waterways not defined in Type 1.	Class 2	Class 2 waterways are semi-permanent to permanent with clearly defined banks and had aquatic vegetation present. These sites provide moderate key fish habitat.	50
Cosgroves Creek	9, 11, 15-20	Type 2	Type 2 sites refers to all waterways not defined in Type 1.	Class 3	Class 3 waterways provide minimal key fish habitat and intermittent flows.	50
Cosgroves Creek	13	Type 3	Type 3 sites are ephemeral waterways that do not support native vegetation.	Class 3	Class 3 waterways provide minimal key fish habitat and intermittent flows.	50
Cosgroves Creek	1-8, 14	Type 3	Type 3 sites are ephemeral waterways that do not support native vegetation.	Class 4	Class 4 waterways refer to sites with little or no defined channel, intermittent flow (mainly after rainfall) that provide unlikely key fish habitat.	50

Wianamatta-South Creek	4-5, 24-25, 47-49,	Type 1	Type 1 sites highly sensitive freshwater habitat with in-stream rocks, large woody debris, and native aquatic plants.	Class 1	Class 1 waterways are permanently flowing sites that also provide habitat for protected species and are major key fish habitat.	100
Wianamatta-South Creek	7, 26-28, 30, 39,	Type 1	Type 1 sites highly sensitive freshwater habitat with in-stream rocks, large woody debris, and native aquatic plants.	Class 2	Class 2 waterways are semi-permanent to permanent with clearly defined banks and had aquatic vegetation present. These sites provide moderate key fish habitat.	100
Wianamatta-South Creek	1, 31, 35, 37,	Type 2	Type 2 sites refers to all waterways not defined in Type 1.	Class 1	Class 1 waterways are permanently flowing sites that also provide habitat for protected species and are major key fish habitat.	100
Wianamatta-South Creek	3, 6, 8-10, 13-16, 19, 23, 29, 32-34, 38, 42-46, 51	Type 2	Type 2 sites refers to all waterways not defined in Type 1.	Class 2	Class 2 waterways are semi-permanent to permanent with clearly defined banks and had aquatic vegetation present. These sites provide moderate key fish habitat.	50
Wianamatta-South Creek	2, 36	Type 2	Type 2 sites refers to all waterways not defined in Type 1.	Class 3	Class 3 waterways provide minimal key fish habitat and intermittent flows.	50
Wianamatta-South Creek	12, 40-41, 50,	Type 3	Type 3 sites are ephemeral waterways that do not support native vegetation.	Class 3	Class 3 waterways provide minimal key fish habitat and intermittent flows.	50
Wianamatta-South Creek	11, 17-18, 20-22,	Type 3	Type 3 sites are ephemeral waterways that do not support native vegetation.	Class 4	Class 4 waterways refer to sites with little or no defined channel, intermittent flow (mainly after rainfall) that provide unlikely key fish habitat.	50

3.2 Groundwater Dependent Ecosystems

A desktop review of Groundwater Dependent Ecosystems (GDE) mapping (Australian Bureau of Meteorology Groundwater Dependent Ecosystem Atlas 2020) was conducted to determine the extent of both terrestrial and aquatic GDE's across the study precincts.

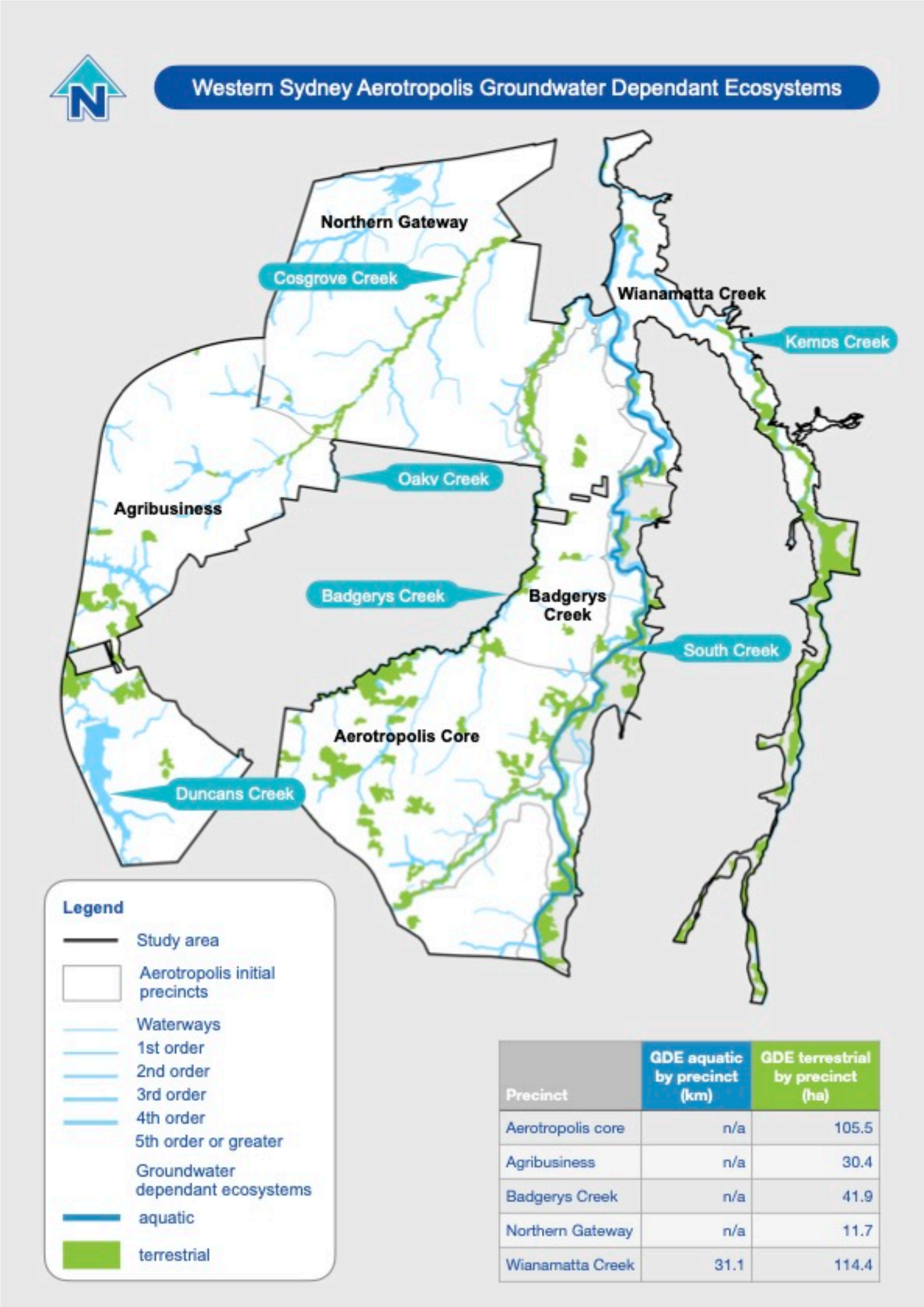
Results of the review indicate that the majority of terrestrial vegetation across the study precincts are classified as high potential GDE (Figure 3-6; Figure 3-7). In addition, there are small areas of vegetation with moderate and low potential GDE, mostly within the Agribusiness and Aerotropolis Core precincts.

A breakdown of the total area of terrestrial GDE by precinct is outlined below and also shown in Figure 3-7:

- Badgerys Creek: 41.9 ha
- Aerotropolis Core: 105.5 ha
- Agribusiness: 30.4 ha
- Northern Gateway: 11.7 ha
- Wianamatta-South Creek: 114.4 ha

In addition, South Creek is considered an aquatic GDE, which is contained within the Wianamatta-South Creek Precinct and totals 31.1 km. In an undeveloped state Wianamatta-South Creek would be typically charged by groundwater (Australian Bureau of Meteorology Groundwater Dependent Ecosystem Atlas 2020). However, due to the development of the Wianamatta-South Creek catchment, including increased cover of impervious surfaces and drainage infrastructure, the associated increase in stormwater inputs to this system are more than likely to dominate flows in Wianamatta-South Creek.

Figure 3-6 Aquatic and terrestrial Groundwater Dependent Ecosystems (GDE's) – Wianamatta-South Creek, Aerotropolis



Precinct	GDE aquatic by precinct (km)	GDE terrestrial by precinct (ha)
Aerotropolis core	n/a	105.5
Agribusiness	n/a	30.4
Badgerys Creek	n/a	41.9
Northern Gateway	n/a	11.7
Wianamatta Creek	31.1	114.4

Figure 3-7 Aerotropolis Groundwater Dependent Ecosystems

3.3 High Ecological Value Ecosystems

A desktop assessment of High Ecological Value (HEV) Waterways mapping was conducted to determine the extent of HEV Protect and Improve classified areas across the study precincts and to inform desktop selection of streams for validation and RRS development.

The extent of HEV considered by this study was limited to those areas within the 100-year flood extent (1% AEP) and the vegetated riparian zone (VRZ) as defined by the *NSW Water Management Act* 2000 (Figure 3-8).

The review of HEV mapping across relevant Local Government Areas (LGA's) within the Aerotropolis, including Penrith and Liverpool LGA, indicated that substantial riparian and riparian-woodland interface areas were classified as "HEV Protect" or "HEV Improve".

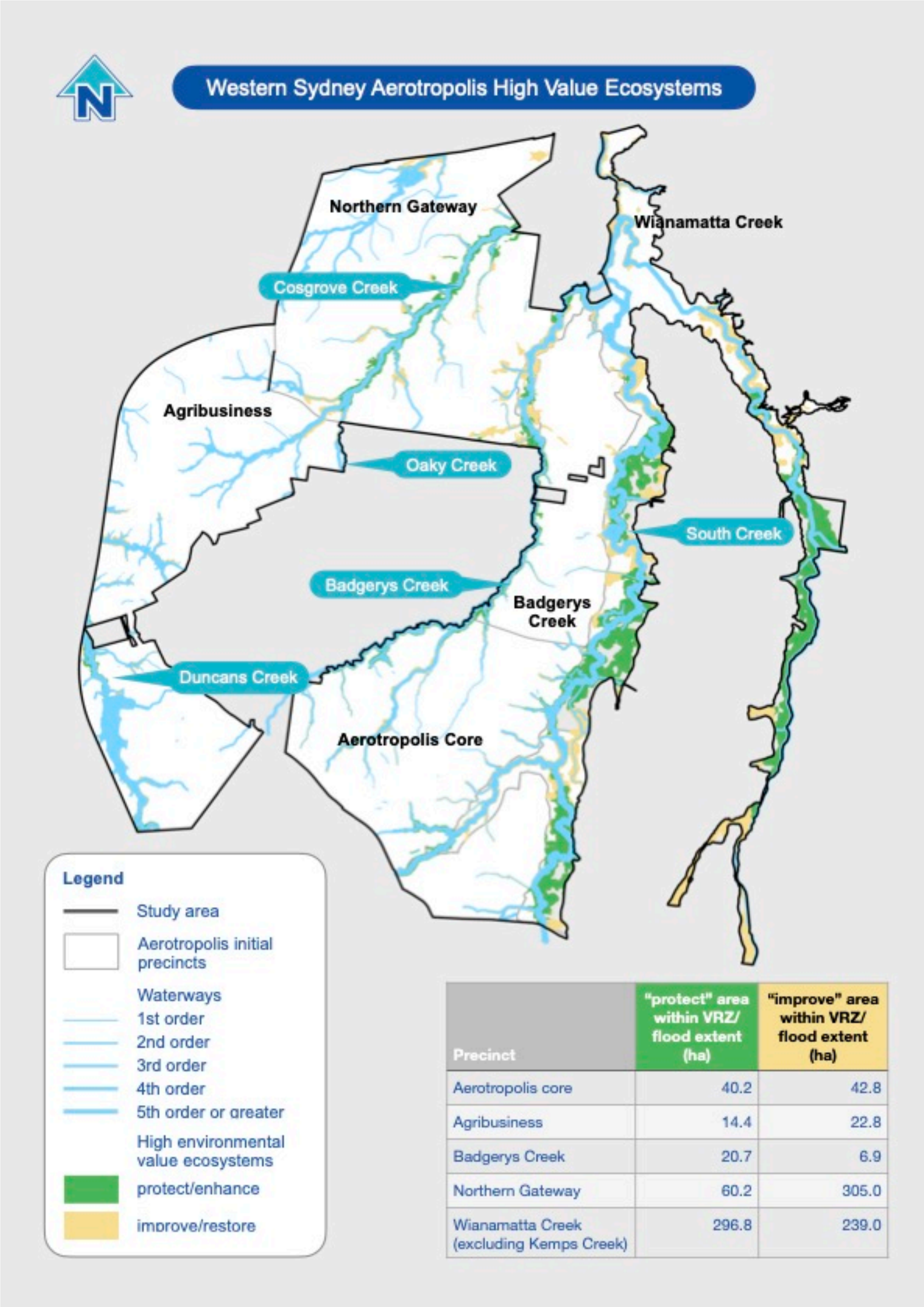
Within the study precincts, the majority of HEV mapped land was contained within the Wianamatta-South Creek Precinct.

Extensive areas of HEV were also mapped along the riparian corridor and floodplain of Badgerys Creek and Cosgroves Creek (Figure 3-8).

A breakdown of the area of "HEV Protect" and "HEV Improve" contained within each study precinct is shown in Table 3-2 and Figure 3-8.

Table 3-2 Breakdown of the area of High Ecological Value Ecosystems (HEV) Protect and Improve across study precincts.

Precinct	HEV Protect (ha)	HEV Improve (ha)
Aerotropolis Core	40.2	42.8
Agribusiness	14.4	22.8
Badgerys Creek	20.7	6.9
Northern Gateway	60.2	305.0
Wianamatta-South Creek (ex Kemps Creek)	296.8	239.0



Precinct	"protect" area within VRZ/ flood extent (ha)	"improve" area within VRZ/ flood extent (ha)
Aerotropolis core	40.2	42.8
Agribusiness	14.4	22.8
Badgerys Creek	20.7	6.9
Northern Gateway	60.2	305.0
Wianamatta Creek (excluding Kemps Creek)	296.8	239.0

Figure 3-8 High Ecological Value and Water Dependent Ecosystems (HEV) clipped to the study boundaries

3.4 Strahler Stream Order and Waterways Identified for Field Validation.

Stream Order and identification of waterways for field validation were determined by desktop review of spatial data which included NSW Waterways Strahler Stream Ordering (PPO 2019) and 1:25,000 NSW Topographic Maps for Outer Sydney Region (LPI 2006).

Stream order across the Aerotropolis ranged from First to Sixth (Figure 3-9; Figure 3-10). A breakdown by Precinct is shown in Figure 3-11 to Figure 3-15.

Review of the resulting stream ordering and HEV mapping determined which waterways across the Aerotropolis were suitable, as per the criteria outlined in section 2.1.5, for field validation. Waterways for field validation are shown in Figure 3-11-Figure 3-15 and a breakdown of stream order by precinct is shown in Table 3-3.

Kemps Creek within Wianamatta-South Creek Precinct was outside the scope of this project and therefore excluded.

Table 3-3 Breakdown of stream order by precinct for waterways identified for field validation.

Precinct	1st order (km)	2nd order (km)	3rd order (km)	4th order (km)	≥ 5th order (km)
Aerotropolis Core	3.87	3.54	5.80	3.37	0
Agribusiness	6.38	3.23	7.99	11.38	0
Badgerys Creek	0.89	0.44	0.01	5.82	0
Northern Gateway	1.48	2.36	3.80	14.28	0
Wianamatta-South Creek (ex. Kemps Creek)	0	0	0.05	4.22	16.93

Figure 3-9 Section of Wianamatta-South Creek identified for field validation

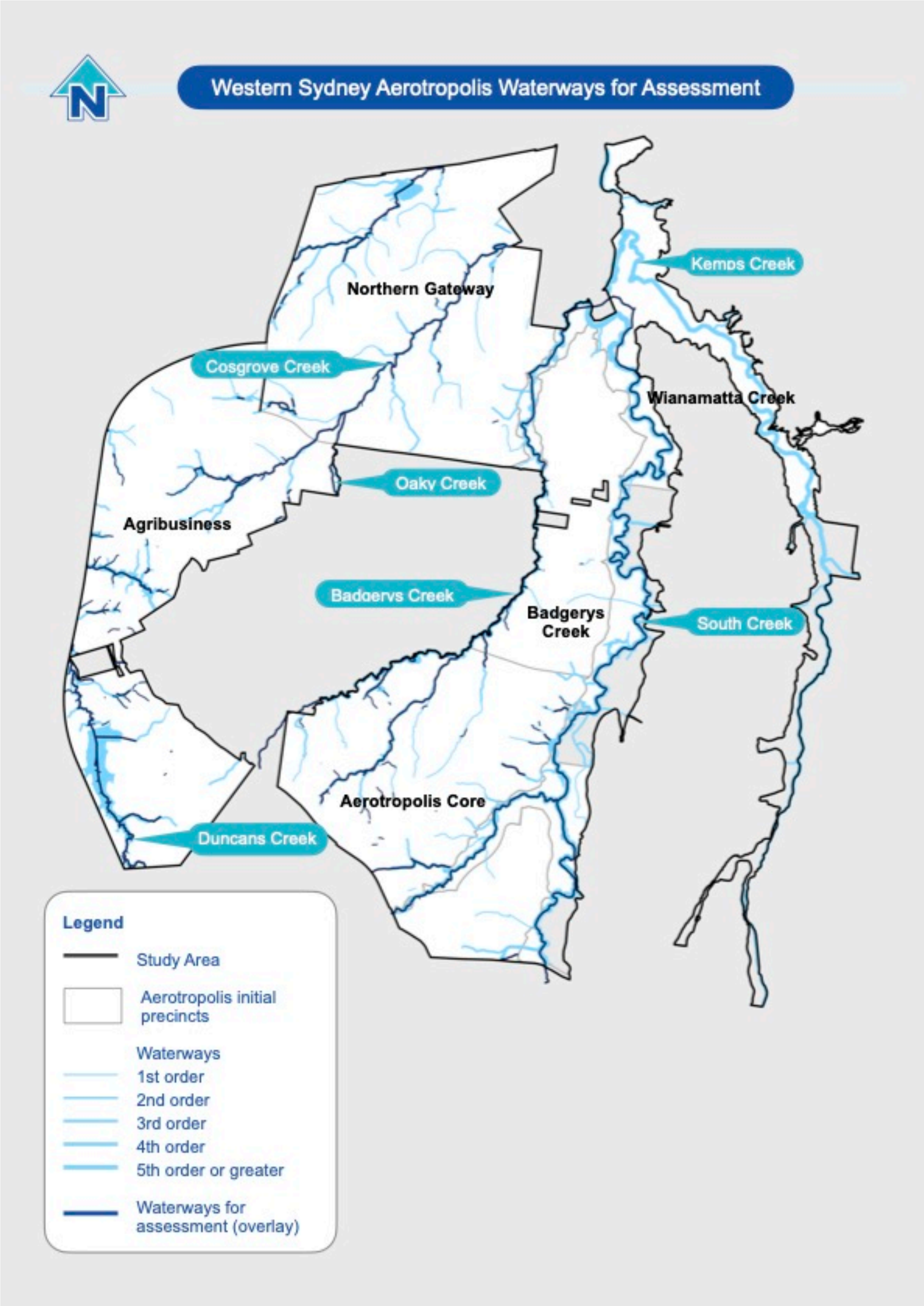


Figure 3-10 Strahler stream order and waterways for assessment within the Aerotropolis

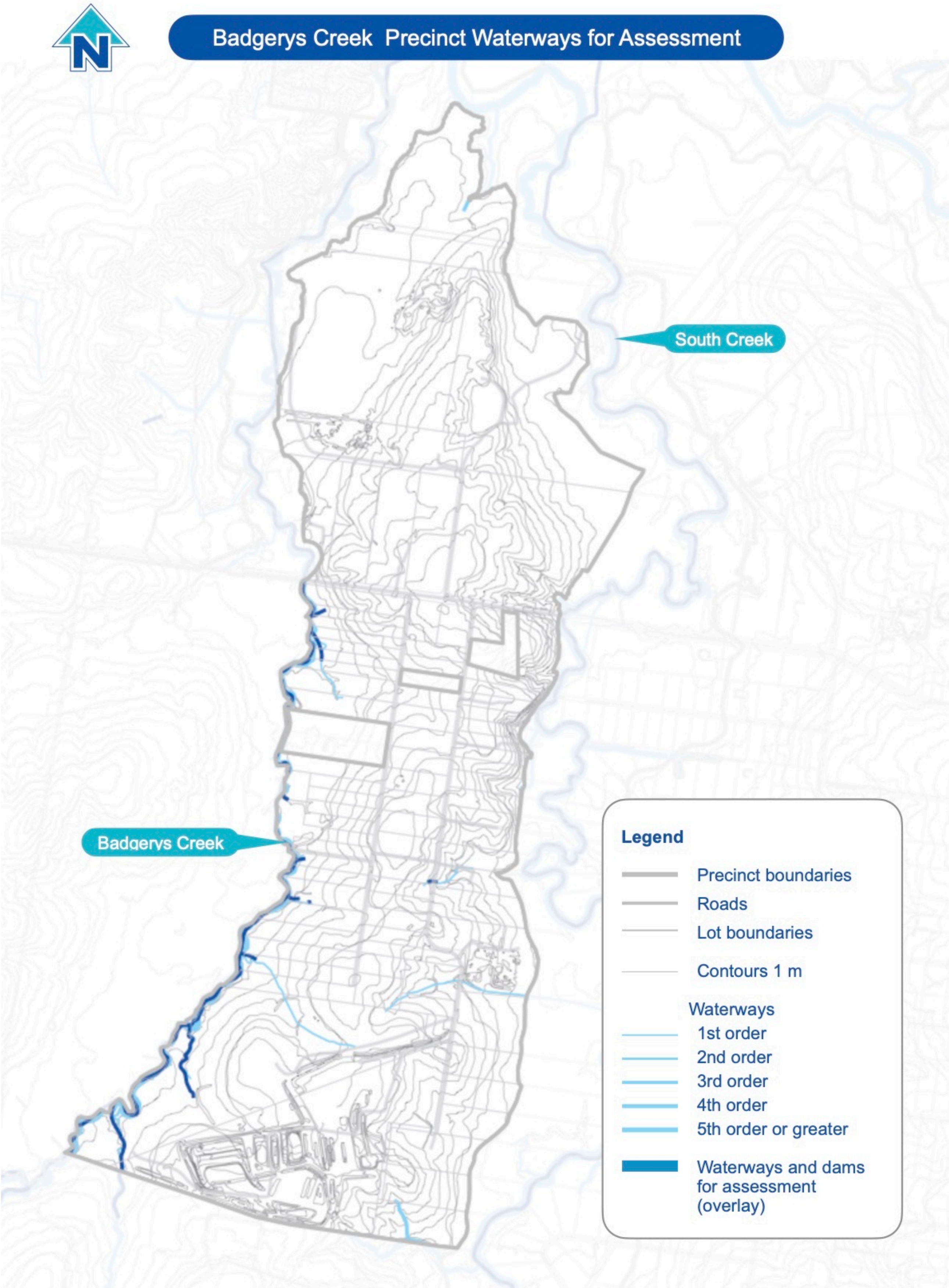


Figure 3-11 Badgerys Creek Precinct Strahler stream order and waterways for assessment

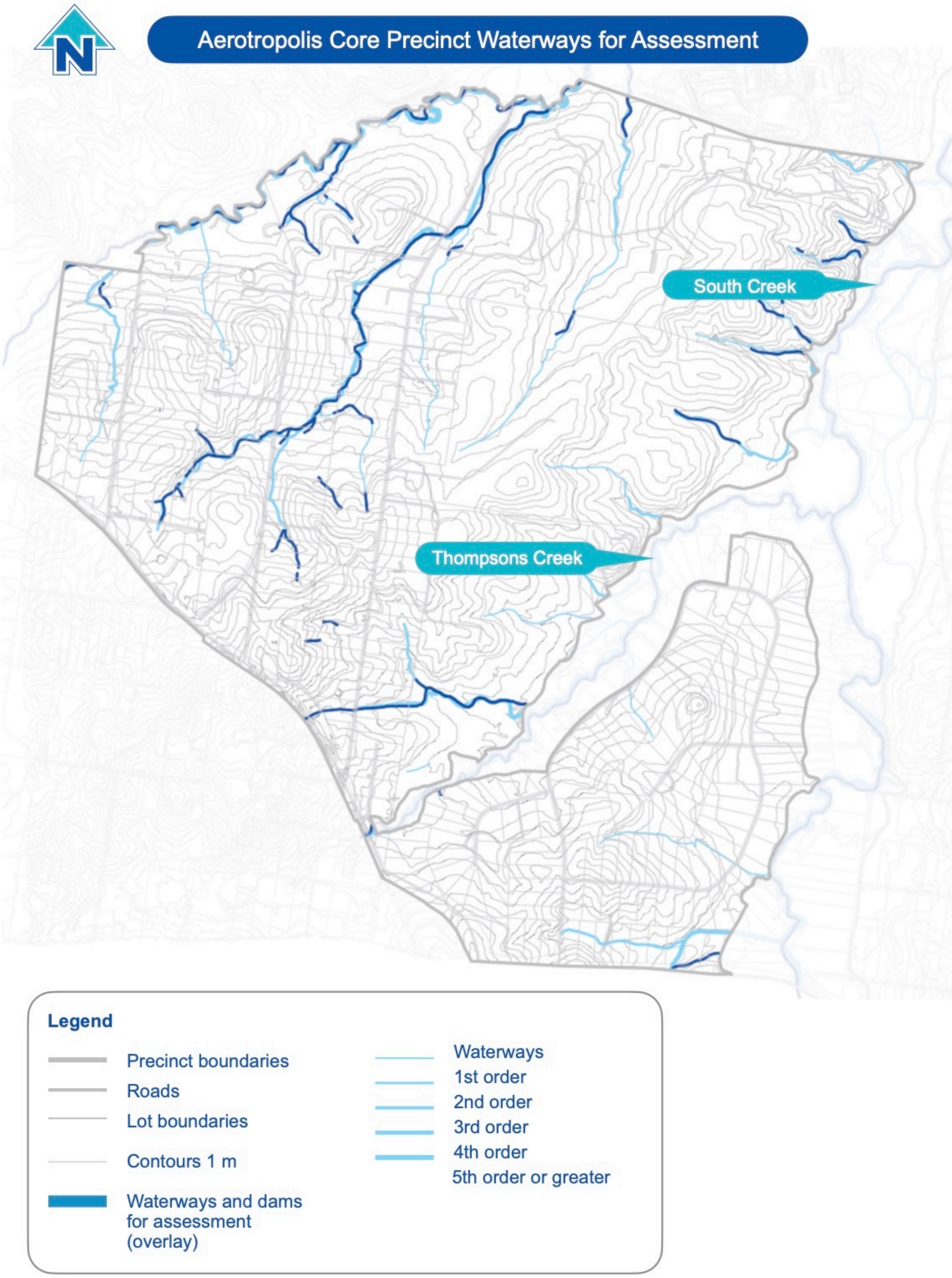


Figure 3-12 Aerotropolis Core Precinct Strahler stream order and waterways for assessment

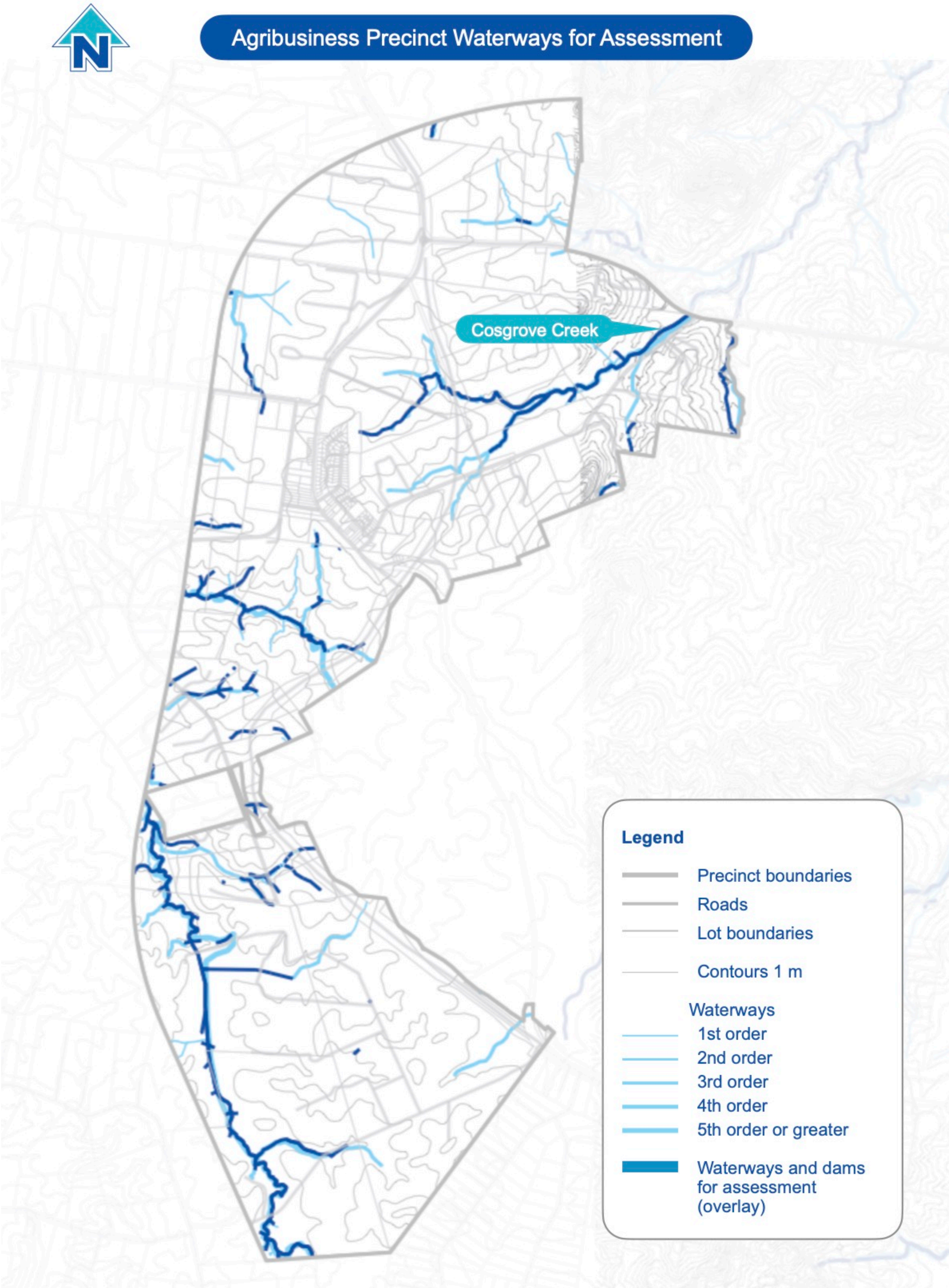


Figure 3-13 Agribusiness Precinct Strahler stream order and waterways for assessment

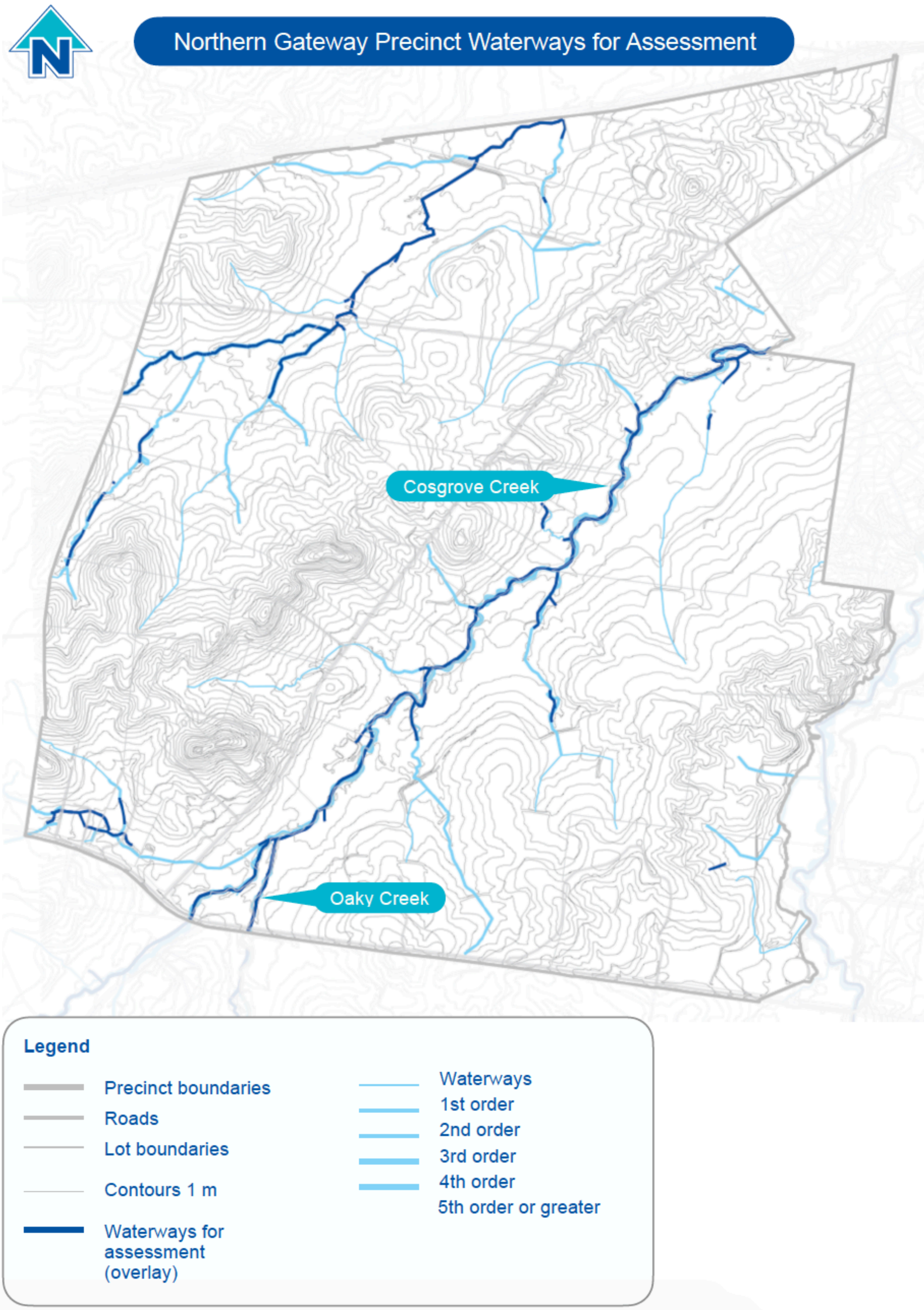


Figure 3-14 Northern Gateway Precinct Strahler stream order and waterways for assessment

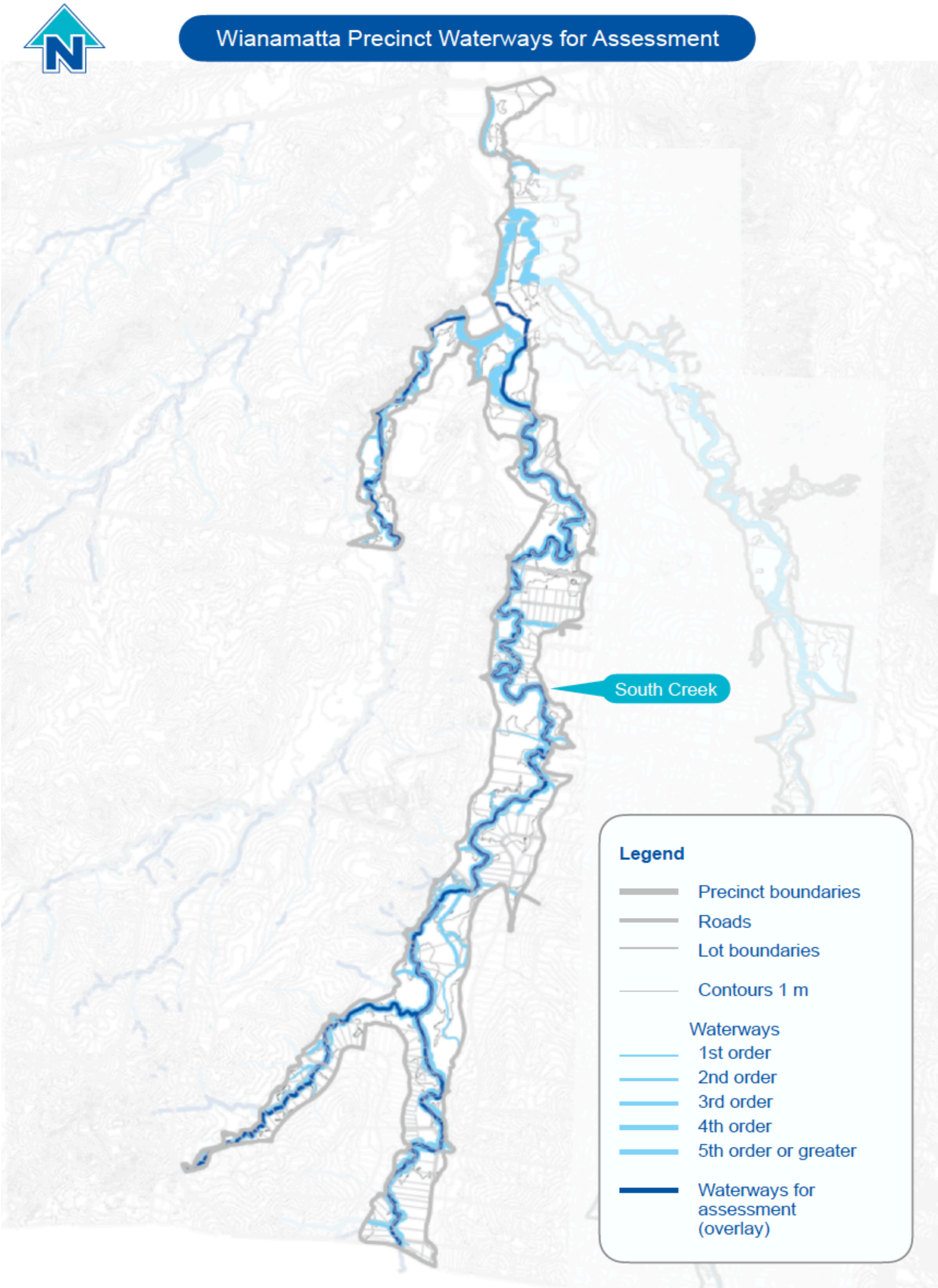


Figure 3-15 Wianamatta Precinct Strahler stream order and waterways for assessment

3.5 Field validated waterways with no top of bank

Field validation of waterways was undertaken across the study precincts, the primary aim of which was to validate if waterways assessed met the definition of a river as defined by WM Act and WM Regulation and to determine if creek bed and banks were present, in which case top of bank was mapped.

Section 3.5 presents results of field validation of waterways with no defined top of bank. Excluded are minor waterways in Wianamatta-South Creek Precinct.

64 waterways that were identified for field validation were found to lack a defined top of bank (ToB), however for the majority overland flow paths were present with many showing signs of significant channel/flow path modification (Figure 3-16).

A summary of field validated waterways with no defined top of bank, broken down by precinct is provided in the following section.

Figure 3-16 Typical example of waterway overland flow path and no defined top of bank.

3.5.1 Badgerys Creek Precinct

Within the Badgerys Creek precinct, three waterways were field validated as not having defined top of bank in line with the WM Act and WM Regulation. An overview of these sites is outlined in Table 3-4 (with an example shown in Figure 3-17) and their locations are shown in Figure 3-18.

Table 3-4 Badgerys Creek Precinct summary of field validation of waterways with no defined top of bank.

Site ID	Site Description
39	No clearly defined top of bank present at Site 39 leading into Badgerys Creek. Flow paths in this area have been largely modified by the nearby quarry.
40	No defined top of bank present at Site 40 leading to Badgerys Creek, with the dominant land use (agricultural land and farm dams) contributing to altering overland flow paths.
41	No top of bank present at Site 41, and this site consisted of agricultural paddocks for stock, with under-scrubbed woodland. Faint overland flow path present adjacent to Badgerys Creek.

Figure 3-17 Aerial image of site 41. Overland flow path is evident in centre of image

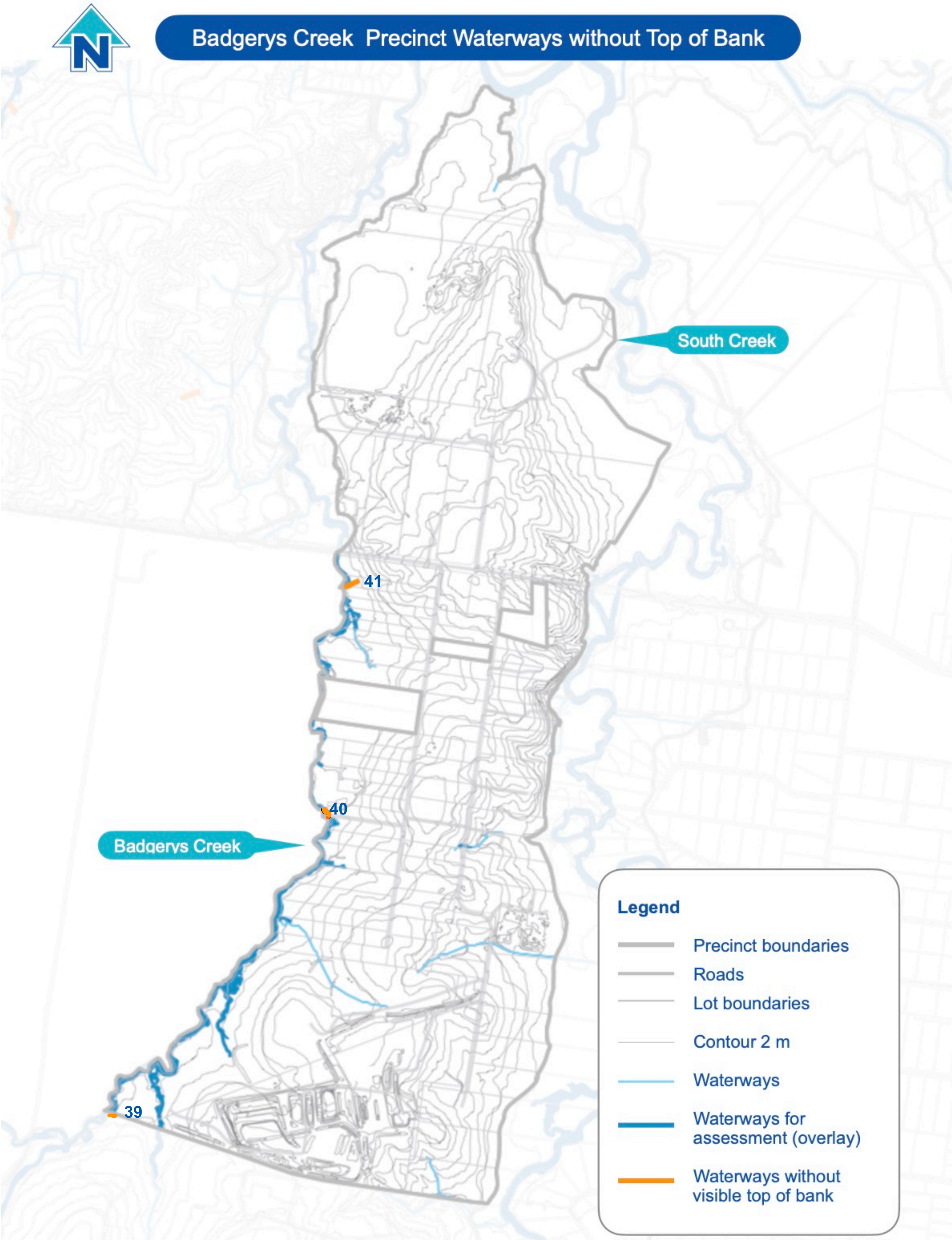


Figure 3-18 Field validated waterways with no defined top bank – Badgerys Creek Precinct. Reference numbers link to Table 3-4

3.5.2 Aerotropolis Core Precinct

Across the Aerotropolis Core precinct, 22 sites were field validated as not having defined top of bank present in line with the WM Act and WM Regulation.

An overview of these sites is outlined in **Error! Reference source not found.** and their locations are shown in Figure 3-19. Example photos of field validated waterways are shown in Figure 3-20 to Figure 3-23.

Table 3-5 Aerotropolis Core Precinct summary of field validation of waterways with no defined top of bank.

Site ID	Site Description
1	There is no defined top of bank present at Site 1, as this area is comprised of cleared and agricultural land, and there have also been significant upgrades to roads and stormwater infrastructure in the surrounding area.
2	There is no top of bank present at Site 2, as this site is comprised of urban yards, pasture, and grasslands.
3	There is no top of bank channel at Site. This site was an overland flow path from Dam 4142 to a small dam downstream.
4	There is no defined top of channel at Site 4. There is significant modification of natural flow paths upstream due to the Northern Road and the downstream region is paddocks and a farm dam.
5	There is no defined top of channel at Site 5, and this area is grassland and under-scrubbed forest.
6	There was no top of bank present at Site 6. This site consisted of paddocks, urban yards, and the presence of a farm dam wall, which modified natural hydrology.
7	There was no top of bank present at Site 7, where pasture, grasslands and urban yards dominated the landscape.
8	There was no top of bank present at Site 8, as this area consisted of paddocks and urban yards.
	There was no top of bank present at Site 9, as this area consisted of paddocks and urban yards.
10	There was no top of bank present at Site 10, and this site was predominantly pasture and grassland.
11	There was no top of bank present at Site 11, as natural flow paths were altered by the presence of farm dams and intensive agricultural land use and was predominantly grassland.
12	There was no top of bank present at Site 12, with this site was predominantly pasture and grassland. Farm dams altered natural flow paths, leading to some overland flow but no defined channels.
13	There was no top of bank present at Site 13, due to the presence of several farm dams influencing flow paths.
14	There was no top of bank present at Site 14, as this area was urban yards.
15	There was no top of bank present at Site 15. This site consisted of a series of farm dams and possible overland flow paths.
16	There was no top of bank present at Site 16, as natural flow paths had been modified due to clearing, commercial and residential land use.
17	There was no top of bank present at Site 17. This area consisted of paddocks and under-scrubbed forest woodland.
18	There was no top of bank present at Site 18. This area was paddocks with a potential overflow path leading to the nearby farm dam.
19	There was no top of bank present at Site 19, as this site was a farm dam.
20	There was no top of bank present at Site 20. This site was instead a farm dam, and also included intensive agriculture and structures.
21	There was no defined top of bank at Site 21, where it was a paddock dominated by pasture and grassland. There was also a driveway present that modified flow paths.
22	There was no defined top of bank at Site 22, as this section of pasture was an overland flow path.

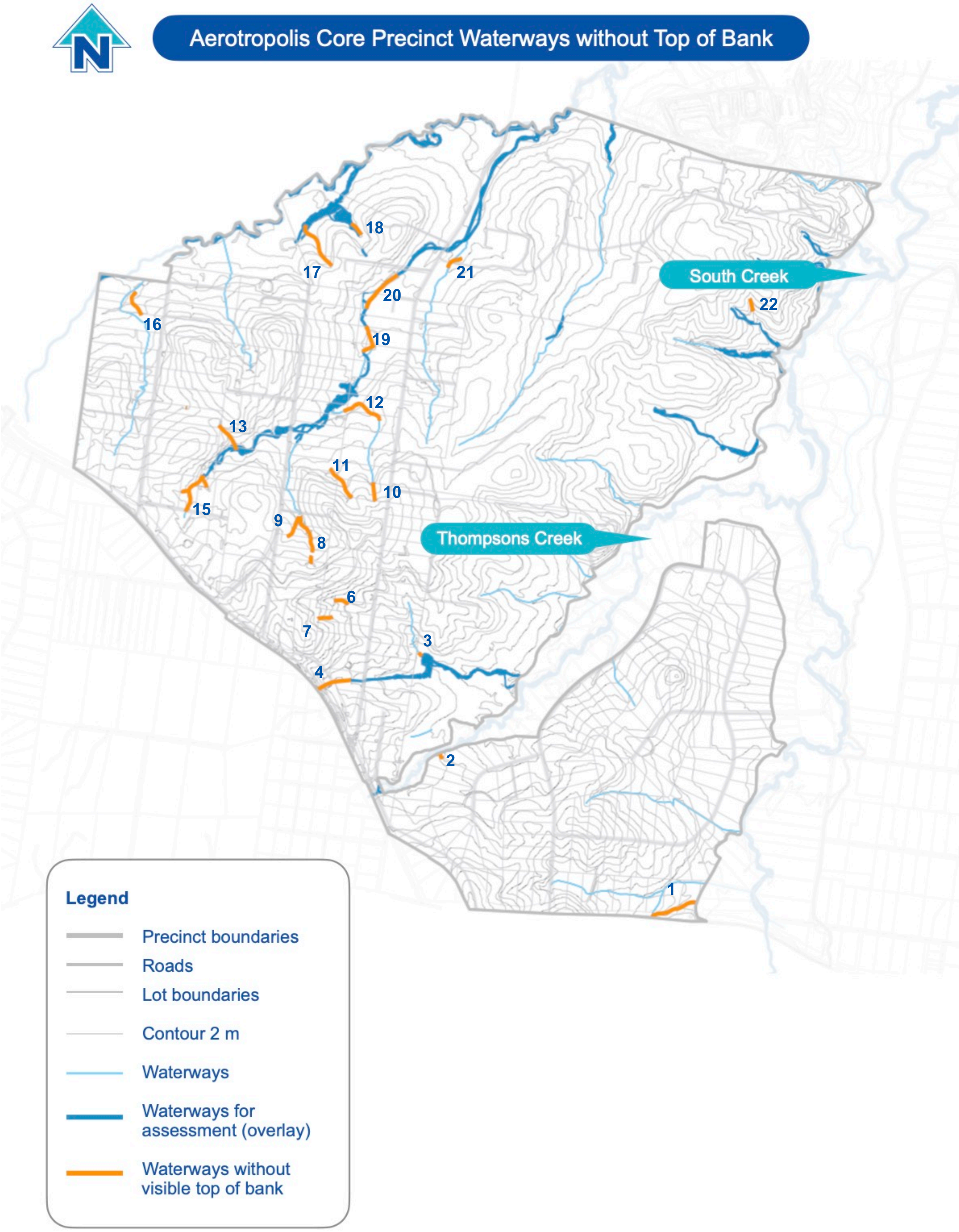


Figure 3-19 Field validated waterways with no defined top bank – Aerotropolis Precinct. Reference numbers link to Table 3-5

Figure 3-20 Site 7 showing overland flow path leading to farm dam

Figure 3-21 Site 10 showing overland flow path of watercourse

Figure 3-22 Site 16 showing highly modified overland flow path and farm dam

Figure 3-23 Site 21 showing overland flow path

3.5.3 Agribusiness Precinct

Across the Agribusiness Precinct, 20 sites were field validated as not having defined top of bank present in line with the WM Act and WM Regulation. An overview of these sites is outlined in Table 3-6 and their locations are shown in Figure 3-24. Example photos of field validated waterways are shown in Figure 3-25 to Figure 3-28.

Table 3-6 Agribusiness Precinct summary of field validation of waterways with no defined top of bank.

Site ID	Site Description
24	There was no top of bank present at Site 24. This site has been modified through clearing and is located in agricultural paddocks and roads have been created nearby.
25	There was no defined top of bank at Site 25, as this site was a series of farm dams and modified paddocks used for stock.
26	There was no defined top of bank channel present at Site 26, due to the presence of farm dam and modification of surrounding overland flow paths due to the construction of the Northern Road upgrades.
27	There was no top of bank present at Site 27, as this area consists of cleared paddocks.
28	There was no defined top of bank channel present at Site 28, as at this site two farm dams were located next to each other and separated by the dam wall. An artificial outlet had been cut into the upper dam (Dam 68300) that led straight into the lower dam (Dam 520125).
29	There was no top of bank present at Site 29, as this site has been highly modified as part of the development and upgrade of the Northern Road.
30	There was no defined top of bank at Site 30, where it was a paddock dominated by pasture and grassland and a series of farm dams.
31	There was no defined top of bank at Site 31, with the upper section of this reach being grassland and the low section being modified due to the presence of the nearby farm dam, which had a significant dam wall and outlet which created an overland flow path.
32	There was no defined top of bank at Site 32, as this site consisted of paddocks dominated by pasture and grassland, and there was a farm dam present.
33	There was no defined top of bank at Site 36, as this site was downstream of a farm dam and instead was pasture and grassland.
34	There was no defined top of bank at Site 34, and the site was dominated by dense exotic and native vegetation.
35	There was no top of bank present at Site 35. Whilst there is a channel present upstream, construction of a road, paddocks and a farm dam are present downstream and there is no channel present.
36	There was no defined top of bank at Site 36. This site consisted of pasture and grassland, and natural flow paths is being modified by the construction of a major road and associated stormwater infrastructure within this area.
37	There was no top of bank present at Site 37. Instead, this site is part of a farm dam.
38	There was no top of bank present at Site 38. This site was pasture and grassland, which been altered as a result of the nearby quarry and dams.
100	There was no top of bank present at Site 100. This site is a potential overland flow path from a farm dam into Cosgroves Creek.
101	There was no top of bank present at Site 101. This site is downstream of a farm dam and leading towards Cosgroves Creek, however the dam outlet had been modified for overflow into the creek to occur further upstream.
102	There was no top of bank present at Site 102, as this area consists of cleared paddocks and a road.
103	There was no top of bank present at Site 103, as this site consists of several farm dams and agricultural land use.

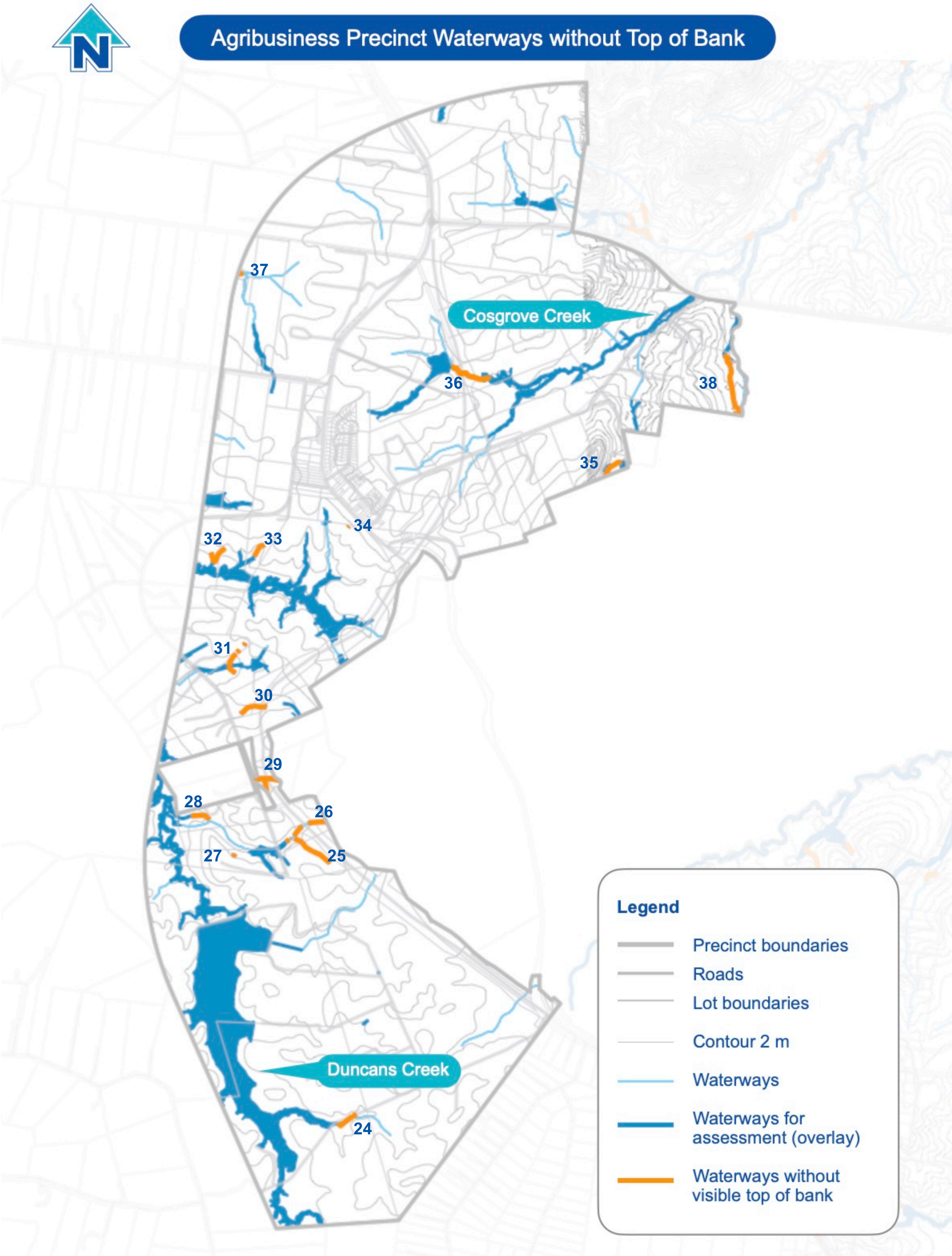


Figure 3-24 Field validated waterways with no defined top bank – Agribusiness Precinct. Reference numbers link to Table 3-6

Figure 3-25 Site 30 showing overland flow path entering farm dam

Figure 3-26 Site 32 showing overland flow path heading downstream to farm dam

Figure 3-27 Site 36 showing overland flow path heading right to left. *Casuarina spp.* indicate location of flow path

Figure 3-28 Site 38 showing heavily vegetated overland flow path looking upstream

3.5.4 Northern Gateway Precinct

Across the Northern Gateway precinct, 18 sites were field validated as not having defined top of bank present in line with the WM Act and WM Regulation. An overview of these sites is outlined in Table 3-7 and their locations are shown Figure 3-29. Example photos of field validated waterways are shown in Figure 3-30 - Figure 3-33.

Table 3-7 Northern Gateway Precinct summary of field validation of waterways with no defined top of bank.

Site ID	Site Description
43	There was no top of bank present at Site 43, as this was a potential overland flow path into a nearby farm dam.
44	There was no top of bank present at Site 44, as this area was an overland flow path from the upstream farm dam.
45	There was no top of bank present at Site 45, as this area consisted of cleared paddocks and farm dams.
46	There was no defined top of bank present at Site 46, as this site was pasture with potential overland flow from the upstream farm dam.
47	There was no top of bank present at Site 47, as it was an overflow path from behind the upstream dam wall into Cosgroves Creek.
48	There was no defined top of bank present at Site 48, as this site was pasture with potential overland flow from the upstream farm dam.
49	There was no top of bank present at Site 49, as this area was cleared agricultural paddocks.
50	There was no top of bank present at Site 50. The upstream farm dam wall restricted the flow path of water and the area was part of a paddock for stock.
51	There was no defined top of bank at Site 51, as land use including intensive agriculture, residential structures, roads and farm dams has altered natural flow paths so that they are no longer present.
52	There was no defined top of bank at Site 52, as land use including intensive agriculture, residential structures, roads and farm dams has altered natural flow paths so that they are no longer present.
53	There was no defined top of bank at Site 53, as land use including intensive agriculture, residential structures, roads and farm dams has altered natural flow paths so that they are no longer present.
54	There was no defined top of bank present at Site 54, with this site being pasture and grassland adjacent to Cosgroves Creek. Flow path is a low depression taking flows from farm dam to Cosgroves Creek.
55	There was no defined top of bank present at Site 55, with this site being pasture and grassland adjacent to Cosgroves Creek. However, there is the potential for overland flow due to a farm dam upstream.
56	There was no defined top of bank at Site 56. Instead, there was a wetland complex, which was comprised of sedge and grass species and bounded by trees species such as *Casuarina spp*.
57	There was no defined top of bank at Site 57, as this area consisted of cleared agricultural paddocks and a series of farm dams.
58	There was no defined top of bank at Site 58, as this area consisted of cleared agricultural paddocks and a series of farm dams.
59	There was no defined top of bank at Site 59, as this area consisted of cleared agricultural paddocks and a series of farm dams.
60	There was no defined top of bank at Site 60, as this area consisted of cleared agricultural paddocks and a series of farm dams.

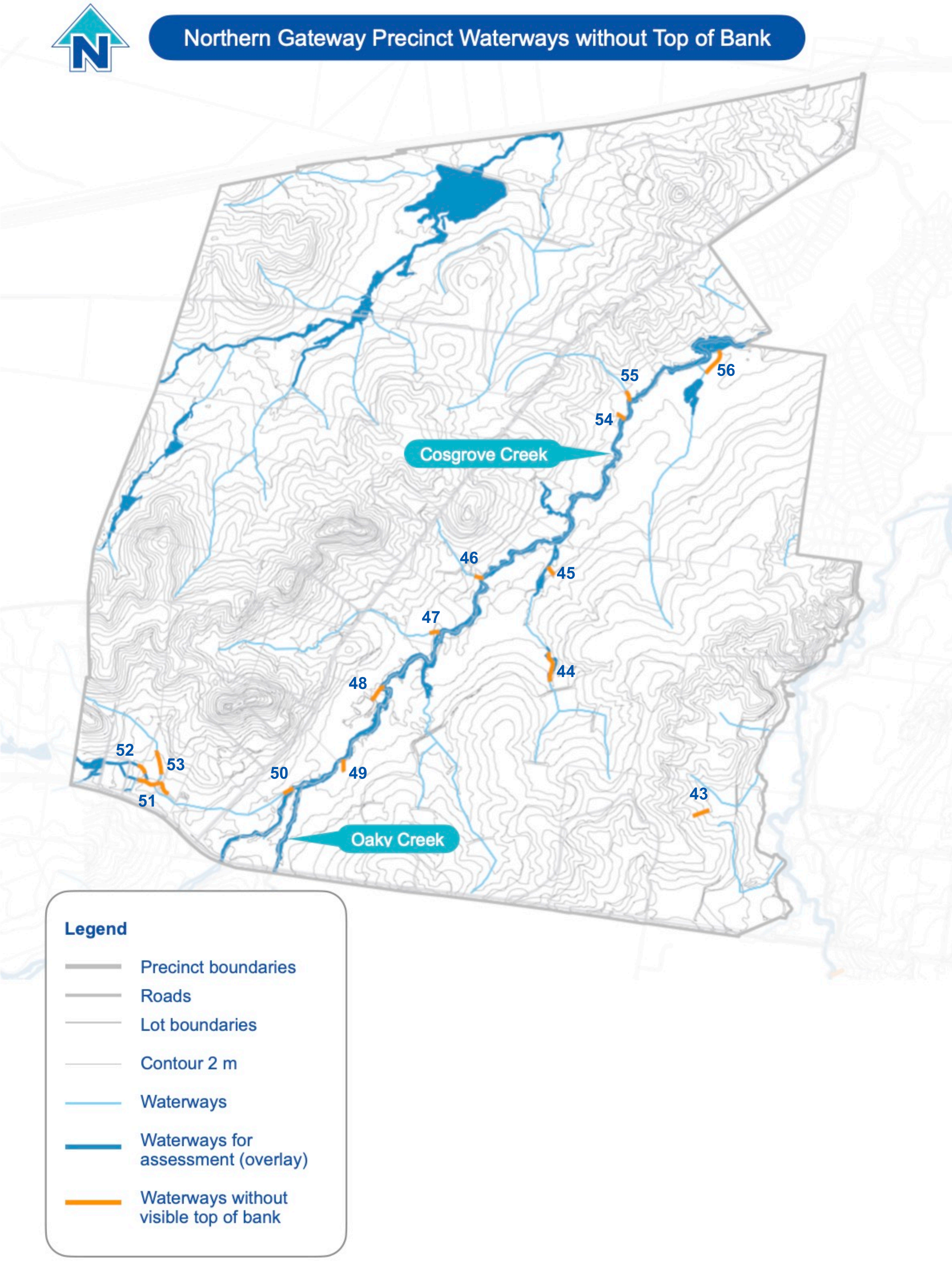


Figure 3-29 Field validated waterways with no defined top bank – Agribusiness Precinct. Reference numbers link to Table 3-7

Figure 3-30 Site 56 showing vegetated low depression overland flow path looking toward Cosgroves Creek

Figure 3-31 Site 53 showing overland flow path looking upstream

Figure 3-32 Site 57 showing overland flow path looking upstream

Figure 3-33 Site 58 showing overland flow path looking upstream

3.6 Field validated waterways with defined top of bank

Field validation of waterways was undertaken across the study precincts, the primary aim of which was to validate if waterways assessed met the definition of a river as defined by WM Act and WM Regulation and to determine if creek bed and banks were present, in which case top of bank was mapped (Figure 3-34).

Section 3.6 presents results of field validation of waterways with defined top of bank. Major waterways within the Wianamatta-South Creek Precinct were also included in this assessment. In the case where farm dams were present in the landscape with defined top of bank upstream and downstream of the site, the top of the bank of the dam was also included in top of bank mapping.

A summary of field validated waterways with defined top of bank, broken down by precinct is provided in the following section.

Figure 3-34 Example of South Creek with defined top of bank – Wianamatta-South Creek Precinct

3.6.1 Badgerys Creek Precinct

Waterway assessment across Badgerys Creek Precinct resulted in a total of 4.84 km of waterways validated as having a defined top of bank. The majority of which was confined to Badgerys Creek and a series of un-named tributaries of Badgerys Creek (Figure 3-35 to Figure 3-37).

Figure 3-35 Badgerys Creek looking South. Badgerys Creek Precinct is to the left of photo

Figure 3-36 Typical section of Badgerys Creek with defined top of bank – Badgerys Creek Precinct

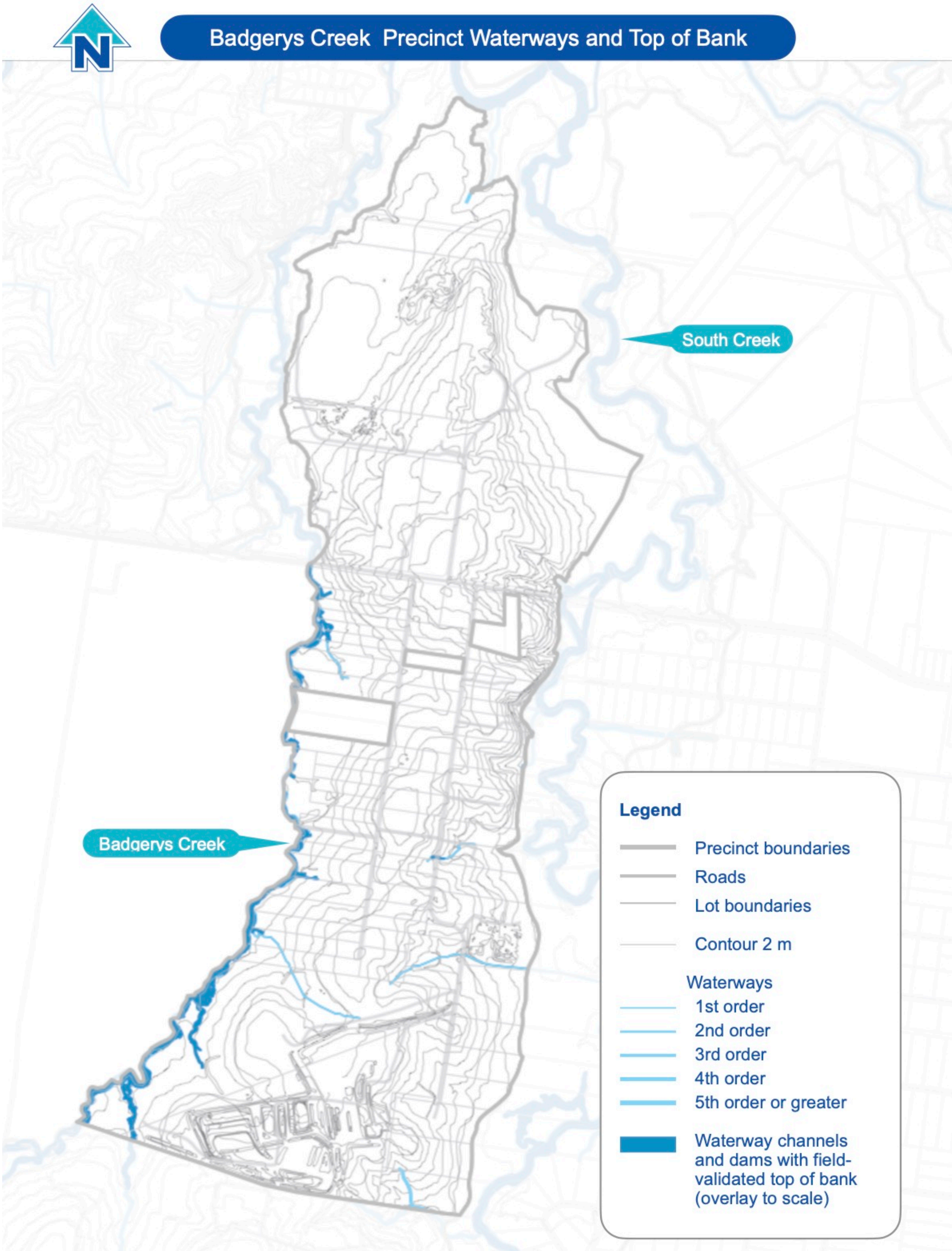


Figure 3-37 Waterways across Badgerys Creek Precinct with defined top of bank. Overlay to scale represents width of the waterway based on top of bank (ToB) mapping

3.6.2 Aerotropolis Core Precinct

Waterway assessment across Aerotropolis Core Precinct resulted in a total of 10.63 km of waterways validated as having a defined top of bank. The majority of which was confined to Badgerys Creek, a long un-named tributary of Badgerys Creek and small un-named tributaries of South Creek (Figure 3-38 to Figure 3-40).

Figure 3-38 View over Aerotropolis Core Precinct north to the Airport site. Wianamatta-South Creek traverses the centre of the photo

Figure 3-39 Section of un-named tributary of Badgerys Creek with defined top of bank

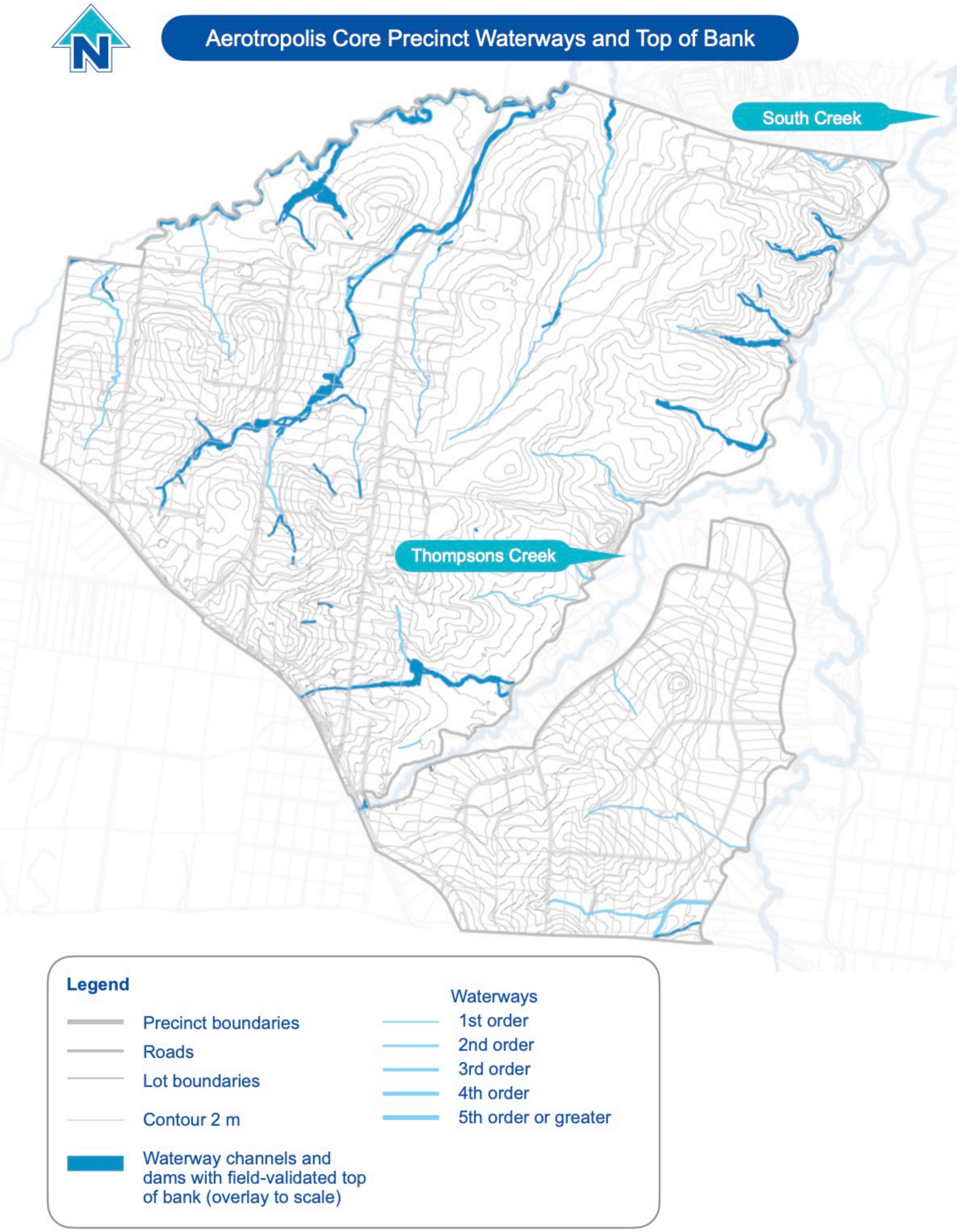


Figure 3-40 Waterways across Aerotropolis Core Precinct with defined top of bank. Overlay to scale represents width of the waterway based on top of bank (ToB) mapping.

3.6.3 Agribusiness Precinct

Waterway assessment across Agribusiness Precinct resulted in a total of 18.40 km of waterways validated as having a defined top of bank (Figure 3-44). The majority of which was confined to Duncans Creek Dam complex (Figure 3-41), the un-named waterway which bisects the central part of the Precinct (Figure 3-42) and Cosgroves Creek (Figure 3-43).

Figure 3-41 Duncans Creek Dam complex looking South (upstream)

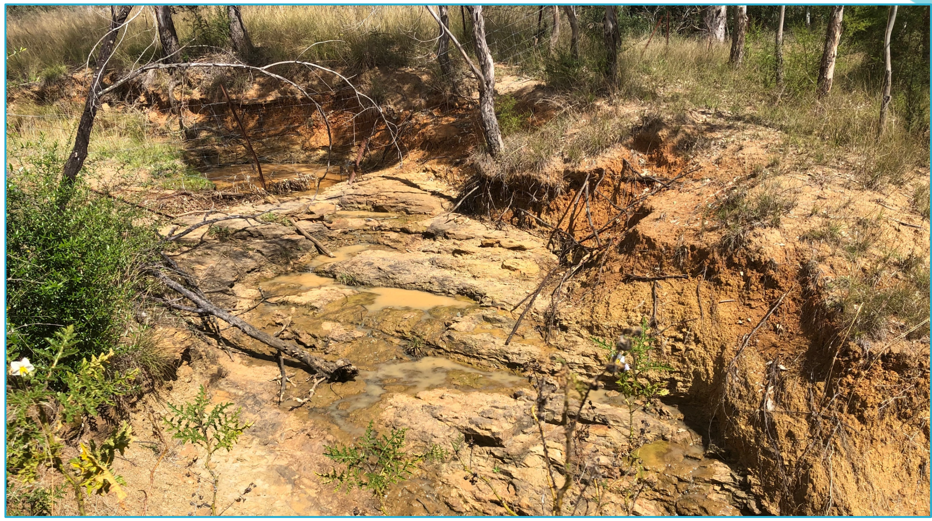


Figure 3-42 Section of the unnamed tributary which bisects the Precinct with defined top of bank

Figure 3-43 Section of Cosgroves Creek with defined top of bank

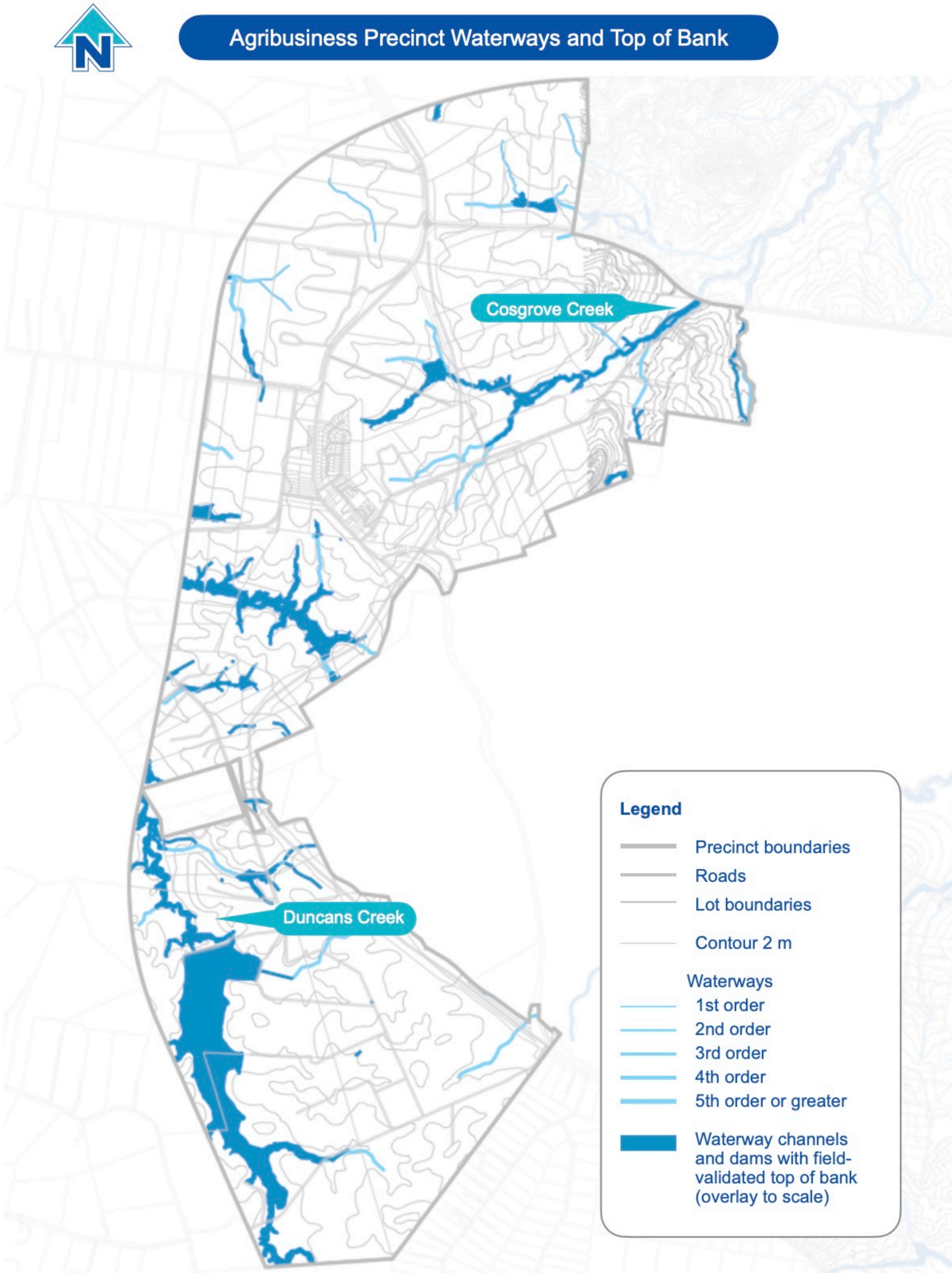


Figure 3-44 Waterways across Agribusiness Precinct with defined top of bank. Overlay to scale represents width of the waterway based on top of bank (ToB) mapping.

3.6.4 Northern Gateway Precinct

Waterway assessment across Northern Gateway Precinct resulted in a total of 9.34 km of waterways validated as having a defined top of bank. However, field assessment did not include the unofficially named Science Creek (see red box in Figure 3-49) as access to this creek was not permitted. Top of bank mapping for this creek was undertaken manually using LiDAR and aerial photography.

The majority of top of bank was associated with Cosgroves Creek (Figure 3-45 and Figure 3-48) and Science Creek (Figure 3-46).

In addition to the validated creeks, a wetland, not featured in the spatial data sets reviewed in the desktop stage, was observed and the perimeter mapped (Figure 3-47). This wetland was located downstream of a farm dam in the overland flow path which joined Cosgroves Creek.

Figure 3-45 Cosgroves Creek looking south (upstream) across Northern Gateway Precinct

Figure 3-46 View west across Northern Gateway Precinct to Science Creek (from left to right mid ground, second large dam); Cosgroves Creek in the foreground

Figure 3-47 Unmapped wetland adjacent to Cosgroves Creek, Northern Gateway Precinct

Figure 3-48 Top of bank in Cosgroves Creek, Northern Gateway Precinct

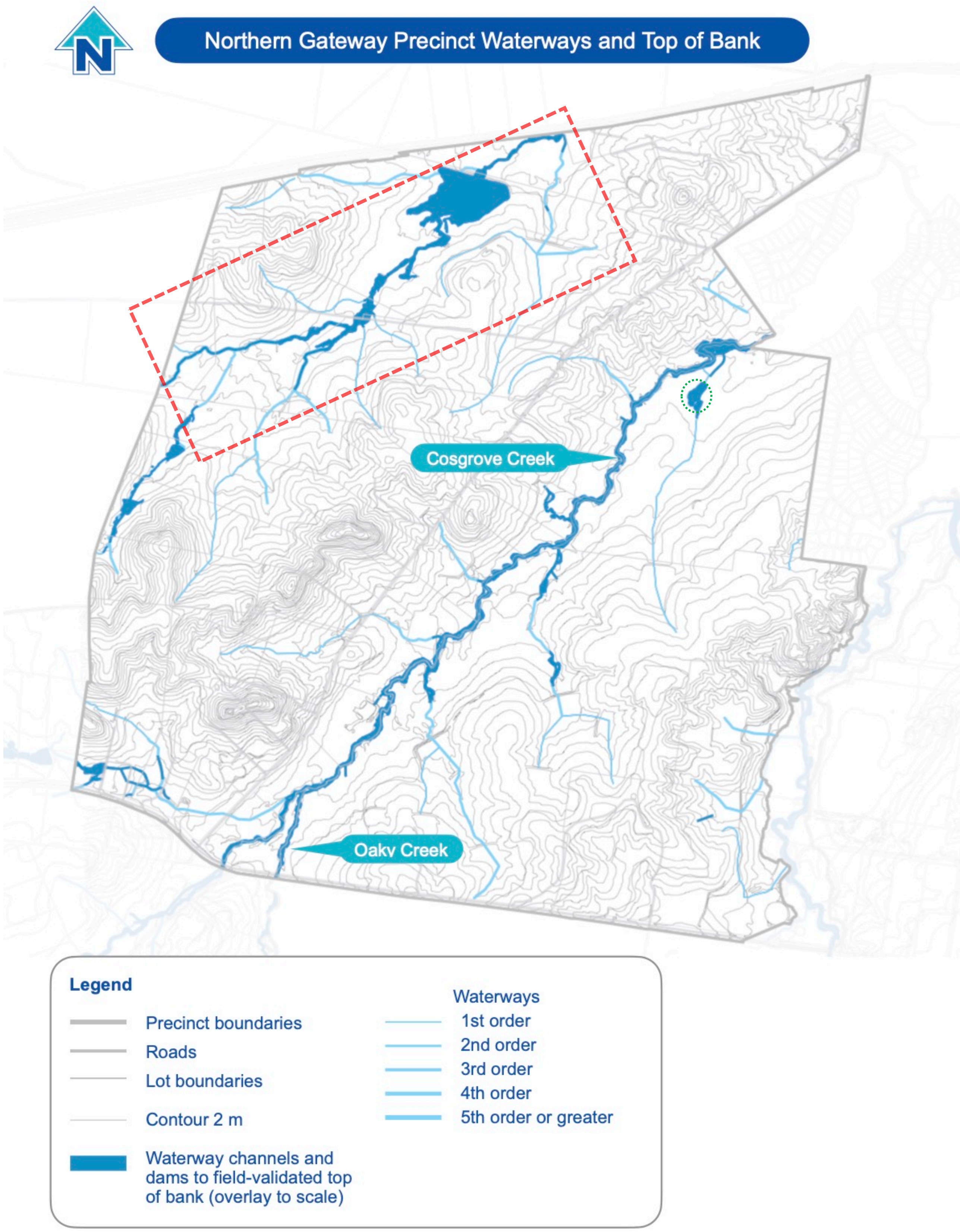


Figure 3-49 Waterways across Northern Gateway Precinct with defined top of bank. The red square indicates where LiDAR and aerial photography was used to demarcate top of bank as access was not permitted to Science Creek. The green circle indicates the location of the wetland adjacent to Cosgroves Creek. Overlay to scale represents width of the waterway based on top of bank (ToB) mapping.

3.6.5 Wianamatta-South Creek Precinct

Waterway assessment across Wianamatta-South Creek Precinct resulted in a total of 30.97 km of waterways validated as having a defined top of bank (Figure 3-54).

Mapping shows the full length of Wianamatta-South Creek, Badgerys Creek and Thompsons Creek within the Precinct have a defined top of bank (Figure 3-54).

In addition to these creeks, field assessment recorded two wetlands which did not feature in the spatial data sets reviewed at the desktop stage (Figure 3-50 - Figure 3-53). The boundary of these wetlands was field validated and mapped.

Figure 3-50 Southern wetland adjacent to Wianamatta-South Creek-Thompsons Creek confluence

Figure 3-51 Northern wetland adjacent to Wianamatta-South Creek-Thompsons Creek confluence

Figure 3-52 Confluence of Wianamatta-South Creek (left) and Thompsons Creek (right) looking south.

Figure 3-53 Confluence of Wianamatta-South Creek (bottom) and Kemps Creek (top) looking south.

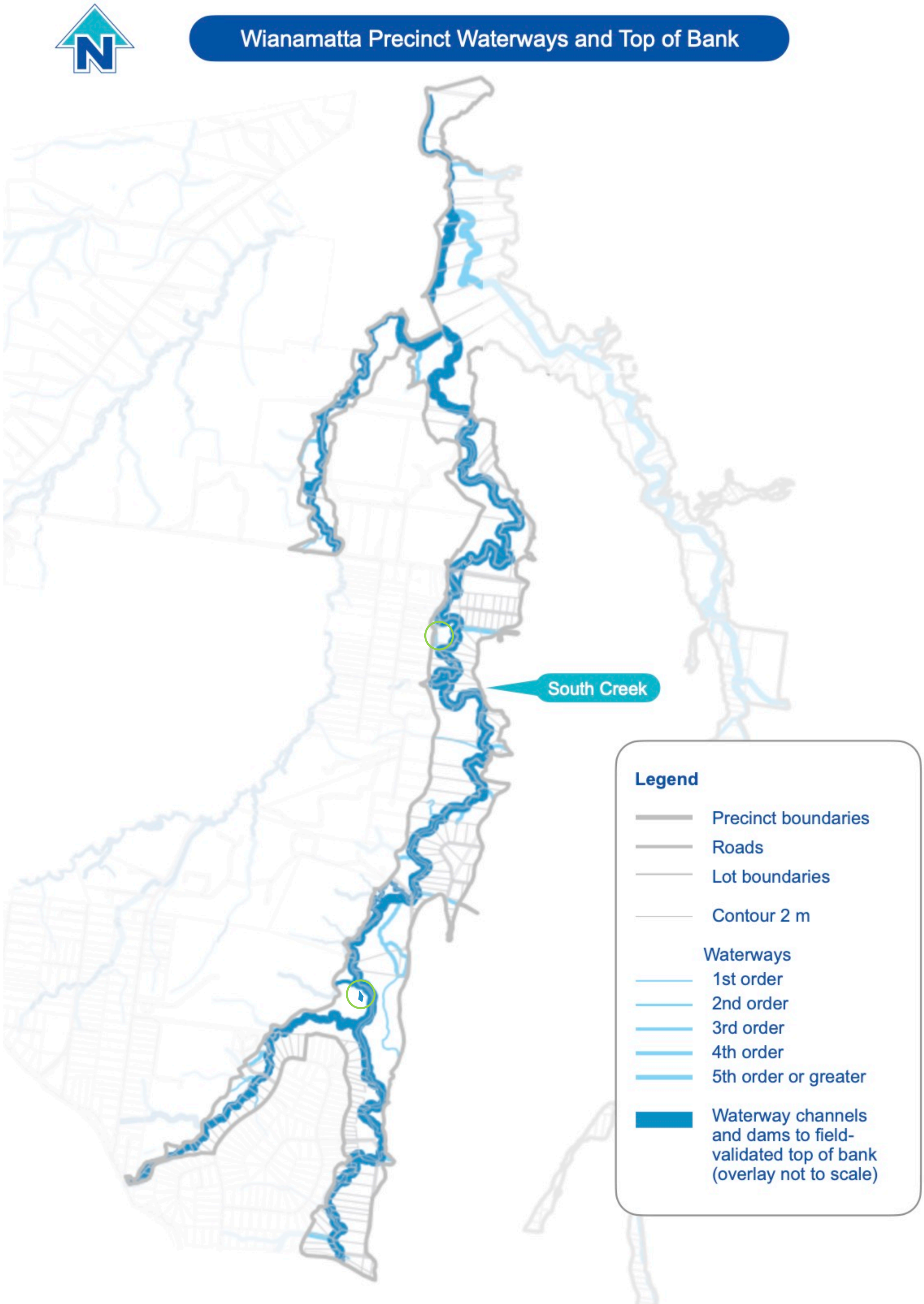


Figure 3-54 Waterways across Northern Gateway Precinct with defined top of bank. The green circle indicates the location of wetlands adjacent to Wianamatta-South Creek. Overlay to scale represents width of the waterway based on top of bank (ToB) mapping.

3.7 First Order Streams with 15 ha Upper Catchments

Hydrologic modelling for the Western Sydney Aerotropolis indicates that in order to efficiently, cost effectively and safely convey stormwater, first order streams with upper catchments of 15 ha or greater should be retained in the landscape as daylighted creek channels. In addition to waterways identified in Section 3.6, these streams should remain in the landscape as natural watercourses or where necessary/appropriate as reconstructed waterways.

It is likely these channels will require realignment and stabilisation to accommodate flows generated under future development. Therefore, construction should be guided by the geomorphic forms of Cumberland Plain waterways, that is wide flow paths punctuated by deep elongated pools i.e mimic that of a natural chain of ponds system (Figure 3-55).

To determine the locations of first order streams with upper catchments 15 ha or greater a desktop GIS review was undertaken by Aurecon as part of the WSA stormwater management strategy.

The results of that review are shown for the study precincts in Figure 3-56.

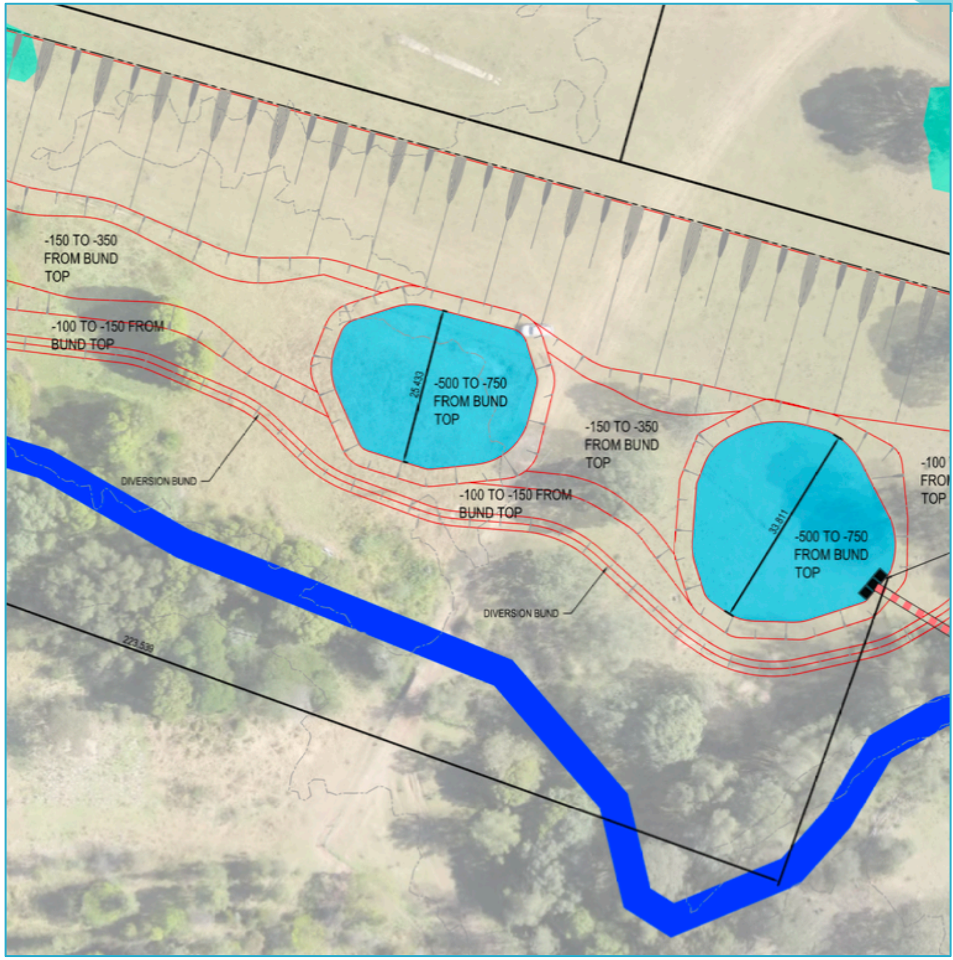
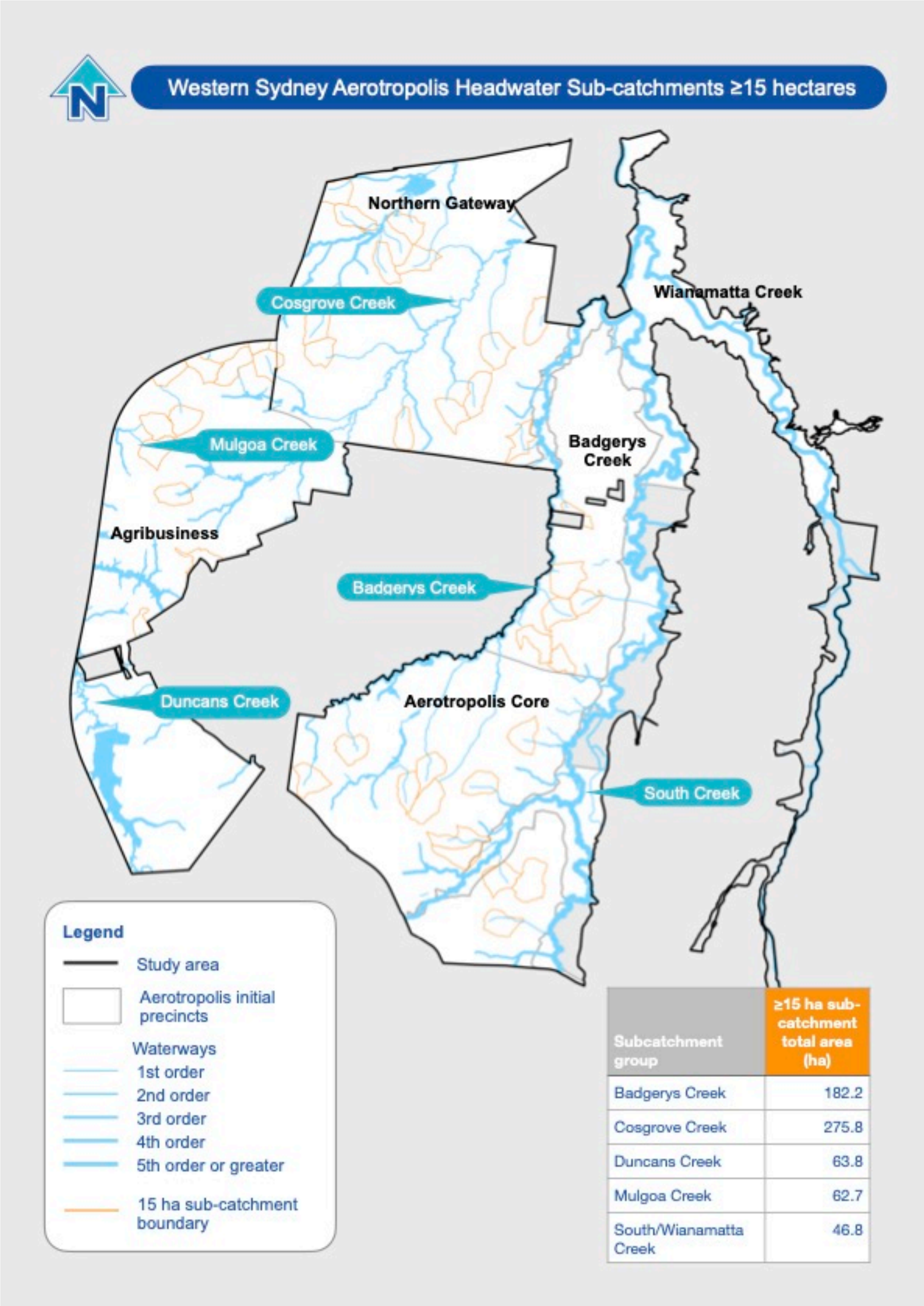


Figure 3-55 Conceptual diagram of chain of ponds creek construction



Subcatchment group	≥15 ha sub-catchment total area (ha)
Badgerys Creek	182.2
Cosgrove Creek	275.8
Duncans Creek	63.8
Mulgoa Creek	62.7
South/Wianamatta Creek	46.8

Figure 3-56 First order streams with upper catchments of 15 ha or greater for Western Sydney Aerotropolis (WSA) study precincts.

3.8 Ecological Assessment of Farm Dams – Protect, Restore and No Ecological Value

Farm dams are an important hydrologic feature of the Western Parkland City that reduce runoff volumes in waterways while recharging the local and regional groundwater table (Figure 3-57). They also provide significant aesthetic benefits and ecological habitat.

A key part of the landscape-led design approach for the Western Parkland City is to, where appropriate, repurpose or rebuild farm dams as water in the landscape features. The retention or replacement of farm dams is an important approach to preserving hydrologic characteristics of the local waterways.

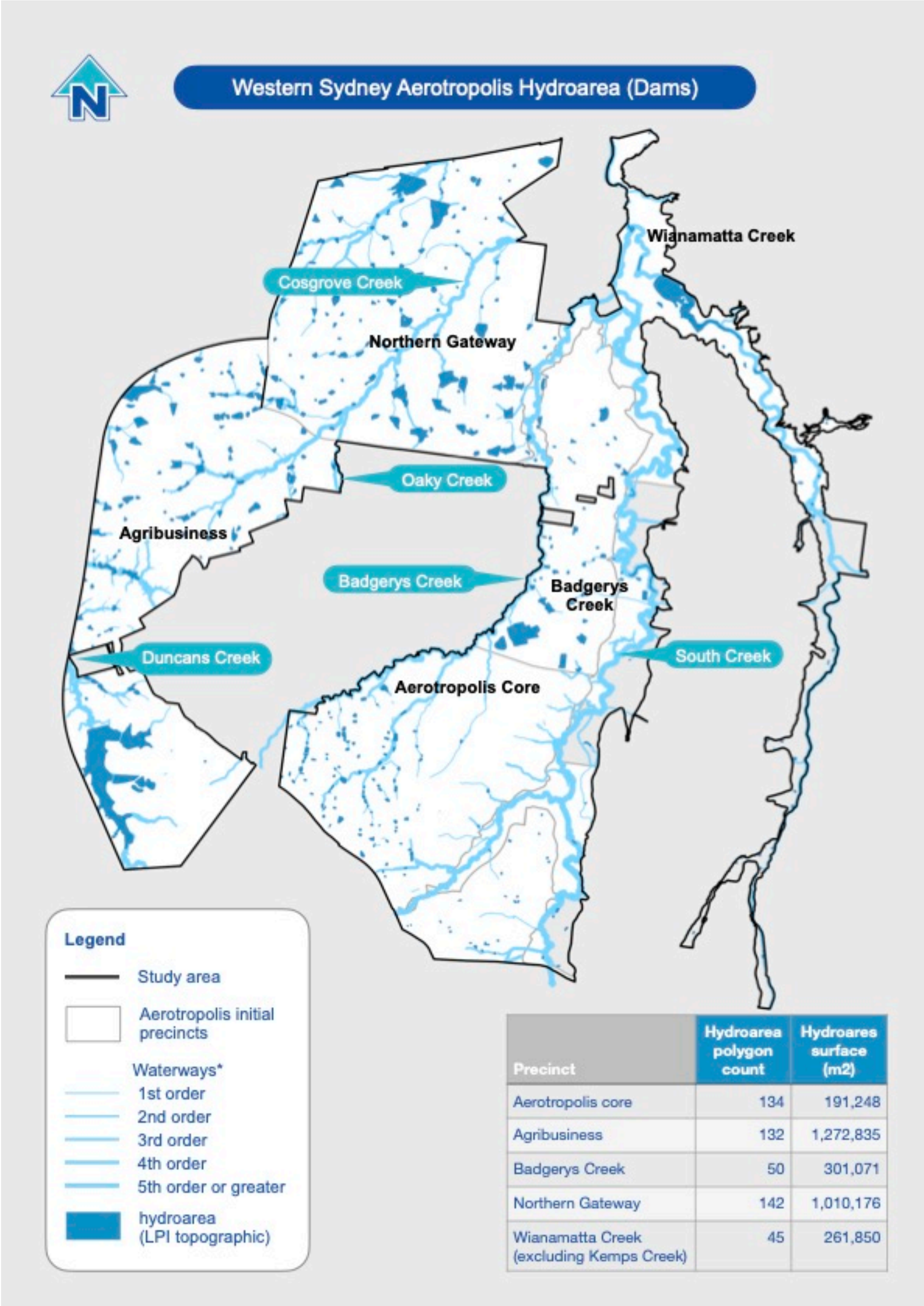
As most farm dams have not been designed for amenity functions or to be located near residential developments, many will need to be redesigned to address issues such as dam stability, safe access, water quality, algal bloom risk, water level fluctuations and wildlife attraction.

Planning will also need to address ownership, responsibility and funding arrangements for retained artificial water bodies.

Based on the assessment criteria identified in the desktop review, a total of 539 farm dams were identified across the initial precincts Figure 3 58. Of these, 80 were identified for ecological assessment across the Badgerys Creek, Aerotropolis Core, Agribusiness and Northern Gateway Precincts. Dams in Wianamatta-South Creek Precinct were excluded from assessment as this precinct was outside the project scope (Figure 3-59).

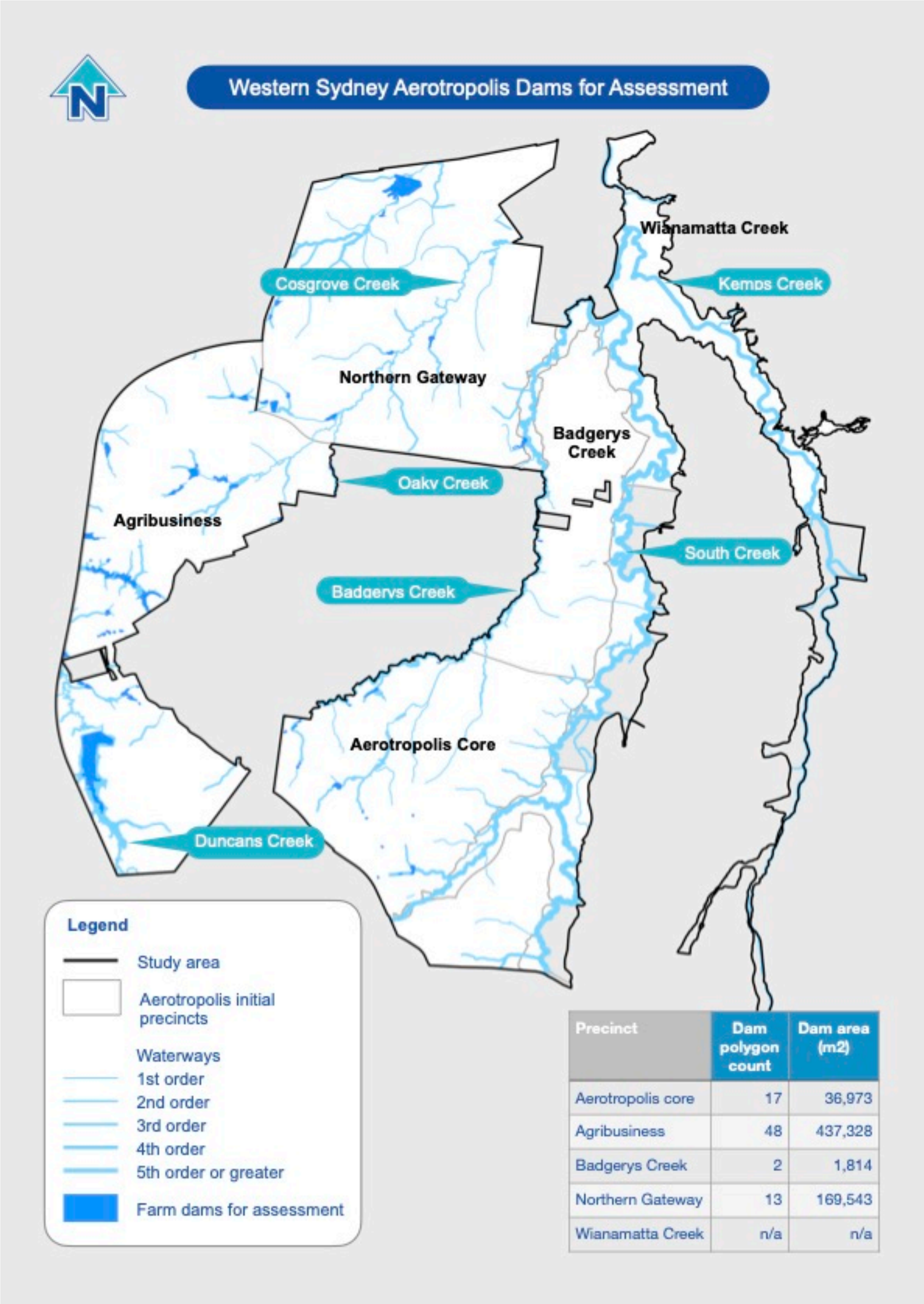
The following section provides detailed results of the farm dam assessment by precinct. Dams assessed are given a recommendation to protect, restore or have no ecological value.

Figure 3-57 Example of farm dam with potential high ecological value to be protected



Precinct	Hydroarea polygon count	Hydroares surface (m2)
Aerotropolis core	134	191,248
Agribusiness	132	1,272,835
Badgerys Creek	50	301,071
Northern Gateway	142	1,010,176
Wianamatta Creek (excluding Kemps Creek)	45	261,850

Figure 3-58 All farm dams (hydro areas) within the Western Sydney Aerotropolis Initial Precincts



Precinct	Dam polygon count	Dam area (m2)
Aerotropolis core	17	36,973
Agribusiness	48	437,328
Badgerys Creek	2	1,814
Northern Gateway	13	169,543
Wianamatta Creek	n/a	n/a

Figure 3-59 Farm dams (hydro areas) identified for ecological assessment within the Western Sydney Aerotropolis Initial Precincts

3.8.1 Badgerys Creek Precinct

Two farm dams were identified for assessment within the Badgerys Creek Precinct. Of these, Dam 3403 received a score that placed it in the Protect category, while Dam 3384 obtained a score reflective of the Restore category (Table 3-8). The location and results for assessed dams within the precinct is depicted in Figure 3-62 and Figure 3-63. A summary of assessment results within this precinct follows.

Table 3-8 Badgerys Creek precinct farm dam assessment summary results**.**

Site ID	Connectivity	Anthropogenic disturbance	Vegetation	Habitat	Hydrological change	Total Percentage	Category
3384	35.71	60	33.85	12.5	64	41.21	Restore
3403	46.43	70	32.31	37.5	88	54.85	Protect

Dam 3384

Dam 3384 received an overall score of 41.21%, placing it in the Restore category (Figure 3-60). This site had moderate connectivity to nearby dams and Badgerys Creek, with a connectivity score of 35.71. There was a small impact from minor roads within the dam catchment, however limited urban impacts such as buildings within the immediate vicinity of the dam. Anthropogenic disturbance was moderate (60), due to the presence of litter, weeds, grazing and domestic animals at the site. Water quality in the dam was also moderately turbid at the time of assessment.

Land use was predominantly agricultural pasture and grassland. There was some canopy vegetation nearby along the creek corridor, however vegetation surrounding the dam was restricted to grasses and lacked complex structure, giving a vegetation score of 33.85. Terrestrial and aquatic weed species were light and included species such as Fireweed (*Senecio madagascariensis*). There was limited habitat at this site, which contributed to a low habitat score (12.5), with light floating aquatic plants and low sedges, however, was predominantly open water. There was moderate hydrological change (score of 64), with high vegetation alteration, moderate earthworks altering upstream flow paths due to surrounding dams, water extraction, limited erosion and banks with moderate gradients.

Figure 3-60 Badgerys Creek precinct: Dam 3384

Dam 3403

Dam 3403 received an overall score of 54.85%, placing it in the Protect category (Figure 3-61). This site had high connectivity to nearby dams, vegetation and Wianamatta-South Creek, with a connectivity score of 46.43. There was a small impact of minor roads within the dam catchment, however some urban and agricultural impacts such as buildings within the immediate vicinity of the dam. Anthropogenic disturbance was moderate (70), due to the presence of low litter and weeds, high grazing and domestic animals at the site. Water quality in the dam had low turbidity at the time of assessment.

Land use was comprised of some agricultural pasture and grassland, with forest woodland along the nearby creek corridor and canopy trees adjacent to the dam contributing to medium complexity, giving a vegetation score of 32.31. Terrestrial and aquatic weed species were light and included species such as Fireweed (*Senecio madagascariensis*) and Privet (*Ligustrum sinense*). There was moderate habitat at this site (score of 37.5), with fallen logs, dead trees, hollows, floating and emergent aquatic plants. There were low hydrological impacts (score of 88), with moderate vegetation alteration and limited erosion.

Figure 3-61 Badgerys Creek precinct: Dam 3403

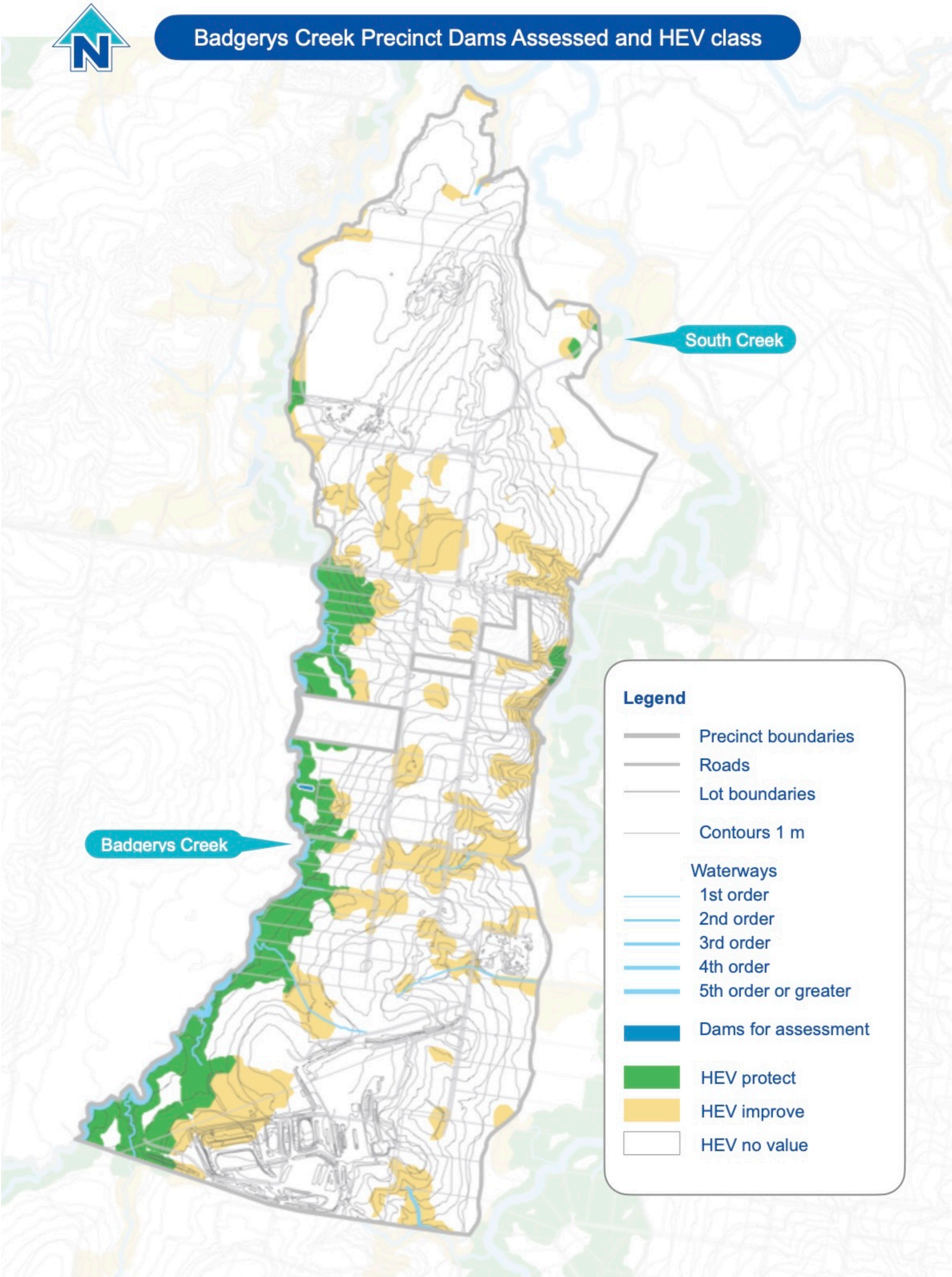


Figure 3-62 Badgerys Creek Precinct farm dams for assessment

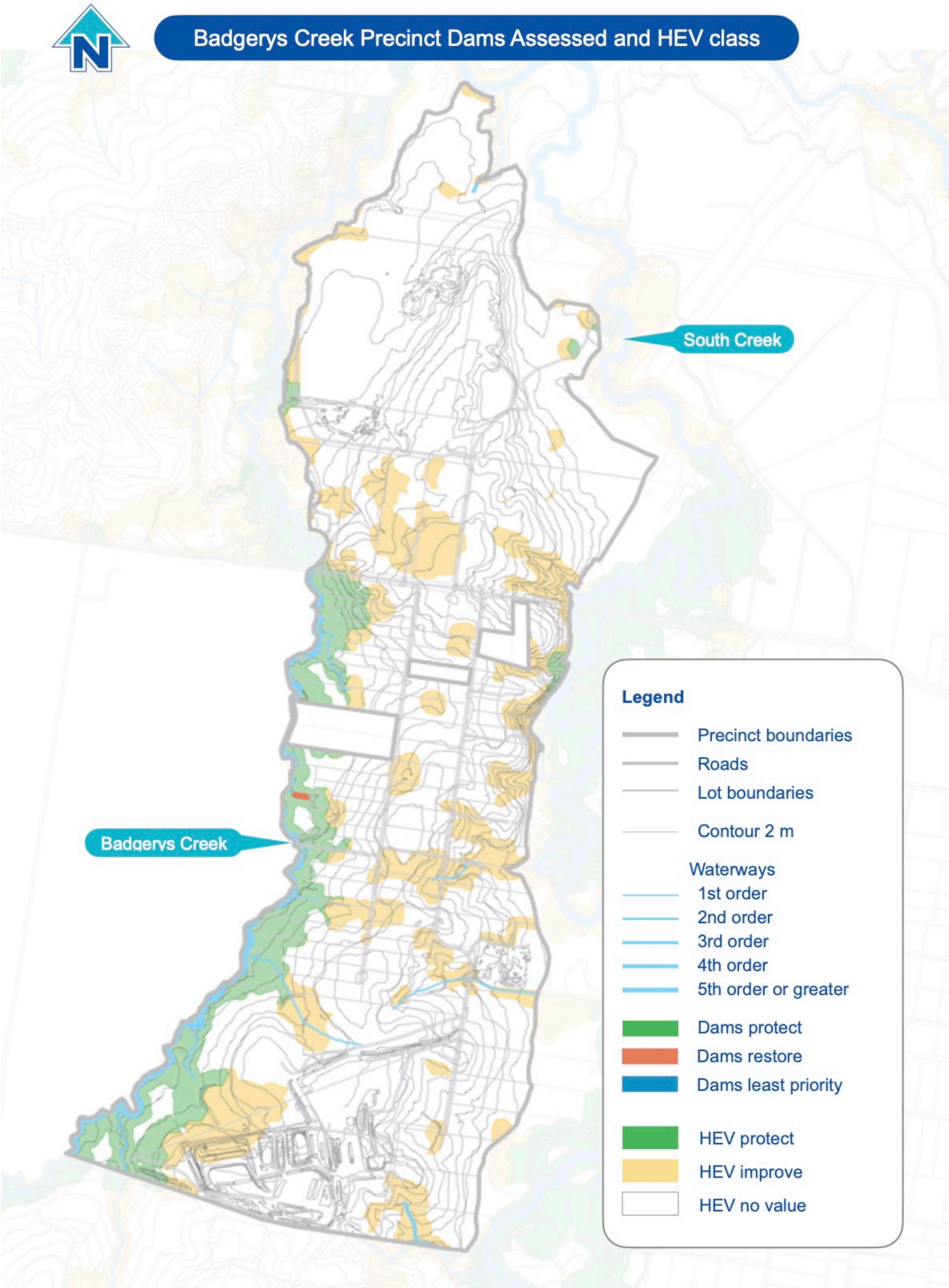


Figure 3-63 Badgerys Creek Precinct results of farm dam assessment

3.8.2 Aerotropolis Core Precinct

Within the Aerotropolis Core Precinct 17 farm dams were identified for assessment, however, upon inspection Dam 3895 was no longer a farm dam and was excluded from subsequent assessment of ecological condition (Table 3-9).

Of the 16 dams assessed, three (3825, 3859 and 3905) received scores that placed them in the Protect category, six were categorised as Restore and seven were determined to be of Least Priority. The location and results of assessed dams within the precinct is depicted in Figure 3-80 and Figure 3-81. A summary of assessment results within this precinct follows.

Table 3-9 Aerotropolis Core precinct farm dam assessment summary results.

Site ID	Connectivity	Anthropogenic disturbance	Vegetation	Habitat	Hydrological change	Total Percentage	Category
3783	32.14	40	-20.38	10.42	52	22.83	Least Priority
3785	42.86	60	-14.23	33.33	72	38.79	Restore
3800	25	80	-30.38	14.58	52	28.24	Least Priority
3802	35.71	80	-4.62	14.58	60	37.14	Restore
3825	42.86	80	44.23	37.5	88	58.52	Protect
3845	28.57	40	-51.73	10.42	64	18.25	Least Priority
3859	28.57	80	24.81	20.83	80	46.84	Protect
3866	25	40	-44.81	12.5	56	17.74	Least Priority
3867	25	60	-7.12	18.75	64	32.13	Least Priority
3895*	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3896	28.57	50	-35.58	10.42	60	22.68	Least Priority
3905	50	50	59.42	62.5	88	61.98	Protect
3907	35.71	40	10.77	31.25	80	39.55	Restore
3969	39.29	50	20.77	29.17	84	44.65	Restore
3998	35.71	50	11.92	29.17	76	40.56	Restore
4127	39.29	40	-2.12	31.25	72	36.08	Least Priority
4142	35.71	70	-3.65	45.833	68	43.18	Restore

* Farm dam no longer present at site 3895

Dam 3783

Dam 3783 received an overall score of 22.83%, placing it in the Least priority category (Figure 3-64). This site had high connectivity to surrounding farm dams, but there was limited links with adjacent natural ecosystems and natural drainage channels had been modified, which contributed to a connectivity score of 32.14. There was also impacts from major and minor roads, urban structures and industrial activity within the dam catchment. Anthropogenic disturbance was high (score of 40), due to high rubbish and recent clearing, low presence of weeds and moderate turbidity at the time of assessment.

The site had limited riparian buffers due to the presence of structures and roads and was predominantly urban yards. Riparian weed density was sparse at the time of assessment, and this site had a low total vegetation score of -20.38. This site also had a low habitat score (10.42), as the vegetation structure had low complexity and there was limited floating aquatic vegetation. There were moderate hydrological impacts at this site (score of 52), with steep banks, high vegetation alteration, moderate erosion and high restrictions from structures affecting the hydrological regime.

Figure 3-64 Aerotropolis Core precinct: Dam 3783

Dam 3785

Dam 3785 received an overall score of 38.79%, placing it in the Restore category (Figure 3-65). This site had high connectivity to surrounding farm dams and moderate links with adjacent natural ecosystems. Impacts from urban structures, agriculture, industrial activity and major and minor roads, were present within the dam catchment, contributing to an overall connectivity score of 42.86. Anthropogenic disturbance was moderate (score of 60), due to low grazing and weeds, moderate litter and turbidity, and high recent clearing at the time of the assessment.

The site had limited riparian buffers due to the presence of urban structures and was predominantly pasture and grassland with some canopy trees present. Riparian and aquatic weed density was low at the time of assessment, and this site had a low total vegetation score of -14.23. This site had a moderate habitat score (33.33), with low vegetation structure complexity, low fallen logs, submerged snags and aquatic vegetation (floating, emergent and submerged). There was also an island and sedge species surrounding the dam. There were low hydrological impacts at this site (score of 72), with moderate vegetation alteration and bank gradient, low erosion and moderate restrictions from structures affecting the hydrological regime.

Figure 3-65 Aerotropolis Core precinct: Dam 3785

Dam 3800

Dam 3800 received an overall score of 28.24%, placing it in the Least priority category (Figure 3-66). This site had high connectivity to surrounding farm dams but due to surrounding urban and agricultural structures, there was no links with adjacent natural ecosystems. Impacts from major and minor roads and altered drainage channels were also present within the dam catchment, contributing to an overall connectivity score of 25 which was one of the lowest within this precinct. Anthropogenic disturbance was low (score of 80) despite the high human activity surrounding the dam, due to low weed species, high litter and drains into the wetland. Turbidity was also low at the time of the assessment.

The site had significantly limited riparian buffers due to the presence of agricultural structures and surrounding land use was predominantly grassland. Riparian weed density was low at the time of assessment, which contributed to a total vegetation score of -30.38. This site had a low habitat score (14.58), with low vegetation structure complexity and aquatic vegetation (floating and emergent species). There were high hydrological impacts at this site (score of 52, which was one of the lowest scores for this precinct), with high vegetation alteration, steep banks, moderate erosion and high restrictions from structures affecting the hydrological regime.

Figure 3-66 Aerotropolis Core precinct: Dam 3800

Dam 3802

Dam 3802 received an overall score of 37.14%, placing it in the Restore category (Figure 3-67). This site had high connectivity to surrounding farm dams and limited links to adjacent natural ecosystems. Impacts from major and minor roads, urban structures and agricultural land use occur within the dam catchment, contributing to an overall connectivity score of 35.71. Anthropogenic disturbance was low (score of 80), due to low weed species, high litter and moderate turbidity at the time of the assessment.

The site had restricted riparian buffers and surrounding land use was predominantly grassland, with urban yards and some scattered paddock trees. Riparian weed density was low at the time of assessment, which contributed to a total vegetation score of -4.62. This site had a low habitat score (14.58), with low vegetation structure complexity, some fallen logs and dead trees. There were moderate hydrological impacts at this site (score of 60), with high vegetation alteration, banks with moderate gradient, low erosion and high restrictions from structures affecting the hydrological regime.

Figure 3-67 Aerotropolis Core precinct: Dam 3802

Dam 3825

Dam 3825 received an overall score of 58.52%, placing it in the Protect category (Figure 3-68). This site had high connectivity to surrounding farm dams was closely linked to adjacent natural ecosystems. There were several urban structures, agricultural land use and major roads within the dam catchment, which contributed to an overall connectivity score of 42.86. Anthropogenic disturbance was low (score of 80), due to low weeds, litter, grazing and turbidity.

Land use surrounding this site was dominated by forest woodland, with some grassland, pasture and scattered trees. There was a wide riparian buffer and light riparian and aquatic weed density, with a high total vegetation score of 44.23. This site also had a high habitat score (37.5), as there were fallen logs, dead trees and hollows present, in addition to snags, moderate coverage of floating and emergent aquatic vegetation. There were low hydrological impacts at this site (score of 88, which was one of the highest scores for this precinct), with moderate vegetation alteration and bank gradients, low erosion and no restrictions from structures affecting the hydrological regime.

Figure 3-68 Aerotropolis Core precinct: Dam 3825

Dam 3845

Dam 3845 received an overall score of 18.25%, placing it in the Least priority category (Figure 3-69). This site had high connectivity to nearby farm dams but had low links to surrounding natural ecosystems. Urban structures, agricultural and industrial land use occurred within the dam catchment, and there were also impacts from major and minor roads (including roadworks along the Northern Road corridor), powerlines and altered drainage channels. This site had an overall connectivity score of 28.57. Anthropogenic disturbance was moderate (score of 40), due to high recent clearing, low siltation and moderate weeds, litter and turbidity.

Land use surrounding this site was dominated by urban yards, with some scattered trees, grasses and cleared areas of exposed soil. There was a restricted riparian buffer, moderate riparian weeds (including African olive (*Olea europaea*) and Rhodes grass (*Chloris gayana*)) and light aquatic weed density (such as *Typha spp*.). This site had the lowest vegetation score for this precinct, with a total score of -51.73. This site also had one of the lowest habitat scores for this precinct (10.42), with low vegetation structural complexity, some submerged snags and emergent vegetation. There were low hydrological impacts at this site (score of 64), with high vegetation alteration, shallow bank gradients, moderate erosion and high restrictions from structures affecting the hydrological regime.

Figure 3-69 Aerotropolis Core precinct: Dam 3845

Dam 3859

Dam 3859 received an overall score of 46.84%, placing it in the Protect category (Figure 3-70). This site had high connectivity to nearby farm dams and was surrounded by agricultural paddocks and urban yards and had an overall connectivity score of 28.57. Anthropogenic disturbance was low (score of 80), due to low grazing and weeds, and water quality had low turbidity at the time of sampling.

There was a wide riparian buffer around this site, and land use was predominantly grassland and pasture, scattered paddock trees and urban yards. Riparian and aquatic weeds (including Fireweed (*Senecio madagascariensis*)) were low, with a total vegetation score of 24.81. This site had a moderate habitat score (20.83), with low vegetation structural complexity, some small hollows and aquatic vegetation (including floating and emergent species). There were low hydrological impacts at this site (score of 80), with high vegetation alteration, moderate bank gradients, and low erosion.

Figure 3-70 Aerotropolis Core precinct: Dam 3859

Dam 3866

Dam 3866 received an overall score of 17.74%, placing it in the Least priority category (Figure 3-71). This was also the lowest overall score within this precinct. This site was surrounded by nearby farm dams, however, adjacent areas were dominated by urban yards, with minor roads, urban and agricultural structures, and altered drainage channels. This contributed to an overall connectivity score of 25. Anthropogenic disturbance was high (score of 40), due to high grazing and litter, and moderate weeds. Water quality had moderate turbidity at the time of sampling and there was algae present.

The riparian buffer was restricted due to urban structures, including houses, sheds and cleared parking areas, and land use was dominated by pasture and urban yards. Riparian and aquatic weeds were light, and this site had a low total vegetation score of -44.81. This site had a low habitat score (12.5), with limited vegetation, some floating and emergent aquatic species, and a small island within the dam. There were high hydrological impacts at this site (score of 56), with high vegetation alteration and human changes, shallow bank gradients, moderate erosion and very low pugging present.

Figure 3-71 Aerotropolis Core precinct: Dam 3866

Dam 3867

Dam 3867 received an overall score of 32.13%, placing it in the Least priority category (Figure 3-72). This site had high connectivity to nearby farm dams, however, had low links to surrounding natural ecosystems. Major roads, multiple urban structures and agricultural (including intensive agriculture) impacts occurred within the dam catchment. This contributed to an overall connectivity score of 25. Anthropogenic disturbance was moderate (score of 60), due to moderate weeds and litter, low grazing, and domestic animal presence. Water quality also had moderate turbidity at the time of assessment.

Land use surrounding this site was dominated by pasture and grassland, with some scattered trees and canopy species present on the edge of the assessment area. There was a restricted riparian buffer and light riparian weed density. This site had a low total vegetation score of -7.12. This site also a low habitat score (18.75), with low vegetation structural complexity, moderate dead trees present, low submerged snags, floating and emergent vegetation. There were moderate hydrological impacts at this site (score of 64), with high vegetation alteration, steep bank gradients, low erosion and moderate restrictions from structures affecting the hydrological regime.

Figure 3-72 Aerotropolis Core precinct: Dam 3867

Dam 3896

Dam 3896 received an overall score of 22.68%, placing it in the Least priority category (Figure 3-73). This site was in close proximity to nearby farm dams, however adjacent natural ecosystems had been largely cleared. Major and minor roads, multiple urban structures, industrial land use and modified drainage channels were examples of impacts within the dam catchment and contributed to a connectivity score of 28.57. Anthropogenic disturbance was moderate (score of 50), due to low weeds, high litter and recent clearing, commercial and industrial use of the site. Water quality also had low turbidity at the time of assessment.

Land use surrounding this site was dominated by urban yards and cleared areas, and some scattered trees towards the edge of the assessment area. The riparian buffer surrounding the dam was significantly restricted, however weed species were sparse. This contributed to a total vegetation score of -35.58. This site had one of the lowest habitat scores for this precinct (10.42), with low vegetation structural complexity, and low floating vegetation present. There were moderate hydrological impacts at this site (score of 60), with high vegetation alteration, moderate bank gradients, low erosion and complete restrictions from structures affecting the hydrological regime.

Figure 3-73 Aerotropolis Core precinct: Dam 3896

Dam 3905

Dam 3905 received an overall score of 61.98%, placing it in the Protect category (Figure 3-74). This site had the highest overall score for both the Aerotropolis Core precinct, and out of all four precincts assessed. This site was in close proximity to nearby farm dams and was closely associated with adjacent natural ecosystems, merging with surrounding wetland vegetation and sedge species. There were minimal impacts from minor tracks and land use was primarily natural vegetation, agricultural and some industrial impacts. This site had the highest connectivity score for this precinct, at 50. Anthropogenic disturbance was moderate (score of 50), due to high grazing, moderate weeds, low litter, moderate dead trees and evidence of feral animals (deer). Water quality also had low turbidity at the time of assessment.

Land use surrounding this site was dominated by forest woodland, with some pasture and grassland and there was a wide riparian buffer surrounding the dam. Riparian weeds were light and included Blackberry (*Rubus fruticosus*), Fireweed (*Senecio madagascariensis*) and Rhodes Grass (*Chloris gayana*). This site had the highest total vegetation score for this precinct of 59.42. This site also had the highest habitat score for this precinct (62.5), with moderate vegetation structural complexity, high fallen logs and dead trees, some small hollows, and trees with delaminating bark. Within the dam, there was also high abundance of submerged snags and woody debris, floating, submerged and emergent vegetation, and a large island present. There were low hydrological impacts at this site (score of 88, which was the highest for this precinct), with moderate vegetation alteration, shallow bank gradients, low erosion and very low restrictions from structures affecting the hydrological regime.

Figure 3-74 Aerotropolis Core precinct: Dam 3905

Dam 3907

Dam 3907 received an overall score of 39.55%, placing it in the Restore category (Figure 3-75). This site had high connectivity to nearby farm dams, with some associations with surrounding natural ecosystems. Urban structures, agricultural land use and minor roads occurred within the dam catchment, which contributed to an overall connectivity score of 35.71. Anthropogenic disturbance was moderate (score of 40), due to high grazing impacts and turbidity, moderate weeds and low litter.

Land use surrounding this site was dominated by a wide riparian buffer comprised of pasture and grassland, with limited areas of canopy trees. Riparian weeds were light and aquatic weed density was moderate, and this site had a low total vegetation score of 10.77. This site had a moderate habitat score (31.25), with low vegetation structural complexity, low submerged snags and fallen logs. There was also moderate coverage of floating vegetation and low emergent and submerged aquatic species. This site had low hydrological impacts (score of 80), with high vegetation alteration, low erosion, moderate bank gradients and very low restrictions from structures affecting the hydrological regime.

Figure 3-75 Aerotropolis Core precinct: Dam 3907

Dam 3969

Dam 3969 received an overall score of 44.65%, placing it in the Restore category (Figure 3-76). This site was located in close proximity to nearby farm dams, with moderate links to surrounding natural ecosystems. Urban structures, agricultural land use and minor roads occurred within the dam catchment, which contributed to an overall connectivity score of 39.29. Anthropogenic disturbance was moderate (score of 50), due to low grazing impacts and litter, and moderate weeds. Water quality was moderately turbid and there was evidence of water pollution as there was a high coverage of algae.

Land use surrounding this site was dominated by a wide riparian buffer comprised of forest woodland canopy species, pasture and grassland. Riparian weeds were light (including Fireweed (*Senecio madagascariensis*)) and aquatic weed density was moderate. This site had a total vegetation score of 20.77. This site had a moderate habitat score (29.17), with moderate vegetation structural complexity, low abundance of submerged snags, and moderate coverage of floating and submerged, and low emergent aquatic vegetation. This site had low hydrological impacts (score of 84), with moderate vegetation alteration, low erosion, moderate bank gradients and very low restrictions from structures affecting the hydrological regime.

Figure 3-76 Aerotropolis Core precinct: Dam 3969

Dam 3998

Dam 3998 received an overall score of 40.56%, placing it in the Restore category (Figure 3-77). This site had some farm dams within the surrounding 1 km, with moderate links to the adjacent natural ecosystem. Major and minor roads occurred within the dam catchment, land use was primarily grassland and drainage channels into and out of the dam had been modified with rock structures to link with Badgerys Creek. This site had an overall connectivity of 35.71. Anthropogenic disturbance was moderate (score of 50), due to low grazing, weeds and litter, moderate recent clearing and high turbidity.

Land use surrounding this site was dominated pasture and grassland, with forest woodland vegetation also present in the nearby Badgerys Creek corridor. Riparian and aquatic weed density was light, and this site had a low total vegetation score of 11.92. This site had a moderate habitat score (29.17), with low vegetation structural complexity, low abundance of fallen logs and high presence of dead trees. There was also a low abundance of submerged snags and aquatic vegetation (including floating, submerged and emergent species). This site had low hydrological impacts (score of 76), with moderate vegetation alteration and bank gradients, low erosion, and moderate restrictions from structures affecting the hydrological regime.

Figure 3-77 Aerotropolis Core precinct: Dam 3998

Dam 4127

Dam 4127 received an overall score of 36.08%, placing it in the Least priority category (Figure 3-78). This site had nearby farm dams and moderate links to the adjacent natural ecosystem. Major and minor roads, several urban structures and agricultural land use occurred within the dam catchment. This site had an overall connectivity of 39.28. Anthropogenic disturbance was high (score of 40), due to high grazing and the presence of domestic animals, low weeds, dead trees and litter. Drains into the wetland had been modified and water quality had high turbidity at the time of assessment.

Land use surrounding this site was dominated pasture and grassland, with scattered trees present. The riparian buffer was slightly restricted, and riparian weed density was light and aquatic weed density was moderate. This site had a low total vegetation score of -2.12. This site had a moderate habitat score (31.25), with moderate vegetation structural complexity, some dead trees and small hollows. There was also a low abundance of submerged snags and aquatic vegetation (including floating, submerged and emergent species). This site had low hydrological impacts (score of 72), with moderate vegetation alteration, low erosion, moderate bank gradients and moderate restrictions from structures affecting the hydrological regime.

Figure 3-78 Aerotropolis Core precinct: Dam 4127

Dam 4142

Dam 4142 received an overall score of 43.18%, placing it in the Restore category (Figure 3-79). This site had high connectivity to surrounding farm dams and merged with large areas of adjacent natural ecosystems, such as sedges. Within the dam catchment, there were impacts from major and minor roads, urban structures and agricultural land use, with an overall connectivity score of 35.71. However, natural drainage channels out of the dam were altered. Anthropogenic disturbance was low (score of 70), due to low grazing, litter and presence of dead trees, and moderate weed species. Water quality had low turbidity at the time of assessment.

This site had a wide riparian buffer and land use surrounding this site was predominantly forest woodland (with limited midstory species) and grassland. Riparian weed density was moderate and aquatic weed density was severe due to the presence of *Typha spp*. This site had a low total vegetation score of -3.65. This site had a high habitat score (45.83), with moderate vegetation structural complexity, fallen logs, dead trees and submerged snags. There was also low abundance of small hollows and aquatic vegetation (including floating, submerged and emergent species). There was also a large area of sedge species present in the area surrounding the dam. This site had moderate hydrological impacts (score of 68), with moderate vegetation alteration, low erosion, steep bank gradients and moderate restrictions from structures affecting the hydrological regime.

Figure 3-79 Aerotropolis Core precinct: Dam 4142

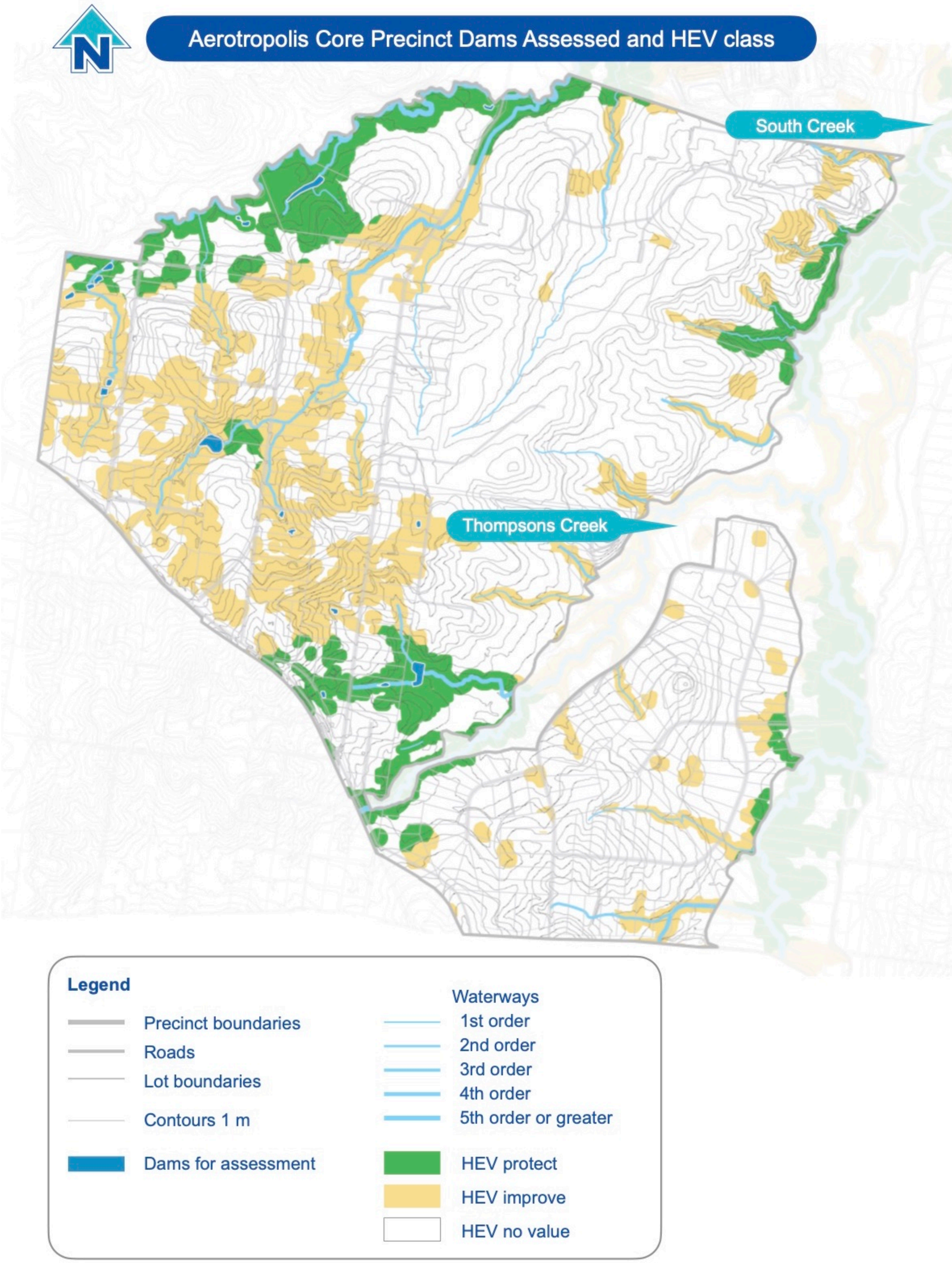


Figure 3-80 Aerotropolis Core Precinct dams for assessment and High Ecological Value Ecosystems (HEV) class

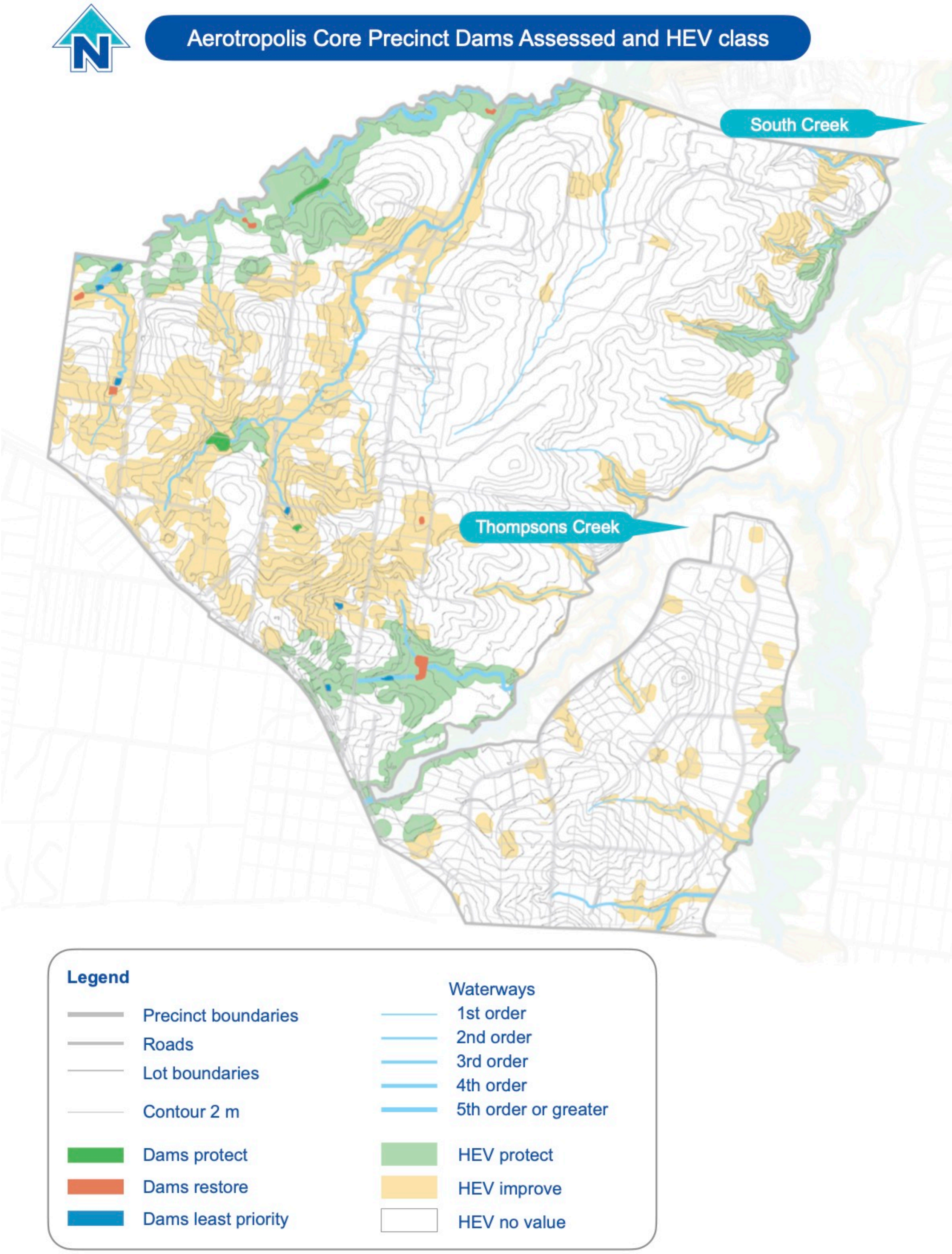


Figure 3-81 Aerotropolis Core Precinct results of farm dam assessment

3.8.3 Agribusiness Precinct

A total of 38 farm dams were assessed within the Agribusiness precinct. However, four sites (Dam 68211, 68214, 68215 and 520179) were no longer a farm dam and two sites (Dam 3110 and 3111) were identified as being spill-over from Dam 3422, therefore these six sites were excluded from subsequent assessment of ecological condition. Of the 32 sites assessed, seven dams (Dam 3267, 68106, 68116, 520104, 520106, 520119 and 520125) were placed in the Protect category, four were categorised as Restore and 21 were identified as being dams of Least Priority (Table 3-10). The location and results of assessed dams within the precinct is depicted in Figure 3-114 and Figure 3-115. A summary of each farm dam within this precinct follows.

Table 3-10 Agribusiness precinct farm dam assessment results.

Site ID	Connectivity	Anthropogenic disturbance	Vegetation	Habitat	Hydrological change	Total Percentage	Category
3106	28.57	70	17.31	8.33	60	36.84	Least Priority
3110*	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3111*	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3113	32.14	40	28.85	20.83	28	29.96	Least Priority
3267	42.86	80	13.27	37.5	76	49.93	Protect
3269	32.14	50	10.77	41.67	44	35.72	Least Priority
3277	28.57	20	24.81	39.58	48	32.19	Least Priority
3314	35.71	50	-18.65	20.83	60	29.58	Least Priority
3417	28.57	10	33.85	31.25	40	28.73	Least Priority
3422	21.43	50	-9.62	20.83	52	26.93	Least Priority
61248	32.14	20	10.38	27.08	48	27.52	Least Priority
62458	32.14	20	17.31	18.75	76	32.84	Least Priority
68044	32.14	20	-2.31	41.67	76	33.50	Least Priority
68052	35.71	50	26.92	27.08	68	41.54	Restore
62458	32.14	20	17.31	18.75	76	32.84	Least Priority
68106	50	60	34.62	45.83	84	54.89	Protect
68116	50	60	24.81	37.5	76	49.66	Protect
68144	25	0	-18.65	12.5	52	14.17	Least Priority
68171	39.29	40	55.38	20.83	44	39.90	Restore
68211	n/a	n/a	n/a	n/a	n/a	n/a	n/a
68214	n/a	n/a	n/a	n/a	n/a	n/a	n/a
68215	n/a	n/a	n/a	n/a	n/a	n/a	n/a
68300	35.71	30	24.81	35.42	56	36.39	Least Priority

68310	35.71	30	34.81	37.5	56	38.80	Restore
68318	32.14	30	27.31	29.17	52	34.12	Least Priority
83597	28.57	0	1.92	37.5	28	19.20	Least Priority
520104	39.29	60	38.85	37.5	92	53.53	Protect
520106	46.43	50	29.81	37.5	76	47.95	Protect
520119	35.71	50	45.38	18.75	80	45.97	Protect
520125	39.29	40	46.35	43.75	68	47.48	Protect
520170	32.14	40	31.35	16.67	56	35.23	Least Priority
520177	39.29	30	6.92	27.08	68	34.26	Least Priority
520179	n/a	n/a	n/a	n/a	n/a	n/a	n/a
520181	32.14	30	6.73	35.42	56	32.06	Least Priority
520182	25	50	-18.65	20.83	56	26.64	Least Priority
520186	39.29	20	27.12	33.33	44	32.75	Least Priority
520190	32.14	50	5.77	14.58	72	34.90	Least Priority
520301	39.29	50	-16.15	29.17	64	33.26	Least Priority

*Site 3110 and 3111 were not farm dams, instead were spill-over from site 3422

Dam 3106

Dam 3106 received an overall score of 36.84%, placing it in the Least priority category (Figure 3-82). This site had other farm dams in close proximity but did not merge with adjacent natural ecosystems. Within the dam catchment, there were impacts from major and minor roads, urban structures and agricultural land use, with an overall connectivity score of 28.57. The natural flow path of water out of the dam was also altered by the dam wall and nearby tracks. Anthropogenic disturbance was low (score of 70), due to low grazing and litter, moderate weed species, low recent clearing and evidence of feral animals. Water quality had low turbidity at the time of assessment.

Land use surrounding this site was dominated by pasture and grassland, with no canopy or midstory species present within the assessment area. Riparian weed density was moderate, including Fireweed (*Senecio madagascariensis*), Thistle (*Cirsium vulgare*), and *Solanum spp*., and aquatic weed density was sparse, contributing to a total vegetation score of 17.31. This site had the lowest habitat score for this precinct (8.33), as it consisted of paddocks, open water and some sedge species adjacent to the farm dam. This site had moderate hydrological impacts (score of 60), with steep banks, complete vegetation alteration, moderate erosion and restrictions from structures affecting the hydrological regime.

Figure 3-82 Agribusiness precinct: Dam 3106

Dam 3113

Dam 3113 received an overall score of 29.96%, placing it in the Least priority category (Figure 3-83). This site was nearby to other farm dams and had some links with adjacent natural ecosystems. Within the dam catchment, there were impacts from major roads (including the construction of a new major road), in addition to urban structures and agricultural land use, with an overall connectivity score of 32.14. Drainage channels into the dam had also been modified, with new stormwater infrastructure from the road construction. Anthropogenic disturbance was high (score of 40), due to high grazing and presence of stock, moderate weed species, low litter and turbidity.

Land use surrounding this site was dominated by pasture and grassland. Riparian weed density was light (including Fireweed (*Senecio madagascariensis*)), and aquatic weed density was sparse. This contributed to a total vegetation score of 28.85. This site had a moderate habitat score (20.83), due to the presence of several dead trees, low vegetation structural complexity, some floating and emergent aquatic vegetation and low abundance of submerged snags. There was also a small area of sedges adjacent to the dam. This site had high hydrological impacts (score of 28), due to having steep banks, complete vegetation alteration, high pugging, moderate erosion and restrictions from structures affecting the hydrological regime.

Figure 3-83 Agribusiness precinct: Dam 3113

Dam 3267

Dam 3267 received an overall score of 49.93%, placing it in the Protect category (Figure 3-84). This site was in close proximity to a number of other farm dams, and merged with a moderate area of adjacent natural ecosystems. Agricultural land use and major and minor roads were present within the dam catchment, contributing to an overall connectivity score of 42.86. This site had the lowest anthropogenic disturbance score for this precinct (score of 80), as weed density was moderate, there was low litter present, and turbidity was low at the time of assessment.

This site had a wide riparian buffer, and land use surrounding this site was dominated by pasture and agricultural fields, and a small area of canopy and exotic species. Riparian weed density was moderate and aquatic weed density was light, with Lantana (*Lantana camara*) and Rhodes grass (*Chloris gayana*) present. This contributed to a low total vegetation score of 13.27. This site had a high habitat score (37.5), as it had moderate vegetation structural complexity, low abundance of fallen logs and submerged snags. Aquatic vegetation, including floating, submerged, and emergent species, were also present. There was also a large area of sedges adjacent to the dam. This site had low hydrological impacts (score of 76), with low erosion, moderate vegetation alteration, steep banks and low restrictions from structures affecting the hydrological regime.

Figure 3-84 Agribusiness precinct: Dam 3267

Dam 3269

Dam 3269 received an overall score of 35.72%, placing it in the Least priority category (Figure 3-85). This site was located close to other farm dams, with limited links to adjacent natural ecosystems. Within the dam catchment, there were impacts from agricultural land use, an urban structure, some industrial activity (road upgrades), major and minor roads. This contributed to an overall connectivity score of 32.14. Anthropogenic disturbance was moderate at this site (score of 50), with high grazing, stock present, low weed presence, moderate litter and modified drains from the dam. Water quality also had low turbidity and some evidence of pollution, as algae was present.

This site had a wide riparian buffer, and land use surrounding this site was dominated by pasture, and a small area of canopy and exotic species. Riparian weed density was moderate and aquatic weed density was light, with Lantana (*Lantana camara*) and Rhodes grass (*Chloris gayana*) present. This contributed to a low total vegetation score of 10.77. This site had a high habitat score (41.67), as it had low vegetation structural complexity, low abundance of fallen logs and dead trees. Aquatic vegetation, including floating, submerged, and emergent species, were also present, in addition to some submerged snags. There was also a large area of sedges adjacent to the dam, a small island present, and a large area of standing water with *Casuarina spp*. and other vegetation present. This site had moderate hydrological impacts (score of 44), with low erosion, moderate vegetation alteration, high pugging, steep banks and low restrictions from structures affecting the hydrological regime.

Figure 3-85 Agribusiness precinct: Dam 3269

Dam 3277

Dam 3277 received an overall score of 32.19%, placing it in the Least priority category (Figure 3-86). This site was located close to other farm dams, with some links to adjacent natural ecosystems. Within the dam catchment, there were impacts from agricultural land use, urban structures, major and minor roads. Drainage channels into and out of the dam had also been modified. This contributed to an overall connectivity score of 28.57. Anthropogenic disturbance was high at this site (score of 20), with high grazing, stock present, high litter and moderate weed species. Water quality also had moderate turbidity and low evidence of pollution, as algae was present at the time of assessment.

Land use surrounding this site was dominated by pasture and grasslands, with an area of forest woodland vegetation along the nearby Cosgroves Creek corridor. Riparian and aquatic weed density was light (including Fireweed (*Senecio madagascariensis*)). This contributed to a moderate total vegetation score of 24.81. This site had a high habitat score (39.58), as it had low vegetation structural complexity, low abundance of fallen logs and moderate presence of dead trees. There was a low coverage of floating, submerged aquatic vegetation and snags, and moderate presence of emergent species. There was also a large area of sedges adjacent to the dam and a small island present. This site had moderate hydrological impacts (score of 48), with low erosion, high vegetation alteration, low impacts from pugging, steep banks and moderate restrictions from structures affecting the hydrological regime.

Figure 3-86 Agribusiness precinct: Dam 3277

Dam 3314

Dam 3314 received an overall score of 29.58%, placing it in the Least priority category (Figure 3-87). This site was near other farm dams and had limited links to adjacent natural ecosystems. Urban and agricultural impacts were present within the dam catchment, in addition to minor roads. This contributed to an overall connectivity score of 35.71. Anthropogenic disturbance was moderate at this site (score of 50), with low grazing and litter, moderate weeds, and high impacts from recent clearing. Water quality also had high turbidity at the time of assessment.

Land use surrounding this site was dominated by pasture and grassland, with several scattered trees. Riparian weed density was moderate and aquatic weed density was light. This contributed to one of the lowest total vegetation scores for this precinct, of -18.65. This site had a moderate habitat score (20.83), having low vegetation structural complexity, low abundance of fallen logs and snags. This site had moderate hydrological impacts (score of 60), with moderate erosion, high vegetation alteration, steep banks and low restrictions from structures affecting the hydrological regime.

Figure 3-87 Agribusiness precinct: Dam 3314

Dam 3417

Dam 3417 received an overall score of 28.73%, placing it in the Least priority category (Figure 3-88). This site was linked to nearby farm dams and merged with a small area of surrounding natural ecosystems. Within the dam catchment, there were high agricultural impacts with some urban structures, powerlines, and altered natural drainage channels. There were also impacts from industrial activity and major roads, with the construction of a new major road and stormwater infrastructure occurring in close proximity to this site. This contributed to an overall connectivity score of 28.57. Anthropogenic disturbance was high at this site (score of 10), with high grazing impacts and stock present, moderate weeds, litter and recent clearing. Water quality also had low turbidity at the time of assessment and there was evidence of low siltation.

Land use surrounding this site was dominated by pasture and grassland, with small areas of *Casuarina spp*. on the dam banks. Riparian weed density was moderate (including species such as Fireweed (*Senecio madagascariensis*) and Thistle (*Cirsium vulgare*)) and aquatic weed density was sparse. This contributed to a high total vegetation score of 33.85. This site had a high habitat score (31.25), with low vegetation structural complexity, low abundance of fallen logs and snags. There was a low coverage of aquatic vegetation, which included floating, emergent, and submerged species. This site had moderate hydrological impacts (score of 40), with low erosion, high vegetation alteration, banks with a moderate gradient, high pugging and moderate restrictions from structures affecting the hydrological regime.

Figure 3-88 Agribusiness precinct: Dam 3417.

Dam 3422

Dam 3422 received an overall score of 26.93%, placing it in the Least priority category (Figure 3-89). This site was located close to other farm dams but lacked links with surrounding natural ecosystems. Within the dam catchment, impacts from major and minor roads, urban structures, agricultural land use and modified drainage channels were present. There were also impacts from high density urban development and industrial activities that occur in the upper catchment of the dam at Luddenham along the Northern Road. This contributed to an overall connectivity score of 21.43, which was the lowest score for this precinct. Anthropogenic disturbance was moderate at this site (score of 50), with low grazing, moderate weeds, low litter and high recent clearing. Water quality also had low turbidity at the time of assessment.

This site had a restricted riparian buffer, and land use was dominated by pasture and grassland, and urban yards with no canopy species present. Riparian weed density was light and aquatic weed density was moderate, which contributed to a low total vegetation score of -9.62. This site had a moderate habitat score (20.83), with low abundance of submerged snags, open water and moderate coverage of aquatic vegetation (consisting of floating, emergent, and submerged species). There was also a small area of sedge species present along the edge of the dam. This site had moderate hydrological impacts (score of 52), with complete vegetation alteration, moderate erosion and bank gradients, and high restrictions from structures affecting the hydrological regime.

Figure 3-89 Agribusiness precinct: Dam 3422.

Dam 61248

Dam 61248 received an overall score of 27.52%, placing it in the Least priority category (Figure 3-90). This site was connected to surrounding farm dams and had limited links to adjacent natural ecosystems. Natural drainage channels into and out of the dam had been modified and minor roads were present. Within the dam catchment, there were also significant impacts from industrial activities, with extensive clearing, and quarry works nearby. This contributed to an overall connectivity score of 32.14. Anthropogenic disturbance was high at this site (score of 20), with low grazing impacts, high weeds, litter and recent clearing, which contributed to high turbidity and low siltation at the time of assessment.

Land use was dominated by grassland, small areas of canopy species along the nearby creek corridor and exposed earth. Riparian weed density was moderate and included species such as Bridal creeper (*Asparagus asparagoides*), Blackberry (*Rubus fruticosus*), Green cestrum (*Cestrum parqui*), *Solanum spp.*, Thistle (*Cirsium vulgare*) and African boxthorn (*Lycium ferocissimum*). Aquatic weed density was also light. This contributed to a low total vegetation score of 10.38. This site had a high habitat score (27.08), with low vegetation structural complexity, moderate abundance of dead trees and some submerged snags. There was also low presence of floating aquatic vegetation and moderate emergent species. This site had moderate hydrological impacts (score of 48), with high vegetation alteration, moderate erosion, very steep bank gradients, and high restrictions from structures affecting the hydrological regime.

Figure 3-90 Agribusiness precinct: Dam 61248

Dam 62458

Dam 62458 received an overall score of 32.84%, placing it in the Least priority category (Figure 3-91). This site was surrounded by other nearby farm dams but was not linked with adjacent natural ecosystems. Within the dam catchment, major and minor roads, urban structures and agricultural land use was present. This contributed to an overall connectivity score of 32.14. Anthropogenic disturbance was high at this site (score of 20), with high grazing impacts, high weeds and low litter. Water quality had high turbidity and moderate evidence of pollution (such as algae and surface scum) at the time of assessment.

Land use was dominated by pasture and grassland, with a few scattered paddock trees. Riparian and aquatic weed density was light, which contributed to a total vegetation score of 17.31. This site had a moderate habitat score (18.75), with low vegetation structural complexity, a few small hollows, and low abundance of snags, floating and emergent vegetation. These was also a small area of sedge species present at the dam edges. This site had low hydrological impacts (score of 76), with high vegetation alteration, moderate erosion and bank gradients, and very low restrictions from structures affecting the hydrological regime.

Figure 3-91 Agribusiness precinct: Dam 62458

Dam 68044

Dam 68044 received an overall score of 33.50%, placing it in the Least priority category (Figure 3-92). This site was located near other farm dams, with up to 50% of the site merged with adjacent natural ecosystems. Within the dam catchment, there were impacts from urban land use (including high density urban areas), major and minor roads, agricultural areas and intensive agriculture. This contributed to an overall connectivity score of 32.14. Anthropogenic disturbance was high at this site (score of 20), with high grazing impacts, stock present, moderate abundance of dead trees, low litter and moderate presence of weeds. Water quality also had moderate turbidity at the time of assessment.

This site had a restricted riparian buffer and land use was dominated by pasture and grassland, with some forest woodland. Riparian weed density was moderate, whereas aquatic weed density was light. This contributed to a low total vegetation score of -2.31. This site had a high habitat score (41.67), with moderate vegetation structural complexity, fallen logs and a range of hollows present. Within the dam, there was a moderate abundance of snags and low coverage of floating and emergent aquatic vegetation, in addition to an area of standing water. This site had low hydrological impacts (score of 76), with moderate human changes and vegetation alteration, low erosion, moderate bank gradients, and low restrictions from structures affecting the hydrological regime.

Figure 3-92 Agribusiness precinct: Dam 68044

Dam 68052

Dam 68052 received an overall score of 41.54%, placing it in the Restore category (Figure 3-93). This site was within a close distance to nearby farm dams, with moderate links to adjacent natural ecosystems. Within the dam catchment, impacts from urban structures, agricultural areas and intensive agriculture, minor and major roads. This contributed to an overall connectivity score of 35.71. Anthropogenic disturbance was moderate at this site (score of 50), with moderate grazing impacts and stock present, low litter, and moderate weeds. Water quality also had moderate turbidity at the time of assessment and appeared to have low pollution present.

Land use was dominated by pasture and grassland, with some forest woodland that lacked midstory vegetation. Riparian and aquatic weed density was light, which contributed to a moderate total vegetation score of 26.92. This site had a moderate habitat score (27.08), with moderate vegetation structural complexity, and low abundance of fallen logs and small hollows. There was also a moderate abundance of snags, floating and emergent aquatic vegetation. This site had moderate hydrological impacts (score of 68), with moderate human changes and vegetation alteration, low erosion, steep banks, and low restrictions from structures affecting the hydrological regime.

Figure 3-93 Agribusiness precinct: Dam 68052

Dam 68103

Dam 68103 received an overall score of 41.66%, placing it in the Restore category (Figure 3-94). This site was close to other farm dams and had some links with adjacent natural ecosystems. There were major and minor roads, and agricultural impacts within the dam catchment. Additionally, drainage channels out of the dam had been modified. This contributed to an overall connectivity score of 39.29. Anthropogenic disturbance was moderate at this site (score of 40), with moderate grazing and weeds, low litter, high turbidity and abundance of dead trees.

The site had a wide vegetated buffer, and land use was dominated by pasture and grassland, with some forest woodland. Riparian weed density was moderate and aquatic weed density was light, which contributed to a low total vegetation score of

13.27. This site had a high habitat score (43.75), with low vegetation structural complexity, high abundance of fallen logs and dead trees, and several hollows. There was also a moderate abundance of snags and floating vegetation, in addition to low submerged and emergent aquatic vegetation. This site had low hydrological impacts (score of 72), with moderate human changes, high vegetation alteration, low erosion, moderate bank gradients, and low restrictions from structures affecting the hydrological regime.

Figure 3-94 Agribusiness precinct: Dam 68103

Dam 68106

Dam 68106 received an overall score of 54.89%, placing it in the Protect category (Figure 3-95). This was the highest overall score within this precinct. This site was in close proximity to other farm dams and had high links with adjacent natural ecosystems. Within the dam catchment, there were major and minor roads, and agricultural land use. This contributed to an overall connectivity score of 50, which as one of the highest within this precinct. Anthropogenic disturbance was moderate at this site (score of 60), with low grazing, moderate weed species, low litter, and moderate abundance of dead trees. Water quality was also moderately turbid at the time of assessment.

The site had a wide vegetated buffer, and the vegetation community consisted of predominantly forest woodland (including unaltered vegetation and areas lacking midstory species), in addition to some pasture and grassland. Riparian and aquatic weed density was light, which contributed to a high total vegetation score of 34.62. This site had the highest habitat score for this precinct (45.83), due to having high vegetation structural complexity, moderate abundance of fallen logs and dead trees, and a range of small and large hollows. There was also a moderate abundance of snags, and low coverage of aquatic vegetation (including floating, submerged, and emergent species). This site had low hydrological impacts (score of 84), with moderate human changes, limited vegetation alteration, low erosion, moderate bank gradients, and very low restrictions from structures affecting the hydrological regime.

Figure 3-95 Agribusiness precinct: Dam 68106

Dam 68116

Dam 68116 received an overall score of 49.66%, placing it in the Protect category (Figure 3-96). This site was in close proximity to other farm dams and had moderate links with adjacent natural ecosystems. Within the dam catchment, there were major and minor roads, and agricultural land use. This contributed to an overall connectivity score of 50, which was one of the highest within this precinct. Anthropogenic disturbance was moderate at this site (score of 60), with low grazing and stock present, moderate weed species, low litter, and low abundance of dead trees. Water quality was also highly turbid at the time of assessment.

The site had a wide vegetated buffer, and the vegetation community was pasture and grassland, with some forest woodland canopy species present. Riparian and aquatic weed density was light, which contributed to a moderate total vegetation score of 24.81. This site had a high habitat score (37.5), due to having moderate vegetation structural complexity, moderate abundance of fallen logs, a low number of dead trees, and some small and large hollows. There was also a moderate abundance of snags, and low coverage of aquatic vegetation (including floating and emergent species). This site had low hydrological impacts (score of 76), with moderate human changes and vegetation alteration, low erosion and steep banks.

Figure 3-96 Agribusiness precinct: Dam 68116

Dam 68144

Dam 68144 received an overall score of 14.17%, placing it in the Least priority category (Figure 3-97). This site had the lowest overall score within this precinct and across all four precincts assessed. It had farm dams within the wider surrounding area (200 m to 1 km) and did not merge with surrounding natural ecosystems. Within the dam catchment, land use was agricultural and there were also industrial impacts from the nearby recent major road upgrades. This included new stormwater infrastructure modifying natural channels into the dam. This contributed to an overall connectivity score of 25. Anthropogenic disturbance was high at this site (score of 0, which was one of the most impacted sites), with moderate grazing and weeds, high recent clearing and low litter. Water quality was also highly turbid at the time of assessment, with moderate siltation and evidence of water pollution.

The site had a restricted vegetated buffer, and the vegetation community was predominantly pasture and grassland, with scattered paddock trees present. Weed density was moderate for riparian species and sparse for aquatic species, which contributed to one of the lowest vegetation scores for this precinct of -18.65. This site had a low habitat score (12.5), due to having low vegetation structural complexity, snags and coverage of emergent aquatic vegetation. This site had high hydrological impacts (score of 52), with high restrictions from structures, high vegetation alteration, moderate erosion and steep banks.

Figure 3-97 Agribusiness precinct: Dam 68144

Dam 68171

Dam 68171 received an overall score of 39.90%, placing it in the Restore category (Figure 3-98). This site was located with other farm dams within 200 m to 1 km and had some links with adjacent natural ecosystems. Within the dam catchment, there were no major or minor roads, however, there were urban structures, agricultural land and modified drainage channels out of the dam. This contributed to an overall connectivity score of 39.29. Anthropogenic disturbance was moderate at this site (score of 40), with high grazing and stock present, low weeds and litter. Water quality also had low turbidity at the time of assessment.

The vegetation community was predominantly under-scrubbed forest woodland, with pasture present. Riparian and aquatic weed density was sparse at the time of assessment, with only Fireweed (*Senecio madagascariensis*) present. This contributed to a high total vegetation score of 55.38, which was the highest score for this precinct. This site had a moderate habitat score (20.83), due to having low vegetation structural complexity, low abundance of fallen logs, dead trees and submerged snags. However, the dam lacked aquatic vegetation. This site had moderate hydrological impacts (score of 44), with moderate vegetation alteration, low erosion, steep bank gradients, high pugging, and low restrictions from structures affecting the hydrological regime.

Figure 3-98 Agribusiness precinct: Dam 68171

Dam 68300

Dam 68300 received an overall score of 36.39%, placing it in the Least priority category (Figure 3-99). This site was in close proximity to nearby farm dams and a large area of the dam merged with the surrounding natural ecosystems. Impacts from major and minor roads, an urban structure, agricultural land use and modified drainage inlet and outlets were present within the dam catchment. This contributed to an overall connectivity score of 35.71. Anthropogenic disturbance was high at this site (score of 30), with moderate grazing and some stock present, low weeds, moderate litter and presence of dead trees. Water quality also had moderate turbidity at the time of assessment, in addition to evidence of polluted water as algae and surface scum were prevalent.

Land use was predominantly pasture and grassland, with some forest woodland vegetation (canopy species only) present. Riparian and aquatic weed density was light at the time of assessment, with Thistle (*Cirsium vulgare*), *Solanum spp*. and African olive (*Olea europaea*) present. This contributed to a moderate total vegetation score of 24.81. This site had a high habitat score (35.42), due to having low vegetation structural complexity, high abundance of fallen logs and dead trees. There was also a low presence of submerged snags, floating and emergent aquatic vegetation. Additionally, a small area of sedges was present adjacent to the dam. This site had moderate hydrological impacts (score of 56), with high vegetation alteration, moderate erosion, very steep bank gradients and moderate restrictions from structures affecting the hydrological regime.

Figure 3-99 Agribusiness precinct: Dam 68300

Dam 68310

Dam 68310 received an overall score of 38.80%, placing it in the Restore category (Figure 3-100). This site was near several farm dams and had links with the surrounding natural ecosystems. Impacts from major and minor roads, urban structures, agricultural and industrial land use, and modified drainage channels were present within the dam catchment. This contributed to an overall connectivity score of 35.71. Anthropogenic disturbance was high at this site (score of 30), with moderate grazing and some stock present, moderate weeds and litter, and low recent clearing. Water quality also had high turbidity at the time of assessment.

Land use was predominantly forest woodland (with midstory species absent), pasture and grassland. Riparian and aquatic weed density was light at the time of assessment. This contributed to a high total vegetation score of 34.81. This site had a high habitat score (37.5), due to having moderate vegetation structural complexity, moderate abundance of fallen logs and some small hollows. There was also a moderate presence of submerged snags, floating aquatic vegetation and low emergent and submerged species of aquatic vegetation. This site had moderate hydrological impacts (score of 56), with moderate vegetation alteration, moderate erosion, steep bank gradients and high restrictions from structures affecting the hydrological regime.

Figure 3-100 Agribusiness precinct: Dam 68310 (large dam in foreground)

Dam 68318

Dam 68318 received an overall score of 32.12%, placing it in the Least priority category (Figure 3-101). This site was near several farm dams and had limited links with the surrounding natural ecosystems. Impacts from major and minor roads, urban structures, agricultural and industrial land use were present within the dam catchment. This contributed to an overall connectivity score of 32.14. Anthropogenic disturbance was high at this site (score of 30), with high grazing and some stock present, moderate weeds, low litter, and high recent clearing. Water quality also had high turbidity at the time of assessment.

Land use was predominantly pasture and grassland, with some scattered paddock trees. Riparian and aquatic weed density was light at the time of assessment. This contributed to a high total vegetation score of 27.31. This site had a high habitat score (29.17), due to having moderate vegetation structural complexity, low abundance of fallen logs and small hollows. There was also a low presence of submerged snags, emergent aquatic vegetation, and low floating species of aquatic vegetation. This site had moderate hydrological impacts (score of 52), with high human changes and vegetation alteration, moderate erosion, steep bank gradients and high restrictions from structures affecting the hydrological regime.

Figure 3-101 Agribusiness precinct: Dam 68318 (uppermost small dam in top right corner)

Dam 83597

Dam 83597 received an overall score of 19.20%, placing it in the Least priority category (Figure 3-102). This site is the largest dam within all four precincts, with an area of 53 ha. It is located within a 1-5 km distance from nearby wetlands and Duncan's Creek. This site does not merge with adjacent natural ecosystems and had impacts from urban and agricultural structures, agricultural land use (including intensive agriculture), minor roads, powerlines, and modified drainage channels. This contributed to an overall connectivity score of 28.57. Anthropogenic disturbance was high at this site (score of 0, which was one of the lowest scores for this precinct), with high grazing and stock, high weeds, low litter, moderate recent clearing, high evidence of feral animals, plant or bark removal and moderate abundance of dead trees. Water quality also had high turbidity, evidence of pollution and high siltation at the time of assessment.

Land use was dominated by pasture and grassland and had a narrow riparian buffer. Riparian weed density was moderate, and aquatic weed density was sparse. This contributed to a low total vegetation score of 1.92. This site had a high habitat score (37.5), due to a low abundance of fallen logs, several hollows (both large and small) and trees with delaminating bark. There was also a low presence of submerged snags and aquatic vegetation (including floating, emergent and submerged species). Large areas of sand/mudflats and standing water were also present. This site had one of the highest hydrological impacts (score of 28), with high human changes, complete vegetation alteration, low erosion, moderate pugging and bank gradients, and complete restrictions from structures affecting the hydrological regime.

Figure 3-102 Agribusiness precinct: Dam 83597

Dam 520104

Dam 520104 received an overall score of 53.53%, placing it in the Protect category (Figure 3-103). This site was located in close proximity to nearby farm dams and had some links with adjacent natural ecosystems. Within the dam catchment, there were impacts from minor roads, urban structures and agricultural land use, which contributed to an overall connectivity score of 39.29. Anthropogenic disturbance was moderate at this site (score of 60), with low grazing and stock, high abundance of dead trees and low weed species present. Water quality also had high turbidity at the time of assessment.

This site had a wide riparian buffer, and the vegetation community was dominated by pasture and grassland, with forest woodland (which lacked midstory species). Riparian weed density was light and aquatic weed density was sparse. This contributed to a high total vegetation score of 38.85. This site had a high habitat score (37.5), due to a moderate vegetation structural complexity, high abundance of fallen logs and dead trees and some hollows (both large and small) present. There was also a low presence of submerged snags and floating aquatic vegetation. This site had one of the lowest hydrological impacts (score of 92), as there were no structures affecting the hydrological regime present, moderate vegetation alteration, no evident erosion and moderate bank gradients.

Figure 3-103 Agribusiness precinct: Dam 520104

Dam 520106

Dam 520106 received an overall score of 47.95%, placing it in the Protect category (Figure 3-104). This site was located close to other farm dams and had moderate links with adjacent natural ecosystems. Within the dam catchment, there were impacts from minor roads and agricultural land use, which contributed to an overall connectivity score of 46.43. Anthropogenic disturbance was moderate at this site (score of 50), with low grazing and litter, moderate weed species and high abundance of dead trees. Water quality also had high turbidity at the time of assessment.

This site had a wide riparian buffer, and the vegetation community consisted of pasture and grassland, and forest woodland (which lacked midstory species). Riparian weed density was moderate (including Blackberry (*Rubus fruticosus*)) and aquatic weed density was sparse, which contributed to a high total vegetation score of 29.81. This site had a high habitat score (37.5), due to a moderate vegetation structural complexity, low abundance of fallen logs, high presence of dead trees, and some hollows (both large and small) present. There was also a moderate presence of submerged snags and low coverage of floating and submerged aquatic vegetation. This site had low hydrological impacts (score of 76), with low impacts from structures affecting the hydrological regime present, moderate vegetation alteration, low erosion and moderate bank gradients.

Figure 3-104 Agribusiness precinct: Dam 520106

Dam 520119

Dam 520119 received an overall score of 47.97%, placing it in the Protect category (Figure 3-105). This site was located within 200 m to 1 km of other wetlands and dams, with some links with adjacent natural ecosystems. Within the dam catchment, there were impacts from major and minor roads, agricultural land use, and modified drainage channels out of the dam into nearby Duncan's Creek. This contributed to an overall connectivity score of 35.71. Anthropogenic disturbance was moderate at this site (score of 50), with moderate grazing and some stock, low weed species, moderate litter, and high turbidity at the time of assessment.

The vegetation community was predominantly pasture and grassland, with scattered paddock trees and some forest woodland. Riparian and aquatic weed density was sparse, with Fireweed (*Senecio madagascariensis*) observed. This contributed to a high total vegetation score of 45.38. This site had a moderate habitat score (18.75), due to a low vegetation structural complexity, low abundance of dead trees, submerged snags, and aquatic vegetation (including floating and emergent species). There was also a small area of sedge species adjacent to the dam. This site had low hydrological impacts (score of 80), with very low impacts from structures affecting the hydrological regime present, high vegetation alteration, low erosion and moderate bank gradients.

Figure 3-105 Agribusiness precinct: Dam 520119

Dam 520125

Dam 520125 received an overall score of 47.48%, placing it in the Protect category (Figure 3-106). This site was surrounded by nearby farm dams and had high links with adjacent natural ecosystems. Within the dam catchment, there were impacts from major and minor roads, agricultural land use, and highly modified drainage channels into (linking it with Dam 68300) and out of the dam. This contributed to an overall connectivity score of 39.29. Anthropogenic disturbance was moderate at this site (score of 40), with moderate grazing and some stock, low weed species, and moderate litter. At the time of assessment, turbidity was low, and there was also evidence of polluted water (low algae and surface scum present) and moderate siltation (from outlet from Dam 68300 above).

The site had a wide riparian buffer, and land use was dominated by forest woodland and some pasture and grassland. The vegetation community was predominantly pasture and grassland, with scattered paddock trees and some forest woodland. Riparian weed density was light (such as *Verbena incompta and Bidens pilosa*), and aquatic weed density was sparse. This contributed to a high total vegetation score of 46.35. This site had a high habitat score (43.75), with moderate vegetation structural complexity, high abundance of dead trees and submerged snags, moderate presence of fallen logs, some small hollows, and low coverage of aquatic vegetation (including floating, submerged and emergent species). There was also a small area of sedge species adjacent to the dam. This site had moderate hydrological impacts (score of 68), with high impacts from structures affecting the hydrological regime present, moderate vegetation alteration, erosion and bank gradients.

Figure 3-106 Agribusiness precinct: Dam 520125

Dam 520170

Dam 520170 received an overall score of 35.23%, placing it in the Least priority category (Figure 3-107). This site was in close proximity to other farm dams, with limited links with adjacent natural ecosystems. Major and minor roads, urban structures, agricultural and industrial land use were present within the dam catchment, including recent upgrades to the nearby Northern Road. This contributed to an overall connectivity score of 32.14. Anthropogenic disturbance was moderate at this site (score of 40), with high grazing and stock impacts, low weeds and litter, low abundance of dead trees and high turbidity at the time of assessment.

The site had a wide riparian buffer, however, land use was dominated by pasture and grassland, with scattered paddock trees. Riparian weed density was light and aquatic weed density was sparse, which contributed to a moderate total vegetation score of 31.35. This site had a low habitat score (16.67), with low vegetation structural complexity, moderate abundance of fallen logs, a low number of dead trees and low coverage of floating aquatic vegetation. This site had moderate hydrological impacts (score of 56), with high impacts from structures affecting the hydrological regime present, complete vegetation alteration, moderate erosion and shallow bank gradients.

Figure 3-107 Agribusiness precinct: Dam 520170 (small dam in centre of image)

Dam 520177

Dam 520177 received an overall score of 34.26%, placing it in the Least priority category (Figure 3-108). This site was in close proximity to other farm dams, with limited links with adjacent natural ecosystems. Major roads, agricultural and industrial land use were present within the dam catchment, including recent upgrades to the nearby Northern Road. This contributed to an overall connectivity score of 39.29. Anthropogenic disturbance was high at this site (score of 30), with high grazing and stock, moderate weeds and recent clearing, and low litter. Water quality also had moderate turbidity at the time of assessment.

The site had a restricted riparian buffer, and the vegetation community was dominated by pasture and grassland, with scattered canopy trees. Riparian weed density was moderate and aquatic weed density was sparse, which contributed to a low total vegetation score of 6.92. This site had a moderate habitat score (27.08), with low vegetation structural complexity, low abundance of fallen logs, and some hollows (both large and small). There was also a moderate coverage of floating and low presence of submerged aquatic vegetation. This site had moderate hydrological impacts (score of 68), with high human changes, high impacts from structures affecting the hydrological regime present, moderate vegetation alteration, low erosion and shallow bank gradients.

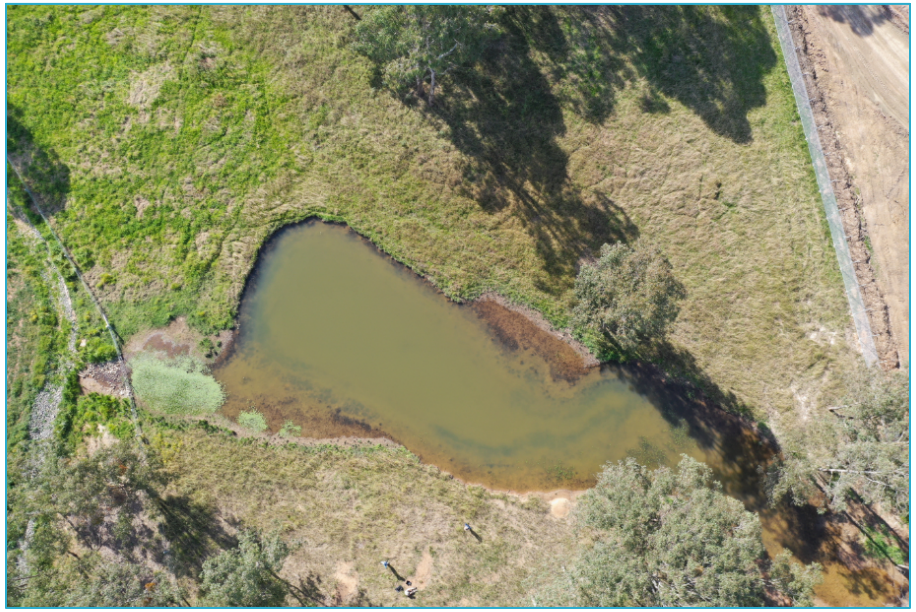


Figure 3-108 Agribusiness precinct: Dam 520177

Dam 520181

Dam 520181 received an overall score of 32.06%, placing it in the Least priority category (Figure 3-109). This site was near other farm dams and merged with moderate areas of adjacent natural ecosystems. Within the dam catchment, there were impacts from major roads, agricultural land use, intensive agriculture, industrial activities, and altered natural drainage channels. This contributed to an overall connectivity score of 32.14. Anthropogenic disturbance was high at this site (score of 30), with high litter, moderate weed species, low impacts from recent clearing, altered drainage channels, and moderate abundance of dead trees. Water quality also had high turbidity and low evidence of pollution at the time of assessment.

The vegetation community at this site consisted of pasture and grassland, and forest woodland (with midstory species absent). Riparian and aquatic weed density was moderate, which contributed to a low total vegetation score of 6.73. This site had a high habitat score (35.42), with low vegetation structural complexity, low abundance of fallen logs, a moderate number of dead trees, and some hollows (both large and small). There was also low abundance of submerged snags, moderate floating aquatic vegetation, and low presence of submerged and emergent aquatic vegetation. This site had moderate hydrological impacts (score of 56), with high human changes, moderate vegetation alteration, moderate erosion, steep banks, and high impacts from structures affecting the hydrological regime.

Figure 3-109 Agribusiness precinct: Dam 520181

Dam 520182

Dam 520182 received an overall score of 26.64%, placing it in the Least priority category (Figure 3-110). This site was in close proximity to other farm dams but lacked links with surrounding natural ecosystems. Within the dam catchment, there were impacts from major and minor roads, a number of urban structures, agricultural land use, intensive agriculture, industrial activities, and altered natural drainage channels. This contributed to an overall connectivity score of 25. Anthropogenic disturbance was moderate at this site (score of 50), with moderate weed species and recent clearing, and high litter. Water quality also had moderate turbidity at the time of assessment.

The vegetation community was predominantly pasture and grassland, with scattered paddock trees and a limited riparian buffer. Weed density of riparian and aquatic species was moderate, which contributed to one of the lowest total vegetation scores for this precinct (-18.65). This site had a moderate habitat score (20.83), with low vegetation structural complexity, low abundance of submerged snags, moderate coverage of floating and emergent aquatic vegetation, and low submerged aquatic vegetation. This site had moderate hydrological impacts (score of 56), with high human changes, high vegetation alteration, low erosion, steep banks, and high impacts from structures affecting the hydrological regime.

Figure 3-110 Agribusiness precinct: Dam 520182

Dam 520186

Dam 520186 received an overall score of 32.75%, placing it in the Least priority category (Figure 3-111). This site was in close proximity to other farm dams and had moderate links with surrounding natural ecosystems. Within the dam catchment, there were impacts from major and minor roads, urban structures and agricultural land use, which contributed to an overall connectivity score of 39.29. Anthropogenic disturbance was high at this site (score of 20), with high grazing and stock impacts, high presence of weed species, low litter and moderate turbidity.

This site had a wide riparian buffer and the vegetation community was predominantly pasture and grassland, with some forest woodland. Weed density of riparian species was moderate, and sparse for aquatic species. This contributed to a high total vegetation score of 27.12. This site had a high habitat score (33.33), with moderate vegetation structural complexity, a low number of fallen logs, a range of hollows (both small and large) and low presence of submerged snags. There was also moderate coverage of floating aquatic vegetation and low cover of submerged and emergent species. This site had moderate hydrological impacts (score of 44), with moderate vegetation alteration and erosion, high pugging, steep banks, and very low impacts from structures affecting the hydrological regime.

Figure 3-111 Agribusiness precinct: Dam 520186

Dam 520190

Dam 520190 received an overall score of 34.90%, placing it in the Least priority category (Figure 3-112). This site was in close proximity to other farm dams but did not merge with surrounding natural ecosystems. Impacts from major and minor roads, urban structures and agricultural land use were present within the dam catchment. This contributed to an overall connectivity score of 32.14. Anthropogenic disturbance was moderate at this site (score of 50), with low grazing, moderate presence of weed species and low litter. Water quality had high turbidity and evidence of pollution at the time of assessment, as there was a high cover of algae and *Azolla spp*.

The vegetation community at this site consisted of pasture and grassland. Riparian weed density was moderate (including Fireweed (*Senecio madagascariensis*)), and aquatic weed density was light. This contributed to a low total vegetation score of 5.77. This site had a low habitat score (14.58), as it was primarily open water with moderate coverage of floating aquatic vegetation and low emergent aquatic vegetation. There was also a small area of sedge species present. This site had low hydrological impacts (score of 72), with complete vegetation alteration, moderate erosion and bank gradients, and very low impacts from structures affecting the hydrological regime.

Figure 3-112 Agribusiness precinct: Dam 520190

Dam 520301

Dam 520301 received an overall score of 33.226%, placing it in the Least priority category (Figure 3-113). This site was in close proximity to other farm dams, with limited links to surrounding natural ecosystems. Impacts from major and minor roads, and agricultural land use were present within the dam catchment. This contributed to an overall connectivity score of 39.29. Anthropogenic disturbance was moderate at this site (score of 50), with low grazing, moderate presence of weed species, a low number of dead trees, and high recent clearing. Water quality had high turbidity and low siltation at the time of assessment.

The vegetation community at this site had a restricted riparian buffer and was predominantly pasture and grassland, with some forest woodland (midstory species absent). Riparian and aquatic weed density was moderate. This contributed to a low total vegetation score of -16.15. This site had a high habitat score (29.17), due to moderate vegetation structural complexity, a low number of fallen logs and dead trees, and a range of hollows present (including both small and large hollows). There was also low abundance of submerged snags and low coverage of aquatic vegetation (including floating, submerged, and emergent species). This site had moderate hydrological impacts (score of 64), with moderate human changes, high vegetation alteration, moderate erosion and bank gradients, and moderate impacts from structures affecting the hydrological regime.

Figure 3-113 Agribusiness precinct: Dam 520301

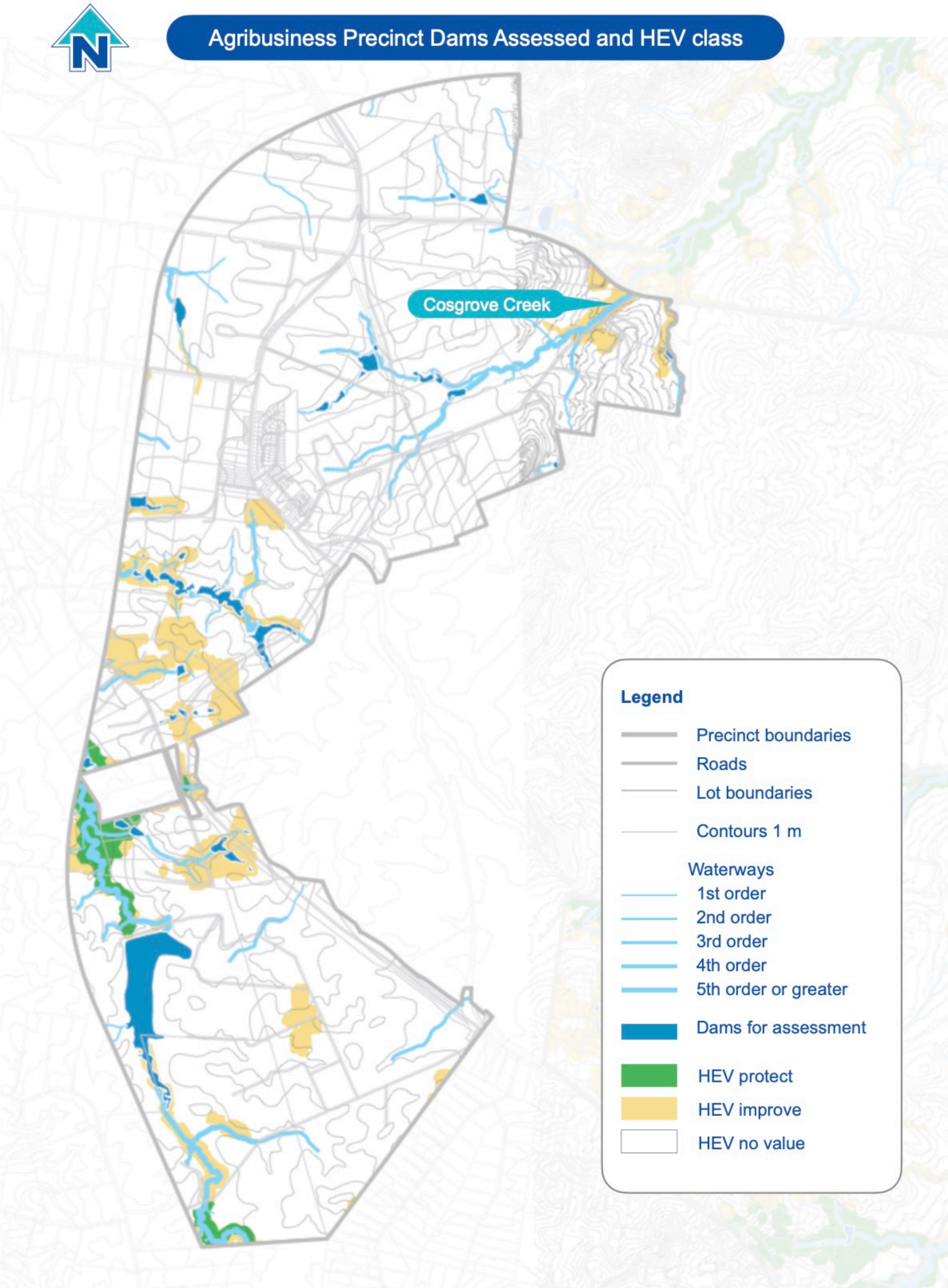


Figure 3-114 Agribusiness Precinct dams for assessment and High Ecological Value Ecosystems (HEV) class

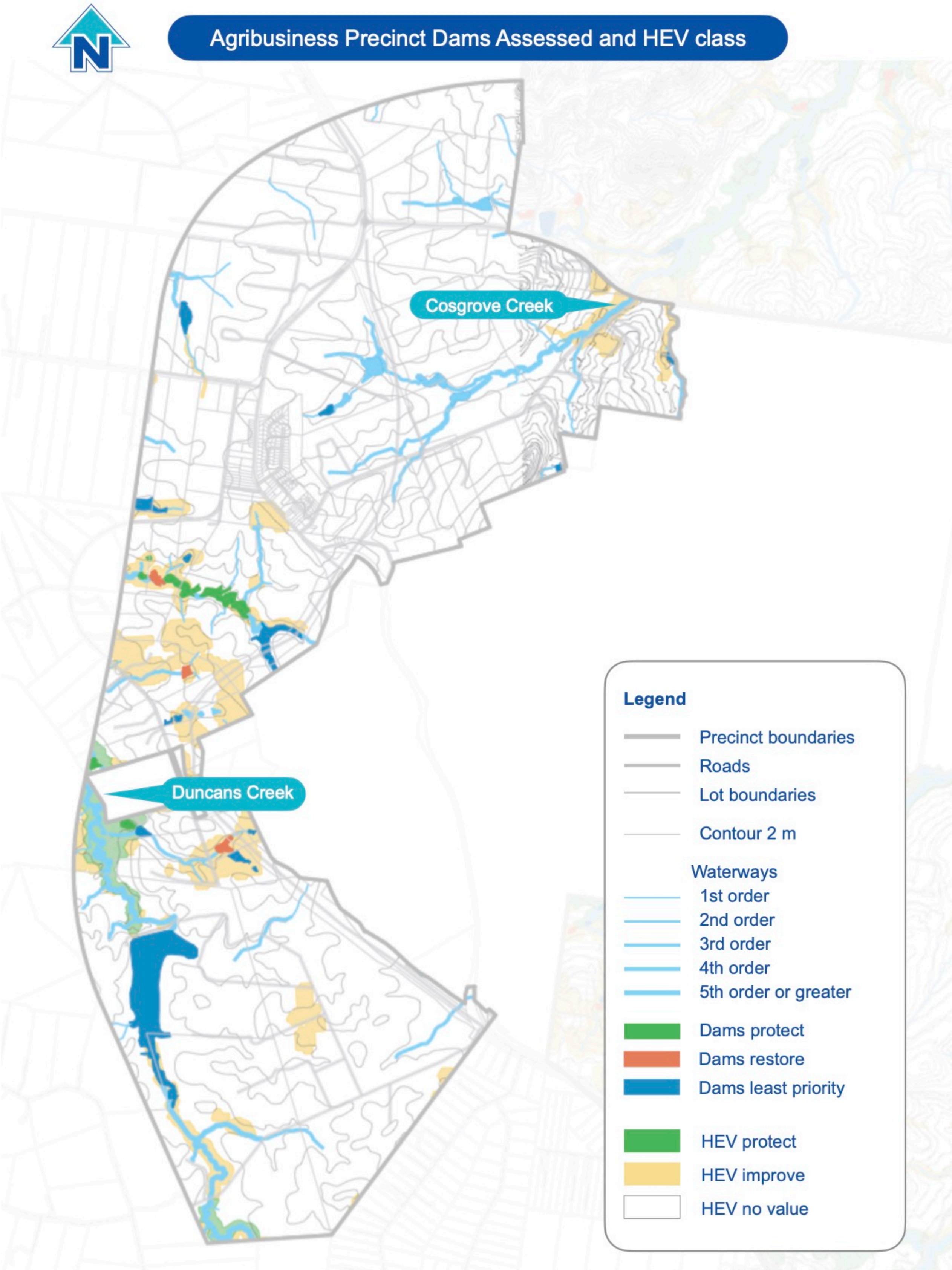


Figure 3-115 Agribusiness Precinct results of dam assessment

3.8.4 Northern Gateway Precinct

A total of 13 farm dams were identified within the Northern Gateway precinct, however, upon inspection one site (Dam 81) was not a farm dam, instead was spill-over from Dam 79 and so was excluded from subsequent assessment of ecological condition. Of the 12 sites assessed, two dams (3210 and 3247) were indicated as Protect, seven were categorised as Restore and three were identified as being dams of Least Priority (Table 3-11). The location and results of assessed dams within the precinct in relation to HEV mapping is depicted in Figure 3-128 and Figure 3-129. A summary of each farm dam within this precinct follows.

Table 3-11 Northern Gateway precinct farm dam assessment summary results

Site ID	Connectivity	Anthropogenic disturbance	Vegetation	Habitat	Hydrological change	Total Percentage	Category
79	35.71	60	19.81	29.17	80	44.94	Restore
81*	n/a	n/a	n/a	n/a	n/a	n/a	n/a
174	46.43	60	19.81	14.58	72	42.56	Restore
196	50	70	19.81	27.08	56	44.58	Restore
3085	35.71	70	19.81	25	64	42.90	Restore
3120	57.14	50	10.77	43.75	76	47.53	Protect
3232	25	60	28.85	12.5	60	37.27	Restore
3240	32.14	20	11.92	22.92	24	22.20	Least Priority
3243	39.29	30	19.81	16.67	60	33.15	Least Priority
3247	35.71	50	29.81	41.67	68	45.04	Protect
3284	28.57	50	16.92	39.58	60	39.02	Restore
3285	25	30	-27.69	35.42	52	22.95	Least Priority
3369	39.29	60	13.27	27.08	52	38.33	Restore

*Site 81 was not a farm dam, instead is the spill-over from site 79

Dam 79

Dam 79 received an overall score of 44.94%, placing it in the Restore category (Figure 3-116). This site had high connectivity to nearby dams, however, had limited surrounding natural vegetation and received a connectivity score of 35.71. Surrounding land use was predominantly agricultural, with some intensive agriculture. Additionally, major and minor roads were located within the dam catchment. Anthropogenic disturbance was moderate (score of 60), due to the presence of low litter, moderate weeds, high grazing and some domestic animals at the site.

The vegetation community had low complexity and was dominated by pasture and grassland, with some scattered trees and sedge species, and a total vegetation score of 19.81. There was moderate habitat at this site (score of 29.17), with open water, medium coverage of floating and emergent aquatic plants, and no dead trees or hollows evident. There were low hydrological impacts at this site (score of 80), with no evidence of structures impacting the hydrological regime and limited erosion, however, there was high vegetation alteration and the dam had steep banks.

Figure 3-116 Northern Gateway precinct: Dam 79.

Dam 174

Dam 174 received an overall score of 42.56%, placing it in the Restore category (Figure 3-117). This site had a large open water body, high connectivity to nearby dams and some adjacent natural vegetation, receiving the highest connectivity score of this precinct at 46.43. There are minor impacts from major and minor roads located within the dam catchment, in addition to agriculture and an airport within a 1 km radius of the site. Anthropogenic disturbance was moderate (score of 60), due to the presence of litter, some weed species, high grazing and domestic animals at the site. Water quality was also turbid at the time of assessment and there was evidence of low siltation.

The vegetation community had low complexity and was dominated by pasture and grassland, with some scattered trees, and a total vegetation score of 19.81. Weed density was light for both riparian and aquatic species. There was low habitat at this site (score of 14.58), with low coverage of floating and emergent aquatic plants, and a few dead trees present. There were limited hydrological impacts at this site (score of 72), with very low impact from structures impacting the hydrological regime and limited erosion, however, there was very high vegetation alteration and the dam had steep banks.

Figure 3-117 Northern Gateway precinct: Dam 174 (centre).

Dam 196

Dam 196 received an overall score of 44.58%, placing it in the Restore category (Figure 3-118). This site was in close proximity to other dams, but had no adjacent natural ecosystems surrounding the dam and outflow channels had been altered, receiving a connectivity score of 46.43. There were no impacts from any roads within the dam catchment, and there were minor impacts from agricultural land use in the surrounding area. Anthropogenic disturbance was moderate (score of 70), due to the presence of low weed species, moderate grazing and domestic animals at the site. Water quality was also turbid at the time of assessment.

The vegetation community lacked complexity and was dominated by pasture and grassland, with some scattered paddock trees, and a total vegetation score of 19.81. Weed density was light for both riparian and aquatic species, and included African boxthorn (*Lycium ferocissimum*) and *Solanum spp*. There was moderate habitat at this site (score of 27.08), with some fallen logs, dead trees, and trees with delaminating bark. Coverage of floating, submerged and emergent aquatic plants was moderate, being prevalent around the edges with open water in the centre of the dam. There were some hydrological impacts at this site (score of 56), with very steep banks, high vegetation alteration, and low pugging from stock present.

Figure 3-118 Northern Gateway precinct: Dam 196

Dam 3085

Dam 3085 received an overall score of 42.90%, placing it in the Restore category (Figure 3-119). This site had high connectivity to other farm dams and limited adjacent natural vegetation, receiving a connectivity score of 35.71. There were some impacts from minor roads within the dam catchment. Land use was predominantly agricultural, and natural drainage channels from the dam were altered. Anthropogenic disturbance was moderate (score of 70), due to the presence of low litter, moderate weed species, low grazing and domestic animals at the site.

The site had a wide riparian buffer but was predominantly pasture and grassland, with some canopy species present and a total vegetation score of 19.81. Riparian weed species were moderate, whilst aquatic weeds were sparse. The vegetation community lacked complexity, however, there were some fallen logs, dead trees, snags and low emergent and submerged aquatic vegetation. This resulted in a moderate habitat score of 25. There were some hydrological impacts at this site (score of 64), with very steep banks, complete vegetation alteration, and moderate restrictions from structures affecting the hydrological regime.

Figure 3-119 Northern Gateway precinct: Dam 3085

Dam 3120

Dam 3120 received an overall score of 47.53%, placing it in the Protect category, which was the highest overall score for this precinct (Figure 3-120). This site had high connectivity to nearby dams, some adjacent natural vegetation, agricultural land use and no roads within the dam catchment, receiving a high connectivity score of 57.14. Anthropogenic disturbance was moderate (score of 50), due to the presence of litter, low weed species, high grazing and domestic animals at the site. Water quality was also turbid at the time of assessment and there was evidence of water pollution due to the presence of algae and aquatic weeds.

Land use was predominantly pasture and grassland, with some canopy vegetation and a total vegetation score of 19.81. However, riparian weeds (including Fireweed (*Senecio madagascariensis*) and African boxthorn (*Lycium ferocissimum*)) were moderate and aquatic weeds were low. This site had the highest habitat score for this precinct (43.75), with high abundance of dead trees and moderate fallen logs, submerged snags, floating and emergent aquatic vegetation, and sedges surrounding the dam. There were low hydrological impacts at this site (score of 76), with limited erosion, however, there was moderate vegetation alteration, very low pugging impacts from stock and the dam had steep banks.

Figure 3-120 Northern Gateway precinct: Dam 3120

Dam 3232

Dam 3232 received an overall score of 37.27%, placing it in the Restore category (Figure 3-121). This site had high connectivity to nearby dams, limited scattered trees, agricultural land use and minor roads within the dam catchment. This resulted in one of the lowest connectivity scores for this precinct (25). Anthropogenic disturbance was moderate (score of 60), due to the presence of medium litter, low weed species, low grazing and domestic animals at the site. Water quality was also turbid at the time of assessment.

Land use was predominantly pasture and grassland, with few scattered trees and light riparian weeds, giving a total vegetation score of 28.84. This site had the lowest habitat score for this precinct (12.5), with low vegetation structural complexity, low fallen logs, and low floating aquatic vegetation. There were moderate hydrological restrictions at this site (score of 60), with high vegetation alteration, steep banks and moderate erosion.

Figure 3-121 Northern Gateway precinct: Dam 3232. Source: GoogleMaps 2020

Dam 3240

Dam 3240 received an overall score of 22.20%, placing it in the Least priority category, which was the lowest overall score for this precinct (Figure 3-122). This site had high connectivity to other farm dams but limited adjacent natural vegetation, receiving a connectivity score of 32.14. There were some impacts from major and minor roads within the dam catchment, and urban structures and agricultural land use were present. A steep dam wall also separated the flood plain from Cosgroves Creek, which runs parallel to the farm dam. Anthropogenic disturbance was high (receiving the lowest score (20) for this precinct), due to the presence of stock and high grazing, moderate weeds and high litter. Water quality also had high turbidity at the time of assessment.

The site had a moderate riparian buffer due to the presence of residential structures, and was predominantly pasture and grassland, with vegetation within the nearby creek corridor. This contributed to a low total vegetation score of 11.92. Riparian weed species were moderate (including Fireweed (*Senecio madagascariensis*) and African boxthorn (*Lycium ferocissimum*)), whilst aquatic weeds were sparse. The vegetation community lacked complexity, however, there were some fallen logs, dead trees, snags and low emergent aquatic vegetation. This resulted in a moderate habitat score of 22.92. This site also had the highest hydrological impacts for this precinct (score of 24), with steep banks, high pugging, complete vegetation alteration, and moderate erosion.

Figure 3-122 Northern Gateway precinct: Dam 3240

Dam 3243

Dam 3243 received an overall score of 33.15%, placing it in the Least priority category (Figure 3-123). This site had high connectivity to other farm dams but no adjacent natural vegetation, minor impacts from roads and agricultural land use within the catchment, receiving a connectivity score of 39.29. Anthropogenic disturbance was high (score of 30), due to the presence of stock and high grazing, moderate weeds and litter. Water quality also had moderate turbidity at the time of assessment.

The site had a wide riparian buffer and was predominantly pasture and grassland with scattered paddock trees. There was moderate riparian weed species, sparse aquatic weeds, and a total vegetation score of 19.81. This site had a low habitat score (16.67), due to a simple vegetation structure, low fallen logs, emergent and submerged vegetation, and a small area of sedges surrounding the dam. There were low hydrological impacts at this site (score of 60), with steep banks, complete vegetation alteration, moderate erosion and structures affecting the hydrological regime.

Figure 3-123 Northern Gateway precinct: Dam 3243

Dam 3247

Dam 3247 received an overall score of 45.04%, placing it in the Protect category (Figure 3-124). This site had high connectivity to other farm dams and was closely linked with the surrounding natural ecosystem and Badgerys Creek, which contributed to a connectivity score of 35.71. However, there was major and minor roads, agricultural land use, and a waste disposal depot within the vicinity of the site, and natural drainage channels have been altered. Anthropogenic disturbance was moderate (score of 50), due to the presence of stock and moderate grazing, medium weed coverage weeds and litter. There was also evidence of feral animals (foxes) at this site. Water quality also had low turbidity at the time of assessment.

The site had a wide riparian buffer and was predominantly pasture and grassland with some forest woodland occurring along the nearby creek corridor. However, riparian weed density was moderate, and contributed to a total vegetation score of 29.81. This site had a high habitat score (41.67), as the vegetation structure had moderate complexity, there were fallen logs and dead trees, and a number of hollows present. At this site, there was also low coverage of aquatic vegetation, including floating, emergent and submerged species, in addition to surrounding sedge species. There were moderate hydrological impacts at this site (score of 68), with steep banks, some vegetation alteration, low erosion and moderate structures affecting the hydrological regime.

Figure 3-124 Northern Gateway precinct: Dam 3247

Dam 3284

Dam 3284 received an overall score of 39.02%, placing it in the Restore category (Figure 3-125). This site had high connectivity to other farm dams and limited connection to surrounding ecosystems. Land use was predominantly agricultural, with several urban structures, powerlines and minor roads within the dam catchment, contributing to a connectivity score of 28.57. Anthropogenic disturbance was moderate (score of 50), due to the presence of stock and low grazing, low weeds and litter. Water quality also had low turbidity at the time of assessment.

The site had a wide riparian buffer and was predominantly pasture and grassland, with a small stand of *Casuarina spp*. along one side of dam bank and several scattered paddock trees, contributing to a low total vegetation score of 16.92. Riparian and aquatic weed density was light and included *Solanum spp*., Fireweed (*Senecio madagascariensis*) and Privet (*Ligustrum sinense*). This site had a high habitat score (39.58), with low vegetation structure complexity, high fallen logs, some dead trees, snags and moderate aquatic vegetation (consisting of floating, submerged and emergent species). At this site there was also a large area of sedges surrounding the farm dam. There were moderate hydrological impacts at this site (score of 60), with steep banks, high vegetation alteration, low erosion and moderate pugging.

Figure 3-125 Northern Gateway precinct: Dam 3284

Dam 3285

Dam 3285 received an overall score of 22.95%, placing it in the Least priority category (Figure 3-126). This site had high connectivity to other farm dams and limited connection to surrounding ecosystems. Within the surrounding catchment there were impacts from major and minor roads, several urban structures, intensive agriculture, powerlines and altered drainage channels. This resulted in one of the lowest connectivity scores for this precinct (25). Anthropogenic disturbance was high (score of 30), due to the presence of stock and high grazing, moderate weeds and litter. Water quality also was moderately turbid at the time of assessment.

The site had a restricted riparian buffer and was predominantly pasture and grassland, with several scattered trees. Riparian weed density was moderate and aquatic weed density was light. This contributed to the lowest vegetation score for this precinct of -27.69. This site had a moderate habitat score (35.42), with some fallen logs and dead trees, snags and low floating and emergent aquatic vegetation. At this site there was also a large island present. There were moderate hydrological impacts at this site (score of 52), with steep banks, high vegetation alteration, moderate erosion and high human induced changes to the natural hydrological regime.

Figure 3-126 Northern Gateway precinct: Dam 3285. Source: GoogleMaps 2020

Dam 3369

Dam 3369 received an overall score of 38.33%, placing it in the Restore category (Figure 3-127). This site had high connectivity to other farm dams but had low connection to surrounding ecosystems. Within the surrounding catchment there were impacts from major and minor roads, and land use was primarily agricultural, contributing to a connectivity score of 39.29. Anthropogenic disturbance was moderate (score of 60), due to the presence of stock and medium grazing, moderate weeds and low litter. Water quality also had low turbidity at the time of assessment.

The site had a wide vegetated buffer and was predominantly pasture and grassland, with some canopy trees present. Riparian weed density was moderate, including Blackberry (*Rubus fruticosus*) and Fireweed (*Senecio madagascariensis*), and aquatic weed density was light. This contributed to a low vegetation score of 13.27. This site had a moderate habitat score (27.08), with moderate vegetation structural complexity, some fallen logs and dead trees, snags and low floating and emergent aquatic vegetation. There were moderate hydrological impacts at this site (score of 52), with steep banks, low pugging, moderate vegetation alteration and erosion, and low human structures impacting the natural hydrological regime.

Figure 3-127 Northern Gateway precinct: Dam 3369

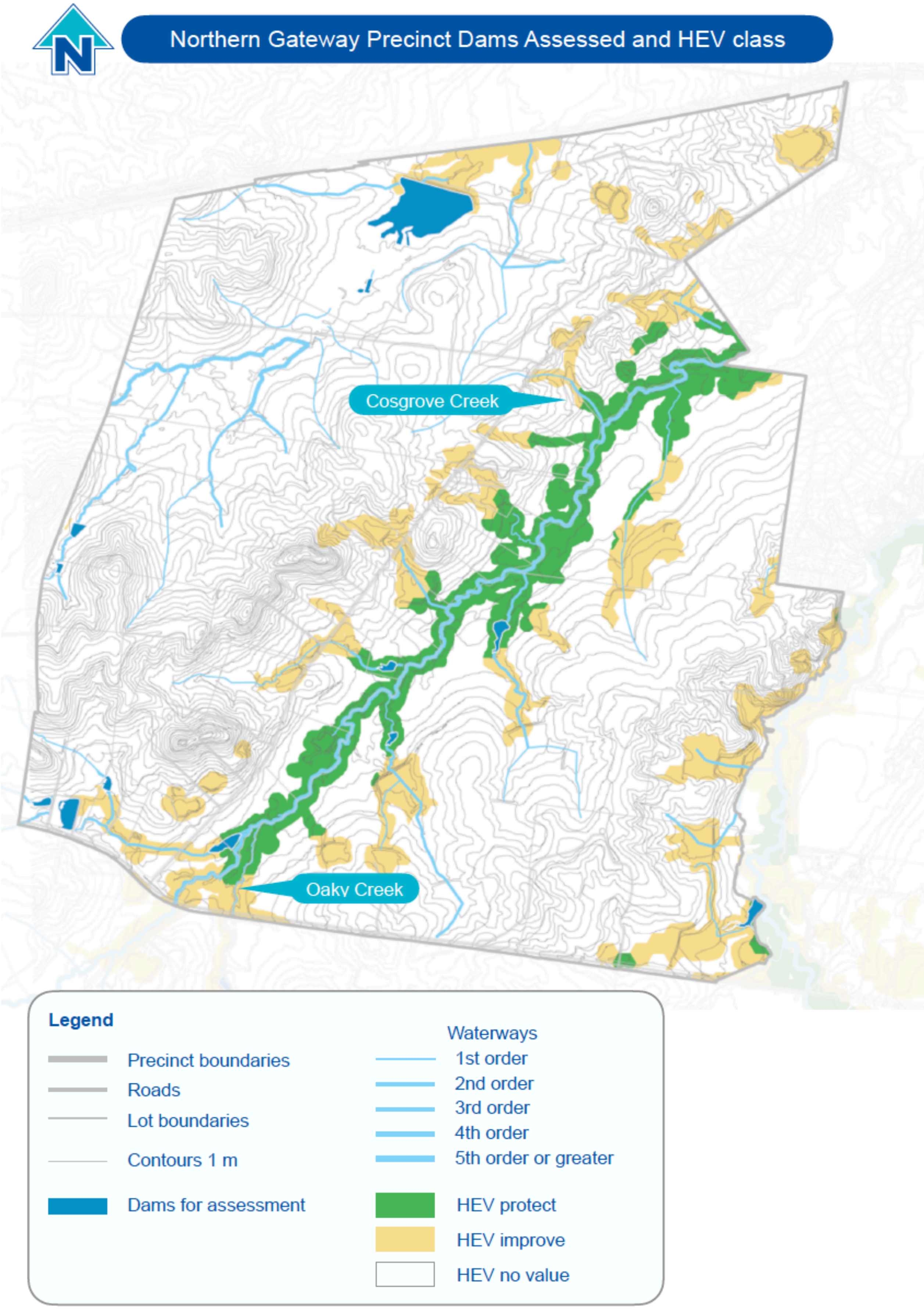


Figure 3-128 Northern Gateway Precinct dams assessed and High Ecological Value Ecosystems (HEV) class

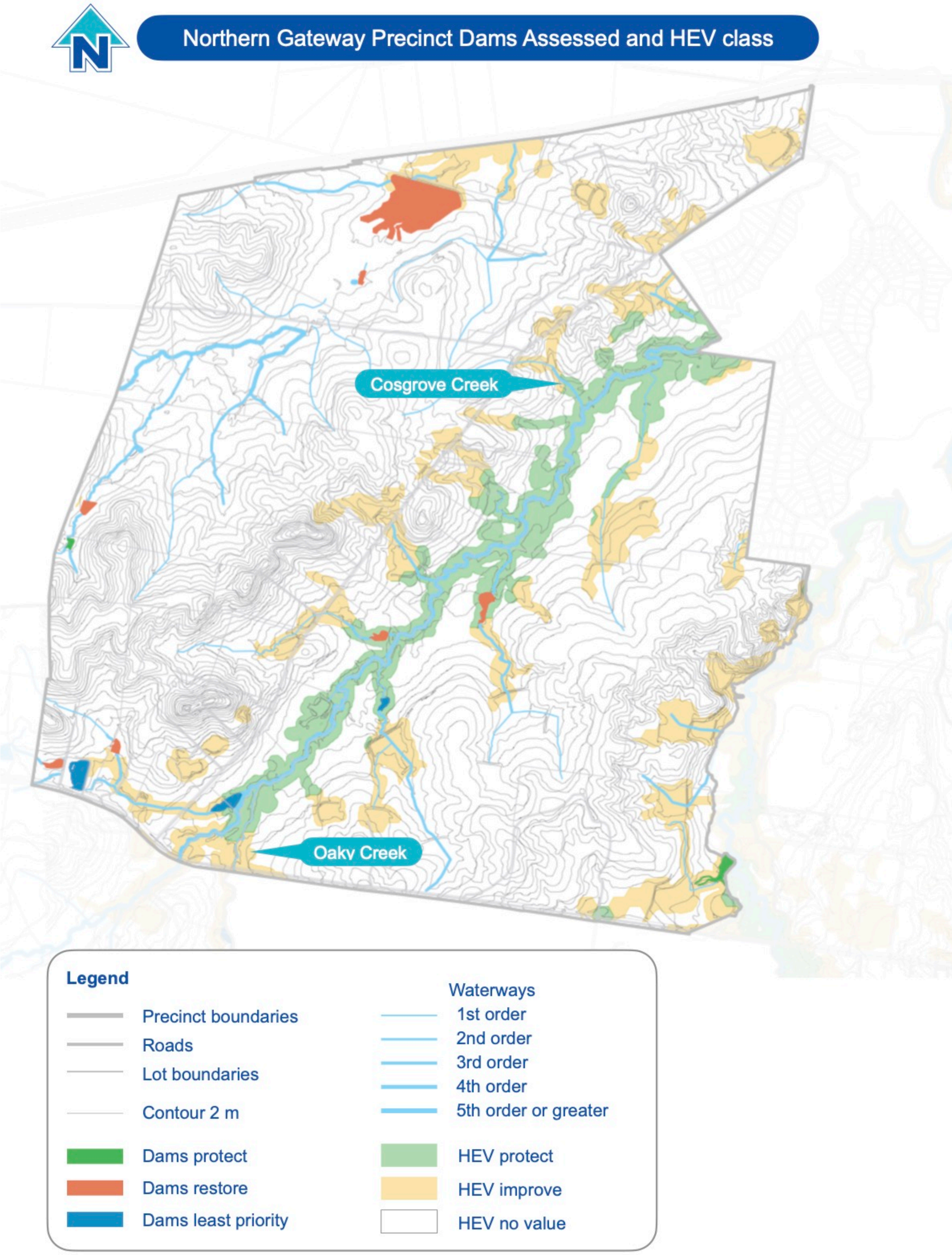


Figure 3-129 Northern Gateway Precinct dams assessment results

3.9 Recommendations for Waterway Planning and Retention

The primary objective of the waterway validation and farm dam assessment is to make recommendations of which waterways, inclusive of creeks, wetlands and farm dams, should be retained within the WSA study precincts and to assign appropriate vegetated riparian zone (VRZ) widths as per those required under the NSW *Water Management Act* 2000. These are shown in Table 3-12 and examples of waterways to be retained are shown in Figure 3-130 and Figure 3-131.

Table 3-12 Required riparian corridor widths according to Strahler stream order (NRAR 2018).

Strahler Stream Order	VRZ Width (m)	Total Riparian Corridor Width (m)
	(each side of watercourse)	
1st order	10 m	20 m + channel width
2nd order	20 m	40 m + channel width
3rd order	30 m	60 m + channel width
4th order and greater, wetlands, estuaries, and tidal influenced watercourse	40 m	80 m + channel width

Length of waterways recommended to be retained within the WSA study precincts, broken down by Strahler stream order are shown in Table 3-13 and Figure 3-132 to Figure 3-137. The recommended waterways for retention and their vegetated riparian zones have been used to inform the Riparian Revegetation Strategy which is detailed in Section 4.

Creeks to be retained and their associated vegetated riparian zones should have an appropriate zoning that promotes waterway function, enhances urban biodiversity and provides green space for the community to find connection to natural places.

Table 3-13 Length of waterways by Strahler stream order recommended to be retained across WSA study precincts.

Precinct	1st order (km)	2nd order (km)	3rd order (km)	4th order (km)	5th order (km)
Badgerys Creek	2.34	0.03	0.02	4.10	0
Aerotropolis Core	9.43	7.18	3.77	6.36	0
Agribusiness	6.88	12.44	8.72	0.80	0
Northern Gateway	11.64	11.59	8.42	0	0
Wianamatta-South Creek (excl. Kemps Creek)	2.91	7.03	0.80	8.46	20.77

An overview of waterways recommended to be retained across the WSA study precincts are shown in Figure 3-132. Waterways recommended to be retained at the precinct scale are shown in the following order;

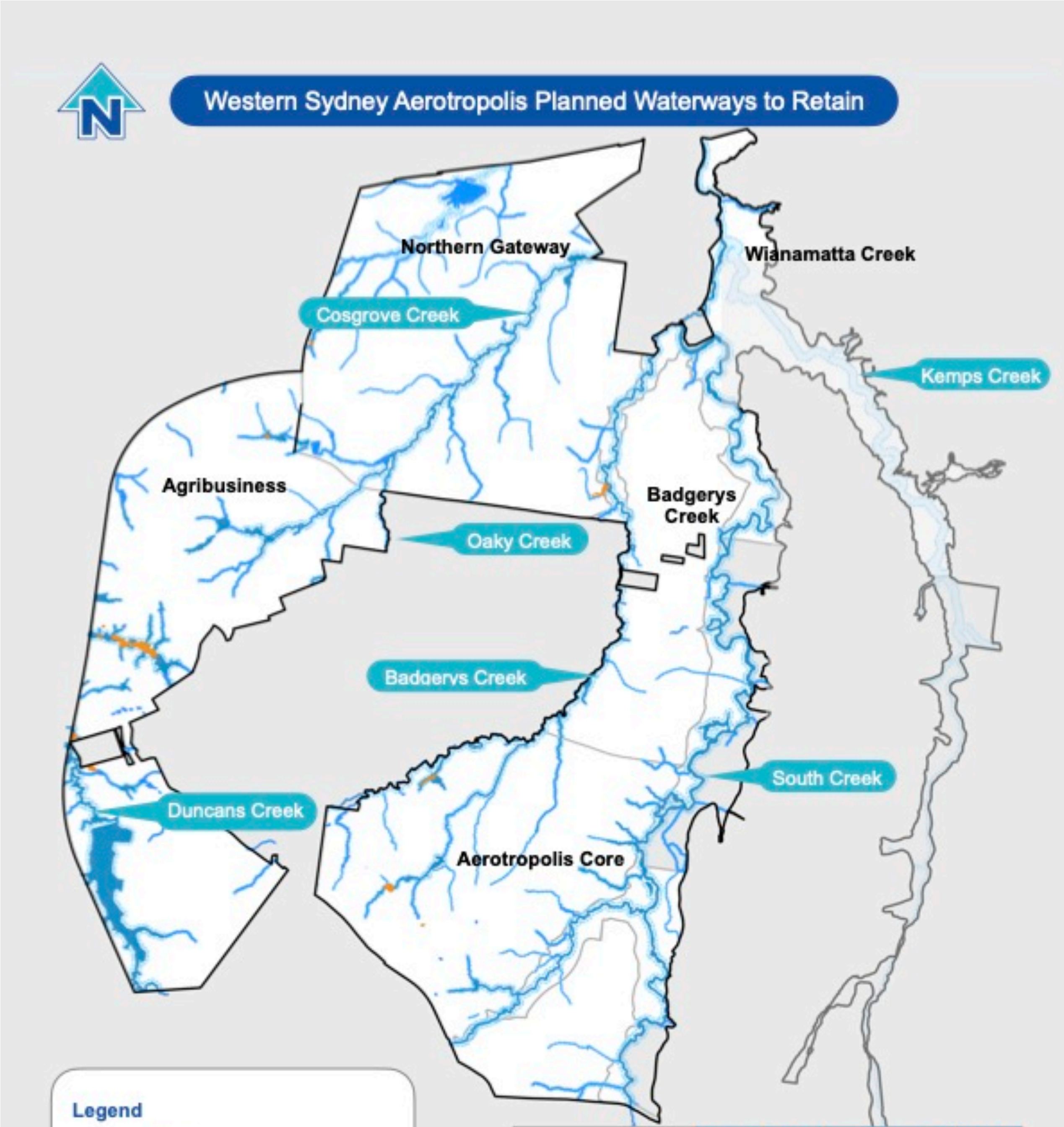
- Badgerys Creek Precinct
- Aerotropolis Core Precinct
- Agribusiness Precinct
- Northern Gateway Precinct
- Wianamatta-South Creek Precinct

It is acknowledged that many of the waterways that have been recommended to be retained are located within developable areas. It is reasonable to expect that when this is the case, realignment/reconstruction/stabilisation will be required. Therefore, alteration of these waterways will be required to consider future flows and have suitable vegetated riparian zones which will be guided by the Riparian Revegetation Strategy (RRS) and site-based Vegetation Management Plans (VMP).

Farm dams to retain in the landscape are primarily based on those assessed as having high ecological value and classified by the assessment process as 'protect'. These dams should also have appropriate zoning that promotes function of a wetland or open water body, enhances urban biodiversity and provides green space for the community to find connection to natural places. To do this it is recommended that these dams are not considered for reengineering to manage stormwater and instead are maintained to protect and restore their ecological values.

Figure 3-130 Farm Dam 3904 – Aerotropolis Core Precinct, recommended to be retained

Figure 3-131 South Creek - Badgerys Creek Precinct to be retained



Precinct	1st order (km)	2nd order (km)	3rd order (km)	4th order (km)	≥ 5th order (km)
Aerotropolis Core	9.43	7.18	3.77	6.36	
Agribusiness	6.88	12.44	8.72	0.80	
Badgerys Creek	2.34	0.03	0.02	4.10	
Northern Gateway	11.64	11.59	8.42		
Wianamatta Creek (excluding Kemps Creek)	2.91	7.03	0.80	8.46	20.77

Figure 3-132 Waterways recommended to be retained across Western Sydney Aerotropolis study precincts including creeks and farm dams

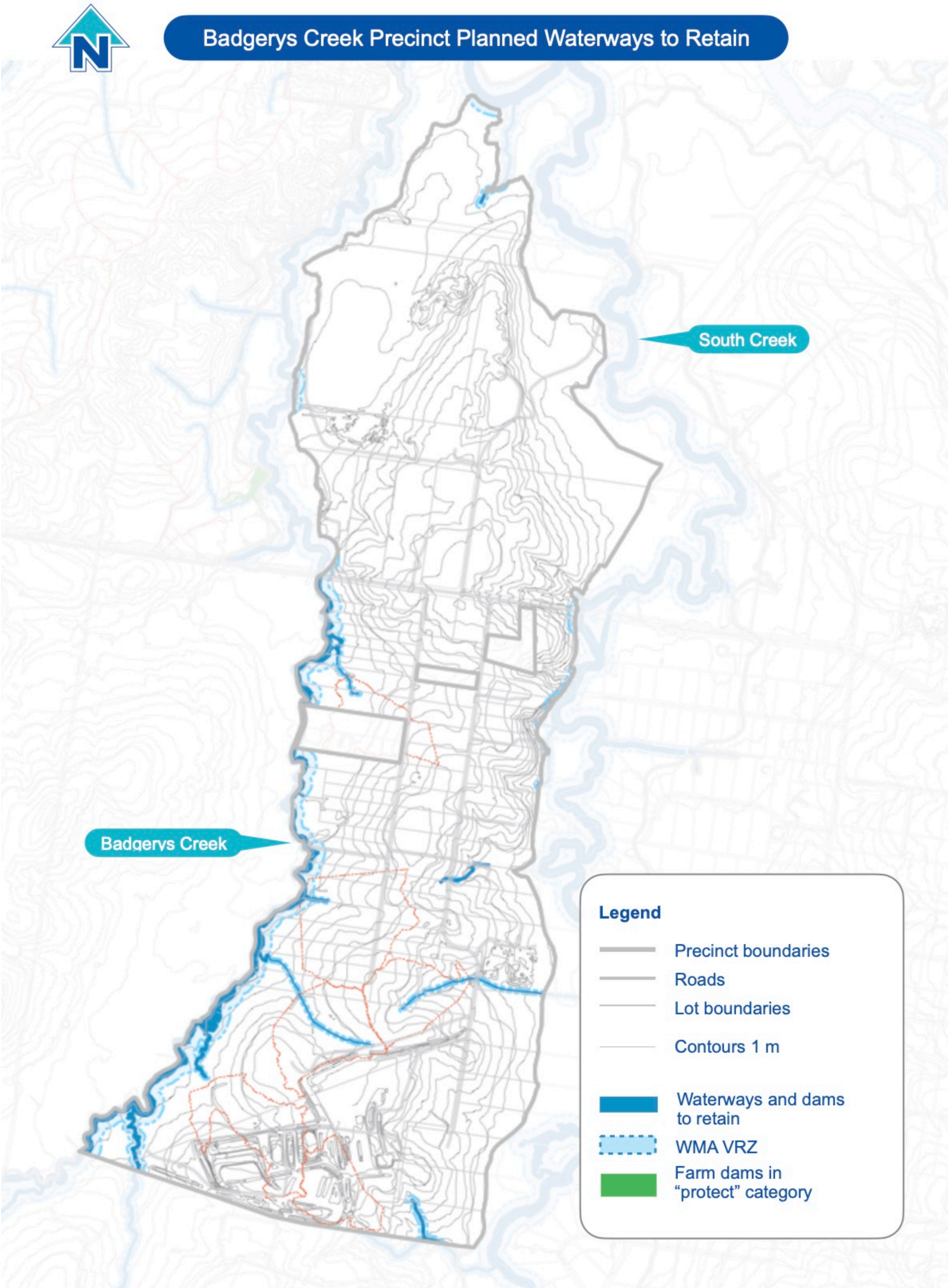


Figure 3-133 Waterways recommended to be retained across Badgerys Creek Precinct including creeks and farm dams

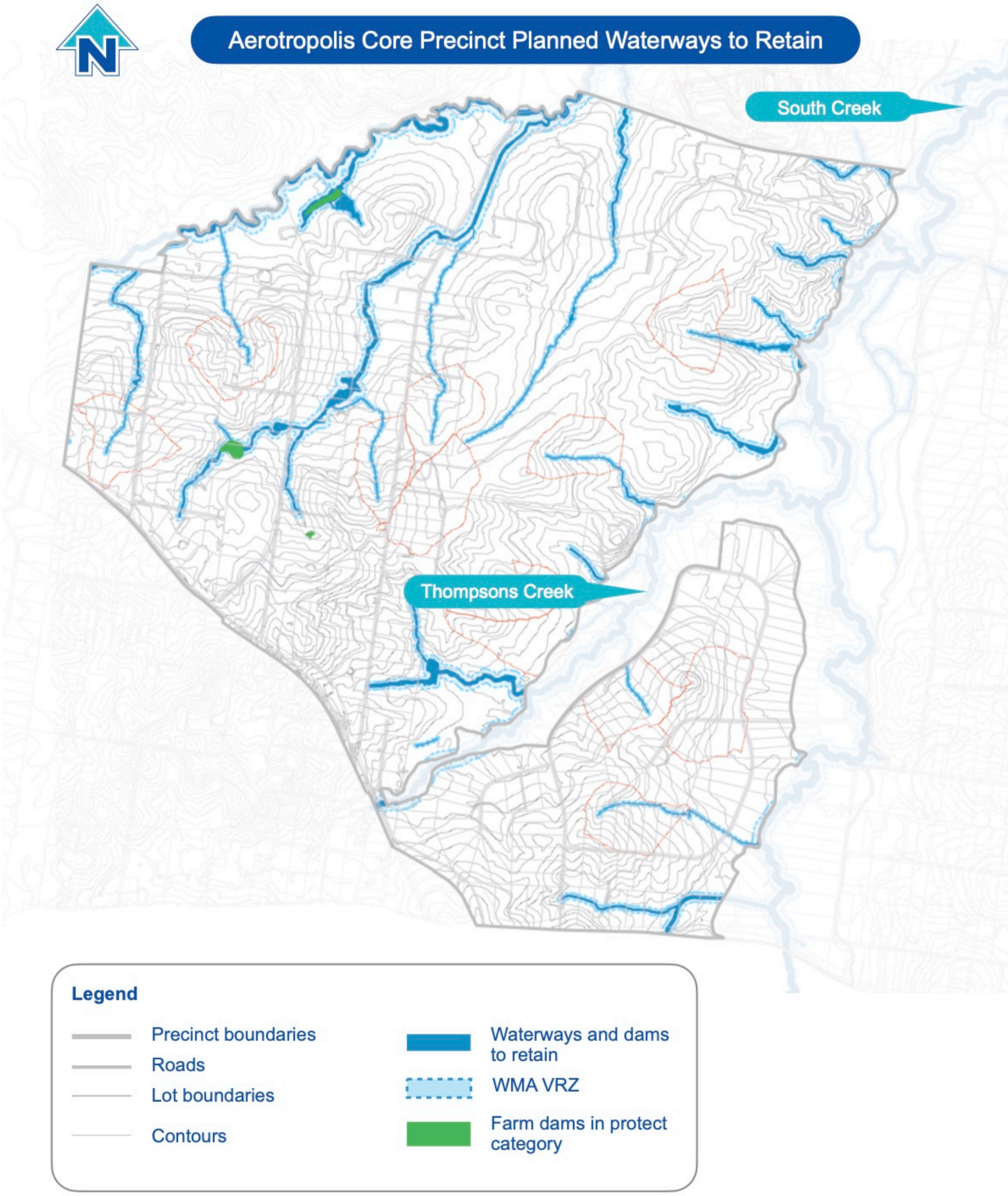


Figure 3-134 Waterways recommended to be retained across Aerotropolis Core Precinct including creeks and farm dams

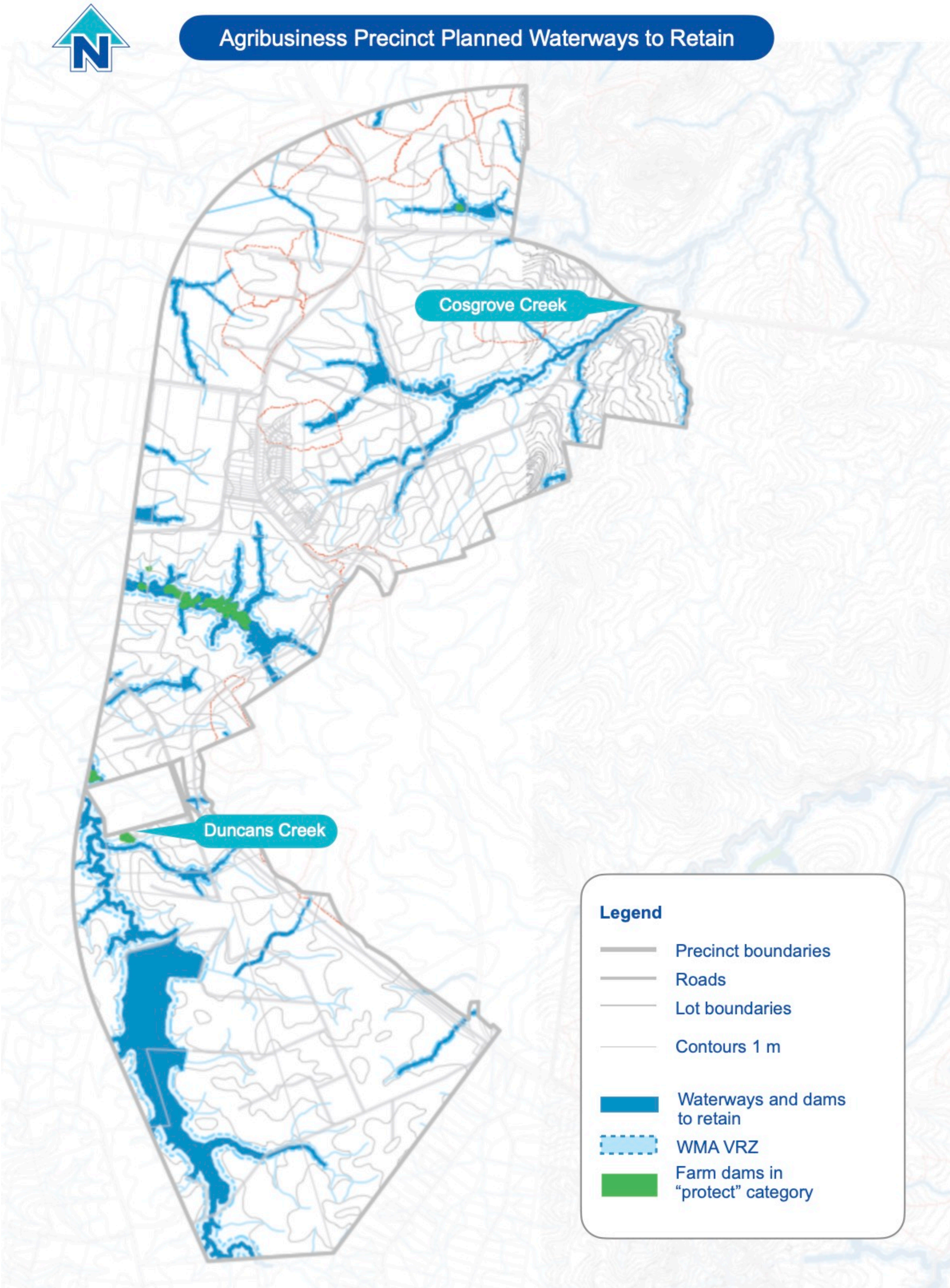


Figure 3-135 Waterways recommended to be retained across Agribusiness Precinct including creeks and farm dams

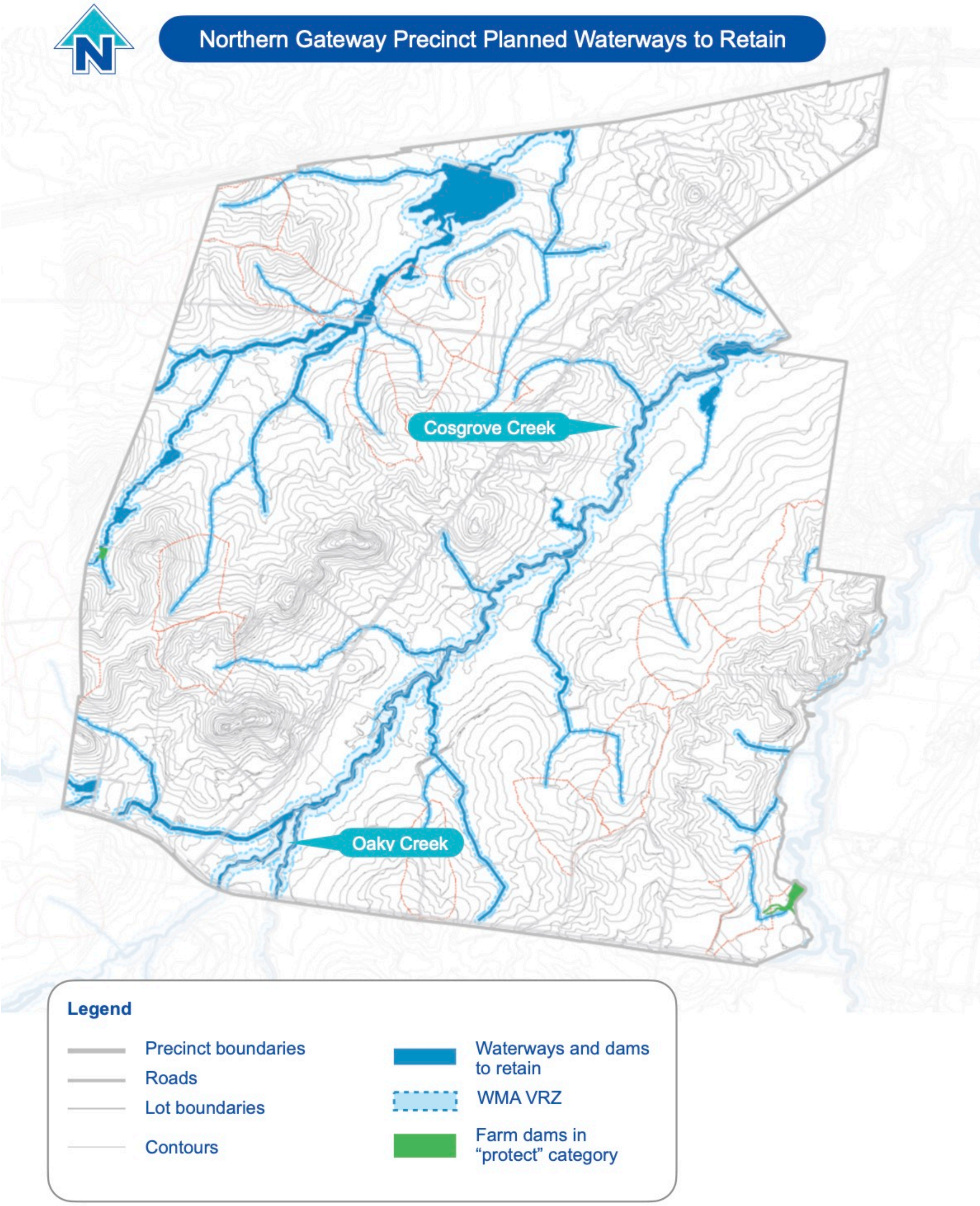


Figure 3-136 Waterways recommended to be retained across Northern Gateway including creeks and farm dams

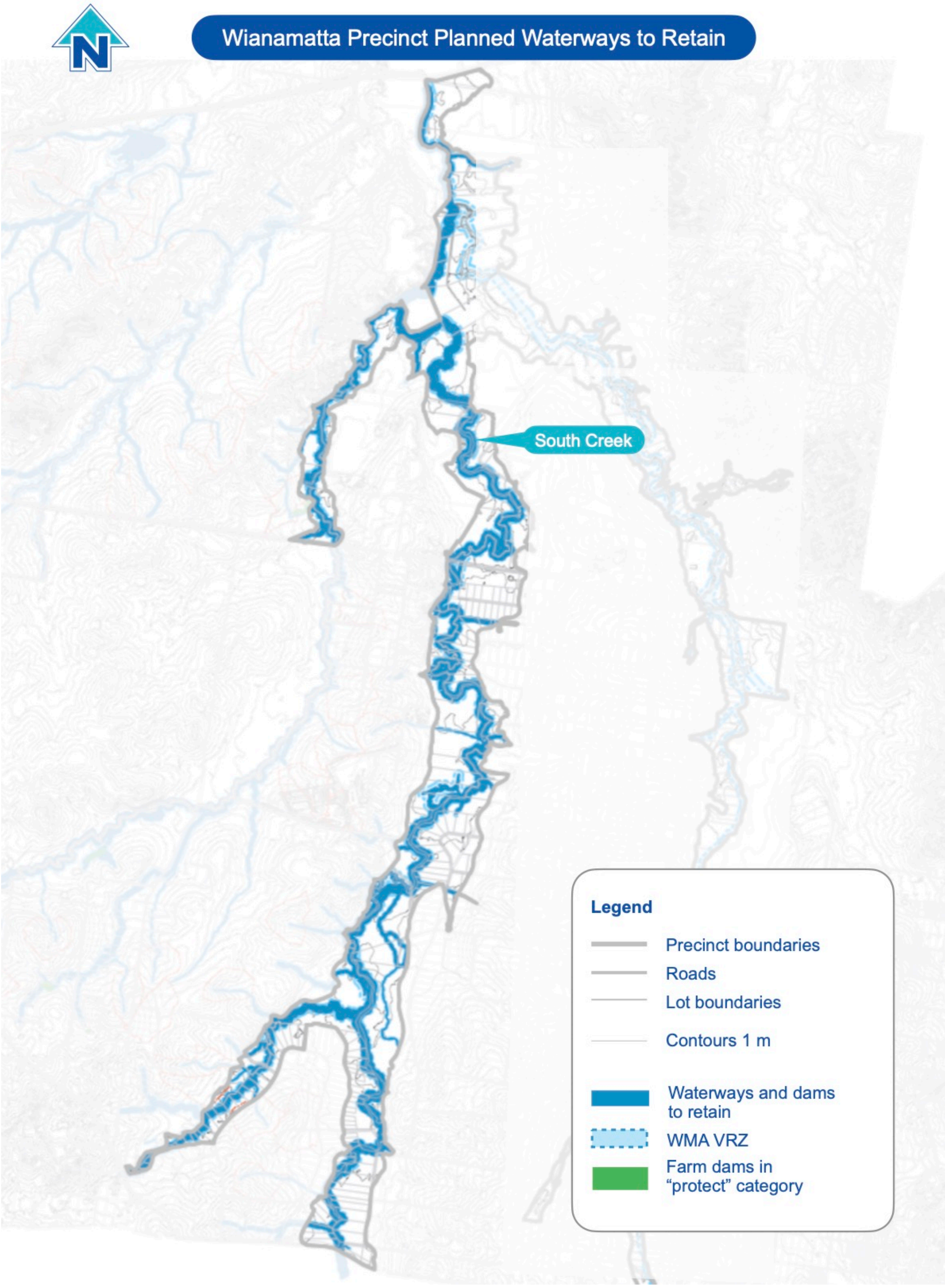


Figure 3-137 Waterways recommended to be retained across Wianamatta-South Creek Precinct including creeks and farm dams

4 Riparian Revegetation Strategy

4.1 Riparian Revegetation Strategy (RRS) Overview

The Western Sydney Aerotropolis Initial Precincts lie primarily within the Wianamatta-South Creek catchment. In order to extend and strengthen the Aerotropolis green-blue grid and achieve landscape-scale integrated water and waterway outcomes, strategic native revegetation of VRZs of Wianamatta-South Creek and its tributaries is required to protect and restore sensitive riparian areas.

In line with integrated water management objectives, landscape-scale vegetation management is crucial to restore and enhance existing riparian vegetation. The Riparian Revegetation Strategy (RRS) for the Aerotropolis Initial Precincts identifies a strategy for the enhancement, protection and maintenance of waterways, riparian corridors and water dependent ecosystems and is essential in achieving cultural, social and biodiversity objectives of the Western Parkland City.

The RRS has been prepared with consideration of the environmental, social and economic aspirations of the Aerotropolis and ensures that the strategy reflects the NSW Governments vision of the Wianamatta-South Creek precinct (and its tributaries) acting as a “cool green corridor” weaving through the Western Parkland City.

The spatial extent of the RRS aligns with waterways recommended to be retained across the study precincts (see. Figure 3-132 - Figure 3-137) and includes the following major creek corridors and their tributaries:

- Wianamatta – South Creek
- Badgerys Creek
- Thompsons Creek
- Science Creek
- Cosgroves Creek
- Duncans Creek

The RRS includes area in excess of 2000 ha across the four Initial Precincts, as well as adjoining areas of the Wianamatta-South Creek Precinct and provides high-level guidance on the extent and cost of riparian vegetation and creek stabilisation management actions and potential for ecosystem credit generation under the NSW Biodiversity Offsets Scheme.

4.2 Purpose & Importance of the RRS

The waterways of the Wianamatta-South Creek catchment are highly vulnerable to the impacts of urbanisation and many are already impacted by agricultural land uses. The RRS aims to stabilise waterways, restore native flora and fauna habitat, enhance and protect native riparian and floodplain ecology and biodiversity and create VRZs that support waterway health and social objectives.

The identification of HEV waterways and water dependent ecosystems in the Aerotropolis Initial Precincts has been prioritised within the RRS to ensure that all opportunities to protect and integrate Threatened Ecological Communities (TECs) into the planning and detailed design phase of future developments are considered.

Several TECs identified within the Aerotropolis Initial Precincts are protected under the NSW *Biodiversity Conservation Act* (2016) and *Environment Protection and Biodiversity Conservation Act* (1999) with some listed as critically endangered at both state and national levels. In line with the Western Parkland City vision, riparian and woodland interface revegetation should be conducted using floral assemblages and structures representative of endemic vegetation communities of the Cumberland Plain – primarily Plant Community Type (PCT) 835 - Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion which is the dominant plant community within the spatial extent covered by the RRS.

Revegetation works aim to strengthen and increase the resilience of TECs by increasing localised flora species abundance and richness, enhancing connectivity to existing and fragmented stands of TECs and ensuring that sustainable maintenance and management is prescribed for treated areas.

Additional to the RRS bolstering ecological enhancement of riparian vegetation and TECs, the strategy also supports a range of complementary environmental, social and economic project objectives. Safeguarded VRZs create enhanced linear linkages for walking and cycling, storytelling and educational spaces as well as urban cooling and greening. VRZs are critical to the aesthetics and amenity of the Western Parkland City and to the provision of ecosystem services associated with WSUD water treatment and water quality when integrated into the landscape-scale integrated water management strategy.

To develop an efficient and effective RRS, various factors that define the current state of creek banks and riparian and floodplain vegetation were considered which included;

- The density of exotic vegetation on creek banks (section 4.3)
- The extent of creek channel erosion (section 4.4)
- The extent of native vegetation in riparian zones and floodplain communities (section 4.5)
- The percentage of native vegetation cover in riparian zones and floodplain communities
- The percentage of exotic vegetation cover in riparian and floodplain communities

A combination of desktop mapping, data analysis and field survey were applied to inform the condition/extent of the above factors, which in turn, has enabled high level costs to be calculated for riparian vegetation management, inclusive of revegetation weed control and creek stabilisation.

The density of exotic vegetation and extent of creek channel erosion was assessed in the field utilising data collected by application of the Rapid Riparian Assessment (RRA) method developed by Findlay et al. (2011) and refined by Dean and Tippler (2016) which was used in the development of the High Ecological Value Water Dependent Ecosystem (HEV) mapping (EES 2019) and Waterway Health Objective for South Creek (EES 2021).

To determine the extent of native vegetation within the RRS study Remnant Vegetation of the Western Cumberland Subregion, 2013 Update, VIS_ID 4207 (DPIE 2020) was reviewed and clipped to the study area.

Mean exotic and native vegetation cover was calculated using floristic and vegetation biometric data collected as part of the field validation stage of the development of the High Ecological Value Water Dependent Ecosystem (HEV) mapping (EES 2019). This was extrapolated across the RRS study area to inform a required management intensity.

Biometric vegetation assessment (as per BAM 2017) was used to assess 50 biometric plots in Plant Community Type (PCT) 835 - Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion Data.

The primary assumption of costs applied to these broad management actions is that the Waterway Health Objectives for South Creek catchment which have been developed by the Environment, Energy and Science Group (EES) (NSW Department of Planning, Industry and Environment) (EES 2021) are met. The combination of these objectives and the RRS will provide a solid foundation on which the vision of the Western Parkland City will be built on.

4.3 Density of exotic vegetation (weeds)

A total of 132 RRA assessments were conducted across the Aerotropolis Initial Precincts area (Figure 4-4) and riparian weed density results extracted from the data set. Assessments were constrained to those waterways surveyed in the field validation stage of this project.

Results from this assessment are mapped in Figure 4-4 to Figure 4-8 and a breakdown of weed density by the length of creek bank is shown in Table 4-1.

Table 4-1 Distance of creek bank (km's) and riparian weed density by study precinct.

Precinct	Sparse (<30%)	Moderate (30-50%)	Heavy (50-70%)	Severe (>70%)
Badgerys Creek	0	7.74	0.57	1.26
Aerotropolis Core	5.05	6.82	2.34	0.31
Agribusiness	5.42	10.74	0.05	0.84
Northern Gateway	0	0.35	1.91	1.03
Wianamatta-South Creek (ex Kemps Creek)	4.04	6.67	24.80	1.29

Figure 4-1 Example of heavy weed density. Unnamed waterway - Agribusiness

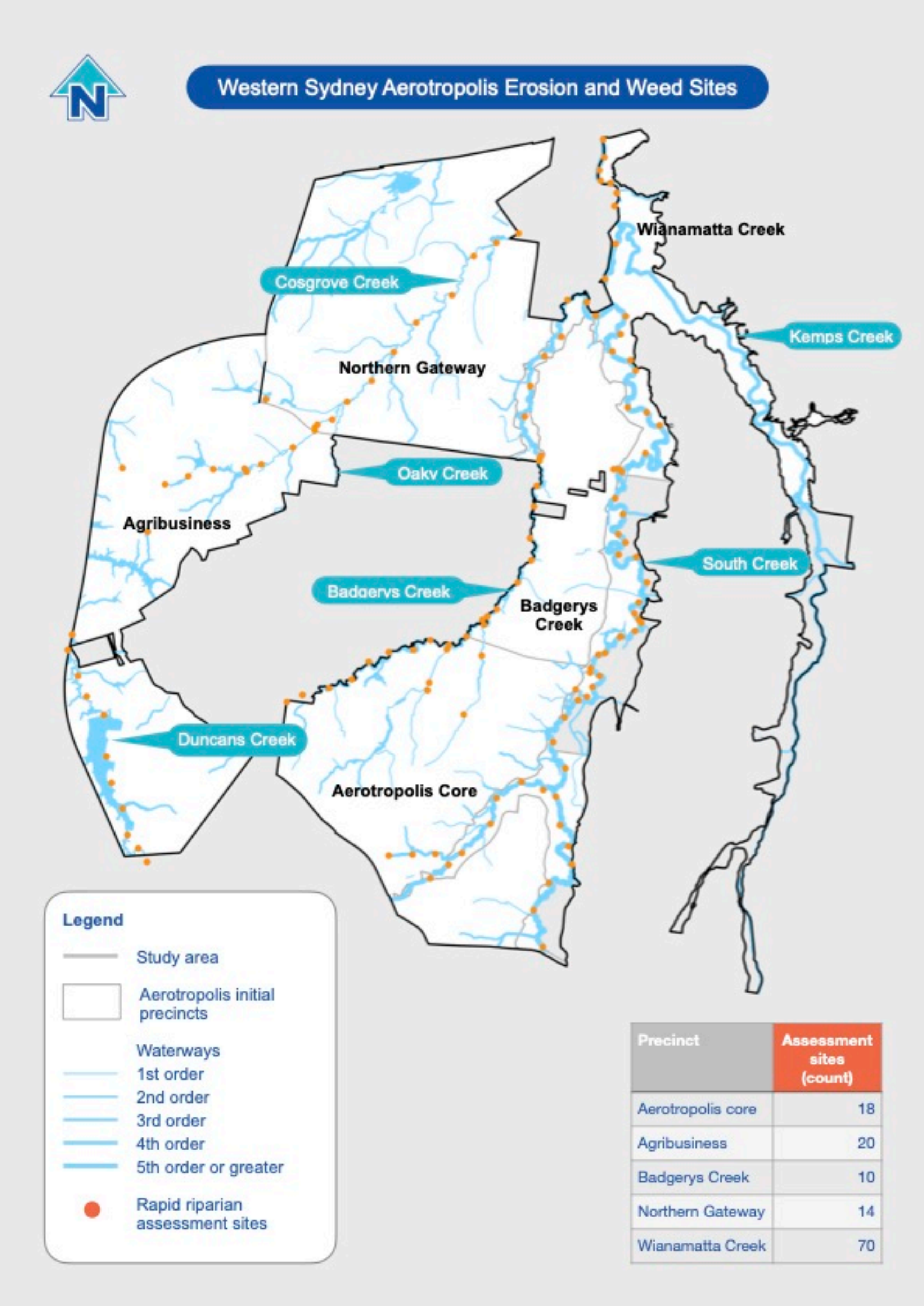
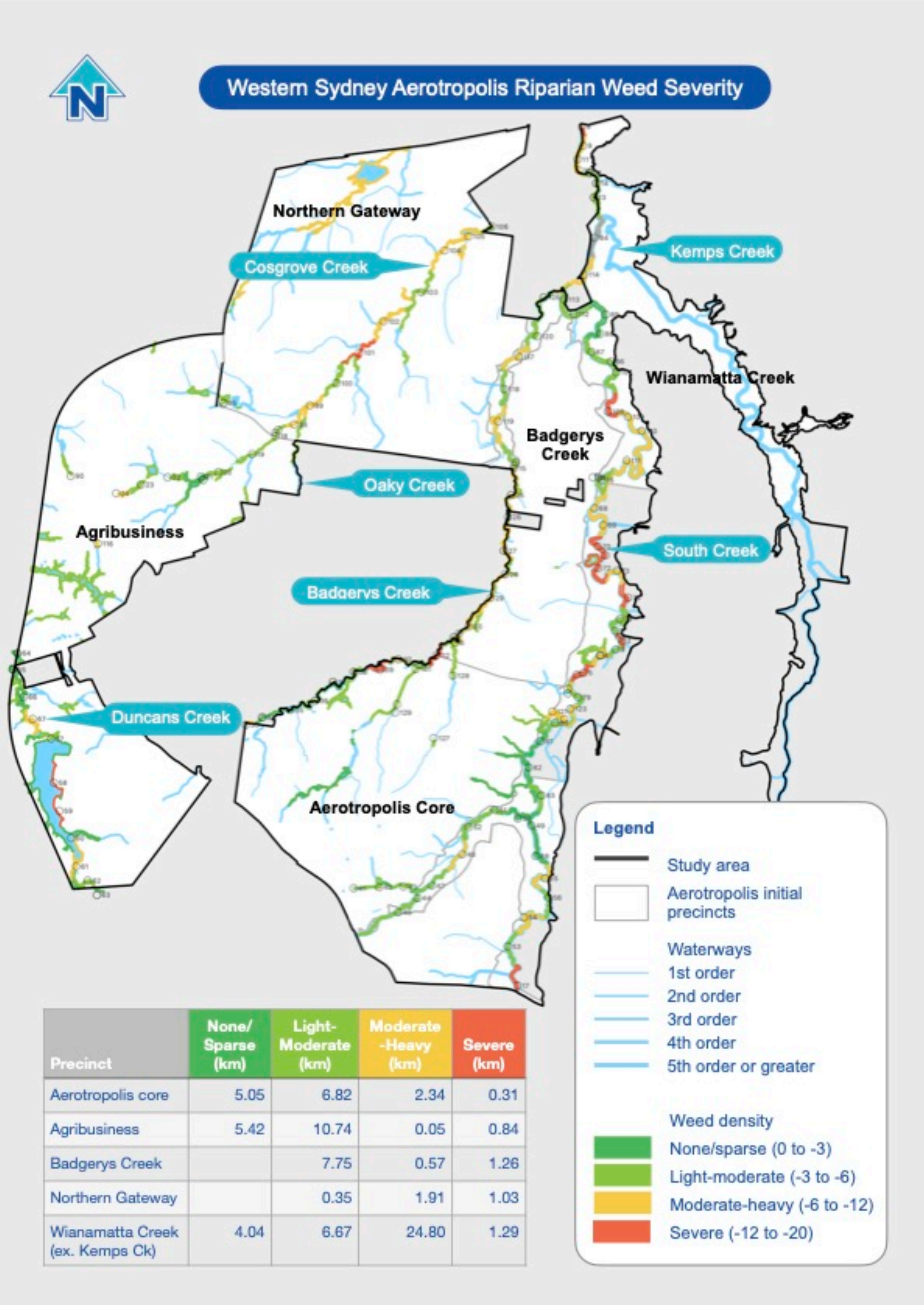


Figure 4-2 Weed density and erosion assessment sites across assessed waterways within Western Sydney Aerotropolis (WSA) initial precincts



Precinct	None/ Sparse (km)	Light-Moderate (km)	Moderate -Heavy (km)	Severe (km)
Aerotropolis core	5.05	6.82	2.34	0.31
Agribusiness	5.42	10.74	0.05	0.84
Badgerys Creek		7.75	0.57	1.26
Northern Gateway		0.35	1.91	1.03
Wianamatta Creek (ex. Kemps Ck)	4.04	6.67	24.80	1.29

Figure 4-3 Riparian weed density of assessed waterways across the Western Sydney Aerotropolis (WSA) Initial Precincts

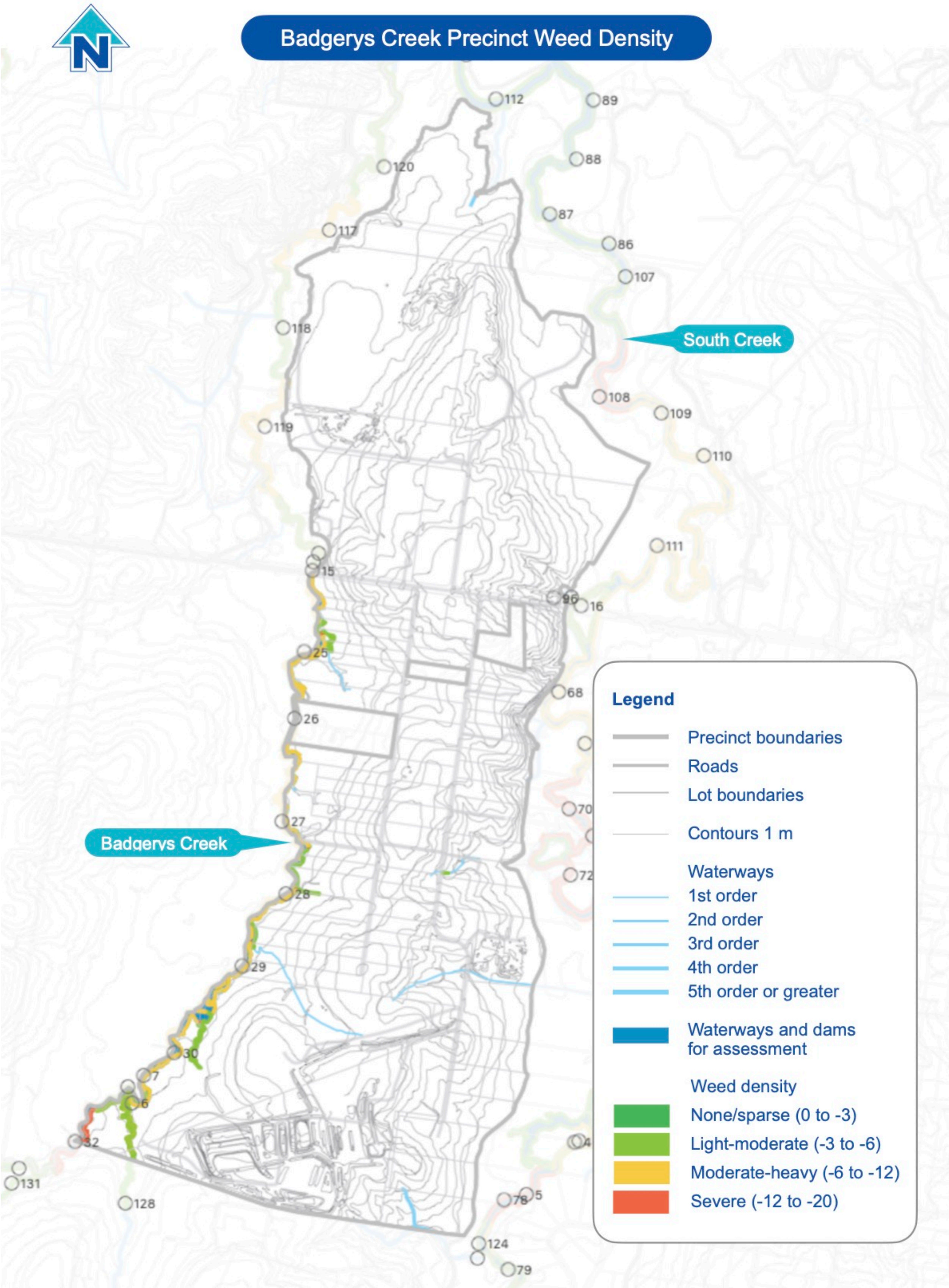


Figure 4-4 Riparian weed density across assessed waterways in Badgerys Creek Precinct

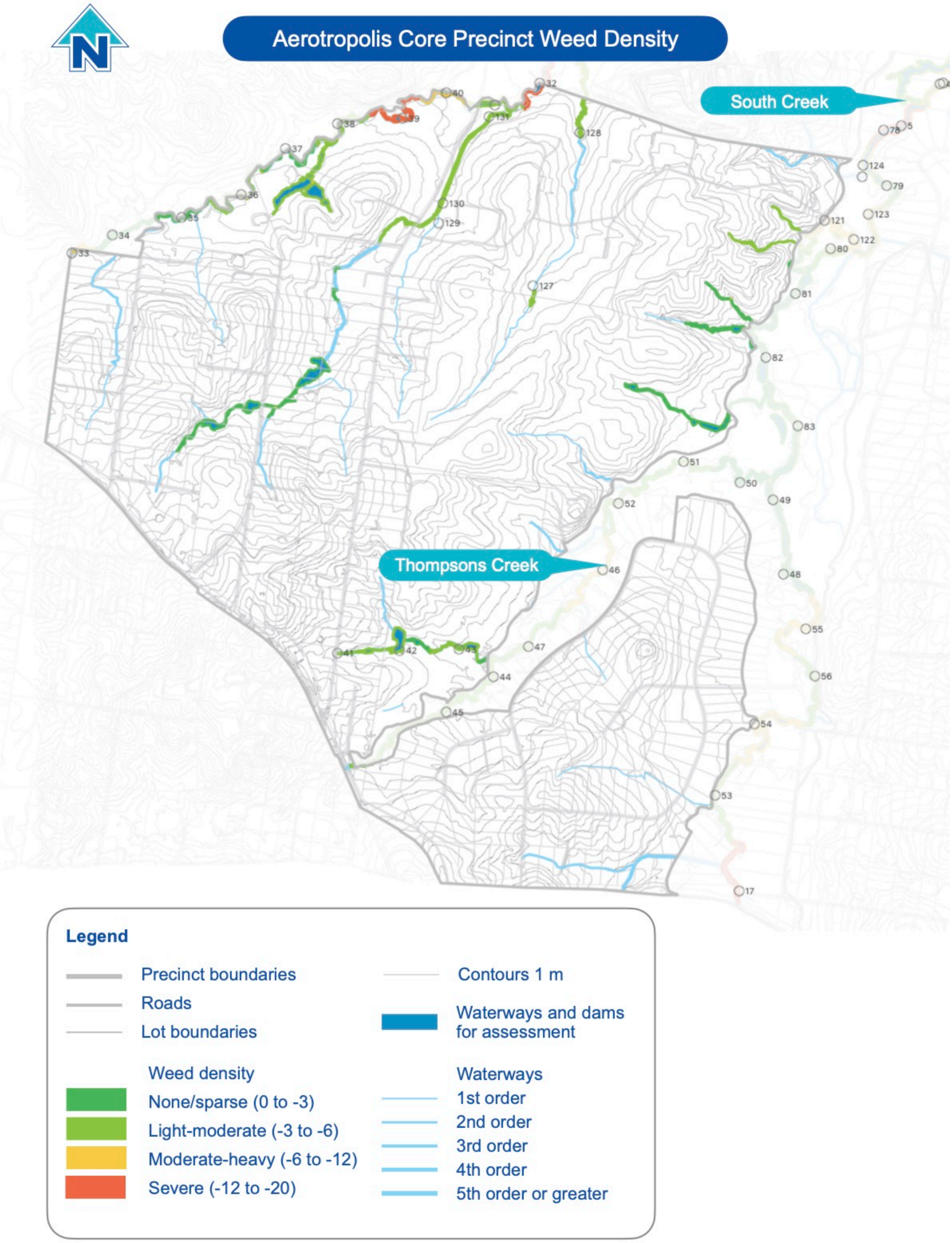


Figure 4-5 Riparian weed density across assessed waterways in the Aerotropolis Core Precinct

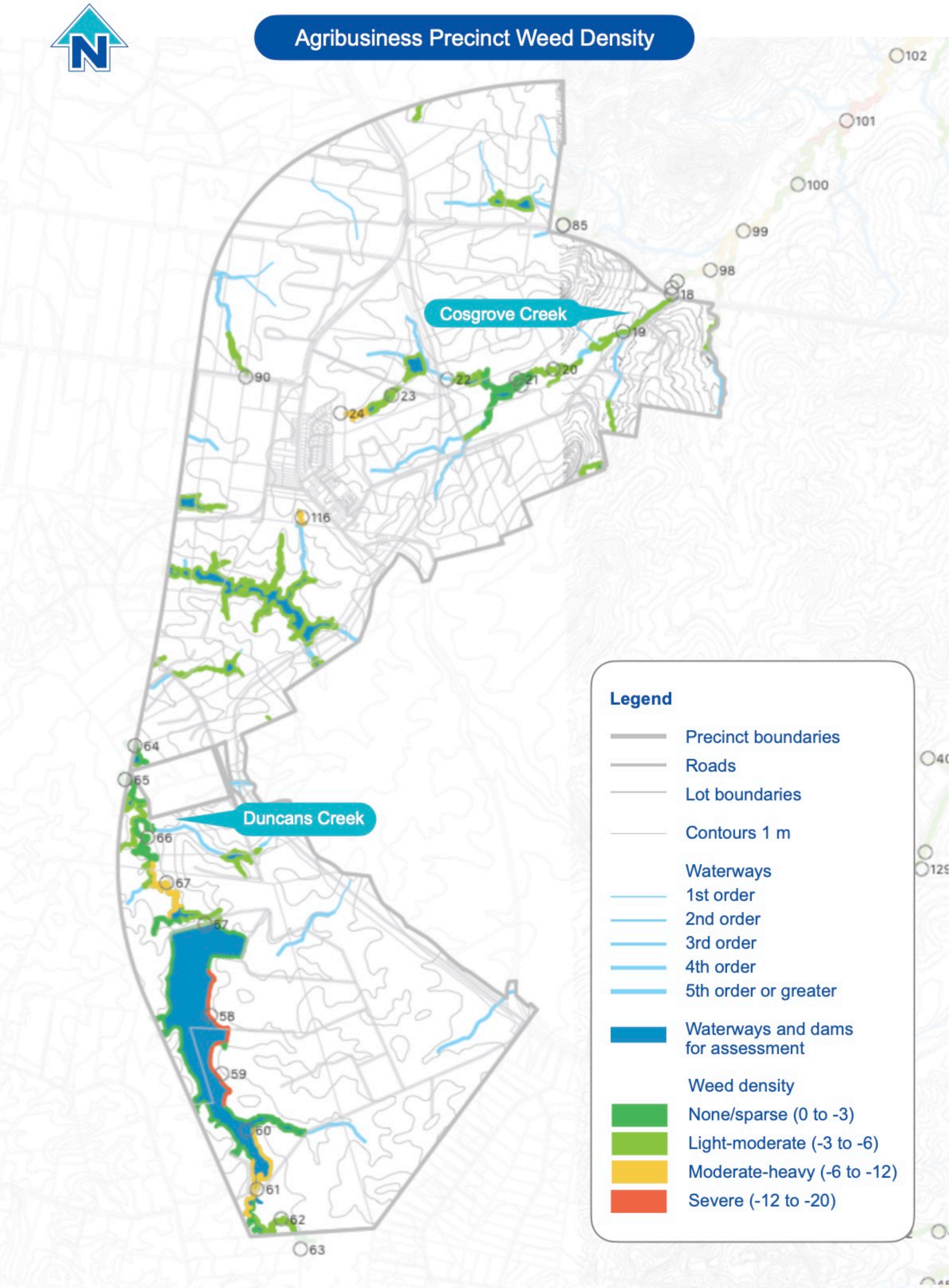


Figure 4-6 Riparian weed density across assessed waterways in the Agribusiness Precinct

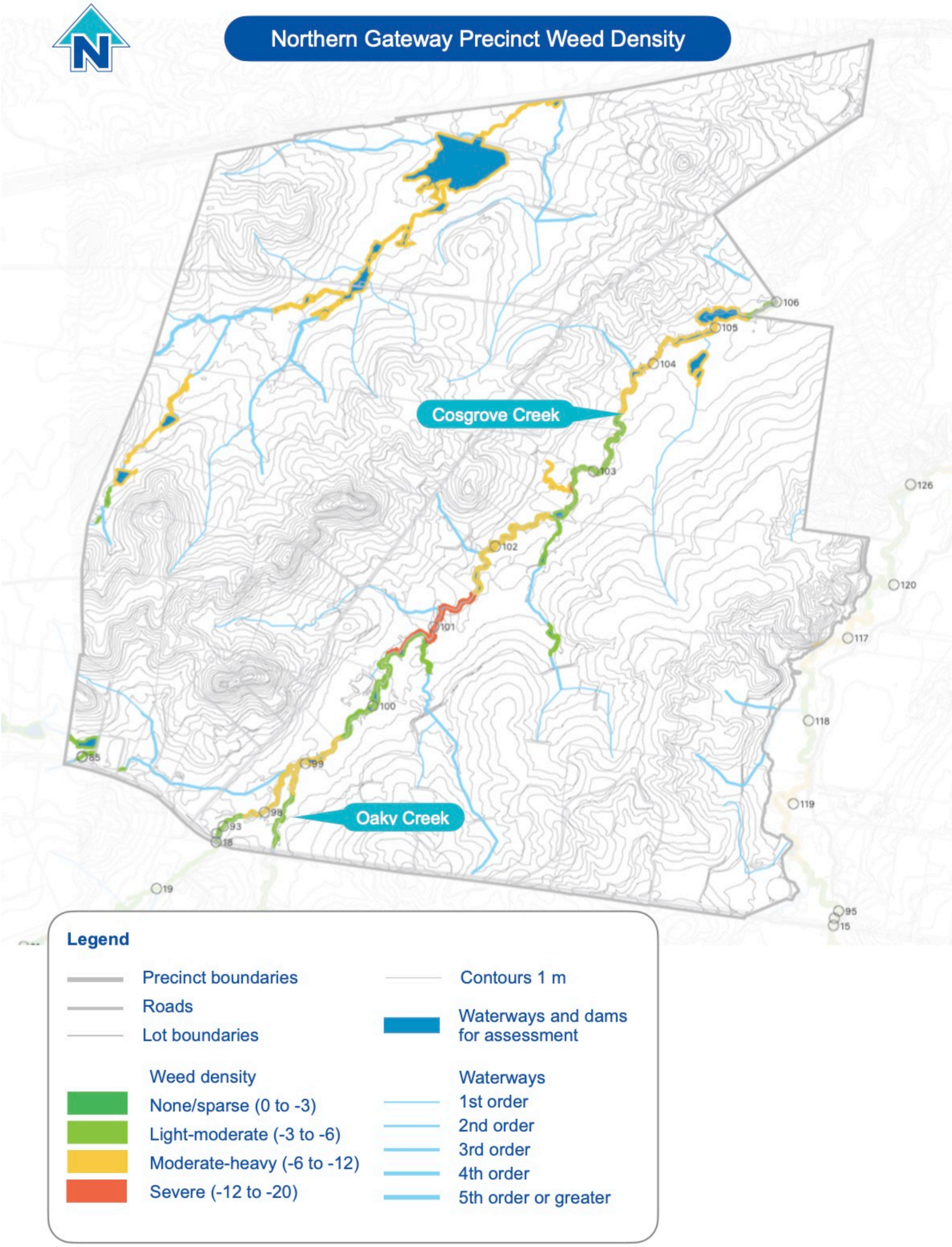


Figure 4-7 Riparian weed density across assessed waterways in the Northern Gateway Precinct

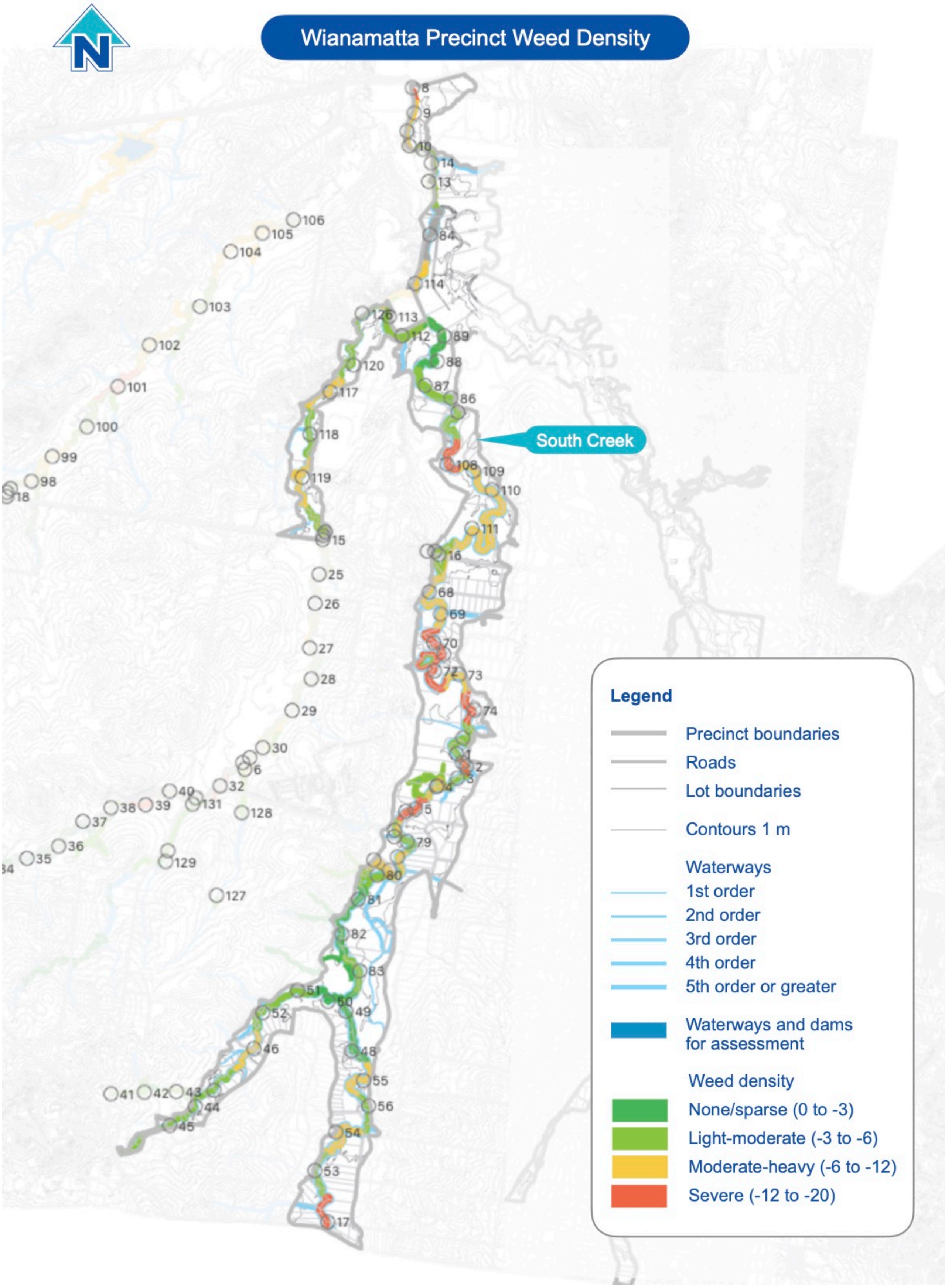


Figure 4-8 Riparian weed density across assessed waterways in the Wianamatta-South Creek Precinct

4.4 Erosion severity

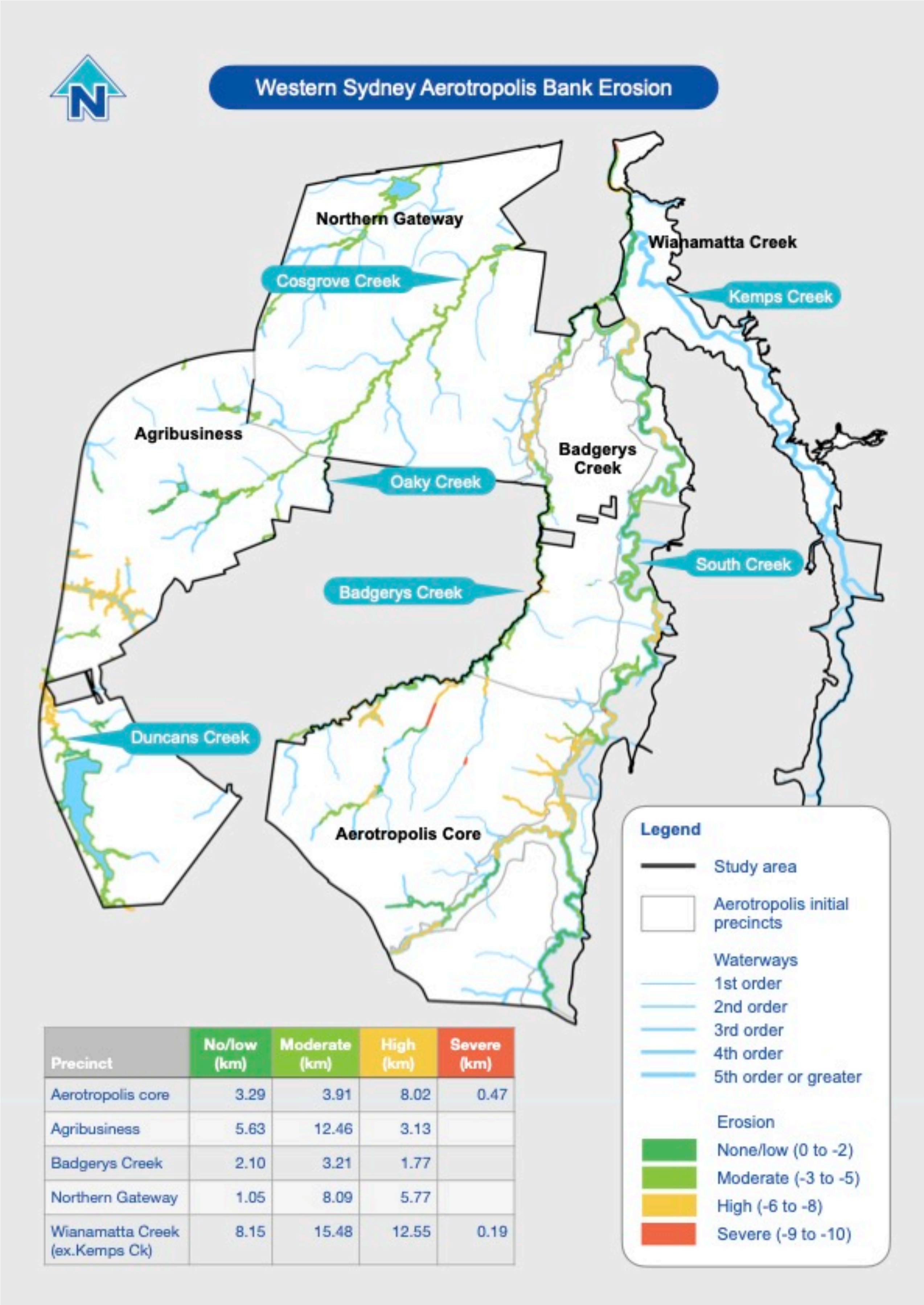
An assessment of the severity of bank erosion across the RRS study area was undertaken utilising data collected during the Rapid Riparian Assessment (RRA) method developed by Findlay et al. (2011) and refined by Dean and Tippler (2016). A total of 132 RRA assessments were conducted across the Aerotropolis Initial Precincts area (Figure 4-9; Figure 4-10) and bank erosion results extracted from the data set. Assessments were constrained to those waterways surveyed in the field validation stage of this project.

Results from this assessment are shown in Figure 4-10 to Figure 4-15 and a breakdown of erosion severity by precinct and length of creek bank is shown in Table 4-2.

Table 4-2 Distance of creek bank (km's) and erosion severity by study precinct.

Precinct	Low (<30%)	Moderate (30-50%)	High (50-70%)	Severe (>70%)
Badgerys Creek	2.1	3.21	1.77	0
Aerotropolis Core	3.29	3.91	8.02	0.47
Agribusiness	5.63	12.46	3.13	0
Northern Gateway	1.05	8.09	5.77	0
Wianamatta-South Creek (ex Kemps Creek)	8.15	15.48	12.55	0.19

Figure 4-9 Example of severe bank erosion on unnamed waterway – Agribusiness Precinct



Precinct	No/low (km)	Moderate (km)	High (km)	Severe (km)
Aerotropolis core	3.29	3.91	8.02	0.47
Agribusiness	5.63	12.46	3.13	
Badgerys Creek	2.10	3.21	1.77	
Northern Gateway	1.05	8.09	5.77	
Wianamatta Creek (ex.Kemps Ck)	8.15	15.48	12.55	0.19

Figure 4-10 Erosion severity of assessed waterways across the Western Sydney Aerotropolis (WSA) Initial Precincts

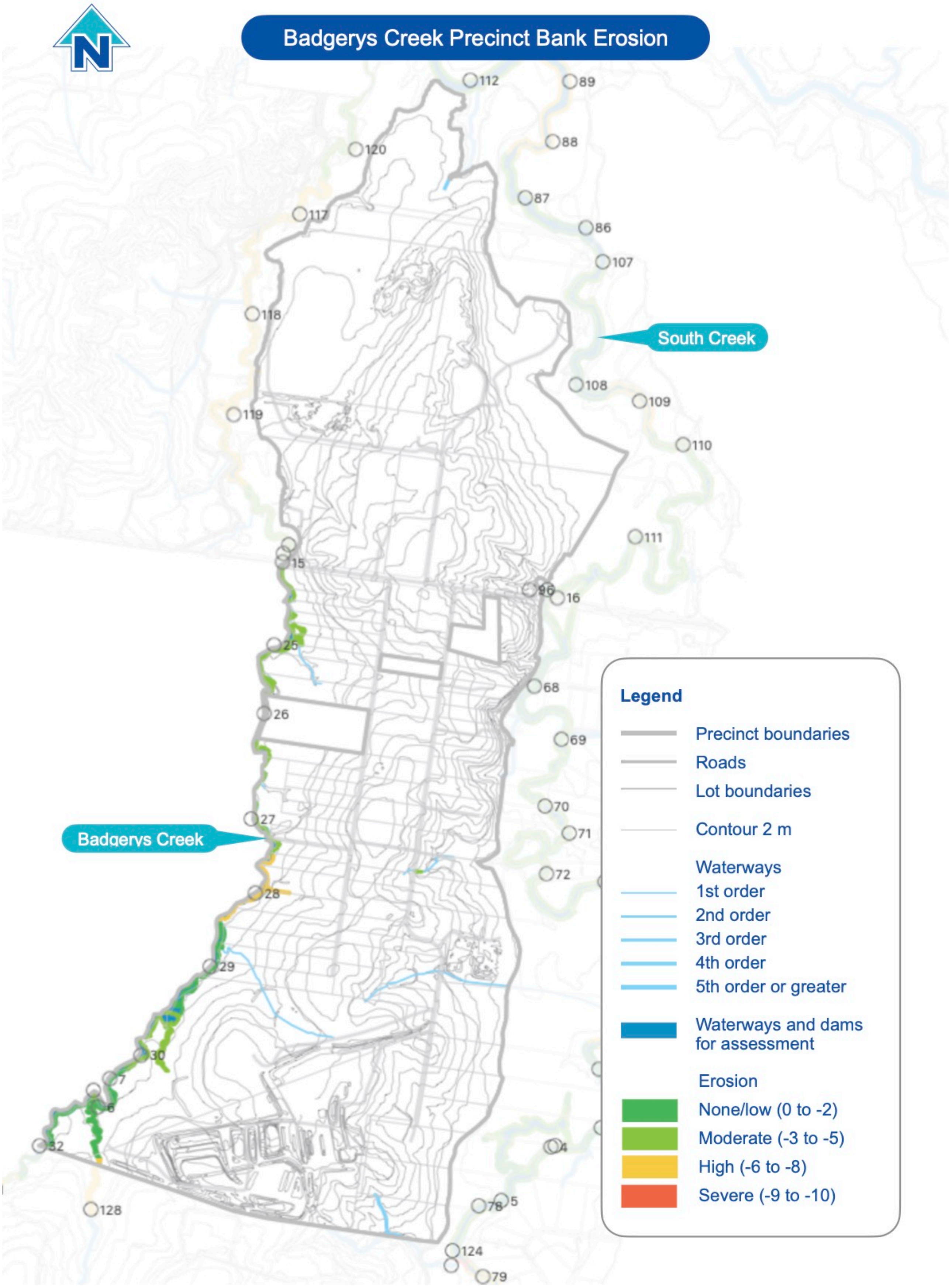


Figure 4-11 Erosion severity across assessed waterways in Badgerys Creek Precinct

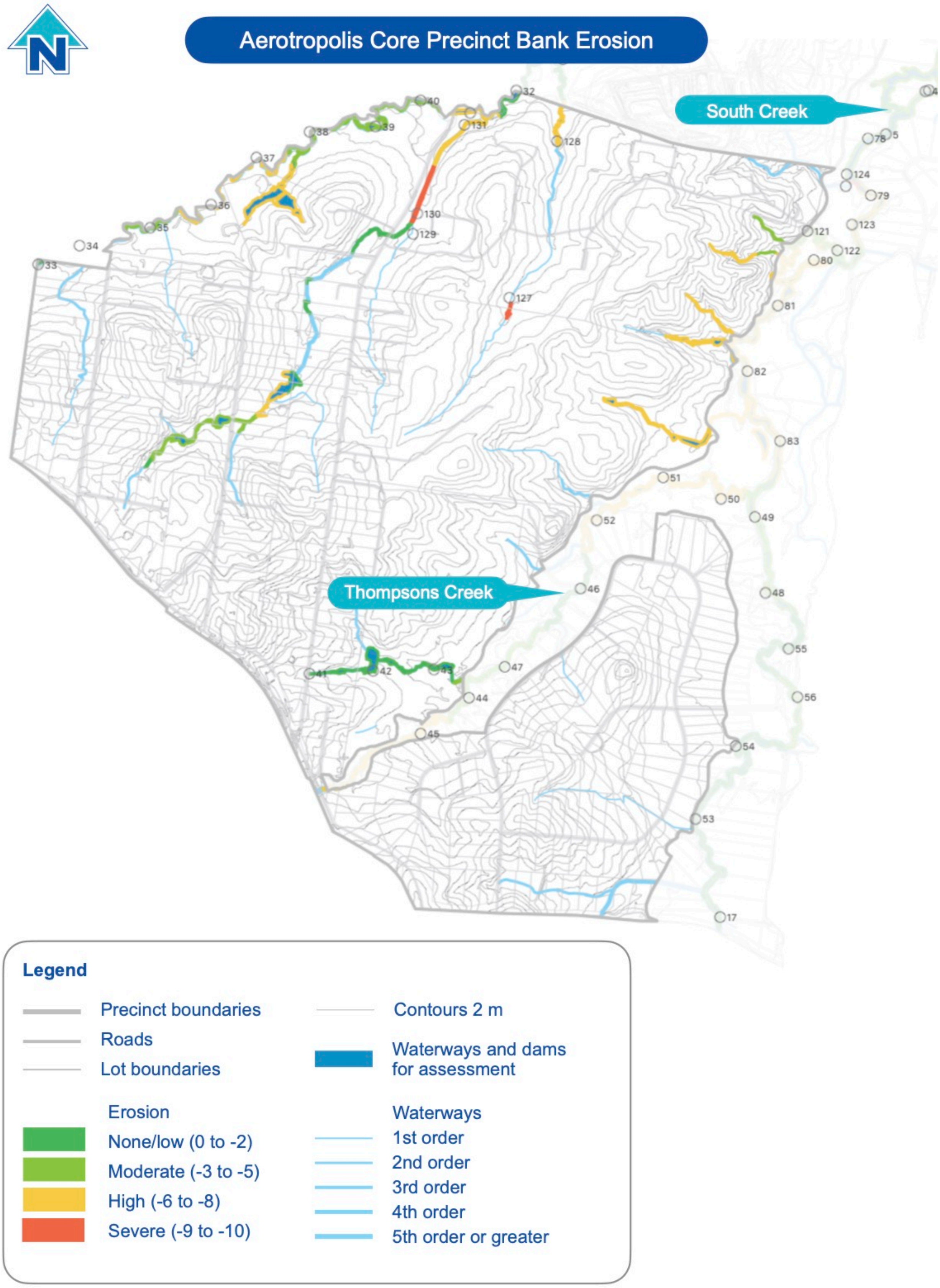


Figure 4-12 Bank erosion severity across assessed waterways in Aerotropolis Core Precinct

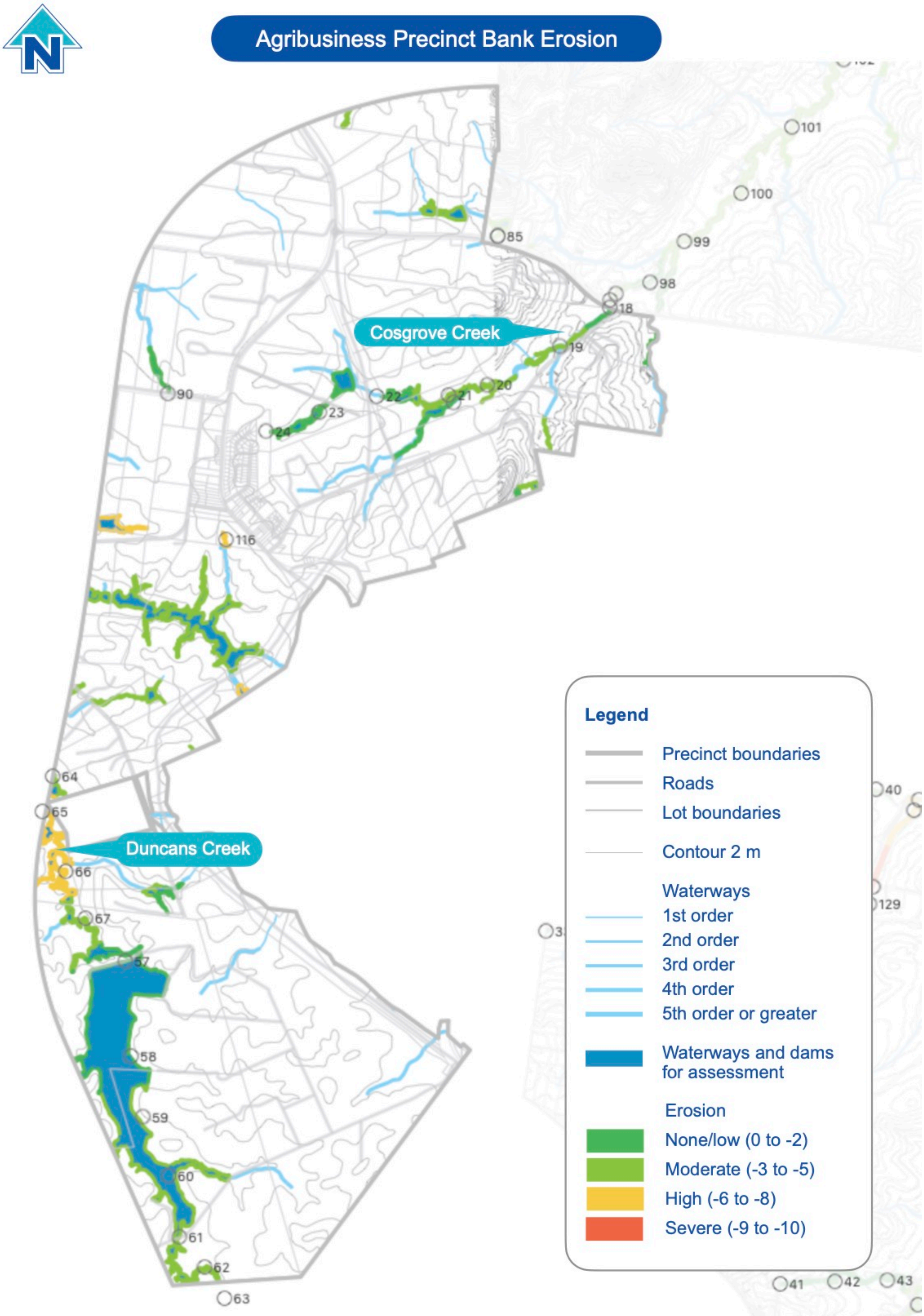


Figure 4-13 Bank erosion severity across assessed waterways in Agribusiness Precinct

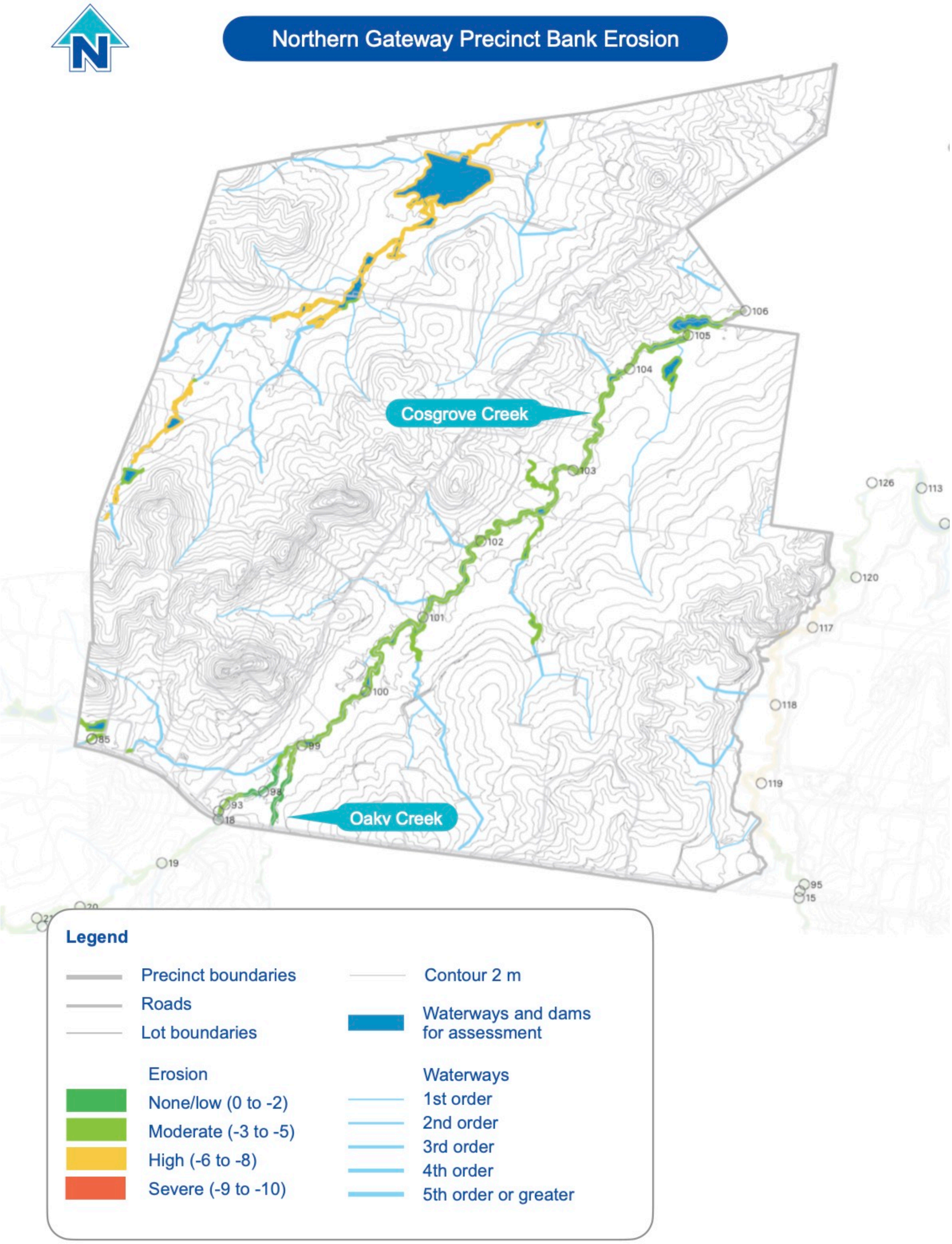


Figure 4-14 Bank erosion severity across assessed waterways Northern Gateway Precinct

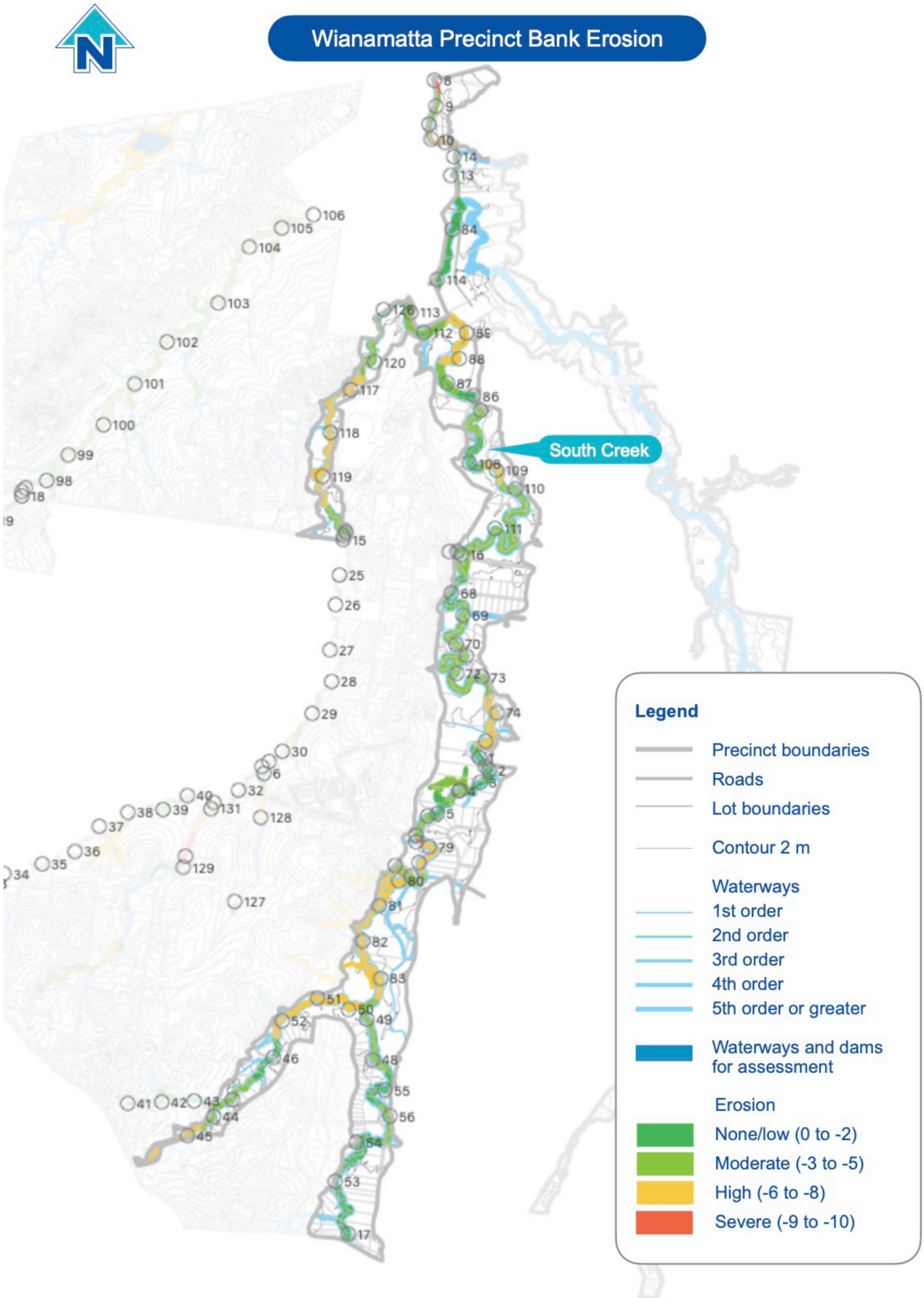


Figure 4-15 Bank erosion severity across assessed waterways in Wianamatta-South Creek Precinct

4.5 Extent of native vegetation

To determine the extent of remnant vegetation within the RRS study area, spatial data for Remnant Vegetation of the western Cumberland subregion, 2013 Update. VIS_ID 4207 (DPIE 2020) was reviewed, and the area of remnant vegetation contained within the HEV Protect and Improve zones calculated. Results are shown in Table 4-3 and Figure 4-16 and Figure 4-17.

Table 4-3 Remnant vegetation within High Ecological Value (HEV) protect and improve zones across the Riparian Revegetation Strategy (RRS) study area.

Precinct	HEV Protect (Hectares)	HEV Improve (Hectares)
Badgerys Creek	11.4	1.2
Aerotropolis Core	23.4	10.6
Agribusiness	9.2	12.4
Northern Gateway	23.9	7.8
Wianamatta-South Creek	230.6	112.2

4.6 RRS Management zones

To effectively manage revegetation of riparian and floodplain vegetation across the Western Sydney Aerotropolis, management zones have been delineated, each requiring different management actions which consider;

- Extent and condition of existing remnant vegetation
- Weed density
- Requirements for Vegetated Riparian Zones (VRZ) under NSW *Water Management Act* 2000
- Flood risk
- Erosion severity

To allow for these considerations and enable high level cost estimates for ongoing management of approximately 2000 ha of land covered by the RRS, four management zones (MZ) (Figure 4-17) have been defined which include:

Management Zone 1

Incorporates land mapped as HEV 'Protect' between creek channel to the outer edge of the 1% AEP extent. The primary function of this zone is to protect remnant vegetation and associated biodiversity. Management of this zone seeks to protect existing native vegetation patches and restore a fully structured (canopy, midstory and ground cover) PCT 835 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion

Management Zone 2

Incorporates land mapped as HEV 'Improve' between the creek channel to the outer edge of the 1% AEP Flood extent. The primary function of this zone is to improve the connectivity of remnant biodiversity and provide buffers to HEV 'Protect'. Management of this zone seeks to either revegetate a fully structured PCT 835 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion within the vegetated riparian zone (VRZ) or create a near continuous tree canopy while maintaining flood conveyance in areas outside the VRZ. This zone may include WSUD elements if existing flood planning levels are not affected.

Management Zone 3

Incorporates land mapped as the 1% AEP Floodway that excludes areas mapped as HEV and VRZ. The primary function of this zone is flood conveyance. Management of this zone aims to create a mosaic of native tree canopy cover with native groundcover (i.e native grasses, forbs and herbs) and excludes midstory vegetation. This zone may include WSUD elements if desired flood planning levels are not affected.

Management Zone 4

Incorporates areas of VRZ that are not mapped as HEV. The primary function of this zone is to protect and enhance the vegetated riparian zone along creek lines. The management of this zone seeks to reinstate a fully structured (canopy, midstory and ground cover) PCT 835 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion on to land that contains limited existing ecological value (similar to zone 4a).

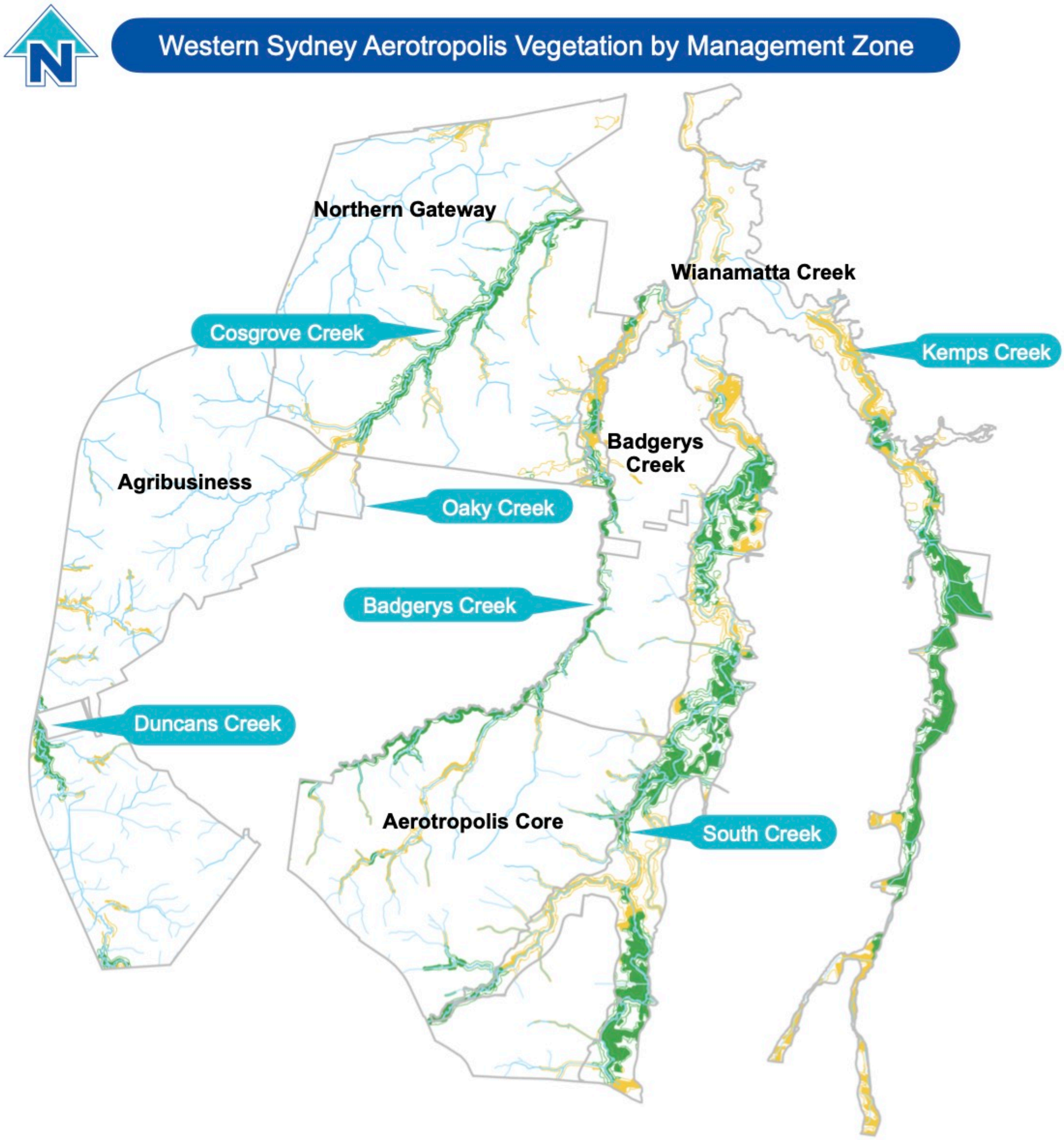
Management Zone 4A

Incorporates public open space between the 1% AEP floodway and 1% AEP flood extent that are not mapped as HEV. The primary function of this zone is to expand habitat and tree canopy outside of remnant native vegetation patches and into zones that are less critical for flood conveyance. The management of this zone seeks to reinstate a fully structured (canopy, midstory and ground cover) PCT 835 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion on to land that contains little existing ecological value (similar to zone 4a). This zone may include WSUD elements if existing flood planning levels are not affected.

A breakdown of management zones area per study precinct is shown in Table 4-4 and Figure 4-17. A cross section landscape architect interpretation of management zones is shown in Figure 4-18 and Figure 4-19.

Table 4-4 Breakdown of the total area of each management zone by study precinct.

Precinct	MZ 1 (Hectares)	MZ 2	MZ 3	MZ 4	MZ 4A
Badgerys Creek	20.7	6.9	7.7	2.0	21.3
Aerotropolis Core	40.2	42.8	2.0	13.5	0.1
Agribusiness	14.4	22.8	0	88.5	20.5
Northern Gateway	60.2	59.3	10.4	66.8	62.9
Wianamatta-South Creek (incl. Kemps Creek)	378.5	305.0	453.6	32.8	268.9



Legend

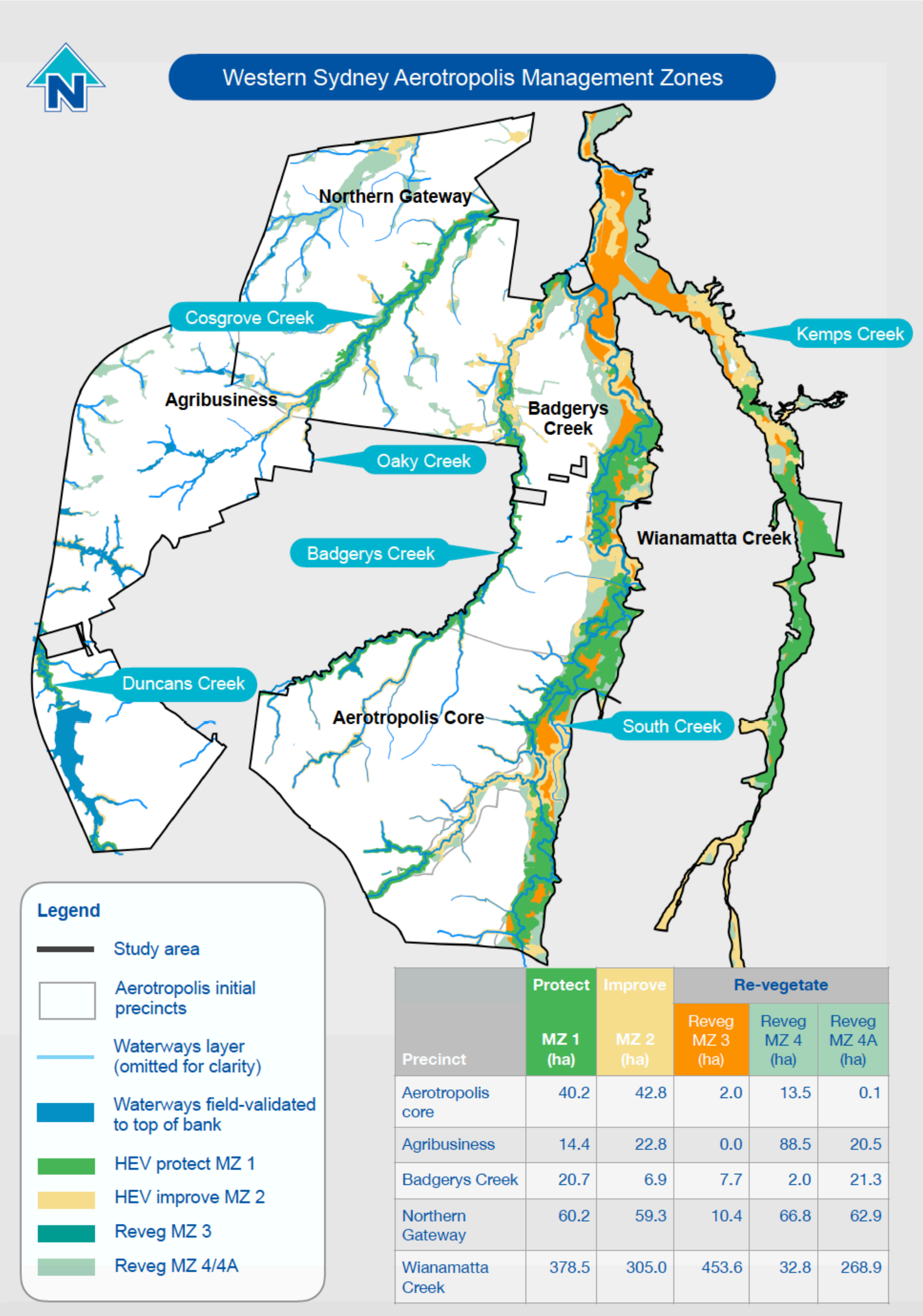
- Precinct boundaries
- Waterways (stream order not shown for clarity)

Cumberland Plain vegetation (2013)

- in HEV protect MZ 1
- in HEV improve MZ 2

	CP vegetation by Zone	
	Protect	Improve
Precinct	MZ 1 (ha)	MZ 2 (ha)
Aerotropolis core	23.4	10.6
Agribusiness	9.2	12.4
Badgerys Creek	11.4	1.2
Northern Gateway	23.9	7.8
Wianamatta Creek	230.6	112.2

Figure 4-16 Remnant native vegetation in High Ecological Value Ecosystems (HEV) Protect and Improve zones within the Riparian Revegetation Strategy (RRS) study area



Precinct	Protect MZ 1 (ha)	Improve MZ 2 (ha)	Re-vegetate Reveg MZ 3 (ha)	Re-vegetate Reveg MZ 4 (ha)	Re-vegetate Reveg MZ 4A (ha)
Aerotropolis core	40.2	42.8	2.0	13.5	0.1
Agribusiness	14.4	22.8	0.0	88.5	20.5
Badgerys Creek	20.7	6.9	7.7	2.0	21.3
Northern Gateway	60.2	59.3	10.4	66.8	62.9
Wianamatta Creek	378.5	305.0	453.6	32.8	268.9

Figure 4-17 Riparian Revegetation Strategy (RRS) management zones across the Western Sydney Aerotropolis

Typical Section

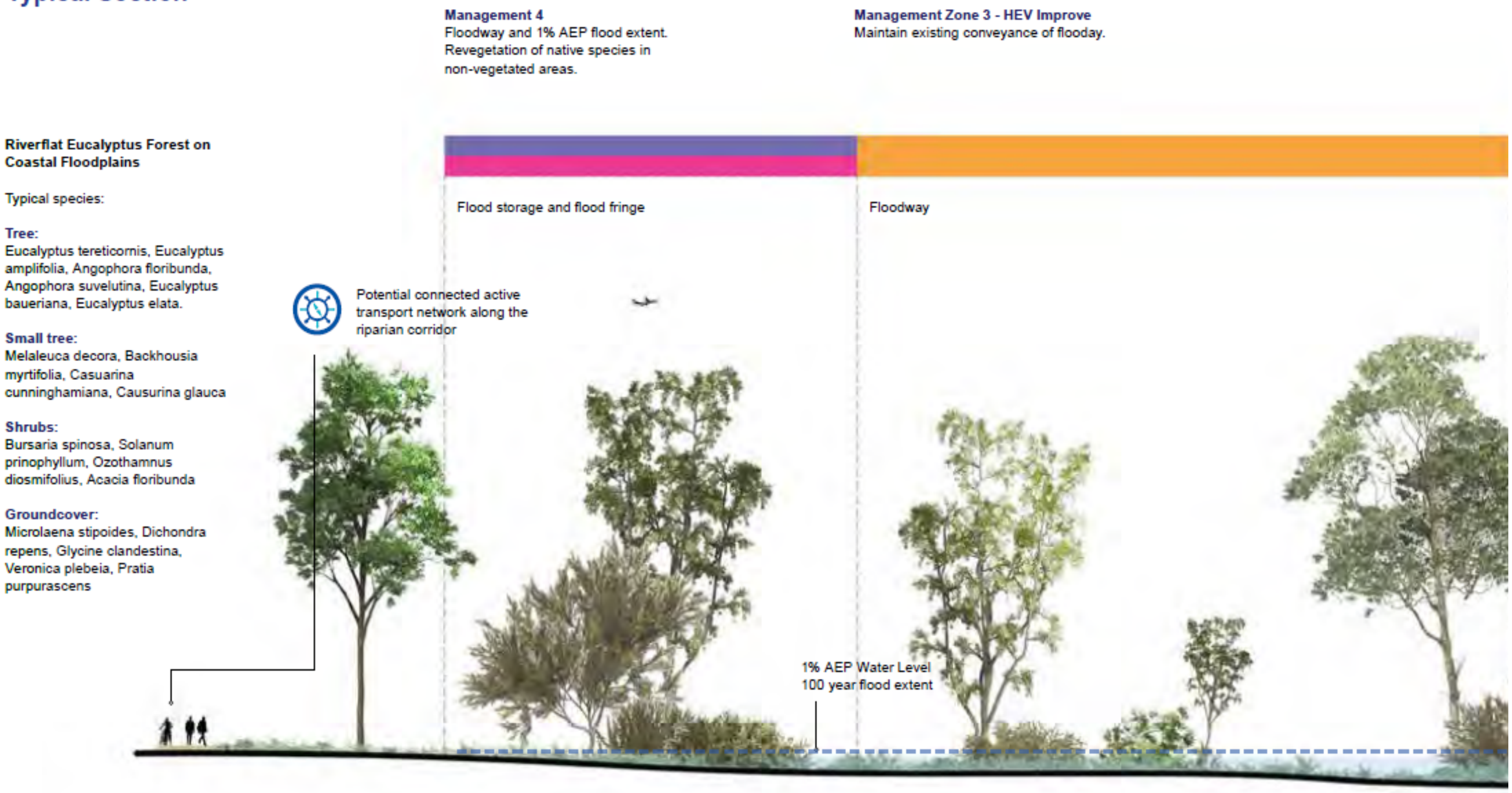


Figure 4-18 Cross section landscape architect interpretation of MZ4 and MZ3 (Aurecon ARUP 2021)

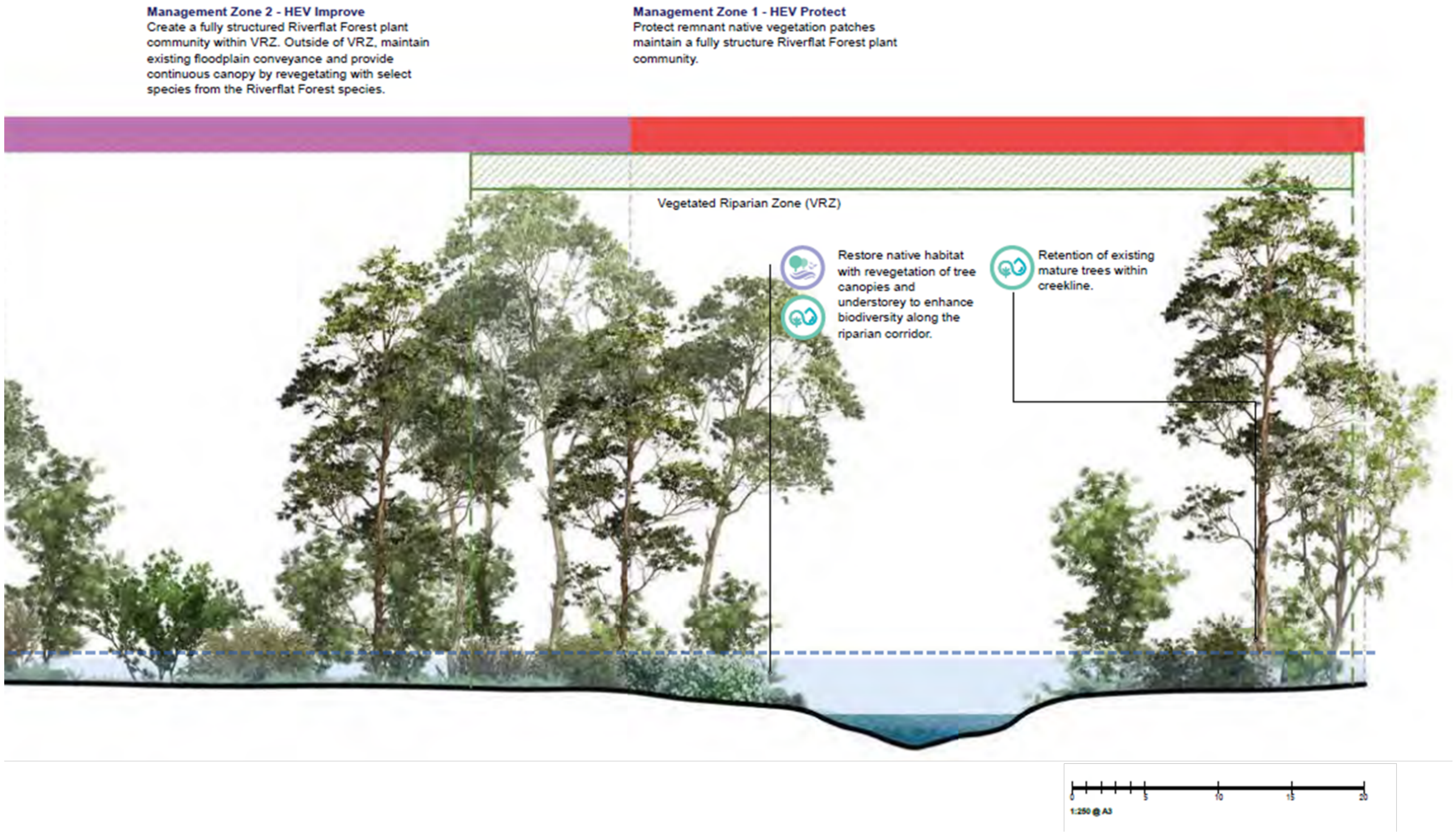


Figure 4-19 Cross section landscape architect interpretation of MZ2 and MZ1 (Aurecon ARUP 2021)

4.7 Management cost calculations

In collaboration with Sydney Water and Blacktown City Council (BCC), industry-best practice costs for primary and secondary weed treatment, site preparation, direct seeding, revegetation, creek stabilisation and ongoing management and monitoring were derived to provide high level cost estimations for each management zone.

Due to the broad spatial extent of the area covered by the RRS high level management actions have been identified and costs applied. These include;

- Primary weed control of woody weeds
- Follow up weed control of woody weeds
- Revegetation of canopy, midstory and groundcover
- Broadscale direct seeding of ground cover

It is acknowledged additional management actions may be required at the site level, however the scope of this RRS is to provide high level, broad scale actions and associated costs.

All management actions and costs have been applied to a five-year period which is the typical industry standard for Vegetation Management Plans (VMP). It is acknowledged the scale of management required across the RRS area will require more than five years, however the scope of this RRS is to provide high level, broad scale actions and associated costs aligned with industry standards.

Calculation of Management Zone (MZ) areas enabled the application of $/m^2/year estimate for the cost of differing intensities of weed management, site preparation and revegetation. Weed management and revegetation costs were calculated separately within each MZ.

Weed Management

Primary (first-year actions) and secondary (follow-up actions) weed management costs over the five-year period were estimated for each MZ using applied market rate averages contributed by Sydney Water and Blacktown City Council.

Assumptions of weed density in each management zone were developed using data collected in field via riparian vegetation assessment (see Section 4.3) and biometric vegetation survey data used in the development of HEV mapping. This included 50 Biodiversity Assessment Method (BAM) (DPIE 2017) survey plots which were used to survey PCT 835 remnant vegetation patches across Wianamatta-South Creek catchment.

Of the 50 BAM survey plots, 28 were surveyed using a "Rapid BAM" method which collected data relating to dominant plant species and community biometrics and 12 plots were surveyed according to the NSW BAM (DPIE 2017).

Estimated weed cover was calculated proportionate to total native vegetation cover recorded for each of the 50 plots. Data was then used derive the estimated mean native and weed percentage cover. Results of this process show extrapolated mean native vegetation cover of PCT 835 across Wianamatta-South Creek catchment was 66.09% and mean weed cover was 33.91%.

Weed density thresholds were then derived with categories based on the percentile approach applied to develop HEV Protect and Improve mapping (EES 2019). Weed management categories (WMC) were then matched. The relationship between WMC and weed density is shown below:

- Sparse: Plots comprised of less than 5% weed cover
- Low: Plots comprised of 5% - 49% weed cover
- Moderate: Plots comprised of 50% - 80% weed cover
- High: Plots comprised of greater than 80% weed cover

Percentage of survey plots were then allocated a WMC which was used to inform an estimation of the severity of weed cover (or "weediness") across the RRS according to defined thresholds. According to the above-mentioned WMC thresholds, the following was calculated:

- 10% of plots had "Sparse" weed cover.
- 63% of plots had "Low" weed cover.
- 22% of plots had "Moderate" weed cover.
- 5% of plots had "High" weed cover.

Management intensities were moderated with respect to WMCs via graduated cost allocations to industry-best practice $/m^2/year values. The following cost allocations informed the WMC cost estimations:

- Sparse: Treated at 25% of $/m^2/year value.
- Low: Treated at 80% of $/m^2/year value.
- Moderate: Treated at 100% of $/m^2/year value (full $/m^2/year cost)
- High: Treated at 120% of $/m^2/year value

The following schedule of $/m^2/year costs was applied to each respective MZ:

- HEV Protect (MZ1): Year 1 @$2/m^2; 4 years @50c/m^2
- HEV Improve (MZ2): Year 1 @$2/m^2; 4 years @50c/m^2
- VRZ Revegetation (MZ4): Year 1 @$2/m^2; 4 years @$1/m^2
- Floodway Revegetation 4 (MZ3): Year 1 @$2/m^2; 4 years @50c/m^2
- 100 Year Revegetation 4A (MZ4A): Year 1 @$2/m^2; 4 years @50c/m^2

Total weed management costs for each MZ were derived by calculating per hectare (ha) costs via application of $/m^2/year cost allocations and applying this to total MZ area (ha) (Table 4.4). Costs associated with five years of weed management within each MZ were totalled to reach an Aerotropolis Initial Precincts VRZ weed management estimated cost (Table 4-5).

Revegetation & Direct Seeding

Revegetation and direct seeding an area in excess of 2000 ha requires extensive planning and a commitment to ongoing maintenance. The RRS acknowledges that a large proportion of the area to be revegetated is located within areas protected under the NSW *Water Management Act* 2000 and within TECs protected under State and Federal legislation.

Capital costs and $/m^2/year values associated with bulk revegetation and direct seeding (i.e. tube stock and bulk seed purchase) were based on costing's provided by Sydney Water and BCC. These values were used to develop models of particular revegetation scenarios, with varying combinations of hand-planting and mechanical direct seeding, dependent on implementation feasibility and MZ objectives.

The following figures derived in collaboration with Sydney Water and BCC have informed initial revegetation cost estimates:

- Revegetation of riparian areas: 8/m^2 ($80,000/ha)
- Ground cover planting: $3 per plant (installed and established)
- Full ground cover revegetation: 5 plants/m^2 (50,000 plants/ha)
- Assisted ground cover revegetation: 2 plants/m^2 (20,000 plants/ha)
- Woodland Planting: 1 tree per 25m^2 (16 trees/ha for woodland planting/30% canopy cover)
- Capital Seed Cost: Seed at $80-$180/kg (seed to be applied at 50kg/ha i.e. $4000 - $9000/ha)
- Endemic Seed: Western Sydney region (rare) $200-$600/kg
- Endemic Wildflower Seed: $500-$1000/kg

High-level cost estimates are intended to provide project stakeholders with an indication of the financial responsibility associated with the revegetation of an area in excess of 2000 ha.

Costs associated with labour, project planning, preparation of a vegetation management plan, project management and ongoing monitoring have not yet been addressed in estimations. Revegetation estimations provide a high-level indication of the capital costs associated with revegetation and primary weed control only.

Creek stabilisation

Erosion Severity Categories (ESC) (Table 4-6) were used to provide costs estimates to undertake creek stabilisation works across the area covered by the RRS.

Erosion Severity Categories are as follows;

- Low/No = < 30% bank erosion
- Moderate = 30 – 50% bank erosion
- High = 50-70% bank erosion
- Severe = > 70% bank erosion

Cost estimates were calculated on per linear meter basis which assumes both creek banks and creek bed are treated using a baseline average cost of $4,250 per linear metre.

This baseline cost was developed using information provided by Blacktown City Council and Sydney Water and considers creek bed and bank stabilisation to be any action not limited to, reshaping and/or regrading, excavation, rock or riprap armouring, installation of woody debris, revegetation and/or a combination of the aforementioned.

Cost estimates have been derived under the major assumption that stormwater will be managed under a Parkland City scenario and guided by the Waterway Health Objectives for South Creek. This is particularly relevant for reducing erosive flows of excess stormwater runoff. If these waterway objectives are not met the creek stabilisation cost would be roughly double.

Graduated cost allocation was applied to the baseline average cost for creek stabilisation of $4,250 per linear metre, with respect to the assigned ESC which is detailed below;

- No-Low: 0% of cost (i.e. No cost allocated; $0 AUD/l.m.)
- Moderate: 50% of cost (i.e. $2,125 AUD/l.m.)
- High: 100% (i.e. Full cost; $4,250/l.m.)
- Severe: 150% (i.e. Intensive action cost; $6,375/l.m.)

A total of 95.3 km has been identified through field assessment and desktop mapping as subject to future stabilisation works.

Cost estimates for stabilisation works have been included for Kemps Creeks, however, no field assessment of creek condition has been undertaken. Therefore, cost estimates have been based on the average rate of $4,250 per linear meter.

4.8 Management intensity per Management Zone

High level vegetation management actions have been allocated to each study precinct based on the principal to protect and improve water dependent ecosystems within the RRS study area.

The table below shows the total area within each MZ where high level vegetation management actions are recommended.

Table 4-5 Area of high-level vegetation management for each Management Zone.

Management Zone	Fully structured revegetation	Canopy and ground cover revegetation	Primary weed control	Secondary weed control
	Hectares			
MZ 1	0	0	514	514
MZ 2	0	292*	436	436
MZ 3	0	203*	203	203
MZ 4	373	0	373	373
MZ 4A	437	0	437	437

* Canopy and ground cover only to ensure no impact to flood conveyance.

The level of creek stabilisation works has been allocated based on the erosion severity (Table 4-6Table 4-2) which is a reflection of the works required.

The table below shows the total length of creek stabilisation, the intensity of works required to mitigate the current severity of erosion and the cost allocation per linear meter.

Table 4-6 Intensity of creek stabilisation works across the Riparian Revegetation Strategy (RRS) study area excluding Kemps Creek.

Erosion Severity Category	Length (linear meters)	Intensity or works	% of cost allocation
No-low	20,220	None	0
Moderate	43,150	Low	50
High	31,240	Moderate	100
Severe	660	High	150

4.9 Cost estimates for Riparian Revegetation Strategy

Cost estimates for vegetation management and creek stabilisation have been calculated using the methods described in section 4.7 and applying to the areas and lengths detailed in section 4.8.

Table 4-7 provides a breakdown of management costs by management zone across the area covered by the RRS. Costs associated with revegetation and weed management within each MZ are listed.

All costs shown in this section provide high level estimates of RRS capital costs and are based on information provided by leaders in western Sydney waterway management.

Table 4-7 Breakdown of vegetation management costs per Riparian Revegetation Strategy (RRS) management zone (MZ)

Management Zone	Weed control	Revegetation	MZ total
MZ 1 - HEV Protect	$16,633,040	0	$16,633,040
MZ 2 - HEV Improve	$14,134,848	$23,408,000	$37,542,848
MZ 3 - 1% AEP Floodway Revegetation	$6,588,496	$1,842,000	$8,430,496
MZ 4 VRZ Revegetation	$22,993,398	$37,896,000	$60,889,398
MZ 4A 1% AEP Extent Revegetation	$12,092,932	$3,381,238	$15,474,170
Total Cost Estimate	**$72,442,714**	**$66,527,238**	**$138,969,952**

It is imperative to consider that the above estimate for revegetation and seeding are based on the following: MZ1 HEV Protect with no revegetation; MZ 2 HEV Improve: Cost based on BCC $8/m^2 (hand revegetation due to sensitive area); MZ 3 1 % AEP Floodway Revegetation: The cost of 16 canopy trees/ha and the raw cost of seed (labour/machine costs to be explored further); MZ 4 VRZ Revegetation: The cost based on BCC $8/m^2 (hand revegetation due to sensitive area); MZ 4A 1% AEP Extent Revegetation: The cost of 16 canopy trees/ha and the raw cost of seed (labour/machine costs to be explored further).

Table 4-8 provides a breakdown of creek stabilisation costs associated with each Erosion Severity Category (see Table 4-6) for the area covered by the RRS, including the estimated costs for Kemps Creek, which were calculated based on a desktop study with no field data input.

Table 4-8 Bed and bank stabilisation estimated cost by management zone (MZ)

Erosion Severity Category	Total length (m)	% Cost allocation	$/linear meter	Total
No-low	20,220	0	0	$0
Moderate	43,150	50%	$2,125	$91,693,750
High	31,240	100%	$4,250	$132,770,000
Severe	660	150%	$6,375	$4,207,500
Total Cost Estimate	**95,270**			**$228,671,250**
Estimated Cost for Kemps Creek	**16,299**		**$4,250**	**$69,270,750**
Total Cost Estimate for Aerotropolis Precinct	**111,569**			**$297,942,000**

Table 4-9 shows the total estimated cost for high level vegetation and creek stabilisation costs for the area covered by the RRS for the Western Sydney Aerotropolis Initial Precincts. Consideration of costs associated with high level vegetation and creek stabilisation should be prioritised and staged over time.

Table 4-9 Riparian Revegetation Strategy (RRS) total capital cost estimate for high level vegetation and creek stabilisation management actions

Estimated Total: RRS Vegetation Mgt. + Creek Stabilisation Works
Vegetation Management Cost = $138,969,952
Creek Stabilisation Cost = $297,942,000
Total = $436,911,952

4.10 Limitations/Assumptions of cost estimate

Cost estimates for the RRS have been prepared using refined industry best-practice $/m^2/year values (where available) and has endeavoured to account for variability within weed management and revegetation estimates.

However, given the scale and complexity of the study area, there are numerous variables that have been considered during preparation of the estimates, but are not yet represented in costs.

The following is a summary of limitations and assumptions for consideration for refining estimates in future phases of the RRS development:

- A comprehensive consideration of labour costs (pending discussions regarding the internal or external tendering of works).
- Project management costs over a minimum of five years.
- Machine hire for site preparation/soil ripping for areas up to > 1000ha.
- Watering truck hire for areas up to > 1000ha (and for five years minimum).
- Future maintenance spraying of planting areas.
- Pre-slashing and herbicide spraying prior to seeding/planting tube stock.
- Cost of water retaining granules where/if required.
- Any associated erosion controls.
- Any fencing and/or protection of plantings from pests. I.e. "best practice" tree guards and mats in selected cases.
- Feasibility of machine access to rip soil i.e. planning and management costs associated with private property access.
- Feasibility of machine ripping near to TECs without disturbing existing vegetation and/or soils (models currently assume all areas of MZ's are accessible for seeding).
- Limitations, costs and timeline impacts associated with collecting tonnes of endemic TEC seed.
- Consideration of "best practice" expansion areas/weed breaks (20m buffer zones around plantings/remnants).
- Variations of costs associated with different sowing methods.
- Costs associated with the construction and establishment of a project specific seed orchard (if deemed required).
- Any implementation of translocation and transplanting of plants or soils.
- Educational signage and recreational infrastructure etc. (if required at planting sites).

Costs estimates for Kemps Creek were calculated based on a desktop study with no field data input. It is strongly recommended that an assessment of riparian vegetation and bed and bank stabilisation be undertaken, in addition to top of bank mapping. This will enable more accurate creek revegetation and stabilisation costings for future planning of the area.

4.11 Potential Generation of Ecosystem Credits

Potential Ecosystem Credit generation (BAM 2017) for the area covered by the RRS was undertaken using the OEH BAM Calculator (OEH 2020), which utilises calculations-based comparison of current state vegetation biometrics with Plant Community Type specific condition benchmarks.

For area covered by the RRS these calculations were based on PCT 835 – Cumberland River Flat forest within the Sydney Basin IBRA region (with an estimated 30% native vegetation cover) and predicted that these zones provide potential habitat for threatened species associated with PCT 835. This PCT is mapped across the RRS area as the dominant community.

Potential ecosystem credit generation has been based on all available land within the area covered by the riparian revegetation strategy. The number of potential credits generated are estimates and do not take into consideration current or planned future offsets.

Due to the size of the area covered by the RRS, a number of assumptions and extrapolations were required to calculate the potential generation of Biodiversity Credits which are detailed below:

Management Zone 1 (HEV Protect)

The average composition scores from the BAM plots surveyed for the HEV mapping validation were used, in addition to the average structural and functional scores from the Rapid BAM plots which were all undertaken in PCT 835.

Review of native vegetation mapping showed 289.5 hectares of PCT 835 are contained withing MZ1.

Management Zone 2 (HEV Improve)

To calculate potential credit generation MZ2 was split into two zones. This included MZ2A which was classified as having degraded vegetated that received condition in the ‘improve’ category, therefore the composition, structure and functional scores were based on the 25th percentile of the Rapid BAM results for the PCT 835 Improve sites. The area in zone MZ2A was calculated as 144.2 hectares.

MZ2B was classified as having no vegetation (due to a lack of canopy species), with a total area of 292.6 hectares. Therefore, the 25th percentile of groundcover species based on the Rapid BAM results for the PCT 835 Improve category were used.

Management Zone 3 (1% AEP Floodway)

For zone MZ3 which had an area of 203.6 hectares, predicted credits were calculated based on a prediction of groundcover species which was calculated as the 25th percentile of the Rapid BAM results for the PCT 835 Protect category and canopy species based on the 25th percentile of the Rapid BAM results for the PCT 835 Protect category).

Management Zone 4 (VRZ revegetation)

Had an area of 473.7 hectares, predicted credits were calculated in line with potential presence of groundcover species based on the 25th percentile of the Rapid BAM results for the PCT 835 protect category and canopy species based on the 25th percentile of the Rapid BAM results for the PCT 835 protect category.

Management Zone 4A (1% AEP Flood Extent)

For zone MZ4A which has an area of 373.7 hectares, predicted credits were calculated based on potential presence of groundcover species which was calculated as 25th percentile of the Rapid BAM results for the PCT 835 Protect category and canopy species based on the 25th percentile of the Rapid BAM results for the PCT 835 Protect category.

Data used to calculate the potential Ecosystem Credit generation is supplied in Appendix A.

The potential Ecosystem Credits generated for PCT 835 – Cumberland River Flat Forest within the Sydney Basin for each RRS MZ is shown in Table 4-10.

Total potential ecosystem credit generation across the management zones is estimated at 2388. Review of the BioBanking ecosystem credit transaction register (OEH 2021) indicates that the average price per credit based on the last two years of credit trading for PCT 835 is estimated at approximately $16,145.26 (Appendix B). However, this is based on a desktop review, therefore more accurate credit generation and potential revenue of credits should be assessed in conjunction with more intensive field assessments.

Table 4-10 Estimated potential Ecosystem Credit generation by Riparian Revegetation Strategy (RRS) management zone (MZ).

Management Zone	Estimated Credit Generation
MZ 1 HEV Protect	1679
MZ 2A - HEV Improve – Native canopy vegetation	189
MZ 2A - HEV Improve – No native canopy or midstory	157
MZ 3 – 1% AEP Floodway	54
MZ 4 - VRZ	125
MZ4A 1% AEP Flood Extent	184
Total Potential Ecosystem Generation	**2388**

Note the results presented in Table 4-10 have been derived using a desktop approach using data from 12 full BAM plots and 50 Rapid BAM plots. Due to the spatial extent covered by the RRS (~ 2000 ha) further assessment using BAM plots is required to accurately predict credit generation and satisfy the survey requirements outlined in the BAM (2020).

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