



**PONDICHERRY
LAKE PRECINCT
WATER MANAGEMENT ACT ASSESSMENT**

APRIL 2020



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CONTENTS

EXECUTIVE SUMMARY.....	1
1. INTRODUCTION.....	2
1.1. Purpose of this Report.....	2
2. THE PONDICHERRY PRECINCT	3
2.1. Local and Regional Context.....	3
2.2. The Vision for Pondicherry	4
3. PLANNING POLICY AND REZONING CONTEXT	5
3.1. Pondicherry Precinct Rezoning	5
3.2. Water Management Act 2000 Approval.....	5
3.3. State Government Directives – Design Led Planning.....	5
4. ASSESSMENT	7
4.1. Existing Conditions	7
4.2. Urban Design Response.....	8
4.3. The Lake Precinct – Compliance with the Water Management Act 2000	10
5. SUMMARY AND CONCLUSION.....	13

APPENDICES

1. Pondicherry Water Management Options – Urban Design Analysis (Design+Planning)
2. Pondicherry Water Cycle Concept – Ecological Considerations (Eco Logical Australia)
3. Pondicherry Flood Modelling (Calibre Consulting)

EXECUTIVE SUMMARY

The Pondicherry Precinct is part of the South West Growth Area and is being rezoned under the *State Environmental Planning Policy (Sydney Region Growth Centres) 2006* (Growth Centres SEPP) for urban development in partnership between the *NSW Department of Planning, Industry and Environment* (DPIE) and the landowner (Leppington Pastoral Company Pty Ltd).

The rezoning of the Pondicherry Precinct requires the management of stormwater from not only the Pondicherry Precinct itself, but also the existing Oran Park project. The Oran Park drainage strategy has relied on the existing on-line farm dams to detain water in storm events greater than the 2-year occurrence. Given this unique situation, a strategy for the management of stormwater is proposed which involves the replacement of the existing dams with a Lake system to deliver an outcome that delivers a high environmental, social and economic benefit to the future community.

The detailed design of the Lake system will be undertaken in consultation with the relevant Government agencies and authorities to ensure that the outcome delivers on Governments desire to achieve activation along South Creek and provides high amenity within a place-based design-led outcome that strengthens the blue and green grid interaction.

This report has been produced for consideration by the *Natural Resource Access Regulator* (NRAR) and provides a merit assessment of the strategy for managing stormwater and riparian corridors within Pondicherry. This merit assessment is needed due to the three options presented not meeting the standardised assessment criteria for development of Waterfront Land as documented in NRAR's *Guidelines for Controlled Activities on Waterfront Land — Riparian Corridors* (NRAR, 2018).

A comprehensive assessment of the options for the management of stormwater has been undertaken to inform the preferred outcome, with this report providing an overview of the detailed work undertaken by specialist urban design (Design+Planning), flood/water management (Calibre Consulting) and ecological consultants (Eco Logical Australia) (refer to Appendices 1, 2 and 3 for these specialist reports).

The three options assessed for stormwater management are listed as follows:

- On-line wet basin (Lake system).
- On-line dry basin.
- Off-line dry basin.

Each of the options for stormwater management require weirs within the stream environment to achieve the required water quality and detention outcomes. In consideration of this, along with the many considerations of the Objects and Principles of the *Water Management Act 2000* (WM Act) and the broader Government objectives for the delivery of new communities within the Priority Growth Areas of Sydney, the consulting team has concluded that the Lake system is best placed to achieve the principles of ecological sustainable development and deliver the optimum social, economic and environmental outcome which is fully compliant with the Objects and Principles of the WM Act and the broader Government objectives of heat island offset and retaining water in the local environment.

Concurrence is sought from NRAR to the proposal for an on-line wet basin in the form of a Lake system within the Pondicherry Precinct. This concurrence will inform the Precinct Planning process and ensure the development outcome envisaged through the Pondicherry rezoning can ultimately be delivered.

1. INTRODUCTION

The Pondicherry Precinct is being progressed through Precinct Planning under the *State Environmental Planning Policy (Sydney Region Growth Centres) 2006* (Growth Centres SEPP). The Precinct Planning (rezoning) process has been underway for several years, with the required background studies for the area having been substantially undertaken. To enable the Precinct Planning process to progress to completion, it is necessary to seek *Natural Resource Access Regulator* (NRAR) concurrence on the method for managing stormwater for the Precinct.

The Pondicherry Precinct is located to the immediate north of the Oran Park Precinct which was rezoned in 2007 and has been progressively developed over the past decade. The rezoning of the Oran Park Precinct included a stormwater management strategy which involved water quality enhancement and stormwater detention within the project up to the 2-year storm event, prior to discharging water into the adjacent creeks. Stormwater flows up to the 100-year storm event are then detained online within the existing farm dams located within the Pondicherry Precinct. In consideration of this existing condition, the stormwater strategy for the Pondicherry Precinct must consider how stormwater for both Pondicherry and Oran Park is managed. To this end, this report is an overview of the assessment work undertaken by specialist flood/water management, environmental and urban design consultants to determine the most appropriate management outcome that complies not only with the WM Act, but recent directions from Government in relation to achieving enhanced blue and green grid networks along South Creek and ensuring that the emerging heat island effect is offset through positive measures relating to retention of water in the local environment and maximising the opportunity for meaningful establishment of tree canopy.

The three options assessed for stormwater management are listed as follows:

- On-line wet basin (Lake system).
- On-line dry basin.
- Off-line dry basin.

Concluding the assessment it is found that the logical outcome of these options is the creation of a Lake system within the Pondicherry Precinct that enables all the relevant objectives and principles across Government to be achieved and delivered as an exemplar for Western Sydney and the emerging new community of Pondicherry. The report briefly describes the three options which have been reviewed through the design process and concludes that the Lake system is best placed to achieve the principles of ecological sustainable development and deliver the optimum social, economic and environmental outcome which is fully compliant with the Objects and Principles of the WM Act.

1.1. Purpose of this Report

This report has been prepared as part of the background studies for the rezoning of the Pondicherry Precinct located in the Camden LGA of the South West Growth Area (SWGA). The report follows a meeting held on Monday 3 February 2020 between the *NSW Department of Planning, Industry and Environment* (DPIE), the *Natural Resource Access Regulator* (NRAR), Camden Council, Greenfields Development Company (the landowner), and the associated specialist consultants.

The report has been prepared in consultation with DPIE and Camden Council to provide a merit assessment of the proposed Lake system against the requirements of the WM Act for referral and concurrence with NRAR. The merit assessment and NRAR concurrence is required as part of the rezoning process due to the Lake system being proposed online within a Strahler system defined 3rd order stream and not meeting the standardised *Guidelines for Controlled Activities on Waterfront Land – Riparian Corridors* (NRAR 2018).

Concurrence is sought from NRAR to inform the Precinct Planning process and ensure the development outcome envisaged through the Pondicherry rezoning can ultimately be delivered.

2. THE PONDICHERRY PRECINCT

2.1. Local and Regional Context

The Pondicherry Precinct is located within the central-west portion of the SWGA within the suburb of Oran Park in the Camden LGA. The Precinct adjoins the existing Oran Park Precinct to the south, South Creek to the east and the Northern Road to the west. The northern boundary adjoins existing farm land which forms part of the future South Creek West Precinct.

The Precinct encompasses approximately 235ha of existing rural land and is located approximately 30km south-west of Parramatta and 10km to the south of the planned Western Sydney Aerotropolis.

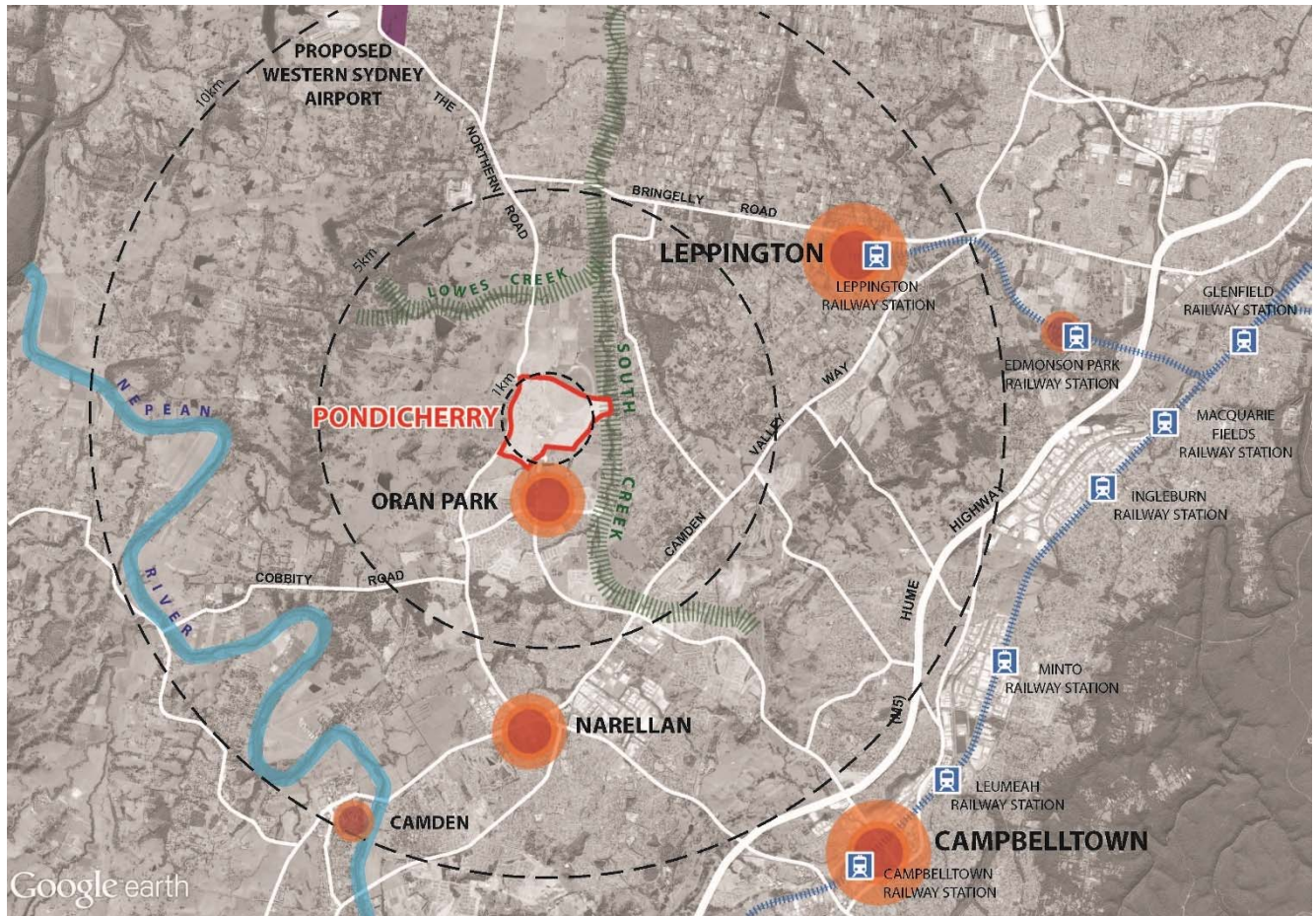


Figure 1: Pondicherry Context Plan

The property details for the Pondicherry Precinct include:

- Lot B DP420694
- Lots 4 & 5 DP1223563
- Lots 50 DP1232523
- Lot C DP391340
- Lot 11 DP1229416
- Lots 500 DP1225924
- Lot 2 DP1217189.

2.2. The Vision for Pondicherry

Pondicherry will deliver a high-quality urban environment following in the footsteps of Oran Park and the principles of community pride, well-being, healthy living and educational excellence. Pondicherry will incorporate a series of thoughtfully planned villages with high local amenity and quality connections to the job opportunities, community and recreational facilities afforded within Oran Park Town and the future Major Centre to the north within the South Creek West Precinct east of The Northern Road.

The urban framework of Pondicherry will respond to the unique characteristics of the existing environment including:

- The retention of existing remnant vegetation and hollow bearing trees where possible;
- Creation of meaningful green-grid connections to South Creek and the local creek networks in Oran Park; and
- Utilising the opportunity of the existing farm dams to provide a unique blue-grid Lakes Precinct as a community focal point of a District nature.

Open Space and access to water are among Sydney's greatest assets. As the population expands within Sydney's south-west it is essential that future communities are afforded quality open space areas incorporating, where appropriate high amenity water features which contribute to the blue-green grid, urban heat island offsets and the creation of a strong sense of place. The Lakes Precinct will provide a strong recreational focus including both active and passive uses along with the co-location of a District level sporting facility. The Lakes Precinct will include a Neighbourhood Centre and opportunity for mixed use activities including commercial, residential, civic, recreation, and social infrastructure. The amenity afforded through the expansive Lake system and adjoining open space will be of District appeal and a key attractor for residents, businesses and visitors alike. The bushland setting and backdrop of South Creek further strengthen the Lake Precinct's appeal. This important ecological asset and bushland setting will continue to be preserved and enhanced for community enjoyment. Together, these landscape features will provide a highly attractive and sort after place to live as residents seek to capture the amenity and healthy living benefits the Lake Precinct presents.

Pondicherry will provide a broad range of dwelling types with a particular focus on attractive residential streetscapes structured around well connected, walkable neighbourhoods. The high amenity area of the Lake Precinct will also offer the opportunity for estate housing mixed with medium and high-density residential development encouraging housing diversity and a broad socio-economic mix.

A key aspect of Pondicherry will be the highly walkable urban structure, connected by a network of active pedestrian and cycle paths layered and intertwined with the blue-green grid offered through the local creek corridors, South Creek and the Lake Precinct. The local open spaces also provide intimate opportunity for community building and local resident interaction.

The future North-South Rail corridor forms part of the planning and design for Pondicherry. Two road and one pedestrian crossing will be delivered providing effective permeability across the corridor.

3. PLANNING POLICY AND REZONING CONTEXT

3.1. Pondicherry Precinct Rezoning

The Pondicherry Precinct is one of fourteen precincts in the SWGA, of which eight have been rezoned under *State Environmental Planning Policy (Sydney Region Growth Centres) 2006* (Growth Centres SEPP) for urban development. Pondicherry is being rezoned in partnership between DPIE and the landowner (Leppington Pastoral Company Pty Ltd) through the Precinct Acceleration Protocol (PAP) which allows landowners to accelerate the release of a Precinct within the Growth Area ahead of the Government's land release program through the entering of a Voluntary Planning Agreement.

Resolution of the strategy for riparian corridors and water cycle management remains the key hurdle before the Indicative Layout Plan can be prepared prior to proceeding to stakeholder engagement of the Precinct Plan and ultimately rezoning.

3.2. Water Management Act 2000 Approval

The key NSW legislation governing the management of the State's water resources is the WM Act. The main objective of the WM Act is to manage NSW water in a sustainable and integrated manner that will benefit both present and future generations. The WM Act is administered by *Natural Resources Access Regulator* (NRAR) and establishes an approval regime for activities within waterfront land, defined as the land 40m from the highest bank of a river, lake or estuary.

NRAR's *Guidelines for Controlled Activities on Waterfront Land — Riparian Corridors* (NRAR, 2018) provides a standardised assessment matrix for Riparian Corridors, with widths based on the Strahler stream order system. Where a proposal does not conform with the Guidelines, a merit assessment pathway is required to ensure that the proposal meets the requirements of the WM Act.

This proposal seeks to provide an on-line wet basin (Lake system) within a 3rd order stream. The Lake system does not meet the assessment matrix provided within the Guidelines and therefore requires a merit assessment for review by NRAR. It is noted that due to the existing site conditions, notably the Oran Park Stormwater Management Strategy, all of the options reviewed would not meet the assessment matrix provided within the Guidelines and would therefore require a merit assessment. This report has been prepared to provide evidence that a thorough review of the site conditions and environmental factors has been conducted including an options analysis. The report concludes that the Lake system is best placed to achieve the principles of ecologically sustainable development and deliver the optimum social, economic and environmental outcome which is fully compliant with the Objects and Principles of the WM Act.

A Controlled Activity Approval is not sought at this stage, however the merit assessment and NRAR concurrence is required to inform the Precinct Planning process and ensure the development outcome envisaged through the Pondicherry rezoning can ultimately be delivered.

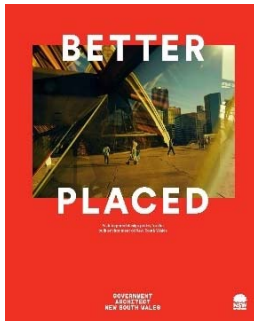
3.3. State Government Directives – Design Led Planning

The Lake Precinct aims to provide a design led, place-based outcome which integrates environmental, social and economic factors to the benefit of the future community. This will be achieved through the delivery of the State Governments directive for delivering ecological sustainable development within an urban setting to fulfil the future housing needs of Sydney.

'The Minister for Planning and Public Spaces is focussed on promoting development throughout NSW that improves people's lives into the future, as well as protecting, restoring and building our State's public spaces and parklands.'

(NSW Department of Planning, Industry and Environment website)

This focus is embodied within the documents *'Better Placed'* and *'Greener Places'* published by the NSW Government Architects Office.



"The NSW Government recognises the importance of good design in making great places and ensuring our cities and towns are Better Placed. Great places and cities don't happen by chance: they are designed, and continue to be designed as we manage the transformation of our cities."



"NSW has a rapidly growing population and we need to ensure that our built environment remains healthy and liveable. As custodians of the future, we need to think about how NSW will be transformed."

The provision of Green Infrastructure will help improve the quality of our urban and rural environments as well as help adapt and mitigate the effects of climate change. Well-designed and planned Green Infrastructure will help absorb flood water, cool the urban environment, clean the air, provide space for local food production and ensure the survival of Sydney's fauna and flora as well as providing space for recreation, sport and leisure."

The Lake Precinct seeks to deliver the objectives of these policy documents by enhancing the quality of the built environment in the South West, raising expectations and working collaboratively with government and other stakeholders in the pursuit of creating better environments.

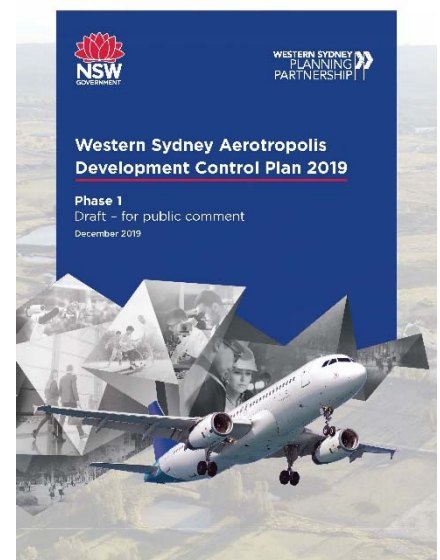
The Planning Partnership through the work being undertaken for the Aerotropolis and specifically the Draft DCP has also defined what is required in order to plan and deliver the vision espoused for the Western Parkland City. It is this approach to planning and urban design which is a key focus for placemaking and embodied in the delivery of the Lake Precinct:

1.8 Western Parkland City – Landscape led Approach

Recognise regional blue and green infrastructure as a major 'city shaper' at the same level of significance as transport and social infrastructure.

Adopt a 'landscape led' approach to planning and urban design as follows:

- a) *start with Country – identify and build city structure and places from the landform and water system.*
- b) *retain water in the landscape – manage the waterway health of the Wianamatta-South Creek Catchment to enable the development of a functional blue-green structure for the Western Parkland City that contributes to flood management and human safety;*
- c) *preserve, extend and restore the green – develop a green infrastructure framework structured around the Wianamatta-South Creek green spine and tributaries where biodiversity land is conserved, along with remnant vegetation, water features and habitat linkages across ridges to link catchments, cultural values and view lines;*
- d) *locate transit corridors within walking distance to landscape amenity – align active and public transport networks within an easy walk from urban development and landscape amenity and safeguard proposed transit corridors to enable efficient delivery as growth progresses;*
- e) *orientate urban development towards landscape amenity and connected to transit corridors – develop fine grain walkable neighbourhoods with creek-oriented schools, community facilities and hubs; and*
- f) *adopt urban typologies – ensure urban development retains water in the landscape using both public and private landscape spaces including streets to provide a high level of liveability.*



4. ASSESSMENT

4.1. Existing Conditions

4.1.1. RIPARIAN CORRIDORS

Eco Logical Australia (ELA) are engaged to undertake the riparian corridor assessment for the Pondicherry Precinct Planning and rezoning. ELA has undertaken onsite investigations as part of their assessment process including validation of watercourses across the Precinct. Pondicherry has been highly modified and includes extensively cleared paddock/pastoral land that is currently used for livestock grazing and crop growing. While some of the creek lines contain remnant vegetation the ecological communities in the creek lines are highly disturbed and incomplete with vast sections having been cleared. The Precinct is also relatively flat, with areas ranging in slope between 1-4%, with some greater slopes adjoining the western boundary and The Northern Road. Waterways across the Precinct range from undefined overland flows, to large online dams, to an incised channel with forested riparian land. Using the Strahler method of stream order, the DPI hydroline map shows twelve 1st order, four 2nd order, one 3rd order, and one 4th order stream (South Creek) within the site. Of these, only three of the higher order streams had a distinctive bed, bank and aquatic habitat, including portions of the 2nd and 3rd order streams the 4th order stream of South Creek.

There is currently 46 ha of online dams (2 large dams) on the 3rd order stream, plus numerous small online and offline dams scattered throughout the study area. The ELA Assessment report is provided as Appendix 2.

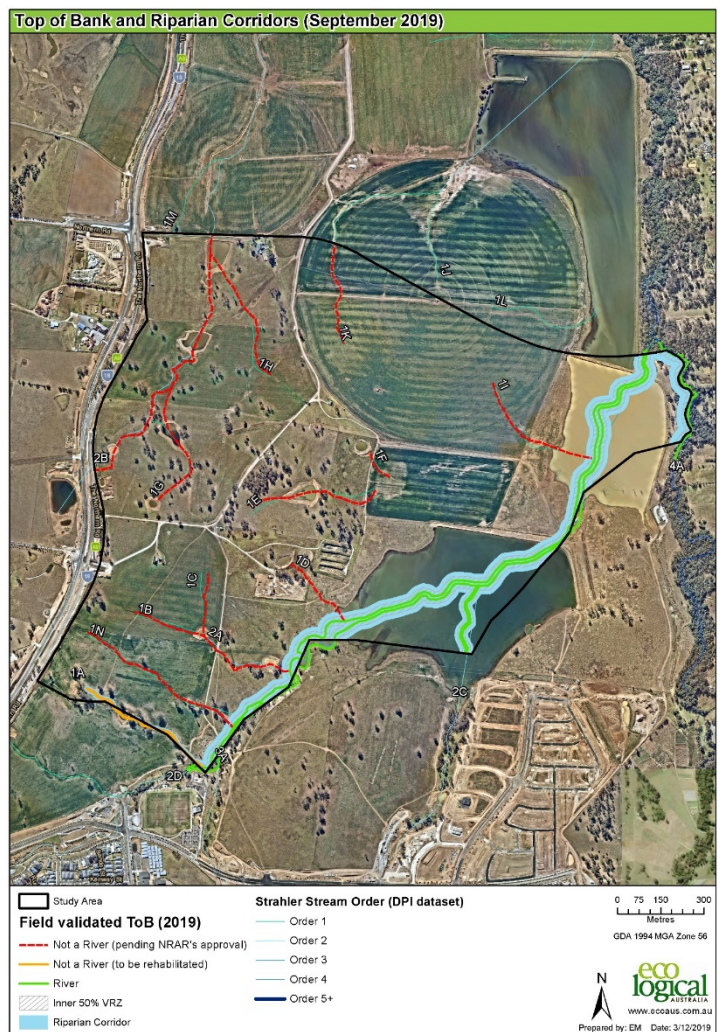


Figure 2: Pondicherry Riparian Corridors

4.1.2. STORMWATER MANAGEMENT

The *Oran Park Precinct Masterplan – Stormwater Quantity Management and Flooding* (Brown 2007) was prepared for the Growth Centres Commission as part of the Oran Park rezoning and identified the stormwater management strategy for the Precinct. This stormwater management strategy incorporated smaller detention basins (detaining up to the 2-year ARI) within a 267ha catchment of Oran Park which drained through Pondicherry via existing online farm dams which would detain the 100-year ARI before discharging into South Creek. This strategy requires a detention volume of 150,000m³ within the Pondicherry Precinct.

The fundamental purpose of the proposed Lake system is to effectively and efficiently replace the existing farm dams, ensuring the Stormwater Management Strategy adopted for Oran Park can be achieved, including detention up to the 100 year ARI and the effective management of flooding downstream, while also delivering the urban environment envisaged for the Growth Centre.

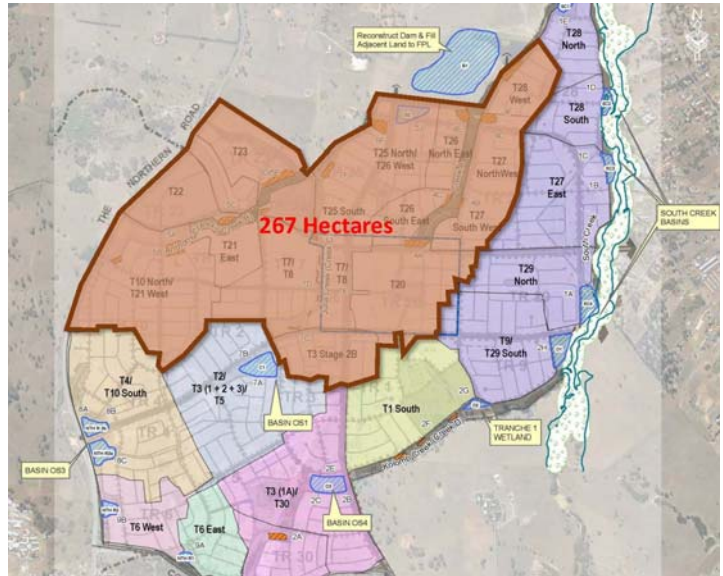


Figure 3: Oran Park drainage catchment to be detained in Pondicherry

Additional detail regarding the Stormwater Management Strategy is provided as part of the Calibre Consulting report included as Appendix 3.

4.1.3. FLOODING

Protection of future properties from flooding is a fundamental consideration of rezoning within the Growth Centre. Calibre Consulting has undertaken extensive consultation with the DPIE and Camden Council to confirm Pondicherry can achieve the required flood mitigation measures ensuring the downstream predevelopment flood levels are not aggravated as a result of development of Pondicherry and continued implementation of the Oran Park Stormwater Management Strategy.

Flood level difference mapping (afflux) is provided as part of the Calibre Consulting report provided as Appendix 3.

4.2. Urban Design Response

A thorough review of the design response options with respect to the above existing conditions has been undertaken by Design+Planning and is provided as Appendix 1, with a brief summary provided below. An assessment of the Lake system concept against the WM Act then follows.

4.2.1. OPTION 1 – ON-LINE WET BASIN (THE LAKE SYSTEM)

The proposed Lake system seeks to retain the existing farm dam waterbody in the environment, albeit in a modified form and which more appropriately connects with the urban context envisaged through the Growth Centre. The Lake system will provide the most efficient detention scheme, while also delivering biological diversity and a major place-making element and community feature.

The Lake Precinct will provide opportunity for the creation of a connected community. This is achieved through an efficient road layout which connects people where they want to go and through the co-location of complementary land uses including the local centre, district playing fields, a K-12 school and mixed-use development including community uses, commercial uses and higher density residential.

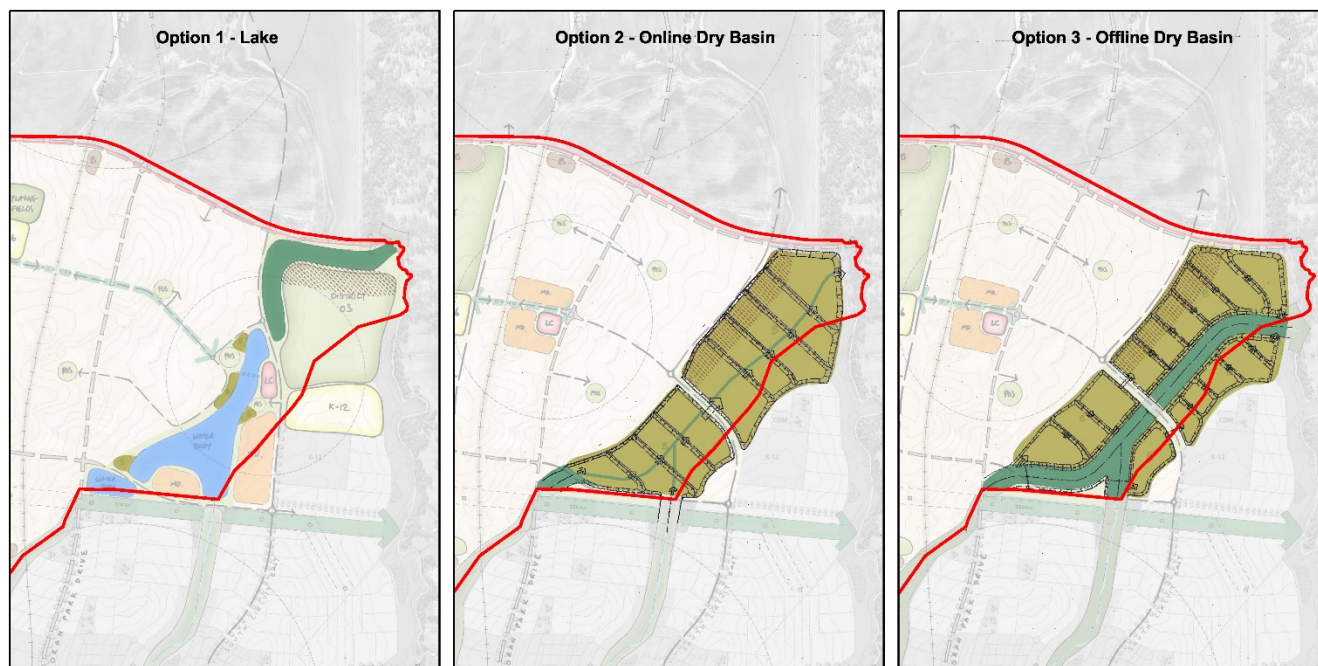
The Lake Precinct also facilitates the creation of meaningful connections to the surrounding creek network including South Creek to the east, Ron's Creek to the south and Anthony Creek to the west and the creation of a holistic Blue-Green grid. Through the delivery of a connected sharepath network this grid promotes alternate transport options of walking and cycling, along with community interaction and enjoyment.

4.2.2. OPTIONS 2 AND 3 – DRY BASIN OPTIONS

Options 2 and 3 are similar in that they promote a dry detention scheme, which would require removal of the existing farm dams and the notion of holding water in the environment. In order to achieve the required detention scheme both dry basin options require considerably more land area than the Lake system and would deliver an environment which creates little meaningful connection to the surrounding community. Further, the dry basin options provide limited biodiversity opportunities and Blue-Green grid connections with the surrounding creek systems and do not provide an opportunity for heat island offset due to the loss of water in the environment.

Due to the topography of the site, the dry basin options also require the relocation of the district playing fields limiting the co-location of significant land uses and activities including the Local Centre and K-12 school. Instead these community building elements would be displaced across the Precinct creating a disconnected urban outcome that discourages active transport options and generates additional unnecessary vehicular trips which are not generated by the Lake system option.

A visual description of the options is provided below.



Ecological Environment	Option 1 (Lake)	Option 2 (Online Dry Basin)	Option 3 (Offline Dry Basin)
Riparian Rehabilitation	6.2ha*	2.8ha*	12.7ha
Open Water	12.3ha	0ha	0ha
Dry Detention Basin	2.0ha	43.4ha	43.3ha
Total Drainage Land Area	20.5ha	46.2ha	56.0ha
Dwelling Yield (Approx.)	2,600	2,240	2,000

LEGEND

 Pondicherry Precinct Boundary

 Possible combined detention and Public Reserve

Note:

* Includes online detention.

* Low flow channel.

4.3. The Lake Precinct – Compliance with the Water Management Act 2000

The below tables provide an assessment of the proposed Lake Precinct against the Objects and Principles of the WM Act and is based on the reports comprising Appendices 1, 2 and 3.

	Clause	Comment
Clause 3 – OBJECTS		
(a)	to apply the principles of ecologically sustainable development, and	<p>Ecological sustainable development is a broad term employed across all aspects of urban design and planning. The Lake Precinct will effectively integrate economic, environmental and social considerations to provide for the needs of present generation without compromising the ability of future generations to meet their own needs.</p> <p>This will be undertaken in the context of the existing conditions including the online farm dams, the detention needs of the upstream Oran Park catchments and relevant government policies and directives. The existing farm dams will be transformed into an ecological asset promoting biological diversity while also fulfilling the detention requirements for the catchment, promoting social benefits of community use and enjoyment and generating economic benefits for the locality.</p>
(b)	to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and	<p>The ultimate aim of the proposed Lake Precinct is to restore what is presently a farm dam environment with poor aquatic habitat into a community asset which also promotes biological diversity.</p> <p>As demonstrated in this report The Lake Precinct will provide the greatest opportunity for promoting biological diversity and in so doing, protect, enhance and restore the waterbody for not only the associated dependant ecosystems and ecological processes but also the future community.</p>
(c)	to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including— (i) benefits to the environment, and (ii) benefits to urban communities, agriculture, fisheries, industry and recreation, and (iii) benefits to culture and heritage, and (iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,	<p>As demonstrated in this report the proposed Lake system will provide the optimum opportunity for creation of place and community building while also providing the greatest opportunity for environmental restoration and diversity of ecosystems. The coalescence of positive ecological outcomes in an urban context is in essence the pursuit of ecological sustainable development and will ultimately lead to positive social, economic and environmental outcomes.</p> <p>The opportunity for the Lake Precinct to provide positive recreational, cultural and heritage benefits for the future community are also far greater than with any of the other options analysed.</p>
(d)	to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,	Through Council, community will play an important role in the management of the Lake Precinct into the future. Through building positive relationships between community and the Lake Precinct a strong sense of place is established leading to a strong sense of community ownership and pride.
(e)	to provide for the orderly, efficient and equitable sharing of water from water sources,	Water sharing is not proposed as part of the Lake Precinct and Stormwater Management Strategy. If water extraction was to be proposed in the future, this would be subject to the required environmental assessments and regulatory requirements.
(f)	to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,	The rezoning process for Pondicherry will review and assess all matters of environmental significance including the land, its soil, its native vegetation and its native fauna with protection measures implemented where required as part of that process.
(g)	to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,	The Lake Precinct proposes a sustainable and efficient water management strategy including both detention and water quality treatment to protect the downstream creek system. Water use is not proposed and would be subject to the required environmental assessments and regulatory requirements if proposed in the future.
(h)	to encourage best practice in the management and use of water.	The Lake Precinct proposes an online detention system with all water quality being conducted offline prior to discharge into the waterbody. This mirrors the normal water cycle management process required through the Growth Centres DCP and Council policies and ensures the water is treated and cleaned prior to discharge into the online system.

	Clause	Comment
Clause 5 – WATER MANAGEMENT PRINCIPLES		
(1)	The principles set out in this section are the water management principles of this Act.	
(2)	<p>Generally —</p> <ul style="list-style-type: none"> (a) water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and (b) habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and (c) the water quality of all water sources should be protected and, wherever possible, enhanced, and (d) the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and (e) geographical and other features of Aboriginal significance should be protected, and (f) geographical and other features of major cultural, heritage or spiritual significance should be protected, and (g) the social and economic benefits to the community should be maximised, and (h) the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements. 	<ul style="list-style-type: none"> (a) This principle relates primarily to the protection of existing values. The existing farm dams are of little ecological or biodiversity benefit. The Lake system will instead rehabilitate the existing dams to a biologically diverse environment through delivery of open water bodies, wetlands and riparian rehabilitation, providing habitat for terrestrial, marine and other aquatic ecosystems. (b) This principle relates primarily to the protection of existing values. The proposed Lake system seeks to retain the existing farm dam waterbody in the environment, albeit in a modified form and which more appropriately connects with the urban context. The Lake system provides the most efficient detention scheme, while also delivering habitat restoration and biological diversity and thereby significantly improving the overall health of the ecosystem. (c) This principle relates primarily to the protection of existing values. The ultimate aim of the Lake system is to restore what is presently a farm dam environment of low aquatic habitat into a community asset which promotes biological diversity. This will protect and enhance the existing water source for the enjoyment of the future community. (d) Any license proposed in the future, would be subject to the required environmental assessments and regulatory requirements. (e) An Aboriginal assessment has been undertaken as part of the wider Pondicherry rezoning, with protection measures to be implemented as needed subject to that process. (f) The rezoning process for Pondicherry will review and assess all geographical and other features of major cultural, heritage or spiritual significance with protection measures implemented where required as part of that process. (g) As detailed in this report, the social and economic benefits of the community will be maximised through delivery of the Lake Precinct. This is particularly the case in the context of the stormwater detention requirements and comparison with the other options analysed. The Lake Precinct will provide a significant community focal point facilitating the co-location of land uses and promoting community interaction and enjoyment. (h) The delivery of a Lake Precinct will provide opportunity to monitor the asset over time to provide insight into the success and identify changes to management regimes as needed.
(3)	<p>In relation to water sharing —</p> <ul style="list-style-type: none"> (a) sharing of water from a water source must protect the water source and its dependent ecosystems, and (b) sharing of water from a water source must protect basic landholder rights, and (c) sharing or extraction of water under any other right must not prejudice the principles set out in paragraphs (a) and (b). 	Water sharing is not proposed as part of the Lake Precinct and Stormwater Management Strategy. If water extraction was to be proposed in the future, this would be subject to the required environmental assessments and regulatory requirements.
(4)	<p>In relation to water use —</p> <ul style="list-style-type: none"> (a) water use should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and (b) water use should be consistent with the maintenance of productivity of land in the long term and should maximise the social and economic benefits to the community, and (c) the impacts of water use on other water users should be avoided or minimised. 	<p>Water use is not proposed as part of the Lake Precinct and Stormwater Management Strategy.</p> <p>The strategy includes an online Lake system with a controlled outlet facilitating the required detention, while also allowing stormwater flows to South Creek which do not exceed the pre-development rates.</p> <p>If water use was to be proposed in the future, such as irrigation of public reserves by Council, this would be subject to the required environmental assessments and regulatory requirements.</p>

(5)	<p>In relation to drainage management —</p> <p>(a) drainage activities should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and</p> <p>(b) the impacts of drainage activities on other water users should be avoided or minimised.</p>	<p>Calibre Consulting has been engaged to undertake the required drainage management modelling to inform the Lake Precinct design and detention requirements. Calibre are highly skilled and experienced in this field having produced the Oran Park Stormwater Management Strategy (2007) (then trading as Brown Consulting) and continuing to be the consulting Stormwater and Civil Engineer on the Oran Park project.</p> <p>The drainage strategy employed as part of the Lake Precinct will include detention volume above the permanent water level of the proposed lakes, the outflow will be controlled through weirs and culverts to ensure that the pre-development flow rate is achieved. The permanent water level has a number of advantages including reducing the footprint required for detention volumes. The permanent water provides a flat level surface, allowing the detention volume to be applied over the whole Lake area. By allowing a detention depth of up to 1m, the Lake system option will allow the detention storage footprint to reduce to approximately 20.5 ha. The total footprint can be made up of 13 -14ha within open water bodies, with additional detention storage included within a formed riparian corridor to the north.</p> <p>This system will minimise the land degradation currently experienced on site and will rehabilitate the existing dams to a biologically diverse environment including through the delivery of open water bodies, wetlands and riparian rehabilitation and the resultant terrestrial, marine and other aquatic ecosystems.</p> <p>The provision of a controlled outlet to the Lake system also ensures water is not held in the environment in the way the existing farm dams operate. Instead the controlled outlet will allow low flows to continue entering South Creek at a rate which does not exceed the pre-development scenario.</p>
(6)	<p>In relation to floodplain management —</p> <p>(a) floodplain management must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and</p> <p>(b) the impacts of flood works on other water users should be avoided or minimised, and</p> <p>(c) the existing and future risk to human life and property arising from occupation of floodplains must be minimised.</p>	<p>As part of the Governments rezoning of Oran Park, the existing farm dams were identified for detention within the overall Water Cycle Management Strategy (2007) of the Precinct. Floodplain Management is therefore inherent in the proposal.</p> <p>The Lake Precinct is promoted as the most ecologically sustainable development outcome for fulfilling the detention requirements, while also delivering the most biological diversity within the future environment, including through the delivery of open water bodies, wetlands and riparian rehabilitation and the resultant terrestrial, marine and other aquatic ecosystems.</p>
(7)	<p>In relation to controlled activities —</p> <p>(a) the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and</p> <p>(b) the impacts of the carrying out of controlled activities on other water users must be avoided or minimised.</p>	<p>The proposed Lake Precinct seeks to replace the existing farm dam environment with limited aquatic habitat with a community asset which promotes biological diversity.</p> <p>Whilst some disturbance of the existing environment is expected during construction, the existing environment is already in a degraded form with little biodiversity benefit.</p>
(8)	<p>In relation to aquifer interference activities —</p> <p>(a) the carrying out of aquifer interference activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and</p> <p>(b) the impacts of the carrying out of aquifer interference activities on other water users must be avoided or minimised.</p>	<p>The proposed Lake Precinct will replace existing farm dams on site and will not constitute aquifer interference activities.</p>

5. SUMMARY AND CONCLUSION

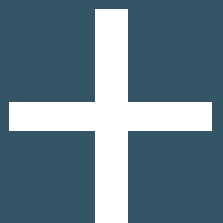
This report has been prepared to provide a merit assessment of the Lake system concept proposed within the Pondicherry Precinct of the South West Growth Area. This merit assessment is provided to NRAR as the custodians of the WM Act which seeks to *manage NSW water in a sustainable and integrated manner that will benefit both present and future generations.*

This report has been prepared with assistance from Eco Logical Australia and Calibre Consulting and concludes that the Lake system concept can fully comply with the Objects and Principals of the WM Act, through the provision of an ecological sustainable development which also provides the optimum urban outcome to the benefit of the future community.

This report is provided to NRAR as part of the background studies to the Precinct Planning for Pondicherry, with concurrence required in order to inform the Precinct Planning process and ensure the development outcome envisaged through the Pondicherry rezoning can ultimately be delivered.



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APPENDIX 1

Pondicherry Water Management Options – Urban Design Analysis
Design+Planning



PONDICHERRY WATER MANAGEMENT OPTIONS URBAN DESIGN ANALYSIS

Prepared for
Department of Planning Industry and Environment

February 2020



1. Introduction	2
2. Context	3
3. Existing Conditions	4
4. Water Management	5
5. Urban Design Principles & Options Analysis	6
6. Preferred Option	12

1. Introduction

Located in the South West Growth Area (SWGA) and forming part of the suburb of Oran Park, the Pondicherry Precinct (the Precinct) will be home to over 8,000 people living within a master planned community of varying housing types. Pondicherry will deliver a high-quality urban environment following in the footsteps of Oran Park Town and the principles of community pride, well-being, healthy living and educational excellence. Pondicherry will incorporate a series of thoughtfully planned villages with high local amenity and quality connections to the job opportunities, community and recreational facilities afforded within Oran Park Town and the future Major Centre to the north.

This Report has been prepared to assess water management options that have been prepared for the Pondicherry Precinct, with a focus on ensuring that the vision for the Precinct is achieved, as well as the NSW Government's aspirations for the South Creek Blue and Green Grid and a place based urban design approach. Three options have been reviewed to manage stormwater and flood event flows, each of which present their own opportunities and constraints. The three options considered in this report are:

- Option 1: Online Wet Basin
- Option 2: Online Dry Basin
- Option 3: Offline Dry Basin

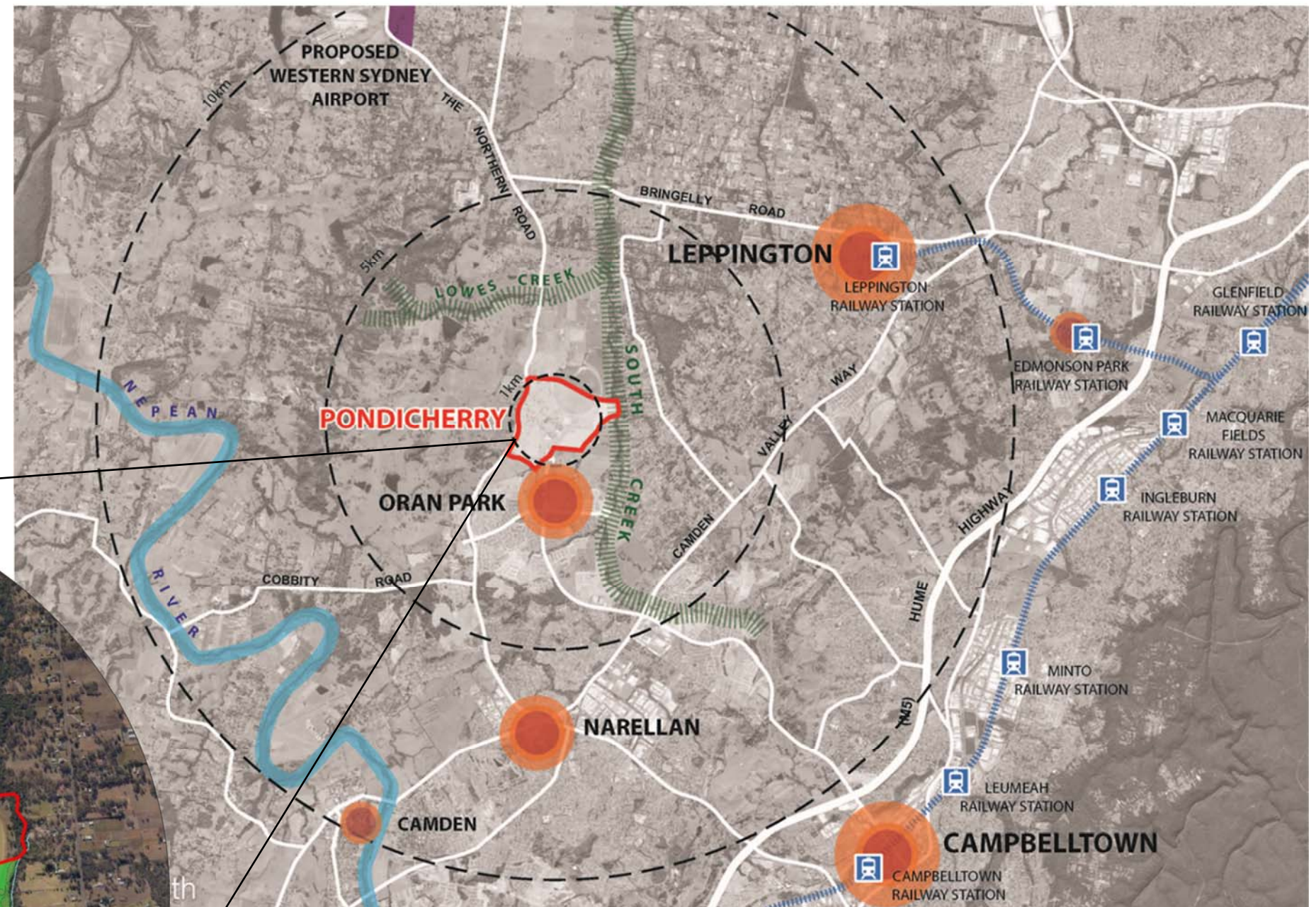
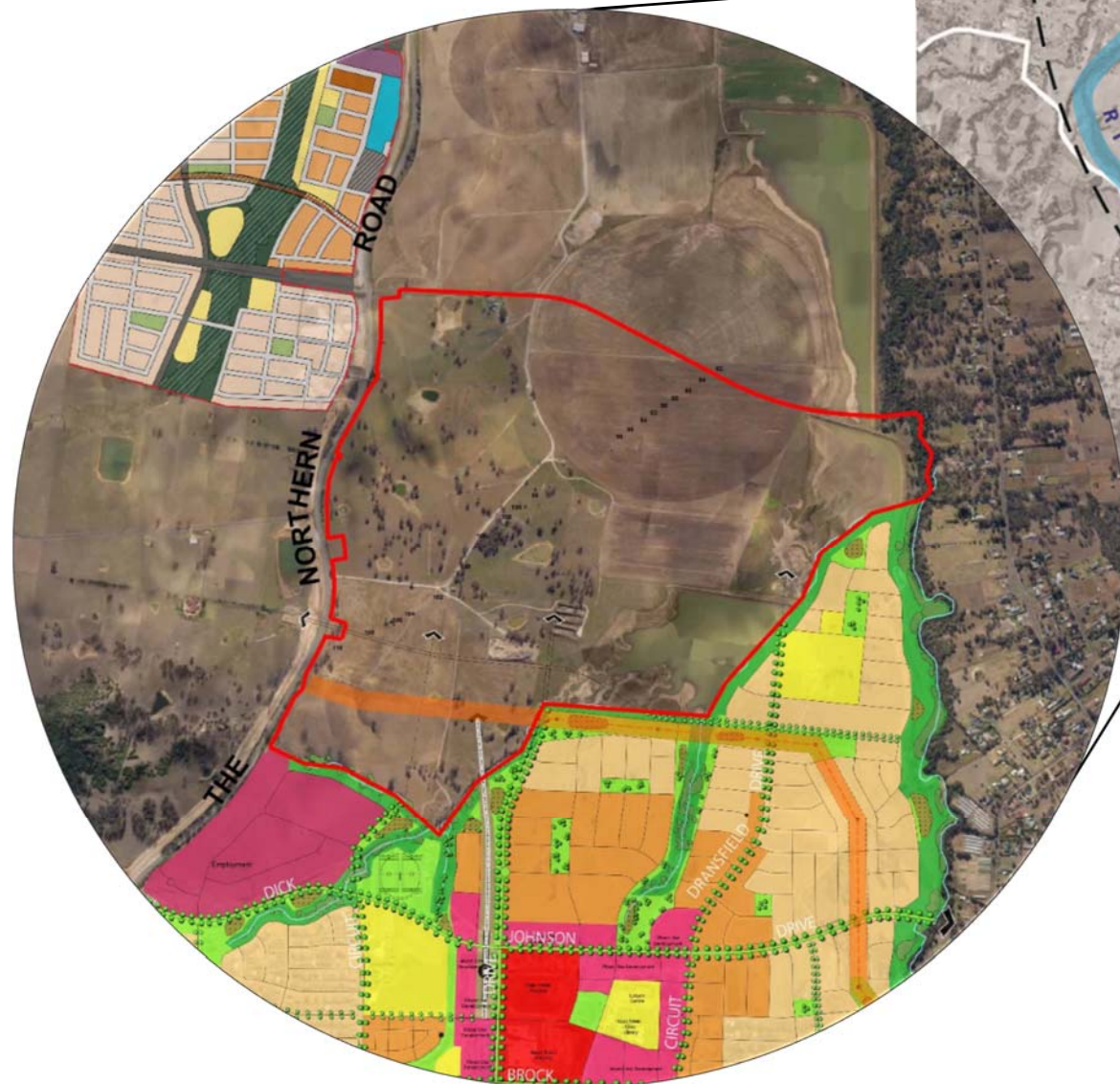
Each of the options have been designed to meet the water management requirements of the Precinct, as well as the requirements of the Oran Park Precinct. In this regard, it must be noted that the existing southern dam of the Precinct forms part of the existing water management strategy for the Oran Park Precinct. Furthermore, each of the options will require the installation of engineered weir structures, and in some instances, multiple structures to manage flows.

The assessment undertaken in Section 5 determines that The online wet basin identified in Option 1 best achieves the urban design principles and Government aspirations for a cool, green and connected Precinct, while achieving compliance with the Objects and Principle of the Water Management Act 2000.

2. Context

Pondicherry is located directly north of Oran Park Town and the Oran Park Town Centre. Its proximity to the future Oran Park Town Centre Train Station, together with strategic road network connections, particularly The Northern Road, will enable direct and convenient access to the Western Sydney Aerotropolis (WSA) and the Western Sydney International (Nancy-Bird Walton) Airport (the Airport). The broader strategic road network and future rail expansion will benefit Pondicherry, ensuring that the future residents of the Precinct will have access to employment, entertainment and leisure opportunities of the broader Western and Eastern Sydney area.

The Precinct encompasses strong Blue and Green Grid Links with direct connection to Rons Creek providing links to the Oran Park Town Centre and South Creek north to the WSA. Extension and expansion of the Blue and Green Grid from the Oran Park Town Centre will facilitate pedestrian and cycle links along the creek network and provide active transport alternatives for residents in the region.



3. Existing Conditions

Pondicherry is an actively farmed site, currently being used for dairy, grazing and crop production with several rural works dwellings present. The Precinct is predominantly cleared, with scattered vegetation and open pastures. The existing site is typical of the surrounding land uses to the north, east and west which includes several soil mix businesses, market gardening and poultry activities.

The site is characterised by a central ridgeline running from the western side of The Northern Road in a south-east / north-west direction. The ridge is at its highest in the south-west corner of the Precinct adjoining The Northern Road. The ridge includes steeper slopes to the eastern side with flatter land located in the north-west corner and forming existing farm dams along the eastern boundary adjacent South Creek.

The Precinct sits wholly within the South Creek catchment, with the eastern perimeter including a small length of South Creek classified as a 4th Order Stream (Strahler System). The entire boundary adjoining the Oran Park Precinct includes a tributary of South Creek, with the majority of this being classified as a 3rd Order Stream. This tributary has been modified at the eastern end to form two farm dams. The dams are utilised as part of the existing farming operations for both livestock and crop irrigation. The southern farm dam also contributes to the provision of stormwater detention for the Oran Park Precinct (135,500m³). The site also includes a 2nd Order Stream at the south-west portion of the site, with several 1st Order Streams recommended for removal.



5. Urban Design Principles & Options Analysis

The assessment of the options undertaken in this report have been based on a suite of urban design principles, detailed below,

- Co-locate land uses and activities to promote the efficient use of land and delivers a liveable, productive and sustainable Precinct.
- Establish an urban structure and identity with a defining spatial element that strengthens the Blue and Green Grid links to South Creek.
- Establish a logical and legible road and transport network the promotes links to existing and future centres and activity nodes.
- Deliver an integrated approach to water management and waterway health that also creates a focal point for the enjoyment of the community.

The urban design principles seek to ensure the vision for the Pondicherry Precinct is achieved, as well as meeting the overarching principles and objectives of the Water Management Act 2000, Western Parklands City District Plan and Draft Camden Local Strategic Planning Statement.



5.1. Option 1: Online Wet Basin

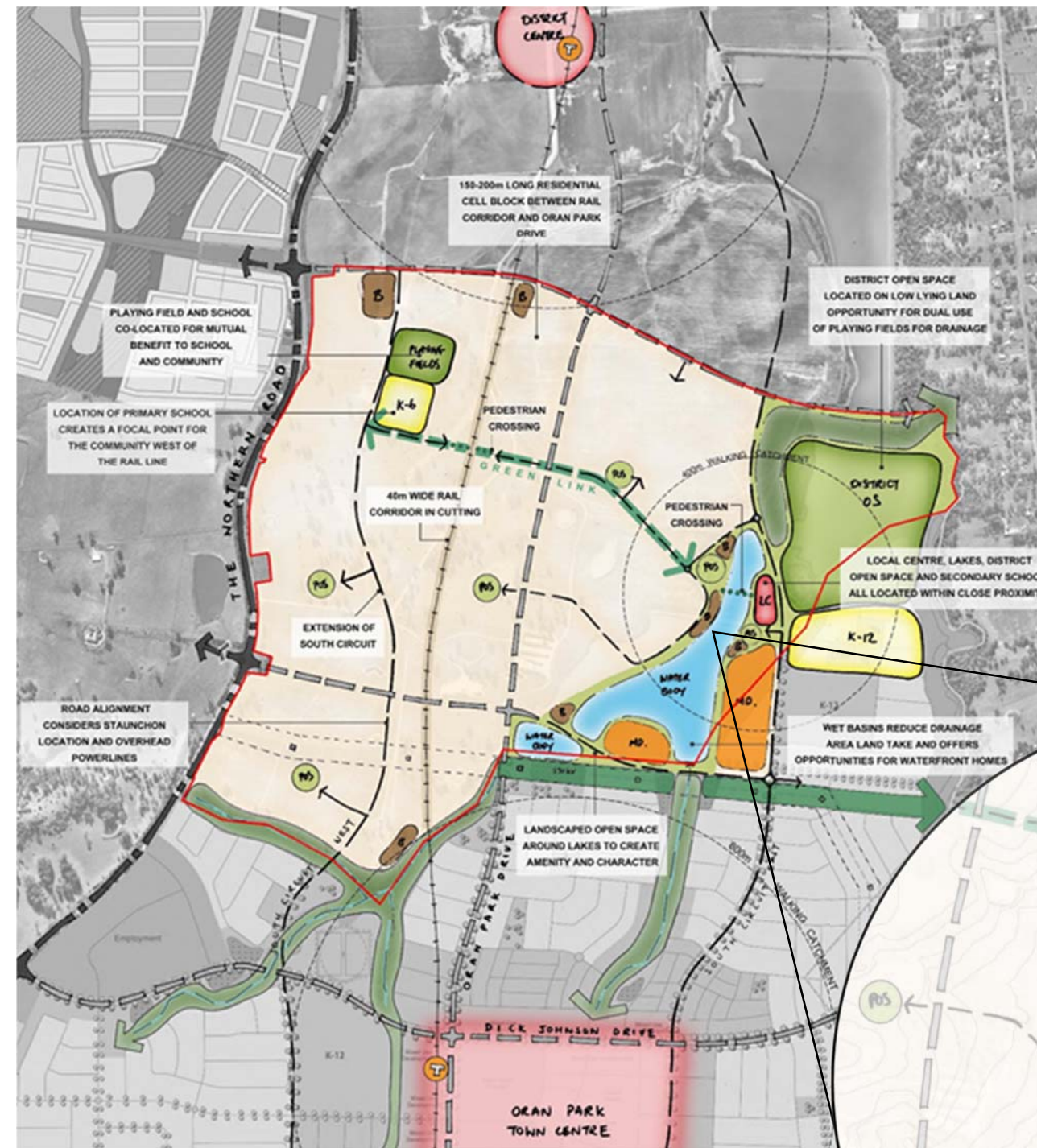
Option 1 is an online wet basin that utilises the existing, albeit to be reconfigured, farm dam on the south-east of the Precinct. An online wet basin would enable the existing stormwater strategy to be accommodated within the reconfigured dam. The detention strategy for Option 1 creates a Lake system that utilises a 12.3-hectare water body (reconfiguration of the existing dam), integrated with rain gardens for water quality purposes and a vegetated riparian corridor with additional online detention and weir to manage major flows. This detention strategy is the most efficient of the three options explored, totalling 21 hectares.

Importantly, the creation of a water feature would create a major place-making element in the urban environment. While the hydrologic function of the waterbody is an important aspect of this option, the amenity and place-making opportunities that a waterbody affords cannot be understated.

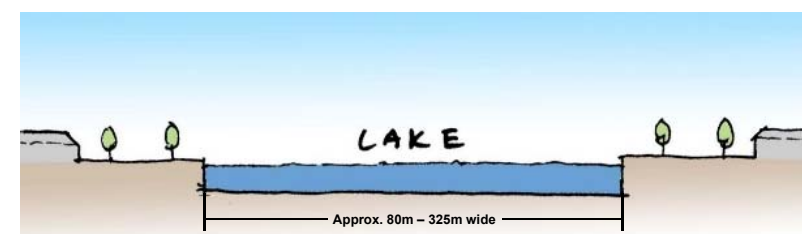
As illustrated in the Wet Basin Concept Structure Plan, a Lake system creates social and economic opportunities through the establishment of an urban hub, where multiple land uses, and activities are co-located. The co-location of higher density housing, district playing fields, school and local centre not only promotes a more efficient use of land, but also creates a highly functional and connected focal point for the community.

The use of the existing dam also enables a more logical and legible road network that promotes strong north-south and east-west connectivity, including to Oran Park Town Centre to the south and land to the north. There is the opportunity to provide a transport network that integrates traditional modes of transport, with active pedestrian and bicycle transport alternatives. This is achieved through the extension of creek lines south to Oran Park, particularly Ron's Creek, providing a direct Blue and Green link from the lake and associated uses to the Oran Park Town Centre. The design also provides Blue and Green connectivity to South Creek and ultimately the WSA, which maintains the State Government's desire to establish South Creek as a focal point for an integrated open space and pedestrian/cycle link.

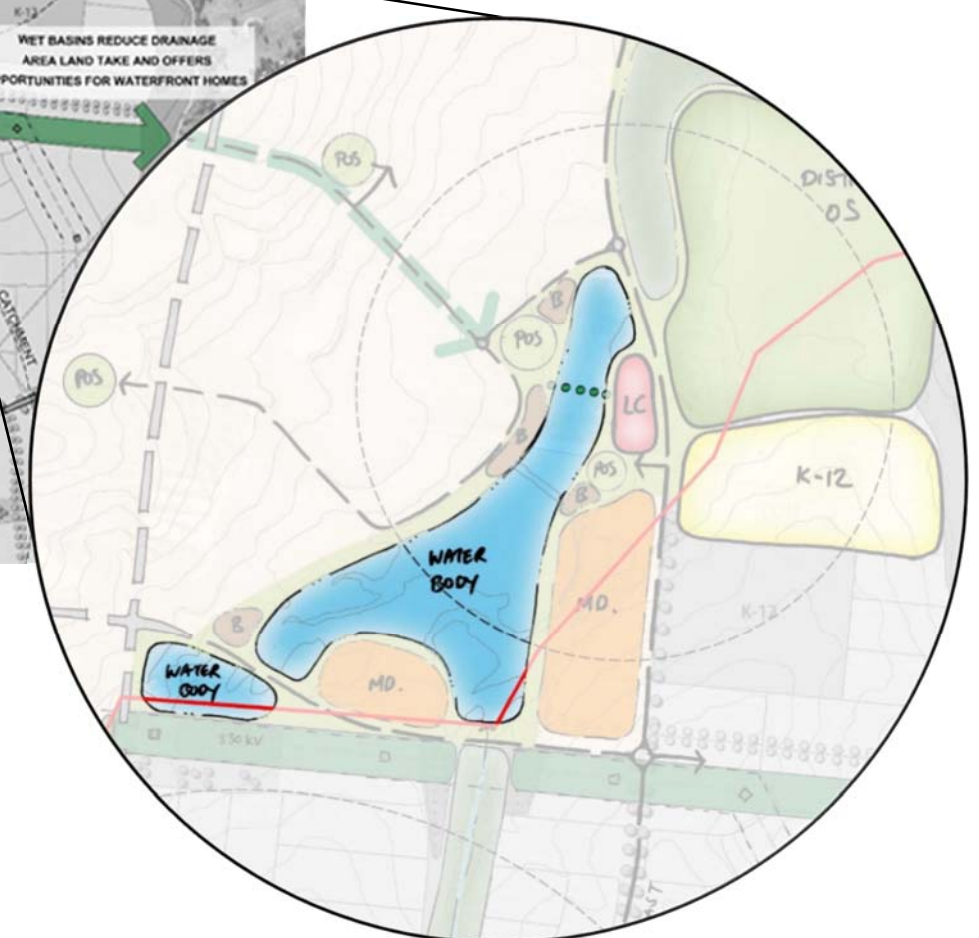
The urbanisation of the Precinct will bring with it impervious surfaces that absorb heat and create urban heat islands. While tree canopy will be maximised to help reduce the effects of urban heat islands, the retention of a Lake system, incorporating a large water body, can help offset the effects of urban heat islands. Furthermore, there is an opportunity to improve the water quality of the existing water body through the Lake system to establish an environment that can support a diversity of aquatic life including both flora and fauna.



Concept Structure Plan – Online Wet Basin



Cross Section – Online Wet Basin



5.2. Option 2: Online Dry Basin

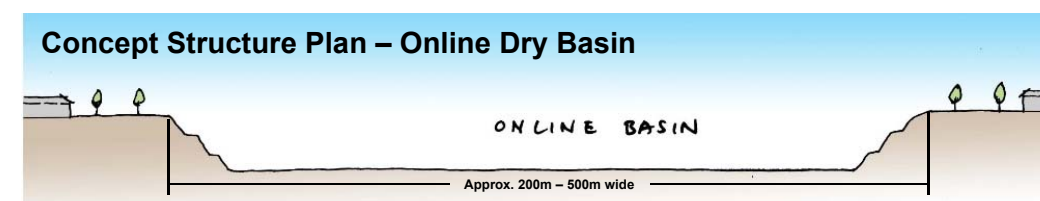
Option 2 is an online dry basin that would require the reforming of the existing large dams within the Precinct. An online dry basin would require a significant amendment to the current stormwater strategy of holding water in existing farm dams. The detention strategy for Option 2 employs a series of cascading online dry detention basins, each with their own outlet and weir structure to manage major flows, totalling an area of 46 hectares. As noted in Calibre's report the reason for the additional detention area required by this option relative to the Wet Basin (totalling approximately 26ha) is due to the fall required to drain a dry detention basin thereby losing detention capacity. A further constraint this option creates is the need for additional fill on the balance of the Precinct to enable the basin to operate optimally. This is due to the Pondicherry Catchment needing to drain into the dry basin, which was not contemplated by the *Oran Park Master Plan Stormwater Strategy*.

Unlike Option 1, an online dry basin does not provide a meaningful place-making opportunity. It instead creates a poor urban interface with South Creek and the surrounding residential areas. Furthermore, it limits the co-location of land uses and activities, with the local centre removed from major land use activities, such as the district playing fields and school, rather than an integral ingredient to a cohesive community outcome and special urban place for residents. This creates a disconnected urban outcome, that discourages active transport options and potentially generates additional, unnecessary vehicular trips.

The dry basins will be vegetated appropriately to enable water quality treatment to occur. However, there is a potential that the vegetation can create a bushfire protection constraint to nearby houses. The vegetation will need to be maintained on a regular basis to ensure that flow rates during storm events can be achieved. To facilitate ongoing management of the vegetation, access tracks for Council maintenance vehicles will also need to be provided.

The introduction of online dry basis compromises the creation of a strong north-south road network. While access through the basins is possible, roads will need to be limited to ensure the functionality of the basins. Direct road access to the Oran Park Town Centre will be limited to the extension of Oran Park Drive, with the creation of a meaningful active transport link between the Pondicherry Local Centre and the future Train Station at Oran Park jeopardised with no ability to leverage off the riparian corridor network. Connectivity to the north-south Blue and Green link along South Creek will also be difficult to achieve as the basins create a significant disconnect between the Precinct and South Creek.

Due to the topography of the site, this option also requires the relocation of the district playing fields limiting the co-location of significant land uses and activities including the Local Centre and K-12 school and instead displacing them across the Precinct.



Cross Section – Online Dry Basin



5.3. Option 3: Offline Dry Basin

Option 3 is an offline dry basin that would, like Option 2, require the reforming of the existing large dams within the Precinct. Like the online basin in Option 2, Option 3 employs a series of cascading dry detention basins. However, the key difference of Option 3 is that it proposes the reinstatement of Anthony Creek and Rons Creek, necessitating the introduction of multiple engineered weir structures to divert existing stormwater drainage within the creeks to the basins. Together with the dry basins, Option 3 represents, by far, the most inefficient option, with the basins and riparian corridor totalling an area of 56 hectares. Like Option 2, Option 3 also creates the need for additional fill on the balance of the Precinct to enable the basins to create fall and operate optimally.

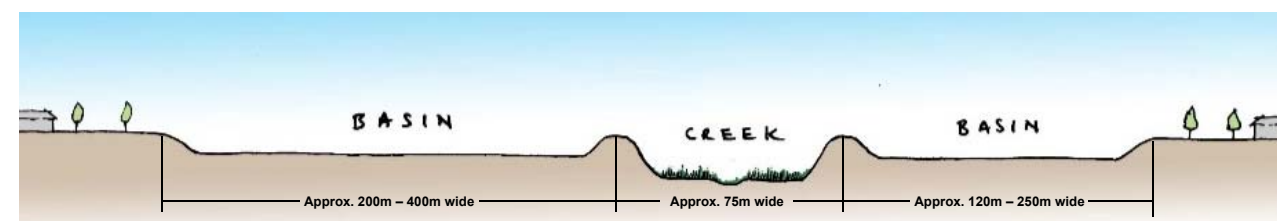
While achieving somewhat of an opportunity for a creek environment, it is an extremely poor urban and overall environmental outcome as it will be highly engineered. It will also be an area that will be hard to access, fire prone and create a poor urban interface, limiting any benefit a creek environment may create.

Much like Option 2, an offline dry basin does not provide a meaningful place-making opportunity. It instead creates a weak urban interface with South Creek and the surrounding residential areas. Furthermore, it limits the co-location of land uses and activities, with the local centre removed from major land use activities, such as the district playing fields and school, rather than an integral ingredient to a cohesive community outcome and special urban place for residents. This creates a disconnected urban outcome, that discourages active transport options and potentially generates additional, unnecessary vehicular trips.

The introduction of offline dry basis compromises the creation of a strong north-south road network. While access through the basins is possible, roads will need to be limited to ensure the functionality of the basins and riparian corridor. Direct road access to the Oran Park Town Centre will be limited to the extension of Oran Park Drive. However, the creation of a meaningful active transport link between the Pondicherry Local Centre and the future Train Station at Oran Park will be jeopardised with no ability to leverage off the riparian corridor network.



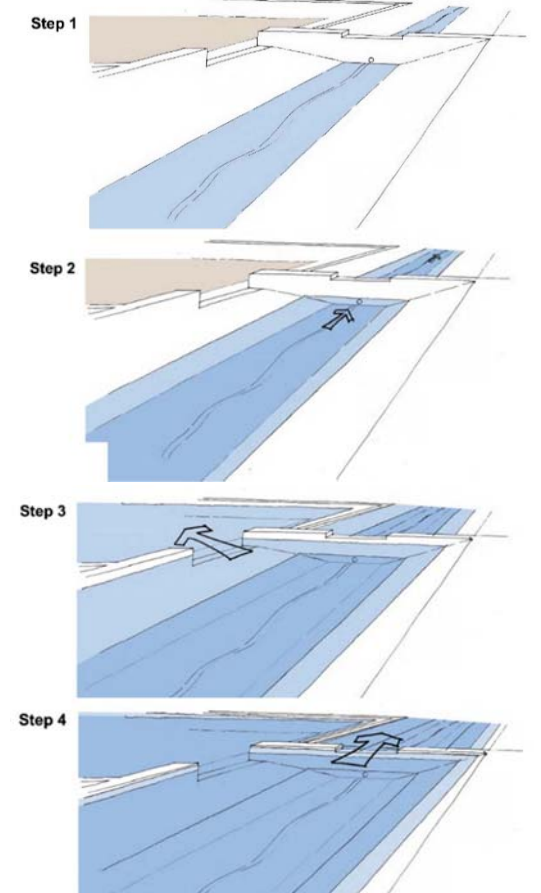
Concept Structure Plan – Online Dry Basin



Cross Section – Offline Dry Basin

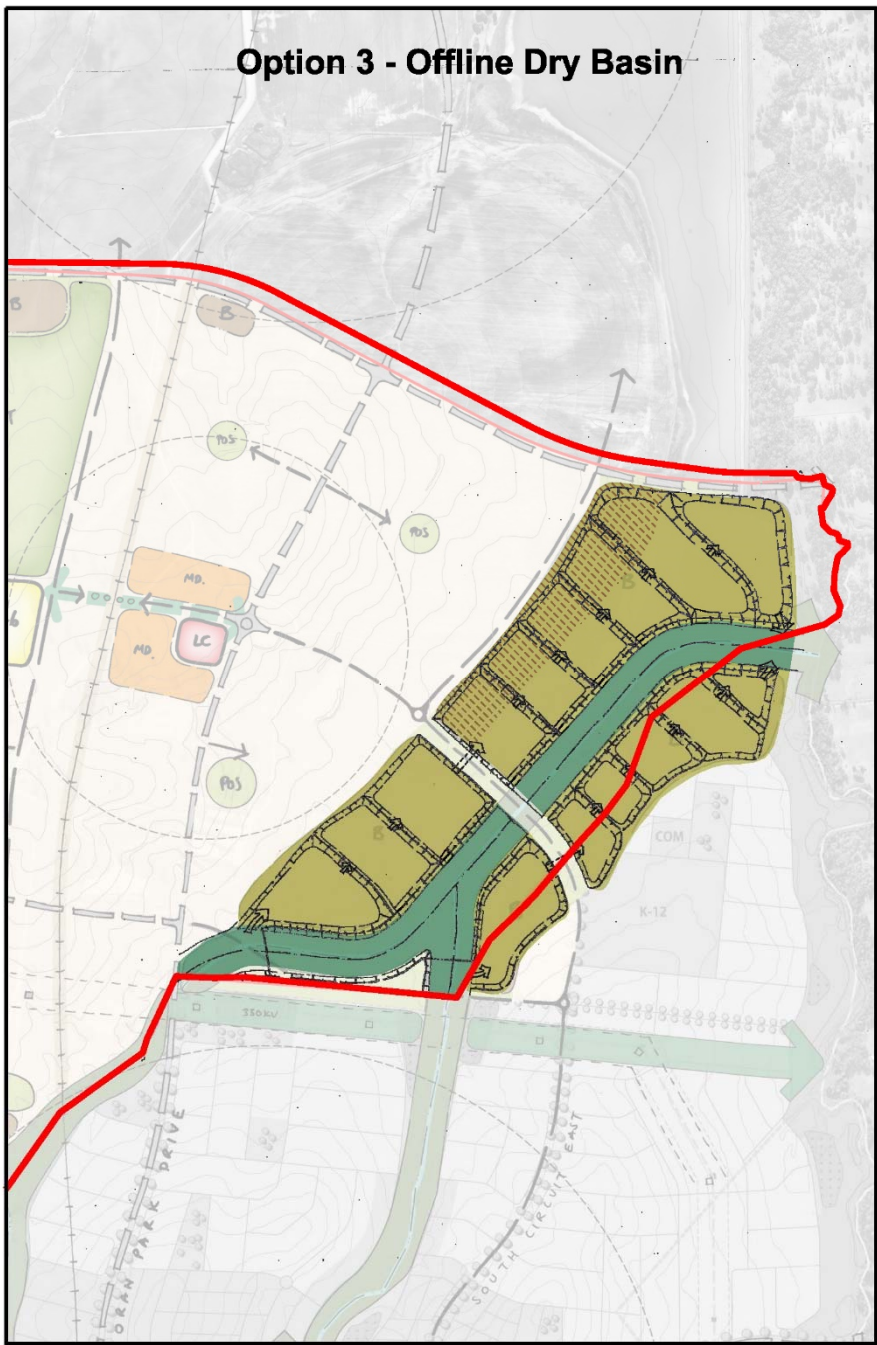
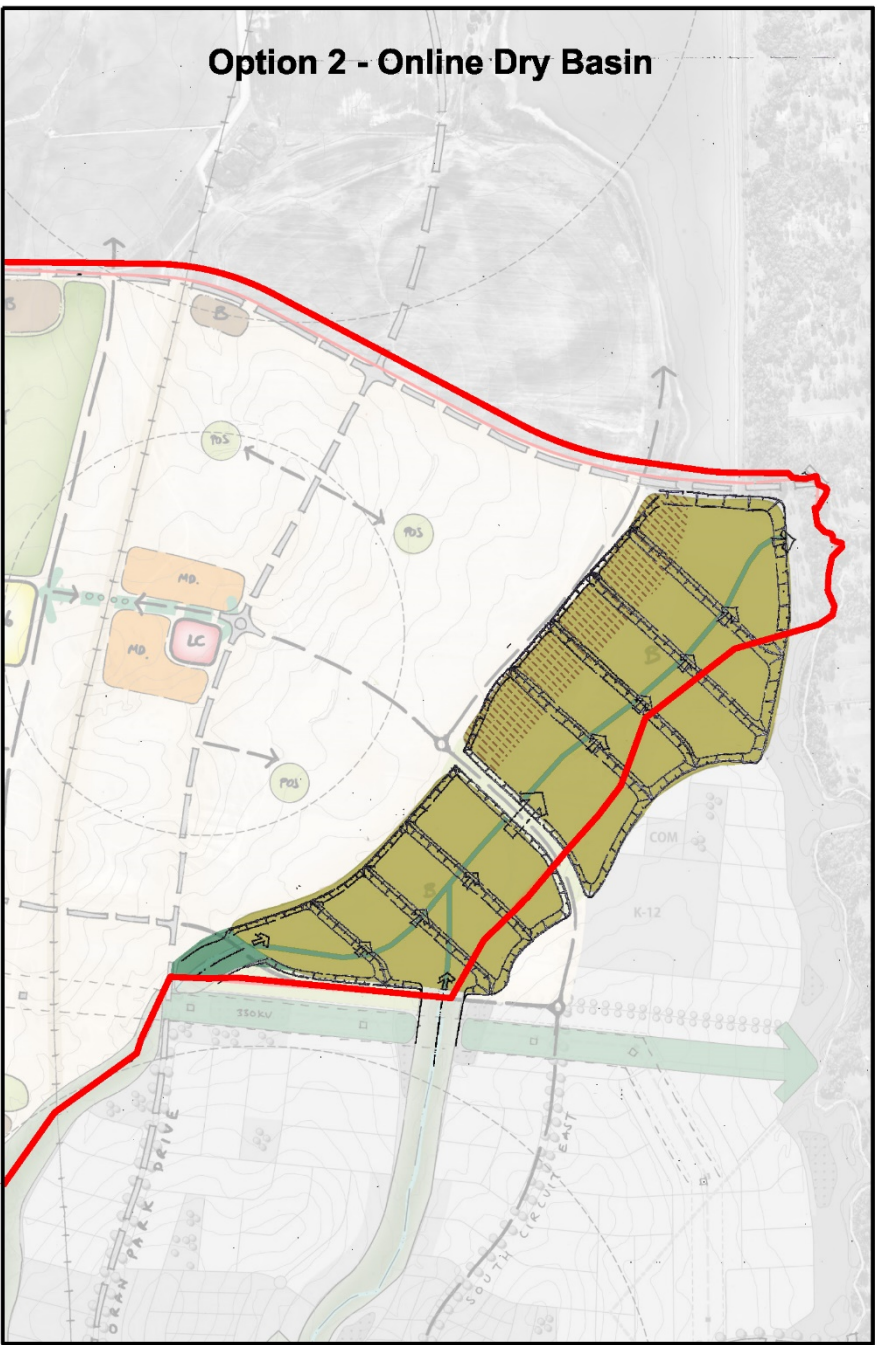
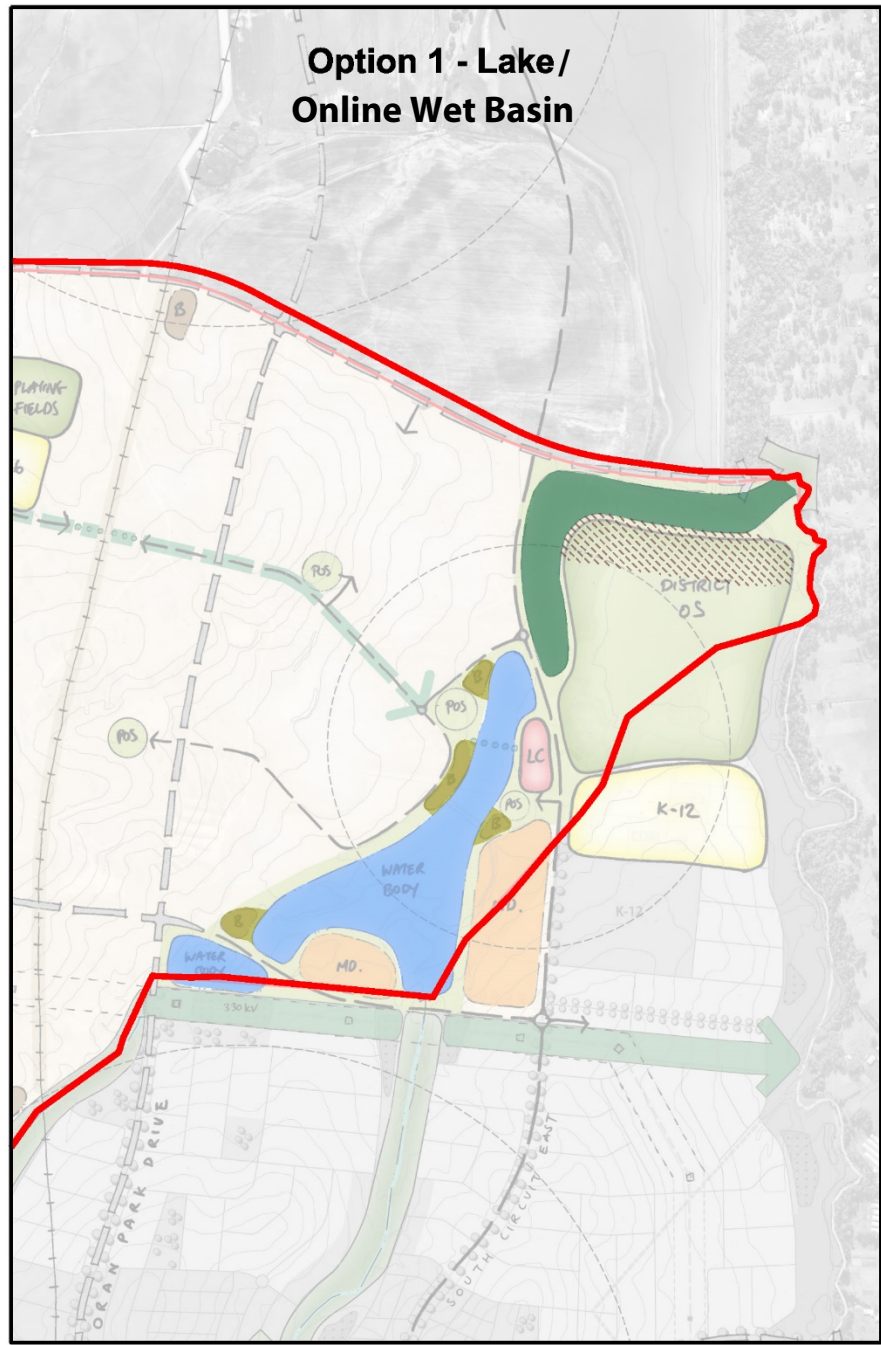


Weir Structure Operation



5.4. Option Comparison

Each of the options, illustrated below, have been analysed, with their respective positive and negatives identified on page 11.



Ecological Environment	Option 1 (Lake)	Option 2 (Online Dry Basin)	Option 3 (Offline Dry Basin)
Riparian Rehabilitation	6.2ha [^]	2.8ha ⁺	12.7ha
Open Water	12.3ha	0ha	0ha
Dry Detention Basin	2.0ha	43.4ha	43.3ha
Total Drainage Land Area	20.5ha	46.2ha	56.0ha
Dwelling Yield (Approx.)	2,600	2,240	2,000

LEGEND
Pondicherry Precinct Boundary
Possible combined detention and Public Reserve
Note:
[^] Includes online detention.
⁺ Low flow channel.

Option 1: Online Wet Basin

Open Water	Dry Detention Basin	Riparian Corridor	Total Area	Yield
12.3ha	2ha	6.2ha	20.5ha	2,600

Positives

- The water body will retain the existing water of the farm dams in the environment albeit in a modified form.
- A water body creates a major place-making element in the urban environment.
- Establishment of a more typical riparian corridor downstream from the lake feature will assist in creation of a Blue-Green Grid link between South Creek, the Pondicherry Local Centre and Oran Park Town Centre beyond.
- A water body would require the smallest footprint for detention and water management.
- An urban hub will be meaningfully integrated with the water feature.
- Incorporation of a water body fosters a logical road network.
- The water body helps with heat island relief.
- A meaningful Blue-Green grid interface with South Creek can be created.
- No need to divert water out of streams for detention.
- The water body and riparian corridor will enable a greater variety of aquatic and land-based flora and fauna to establish.

Negatives

- Does not meet NRAR Guidelines and requires a merit assessment.

Option 2: Online Dry Basin

Open Water	Dry Detention Basin	Riparian Corridor	Total Area	Yield
0ha	43.4ha	2.8ha	46.2ha	2,240

Positives

- Fulfills the water quality and detention requirements of the development.
- The design introduces a low flow channel and controlled outlet providing increased environmental flows to South Creek relative to the existing farm dams.

Negatives

- An online dry basin creates a limited placemaking opportunity with poor urban interface to South Creek and the broader community.
- An online dry basin would require a large land footprint resulting in a reduction in yield which is out of keeping with the principle imperative of the Growth Centre.
- Aesthetically an online dry basin does not provide strong amenity for the urban area and creates a greater opportunity for weed infestation.
- The tiered detention basins will require multiple access tracks for Council maintenance vehicles.
- Vegetation of the basins creates potential bushfire issues.
- The district playing fields, K-12 school and local centre are dislocated within the urban framework.
- The road network and opportunity for active transport options is compromised due to basin size and configuration.
- The opportunity for maximising heat island offsets is minimised
- The establishment of a meaningful urban Blue-Green Grid interface along South Creek is jeopardised.
- Does not meet the NRAR Guidelines and requires a merit assessment.

Option 3: Offline Dry Basin

Open Water	Dry Detention Basin	Riparian Corridor	Total Area	Yield
0ha	43.3ha	12.7ha	56.0ha	2,000

Positives

- Fulfills the water quality and detention requirements of the development.
- Reinstates the 3rd Order riparian corridor connecting to South Creek albeit with significant engineered weir structures within the corridor to divert water out of the creek system for detention requirements.
- The design introduces a low flow channel and controlled outlet providing increased environmental flows to South Creek relative to the existing farm dams.

Negatives

- An offline dry basin creates a limited placemaking opportunity with poor urban interface to South Creek and the broader community.
- An offline dry basin would require a large land footprint resulting in a reduction in yield which is out of keeping with the principle imperative of the Growth Centre.
- Aesthetically an offline dry basin does not provide strong amenity for the urban area and creates a greater opportunity for weed infestation.
- The tiered detention basins will require multiple access tracks for Council maintenance vehicles.
- Vegetation of the basins creates potential bushfire issues.
- The district playing fields, K-12 school and local centre are dislocated within the urban framework.
- The road network and opportunity for active transport options is compromised due to basin size and configuration.
- The opportunity for maximising heat island offsets is minimised
- The establishment of a meaningful urban Blue-Green Grid interface along South Creek is jeopardised.
- Significant in stream weir structures are required to divert water out of the creek system for detention requirements.
- Does not meet the NRAR Guidelines and requires a merit assessment.

6. Preferred Option

Based on the analysis of each of the Water Management Options identified above, the preferred option is the online wet basin of Option 1. While Options 2 and 3 can meet the water management needs for Oran Park and Pondicherry, only the Lake system of Option 1 provides the opportunity to create a strong place making element while also creating an environmental benefit through the promotion of biological diversity.

A water body integrated into the urban environment generates a number of direct and indirect benefits, including:

- Creation of a focal point that can be enjoyed by the broader community.
- Co-location of uses and activities, which creates an economic benefit to the community.
- Strengthening of Blue and Green Grid linkages between South Creek, the Local Centre and the Oran Park Town Centre and future Train Station.
- Establishment of a network of open space around the water body that serves a broader range of the community in one location.
- Creation of a walking and cycling friendly environment around the water body that encourages the use of alternate modes of transport across the Precinct and beyond.
- Provision of an environment that can support aquatic and land-based flora and fauna and enable the opportunity for education of the community that fosters ownership of the natural environment.
- Facilitation of a broad range of land uses and housing typologies with a high degree of amenity including mixed use development, low, medium and high density residential.
- An efficient use of land that also meets the water management needs of the Precinct.

As demonstrated in Section 5, the Lake system identified in Option 1 best achieves the urban design principles identified in this document, as well as the objectives and principles of the Western Parklands City District Plan and the Draft Camden Local Strategic Planning Statement. Furthermore, Option 1 broadly achieves the Objects and Principle of the Water Management Act 2000.





APPENDIX 2

Pondicherry Water Cycle Concept – Ecological Considerations
Eco Logical Australia

A stylized topographic map with green contour lines is positioned on the left side of the page, extending from the top left towards the bottom left.

Pondicherry Water Cycle Concept – Ecological Considerations

NSW Department of Planning, Industry & Environment

DOCUMENT TRACKING

Project Name	Pondicherry Water Cycle Concept – Ecological Considerations
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Prepared by	Ian Dixon, Katherine Lang
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Template 2.8.1

Contents

1. Introduction.....	5
2. Legislative context	7
2.1 <i>Water Management Act 2000</i>	7
2.2 NSW Wetlands Management Policy.....	8
3. Existing environmental conditions	10
3.1 Field Survey Methods.....	10
3.2 Condition.....	10
4. Description of options	17
5. Criteria	20
6. Assessment of options	21
6.1 WM Act Comments	23
7. Conclusion and recommendations	25
8. References	26
Appendix A Reach Descriptions	27

List of Figures

Figure 1: Riparian study area in Pondicherry.....	6
Figure 2: Top of Bank (validated September 2019) and reach numbers.....	16
Figure 3. Riparian Habitat Design Options.....	19

List of Tables

Table 1: Reach descriptions subset.....	12
Table 2 Key ecological objects and principles.....	20
Table 3 Scenario Assessment Results	21
Table 4: WM Act Review.....	23

Abbreviations

Abbreviation	Description
DPIE	NSW Department of Planning and Environment
ELA	Eco Logical Australia
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
GDC	Greenfields Development Company
NRAR	Natural Resources Access Regulator
RC	Riparian Corridor
ToB	Top of Bank
WM Act	NSW <i>Water Management Act 2000</i>
VRZ	Vegetated Riparian Zone

1. Introduction

The NSW Department of Planning, Industry and Environment (DPIE) has identified Pondicherry as a priority area for development within the South West Growth Centre. The site has two large existing farm dams that are 'on-line'. Typically, masterplanning of such precincts results in the decommissioning of dams, the re-establishment of watercourses and construction of off-line dry stormwater basins. For the Pondicherry precinct, there may be benefits of maintaining the two dams as part of the water cycle management system that also provides aesthetic and cooling outcomes. In order to seek certainty for masterplanning, the Department of Planning, Industry and Environment engaged Eco Logical Australia to consider the ecological merits of three concepts:

1. Retain the dams on-line as a water feature of the precinct
2. Remove the dams and construct an on-line dry basin system
3. Remove the dams, re-establish a watercourse and construct off-line dry basins

This report provides an assessment of the aquatic ecology merits of each concept. The report will contribute to other investigations being undertaken into urban design aspects (being undertaken by Design & Planning and hydrological/water quality aspects (calibre Consulting). This report:

- Describes the general riparian and aquatic values currently on site
- Describes the three scenarios
- Identifies and applies aquatic ecology criteria to compare the three scenarios
- Provides a recommendation based on which option best meets the Principles and Objects of the *Water Management Act 2000*

For the purpose of this assessment, the study area covers the following lots or part lots in Oran Park (Figure 1):

- Lot B, DP420694
- Lots 4 and 5 DP1223563
- Lot 50, DP1232523
- Lot C, DP391340
- Lot 11, DP1229416
- Lots 500, DP1225924
- Lot 2, DP1217189.



Figure 1: Riparian study area in Pondicherry

2. Legislative context

The specific regulatory requirements of the *Water Management Act 2000* are the focus of this paper. Other aquatic legislation and policies will be reviewed as required as part of future documentation prepared for later stages of the Pondicherry Precinct planning.

2.1 *Water Management Act 2000*

The main objective of the *Water Management Act 2000* (WM Act) is to *manage NSW water in a sustainable and integrated manner that will benefit current generations without compromising future generations' ability to meet their needs.*

The relevant principles for this development and the scope of this study, as set out section 5 of the WM Act, are as follows.

Generally (1):

- a. water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and*
- b. habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and*
- c. the water quality of all water sources should be protected and, wherever possible, enhanced, and*
- d. the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and*
- e. geographical and other features of Aboriginal significance should be protected, and*
- f. geographical and other features of major cultural, heritage or spiritual significance should be protected, and*
- g. the social and economic benefits to the community should be maximised, and*
- h. the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements.*

In relation to controlled activities (2):

- a. the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and*
- b. the impacts of the carrying out of controlled activities on other water users must be avoided or minimised.*

The objects of the WM Act, outlined in section 3 of the Act, and listed below, are to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular:

- a. to apply the principles of ecologically sustainable development*

- c. *to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality*
- d. *to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:*
 - i *benefits to the environment*
 - ii *benefits to urban communities, agriculture, fisheries, industry and recreation*
 - iii *benefits to culture and heritage*
 - iv *benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water*
- e. *to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,*
- f. *to provide for the orderly, efficient and equitable sharing of water from water sources,*
- g. *to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,*
- h. *to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,*
- i. *to encourage best practice in the management and use of water.*

Note: ESD is defined by the Commonwealth Government 1990 as ‘*using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased*’

The WM Act is administered by Natural Resources Access Regulator (NRAR) and establishes an approval regime for activities within waterfront land, defined as the land 40 m from the highest bank of a river, lake or estuary. Under WM Act framework, activities and works proposed on waterfront land are regulated. These activities include:

- the construction of buildings or carrying out of works
- the removal of material or vegetation from land by excavation or any other means
- the deposition of material on land by landfill or otherwise
- any activity that affects the quantity or flow of water in a water source.

NRAR’s *Guidelines for Controlled Activities on waterfront land—Riparian corridors* (NRAR, 2018) provides a fast-track assessment pathway for development that meets pre-determine criteria. The water cycle concepts discussed in this paper are acknowledged to be outside of the fast-track *Guidelines for Controlled Activities on waterfront land—Riparian corridors* and will therefore be subject to a merit based assessment.

2.2 NSW Wetlands Management Policy

The NSW Wetlands Management Policy (DECCW, 2010) aims to provide for the protection, ecologically sustainable use and management of NSW wetlands. Wetlands include lakes, lagoons, estuaries, rivers, floodplains, swamps, bogs, billabongs, marshes, coral reefs and seagrass beds. For the sustainable management of wetlands, the NSW Government adopts 12 principles to guide decision-making. The themes of these 12 policies include:

- Catchment scale
- Water regimes
- Floodplain connectivity
- Wetlands of significance
- Land management practices
- Cultural values
- Rehabilitation
- Climate change
- Research
- Protection and offsetting
- Cooperation and incentives
- Monitoring and reporting.

3. Existing environmental conditions

3.1 Field Survey Methods

The Strahler stream order classification was extracted from the DPI Hydroline Spatial Data. Top of bank had previously been preliminarily assessed in the field by ELA in 2017 and validated by ELA in September 2019 by a Senior Aquatic Ecologist.

1. Top of Bank Mapping – The geomorphic Top of Bank (ToB) for the creek was mapped using a GPS-enabled tablet and cross-checked with 0.5 m contours and high-resolution aerial imagery. The ToB identifies the geomorphologic extent of the watercourse and forms the basis for measuring any VRZ.

2. Riparian habitat assessment – An assessment of riparian condition and recovery potential was conducted for the creek. This assessment considered native vegetation cover, connectivity, quality, bed and bank stability and habitat diversity.

3. Aquatic habitat assessment – An assessment of the aquatic habitat within the reach was completed, which examined the general quality of aquatic habitats, including vegetation structure, regeneration and weed infestations.

3.2 Condition

The Pondicherry precinct is highly modified, with the dominant land use utilising extensively cleared paddock/pasture. No groundwater dependant ecosystems were identified (besides riparian vegetation).

Waterways ranged from undefined overland flows, to large online dams, to an incised channel with forested riparian land. Using the Strahler method of stream order, the DPI hydroline map shows twelve 1st order, four 2nd order, one 3rd order, and one 4th order stream within the site. Of these, only three of the higher order streams had a distinctive bed, bank and aquatic habitat.

Appendix A has the full description of all reaches on site, using reach names shown in Figure 2. The current condition of the higher order streams and large existing dams is summarised below (reach 3A, 3C, 4A and 2D).

There is currently 46 ha of online dams (2 large dams) on the 3rd order stream, plus numerous small online and offline dams scattered throughout the study area.

The two dams are positioned along a third order creek. They are supported by dam walls greater than 5 m high. These walls obstruct the creek's natural flow and are an obstruction to fish passage in the catchment.


The dams provided poor aquatic habitat with sparse macrophytes, degraded banks due to cattle trampling and turbid water. There was very little to no riparian vegetation present, with pasture dominating the 'riparian zone'.


Maintaining the dams in their current condition would not benefit the system, other than supporting flora and fauna that can tolerate disturbed conditions. Cattle would continue to trample and degrade



the bed and banks of the waterway, leading to long-term sedimentation and high turbidity in the dam.


Due to nature and location of the large farm dams on site, there is currently no aquatic habitat connectivity laterally across the site between the Oran Park Precinct and South Creek.

Table 1: Reach descriptions subset

Reach	Strahler	Likely WM Act 'river' status	Typical features	Representative photos
2D	2 nd	River	Defined channel with shallow pooled water and dense macrophytes. Cattle fenced off from riparian vegetation. Steep banks and scattered trees with the study area, dominated by herbaceous groundcovers. Creek flows from upstream development that has protected and restored a 40 - 50 m wide riparian corridor. Reach cuts southern tip of study area, then joins with Reach 3A offsite.	<div><div><div>Date & Time: Wed, 04 Sep 2019 16:42:45 AEST</div><div>Position: -033.993299° S +150.736938° E</div><div>Altitude: 88m</div><div>Datum: WGS-84</div><div>Azimuth: +001° +0018mils</div><div>Elevation Grade: +104%</div><div>Horizon Grade: +086%</div><div>Zoom: 1X</div><div>Pondicherry</div></div></div>

Reach	Strahler	Likely WM Act 'river' status	Typical features	Representative photos
3A	3 rd	River	<p>The reach length consists of about 1/3 defined channel and 2/3 large online dams. The channel area was highly impacted from unfenced cattle, with steep eroded banks, compacted and trampled bed, incised channel, sedimentation of bed, turbid water, and a thin row of riparian trees with limited recruitment. Channel habitat for macroinvertebrates and amphibians was very poor. Fish passage along the creeks was severely obstructed by several dam walls, each >5 m high. The lower dam spills into a large and narrow third dam off site and also a secondary overflow channel into South Creek. Numerous large invasive Carp were observed in third dam. The dam water was turbid and green with filamentous algae. Several species of common wetland birds were observed using the dams. Overall, there was a poor cover of aquatic macrophytes in the dams and channel, and limited aquatic value.</p>	 <p>Top Photo Metadata: Date & Time Recd: 04 Sep 2019 11:26 AEST Position: -33.991985° S, 150.736632° E Altitude: 85m Datum: WGS-84 Azimuth/Bearing: 032° N33E 1.20mils (True) Elevation Grade: -021% Horizon Grade: +001% Scene: IX Reach: 3A Pondicherry</p> <p>Bottom Photo Metadata: Date & Time Recd: 04 Sep 2019 11:37:38 AEST Position: -33.995626° S, 150.740753° E Altitude: 83m Datum: WGS-84 Azimuth/Bearing: 035° N35E 0.98mils (True) Elevation Grade: -002% Horizon Grade: +001% Scene: IX Reach: 3A Pondicherry</p>

Reach	Strahler	Likely WM Act 'river' status	Typical features	Representative photos
				<div><p>Date & Time: Wed, 04 Sep 2019, 13:44:13 AEST Position: -33.982930° / +150.751377° Altitude: 39m Datum: 2952-06 Approximate Bearing: 254° 35296 8169m/s (True) Intersected Grade: -0.15% Horizontal Grade: -0.03% Zoom: 1X Reach: 3A Pondicherry</p></div> <div><p>Date & Time: Wed, 04 Sep 2019, 13:44:38 AEST Position: -33.982661° / +150.751661° Altitude: 39m Datum: 2952-06 Approximate Bearing: 254° 35296 8169m/s (True) Intersected Grade: -0.21% Horizontal Grade: -0.02% Zoom: 1X Reach: 3A Pondicherry</p></div>

Reach	Strahler	Likely WM Act 'river' status	Typical features	Representative photos
4A	4 th	River (South Creek)	<p>This reach forms the eastern perimeter of the study area. Cattle exclusion fencing has protected trampling of riparian land and banks, but severe weed infestations dominant the mid-storey vegetation. African Olive, Lantana and Blackberry are invasive species that compete with native plants and reduce the long-term survival of the endemic community. The channel was mostly dry with some stagnant pools, a meandering deep and narrow form through the forest. Large amounts of woody debris instream would help slow flows and trap plant propagules. Large amounts of rubbish had also been trapped instream.</p>	 <p> Date & Time: Wed, 04 Sep 2019, 13:11:54 AEST Position: -33.960890° / 150.755445° Altitude: 79m Datum: WGS-84 Azimuth/Bearing: 325° N35W 5778mils (True) Elevation Grade: +028% Horizon Grade: -002% Zoom: 1X Reach 4A, Pondicherry </p>

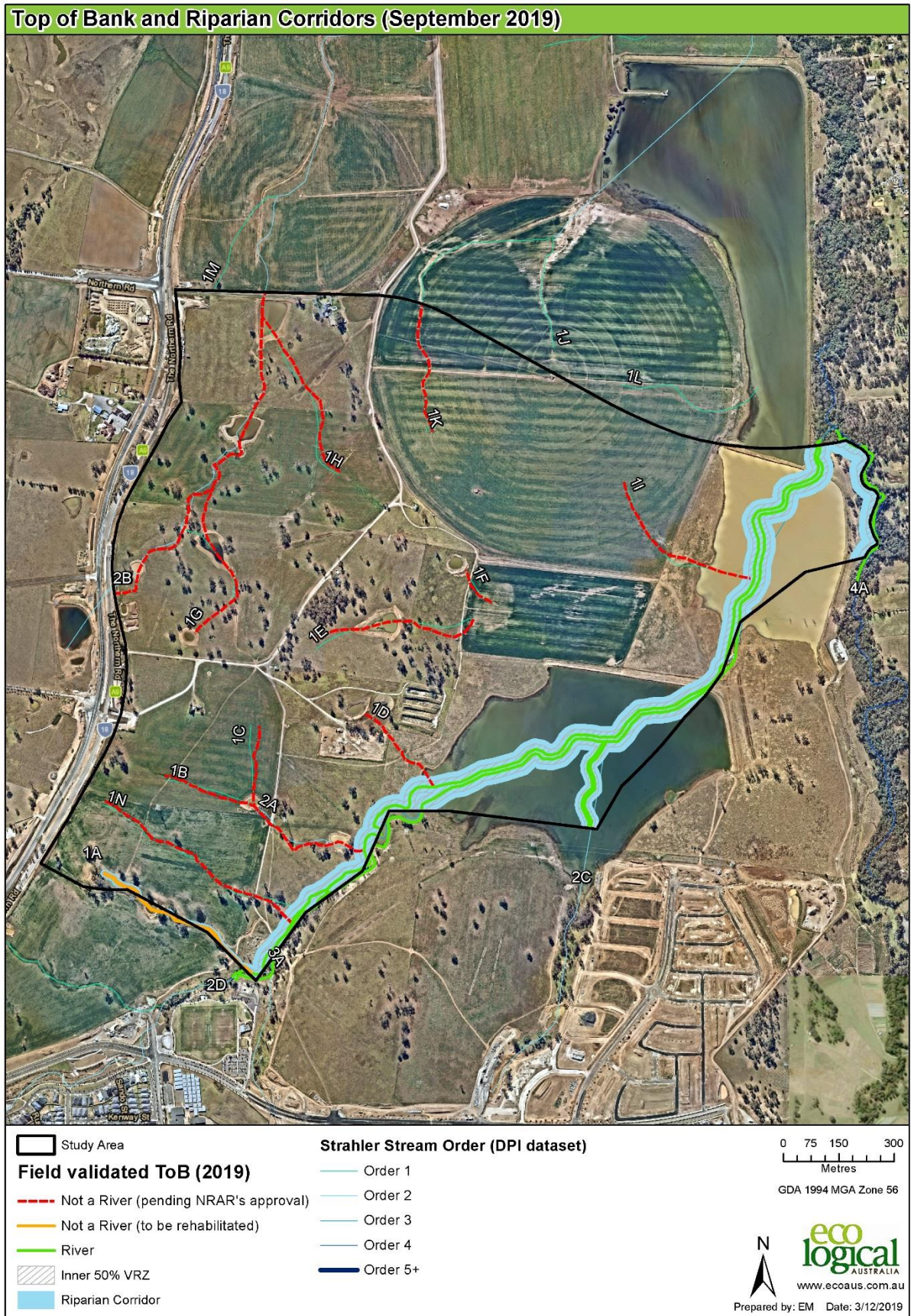


Figure 2: Top of Bank (validated September 2019) and reach numbers

4. Description of options

The current options under consideration are shown in Figure 3. The preferred option will be that which is most closely aligned with the WM Act Principles and Objects and that also provides for additional riparian or aquatic features into the detailed design and future management of the site.

The hydrological function of each option is described by Calibre Consulting.

Option 1 - Lake

The objective of this option is to create a combination of a large open water body and riparian rehabilitation with small offline basins for water treatment. The two dams would be reshaped into a number of tiered lakes. The lakes would be online and provide permanent bodies of water along the creek. The system would have the potential to contain fringing aquatic habitat and open water areas.

Water would be fed into the system via the natural creek catchment and stormwater. The riparian land fringing the lakes would have a variety of treatments including commercial, recreational and environmental areas.

Downstream of the lake, the riparian rehabilitation area is proposed adjacent to South Creek and is likely to consist of a low flow channel, banks, some wetland areas and a structured woodland terrestrial ecosystem. This is in line with riparian corridors that are currently existing along South Creek and the tributaries upstream in the Oran Park and Turner Road Precinct.

Option 2 – Dry Online Basin

A series of dry vegetated detention basins would be built along the third order creek, making it an online basin. A low flow channel (for the <2 year events) would be constructed through the centre, with weir structures holding large rain events. Controlled piped outlets would allow water to move from one detention cell to the next.

The low flow channel would provide habitats of sorts, however the broader basins (or cells) would most likely contain monocultures of grass with some potential for dual use as sporting fields.

Option 3 – Dry Offline Basin

A dry vegetated detention basin would be built in the outer edges watercourse and have the equivalent riparian zone through the centre for a third order stream.

The inner riparian zone would be revegetated to a functioning riparian community representative of ecological communities native to the area.

The two dam walls would be removed and the channel would be reduced to a width that is representative of upstream and downstream. This stretch of the creek would be restored to provide riparian and aquatic habitat.

The dry vegetated detention basins also formed in detention cells and separated by weir structures would include a low flow channel (for the <2 year event) with significant in stream structures to transfer

flood waters above the 2 year event offline and into the detention basins. The offline detention basins would provide some potential for dual land use with accessible green space for the community and a catchment area in times of rain.

The following sections provide an ecological assessment under each option. The assessment is put in context of the principles and objects of WM Act (refer to section 2.1 above).

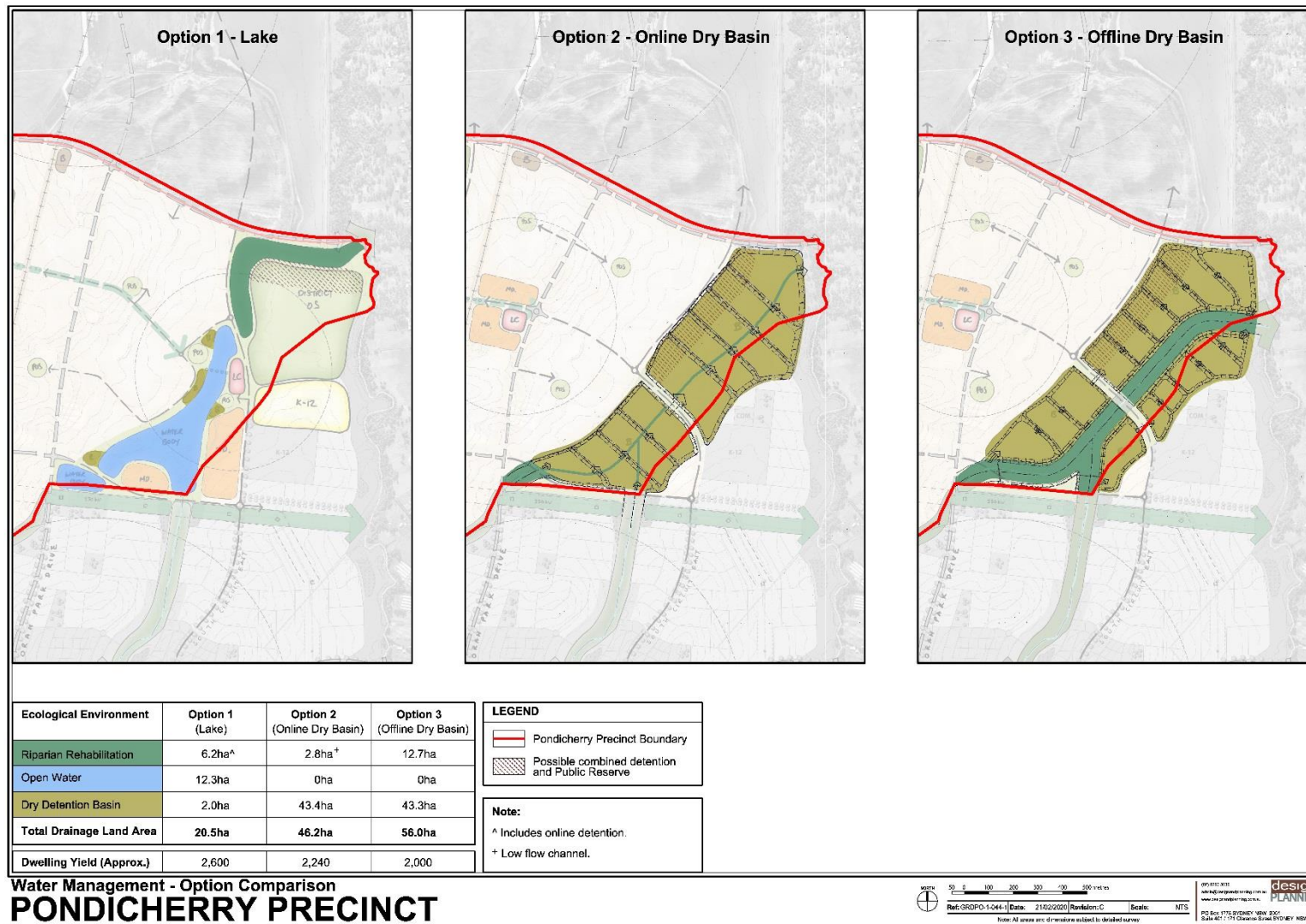


Figure 3. Riparian Habitat Design Options

5. Criteria

ELA have proposed a set of criteria based on the key WMA principles in order to evaluate and compare the 3 scenarios for the site at this, the planning stage of the Pondicherry development (refer to Table 2). ELA note that there will be other objects and principles that will also apply as the works progress e.g. relating to controlled activities and adaptive management, these are listed in full in section 2.1 of this report.

Table 2 Key ecological objects and principles

Objects (WMA Section 3)	Principle (WMA section 5)	Criteria
b) to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality	<i>a. water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded</i>	1. Riparian habitat area provided.
(f) to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna	<i>b. habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored</i>	2. Diversity of riparian habitat. 3. Habitat connectivity.

6. Assessment of options

For each scenario, we have considered only the riparian rehabilitation and open water areas as holding riparian habitat value. The dry drainage basins, will not hold water in the long term, will be used for water quality treatment, will not include a diverse range of native plant species and in some cases may be used for open space.

Table 3 Scenario Assessment Results

Option	Criteria		
	Habitat Area	Habitat Diversity	Habitat Connectivity
1. Lake	18.5 ha (6.2ha of riparian rehabilitation plus 12.3 ha of open water body)	<ul style="list-style-type: none"> • Terrestrial Woodland, Riparian variability within the lake, • Aquatic/benthic variability within the lake, • Emergent vegetation at lake edges • Wetlands • River bed and banks 	<ul style="list-style-type: none"> • Aquatic habitat connectivity can be designed into the lake system and be available most often due to standing water • Terrestrial habitat connectivity via pockets of fringing vegetation and the riparian restoration area provided between Oran Park and South Creek
2. Online Dry basins	2.8 ha (riparian rehabilitation)	<ul style="list-style-type: none"> • River bed and banks 	<ul style="list-style-type: none"> • Aquatic species passage during high flows
3. Offline Dry Basin	12.7 ha (riparian rehabilitation)	<ul style="list-style-type: none"> • Terrestrial riparian vegetation • River bed and banks 	<ul style="list-style-type: none"> • Aquatic habitat connectivity through the river bed available during high flows • Terrestrial habitat connectivity between Oran Park and South Creek established and continuous through the riparian restoration corridor.

Option 1 - Lake

The proposed open water lake system presents a variety of opportunities to diversify the aquatic habitat available on site. Design of the benthic environment and the banks of the lake system could include areas of emergent vegetation, stepped depth edges and pockets of terrestrial fringing vegetation to allow for the use of the lake by a wider variety of native fauna including wading birds, frogs, turtles and bats. The lake will also serve to combat the heat island effect in the locality and provide a continued water source for more mobile fauna in the region e.g. raptors and other native birds.

A tiered lake system would create refuge areas for fauna with large bodies of holding water, rather than drying slowly in the downstream creeks in extended dry periods. Fish passage could be reinstated in the currently tributaries of South Creek.

The aquatic habitat would be enhanced with aquatic macrophytes. The macrophytes in slow-flowing or still water would filter excess nutrients and sediment from the water. There would be habitat creation for macroinvertebrates, wader birds and amphibians.

This is the preferred option as it provides the highest area of riparian habitat (18.5 ha), the highest diversity of habitat, good lateral connectivity and also provides more opportunities to incorporate additional riparian features into detailed design. This option also highlights the possible integration of riparian habitat outcomes into a site that has significant flooding constraint. This option also most closely aligns with the relevant objects and principles of the WM Act.

Option 2 – Online Dry Basin

This option will see the least area of riparian habitat created and maintained.

Online dry detention basins will see no permanent water integrated into the landscape and no open water areas. This option will include a low flow channel that will only provide temporal aquatic habitat and connectivity during high rainfall events.

Riparian habitat diversity will be confined to dry terrestrial plantings in the bed and banks of the low flow channel, with some capacity to incorporate native sedge and grass species into the basins. Water treatment will occur within the riparian area and potential for open space uses within the dry basin extent.

Drying an area of the South Creek catchment would isolate the upstream and downstream sections, except in times of high rainfall. There would be the overall removal of, aquatic habitat from the area.

The loss of permanent water in the dam would, however, have a negative impact to the extent of regional aquatic and wetland habitat remaining in an increasingly urbanised landscape, where a multitude of dams are lost each year.

This option is the least aligned of the three, to the objects and principles of the WM Act.

Option 3 – Offline Dry Basins

Option 3 provides less ha of riparian habitat than option 1 and more than option 2. This option does not incorporate any open water aquatic habitat. This in turns results in a lower habitat diversity than option 1.

An offline dry vegetated detention basin would provide the potential for dual land use with accessible green space for the community and a catchment area in times of rain.

The restored riparian corridor would increase flora and fauna biodiversity and connectivity between the areas outside the site and South Creek. The continuous corridor would also provide an opportunity for cryptic native species to utilise the habitat connectivity. It is worth noting here that the connectivity will be predominantly terrestrial.

The low flow channel in the detention cells will require significant instream structures to transfer flood waters above the 2 year events. This will limit the ability to restore the creek bed with ephemeral habitat for macroinvertebrates, fish, amphibians and birds because of decreased sedimentation, increased water clarity and habitat complexity.

As with option 2, the loss of permanent water in the dam would, have a negative impact to the extent of regional aquatic and wetland habitat remaining in an increasingly urbanised landscape, where a multitude of dams are lost each year.

This option does align somewhat with the object and principles being considered in this paper and is the more traditional style of riparian restoration. This option provides good terrestrial riparian habitat connectivity. This option does not as fully utilise the opportunity to maximise habitat diversity, introduces instream structures that will negatively impact on connectivity and provision of ephemeral instream habitat and does not provide any capacity to hold permanent water in the landscape.

6.1 WM Act Comments

ELA was requested to comment on specific WM Act clauses, refer to table 4 below.

Table 4: WM Act Review

Clause		Comment
Clause 5 – WATER MANAGEMENT PRINCIPLES		
(1)	The principles set out in this section are the water management principles of this Act.	
(2)	Generally— <ul style="list-style-type: none"> a. water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and b. habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and c. the water quality of all water sources should be protected and, wherever possible, enhanced, and d. the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and e. geographical and other features of Aboriginal significance should be protected, and f. geographical and other features of major cultural, heritage or spiritual significance should be protected, and g. the social and economic benefits to the community should be maximised, and h. the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements. 	<p>This principle relates primarily to the protection of existing values. The existing farm dams and riparian zone are of very poor quality and provide very little worth protecting. In terms of potential for restoration, Options 1 and 3 provide significant habitat restoration, with Option 1 provide the greatest amount and the greatest diversity.</p> <p>All three options can be monitored to provide insight into their success and to identify changes to management regimes.</p>
(3)	In relation to water sharing— <ul style="list-style-type: none"> a. sharing of water from a water source must protect the water source and its dependent ecosystems, and b. sharing of water from a water source must protect basic landholder rights, and c. sharing or extraction of water under any other right must not prejudice the principles set out in paragraphs (a) and (b). 	No extraction of water is proposed under any of the options and therefore all options are consistent with this principle. If water extraction is proposed in future it will be subject to environmental assessment and regulatory requirements.
(4)	In relation to water use—	None of the options propose to use or extract water and will not

Clause	Comment
<ul style="list-style-type: none"> a. water use should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and b. water use should be consistent with the maintenance of productivity of land in the long term and should maximise the social and economic benefits to the community, and c. the impacts of water use on other water users should be avoided or minimised. 	<p>result in decline of native vegetation. All options are therefore consistent with this principle.</p> <p>If Council was to use water from any of the options (for example irrigation of open space areas), this would need to be subject to environmental assessment and regulatory control at that point in time.</p>
<p>(5) In relation to drainage management—</p> <ul style="list-style-type: none"> a. drainage activities should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and b. the impacts of drainage activities on other water users should be avoided or minimised. 	Options 1 and 3 provide for rehabilitation of riparian zone. No decline in existing native vegetation is expected as there is little /no existing native vegetation along this reach of watercourse.
<p>(6) In relation to floodplain management—</p> <ul style="list-style-type: none"> a. floodplain management must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and b. the impacts of flood works on other water users should be avoided or minimised, and c. the existing and future risk to human life and property arising from occupation of floodplains must be minimised. 	
<p>(7) In relation to controlled activities—</p> <ul style="list-style-type: none"> a. the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and b. the impacts of the carrying out of controlled activities on other water users must be avoided or minimised. 	Controlled Activity to be obtained at DA stage, however options 1 and 3 most likely to meet this objective through rehabilitation of native vegetation.
<p>(8) In relation to aquifer interference activities—</p> <ul style="list-style-type: none"> a. the carrying out of aquifer interference activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and b. the impacts of the carrying out of aquifer interference activities on other water users must be avoided or minimised. 	

7. Conclusion and recommendations

It is understood that the Pondicherry precinct will require a merit based assessment under the WM Act and this initial paper is to begin the NRAR consideration of the options to incorporate aquatic and riparian habitat in the rezoning of the precinct.

A subset of objects and principles of the WMA were the focus of this review, those relating specifically to aquatic and riparian ecology were considered. This paper has found that the re-design of the riparian system across the site can meet the objectives and principles of the WM Act, and will improve the existing aquatic and riparian quality if it:

- Incorporates aquatic and riparian habitat connectivity and diversity
- Slows water and filters sediment, nutrients and pollutants prior to entering the lakes
- Provides at least native riparian trees along the shore to provide shade and organic debris to the water
- Prohibits the use of exotic deciduous street trees in the precinct.

Of the three options proposed for integrating aquatic ecology and terrestrial riparian habitat into the redevelopment of the precinct, each option provided some merit. Option 1 and 3 both met the objects and principles of the WM Act well and provided a good level of riparian habitat area and quality. Option 1 was considered the preferred option as it provided the highest area of potential habitat (aquatic and terrestrial), highest diversity of habitat whilst also including a permanent lake system which will have the additional value of holding water in a region where farm dams are regularly being removed and not replaced.


8. References


Natural Resources Access Regulator (NRAR) 2018. *Controlled activities on waterfront land – Riparian corridors*. NSW Department of Industry. Available online:


https://www.industry.nsw.gov.au/_data/assets/pdf_file/0004/156865/NRAR-Guidelines-for-controlled-activities-on-waterfront-land-Riparian-corridors.pdf


Riches, M., Gilligan, D., Danaher, K. and Pursey, J. 2016. *Fish Communities and Threatened Species Distributions of NSW*. NSW Department of Primary Industries.


Appendix A Reach Descriptions


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1A	1 st	Not a river	No defined bed or bank (overland flows only). One small online dam.	


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1B	1 st	Not a river	No defined bed or bank (overland flows only). One small online dam.	 <p> Date & Time: Wed, 04 Sep 2019, 16:04:54 AEST Position: -33.92853° / +151.734175° Altitude: 90m Datum: GNS 84 Azimuth: ~ 60° ~ 200m/s Horizontal Grade: +0.8% Zoom: 1X Reach: 1B Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1C	1 st	Not a river	No defined bed or bank (overland flows only). One small online dam.	 <p> Date & Time: Sat, 04 Sep 2019, 6:15:37 AEST Position: -33.928135° / 151.755711° Altitude: 93m Datum: WGS 84 Azimuth: +000° +1492m/s Elevation: Grade: +0.44% Horizon Grade: +0.87% Zoom: 1X Reach: 1C Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1D	1 st	Not a river	No defined bed or bank (overland flows only). One small online dam.	 <p> Date & Time: Wed, 04 Sep 2019, 12:12:58 AEST Position: -133.787595° / +150.741707° Altitude: 89m Datum: GDA95-96 Approximate bearing: 149° 38'E 2040miles direct Elevation Grade: 0.14% Horizontal Grade: +0.00% Stream: 1X Reach: 1D Pondicherry </p>

Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1E	1 st	Not a river	No defined bed or bank (overland flows only). One small online dam.	 <p> Date & Time: Wed, 04 Sep 2019, 12:24:39 AEST Position: -33.985219° / 151.946601° Altitude: 88m Datum: GNSD 96 Azimuth/Heading: 337° 387° 1345m/s (True) Horizontal Accuracy: 0.2M Vertical Accuracy: ±0.02M Zoom: 1X Reach: 1E Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1F	1 st	Not a river	No defined bed or bank (overland flows only). One small online dam.	 <p> Date & Time: Wed, 04 Sep 2019, 12:26:29 AEST Position: -33.784018° / +150.764169° Altitude: 85m Datum: GDA95-96 Approximate bearing: 180° 360E 2801 miles of track Elevation Grade: 0.1% Horizontal Grade: +0.00% Zoom: 1X Reach 1F Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1G	1 st	Not a river	No defined bed or bank (overland flows only). Two small online dams.	 <p> Date & Time: Wed, 04 Sep 2019, 15:39:12 AEST Position: -33.982657° / 151.79668° Altitude: 95m Datum: GRS 90 Azimuth: -0.95° / 89.9mils Elevation Grade: +0.95% Horizontal Grade: +0.95% Zoom: 1X Reach: 1G Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1H	1 st	Not a river	No defined bed or bank (overland flows only).	 <p> Date & Time: Sat, 04 Sep 2015, 15:45:07 AEST Position: -33.976684° / +151.536077° Altitude: 88m Datum: WGS 84 Azimuth: -1.16° -2098mils Horizontal GSD: +0.94m Vertical GSD: +0.92m Zoom: 1X Reach: 1H Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1I	1 st	Not a river	No defined bed or bank (overland flows only).	
1J	1 st	Off site	-	Off site, no photo


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1K	1 st	Not a river	No defined bed or bank (overland flows only).	 <p> Date & Time: Wed, 04 Sep 2019, 14:26:47 AEST Position: -33.977778° / +151.742778° Altitude: 89m Datum: GRS85 98 Approximate: +001° +5303m/s Elevation Grade: +0.1% Horizontal Grade: +0.03% Zoom: 1X Reach: 1K Pondicherry </p>
1L	1 st	Off site	-	Off site, no photo
1M	1 st	Not a river	-	Off site, no photo


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
1N	1 st	Not a river	No defined bed or bank (overland flows only).	 <p> Date & Time: Wed, 04 Sep 2019 11:25:56 AEST Position: -133.791692° / +150.737687° Altitude: 58m Datum: WGS-84 Azimuth/Bearing: 309° N59W 5387mils (True) Elevation Grade: -0.01% Horizon Grade: -0.01% Zoom: 1X Reach 1N Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
2A	2 nd	Not a river	No defined bed or bank (overland flows only). One small online dam. Minor gully depressions but filled with pasture species.	 <p> Date & Time: Wed, 04 Sep 2019, 11:31:02 AEST Position: -33.790342° S, 151.796942° E Altitude: 89m Datum: GDA95 48 Approximate bearing: 347° N0000 3018m (True) Horizontal Accuracy: 0.15m Vertical Accuracy: +0.01m Zoom: 1X Reach: 2A Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
				<p>Date & Time: Wed, 04 Sep 2019 11:37:02 AEST Position: -33.390482 / 151.60740922 Altitude: 87m Datum: WGS 84 Azimuth/Bearing: 260° 580W 4622mils (true) Elevation Grade: 10.1% Horizon Grade: 10.1% Zoom: 1X Reach: 2A Box: 100m x 100m</p> 

Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
2B	2 nd	Not a river	No defined bed or bank (overland flows only). Three small online dams. Minor gully depressions occur but are filled with pasture species and associated with dams.	 <p> Date & Time: Wed, 04 Sep 2019, 15:10:17 AEST Position: -33.981679° / 151.796678° Altitude: 93m Datum: WGS-84 Azimuth: 100° = 1886m/s Elevation Grade: +0.98% Horizon Grade: +0.84% Azimuth: 100° Reach: 2B Pondicherry </p>

Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
				<p>Date & Time: Wed, 04 Sep 2019, 15:18:00 AEST Position: -033.982620° / +150.936656° Altitude: 94m Datum: WGS-84 Azimuth: -115° / 244mils Elevation Grade: 40.7% Horizon Grade: 4.6% Stream ID: Reach ID: Pondicherry</p> 


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
2C	2 nd	River	Online dam within the site. Channel upstream of dam is off site and not assessed.	 <p> Date & Time: Wed, 04 Sep 2019, 15:01:09 AEST Position: -33.986954° / +150.986920° Altitude: 89m Datum: GCS: 83 Datum: +101° +1700m/s Elevation Grade: +0.99% Horizon Grade: +0.85% Reach: 2C Reach: 2D Pondicherry </p>
				Off site, no photo


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
2D	2 nd	River	<p>Defined channel with shallow pooled water and dense macrophytes. Cattle fenced off from riparian vegetation. Steep banks and scattered trees with the study area, dominated by herbaceous groundcovers.</p> <p>Creek flows from upstream development that has protected and restored a 40 - 50 m wide riparian corridor. Reach cuts southern tip of study area, then joins with Reach 3A offsite.</p>	 <p> Date & Time: Wed, 04 Sep 2019, 14:22:05 AEST Position: +133.983298, +150.736938 Altitude: 88 m Datum: WGS 84 Azimuth: +001, +0018 mjd Elevation Grade: +104% Horizon Grade: +086% Zoom: 1X Pondicherry </p>


Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
3A	3 rd	River	<p>The reach length consists of about 1/3 defined channel and 2/3 large online dams. The channel area was highly impacted from unfenced cattle, with steep eroded banks, compacted and trampled bed, incised channel, sedimentation of bed, turbid water, and a thin row of riparian trees with limited recruitment. Channel habitat for macroinvertebrates and amphibians was very poor. Fish passage along the creeks was severely obstructed by several dam walls, each >5 m high. The lower dam spills into a large and narrow third dam off site and also a secondary overflow channel into South Creek. Numerous large invasive Carp were observed in third dam. The dam water was turbid and green with filamentous algae. Several species of common wetland birds were observed using the dams. Overall, there was a poor cover of aquatic macrophytes in the dams and channel, and limited aquatic value.</p>	 <p> Date: 04 Sep 2019 11:10:30 AEST Position: -33.954985, 151.204500 Altitude: 85m Datum: 935-84 Azimuth/Bearing: 062° N69E 1/20m to River Elevation Grade: -0.21% Horizon Grade: 1.00% Zoom: 1X Reach 3A Pondicherry </p>

Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
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Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
				<div><div><div>Date & Time: Wed, 04 Sep 2019, 13:45:13 AEST</div><div>Position: -33.986930° / +150.961377°</div><div>Altitude: 89m</div><div>Datum: GCS-AU</div><div>Approximate Bearing: 262° 35499' 4100m (True)</div><div>Elevation Grade: -0.1%</div><div>Horizontal Grade: +0.00%</div><div>Zoom: 1X</div><div>Reach: 9A</div><div>Pondicherry</div></div></div>

Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
				<p> Date & Time: Wed, 04 Sep 2019, 13:43:58 AEST Position: -33.593661° / +151.551661° Altitude: 89m Datum: GAD68 84 Azimuth/Heading: 262° NGA84 6320mils (True) Elevation Grade: -0.21% Horizontal Grade: -0.02% Zoom: 1X Reach: 3A Pondicherry </p> 

Reach name	Strahler stream order	Likely WM Act 'river' status (to be confirmed with NRAR)	Typical features	Representative photos
4A	4 th	River (South Creek)	<p>This reach forms the eastern perimeter of the study area. Cattle exclusion fencing has protected trampling of riparian land and banks, but severe weed infestations dominant the mid-storey vegetation. African Olive, Lantana and Blackberry are invasive species that compete with native plants and reduce the long-term survival of the endemic community. The channel was dry, with a meandering deep and narrow form through the forest. Large amounts of woody debris instream would help slow flows and trap plant propagules. Large amounts of rubbish had also been trapped instream.</p>	 <p> Date & Time: Wed, 04 Sep 2019, 13:14:54 AEST Position: -33.783890° / 151.967654E Altitude: 73m Datum: WGS1984 Azimuth/Heading: 325° (NSW 5778mils True) Elevation Grade: +028% Horizon Grade: -002% Zoom: 1X Reach: 4A Pondicherry </p>



APPENDIX 3

Pondicherry Flood Modelling

Calibre Consulting

Date:	Friday, 1 November 2019
To:	Nicole McNamara
From:	Troy Eyles
SUBJECT:	PONDICHERRY FLOOD MODELLING

1.1 Introduction

Calibre has prepared flood modelling for the future lakes within the Pondicherry Precinct. The modelling has been prepared using two methods, the Australian Rainfall and Runoff 1987 (ARR87) and Australian Rainfall and Runoff 2016 (ARR2016) as detailed within this memo.

1.1.1 Site Description

The site locality of Pondicherry is shown in Figure 1.

The Pondicherry Precinct is located approximately 5 km downstream of the uppermost headwaters of South Creek, and 3.7 km downstream of Camden Valley Way. South Creek forms the southern boundary of the precinct. The catchment area of South Creek upstream of the Pondicherry/Oran Park Precinct is approximately 871 ha.

Oran Park Precinct (upstream of Pondicherry) includes two major tributaries that discharge to South Creek via the existing dams in Pondicherry, with a combined 458 ha area that drain east of Northern Road to South Creek. The largest of the two tributaries is approximately 377 ha in size and drains to an existing large dam with an estimated storage capacity of 1,500 ML at crest level. This dam has water level control in the form of a valved outlet, which would restrict water from discharging from the dam during a flood unless open. This outlet discharges into an excavated channel that leads to another dam further downstream and South Creek. A smaller tributary of approximately 81.3 ha also drains to this dam.

The catchment area is predominantly cleared grazed land on ridges. While some of the creek lines contain remnant vegetation, most are predominantly cleared. Average catchment slopes range between 1% and 4%.



Figure 1: Pondicherry Locality Plan

Pondicherry drains to South Creek which also forms the Eastern boundary to the site.

1.1.2 Background

The Oran Park Precinct Masterplan Stormwater Quantity Management and Flooding (2007) was prepared for the Growth Centres Commission and identified the stormwater management for the Oran Park Precinct (draining into Pondicherry). The stormwater management took the form of small detention storage associated with water quality improvement features, and larger detention basins to manage major flows up to the 100 year average recurrence interval (ARI). The smaller storages located through the site will be used to attenuate bank-full flows (up to the 2 year ARI) to mitigate erosion and ensure ecologically sustainable creeks through the site. The larger detention storages will be used to ensure that flooding in South Creek is not heightened as a result of the development in the Oran Park Precinct. In addition to detention basins, the commercial land use of town centre is proposed to incorporate lot based onsite detention (for the 2 year ARI) to protect the creeks immediately downstream. This would form an OSD component of their rainwater storage.

1.2 RELEVANT GUIDELINES

This section outlines the planning context and design criteria relevant to Pondicherry in addition to the Water Cycle Management & Flooding Oran Park Precinct. The section also provides a brief description of relevant publications.

1.2.1 Engineering Design Specification (Camden Council, 2009)

This specification contains technical design data for the calculation of flows, flood elevations and velocities along with technical standards for the design of drainage infrastructure. The hydrologic parameters include rainfall intensity charts and runoff parameters for flow estimation. The document also outlines hydraulic parameters and design requirements for pits, culverts and pipes.

1.2.2 Flood Risk Management Policy (Camden Council, 2006)

The Flood Risk Management Policy establishes flood risk management planning and development for all flood prone land within the Camden LGA. Flood prone land is susceptible to flooding by the Probably Maximum Flood (PMF) event. The policy has regard to the requirements of the New South Wales Government Floodplain Development Manual – April 2005.

1.2.3 Water Management Act 2000

The key NSW legislation governing the management of the state's water resources is the Water Management Act 2000 and the Water Act 1912. The Water Management Act 2000 replaces Water Act 1912 which represented outdated principles in water management.

The objective of the Water Management Act 2000 is to provide sustainable and integrated management of water resources for the benefit of both present and future generations (NSW Office of Water, 2014). The NSW Office of Water administers the Water Management Act 2000 and regulates controlled activities carried out around and on waterfront land.

Amendments have been made to the legislation since it was passed by NSW parliament in December 2000. In 2012, the Guidelines for Riparian Corridors on Waterfront Land (NSW Office of Water, 2012) allowed construction of online detention basins in riparian corridors. The revision also streamlined the categorisation of streams and permitted activities around the riparian corridors. The document prepared by the Office of Water provides a recommended riparian corridor width based on water course orders as classified under the Strahler System of ordering watercourses using the 1:25,000 topographic maps. The Office of Water recognise that if the water course does not conform to the riparian corridor matrix provided in the document, the application would be subject to a merit assessment to ensure that minimal harm will occur to the waterfront land.

1.2.4 Other Relevant Specifications

- AS/NZ3500.3 Plumbing and Drainage - Stormwater Drainage

- Australian Rainfall & Runoff (Engineers Australia)
- Australian Runoff Quality (Engineers Australia)
- Technical Note: Interim Recommended Parameters for Stormwater Modelling – North-West and South-West Growth Centres
- Building Code of Australia Housing Provisions (current edition)
- Managing Urban Stormwater - Soils and Construction (current edition)
- Water Sensitive Urban Design in the Sydney Region Resource Kit (2003)
- Water Sensitive Urban Design Technical Guidelines for Western Sydney (2004)
- Map of Salinity Potential in Western Sydney (2002)
- WSROC Western Sydney Salinity Code of Practice (2004)
- DNR Local Government Salinity Initiative Publications (various)
- NSW Floodplain Development Manual (2005)
- MUSIC Manual (Version 5)
- XP-RAFTS Manual (2009).

1.3 STORMWATER QUANTITY MANAGEMENT

Urbanisation has the potential to impact the hydrology and hydraulics within the development site, downstream areas and watercourses. Urban stormwater is predominantly runoff from impervious areas such as roads, roofs, footpaths and car parks. Runoff from pervious areas such as gardens, lawns and vegetated open spaces contribute additional stormwater runoff during high intensity rainfall events.

Urbanised catchments are characterised with increased impervious areas which are smoother and allow stormwater to flow and concentrate faster. As a result, post-development catchments discharge greater stormwater volumes at higher flow rates leading to more frequent high flow events when stormwater runoff is not managed. The potential impacts of increased stormwater runoff quantity include:

- Increases in channel forming flows. The increased frequency of high flow events changes the channel forming flow and affects channel shape. This may damage or destroy important in-stream and bank habitats
- Increases in peak flows. Increased peak flows increase downstream flood risks and place greater pressure on downstream drainage infrastructure
- Increases in flood levels. Higher flood levels may pose risks to public safety and subdivision assets

As a result, a stormwater quantity management strategy is required to mitigate the risks and consequences of urbanisation on the existing catchments.

1.4 Hydrology

The hydrology modelling was undertaken in XP RAFTS modelling package this model was run for both existing and developed catchment nodes for both the ARR 1987 and ARR 2016 storm patterns. The local hydrographs for each node was then

extracted from this model and used as source data for an inflow source-area shape file in the 2D hydraulic (TuFLOW) flood model.

Catchments were developed for the pre and post development scenarios to estimate the hydrology of the catchment under ultimate development conditions using XP-RAFTS, and model the changing hydrological regime as the catchment develops from present to ultimate conditions.

To model the ARR 1987 scenario, the XP-RAFTS model was run for a number a number of storm durations from 5 mins to 72hrs and the critical flow duration was determined. The flow hydrographs for each catchment were exported and run as inflows in the TuFLOW model.

For the 2016 model, the XP-RAFTS model was revised to include the ARR2016 durations and temporal patterns and the critical duration and temporal pattern was determined. This model was run and revised flow hydrographs for each catchment were exported and run as inflows in the TuFLOW model.

1.5 Hydraulics

The inflows for the predeveloped and post developed scenarios were input into the hydraulic models for the two modelling scenarios (ARR87 and ARR2016). A stormwater management strategy which will include detention storage that are strategically located in the development to ensure that post-development flows do not exceed pre-development flows within South Creek.

The material roughness as used in the council model was applied to the pre developed flood model. The model was updated to reflect the development scenario and included the additional lot filling to represent the flood free development scenario



Figure 2: Development model lot filling

The terrain downstream of the Pondicherry release area remained the same for the pre and post development scenarios. The dam to the north of Pondicherry remained for both modelled scenarios to ensure an “apples with apples” comparison. The detention for the Oran Park and Pondicherry Precincts has been provided within the Pondicherry boundary.

1.6 Flood Results

The proposed flood mapping shows the provision of detention within the Pondicherry development ensures the predevelopment flood levels are not aggravated as a result of the development of the Pondicherry release area. The afflux (flood level difference) mapping shows that the flood levels remain the same or improved as a result of the strategy.

The proposed detention volume within the precinct is approximately 150,000m³. The proposed flood model was undertaken with the proposed lakes, however calculations have been undertaken for 2 options.

1.7 Basin options

Two options have been investigated to provide the required detention volumes within Pondicherry. The options include an online lakes system replacing the existing farm dams with the detention volume within the free space above the permanent water, and a dry basin scenario.

1.7.1 Lakes System Option

The Lakes system option looks to convert the existing dams into a formalised lakes system. The online existing dam currently provides a large permanent water level, the option will maintain the concept of permanent water, allow the water body to have multi purposed uses.

The detention volume required will be above the permanent water level of the proposed lakes, the outflow will be controlled through weirs and culverts to ensure that the existing flow rate is achieved. The permanent water level has a number of advantages including reducing the footprint required for detention volumes. The permanent water provides a flat level surface, allowing the detention volume to be applied over the whole lakes area. By allowing a depth of up to 1m deep, the lakes option will allow the detention storage to reduce the detention footprint to approximately 20 ha. The total footprint can be made up of 13 -14ha within open water bodies, the additional detention has been included in a basin to the north (within a dry basin, playing fields and/or open space).

The existing topography has grade, therefore the concept will allow weirs between water bodies to permit the lakes to cascade and have level changes to provide a close relationship with the surrounding topography. The weirs and level changes across the water body also allow for the water quality components and drainage networks to drain into the Lakes.

1.7.2 Dry Basin Option

An alternative solution to the water bodies is a dry detention basin. This basin will hold no permanent water and drain dry once the storm event has passed. The design of the basin will include batters to a basin with a grade (slope) on the basin floor to ensure that the flows are drained to the outlet, the outlet(s) will choke the outflows to meet the existing flow rate and the basin will fill.

The dry basin concept will need a significantly larger foot print then that of a permanent water body due to the reduced volume caused by the slope on the basin. A minimum of 1% grade along the basin floor will be required to ensure the basin drains dry, therefore for every 100m length of the basin, the detention depth will reduce from 1m to 0m.

The footprint to provide 150,000m³ of detention volume will be minimum of 36 ha plus the inclusion of batters. The dry basins will need to have a maximum radius of 100m to provide a manageable detention depth, therefore a number of individual outlets will be required.

Further to increasing the basin footprint and reducing other land uses within the precinct, the dry basin will have an additional constraints on the development levels surrounding the basin. The allowance for a slope on the base of the basin will raise the levels on the basin(s) and as a result require a greater extent of fill on the developable land. The surrounding levels will need to remain flood free but also ensure the catchment can discharge into the basin surface level. The basin outlet levels are fixed to need to ensure the basin can drain to South Creek but surface levels also need to match the levels adjoining the Pondicherry

precinct. Further investigation will be required to ensure the proposed grading can drain to a dry basin option given the fix constraints.

1.8 Flood Evacuation

Generally, The existing Dams are flooded buy the majority of the Pondicherry is not considered flood prone, and therefore the issue of flood evacuation does not have to significantly influence urban design as areas except for along South Creek within the flood fringe (PMF) are proposed to be filled. A flood evacuation plan will be required as part of the future development application process. Given that flood free ground is close by, evacuation should be considered an acceptable solution to manage flood risk.

As recommended by Camden Council and Australian Rainfall and Runoff, a 'minor' and 'major' drainage system approach is proposed to manage local runoff. This typical requirement allows safe passage of flood flows along the road once the drainage pipe capacity is exceeded. Flows are also accommodated in the drainage corridors where riparian buffers are located.

Proposed lot and habitable floor levels would at a minimum conform to Growth Centres DCP, with the habitable floor levels being a minimum of 500 mm above the 100 year ARI flood levels throughout the site. The relevance of this planning control is restricted to lots fronting riparian corridors and South Creek.

1.9 Stormwater Quality

The Oran Park Precinct provides basins associated with 2 year detention and water quality treatment. The stormwater runoff has been treated to meet Council removal targets prior to discharging into the creeks and entering Pondicherry. The proposal includes a number of bioretention basins located around the proposed detention basin to remove Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) from the stormwater runoff throughout the Pondicherry Precinct. All stormwater runoff will be treated prior to entering the Pondicherry basins.

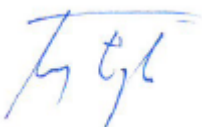
1.10 Conclusion

The stormwater hydrological and hydraulic analysis has shown that the flooding constraints can be considered within the Precinct.

The objectives of the stormwater quality and quantity management strategy for the Pondicherry Precinct will be achieved by;

- Ensuring no increase in peak flows in South Creek for all storm events up to the 100 year ARI event. The strategy utilises a detention volume within either a lake system or dry basins to manage flows from the developed catchment.
- Provide fill levels within South Creek flood fringe that achieve floor levels a minimum of 500mm above the proposed 100 year ARI flood level
- Proposal managers major and minor stormwater flows using structures
- Water quality treatment is undertaken prior to stormwater entering the basins.

Yours sincerely


















Troy Eyles

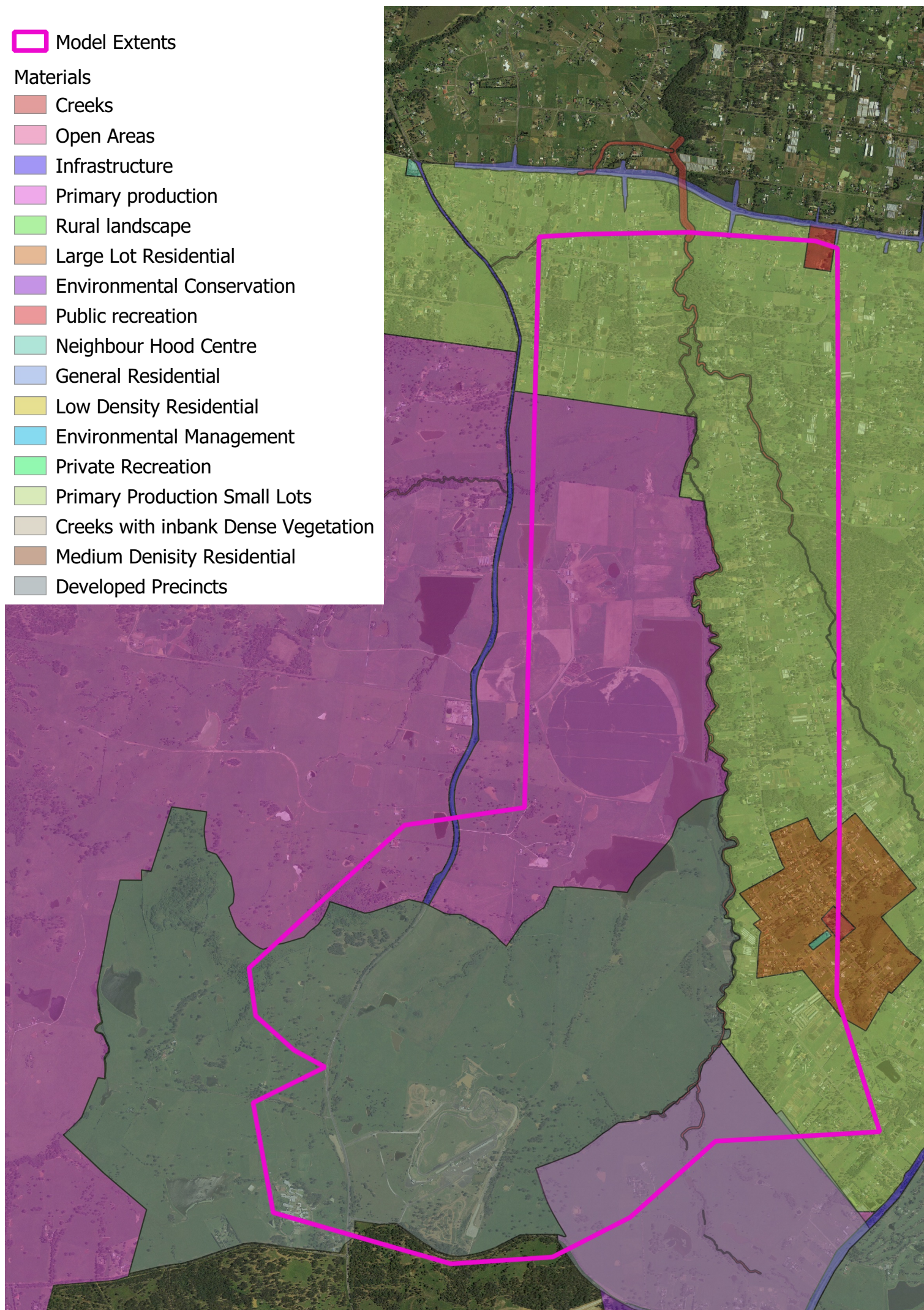
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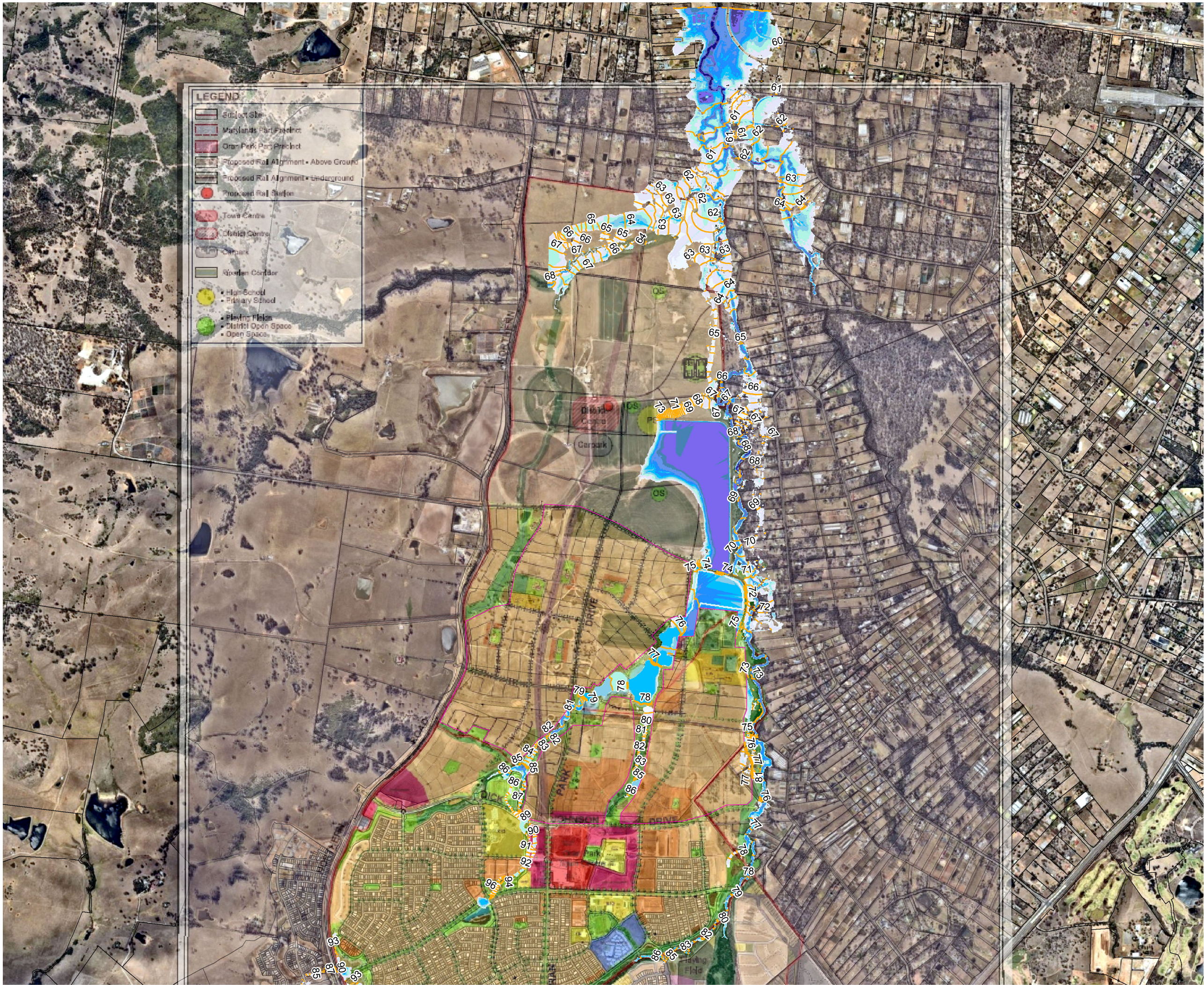
1. Hydraulic Modelling Results

 Model Extents

Materials

-  Creeks
-  Open Areas
-  Infrastructure
-  Primary production
-  Rural landscape
-  Large Lot Residential
-  Environmental Conservation
-  Public recreation
-  Neighbour Hood Centre
-  General Residential
-  Low Density Residential
-  Environmental Management
-  Private Recreation
-  Primary Production Small Lots
-  Creeks with inbank Dense Vegetation
-  Medium Denisity Residential
-  Developed Precincts





LEGEND:

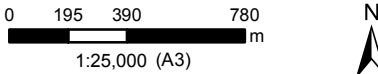
2d_zsh_fill_R2

Flood Depth (m)

- 0 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 3.50
- 3.50 - 4.00
- 4.00 - 4.50
- 4.50 - 5.00
- > 5.00

Cadastral Lot Boundaries
(From SIX Maps)

NOTES:



PROJECT:
PONDICHERY DEVELOPMENT

CLIENT:
DEPARTMENT OF PLANNING

DRAWING NO: L03017.407
OPT1_ARR1987_DEPTH_DEV

ISSUE:
01

MAP SERIES:

ISS	BY	CHK	DATE	DETAILS
01	DH		21/10/2019	DRAFT



LEGEND:

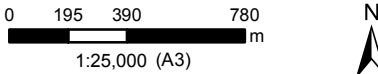
2d_zsh_fill_R2

Flood Afflux (m)

- < -0.1
- 0.1 - -0.05
- 0.05 - -0.01
- 0.01 - 0
- 0 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

Cadastral Lot Boundaries (From SIX Maps)

NOTES:



PROJECT:
PONDICHERRY DEVELOPMENT

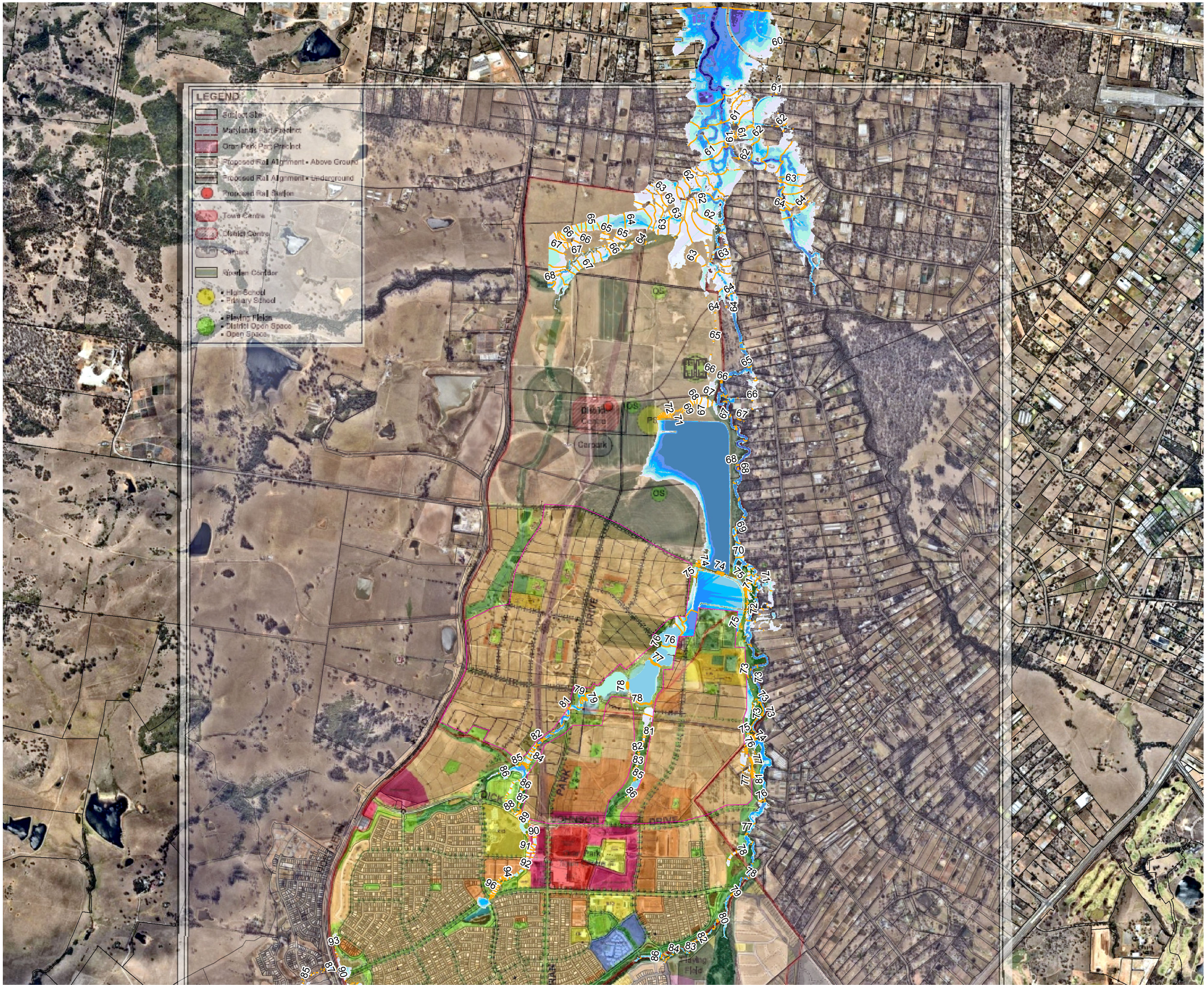
CLIENT:
DEPARTMENT OF PLANNING

DRAWING NO: L03017.407
OPT1_ARR1987_AFFLUX

ISSUE:
01

MAP SERIES:

ISS	BY	CHK	DATE	DETAILS
01	DH		21/10/2019	DRAFT



LEGEND:

2d_zsh_fill_R2

Flood Depth (m)

0 - 0.15

0.15 - 0.25

0.25 - 0.50

0.50 - 0.75

0.75 - 1.00

1.00 - 1.25

1.25 - 1.50

1.50 - 2.00

2.00 - 2.50

2.50 - 3.00

3.00 - 3.50

3.50 - 4.00

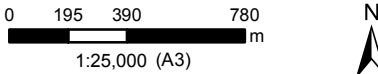
4.00 - 4.50

4.50 - 5.00

> 5.00

Cadastral Lot Boundaries
(From SIX Maps)

NOTES:



PROJECT:
**PONDICHERRY
DEVELOPMENT**

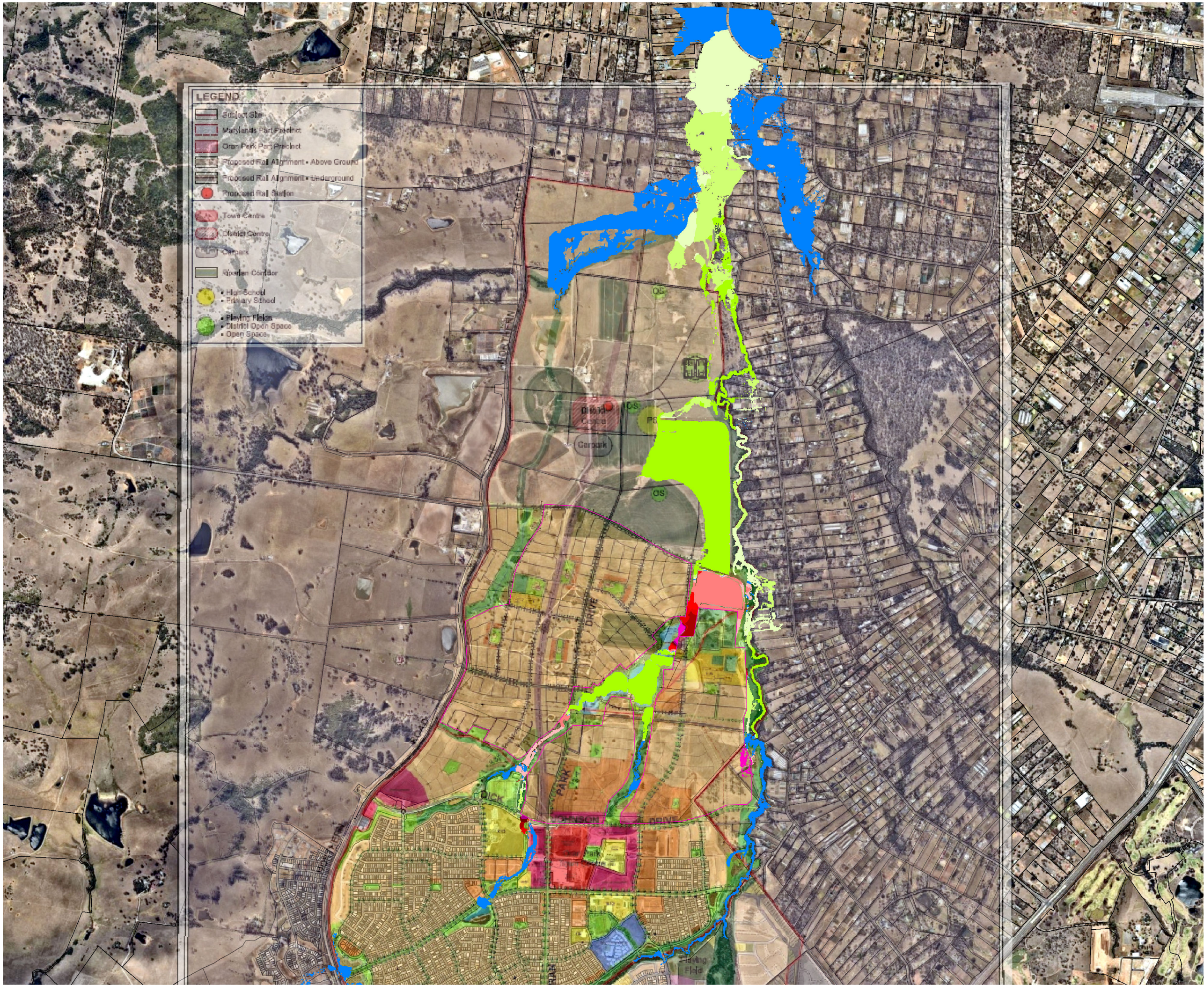
CLIENT:
DEPARTMENT OF PLANNING

DRAWING NO: L03017.407
OPT1_ARR2016_DEPTH_DEV

ISSUE:
01

MAP SERIES:

ISS	BY	CHK	DATE	DETAILS
01	DH		21/10/2019	DRAFT



LEGEND:

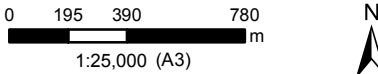
2d_zsh_fill_R2

Flood Afflux (m)

- < -0.1
- 0.1 - -0.05
- 0.05 - -0.01
- 0.01 - 0
- 0 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

Cadastral Lot Boundaries
(From SIX Maps)

NOTES:



PROJECT:
**PONDICHERRY
DEVELOPMENT**

CLIENT:
DEPARTMENT OF PLANNING

DRAWING NO: L03017.407
OPT1_ARR2016_AFFLUX

ISSUE:
01

MAP SERIES:

ISS	BY	CHK	DATE	DETAILS
01	DH		21/10/2019	DRAFT