COUNCIL AGENDA ADDENDUM

ORDINARY COUNCIL MEETING

25 September 2019

LIVERPOOL CITY COUNCIL

LIVERPOOL THE GREAT SOUTH WEST

FRANCIS GREENWAY CENTRE

170 GEORGE STREET LIVERPOOL

ADDENDUM ITEMS

PAGE

EGROW 05	Draft Liverpool Contributions Plan 2019 – Austral and Leppington North

Strategic Direction	Strengthening and Protecting our Environment Exercise planning controls to create high-quality, inclusive urban environments
File Ref	222530.2019
Report By	Barry Millwood - Strategic Planning Contractor
Approved By	Tim Moore - Director, City Economy and Growth / Deputy CEO

EXECUTIVE SUMMARY

The Austral/ Leppington North urban development area has recently undergone a refresh of the planning controls, as considered by Council at its meeting of 27 March 2019 (EGROW 06). This amendment provided Council with the opportunity to update specific elements of the accompanying development contributions plan, particularly as it relates to stormwater management, water quality and the escalating cost of land and works.

The draft *Liverpool Contributions Plan 2019 – Austral and Leppington North* (refer to Attachment to be provided as an addendum to the Council business paper) proposes a rate of $56,097 per lot created. This is an increase of approximately $500 from the current rate, though this is currently capped at $30,000. Despite the minor increase, the draft Contributions Plan has been comprehensively reviewed to ensure that the precinct is supported by a robust plan that minimises financial risk to Council and provides value for money to developers and the broader community.

In addition to addressing the changes included in the most recent amendment to the SEPP and DCP, the update to the draft Contributions Plan enables Council to commence the process to incrementally increase the NSW Government imposed cap on contributions within the precinct. In this regard, the draft Contributions Plan is consistent with the NSW Government's latest directions in relation to contributions, specifically what Council can collect (roads, drainage, open space, land) and cannot collect (any community facilities, high level park embellishment).

The draft Contributions Plan needs to be placed on public exhibition in accordance with the provisions of the *Environmental Planning and Assessment Act* and Regulations. Following exhibition, a report will be prepared for Council to adopt the contributions plan, subject to any necessary amendments in response to exhibition. If no submissions are received, the finalisation of the draft Contributions Plan can be delegated to the CEO.

RECOMMENDATION

That Council:

1. That Council endorse draft *Liverpool Contributions Plan 2019 – Austral and Leppington North* for public exhibition in accordance with the provisions of the *Environmental Planning and Assessment Act, 1979* and *Environmental Planning and Assessment Regulation 2000*;

2. Delegate authority to the CEO to make any typographical or other editing amendments to the draft *Liverpool Contributions Plan 2019 – Austral and Leppington North* prior to exhibition if required; and

3. Delegate authority to the CEO to finalise *Liverpool Contributions Plan 2019 – Austral and Leppington North* following its public exhibition if no submissions are received or report back to Council the results of any submissions received and how the plan addresses those submissions.

REPORT

Background

The Austral and Leppington North Precincts were rezoned by the NSW Government for urban development in March 2013. The NSW Government controlled the preparation of the Indicative Layout Plan, the rezoning and the subsequent Development Control Plan all with input from Council.

The NSW Government also prepared *Liverpool Contributions Plan 2014 - Austral and Leppington North,* based on the Indicative Layout Plan and with input from Council. This contributions plan came into force on 26 May 2015. Council has been collecting contributions since that time to fund infrastructure in the precinct. This contributions plan for the precinct is subject to a cap on contributions imposed by the NSW Government.

There is a procedure for having the cap progressively lifted and for recovering foregone funds from the NSW Government. This begins with preparing a submission to the Independent Pricing and Regulatory Tribunal (IPART) to obtain an assessment of the contributions plan. Council has been advised that IPART will only consider a recently made plan. Accordingly an updated contributions plan for the Austral Leppington North Precincts has been prepared in conjunction with consultants.

Scope of Contributions Plan

The Draft Contributions Plan would continue to levy contributions from residential, non-residential, commercial and industrial developments for the following:

- Local parks (Land and embellishment) (levied on residential development only);
- Local roads (Land and construction);
- Local drainage (Land and construction of swales and basins);
- Local community facilities (Land only) (levied on residential development only); and
- Administration costs.

Council is bound by a Ministerial Direction which limits the range of facilities that it may include in the contributions plan. Those facilities which are excluded from the Draft Contributions Plan include:

- Local community facilities;
- Significant park embellishment;
- Major community facilities (including libraries); and
- Major recreation facilities.

Outline of changes

Since the current contributions plan came into force a number of changes have taken place that need to be incorporated into the version of the plan that will be submitted to IPART. A summary of the key changes is included below.

Amendments to Indicative Layout Plan

Since the completion of the original Indicative Layout Plan, some amendments have been proposed by Council as initially reported to Council at its meeting of 27 June 2018. They included amendments to the Growth Centres State Environmental Planning Policy (SEPP) 2006 (the land use zoning plan) and the Development Control Plan (DCP). These amendments were then endorsed for public exhibition by Council at its meeting of 27 March 2019. Council has recently received Gateway Approval to exhibit the amendments to the SEPP subject to some conditions.

The changes to the DCP are as follows:

- Some minor adjustments to the street network;
- Deletion of some creek crossings;
- Adjustments to the drainage network arising from a recent review of the drainage strategy (details below);
- Street cross section design to improve traffic safety and incorporate water sensitive urban design; and
- Redesign of stormwater quality management controls.

These changes result in some minor changes to the scope of works in the contributions plan.

Adjustment to the scope of drainage works

Council in 2017 commissioned consultants to review the drainage strategy for the Austral and Leppington North Precincts and prepare detailed concept designs for each item of major drainage infrastructure. The detailed concept designs assists with implementation of land development.

As a result, the following amendments are proposed to the drainage strategy:

- Deletion of two detention basins;
- Replacement of some drainage channels with pipes;
- Deletion of some road frontages to deleted channels; and
- Deletion of separate rain gardens (water quality measures), which are replaced with works in the land subdivision (included in DCP amendment).

Adjustment to the value of land

Since the adoption of the original contributions plan in 2015 the value of land has increased substantially. Council, in recent negotiations for the acquisition of land have experienced substantial increases in the value of land (determined by the NSW Valuer-General and the Land and Environment Court), even in excess of the indexed value anticipated by the current contributions plan.

Revised estimates for the acquisition of englobo land from independent valuers have now been received and incorporated in the draft Contributions Plan. The cap on contributions is likely to have contributed to the increase in the englobo land values.

Despite the general increases in land acquisition costs across the precinct, the cost of acquisition of flood liable land is expected to be reduced, as identified in the independent valuers report.

It must be emphasised that the scope of land acquisition will in fact decline slightly as a result of the revised ILP. Any increase in land acquisition costs is not as a result of Council seeking to acquire additional land.

Adjustment to the value of infrastructure

The unit cost of infrastructure other than drainage has been indexed to today's values.

The average contribution per conventional lot, if there was no State imposed cap, under the current contributions plan would be $55,532. The proposed contribution under the draft Contributions Plan would be $56,120 per lot.

The main reasons for the change in the per lot contribution is the increased cost of drainage infrastructure (including land and works) which is mostly offset by reductions in the acquisition cost of specific, flood liable land, and the overall number of stormwater structures required to support the precinct.

Next steps

Exhibition

The next step is to exhibit the draft Contributions Plan for a period of 28 days. Following exhibition it is anticipated that a further report on submissions will be submitted for Council's determination.

Submission to IPART

Once the revised contributions plan has been adopted a submission to IPART will be prepared by consultants, familiar with the requirements of IPART. It is anticipated that IPART will do an initial assessment of the submission and will have a series of meetings with Council/our consultants to explore fine detail in all the costings supporting the Contributions Plan. It is anticipated that this process may take 6 – 12 months.

Once IPART has done an assessment, it will issue a preliminary report for Council to comment on and then following receipt of comments, prepare a final report to submit to the Minister for Planning and Public Spaces.

Ministerial Determination

Once the Contributions Plan has been approved the Minister will then determine whether to provide gap funding for the value of contributions foregone due to the cap and whether to alter the cap.

It must be emphasised that any eventual removal of the cap will not apply to existing consents or new applications once the new contributions plan has been made. It will only apply to new applications determined or received after the Minister determines to remove the cap, a process that has to date involved the cap lifting by $5,000 each year for 2 years before reverting to the full contribution amount.

CONSIDERATIONS

Economic	Deliver and maintain a range of transport related infrastructure such as footpaths, bus shelters and bikeways. Deliver a high quality local road system including provision and maintenance of infrastructure and management of traffic issues. Ensures equity across the precinct in provision of infrastructure to support the community.
Environment	Manage the environmental health of waterways. Support the delivery of a range of transport options.
Social	Provide cultural centres and activities for the enjoyment of the arts. Provide public communal spaces that support incidental interactions.

Civic Leadership	Act as an environmental leader in the community. Foster neighbourhood pride and a sense of responsibility. Actively advocate for federal and state government support, funding and services.
Legislative	Ensures consistency with the *Environmental Planning and Assessment Act, 1979*, *Environmental Planning And Assessment Regulation 2000*, and relevant planning circulars and directions related to developer contributions.

ATTACHMENTS

1. Draft Liverpool Contributions Plan 2019 - Austral and Leppington North

LIVERPOOL CITY COUNCIL

LIVERPOOL CONTRIBUTIONS PLAN 2019 - AUSTRAL AND LEPPINGTON NORTH

Adopted: xxxx

Content Manager 239021.2019

LIVERPOOL THE GREAT SOUTH WEST

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1 Summary of Plan

1.1 Preamble

The Austral and Leppington North Precincts are urban release areas in Sydney's South West Growth Area. Although the Austral Precinct is solely within the Liverpool LGA, the Leppington North Precinct straddles the Liverpool and Camden LGAs.

A range of new and augmented infrastructure needs to be planned, programmed, funded and delivered in order to support this planned development.

The infrastructure will be delivered or coordinated by a number of parties including State Government public authorities, State-owned corporations, councils, developers and private providers.

Councils typically fund the provision of local infrastructure through a combination of general revenue (from rates and other charges), development contributions under the Environmental Planning and Assessment Act 1979, and grants from the State or Commonwealth government. Much of the capital cost of local infrastructure in new urban areas is funded by development ('section 7.11') contributions as there is often a clear relationship between the need for new or upgraded infrastructure and population growth attributable to the new development.

This Plan addresses the provision in the Precincts of those public amenities and public services - or local infrastructure - to be delivered by or on behalf of Liverpool City Council. The provision of local infrastructure in the Plan is estimated to cost approximately $877m and includes:

- open space and recreation facilities, such as sports fields, sports courts, playgrounds, walking trails and bike paths;
- community and cultural facilities, such as an aquatic and recreation centre and multi-purpose community centres;
- water cycle management facilities, such as detention basins and stormwater channels; and
- traffic and transport management facilities, such as upgrades to existing roads, new roads and intersections.

This Plan amends the original version of the contributions plan that was adopted by Council in November 2014. The most recent updates to the Plan account for changes to State Government policy and legislation and other necessary adjustments which ensure the proposed infrastructure provision is efficient and appropriate for the needs of the development and that the contributions are cost reflective.

1.2 Summary of contribution rates and local infrastructure costs

The tables on the following pages show the contribution rates for essential infrastructure applicable to development (which is the subject of this Plan) and the total value of works required to cater for the needs of the new development, including non-essential infrastructure. All costs in this Plan are expressed in June quarter 2019 dollars. Contributions for non-essential infrastructure do not apply under this Plan.

Contributions as land areas are only shown below to indicate the shares of land represented by the monetary contributions, and are not additional to monetary contributions.

Example contribution rate calculations are also shown for residential and non-residential development scenarios.

1.2.1 Monetary Contribution Rates

ESSENTIAL INFRASTRUCTURE		RESIDENTIAL DEVELOPMENT*				NON RESIDENTIAL DEVELOPMENT**
Item	Item Cost apportioned to Austral and Leppington North Development	$ per additional person	$ per residential lot for a dwelling house	$ per attached dwelling, semi-attached dwellings and multi-dwelling housing	$ per dwelling in all other residential accommodation	$ per hectare of equivalent NDA
Open Space						
Land	$276,127,956	$5,557	$18,895	$14,449	$14,449	
Works	$131,920,139	$2,655	$9,027	$6,903	$6,903	
Subtotal	$408,048,095	$8,213	$27,923	$21,353	$21,353	
Community Facilities						
Land	$6,424,768	$129	$440	$336	$336	
Subtotal	$6,424,768	$129	$440	$336	$336	
Roads						
Land	$23,388,185	$442	$1,503	$1,149	$1,149	$20,416
Works	$80,983,682	$1,530	$5,203	$3,979	$3,979	$70,692
Subtotal	$104,371,867	$1,972	$6,705	$5,128	$5,128	$91,107
Drainage						
Land	$125,622,453					$109,657
Works	$226,315,751					$197,554
Subtotal	$351,938,204					$307,211
Plan Administration						
Allowance	$6,588,294					$5,751
Subtotal	$6,588,294					$5,751
TOTAL	$877,371,228	$10,314	$35,068	$26,816	$26,816	$404,070

*Residential development also pays drainage and plan administration contributions (calculated on an NDA basis).
** NDA rates for roads apply to non-residential development only.

NON ESSENTIAL INFRASTRUCTURE		RESIDENTIAL DEVELOPMENT			
Item	Item Cost apportioned to Austral and Leppington North Development	$ per additional person	$ per residential lot for a dwelling house	$ per attached dwelling, semi-attached dwellings and multi-dwelling housing	$ per dwelling in all other residential accommodation
Community Facilities					
Local Facilities Works	$20,360,684	$410	$1,393	$1,065	$1,065
Regional Facility Works	$36,396,838	$733	$2,491	$1,905	$1,905
TOTAL	$56,757,521	$1,142	$3,884	$2,970	$2,970

1.2.2 Land contribution rates

ESSENTIAL INFRASTRUCTURE		RESIDENTIAL DEVELOPMENT*				ALL DEVELOPMENT""
Item	Item Total Area apportioned to Austral and Leppington North Development (m2)	m^2 per additional person	m^2 per dwelling house	m^2 per attached dwelling, semi-attached dwellings and multi-dwelling housing	m^2 per dwelling in all other residential accommodation	m^2 per hectare of equivalent NDA
Open Space						
Land	1,068,519	21.51	73.12	55.91	55.91	
Community Facilities						
Land	14,341	0.29	0.98	0.75	0.75	
Roads						
Land	57,480	1.09	3.69	2.82	2.82	50.18
Drainage						
Land	719,601					628.15
TOTAL	1,859,941	22.88	77.79	59.49	59.49	678.32

1.2.3 Example contribution calculations

The **residential contribution** (for essential infrastructure) equals the sum of:

- The open space contribution per dwelling,
- The community facilities contribution per dwelling,
- The transport contribution per dwelling,
- The stormwater infrastructure contribution per hectare of NDA, and
- The plan preparation and administration contribution per hectare of NDA.

Contributions for open space, community facilities and transport infrastructure are levied based on the number of people expected to reside in the new dwelling, while contributions for stormwater infrastructure and plan administration are levied by the area (NDA) of the development.

This approach best aligns the contribution payable by a development to its estimated share of the demand for the different kinds of infrastructure in the Plan.

Below is an example of how to calculate the contribution payable by development.

Consider a scenario where a developer has 0.2 hectares (NDA) and applies to develop 5 low density dwelling houses on this land.

The total contribution under this Plan =

($27,923 x 5) + ($440 x 5) + ($6,705 x 5) + ($307,211 x 0.2) + ($5,751 x 0.2) = $237,930

This equals a contribution of $47,586 per dwelling, on average, for this development.

Up until 1 July 2020, development is unlikely to be levied the full contribution amount. Section 2.8 explains how the cap on monetary contributions impacts the contribution payable by development in a given period.

The non-residential contribution equals the sum of:

- The transport contribution per NDA,
- The stormwater infrastructure contribution per NDA, and
- The plan preparation and administration contribution per NDA.

Below is an example of how to calculate the contribution payable by development.

Consider a scenario where a developer applies to develop a 0.5 hectare (NDA) site for commercial offices.

The total contribution under this Plan =

($91,107 x 0.5) + ($307,211 x 0.5) + ($5,751 x 0.5) = ($404,070 x 0.5) = $202,035

There is no cap on contributions for non-residential development.

1.3 Overview and structure of Plan

Section 7.11 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) allows a consent authority responsible for determining a development application to grant consent to the proposed development subject to a condition requiring the payment of a monetary contribution, or the dedication of land free of cost, or a combination of them, towards the provision of public amenities and public services to meet the development.

Where the consent authority is a council or an accredited certifier, such a contribution may be imposed on a development only if it is of a kind allowed by and determined in accordance with a contributions plan, such as this Plan.

This Plan has been prepared to authorise the imposition of development contributions on development expected to occur in the Austral Precinct and that part of the Leppington North Precinct that is situated in the Liverpool LGA.

This Plan has been prepared:

- in accordance with the EP&A Act and Environmental Planning and Assessment Regulation 2000 (EP&A Regulation); and
- having regard to the latest Practice Notes issued by the NSW Department of Planning, Industry and Environment.

There are minimum requirements for development contributions plans set out in the EP&A Regulation. Each requirement, and reference to the clause or Part of this document that deals with that requirement, are listed below:

The purpose of the plan	Clause 2.4
The land to which the plan applies	Clause 2.3
The relationship or nexus between the expected development in the area and the community infrastructure that is required to meet the demands of that development	Part 3
The formulas to be used for determining the reasonable contributions required from expected development for different types of community infrastructure;	Clauses 4.2.2, 4.3.2, 4.4.2, 4.5.2, 4.6.2
The contribution rates for the anticipated types of development in the area;	Clause 1.2
The council's policy concerning the timing of the payment of monetary development contributions, and the imposition of development conditions that allow deferred or periodic payment,	Clause 2.9

Maps showing the specific public amenities and services proposed to be provided by the council, supported by a works schedule that contains an estimate of their cost and staging (whether by reference to dates or thresholds)	Part 5
If the plan authorises monetary development contributions or section 7.12 levies paid for different purposes to be pooled and applied progressively for those purposes, the priorities for the expenditure of the contributions or levies, particularised by reference to the works schedule.	Part 5

2 Administration and operation of the Plan

2.1 Definitions used in this Plan

Except where indicated in this clause, the definitions of terms used in this Plan are the definitions included in the EP&A Act, EP&A Regulation and the *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*, are adopted by this Plan.

In this clause, 'existing' means at the date on which this Plan came into effect.

In this Plan, the following words and phrases have the following meanings:

Bank Guarantee means an irrevocable and unconditional undertaking without any expiry or end date in favour of the Council to pay an amount or amounts of money to the Council on demand issued by an Australian bank, non-bank financial institution, or insurance company subject to prudential supervision by the Australian Prudential Regulatory Authority and has a credit rating of 'A' or above (as assessed by Standard and Poors) or 'A2' or above (as assessed by Moody's Investors Service) or 'A' or above (as assessed by FitchRatings).

Council means Liverpool City Council.

CPI means the *Consumer Price Index (All Groups - Sydney)* published by the Australian Bureau of Statistics.

EP&A Act means the Environmental Planning and Assessment Act 1979.

EP&A Regulation means the Environmental Planning and Assessment Regulation 2000.

ILP means the Austral and Leppington North Precincts Indicative Layout Plan.

LGA means local government area.

Precincts means the area of land shown in Figure 2.1 of this Plan.

Net Developable Area means the area of land to which a development application relates and includes the area of any land that the development consent authorises, or requires, to be used as a road, or reserved or dedicated as a public road but excludes:

(a) existing roads to be used as part of the proposed road network;

(b) existing educational establishments (as defined in the Standard Instrument);

(c) any part of the land that is below the level of a 1:100 ARI flood event, if that part of the land is unsuitable for development by virtue of it being at or below that level;

(d) any land that the development consent authorises, or requires, to be reserved, dedicated or otherwise set aside as, or for the purpose of, any of the following:

(i) a government school (within the meaning of the *Education Act 1990*);

(ii) a tertiary institution, including a university or TAFE establishment, that provides formal education and is constituted by or under an Act.

(iii) an emergency services facility;

(iv) a health services facility owned and operated by a public authority;

(v) a golf course;

(vi) a passenger transport facility;

(vii) a public reserve or a drainage reserve (within the meaning of the *Local Government Act 1993*);

(viii) a public transport corridor (other than a road corridor);

(ix) a public utility undertaking;

(x) roads or other public amenities or public services, in connection with which development contributions have been imposed under section 7.11 or section 7.12 of the Act or may be imposed in accordance with a contributions plan approved under section 7.18 of the EP&A Act;

(xi) roads or other infrastructure in connection with which Special Infrastructure Contributions have been, or may be, imposed in accordance with section 7.24 of the EP&A Act.

Planning Agreement means a Voluntary Planning Agreement referred to in section 7.4 of the EP&A Act.

Residential Accommodation has the same meaning as in the *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*.

Social Infrastructure Assessment means the report titled, *Austral and Leppington North Precincts - Demographic and Social Infrastructure Assessment*, prepared by Elton Consulting, July 2011.

Special Infrastructure Contribution means a contribution referred to in section 7.24 of the EP&A Act.

State Environmental Planning Policy (Sydney Region Growth Centres) 2006 means the State Environmental Planning Policy amended from time to time.

Transport Assessment means the Austral and Leppington North (ALN) Precincts Transport Assessment prepared by AECOM, July 2011.

Works In Kind means the undertaking of a work or provision of a facility by an applicant which is already nominated in the works schedule of a contributions plan as a means of either fully or partly satisfying a condition of consent requiring development contributions to be made.

Works Schedule means the schedule of the specific public amenities and public services for which contributions may be required as set out in Part 5 of this Plan.

2.2 Name of Plan

This Plan is called Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts (the Plan).

2.3 Land to which Plan applies

This Plan applies to the Austral and Leppington North Precincts within the Liverpool LGA (i.e., the Precincts), as illustrated in Figure 2.1 over page.

Figure 2.1 **Land to which this Plan applies**

2.4 Purposes of Plan

The purposes of the Plan are to:

- Provide an administrative framework under which specific public amenities and services strategies to serve the Precincts may be implemented and coordinated.
- Ensure that adequate public amenities and services are provided for as part of any new development in the Precincts.
- To authorise the Council or accredited certifiers to impose conditions under section 7.11 of the EP&A Act when granting consent to development on land to which this Plan applies.
- Provide a comprehensive strategy for the assessment, collection, expenditure accounting and review of development contributions relating to the Precincts on an equitable basis.
- Ensure that the existing community is not burdened by the provision of public amenities and services required as a result of future development in the Precincts.
- Enable the Council to be both publicly and financially accountable in its assessment and administration of the Plan.

2.5 Adoption of Plan

This Plan was adopted by Council on x and came into effect on x. Previous versions of the plan were by Council on 26 May 2015 and 26 November 2014.

This Plan applies to development applications determined after the date on which the Plan came into effect.

2.6 Relationship to other plans

This Plan repeals Liverpool Contributions Plan 2014 - Austral and Leppington North Precincts.

The land to which this Plan applies is not otherwise subject to any contributions plans made under Subdivision 3 of Division 7.1 of Part 7 of the EP&A Act.

This Plan does not limit or otherwise affect any requirements for the payment of Special Infrastructure Contributions pursuant to Subdivision 4 of Division 7.1 of Part 7 of the EP&A Act.

This Plan has been prepared in conjunction with the *Camden Growth Areas Contributions Plan* as it applies to the Leppington North Precinct (Camden). The Precincts, which comprise land situated in both the Camden and Liverpool LGAs, have been released concurrently and their combined infrastructure needs have been established under an Infrastructure Delivery Plan for the Austral and Leppington North Precincts. This Plan addresses development contributions in respect to development expected to take place in the Liverpool LGA component of the Precincts.

2.7 Types of development to be levied

Except as provided for by this clause, this Plan applies to:

- Residential Accommodation development, insofar as the Plan authorises the imposition of a requirement for a development contribution for the types of public amenities and public services described in clauses 4.2 to 4.6 of this Plan; and
- All other development, insofar as the Plan authorises the imposition of a requirement for a development contribution for the types of public amenities and public services described in clauses 4.4 to 4.6 of this Plan.

This Plan does not apply to development:

- for the sole purpose of affordable housing;
- for the sole purpose of the adaptive reuse of an item of environmental heritage;
- for the purposes of public infrastructure provided by or on behalf of State Government or the Council;
- for the purposes of public amenities or public services under this Plan or another contributions plan prepared under section 7.13 of the EP&A Act;
- for works to be carried out by Sydney Water, Endeavour Energy or equivalent water, sewer or energy provider; or
- that in the opinion of Council does not increase the demand for the categories of public amenities or public services addressed by this Plan.

2.8 Authority to require contributions

2.8.1 Monetary contributions

This Plan authorises the Council, when granting consent to an application to carry out development to which this Plan applies, to impose a condition under section 7.11 of the EP&A Act requiring the payment of a monetary contribution to the Council towards:

- the provision of public amenities and public services as specified in the Works Schedule to meet the demands of the development; and / or
- the recoupment of the cost of public amenities and public services previously provided in advance of development within the area.

This Plan requires the Council or an accredited certifier, when determining an application for a complying development certificate relating to development to which this Plan applies, to impose a condition under section 7.11 of the EP&A Act requiring the payment of a monetary contribution towards:

- the provision of public amenities and public services as specified in the Works Schedule to meet the demands of the development; and / or
- the recoupment of the cost of public amenities and public services previously provided in advance of development within the area.

2.8.2 Land contributions

This Plan authorises the Council, by imposition of a condition of development consent, to require in connection with any development on land to which this Plan applies (and in addition to any monetary contribution that may be sought) the dedication free of cost to the Council of any part of the development site that is land that is to be acquired under this Plan.

The extent of land that may be required in the consent shall not exceed the amount of land the value of which does not exceed the monetary contribution otherwise authorised by this Plan.

The monetary development contribution otherwise authorised by this Plan shall be reduced by an amount corresponding to the value of the land required to be dedicated.

Where the value of the land exceeds the monetary development contribution otherwise authorised, the developer may offer to enter into a Planning Agreement dealing with an appropriate settle-up in exchange for the dedication of the remainder.

Further information on land contributions is included in clauses 2.9.5 and 2.11 of this Plan.

2.8.3 Cap on monetary contributions for residential development

On 28 July 2017, the Minister for Planning issued the *Environmental Planning and Assessment (Local Infrastructure Contributions) Amendment Direction 2017* that requires councils to submit contributions plans to IPART for assessment if they wish to levy contributions above the prevailing capped amount.

Without a review of the plan by IPART, the maximum contribution amount applying to residential development in the Precincts is $30,000 per dwelling/lot. Once IPART reviews the plan and the Minister or its delegate publishes the Government's advice about the IPART recommendations, the contribution rates applying to residential development are the lower of the applicable contribution amount in Section 1.2 (for essential infrastructure only) or $45,000 per dwelling/lot from 1 July 2019 to 30 June 2020.

From 1 July 2020, the contribution amounts in Section 1.2 will apply to residential development, assuming these rates are in accordance with the IPART- review and the Government's subsequent advice on the plan.

Applicants should inquire with the Council as to the current rates that apply to residential development.

2.8.4 Obligations of accredited certifiers

In relation to an application made to an accredited certifier for a complying development certificate:

- the accredited certifier must, if a complying development certificate is issued, impose a condition requiring a development contribution, if such a contribution is authorised by this Plan; and
- any such contribution may only be a monetary contribution required under this Plan; and
- the amount of the monetary contribution that the accredited certifier must so impose is the amount determined in accordance with this Plan in respect of the development.

It is the responsibility of the principal certifying authority to accurately calculate and apply the local infrastructure contribution conditions to complying development certificates. Deferred payments of contributions required by a condition of a complying development certificate will not be accepted.

2.8.5 Variation to contributions authorised by this Plan and contributions for unanticipated development

Council retains the right to reduce the development contribution otherwise calculated in accordance with the provisions of this Plan.

A developer's request for variation to a contribution calculated in accordance with this Plan must be supported by written justification included with the development application. Such request will be considered as part of the assessment of the application.

There may be circumstances when development is proposed that was not anticipated when this Plan was made and that is not specifically identified to be levied under this Plan, but which would if carried out, result in the provision of, or increase the demand for, the public amenities and services included in this Plan. In these circumstances, Council will calculate a reasonable contribution proportionate to the demand for amenities and services generated by the unanticipated development, and impose that contribution on the consent for that development.

This clause does not apply to accredited certifiers other than the Council. Accredited certifiers other than the Council must not:

- vary, waive or modify a development contribution calculated in accordance with this Plan, or
- impose any contribution other than a monetary contribution specifically authorised by this Plan.

2.9 Payment of contributions

2.9.1 Timing of payment

Council requires contributions to be satisfied in full, as follows:

Development applications involving subdivision only

Monetary contributions are required to be paid prior to the release of the subdivision certificate whether by Council or an accredited certifier (in the case of strata subdivision). Any dedication of land to Council, in lieu of a monetary contribution, shall be shown on the plan of subdivision.

Development applications involving building work only

Monetary contributions are required to be paid to Council prior to the issuing of the construction certificate, whether by Council or an accredited certifier. Dedication of land to Council, in lieu of monetary contribution, shall be shown on a plan of subdivision, to be registered prior to the issue of an occupation certificate.

Development applications involving subdivision and building work (for example, dual occupancy and integrated housing)

Monetary contributions are required to be paid to Council prior to the release of the construction certificate or subdivision certificate, whichever occurs first, whether by Council or an accredited certifier. Any dedication of land to Council, in lieu of monetary contribution, shall be shown on a plan of subdivision, to be registered prior to issue of an occupation certificate.

Development applications where no building works are proposed

Monetary contributions are required to be paid to Council prior to occupation / commencement of the development. Any dedication of land to Council, in lieu of monetary contribution, shall be shown on a plan of subdivision to be registered prior to issue of an occupation certificate.

2.9.2 Obligations of accredited certifiers

It is the responsibility of an accredited certifier issuing a construction certificate to certify that the contributions have been paid to Council prior to the issue of the certificate. The accredited certifier must ensure that the applicant provides a receipt (or receipts) confirming that contributions have been fully paid and copies of such receipts must be included with copies of the certified plans provided to the Council in accordance with clause 142(2) of the EP&A Regulation. Failure to follow this procedure may render such a certificate invalid and expose the certifier to legal action.

The only exceptions to the requirement are where Works In Kind, material public benefit, dedication of land and/or deferred payment arrangement has been agreed by the Council. In such cases the Council will issue a letter confirming that an alternative payment method has been agreed with the applicant.

2.9.3 Deferred payments

Council will allow payment of contributions to be deferred in the following cases only:

- where the applicant has the intention and ability to dedicate land or provide a material public benefit in part or to full satisfaction of a condition imposed by development consent, and that offer of land or material public benefit is acceptable to the Council; or
- in other circumstances, to be outlined in writing by the applicant and determined formally by Council on the merits of the case.

In the circumstances where deferred payments are accepted, the debtor must lodge with Council an unconditional bank guarantee for the amount to be deferred. Bank guarantees will be accepted on the following conditions:

- The guarantee must carry specific wording outlining the purpose for which those contributions were due, for example, "drainage contributions for Stage 3".
- The guarantee will be for the contribution amount plus the estimated amount of compound interest foregone by Council for the anticipated period of deferral (Refer to formula in clause 2.9.4 below).

Council may call up the guarantee at any time without reference to the applicant, however, the guarantee will generally be called up only when cash payment has not been received, and land is not dedicated or material public benefit not provided by the end of the period of deferral.

The period of deferral must be for a limited time only as agreed where land is to be dedicated or a material public benefit is to be provided. The period of deferral may be extended subject to providing a further bank guarantee for the extended period in accordance with the above terms.

Council will discharge the bank guarantee when payment is made in full by cash payment, land transfer or by completion of Works In Kind.

2.9.4 Formula for bank guarantee amounts

The following formula to be applied to all bank guarantees for contributions is:

Guarantee Amount = $P + P(CI \times Y)$

Where

P = Contribution due;

CI = Compound interest rate comprised of Council's estimate over the period plus 3 percent allowance for fluctuations); and

Y = Period of deferral (years).

2.9.5 Methods of settling contribution requirements

Contributions may be made by one or a combination of the methods described below.

Monetary contribution

A monetary contribution is the most common method of settling contribution requirements. However, Council may consider the transfer of land to Council or providing Works In Kind, but only where the offered land and or works are included in this Plan's Works Schedule (Part 5 of this Plan).

Transfer of land

An applicant may transfer land to Council in part or in full satisfaction of a contribution requirement. The land may be for open space, community facilities, drainage or roads and must be land, which is included in this Plan's Works Schedule (Part 5 of this Plan). The value of the land will be determined by an independent valuer appointed by Council.

Where land which is the subject of a development application contains land identified for acquisition under this Plan, Council may as a condition of consent require that land to be dedicated free of charge to Council. Monetary contributions will be adjusted accordingly to reflect the value of the land to be dedicated in lieu of payment of cash.

Works In Kind

Applicants are encouraged to provide Works In Kind in part or full satisfaction of a contribution. The works must be included in this Plan's Works Schedule (Part 5 of this Plan). The value of contingency for individual works will be paid where it can be proven to Council's satisfaction that unforeseen circumstances have given rise to additional costs.

Prior to proceeding with the works, applicants will be required to provide details of the works to be undertaken (including a development application), financial guarantees, bank guarantees and administration.

Applicants may provide land or works included in Part 5 of this Plan in excess of that required for the development. The value of the works will be determined in accordance with Council's Works in Kind Procedure, available from Council's administration office.

2.9.6 Goods and Services Tax

No Goods and Services Tax (GST) is applicable to the payment of contributions made under section 7.11 of the EP&A Act. This exemption applies to both cash contributions and land or works in lieu of contributions.

2.10 Contributions demand credits for existing development

Monetary contributions determined under this Plan will be calculated according to the estimated net increase in demand for the particular public amenities and public services that are included in this Plan and that a particular development is projected to generate.

The Plan addresses the provision of:

- roads, transport, and drainage facilities (being 'economic infrastructure'); and
- open space, recreation, community and cultural facilities (being 'social infrastructure'),

that have been designed to meet the needs of the urban development of the Precincts.

The planned economic infrastructure is to facilitate the conversion of the area from semi-rural development context to an urban development context. It is the wholesale re-development of the land for urban purposes (particularly through land subdivisions) that necessitates the provision of the economic infrastructure. The economic infrastructure currently available does not meet the needs of the planned urban development and whole new road and drainage networks have to be designed and built to meet those needs. No credit will therefore be given in the calculation of contributions for the demand for economic infrastructure attributable to development that existed at the time this Plan was prepared.

The planned social infrastructure is also to facilitate that same conversion, however there are people already living in the area that demand and use social infrastructure. It is also likely that current populations will, to some extent, demand the recreation and community facilities that will be provided under this Plan.

Consistent with the above, in calculating contributions under this Plan a credit will be given in the calculation of contributions only for the demand for social infrastructure attributable to development that existed at the time this Plan was prepared. That is, a contribution for social infrastructure will only be due to any net increase in population relating to the proposed development.

To determine the net increase in demand for social infrastructure requires that an assessment be made of:

- in the case of the first urban development of the land - the existing residential population on the site when the first version of the plan came in to effect in 2014, or
- in the case of any subsequent urban development on the land - the assumed residential population on the site at the date of lodgement of the application,

whichever is relevant.

The information included in Appendix A of this Plan will be used to calculate the estimated net increase in residential population in the case of the first urban development of the land.

A precise population attributable to each existing residential development is not available. Instead, this Plan assesses existing population on the basis of average dwelling occupancy figures for the Austral and Leppington North Precincts.

The assumed household occupancy rate for the purpose of determining net increase in demand for social infrastructure and the calculation of open space and recreation, and community and cultural facilities contributions under this Plan is 3.1 persons per dwelling.[1]

2.11 Adjustment to contribution rates and contribution amounts

2.11.1 Overview

The purpose of this clause is to ensure that the monetary contribution rates imposed at the time of development consent reflect the current costs of provision of the facilities included in this Plan.

To convert the cost of facilities included in the Plan to a current cost, the monetary contribution rates shown in Part 1 of this Plan are to be adjusted in accordance with the provisions set out below:

- at the time of imposing a condition on a development consent requiring payment of the monetary contribution; and again
- at the time that the monetary contribution is to be paid pursuant to the condition imposed on that same development consent.

The adjusted contribution rates will also be published quarterly on the Council's website *www.liverpool.nsw.gov.au*.

This process is distinct and separate from clause 2.12, which deals with future reviews of this Plan. Future reviews will not affect any consent granted in accordance with this Plan and such reviews are required to be publicly exhibited.

2.11.2 Adjustment methods

The Consumer Price Index (CPI) is the most commonly used index for adjusting contribution rates, and for simplicity, is applied to contribution rates levied on development under this Plan. However, it is not the most suitable index for escalating capital works costs nor contributions relating to land that is yet to be acquired.

Capital works costs in the schedule of works are escalated to the base date of this Plan by ABS producer price indexes (PPIs):

- PPI - Building Construction NSW (cat no. 30) for community facilities
- PPI – Non-Residential Building Construction NSW (cat no. 3020) for open space facilities; and
- PPI - Road and Bridge Construction NSW (cat no. 3101) for roads and stormwater facilities.

Land prices do not correlate with movements in the prices of goods and services, especially in urban release areas. As a result, Council will prepare and regularly publish a customised Land Value Index (LVI), generally consistent with in the contributions management arrangements it applies to other land release areas within the Liverpool LGA.

In accordance with the provisions of clause 32(3) of the EP&A Regulation, Council, without the necessity of preparing a new or amending contributions plan, will adjust the monetary development contribution rates set out in this Plan to reflect quarterly changes to both:

- the CPI (for all Works Schedule items identified in this Plan apart from the items comprising land yet to be acquired); and
- the customised LVI (for Works Schedule items identified in this Plan involving land yet to be acquired).

[1] *Austral and Leppington North Precincts – Demographic and Social Infrastructure Assessment*, prepared by Elton Consulting, page 14 identifies rates of 3.2 and 3.0 persons per dwelling in Austral and Leppington suburbs in 2006. A rate of 3.1 is assumed to be an average occupancy rate across both suburbs.

2.11.3 Works Schedule items other than land

The monetary contributions rates for Works Schedule items as set out in Part 5 of this Plan will be adjusted to reflect quarterly variations in the Consumer Price Index (All Groups - Sydney) from the date that the Plan came into effect.

The adjustments shall be made at the time of granting development consent so as to determine the appropriate contribution to be included on any relevant consent. A further adjustment will be made at the time of payment to reflect any further changes between the date of consent and payment of contribution.

Contribution at time of development consent

$$C_2 = \frac{C_1 \times CPI_2}{CPI_1}$$

Contribution at time of payment

$$C_3 = \frac{C_2 \times CPI_3}{CPI_2}$$

Where:

C_1 = Contribution of rate for works as shown in this Plan

C_2 = Contribution rate for works as included or to be included in the conditions imposed on the development consent

C_3 = Contribution rate for works at the time that the contribution is to be paid

CPI_1 = *Consumer Price Index (All Groups - Sydney)* result at the time that the Plan was prepared - i.e. June quarter 2019

CPI_2 = *Consumer Price Index (All Groups - Sydney)* result for the quarter immediately prior to the date of granting the relevant development consent

CPI_3 = *Consumer Price Index (All Groups - Sydney)* result for the quarter immediately prior to the date that the contribution is to be paid

2.11.4 Land

The monetary contributions rates for Works Schedule items that relate to land as set out in Part 5 of this Plan will be adjusted in accordance to reflect quarterly variations in the Land Value Index (published on the Liverpool City Council website) from the date that the Plan came into effect.

The adjustments shall be made at the time of granting development consent so as to determine the appropriate contribution to be included on any relevant consent. A further adjustment will be made at the time of payment to reflect any further changes between the date of consent and payment of contribution.

Contribution at time of development consent

$$C_2 = \frac{C_1 \times LVI_2}{LVI_1}$$

Contribution at time of payment

$$C_3 = \frac{C_2 \times LVI_3}{LVI_2}$$

Where:

C_1	=	Land component of contributions as shown in this Plan
C_2	=	Land component of contributions subject of the conditions imposed on the development consent
C_3	=	Land component of contributions at the time that the contribution is to be paid
LVI_1	=	Land Value Index at the time that the Plan was prepared - i.e. June quarter 2019 = 100
LVI_2	=	Land Value Index at the time of granting the relevant development consent
LVI_3	=	The latest Land Value Index at time that the contribution is to be paid

2.11.5 Calculation of Land Value Index

The Land Value Index is a measure to reflect the changes in land values during the life of the Plan from the date of the adoption of the Plan.

The land costs included in the Works Schedule in Part 5 of this Plan are based on estimates provided in the report prepared by CivicMJD (1 July 2019). This provided an update to the valuations by CivicMJD in its report dated 2018.

The values are shown in Table 2.1.

Table 2.1 Assumed land values for various classifications

Land classification	Base assumed land cost (per sqm)	Land cost (per sqm) including average acquisition contingencies of 12%
Riparian corridors (constrained land and land below the 20-year Annual Recurrence Interval (ARI) event)	$35	$39.20
Residential land between the 20-year and 100-year ARI events	$135	$151.20
Low density residential prime land (R2) above the 100-year ARI event	$340	$380.80
Medium density residential prime land (R3) above the 100-year ARI event	$430	$481.60
Commercial/ Neighbourhood Business (B1) prime land within the town centre and above the 100 -year ARI event	$400	$448.00
Commercial/ Business Development prime land (B5) within the town centre and above the 100-year ARI event	$450	$504.00
Employment lands/ Industrial	$370	$414.40

Notes:

Refer to section 5.0 of the original MJ Davis Valuations report (undated) for Leppington and Leppington North but may include Special Land Value at date of acquisition, Severance, Solatium and Disturbance as required to be paid pursuant to the *Land Acquisition (Just Terms Compensation) Act 1991.*

The derivation of the Land Value Index, its quarterly updates and accompanying contributions rates for Austral Leppington North, are published on Council's website.

2.12 Review of Plan and contribution rates

Council will review this Plan on a regular basis.

The review process will canvass, as a minimum, the following issues (where data is available):

- development activity in terms of latest information on net additional dwellings and populations;
- likely total development activity to be experienced during the remainder of the Precincts development;
- progress in the delivery of public amenities and services identified in Part 5 of this Plan;
- modification of facility concepts, changes in anticipated facility costs, facility timing and land values;
- annual contributions received and expenditure information; and
- any other factors likely to affect the delivery of works identified in this Plan.

Pursuant to clause 32(3) of the EP&A Regulation, Council may make only minor adjustments or amendments to the Plan without prior public exhibition and adoption by Council. Minor adjustments could include minor typographical corrections and amendments to rates resulting from changes in the indexes adopted by this Plan.

Amendments beyond those authorised under clause 32 of the EP&A Regulation require the preparation of a new draft plan which in turn must meet the requirements of the EP&A Act and EP&A Regulation (including public exhibition of the draft plan for a period of at least 28 days). The nature of the proposed amendments and reasons for same would be clearly outlined as part of the exhibition.

Amendments requiring public exhibition would include adjustments to contribution rates taking account of more recent information and, where relevant, the following:

- actual costs of completed works;
- reviewed costs of yet to be completed works and land acquisition;
- adjustment in projected project management and contingency costs associated with works; and
- plan management and administration costs.

Plan reviews of the type described above will not affect any development contributions obligation required under any consent that is granted under this Plan.

2.13 Pooling of funds

Council's ability to forward fund services and amenities identified in this Plan is very limited. Consequently their provision is largely contingent upon the availability of contributions funds.

To provide a strategy for the orderly delivery of the public services and amenities, this Plan authorises monetary contributions paid for different purposes in accordance with the conditions of various development consents authorised by this Plan and any other contributions plan approved by the Council to be pooled and applied progressively for those purposes.

The priorities for the expenditure of pooled monetary contributions under this Plan are the priorities for works as set out in the Works Schedule in Part 5.

In any case of the Council deciding whether to pool and progressively apply contributions funds, the Council will have to first be satisfied that such action will not unreasonably prejudice the carrying into effect, within a reasonable time, of the purposes for which the money was originally paid.

3 Demand for public amenities and public services

3.1 Summary of this Part

The Austral and Leppington North Precincts are part of the South West Growth Area, as planned by the State Government.

The Austral Precinct and a portion of the Leppington North Precinct are in the Liverpool LGA and so Liverpool City Council will serve as a consent authority for much of the development. Council will also be the manager of most of the new public infrastructure that will be required to be delivered in its jurisdiction.

Planning for housing and other development requires the parallel planning for public infrastructure to support the development and the incoming population.

The incoming population is directly related to the expected number and type of residential dwellings and extent of non-residential development floor space in an area.

The extent of public amenities and services required for the future development of an area is usually based on standards or benchmarks rates (e.g. per capita provision).

The application of the provision standards to the estimate of expected development enables a list of infrastructure requirements to meet that development to be compiled.

This connection between expected development, infrastructure standards, and the resultant infrastructure list directly informs the contribution requirements in this Plan.

A range of infrastructure studies have been prepared to inform the infrastructure list (or Works Schedule). Part 4 of this Plan provides more detail on the servicing requirements expressed in these studies.

3.2 Development and infrastructure planning context

3.2.1 Growth Areas Structure Planning

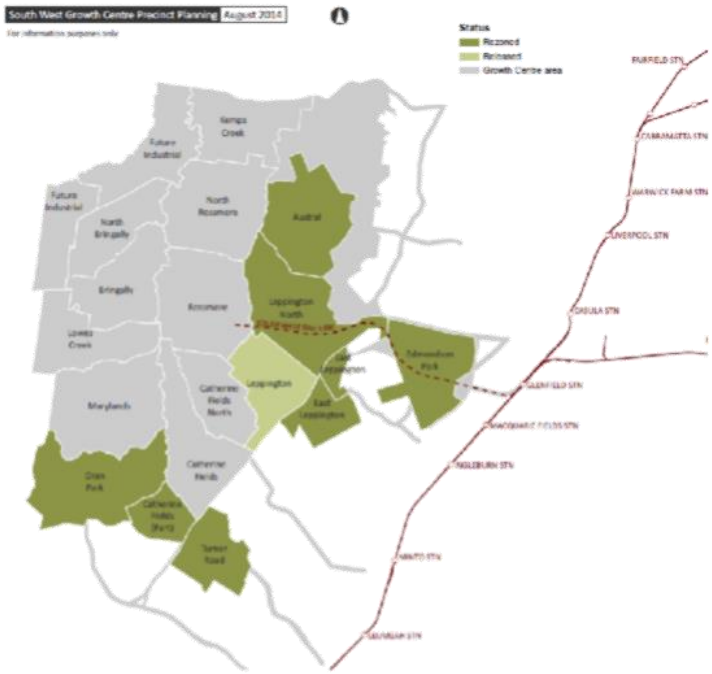
The land affected by this Plan is within the Austral and Leppington North Precincts in Sydney's South West Growth Area.

To facilitate planning and orderly development of the South West Growth Area, this area has been divided into seventeen precincts. The locations of the early release precincts, including Austral and Leppington North Precincts, are shown in Figure 3.1 over page.

The Austral and Leppington North Precincts were released for precinct planning purposes by the Minister for Planning in October 2009. The Austral Precinct is wholly located in the Liverpool LGA, while the Leppington North Precinct is located partly in the Liverpool LGA and partly in the Camden LGA. This contributions plan relates to the Austral Precinct and that part of the Leppington North Precincts that is within the Liverpool LGA.

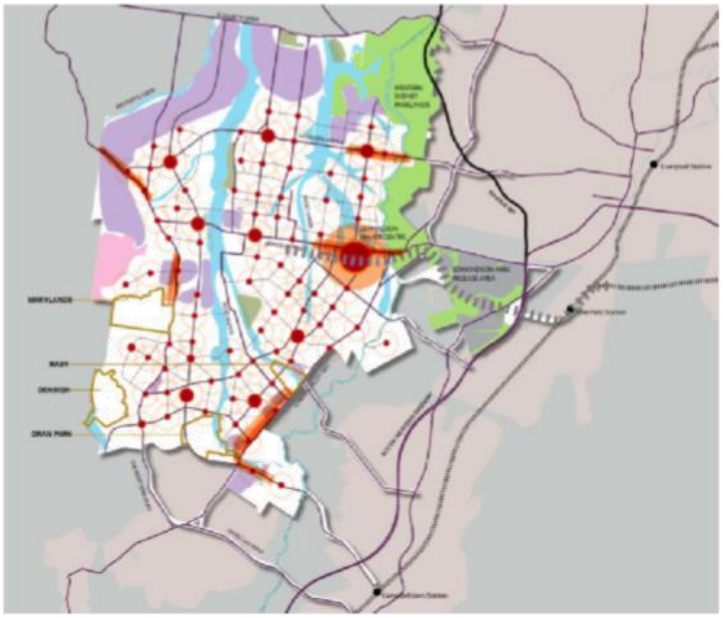
A structure plan has been prepared for the Growth Area (formerly referred to as the Growth Centre), a copy of which is included as Figure 3.2 over page. Apart from local neighbourhood centres, the structure plan proposes ten (10) new town or village centres. The largest of these is the planned Major Town Centre at Leppington that will be located in the Leppington North Precinct in the adjoining Camden LGA, immediately adjacent to the southern boundary of the land affected by this Plan. The Western Sydney Parkland forms the northern and eastern boundaries of the Precincts.

The Leppington Major Centre will be a major service provider for properties in the Precincts and some of the regional facilities of the centre will be located within the land affected by this Plan. Other infrastructure investment is underway to support the future Leppington Major Centre, including a new rail line from Glenfield via Edmondson Park.



Source: Department of Planning and Environment, 2014 (now Department of Planning, Industry and Environment).

Figure 3.1 South West Growth Area early release precincts



Source: South West Growth Centres Structure Plan Edition 3, prepared by Department of Planning and Environment (now Department of Planning, Industry and Environment).

Figure 3.2 South West Growth Area Structure Plan

Table 3.1 provides a context for the area the subject of this Plan in terms of the planned dwellings and population illustrating that the majority of housing and population in the Austral and Leppington North Precincts will be located in the Liverpool LGA.

Table 3.1 Estimated dwelling and populations

District	Area (ha)	Projected dwellings	Projected population
South West Growth Area (17 Precincts)	17,000	110,000	300,000
Austral and Leppington North Precincts		16,133*	49,686*

Sources: Growth Centres Commission (Structure Plan Explanatory Note); Department of Planning and Infrastructure (now Department of Planning, Industry and Environment)

*Gross estimated dwellings and population included in this Plan

3.2.2 Precinct Planning

A package of information on anticipated development and required infrastructure has been prepared for the Austral and Leppington North Precincts, including:

- Indicative Layout Plan (ILP) to guide planning and assessment of the precincts.
- An amendment to *State Environmental Planning Policy (Sydney Growth Centres) 2006* to facilitate the formal rezoning of the land to enable urban development.
- Development Control Plan.
- Contributions plans prepared by Camden Council and Liverpool City Council (this Plan).
- Infrastructure Delivery Plan (IDP).

Key information sources that have underpinned infrastructure planning and costing in this Plan are listed included in Table 3.2.

Table 3.2 Studies supporting infrastructure planning and costing

Public amenity or service	Studies informing infrastructure need and cost
Land acquisition for public amenities or services	MJ Davis Valuations Pty Ltd, Austral and Leppington North Precincts, 2014
	CivicMJD, Valuation Report - Various Residential and Industrial Release Areas (in Liverpool LGA), June 2018
	CivicMJD, Land Valuations for the Austral Precinct, July 2019
Stormwater drainage works	Cardno (NSW/ACT) Pty Ltd, *Austral & Leppington North Precincts Water Cycle Management WSUD Report*, prepared for NSW Department of Planning and Infrastructure, April 2011, plus *Responses to Exhibition Submissions*, December 2012
	SMEC, Austral and Leppington North Design of Water Management Infrastructure Detailed Concept Design Report and its associated input studies, prepared for Liverpool City Council, March 2019
Roads and transport works	AECOM Australia Pty Ltd, *Austral and Leppington North (ALN) Precincts Transport Assessment*, prepared for NSW Department of Planning and Infrastructure, July 2012
Open space and recreation, community and cultural facilities works	Elton Consulting, Austral and Leppington North Precincts - Demographic and Social Infrastructure Assessment, August 2011, plus Addendum, July 2012

More detail on the Precincts' infrastructure requirements is included in the Parts 4 and 5 of this Plan.

3.2.3 Infrastructure Delivery Plan

The Infrastructure Delivery Plan (IDP) provides an overview of the urban infrastructure requirements for the Austral and Leppington North Precincts, and how those requirements will be met.

The IDP provides, amongst other things, a basis for ongoing discussion between planning and infrastructure agencies to guide, inform and improve the delivery of infrastructure. It also serves the purpose of acquainting owners and developers of land in the Precincts with how and when infrastructure is likely to be provided.

Coordination in infrastructure delivery will be critical to the timely roll-out of urban development of the Precincts. Coordination is even more critical in an environment where the land is comprised of relatively small parcels held by a large number of land owners. This is the case in in the Precincts.

The IDP provides the following directions for the delivery of local infrastructure to the land to which this Plan applies:

- Identifies the need to prepare contributions plans for local infrastructure. This Plan addresses this requirement.
- Requires staging plans for local infrastructure to accord with the indicative priority development areas identified in the IDP. The staging outcomes in this Plan reflect the IDP.
- Identifies that total local infrastructure costs are likely to be higher than the likely contribution receipts, given the contributions caps that are in place. The funding of higher order recreation and community facilities is particularly uncertain. Council, in partnership with the State Government, will therefore need to explore other sources of funding or other delivery options.
- Provides that councils have prepared, or are required to prepare, Community Strategic Plans as the key documents guiding councils' activities in the coming decades. This is now the mandated way for councils in NSW to undertake and report their resource planning and the delivery of services and facilities to their communities. Supporting the implementation of the strategic plans will be the resourcing strategies (including long-term financial plans, workforce management plans and asset management plans), delivery plans and operational plans. Councils' Community Strategic Plans must be prepared with due consideration of the various strategies and policies that impact on the local area from both the State (including the Metropolitan Strategy and the State Plan) and Federal Government levels.
- Provides that the effective management of development growth will require a significant ongoing commitment from State Government, particularly in the delivery of infrastructure and services. State Government's role will span a range of agencies and joint commitment and action through the Metropolitan and Sub-regional Strategy will be required to ensure consistent, timely and quality delivery of infrastructure and services to this part of the South West Growth Area.
- Provides that funding constraints mean that there should be an even greater emphasis placed on partnering with developers to provide the necessary local infrastructure (through, for example, Planning Agreements and Works in Kind agreements).

3.3 Expected development outcomes

3.3.1 Existing development

Existing development in the area is characterised by mainly rural and rural residential land uses.

When the land was rezoned for urban development, the majority of land in the Precincts was used for either small scale agricultural purposes such as market gardens or rural residences. Rural residencies are often used as a place of business. This may include ownership of trucks, horses or running construction businesses.

At the time of rezoning, some of the land in the Precincts was developed for purposes that might be characterised as urban uses – for example, private schools and retirement living establishments.

3.3.2 Net Developable Area

The capacity for development of land is restricted by a number of factors, including:

- natural constraints such as riparian and flood prone lands;
- man-made constraints such as existing infrastructure, easements and other legal restrictions, and existing infrastructure such as gas and transmission lines.

In addition to the constraints, there are future constraints. For example, certain land is needed to be set aside or reserved for public purposes such as roads, government buildings, education and health facilities, and so on.

Taking these matters into consideration allows a calculation of the amount of 'economic' land that is available for development. The planned development of this 'Net Developable Area' (or NDA) is the development that will generate the demand for the urban infrastructure such as roads and drains that are required to sustain it. Net Developable Area is therefore one of the bases used to determine contributions under this Plan.

The Precincts together have an estimated total Net Developable Area of approximately 1,030 hectares.[2]

3.3.3 Overview of expected development

The Precinct Plan for both Austral and Leppington North Precincts has been prepared with reference to the Structure Plan and the indicative dwelling and town centre targets, and achieves the following outcomes:

- Leppington Major Centre and nearby employment land, with capacity for up to 13,000 jobs in retailing, light industrial, business park, human services and entertainment sectors.
- Approximately 17,350 dwellings and a population of approximately 54,300.
- A Town Centre in Austral with retail floor space in the order of 30,000 square metres.
- Three neighbourhood centres each with retail floor space in the order of 10,000 square metres.
- 4 primary schools and 2 high schools.
- 85 hectares of light industrial land for local jobs and local services.
- A new TAFE college and Regional Integrated Primary Health Care centre located in Leppington Major Centre.
- Regional level community and cultural facilities in Leppington Major Centre.

Expected development in the Precincts will be characterised by the following:

- A part of the Leppington Major Centre civic precinct and bulky goods retailing located immediately to the north of Bringelly Road.
- Four (4) neighbourhood retail shopping centres and up to eight (6) schools.
- A range of lower density residential areas, including medium density around the various retail centres, infill low density urban residential and lower density Environmental Living zones just beyond the creek corridors and rural transition along the western boundary.
- A light Industrial area to the north of Fifteenth Avenue.

[2] Total NDA is 1,131 hectares. 'Equivalent NDA' (that is, total NDA adjusted to reflect the lower residential development potential of Environment zoned lands and higher potential of some areas) is used to calculate contributions under this Plan. Equivalent NDA for the Precincts is approximately 1,146 hectares.

- Open space and drainage facilities along the Bonds Kemps and Scalabrini Creek corridors as well as adjacent to the Western Sydney Parklands and along other minor, unnamed creeks that pass through the Austral Precinct.
- Areas reserved for environmental conservation and environmental protection, principally along the Kemps Creek corridor and in the north of the Austral Precinct, as well as a corridor for the South West Rail Line.

The extent of development is reflected in the final Indicative Layout Plan adopted by the Department of Planning and Infrastructure (now Department of Planning, Industry and Environment).

Table 3.3 outlines the expected extent of development in the Liverpool LGA portion of the Austral and Leppington North Precinct based on the final Indicative Layout Plan. The Equivalent NDA makes allowance for higher and lesser densities.

The proposed arrangement of these component land uses is shown in Figure 3.3.

Table 3.3 Expected Net Developable Area

Land Use	NDA (ha)	Equivalent NDA assuming 15dw/ha
Environmental Living (4 dwellings/ha)	107.79	28.74
Environmental Living (10 dwellings/ha)	45.69	30.46
Very Low Density Residential (10 dw/ha)	9.23	6.15
Lower Density Residential (15 dw/ha)	703.00	703.00
Low Density Residential (20 dw/ha)	56.35	75.13
Medium Density Residential (25 dw/ha)	13.85	23.08
R3 Medium Density Residential (25 dw/ha)	125.38	208.97
Sub Total Residential	1,061	1,076
Neighbourhood Centre	9.90	9.90
Bulky Goods	24.14	24.14
Light Industrial	36.01	36.01
Sub Total Employment	70.05	70.05
TOTAL	1,131	1,146

Source: Department of Planning and Infrastructure (now Department of Planning, Industry and Environment).

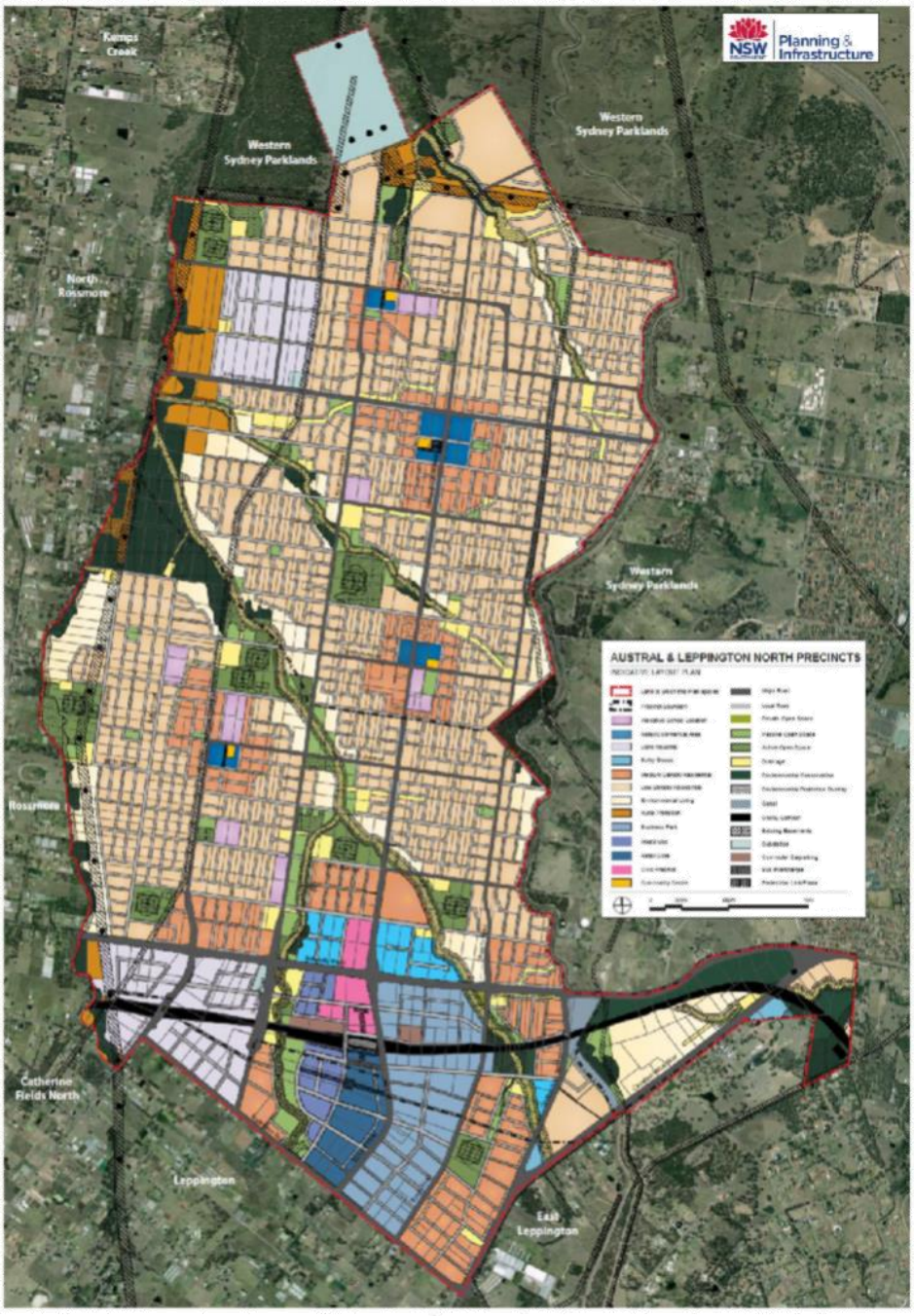


Figure 3.3 **Expected land use in the Precincts**

3.3.4 Demographic characteristics

The likely demographic characteristics of a development area are important for understanding and planning for the future social infrastructure needs of that area.

The demographic characteristics of the existing rural population do not provide a robust indicator of the future demography of the Precincts.

The report *Austral and Leppington North Precincts - Demographic and Social Infrastructure Assessment* (the 'Social Infrastructure Assessment') prepared by Elton Consulting analyses the demographics and housing market conditions in the Camden, Liverpool and Campbelltown LGAs.

The Social Infrastructure Assessment makes the following conclusions about the anticipated demography of the future release area:

- There will initially be a comparable proportion of young couples and families with children to other release areas in the region, but a greater range of family types, reflecting the wider range of housing types and price markets to be provided.
- Proportions of empty nesters and older people will be initially similar to that usually experienced in new release areas, but, given the differing housing stock, will rapidly increase to approximate those in the wider district once services and public transport become well established.
- Over time, the population will become more diverse. Increasing proportions of young adults and older people will be attracted to the area once Leppington Major Centre is established. The proportion of the population who are young children and young adults will decline as the population ages and the proportion of older children with older parents grows. The proportion of the population aged 55+ years will also increase considerably as the area matures.
- Owner occupiers are likely to provide a stable group that will age in place through the life cycle stages, while tenant households will experience greater turnover, thereby maintaining a similar age profile as in the initial stages.
- Over time the population profile is likely to come to more closely approximate that of an established area with a variety of age and household characteristics, rather than a traditional new release area with particular age concentrations.
- Changing demographic, cultural and lifestyle patterns that will occur through the life of the development; and the relative uncertainty about the future composition of the population and its precise needs, gives rise to a need to plan for flexibility in social infrastructure facilities to enable them to respond and adapt as the particular requirements and lifestyle preferences of the population are ascertained.

3.3.5 Dwelling occupancy rates

The amount and mix of the types of expected residential development will inform estimate of the future population of an area. The need for social infrastructure is usually based on per capita benchmarks. As development contributions are levied on a development-by-development basis, in order for the contribution to be reasonable there needs to be an assumption of how many people are likely to live in the proposed development.

This Plan therefore assumes standard dwelling occupancy rates for the purpose of determining the estimated occupancy of development that is approved during the life of the Plan.

The occupancy rates used to calculate contributions under this Plan are those determined by the Social Infrastructure Assessment. They are shown in Table 3.4.

Table 3.4 Dwelling occupancy rates assumed in this Plan

Development type	Occupancy rate
Subdivided lots	3.4 persons per lot
Detached dwelling, detached dual occupancy (each dwelling)	3.4 persons per dwelling
Semi-detached, town house, terrace, attached dual occupancy (each dwelling)	2.6 persons per dwelling
Flat, unit, apartment, secondary dwellings	1.8 persons per dwelling
Seniors living dwellings	1.5 persons per dwelling

3.3.6 Anticipated resident population

The anticipated population in the Austral and Leppington North Precincts has been determined on the basis of the Net Developable Area for various types of residential development, the minimum density of dwellings in those areas (specified in the draft SEPP amendment), and the assumed average occupancy rates for those dwellings.

The anticipated population is shown in Table 3.5.

Table 3.5 Calculation of anticipated resident population

Dwelling type	Projected dwellings	Assumed dwelling occupancy rate	Population
Low density and environmental living (detached dwellings)	12,652	3.4	39,186
Medium density residential (semi-detached etc.)	3,481	2.6	13,159
Less assumed existing population (see Appendix A)			-2,659
Expected net additional population			49,686

3.3.7 Anticipated non-residential floor space

The predominant economic land use in the Precincts will be residential development. There will also be some non-residential development including neighbourhood retail centres, a light industrial area; and a bulky goods retailing area adjoining the neighbouring Leppington Major Centre in Camden LGA.

The anticipated extent of these non-residential developments is shown in Table 3.6.

Table 3.6 Anticipated non-residential development potential

Land use category	Net Developable Area (ha)	Projected gross floor area (m^2)*
Neighbourhood Retail Centre	9.90	44,550
Bulky goods	24.14	108,630
Light Industrial	36.01	162,045
Total	70.05	315,225

* based on an assumed average floor space ratio of 0.45:1

Source: Department of Planning and Infrastructure (now Department of Planning, Industry and Environment)

3.4 Infrastructure demand arising from the expected development

Future development in the South West Growth Area will result in an additional population of up to 300,000 people.

Existing public amenities and services in the Precincts have been essentially designed to accommodate the existing predominantly rural living environment. A change in the development profile from rural to urban development is now planned. More particularly, the Precincts are planned to have a low density suburban character. The projected influx of an estimated 49,686 new residents demands a significant investment in new and augmented public amenities and services.

Research on infrastructure needs for the impending urban development has identified the following impacts on public services and public amenities:

- increased demand for active and passive recreation facilities, such as recreation centres, sports fields, sports courts, playgrounds, walking trails and bike paths;
- increased demand for spaces that will foster community life and the development of social capital in the Precincts, such as multi-purpose community centres and libraries;
- increased demand for facilities that will support safe and convenient travel between land uses both within the Precincts and to and from destinations outside of the area, such as upgrades to existing roads, new roads, intersections and public transport facilities; and
- increased demand for stormwater drainage facilities as a result of the extra stormwater runoff generated by impervious surfaces associated with urban (as distinct from rural) development, as well as water quality devices consistent with Water Sensitivity Urban Design (WSUD) principles.

A range of public facilities and public amenities have been identified as being required to address the impacts of the expected development, including:

- open space and recreation facilities;
- community and cultural facilities;
- water cycle management facilities; and
- traffic and transport management facilities.

More detail on the demand for public services and amenities, the relationship with the expected development, and the strategies for the delivery of required infrastructure is included in Part 4 of this Plan.

The costs, indicative timing, and proposed location of individual items for the public amenities and public services included in this Plan are shown in Part 5 of this Plan.

4 Strategy plans

4.1 Infrastructure costs and delivery generally

4.1.1 Apportionment of the infrastructure costs to expected development

The costs for public services and amenities were informed by the studies that support the infrastructure planning of the area (refer Table 3.2).

The development monetary contribution for each of the facilities identified in this Plan is determined by dividing the total cost of the facility by the contribution catchment (which is expressed in persons or NDA). This process ensures that fair apportionment of facility costs is calculated for development expected to occur under this Plan.

The contribution catchments for each infrastructure type are:

- in the case of open space and recreation facilities land and works, the expected additional resident population of the Precincts;
- in the case of community and cultural facilities land and works, the number of people (or future residents) the respective facility has been designed for;
- in the case of road and transport land and works, the expected additional resident population of the Precincts for residential development and the estimated equivalent Net Developable Area of the Precincts for non-residential development; and
- in the case of stormwater drainage land and works and plan administration, the estimated equivalent Net Developable Area of the Precincts for all development.

The infrastructure included in this Plan has generally been sized to reflect the demand generated by the expected development under this Plan. Some facilities, such as the proposed aquatic and indoor recreation centre, have been designed to serve a wider catchment and the contribution rate reflects that wider contribution catchment. Council will need to make arrangements to ensure that the cost attributable to the demand sources external to the Precincts is met (for example, by subsequent contributions plans, joint contributions plans, special rates, grants).

More details on this apportionment are discussed in the remainder of Part 4 of this Plan.

4.1.2 Delivery of the infrastructure

Council will require contributions from developers under this Plan toward provision of the public amenities and public services identified in this Plan. These contributions may be in the form of monetary contributions, dedications of land free of cost, or a combination of these.

Developers may choose to provide, subject to the agreement of the Council, one or more infrastructure items identified in this Plan as Works In Kind or provide another type of material public benefit as means of satisfying development contributions required under the Plan (refer clause 2.9.5 of this Plan). A Works In Kind Agreement must be in place prior to commencing the works in accordance with the Council's Works In Kind Agreements Policy.

Substantial research has been applied to the derivation of the Plan's Works Schedule and the planning for the location of all facilities has been completed but detailed design will be carried out in the development phase. The facilities will be developed in a manner that allows them to effectively serve the demand attributable to development envisaged under this Plan.

The facilities strategies included in Part 4 of this Plan are based on strategic information. It is likely that, as the planning process for the different development areas proceeds, modified and more cost effective solutions that still meet the strategy objectives will be developed.

Council will prepare design concepts for the facilities so that specification and costing of the facilities can be more accurately defined as implementation of this Plan proceeds. This may result in amendment of this Plan.

Where alternatives to the Works Schedule are proposed in conjunction with the development of areas and the alternatives are approved by the Council, the development contribution applicable to a development the subject of a development application may be reviewed, or the Works Schedule in this Plan updated, or both.

4.1.3 Infrastructure staging and priority

The overarching strategy that guides the staging and priority of infrastructure is the Infrastructure Delivery Plan. This will be developed and refined in accordance with the anticipated development program for the Austral and Leppington North Precincts. The provision of facilities included in this Plan will be programmed, as far as practicable, to align with these broader programs.

The initial development areas, as discussed in the Infrastructure Delivery Plan and clause 3.2.3, include:

- Land in and around the Leppington Major Centre.
- Land located north and south of Fifteenth Avenue on the eastern edge of the Austral Precinct.

The second of these areas is within the Liverpool LGA, while the Leppington Major Centre is just south of the border with Camden Council and so the land around this centre may include land in the Liverpool LGA.

Ideally, development will proceed outward from the railway station and retail core. The existing land ownership pattern and other influences (such as the demand for different land use types) however means that this order of development is unlikely to occur. The Infrastructure Delivery Plan strategies reflect this:

There should not be any assumption that services are 'reserved' for particular areas in the early stages. If owners and developers of land located outside the initial development areas consult and work cooperatively with infrastructure providers and owners of adjacent land, there is no reason why those lands could not also be developed.[3]

With these uncertainties, the facility staging and priorities details that are shown in Part 5 of this Plan are general in their scope, and will be subject to regular review.

[3] *Austral and Leppington North Precincts Infrastructure Delivery Plan*, Draft Report for Exhibition, prepared by Newplan, August 2011, Section 4.2.

4.2 Open space and recreation facilities

4.2.1 Relationship between the expected types of development and the demand for additional public facilities

The requirements for local, district and regional scale open space and recreation facilities as a result of the expected development of the Precincts are documented in the report Austral and Leppington North Precincts – Demographic and Social Infrastructure Assessment, prepared by Elton Consulting in August 2011. This is supplemented by an Addendum, prepared by Elton Consulting in July 2012.

The information below comprises a summary of sections of that report that describe the demand for new and upgraded public amenities and services.

Existing provision

There are limited open space and recreation facilities accessible to the current residents of the Precincts. However the extent of provision is consistent with the area's small population and semi-rural character [4]

There are three identified local public open space areas located within the Liverpool LGA part of the Austral and Leppington North Precincts. These are:

- Craik Park (includes children's playground, sports field and tennis courts);
- WV Scott Memorial Park (includes children's playground, sports fields, cricket practice nets, netball courts and bushland); and
- Starr Park (bushland).

In addition there is a significant area of district and regional parks and bushlands on the periphery of the Austral Precinct, including:

- Western Sydney Regional Parklands;
- Grimson Park (in West Hoxton); and
- Kemps Creek Nature Reserve (high conservation value bushland – no public access).

The level of open space provision reflects the rural residential lifestyle of the area. That is, the demand for public open space (particular local and passive open space) is significantly reduced in locations where residents live on their own substantial parcel of land.

With the proposed development of the area to an urban environment and its associated influx of new residents, the area will require significantly more land for open space and recreation purposes.

Trends in facility provision

Current and emerging trends and factors that have been considered in the planning and specification of Austral and Leppington North Precincts recreation infrastructure included the following:

- Significant and ongoing popularity of informal recreation activities (e.g. walking), and activities requiring fixed commitments are declining in favour of informal and more flexible activities.
- Facilities that are flexible in their service provision.

[4] Social Infrastructure Assessment, page 16

- Growing awareness and interest in health and fitness as part of a balanced lifestyle rather than an emphasis solely on leisure.
- Increasing demand for outdoor recreation.
- Growing awareness of the importance of incidental exercise within employment and residential areas, increasing the demand for walking and cycling paths.
- An increasing emphasis on quality as well as quantity.
- An increasing demand for access for young people and improved accessibility more generally.
- An increased demand for natural areas and adventure-based activities.
- The increased duration of playing seasons requiring consideration of alternative playing surfaces.

Planning principles for open space and recreation

Principles for the provision of sustainable open space and recreation infrastructure that have guided the selection of infrastructure items included in this Plan include the following:

- Open space should be largely publicly provided.
- Meet a diverse range of open space and recreation needs and opportunities.
- Avoid exerting pressure on open space and recreation facilities in surrounding areas.
- Quality of open space is more important than quantity.
- A physically and visually connected network; and represent a non-vehicular system that connects major activities and open spaces by walking and cycling.
- Comprise a local, district and regional hierarchy of spaces.
- Reflect and complement the natural, ecological, waterway and visual features of the area; and incorporate natural areas and riparian corridors into the open space system where possible.
- Integrate a network of open space with stormwater management and water-sensitive urban design [5]

Recreation demand assessment based on forecast demographics

The size and characteristics of the population in the Precincts is discussed in Part 3 of this Plan.

Implications for recreation demand as a result of the expected mix of residents is discussed in detail in Table 9.1 of the Social Infrastructure Assessment.

In summary:

- Future developments will initially contain a predominance of families with children, adolescents and young people, and only over time will there be a balance of more middle aged and older people.
- The major target groups for recreation planning in new release areas are children aged 0-14 years, and adults aged 25-40 years.

[5] Social Infrastructure Assessment, Section 3.1

- Local open space is important in encouraging informal interaction and creating opportunities for new and existing residents to come together, as well as for encouraging extended family activity, for walking and cycling as well as family gatherings.
- The level of local open space will in part be informed by prevailing council standards of provision.

In relation to the last point, the following plans and strategies provide guidance:

- Liverpool City-Wide Recreation Strategy 2020 (2003); and
- Liverpool City Council Provision Rates Indicative Draft 21 September 2010.

The following is a summary of Liverpool City Council's standards relating to open space:

- The provision of open space in new release areas is based on a standard of 2.83 hectares per 1,000 people;
- Local parks (minimum 2,000 square metres) to be provided within a five-minute walk of most dwellings;
- 1 key suburb park (district park) with a minimum size of 3 hectares per 5,000 – 10,000 people;
- 1 double playing field of minimum 4 hectares per 10,000 people (local sporting field);
- 1 district sporting field per 60,000 people approximately;
- District sporting fields to be minimum 6 hectares and, where possible, co-located with other commercial, community and recreation space in larger neighbourhood activity hubs;
- Split between active and passive open space to reflect quality considerations, rather than a firm 50:50 split; and
- High use recreation facilities and quality open public spaces should be provided away from electricity transmission lines, wherever practicable [6].

The above considerations have informed the open space and recreation requirements for the future development of the Precincts.

Local and district open space requirements

The total area of local and district open space land required was calculated in the Social Infrastructure Assessment on the basis of meeting the combined needs of the Austral and Leppington North Precincts' developments.

The planning of open space areas was undertaken as part of the Precinct planning phase in an iterative manner. Earlier versions of the ILP identified more extensive passive open space areas aligning with the numerous drainage lines traversing the Austral and Leppington North Precincts. The size of the open space areas was reduced in acknowledgment of the very high cost of acquiring the substantial areas required for meeting open space demands.

The benchmark figure in the report proposed a rate of 2.9 hectares per 1,000 population. For a forecast population of 52,345 people in the Precincts (including the existing population), application of this benchmark would result in a requirement of approximately 151.8 hectares of district and local open space.

This Plan proposes to provide marginally less than the total Austral and Leppington North Precincts benchmark rate for open space (2.9 hectares per 1,000 residents). Table 4.1 shows that some of the land has been obtained free of cost so that the incoming population (49,686 residents) is required to provide only 104.84 hectares, or 2.11 hectares per 1,000 residents. The incoming population benefits from open space areas greater than the benchmark rate, while paying for less than the benchmark rate. The proposed inclusion of 104.84 hectares of land in this Plan for open space purposes is considered reasonable on these grounds.

[6] Social Infrastructure Assessment, p76

The extent of open space is based on the final Indicative Layout Plan prepared by the NSW Department of Planning and Infrastructure (now NSW Department of Planning, Industry and Environment).

For the Precincts, Table 4.1 sets out the how the required amount of open space land was achieved.

Table 4.1 Proposed provision of district and local open space

Open space	Area (ha)
Land to be acquired	104.84
Land dedicated from the NSW Government (Office of Strategic Lands)	5.67
Land currently owned or managed by Liverpool City Council	13.50
Total open space to be provided in Precincts	124.01
Total population in Precincts (persons)	49,686
Open space provision rate (ha/1,000 persons)	2.5

Source: Department of Planning and Infrastructure (now Department of Planning, Industry and Environment).

Table 4.2 provides a breakdown of this open space according to type.

Table 4.2 Proposed provision of district and local open space

Open space type	Acquisition land area (ha)	Dedication land area (ha)	Total open space (ha)
Local passive open space	36.16		36.16
Local sporting fields (active recreation)	26.52	9.70 (Craik Park) 5.67 (NSW Govt. dedication)	36.22
District passive open space	33.09	3.80 (Council land)	42.56
District sporting fields (active recreation)	9.07		9.07
Total open space	104.84	19.17	124.01

Source: Department of Planning and Infrastructure (now Department of Planning, Industry and Environment).

The data in Table 4.1 show a weighting toward the provision of passive rather than active open space. The high percentage of passive open space arises in part because of the extensive creek networks that traverse the Precincts.

The above land also does not include:

- Regional active open space available in Western Sydney Parklands;
- Riparian and other conservation land such as bushland;
- Open space under transmission lines; and
- Playing fields within school sites.

The costs associated with open space land and works will be apportioned solely to new residential development. No contributions for Precincts open space facilities will be required of non-residential development as the need for the facilities has been based on the anticipated residential development only.

Recreation facilities requirements

The facilities described in Table 4.3 (on the following pages) have been determined in the Social Infrastructure Assessment as being required to meet the needs of expected development in the Austral and Leppington North Precincts, and in some cases the wider Growth Area catchment.

Some of the facilities are located in the Camden LGA portion of the Leppington North Precinct and are therefore not included in the Works Schedules that comprise Part 5 of this Plan. The full list of Austral and Leppington North Precincts' requirements is shown for completeness.

Table 4.3 Recreation facilities requirements

Facility	Size	Description	Provision	Provision in the Precincts
Local passive parks	Min. 0.2ha up to 0.5ha	Local parks should have a range of play spaces and opportunities and cater to older children and young people as well as the traditional playground for young children. Grassed area for ball games, seats, shelter. May contain practice wall, fitness equipment, other elements.	Within 400-500m walking distance of 90% of dwellings	Many dispersed throughout the Precinct mainly focused along the riparian corridors but generally well distributed around the area
District (key suburb) parks	Min. 3ha	'Something for everyone', family parks. Includes a combination of outdoor courts (basketball, netball), skate park, BMX track, shared pathways, children's play equipment, outdoor fitness equipment, performance space, specialised recreation facilities, water feature, picnic / barbecue facilities, unleashed dog exercise area.	6-7 parks	7 concentrations of district passive recreation facilities sized between 3 and 16 hectares
Children's playgrounds (0-4years)	Min. 0.3ha for standalone playgrounds	Co-located with parks, sportsgrounds, courts, schools, community facilities, conservation areas. Regional, district, local hierarchy in terms of play equipment and range of experiences. Each play area should offer a different experience. Include road safety bike track at regional playground. Include children's bike paths in district and regional playgrounds. Can be co-located with playspaces for 5 to 12-year olds – within sight distance for carers but physically separated. Fencing if adjacent to water, road, steep slope. Seating, shade, water provided.	11 playgrounds	18 playgrounds or playspaces to be provided on local and district passive parks
Play spaces (5 to 12-year olds)	Min. 0.3ha for standalone playgrounds. Where co-located the space may be reduced.	Allows for more independent play, skill development and cognitive development. However, they still require adult supervision. More challenging equipment These may include bouldering features, climbing areas, 'learn to' cycleways through to cycle obstacle course, skate facility, BMX/mountain bike jumps and tracks. These areas could be co-located with children's playgrounds, school or community facilities for supervision and convenience of use by carers.	13 play spaces	See above

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Facility	Size	Description	Provision	Provision in the Precincts
Local sportsground	Min. 4ha (ideally 5ha)	1 double field per 5,000 people. To accommodate demand for local sport and recreation training and competition. Rather than a series of single fields facilities are grouped to provide economies of scale for infrastructure. To be located close to schools. Inclusions : – 2 multi-purpose rectangular fields or 1-2 full-sized cricket/AFL ovals (plus practice nets) – 2 tennis / netball courts – 2 half-court basketball courts, or 2 multi-purpose courts – Lights for training – Amenities with change rooms, canteen, meeting room – Parking co-located with a playground, school, community facility, play space.	8 double playing fields or 20 single fields.	6 additional local sportsgrounds to complement an existing sportsground at Craik Park
District sportsground	Min. 6ha up to 10ha	The local sports park identified above may be expanded to incorporate one of the proposed district grounds dependent on location and access. Requirements – To be located near public transport routes, no further than 2 km from all dwellings – To be co-located, where possible, with other commercial, community and recreation space in neighbourhood activity hub – Provide for district standard adult competitions and training or junior regional or state school championships. – Amenity buildings, parking, storage core inclusions – Located on land without flooding or transmission line constraints. Given the timeframe before the population threshold warrants a district standard facility. The final mix of courts and fields will require community consultation and council input based on most recent open space planning principles and research. Inclusions: – 4 multi-purpose rectangular fields, parking and landscaped buffer – No flooding or transmission line restrictions – Higher quality fields than local – Maybe combined with playground, netball training courts or multi-purpose tennis/basketball/netball courts. Add practice nets if cricket wickets – May include lawn bowling club or similar.	1 complex of four playing fields	1 complex of four playing fields on a new 9.1ha park located between Ninth and Tenth Avenues

Source: Social Infrastructure Assessment, pages 79-84.

Regional open space and recreation facilities requirements

The Leppington railway station will be located just outside the southern boundary of the Precincts in the surrounding Major Centre. Leppington Major Centre is the only major centre to be developed in the entire South West Growth Area, and will include some of the land at the southern edge of the Precincts. This centre is being designed to serve a user catchment of around 300,000 residents.

Associated with this centre and located within the Liverpool LGA, the Regional Indoor Sports and Aquatic Centre is proposed to service the population of the Precincts and beyond. Details of this facility are included in clause 4.3 Community and Cultural Facilities.

Other regional open space demands are expected to be met by the Western Sydney Parklands, which adjoin the Austral and Leppington North Precincts to the east. It is expected that the embellishment of the Parklands will be carried out in the manner of other regional parks in the Sydney region (e.g. Centennial Park in the Sydney City LGA).

The Growth Area catchment, equivalent in scale to Canberra, will require substantial recreation facilities to meet the regional demand. Apart from the Aquatic Centre, the planning for regional facilities also includes a regional stadium. The Western Sydney Parklands Trust has prepared an options paper in relation to the stadium and envisages that it will be located in the Western Sydney Parklands.[7]

This Plan does not require contributions toward a stadium or any embellishments in the Western Sydney Parklands.

4.2.2 How are the contributions calculated?

Contributions will be collected only from residential development toward open space and recreation facilities identified under this Plan.

Monetary contributions are calculated on a per person or per resident basis, then factored up to a per lot or per dwelling amount.

The monetary contribution per person in a development containing residential dwellings or lots (whether or not that development also comprises non-residential floor space) is calculated as follows:

$$\text{Contribution per resident (\$)} = \sum \frac{(\$INF)}{P}$$

Where:

$INF = the estimated $ cost - or if the facility is existing, the indexed, completed cost - of providing each of the open space and recreation facilities (refer Part 5 – Works Schedule).

P = the estimated resident population (in persons) that will demand each facility - that is, the expected net additional population of the Precincts (refer Table 3.5)

The monetary contribution for different residential development types is determined by multiplying the contribution per person by the estimated increase in population as a result of the development and using the assumed occupancy rates included in clause 3.3.5 of this Plan.

For convenience, these rates are reproduced in Table 4.4.

[7] The *Western Sydney Parklands Trust Plan of Management* identifies a proposal for a regional sporting hub in the southern end of the Western Sydney Parklands, in the vicinity of the Austral and Leppington North Precincts, subject to funding.

Table 4.4 Assumed residential development occupancy rates

Development type	Occupancy rate
Subdivided lots	3.4 persons per lot
Detached dwelling, detached dual occupancy (each dwelling)	3.4 persons per dwelling
Semi-detached, town house, terrace, attached dual occupancy (each dwelling)	2.6 persons per dwelling
Flat, unit, apartment, secondary dwellings	1.8 persons per dwelling
Seniors living dwellings	1.5 persons per dwelling

4.3 Community and cultural facilities

4.3.1 What is the relationship between the expected types of development and the demand for additional public facilities?

The requirements for community and cultural facilities as a result of the expected development of the Precincts are documented in the Social Infrastructure Assessment.

The following is summary of the information and approach used to arrive at the community and cultural facilities requirements of the Precinct.

Existing provision

There are very limited community and cultural facilities accessible to the current residents of the Precincts. They include two (2) schools and three (3) child care centres, three (3) places of worship and two (2) seniors living developments.

Other facilities are located further afield, including in the Camden LGA and surrounding suburbs of Liverpool LGA. District level facilities are located in the newer suburbs further east around Horningsea Park and further south in Camden LGA, and have been designed to meet the needs of incremental urban growth in those locations, rather than any growth envisaged in the Austral and Leppington North Precincts.

The limited extent of provision is consistent with the area's small population and semi-rural character [8].

Principles for sustainable community infrastructure

Principles for the provision of sustainable community facilities infrastructure described in the Social Infrastructure Assessment and that have guided the selection of infrastructure items included in this Plan include the following:

- Facilities should be provided in an efficient, timely and co-ordinated way to support the pattern of development; ensuring that services are available to residents as early as possible and they are not disadvantaged through delays in delivery.
- Efficient use of limited resources by designing facilities to be multipurpose, co-located with other facilities and able to accommodate shared and multiple use arrangements.
- Cluster related facilities and services to promote civic identity, safety and focal points for the community.
- Ensure that facilities, services and open space are accessible by public transport and located to maximise access for pedestrians and cyclists.
- Ensure flexibility in the design and use of facilities, so they can respond and adapt as needs change. Avoid arrangements for single uses or specific target groups that may quickly become outdated.
- Promote equitable access for all sections of the population, through the distribution, design and management (including cost) of facilities.
- Provide environmentally and economically sustainable buildings.
- Ensure viable levels of resourcing of facilities and services, both capital and recurrent funding.
- Promote innovation and creativity between agencies in services delivery and integration
- Develop sustainable ownership, governance, management and maintenance arrangements for facilities.

[8] Social Infrastructure Assessment, page 18

Community facilities demand assessment based on forecast demographics

The anticipated size and characteristics of the resident population in the Precincts is discussed in Part 3 of this Plan.

Various standards of provision for local and district community facilities have been adopted by the Department of Planning and Infrastructure (now Department of Planning, Industry and Environment), Camden Council and Liverpool City Council. The standards have been used as a basis for determining facility needs in the Austral and Leppington North Precincts as a whole.

A summary of these standards is included in Table 4.5.

Table 4.5 Comparison of community facility provision standards

Facility type	Former Department of Planning & Infrastructure & Growth Centres Commission standard	Camden Council standard	Liverpool City Council standard
Libraries - Branch - District	1 branch facility for each 33,000 persons 1 district facility for each 40,000 persons	39 square metres per 1,000 persons + 20% circulation space	42 square metres per 1,000 persons
Multi-purpose community centre in smaller activity centre	1 centre for each 6,000 persons Each centre with a size of 2,000-2,500 square metres	42 square metres per 1,000 persons 2.5 x floor area for land component	Indicative 1 centre for each 10,000 people, with an average size of 600 square metres for each centre To be located in activity centres with shops, schools etc. Facilities are to provide flexible multipurpose spaces and spaces for outreach services. Smaller 600m^2 facilities contribute to the overall level of provision of 60-85m^2 per 1,000 people
Multipurpose community centres in larger activity centre	1 centre for each 20,000 persons 1 community service centre for each 60,000 persons	22 square metres per 1,000 persons 2.5 x floor area for land component	Indicative 1 centre for each 60,000 persons, with a built area of about 1,500 square metres To be located in larger activity centres and commercial and transport hubs to provide flexible multipurpose spaces and provide a base for organisations and the delivery of services Larger 1,500m^2 facilities contribute to the overall level of provision of 60-85m^2 per 1,000 people
Youth Centre	1 centre for each 20,000 persons	89 square metres per 1,000 persons + outdoor space	No longer provided by Council as a stand-alone purpose-built facility. The size and layout of multipurpose community facilities now provide appropriate and designated spaces for delivering youth services, programs and activities. Outdoor spaces, like half-court basketball courts and skate parks, are now provided as standard for informal activities and programs for young people.

Sources: Social Infrastructure Assessment Table 8.1

Community and cultural facility requirements

This Plan proposes to provide primarily for a residential population in a suburban setting. Regional level facilities are proposed to be provided in the Leppington Major Centre in Camden LGA. The community and cultural facilities proposed in the Precincts have either a local or district service catchment. This Plan nevertheless proposes that development contribute towards regional facilities that are located in Liverpool LGA, by providing its reasonable share towards the Regional Aquatic Centre including associated public art.

One of the four (4) proposed multi-purpose community centres has been scaled-up to service a district scale population of approximately 40,000 residents, which approximates the catchment of the Precincts. The other three (3) centres will provide for a neighbourhood catchment of approximately 10,000 residents each. The cost of these four facilities are shared equally across the entire Precincts incoming residential population.

Proposed community and cultural facility provision

Regional infrastructure required on the northern fringe of the Leppington Major Centre and provided in the Precincts, and serving a surrounding population of around 120,000, includes the Regional Indoor Sports and Aquatic Centre. This centre is to be located on a 5 hectare site, including a 3 hectare facility and outdoor elements and 2 hectares for parking and landscaping. Building components include the following:

- Aquatic facilities include an indoor 50 metre x 10 lane Olympic pool, training pool, 25 metre leisure pool, heated teaching pool; children's play pool / wave pool / whirl pool / water slides, diving pool.
- Indoor Sports to include 4 indoor sports courts each large enough for netball
- Fitness centre incorporating weights, aerobics/Dance/Yoga/Pilates activity room with wooden floor, spin cycle room,
- Wellness / health services – physiotherapy, nutrition etc.
- Spa, sauna, steam room
- Retractable seating for 1,500 this would increase to 3,500 in stage 2.
- General amenity, kiosk and café, equipment sales, change, lockers, toilets, crèche facilities for users
- Outdoor elements - may include water play park, BMX, skate, sports oval and netball, tennis, basketball courts. May be integrated with a youth recreation facility.

Local and district level infrastructure includes the following:

- A multi-purpose community centre in Austral of 1,500 square metres floor area, including a variety of flexible multi-purpose spaces suited to a range of community activities and programs. Also, the building is proposed to include office and service delivery areas for human services and spaces suitable for young people and older people.
- Three (3) multi-purpose community centres in other neighbourhood centres in the Precincts, each with an approximate building area of 750 square metres.

This Plan includes provision for the land and works associated with these facilities, but acknowledges that with respect to the Regional Sports and Aquatic Centre, the demand is spread over a large catchment (120,000 residents). This Plan therefore authorises contributions that are commensurate with the Precincts' level of demand for the regional facilities, i.e.:

49,686 persons / 120,000 persons = 41.4%,

Or an apportionment factor of 0.42.

Council will seek funding from other sources to meet the balance of the cost of the facility, including development contributions from future developments in other South West Growth Area Precincts situated within the Liverpool LGA.

Location and staging matters

Facilities should generally be co-located with or adjacent to open space in activity centres. There are multiple ways to arrange the spaces and further planning should concentrate on combination and co-location options.

A number of sites have been identified in the ILP for these purposes but there is a significant amount of planning and acquisition of land required even before preliminary designs can be prepared.

The design of facilities will depend upon a variety of factors, including the availability of funds, the aspirations of the responsible council, and evolving best practice. Detailed needs and feasibility assessments need to be undertaken as the population of the area grows.

Existing higher order facilities in the surrounding region (including those in both the Liverpool and Camden LGAs) offer some opportunity to meet interim needs either in their current form or through expansion (for example, the Casula Powerhouse).

The general principle will be that the local and district community facilities will not be built until the surrounding population that each services has reached a threshold of 5,000 residents for the local centres and 30,000 for the larger district centre. Should the demand for two facilities require the facility to be constructed within a similar time-frame, Council must necessarily prioritise these so to manage the delivery as efficiently as possible within the constraints of funding and resources.

4.3.2 How are the contributions calculated?

Contributions will be collected from residential development toward community and cultural facilities identified under this Plan.

Monetary contributions are calculated on a per person or per resident basis, then factored up to a per lot or per dwelling amount.

The monetary contribution per person in a development containing residential dwellings or lots (whether or not that development also comprises non-residential floor space) is calculated as follows:

$$\text{Contribution per resident (\$)} = \sum \frac{(\$INF)}{P}$$

Where:

$INF = the estimated $ cost - or if the facility is existing, the indexed, completed cost - of providing each of the community and cultural facilities (refer Part 5 – Works Schedule)[9]

P = the estimated resident population (in persons) that will demand each facility - that is, the expected net additional population of the Precincts (refer Table 3.5)

The monetary contribution for different residential development types is determined by multiplying the contribution per person by the estimated increase in population as a result of the development and using the assumed occupancy rates included in clause 3.3.5 of this Plan.

For convenience, these rates are reproduced in Table 4.6.

Table 4.6 Assumed residential development occupancy rates

Development type	Occupancy rate
Subdivided lots	3.4 persons per lot
Detached dwelling, detached dual occupancy (each dwelling)	3.4 persons per dwelling
Semi-detached, town house, terrace, attached dual occupancy (each dwelling)	2.6 persons per dwelling

[9] In the case of the regional facility, the cost is the cost fairly apportioned to the Precincts' expected population - that is, 41% of the total cost (see section on 'Community and cultural facility requirements' above).

Development type	Occupancy rate
Flat, unit, apartment, secondary dwellings	1.8 persons per dwelling
Seniors living dwellings	1.5 persons per dwelling

4.4 Water cycle management facilities

4.4.1 What is the relationship between the expected types of development and the demand for additional public facilities?

Stormwater runoff in the Austral and Leppington North Precincts was proposed in precinct planning to be managed through a comprehensive Water Sensitive Urban Design (WSUD) approach.

Informed by a range of studies, the report *Austral and Leppington North Precincts Water Cycle Management WSUD Report* (the WSUD Strategy) prepared by Cardno Pty Ltd established the preliminary framework for the management of stormwater quantity and quality related to the expected urban development of the Precincts. This report was informed by a range of studies including:

- Cardno (2011), *Biodiversity Conservation Assessment*, Draft Final Report, prepared for the Department of Planning, January.
- Cardno (2011), *Riparian Corridor and Flooding Assessment*, Draft Final Report, prepared for the Department of Planning, February.
- GeoEnviro Consulting (2010), *Geotechnical, Salinity and Acid Sulfate Soil Investigation*, prepared for the Department of Planning, December.
- JBS Environmental (2010), *Preliminary Environmental Site Assessment*, Final report, prepared for the Department of Planning, December.
- Growth Centres Commission (2006), *Growth Centres Development Code*, November.

The main water management infrastructure was proposed to manage flooding within the project area and to minimise downstream impacts includes detention basins, trunk drainage pipes, overland flow paths/constructed channel systems, and culvert crossings. A series of bioretention systems and gross pollutant traps (GPTs) were also proposed to manage stormwater quality within the project area.

The WSUD Strategy acknowledged that development of an area:

- generates demand for water supply;
- requires management of wastewater as well as stormwater; and
- increases the area of impermeable surfaces and so exacerbates potential flooding issues, impacts on the quality of stormwater and potentially affects riparian corridors.

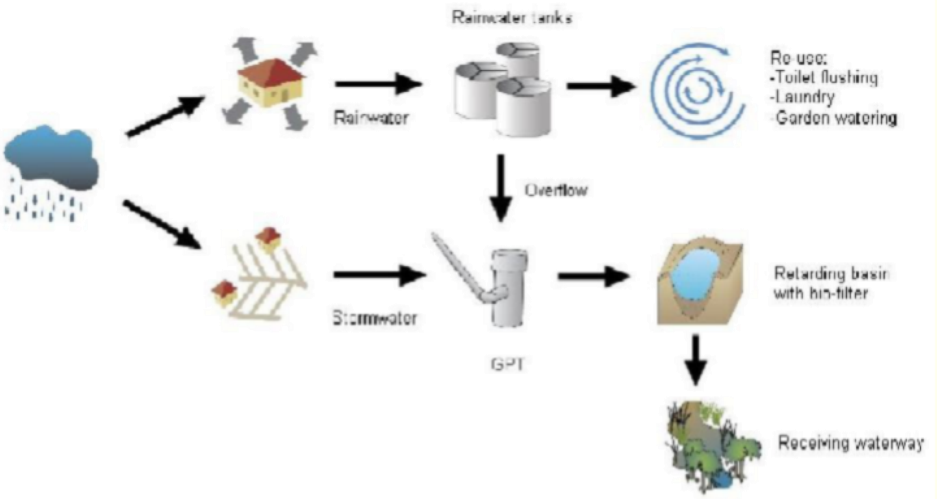
These water related issues are locality based and caused directly and solely by the development activity and so should be ameliorated by that same development activity.

To minimise the potential cost of the stormwater management scheme, the WSUD Strategy investigated the following:

- harvesting of rainwater for toilet, laundry and garden use in residential lots; and
- treatment measures to improve stormwater quality, promote infiltration and attenuate run-off to emulate a more natural rainfall/ runoff regime.

Figure 4.1 (over page) is a schematic describing the approach recommended with the WSUD strategy.

The schematic illustrates that 'rainwater' works will be required in conjunction with development consents for individual dwellings, while other ('stormwater') works relate to the broader catchment and so will be funded through development contributions obtained under this Plan.



Source: Austral and Leppington North Precincts Water Cycle Management WSUD Report, page 17

Figure 4.1 Concept Stormwater Treatment Train

Refinements to the water cycle management strategy

SMEC Australia Pty Ltd (SMEC) was engaged by Council in 2018/19 to refine the water cycle management strategy and undertake investigation and detailed concept design of proposed flood mitigation, water quality control structures and other stormwater infrastructure within the Precincts. This resulted in certain changes to the originally proposed stormwater facilities as explained below.[10]

The concept design of the proposed stormwater management infrastructure was carried out by SMEC in two distinct phases.

The first phase involved a data review, preliminary ecological and environmental assessment, hydrologic and hydraulic modelling and the optimisation of the detention basin layout.

The second phase involved the preliminary concept design and the final detailed concept design of the water management facilities, as well as flood mapping, dam break assessment, additional topographic survey, investigation of utility conflicts, geotechnical assessment and the preparation of a more detailed Review of Environmental Factors (REF).

The basin optimisation and the concept design were carried out in accordance with the Australian Rainfall and Runoff (ARR2016) procedures. The basin optimisation study resulted in a reduced number of detention basins from the earlier WSUD Strategy, and some basins only being designed to control the 50% AEP flows. Another two basins were subsequently removed based on the results of further modelling during the concept design.

As a result of SMEC's findings, the Plan includes:

- eight detention basins designed to control the 50% and 1% AEP flows, and
- eleven basins designed to control only the 50% AEP flow.

[10] SMEC Australia (2019), Detailed Concept Design Report - Austral and Leppington North Design of Water Management Infrastructure, prepared for Liverpool City Council, March (SMEC Concept Design Report).

The remaining flood mitigation infrastructure such as trunk drainage pipes, channels, and culverts are designed to convey flows up to the 1% AEP event.

Adopting a systems-based approach to infrastructure design

SMEC adopted a systems-based or integrated approach for the design of the water management infrastructure. There are 62 drainage systems and these were grouped into three categories as follows:

- Drainage systems with 1% AEP basins
- Drainage systems with 50% AEP basins
- Drainage systems without basins.

A typical drainage system with a basin includes trunk drainage pipes and channels, a detention basin and water quality controls such as GPT/sedimentation pond, biofilters and raingardens. The need for culverts along the major creeks and creek enhancement works have also been identified (see the sections below).

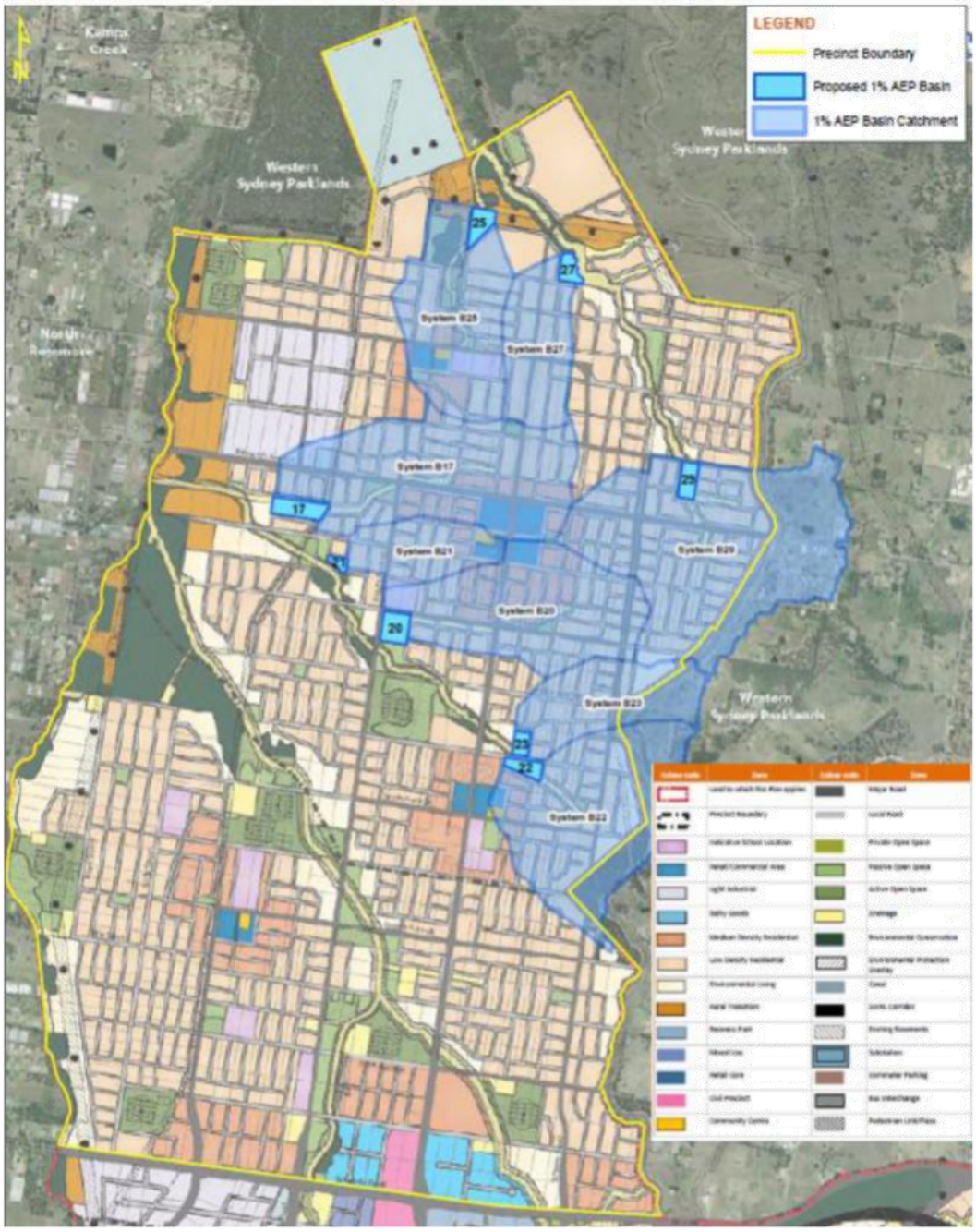
Only eight of the non-basin drainage systems include trunk infrastructure works (either pipe or channel). Streetscape raingardens will be implemented throughout these drainage systems to manage stormwater quality but these will be implemented through development controls rather than via this Plan. The drainage systems and locations of proposed trunk infrastructure that comprises stormwater channels and basins are shown in Figures 4.2, 4.3 and 4.4 on the following pages.

Supplementary streetscape raingardens

The earlier WSUD Strategy recommended an end-of-pipe approach to managing stormwater quality, by either co-locating bioretention and detention basins or providing stand-alone end-of-pipe biofilters. Although a treatment train approach was advocated, most of the water quality improvement was to be achieved by the end-of-pipe bioretention basins. However, it is not possible to operate a biofilter in some basins due to hydraulic constraints.

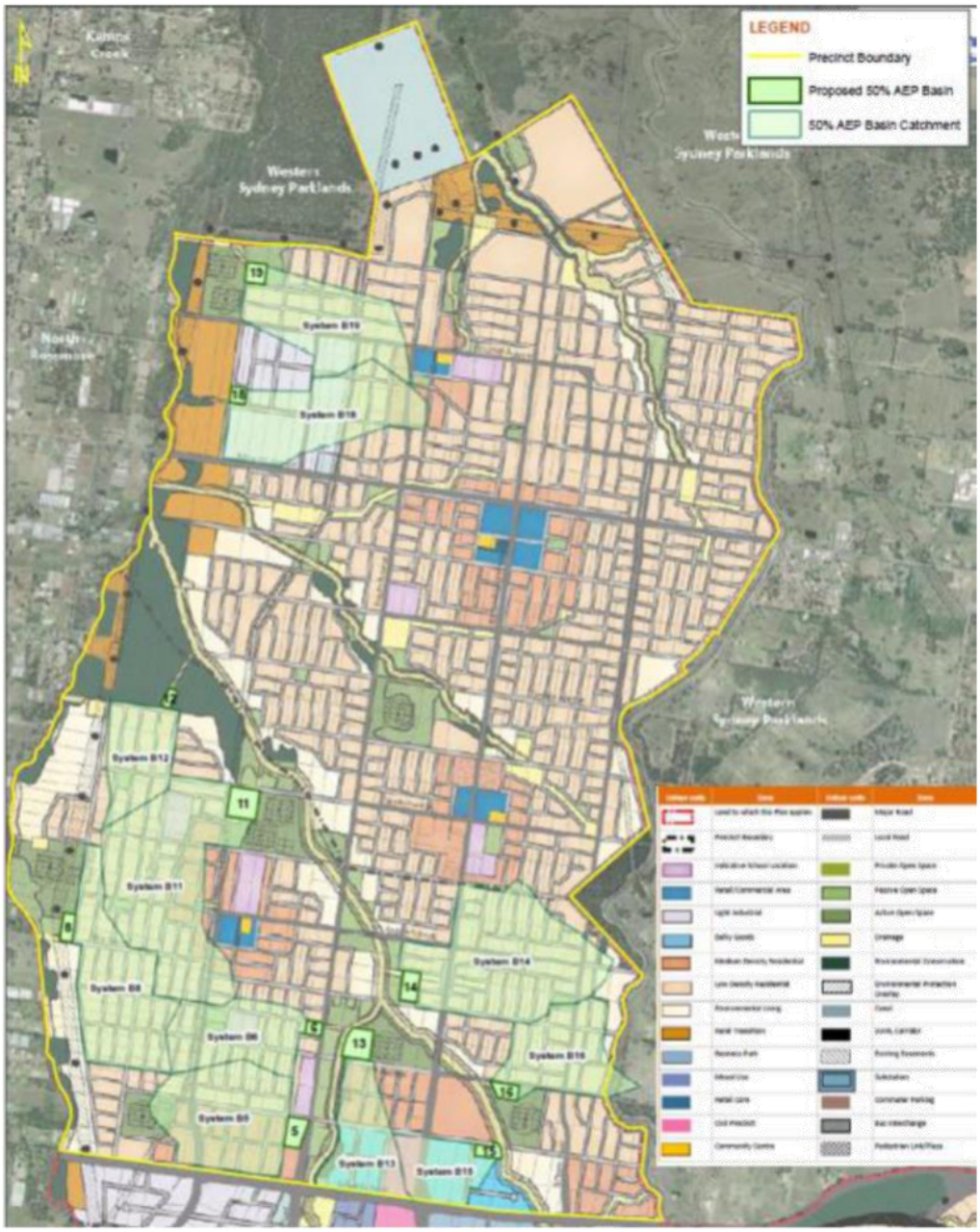
Additionally, due to the limited footprint area, the majority of the co-located biofilters were undersized relative to their catchments. Therefore, supplementary streetscape controls (i.e. raingardens) are proposed to meet the water quality treatment targets and replace the stand-alone end-of-pipe biofilters.

For drainage systems with biofilters co-located within detention basins, the required supplementary streetscape raingarden area is defined as a percentage of the total catchment. For drainage systems without co-located biofilters, a minimum raingarden area is defined as a percentage of the development area, based on land use.



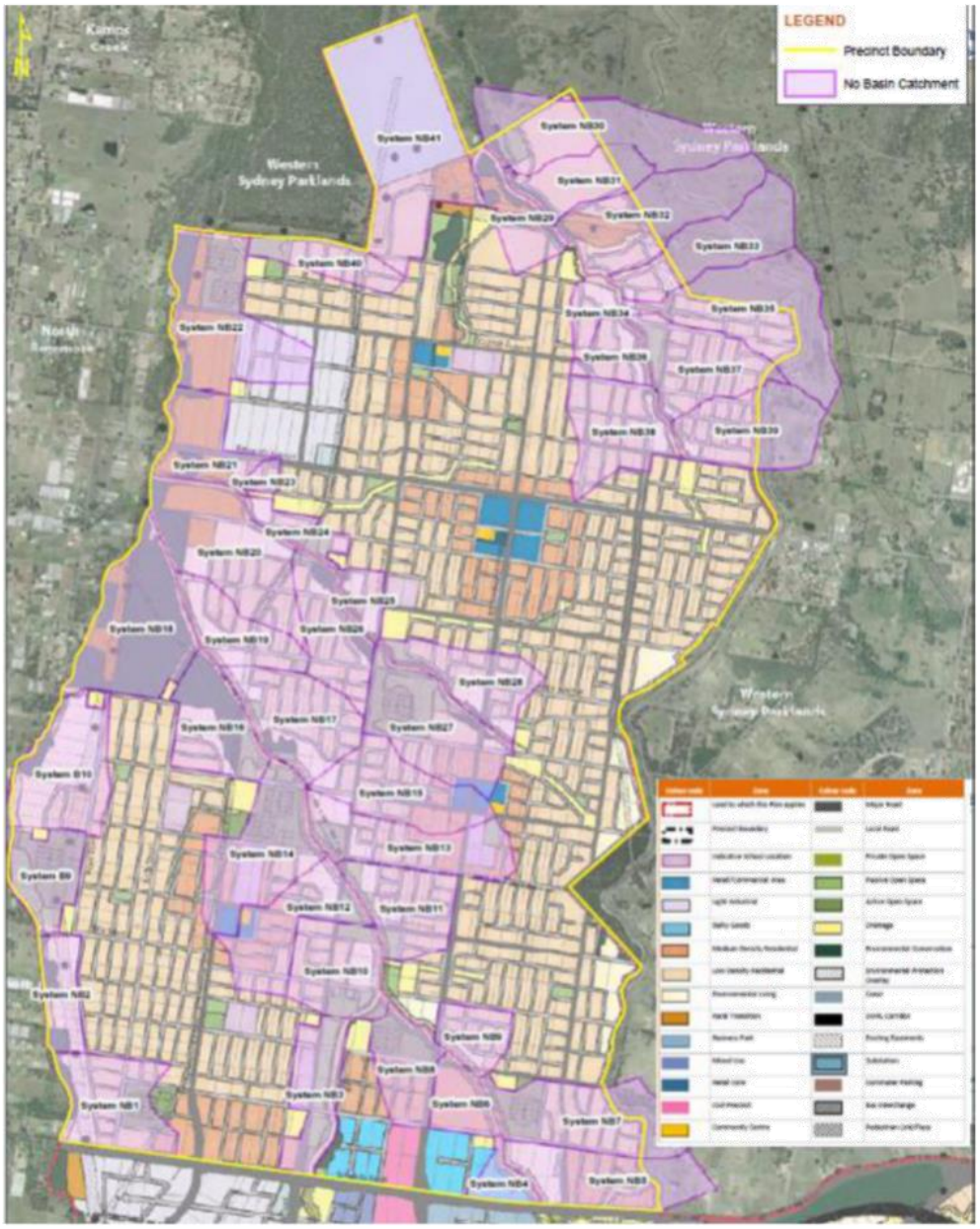
Source: SMEC Concept Design Report, page 58.

Figure 4.2 Drainage catchments with 1% AEP basins



Source: SMEC Concept Design Report, page 98.

Figure 4.3 Drainage catchments with 50% AEP basins



Source: SMEC Concept Design Report, page 151.

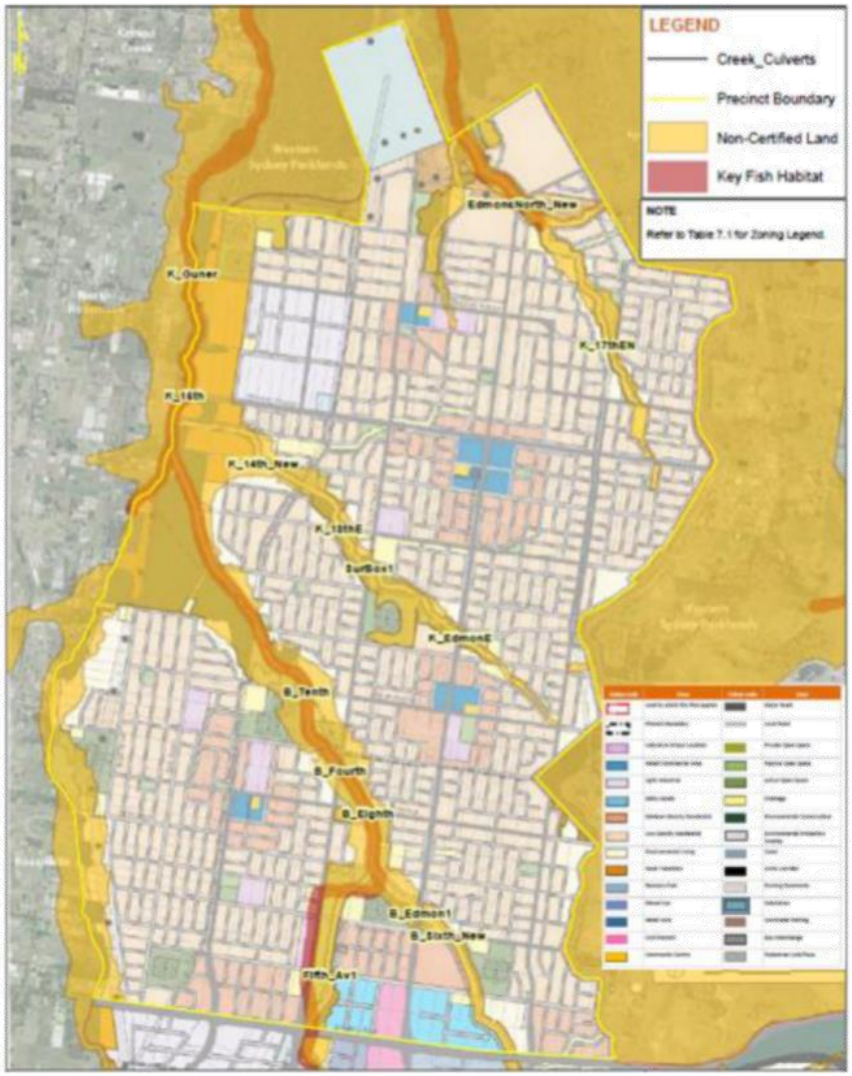
Figure 4.4 Drainage systems without basins

Creek enhancement works

In addition to the design of the drainage and water quality infrastructure, creek enhancement works (i.e. filling of flood fringe areas up to the post development 1% AEP flood level), were proposed to maximise development potential. SMEC's modelling results indicated that the 1% AEP flood levels were increased in some locations because of the filling, but the increases were not significant. Therefore, for future development the post development 1% AEP flood levels (with filling) should be adopted as the flood planning level.

Creek culverts

This Plan also includes 12 creek culverts based on SMEC's recommendations to remove 14 existing culverts, redesign nine existing culverts and add three new culverts compared with the earlier WSUD Strategy. The 12 creek culvert locations are shown in Figure 4.5.



Source: SMEC Concept Design Report, page 179.

Figure 4.5 Creek culverts

SMEC Australia provided Council with updated cost estimates for each of the stormwater infrastructure facilities[11] and Council has adopted these estimates with some revisions, mainly to reflect a lower allowance for contaminated soil disposal but also to ensure that culverts are not double counted with the road costings. A contingency is still retained in the cost estimates to account for the major risks in delivering the infrastructure which were identified by SMEC. These risks include the possible variations to the finished design surface levels, conflicts with other utility infrastructure, the need to dispose of contaminated soil offsite and soft soil conditions [12] .

More detail on all of the drainage systems and infrastructure items and their costs (for which contributions are collected under this Plan) are included in the maps and schedules included in Part 5. Council will encourage the provision of water cycle management facilities as Works In Kind in conjunction with the civil works undertaken as part of land subdivision.

A range of 'non-trunk' reticulation works not addressed by this Plan will also be required to be undertaken directly by the developer as conditions of consent under section 4.17(1)(f) of the EP&A Act. The facilities may include lot-scale on-site detention (OSD) basins, rainwater tanks, construction of kerb, gutter and piping in local roads, installation of drainage pits and grates, and pipe connections to the trunk drainage network.

4.4.2 How are the contributions calculated?

Contributions are determined on a Net Developable Area basis.

The monetary contribution per hectare is calculated as follows:

$$\text{Contribution per hectare of equivalent net developable land (\$)} = \sum \frac{(\$INF)}{NDA}$$

Where:

$INF = the estimated cost, or if the facility has been completed, the indexed actual cost, of providing each of the water cycle management infrastructure items in the area to which this Plan applies (refer Part 5 – Works Schedule)

NDA = the total area of equivalent net developable land (in hectares) that will generate demand for facilities – refer to Table 3.3 of this Plan

To determine the total contribution that would apply to a proposed development, multiply the contribution rate by the amount of net developable land (in hectares) on the site the subject of the proposed development.

[11] SMEC Concept Design Report, pp 210-211.
[12] SMEC Concept Design Report, pp x-xi.

4.5 Transport management facilities

4.5.1 What is the relationship between the expected types of development and the demand for additional public facilities?

Occupants of expected development in the Precincts will utilise a transport network comprising:

- facilities for private vehicles, including roads and intersections;
- facilities for public transport, including rail and bus facilities focused on the planned Leppington railway station; and
- facilities for walking and cycling.

The existing transport network, including the network for pedestrians and cyclists, has been planned to serve existing and approved developments (that is, predominantly rural residential developments) in the area, and not the future development envisaged for the area.

The ILP for the Austral and Leppington North Precincts and the *Austral and Leppington North (ALN) Precincts Transport Assessment* prepared by AECOM (the 'Transport Assessment') together identify a range of transport infrastructure works that will be required to mitigate the impacts and otherwise accommodate the expected development.

Details of:

- the assumptions of expected land use and development;
- the methodology used to determine the need for transport facilities attributable to the expected development in the Austral and Leppington North Precincts; and
- the scope and specification of those facilities,

are contained in the Transport Assessment.

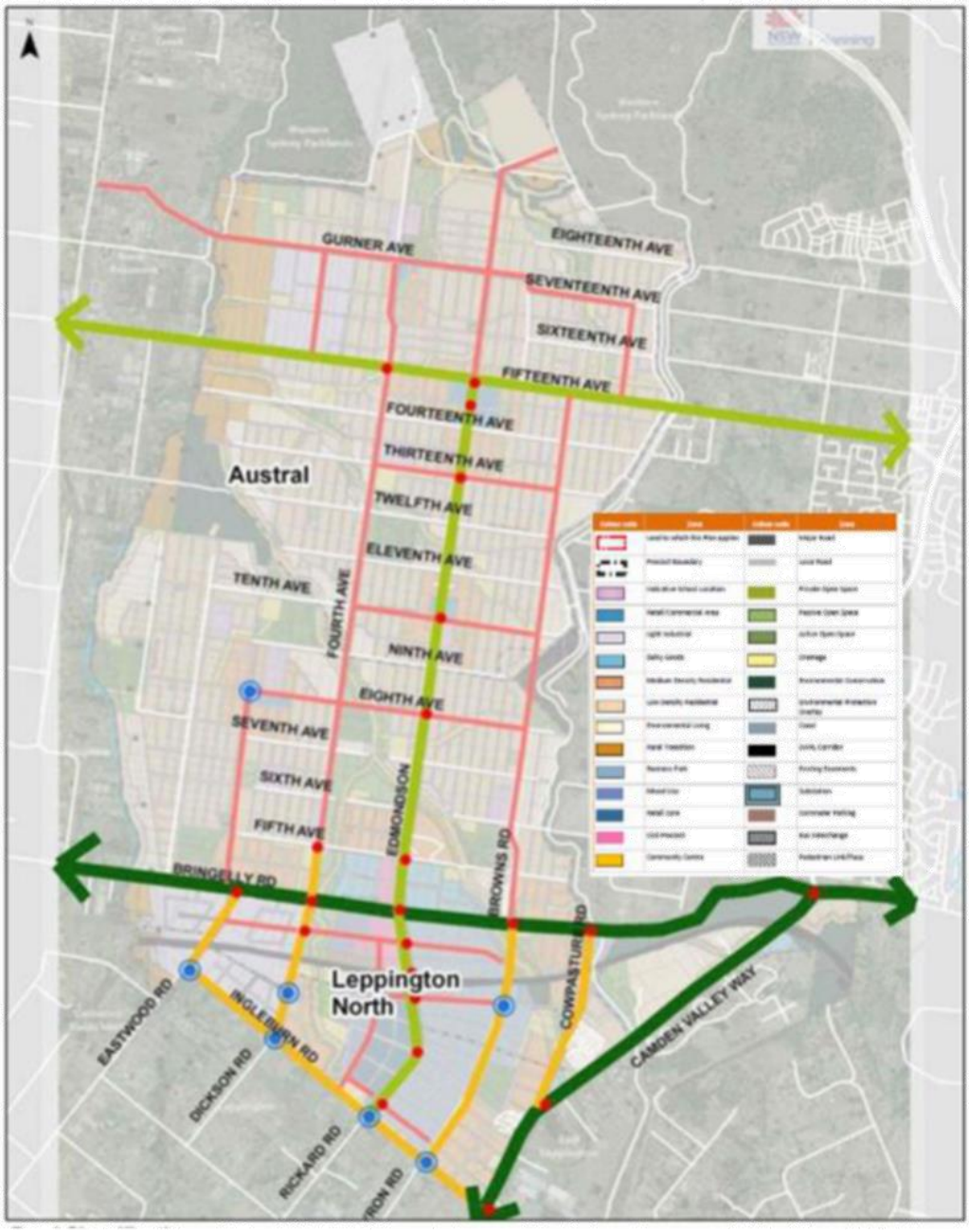
The following is a summary of the approach utilised in the Transport Assessment for planning for the transport needs in the Precincts.

Proposed road and intersection hierarchy

The proposed road network complements a broader hierarchy envisaged for the South West Growth Area.

The proposed hierarchy comprises 'principal arterial', 'transit boulevard', 'sub arterial' and 'collector' roads. These will connect to a network of existing and new roads in adjoining Growth Area Precincts. Following finalisation of the ILP a road safety assessment of the proposed street network was undertaken by Council. As a result additional roundabouts were found necessary and are included in the contributions plan.

The proposed road hierarchy and intersection treatments for the future development of the Austral and Leppington North Precincts are shown in Figure 4.6.



Source: Transport Assessment, Figure 13

Figure 4.6 **Proposed road hierarchy and intersection treatments – Austral and Leppington North Precincts**

Proposed walking and cycling facilities

Providing viable alternatives to the private car for journeys with destinations both within and outside the development area is viewed as essential to encouraging sustainable development. A comprehensive bicycle network is proposed for both the Austral and Leppington North Precincts, which will link the centres, schools, transport nodes and various residential neighbourhoods with key strategic routes and onward destinations.

The proposed network will include a mixture of dedicated bicycle facilities that will take the form of:

- Off-Road (Shared Path);
- On-Road (Cycle Lane); and
- On-Road (Signed Route).

All proposed roads throughout the Austral and Leppington North Precincts will have dedicated pedestrian footpaths. Footpaths will be provided in conjunction with the adjacent road project with an increased width of footway allowed for – i.e. 1.2 to 2.5m.

Leppington North Precinct will be a focus for walking and cycling trips because of the location of the Leppington Major Centre but there is proposed to be a similar level of provision in the Austral Precinct. In addition, an off-road cycleway is proposed to be provided along the edge of the Western Sydney Parklands. This facility to be funded from sources apart from development contributions.

Figure 4.7 over page shows the proposed walking and cycle network for Leppington North Precinct.

Public transport facilities

The Austral and Leppington North Precincts are proposed to benefit from good public transport accessibility through the South West Rail Line and a comprehensive proposed bus network and bus servicing strategy linking key centres, transport nodes, schools, employment opportunities and residential areas.

The only public transport work addressed by this Plan is the proposed provision of bus shelters to serve bus routes throughout the Precincts. All other public transport works, apart from the roads and intersections that will cater for buses and other general traffic and bus shelters, are not addressed by this Plan and will be delivered using funding and delivery mechanisms apart from development contributions.

Source: Transport Assessment, Figure 25

Source: Transport Assessment, Figure 25

Figure 4.7 Proposed walkways and cycleways

Funding and delivery dependent on road hierarchy

Some of the required transport works are to meet a regional demand that extends beyond the Precincts boundary to the remainder of the South West Growth Area.

The State Government has identified a number of works in the Precincts that are intended to be provided through the State budget or through Special Infrastructure Contributions under the EP&A Act (refer to *Environmental Planning and Assessment (Special Infrastructure Contribution - Western Sydney Growth Areas) Determination 2011*). The works include arterial road and public transport links as well as rail and bus passenger transport facilities (such as interchanges and bus shelters on roads to be funded via Special Infrastructure Contributions).

Figure 4.8 over page shows the major road infrastructure planned to be provided across both the Austral and Leppington North Precincts, including delineation of those roads that are intended to be funded via Special Infrastructure Contributions.

Special Infrastructure Contributions will be imposed via conditions of consent on developments in the Precinct. More details on the applicability of Special Infrastructure Contributions can be found by accessing the Department of Planning, Industry and Environment's website.

Planned higher order roads for the Precinct not covered by State Government funding are to be provided by councils. They are usually funded through land or monetary development contributions but are often constructed as Works In Kind by the developer (that is, works carried out instead of, or as payment towards, a development contribution). Such roads can be constructed by the developer through a Works In Kind agreement at the time of subdivision and dedicated to the local council as public roads once constructed.

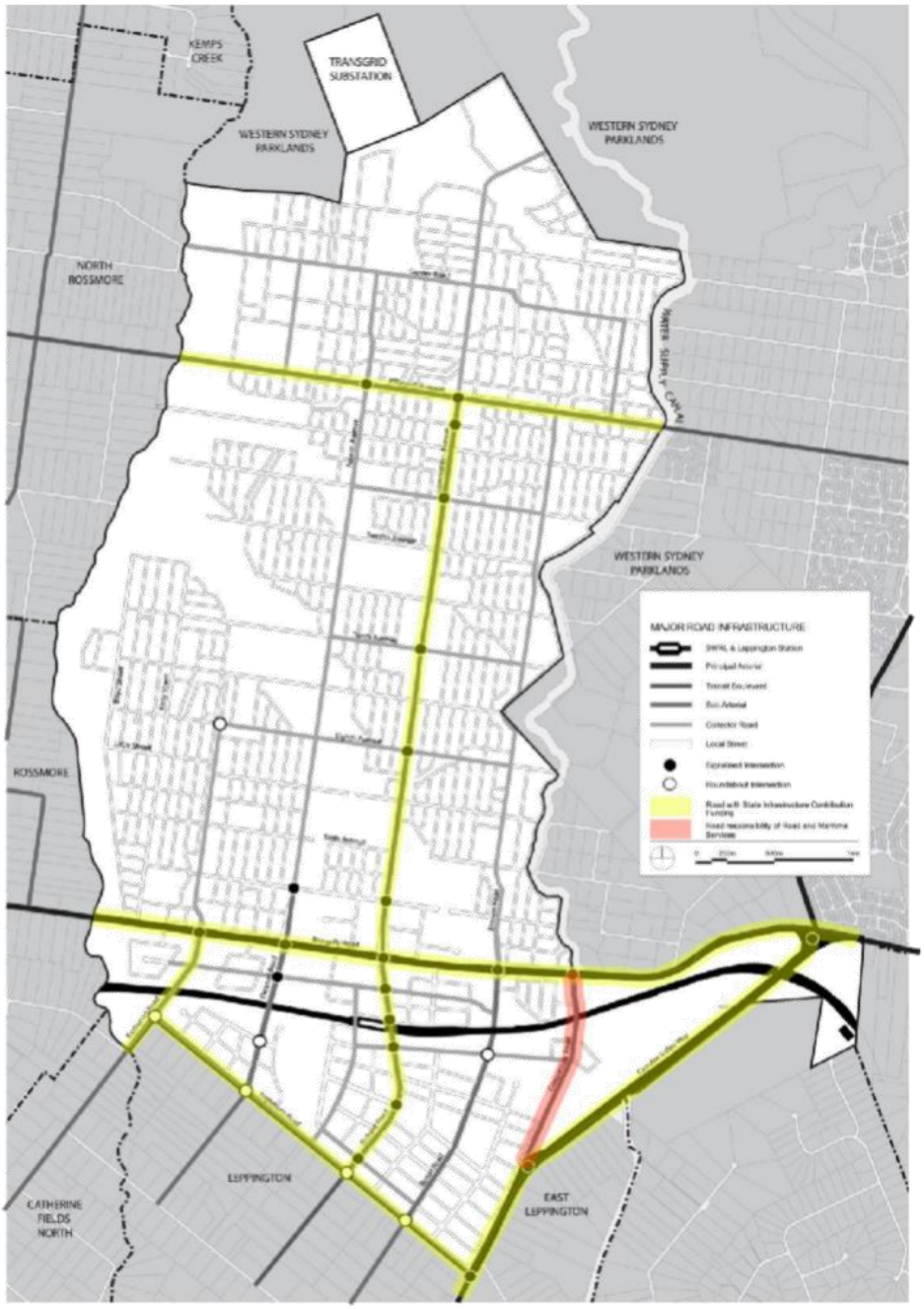
Collector roads may be delivered by a combination of development contributions and direct provision by developers as a condition of development consent. Usually, where private development lots front onto a collector road then that road is usually provided by the developer as part of the subdivision works. On existing streets, half frontages to open space and drainage will be funded by contributions.

New local roads are also usually provided by developers as, in most cases, they have private lots fronting onto them and are needed for the development to function safely. In this Plan there are a number of works defined as 'new road half-width' and 'upgrade road half-width'. These works relate to circumstances where the 'half-road' does not adjoin private land and is therefore not able to be provided by that development. Roads in front of public parks fall into this category.

Roads that do not or will not have development fronting them - such as bridges and crossings of open space - are often funded through development contributions. In some cases, development will front a road that is half on the adjoining property and in turn fronts open space. In this situation it would be difficult to construct the road without contributions.

For public schools only two frontages are expected to be funded by the school. In some cases frontages to a school site on an existing street will be funded by contributions.

The selection of some facilities for inclusion in this Plan has also been based on the land ownership arrangement given that there may be difficulty in developers providing key transport links through parts of the Precincts where the ownership is fragmented. The integrated use of the different implementation mechanisms cited above will result in the transport infrastructure that is required as a consequence of the expected development in the Precincts being provided.



Source: Department of Planning and Infrastructure

Figure 4.8 **Planned major road infrastructure - Austral and Leppington North Precincts**

Infrastructure works identified in this Plan

Works the subject of a development contribution condition that are addressed under this Plan include the following and a detailed list is included in the Works Schedules in Part 5 of this Plan:

- Approximately 13 kilometres of new roads or road upgrades for full or half road widths as required;
- 12 pedestrian crossings (plus road sections over creek culverts and crossings otherwise in drainage costs)
- Fifty (50) pedestrian refuge crossings or thresholds;
- 10 intersections (9 new roundabouts and one new signalized intersection); and
- Forty-two (42) bus shelters.

4.5.2 How are the contributions calculated?

The determination of reasonable contribution rates for transport facilities in development contributions plans is often based on the number of vehicle trips generated by development. Apportionment to the different classes of development (that is, residential, commercial, employment, etc.) of the costs of facilities that are determined on a per trip basis is then derived by calculating the degree to which the traffic generated by each land use class will use the different road links and intersections included in the contributions plan.

However, at the time of preparing this Plan, there has been limited knowledge of likely trip origins and destinations by different development classes available to inform this method of apportionment.

This Plan instead determines contributions for traffic and transport facilities by first splitting the costs between residential and non-residential development based on the relative net developable areas of each class of development. It then levies residential development its share of the costs on a per person basis and non-residential development its share of costs on a net developable land basis.

The per resident approach for residential development is considered to best reflect the demand for traffic and transport facilities by the additional population. The net developable land area approach for determining contributions for non-residential development is considered reasonable because the land use mix and employment numbers attributable to the different non-residential land uses expected in the Precinct have been assessed only at a strategic network level at the time of preparing this Plan.

Formula for Residential Development

Contributions will be collected from residential development toward road and transport facilities identified under this Plan.

Monetary contributions are calculated on a per person or per resident basis, then factored up to a per lot or per dwelling amount.

The monetary contribution per person in a development containing residential dwellings or lots (whether or not that development also comprises non-residential floor space) is calculated as follows:

$$\text{Contribution per resident (\$)} = \sum \frac{(\$INF)}{P}$$

Where:

$INF = apportioned share to residential development (93.89%) of the estimated $ cost - or if the facility is existing, the indexed, completed cost - of providing each of the road and transport facilities (refer Part 5 – Works Schedule).

P = the estimated resident population (in persons) that will demand each facility - that is, the expected net additional population of the Precincts (refer Table 3.5)

The monetary contribution for different residential development types is determined by multiplying the contribution per person by the estimated increase in population as a result of the development and using the assumed occupancy rates included in clause 3.3.5 of this Plan.

For convenience, these rates are reproduced in Table 4.7.

Table 4.7 Assumed residential development occupancy rates

Development type	Occupancy rate
Subdivided lots	3.4 persons per lot
Detached dwelling, detached dual occupancy (each dwelling)	3.4 persons per dwelling
Semi-detached, town house, terrace, attached dual occupancy (each dwelling)	2.6 persons per dwelling
Flat, unit, apartment, secondary dwellings	1.8 persons per dwelling
Seniors living dwellings	1.5 persons per dwelling

Formula for Non-Residential Development

Contributions for non-residential development are determined on a Net Developable Area basis.

The monetary contribution per hectare is calculated as follows:

$$\text{Contribution per ha of equivalent net developable land (\$)} = \sum \frac{(\$INF)}{NDA}$$

Where:

$INF = the apportioned share to non-residential development (6.11%) of the estimated cost, or if the facility has been completed, the indexed actual cost, of providing each of the transport management infrastructure items in the area to which this Plan applies (refer Part 5 – Works Schedule).

NDA = the total area of equivalent net developable land (in hectares) that will generate demand for each facility by non-residential development – refer to Table 3.3 of this Plan.

To determine the total contribution that would apply to a proposed non-residential development, multiply the contribution rate by the amount of equivalent net developable land (in hectares) on the site the subject of the proposed development.

4.6 Plan management and administration

4.6.1 What is the relationship between the expected types of development and the demand for additional public facilities?

Councils incur significant costs in the preparation and administration of contributions plans.

Council staff are deployed to:

- prepare and review contributions plans;
- account for contributions receipts and expenditure; and
- co-ordinate the implementation of contributions plans and works, including involvement in negotiating Works in Kind and material public benefit agreements.

Consultant studies are also commissioned by Council from time to time in order to determine the value of land to be acquired, the design and cost of works, as well as to review the development and demand assumptions of the contributions plan. Council is also required to engage the services of legal professionals from time to time to assist it in the administration of this Plan.

As these costs arise directly as a result of the development in the Plan area, it is reasonable that the costs associated with preparing and administering this Plan be recouped through contributions from development.

Costs associated with the ongoing administration and management of the Plan will be levied on all applications that are required to pay a development contribution.

Costs included in this Plan for these purposes are determined are based on the recommended rate by IPART, being 1.5% of the cost of works.

4.6.2 Calculation of contributions

Contributions will be collected from development toward Plan preparation and administration activities.

The monetary contribution per hectare of net developable land is calculated as follows:

$$\text{Contribution per ha of equivalent net developable land (\$)} = \sum \frac{(\$INF)}{NDA}$$

Where:

$Admin = 1.5% of capital works costs in accordance with IPART's benchmark (refer Part 5 – Works Schedule)

NDA = the total area of equivalent net developable land (in hectares) of the area to which this Plan applies as shown in Table 3.3 of this Plan.

To determine the total contribution that would apply to a proposed development, multiply the contribution rate by the amount of equivalent net developable land (in hectares) on the site the subject of the proposed development.

5 Works Schedules and Map

Works Schedules

The schedules contained in this section are extracted from the following MS Excel spread sheet:

Liverpool S7.11 Schedules October 2018.xls.XLSX

The spread sheet also contains details on the components of each facility, as well as the assumptions informing the calculation of costs included in this Part. Refer to the source spread sheet file for more information on works and land items included in this Plan.

Infrastructure Map

The infrastructure referred to in the contributions plan is shown on the Austral Leppington North Infrastructure Map, which is a separate document. This map can be viewed at a large scale and shows all the infrastructure items on the one map in relation to property boundaries and the proposed local streets under the ILP.

5.1 Open space and recreation facilities

Land

Item	Facility	Area (ha)	Cost
	Future Land Acquisition		
LALP	Local passive open space facilities	37.5339	$90,959,820
LALS	Local sporting field facilities	26.8682	$67,252,192
LADP	District passive open space facilities	33.3807	$64,170,334
LADS	District sporting field facilities	9.0691	$24,160,473
	Subtotal	106.8519	$246,542,818
	Land Acquisition Contingency		$29,585,138
	TOTAL ESSENTIAL OPEN SPACE INFRASTRUCTURE LAND ACQUISITION COSTS	106.8519	$276,127,956

Staging / Priority of infrastructure - when surrounding development proceeds.

LALP - Local Passive Open Space

Item	Area (ha)	Acquisition Cost
LP2	1.6146	$5,489,640
LP4	0.0972	$330,480
LP5	1.8031	$1,837,161
LP6	0.5036	$1,712,192
LP7	0.8372	$3,599,802
LP8	2.3162	$2,540,522
LP10	1.3320	$1,159,200
LP11	1.4399	$1,813,920
LP12	1.2173	$1,170,955
LP13	0.9572	$906,720
LP16	0.6532	$2,061,670
LP17	0.6713	$2,282,420
LP22	1.2139	$5,159,075
LP25	0.9098	$1,228,230
LP26	0.1708	$230,580
LP27	0.4352	$1,479,680
LP28	0.6337	$611,095
LP29	1.3538	$2,834,090
LP30	0.4333	$505,310
LP31	0.5520	$615,275
LP32	2.1575	$2,892,974
LP33	0.5072	$771,215
LP34	0.3354	$819,505
LP35	0.8813	$3,014,508
LP39	0.5964	$2,027,661
LP40	0.5879	$2,528,130
LP44	0.5196	$1,469,018
LP45	2.1657	$6,994,960
LP46	0.2426	$219,320
LP49	0.5679	$1,028,307
LP50	0.4252	$231,943

Item	Area (ha)	Acquisition Cost
LP51	0.3487	$759,626
LP52	0.1733	$371,757
LP53	0.3139	$1,349,879
LP55	0.5859	$2,519,468
LP56	0.3316	$1,226,828
LP57	0.1351	$51,021
LP58	0.1913	$650,252
LP59	0.2575	$875,593
LP60	0.3275	$1,113,526
LP61	0.2725	$926,376
LP62	2.4292	$9,514,289
LP63	0.0325	$110,649
LP64	2.3271	$7,912,121
LP65	0.2558	$869,688
LP66	1.4202	$3,143,190

LADP - District Passive Open Space

Item	Area (ha)	Acquisition Cost
DP2	3.6531	$3,506,140
DP3	3.9971	$8,890,655
DP4	2.2378	$3,131,900
DP5	2.2284	$2,999,285
DP6	6.1467	$15,923,995
DP7	0.3658	$215,230
DP8	0.5594	$1,901,960
DP9	0.3295	$1,120,300
DP10	10.4438	$17,684,205
DP11	2.6598	$7,004,191
DP12	0.7593	$1,792,473

LALS - Local Sporting Fields

Item	Area (ha)	Acquisition Cost
LS1	5.7696	$20,914,746
LS4	6.1658	$15,878,348
LS8	2.6640	$4,338,932
LS9	12.2688	$26,120,166

LADS - District Sporting Fields

Item	Area (ha)	Acquisition Cost
DS1	9.0691	$24,160,473

Works

Item	Area (ha)	Cost	Project On Costs	Demolition Allowance	Total Cost
Local Passive Open Space embellishment					
LP2	1.6146	$1,296,788	$354,023	$58,378	$1,709,190
LP4	0.0972	$94,828	$25,888	$0	$120,717
LP5	1.8031	$1,441,900	$393,639	$29,189	$1,864,728
LP6	0.5036	$389,601	$106,361	$0	$495,962
LP7	0.8372	$631,562	$172,416	In DC15	$803,978
LP8	2.3162	$1,793,970	$489,754	$0	$2,283,724
LP10	1.3320	$977,747	$266,925	$58,378	$1,303,050
LP11	1.4399	$1,056,553	$288,439	$0	$1,344,992
LP12	1.2173	$999,184	$272,777	$0	$1,271,961
LP13	0.9572	$710,941	$194,087	$0	$905,028
LP16	0.6532	$497,083	$135,704	$0	$632,786
LP17	0.6713	$511,253	$139,572	$0	$650,825
LP22	1.2139	$1,006,140	$274,676	$87,568	$1,368,384
LP25	0.9098	$684,249	$186,800	$29,189	$900,238
LP26	0.1708	$123,890	$33,822	$0	$157,712
LP27	0.4352	$339,997	$92,819	$58,378	$491,195
LP28	0.6337	$479,105	$130,796	$58,378	$668,279
LP29	1.3538	$1,100,737	$300,501	$58,378	$1,459,617
LP30	0.4333	$335,105	$91,484	In DC25	$426,588
LP31	0.5520	$420,675	$114,844	In DC25	$535,520
LP32	2.1575	$1,683,075	$459,480	$29,189	$2,171,744
LP33	0.5072	$364,933	$99,627		$464,560
LP34	0.3354	$240,322	$65,608	$0	$305,930
LP35	0.8813	$763,538	$208,446	$0	$971,984
LP39	0.5964	$456,903	$124,734	$0	$581,637
LP40	0.5879	$450,785	$123,064	$29,189	$603,039
LP44	0.5196	$401,200	$109,528	$0	$510,728
LP45	2.1657	$1,594,180	$435,211	$0	$2,029,391
LP46	0.2426	$173,836	$47,457	$0	$221,293
LP49	0.5679	$431,054	$117,678	$29,189	$577,921
LP50	0.4252	$301,567	$82,328	$0	$383,894
LP51	0.3487	$274,826	$75,027	$29,189	$379,042
LP52	0.1733	$124,303	$33,935	$0	$158,238
LP53	0.3139	$252,030	$68,804	$0	$320,835
LP55	0.5859	$550,636	$150,324	$0	$700,960
LP56	0.3316	$264,833	$72,299	$0	$337,132
LP57	0.1351	$95,272	$26,009	$0	$121,282
LP58	0.1913	$163,048	$44,512	$0	$207,560
LP59	0.2575	$211,122	$57,636	$0	$268,758
LP60	0.3275	$261,882	$71,494	$0	$333,376
LP61	0.2725	$221,956	$60,594	$0	$282,550
LP62	2.4292	$1,786,333	$487,669	$0	$2,274,002
LP63	0.0325	$47,930	$13,085	$0	$61,015
LP64	2.3271	$1,712,285	$467,454	$0	$2,179,739
LP65	0.2558	$209,862	$57,292	$0	$267,155

Item	Area (ha)	Cost	Project On Costs	Demolition Allowance	Total Cost
LP66	1.4202	$1,050,090	$286,675	$0	$1,336,764
Subtotal	37.5339	$28,979,113	$7,911,298	$554,595	$37,445,005
District Passive Open Space embellishment					
DP2	3.6531	$3,014,217	$822,881	$116,757	$3,953,856
DP3	3.9971	$2,861,116	$781,085	$87,568	$3,729,768
DP4	2.2378	$1,540,013	$420,424	$87,568	$2,048,005
DP5	2.2284	$1,975,897	$539,420	$116,757	$2,632,074
DP6	6.1467	$4,660,309	$1,272,264	$116,757	$6,049,330
DP7	0.3658	$258,037	$70,444	$0	$328,481
DP8	3.7543	$3,007,335	$821,003	$0	$3,828,338
DP9	0.3295	$931,706	$254,356	$58,378	$1,244,440
DP10	10.4438	$7,417,007	$2,024,843	$58,378	$9,500,228
DP11	6.4326	$4,772,867	$1,302,993	$0	$6,075,860
DP12	0.7593	$517,160	$141,185	$58,378	$716,723
Subtotal	40.3484	$30,955,664	$8,450,896	$700,541	$40,107,101
Local Sporting Fields embellishment					
LS1	5.7696	$5,178,157	$1,413,637	$116,757	$6,708,551
LS4	6.1658	$5,435,016	$1,483,759	$175,135	$7,093,910
LS5	0.0000	$5,419,289	$1,479,466	$0	$6,898,755
LS8	2.6640	$3,471,283	$947,660	$116,757	$4,535,700
LS9	12.2688	$9,991,042	$2,727,555	$116,757	$12,835,354
Subtotal	26.8682	$29,494,788	$8,052,077	$525,405	$38,072,270
District Sporting Fields embellishment					
DS1	9.0691	$7,170,487	$1,957,543	$262,703	$9,390,733
Subtotal	9.0691	$7,170,487	$1,957,543	$262,703	$9,390,733
Total Construction Costs		$96,600,051	$26,371,814	$2,043,243	$125,015,109
Construction Contingency					$6,905,031
TOTAL ESSENTIAL OPEN SPACE CONSTRUCTION COSTS					$131,920,139

Staging / Priority of infrastructure - as and when surrounding development proceeds.
Project On Costs excludes construction and contingency

5.2 Community and cultural facilities

Land

Item	Facility	Area (ha)	Cost
	Future Land Acquisition		
LACF	Land for Local Community Facilities	1.4341	$5,736,400
	Subtotal	1.4341	$5,736,400
	Land Acquisition Contingency		$688,368
TOTAL ESSENTIAL COMMUNITY FACILITY INFRASTRUCTURE LAND ACQUISITION COSTS		1.4341	$6,424,768

LACF - Local Community Facilities

Item	Total Area	Acquisition Cost
CF2	0.3412	$1,364,800
CF3	0.2867	$1,146,800
CF4	0.5339	$2,135,600
CF5	0.2723	$1,089,200

Works

Item	Facility	Area (ha)	Cost to Plan	Project On Costs	Demolition Allowance	Total Cost to Plan	Priority / Staging
	Regional Community Facility						
LS1	Aquatic and Indoor Recreation Centre construction	5.2141	$26,292,267	$7,177,789	$25,241	$33,495,297	1
	Subtotal	5.2141	$26,292,267	$7,177,789	$25,241	$33,495,297	
	Local Community Facilities						
CF2	Local Community Facility construction						
CF3	Local Community Facility construction	0.3412	$3,003,443	$819,940	$30,480	$3,853,864	2
CF4	Local Community Facility construction	0.2867	$2,938,779	$802,287	$30,480	$3,771,546	2
CF5	Local Community Facility construction	0.5339	$5,784,381	$1,579,136	$30,480	$7,393,997	3
	Subtotal	0.2723	$2,921,694	$797,622	$0	$3,719,316	2
	Public Art	1.4341	$14,648,297	$3,998,985	$91,440	$18,738,722	
PA1	Regional Community Facility						
PA2	Local Community Facilities						
	Subtotal		$788,768	$215,334	$0	$1,004,102	4
	Total Construction Costs		$439,449	$119,970	$0	$559,418	5
	Construction Contingency		$1,228,217	$335,303	$0	$1,563,520	
TOTAL NON ESSENTIAL COMMUNITY FACILITY CONSTRUCTION COSTS						$56,757,521	

Note Cost of Regional Community Facility LS5 has been adjusted to reflect residential catchment within the Precincts that will contribute to facility (41.4%) as facility will serve population of 120,000 people.
Project On Costs excludes construction and contingency

Priority / Staging

1 As residential catchments in adjoining Precincts establish, facility to serve 120,000 population.
2 As population in catchment area reaches 10,000.
3 At completion of residential development within the Precincts, facility to serve population of 40,000.
4 To be delivered with Aquatic and Indoor Recreation Centre.
5 To be delivered with Local Community Facilities.

5.3 Water cycle management facilities

Land

Item	Facility	Area (ha)	Cost
	Future Land Acquisition		
LAC	Land for Trunk Drainage Channels	47.8209	$39,846,554
LAB	Land for Trunk Drainage Basins	24.1392	$72,316,350
	Subtotal	71.9601	$112,162,904
	Land Acquisition Contingency		$13,459,549
TOTAL ESSENTIAL DRAINAGE INFRASTRUCTURE LAND ACQUISITION COSTS		71.9601	$125,622,453

LAC - Trunk Drainage Channels

Item	Total Area	Acquisition Cost
Chn B19	0.9455	$1,172,670
Chn B18	0.2824	$360,716
Chn B17.4	1.8932	$1,899,114
DC6	0.4735	$165,725
DC7A	1.8283	$639,921
DC9	1.8287	$640,031
Chn B8	0.2857	$274,247
Chn B11	0.2343	$244,993
DC18	1.1021	$385,739
DC19A	1.1322	$396,262
DC20	3.1912	$1,116,922
Chn B6	0.2135	$342,107
Chn B14.2	0.2563	$263,137
DC23	0.4119	$144,152
DC24	2.2938	$802,823
DC25	0.8323	$291,307
CHN B17.2-3	1.1949	$1,194,539
CHN B17.1-2	1.6094	$5,474,399
Chn B25	1.4446	$505,617
DC32	3.1592	$1,105,713
DC33	4.6023	$2,366,435
Chn NB33	0.5620	$277,240
DC38	0.5157	$1,030,597
DC40	1.0908	$381,786
DC41	1.2289	$438,662
Chn B29C	0.6988	$1,959,037
Chn 29b.2	0.4357	$851,653
Chn 29b.1	0.4715	$428,940
Chn B20.1-3	1.2827	$4,151,994
DC53	1.0245	$358,581
Chn B20.5	0.0481	$46,522
DC54	0.8779	$309,310
DC55	0.5351	$201,164
Chn B22	1.3585	$2,752,544
Chn B14.1	0.5553	$1,066,704
DC61	0.6753	$236,355
Chn B16	0.1352	$142,624
DC63	3.0978	$1,084,226
Chn NB5	0.8075	$2,626,424
DC65	0.4990	$174,645
DC66	1.2761	$740,367
DC67	1.4295	$800,614

LAB - Trunk Drainage Basins

Item	Total Area	Acquisition Cost
B5	1.4259	$5,810,491
B6	0.5423	$1,843,831
B8	0.8821	$2,999,021
B11	2.2508	$6,647,005
B13	1.8546	$7,192,729
B14	1.3321	$3,948,705
B15	0.8328	$2,678,705
B16	0.9374	$3,187,086
B17	2.2928	$7,795,465
B18	0.6628	$2,253,564
B19	1.0110	$2,209,242
B20	2.0244	$5,744,656
B21	0.5808	$1,345,350
B22	1.3260	$4,526,908
B23	0.9568	$2,088,794
B25	1.6643	$3,964,541
B27	1.2901	$3,710,420
B29	1.4567	$2,693,080
B32	0.8157	$1,676,756

Staging / Priority of infrastructure - As land affected by acquisition is developed or as required to service development.

Works

System	Detention Basin	Trunk Drainage Works	Water Quality Works	Construction Cost	Project On Costs	Contingency	Total Cost
Drainage Systems with 1% AEP Basins							
Drainage System B17	Basin 17	Chn B17.1, Chn B17.2, Chn B17.3 and Chn B17.4 (open channel)	Bioretention B17, GPT B17	$24,249,473	$4,325,779	$4,589,051	$33,164,303
Drainage System B20	Basin 20	Chn B20.1, Chn B20.2 and Chn B20.3 (open channels), B20 pipe (Pipe B20.1, Pipe B20.2, Pipe B20.3, Pipe B20.4, Pipe B20.5, Pipe B20.6 and Pipe B20.7	Bioretention B20, GPT B20	$10,455,627	$1,843,942	$1,837,320	$14,136,889
Drainage System B21	Basin 21	Pipe B21.1, Pipe B21.2 and Pipe B21.3	GPT B21	$2,056,463	$363,972	$370,020	$2,790,455
Drainage System B22	Basin 22	Chn B22 (open channel)	GPT B22	$8,682,075	$1,543,912	$1,610,674	$11,836,661
Drainage System B23	Basin 23	Pipe B23.1, Pipe B23.2 and Pipe B23.3	GPT B23	$3,327,278	$588,295	$594,689	$4,510,262
Drainage System B25	Basin 25	Pipe B25.1, Pipe B25.2 and Pipe B25.3, Chn 25 (open channel)	Bioretention B25, GPT B25	$10,605,354	$1,881,145	$1,935,610	$14,422,109
Drainage System B27	Basin 27	Pipe B27.1, Pipe B27.2 and Pipe B27.3	Bioretention B27, GPT B27	$5,011,651	$881,149	$862,674	$6,755,474
Drainage System B29	Basin 29	Chn B29b.1, Chn B29b.2, Chn B29c (open channels), Pipe B29a.1, Pipe B29a.2, Pipe B29a.3, Pipe B29a.4, Pipe B29a.5 and Pipe B29a.6, Pipe	GPT B29a, GPT B29b and GPT B29c, Sedimentation pond B29, Bioretention – B29	$11,660,864	$2,063,328	$2,094,659	$15,818,851

		B29b.1, Pipe B29b.2, Pipe B29b.3 and Pipe B29b.4					
	Subtotal			$76,048,785	$13,491,522	$13,894,697	$103,435,004
Drainage Systems with 50% AEP Basins							
Drainage System B5	Basin 5	Pipe B5.1, Pipe B5.2, Pipe B5.3 and Pipe B5.4	GPT B5	$6,825,964	$1,203,293	$1,195,989	$9,225,246
Drainage System B6	Basin 6	Pipe B6.1, Pipe B6.2, Pipe B6.3, Pipe B6.4 and Pipe B6.5, Chn B6	Bioretention B6, GPT B6	$4,223,729	$741,805	$721,637	$5,687,171
Drainage System B8	Basin 8	Pipe B8.1, Pipe B8.2, Pipe B8.3, Pipe B8.4 and Pipe B8.5, Chn B8	Bioretention B8, GPT B8	$5,152,081	$909,282	$909,799	$6,971,162
Drainage System B11	Basin 11	Pipe B11.1, Pipe B11.2, Pipe B11.3, Pipe B11.4, Pipe B11.5, Pipe B11.6, Pipe B11.7, B11.8, B11.9, and Pipe B11.10, Chn B11	Bioretention B11, GPT B11	$11,799,998	$2,067,475	$1,983,171	$15,850,644
Drainage System B12	Basin 12	Chn B12	Bioretention B12, GPT B12	$2,775,251	$491,964	$504,506	$3,771,721
Drainage System B13	Basin 13	Pipe B13.1, Pipe B13.2 and Pipe B13.3	Bioretention B13, GPT B13	$6,998,847	$1,241,591	$1,278,428	$9,518,866
Drainage System B14	Basin 14	Pipe B14.1, Pipe B14.2, Pipe B14.3, Pipe B14.4, Pipe B14.5, Pipe B14.6, Pipe B14.7, Pipe B14.8, Pipe B14.9, Pipe B14.10, and Pipe B14.11, Chn B14.1 and Chn B14.2	Bioretention B14, GPT B14	$10,175,940	$1,783,786	$1,715,964	$13,675,690
Drainage System B15	Basin 15		Bioretention B15, GPT B15	$2,381,657	$421,319	$427,136	$3,230,112
Drainage System B16	Basin 16	Pipe B16.1, Pipe B16.2, Pipe B16.3 and Pipe B16.4, CHN B16	Bioretention B16, GPT B16	$5,111,927	$898,043	$875,027	$6,884,997
Drainage System B18	Basin 18	Pipe B18.1, Pipe B18.2, Pipe B18.3, Pipe B18.4, Pipe B18.5, Pipe18.6 and Pipe 18.7	Bioretention B18, GPT B18	$5,413,165	$929,536	$783,744	$7,126,445
Drainage System B19	Basin 19	Pipe B19.1, Pipe B19.2, Pipe B19.3, Pipe B19.4, Pipe B19.5, Pipe B19.6, Pipe B19.7 and Pipe B19.8, Chn B19	Bioretention B19, GPT B19	$7,957,090	$1,395,696	$1,347,549	$10,700,335
B32*	Basin 32	DC65, DC66		$4,317,035	$647,555	$733,896	$5,698,486
Sub Total				$73,132,684	$12,731,345	$12,476,846	$98,340,875
Drainage Systems without Basins							
Drainage System NB5				$3,626,257	$605,337	$409,326	$4,640,920
Drainage System NB13				$1,093,709	$186,506	$149,663	$1,429,878
Drainage System NB14				$776,125	$132,480	$107,075	$1,015,680

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Drainage System NB15	$1,416,193	$241,760	$195,537	$1,853,490
Drainage System NB33	$1,010,720	$170,759	$127,675	$1,309,154
Drainage System NB35	$1,682,890	$286,276	$225,618	$2,194,784
Drainage System NB37	$1,005,778	$171,567	$138,000	$1,315,345
Drainage System NB38	$444,754	$76,108	$62,632	$583,494
Sub Total	$11,056,426	$1,870,793	$1,415,526	$14,342,745
Creek Culverts (stormwater works only)				
B_Eighth	$1,103,487	$188,300	$151,845	$1,443,632
B_Fourth	$1,232,952	$210,898	$173,036	$1,616,886
B_Tenth	$1,345,777	$229,820	$186,357	$1,761,954
EdmonsNorth_New	$1,020,077	$175,622	$150,735	$1,346,434
Fifth_Av1	$1,484,838	$253,710	$206,565	$1,945,113
K_13thE	$240,250	$41,045	$33,383	$314,678
K_17thEN	$760,626	$129,832	$104,919	$995,377
Surbox1	$590,547	$100,833	$81,673	$773,053
Sub Total	$7,778,554	$1,330,060	$1,088,513	$10,197,127
TOTAL ESSENTIAL STORMWATER INFRASTRUCTURE	$168,016,449	$29,423,720	$28,875,582	$226,315,751

*Basin 32 (B32) was outside the scope area of the SMEC study

Staging / Priority of infrastructure - when surrounding development proceeds.

Project On Costs excludes construction and contingency

5.4 Transport management facilities

Land

Item	Facility	Area (ha)	Cost
	Future Land Acquisition		
LACR	Land for new Collector Roads	4.3614	$15,983,248
LALR	Land for new Local Roads	1.7768	$4,899,060
	Subtotal	6.1382	$20,882,308
	Land Acquisition Contingency		$2,505,877
TOTAL ESSENTIAL ROAD INFRASTRUCTURE LAND ACQUISITION COSTS		6.1382	$23,388,185

LACR - Collector Roads

Item	Total Area	Acquisition Cost
CR1	0.4470	$1,519,800
CR14	0.5150	$2,060,000
CR15	0.3010	$1,023,400
CR16	0.3270	$1,111,800
CR17	1.2800	$5,504,000
CR18	0.4733	$1,399,990
CR1A	0.4610	$1,567,400
CR21	0.0748	$252,680
CR22	0.4032	$1,275,238
CR35	0.0791	$268,940

LALR - Local Roads

Item	Total Area	Acquisition Cost
LR28	0.0254	$109,220
LR33	0.1824	$620,160
LR39A	0.0628	$213,520
LR39B	0.0480	$163,200
LR39C	0.0680	$231,200
LR39D	0.0899	$305,660
LR48	0.1254	$280,810
LR59A	0.0886	$301,240
LR59B	0.0522	$119,770
LR61	0.0459	$195,075
LR64	0.1440	$489,600
LR67	0.2641	$594,540
LR68	0.0238	$80,920
LR69A	0.0716	$243,440
LR70	0.0650	$260,000
LR72	0.0402	$172,860
LR73	0.1150	$391,000
LR74	0.0219	$74,460
LR76	0.0808	$52,385
LR28	0.0254	$109,220
LR33	0.1824	$620,160
LR39A	0.0628	$213,520
LR39B	0.0480	$163,200

Works

Item	Facility	Length (m)	Cost	Project On Costs	Demolition Allowance	Total Cost	Staging / Priority
	Local Roads						
LR3	Upgrade road half width	160	$316,032	$78,376	$0	$394,408	*1
LR5	Upgrade road half width	140	$276,528	$68,579	$0	$345,107	*1
LR6	Upgrade road half width	225	$444,420	$110,216	$0	$554,637	*1
LR11	Upgrade road half width	90	$177,768	$44,087	$0	$221,855	*1
LR13	Upgrade road half width	455	$898,717	$222,882	$0	$1,121,599	*1
LR13A	Upgrade road half width	240	$474,048	$117,564	$0	$591,612	*1
LR16	Upgrade road half width	105	$207,396	$51,434	$0	$258,830	*1
LR18	Upgrade road half width	120	$237,024	$58,782	$0	$295,806	*1
LR22	Upgrade road half width	235	$464,172	$115,115	$0	$579,287	*1
LR24	Upgrade road half width	80	$158,016	$39,188	$0	$197,204	*1
LR26	Upgrade road half width	280	$553,056	$137,158	$0	$690,215	*1
LR27	Upgrade road full width	150	$457,793	$113,533	$0	$571,325	*1
LR28	Upgrade road half width	85	$167,892	$41,637	$0	$209,529	*1
LR33	New road full width	90	$259,025	$64,238	$0	$323,264	*1
LR35	Upgrade road half width	510	$1,007,353	$249,824	$0	$1,257,176	*1
LR36	Upgrade road full width	330	$1,007,144	$249,772	$0	$1,256,916	*1
LR37	Upgrade road half width	325	$641,941	$159,201	$0	$801,142	*1
LR39	Upgrade road half width	80	$158,016	$39,188	$0	$197,204	*1
LR39A	New road half width	80	$128,106	$31,770	$0	$159,877	*1
LR39B	New road half width	60	$96,080	$23,828	$0	$119,908	*1
LR39C	New road half width	85	$136,113	$33,756	$0	$169,869	*1
LR39D	New road half width	115	$184,153	$45,670	$0	$229,823	*1
LR46	Upgrade road half width	65	$128,388	$31,840	$0	$160,228	*1
LR46B	Upgrade road half width	50	$98,760	$24,493	$0	$123,253	*1
LR46C	Upgrade road half width	55	$108,636	$26,942	$0	$135,578	*1
LR48	Upgrade road half width	144	$284,429	$70,538	$0	$354,967	*1
LR57	Upgrade road full width	320	$976,625	$242,203	$0	$1,218,828	*1
LR59A	New road half width	60	$96,080	$23,828	In DC47	$119,908	*1
LR59B	New road half width	35	$56,047	$13,900	$27,823	$97,769	*1
LR61	New road half width	100	$160,133	$39,713	$0	$199,846	*1
LR64	New road full width	90	$259,025	$64,238	$0	$323,264	*1
LR67	New road half width	300	$480,399	$119,139	In LS7 and LP42	$599,538	*1
LR69	Upgrade road half width	90	$177,768	$44,087	$0	$221,855	*1
LR69A	New road full width	90	$259,025	$64,238	$0	$323,264	*1
LR70	New road half width	65	$104,086	$25,813	$0	$129,900	*1
LR72	New road half width	100	$160,133	$39,713	$0	$199,846	*1
LR73	New road half width	100	$160,133	$39,713	$27,823	$227,669	*1
LR74	New road half width	30	$48,040	$11,914	$0	$59,954	*1
LR75	New road half width	160	$256,213	$63,541	$27,823	$347,577	*1
	Subtotal	5,894	$12,264,716	$3,041,650	$83,469	$15,389,835	
	Collector Roads						
CR1	Upgrade road half width	475	$1,100,667	$272,965	$0	$1,373,632	*1
CR1A	New road full width	225	$763,637	$189,382	$55,646	$1,008,665	*1
CR7	Upgrade road half width	115	$266,477	$66,086	$0	$332,564	*1

Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Item	Facility	Length (m)	Cost	Project On Costs	Demolition Allowance	Total Cost	Staging / Priority
CR7A	Upgrade road full width	105	$398,359	$98,793	$0	$497,153	*1
CR8	Upgrade road half width	240	$556,126	$137,919	$0	$694,046	*1
CR9	Upgrade road full width	70	$265,573	$65,862	$0	$331,435	*1
CR10	Upgrade road half width	85	$196,961	$48,846	$0	$245,808	*1
CR11	Upgrade road full width	345	$1,308,895	$324,606	$0	$1,633,501	*1
CR12	Upgrade road half width	130	$301,235	$74,706	$0	$375,941	*1
CR14	New road half width	495	$944,729	$234,293	$111,292	$1,290,313	*1
CR15	New road full width	155	$526,061	$130,463	$27,823	$684,347	*1
CR16	New road half width	340	$648,904	$160,928	$111,292	$921,125	*1
CR17	New road full width	320	$1,086,062	$269,343	$55,646	$1,411,051	*1
CR18	New road half width	420	$801,588	$198,794	$27,823	$1,028,205	*1
CR19	Upgrade road full width	80	$303,512	$75,271	$0	$378,783	*1
CR19A	Upgrade road half width	80	$185,375	$45,973	$0	$231,349	*1
CR21	New road half width	70	$133,598	$33,132	$0	$166,730	*1
CR21A	Upgrade road half width	70	$162,204	$40,226	$0	$202,430	*1
CR22	New road half width	325	$620,276	$153,829	$222,584	$996,689	*1
CR24	Upgrade road half width	115	$266,477	$66,086	$0	$332,564	*1
CR25	Upgrade road full width	215	$815,688	$202,291	$0	$1,017,979	*1
CR26	Upgrade road full width	150	$569,085	$141,133	$0	$710,218	*1
CR27	Upgrade road full width	155	$588,054	$145,837	$0	$733,892	*1
CR27A	Upgrade road full width	140	$531,146	$131,724	$0	$662,870	*1
CR28	Upgrade road half width	150	$347,579	$86,200	$0	$433,779	*1
CR29	Upgrade road half width	400	$926,877	$229,866	$0	$1,156,743	*1
CR29A	Upgrade road full width	160	$607,024	$150,542	$0	$757,566	*1
CR30	Upgrade road half width	95	$220,133	$54,593	$0	$274,726	*1
CR31	Upgrade road half width	90	$208,547	$51,720	$0	$260,267	*1
CR35	New road half width	70	$133,598	$33,132	$0	$166,730	*1
CR38	Upgrade road half width	80	$185,375	$45,973	$0	$231,349	*1
CR39	Upgrade road half width	60	$139,032	$34,480	$0	$173,511	*1
CR40	Upgrade road half width	30	$69,516	$17,240	$0	$86,756	*1
CR42	Upgrade road full width	285	$1,081,261	$268,153	$0	$1,349,414	*1
CR43	Upgrade road half width	50	$115,860	$28,733	$0	$144,593	*1
CR44	Upgrade road half width	50	$115,860	$28,733	$0	$144,593	*1
CR45	Upgrade road half width	240	$556,126	$137,919	$0	$694,046	*1
D1	Design of Collector Road upgrade of Fourth Avenue	Item	$1,365,804	$0	$0	$1,365,804	*7
D2	Design of Collector Road of Browns Road Extension	Item	$514,182	$0	$0	$514,182	*8
	Centre line design of existing roads	34350	$687,000	$0	$0	$687,000	*9
	Subtotal		$20,614,465	$4,475,775	$612,106	$25,702,346	
	Pedestrian/Bridge Crossings						
PB1	Pedestrian crossing of DC20	Item	$106,922	$26,517	$0	$133,438	*4
PB2	Pedestrian crossing of DC19A	Item	$106,922	$26,517	$0	$133,438	*5
PB4	Pedestrian crossing of DC14	Item	$106,922	$26,517	$0	$133,438	*3
PB5	Pedestrian crossing of DC53	Item	$106,922	$26,517	$0	$133,438	*3

Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Item	Facility	Length (m)	Cost	Project On Costs	Demolition Allowance	Total Cost	Staging / Priority
PB6	Pedestrian crossing of DC26	Item	$106,922	$26,517	$0	$133,438	*3
PB7	Pedestrian crossing of DC33	Item	$106,922	$26,517	$0	$133,438	*3
PB8	Pedestrian crossing of DC30	Item	$106,922	$26,517	$0	$133,438	*3
PB10	Pedestrian crossing of DC63	Item	$106,922	$26,517	$0	$133,438	*1
PB11	Pedestrian crossing of DC61 at Sixth Ave	Item	$106,922	$26,517	$0	$133,438	*1
PB13	Pedstrian crossing - Creek Twelfth Avenue	Item	$106,922	$26,517	$0	$133,438	*1
PB14	Pedestrian crossing - Creek Fourteenth Avenue	Item	$106,922	$26,517	$0	$133,438	*1
PB15	Pedestrian crossing - Bonds Creek Ninth Avenue	Item	$106,922	$26,517	$0	$133,438	*2
BR12	Crossing upgrade - Kemps Creek Gurner Road (upgrade crossing to 100 ARI)	120	$3,825,664	$948,765	$17,115	$4,791,543	*6
	Subtotal		$5,108,722	$1,266,963		$6,392,799	
	Road segments over culverts						
Clv B29.b.2	Channel Crossing Type 2	50	$854,251	$211,854	$0	$1,066,105	*3
Chn NB5	Channel Crossing Type 1	25	$427,126	$105,927	$0	$533,053	*3
Clv B20.2	Channel Crossing Type 2	30	$512,551	$127,113	$0	$639,663	*3
Clv B20.3	Channel Crossing Type 2	30	$512,551	$127,113	$0	$639,663	*3
Clv B17.3	Channel Crossing Type 2	30	$512,551	$127,113	$0	$639,663	*3
Clv B17.1	Channel Crossing Type 2	30	$512,551	$127,113	$0	$639,663	*3
Fifth_Av1	Scalabrini Creek Fifth Avenue (replace collector road pavement)	60	$1,320,206	$327,411	$0	$1,647,618	*2
B_Eighth	Bonds Creek Eighth Avenue (upgrade crossing to 100 ARI) (Collector Street)	110	$2,420,378	$600,254	$0	$3,020,632	*1
BR4	Bonds Creek Tenth Avenue (replace local road pavement)	80	$244,156	$60,551	$0	$304,707	*1
B_Fourth	Bonds Creek Fourth Avenue (upgrade crossing to 100 ARI) (Collector Street)	175	$3,850,602	$954,949	$0	$4,805,551	*2
Surbox1	Unnamed Creek Fourth Avenue (upgrade crossing to 100 ARI) (Collector Street)	100	$2,200,344	$545,685	$0	$2,746,029	*2
BR8	Unnamed Creek Thirteenth Avenue (upgrade crossing to 100 ARI)	95	$289,935	$71,904	$0	$361,839	*1
K_17thEN	Unnamed Creek Seventeenth Avenue (replace collector road pavement)	105	$2,310,361	$572,970	$0	$2,883,331	*1
K_11thE	Unnamed Creek Eleventh Avenue (replace local road pavement)	110	$1,879,353	$466,079	$0	$2,345,432	*1

Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Item	Facility	Length (m)	Cost	Project On Costs	Demolition Allowance	Total Cost	Staging / Priority
Edmons North_New	Unnamed Creek extension of Edmondson Avenue (new crossing)	35	$597,976	$148,298	$0	$746,274	*3
	Subtotal		$22,096,631	$5,479,964		$27,576,596	
	Intersections						
IN2	Roundabout Eighth Avenue/Western N-S Collector	Item	$172,224	$42,712	$0	$214,936	*1
IN3	Traffic Signals Fourth Avenue / Fifth Avenue	Item	$833,800	$206,782	$0	$1,040,582	*1
IN4	Roundabout Fourth Avenue / Eighth Avenue	Item	$172,224	$42,712	$0	$214,936	*1
IN5	Roundabout Gurners Ave / Fourth Ave	Item	$172,224	$42,712	$0	$214,936	*1
IN6	Roundabout Gurners Ave / Extension of Edmondson Ave	Item	$172,224	$42,712	$0	$214,936	*1
IN7	Roundabout Sixteenth Ave / North South Collector Street	Item	$172,224	$42,712	$0	$214,936	*1
IN8	Roundabout Fourth Ave / Thirteenth Ave	Item	$172,224	$42,712	$0	$214,936	*1
IN9	Roundabout Thirteenth Ave / North South Collector Street	Item	$172,224	$42,712	$0	$214,936	*1
IN10	Roundabout Fourth Ave / Eleventh Ave	Item	$172,224	$42,712	$0	$214,936	*1
IN11	Roundabout Fourth Ave / Tenth Ave	Item	$172,224	$42,712	$0	$214,936	*1
	Subtotal		$18,444,892	$4,574,333		$23,019,225	
	Pedestrian Crossings						
PC1	Allowance for 50 Pedestrian Crossing/Refuge Works locations TBD	50	$1,363,867	$338,239	$0	$1,702,106	*2
	Subtotal		$1,363,867	$338,239	$0	$1,702,106	
	Public Transport Facilities						
PT1	Allowance for 42 bus shelters locations TBD	42	$973,805	$241,504	$0	$1,215,309	*1
	Subtotal	42	$973,805	$241,504	$0	$1,215,309	
	Total Construction Costs		$61,395,001	$14,529,651	$695,575	$76,637,342	
	Construction Contingency					$4,346,340	
	TOTAL ESSENTIAL ROAD INFRASTRUCTURE COSTS					$80,983,682	

Note cost of BR12 has been apportioned 50% to the Austral and Leppington North Precincts and 50% to the Rossmore Precinct.

Priority / Staging

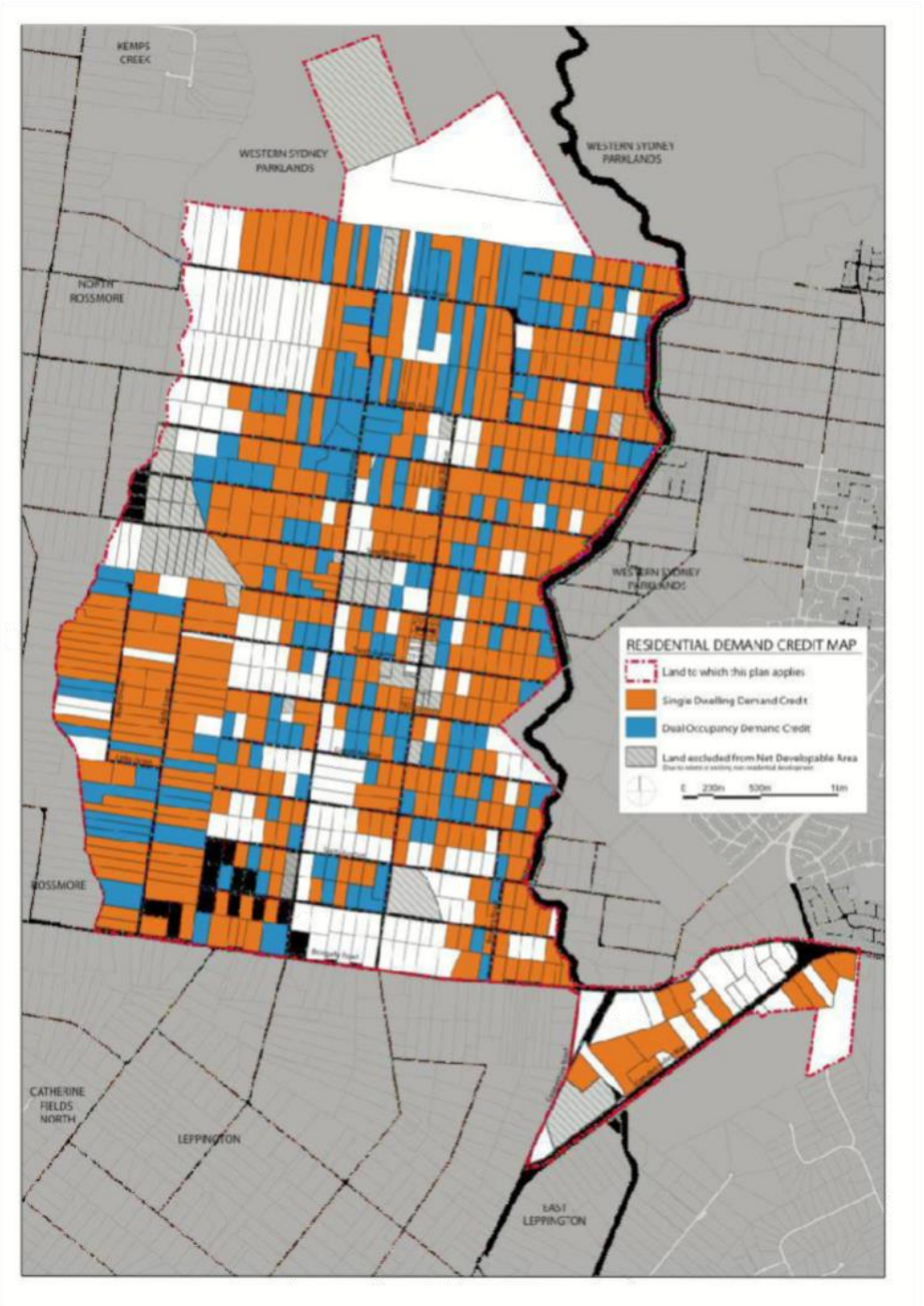
*1	When surrounding development proceeds.
*2	As adjoining road upgrades are carried out.
*3	When the drainage channel is constructed.
*4	When Open Space DP4 is constructed
*5	When Open Space LP13 is constructed.
*6	As and when surrounding development proceeds and after Rossmore Precinct rezoned.
*7	Prior to construction of Fourth Avenue upgrade works.
*8	Prior to construction of Browns Road Extension works.
*9	Prior to development taking place

Appendix A

Demand Credit Analysis for Precincts

Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Allowances for existing development in the calculation of open space and recreation, and community and cultural facilities contributions



Appendix A

Demand credits

Land Use	Single Dwelling Demand Credits	Dual Occupancy Demand Credits	Population Demand Credit
Environmental Living (4 Dwellings/ha)	33	14	207.4
Environmental Living (6 Dwellings/ha)	20	6	108.8
Low Density Residential	300	133	1,924.4
Medium Density Residential	89	26	479.4
Total	442	179	2,720

Assumed occupancy

Single dwelling	3.4
Dual occupancy	6.8
Special use	1.5

Land Use Coding

Environmental Living (4 dwellings / ha)	EL
Environmental Living (6 dwellings / ha)	LL
Low density residential	LD
Medium density residential	MD

Lots with Single Dwelling Demand Credit

Lot No.	DP	Land Type
19	3403	LD
18	3403	LD
17	3403	LD
16	3403	LD
15	3403	LD
1	233174	LD
2	233174	LD
12	3403	LD
111	1010191	LD
14	831988	LD
1	519215	LD
22	791237	LD
21	791237	LD
A	416820	LD
2	201865	LD
144	2475	LD
143	2475	LD
142	2475	LD
140	2475	LD
139	2475	LD
138	2475	LD
160	2475	LD
2	512264	LD
1	512264	LD
156	2475	LD
154	2475	LD
153	2475	LD
152	2475	LD
151	2475	EL
218	2475	LD
A	373652	LD
B	373652	LD
215	2475	LD
229	2475	LD
228	2475	LD
2	615379	LD

Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lot No.	DP	Land Type
226	2475	LD
225	2475	LD
224	2475	LD
223	2475	LD
291	2475	LD
2	34883	LD
1	331146	LD
289	2475	LD
288	2475	EL
1	619379	LD
B	417374	LD
303	2475	LD
302	2475	LD
301	2475	LD
300	2475	LD
298	2475	LD
296	2475	LD
295	2475	LD
B	369323	LD
358	2475	LD
357	2475	LD
356	2475	LD
354	2475	LD
352	2475	LD
350	2475	LD
349	2475	LD
348	2475	LD
3600	1000185	MD
363	2475	MD
365	2475	MD
368	2475	MD
369	2475	MD
370	2475	MD
B	413204	LD
A	413204	LD
B	414227	LD
11	1103748	MD
36	3403	MD
B	411087	LD
2	395169	LD
1	619739	LD
2	619739	LD
2	631289	LD
1	631289	LD
431	6222608	LD
3601	1000185	LD
321	778465	LD
320	778465	LD
1	562807	MD
1	574738	LD
2	574738	LD
379	2475	LD
380	2475	LD
431	2475	LD
B	339407	LD
A	339407	LD
426	2475	LD
425	2475	LD
424	2475	LD
423	2475	LD
422	2475	MD
421	2475	MD

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Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lot No.	DP	Land Type
490	2475	MD
488	2475	LD
487	2475	LD
486	2475	LD
485	2475	LD
484	2475	LD
483	2475	LD
482	2475	LD
480	2475	LD
479	2475	LD
478	2475	LD
416	2475	MD
415	2475	MD
D	406540	MD
3	510228	LD
5	510228	LD
4	30409	LD
6	30409	EL
5	30409	EL
15	30409	EL
16	30409	EL
17	30409	EL
647	2475	EL
21	30409	EL
22	30409	LD
532	2475	LD
10	874699	LD
1	938137	LD
2	938137	LD
3	938137	LD
4	938137	LD
5	938137	MD
6	938137	MD
640	2475	LD
A	414563	MD
B	414563	MD
C	414563	LD
547	2475	LD
548	2475	LD
549	2475	LD
550	2475	LD
551	2475	LD
552	2475	LD
626	2475	LD
628	2475	LD
631	2475	LD
632	2475	LD
634	2475	LD
636	2475	MD
637	2475	MD
100	1022124	LD
2	201514	LD
3	201514	LD
671	2475	LD
672	2475	LD
673	2475	LD
674	2475	LD
676	2475	EL
721	2475	EL
722	2475	LD
726	2475	LD
4	201514	LD

Appendix A

Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lot No.	DP	Land Type
101	1022124	LD
2	503020	LD
3	503020	LD
4	503020	LD
A	386133	LD
714	2475	LD
715	2475	LD
716	2475	LD
717	2475	LD
718	2475	LD
684	2475	LD
685	2475	LD
686	2475	LD
688	2475	LD
689	2475	LD
690	2475	LD
691	2475	LD
11	1044691	LL
2	548700	LL
12	1044691	LL
706	2475	LD
709	2475	LD
710	2475	LD
712	2475	LD
713	2475	LD
769	2475	LD
768	2475	LD
767	2475	LD
766	2475	LD
763	2475	LD
762	2475	LD
787	2475	LD
784	2475	LD
783	2475	LD
782	2475	LD
780	2475	LD
2	555992	LD
752	2475	LD
2	570646	LD
1	570646	LD
A	370483	LD
11	776297	LD
12	776297	EL
799	2475	LD
101	591853	LD
102	591853	LD
A	363000	LD
802	2475	EL
803	2475	EL
804	2475	LD
85	2475	LD
806	2475	LD
807	2475	LD
808	2475	LD
847	2475	LD
810	2475	LD
812	2475	LD
814	2475	MD
1	238636	MD
2	238636	MD
3	238636	MD
4	238636	MD

Appendix A

Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lot No.	DP	Land Type
5	238636	MD
6	238636	MD
7	560787	MD
8	560787	MD
9	560787	MD
B	40482	MD
A	40482	MD
841	2475	LD
842	2475	LD
819	2475	LD
820	2475	LD
822	2475	LD
823	2475	LD
824	2475	LL
827	2475	LL
828	2475	LL
829	2475	LD
830	2475	LD
831	2475	LD
832	2475	LD
833	2475	LD
834	2475	MD
872	2475	LD
871	2475	LD
870	2475	LD
869	2475	LD
867	2475	MD
874	2475	LD
875	2475	LD
876	2475	LD
877	2475	LD
878	2475	MD
213	813479	MD
212	813479	MD
211	813479	MD
20	708107	MD
31	632173	MD
32	632173	MD
101	790560	MD
100	790560	MD
1	31151	MD
2	31151	MD
3	31151	MD
4	31151	MD
5	31151	MD
6	538235	MD
71	627424	MD
72	627424	MD
882	2475	MD
883	2475	LD
885	2475	LD
887	2475	LD
861	2475	LD
860	2475	LD
855	2475	LD
85	740973	EL
86	740973	EL
87	740973	EL
88	740973	EL
89	740973	EL
141	707894	LD
142	707894	LD

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Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lot No.	DP	Land Type
131	732036	LD
132	732036	LD
101	712544	LD
101	854174	LD
82	740973	LD
81	740893	LD
7	2756	LD
61	596624	LD
1	802655	LD
2	802655	LD
42	791236	LD
41	791236	LD
D	411796	LD
C	411796	LD
B	411796	LD
A	411796	LD
B	391036	LD
19	2756	LD
18	2756	LD
A	385901	LD
16	2756	LD
15	2756	LD
11	519909	MD
12	519909	MD
131	879822	MD
132	879822	MD
1	598602	MD
111	591857	MD
B	378927	MD
2	567541	MD
3	538092	MD
2	538092	MD
941	2475	MD
11	571579	MD
10	571579	MD
899	2475	EL
1900	614637	EL
1901	614637	EL
933	2475	EL
903	2475	EL
906	2475	LD
927	2475	LD
928	2475	LD
909	2475	LD
911	2475	LD
919	2475	LD
920	2475	LD
923	2475	LD
42	623270	LD
20	565535	LD
2	557622	LD
5	563539	LD
4	563539	LD
1	211782	LD
2	211782	LD
B	405649	LD
1	795818	LD
A	386802	LD
B	386802	LD
4	615872	LD
3	615872	LD
51	610394	LD
52	610394	LD
A	417196	LD

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Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lot No.	DP	Land Type
B	417196	LD
3	2756	MD
11	1007049	MD
B	408221	MD
1	581050	MD
2	581050	MD
D	408221	MD
1130	2475	MD
1128	2475	MD
1126	2475	MD
1119	2475	LD
1060	2475	LD
1059	2475	LD
1057	2475	LD
1049	2475	LD
1050	2475	LD
999	2475	LD
998	2475	LD
996	2475	LD
993	2475	LD
988	2475	LD
989	2475	LD
952	2475	LD
953	2475	LD
5	236726	LD
6	236726	LD
1004	2475	EL
1005	2475	EL
1006	2475	EL
1065	2475	MD
1066	2475	MD
1067	2475	MD
1114	2475	MD
1116	2475	MD
14	533382	EL
4	126820	EL
1145	2475	EL
1144	2475	EL
1102	2475	LD
1103	2475	LD
2	201643	LD
1013	2475	LD
1012	2475	LD
1011	2475	LD
1010	2475	LD
1007	2475	LD
1040	2475	EL
971	2475	LD
972	2475	LD
976	2475	LD
977	2475	LD
954	2475	LD
955	2475	LD
956	2475	LD
958	2475	LD
959	2475	LD
961	2475	LD
963	2475	LL
968	2475	LL
970	2475	LL
101	789832	LL
102	789832	LL
1017	2475	LL
1031	2475	LL
1078	2475	LD

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Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lot No.	DP	Land Type
1079	2475	LD
1101	2475	LD
1100	2475	LD
1099	2475	LD
1098	2475	LD
1148	2475	MD
1163	2475	MD
1161	2475	MD
1160	2475	MD
1	126822	MD
10	1124205	MD
A	355182	MD
1159	2475	MD
11	1124205	MD
C	337828	LD
2	501499	LL
1	501499	LL
14	19406	LL
2	513043	LL
C	389531	LL
D	389531	LL
2	531654	LL
2	205472	LD
3	205472	LD
5	205472	LD
6	205472	LD
1037	2475	LD
20	730327	LD
41	623270	EL
362	2475	

Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lots with Dual Occupancy Demand Credit

Lot No.	DP	Land Type
3	233174	LD
112	1010191	LD
2	606317	LD
100	634734	LD
100	634734	LD
2	519215	LD
4	3403	LD
B	416820	LD
1	3403	LD
1	201865	LD
3	201865	LD
141	2475	LD
157	2475	LD
155	2475	LD
150	2475	LD
221	2475	LD
220	2475	LD
219	2475	LD
217	2475	LD
212	2475	LD
231	2475	LD
230	2475	LD
1	34883	LD
C	417374	LD
294	2475	LD
A	369323	LD
359	2475	LD
353	2475	LD
364	2475	MD
366	2475	MD
367	2475	MD
372	2475	LD
4	1117859	LD
12	1103748	MD
2	749642	LD
1	395169	LD
3	395169	LD
2	562807	MD
3	574738	LD
377	2475	LD
378	2475	LD
433	2475	LD
432	2475	LD
429	2475	LD
428	2475	LD
427	2475	LD
489	2475	MD
481	2475	LD
479	2475	LD
5	1117859	MD
B	389089	MD
C	406540	LD
495	2475	MD
6	1117859	LD
2	510228	LD
1	510228	LD
4	510228	LD
405	2475	LD
404	2475	LD
403	2475	LD
14	30409	EL

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Lot No.	DP	Land Type
118	575004	LD
119	575004	LD
20	30409	LD
23	30409	LD
24	30409	LD
655	2475	LD
25	30409	EL
2	204217	LD
535	2475	LD
638	2475	MD
641	2475	LD
545	2475	LD
546	2475	LD
629	2475	LD
633	2475	LD
635	2475	MD
13	776298	EL
723	2475	LD
724	2475	LD
687	2475	LD
711	2475	LD
765	2475	LD
779	2475	LL
781	2475	LD
761	2475	EL
760	2475	EL
790	2475	LD
32	878676	LD
10	776297	LD
798	2475	LD
103	591853	LD
846	2475	EL
845	2475	EL
844	2475	LD
811	2475	LD
840	2475	LD
839	2475	LD
817	2475	MD
821	2475	LD
825	2475	LL
835	2475	MD
873	2475	LL
859	2475	LD
858	2475	LD
886	2475	LD
884	2475	LD
856	2475	EL
83	740973	EL
84	740973	EL
9	2756	LD
121	738282	LD
122	738282	LD
102	712544	LD
A	391036	LD
112	591857	MD
A	378927	MD
940	2475	MD
942	2475	MD
102	621868	MD
898	2475	EL
936	2475	LD
935	2475	LD

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Lot No.	DP	Land Type
934	2475	EL
904	2475	LD
905	2475	LD
907	2475	LD
908	2475	LD
926	2475	LD
929	2475	LD
930	2475	LD
912	2475	LD
913	2475	LD
914	2475	LD
921	2475	LD
922	2475	LD
924	2475	LD
43	623270	LD
21	565535	LD
1	557622	LD
A	388784	LD
B	388784	LD
2	2756	LD
2	596773	LD
1	596773	LD
6	2756	LD
A	408221	MD
1	581189	MD
1123	2475	LD
1120	2475	LD
1058	2475	LD
1048	2475	LD
997	2475	LD
986	2475	LD
951	2475	LD
1063	2475	MD
1064	2475	MD
1115	2475	MD
1113	2475	MD
A	416093	MD
B	416093	MD
1164	2475	EL
1146	2475	EL
1077	2475	LD
1008	2475	LD
1009	2475	LD
978	2475	LD
975	2475	LD
974	2475	LD
973	2475	LD
1	126820	LL
969	2475	LL
964	2475	LL
960	2475	LD
957	2475	LD
3	519215	LD
725	2475	LD
786	2475	LD
764	2475	LD

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Liverpool Contributions Plan 2019 - Austral and Leppington North Precincts

Lots with No Demand Credit

Lot No.	DP	Land Type
1	606317	LD
91	1050385	LD
15	831988	LD
158	2475	LD
214	2475	LD
213	2475	LD
222	650859	LD
297	2475	LD
299	2475	LD
355	2475	LD
37	3403	LD
1	749642	LD
1	204217	LD
627	2475	MD
630	2475	MD
639	2475	MD
707	2475	LD
708	2475	LD
809	2475	LD
813	2475	LD
843	2475	LD
818	2475	MD
857	2475	EL
868	2475	LD
111	875377	LD
112	875377	LD
9	2756	LD
62	596624	LD
102	854174	LD
C	385901	LD
2	598602	MD
910	2475	LD
915	2475	LD
917	2475	LD
918	2475	LD
12	1007049	MD
1125	2475	MD
1127	2475	MD
1129	2475	MD
1122	2475	LD
1056	2475	LD
1055	2475	LD
994	2475	LD
995	2475	LD
987	2475	LD
946	2475	LD
945	2475	LD
944	2475	LD
943	2475	LD
1	236726	EL
962	2475	LL
1014	2475	LD
1035	2475	LD

Appendix A

Appendix B

Background Information

Background Information

AECOM Australia Pty Ltd (2011), *Austral and Leppington North (ALN) Precincts Transport Assessment*, prepared for NSW Department of Planning and Infrastructure, July

Cardno (NSW/ACT) Pty Ltd (2011), *Austral & Leppington North Precincts Water Cycle Management WSUD Report*, prepared for NSW Department of Planning and Infrastructure, April

CivicMJD (2018), Valuation Report – Various Residential and Industrial Release Areas (in Liverpool LGA), June

CivicMJD (2019), Land Valuations for the Austral Precinct, 1 July

Department of Planning and Infrastructure (2011), Precinct Planning Package

Elton Consulting (2011), Austral and Leppington North Precincts - Demographic and Social Infrastructure Assessment, July

Environmental Planning and Assessment (Special Infrastructure Contribution - Western Sydney Growth Areas) Determination 2011

MJ Davis Valuations Pty Ltd (2011), Section 94 Contributions and Infrastructure Delivery Plan - Austral and Leppington North Precincts

Newplan (2011), *Austral and Leppington North Precincts Infrastructure Delivery Plan*, Draft Report for Exhibition, prepared by Newplan, August

NSW Department of Planning and Environment (2019), Local Infrastructure Contributions Practice Note – January 2019

NSW Department of Infrastructure, Planning and Natural Resources (2005), *Development Contributions Practice Notes – July 2005*

SMEC Australia (2019), Detailed Concept Design Report - Austral and Leppington North Design of Water Management Infrastructure, prepared for Liverpool City Council, March

PRES 01	Mosquito Management Plan

Strategic Direction	Strengthening and Protecting our Environment Develop, and advocate for, plans that support safe and friendly communities
File Ref	230220.2019
Report By	Kevin Smith - Acting Manager City Works
Approved By	Peter Patterson - Director City Presentation

EXECUTIVE SUMMARY

Recently, mosquito management in many parts of Australia has taken on a regional focus with collaborative strategies employed by adjacent local governments. For example in far north NSW a number of councils have formed the Regional Mosquito Management Group.

Liverpool City Council (LCC) has initiated the process to facilitate creating a relationship between various stakeholders along the Georges River and neighbouring councils. This relationship is in the early stages of development with commitment from a number of stakeholders to participate in a working group.

The warmer weather is approaching and so is the risk from mosquito issues. While LCC continues to collaborate with stakeholders it has taken the initiative to engage the Department of Health to prepare a Mosquito Management Plan for the Liverpool Local Government Area (LGA) for this summer. This report provides an update on the progress of the working group to date, the status of the draft mosquito management plan and recommends actions to be implemented now to address the mosquito risk this summer.

RECOMMENDATION

That Council:

1. Notes this report on progress with implementing the mosquito management plan; and

2. Allocates $30,000 in the 2019/2020 Operational Plan to address mosquitoes in Liverpool.

BACKGROUND

Mosquitoes are a natural part of the Australian environment. They adapt to a wide range of habitats. They are a food source for birds, bats, fish and frogs but a small number of mosquito species are serious nuisance-biting pests and vectors of disease-causing pathogens.

Emerging public health threats can take many forms. As urbanisation and changing climate influences the local environment, the pest and public health risks associated with mosquitoes may rise. Australia experienced one of its worst outbreaks of mosquito-borne Ross River virus disease on record during 2015. This highlighted the importance of understanding the connections between mosquitoes, wetlands, wildlife and human health.

Wetland managers, whether they're building wetlands in densely urbanized suburbs or managing existing wetlands, have a duty of care to ensure both pest and public health risks associated with mosquitoes are minimised. Mosquitoes will always be active during the warmer months and local authorities should develop strategic plans to ensure the local community is not adversely impacted. Like bushfires and floods, outbreaks of mosquito-borne disease are, essentially, an environmental hazard that needs to be managed.

ACTIONS TO DATE

Liverpool City Council recently took the initiative to host a conversation about establishing a working group to develop a regional mosquito management plan. This meeting was held at our Depot Operations office on Tuesday 4 June 2019. Representatives from Canterbury-Bankstown Council, Fairfield City Council, Sutherland Shire Council, Campbelltown Council, National Parks and Wildlife Service, Sydney Water, Georges River keeper, Sydney Olympic Park and NSW Health were invited to attend.

Dr Cameron Webb from NSW Health presented two papers at this meeting: "*Mosquitoes of pest and public health concern in the Georges River Region*" and "*Managing Mosquitos in Georges River Liverpool*". Both presentations highlighted facts about virus carrying mosquitoes, monitoring programs, community awareness and the options for establishing a regional mosquito management plan.

On 16 July 2019, LCC invited all stakeholders to register their support and participation in a working group to develop a regional mosquito management plan for the Georges River area for the future. To date, Council has received responses from the following stakeholders confirming their support:

- Professor Mark J Ferson – South Eastern Sydney Public Health
- Rob Stevenson – Fairfield City Council
- David Dekel – Canterbury Bankstown Council
- John Birkett – Liverpool Public Health Unit
- Beth Salt – Georges River keeper
- Jaynia Sladek – Sutherland Shire Council

LCC is leading this working group and will arrange regular meetings to discuss and develop resources, including factsheets that will provide our community a consistent response to concerns about mosquitoes, while at the same time collaborating with Dr. Webb on a regional mosquito management plan for the Georges River area.

Stakeholders have registered interest in participating in the working group, however their role at this stage is limited to observing until further commitment is received from the NSW State Government in accepting the leadership role and funding for the development of a regional management plan.

In the interim, as we await further assistance/direction from the NSW Government, LCC has taken the opportunity to engage Dr. Webb to prepare a mosquito management plan proposal specific to the Liverpool City Council LGA. This plan includes undertaking mapping of the LGA to identify priority areas and potential control options to target specific mosquito larvae.

MOSQUITO MANAGEMENT PLAN

During the 2018/2019 summer, mosquitoes were identified as a problem at numerous locations across the Liverpool LGA. The objective of the mosquito management plan is to manage the pest and public health risks for the coming summer period and beyond.

NSW Health has been engaged by LCC to prepare a mosquito management plan. A draft report was received on Thursday 5 September 2019. This report is currently being reviewed.

Even though the report is in draft form, LCC has enough information to make an informed decision now to ensure proper strategies are in place to prepare for the summer and the mosquito threat.

To date there has been limited mosquito monitoring conducted in the Liverpool LGA. As part of the NSW Arbovirus Surveillance and Mosquito Monitoring Program, the South Western Sydney Local Health District Public Health Unit has undertaken monitoring in wetlands adjacent to LCC (ie. Bankstown, Picnic Point). Limited mosquito sampling has also been undertaken in the suburbs of Liverpool, Cabramatta, Holsworthy, Chipping Norton and Wattle Grove. Medical Entomology conducted limited mosquito investigations in the western areas of LGA around the suburb of Luddenham. Site inspections were also undertaken in estuarine wetlands adjacent to the suburbs of Voyager Point and Hammondville in early August 2019. This information has been used to form the conclusions in the report and its action plan.

The report states:

> *"There is often broad reference to Georges River and associated estuarine wetlands as sources of pest mosquitoes. However, due to the topography of the river adjacent to LCC, the primary sources of mosquitoes are those mangrove, saltmarsh, and she-oak woodland habitats downstream alongside the suburbs of Chipping Norton, Hammondville and Voyager Point. Upstream from these areas, the banks of the river become steep and/or heavily developed and there is relatively little wetland available for major pest mosquitoes. While there may be small pockets of wetlands where*

mosquitoes are present, their abundance will remain relatively low or only infrequently abundant.

Within LCC, the highest priority areas for mosquito control are the estuarine and brackish water wetlands adjacent to the suburbs of Hammondville and Voyager Point. In reviewing the LCC vegetation maps and coastal management zones, and in combination with surveys of wetlands in July 2019, it appears that the highest risk areas are shoe-oak woodlands adjacent to Lieutenant Cantello Reserve, Hammondville. While there are areas of saltmarsh, sedgeland, and mangroves nearby in Voyager Point, there is no conclusive evidence yet that these areas pose a significant risk of producing large populations of Aedes vigilax and control is not currently recommended for this area."

The Mosquito Management plan is still in draft format, it will be endorsed by the CEO as an operational plan.

MOSQUITO MANAGEMENT STRATEGY

There are nine key strategies in the Action Plan. They are;

1. Initiate participation with NSW Arbovirus Surveillance and Mosquito Monitoring Program.
2. Identify mosquito control priority sites.
3. Create mosquito risk maps of key habitats within the LCC LGA.
4. Target mosquito control activities.
5. Take lead role in regional mosquito management working group.
6. Review local public education material.
7. Stormwater management.
8. Natural resource management.
9. Mosquito research projects.

All the strategies should be supported.

However, the three strategies that must be implemented now for the coming summer are:

1. Surveillance

While local government is responsible for the setting and collection of mosquito traps, the NSW Arbovirus Surveillance and Mosquito Monitoring Program facilitates the identification of mosquito specimens, testing for pathogens and provision of reports.
It is recommended that LCC participate in the surveillance program and purchase 2 traps for placement at Hammondville / Voyager Point and Chipping Norton. The collection program is from December to April.

2. Mosquito Management

Habitats associated with the Georges River foreshore at Hammondville have been identified as high risk areas. Judicious use of mosquito control agents is required and between 4-6 treatments are required from November to March.

3. Public Education Programs

A framework for communicating issues regarding mosquito and mosquito borne disease awareness, together with information about personal protection measures to be used against mosquitoes has been provided and requires implementation.

FUTURE ACTIONS

An opportunity exists for LCC to take a lead role in the formation of a working group of local and state government organisations and other stakeholders, to address the mosquito issues facing the community along the Georges River. Such a group of contiguous authorities would be well placed to collaboratively better manage the pest and public health risk associated with local mosquitoes in cost effective ways. LCC will continue to pursue this opportunity.

CONSIDERATIONS

Economic	Explore a regional approach to mosquito management to improve the effectiveness of plans. A regional approach allows cost savings to be achieved. A regional approach allows a specific focus to be given to mosquito related issues.
Environment	Decrease the risk to public health from mosquitoes. Adopt mosquito control agents that are registered for use in estuarine wetlands. Do not use control agents in natural environments if there is a potential to have non-target impacts.
Social	Decrease the potential for mosquitoes to impact on the comfort and experiences of those living or undertaking recreational activities. Provide education programs to inform the community of protection measures and public health risks from mosquitoes.
Civic Leadership	Take the lead role in a regional mosquito management working group.
Legislative	There are no legislative considerations relating to this report.

ATTACHMENTS

1. Mosquito Management Plan - Liverpool City Council

Mosquito Management Plan: Liverpool City Council, NSW.

Dr Cameron E Webb
Medical Entomology
NSW Health Pathology

Report prepared for Liverpool City Council, September 2019

NSW GOVERNMENT Health Pathology

Draft Report Preparation

Dr Cameron Webb PhD BSc (Hons)
Principal Hospital Scientist
Department of Medical Entomology
NSW Health Pathology
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Phone: 02 9845 7548

EXECUTIVE SUMMARY

- There are over 60 different types of mosquito across metropolitan Sydney but relatively few of these mosquitoes pose substantial health risks. Mosquito populations associated with wetlands and other habitats within the Liverpool City Council (LCC) local government area pose actual and potential pest and public health risks.
- In preparation of this management plan, reference was made to existing data on mosquito populations and mosquito-borne disease within LCC and broader areas of western Sydney. There has been limited mosquito monitoring conducted in the LCC area. As part of the NSW Arbovirus Surveillance and Mosquito Monitoring Program, the South Western Sydney Local Health District Public Health Unit has undertaken mosquito sampling in wetlands adjacent to LCC (i.e. Bankstown, Picnic Point). Limited mosquito sampling has also been undertaken in the suburbs of Liverpool, Cabramatta, Holsworthy, Chipping Norton and Wattle Grove. Medical Entomology has also conducted limited mosquito investigations in the western areas of LCC around the suburb of Luddenham. Site inspections were also undertaken by Medical Entomology and LCC staff in estuarine wetlands adjacent to the suburbs of Voyager Point and Hammondville in early August 2019.
- There are three groups of mosquitoes that pose the greatest pest and public health concern. Mosquitoes associated with estuarine wetlands along Georges River, primarily *Aedes vigilax*, are the most important from a pest and public health concern but there are mosquitoes found in freshwater environments (e.g. *Coquillettidia linealis*, *Culex annulirostris*), urban storm water infrastructure (e.g. *Culex quinquefasciatus*, *Culex molestus*), and backyard habitats (e.g. *Aedes notoscriptus*) that can also pose risks.
- A diverse range of mosquitoes is present in the local area including species that are known nuisance-biting pests and vectors of pathogens including Ross River virus (RRV) and Barmah Forest virus (BFV); two mosquito-borne pathogens known to have infected people in the local region. While mosquito-borne disease cases are reported from LCC, there are relatively few locally acquired cases given the absence of wildlife (e.g. wallabies, kangaroos) that represent important reservoirs of the pathogens from areas where there is concomitant abundant mosquito populations. The health risks are highest in suburbs to the east of LCC region, especially Wattle Grove, Holsworthy, Hammondville, Voyager Point, and, to a lesser extent, Chipping Norton.
- A suite of strategies to manage mosquitoes and their pest and public health impacts is included in the action plan of this report. High priority activities are the participation in the NSW Arbovirus Surveillance and Mosquito Monitoring Program, map and develop priority mosquito control habitats, considered targeted mosquito control agent applications in wetlands adjacent to Georges River and suburbs of Hammondville and Voyager Point, and develop a locally relevant mosquito awareness program.
- Targeted mosquito control in the estuarine and brackish-water wetlands along the Georges River adjacent to Lietenant Cantello Reserve are the highest priority as they provide the most suitable habitats for *Aedes vigilax*. Mosquito control in this area, involving ground-based larvicide applications to habitats following either high tides (those over 1.9m) or major rainfall events would provide suppression of the pest and public health risks associated with widely dispersing mosquito populations. While there are pockets of estuarine wetland found elsewhere along the Georges River (especially upstream from the M5 motorway crossing), these habitats are generally far less suitable for mosquitoes as mangroves are either regularly flushed or other estuarine habitats are not extensive enough to pose a serious mosquito risk.
- Community education will play a key role in raising awareness of the pest and public health risks associated with mosquitoes in LCC while promoting personal protection measures to

minimize exposure of the community to mosquito bites. Locally relevant communication strategies can be developed and a framework of content and delivery schedule is provided in this document.

- Mosquito risk should be considered in other aspects of LCC plans of management for natural and urban landuse. Particular priorities are consideration of mosquito risk in urban development, vegetation, stormwater and climate change response management strategies, especially water sensitive urban design to be incorporated into new urban development concomitant with the development of Western Sydney International Airport.
- An opportunity exists for LCC to take a lead role in the formation of a working group of local and state government organisations, and other stakeholders, to address the mosquito issues facing the community along the Georges River. Such a group of contiguous authorities would be well placed to collaboratively better manage the pest and public health risk associated with local mosquitoes in cost effective ways.

TABLE OF CONTENTS

INTRODUCTION

The pest and public health threats association with mosquitoes are of growing concern to local authorities. Notwithstanding the public health risks associated with mosquito-borne pathogens, the potentially severe nuisance-biting impacts of mosquitoes have the potential to substantially impact the comfort and experiences of those living, or undertaking recreational activities, in close proximity to wetlands.

There are over 60 different species of mosquito found in the greater Sydney metropolitan area. While mosquitoes associated with a range of habitats have the potential to impact the local community, those mosquitoes found in estuarine habitats associated with the major estuaries of the region hold the greatest potential pest impacts due to their exceptional abundance, wide dispersal from habitats, propensity to bite people, and demonstrated role in pathogen transmission.

Little is known of the mosquitoes in the Liverpool City Council local government area. There has not been any detailed studies conducted. However, information gained from neighbouring local government areas can assist in determining the likely mosquito risks impacting the local community. Mosquito populations associated with the greater Georges River region have the potential to cause serious nuisance biting impacts and may also pose significant public health risks through the transmission of arboviruses (e.g. Ross River virus (RRV) and Barmah Forest virus (BFV)). Abundant populations of the saltmarsh mosquito, *Aedes vigilax*, routinely occur at many areas along the river where estuarine wetlands occur, especially saltmarsh, mangroves, and coastal woodlands.

As a result of the known pest and public health risks associated with mosquitoes in the local region, authorities undertake sampling as part of the NSW Arbovirus Surveillance and Mosquito Monitoring Program between the suburbs of Bankstown (Deepwater Reserve) and Illawong. This sampling has been underway for over a decade and activity of RRV and BFV is often detected, prompting the NSW Health Local Health District to issue public health warnings to residents and visitors to the region. Based on this understanding of local mosquitoes, it is expected that mosquitoes dispersing from habitats along the Georges River may potentially also impact the community in suburbs within the eastern region of LCC (e.g. Hammondville, Voyager Point, Chipping Norton).

Beyond the mosquitoes associated with wetlands along the Georges River, mosquitoes of secondary pest importance are associated with freshwater or brackish-water wetlands. Mosquitoes such as *Culex annulirostris*, *Culex quinquefasciatus*, *Coquillettidia linealis* and *Mansonia uniformis* can be associated with constructed and natural occurring freshwater wetlands; *Aedes procax*, *Aedes multiplex*, and *Verrallina funerea* can be associated with fresh to brackish water coastal swamp forest environments; *Aedes notoscriptus* that is closely associated with water-holding containers within urban environments. It is expected that these mosquitoes are also found throughout LCC.

In recent years, there has been increasing concern among the local authorities and community regarding the pest and public health risks associated with local mosquito populations. During the 2018-2019 summer, mosquitoes were identified as a problem at numerous locations across LCC concomitant with concerns regarding mosquito-borne disease. While it has been acknowledged that a regional approach to mosquito management is required that includes cooperation between local and state government agencies, LCC engaged Medical Entomology to develop a mosquito management plan for the local area. The objective of this plan is to provide framework for LCC to better manage the pest and public health risks associated with the local area in a sustainable way that allows for future collaboration with local stakeholders and the community.

MOSQUITO BIOLOGY

Mosquitoes are small blood sucking insects that belong to the family of flies called Culicidae (Order Diptera) and there are more than 300 different species in Australia with each species closely associated with particular habitats. These habitat associations are wide ranging but generally narrow for specific species.

Mosquitoes have a relatively short but complex life cycle consisting of eggs, four aquatic larval stages (instars), an aquatic pupal stage and a terrestrial adult stage. Mosquitoes are dependent on water, with the immature stage totally aquatic, and without access to free-standing water of some kind, the larvae cannot complete their development to the adult phase. Immature mosquitoes cannot complete their development in damp soil or moist vegetation.

A gravid adult female mosquito will typically lay eggs either on the water surface (usually with eggs in the form of a floating raft) or on a frequently inundated substrate (usually singularly or in small groups). The 'oviposition sites' may include frequently inundated soil or vegetation at the edge of a wetland, soil or leaf litter where temporary pools form after rainfall or inside water holding containers (e.g. tins, tyres etc).

While some mosquito eggs (such as those laid by *Aedes* or *Verrallina* species) can be desiccation resistant and remain unhatched for many months before being inundated by tides or rainfall, most eggs (particularly those laid by *Culex* and *Anopheles* species) will hatch within 2-3 days. On hatching, the young larvae (commonly called wrigglers) feed continuously on aquatic particulate matter and grow through four different instars or moults. The larvae of some mosquito species have developed specialised mouthparts and are predatory, feeding on other mosquito larvae and aquatic invertebrates. The final larval stage (4th instar) develops into a pupa (commonly called tumbler) from which the adult mosquito emerges approximately 2 days later. During summer, it generally takes seven to ten days from the hatching of larvae to the emergence of adults. This relatively consistent life cycle enables estimations of mosquito population increases based on the environmental conditions of temperature, humidity, rainfall, and tides.

On average, a female mosquito may live approximately 2-3 weeks but the male's lifespan is much shorter. Adult mosquitoes are most active from dusk until dawn, seeking refuge during the day in cool and humid habitats such as well-vegetated areas or under houses. Some pest species, however, can be active during the day and disperse many kilometres from larval habitats. These day active mosquitoes can often be particularly active in shaded areas around wetlands protected from wind by dense vegetation. Mosquitoes will also be active in these shaded areas when mosquito abundance is high.

Within their lifetime, both adult male and female mosquitoes will feed on nectar and plant fluids, but it is only the female that will seek a blood meal required to provide protein for egg development. While many mosquitoes are generalist feeders, some specialise in feeding on humans, mammals, birds or amphibians.

There is a paucity of knowledge regarding the ecological role of mosquitoes. Both the adult and immature stages are food for a range of insectivorous animals including birds, bats, fish, frogs, and a range of invertebrates. Some mosquitoes are also thought to play a role in the pollination of plants. However, there is no evidence that any plant or animal in Australia is completely reliant on mosquitoes. Even for those insectivorous animals, mosquitoes may comprise only a small percentage of their diet compared to other prey.

MOSQUITOES AND LIVERPOOL CITY COUNCIL

Mosquito habitats

Liverpool City Council is a local government area that encompasses approximately 300 square kilometres. The local environment is diverse and poses starkly different mosquito risks across the region. While there are dozens of different mosquitoes found in the LCC area, the abundance of each mosquitoes and its pest and public health risks will be primarily determined by the presence of suitable habitats.

Estuarine environments and Georges River

The most significant actual and potential mosquito habitats are those located to the east of the LCC area adjacent to Georges River. These habitats of significance are typically those that are estuarine or brackish water in nature including mangrove and saltmarsh habitats as well as she-oak woodlands (Figure 1). It is these areas where water is retained following major rainfall events or where exceptionally high tides inundate low lying areas that mosquito populations will be greatest.

It is important to note that not all areas where mangroves, saltmarsh, sedgeland and other brackish-water and estuarine environments occur will be the source of substantial mosquito populations. Studies along tidal river systems in Sydney have demonstrated that some areas of estuarine wetland will be far more productive for mosquitoes than others. Many areas of mangroves are regularly flushed by the natural tidal cycle and are, consequently, less suitable for mosquitoes. Conversely, some saltmarsh and sedgeland environments are only infrequently inundated by tides, or only by rainfall, and may quickly drain or dry thus limiting opportunities for mosquitoes.

There is often broad reference to Georges River and associated estuarine wetlands as sources of pest mosquitoes. However, due to the topography of the river adjacent within LCC, the primary sources of mosquitoes are those mangrove, saltmarsh, and she-oak woodland habitats downstream alongside the suburbs of Chipping Norton, Hammondville, and Voyager Point. Upstream from these areas, the banks of the river become steep and/or heavily developed and there is relatively little wetland available for major pest mosquitoes. While there may be small pockets of wetlands were mosquitoes are present, their abundance will remain relatively low or only infrequently abundant.

This conclusion is supported by mosquito sampling in the Warwick Farm, Chipping Norton, and Liverpool region during the 2018-2019 season associated with mosquito investigations carried out by Sydney Water (Horseshoe Lagoon and Liverpool Wastewater Treatment Plant) and South Western Sydney Local Health District Public Health Unit. These investigations demonstrated that the most abundant mosquitoes were those associated with freshwater wetlands and stormwater infrastructure rather than estuarine habitats.

While the extent of potentially productive estuarine habitats is somewhat limited within LCC, those habitats identified could produce relatively large numbers of mosquitoes of pest and public health concern and, as these mosquitoes disperse widely from habitats, often over 3km, the impacts could be substantial. As a consequence, targeted mosquito control activities in these areas could have much broader benefits with regard to suppressing mosquito activity in surrounding suburbs.

Urban environment and freshwater waterways

While there is an abundance of freshwater streams, creeks, and rivers throughout the majority of the LCC area, these habitats are unlikely to pose significant mosquito problems when compared

to comparable environments across other local government areas of western Sydney. Where there are large freshwater wetlands or marshland/sedgeland that retains water following major rainfall events, there may be a local abundance of freshwater mosquito species.

Urban freshwater waterways can be a source of pest mosquitoes. Notwithstanding especially stormwater infrastructure and associated elements of water sensitive urban design (including drains, bioretention basins, swales, gross pollutant traps, septic tanks), densely vegetated creeks can be a potential source of pest mosquitoes. Water bodies that are either deep or contain regular water movement are generally less suitable for mosquitoes, where there is an abundance of aquatic vegetation, either emergent macrophytes (e.g. *Typha* or *Phragmites* spp.) or floating aquatic plants (e.g. duckweed, water hyacinth) mosquito populations can increase.

The construction of wetlands and stormwater management devices may provide opportunities for mosquitoes, and these risk should be considered, especially with regard to Water Sensitive Urban Design (WSUD). Systems can be complex and contain many elements (e.g. wetlands, drains, swales, bioretention basins, rain gardens), each bringing a different level of risk regarding the creation of actual and potential mosquito habitats.

Perhaps the most widespread mosquito habitats across LCC are those found in backyards and other domestic settings. Whether it is low to high density residential development, there are opportunities for mosquitoes. Water-holding containers of a wide range of size and shape can be found in urban areas. Studies in QLD and WA have identified a complex mix of habitats that can be used by mosquitoes, from pot plant saucers and bird baths to roof gutters, and from discard tyres to accumulations of bottles and cans. Similarly, studies in Newcastle and Tweed Heads have shown that roof guttering, rainwater tanks, pot plant saucers, water-holding plants, discarded children's toys and wading pools, as well as boats, kayaks, trailers, and other large objects that collect rainwater can be a source of mosquitoes. Given the incredibly diverse range of potential mosquito sources in backyards, it can be challenging for the general community to both identify sources of mosquitoes and then there are practical barriers to reducing their abundance (e.g. items too heavy to life and empty).

It is impractical for local authorities to undertake mosquito control across these diverse and widespread habitats, an alternate strategy is to reduce opportunities for mosquitoes in these habitats through community education programs. Studies in northern NSW that surveyed the local community about their attitudes to mosquitoes and mosquito control revealed that the community was looking for more information from local authorities, either local or state government agencies, about how best to deal with backyard mosquitoes. With the strong links to local community, local government is well placed to provide this service.

Backyard swimming pools are often cited as a source of problematic mosquito populations. While it is the case that a neglected "green" swimming pool will be a source of mosquitoes, the types of mosquitoes present in these habitats are more likely to be nuisance pests than those posing a health risk. There is, however, no doubt that a well maintained swimming pool will not produce mosquitoes and measures should be taken to ensure pool owners adequately maintain their pools so that they do not produce nuisance mosquitoes.

Peri-urban and rural environments

In the western areas of LCC, the environment is currently dominated by peri-urban and rural land use with many areas containing rural properties with some localised development. The suburbs of Luddenham, Bringelly, Greendale, and Badgery's Creek contain open areas with some small dams and waterways but it lacks any substantial wetlands that pose substantial potential mosquito habitats.

Farm dams are generally not considered a substantial source of mosquitoes. Unless these structures are overgrown with aquatic vegetation, they produce generally low numbers of mosquitoes. The production of mosquitoes can be even lower during periods of below average rainfall where water levels fall below fringing vegetation. Where only exposed sediments are present, less suitable conditions for mosquitoes occur.

Small creeklines throughout this region generally do not produce abundant mosquitoes. They are mostly steep-sided and fish are common. There is little evidence that these habitats produce large numbers of mosquitoes but, during periods of below average rainfall, creeklines can divided into a series of disconnected shallow and stagnant ponds. Under these conditions, fish and other mosquito predators are often reduced in abundance and mosquitoes can take advantage of these conditions.

There can often be mosquito issues develop in association with agricultural landuse. Beyond farm dams, as discussed above, irrigation and water management issues can create potential mosquito problems. Water storages, especially rainwater tanks or other water storage structures that are uncovered or unscreened can be used by mosquitoes. Similarly, where waste-water runoff from livestock is collected onsite in drains, pits or other structures, mosquitoes can take advantage of these habitats. In situations where runoff from irrigation collects in low-lying areas around properties and persists in ground pools for more than a week, suitable conditions will be provided for some mosquitoes. Together with other legislative requirements to responsibly manage water and natural resources on rural lands, considering potential mosquito risk should be considered.

These western areas of LCC are likely to undergo substantial redevelopment over the coming decade in conjunction with urban expansion and the construction of the Western Sydney International Airport. While there may not be a substantial mosquito habitats currently, the dramatically changing landscape is likely to bring with it concomitant changes in local mosquito problems. The most important consideration for these areas will be the incorporation of WSUD elements and other stormwater infrastructure that may increase opportunities for mosquitoes that do not currently exist. Based on the experiences in recent years associated with the Horseshoe Lagoon and Liverpool Wastewater Treatment Plant, it is clear that freshwater wetlands and aspects of stormwater infrastructure may create opportunities for mosquitoes and this potential should be addressed in associated management plans.

Mosquito populations

The NSW Arbovirus Surveillance and Mosquito Monitoring Program involves local government and NSW Health Public Health Units around NSW collecting mosquitoes on a weekly basis during the period November through May using carbon dioxide baited light traps. These traps collect host-seeking mosquitoes and collections are analysed to determine the diversity and abundance of mosquito populations, assess potential pest and public health threats, and test to determine if any of the mosquitoes are carrying a mosquito-borne pathogen of human health importance (e.g. RRV or BFV).

Monitoring of mosquito populations along the Georges River is coordinated by South Eastern Sydney and South West Sydney Public Health Units and includes sampling in suburbs from Illawong in the east to Deepwater Reserve, Bankstown, in the west. While there has not been any routine mosquito sampling undertaken in LCC, during the 2018-2019, there was some *ad hoc* mosquito sampling in the suburbs of Chipping Norton, Wattle Grove, Warwick Farm, and Cabramatta in response to complaints regarding local mosquitoes. In combination with other studies conducted across western Sydney, it is possible to make an assessment of the mosquitoes and their habitats likely to pose actual or potential pest and/or public health concern

in the local area. The mosquitoes, their pest and public health concerns are summarised in Table 1.

The mosquito of greatest concern is *Aedes vigilax*. Conditions that are most suitable for this mosquito are moderately ephemeral ground pools within saltmarsh, mangrove, or sedgeland environments. In some regions, the mosquito is also found in brackish to saline conditions in coastal swamp forests and she-oak woodlands. However, in these two habitats, rainfall is the driving factor creating favourable conditions more so than tidal inundation.

The most productive habitats for *Aedes vigilax* are those dominated by saltmarsh vegetation, especially *Sarcocornia quinqueflora* and *Sporobolus virginicus*. These habitats, positioned above mean high water mark and only inundated by spring tides can be highly productive with the actual productivity determining by extent of tidal inundation and prevailing rainfall. *Aedes vigilax* lays desiccation resistant eggs on substrates and vegetation, these eggs may persist for many years before hatching following favourable conditions. Regularly flushed mangrove habitats are generally not suitable for mosquito production given the water movement and abundance of predatory fish. However, sections of mangroves only infrequently inundated, or heavily degraded and subsequently providing pools and impoundments of water retained after tides or rainfall, can be productive habitats. Recent studies from NSW and SE QLD indicate that degraded mangrove habitats are more likely to support productive conditions for mosquitoes.

In both saltmarsh and mangrove habitats, once favourable conditions do occur (e.g. tidal rainfall inundation), some eggs will remain unhatched, only to hatch if surface water persists for long periods or entering another dry-flood scenario. Surface water must persist for at least 7 days following inundation to allow immature stages of mosquitoes to complete development. Habitats that in less than five days are unlikely to provide suitable conditions for mosquitoes. Habitats that remain inundated for long periods (e.g. many weeks) generally do not produce substantial numbers of mosquitoes. These permanent or semi-permanent habitats are more typically supportive of predators (e.g. fish, predatory macroinvertebrates) or competitors (e.g. filter feeding macroinvertebrates) and generally gravid adult mosquitoes are less likely to lay eggs around these habitats where regular hatching can occur.

In freshwater and brackish-water environments, a suite of mosquitoes may be present but one of the most likely pests in *Culex annulirostris*. Together with other freshwater mosquitoes, such as *Coquillettidia linealis* and *Mansonia uniformis*, this mosquito may pose a nuisance-biting and public health threat in freshwater wetlands, especially those with an abundance of aquatic vegetation. Where stormwater infrastructure occurs, additional mosquitoes such as *Culex quinquefasciatus* and *Culex molestus* may also cause pest problems. These two mosquitoes have already been identified as causing a serious nuisance around waterbodies associated with Horseshoe Lagoon and Liverpool Wastewater Treatment Plant.

In residential and industrial areas, especially residential backyards, mosquitoes associated with water-holding containers may be problematic. *Aedes notoscriptus* is one of the most widespread nuisance-biting mosquitoes in Australia. Once only associated with tree-hole habitats, this mosquito is now adapted to water-holding containers in urban environments. The mosquito will lay eggs in association with small water holding containers such as tins, pots, ornamental ponds, roof guttering, water tanks and discarded tyres, as well as water holding plants (e.g. bromeliads) and tree holes. The mosquito is a nuisance-biting pest and potential vector of RRV and BFV as well as dog heartworm parasites

Pest and public health risks

A summary of the actual and potential mosquito-borne pathogens occurring in the local area, together with threats from overseas, is provided in Table 2. Notwithstanding the public health

risks associated with mosquitoes, nuisance-biting alone can pose a threat to community well-being.

It is difficult to quantify the impact of nuisance biting impacts associated with mosquitoes in a specific area due to spatial and temporal fluctuation in mosquito abundance resulting from the mix of different mosquito species, their respective habitats and the environmental and/or climatic conditions that trigger population increases. The tolerance level of individuals varies substantially and is often dependent on the extant mosquito populations and previous personal experiences. However, there are strong indicators that nuisance biting alone can have negative impacts on a homeowner's standard of living as well as the economic impacts on residential and recreational developments. It becomes even more difficult to accurately assess changes in pest impacts before and after any intervention that changes the abundance and diversity of mosquitoes (e.g. mosquito control program, habitat modification) in the local area without an appropriate mosquito surveillance program.

The NSW Arbovirus Surveillance and Mosquito Monitoring Program lists average trap densities of adult mosquitoes greater than 100 per trap as high with over 1,000 per trap as very high to extreme when exceeding 10,000 per trap. Generally, when the abundance of adult mosquitoes, especially known biting pests such as *Aedes vigilax*, exceed 100 per trap in residential areas, nuisance biting impacts are experienced with considerable impacts often reported when collections exceed 500 per trap. Collections of *Aedes vigilax* and other mosquitoes along the Georges River regularly exceed 1,000 mosquitoes per trap and there is little doubt that current levels of pest impacts are already substantial in some suburbs of LCC.

Mosquito-borne RRV and BFV are detected on an almost annual basis along the Georges River, and there have been confirmed cases of locally acquired disease in the local region. The disease caused by these two pathogens is not fatal but can be severely debilitating. Symptoms include fever, rash, headache, fatigue, and joint pain. The severity of these symptoms can be variable and in some cases last many weeks or months. Infection with RRV is the most commonly reported mosquito-borne disease across Australia each year with around 5,000 cases occurring annually.

In the approximate 25 years to December 2018, there was an average of 7.5 cases of RRV disease reported in the South Western Sydney Local Health District as recorded by the NSW Health Notifiable Conditions Information Management System (NCIMS), Communicable Diseases Branch and Centre for Epidemiology and Evidence, NSW Health (Figure 1). While the total number of cases are relatively low compared to regional areas outside metropolitan Sydney, it is important to note that there may be underdiagnoses of the disease due to a lack of awareness among health professionals and many visitors to the region may be exposed by not diagnosed when returning to the residential suburbs elsewhere in Sydney.

The risk of mosquito-borne disease is driven by a combination of factors including mosquito abundance and diversity and populations of wildlife. The reservoir hosts of RRV are thought to most importantly be kangaroos and wallabies. Mosquitoes must first bite these animals to pick up and become infected with themselves before then transmitting to people. As a consequence, local transmission of RRV in metropolitan Sydney has always been associated with areas where kangaroos (e.g. Western Sydney, Hawkesbury) or wallabies (e.g. Georges River) have been present.

The annual risk of mosquito-borne disease in the suburbs along Georges River has been recognised by local health authorities but it is important to note that the greatest risk within LCC is in the areas to the east of the local government area where there is a concentration of productive mosquito habitat and the presence of wildlife. While there may be areas of the local government area where kangaroos and wallabies may be present, in the absence of abundant mosquito populations, the risk of mosquito-borne disease is likely to be very low.

Mosquitoes and mosquito-borne disease from outside the region

Concern is often raised in the community regarding the mosquito-borne disease of international significance. Fortunately, Australia is relatively free of the mosquitoes and their pathogens that cause a substantial burden of disease in many parts of the world.

Australia was declared malaria free in the 1980s and any local cases of parasite infection reported are acquired overseas. While there are mosquitoes (e.g. *Anopheles annulipes*) present in the local area capable of transmitting the parasites, there is an extremely low risk that international travellers would trigger local outbreaks given that symptomatic individuals are likely to be treated quickly and highly unlikely to come into contact with local mosquitoes.

Exotic mosquitoes and mosquito-borne pathogens are of an increasing threat in Australia more generally and local, state and federal government authorities are steadily building capacity to respond to the threat posed by these pest and public health risks to ensure a rapid and effective response to exotic mosquito incursion or confirmed local transmission of exotic mosquito-borne pathogens.

Mosquito-borne disease caused by viruses including dengue (DENV), chikungunya (CHIKV) and Zika (ZIKV) in many parts of the world and Australian travellers are increasingly returning home infected with these pathogens. Dengue is of greatest concern given it is currently considered one of the most important mosquito-borne diseases internationally with South America, SE Asia and Pacific suffering significant outbreaks in recent years. Notwithstanding the direct health risks to local travellers, the potential movement of exotic mosquitoes (e.g. *Aedes aegypti* and *Aedes albopictus*) in their belongings may bring increased health threats to the local region.

Impact of climate change

There is little doubt that the climate of western Sydney is changing. Rising temperatures, reduced rainfall, and increasingly frequent extreme weather events are all expected to influence local mosquito populations. However, these conditions will not necessarily bring dramatic change to mosquito-borne disease risk and the perception that a changing climate will increase mosquito-borne disease risk is not always supported by our understanding of local mosquitoes.

There is likely to be an extension of the mosquito season as weather warms. This will mean more mosquitoes during early spring and mid-late autumn. With a "longer" mosquito season, the pest and public health threats associated with local mosquitoes may increase. However, the magnitude of these impacts will be influenced by season dynamics of rainfall and temperature. In addition, sea level rise may influence the productivity of local estuarine wetlands.

Perhaps one of the most crucial considerations for LCC is how urban water and wetlands conservation strategies may influence local mosquito populations. Increasing use of rainwater tanks, combined with the community's water hoarding strategies (e.g. bins, buckets etc to store water in backyard), may create opportunities for mosquitoes. An emphasis on "greening" the local government area may also enhance conditions for mosquitoes, especially where wetlands are constructed for water storage or water recycling schemes.

It is important that mosquitoes are considered in all aspects of climate change adaptation strategies developed by LCC over coming years.

Table 1. Summary of common mosquitoes likely to occur in the Liverpool City Council region, their habitat associations, potential pest and public health concerns.

Mosquito species	Habitat associations	Potential pest and public health threat[1]
Aedes alternans	Estuarine and freshwater wetlands; mostly ephemeral in nature	Minor nuisance-biting pest; Minor vector of mosquito-borne pathogens
Aedes multiplex	Freshwater wetlands; mostly ephemeral in nature	Moderate nuisance-biting pest; Minor vector of RRV and BFV
Aedes notoscriptus	Freshwater container habitats in urban areas; especially domestic backyards	Moderate nuisance-biting pest; Moderate vector RRV and BFV
Aedes procax	Freshwater wetlands; mostly ephemeral in nature	Moderate nuisance-biting pest; Moderate vector of RRV and BFV
Aedes vigilax	Estuarine wetlands	Major nuisance-biting pest; Major vector of RRV and BFV
Anopheles annulipes	Brackish water and freshwater wetlands	Minor nuisance-biting pest; Minor vector of mosquito-borne pathogens
Coquillettidia linealis	Freshwater wetlands	Moderate nuisance-biting pest; Minor vector of mosquito-borne pathogens
Coquillettidia xanthogaster	Freshwater wetlands	Minor nuisance-biting pest; Minor vector of mosquito-borne pathogens
Culex annulirostris	Freshwater wetlands	Moderate nuisance-biting pest; Moderate vector of RRV and BFV
Culex molestus	Urban stormwater and waste-water infrastructure; occasionally freshwater wetlands	Minor nuisance-biting pest; Minor vector of mosquito-borne pathogens
Culex quinquefasciatus	Freshwater wetlands, commonly polluted urban habitats	Moderate nuisance-biting pest; Minor vector of mosquito-borne pathogens
Culex sitiens	Estuarine wetlands; mostly permanently inundated	Rarely a nuisance-biting pest
Mansonia uniformis	Freshwater wetlands; mostly permanent with abundant floating aquatic plants	Moderate nuisance-biting pest; Minor vector of RRV and BFV
Verrallina funerea	Brackish water wetlands; mostly ephemeral in nature	Moderate nuisance-biting pest; Minor vector of RRV and BFV

[1]Based on current understandings resulting from field observation, results of NSW Arbovirus Surveillance and Mosquito Monitoring Program, and published laboratory studies

a

b

Figure 1. Examples of actual and potential estuarine mosquito habitat within Liverpool City Council in the suburbs of Voyager Point (a) and Hammondville (b). The productivity of these habitats for mosquitoes including *Aedes vigilax* will be determined by the frequency of tidal inundation and seasonal rainfall.

Table 2. Summary of mosquito-borne pathogens of concern within the Liverpool City Council region and those from outside the region that may be a risk to travellers.

Pathogen	Symptoms and associated risk
Ross River virus	Transmission has been recorded in the local region. Symptoms can vary greatly between individuals and may include fever, rash and a condition known as polyarthritis with arthritic pain in the ankles, fingers, knees and wrists. Generally, the arthritic pain is greater with RRV infection compared to BFV. The primary animal hosts of RRV are macropods (i.e. kangaroos and wallabies).
Barmah Forest virus	Transmission has been recorded in the local region but far less common than RRV. Symptoms can vary greatly between individuals and may include fever, rash and a condition known as polyarthritis with arthritic pain in the ankles, fingers, knees and wrists. Generally, the rash tends to be more florid with BFV infection but the arthritic pain is greater with RRV infection. The primary animal hosts of BFV unconfirmed but are thought to be birds with mammals also potentially playing an important role.
Kunjin virus	No cases of human disease reported in the local area and risk considered extremely low. The primary animal hosts of KUNV are thought to be birds and serologically positive birds have been found in western Sydney. Significant veterinary impacts (i.e. horse illness) reported in 2011 outside Sydney metropolitan region.
Other endemic arboviruses	A range of other alphaviruses, and flaviviruses are occasionally detected in mosquitoes along Georges River but the local public health risks are either considered low or have not been well defined. The most commonly reported virus is Stratford virus (STRV) but the health risks are not well understood.
Japanese encephalitis virus	Not known from local region. Infected individuals returning to Australia from travel in SE Asia have been reported. No risk of local transmission.
Dengue viruses	Not known from local region. Travellers returning from overseas may be diagnosed by local health authorities. There is currently no risk of local transmission due to the absence of mosquitoes capable of spreading the pathogen (e.g. *Aedes aegypti* or *Aedes albopictus*).
Chikungunya virus	Not known from local region. Travellers returning from overseas may be diagnosed by local health authorities. There is currently no risk of local transmission due to the absence of mosquitoes capable of spreading the pathogen (e.g. *Aedes aegypti* or *Aedes albopictus*).
Zika virus	Not known from local region. Travellers returning from overseas may be diagnosed by local health authorities. There is currently no risk of local transmission due to the absence of mosquitoes capable of spreading the pathogen (e.g. *Aedes aegypti* or *Aedes albopictus*).
Malaria	Not known from local region and Australia has been declared malaria free by the World Health Organisation in 1980s. Travellers returning from overseas may be diagnosed by local health authorities. There is currently no risk of local transmission.

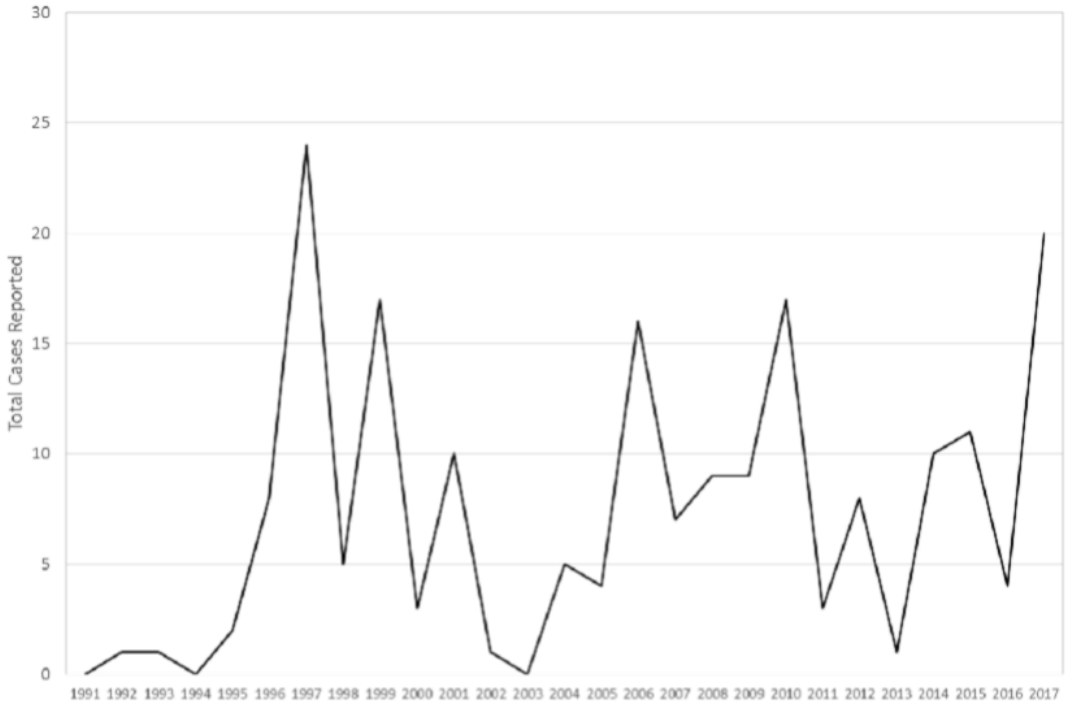

Figure 2. Ross River virus notifications in South Western Sydney Local Health District residents, January 1991 to December 2018. (Source: NSW Health Notifiable Conditions Information Management System (NCIMS), Communicable Diseases Branch and Centre for Epidemiology and Evidence, NSW Health)

MOSQUITO MANAGEMENT STRATEGIES

Environmentally sustainable mosquito management

It is not necessary for local authorities to eradicate all local mosquito populations to have a positive improvement to the health and well-being of local community. Many of the mosquitoes present in the LCC area are native species and an intrinsic part of the local ecosystem. The objective of mosquito management should be reducing the contact between people and mosquitoes to reduce the associated pest and public health risks, without adversely impacting the local ecosystem.

While mosquito control has been effectively employed by local authorities around Australia to reduce the impacts of pest mosquitoes, there is a paucity of evidence that mosquito control significantly reduces the rate of mosquito-borne disease. Mosquito control alone is not the only solution, there are a range of additional approaches that need to be incorporated into an integrated, site-specific strategy.

In recent decades, mosquito management in many parts of Australia has taken on a regional focus with collaborative strategies employed by adjacent local governments. These councils typically share a common problem, either a network of productive mosquito habitats or contiguous suburban areas. In SE QLD and far north NSW, a number of councils have formed the Regional Mosquito Management Group (RMMG). Similarly, in WA there is a number of CLAGs throughout the state that operate with the assistance of the state health authority. The advantage of these approaches is that there are cost savings associated with mosquito management across the region while also enabling regionally specific focuses on specific mosquito related issues.

A summary of mosquito management strategies, their advantages and disadvantages is summarised in Table 3.

Mosquito and mosquito-borne pathogen surveillance

Mosquito and mosquito-borne pathogen surveillance should form the basis of local mosquito management strategies in the region. The provision of reliable information on mosquito populations, as well as mosquito-borne disease activity, will be crucial in shaping mosquito management strategies. Without data on changes in mosquito abundance and diversity within and between seasons, strategic cost-effective modifications to mosquito control and surveillance programs will not be possible.

Elements of a strategic surveillance program include monitoring mosquito abundance and diversity with respect to local environmental conditions, monitoring mosquito-borne pathogen activity within local mosquito populations, and monitor notifications of mosquito-borne disease in human population. Each of these surveillance strategies brings a specific set of information to local authorities and there must be clear guidelines on this information will vary the response to local mosquito threats.

There would be great benefit to LCC in participating the NSW Arbovirus Surveillance and Mosquito Monitoring Program. This is a state-wide program that includes a number of local governments and public health units in metropolitan Sydney. Mosquito sampling is typically undertaken between December and March with weekly collection and processing of adult mosquitoes. Adult mosquitoes are collected with carbon dioxide baited light traps (technically known as Encephalitis Virus Surveillance (EVS) traps) are effective at collecting the mosquitoes of pest and public health concern while minimising non-target insect collections.

These traps use carbon dioxide (supplied as either block or pellet dry ice or via gas cylinder) to attract host seeking mosquitoes. Female mosquitoes are attracted to the carbon dioxide (i.e.

simulating exhalation of warm blooded animal), a small light serves as a focus and a battery operated fans blows the incoming mosquitoes into a catch bag. These traps are typically only operated once a week, set in the late afternoon and collected the following morning. This is generally done early in the week to allow processing of collections and notifications to stakeholders by the end of the working week. Standard operating procedures for these activates are available.

While local government is responsible for the setting and collection of mosquito traps, the NSW Arbovirus Surveillance and Mosquito Monitoring Program facilitates the identification of mosquito specimens, testing specimens for the presence of mosquito-borne pathogens, and the provision of weekly reports. These reports provide a summary of results, implications for pest and public health risks, and commentary regarding prevailing season climatic conditions and implications for the remainder of the season and potential mosquito impacts.

The costs to LCC would include purchase of EVS traps (approximately $290 each) and consumables associated with trapping (i.e. batteries and dry-ice). There is also an opportunity for mosquito traps to be loaned to local governments from Medical Entomology, NSW Health Pathology, but availability cannot always be guaranteed. Consumable costs are variable but estimated at approximately $3/week for batteries (approximately $70 per season) and approximately $30/week for dry-ice (approximately $360 per season). These costs are offset by funds provided by Environmental Epidemiology Unit, Health Protection NSW, to participant local government agencies of $25/trap/week (approximately $600 per season). The major cost to participant agencies is the staffing time of council employees to set and collect traps (estimated at less than 4h per week) as well as arrange transport of specimens to Medical Entomology laboratories at Westmead Hospital. There are various options for this including the use of a courier service, council staff physical drop off traps to Westmead Hospital, or arrangements could be made with the local Public Health Unit to assist in transport of traps.

The information gathered by mosquito monitoring can be used to strengthen public health messages and other public health education initiatives of LCC and local stakeholders. Seasonal warnings of mosquito activity can be accompanied by data from surveillance programs. For example, using data on mosquito activity, health warnings may include comments on increased mosquito activity such as “current mosquito populations are well above the long-term average” or “there are current three times as many mosquitoes being collected compared to this time last month”. By including this data in public health messages, it would be expected to strengthen impact and engagement giving the message immediacy that seasonal routine messages may not. Whether this then results in behaviour change in the community is less well understood.

Quantified mosquito population sampling can also assist with the response to community complaints about mosquitoes. It is commonly stated that “this season is the worst ever for mosquitoes” when, in reality there may not be many more than the usual number of mosquitoes. Individuals vary in their sensitivity to mosquito bites and the level at which nuisance becomes serious. There will also be great variability in the awareness and willingness of the community to contact local authorities to complain. Having access to reliable mosquito population data assists in responding to these enquires from the community.

Mosquito management

Adaptive management and habitat modification

The most significant pest mosquito is *Aedes vigilax* and while it is generally associated with estuarine wetlands where saltmarsh and mangrove vegetation is present, the production of mosquitoes from these habitats is not uniform across the region. The frequency of tidal inundation and extent of water retained on site will be critical factors in determining mosquito productivity.

Studies elsewhere in Sydney have demonstrated with abundance *Aedes vigilax* populations can actually be a symptom of poor health of estuarine wetlands and the rehabilitation of wetlands can reduce mosquito abundance. For example, more frequent inundation and flushing of wetlands will reduce the suitability of habitats for *Aedes vigilax*.

The majority of mangrove areas in LCC are somewhat restricted due to the nature of the Georges River within the local area. However, there are areas of saltmarsh, sedgelands, and shoe-oak forest where clearly water is retained following tidal or rainfall inundation. These areas are far more likely to produce abundant mosquito populations. While mosquito control can be applied to these habitats (see section below), modification of habitats could be employed as a strategy also.

Habitat modification to allow manipulation of water levels or tidal flushing frequency can be used to reduce the suitability of these estuarine and brackish water habitats for *Aedes vigilax*. Habitat modification of this nature would need to be undertaken in collaboration with local stakeholders to ensure any strategies employed were consistent with the legislative requirements to protection the local environment. Such strategies are likely to face many challenges given the various landowners/managers in these regions. Where wetland rehabilitation may have previously been considered for non-mosquito issues (e.g. loss of biodiversity, weed invasion, erosion, loss of amenity), the potential to include elements of the rehabilitation projects design to assist in reducing suitability of modified habitats for mosquitoes would be considered a co-benefit and may strengthen the case for funding support.

Beyond estuarine environments, the continued development of freshwater habitats within urban environments, especially stormwater systems, must be considered. Mosquito risk is overlooked in WSUD but reducing mosquito risk in WSUD systems is often a co-benefit of carefully considered strategies for the design, construction and maintenance of these habitats. Critical to the likelihood of these habitats creating opportunities for mosquitoes is the retention of water following rainfall. It is common that such structures are designed to facilitate infiltration of water within 72h or sooner. This is best achieved by ensuring ephemeral water bodies are free draining where possible while structures retaining water for longer periods (e.g. gross pollutant traps, and sumps) are routinely maintained to reduce their suitability for mosquitoes.

With regard to bioretention swales, the rate of infiltration is achieved through careful consideration of construction and soil types. However, factors that change this infiltration rate can raise the potential for mosquito production. Sedimentation during the construction phases, or shortly after, can slow infiltration rates while the establishment of vegetation in the structures can assist sedimentation rates and accumulation of organic material that will also slow infiltration rates. These habitats can also be further modified through maintenance, especially where vegetation is managed through mowing. Similarly, where the community uses these structures for recreation (e.g. bike riding, pedestrian thoroughfare, etc.), compaction can occur, as well as the formation of wheel ruts, which may create opportunities for mosquitoes where persistent surface pools of water occur.

Constructed wetlands are becoming increasingly common components of urban developments and designed for stormwater collection, waste water treatment and/or water storage, sediment management while also often bringing with them side benefits for wildlife conservation, passive recreation, community education and aesthetic appeal. However, mosquitoes including *Culex annulirostris* and *Culex quinquefasciatus*, as well as a suite of other mosquitoes, may also become established in these habitats. Recent mosquito problems associated with extensive freshwater wetlands around Warwick Farm (e.g. Horseshoe Lagoon) has highlighted that favourable conditions, these mosquitoes can also pose serious pest and public health concern.

Mosquito control agents: Larvicides and Insect Growth Regulators

The two most appropriate mosquito control agents targeting larval populations are *Bacillus thuringiensis israelensis* (e.g. trade name Teknar; Vectobac) or *s*-methoprene (e.g. trade name

Prolink; Altosid). *Bacillus thuringiensis israelensis* is a bacterial based product that, when ingested, is fatal to mosquito larvae. The insect growth regulator, *s*-methoprene, stops adult mosquitoes emerging from pupae. Both *Bacillus thuringiensis israelensis* and *s*-methoprene have been shown to have no significant impact on non-target aquatic organisms (including fish, shrimps, copepods and amphibians) when applied at their recommended application rate.

These two control agents are registered for use in estuarine wetlands against *Aedes vigilax* by the Australian Pesticides and Veterinary Medicines Authority (APVMA) and are commonly used to management populations of this mosquitoes in Queensland, Victoria, Western Australia, Northern Territory, and New South Wales (including Sydney Olympic Park). There are various formulations of both products and they can be applied in targeted mosquito control activities through ground application (i.e. backpack or vehicle mounted application equipment) or, over larger areas, aerially via helicopter. Remote piloted aircraft are also being investigated as cost-effective options for mosquito control agent application. However, there is still a paucity of evidence to demonstrate how effective they can be in local environments. There are various considerations required when assessing the most cost-effective approach of mosquito control agent application with careful consideration to relevant legislation. This is of particular concern where aerial application may be required in wetlands close to residential areas.

There is a number of other mosquito control agents currently available and registered for use in Australia but they are not widely used. One of the more recent products is a monomolecular film that is applies to water-holding containers to "drown" mosquito larvae. While registered for use in these containers, it is not to be used in natural environments due to potential non-target impacts.

Within LCC, the highest priority areas for mosquito control are the estuarine and brackish water wetlands adjacent to the suburbs of Hammondville and Voyager Point. In reviewing the LCC vegetation maps and coastal management zones, and in combination with surveys of wetlands in July 2019, it appears that the highest risk areas are shoe-oak woodlands adjacent to Lieutenant Cantello Reserve, Hammondville. While there are areas of saltmarsh, sedgeland, and mangroves nearby in Voyager Point, there is no conclusive evidence yet that these areas pose a significant risk of producing large populations of *Aedes vigilax* and control is not currently recommended for this area.

In the proposed areas of treatment, ground based application of liquid formulation of *Bacillus thuringiensis israelensis* (e.g. Teknar, Vectobac). Registered for use against *Aedes vigilax* larvae in tidally influenced environments at rates of 600mL to 1.2L per hectare, this product consistently provides over 80% control of mosquitoes when applied appropriately. Contractors would typically apply the product from backpack sprayers with treatments scheduled between 2 days to 5 days following inundation of the site by tides or rainfall. It is important to note that this product does not provide any residual control so "pre-treatment" is not appropriate and reduced efficacy of the product is reported when larvae are too old as they stop feeding and are no longer susceptible to product. For this reason, during the initial stages of treatment, careful consideration is required as to the environmental factors triggering a hatch of larvae and the developmental stages of mosquito larvae. As this product provides no residual control, retreatment is required throughout the season and, while the frequency of application will vary with prevailing conditions, up to 6 treatments per season would be expected.

An alternative to *Bacillus thuringiensis israelensis* is *s*-methoprene. While *s*-methoprene is generally more expensive (approximately $530 per hectare for product alone[1]) than *Bacillus thuringiensis israelensis* formulations (approximately $21 per hectare for product alone[1]), there are sustained release formulations that may prove more cost-effective overall. Sand, pellet, and briquette formulations are available with pellet formulation the most suitable given local

[1] Based on quotation provided by Pacific Biologics, dated 5 September 2019, for Tecknar 1200 (10L), Prolink XR pellets (10kg)

conditions. This product provides up to 30 days control of mosquito larvae when applied at 3-4 kg/Ha (approx. 2-4 pellets/m^2). There is an advantage in that treatments may be limited to 3 per season given the anticipated duration of control.

The costs to undertake treatment will vary depending on the formulation of control agent used and frequency of application. An estimated cost provided by specialist contractors (Feral Biz) was $1,200+GST per hectare (excluding the cost of mosquito control agent). Costs associated with specific pre- and post-treatment larval provided by Medical Entomology (NSW Health Pathology) would be approximately $2,400+GST per treatment (a thorough assessment of first treatment would be considered adequate to demonstrate effectiveness).

Mosquito control agents: Adulticides

There are other approaches to mosquito control that involve the application of adulticides (e.g. pyrethroids), typically in the form of a fog, ultra-low volume mist, or as residual liquid applied to terrestrial plants or buildings. While insecticides are registered by the APVMA for use against mosquitoes, there is far greater likelihood of non-target impacts and this group of insects can be highly toxic to aquatic life and so are not recommended for use in close proximity to freshwater or estuarine wetlands.

Given the high likelihood of non-target impacts, the use of adulticides is not recommended at this stage. Should this option be pursued, a detailed plan of management would need to be developed in collaboration with pest control operators to ensure that a suitable product formulation is selected and application schedule is decided on. Considerations will need to be given to the use of these products in public spaces and in areas of potentially significant environmental quality.

Mosquito control agents: Biological control

The use of mosquito predators or competitors is often promoted as an alternative method to reduce mosquito abundance compared to the application of insecticides. Unfortunately, there are few examples of where "biological control" has successfully be applied to mosquitoes associated with estuarine wetlands. The promotion of fish movement into the wetlands through increased tidal frequency and volumes entering the wetlands will assist but the release of fish into these habitats will be of minimal benefit given the most productive habitats are those of a moderate to highly ephemeral nature. Insectivorous bats are often cited as a potentially usefully component of integrated mosquito management but there is little evidence that any local microbat species consumes enough adult mosquitoes to reduce the associated pest and public health impacts. Studies in coastal wetlands elsewhere in NSW have demonstrated that these bats more frequently feed on larger insect (e.g. moths) than mosquitoes.

Irrespective of control agent applied to local habitats, assessing the effectiveness of mosquito control is required. All aspects of mosquito control should be recorded. Key mosquito habitats should be identified and data on mosquito surveys, mosquito abundance and diversity (e.g. density of immature mosquitoes, abundance of adult mosquitoes in nearby traps), designated "risk factor" that relates to likely productivity of habitats, preferred control agent and trigger points for treatment (e.g. following highest tides of the month, detection of immature mosquitoes etc).

A detailed record of control agents applied (including product name, active ingredient/s, application method and application rates) should be made, to track the influence on mosquito populations and avoid missed treatments or over application This will also assist the development of a baseline level on operational considerations for planning and training purposes. There is also legislation associated with the use of insecticides in public spaces that must be addressed.

Table 3. Summary of advantages and disadvantages of environmental, chemical and biological mosquito control strategies to be considered by Liverpool City Council

Option	Advantages	Disadvantages
Mosquito surveillance	▪ Provides accurate measure of mosquito abundance and diversity ▪ Consumable costs minimal (especially in conjunction with funding provided by NSW Health)	▪ Does not specific offer mosquito population control ▪ Staffing costs and operational considerations can be disruptive ▪ Initial costs of mosquito trapping equipment relative expensive
Adulticides (thermal fogging/ULV)	▪ Rapid, flexible and relatively cost-effective strategy via truck mounted or backpack application ▪ Large areas can be covered quickly ▪ Useful strategy in emergency response to disease outbreakss ▪ Useful for exotic mosquito incursion response	▪ Potentially highly visual activity that may not be considered appropriate by community ▪ Some products have unpleasant smell ▪ Difficult to achieve effective long term control ▪ Effectiveness highly dependent on environmental/climatic conditions ▪ Potentially significant direct non-target impacts
Adulticides (residual insecticides)	▪ Potentially long periods of mosquito control in some situations (e.g. domestic settings) ▪ Useful in emergency response to disease epidemics ▪ Useful for exotic mosquito incursion response	▪ Potentially significant direct non-target impacts ▪ Not appropriate close to wetlands where insecticide is highly toxic to aquatic organisms ▪ Time consuming to cover large areas ▪ Potential development of insecticide resistance
Larval control (*Bti*)	▪ Proven effective for mosquito control in estuarine and freshwater habitats ▪ Relatively cost effective ▪ Minimal direct non-target impacts ▪ Simple to assess treatment effectiveness	▪ Reapplication regularly required throughout season as no residual control provided ▪ Requires accurate mapping of larval mosquito habitats and monitoring larval populations ▪ Reduced efficacy in heavily polluted habitats or those containing high levels of organic material
Larval control (monomolecular film)	▪ Highly effective against pupae ▪ Sustained control in water holding containers	▪ Not to be used in natural water bodies ▪ Potential non-target impacts of water surface dwelling insects

Larval control (*s*-methoprene)	▪ Proven effective for mosquito control ▪ Minimal direct non-target impacts ▪ Sustained release formulations provide residual efficacy (i.e. reapplication frequency reduced) ▪ Larvae are retained in ecosystem for longer periods to provide food mosquito predators	▪ Time consuming to apply sustained release formulations (i.e. briquettes must be tethered to stakes to prevent 'encapsulation' by sediments) ▪ No opportunity for reapplication if treatment fails ▪ Relatively expensive
Habitat modification (wetlands)	▪ Potential long term solution without reliance on routine application of control agents ▪ May assist the rehabilitation of degraded wetlands (e.g. restore tidal flushing)	▪ May not significantly reduce mosquito populations over large wetland areas ▪ May adversely impact local wetland/environment if planning not suitably assessed ▪ May require regular maintenance to remain effective
Habitat modification (stormwater)	▪ Routine removal of sediment and vegetation may improve functioning of stormwater systems	▪ Routine maintenance is required ▪ Major works may be expensive
Biological control (fish)	▪ Potential long term solution without reliance on routine application of chemical control agents ▪ Introduction of native species complementary to other wetlands management objectives ▪ Enhances community engagement	▪ Not suitable for ephemeral and/or highly polluted habitats ▪ Only fish species endemic to the local area can be released
Commercial mosquito traps	▪ Available at retail outlets and popular with general community ▪ Relatively inexpensive and simple to operate	▪ No demonstrated reduction in overall mosquito populations ▪ No demonstrated evidence they prevent mosquito-borne disease

Public education programs

It is important to note that mosquitoes are a natural part of the Australian environment, including the wetlands and bushland areas within the LCC region and it should be expected that mosquitoes will always be active during the warmer months. Public education programs to raise awareness of the pest and public health threats associated with mosquitoes and promotion of strategies to protect the community from this bites are critical to integrated mosquito management programs.

A key component in public education programs is to raise awareness of mosquitoes as a potential health risk and more than just a nuisance. Studies from around Australia demonstrate that there are still significant gaps in the community's understanding of mosquitoes and their local health risks. There is often a perception that the public health risks associated with mosquitoes are only an issue overseas or, conversely, there may be disproportionate concern about mosquitoes locally by residents with links to overseas where they may have grown up, spent considerable time, or have friends and family experiencing the burden of mosquito-borne diseases such as dengue or malaria.

Notwithstanding the importance of providing motivation of LCC residents to minimise the production of mosquitoes from their own backyards, it is important to provide seasonal reminders of mosquito risk based on prevailing weather conditions and the results of mosquito surveillance programs. These factors may assist in identifying areas of LCC that are at greater risk of both the pest and public health risks associated with mosquitoes. For example, spending time fishing along the river or undertaking recreation in parklands or bushland areas along the Georges River or bushland areas to the south-east of LCC may bring a greater likelihood of exposure to mosquitoes and, potentially, Ross River virus. Education and awareness programs, often undertaking in conjunction with the local Public Health Unit, may assist in raising awareness of these issues during periods when the pest and public health risks are elevated. For example, during school holidays, long weekends, or when locally relevant cultural or religious festivals result in mass gathering events in parklands or other areas adjacent to wetlands where mosquito populations are elevated.

Personal protection measures can reduce the risks of mosquito-borne disease by preventing mosquito bites or by reducing the activity of mosquitoes in and around the home. This approach of raising awareness of public health risks associated with mosquitoes, together with encouraging behavior that reduces exposure to mosquitoes.

The use of personal insect repellents is the first line of protection against biting mosquitoes and, consequently, mosquito-borne disease. A wide range of formulations, including aerosols, creams, lotions, pump sprays and sticks are registered for use in Australia by the APVMA. However, regardless of the formulation, the most effective products are those that contain DEET (diethyltoluamide or N,N-diethyl-3-methylbenzamide) and Picaridin, two chemicals known to be effective insect repellents and widely available in commercial formulations. Both products have been proven to be effective against a range of Australian mosquitoes and very few adverse health impacts have been reported internationally when used as recommended.

There are many repellents available that contain 'natural' compounds derived from plants, including eucalyptus, tea-tree, catmint and citronella extracts. While such products are available for individuals wishing to avoid so-called 'chemical' repellents, it should be recognized that they also are chemicals and some people will find they cause skin irritations. More importantly, however, they generally offer substantially lower protection times when compared to those containing DEET or picaridin and will therefore need to be reapplied more frequently to provide protection.

In addition to topical mosquito repellents, there is a range of products including to coils, sticks and other 'burner' devices that purport to repel mosquitoes. Mosquito coils and sticks that contain insecticides generally provide better protection than those containing plant-derived products. There are also "smokeless" products increasingly available that are impregnated with an insecticide (usually a pyrethroid) that is released when heated, either by burning (coils and sticks), heated by a small electrical unit (vaporising mat) or dispersed by a battery operated fan (clip-on devices). These products are generally designed for indoor or sheltered outdoor areas and should be used as directed.

An essential component of community education is to increase awareness of the importance of backyard mosquito habitats. Even in suburbs relatively close to wetland areas, the production of mosquitoes from backyard habitats, especially *Aedes notoscriptus*, can cause relatively greater nuisance-biting problems as the mosquitoes are in close proximity to dwellings and are persistent biters. It would be expected that there will be opportunities across the urban areas of LCC for these mosquitoes and while these mosquitoes may be responsible for nuisance-biting impacts of residents, the blame is often directed towards local wetlands as the source of mosquitoes. This is not always the case.

Key habitats for this mosquito are small to medium sized water-holding container. These can be naturally occurring habitats, such as tree holes, water holding plants (e.g. bromeliads and some lilies) or fallen palm fronds. More commonly, they are artificial containers. Almost any structure that can hold water can be a source of mosquitoes, from a discard lid of a soft drink bottle to an unscreened rainwater tank.

Rainwater tanks are a common source of mosquitoes. While modern and well installed tanks actual pose minimal risk, in situations where screening is not adequately in place or that the tank is not satisfactorily installed or constructed (i.e. where gaps exist for mosquitoes to gain access inside), they can be a major source of pest mosquitoes.

A framework for communicating issues regarding mosquito and mosquito-borne disease awareness, together with promotion of personal protection measures to be used against mosquitoes is provided in Table 4.

Table 4. Proposed Liverpool City Council communication plan framework to raise awareness of mosquitoes and mosquito-borne disease in combination with promotion of personal protection measures

Public message type	Timing and trigger	Notes
Routine	Issued at the start of the mosquito season (November/December)	Media release, newspaper and radio advertisements, social media, flyer/poster/brochure distribution; Standard messages regarding awareness of mosquitoes and their health impacts, personal protection recommendations. Reminders of LCC involvement with mosquito surveillance and control programs.
Environmental-prompted	Substantial rainfall; extreme weather	Media release, social media. Reminders of possible mosquito population increase, backyard clean up to minimise opportunities for mosquitoes.
Surveillance-prompted (mosquitoes)	Increased mosquito abundance detected in surveillance program.	In partnership with South Western Sydney Local Health District Public Health Unit and NSW Health. Media release, newspaper and radio advertisements, social media. Messages include specific mention of mosquito population change (e.g. twice as many mosquitoes as usual; dramatic increase compared to earlier in season). Reminders of LCC mosquito surveillance control program.
Surveillance-prompted (arboviruses)	Detection of arboviruses (e.g. Ross River virus) in local mosquitoes	In partnership with South Western Sydney Local Health District Public Health Unit and NSW Health. Media release, newspaper and radio advertisements, social media. Messages reinforce recommended personal protection measures, background on specific mosquito-borne pathogen and clinical consequences and diagnosis. Reminders of mosquito control program.
Outbreak-prompted	Increase in human disease notifications; consultation with DHHS.	DHHS lead agency; Possible media conference, media release, newspaper and radio advertisements, social media. Messages reinforce recommended personal protection measures, background on specific mosquito-borne pathogen and clinical consequences and diagnosis. Reminders of mosquito control program.
Event-prompted	Seasonal events (e.g. school holidays, long weekends) or mass gathering events (e.g. music, market, or cultural events) near Georges River wetlands	Media release, newspaper and radio advertisements, social media. Engagement with local businesses, event organisers. Event specific items (e.g. coasters, tide charts, tourist guides).

MOSQUITO MANAGEMENT ACTION PLAN

Strategies	Strategic actions and benefits	Partner Stakeholders	Schedule
Initiate participation with NSW Arbovirus Surveillance and Mosquito Monitoring Program	▪ Seasonal adult mosquito surveillance (December through to April) at a minimum of two locations (Hammondville/Voyager Point and Chipping Norton) during the 2019-2020 [Estimate 6h/week LCC staff; consumable cost contribution from EEU] ▪ Purchase 2 Encephalitis Virus Surveillance traps from Australian Entomological Supplies [http://www.entosupplies.com.au/]; alternatively arrange for a loan of equipment from Medical Entomology, NSW Health Pathology ▪ Liaise with EEU, SWPHU, and Medical Entomology to assist with the selection of appropriate trapping locations ▪ Trapping would provide increased understanding of local mosquito populations, gain access to information on seasonal prevalence of mosquitoes and mosquito-borne pathogens, and allow access to additional resources to assist mosquito management and public health communications (e.g. workshops, online material) **Estimated costs 2019-2018 (excluding LCC staff costs): $1,030 (less $600 funds provided by EEU)**	EEU; SWPHU; MEDENT	Commence December 2019
Identify mosquito control priority sites	▪ Document known actual and potential mosquito habitats based on historical data and the experience of local stakeholders (e.g. MEDENT, SWPHU) ▪ Survey of known and suspected estuarine or brackish-water wetlands that may representing productive habitat for *Aedes vigilax* ▪ Sampling habitats for larval populations of *Aedes vigilax* and other mosquito species following key environmental events (i.e. within 10 days of a spring tide; substantial rainfall event or major storm event) **Estimated costs 2019-2020 (excluding LCC staff costs): Nil**	MEDENT; SWPHU	Underway, to be completed April 2020
Create mosquito risk maps of key habitats within council	▪ On completion of identification of actual and potential mosquito habitats, create map to incorporate into LCC GIS system (i.e. a "mosquito habitat" layer) ▪ Resource will assist LCC coordinate any mosquito surveillance and/or control activities as well as response to enquiries from public **Estimated costs 2019-2020 (excluding LCC staff costs): TBC**	MEDENT	To be completed October 2020

Targeted mosquito control activities	▪ Habitats associated with Georges River foreshore at Hammondville were identified as providing productive conditions *Aedes vigilax* ▪ Judicious use of mosquito control agents (specifically the larvicide *Bacillus thuringiensis israelensis*) following favourable environmental conditions will suppress abundance of pest mosquitoes ▪ Estimated that 4-6 treatments would be required between November and March (cost TBC following consultation with contractors) ▪ Conduct pre- and post-treatment larval population surveys to determine effectiveness of mosquito control activities (on at least two occasions during the 2019-2020 mosquito control season) ▪ Review safe work practice for mosquito control and surveillance methodology **Estimated costs 2019-2020 (excluding LCC staff costs): $12,500+GST (Pest control contractors, mosquito control agents, mosquito surveillance and assessment)**	Private contractors	Commence November 2019
Take lead role in regional mosquito management working group	▪ Following initial meeting in June 2019, identify potential additional stakeholders in a regional mosquito management working group ▪ Formalise relationship between stakeholders ▪ Identify resources to assist with mosquito surveillance (e.g. community groups) ▪ Identify gaps in current knowledge that could be filled with the assistance of stakeholders (e.g. research projects at local universities) ▪ Schedule at least one face-to-face meeting with all stakeholders ahead of the 2017-2018 mosquito season **Estimated costs 2019-2020 (excluding LCC staff costs): TBC**	EEU; SWPHU; MEDENT; SSEPHU; CBC; CC; FC; SSC; GRK; SW; NPWS; OEH	To be completed February 2020
Review local public education material	▪ Review mosquito information provided on NSW Health website to ensure consistency with LCC content ▪ Revise mosquito awareness information and recommendations on personal protection measures with more specific information on the safe and effective use of insect repellents with a local perspective (see Appendix 1) ▪ Consider adding non-English language public health material ▪ Investigate social media as pathway of public health information to community **Estimated costs 2019-2020 (excluding LCC staff costs): TBC**	EEU; SWPHU	To be completed December 2019
Storm water Management	▪ Liaise with LCC departments with regard to construction and maintenance of storm water infrastructure (e.g. Water Sensitive Urban Design, green infrastructure) to ensure that actual and potential mosquito risk is considered **Estimated costs 2019-2020 (excluding LCC staff costs): Nil**	Various	Commence 2021 and beyond

Natural Resource Management	▪ Liaise with LCC departments with regard to wetland, bushland, and parkland management to ensure that actual and potential mosquito risk is considered, especially wetland construction and/or rehabilitation projects **Estimated costs 2019-2020 (excluding LCC staff costs): Nil**	Various	Commence 2021 and beyond
Mosquito research projects	▪ Investigate partnerships with local institutes to undertake research into matters relating to mosquito biology, surveillance, and control with a view to outcomes informing local mosquito management **Estimated costs 2019-2020 (excluding LCC staff costs): Nil**	Various	Commence 2021 and beyond

EEU: Environmental Epidemiology Unit, Health Protection NSW; SWPHU: South Western Sydney Local Health District Public Health Unit; MEDENT: Medical Entomology, NSW Health Pathology; SSEPHU: Sydney South Eastern Local Health District Public Health Unit; CBC: Canterbury Bankstown City Council; CC: Campbelltown Council; FC: Fairfield Council; SSC: Sutherland Shire Council; GRK: Georges River Keeper; SW: Sydney Water; NPWS: National Parks and Wildlife Service; OEH: NSW Office of Environment and Heritage

REFERENCES AND FURTHER READING

Boyd, A.M. and Kay, B.H. 2001. Solving the urban puzzle of Ross River and Barmah Forest virus. Arbovirus Research in Australia, 8: 14-22.

Breitfuss, M., Hurst, T., Ryan, P. and Kay, B.H. 2005. Practical freshwater mosquito control: Defining productive habitats and implementing effective control strategies. Arbovirus Research in Australia, 9: 52-57

Claflin, S.B. and Webb, C.E., 2017. Surrounding land use significantly influences adult mosquito abundance and species richness in urban mangroves. Wetlands ecology and management, 25(3), pp.331-344.

Claflin, S.B. and Webb, C.E., 2015. Ross River virus: many vectors and unusual hosts make for an unpredictable pathogen. PLoS Pathogens, 11(9), p.e1005070.

Cutcher, Z., Williamson, E., Lynch, S.E., Rowe, S., Clothier, H.J. and Firestone, S.M. 2017. Predictive modelling of Ross River virus notifications in southeastern Australia. Epidemiology & Infection, 145(3), pp.440-450.

Dale, P.E.R. and Hulsman, K. 1990. A critical review of salt marsh management methods for mosquito control. Aquatic Science, 3: 281-311.

Fradin, M.S. and Day J.F. 2002. Comparative efficacy of insect repellents against mosquito bites. The New England Journal of Medicine. 347: 13-18.

Gilles, M., Galloway, D., Horwitz, P. and Larson, A. 2004. Reintegrating coastal development and public health in Western Australia. EcoHealth, 1(4), pp.340-350.

Glasgow, K.M., Bateman-Steel, C.R., Pope, B. and Ferson, M.J. 2018. The right kind of viral: boosted Facebook advertisements for health protection messages. The Medical Journal of Australia, 209(10), p.447.

Hanford, J.K., Webb, C.E. and Hochuli, D.F. 2019. Habitat Traits Associated with Mosquito Risk and Aquatic Diversity in Urban Wetlands. Wetlands, 1-16.

Jardine, A., Neville, P.J. and Lindsay, M.D., 2015. Proximity to mosquito breeding habitat and Ross River virus risk in the peel region of Western Australia. Vector-Borne and Zoonotic Diseases, 15(2), pp.141-146.

Lawler, S.P. 2017. Environmental safety review of methoprene and bacterially-derived pesticides commonly used for sustained mosquito control. Ecotoxicology and Environmental Safety, 139, pp.335-343.

Mosquito Control Association of Australia Inc. 2009. Australian Mosquito Control Manual. Mosquito Control Association of Australia.

Muller, M. and McGinn, D. 1997. Saltmarsh mosquito control – towards best practice. Arbovirus Research in Australia, 7: 194-196.

Ramírez, A.L., van den Hurk, A.F., Meyer, D.B. and Ritchie, S.A. 2018. Searching for the proverbial needle in a haystack: advances in mosquito-borne arbovirus surveillance. Parasites & Vectors, 11(1), p.320.

Ratnayake, J., Dale, P.E., Sipe, N.G. and Daniels, P. 2006. Impact of biting midges on residential property values in Hervey Bay, Queensland, Australia. Journal of the American Mosquito Control Association, 22(1), pp.131-134.

Russell, R.C. 1990. Mosquitoes and Mosquito Borne Disease in Southeastern Australia. Published by the Department of Medical Entomology, Westmead Hospital and the University of Sydney. 306pp.

Russell, R.C. 1998. Mosquito-borne Arboviruses in Australia: The current scene and implications of climate change for human health. International Journal of Parasitology, 28: 995-969.

Russell R.C. 2009. Mosquito-borne disease and climate change in Australia: time for a reality check. Australian Journal of Entomology, 48: 1-7.

Russell, T. and Kay, B.H. 2008. Biologically based insecticides for the control of immature Australian mosquitoes: a review. Australian Journal of Entomology, 47: 232-242.

Silver, J.B. 2008. Mosquito Ecology: Field Sampling Methods. 3rd Ed. (Springer: New York).

Stephenson, E.B., Peel, A.J., Reid, S.A., Jansen, C.C. and McCallum, H. 2018. The non-human reservoirs of Ross River virus: a systematic review of the evidence. Parasites & Vectors, 11(1), p.188.

Toi, C.S., Webb, C.E., Haniotis, J., Clancy, J. and Doggett, S.L. 2017. Seasonal activity, vector relationships and genetic analysis of mosquito-borne Stratford virus. PloS One, 12(3), p.e0173105.

Tomerini, D.M., Dale, P.E. and Sipe N. 2011. Does mosquito control have an effect on mosquito-borne disease? The case of Ross River virus disease and mosquito management in Queensland, Australia. Journal of the American Mosquito Control Association, 27: 39-44.

van den Hurk, A.F., Hall-Mendelin, S., Johasen, C.A., Warrilow, D, and Ritchie, S.A. 2012. Evolution of mosquito-based arbovirus surveillance systems in Australia. Journal of Biomedicine and Biotechnology doi: 10.1155/2012/325659

Webb, C.E. 2015. Are we doing enough to promote the effective use of mosquito repellents? The Medical Journal of Australia, 202(3), pp.128-129.

Webb, C.E., Ironside, A. and Mansfield, S., 2013. A comparison of oviposition preference in the presence of three aquatic plants by the mosquitoes *Culex annulirostris* Skuse and *Culex quinquefasciatus* Say (Culicidae: Diptera) in laboratory tests. General and Applied Entomology: The Journal of the Entomological Society of New South Wales, 41, p.21.

Webb, C.E. and Hess, I.M. 2016. A review of recommendations on the safe and effective use of topical mosquito repellents. Public Health Research & Practice, 26(5): e2651657.

Webb, C.E., Doggett S.L. and Russell R.C. 2016. A guide to the mosquitoes of Australia. CSIRO Publishing, Clayton South, Australia.

Webb, C.E. 2013. Managing mosquitoes in coastal wetlands. In Paul S (ed) Workbook for managing urban wetlands in Australia, 1st edn. Sydney Olympic Park Authority, Sydney, Australia, pp 321-340

APPENDIX 1: Mosquito information for Liverpool City Council community education and communications programs

The following is proposed content to be used for mosquito awareness and educational material to be distributed via fact sheets, flyers, Liverpool City Council website and social media platforms.

Beating the bite of mosquitoes in Liverpool City Council

Mosquito bites can make you sick

Mosquitoes aren't just a nuisance - they can spread pathogens that cause serious diseases. While the Liverpool region is free of some of the most serious global diseases such as dengue or malaria, local mosquitoes can cause debilitating illnesses.

Mosquitoes can transmit pathogens that cause a number of serious human diseases. In Liverpool City Council, the most common diseases are caused by Ross River and Barmah Forest viruses.

The mosquitoes that spread dengue, chikungunya, or Zika viruses are not found in the Liverpool City Council region.

If you're travelling overseas, you and your family may be at risk of mosquito-borne diseases such as malaria, dengue, yellow fever, chikungunya or Zika. While vaccines are available for some diseases (e.g. yellow fever and Japanese encephalitis) and medicines can help prevent malaria, all travellers should also use insect repellents and other general protective measures to avoid mosquito bites.

This is how you avoid mosquito bites

To protect you and your family from mosquito bites and reduce the risk of disease when spending time outdoors:

- mosquitoes will be most active between October and April
- mosquitoes are most active around dawn and dusk, so take special care during these times
- wetland and bushland areas are where mosquitoes pose the greatest health risk
- cover-up with loose-fitting, long sleeved shirts and long pants
- apply mosquito repellent to exposed skin

To prevent mosquitoes breeding around your home:

- remove sources of water from around the home
- avoid water-holding plants such as bromeliads
- regularly clean out gutters and drains
- ensure rainwater and/or septic tanks correctly maintained
- screen windows and doors

Choosing and using the right insect repellent

Using a mosquito repellent on all exposed skin areas will provide a safe and reliable way to reduce mosquito bites. Regardless of the formulation that you use, follow the instructions on the packaging. Avoid putting repellent near the eyes and mouth, or over open wounds, broken skin or abrasions.

Many of the different brands of mosquito repellent contain similar ingredients. The most effective mosquito repellents contain Diethyltoluamide (DEET) or Picaridin. Repellents containing oil of lemon eucalyptus (OLE) (also known as Extract of Lemon Eucalyptus) or para menthane diol (PMD) also provide adequate protection.

The strength of a repellent determines the duration of protection with the higher concentrations providing longer periods of protection. If you're only outside for short periods, lower dose formulations will work but always check the label for reapplication times.

Plant-based products (such as Eucalyptus or Citronella) provide only limited protection and require more frequent reapplication.

When using mosquito repellent, irrespective of formulation, it is important to cover all exposed skin. It is often a good idea to "rub in" repellent in a similar manner to applying sunscreen.

Mosquito repellent needs to be reapplied after swimming. Mosquito repellents also don't last as long when sweating due to strenuous activity or hot weather so it may need to be reapplied more frequently.

Personal (e.g. clip-on) spatial repellent products containing active ingredients such as metofluthrin are likely to assist in reduce mosquito bites but should always be used in combination with topical mosquito repellents.

Mosquito repellent wrist bands and patches have been shown not to provide adequate protection from mosquitoes and should be avoided.

Are mosquito repellents safe for families?

Insect repellents are used by Australians on millions of occasions each year and adverse reactions are rarely reported.

You should always choose a mosquito repellent formulation approved for use by the Australian Pesticides and Veterinary Medicines Authority (APVMA). These are most commonly available from supermarkets and pharmacies. The APVMA only registers formulations that are safe and effective if instructions on label are followed.

Most insect repellents are safe for use on children aged 3 months and older when used according to directions. However, some formulations are only recommended for children aged 12 months and older so always check the product label for recommended age use and never allow young children to apply their own repellent.

Infants aged less than 3 months can be protected from mosquitoes by using an infant carrier draped with mosquito netting that is secured along the edges.

Mosquito repellents, when used according to product label instructions, are considered safe for use during pregnancy and while breast-feeding.

If you're using sunscreen, apply the sunscreen first and then apply the repellent. Be aware that DEET-containing repellents may decrease the sun protection factor (SPF) of sunscreens so you may need to re-apply the sunscreen more frequently.

Covering up with clothing

Minimising the amount of exposed skin reduces the risk of mosquito bites by wearing loose fitting clothing with long sleeves and pants. Mosquitoes will bite through tight clothing. Mosquitoes also tend to be attracted to dark coloured clothing but wearing light coloured clothing won't actually keep them away. Also wear socks and shoes where possible.

If spending a lot of time outdoors where mosquitoes are active, either due to work of activities such as gardening, bushwalking, or fishing, consider using clothing pre-treated with insecticides (e.g. permethrin) but remember that repellent must still be applied to exposed skin.

Reduce mosquitoes around your home

Mosquitoes need water. They lay eggs in or around backyard ponds or other water-holding containers so to reduce the risk of mosquitoes breeding in around the home the following steps can be taken:

- cleaning up your backyard and removing all water-holding rubbish, including tires and containers
- flush out bird baths and pet bowls once a week
- fill pot plant bases with sand to avoid standing water
- introduce native fish to backyard ponds
- storing anything that can hold water undercover or in a dry place
- flush out the leaves of water-holding plants such as bromeliads once a week
- keep drains and roof guttering clear to avoid pooling water
- cover or securely screen the openings of septic tanks and rainwater tanks
- store trailers or boats under cover or cover with tight fitting tarpaulins

Properly cleaned and chlorinated swimming pools are rarely a source of mosquito breeding but neglected pools can be a haven for mosquitoes. "Green" pools can often be a source of mosquitoes, especially in ground pools that contain relatively shallow water and an accumulations of leaves and other detritus.

You can prevent mosquitoes entering the home by using flyscreens on windows and doors, and screening chimneys, vents and other entrances. There are many flexible and seasonally adaptable options available for screening outdoor areas such as verandas and balconies.

Aerosol insecticide sprays, mosquito coils (used outdoors) and vapourising mats (used indoors) can help to reduce mosquito activity. These products should be used in addition to, not in place of, other measures such as appropriate clothing and topical mosquito repellents.

Also consider using a surface insecticide spray in areas where mosquitoes like to rest. During the day, mosquitoes rest and hide in cool shady areas such as in and around the home before emerging at dusk to feed but make sure you avoid aquaria and fish ponds as fish are acutely sensitive to these insecticides.

Devices that use light to attract and electrocute insects have not been proven to be effective in reducing mosquito numbers and often kill more harmless insects.

Traveling overseas, consider the risk of mosquitoes

Whether you're travelling overseas on holiday or to visit friends and family, consider the additional risks associated with mosquito bites.

Potentially fatal disease can result from infection with pathogens such as dengue, chikungunya, Zika, Japanese encephalitis, or yellow fever viruses. Malaria parasites are a serious health risk too.

The risks of these disease will vary depending on the country you're visiting so consult your local doctor or travel health professional. See the 'staying healthy when travelling overseas' factsheet on the Smartraveller website for further information on safe travel for specific destinations.

Generally, to reduce mosquito risk while travelling overseas, please consider the following:

- stay and sleep in screened or air-conditioned rooms
- use a bed net if spending time in a country at risk of malaria. Nets are most effective when they are treated with a pyrethroid insecticide, such as permethrin. Pre-treated bed nets can be purchased before travelling, or nets can be treated after purchase
- avoid known areas of high mosquito-borne disease transmission or outbreaks. This is particularly important for people at higher risk of complications from mosquito-borne diseases, such as pregnant women if exposed to Zika or malaria, or when travelling with young children
- avoid bringing home gifts or souvenirs that may contain mosquito eggs (e.g. vases, garden ornaments)

Modified from NSW Health Fact Sheet, last updated 17 January 2017; accessed for review 1 September 2019.[https://www.health.nsw.gov.au/Infectious/factsheets/Pages/mosquito.aspx]