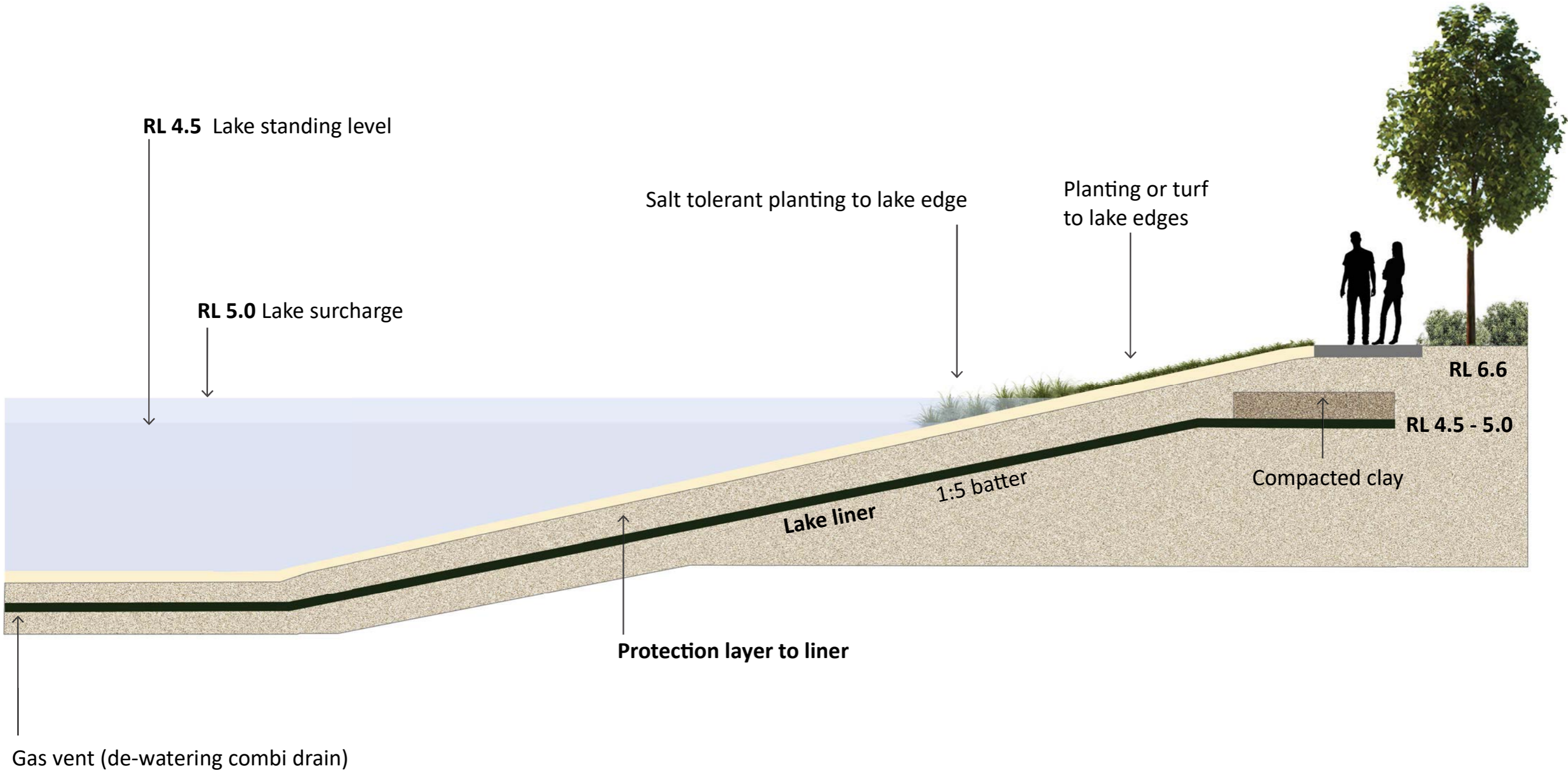
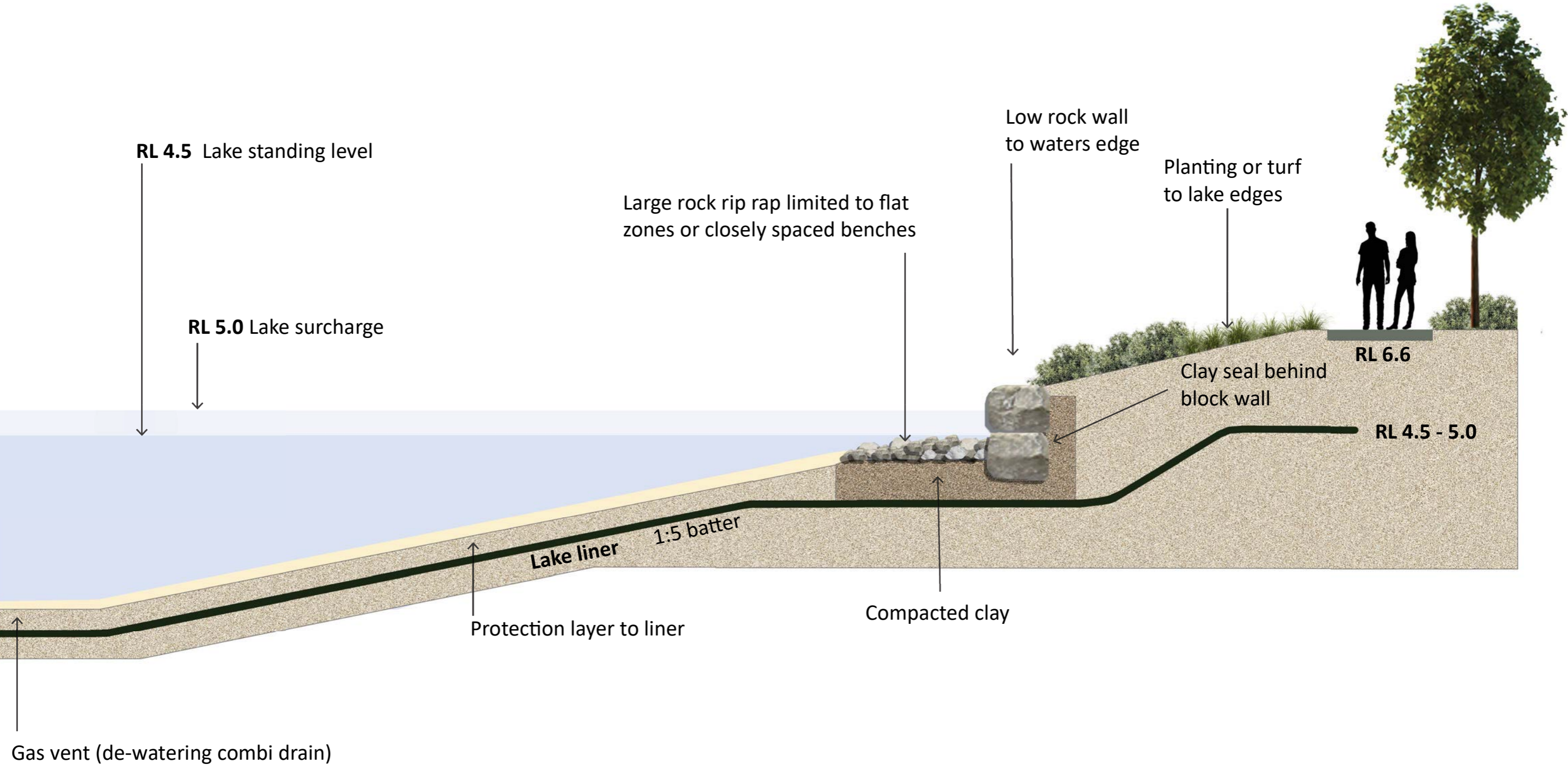


Riverlea
Natural Lake Edge

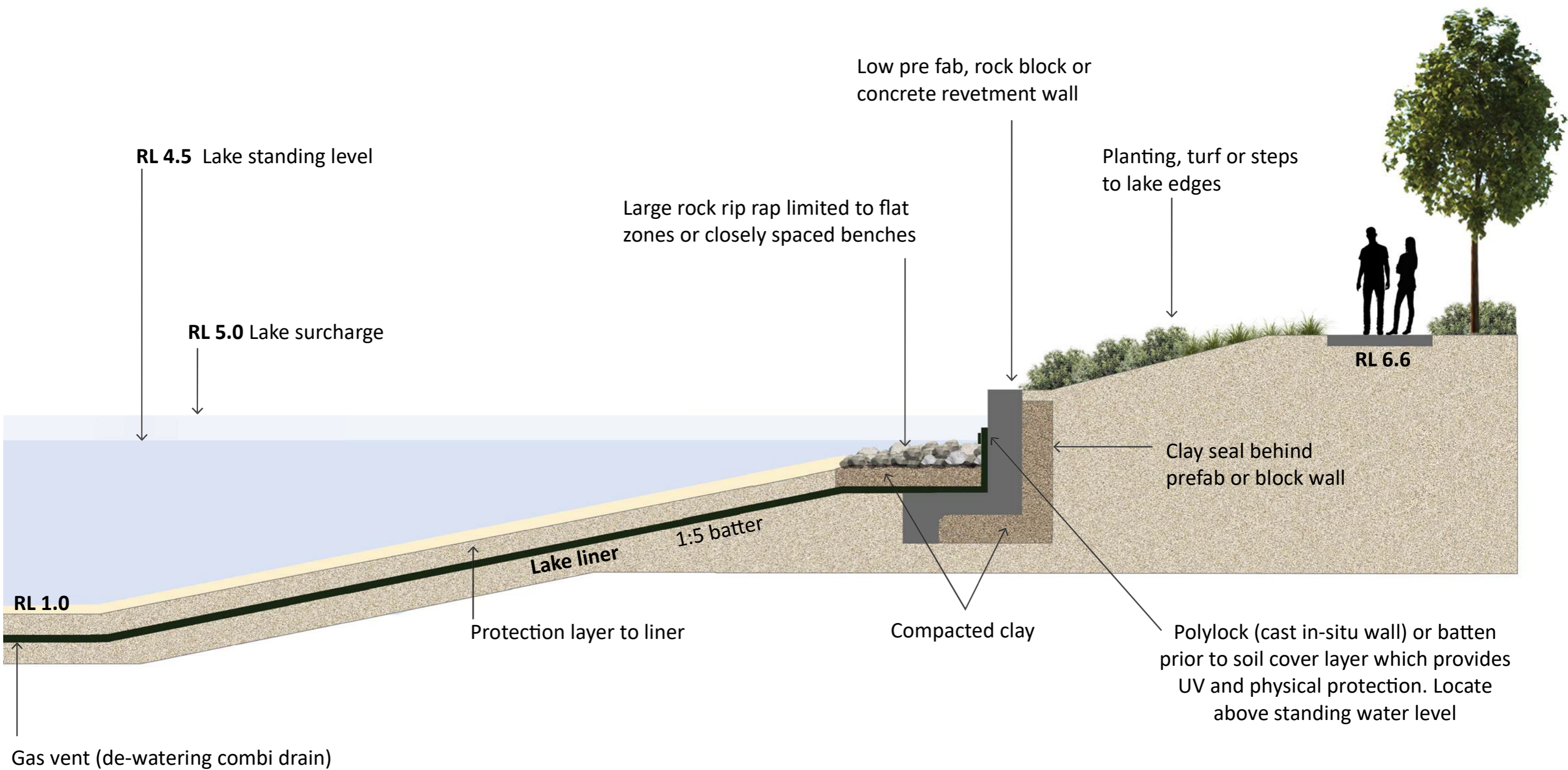


Riverlea
Low rock wall edge

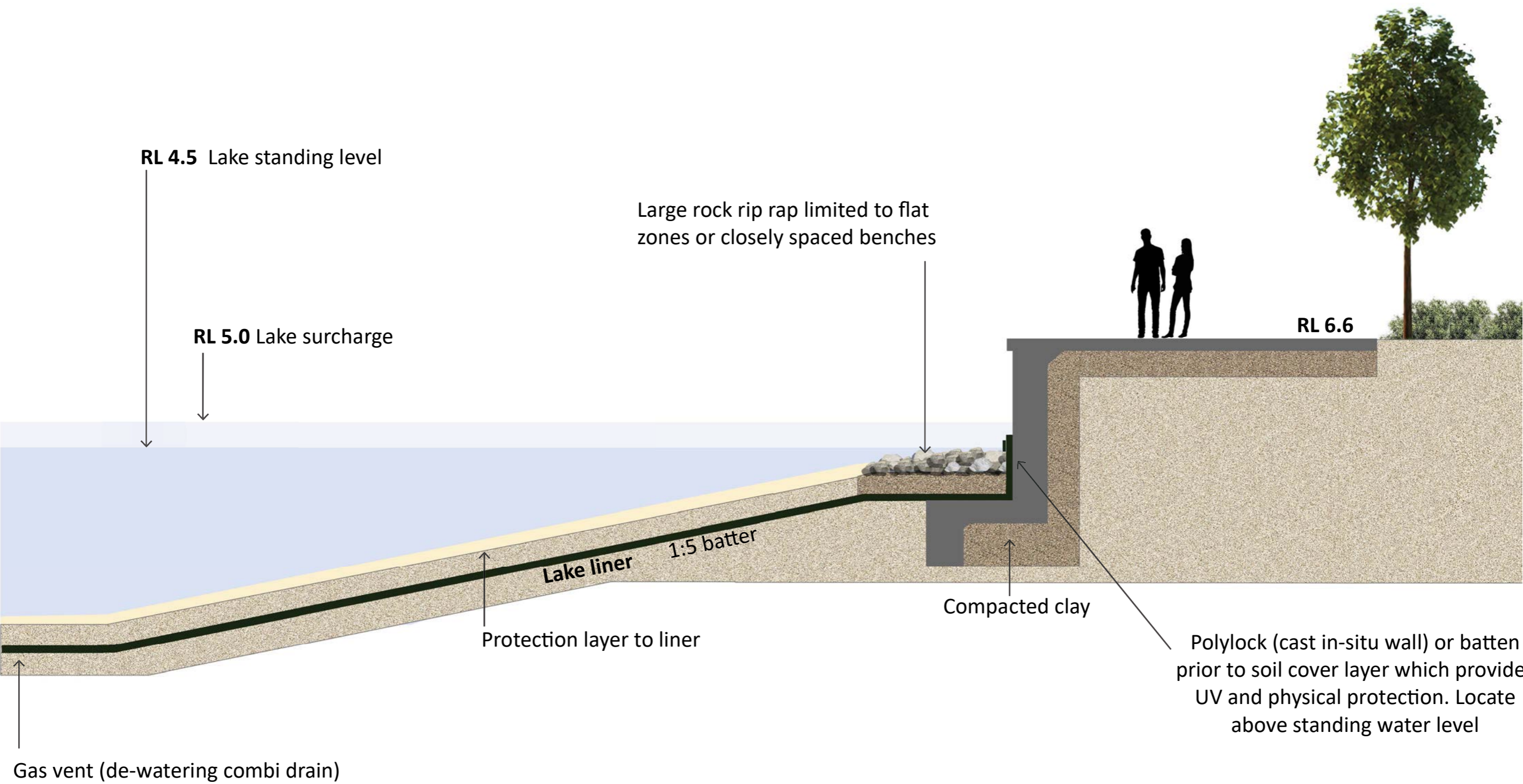


Riverlea

Low revetment wall edge

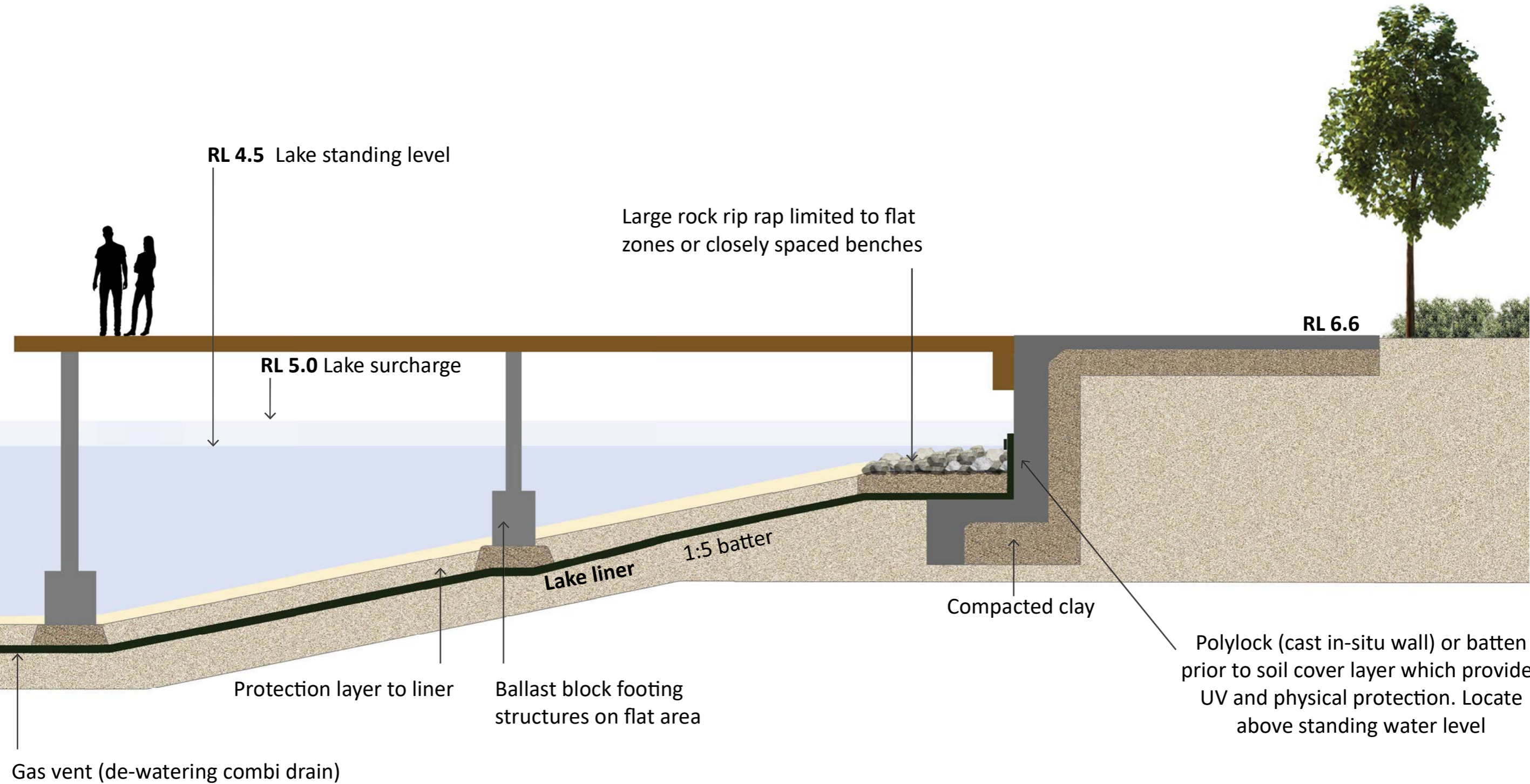


Riverlea
Structural Edge



Riverlea

Deck or jetty edge



Riverlea

Indicative imagery



Block walls and planted batters



Combination of decking, block walls and natural lake edges



Indicative Polylock/termination bar fixing



Structural edges



Riverlea

Indicative imagery



Block wall and planted batter



Pre- fabricated edge



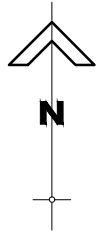
Natural planted edge



Natural salt tolerant planting

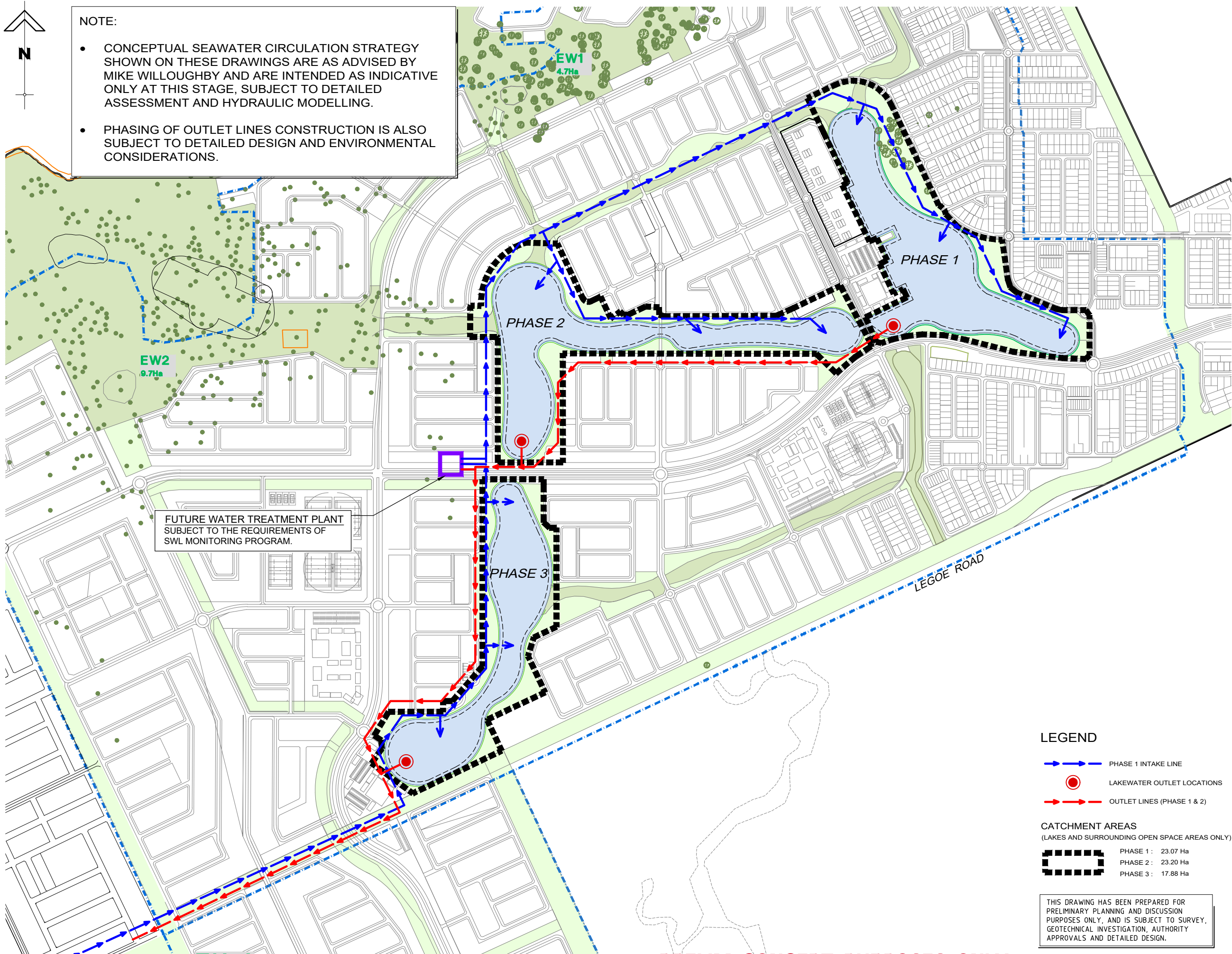


Rock wall/batter and natural edge



NOTE:

- CONCEPTUAL SEAWATER CIRCULATION STRATEGY SHOWN ON THESE DRAWINGS ARE AS ADVISED BY MIKE WILLOUGHBY AND ARE INTENDED AS INDICATIVE ONLY AT THIS STAGE, SUBJECT TO DETAILED ASSESSMENT AND HYDRAULIC MODELLING.
- PHASING OF OUTLET LINES CONSTRUCTION IS ALSO SUBJECT TO DETAILED DESIGN AND ENVIRONMENTAL CONSIDERATIONS.



FUTURE WATER TREATMENT PLANT
SUBJECT TO THE REQUIREMENTS OF
SWL MONITORING PROGRAM.

LEGEND

- → → PHASE 1 INTAKE LINE
- LAKEWATER OUTLET LOCATIONS
- → → OUTLET LINES (PHASE 1 & 2)

CATCHMENT AREAS
(LAKES AND SURROUNDING OPEN SPACE AREAS ONLY)

- PHASE 1 : 23.07 Ha
- PHASE 2 : 23.20 Ha
- PHASE 3 : 17.88 Ha

THIS DRAWING HAS BEEN PREPARED FOR
PRELIMINARY PLANNING AND DISCUSSION
PURPOSES ONLY, AND IS SUBJECT TO SURVEY,
GEOTECHNICAL INVESTIGATION, AUTHORITY
APPROVALS AND DETAILED DESIGN.

SCALE 50 0 50 100 150 200 250 (metres)
1 : 5000 (FULL SIZE)

RIVERLEA
DEVELOPMENT

PROPOSED
DEVELOPMENT
AT BUCKLAND PARK
SOUTH AUSTRALIA

A1 ORIGINAL SIZE BEFORE REDUCTION

G	SWL CIRCULATION STRATEGY MODIFICATION	17-09-24
F	SWL CIRCULATION STRATEGY MODIFICATION	24-05-24
E	MASTER PLAN UPDATE / SWL LINES	20-09-23
D	CONCEPT UPDATED	18-08-22
C	INTAKE LINE DIA AMENDED	09-02-22
B	CONCEPT LAYOUT UPDATE	02-02-22
A	ORIGINAL ISSUE	25-11-20
VER.	DESCRIPTION	DATE

COPYRIGHT (C)
This drawing is copyright and the property of Burchills Engineering Solutions. It must not be retained, copied or used without the authority of Burchills Engineering Solutions.
DISCLAIMER
This drawing and its contents are electronically generated, are confidential and may only be used for the purpose for which they were intended.
Burchills Engineering Solutions will not accept responsibility for any consequences arising from the use of the drawing for other than its intended purpose or where the drawing has been altered, amended or changed either manually or electronically by any third party.
NOTE
This is an uncontrolled document issued for information purposes only, unless the checked sections are signed or completed. Figured dimensions take precedence over scale. Do not scale reduced size drawings. Verify dimensions prior to commencing any on-site or off-site works or fabrication.



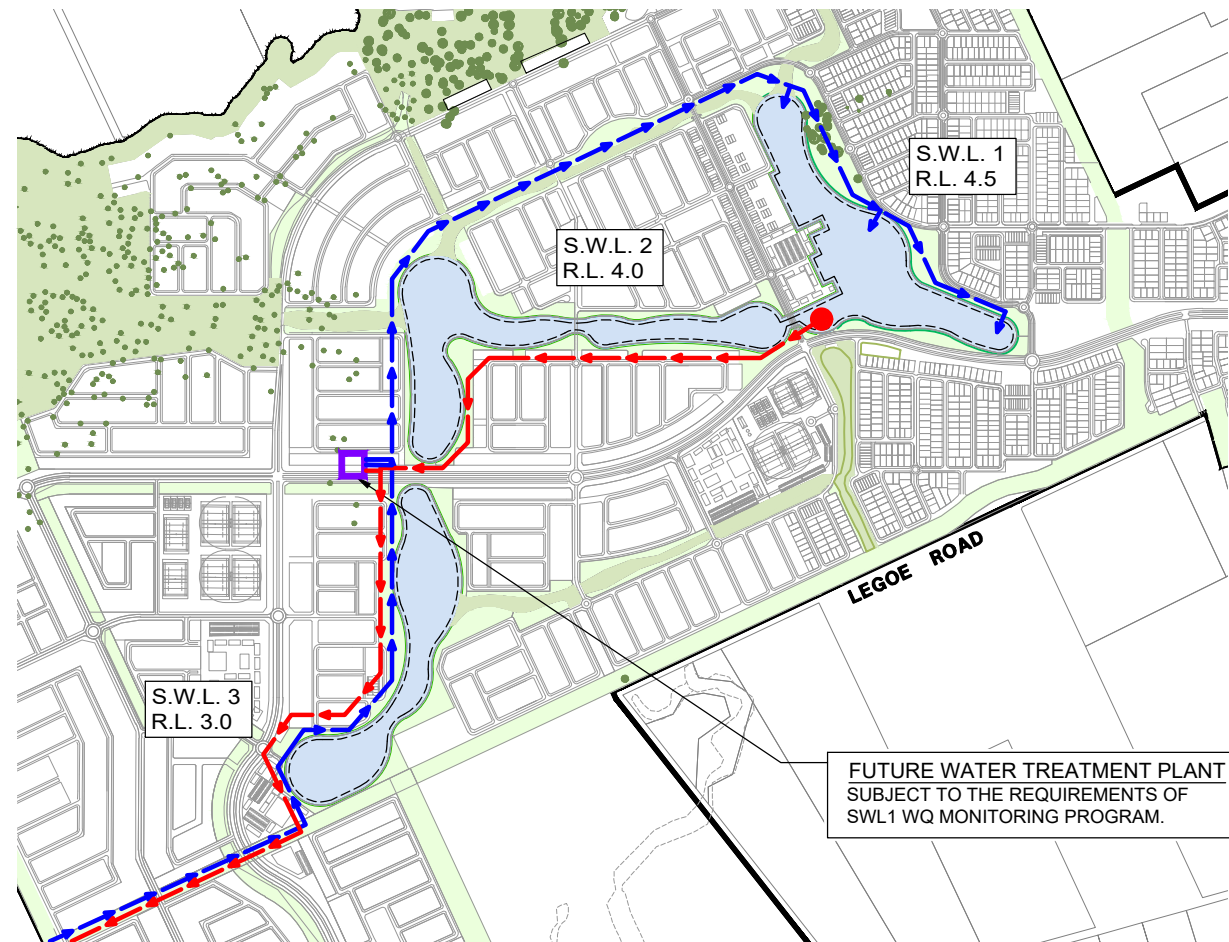
Level 2, Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

PROJECT:

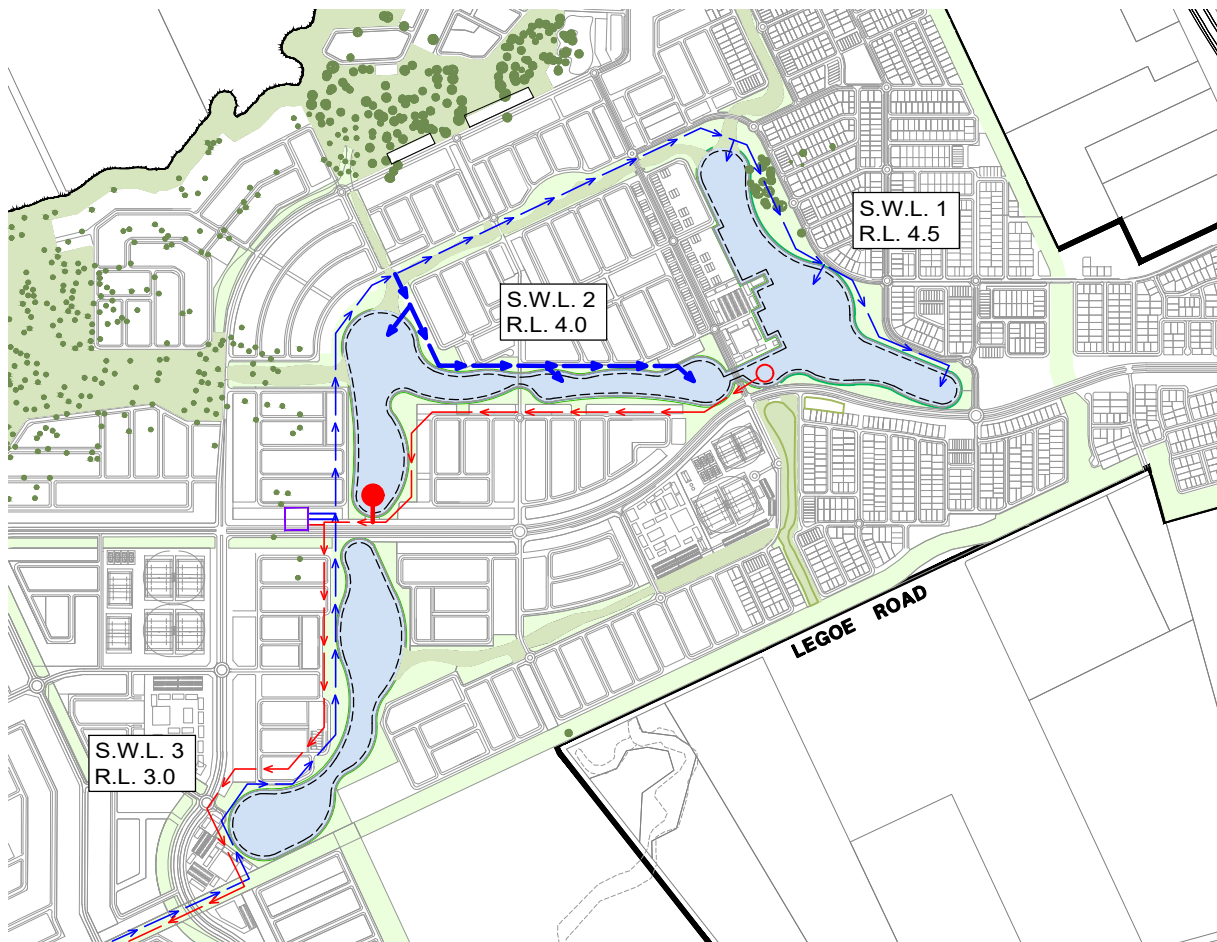
GENERAL SITE EARTHWORKS
PRE-DESIGN AND
CONCEPTUAL

DRAWING TITLE:
CONCEPTUAL SEAWATER
CIRCULATION STRATEGY
LAYOUT PLAN
(PHASES 1 & 2)

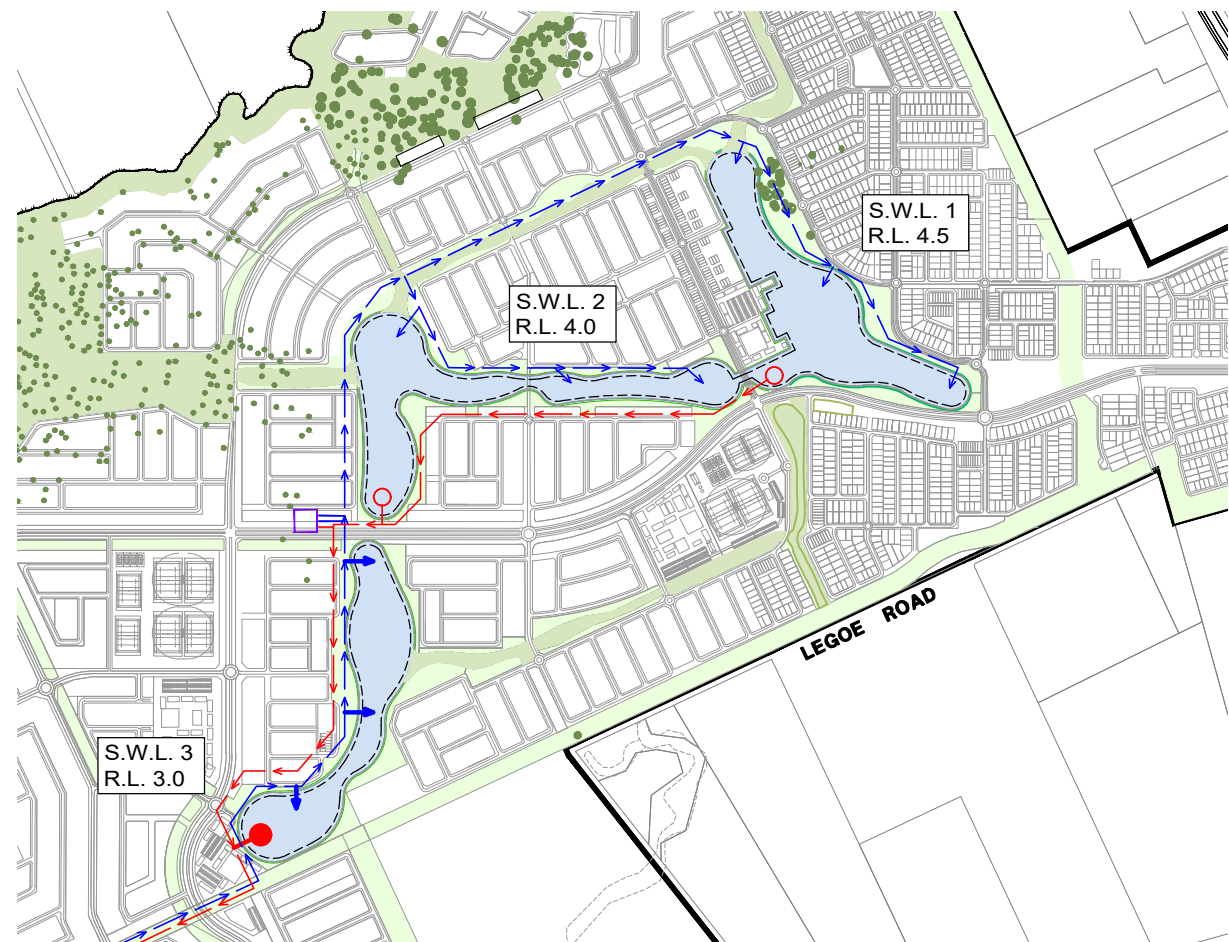
DEVEL. APPLIC. No. : -	DATE : 17-09-24
PROJECT LEADER : PAUL KELLY	
DESIGNER : NILL - DRAFTING ONLY	
DRAFTSPERSON : ADAM COOPER	
CHECKED :	
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365	
RPEQ No. :	
SCALE : AS NOTED	DATUM : AHD
PROJECT No. : BE170039	DRAWING No. : SK113
	VERSION : G



PHASE 1 - SWL 1 CIRCULATION



PHASE 2 - SWL 1 & 2 CIRCULATION



PHASE 3 - SWL 1, 2 & 3 CIRCULATION

NOTE:

- CONCEPTUAL SEAWATER CIRCULATION STRATEGY SHOWN ON THESE DRAWINGS ARE AS ADVISED BY MIKE WILLOUGHBY AND ARE INTENDED AS INDICATIVE ONLY AT THIS STAGE, SUBJECT TO DETAILED ASSESSMENT AND HYDRAULIC MODELLING.
- PHASING OF OUTLET LINES CONSTRUCTION IS ALSO SUBJECT TO DETAILED DESIGN AND ENVIRONMENTAL CONSIDERATIONS.

THIS DRAWING HAS BEEN PREPARED FOR PRELIMINARY PLANNING AND DISCUSSION PURPOSES ONLY, AND IS SUBJECT TO SURVEY, GEOTECHNICAL INVESTIGATION, AUTHORITY APPROVALS AND DETAILED DESIGN.

SCALE 100 0 100 200 300 400 500 (metres)
1 : 10000 (FULL SIZE)

RIVERLEA DEVELOPMENT

PROPOSED DEVELOPMENT AT BUCKLAND PARK SOUTH AUSTRALIA

A1 ORIGINAL SIZE BEFORE REDUCTION

VER.	DESCRIPTION	DATE
G	SWL CIRCULATION STRATEGY MODIFICATION	17-09-24
F	SWL CIRCULATION STRATEGY MODIFICATION	24-05-24
E	MASTER PLAN UPDATE / SWL LINES	20-09-23
D	SWL 1 R.L. AMENDED	24-02-23
C	SWL 3 INTAKE PIPE DIA AMENDED	13-10-22
B	CONCEPT MASTERPLAN UPDATED	01-08-22
A	ORIGINAL ISSUE	07-06-22

COPYRIGHT (C)
This drawing is copyright and the property of Burchills Engineering Solutions. It must not be retained, copied or used without the authority of Burchills Engineering Solutions.
DISCLAIMER
This drawing and its contents are electronically generated, are confidential and may only be used for the purpose for which they were intended.
Burchills Engineering Solutions will not accept responsibility for any consequences arising from the use of the drawing for other than its intended purpose or where the drawing has been altered, amended or changed either manually or electronically by any third party.
NOTE
This is an uncontrolled document issued for information purposes only, unless the checked sections are signed or completed. Figured dimensions take precedence over scale. Do not scale reduced size drawings. Verify dimensions prior to commencing any on-site or off-site works or fabrication.

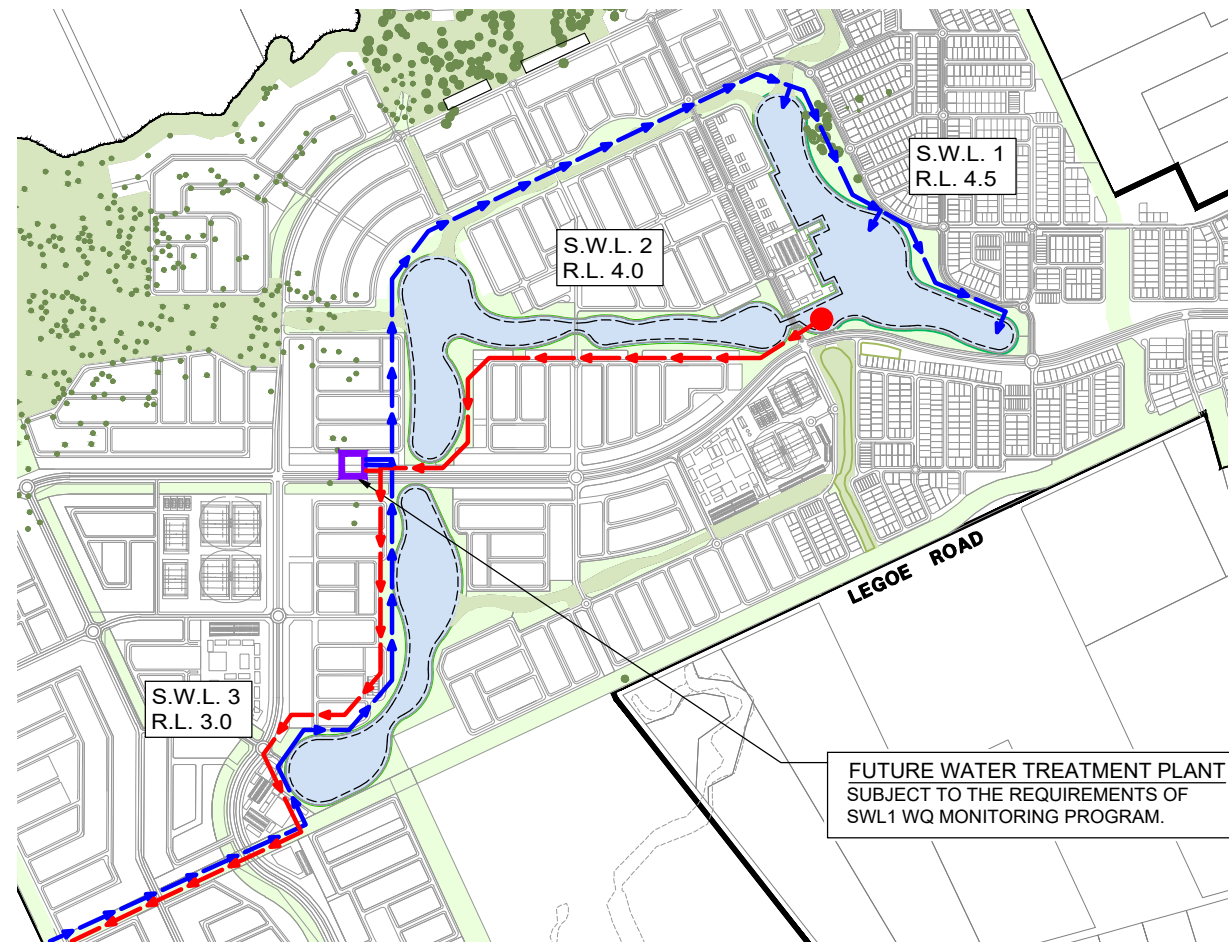


Level 2, Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

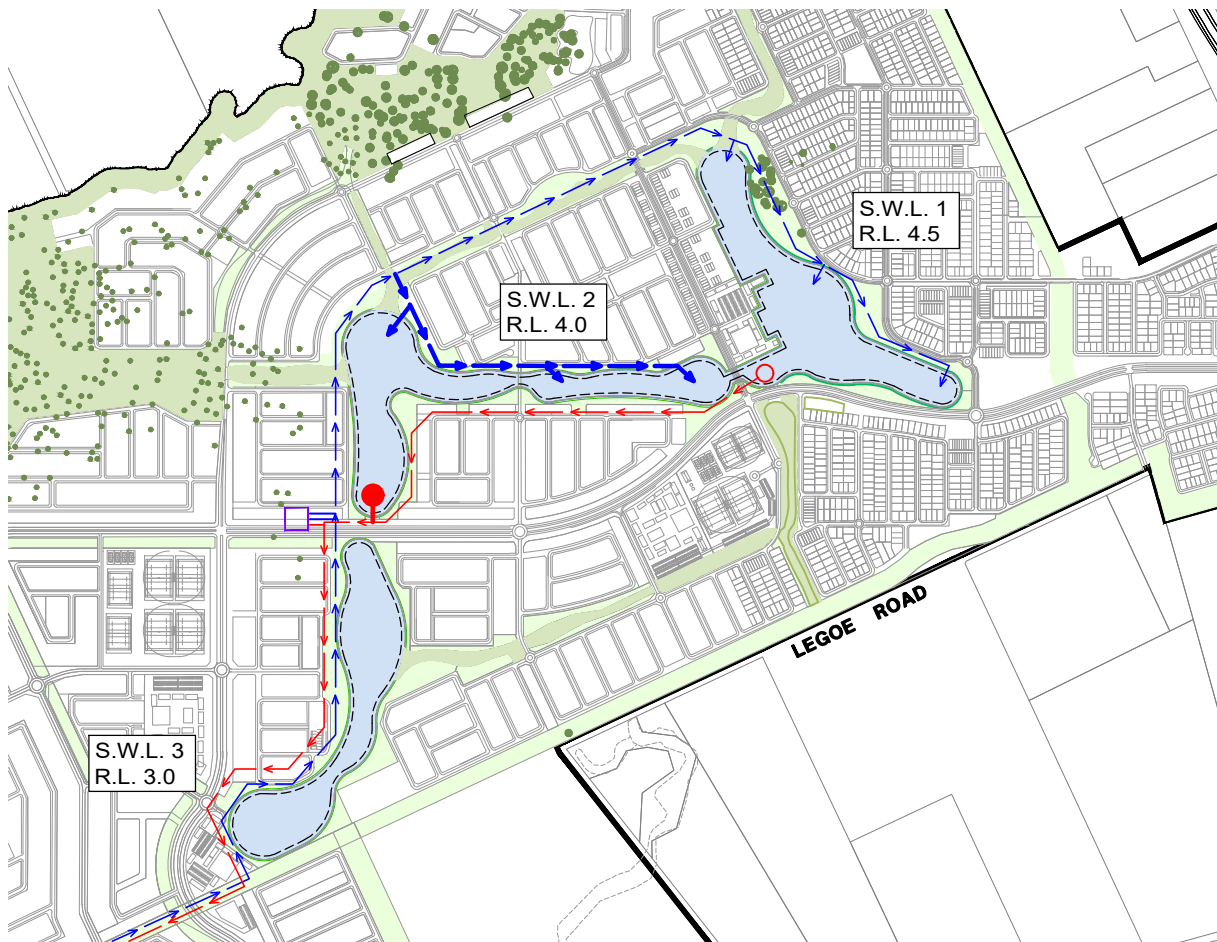
PROJECT:
GENERAL SITE EARTHWORKS PRE-DESIGN AND CONCEPTUAL

DRAWING TITLE:
CONCEPTUAL SALTWATER LAKES CIRCULATION SYSTEM PHASING PLANS

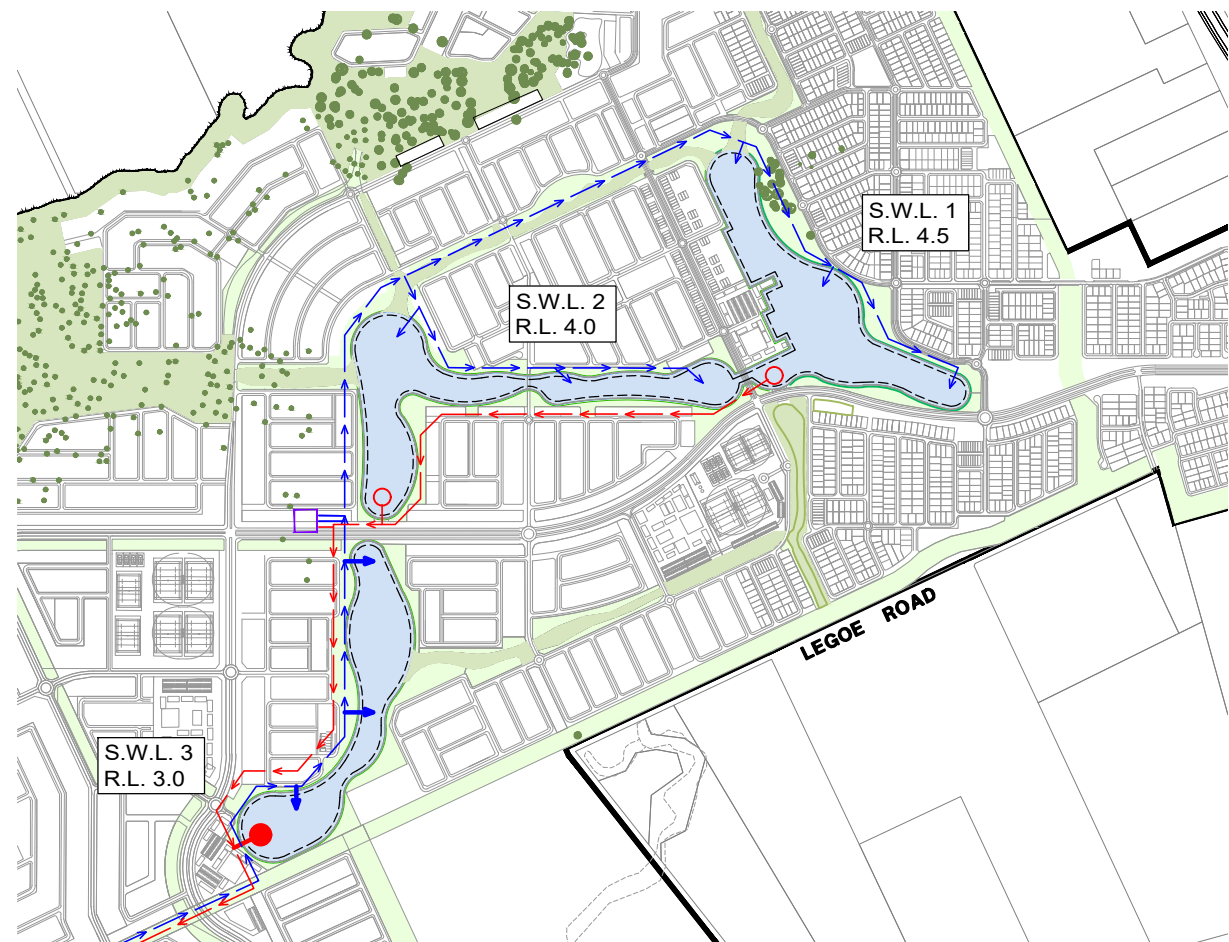
DEVEL. APPLIC. No. : -	DATE : 17-09-24
PROJECT LEADER : PAUL KELLY	
DESIGNER : NILL - DRAFTING ONLY	
DRAFTSPERSON : ADAM COOPER	
CHECKED :	
APPROVED FOR AND ON BEHALF OF BUCHILLS ENGINEERING SOLUTIONS	ABN 76 166 942 365
RPEQ No. :	
SCALE : AS NOTED	DATUM : AHD
PROJECT No. : BE170039	DRAWING No. : SK138
	VERSION : G



PHASE 1 - SWL 1 CIRCULATION



PHASE 2 - SWL 1 & 2 CIRCULATION



PHASE 3 - SWL 1, 2 & 3 CIRCULATION

NOTE:

- CONCEPTUAL SEAWATER CIRCULATION STRATEGY SHOWN ON THESE DRAWINGS ARE AS ADVISED BY MIKE WILLOUGHBY AND ARE INTENDED AS INDICATIVE ONLY AT THIS STAGE, SUBJECT TO DETAILED ASSESSMENT AND HYDRAULIC MODELLING.
- PHASING OF OUTLET LINES CONSTRUCTION IS ALSO SUBJECT TO DETAILED DESIGN AND ENVIRONMENTAL CONSIDERATIONS.

THIS DRAWING HAS BEEN PREPARED FOR PRELIMINARY PLANNING AND DISCUSSION PURPOSES ONLY, AND IS SUBJECT TO SURVEY, GEOTECHNICAL INVESTIGATION, AUTHORITY APPROVALS AND DETAILED DESIGN.

SCALE 100 0 100 200 300 400 500 (metres)
1 : 10000 (FULL SIZE)

RIVERLEA DEVELOPMENT

PROPOSED DEVELOPMENT AT BUCKLAND PARK SOUTH AUSTRALIA

A1 ORIGINAL SIZE BEFORE REDUCTION

VER.	DESCRIPTION	DATE
G	SWL CIRCULATION STRATEGY MODIFICATION	17-09-24
F	SWL CIRCULATION STRATEGY MODIFICATION	24-05-24
E	MASTER PLAN UPDATE / SWL LINES	20-09-23
D	SWL 1 R.L. AMENDED	24-02-23
C	SWL 3 INTAKE PIPE DIA AMENDED	13-10-22
B	CONCEPT MASTERPLAN UPDATED	01-08-22
A	ORIGINAL ISSUE	07-06-22

COPYRIGHT (C)
This drawing is copyright and the property of Burchills Engineering Solutions. It must not be retained, copied or used without the authority of Burchills Engineering Solutions.
DISCLAIMER
This drawing and its contents are electronically generated, are confidential and may only be used for the purpose for which they were intended.
Burchills Engineering Solutions will not accept responsibility for any consequences arising from the use of the drawing for other than its intended purpose or where the drawing has been altered, amended or changed either manually or electronically by any third party.
NOTE
This is an uncontrolled document issued for information purposes only, unless the checked sections are signed or completed. Figured dimensions take precedence over scale. Do not scale reduced size drawings. Verify dimensions prior to commencing any on-site or off-site works or fabrication.



Level 2, Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

PROJECT:
GENERAL SITE EARTHWORKS PRE-DESIGN AND CONCEPTUAL

DRAWING TITLE:
CONCEPTUAL SALTWATER LAKES CIRCULATION SYSTEM PHASING PLANS

DEVEL. APPLIC. No. : -	DATE : 17-09-24
PROJECT LEADER : PAUL KELLY	
DESIGNER : NILL - DRAFTING ONLY	
DRAFTSPERSON : ADAM COOPER	
CHECKED :	
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365	
RPEQ No. :	
SCALE : AS NOTED	DATUM : AHD
PROJECT No. : BE170039	DRAWING No. : SK138
	VERSION : G

RIVERLEA
DEVELOPMENT

PROPOSED
DEVELOPMENT
AT BUCKLAND PARK
SOUTH AUSTRALIA

A1 ORIGINAL SIZE BEFORE REDUCTION

A	ORIGINAL ISSUE	01-08-22
VER.	DESCRIPTION	DATE

COPYRIGHT (C)
This drawing is copyright and the property of Burchills Engineering Solutions. It must not be retained, copied or used without the authority of Burchills Engineering Solutions.

DISCLAIMER
This drawing and its contents are electronically generated, are confidential and may only be used for the purpose for which they were intended.
Burchills Engineering Solutions will not accept responsibility for any consequences arising from the use of the drawing for other than its intended purpose or where the drawing has been altered, amended or changed either manually or electronically by any third party.

NOTE
This is an uncontrolled document issued for information purposes only, unless the checked sections are signed or completed. Figured dimensions take precedence over scale. Do not scale reduced size drawings. Verify dimensions prior to commencing any on-site or off-site works or fabrication.



Level 2, Connaught Centre
26 Marine Parade, Southport QLD 4215
PO Box 3766, Australia Fair, Southport QLD 4215
Phone: +61 7 5509 6400
Fax: +61 7 5509 6411
Email: admin@burchills.com.au
Coote Burchills Engineering Pty Ltd
ABN 76 166 942 365

PROJECT:

GENERAL SITE EARTHWORKS
PRE-DESIGN AND
CONCEPTUAL

DRAWING TITLE:

SALT WATER LAKES OUTLET
PLAN

DEVEL. APPLIC. No.: - DATE: 10-08-22

PROJECT LEADER: PAUL KELLY

DESIGNER: ADAM COOPER

DRAFTSPERSON: ADAM COOPER

CHECKED:

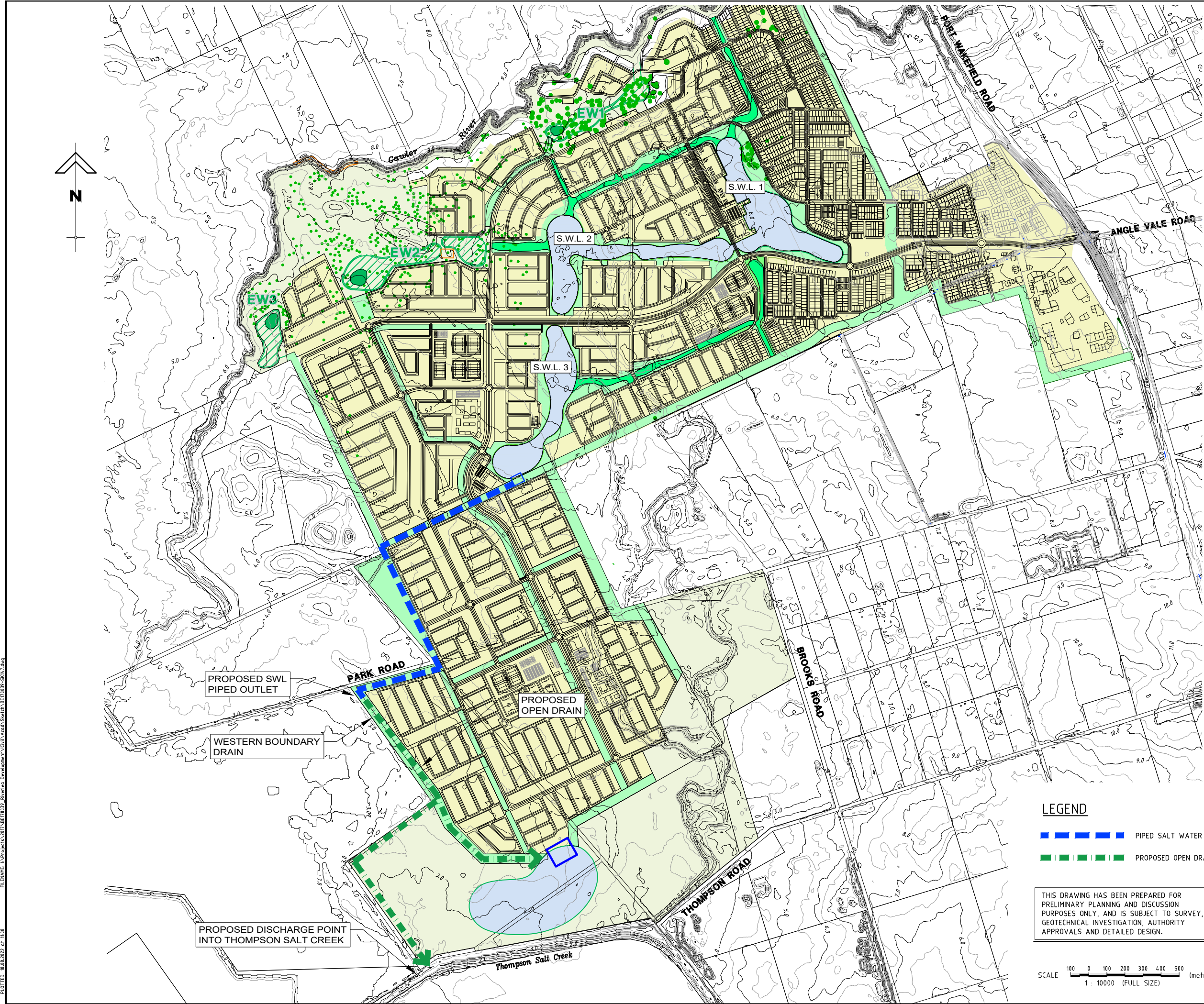
APPROVED FOR AND ON BEHALF OF
BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365

RPEQ No.:

SCALE: AS NOTED DATUM: AHD FULL SIZE: A1

PROJECT No.: DRAWING No.: VERSION:

BE170039 SK147 A



LEGEND

- PIPED SALT WATER LAKE OUTLET
- PROPOSED OPEN DRAIN

THIS DRAWING HAS BEEN PREPARED FOR
PRELIMINARY PLANNING AND DISCUSSION
PURPOSES ONLY, AND IS SUBJECT TO SURVEY,
GEOTECHNICAL INVESTIGATION, AUTHORITY
APPROVALS AND DETAILED DESIGN.

SCALE 100 0 100 200 300 400 500 (metres)
1 : 10000 (FULL SIZE)

OFFICIAL

Condition No.	Condition	Walker Comment	Walker Suggestion
1	The developer is to provide an updated Social Infrastructure Statement and associate Social Infrastructure Strategy, to the reasonable satisfaction of Council which addresses current report gaps.	Walker commits to providing a Social Impact Statement for Precinct 2 to the Council's satisfaction and a Community Development Framework for Riverlea. This matter is included in Walker's Statement of Commitments.	Condition Accepted
2	The developer shall enter into an agreement relating to the provision of affordable housing with the South Australian Housing Authority (SAHA).	The relevant Affordable Housing - Land Management Agreement/s (LMA) have been executed between Walker and SAHA (Delegate for the Minister). This matter is included in Walker's Statement of Commitments.	Condition Satisfied and ongoing
3	The developer to provide the current Community Development Framework document to Council.	The Council provided a Community Engagement Strategy (prepared by Stan Salagaras 2023). Walker upholds a live Community Business Plan discussed with the Council at monthly meetings .	Condition Satisfied
4	Prior to the approval of any stage abutting the proposed lake, engineering detail shall be provided to Council outlining additional design parameters and minimum clearance distances of road infrastructure to the lake edge.	This is a Detailed Engineering Design matter to be further considered as each Stage abutting the Lake progresses.	Suggest this Condition be Remove
5	Any Council infrastructure which is damaged or removed as part of the approved division shall be reinstated in full, at a standard, to the satisfaction of Council.	This is a standard requirement outside the realms of a Planning Consent.	Suggest this Condition be Remove - Include as a note possibly
6	The Applicant shall prepare a Lakes Management Plan (LMP) to Council's satisfaction and to be approved by Council prior to the commencement of any lakes construction. The Lakes Management Plan shall detail the following matters to Council's satisfaction: (a) Lake Owners Responsibilities i. Lake Ownership Summary ii. Permitted Lake Uses consistent with Secondary Contact standards iii. Prohibited Lake Uses iv. Land Adjacent to Lake (b) Infrastructure Operational Requirements i. Saltwater Exchange [Intake?] Pump Station ii. Revetment Walls iii. Sandstone Block Edge iv. Lake Safety Bench v. Inlet Weir Structures vi. Outlet Weir and Culvert Crossing Structures vii. Lake Outflow Channels viii. Lake Access Ramps ix. Lake flushing parameters following a major storm or flooding inclusive of impact on downstream infrastructure (c) Operational Requirements i. Water Quality Monitoring & performance parameters consistent with Secondary Contact standards ii. Lake Water Quality consistent with Secondary Contact standards iii. Discharge Water Quality iv. Lake Edge Design and Substrate v. Aquatic ecology of the proposed lake vi. Impacts to Matters of State Environment Significance vii. Saltwater Exchange Operational Requirements (d) Monitoring and Maintenance i. Maintenance of Lake structures including clay liner	This matter will be progressed with Council and form part of the "Operations and Maintenance Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i> .	Condition Accepted

OFFICIAL

7	<p>Included in the Lakes Management Plan (LMP) shall be a Lakes Operational Phase Management Plan (OPMP) to Council's satisfaction and to be approved by Council prior to the commencement of any lakes construction. The Lakes Operational Phase Management Plan shall detail the following matters to Council's satisfaction:</p> <ul style="list-style-type: none"> • Lake Water Quality Monitoring and Pump Station Control Systems Monitoring and infrastructure consistent with Secondary Contact standards • Pump Station Monitoring Provisions and Infrastructure • Salt Water Lake Quality, Salinity, Nutrient & Pollutant Loads Monitoring Provisions prescribed as "Performance Indicators" inclusive of minimum / maximum measures / parameters consistent with Secondary Contact standards and will include; <ul style="list-style-type: none"> o Dissolved Oxygen o Temperature o Salinity o pH o Turbidity o Total nitrogen o Total phosphorus o Suspended solids o Chlorophyll_A • Upstream Catchment Management • Lake Water Quality Performance - Operating Range Criteria • Lake Maintenance - Desilting and Dredging • Public Relationship Management • Public Safety - Lake Safety Signage & Lighting • Maintenance Period Provisions - Lake, Pump Station and Ancillary Equipment • Applicants Continued Monitoring of the Lakes Performance • Containment bund removal processes and clay liner overlap to prevent leakage. 	<p>This matter will be progressed with Council and form part of the "Operations and Maintenance Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i>.</p>	Condition Accepted
8	<p>The Lake water quality shall at all times achieve the performance indicators outlined within the Lakes Operational Phase Management Plan consistent with Secondary Contact standards unless otherwise agreed to by Council.</p>	<p>This matter will be progressed with Council and form part of the "Operations and Maintenance Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i></p>	Condition Accepted
9	<p>If the lake is not performing to the performance requirements further investigation and/or review to incorporate adequate changes to the existing maintenance performance issues are to be made to achieve the water quality performance. The applicant shall submit to Council for approval the proposed amendments to the operational procedures.</p>	<p>This matter will be progressed with Council and form part of the "Operations and Maintenance Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i>.</p>	Condition Accepted
10	<p>The applicant shall monitor and report to Council the results of any issues related to the build- up and/or collection of debris/gross pollutants upstream of inlets.</p>	<p>This matter will be progressed with Council and form part of the "Operations and Maintenance Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i>.</p>	Condition Accepted
11	<p>The lakes and associated stormwater system shall be designed and constructed to comply with the National Water Quality Management Strategy guidelines to ensure appropriate water quality targets are addressed.</p>	<p>This part of the Detailed Design will be progressed with Council and form part of the "Operations and Maintenance Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i>.</p>	Condition Accepted
12	<p>The developer is required to provide an on-going monitoring, review and the reporting of the Lake Performance / Maintenance requirements associated with maintaining the Lake water quality to the Performance Criteria. Undertake review that may be required upon the identification of performance - related issues, as confirmed by Council, during the establishment and maintenance period of the lake prior to Council's acceptance of the lake infrastructure. This is to include the provision to Council of technical reports prepared quarterly and submitted for approval by suitably qualified and experienced persons identifying the minimum testing regime until such time as Council deems this monitoring is no longer necessary, period not to exceed the agreed testing and monitoring period established between Council and the developer's representative.</p>	<p>This part of the Detailed Design will be progressed with Council and form part of the "Operations and Maintenance Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i>.</p>	Condition Accepted
13	<p>Soil testing shall be undertaken in areas identified with potential for Acid Sulphate Soils, prior to any construction occurring in these areas. The resultant reports and recommendations shall be complied with in the civil design at these locations, to the reasonable satisfaction of Council. In the event that Acid Sulphate Soils are encountered, appropriate management strategies including, but not limited to, may be required;</p> <ul style="list-style-type: none"> • lime neutralisation treatment and verification of excavated materials at various formulated rates; • remediation of previously disturbed ASS; and • monitoring of groundwater drawdown and quality through a network of groundwater monitoring wells during excavations. 	<p>This part of the Detailed Design will be progressed with the Council via a Construction Environmental Management Plan within the "Construction Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i>.</p>	Condition Accepted

OFFICIAL

14	Subsequent to completion & submission of the LMP and OPMP referenced in above conditions and approval by the relevant authority, the applicant shall facilitate a workshop relating to the operational and construction detail of the lake and lake edge with relevant Council stakeholders.	This matter will be progressed with Council and form part of the "Operations and Maintenance Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i> .	Condition Accepted
15	The Developer shall provide and make available to the public, quality information detailing the following: • Lake public access requirements in terms of the prescribed and limited public use consistent with Secondary Contact standards; • General public safety provisions; and • A basic explanation relating to the performance elements of the lake and its functionality including water quality objectives.	Noted	Condition Accepted
16	Typical cross sections be provided to show indicative alignment of intake and outfall lines with other services and clearance to ensure that appropriate land space is allocated for them. Cross sections to be provides prior to any construction detail of a stage containing or abutting the lake.	Walker (Brent) has provided typical cross sections to the Council to show indicative alignment of intake and outfall lines.	Condition Satisfied
17	The developer is to provide revised landscape detail of a single, hard - edge treatment of the lake circumference. Such detail to be reviewed and approved to the reasonable satisfaction of Council, prior to any construction approval being issued for the lakes.	This matter forms part of the Detailed Designwill be progressed with Council and form part of the "Design Mechanim" as outlined within the Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed.	Suggest Condition be Removed
18	Prior to the transfer of water source within those swales initially proposed for use with saltwater prior to stormwater, soil testing shall be undertaken and any required remediation prior to planting to ensure appropriate landscape conditions.	Noted	Condition Accepted
19	An amended Landscape Masterplan shall be provided to the reasonable satisfaction of Council to address matters resulting from the EIS review, as provided to the developer. This report shall be provided and endorsed by Council prior to the submission of construction documentation for any stage which would look to vest open space to Council.	Noted - This is expected June 2024	Condition Accepted
20	An updated Pedestrian and Cycling network plan shall be provided to the reasonable satisfaction of Council to address matters raised as a result of the EIS review and provided to the developer. This report shall be provided and endorsed by Council prior to the submission of construction documentation for any stage which would otherwise rely on the assumptions of the plan.	Noted - This is expected June 2024	Condition Accepted
21	Prior to construction commencing within the lakes a fencing plan shall be submitted for Council approval to determine any areas of reserve that would require fencing adjacent the lakes.	This matter will be progressed with Council and form part of the "Design Mechanim" as outlined within the <i>Riverlea Development Lakes and Lakes Infrastructure - Vesting Principles/Framework Deed</i> .	Suggest Condition be Removed
22	An arborist report, prepared by a suitably qualified arborist shall be prepared and submitted in support of any stage which proposes works in proximity to regulated and significant trees within the site. The recommendations of the report, inclusive of any construction methodology, shall be complied with at all times.	Tree damaging activity is already covered under the Provisions of the <i>Native Vegetation Act 1991</i> or the <i>Planning, Development and Infrastructure Act 2016</i> .	Suggest Condition be Removed
23	Landscaping design for any stage which contains public roadways adjacent areas of open space are to include construction cross-sections so that any slope batter can be accommodated outside of the landscape or conservation area.	This matter relates to Detailed Landscaping Design to be further considered as each Stage progresses to Detailed Engineering Design.	Suggest Condition be Removed
24	A detailed landscaping plan relating to the areas identified as woodland/conservation area shall be provided to Council prior to any construction detail being approved which contains or abuts this area.	This would be subject to further detailed design with any impact requiring further application/assessment under <i>Native Vegetation Act 1991</i> or the <i>Planning, Development and Infrastructure Act 2016</i> .	Suggest Condition be Removed
25	An updated flood report shall be provided to the reasonable satisfaction of Council to address matters raised as a result of the EIS review and provided to the developer. This report shall be provided and endorsed by Council prior to the submission of construction documentation for any stage which would otherwise rely on the assumptions of the report.	An update Stormwater and Floodwater Report (Technical Paper) has been provided by WGA and given to Council for review and approval (December 2023).	Condition Satisfied - Provided to Council
26	An updated SMP shall be provided to the reasonable satisfaction of Council to address matters raised as a result of the EIS review and provided to the developer. This report shall be provided and endorsed by Council prior to the submission of construction documentation for any stage which would otherwise rely on the assumptions of the SMP.	An update Stormwater Management Plan (SMP) has been finalised by WGA and was given to Council for their review and approval (January 2024).	Condition Satisfied - Provided to Council
27	An updated Bulk Earthworks plan in support of the updated SMP shall be provided to the reasonable satisfaction of Council to address matters raised as a result of the EIS review and provided to the developer. This plan shall be provided and endorsed by Council prior to the submission of construction documentation for any stage which would otherwise rely on the assumptions of the SMP and earthworks plan.	An update Stormwater Management Plan (SMP) has been finalised by WGA and was given to Council for their review and approval (January 2024).	Condition Satisfied - Provided to Council
28	The developer shall provide updated MUSIC modelling for the proposed stormwater system, to the reasonable satisfaction of Council.	An updated MUSIC Model for the Stormwater system (Technical Paper) has been provided by WGA in the SMP and given to Council for review and approval (January 2024). Repeated Condition.	Suggest Condition be Removed
29	Once the updated SMP document referred to in the above condition has been submitted to the relevant authority to its reasonable satisfaction in accordance with the conditions attached to this authorisation, the applicant shall attend a Stormwater Management study workshop conducted by the Council and relevant stakeholders from Planning & Land Use Services.	An updated SMP has be given to Council for review and approval. Walker is happy to attend a workshop arrangd by Council for this purpose.	Suggest Condition be Removed - Include as a possible note for the Council to organise workshop

OFFICIAL

30	An updated Traffic Impact Assessment shall be provided to the reasonable satisfaction of Council to address matters raised as a result of the EIS review and provided to the developer. This report shall be provided and endorsed by Council prior to the submission of construction documentation for any stage which would otherwise rely on the assumptions of the Impact Assessment.	The necessity for an updated Traffic Impact Assessment has been responded to the reasonable matters raised as a result of the EIS review.	Suggest Condition be Removed - Updated TIA for Precincts 1 & 2 already provided
31	Updated Parking Plan to be provided to Council's satisfaction to address issues raised in the EIS review and provided to the developer. This report shall be provided and endorsed by Council prior to the submission of construction documentation for any stage which contains or abuts the lakes.	Parking Plan to be progressed and updated by ETA	Condition Accepted
32	Appropriate traffic calming measures complying with relevant A/S to Council's reasonable satisfaction shall be incorporated into any civil design.	This is a Detailed Engineering Design matter - Also reflected as suggested Condition 51	Suggest Condition be Removed - a note maybe - Also reflected as suggested Condition 51
33	Swept paths demonstrating the largest service vehicles turning movements through any bend or intersection shall be provided as part of the civil design submission for any stage of the development, to the reasonable satisfaction of Council.	This is a Detailed Engineering Design matter - Also reflected as suggested Condition 51	Suggest Condition be Removed - a note maybe - Also reflected as suggested Condition 51
34	A Traffic Impact Assessment which provides consideration towards potential impacts to the surrounding road networks, and any remediation or upgrade shall be provided prior to construction commencing on the lakes.	The necessity for an updated Traffic Impact Assessment has been responded to the reasonable matters raised as a result of the EIS review and provided to Council (Feb 2024).	Suggest Condition be Removed - TIA for Precincts 1 & 2 already provided to Council.
35	A Gawler River Management and Landscape Masterplan shall be provided for the consideration and approval of Council which is able to demonstrate an appropriate conservation and design strategy to allow for future use of the land. This Masterplan shall be provided and endorsed by Council prior to the submission of construction documentation for any stage which has the benefit of frontage to the Gawler River. The applicant shall undertake works in general accord with this Masterplan, except where varied through the agreement of Council within detailed design.	Suggest rewording of the condition to remove - prior to the submission of construction documentation for any stage which has the benefit of frontage to the Gawler River.	Condition Accepted - Suggest rewording of the condition
36	The discharge of groundwater or surface water from the subject site must only occur when it meets relevant water Guidelines and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the ANZECC 2000) Guidelines.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - Also reflected as suggested Condition 45 & 55
37	The development is to comply at all times with the recommendations and conditions of the endorsed Cultural Heritage Management Plan for the development.	This matter is included in Walker's Statement of Commitments.	Condition Accepted
38	The development is to comply at all times with the recommendations and conditions of the EBS Ecology – Flora and Fauna Management Plan prepared in support of the development.	This matter is included in Walker's Statement of Commitments.	Condition Accepted
39	Detailed design including planting palettes, revegetation areas, species selection and earthworks is to be provided and approved by the relevant authority prior to commencement of any works within Native vegetation areas or identified conservation zones within the development so as to ensure broader biodiversity and community value.	Works constituting development or requiring approval from other authorities (i.e. the Native Vegetation Council) will require separate assessment and approval regardless of a condition.	Suggest this condition be Removed- a note possibly
40	Prior to construction commencing, a Soil Erosion and Drainage Management Plan (SEDMP) must be prepared in accordance with the EPA's Code of Practice for the Building and Construction Industry and submitted to the reasonable satisfaction of the Council. The SEDMP must be implemented during construction to prevent soil sediment and pollutants leaving the site or entering waters (including the stormwater system) during development of the site. The SEDMP must include elements such as: • The installation of a shaker pad at the entrance/exit to the development site • Avoiding unnecessary cut and fill and unnecessary clearing of vegetation • Protecting exposed soil through temporary vegetation, jute matting, hay bales or silt fences, fencing and containing of stockpiles	Noted	Condition Accepted - Suggest merging Conditions 40, 41 & 42 into one Condition.
41	The temporary erosion and sediment control measures shall be maintained and be functional until the end of the Maintenance Period for the works or earlier if Council's delegated officer considers they are no longer required.	Noted	Condition Accepted - Suggest merging Conditions 40, 41 & 42 into one Condition.
42	Gross pollutants shall be captured at or near the lake discharge location. The capture mechanism shall be non-return, to ensure gross pollutants captured by the trap cannot remobilise into the lake during higher tidal events. A trash rack at the lake discharge is not sufficient to satisfy this condition.	Noted	Condition Accepted - Suggest merging Conditions 40, 41 & 42 into one Condition.
43	Include mechanisms in the overall lake and stormwater design to minimise the potential for gross pollutants to enter the lake from the surrounding development and upstream catchments.	This matter will be covered elsewhere	Suggest this condition be Removed - This issue will be covered elsewhere i.e. Items 6 & 7
44	Upon the completion of all works associated with a relevant Stage of the development, all drainage infrastructure that is necessary to be installed on the land so as to ensure that all roads and allotments that are created within that Stage can be adequately drained, shall be constructed in accordance with the stormwater report, to the satisfaction of the Council.	Noted	Suggest this condition be Removed - This issue will be resolved with the Council at Practical Completion and upon a request for the Stage Clearance.
45	All roads and drainage infrastructure associated with the approved development shall be constructed in accordance with the Council's Land Division Requirements, the approved documentation, and shall be to the Council's satisfaction.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at Practical Completion
46	Subsequent to the commencement of interim stormwater management for Precinct 2, groundwater salinity and level monitoring works shall be undertaken by the developer. The results and accompanying report of these works shall be provided to Council together with any recommendations on the finding, to determine any potential impacts to road pavement and stormwater infrastructure due to groundwater levels.	Noted	Condition Accepted - Requires input from LBWco for groundwater salinity and level monitoring
47	No works shall commence on any landscaping or civil construction works until design documentation has been submitted and approved by Council.	This is a Detailed Design matter	Suggest this condition be Removed -
48	All landscaping, plantings and vegetation within the development shall be designed and constructed in accordance with the Council's Land Division Requirements and shall be to the Council's satisfaction.	This is a Detailed Design matter	Suggest this condition be Removed -
49	Appropriate scour protection shall be constructed to the reasonable satisfaction of Council at all stormwater discharge locations.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at Practical Completion

OFFICIAL

50	All bridges, culverts, underground drains and inlets reasonably necessary for any proposed road forming part of the development shall be constructed on the land, in accordance with recognised engineering practice and shall be to the Council's satisfaction.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at Practical Completion
51	All roads shall be designed in such a way so as to provide for the safe movement of all road users within the approved development, to the satisfaction of the Council.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at Detailed Design and Practical Completion
52	Road reserves must be paved and filled with materials following Council's Land Division Requirements, Aus Roads Standards, and such filling must be supervised and subsequently certified by a professional engineer, to the Council's satisfaction.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at Practical Completion
53	All paved footpaths and shared paths associated with the development shall be constructed in accordance with the Council's Land Division Requirements and shall be to the Council's satisfaction.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at Practical Completion
54	Adequate provision shall be made for the creation of appropriate easements and reserves for the purposes of drainage, electricity supply, water supply and sewerage services. Any drain which is located within the balance of the land is to be granted a drainage easement in favour of Council prior to any discharge to or use of the drain.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at land division Clearance
55	Any drain which is necessary for the safe and efficient drainage of the land and the disposal of stormwater and effluent from the land shall be provided and constructed on the land following recognised engineering practice to the satisfaction of the Council.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at Practical Completion
56	All necessary electrical services shall be installed on the land in accordance with recognised engineering practice, to the satisfaction of the Council.	Prescribed requirement—general land division (S. 102 (1)(c)(v) of the Act and Part 9 Division 6 of the Regulations)	Suggest this condition be Removed - This issue will be resolved with the Council at Practical Completion



Empirical
Traffic
Advisory

Riverlea - Precinct 2

Land Division Masterplan

Transport Impact Assessment
#eta1000045

DATE
30 September 2024

Document Information

Project Name	Riverlea - Precinct 2
Project Location	Land Division Masterplan
Type	Transport Impact Assessment
Version	1
Issue Date	30 September 2024
Client	Walker Buckland Park Developments Pty Ltd
Project Number	1000045
Filename	240930_1000045_riverlea_prec2_tia_1.docx

© Empirical Traffic Advisory 2023

The information contained in this document is confidential and intended solely for the use of the client for the purpose for which it has been prepared and no representation is made or is to be implied as being made to any third party. Use or copying of this document in whole or in part without the written permission of Empirical Traffic Advisory constitutes an infringement of copyright. The intellectual property contained in this document remains the property of Empirical Traffic Advisory.

Quality Record


Issue	Date	Description	Author	Checked	Approved	Signed
0	29 January 2024	Final	PSM	DK	PSM	PSM
1	30 September 2024	Updated for future precinct volume clarifications (refer 4.2.3) and updated Figure 5.1 Proposed Road Hierarchy. New table 6.7 added and 6.8 updated (former 6.7)	PSM	TJ	PSM	

Table of Contents

1	Introduction	1
1.1	Background	1
1.2	Purpose of this Report	1
1.3	References	1
2	Existing Conditions	2
3	Development Proposal	3
4	Traffic Assessment	4
4.1	Previous Assessment	4
4.2	Traffic Generation	4
4.3	Traffic Impact	12
5	Access	14
5.1	Employment Land	15
5.2	Road Cross Sections	15
5.3	T-junctions	20
5.4	Roundabouts	20
5.5	Cul-de-sacs & Laneways	21
5.6	Vehicle Speed Management	21
5.7	Intersection Sight Distance	21
5.8	Street Gradients for Vehicles	22
5.9	Parking	22
5.10	Public Transport	23
5.11	Heavy Vehicles	23
5.12	Bicycle Access	24
6	Intersections	25
6.1	Intersection 3 Assessment	25
6.2	Intersection 4 Assessment	26
6.3	Intersection 5 Assessment	28
6.4	Intersection 5A Assessment	30
6.5	Intersection 5B Assessment	31
6.6	Intersection 6 Assessment	32
6.7	Intersection Summary	34
6.8	Intersection Upgrade Timing	35
7	Conclusions	37
Appendix A	Intersection 3 SIDRA Summary	A-1
Appendix B	Intersection 4 SIDRA Summary	B-1
Appendix C	Intersection 5 SIDRA Summary	C-1
Appendix D	Intersection 5a SIDRA Summary	D-1
Appendix E	Intersection 5b SIDRA Summary	E-1
Appendix F	Intersection 6 SIDRA Summary	F-1
Appendix G	Concept Plans and Turn Path Diagrams	G-1

Figures

Figure 2.1:	Site and Surrounding Environs	2
Figure 3.1:	Precinct 2 Layout	3
Figure 4.1:	Predicted Daily Traffic Volumes	7
Figure 4.2:	Predicted Peak Hour Traffic Volumes	8
Figure 4.3:	Predicted Daily Traffic Volumes With Future Volumes	10
Figure 4.4:	Predicted Peak Hour Traffic Volumes With Future Volumes	11
Figure 4.5:	Location of Key Intersections	12
Figure 5.1:	Proposed Road Hierarchy	14
Figure 5.2:	Cross Section – Distributor Road	15
Figure 5.3:	Cross Section - Neighbourhood Centre Road	16
Figure 5.4:	Cross Section – Collector Road A	16
Figure 5.5:	Cross Section – Collector Road B	17
Figure 5.6:	Cross Section – Collector Road C	17
Figure 5.7:	Cross Section – Collector Road D	18
Figure 5.8:	Local Esplanade Roads (with indented parking)	18
Figure 5.9:	Local Esplanade Roads (on-street parking)	19
Figure 5.10:	Local Streets	19
Figure 5.11:	Laneways	20
Figure 5.12:	Proposed Bus Routes in Precinct 2	23
Figure 5.13:	Proposed Bicycle Routes (extract from Landscape Masterplan)	24
Figure 6.1:	Intersection 3 – Precinct 2 AM & PM Peak Hour Turning Volumes	25
Figure 6.2:	Intersection 4 – Precinct 2 AM & PM Peak Hour Turning Volumes	26
Figure 6.3:	Intersection 4 – AM & PM Ultimate Peak Hour Turning Volumes	26
Figure 6.4:	Intersection 5 – Precinct 2 AM & PM Peak Hour Turning Volumes	28
Figure 6.5:	Intersection 5 – AM & PM Ultimate Peak Hour Turning Volumes	28
Figure 6.6:	Intersection 5A - PM Peak Hour Turning Movement Volumes	30
Figure 6.7:	Intersection 5B - PM Peak Hour Turning Movement Volumes	31
Figure 6.8:	Intersection 6 – Precinct 2 AM & PM Peak Hour Turning Volumes	32
Figure 6.9:	Intersection 6 – AM & PM Ultimate Peak Hour Turning Volumes	32
Figure 6.10:	Intersections – Initial Layout	34
Figure 6.11:	Intersections – Ultimate Layout	34

Tables

Table 4.1:	Traffic Generation for Precinct 2	5
Table 4.2:	Precinct 1 Stages adjacent Precinct 2	6
Table 4.3:	Ultimate Riverlea Development Additional Traffic	9
Table 4.4:	Summary of intersections on Riverlea Boulevard	13
Table 6.1:	Intersection 3 – SIDRA Summary	25
Table 6.2:	Intersection 4 – SIDRA Summary	27
Table 6.3:	Intersection 5 – SIDRA Summary	29
Table 6.4:	Intersection 5a – SIDRA Summary	30
Table 6.5:	Intersection 5b – SIDRA Summary	31
Table 6.6:	Intersection 6 – SIDRA Summary	33
Table 6.7:	Intersection Distance and 95th%ile Queue Comparison	35
Table 6.8:	Intersection Upgrade Timing	36

1 INTRODUCTION

1.1 Background

Riverlea is a major development which will form a new township in the northern area of greater Adelaide. The township will provide approximately 12,000 dwellings, a district centre, neighbourhood centres, educational facilities, mixed use precincts and recreation precincts to cater for 33,000 residents. The development will be undertaken over 20 years.

Key to the development is the street and road network which will provide access for the daily services and needs of the community. A master plan has been prepared for the whole township, however revisions are proposed to Precincts 1 and 2 to commence creation of the township.

Precinct 2 was included in the masterplan, however it is proposed to revise the layout to integrate better with Precinct 1, which has provided the initial neighbourhood centre, key road network to Port Wakefield Highway and associated residential development.

1.2 Purpose of this Report

This report sets out an assessment of the anticipated traffic and transport implications of the proposed development in Precinct 2, including consideration of the:

- existing and estimated traffic conditions surrounding the site;
- traffic generation characteristics of the proposed development;
- proposed access arrangements for the site;
- overview of the layout based on the master plan for Precinct 2;
- transport impact of the development proposal on the surrounding township road network.

1.3 References

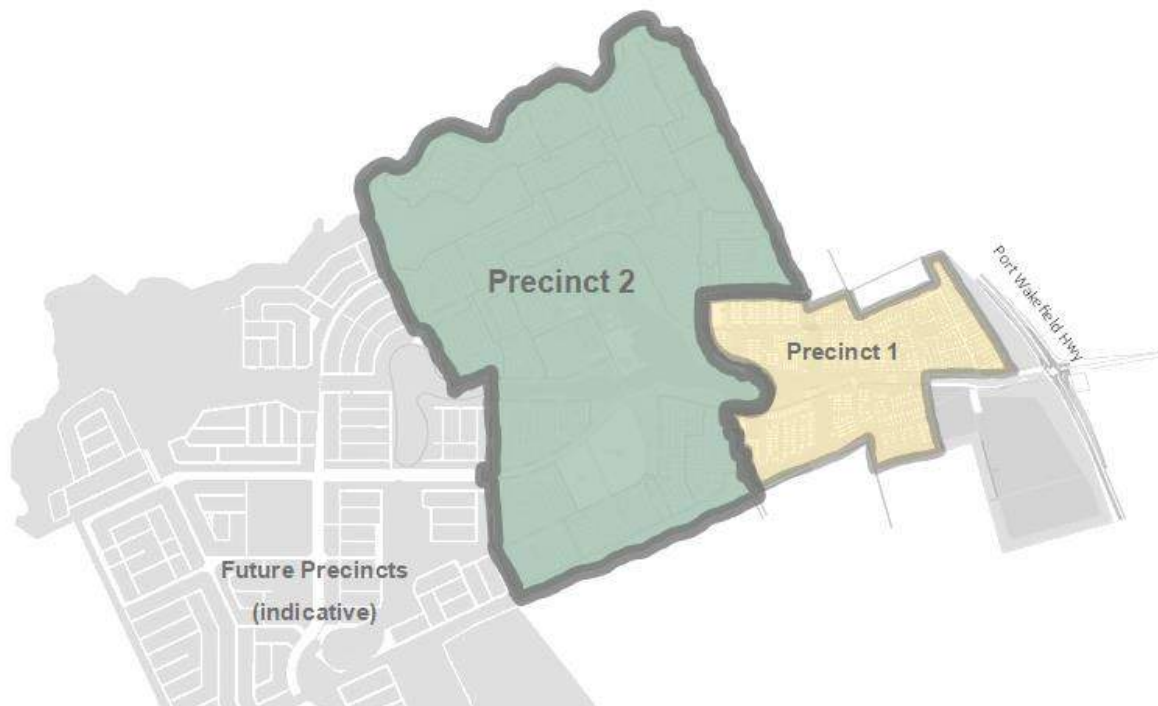
In preparing this report, reference has been made to a number of background documents, including:

- Masterplan for the proposed development provided by Walker Corp (dated 4th June 2013)
- Precinct 2 masterplan provided by Walker Corp (August 2022)
- '*Buckland Park Traffic Impact Assessment*' Parsons Brinckerhoff Australia Pty Ltd, 1 April 2009
- Riverlea Precinct 2 Traffic Assessment, GTA Consultants, 2015
- various technical data as referenced in this report
- other documents as nominated.

2 EXISTING CONDITIONS

The subject site is located within the Riverlea development, which is located adjacent Port Wakefield Highway opposite Angle Vale Road. The location of the site can be seen in Figure 2.1.

Figure 2.1: Site and Surrounding Environs



(Basemap courtesy of Walker Corp)

3 DEVELOPMENT PROPOSAL

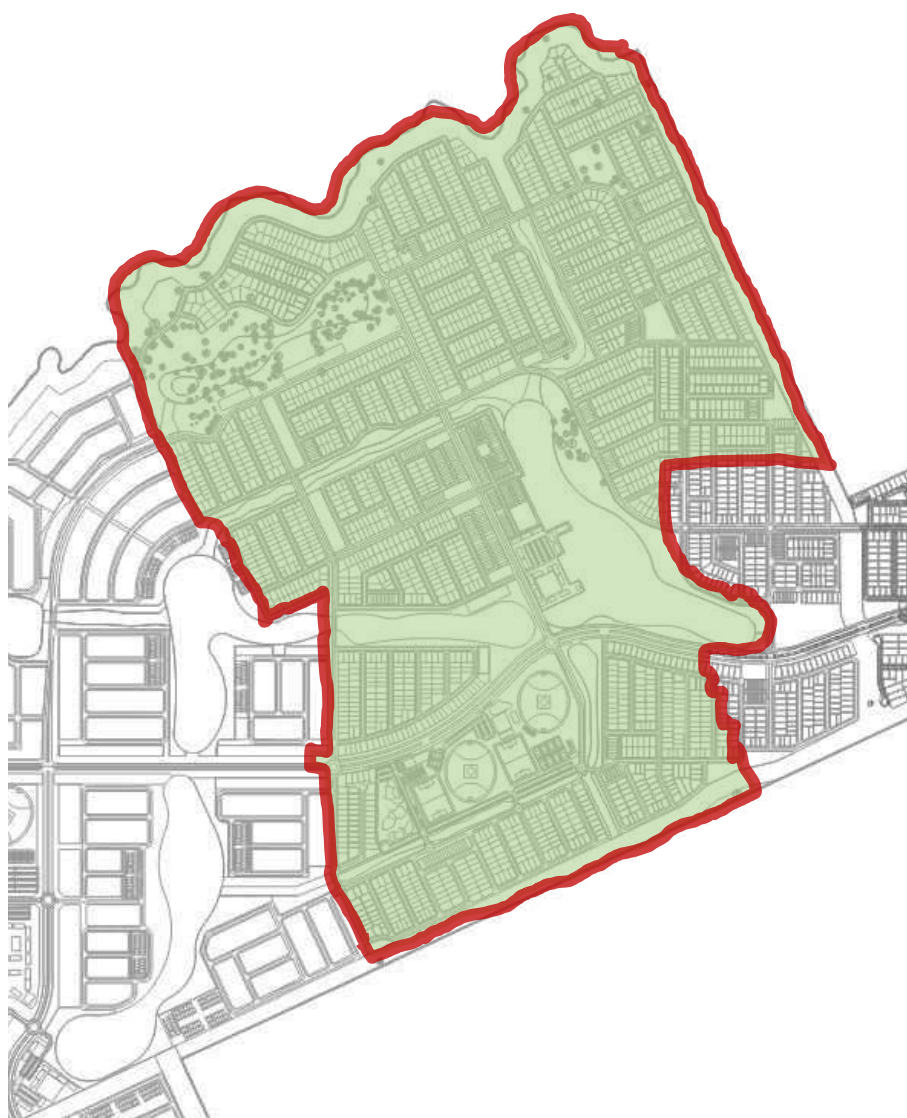
The revised Precinct 2 development is proposed to comprise approximately 3,100 low and medium density dwellings. A neighbourhood centre, school and sports facility will be included within the site.

Vehicle access to Precinct 2 will be from Riverlea Boulevard which has been constructed thorough Precinct 1 to Port Wakefield Highway. The proposed road network will connect to Riverlea Boulevard with various types of intersections to manage the anticipated traffic demands.

The revised precinct road network will comprise distributor, collector and local access roads, and some laneways.

The proposed site layout can be seen in Figure 3.1

Figure 3.1: Precinct 2 Layout



4 TRAFFIC ASSESSMENT

4.1 Previous Assessment

The traffic assessment for the previously approved Riverlea township was undertaken by Parsons Brinkerhoff (2013). The assessment was undertaken on the site master plan and did not consider individual precincts. However, the traffic assessment did include traffic generation of the master plan at 5-year intervals based on the anticipated dwelling occupancy.

Precinct 1 has since commenced with traffic management constructed on Riverlea Boulevard including traffic signals for Port Wakefield Highway/Angle Vale Road intersection upgrade, and a roundabout at the Guilding Terrace/Riverlea Boulevard intersection.

4.2 Traffic Generation

4.2.1 Design Rates

Based on experience with other land divisions in greater Adelaide, a traffic generation rate of 8 trips per dwelling per day, and 0.85 trips per dwelling per hour (peak hour) as an average across all dwellings provides a robust method of traffic demand estimation. It is noted that in the City of Playford, 76.4% of people travelled to work in a private car, 3.3% took public transport and 1.2% rode a bike or walked. 5.4% worked at home (extract from census 2021 data). Hence car use in the City of Playford is higher than the greater Adelaide average.

As such, this rate has been applied for this assessment which is based on traffic generation of each stage in the precinct and distribution across the road network in Precinct 2 and connecting to Precinct 1.

It has been assumed the neighbourhood centre will attract traffic from the residents within Riverlea with negligible passing trade from along Port Wakefield Highway. Estimates of peak hour and daily traffic volumes are set out in Table 4.1.

Precinct 2 will provide approximately 3,100 dwellings (low and medium density) which will result in approximately 25,000 trips per day and approximately 2,600 trips per hour during the peak hours.

It should be noted that some Precinct 1 stages are included in this assessment as they will contribute to the road network at key intersections assessed in this report. This includes 157 dwellings in Stages 4 and 5 which are part of Precinct 1. These are shown in Table 4.2.

The Precinct 1 stages will add 1,256 trips per day and 133 trips per hour to the road network as part of this analysis.

It is noted that whilst the base traffic generation rate has been updated, the traffic generation is consistent with the Traffic Impact Assessment for Buckland Park (2009), and the 2015 Precinct 2 assessment by GTA Consultants, with regards to the anticipated traffic demands of the precinct.

Rates provided within the RTA Guide suggest the neighbourhood centre of approximately 5,500 sq.m total floor area will typically attract 6,750 vehicle trips per day (weekday). The proposed school is likely to have an attendance of up to 1,000 students. Traffic generation rates for schools by Transport for New South Wales (*Roads and Maritime Services Trip Generation Surveys, Schools Analysis Report, Issue*

A, 2014) indicates a trip generation of 1.34 trips per student per day. Application of this rate suggests the proposed school is likely to attract 1,340 trips per day.

As previously mentioned, the traffic associated with the proposed school and neighbourhood centre are anticipated to be associated with Precinct 2 and not “passing trade” from along Port Wakefield Highway. Hence it can be assumed that approximately 30% of all traffic generated by Precinct 2 will be internal to the Precinct 2 site.

Table 4.1: Traffic Generation for Precinct 2

Stage	Detached	Apartments	Total Dwellings	Daily Trips	Peak Hour Trips
8	91		91	728	77
10	90		90	720	77
11	121		121	968	103
12	122		122	976	104
14	188		188	1504	160
15	112		112	896	95
16	99		99	792	84
17	99	175	274	2192	233
18	92		92	736	78
19	86		86	688	73
20	94		94	752	80
21	121		121	968	103
22A	115		115	920	98
22	110	105	215	1720	183
23	107	35	142	1136	121
24	87		87	696	74
25	111		111	888	94
26	94		94	752	80
27	143		143	1144	122
36	152	35	187	1496	159
37	43		43	344	37
38	101		101	808	86
39	135		135	1080	115
40	105		105	840	89
41	108		108	864	92
TOTAL			3076	24608	2617

Table 4.2: Precinct 1 Stages adjacent Precinct 2

Stage	Detached	Apartments	Total Dwellings	Daily Trips	Peak Hour Trips
4	126		126	1008	107
5	217		217	1736	184
TOTAL			343	2744	291

4.2.2 Distribution and Assignment

The directional distribution and assignment of traffic generated by the proposed development will be influenced by a number of factors, including the:

- configuration of the distributor road network in the immediate vicinity of the site;
- existing operation of intersections providing access between the local, collector and distributor road network;
- surrounding employment centres, retail centres and schools in relation to the site;
- configuration of access points to the site.

Having consideration to the above, it has assumed that 30% of all trips generated will be internal and the remaining 70% will be external to the Riverlea site (that is to and from Port Wakefield Highway and Angle Vale Road).

Based on the above, Figure 4.1 and Figure 4.2 indicate the predicted traffic volumes for daily and peak hour periods expected on the road network around Riverlea Boulevard. These volumes have been developed to assist in assessing the proposed intersections for appropriate layouts.

Figure 4.1: Predicted Daily Traffic Volumes



Figure 4.2: Predicted Peak Hour Traffic Volumes



In addition, the directional splits of traffic (i.e. the ratio between the inbound and outbound traffic movements) in the AM and PM peak periods are 90:10 (90% outbound 10% inbound) and 10:90 (10% outbound and 90% inbound) respectively for the external trips.

These AM directional splits have been assumed based on the majority of residential traffic likely to be leaving while the PM directional splits have been assumed based on some residents leaving for other activities external to the development site while the inbound traffic is generally residents returning from work.

The internal trip directional splits are assumed to be 50:50 during both peak periods. This internal traffic is likely to be more even with AM directional splits likely to be associated with student drop off and PM directional split likely to be a result of customers at the neighbourhood centre.

The traffic volumes are consistent with the Traffic Impact Assessment (2015) for the traffic demands for Precinct 2 on the distributor road network in Riverlea.

4.2.3 Future Traffic Demands – Ultimate Scenario

As the Riverlea development progresses to the west, there will be additional traffic demands on Riverlea Boulevard. The anticipated traffic volumes will be dependant on the future land uses to the west including additional neighbourhood centres, schools, and employment areas that define an areas level of self-sufficiency (that is ability to remain within that area for daily needs) and reduce external trips. As Riverlea develops further west, the level of self-sufficiency is expected to increase and reduce rate of growth of traffic on Riverlea Boulevard.

For the purposes of this assessment, the same anticipated traffic demands from the west as applied in the 2015 assessment will be used. These were based on the traffic volumes for the ultimate Riverlea site as determined by ‘*Buckland Park Traffic Impact Assessment*’ (Parsons Brinckerhoff Australia Pty Ltd, 1 April 2009). This will provide consistency across assessments.

The additional traffic generation for the analysis from additional development to the west is expressed as additional trips per hour on Riverlea Boulevard for eastbound and westbound flows. These will be added to the Precinct 2 generated Riverlea Boulevard traffic volumes to identify future traffic volumes. These are shown below in Table 4.3.

Table 4.3: Ultimate Riverlea Development Additional Traffic

Riverlea Boulevard Direction Flow	Peak - Trips per hour	
	AM	PM
Eastbound	+1,248	+534
Westbound	+345	+1,156
<u>Total</u>	<u>+1,593</u>	<u>+1,690</u>

*Note: Additional traffic volumes determined by ‘*Buckland Park Traffic Impact Assessment*’ (Parsons Brinckerhoff Australia Pty Ltd, 1 April 2009) as used in the previous Precinct 2 assessment dated 2015

The peak hour volumes would translate to approximately 1,870 to 1,990 additional dwellings from future precincts of the development to the west. Based on current forecast yields of Precinct 3, these additional volumes would account for approximately 60% of future Precinct 3 dwellings.

Utilising the above number of future dwellings, Figure 4.3 and Figure 4.4 indicate the predicted traffic volumes for daily and peak hour periods expected on the road network around Riverlea Boulevard incorporating approximately 60% of Precinct 3.

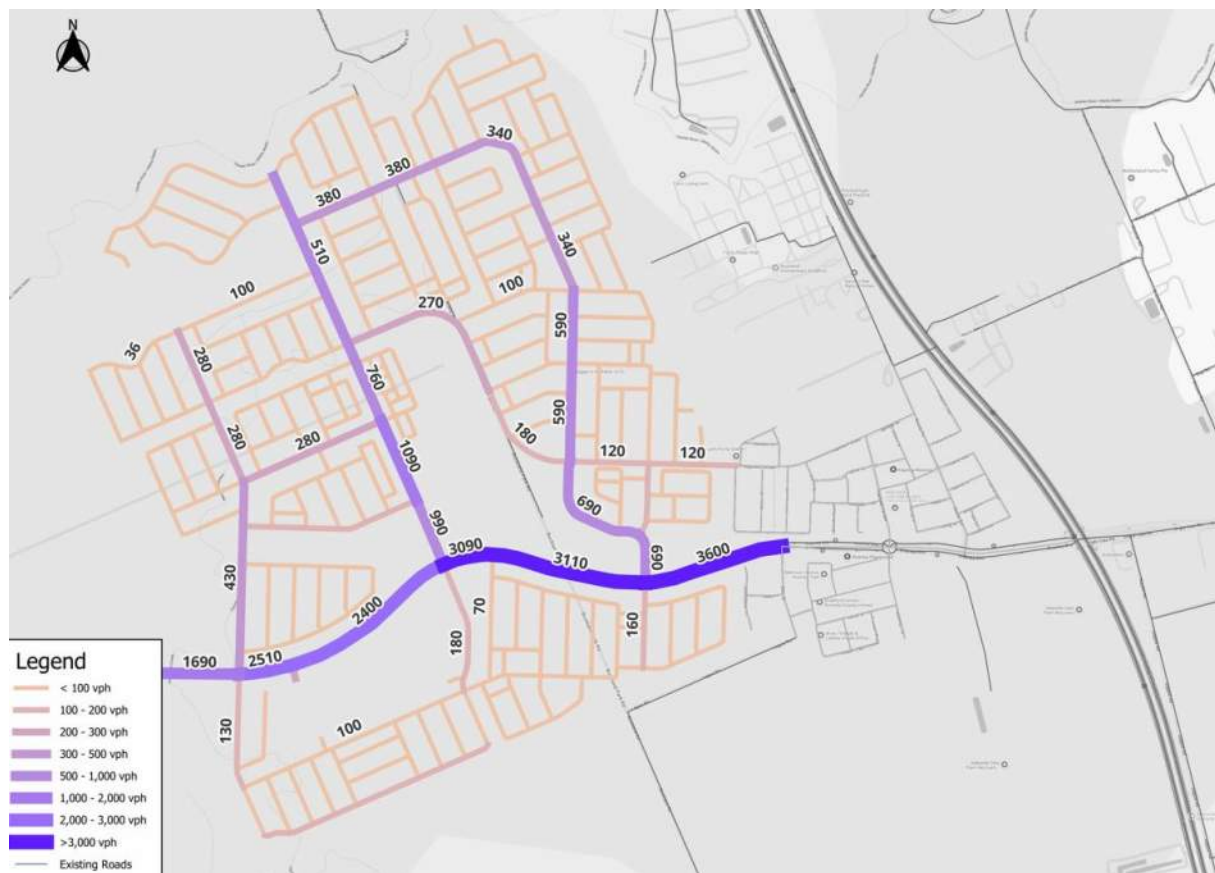
It should be noted that the modelling assumes all traffic from Precinct 3 will use Riverlea Boulevard as a worst-case scenario of the intersection modelling. This assumption is also premised on the modelling which indicates that downstream intersections will begin to reach capacity with the ultimate traffic volumes. Hence, it would be more efficient for drivers to enter at the western end of Riverlea Boulevard (in Precinct 3) compared to other parts of the road network in order to minimise delays compared to attempting to join Riverlea Boulevard at other intersections in Precinct 2 to the east.

Whilst some traffic could be expected to use the collector road network in the northern part of Precinct 2, it is expected that these volumes would remain low and within collector road volumes (i.e. less than 3,000 vehicles per day).

Figure 4.3: Predicted Daily Traffic Volumes With Future Volumes



Figure 4.4: Predicted Peak Hour Traffic Volumes With Future Volumes



As development occurs to the west, it would be expected that traffic assessments will be revised for each intersection on Riverlea Boulevard, as well as monitoring of traffic volumes to ascertain operating conditions actually occurring.

4.3 Traffic Impact

The impact of Precinct 2 traffic on the road network intersections is considered in this section with up to three intersection layout considered as follows:

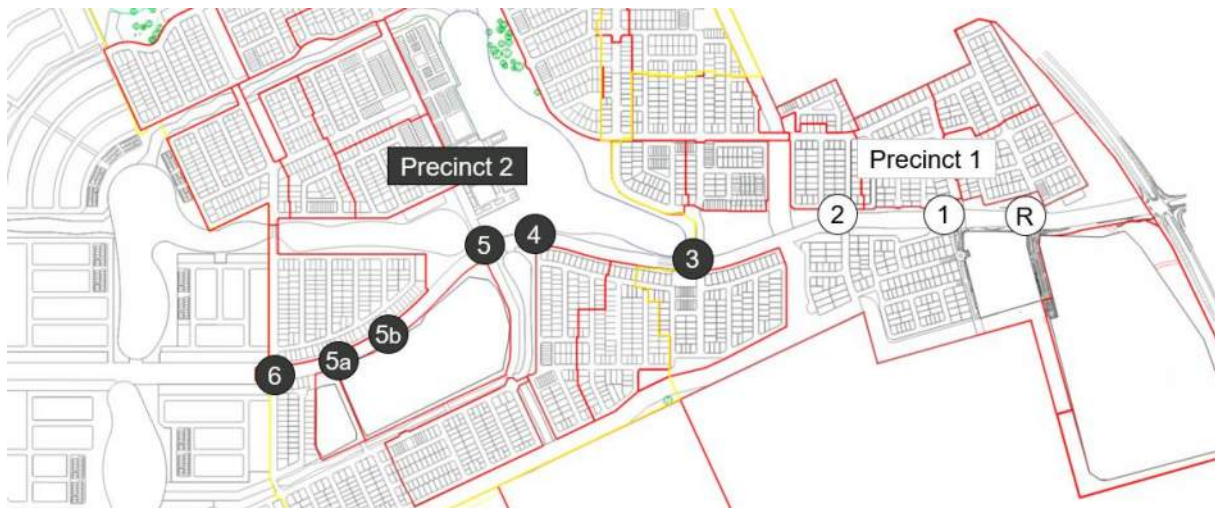
Initial The initial intersection layout proposed for the precinct.

Interim Where applicable, minor upgrades that could be undertaken to maintain the life of the initial intersection.

Ultimate The ultimate layout of the intersection when considering ultimate traffic volumes on Riverlea Boulevard

The impact of the development traffic has been assessed using SIDRA Intersection at key intersections throughout Precinct 2. The key intersection locations are shown in Figure 4.5.

Figure 4.5: Location of Key Intersections



The previous assessment undertaken by GTA Consultants in 2015 included assessment of all intersections from Port Wakefield Highway to Precinct 2.

Given Precinct 1 has commenced with construction of some intersections, this assessment will only consider the intersections within Precinct 2.

A summary of the intersections from previous assessments and new intersections are shown in Table 4.4.

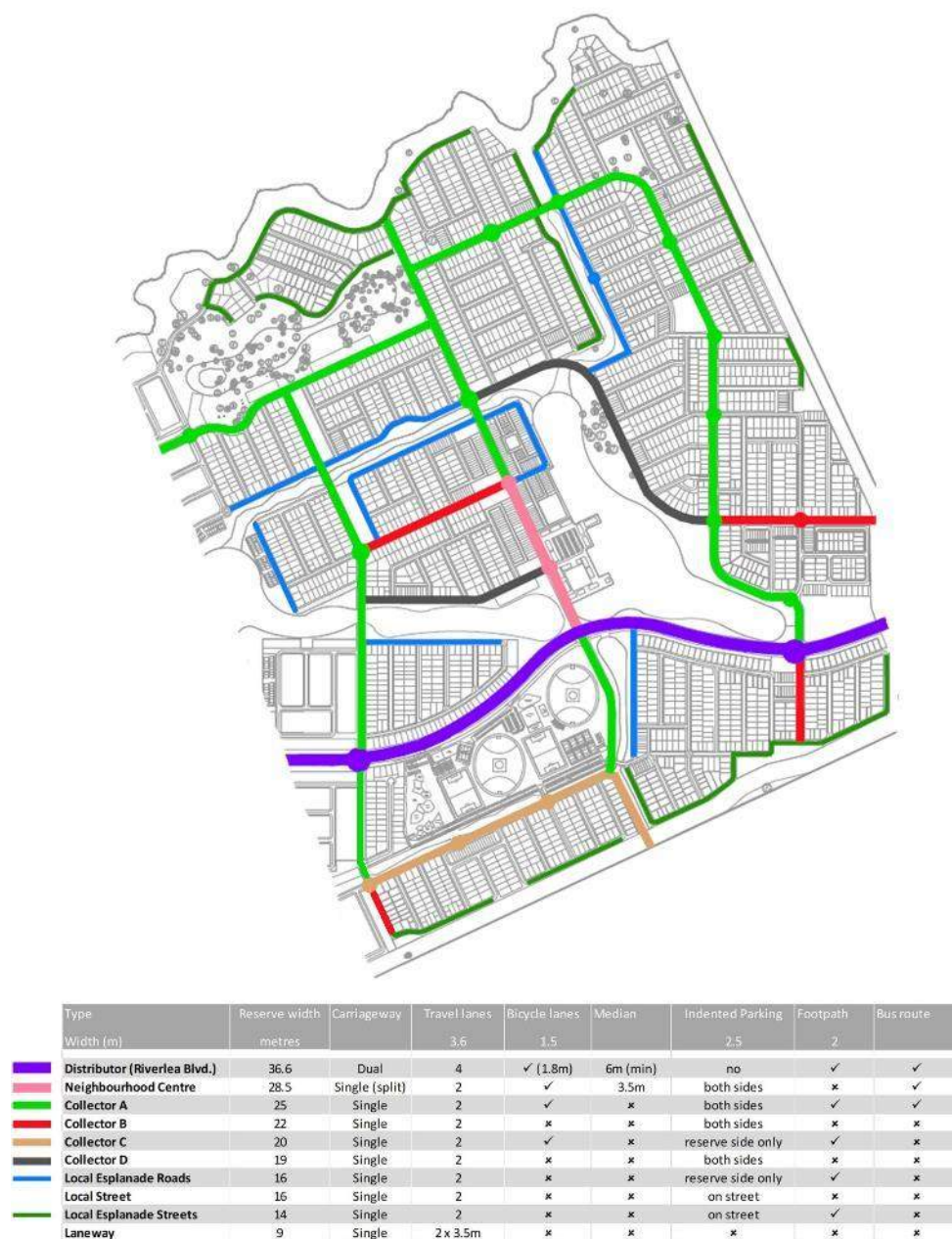
Table 4.4: Summary of intersections on Riverlea Boulevard

Intersection	Description
Precinct 1 intersections: Not part of this assessment	P Port Wakefield Road/Riverlea Boulevard/Angle Vale Road Intersection: Constructed with Precinct 1 as signalised 4-way intersection. Preliminary analysis of this intersection has indicated it is capable of accommodating up to 4,500 dwellings prior which would cater for Precinct 1 and 2 traffic demands. The growth of proposed District Centre may impact this intersection and should be revised as part of planning for District Centre. Future precincts 3 and 4 impacts on this intersection will need to be considered in conjunction with a secondary access to the development area from the south. The PB Report (2009) indicated that the initial Riverlea Boulevard intersection at Port Wakefield Highway will continue to operate satisfactorily for 11 years of development which would equate to approximately 4,740 allotments created and approximately 3,500 dwellings occupied. This accords with the preliminary analysis of the intersection.
	R Reedy Road intersection. Currently T-junction with Reedy Road to north. Future upgrade as part of recently approved neighbourhood centre with left-turn access to south side of Riverlea Boulevard. Further consideration of the intersection upgrade required for future District Centre proposed to south of Riverlea Boulevard. No further review as part of this report.
	1 Guilding Terrace intersection with Riverlea Boulevard has been constructed as a 2-lane roundabout. This intersection will operate satisfactorily with capacity beyond Precinct 2. No further review as part of this report.
	2 Proposed T-junction for residential access. No change to configuration from previous.
Precinct 2	3 Proposed 4-way intersection with 2-lane roundabout.
	4 Proposed T-junction for residential access. No change to configuration from previous.
	5 Proposed 4-way intersection in Precinct 2 – Provides access to Neighbourhood Centre and School/Sports Grounds.
	5a Unsignalised intersection on Riverlea Boulevard for access to school site
	5b Pedestrian Actuated Crossing on Riverlea Boulevard adjacent school site
	6 Proposed T-junction for residential access. End of Precinct 2.

5 ACCESS

The layout of the street network for the proposed development is based on a modified grid layout, with local streets connecting to a number of key collector streets and then to the distributor road. A modified grid can provide advantages to a residential area in managing traffic to low volumes on each street, limiting the ability for rat-running through the area, managing the speed environment and providing convenient access for walking, cycling and public transport through the area. The proposed road configuration is shown in Figure 5.1 which indicates the road hierarchy and traffic management.

Figure 5.1: Proposed Road Hierarchy



5.1 Employment Land

It is understood that future employment lands have been identified to the south of Precinct 2 which will connect to this precinct via the road at Intersection 5. The Employment Land will be approximately 46 hectares in size and provide light industrial and business park uses when developed. It is noted that this area will be developed separately to the residential development once a demand has been developed for its use. No layout or specification for the land uses has been identified for analysis in this report, however the road to Intersection 5 will be capable of supporting access for the site.

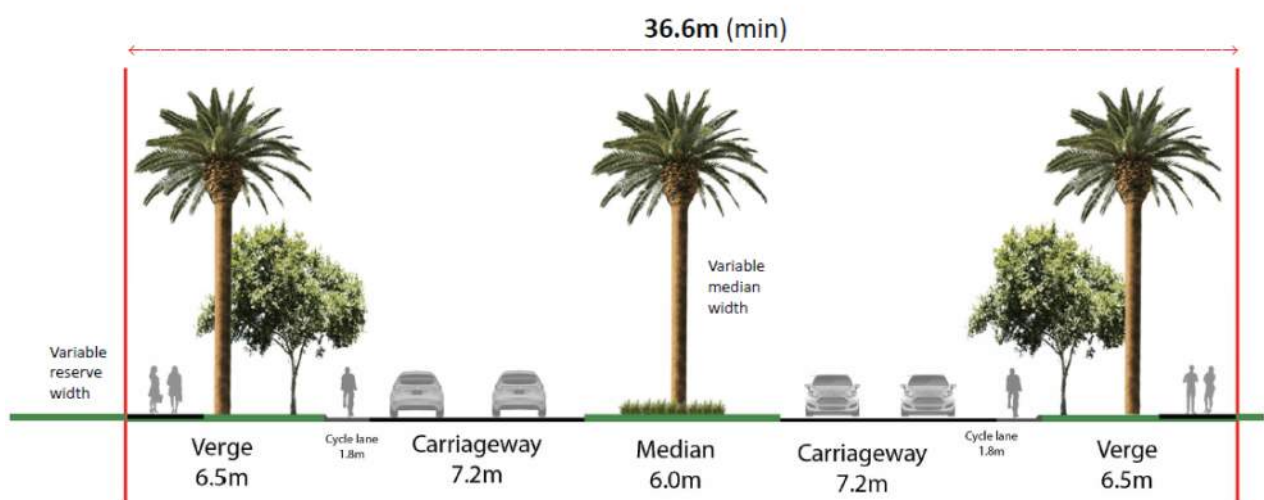
Given the size of the Employment Land site it is appropriate to assume access will be available from Riverlea Boulevard via Intersection 5, and also from Carmelo Road at the southern end of the site. It is assumed that heavy vehicle movements (such as articulated vehicles) would generally access the site from the Carmelo Road access frontage rather than use the Riverlea Boulevard route. Hence the proposed road reserve and cross section for this connection is considered appropriate with Collector A and C cross sections proposed. This would be suitable for access to the employment lands for light vehicles and small heavy vehicles.

The traffic impact of the development of the Employment Lands would be undertaken with any master planning or development applications for the site. This would include analysis of the impact on Riverlea Boulevard and Intersection 5 (and access road) where required.

5.2 Road Cross Sections

The proposed development will comprise roads of varying widths suited to the function of streets within the network. These align with the proposed street hierarchy as shown in Figure 5.1 previously in this report. Cross sections have been developed in conjunction with the Landscape Plan and are shown in the following figures.

Figure 5.2: Cross Section – Distributor Road



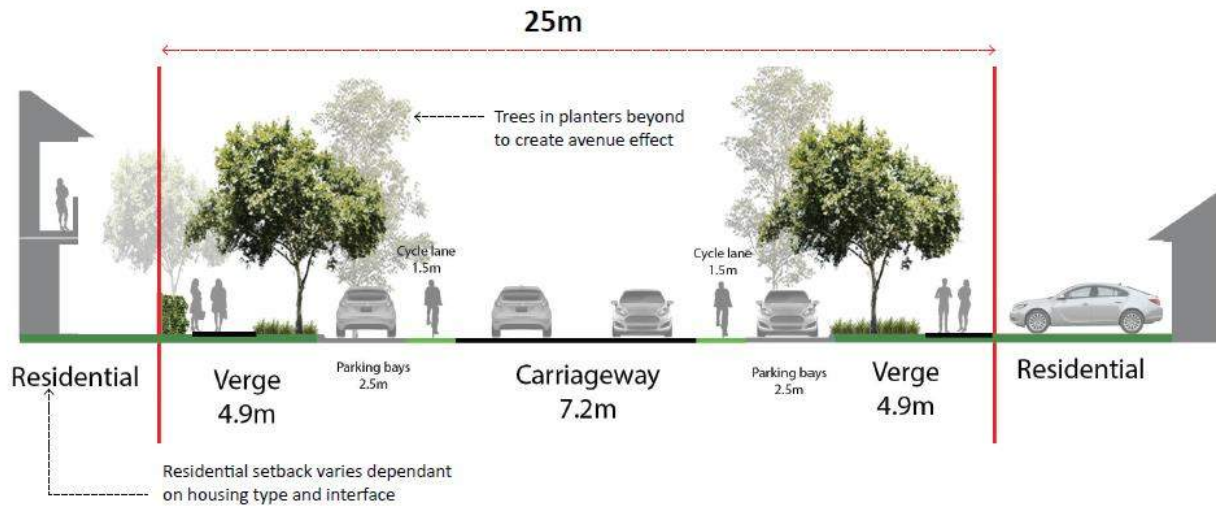
Riverlea Boulevard

Figure 5.3: Cross Section - Neighbourhood Centre Road



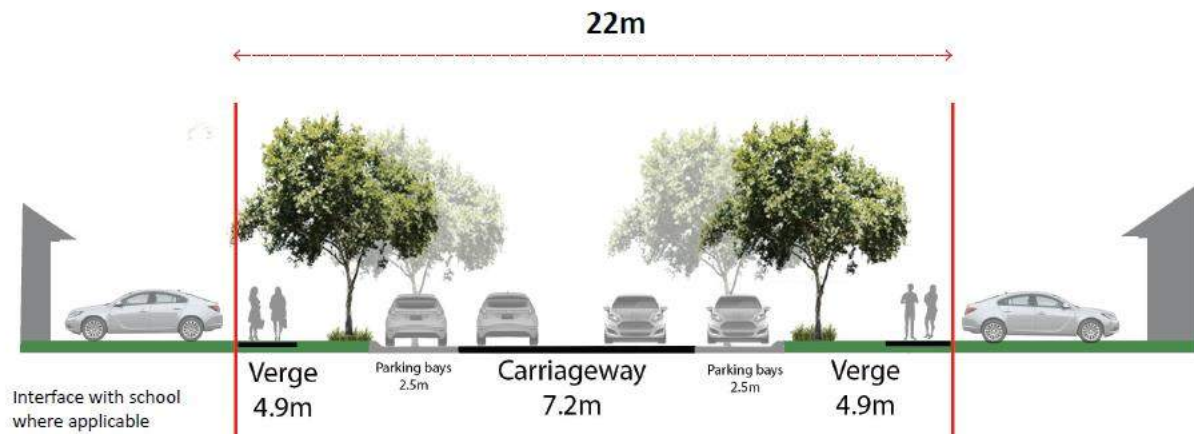
Neighbourhood Centre Retail Avenue

Figure 5.4: Cross Section – Collector Road A



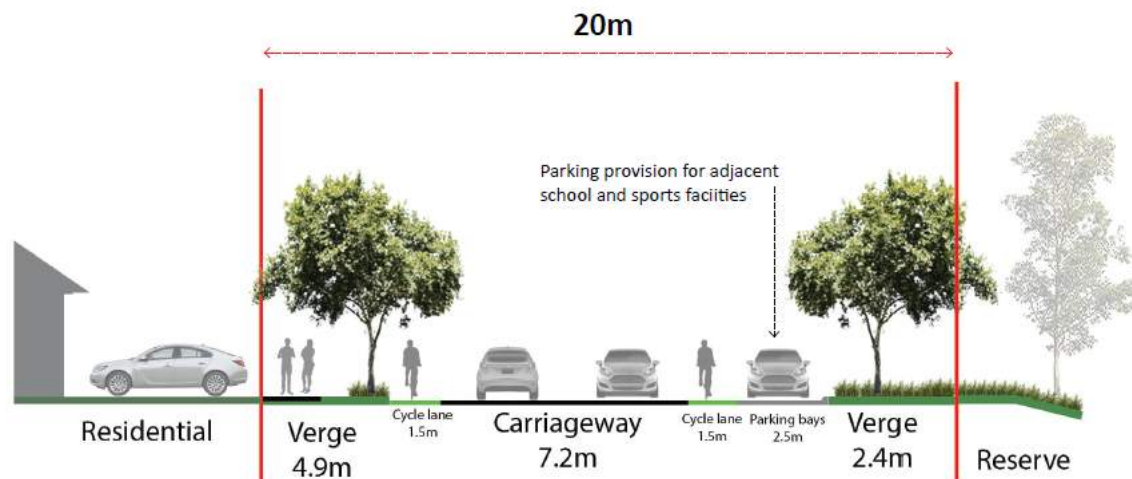
General Residential Collector Road accommodating bus route, cycle lanes and indented car parking

Figure 5.5: Cross Section – Collector Road B



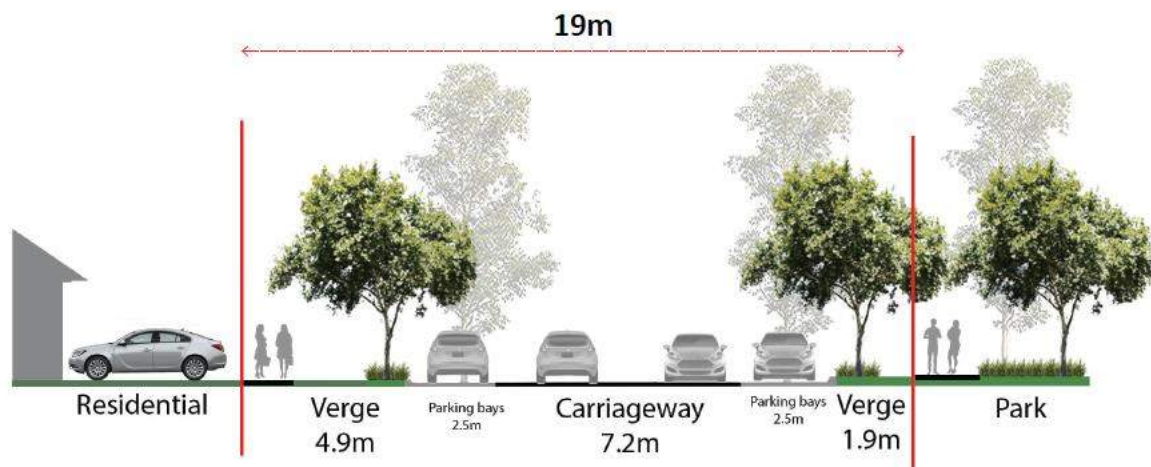
Residential Collector Road accommodating indented car parking and footpaths. Utilised as a 'kiss and ride' school collector road.

Figure 5.6: Cross Section – Collector Road C



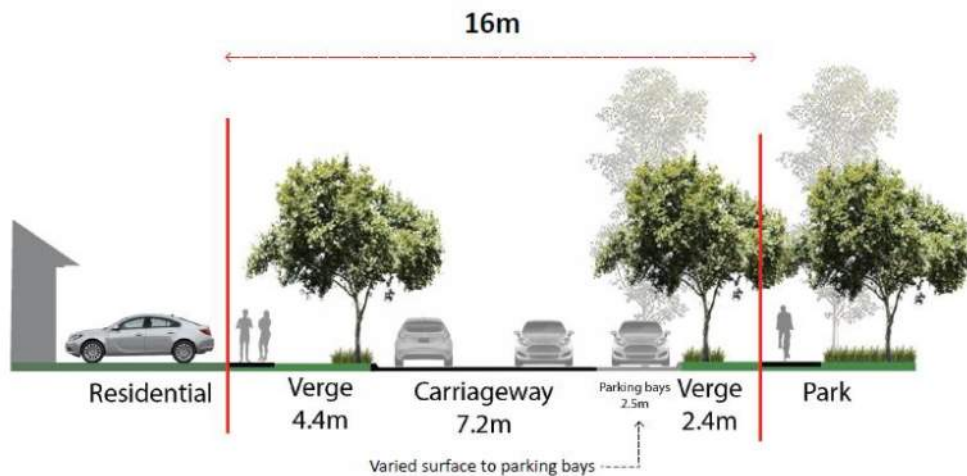
Residential Collector Road alongside drainage reserve where cycle lane connection is required. Includes indented car parking to residential frontages

Figure 5.7: Cross Section – Collector Road D



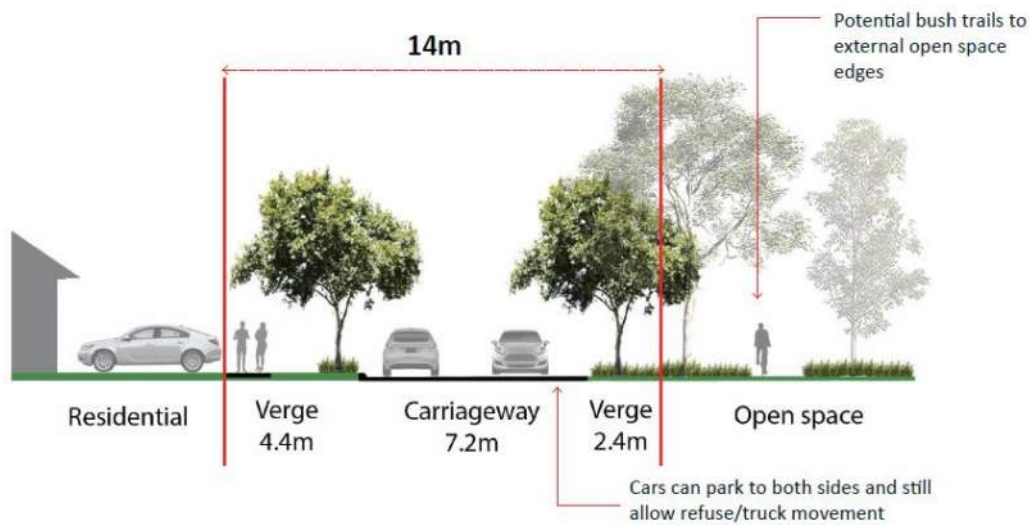
Residential Collector Road alongside major park reserves providing indented car parking bays to both residential and park frontages

Figure 5.8: Local Esplanade Roads (with indented parking)



Local residential roads with optional indented car parking bays to drainage reserve frontage

Figure 5.9: Local Esplanade Roads (on-street parking)



Local residential streets interfacing with open space, external boundaries and reserves, accommodating on-street car parking

Figure 5.10: Local Streets

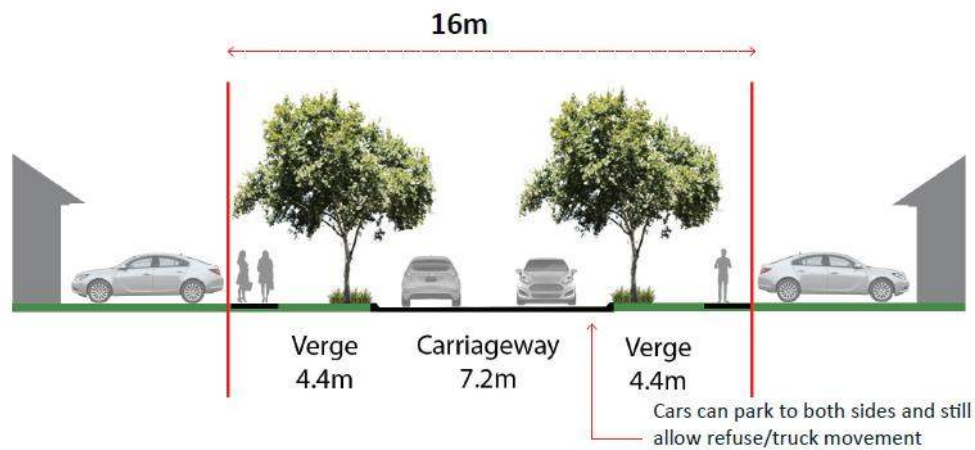
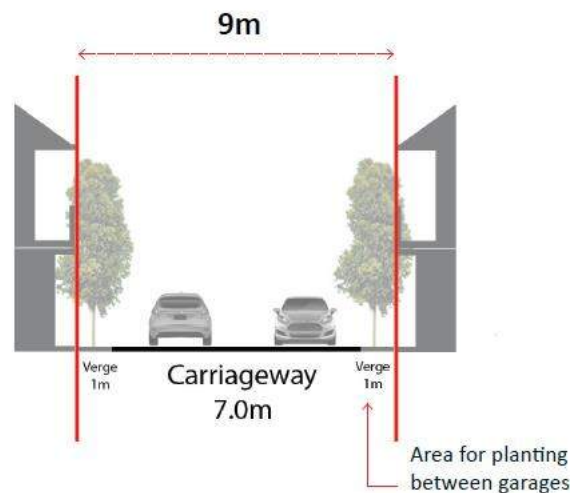


Figure 5.11: Laneways



5.3 T-junctions

The majority of the local street intersections within the proposed development will be controlled by T-Junctions. Realigned T-junctions are proposed at number of locations throughout the development. A realigned T-junction is designed to effect a change in the vehicle travel path thereby slowing traffic via deflection of traffic movements and/or reassignment of priority. These are effective in limiting street lengths and managing speeds on a local road network whilst maintaining a modified grid network. As a result, the safety within the local road network can be improved.

Traffic management measures are required at T-junctions to ensure drivers understand the give-way priority assigned. Generally, the right angle bend in conjunction with appropriate kerb alignments will be sufficient however a review in detailed design should consider the following methods to clarify give way priority:

- Give way signs on the minor road approach.
- Pavement marking on the bend for the centreline and parking control.
- Distinctive pavement on the minor road approach.
- Consideration of the radius of bends to ensure suitable turn paths are achieved for the anticipated traffic volumes and vehicle types.

5.4 Roundabouts

A roundabout is an effective form of intersection control and reduces the relative speeds of conflicting vehicles by providing impedance to all vehicles entering the roundabout. A number of roundabout controlled intersections are proposed in Precinct 2, especially where collector roads form four-way intersections.

It is recommended that the roundabouts be designed to allow full turning movements for larger vehicles, and in order to cater for semi-trailers a mountable island should be provided. The roundabouts will be required to conform to the relevant standards and guidelines, and the Code, which would be confirmed in detailed design.

5.5 Cul-de-sacs & Laneways

The development will incorporate circular cul-de-sacs at a number of locations. It is recommended that 18 metre diameter circular cul-de-sacs be provided to enable turning movements by larger vehicles including waste collection vehicles.

Laneways are proposed in a number of locations to provide rear-loaded access to higher density dwellings, for instance row dwellings. The laneways will be wide enough to enable access to garages, provide for rear waste collection.

5.6 Vehicle Speed Management

Austroads Guide to Road Design Part 3: Geometric Design states a typical acceleration of 1km/h for every 5 metres is possible for private vehicles from a stationary position. Therefore, a vehicle can be expected to reach 50km/h (the expected posted speed limit) from a stopped position after 250 metres.

Figure 3.4 Acceleration on straights (in the Guide) indicates that based on an entry speed of 20km/h (typical for most right angle bends) straights up to 300 metres in length will maintain a maximum speed of 40km/h. This would be most local streets in a semi-grid layout as proposed in Precinct 2.

Streets with higher entry speeds would be collector roads where roundabouts are typically used to manage speeds along these roads. With an entry speed of 30km/h, straights of up to 300 metres will maintain speeds less than 50km/h which would be suitable for collector roads.

Generally, most streets in the proposed development will be less than 300 metres in length. These streets will generally assist in creating a speed environment of less than 50km/h, and closer to 35km/h where streets are less than 200 metres long.

Urban design techniques to assist in managing vehicle speeds including tree plantings and house design/driveways, in conjunction with carriageway design techniques will be considered in the context of street design features to manage speeds.

Notwithstanding the above, vehicle speeds within Precinct 2 will be generally managed and can be confirmed in design of the built form for the land division.

5.7 Intersection Sight Distance

In order to provide fundamental safety at intersections, adequate sight distances must be provided at each one. There are three categories of sight distances, these are:

- Approach Sight Distance (ASD)
- Safe Intersection Sight Distance (SISD)
- Minimum Gap Sight Distance (MGSD).

A description and review of each of these sight distances for the proposed development is discussed in the following sections.

Approach Sight Distance (ASD)

ASD is the sight distance required for a driver of a vehicle on a minor road approaching an intersection to observe the holding line for the intersection on the ground. The distance is required such that the driver can observe the holding line, react and stop as required.

Based upon the table provided with the Austroads 'Guide to Road Design Part 4a: Signalised and Signalised Intersections' (2009, henceforth referred to as Austroads Guide) a design speed of 50km/h has an ASD of 55 metres.

Safe Intersection Sight Distance (SISD)

SISD is the sight distance required for a driver of a vehicle on a major road approaching an intersection to observe a vehicle within the intersection. The SISD is required such that if a vehicle has stopped (i.e. stalled) within an intersection the driver of the approach vehicle on the major road will observe the vehicle and be able to react and stop if required.

Based upon the table provided with the Austroads Guide a design speed of 50km/h has an SISD of 97 metres.

Minimum Gap Sight Distance (MGSD)

MGSD is the sight distance required for a driver of a vehicle on a minor road at the intersection to observe vehicles in the conflicting streams. The distance is required such that the vehicle can view approaching vehicles in order to safely commence the desired manoeuvre.

The MGSD is based upon the number of lanes the vehicle is required to cross, the type of manoeuvre that is required.

Austroads Guide requires a road with a design speed of 50km/h has an MGSD of 69 metres for the critical right turn movement on a two lane/two way road.

Sight Distance Summary

An assessment of the above horizontal sight distances indicates the intersections within the proposed development can provide the minimum requirements. A further sight distance assessment is recommended during detailed design to ensure the horizontal and vertical sight distances are met.

5.8 Street Gradients for Vehicles

It is noted that the current site is very flat and roads will generally be designed with appropriate grades for stormwater management, as opposed to achieving compatibility with existing terrain in undulating environments. Hence, grades of streets are not considered to be an issue within the precinct.

5.9 Parking

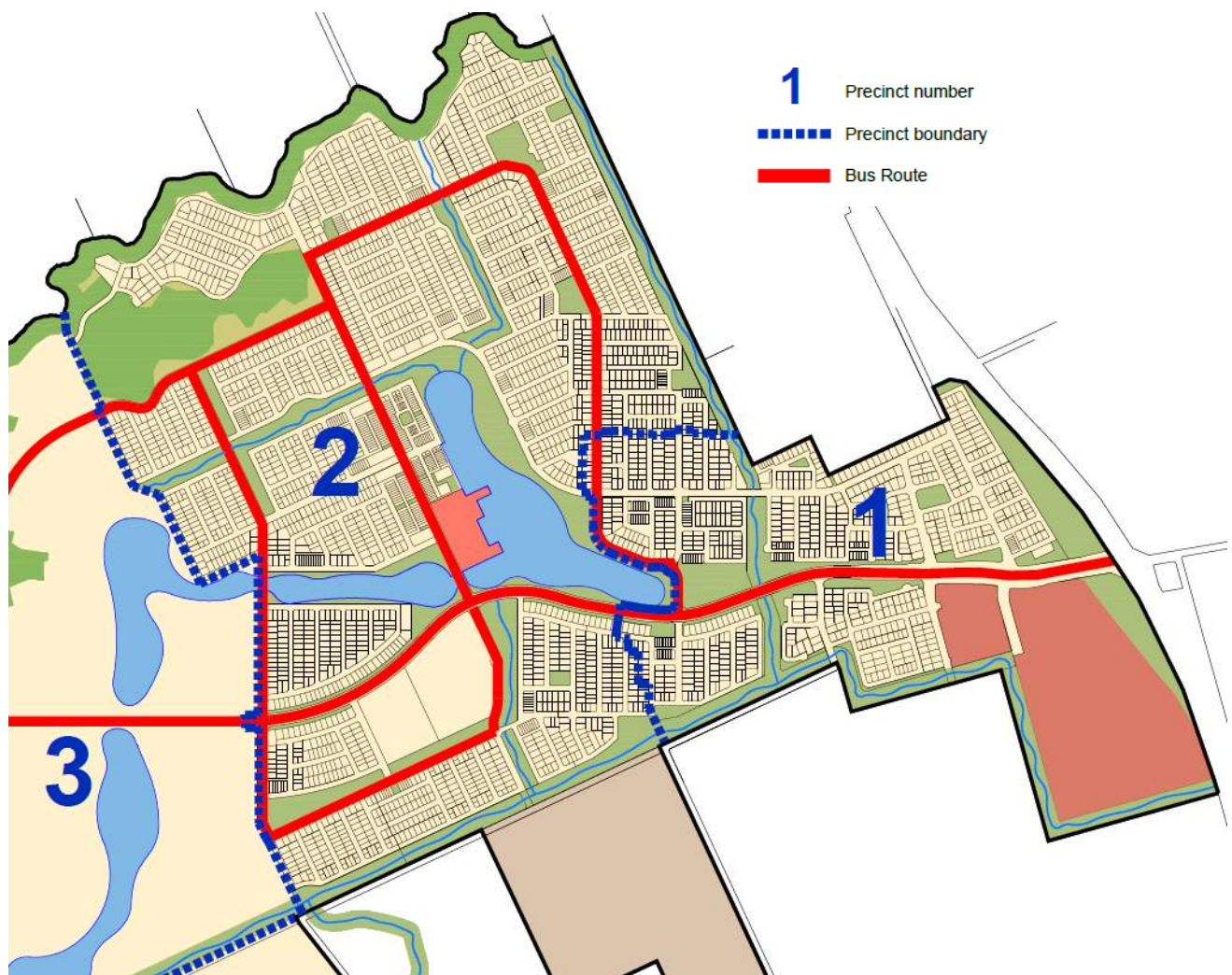
The proposed development will provide a high level of on-street parking which will cater for a minimum of 1 on-street space per 3 dwellings or more based on the proposed road cross sections. These cross sections include a variety on-street parking on the carriageway or indented parking bays.

The frontages of reserves will provide a high level of parking where available. The need for parking at reserves has been considered by an assessment provided in Appendix A.

5.10 Public Transport

Bus routes are proposed to provide public transport access to the Riverlea township. Figure 5.12 indicates the road network to be available for bus services. The actual services will be confirmed on conjunction with agreement from the Department for Infrastructure and Transport. It is envisaged that the proposed bus routes will utilise the distributor and collector roads to provide a bus route that will be within approximately 400 metres of all residential allotments within the Riverlea township.

Figure 5.12: Proposed Bus Routes in Precinct 2



Extract from Walker plan "Overall Bus Routes", 12 April 2023

5.11 Heavy Vehicles

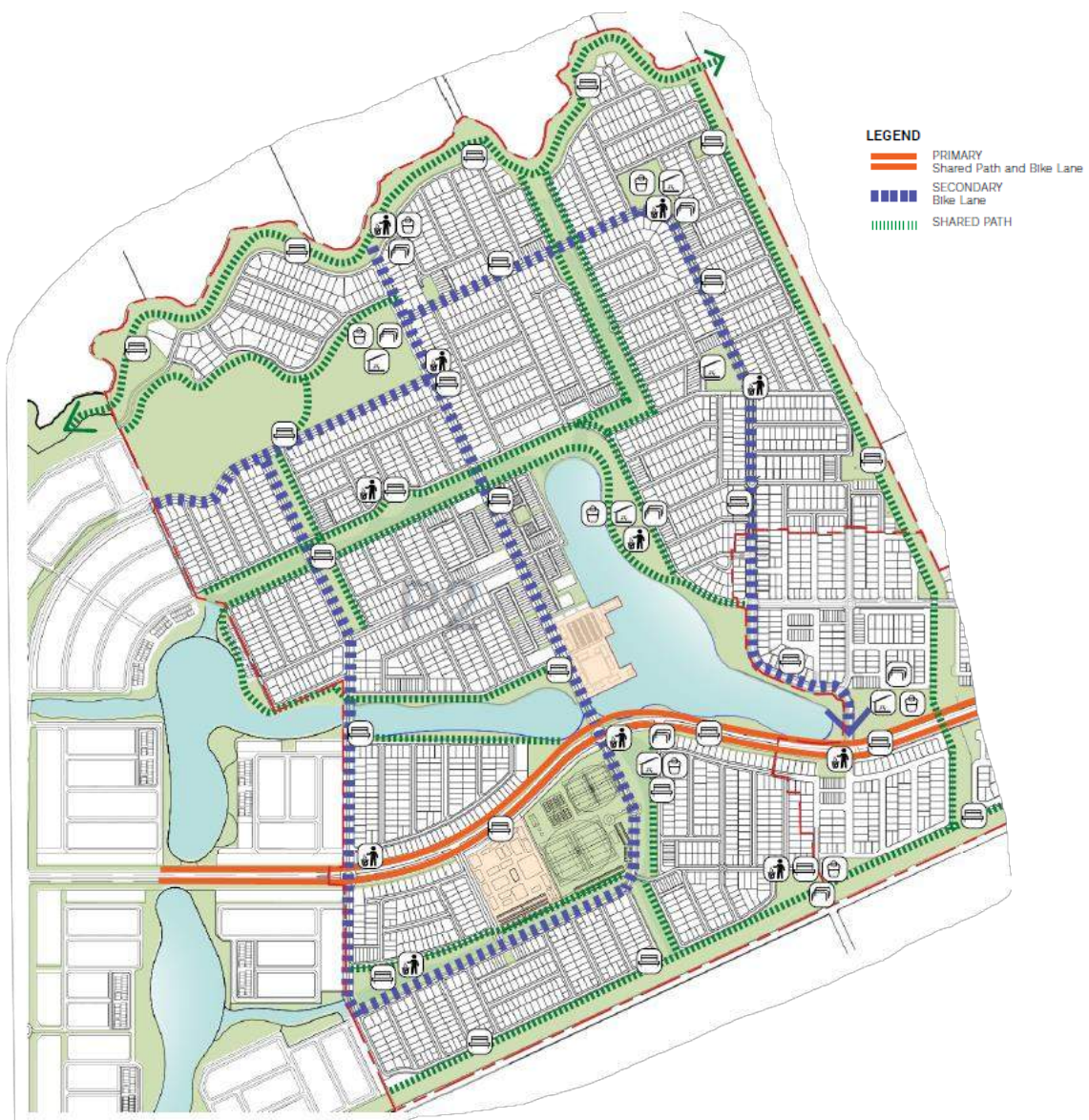
Heavy vehicles will use the proposed road network on an occasional service for waste collection within the proposed residential area. The proposed road network will be capable of providing appropriate access subject to detailed design of intersections and junction to ensure safe and appropriate turning movements are available.

The cul-de-sac streets will enable trucks to turn to enter and exit in a forward direction. The cul-de-sacs should be confirmed in detailed design to ensure adequate space is available.

5.12 Bicycle Access

Bicycle access is proposed with bicycle routes on key collector roads in Precinct 2 as shown in Figure 5.13 where bicycle lanes and/or paths can be considered. These roads will provide key access within and throughout Precinct 2 for bicycles. The low speed design and low volumes on most of the local street network will also facilitate safe bicycle access. The proposed network will provide a high level of accessibility to the neighbourhood centre and school precincts within the site.

Figure 5.13: Proposed Bicycle Routes (extract from Landscape Masterplan)



6 INTERSECTIONS

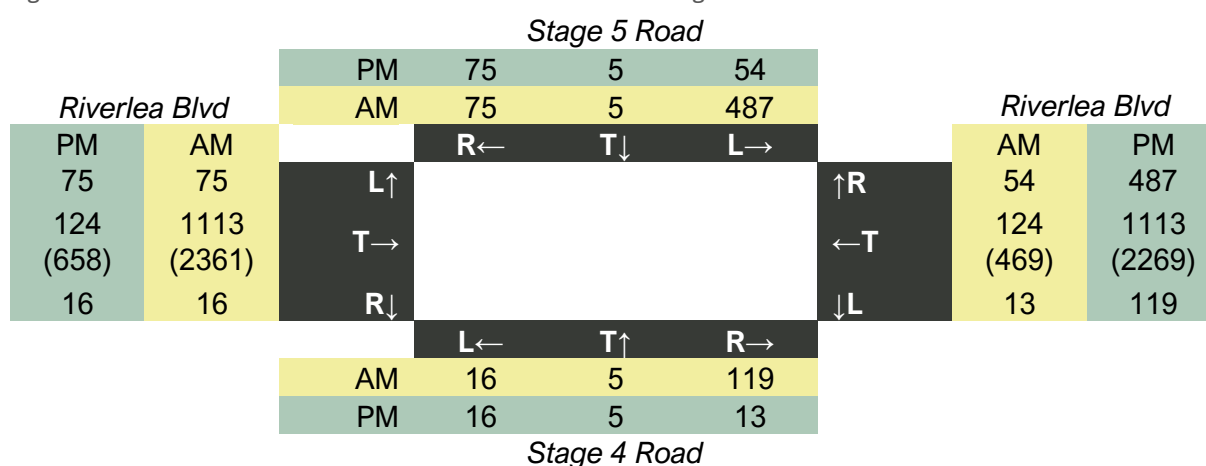
Each intersection has been assessed individually for performance based on anticipated traffic demands. Schematic layouts for each intersection have been prepared to indicate required lane arrangements. Other features such as pedestrian crossings, suitable turn paths for design vehicles and location of traffic signal posts are assumed to be included and to be confirmed in detailed design.

6.1 Intersection 3 Assessment

A roundabout is proposed at this intersection as part of Precinct 1 development (Silverleaf Drive in Stage 4), with 2 lanes for eastbound and westbound traffic on Riverlea Boulevard. A single lane approach for the north and south legs.

The anticipated AM and PM peak hour traffic volumes for Precinct 2 volumes at intersection 3 are shown in Figure 6.1. The Ultimate through volumes on Riverlea Drive are also shown.

Figure 6.1: Intersection 3 – Precinct 2 AM & PM Peak Hour Turning Volumes



6.1.1 Intersection 3 Analysis Summary

A summary of the Intersection 3 analysis is summarised in Table 6.1. SIDRA intersection outputs are provided in Appendix A.

Table 6.1: Intersection 3 – SIDRA Summary

Intersection Type	Peak Period	Degree of Saturation	Level of Service	Maximum Vehicle Queue (m)
Roundabout Initial Layout	AM Peak	0.838	A	64.2
	PM Peak	0.603	A	41.2
Roundabout Interim Layout	AM Peak	0.735	A	41.8
	PM Peak	0.602	A	40.8
Signals Ultimate Volumes	AM Peak	0.860	B	62.4
	PM Peak	0.839	A	117.2

The SIDRA Intersection analysis indicates that the proposed roundabout with the additional left turn lane at Intersection 3 will operate satisfactorily and within capacity for the predicted Precinct 2 traffic volumes.

The initial single lane on the northern intersection leg will not be able to accommodate the left turn volumes in the AM peak with the high eastbound volumes in the AM peak. Once the AM eastbound volumes exceed 600 vehicles, the additional left turn lane will be required.

An analysis of the ultimate traffic volumes has found that the roundabout will be able to accommodate all of the Ultimate AM or PM peak period traffic volumes with significant queueing predicted on the Riverlea Boulevard approaches. Further modelling has found the roundabout will accommodate up to 1800 vehicles per hour eastbound and westbound during the AM and PM peak periods respectively. on the eastern approach, which equates to about 75% of the Ultimate traffic flow westbound.

Hence, the roundabout should be monitored following further development to the west to determine the timing required for the interim upgrade, and then the Ultimate upgrade to traffic signals.

Traffic signals will be required in the ultimate layout when Riverlea is developed to the west. In particular, a free flowing left turn will be required from Osprey Drive (north leg) to Riverlea Boulevard (east leg) due to the high eastbound flows on Riverlea Boulevard in the AM peak period and filtered right turn movements to accommodate the high right turn flows northbound in the PM peak period.

6.2 Intersection 4 Assessment

The anticipated AM and PM peak hour traffic volumes for Precinct 2 volumes at intersection 5 are shown in Figure 6.1.

Figure 6.2: Intersection 4 – Precinct 2 AM & PM Peak Hour Turning Volumes

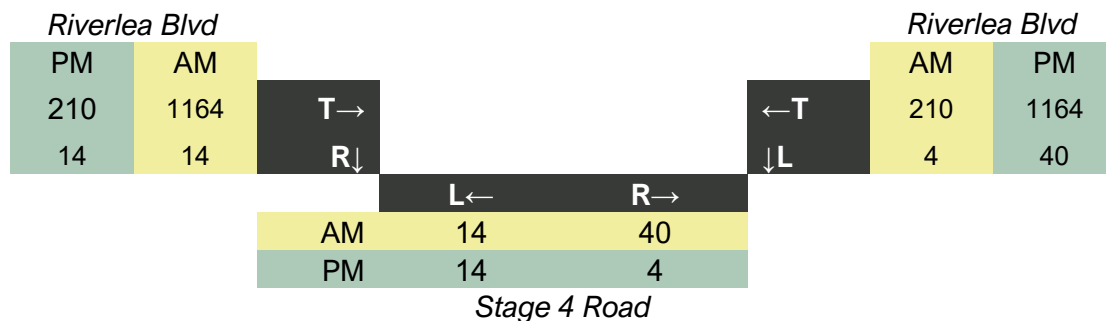
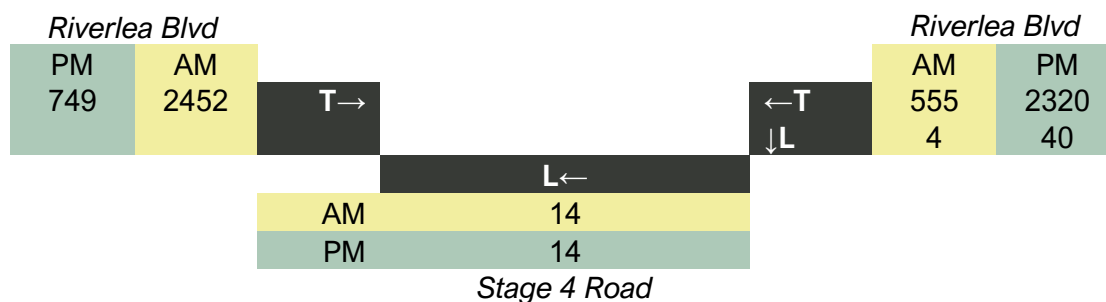


Figure 6.3: Intersection 4 – AM & PM Ultimate Peak Hour Turning Volumes



6.2.1 Intersection 4 Analysis Summary

A summary of the Intersection 4 analysis is summarised in Table 6.2. SIDRA intersection outputs are provided in Appendix B.

Table 6.2: Intersection 4 – SIDRA Summary

Intersection Type	Peak Period	Degree of Saturation	Level of Service	Maximum Vehicle Queue (m)
Unsignalised Precinct 3 Volumes	AM Peak	0.751	N/A*	23.8
	PM Peak	0.332	N/A*	2.0
Unsignalised Ultimate Volumes	AM Peak	0.675	N/A*	0.6
	PM Peak	0.650	N/A*	1.7

* Level of Service unable to be shown due to continuous through movements.

Intersection 4 will provide access to the residential area adjacent with a small number of dwellings comparatively. A T-Junction is proposed as the initial intersection which will operate satisfactorily for the development of Precinct 2.

The operation of the intersection, in particular right turns from South to the East (during AM Peak Periods) will deteriorate as traffic volumes increase in Riverlea Boulevard. Given the proximity of the intersection to Intersection 5, it is likely that there will be more gaps than able to be considered by SIDRA.

However, the assessment of Intersection 5 (summarised in the next section) the right turn lane overflows past Intersection 4 during the overall Precinct 4 and Ultimate volumes. Hence, the intersection should be monitored following further development to the west to determine the timing required for the Intersection 5 upgrade, which will require the closure of the right turn movements.

Once the Ultimate volumes are present, the left in, left out arrangement of the intersection will operate satisfactorily.

6.3 Intersection 5 Assessment

Intersection 5 is proposed to be a four-way intersection linking between the Neighbourhood Centre to the north and school/sports precinct to the south of Riverlea Boulevard. This intersection is a key location for access in this precinct, in particular for pedestrian and cyclist movements to and from retail/commercial, school and sporting uses. The anticipated AM and PM peak hour traffic volumes for Precinct 2 volumes at intersection 5 are shown in Figure 6.1. There will be high traffic volume of vehicle turning left from NCe Road to travel east on Riverlea Boulevard in the AM Peak, and return to turn right into NCe Road in the PM peak.

Figure 6.4: Intersection 5 – Precinct 2 AM & PM Peak Hour Turning Volumes

		Stage 5 Road					
		PM	91	25	108		
Riverlea Blvd		AM	91	25	651	Riverlea Blvd	
PM	AM		R←	T↓	L→	AM	PM
91	91	L↑				108	651
99	433	T→				99	433
5	5	R↓				17	93
			L←	T↑	R→		
		AM	5	25	93		
		PM	5	25	17		
		Stage 4 Road					

Figure 6.5: Intersection 5 – AM & PM Ultimate Peak Hour Turning Volumes

		Stage 5 Road					
		PM	91	32	108		
Riverlea Blvd		AM	91	32	651	Riverlea Blvd	
PM	AM		R←	T↓	L→	AM	PM
91	91	L↑				108	651
633	1681	T→				444	1589
7	7	R↓				17	93
			L←	T↑	R→		
		AM	5	32	147		
		PM	5	32	42		
		Stage 4 Road					

6.3.1 Intersection 5 Analysis Summary

A summary of the Intersection 5 analysis is summarised in Table 6.3. SIDRA intersection outputs are provided in Appendix C.

Table 6.3: Intersection 5 – SIDRA Summary

Intersection Type	Peak Period	Degree of Saturation	Level of Service	Maximum Vehicle Queue (m)
Roundabout Precinct 3 Volumes	AM Peak	0.615	A	33.0
	PM Peak	0.434	A	23.1
Signalised Precinct 3 Volumes	AM Peak	0.635	B	100.5
	PM Peak	0.815	C	253.3
Signalised Ultimate Volumes	AM Peak	0.817	C	363.4
	PM Peak	0.805	C	284.2

Intersection 5 will provide access to the proposed Neighbourhood Centre (to the north) and Sports Fields/School to the south. It will have a mix of traffic movements in conjunction with high flows on Riverlea Boulevard. Pedestrian access should be considered at this intersection with crossings on each side of the intersection.

A roundabout could be provided similar to Intersection 3. There will be a high volume of left turns from NCe Road (north) to Riverlea Boulevard (east) which will require a left turn lane to provide appropriate level of service. Given the nearby school and sports fields, a roundabout would not provide the best pedestrian access as traffic volumes grow on Riverlea Boulevard. Similar to Intersection 3, a roundabout will struggle to cope with future westbound PM peak period flows, with long queues predicted in modelling the longer term roundabout. A roundabout at this location would not operate beyond part development of Precinct 3 to the west without significant modifications, including a bypass lane from NCe Road to Riverlea Boulevard (east) for eastbound traffic for the AM Peak period.

An alternative to improve pedestrian access would be to provide traffic signals as the Initial Intersection. This would provide appropriate traffic capacity whilst providing a high level of pedestrian access across Riverlea Boulevard. A slightly smaller signalised intersection (compared to the ultimate layout) could be provided initially with single right turn lane on Riverlea Boulevard.

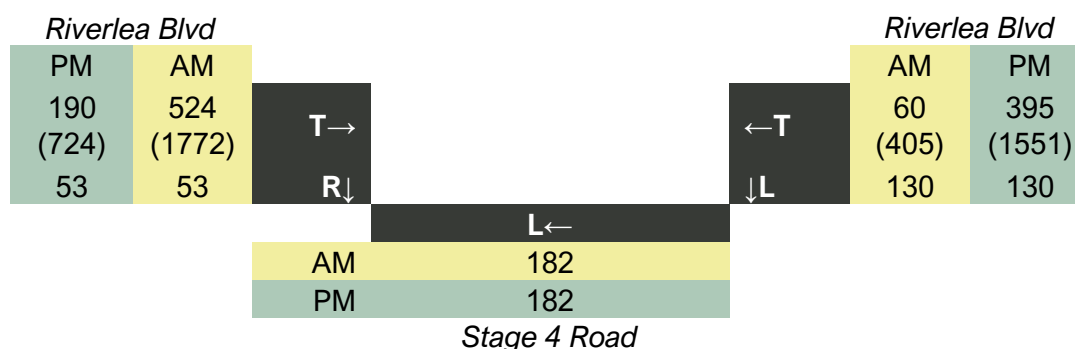
The Precinct 3 PM peak period indicates that the right turn movements to the NCe Road will over spill the capacity of the turning lane. While the lane is overspilling, the volume of westbound vehicles is able to traverse the intersection with minimal impacts.

Traffic signals will be required in the ultimate layout. In particular, a free flowing left turn will be required from NCe Road (north) to Riverlea Boulevard (east) due to the high eastbound flows on Riverlea Boulevard in the AM peak period. Traffic signals utilising a high frequency cycle (that is shorter cycle time) will maintain traffic capacity more effectively and will assist with pedestrian access with more frequent phases occurring.

6.4 Intersection 5A Assessment

Intersection 5A is located adjacent the proposed school and provides access for residential stages to the south of Riverlea Boulevard. The intersection will initially be an unsignalised T-junction. The anticipated AM and PM peak hour traffic volumes for the intersection are shown in Figure 6.6.

Figure 6.6: Intersection 5A - PM Peak Hour Turning Movement Volumes



Through values on Riverlea Boulevard within Brackets indicate the future traffic for the Ultimate intersection analysis.

6.4.1 Intersection 5A Summary

A summary of the Intersection 5a analysis is summarised in Table 6.4. SIDRA intersection outputs are provided in Appendix D.

Table 6.4: Intersection 5a – SIDRA Summary

Intersection Type	Peak Period	Degree of Saturation	Level of Service	Maximum Vehicle Queue (m)
Unsignalised Precinct 3 Volumes	AM Peak	0.288	N/A*	3.9
	PM Peak	0.297	N/A*	5.3
Unsignalised Ultimate Volumes	AM Peak	0.488	N/A*	4.8
	PM Peak	0.710	N/A*	16.5

* Level of Service unable to be shown due to continuous through movements.

The SIDRA intersection analysis indicates that the proposed unsignalised T-junction at Intersection 5A would operate satisfactorily and within capacity for the predicted Precinct 2 traffic volumes.

Being a T-junction, right turn efficiency can deteriorate if higher flows occur on Riverlea Boulevard. It is recommended that the intersection provide right and left turn entry and left turn exit only. Right turn out movements can be accommodated via Intersection 6 initial and ultimate arrangements. The intersection should be monitored to determine if additional upgrades should occur based on additional development to the west.

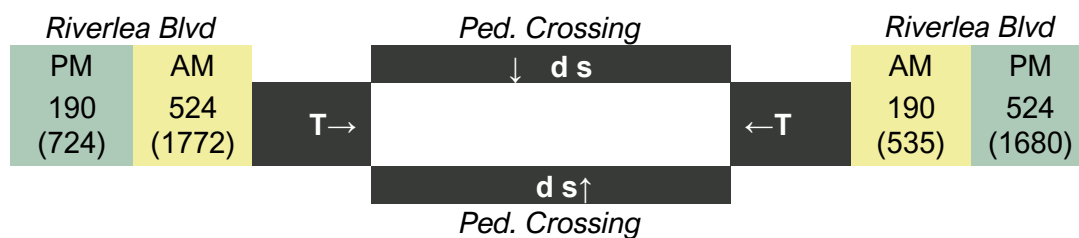
The School Road does link back to intersection 5 which has a higher capacity and would provide for connectivity back to the neighbourhood centre to the north. This may become a loop circuit for people delivering children to school. For the purpose of this assessment, this link has not been considered, with all traffic entering and exiting the site via Riverlea Boulevard.

Given the location adjacent a school, there may be a need for traffic signals to facilitate safe pedestrian crossing (Intersection 5b discussed below).

6.5 Intersection 5B Assessment

Intersection 5B is recommended to be a Pedestrian Actuated Crossing located to the east of the School Road, located approximately 170m from Intersection 6. The intersection provides a pedestrian crossing opportunity across Riverlea Boulevard associated with the western portion of the school and sports precinct. Pedestrian connection to the eastern portion can be provided by the signals located at Intersection 5. The anticipated AM and PM peak hour traffic volumes for the intersection are shown in Figure 6.7.

Figure 6.7: Intersection 5B - PM Peak Hour Turning Movement Volumes



Through values on Riverlea Boulevard within Brackets indicate the future traffic for the Ultimate intersection analysis.

6.5.1 Intersection 5B Summary

A summary of the Intersection 5B analysis is summarised in Table 6.5. SIDRA intersection outputs are provided in Appendix E.

Table 6.5: Intersection 5b – SIDRA Summary

Intersection Type	Peak Period	Degree of Saturation	Level of Service	Maximum Vehicle Queue (m)
Signalised PAC Precinct 3 Volumes	AM Peak	0.349	A	58.0
	PM Peak	0.349	A	58.0
Signalised PAC Ultimate Volumes	AM Peak	0.591	A	135.7
	PM Peak	0.560	A	122.7

The SIDRA intersection analysis indicates that the proposed PAC at Intersection 5A would operate satisfactorily and with vehicle queues not extending to Intersection 5 or 6. The intersection will have capacity for the predicted Precinct 2 traffic volumes and ultimate volumes.

The intersection should be monitored to determine if additional upgrades should occur based on additional development to the west.

6.6 Intersection 6 Assessment

Intersection 6 will initially be at the end of the Riverlea Precinct 2 development, with a modified T-junction proposed to connect to residential stages to the north and south. Longer-term Riverlea Boulevard will continue west which will require a 4-way intersection to be appropriately managed.

The anticipated AM and PM peak hour traffic volumes for Precinct 2 volumes at intersection 5 are shown in Figure 6.8.

Figure 6.8: Intersection 6 – Precinct 2 AM & PM Peak Hour Turning Volumes

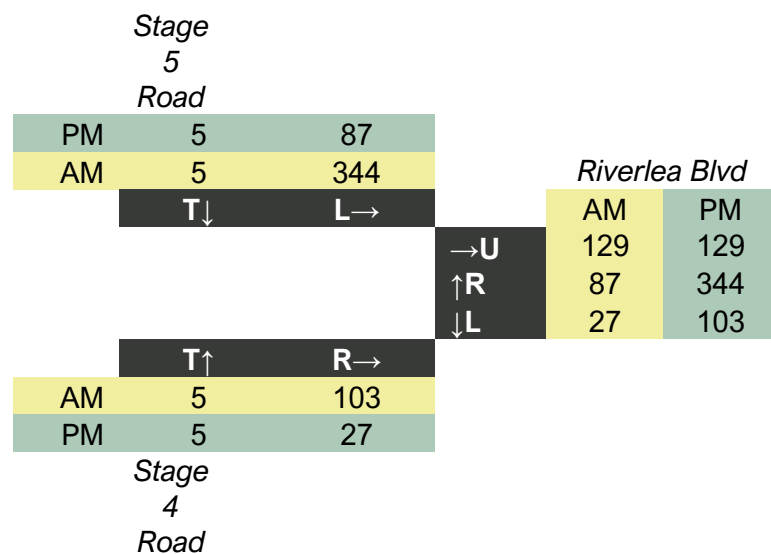
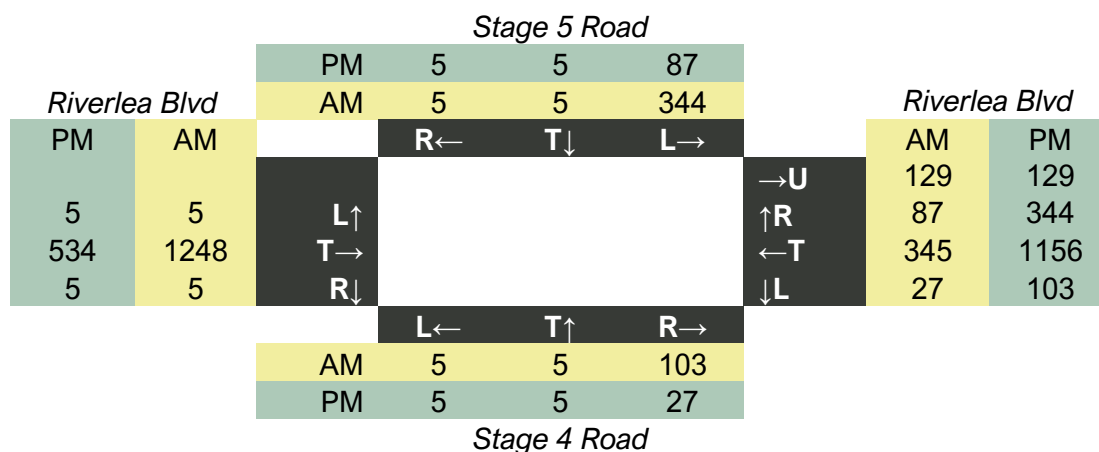


Figure 6.9: Intersection 6 – AM & PM Ultimate Peak Hour Turning Volumes



6.6.1 Intersection 6 Summary

A summary of the Intersection 6 analysis is summarised in Table 6.6. SIDRA intersection outputs are provided in Appendix F.

Table 6.6: Intersection 6 – SIDRA Summary

Intersection Type	Peak Period	Degree of Saturation	Level of Service	Maximum Vehicle Queue (m)
Unsignalised T Precinct 3 Volumes	AM Peak	0.224	N/A*	7.5
	PM Peak	0.436	N/A*	19.9
Roundabout Ultimate Volumes	AM Peak	0.710	A	40.0
	PM Peak	0.549	A	44.3

* Level of Service unable to be shown due to continuous through movements.

The initial intersection arrangement can be provided with a single traffic lane in each direction on Riverlea Boulevard and accommodate the volumes associated with Precinct 2.

The ultimate layout for the intersection will be a 4-way intersection with the extension of Riverlea Boulevard to the west. Given there will be very few traffic movements north-south across Riverlea Boulevard, it is recommended that the ultimate intersection be a roundabout.

6.7 Intersection Summary

The analysis of the intersections in Precinct 2 for the Initial and Ultimate layouts is summarised in the Figure 6.10 and Figure 6.11 below with the recommended intersection layouts.

Figure 6.10: Intersections – Initial Layout

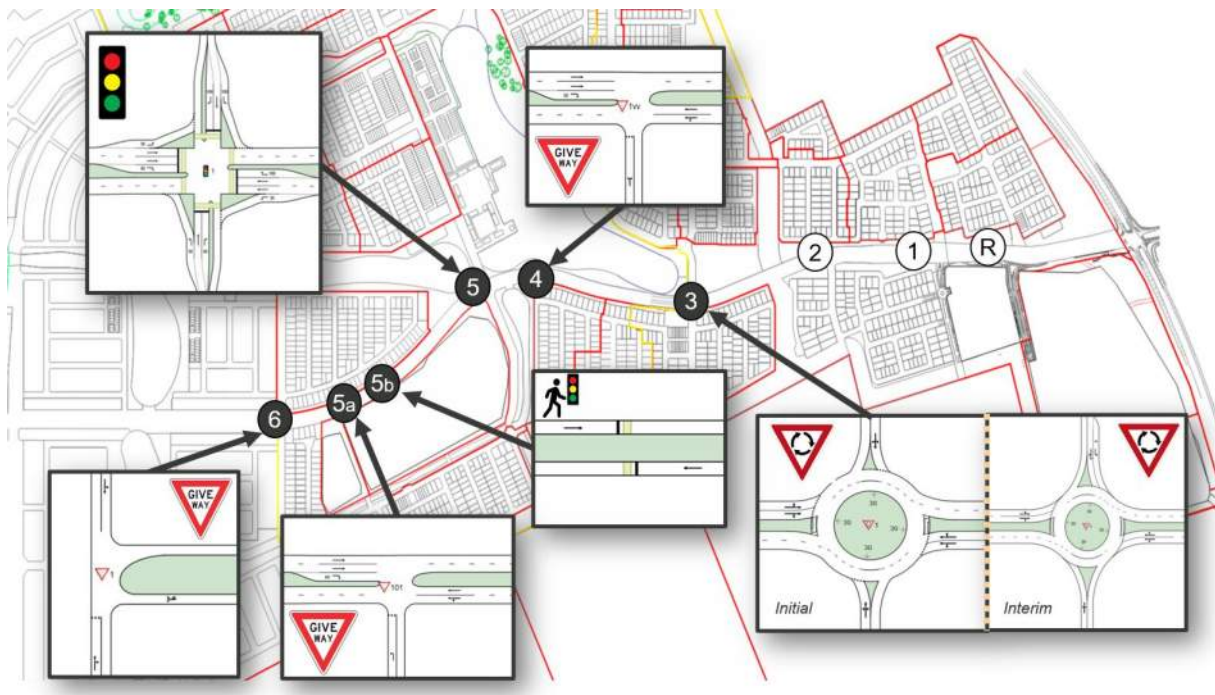
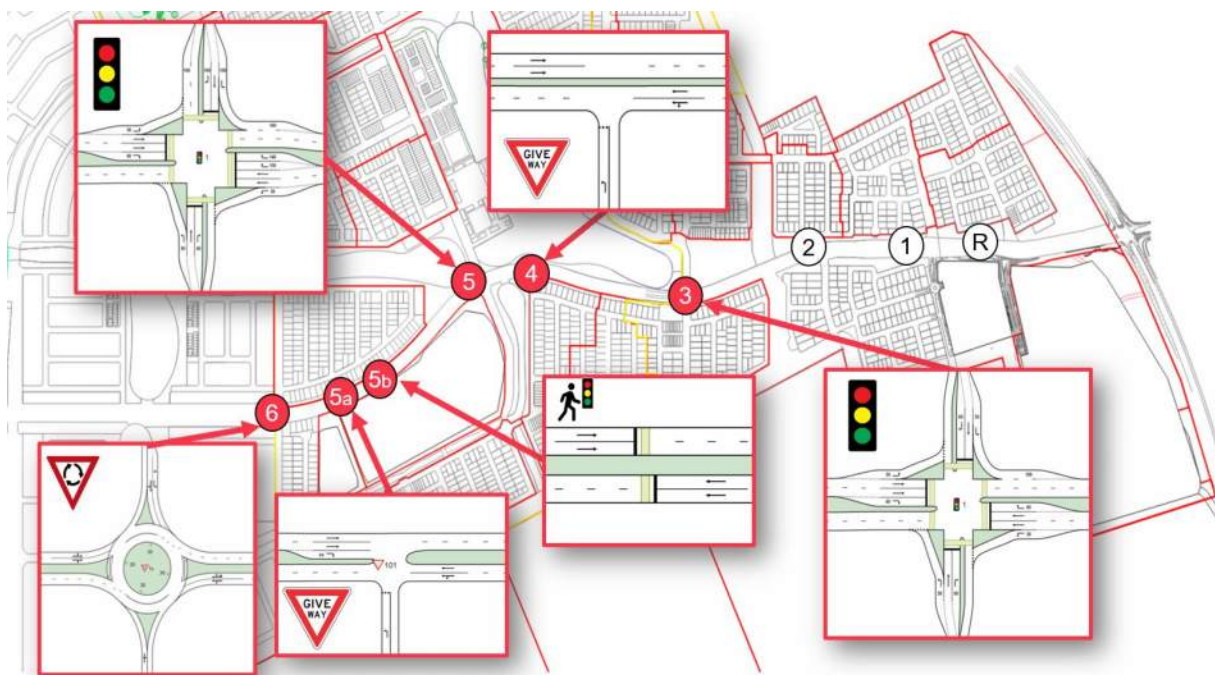


Figure 6.11: Intersections – Ultimate Layout



A comparison of the intersection spacing (excluding unsignalised intersections) and the 95th percentile queues of the ultimate volumes are outlined in Table 6.7. The modelling indicates that the maximum vehicle queues in the AM and PM peaks are not to extend into the intersections.

Table 6.7: Intersection Distance and 95th%ile Queue Comparison

Intersection	Distance to Next Intersection - West (m)	Max 95th%ile Queue to West (m)	Distance to Next Intersection - East (m)	Max 95th%ile Queue to East (m)
3	580	117.2	730	50.9
5	440	363.4	580	284.2
5b	200	135.7	440	122.7
6	-	36.0	200	44.3

6.8 Intersection Upgrade Timing

The likely need to upgrade the intersections from interim to ultimate based on future development to the west for Precinct 3 and 4 has been reviewed as part of the intersection analysis. For this assessment, it should be noted that the additional traffic volumes assumed to be from the west (from the whole development) has been developed from the original PB modelling which considered a secondary access and high level of self-sufficiency in each precinct with schools, employment and activity centres. In simple terms this equates to about 3,000 dwellings if no secondary connection is provided.

Hence it is likely overall that the intersections would need to be upgraded prior to full occupation of Precinct 3 assuming it will be similar size to Precinct 2. This assumption is made on the basis that a secondary access would not be available until Precinct 4 for which planning would occur during the development of Precinct 3. It would be assumed that a secondary connection would be provided prior to full occupation of Precinct 3. The analysis generally indicates intersections will need upgrading by 50% of the occupation of Precinct 3 (or about 1500 dwellings in addition to Precinct 2 dwellings). The above assumes Precinct 2 is complete and occupied.

Given the above, the timing of intersection upgrades is shown in Table 6.8.

Table 6.8: Intersection Upgrade Timing

Intsn.	Initial	Interim	Ultimate
3	Up to 50% of Precinct 3 complete and operating	From 25% of Precinct 3 operational (Requires additional left turn lane on north leg due to increased AM Peak flows)	From 50% of Precinct 3 complete and occupied (due to PM Peak period queue lengths)
4	Until upgrade of Intersection 5	N/A	Median opening to be closed due to extension of right turn lanes for Ultimate intersection 5 layout. Expected to occur when Intersection 5 reaches ultimate capacity volumes as modelled.
5	Initial roundabout or signals – can remain until about 50% of Precinct 3 occupied	N/A	From 50% of Precinct 3 complete and occupied
5a	Initial and Ultimate will be the same unsignalised intersection		
5b	Initial and Ultimate will generally be the same pedestrian crossing		
6	Precinct 2 only	N/A	When Precinct 3 connected to west

7 CONCLUSIONS

Based on the analysis and discussions presented within this report, the following conclusions are made:

1. The proposed Precinct 2 development will include approximately 3,100 residential dwellings with associated neighbourhood centre, educational and recreational facilities within a modified grid network and key access routes to Riverlea Boulevard.
2. Precinct 2 will generate some 25,000 vehicle trips per day which is consistent with the Traffic Impact Assessment prepared for the master plan in 2009, and for Precinct 2 in 2015.
3. For the purposes of this assessment, the same anticipated traffic demands from the west as applied in the 2015 assessment as determined by '*Buckland Park Traffic Impact Assessment*' (Parsons Brinckerhoff Australia Pty Ltd, 1 April 2009). This would equate to approximately 1,990 additional dwellings, which is approximately 60% of future Precinct 3 dwellings.
4. A review of the proposed intersections on Riverlea Boulevard has identified the initial intersection layouts which will cater for Precinct 2 traffic demands, and ultimate intersection layouts which will cater for future traffic demands of Riverlea as it is developed to the west.
5. Previous analysis has found that the Precinct 1 intersections will be able to cater for the traffic demands of Precinct 2, and similarly preliminary analysis of the Port Wakefield Highway / Riverlea Boulevard intersection will be capable of handling the increase demand of Precinct 2 within existing capacity of the intersection. These intersections should be reviewed as part of planning of Precinct 3 to confirm continued suitable operation.
6. The central intersection (5) will provide access to both the neighbourhood centre precinct (to the north) and school precinct (to the south) and is recommended to have traffic signals as an initial option to better accommodate the anticipated traffic movements, but also safer pedestrian and cyclist movements compared to a roundabout.
7. Intersection 6 (at the western end of the precinct) would become a T-junction under the initial arrangement. Once the connection for Precinct 3 is required, the traffic control of this intersection is recommended to be a roundabout.
8. The upgrade of the intersection to the ultimate configurations shown will be dependant on timing of future stages to the west, and should be reviewed as part of the planning and design of these stages to assist in identifying upgrade requirements. Generally the initial intersections will be capable of accommodating approximately 50% of Precinct 3 traffic demands.
9. The configurations of the street network will be conducive to a low speed environment of less than 40km/h on the minor streets, and 50km/h on collector streets which will link to Riverlea Boulevard.
10. The street network will be planned to accommodate bus services when required, with road carriageways suitable for bus travel through the precinct. The actual routes are yet to be confirmed.

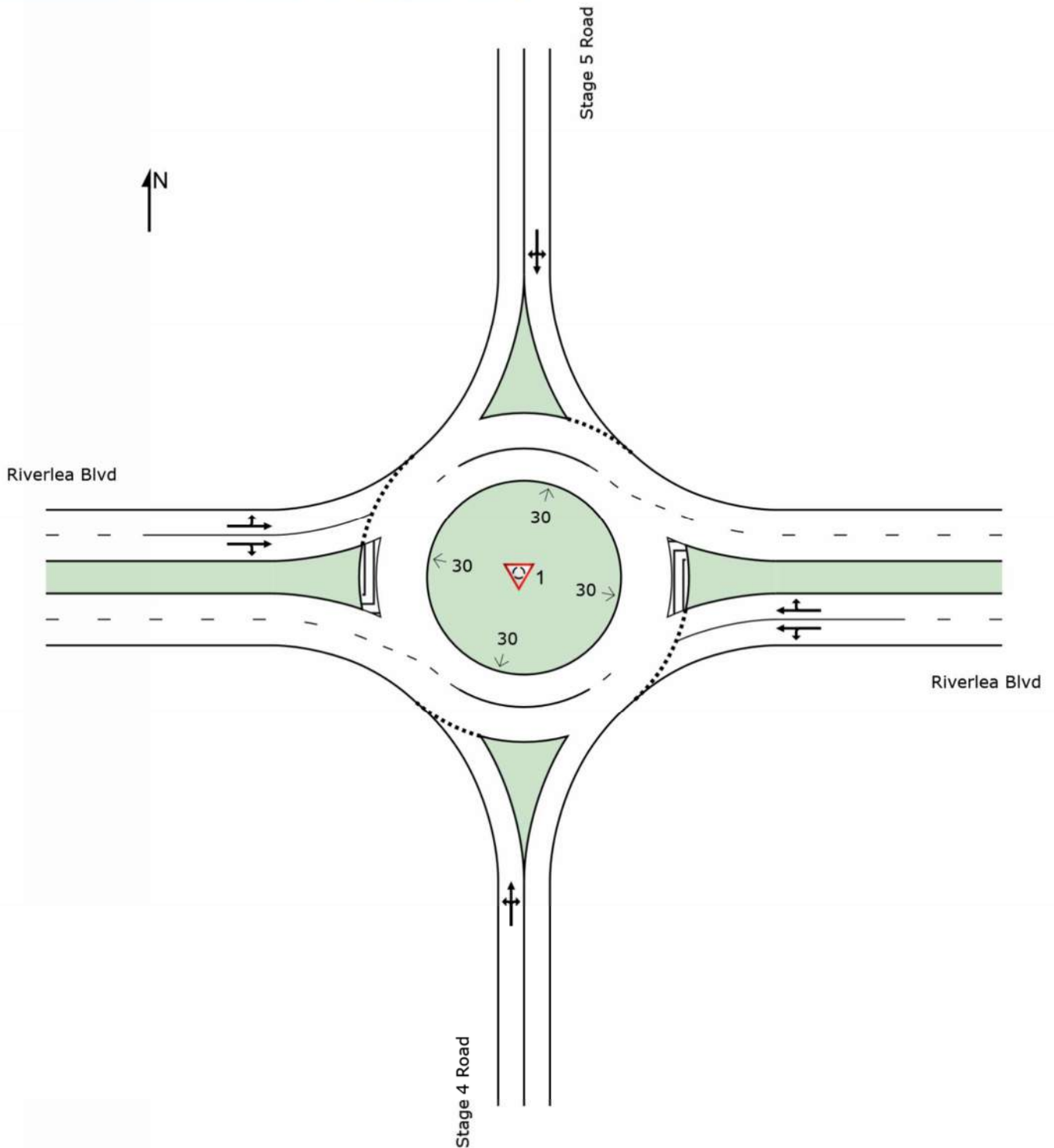
Appendix A Intersection 3 SIDRA Summary

SITE LAYOUT

Site: 1 [Prec2_Int3_AMandPM (Site Folder: General)]

Intersection 3
Part Precinct 2 Volumes
AM and PM Peak
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1 [Prec2_Int3_AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 3
Part Precinct 2 Volumes
AM Peak
Site Category: (None)
Roundabout

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 4 Road															
1	L2	All MCs	17	3.0	17	3.0	0.158	3.6	LOS A	0.7	4.7	0.39	0.61	0.39	47.7
2	T1	All MCs	5	3.0	5	3.0	0.158	3.2	LOS A	0.7	4.7	0.39	0.61	0.39	44.9
3	R2	All MCs	125	3.0	125	3.0	0.158	8.8	LOS A	0.7	4.7	0.39	0.61	0.39	47.2
Approach			147	3.0	147	3.0	0.158	8.0	LOS A	0.7	4.7	0.39	0.61	0.39	47.1
East: Riverlea Blvd															
4	L2	All MCs	14	3.0	14	3.0	0.070	4.0	LOS A	0.4	3.0	0.27	0.37	0.27	50.4
5	T1	All MCs	131	3.0	131	3.0	0.070	3.8	LOS A	0.4	3.0	0.27	0.42	0.27	54.1
6	R2	All MCs	57	3.0	57	3.0	0.070	9.6	LOS A	0.4	2.9	0.28	0.53	0.28	48.2
Approach			201	3.0	201	3.0	0.070	5.4	LOS A	0.4	3.0	0.28	0.44	0.28	52.0
North: Stage 5 Road															
7	L2	All MCs	513	3.0	513	3.0	0.838	14.0	LOS A	8.9	64.2	0.90	1.16	1.59	41.4
8	T1	All MCs	5	3.0	5	3.0	0.838	13.7	LOS A	8.9	64.2	0.90	1.16	1.59	41.6
9	R2	All MCs	79	3.0	79	3.0	0.838	19.2	LOS B	8.9	64.2	0.90	1.16	1.59	43.6
Approach			597	3.0	597	3.0	0.838	14.7	LOS B	8.9	64.2	0.90	1.16	1.59	41.7
West: Riverlea Blvd															
10	L2	All MCs	79	3.0	79	3.0	0.266	4.4	LOS A	1.6	11.8	0.38	0.42	0.38	53.7
11	T1	All MCs	632	3.0	632	3.0	0.266	4.3	LOS A	1.6	11.8	0.39	0.43	0.39	54.0
12	R2	All MCs	17	3.0	17	3.0	0.266	10.1	LOS A	1.6	11.5	0.41	0.44	0.41	49.3
Approach			727	3.0	727	3.0	0.266	4.5	LOS A	1.6	11.8	0.39	0.43	0.39	53.9
All Vehicles			1673	3.0	1673	3.0	0.838	8.5	LOS A	8.9	64.2	0.56	0.71	0.81	48.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay; Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 1 [Prec2_Int3_PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 3
Part Precinct 2 Volumes
PM Peak
Site Category: (None)
Roundabout

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Queue Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 4 Road															
1	L2	All MCs	17	3.0	17	3.0	0.086	8.8	LOS A	0.4	2.5	0.74	0.86	0.74	46.3
2	T1	All MCs	5	3.0	5	3.0	0.086	8.5	LOS A	0.4	2.5	0.74	0.86	0.74	43.6
3	R2	All MCs	14	3.0	14	3.0	0.086	14.0	LOS A	0.4	2.5	0.74	0.86	0.74	45.8
Approach			36	3.0	36	3.0	0.086	10.8	LOS A	0.4	2.5	0.74	0.86	0.74	45.7
East: Riverlea Blvd															
4	L2	All MCs	125	3.0	125	3.0	0.603	4.3	LOS A	5.7	41.2	0.41	0.40	0.41	49.8
5	T1	All MCs	1172	3.0	1172	3.0	0.603	4.2	LOS A	5.7	41.2	0.42	0.44	0.42	53.4
6	R2	All MCs	513	3.0	513	3.0	0.603	10.0	LOS A	5.7	41.0	0.45	0.53	0.45	47.7
Approach			1809	3.0	1809	3.0	0.603	5.8	LOS A	5.7	41.2	0.43	0.46	0.43	51.4
North: Stage 5 Road															
7	L2	All MCs	57	3.0	57	3.0	0.138	3.0	LOS A	0.6	4.5	0.33	0.52	0.33	45.7
8	T1	All MCs	5	3.0	5	3.0	0.138	2.7	LOS A	0.6	4.5	0.33	0.52	0.33	45.8
9	R2	All MCs	79	3.0	79	3.0	0.138	8.2	LOS A	0.6	4.5	0.33	0.52	0.33	48.3
Approach			141	3.0	141	3.0	0.138	5.9	LOS A	0.6	4.5	0.33	0.52	0.33	47.1
West: Riverlea Blvd															
10	L2	All MCs	79	3.0	79	3.0	0.111	5.8	LOS A	0.7	5.0	0.61	0.57	0.61	52.9
11	T1	All MCs	131	3.0	131	3.0	0.111	6.0	LOS A	0.7	5.0	0.62	0.59	0.62	52.8
12	R2	All MCs	17	3.0	17	3.0	0.111	11.9	LOS A	0.6	4.6	0.62	0.60	0.62	48.1
Approach			226	3.0	226	3.0	0.111	6.3	LOS A	0.7	5.0	0.62	0.59	0.62	52.4
All Vehicles			2213	3.0	2213	3.0	0.603	6.0	LOS A	5.7	41.2	0.45	0.48	0.45	51.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay; Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

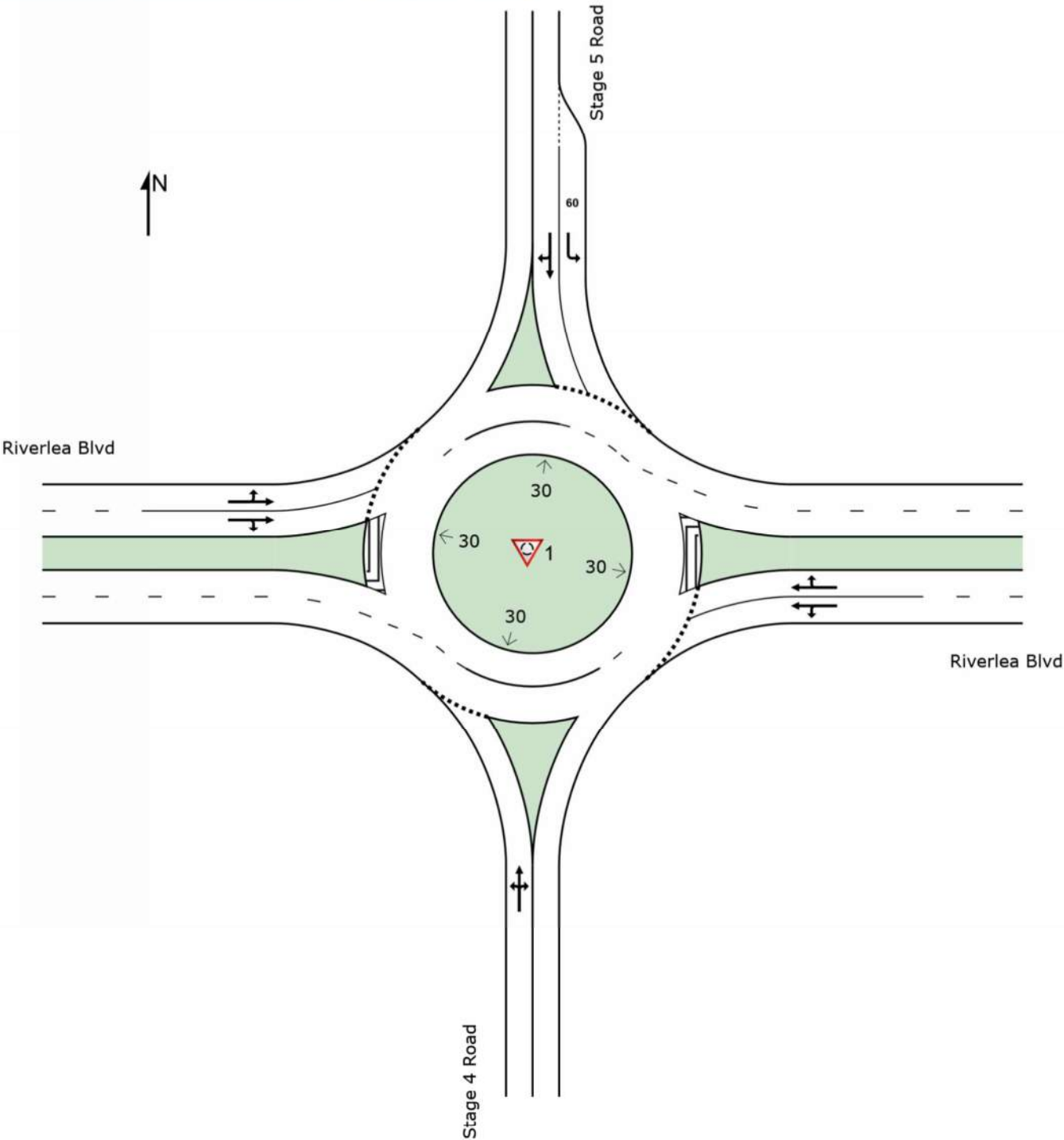
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SITE LAYOUT

Site: 1 [Prec2_Int3_AMandPM_Upgrade (Site Folder: General)]

Intersection 3
Precinct 2 Volumes
AM and PM Peak
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1 [Prec2_Int3_AM_Upgrade (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 3
Precinct 2 Volumes
AM Peak
Site Category: (None)
Roundabout

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of [Veh.	Queue Dist]	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 4 Road															
1	L2	All MCs	17	3.0	17	3.0	0.158	3.6	LOS A	0.6	4.6	0.38	0.61	0.38	47.7
2	T1	All MCs	5	3.0	5	3.0	0.158	3.2	LOS A	0.6	4.6	0.38	0.61	0.38	44.9
3	R2	All MCs	125	3.0	125	3.0	0.158	8.8	LOS A	0.6	4.6	0.38	0.61	0.38	47.2
Approach			147	3.0	147	3.0	0.158	8.0	LOS A	0.6	4.6	0.38	0.61	0.38	47.1
East: Riverlea Blvd															
4	L2	All MCs	14	3.0	14	3.0	0.070	4.0	LOS A	0.4	2.9	0.26	0.37	0.26	50.4
5	T1	All MCs	131	3.0	131	3.0	0.070	3.8	LOS A	0.4	2.9	0.26	0.42	0.26	54.1
6	R2	All MCs	57	3.0	57	3.0	0.070	9.6	LOS A	0.4	2.8	0.27	0.53	0.27	48.2
Approach			201	3.0	201	3.0	0.070	5.4	LOS A	0.4	2.9	0.27	0.44	0.27	52.0
North: Stage 5 Road															
7	L2	All MCs	513	3.0	513	3.0	0.735	11.5	LOS A	5.8	41.8	0.87	1.08	1.36	42.9
8	T1	All MCs	5	3.0	5	3.0	0.211	8.5	LOS A	0.8	5.9	0.72	0.88	0.72	42.4
9	R2	All MCs	79	3.0	79	3.0	0.211	14.0	LOS A	0.8	5.9	0.72	0.88	0.72	44.4
Approach			597	3.0	597	3.0	0.735	11.8	LOS A	5.8	41.8	0.85	1.05	1.27	43.1
West: Riverlea Blvd															
10	L2	All MCs	79	3.0	79	3.0	0.460	4.6	LOS A	3.5	24.9	0.46	0.44	0.46	53.3
11	T1	All MCs	1172	3.0	1172	3.0	0.460	4.6	LOS A	3.5	24.9	0.47	0.45	0.47	53.6
12	R2	All MCs	17	3.0	17	3.0	0.460	10.4	LOS A	3.4	24.3	0.49	0.46	0.49	49.0
Approach			1267	3.0	1267	3.0	0.460	4.6	LOS A	3.5	24.9	0.47	0.45	0.47	53.6
All Vehicles			2213	3.0	2213	3.0	0.735	6.9	LOS A	5.8	41.8	0.55	0.62	0.66	49.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay; Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

 Site: 1 [Prec2_Int3_PM_Upgrade (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 3
Precinct 2 Volumes
PM Peak
Site Category: (None)
Roundabout

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 4 Road															
1	L2	All MCs	17	3.0	17	3.0	0.086	8.8	LOS A	0.3	2.5	0.74	0.86	0.74	46.3
2	T1	All MCs	5	3.0	5	3.0	0.086	8.5	LOS A	0.3	2.5	0.74	0.86	0.74	43.6
3	R2	All MCs	14	3.0	14	3.0	0.086	14.0	LOS A	0.3	2.5	0.74	0.86	0.74	45.8
Approach			36	3.0	36	3.0	0.086	10.8	LOS A	0.3	2.5	0.74	0.86	0.74	45.7
East: Riverlea Blvd															
4	L2	All MCs	125	3.0	125	3.0	0.602	4.3	LOS A	5.7	40.8	0.41	0.40	0.41	49.8
5	T1	All MCs	1172	3.0	1172	3.0	0.602	4.2	LOS A	5.7	40.8	0.42	0.44	0.42	53.4
6	R2	All MCs	513	3.0	513	3.0	0.602	10.0	LOS A	5.7	40.7	0.45	0.53	0.45	47.7
Approach			1809	3.0	1809	3.0	0.602	5.8	LOS A	5.7	40.8	0.43	0.46	0.43	51.4
North: Stage 5 Road															
7	L2	All MCs	57	3.0	57	3.0	0.053	3.1	LOS A	0.2	1.6	0.30	0.40	0.30	47.0
8	T1	All MCs	5	3.0	5	3.0	0.070	2.5	LOS A	0.3	2.2	0.29	0.57	0.29	44.9
9	R2	All MCs	79	3.0	79	3.0	0.070	8.0	LOS A	0.3	2.2	0.29	0.57	0.29	47.1
Approach			141	3.0	141	3.0	0.070	5.8	LOS A	0.3	2.2	0.29	0.50	0.29	47.0
West: Riverlea Blvd															
10	L2	All MCs	79	3.0	79	3.0	0.111	5.8	LOS A	0.7	5.0	0.61	0.57	0.61	52.9
11	T1	All MCs	131	3.0	131	3.0	0.111	6.0	LOS A	0.7	5.0	0.62	0.59	0.62	52.8
12	R2	All MCs	17	3.0	17	3.0	0.111	11.9	LOS A	0.6	4.6	0.62	0.60	0.62	48.1
Approach			226	3.0	226	3.0	0.111	6.3	LOS A	0.7	5.0	0.62	0.59	0.62	52.4
All Vehicles			2213	3.0	2213	3.0	0.602	6.0	LOS A	5.7	40.8	0.44	0.48	0.44	51.1

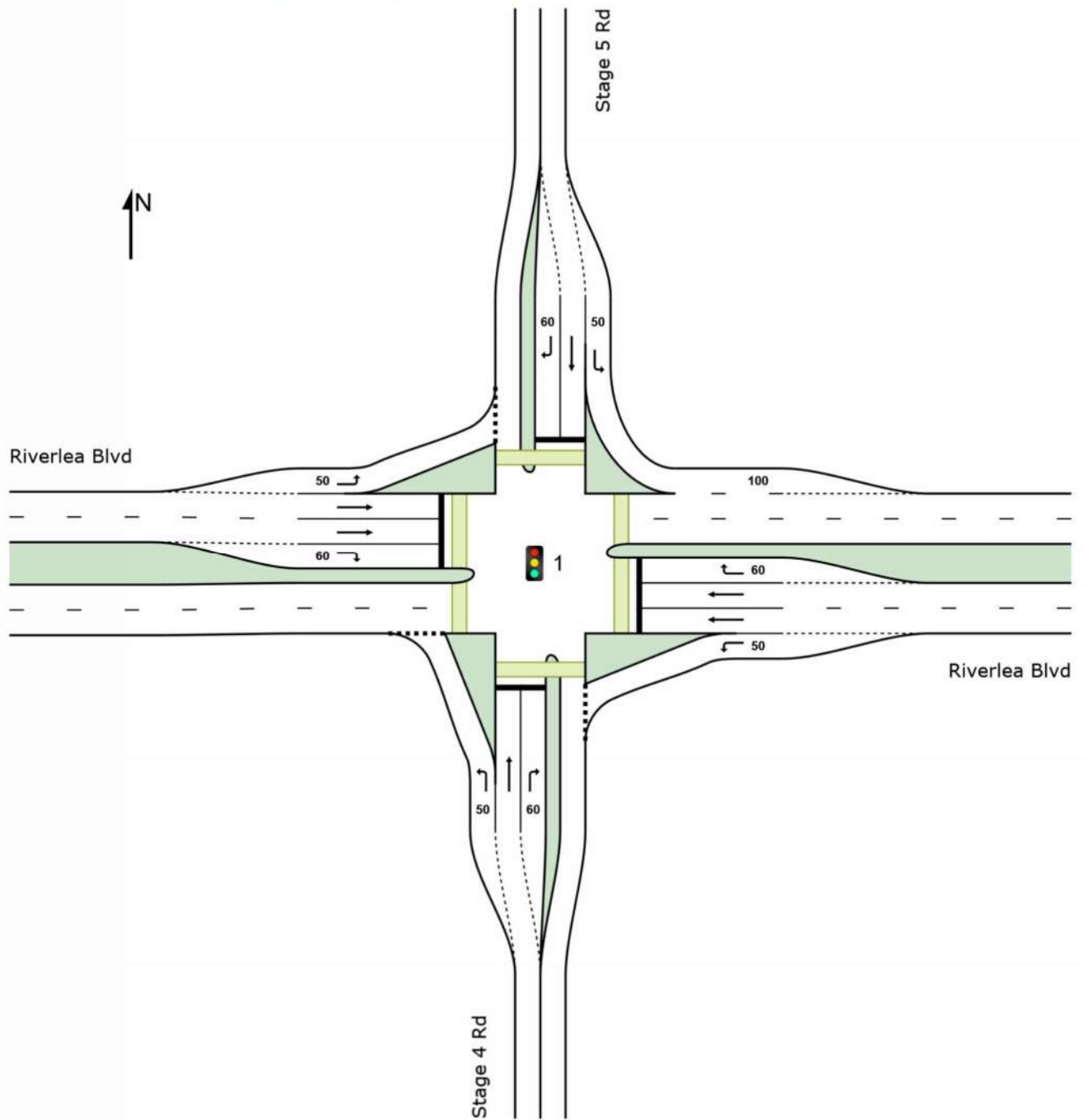
Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay; Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SITE LAYOUT

 **Site: 1 [Prec2_Int3_Ultimate-AMandPM_Upgrade (Site Folder: General)]**

Intersection 3
 Ultimate Volumes
 AM and PM Peak
 Site Category: (None)
 Signals - EQUISAT (Fixed-Time/SCATS) Coordinated

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1 [Prec2_Int3_Ultimate-AM_Upgrade (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 3

Ultimate Volumes

AM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 115 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 4 Rd															
1	L2	All MCs	17	3.0	17	3.0	0.018	5.8	LOS A	0.1	0.8	0.21	0.54	0.21	48.6
2	T1	All MCs	5	3.0	5	3.0	0.024	49.2	LOS D	0.3	1.9	0.91	0.60	0.91	30.1
3	R2	All MCs	125	3.0	125	3.0	* 0.685	61.0	LOS E	7.2	51.7	1.00	0.85	1.09	28.1
Approach			147	3.0	147	3.0	0.685	54.2	LOS D	7.2	51.7	0.91	0.81	0.98	29.6
East: Riverlea Blvd															
4	L2	All MCs	14	3.0	14	3.0	0.010	5.7	LOS A	0.0	0.1	0.02	0.55	0.02	49.4
5	T1	All MCs	494	3.0	494	3.0	0.204	4.0	LOS A	2.7	19.4	0.21	0.18	0.21	56.3
6	R2	All MCs	57	3.0	57	3.0	0.779	34.2	LOS C	2.5	18.2	0.50	0.83	0.87	35.8
Approach			564	3.0	564	3.0	0.779	7.1	LOS A	2.7	19.4	0.24	0.26	0.27	53.0
North: Stage 5 Rd															
7	L2	All MCs	513	3.0	513	3.0	0.279	146.6	LOS F	0.0	0.0	0.00	0.46	0.00	46.4
8	T1	All MCs	5	3.0	5	3.0	0.024	49.2	LOS D	0.3	1.9	0.91	0.60	0.91	30.1
9	R2	All MCs	79	3.0	79	3.0	0.432	57.9	LOS E	4.3	30.9	0.98	0.77	0.98	28.8
Approach			597	3.0	597	3.0	0.432	134.0	LOS F	4.3	30.9	0.14	0.51	0.14	42.7
West: Riverlea Blvd															
10	L2	All MCs	79	3.0	79	3.0	0.077	8.1	LOS A	0.6	4.2	0.17	0.59	0.17	51.3
11	T1	All MCs	2485	3.0	2485	3.0	* 0.860	0.4	LOS A	8.7	62.4	0.14	0.08	0.14	59.3
12	R2	All MCs	17	3.0	17	3.0	0.027	7.3	LOS A	0.1	0.6	0.13	0.57	0.13	48.3
Approach			2581	3.0	2581	3.0	0.860	0.7	LOS A	8.7	62.4	0.14	0.10	0.14	59.0
All Vehicles			3889	3.0	3889	3.0	0.860	24.1	LOS B	8.7	62.4	0.18	0.21	0.19	53.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist]		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Stage 4 Rd												
P1	Full	50	53	51.8	LOS E	0.2	0.2	0.95	0.95	67.2	20.0	0.30
East: Riverlea Blvd												
P21	Stage 1	50	53	51.8	LOS E	0.2	0.2	0.95	0.95	67.2	20.0	0.30
P22	Stage 2	50	53	51.8	LOS E	0.2	0.2	0.95	0.95	67.2	20.0	0.30
North: Stage 5 Rd												
P3	Full	50	53	51.8	LOS E	0.2	0.2	0.95	0.95	67.2	20.0	0.30
West: Riverlea Blvd												
P41	Stage 1	50	53	51.8	LOS E	0.2	0.2	0.95	0.95	67.2	20.0	0.30
P42	Stage 2	50	53	51.8	LOS E	0.2	0.2	0.95	0.95	67.2	20.0	0.30
All Pedestrians		300	316	51.8	LOS E	0.2	0.2	0.95	0.95	67.2	20.0	0.30

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:27:50 PM

PHASING SUMMARY

Site: 1 [Prec2_Int3_Ultimate-AM_Upgrade (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 3

Ultimate Volumes

AM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 115 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Timings based on settings in the Site Phasing & Timing dialog

Phase Times determined by the program

Phase Sequence: DDO - R Filter

Input Phase Sequence: A, D*, D1*, D2*, E, G*, G1*, G2*

Output Phase Sequence: A, E, G1*

Reference Phase: Phase A

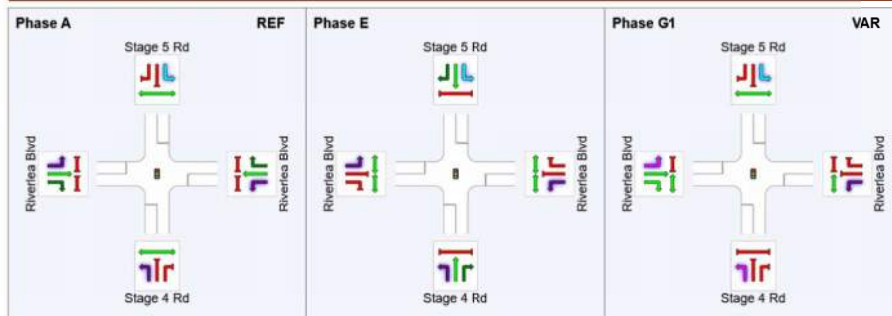
(* Variable Phase)

Phase Timing Summary

Phase	A	E	G1
Phase Change Time (sec)	0	80	101
Green Time (sec)	72	13	6
Phase Time (sec)	80	21	14
Phase Split	70%	18%	12%
Phase Frequency (%)	100.0	100.0	100.0













See the Timing Analysis report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Minor Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.

Output Phase Sequence



REF: Reference Phase

VAR: Variable Phase

 Normal Movement	 Permitted/Opposed
 Slip/Bypass-Lane Movement	 Opposed Slip/Bypass-Lane
 Stopped Movement	 Turn On Red
 Other Movement Class (MC) Running	 Undetected Movement
 Mixed Running & Stopped MCs	 Continuous Movement
 Other Movement Class (MC) Stopped	 Phase Transition Applied

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:27:50 PM

MOVEMENT SUMMARY

Site: 1 [Prec2_Int3_Ultimate-PM_Upgrade (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 3

Ultimate Volumes

PM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 110 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 4 Rd															
1	L2	All MCs	17	3.0	17	3.0	0.070	6.6	LOS A	0.2	1.1	0.28	0.57	0.28	48.0
2	T1	All MCs	5	3.0	5	3.0	0.023	46.5	LOS D	0.3	1.8	0.91	0.60	0.91	30.7
3	R2	All MCs	14	3.0	14	3.0	0.071	52.1	LOS D	0.7	4.8	0.92	0.68	0.92	30.2
Approach			36	3.0	36	3.0	0.071	29.9	LOS C	0.7	4.8	0.61	0.62	0.61	36.7
East: Riverlea Blvd															
4	L2	All MCs	125	3.0	125	3.0	0.087	5.8	LOS A	0.1	0.6	0.02	0.55	0.02	49.3
5	T1	All MCs	2388	3.0	2388	3.0	* 0.839	0.4	LOS A	7.1	50.9	0.12	0.08	0.12	59.4
6	R2	All MCs	513	3.0	513	3.0	0.600	15.4	LOS B	10.7	76.8	0.61	0.79	0.61	43.7
Approach			3026	3.0	3026	3.0	0.839	3.2	LOS A	10.7	76.8	0.20	0.22	0.20	55.6
North: Stage 5 Rd															
7	L2	All MCs	57	3.0	57	3.0	0.031	5.1	LOS A	0.0	0.0	0.00	0.47	0.00	46.5
8	T1	All MCs	5	3.0	5	3.0	0.023	46.5	LOS D	0.3	1.8	0.91	0.60	0.91	30.7
9	R2	All MCs	79	3.0	79	3.0	* 0.412	55.0	LOS D	4.1	29.4	0.97	0.77	0.97	29.5
Approach			141	3.0	141	3.0	0.412	34.5	LOS C	4.1	29.4	0.58	0.64	0.58	34.7
West: Riverlea Blvd															
10	L2	All MCs	79	3.0	79	3.0	0.085	22.6	LOS B	0.3	2.5	0.17	0.59	0.17	51.8
11	T1	All MCs	693	3.0	693	3.0	0.706	40.1	LOS C	16.3	117.2	0.92	0.79	0.92	38.2
12	R2	All MCs	17	3.0	17	3.0	0.227	41.7	LOS C	0.7	5.1	0.74	0.71	0.74	34.1
Approach			788	3.0	788	3.0	0.706	38.4	LOS C	16.3	117.2	0.84	0.77	0.85	39.1
All Vehicles			3992	3.0	3992	3.0	0.839	11.5	LOS A	16.3	117.2	0.34	0.35	0.35	50.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist]		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Stage 4 Rd												
P1	Full	50	53	49.3	LOS E	0.2	0.2	0.95	0.95	64.7	20.0	0.31
East: Riverlea Blvd												
P21	Stage 1	50	53	49.3	LOS E	0.2	0.2	0.95	0.95	64.7	20.0	0.31
P22	Stage 2	50	53	49.3	LOS E	0.2	0.2	0.95	0.95	64.7	20.0	0.31
North: Stage 5 Rd												
P3	Full	50	53	49.3	LOS E	0.2	0.2	0.95	0.95	64.7	20.0	0.31
West: Riverlea Blvd												
P41	Stage 1	50	53	49.3	LOS E	0.2	0.2	0.95	0.95	64.7	20.0	0.31
P42	Stage 2	50	53	49.3	LOS E	0.2	0.2	0.95	0.95	64.7	20.0	0.31
All Pedestrians		300	316	49.3	LOS E	0.2	0.2	0.95	0.95	64.7	20.0	0.31

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:27:33 PM

PHASING SUMMARY

Site: 1 [Prec2_Int3_Ultimate-PM_Upgrade (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 3

Ultimate Volumes

PM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 110 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Timings based on settings in the Site Phasing & Timing dialog

Phase Times determined by the program

Phase Sequence: DDO - R Filter

Input Phase Sequence: A, D*, D1*, D2*, E, G*, G1*, G2*

Output Phase Sequence: A, E, G2*

Reference Phase: Phase A

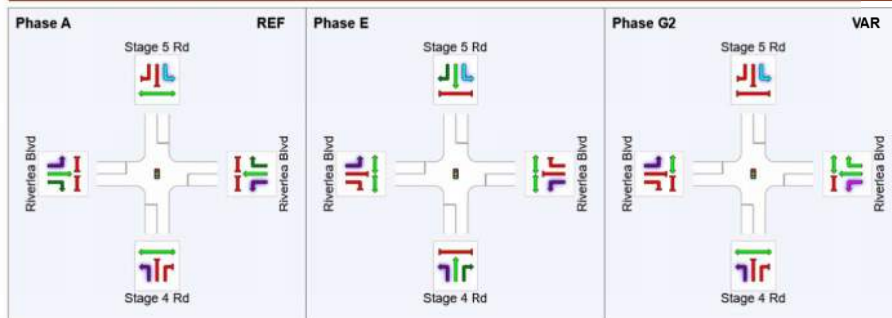
(* Variable Phase)

Phase Timing Summary

Phase	A	E	G2
Phase Change Time (sec)	0	37	58
Green Time (sec)	29	13	44
Phase Time (sec)	37	21	52
Phase Split	34%	19%	47%
Phase Frequency (%)	100.0	100.0	100.0













See the Timing Analysis report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Minor Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.

Output Phase Sequence



REF: Reference Phase

VAR: Variable Phase

 Normal Movement	 Permitted/Opposed
 Slip/Bypass-Lane Movement	 Opposed Slip/Bypass-Lane
 Stopped Movement	 Turn On Red
 Other Movement Class (MC) Running	 Undetected Movement
 Mixed Running & Stopped MCs	 Continuous Movement
 Other Movement Class (MC) Stopped	 Phase Transition Applied

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:27:33 PM

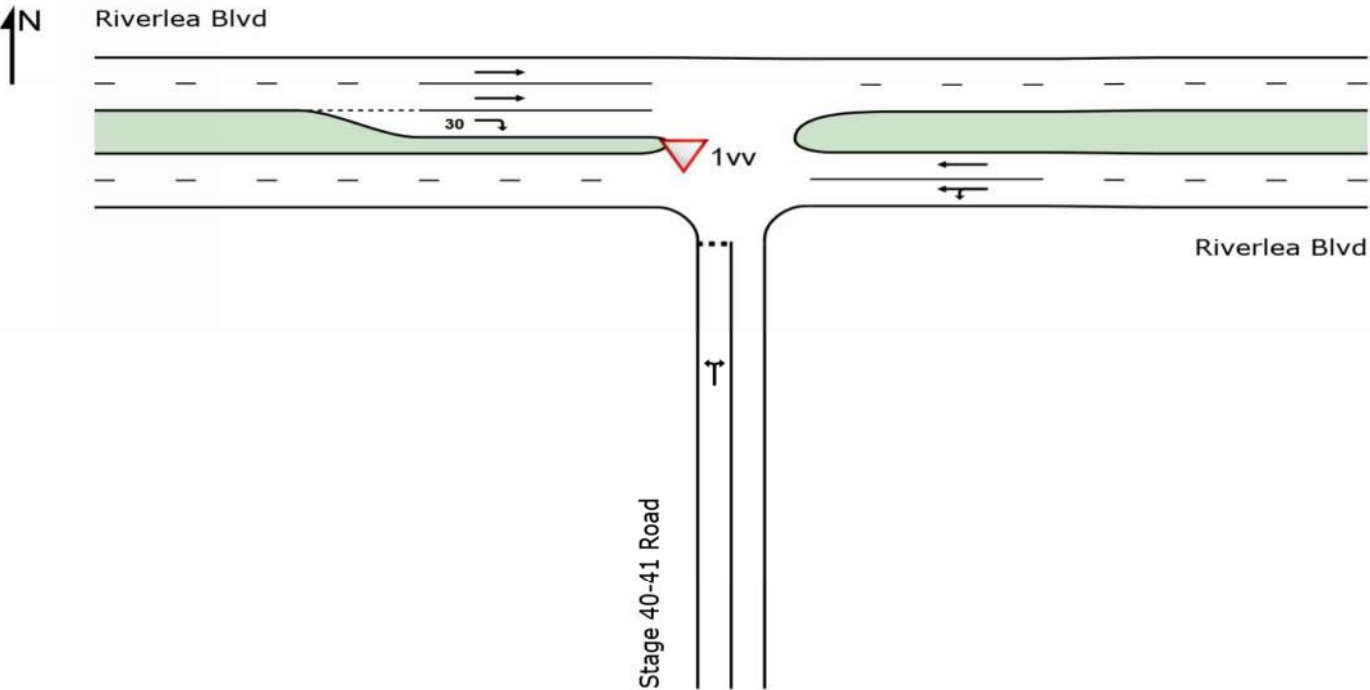
Appendix B Intersection 4 SIDRA Summary

SITE LAYOUT

▼ Site: 1vv [prec2_Intsn4_AMandPM (Site Folder: General)]

Intersection 4
Precinct 2
AM and PM Peak Period
Site Category: (None)
Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1vv [prec2_Intsn4_AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 4
Precinct 2
AM Peak Period
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 40-41 Road															
1	L2	All MCs	15	3.0	15	3.0	0.751	35.3	LOS C	3.3	23.8	1.00	1.24	1.95	23.0
3	R2	All MCs	42	3.0	42	3.0	0.751	108.4	LOS F	3.3	23.8	1.00	1.24	1.95	23.0
Approach			57	3.0	57	3.0	0.751	89.4	LOS F	3.3	23.8	1.00	1.24	1.95	23.0
East: Riverlea Blvd															
4	L2	All MCs	4	3.0	4	3.0	0.059	5.6	LOS A	0.0	0.0	0.00	0.02	0.00	57.1
5	T1	All MCs	221	3.0	221	3.0	0.059	0.0	LOS A	0.0	0.0	0.00	0.01	0.00	59.9
Approach			225	3.0	225	3.0	0.059	0.1	NA	0.0	0.0	0.00	0.01	0.00	59.8
West: Riverlea Blvd															
11	T1	All MCs	1225	3.0	1225	3.0	0.320	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
12	R2	All MCs	15	3.0	15	3.0	0.013	6.4	LOS A	0.0	0.4	0.32	0.56	0.32	48.3
Approach			1240	3.0	1240	3.0	0.320	0.2	NA	0.0	0.4	0.00	0.01	0.00	59.6
All Vehicles			1522	3.0	1522	3.0	0.751	3.5	NA	3.3	23.8	0.04	0.05	0.08	56.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 1vv [prec2_Intsn4_PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 4
Precinct 2
PM Peak Period
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 40-41 Road															
1	L2	All MCs	15	3.0	15	3.0	0.101	8.0	LOS A	0.3	2.0	0.77	0.89	0.77	39.9
3	R2	All MCs	4	3.0	4	3.0	0.101	69.6	LOS E	0.3	2.0	0.77	0.89	0.77	40.0
Approach			19	3.0	19	3.0	0.101	21.7	LOS B	0.3	2.0	0.77	0.89	0.77	39.9
East: Riverlea Blvd															
4	L2	All MCs	42	3.0	42	3.0	0.332	5.7	LOS A	0.0	0.0	0.00	0.04	0.00	56.8
5	T1	All MCs	1225	3.0	1225	3.0	0.332	0.1	LOS A	0.0	0.0	0.00	0.02	0.00	59.6
Approach			1267	3.0	1267	3.0	0.332	0.3	NA	0.0	0.0	0.00	0.02	0.00	59.5
West: Riverlea Blvd															
11	T1	All MCs	221	3.0	221	3.0	0.058	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
12	R2	All MCs	15	3.0	15	3.0	0.058	18.9	LOS B	0.2	1.3	0.82	0.92	0.82	41.6
Approach			236	3.0	236	3.0	0.058	1.2	NA	0.2	1.3	0.05	0.06	0.05	58.4
All Vehicles			1522	3.0	1522	3.0	0.332	0.7	NA	0.3	2.0	0.02	0.04	0.02	59.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

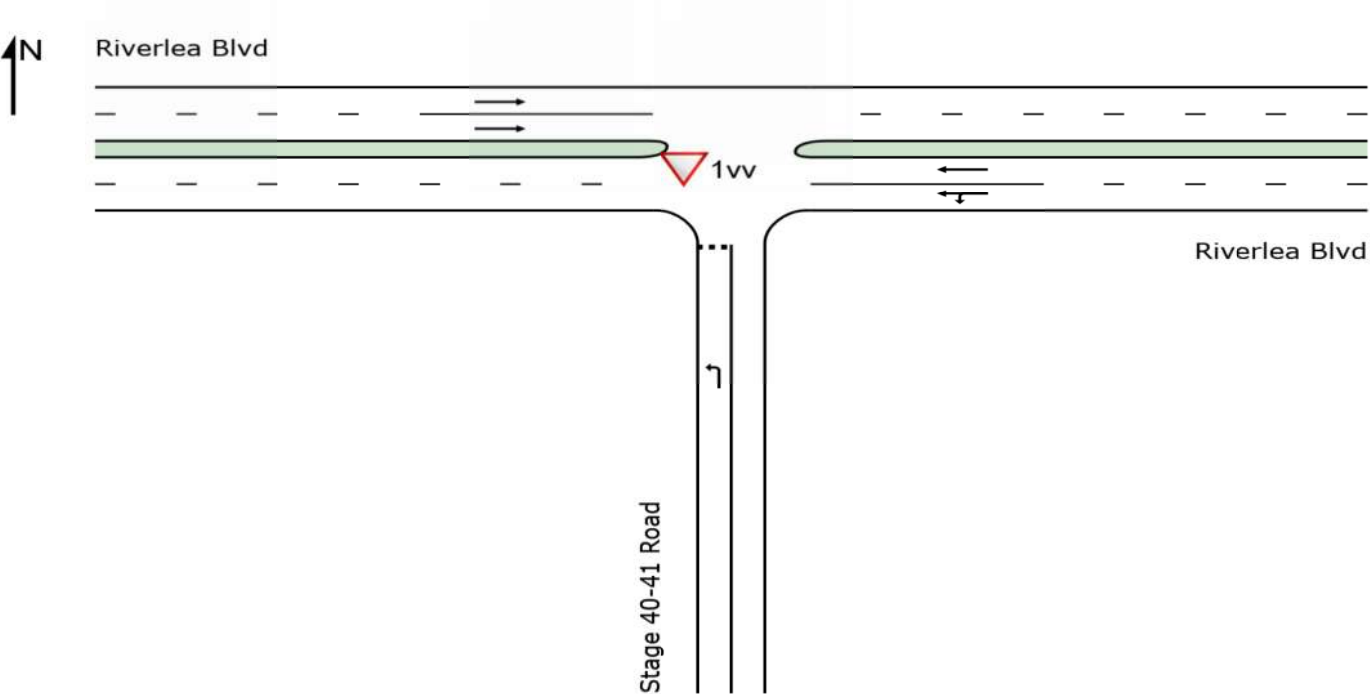
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SITE LAYOUT

▽ Site: 1vv [prec2_Intsn4_AMandPM_Ult (Site Folder: General)]

Intersection 4
 Ultimate Volumes
 AM and PM Peak Period
 Site Category: (None)
 Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1vv [prec2_Intsn4_AM_Ult (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 4
Ultimate Volumes
AM Peak Period
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 40-41 Road															
1	L2	All MCs	15	3.0	15	3.0	0.025	8.4	LOS A	0.1	0.6	0.52	0.68	0.52	46.7
Approach			15	3.0	15	3.0	0.025	8.4	LOS A	0.1	0.6	0.52	0.68	0.52	46.7
East: Riverlea Blvd															
4	L2	All MCs	4	3.0	4	3.0	0.154	5.6	LOS A	0.0	0.0	0.00	0.01	0.00	57.2
5	T1	All MCs	584	3.0	584	3.0	0.154	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach			588	3.0	588	3.0	0.154	0.1	NA	0.0	0.0	0.00	0.00	0.00	59.9
West: Riverlea Blvd															
11	T1	All MCs	2581	3.0	2581	3.0	0.675	0.4	LOS A	0.0	0.0	0.00	0.00	0.00	59.2
Approach			2581	3.0	2581	3.0	0.675	0.4	NA	0.0	0.0	0.00	0.00	0.00	59.2
All Vehicles			3184	3.0	3184	3.0	0.675	0.4	NA	0.1	0.6	0.00	0.00	0.00	59.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
 Vehicle movement LOS values are based on average delay per movement.
 Minor Road Approach LOS values are based on average delay for all vehicle movements.
 NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
 Two-Way Sign Control Capacity Model: SIDRA Standard.
 Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
 Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
 Gap-Acceptance Capacity Formula: SIDRA Standard (Akcelik M3D).
 HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
 Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 1vv [prec2_Intsn4_PM_Ult (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 4
Ultimate Volumes
PM Peak Period
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 40-41 Road															
1	L2	All MCs	15	3.0	15	3.0	0.085	23.9	LOS B	0.2	1.7	0.87	0.94	0.87	39.0
Approach			15	3.0	15	3.0	0.085	23.9	LOS B	0.2	1.7	0.87	0.94	0.87	39.0
East: Riverlea Blvd															
4	L2	All MCs	42	3.0	42	3.0	0.650	5.9	LOS A	0.0	0.0	0.00	0.02	0.00	56.6
5	T1	All MCs	2442	3.0	2442	3.0	0.650	0.4	LOS A	0.0	0.0	0.00	0.01	0.00	59.2
Approach			2484	3.0	2484	3.0	0.650	0.5	NA	0.0	0.0	0.00	0.01	0.00	59.1
West: Riverlea Blvd															
11	T1	All MCs	788	3.0	788	3.0	0.206	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach			788	3.0	788	3.0	0.206	0.1	NA	0.0	0.0	0.00	0.00	0.00	59.9
All Vehicles			3287	3.0	3287	3.0	0.650	0.5	NA	0.2	1.7	0.00	0.01	0.00	59.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
 Vehicle movement LOS values are based on average delay per movement.
 Minor Road Approach LOS values are based on average delay for all vehicle movements.
 NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
 Two-Way Sign Control Capacity Model: SIDRA Standard.
 Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
 Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
 Gap-Acceptance Capacity Formula: SIDRA Standard (Akcelik M3D).
 HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
 Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

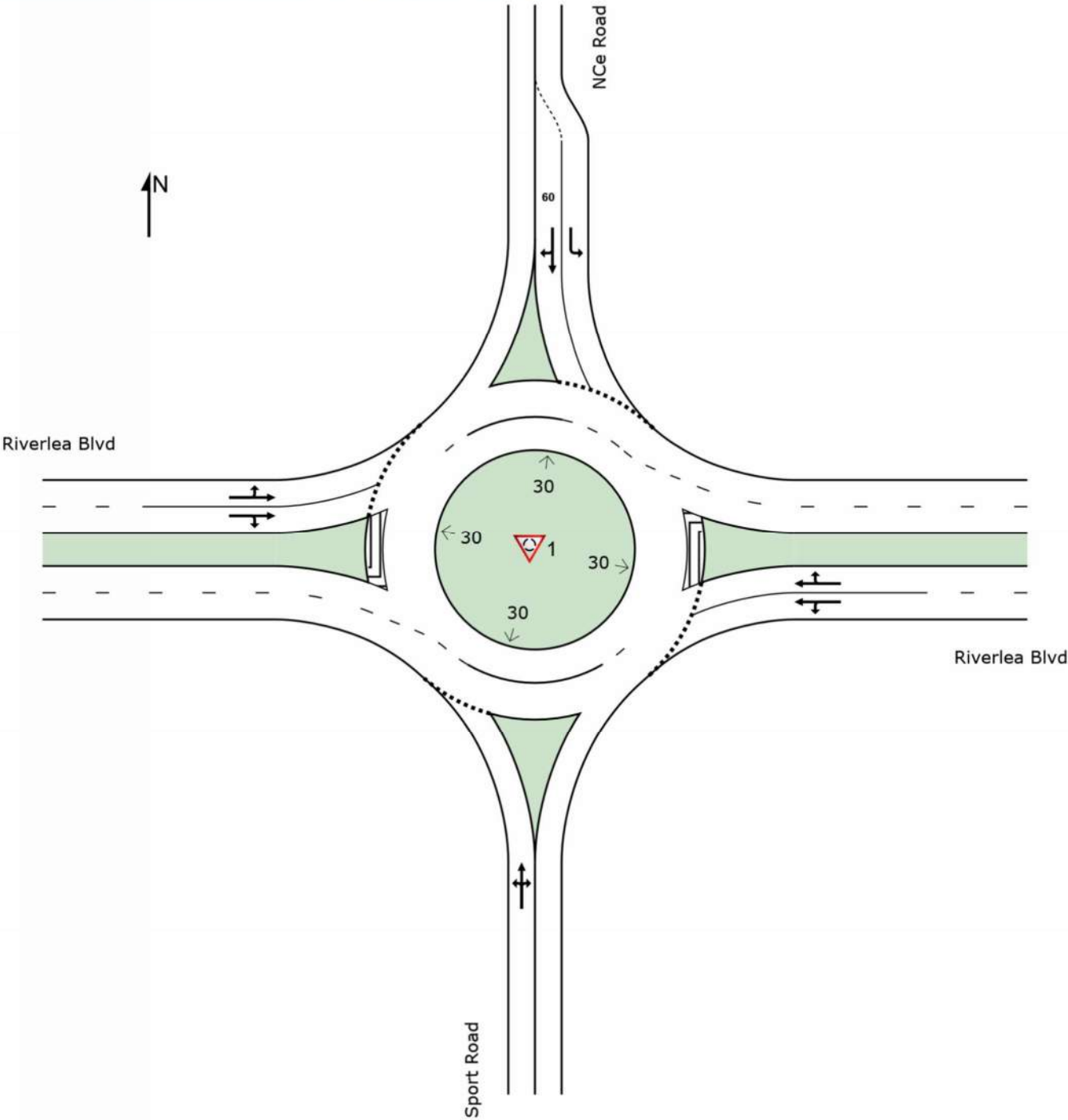
Appendix C Intersection 5 SIDRA Summary

SITE LAYOUT

 Site: 1 [Prec2_Int_5_AMandPM (Site Folder: General)]

Intersection 5
Precinct 2 Volumes
AM and PM Peak
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1 [Prec2_Int_5_AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5
Precinct 2 Volumes
AM Peak
Site Category: (None)
Roundabout

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%				veh	m				
South: Sport Road															
1	L2	All MCs	5	3.0	5	3.0	0.124	3.4	LOS A	0.5	3.6	0.38	0.59	0.38	48.0
2	T1	All MCs	26	3.0	26	3.0	0.124	3.1	LOS A	0.5	3.6	0.38	0.59	0.38	45.2
3	R2	All MCs	98	3.0	98	3.0	0.124	8.6	LOS A	0.5	3.6	0.38	0.59	0.38	47.5
Approach			129	3.0	129	3.0	0.124	7.3	LOS A	0.5	3.6	0.38	0.59	0.38	47.0
East: Riverlea Blvd															
4	L2	All MCs	18	3.0	18	3.0	0.081	4.1	LOS A	0.5	3.3	0.29	0.38	0.29	50.3
5	T1	All MCs	104	3.0	104	3.0	0.081	3.9	LOS A	0.5	3.3	0.29	0.38	0.29	54.6
6	R2	All MCs	114	3.0	114	3.0	0.087	9.7	LOS A	0.5	3.4	0.31	0.59	0.31	46.9
Approach			236	3.0	236	3.0	0.087	6.7	LOS A	0.5	3.4	0.30	0.48	0.30	50.2
North: NCe Road															
7	L2	All MCs	685	3.0	685	3.0	0.615	5.7	LOS A	4.6	33.0	0.69	0.72	0.81	46.0
8	T1	All MCs	26	3.0	26	3.0	0.179	4.9	LOS A	0.7	5.1	0.54	0.71	0.54	44.4
9	R2	All MCs	96	3.0	96	3.0	0.179	10.4	LOS A	0.7	5.1	0.54	0.71	0.54	46.7
Approach			807	3.0	807	3.0	0.615	6.3	LOS A	4.6	33.0	0.66	0.72	0.77	46.0
West: Riverlea Blvd															
10	L2	All MCs	96	3.0	96	3.0	0.212	4.6	LOS A	1.2	8.9	0.41	0.45	0.41	53.6
11	T1	All MCs	456	3.0	456	3.0	0.212	4.5	LOS A	1.2	8.9	0.42	0.45	0.42	54.0
12	R2	All MCs	5	3.0	5	3.0	0.212	10.4	LOS A	1.2	8.6	0.43	0.45	0.43	49.2
Approach			557	3.0	557	3.0	0.212	4.6	LOS A	1.2	8.9	0.42	0.45	0.42	53.8
All Vehicles			1729	3.0	1729	3.0	0.615	5.9	LOS A	4.6	33.0	0.51	0.59	0.56	49.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay; Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 1 [Prec2_Int_5_PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5
Precinct 2 Volumes
PM Peak
Site Category: (None)
Roundabout

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Sport Road															
1	L2	All MCs	5	3.0	5	3.0	0.076	6.2	LOS A	0.3	2.3	0.66	0.74	0.66	47.8
2	T1	All MCs	26	3.0	26	3.0	0.076	5.9	LOS A	0.3	2.3	0.66	0.74	0.66	45.0
3	R2	All MCs	18	3.0	18	3.0	0.076	11.4	LOS A	0.3	2.3	0.66	0.74	0.66	47.3
Approach			49	3.0	49	3.0	0.076	7.9	LOS A	0.3	2.3	0.66	0.74	0.66	46.1
East: Riverlea Blvd															
4	L2	All MCs	98	3.0	98	3.0	0.418	4.5	LOS A	3.0	21.4	0.39	0.41	0.39	49.9
5	T1	All MCs	456	3.0	456	3.0	0.418	4.3	LOS A	3.0	21.4	0.39	0.41	0.39	54.1
6	R2	All MCs	685	3.0	685	3.0	0.434	9.8	LOS A	3.2	23.1	0.37	0.59	0.37	46.7
Approach			1239	3.0	1239	3.0	0.434	7.3	LOS A	3.2	23.1	0.38	0.51	0.38	49.4
North: NCe Road															
7	L2	All MCs	114	3.0	114	3.0	0.090	2.9	LOS A	0.4	3.0	0.27	0.38	0.27	47.1
8	T1	All MCs	26	3.0	26	3.0	0.090	2.3	LOS A	0.4	3.0	0.26	0.53	0.26	45.4
9	R2	All MCs	96	3.0	96	3.0	0.090	7.8	LOS A	0.4	3.0	0.26	0.53	0.26	47.7
Approach			236	3.0	236	3.0	0.090	4.9	LOS A	0.4	3.0	0.26	0.46	0.26	47.2
West: Riverlea Blvd															
10	L2	All MCs	96	3.0	96	3.0	0.118	7.1	LOS A	0.8	5.7	0.72	0.64	0.72	52.5
11	T1	All MCs	104	3.0	104	3.0	0.118	7.6	LOS A	0.8	5.7	0.72	0.65	0.72	52.4
12	R2	All MCs	5	3.0	5	3.0	0.118	13.5	LOS A	0.7	5.1	0.72	0.66	0.72	47.9
Approach			205	3.0	205	3.0	0.118	7.5	LOS A	0.8	5.7	0.72	0.65	0.72	52.3
All Vehicles			1729	3.0	1729	3.0	0.434	7.0	LOS A	3.2	23.1	0.41	0.52	0.41	49.3

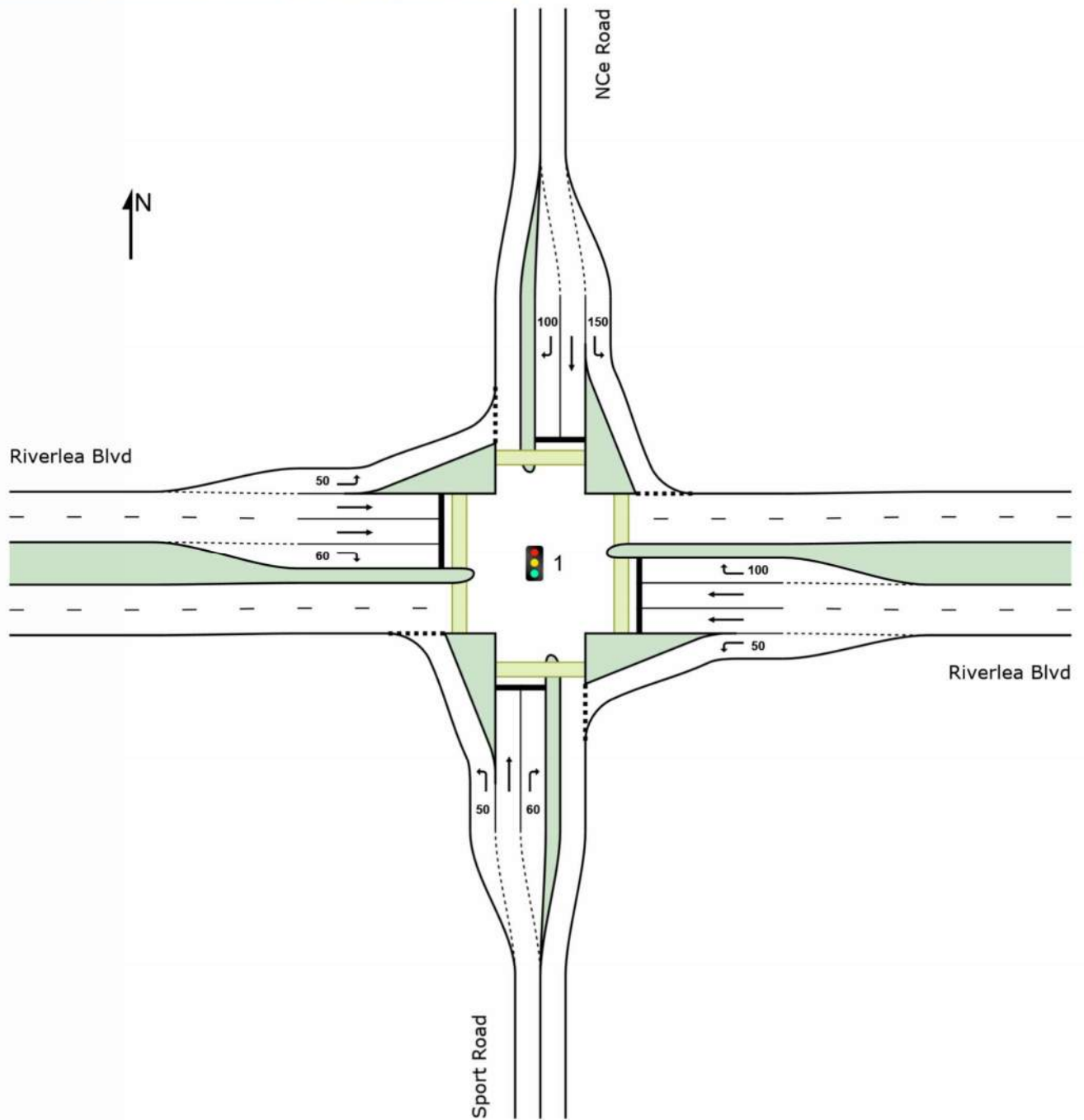
Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay; Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SITE LAYOUT

Site: 1 [Prec2_Int_5_AMandPM_Signals-Staged Ped (Site Folder: General)]

Intersection 5
 Precinct 2 Volumes
 AM and PM Peak
 Site Category: (None)
 Signals - EQUISAT (Fixed-Time/SCATS) Isolated

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1 [Prec2_Int_5_AM_Signals-Staged Ped (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5

Precinct 2 Volumes

AM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 90 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Sport Road															
1	L2	All MCs	5	3.0	5	3.0	0.004	6.1	LOS A	0.0	0.3	0.25	0.54	0.25	48.4
2	T1	All MCs	26	3.0	26	3.0	* 0.204	45.5	LOS D	1.2	8.4	0.98	0.70	0.98	30.9
3	R2	All MCs	98	3.0	98	3.0	* 0.400	44.5	LOS D	4.1	29.4	0.96	0.77	0.96	32.2
Approach			129	3.0	129	3.0	0.400	43.2	LOS D	4.1	29.4	0.93	0.75	0.93	32.3
East: Riverlea Blvd															
4	L2	All MCs	18	3.0	18	3.0	0.012	6.5	LOS A	0.1	0.6	0.20	0.58	0.20	48.8
5	T1	All MCs	104	3.0	104	3.0	0.093	25.1	LOS B	1.7	12.0	0.76	0.58	0.76	42.5
6	R2	All MCs	114	3.0	114	3.0	* 0.398	43.7	LOS D	4.6	33.4	0.94	0.78	0.94	32.7
Approach			236	3.0	236	3.0	0.398	32.7	LOS C	4.6	33.4	0.81	0.68	0.81	37.4
North: NCe Road															
7	L2	All MCs	685	3.0	685	3.0	0.635	10.2	LOS A	14.0	100.5	0.64	0.76	0.64	43.1
8	T1	All MCs	26	3.0	26	3.0	0.204	45.5	LOS D	1.2	8.4	0.98	0.70	0.98	30.9
9	R2	All MCs	96	3.0	96	3.0	0.391	44.5	LOS D	4.0	28.7	0.96	0.77	0.96	32.2
Approach			807	3.0	807	3.0	0.635	15.4	LOS B	14.0	100.5	0.69	0.76	0.69	40.9
West: Riverlea Blvd															
10	L2	All MCs	96	3.0	96	3.0	0.070	7.3	LOS A	0.7	5.0	0.27	0.62	0.27	51.8
11	T1	All MCs	456	3.0	456	3.0	* 0.408	28.0	LOS B	8.1	58.5	0.85	0.71	0.85	41.1
12	R2	All MCs	5	3.0	5	3.0	0.018	40.5	LOS C	0.2	1.4	0.87	0.64	0.87	33.6
Approach			557	3.0	557	3.0	0.408	24.6	LOS B	8.1	58.5	0.75	0.70	0.75	42.6
All Vehicles			1729	3.0	1729	3.0	0.635	22.8	LOS B	14.0	100.5	0.74	0.73	0.74	40.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist]		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Sport Road												
P1	Full	50	53	30.5	LOS D	0.1	0.1	0.82	0.82	45.9	20.0	0.44
East: Riverlea Blvd												
P21	Stage 1	50	53	28.1	LOS C	0.1	0.1	0.79	0.79	43.5	20.0	0.46
P22	Stage 2	50	53	24.3	LOS C	0.1	0.1	0.73	0.73	39.6	20.0	0.50
North: NCe Road												
P3	Full	50	53	30.5	LOS D	0.1	0.1	0.82	0.82	45.9	20.0	0.44
West: Riverlea Blvd												
P41	Stage 1	50	53	28.1	LOS C	0.1	0.1	0.79	0.79	43.5	20.0	0.46
P42	Stage 2	50	53	24.3	LOS C	0.1	0.1	0.73	0.73	39.6	20.0	0.50
All Pedestrians		300	316	27.6	LOS C	0.1	0.1	0.78	0.78	43.0	20.0	0.47

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:21:23 PM

PHASING SUMMARY

Site: 1 [Prec2_Int_5_AM_Signals-Staged Ped (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5

Precinct 2 Volumes

AM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 90 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Timings based on settings in the Site Phasing & Timing dialog

Phase Times determined by the program

Phase Sequence: DDO

Input Phase Sequence: A, D*, D1*, D2*, E, G*, G1*, G2*

Output Phase Sequence: A, D*, E, G*

Reference Phase: Phase A

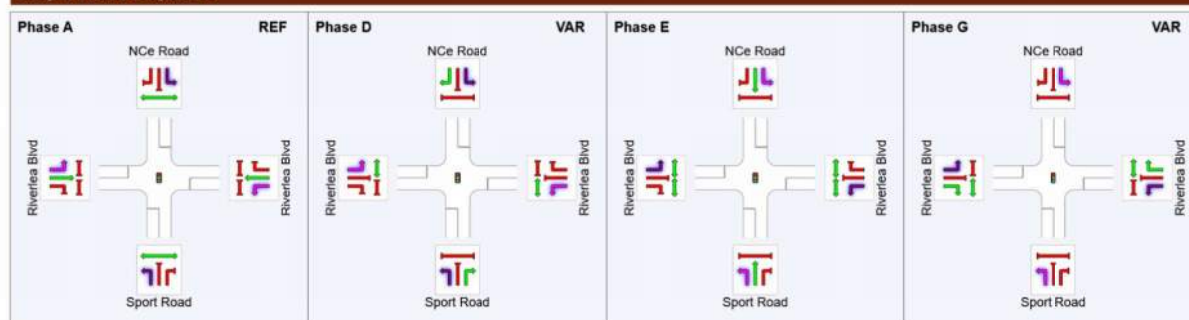
(* Variable Phase)

Phase Timing Summary

Phase	A	D	E	G
Phase Change Time (sec)	0	34	54	68
Green Time (sec)	26	12	6	14
Phase Time (sec)	34	20	14	22
Phase Split	38%	22%	16%	24%
Phase Frequency (%)	100.0	100.0	100.0	100.0

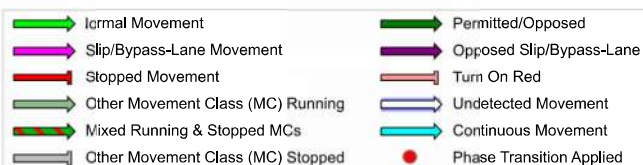
See the Timing Analysis report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Minor Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.

Output Phase Sequence



REF: Reference Phase

VAR: Variable Phase



SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:21:23 PM

MOVEMENT SUMMARY

Site: 1 [Prec2_Int_5_PM_Signals-Staged Ped (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5

Precinct 2 Volumes

PM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 125 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Sport Road															
1	L2	All MCs	5	3.0	5	3.0	0.005	8.9	LOS A	0.1	0.6	0.32	0.55	0.32	46.7
2	T1	All MCs	26	3.0	26	3.0	* 0.284	65.8	LOS E	1.6	11.8	1.00	0.71	1.00	26.5
3	R2	All MCs	18	3.0	18	3.0	0.152	66.7	LOS E	1.1	7.7	0.98	0.70	0.98	26.9
Approach			49	3.0	49	3.0	0.284	60.0	LOS E	1.6	11.8	0.92	0.69	0.92	27.9
East: Riverlea Blvd															
4	L2	All MCs	98	3.0	98	3.0	0.064	6.3	LOS A	0.5	3.3	0.15	0.59	0.15	49.0
5	T1	All MCs	456	3.0	456	3.0	0.273	27.6	LOS B	8.8	63.3	0.69	0.58	0.69	43.0
6	R2	All MCs	685	3.0	685	3.0	* 0.807	41.1	LOS C	35.3	253.3	0.90	0.88	0.92	35.6
Approach			1239	3.0	1239	3.0	0.807	33.4	LOS C	35.3	253.3	0.76	0.75	0.77	38.9
North: NCe Road															
7	L2	All MCs	114	3.0	114	3.0	0.076	5.5	LOS A	0.7	5.2	0.18	0.55	0.18	45.6
8	T1	All MCs	26	3.0	26	3.0	0.284	65.8	LOS E	1.6	11.8	1.00	0.71	1.00	26.5
9	R2	All MCs	96	3.0	96	3.0	* 0.815	74.5	LOS F	6.4	45.9	1.00	0.93	1.27	25.5
Approach			236	3.0	236	3.0	0.815	40.3	LOS C	6.4	45.9	0.60	0.72	0.72	32.5
West: Riverlea Blvd															
10	L2	All MCs	96	3.0	96	3.0	0.120	18.7	LOS B	2.7	19.2	0.55	0.69	0.55	44.6
11	T1	All MCs	104	3.0	104	3.0	* 0.211	53.5	LOS D	2.9	20.8	0.93	0.71	0.93	32.0
12	R2	All MCs	5	3.0	5	3.0	0.014	48.3	LOS D	0.3	1.8	0.82	0.65	0.82	31.4
Approach			205	3.0	205	3.0	0.211	37.1	LOS C	2.9	20.8	0.75	0.70	0.75	36.9
All Vehicles			1729	3.0	1729	3.0	0.815	35.5	LOS C	35.3	253.3	0.75	0.74	0.77	37.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist]		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Sport Road												
P1	Full	50	53	26.3	LOS C	0.1	0.1	0.65	0.65	41.7	20.0	0.48
East: Riverlea Blvd												
P21	Stage 1	50	53	48.5	LOS E	0.2	0.2	0.88	0.88	63.9	20.0	0.31
P22	Stage 2	50	53	32.5	LOS D	0.1	0.1	0.72	0.72	47.9	20.0	0.42
North: NCe Road												
P3	Full	50	53	56.8	LOS E	0.2	0.2	0.95	0.95	72.2	20.0	0.28
West: Riverlea Blvd												
P41	Stage 1	50	53	15.3	LOS B	0.1	0.1	0.70	0.70	30.7	20.0	0.65
P42	Stage 2	50	53	32.5	LOS D	0.1	0.1	0.72	0.72	47.9	20.0	0.42
All Pedestrians		300	316	35.3	LOS D	0.2	0.2	0.77	0.77	50.7	20.0	0.39

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:21:15 PM

PHASING SUMMARY

Site: 1 [Prec2_Int_5_PM_Signals-Staged Ped (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5

Precinct 2 Volumes

PM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 125 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Timings based on settings in the Site Phasing & Timing dialog

Phase Times determined by the program

Phase Sequence: DDO

Input Phase Sequence: A, D, D1*, D2*, E, G, G1*, G2*

Output Phase Sequence: A, D, E, G, G2*

Reference Phase: Phase A

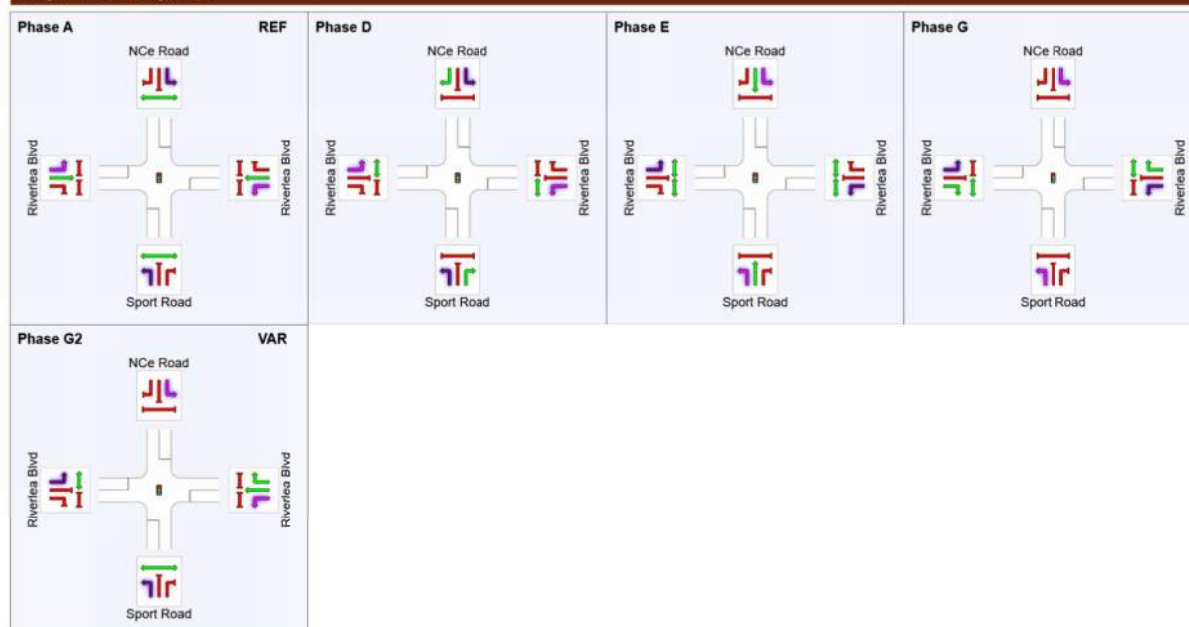
(* Variable Phase)

Phase Timing Summary

Phase	A	D	E	G	G2
Phase Change Time (sec)	0	24	40	54	87
Green Time (sec)	16	8	6	25	30
Phase Time (sec)	24	16	14	33	38
Phase Split	19%	13%	11%	26%	30%
Phase Frequency (%)	100.0	100.0	100.0	100.0	100.0













See the Timing Analysis report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Minor Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.

Output Phase Sequence



REF: Reference Phase

VAR: Variable Phase

 Normal Movement	 Permitted/Opposed
 Slip/Bypass-Lane Movement	 Opposed Slip/Bypass-Lane
 Stopped Movement	 Turn On Red
 Other Movement Class (MC) Running	 Undetected Movement
 Mixed Running & Stopped MCs	 Continuous Movement
 Other Movement Class (MC) Stopped	 Phase Transition Applied

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

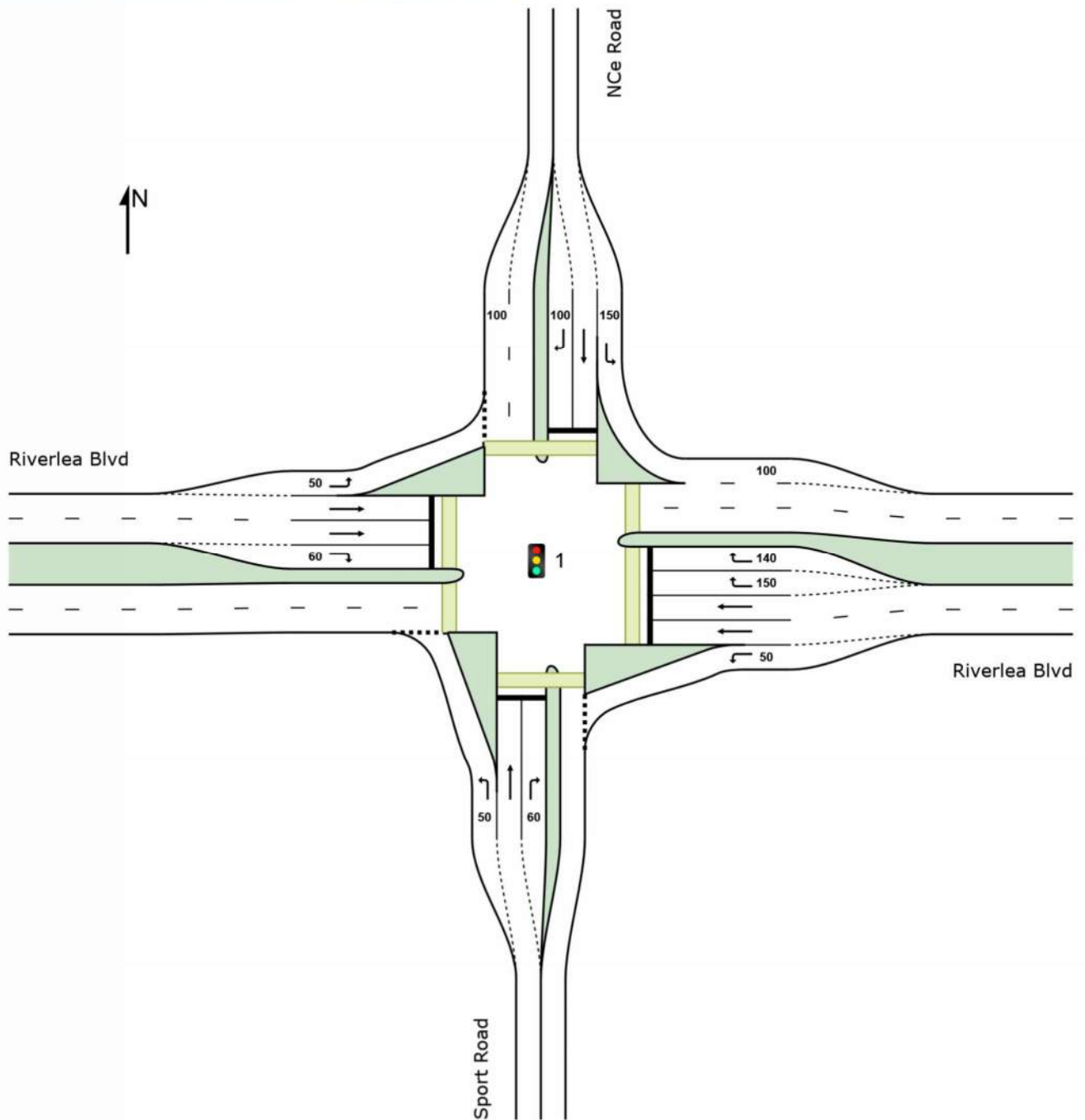
Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:21:15 PM

SITE LAYOUT

Site: 1 [Prec2_Int_5_AMandPM_Signals-Ultimate-Staged Ped (Site Folder: General)]

Intersection 5
Ultimate Volumes
AM and PM Peak
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Isolated

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1 [Prec2_Int_5_AM_Signals-Ultimate-Staged Ped (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5

Ultimate Volumes

AM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 145 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Sport Road															
1	L2	All MCs	5	3.0	5	3.0	0.005	6.7	LOS A	0.1	0.4	0.22	0.54	0.22	48.0
2	T1	All MCs	34	3.0	34	3.0	* 0.421	78.0	LOS F	2.5	17.8	1.00	0.73	1.00	24.4
3	R2	All MCs	155	3.0	155	3.0	* 0.814	79.7	LOS F	11.6	83.2	1.00	0.93	1.18	24.7
Approach			194	3.0	194	3.0	0.814	77.4	LOS F	11.6	83.2	0.98	0.89	1.12	25.0
East: Riverlea Blvd															
4	L2	All MCs	18	3.0	18	3.0	0.011	6.3	LOS A	0.1	0.7	0.14	0.57	0.14	48.9
5	T1	All MCs	467	3.0	467	3.0	0.206	14.8	LOS B	7.6	54.4	0.50	0.43	0.50	48.3
6	R2	All MCs	114	3.0	114	3.0	* 0.802	85.8	LOS F	5.5	39.4	1.00	0.83	1.16	23.9
Approach			599	3.0	599	3.0	0.802	28.0	LOS B	7.6	54.4	0.59	0.51	0.62	40.5
North: NCe Road															
7	L2	All MCs	685	3.0	685	3.0	0.373	11.7	LOS A	0.0	0.0	0.00	0.46	0.00	46.3
8	T1	All MCs	34	3.0	34	3.0	0.421	77.9	LOS F	2.5	17.8	1.00	0.73	1.00	24.4
9	R2	All MCs	96	3.0	96	3.0	0.504	72.6	LOS F	6.6	47.4	0.99	0.78	0.99	25.9
Approach			815	3.0	815	3.0	0.504	21.6	LOS B	6.6	47.4	0.16	0.51	0.16	41.0
West: Riverlea Blvd															
10	L2	All MCs	96	3.0	96	3.0	0.062	41.4	LOS C	0.8	5.8	0.18	0.59	0.18	52.1
11	T1	All MCs	1769	3.0	1769	3.0	* 0.817	42.2	LOS C	50.6	363.4	0.86	0.79	0.86	42.6
12	R2	All MCs	7	3.0	7	3.0	0.083	96.6	LOS F	0.5	3.7	0.98	0.66	0.98	24.8
Approach			1873	3.0	1873	3.0	0.817	42.4	LOS C	50.6	363.4	0.83	0.78	0.83	42.9
All Vehicles			3480	3.0	3480	3.0	0.817	37.0	LOS C	50.6	363.4	0.64	0.68	0.65	40.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist]		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Sport Road												
P1	Full	50	53	16.9	LOS B	0.1	0.1	0.48	0.48	32.3	20.0	0.62
East: Riverlea Blvd												
P21	Stage 1	50	53	54.9	LOS E	0.2	0.2	0.87	0.87	70.2	20.0	0.28
P22	Stage 2	50	53	56.6	LOS E	0.2	0.2	0.88	0.88	72.0	20.0	0.28
North: NCe Road												
P3	Full	50	53	17.9	LOS B	0.1	0.1	0.50	0.50	33.3	20.0	0.60
West: Riverlea Blvd												
P41	Stage 1	50	53	52.3	LOS E	0.2	0.2	0.85	0.85	67.7	20.0	0.30
P42	Stage 2	50	53	56.6	LOS E	0.2	0.2	0.88	0.88	72.0	20.0	0.28
All Pedestrians		300	316	42.5	LOS E	0.2	0.2	0.75	0.75	57.9	20.0	0.35

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:23:26 PM

PHASING SUMMARY

Site: 1 [Prec2_Int_5_AM_Signals-Ultimate-Staged Ped (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5

Ultimate Volumes

AM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 145 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Timings based on settings in the Site Phasing & Timing dialog

Phase Times determined by the program

Phase Sequence: DDO

Input Phase Sequence: A, D, D1*, D2*, E, G, G1*, G2*

Output Phase Sequence: A, D, E, G

Reference Phase: Phase A

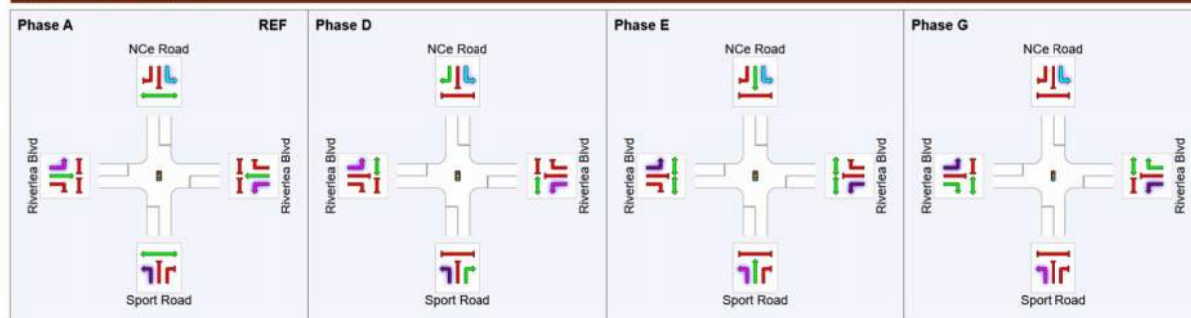
(* Variable Phase)

Phase Timing Summary

Phase	A	D	E	G
Phase Change Time (sec)	0	93	116	130
Green Time (sec)	85	15	6	7
Phase Time (sec)	93	23	14	15
Phase Split	64%	16%	10%	10%
Phase Frequency (%)	100.0	100.0	100.0	100.0













See the Timing Analysis report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Minor Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.

Output Phase Sequence



REF: Reference Phase

VAR: Variable Phase

 Normal Movement	 Permitted/Opposed
 Slip/Bypass-Lane Movement	 Opposed Slip/Bypass-Lane
 Stopped Movement	 Turn On Red
 Other Movement Class (MC) Running	 Undetected Movement
 Mixed Running & Stopped MCs	 Continuous Movement
 Other Movement Class (MC) Stopped	 Phase Transition Applied

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:23:26 PM

MOVEMENT SUMMARY

Site: 1 [Prec2_Int_5_PM_Signals-Ultimate-Staged Ped (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5

Ultimate Volumes

PM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 120 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Sport Road															
1	L2	All MCs	5	3.0	5	3.0	0.010	24.2	LOS B	0.2	1.2	0.63	0.61	0.63	39.1
2	T1	All MCs	34	3.0	34	3.0	* 0.349	64.4	LOS E	2.0	14.6	1.00	0.72	1.00	27.0
3	R2	All MCs	44	3.0	44	3.0	0.361	65.3	LOS E	2.6	18.8	0.99	0.74	0.99	27.3
Approach			83	3.0	83	3.0	0.361	62.4	LOS E	2.6	18.8	0.97	0.72	0.97	27.7
East: Riverlea Blvd															
4	L2	All MCs	98	3.0	98	3.0	0.063	33.6	LOS C	0.5	3.7	0.17	0.59	0.17	48.9
5	T1	All MCs	1673	3.0	1673	3.0	* 0.805	29.3	LOS C	39.6	284.2	0.86	0.79	0.86	44.2
6	R2	All MCs	685	3.0	685	3.0	0.667	40.6	LOS C	21.2	152.6	0.87	0.83	0.87	34.0
Approach			2456	3.0	2456	3.0	0.805	32.6	LOS C	39.6	284.2	0.84	0.80	0.84	40.9
North: NCe Road															
7	L2	All MCs	114	3.0	114	3.0	0.062	5.0	LOS A	0.0	0.0	0.00	0.47	0.00	46.4
8	T1	All MCs	34	3.0	34	3.0	0.349	63.3	LOS E	2.0	14.6	1.00	0.72	1.00	27.0
9	R2	All MCs	96	3.0	96	3.0	* 0.782	70.5	LOS E	6.1	43.6	1.00	0.91	1.23	26.3
Approach			243	3.0	243	3.0	0.782	38.9	LOS C	6.1	43.6	0.53	0.68	0.62	33.1
West: Riverlea Blvd															
10	L2	All MCs	96	3.0	96	3.0	0.090	32.6	LOS C	1.7	12.1	0.39	0.65	0.39	49.1
11	T1	All MCs	666	3.0	666	3.0	0.676	51.3	LOS D	18.2	131.0	0.95	0.82	0.95	35.4
12	R2	All MCs	7	3.0	7	3.0	* 0.080	74.7	LOS F	0.4	3.1	0.98	0.66	0.98	27.1
Approach			769	3.0	769	3.0	0.676	49.2	LOS D	18.2	131.0	0.88	0.79	0.88	36.6
All Vehicles			3552	3.0	3552	3.0	0.805	37.3	LOS C	39.6	284.2	0.83	0.79	0.84	38.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist]		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Sport Road												
P1	Full	50	53	16.1	LOS B	0.1	0.1	0.52	0.52	31.4	20.0	0.64
East: Riverlea Blvd												
P21	Stage 1	50	53	48.7	LOS E	0.2	0.2	0.90	0.90	64.1	20.0	0.31
P22	Stage 2	50	53	19.3	LOS B	0.1	0.1	0.57	0.57	34.7	20.0	0.58
North: NCe Road												
P3	Full	50	53	41.8	LOS E	0.1	0.1	0.84	0.84	57.1	20.0	0.35
West: Riverlea Blvd												
P41	Stage 1	50	53	46.0	LOS E	0.2	0.2	0.88	0.88	61.4	20.0	0.33
P42	Stage 2	50	53	45.2	LOS E	0.2	0.2	0.87	0.87	60.6	20.0	0.33
All Pedestrians		300	316	36.2	LOS D	0.2	0.2	0.76	0.76	51.6	20.0	0.39

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:24:02 PM

PHASING SUMMARY

Site: 1 [Prec2_Int_5_PM_Signals-Ultimate-Staged Ped (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5

Ultimate Volumes

PM Peak

Site Category: (None)

Signals - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 120 seconds (Site Optimum Cycle Time - Minimum Delay)

Variable Sequence Analysis applied. The results are given for the selected output sequence.

Timings based on settings in the Site Phasing & Timing dialog

Phase Times determined by the program

Phase Sequence: DDO

Input Phase Sequence: A, D, D1*, D2*, E, G, G1*, G2*

Output Phase Sequence: A, D, E, G, G2*

Reference Phase: Phase A

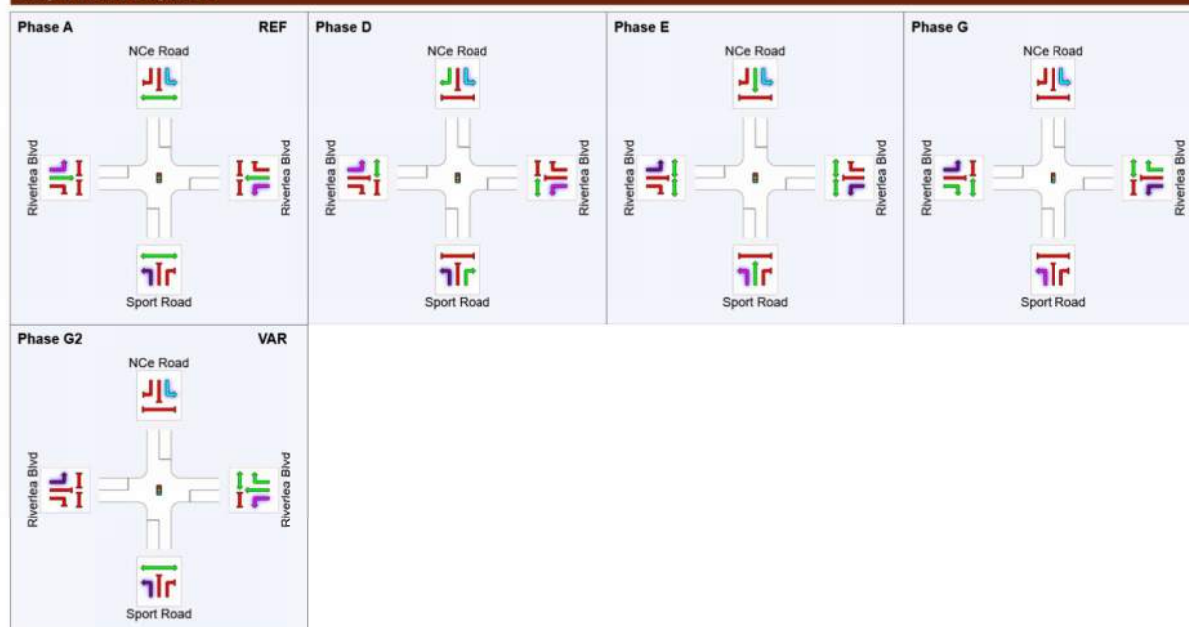
(* Variable Phase)

Phase Timing Summary

Phase	A	D	E	G	G2
Phase Change Time (sec)	0	40	56	70	84
Green Time (sec)	32	8	6	6	28
Phase Time (sec)	40	16	14	14	36
Phase Split	33%	13%	12%	12%	30%
Phase Frequency (%)	100.0	100.0	100.0	100.0	100.0













See the Timing Analysis report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Minor Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.

Output Phase Sequence



REF: Reference Phase

VAR: Variable Phase

 Normal Movement	 Permitted/Opposed
 Slip/Bypass-Lane Movement	 Opposed Slip/Bypass-Lane
 Stopped Movement	 Turn On Red
 Other Movement Class (MC) Running	 Undetected Movement
 Mixed Running & Stopped MCs	 Continuous Movement
 Other Movement Class (MC) Stopped	 Phase Transition Applied

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:24:02 PM

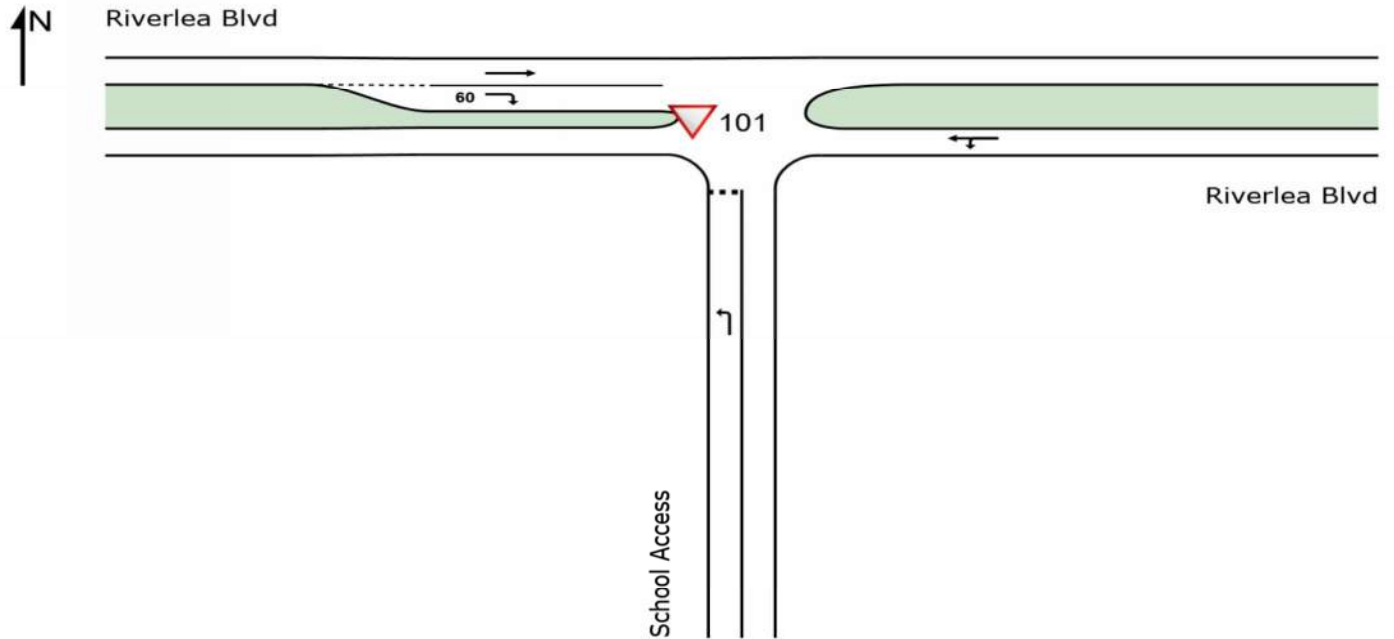
Appendix D Intersection 5a SIDRA Summary

SITE LAYOUT

▽ Site: 101 [Prec2_Int_5a-AMandPM (Site Folder: General)]

Intersection 5a
Precinct 2 Volumes
AM and PM Peak
Site Category: (None)
Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 101 [Prec2_Int_5a-AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5a
Precinct 2 Volumes
AM Peak
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed	
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: School Access															
1	L2	All MCs	192	3.0	192	3.0	0.125	5.8	LOS A	0.5	3.9	0.16	0.54	0.16	52.3
Approach			192	3.0	192	3.0	0.125	5.8	LOS A	0.5	3.9	0.16	0.54	0.16	52.3
East: Riverlea Blvd															
4	L2	All MCs	137	3.0	137	3.0	0.108	5.6	LOS A	0.0	0.0	0.00	0.40	0.00	54.1
5	T1	All MCs	63	3.0	63	3.0	0.108	0.0	LOS A	0.0	0.0	0.00	0.40	0.00	56.4
Approach			200	3.0	200	3.0	0.108	3.8	NA	0.0	0.0	0.00	0.40	0.00	54.8
West: Riverlea Blvd															
11	T1	All MCs	552	3.0	552	3.0	0.288	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
12	R2	All MCs	56	3.0	56	3.0	0.038	6.2	LOS A	0.2	1.2	0.31	0.57	0.31	51.7
Approach			607	3.0	607	3.0	0.288	0.6	NA	0.2	1.2	0.03	0.05	0.03	59.0
All Vehicles			999	3.0	999	3.0	0.288	2.3	NA	0.5	3.9	0.05	0.22	0.05	56.7

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:44:05 PM

MOVEMENT SUMMARY

Site: 101 [Prec2_Int_5a-PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5a
Precinct 2 Volumes
PM Peak
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed	
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: School Access															
1	L2	All MCs	192	3.0	192	3.0	0.180	7.4	LOS A	0.7	5.3	0.47	0.69	0.47	51.3
Approach			192	3.0	192	3.0	0.180	7.4	LOS A	0.7	5.3	0.47	0.69	0.47	51.3
East: Riverlea Blvd															
4	L2	All MCs	144	3.0	144	3.0	0.297	5.7	LOS A	0.0	0.0	0.00	0.15	0.00	56.0
5	T1	All MCs	416	3.0	416	3.0	0.297	0.1	LOS A	0.0	0.0	0.00	0.15	0.00	58.5
Approach			560	3.0	560	3.0	0.297	1.5	NA	0.0	0.0	0.00	0.15	0.00	57.8
West: Riverlea Blvd															
11	T1	All MCs	200	3.0	200	3.0	0.105	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
12	R2	All MCs	56	3.0	56	3.0	0.058	8.0	LOS A	0.2	1.7	0.54	0.71	0.54	50.8
Approach			256	3.0	256	3.0	0.105	1.8	NA	0.2	1.7	0.12	0.15	0.12	57.7
All Vehicles			1007	3.0	1007	3.0	0.297	2.7	NA	0.7	5.3	0.12	0.25	0.12	56.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akcelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

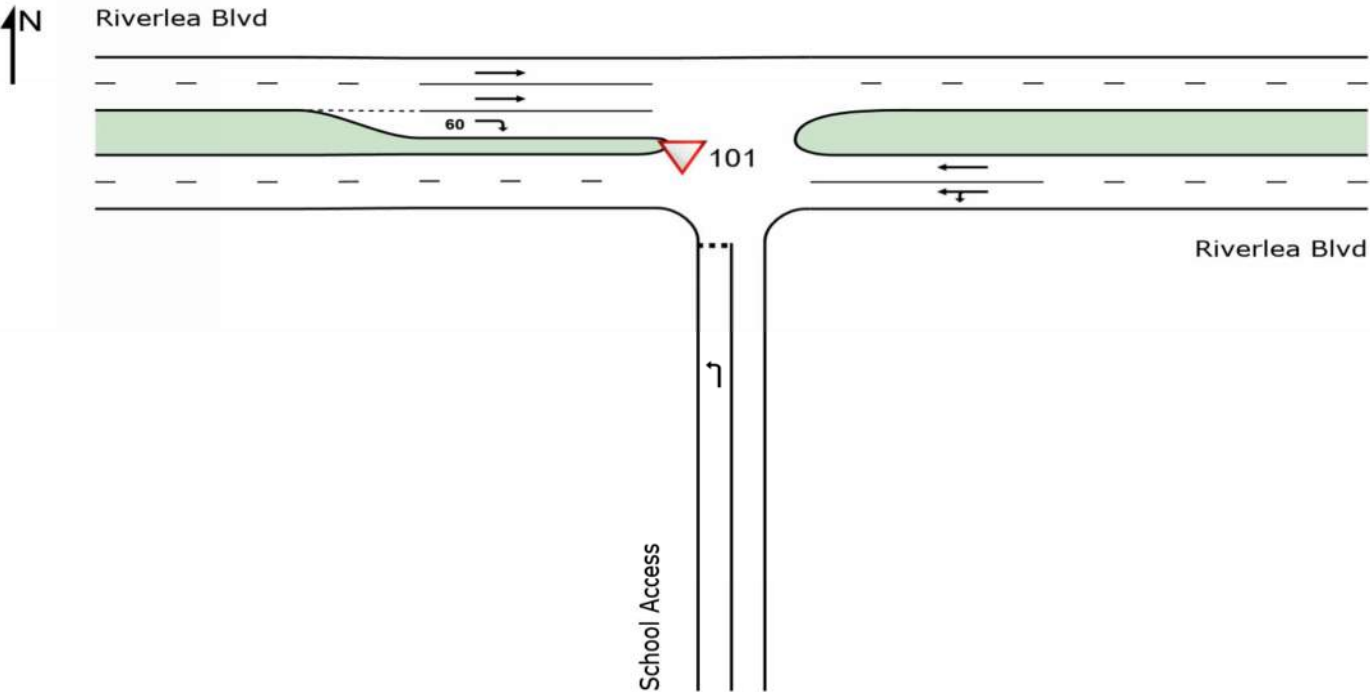
Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:44:27 PM

SITE LAYOUT


Site: 101 [Prec2_Int_5a-AMandPM-Ultimate (Site Folder: General)]

Intersection 5a
 Ultimate Volumes
 AM and PM Peak
 Site Category: (None)
 Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 101 [Prec2_Int_5a-AM-Ultimate (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5a
Ultimate Volumes
AM Peak
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: School Access															
1	L2	All MCs	192	3.0	192	3.0	0.167	6.2	LOS A	0.7	4.8	0.26	0.57	0.26	52.0
Approach			192	3.0	192	3.0	0.167	6.2	LOS A	0.7	4.8	0.26	0.57	0.26	52.0
East: Riverlea Blvd															
4	L2	All MCs	137	3.0	137	3.0	0.149	5.6	LOS A	0.0	0.0	0.00	0.29	0.00	54.9
5	T1	All MCs	426	3.0	426	3.0	0.149	0.0	LOS A	0.0	0.0	0.00	0.10	0.00	59.0
Approach			563	3.0	563	3.0	0.149	1.4	NA	0.0	0.0	0.00	0.14	0.00	58.0
West: Riverlea Blvd															
11	T1	All MCs	1865	3.0	1865	3.0	0.488	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	59.6
12	R2	All MCs	56	3.0	56	3.0	0.073	8.6	LOS A	0.3	2.0	0.53	0.72	0.53	50.6
Approach			1921	3.0	1921	3.0	0.488	0.4	NA	0.3	2.0	0.02	0.02	0.02	59.3
All Vehicles			2676	3.0	2676	3.0	0.488	1.1	NA	0.7	4.8	0.03	0.09	0.03	58.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com
Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:44:41 PM

MOVEMENT SUMMARY

Site: 101 [Prec2_Int_5a-PM-Ultimate (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5a
Ultimate Volumes
PM Peak
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Queue Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: School Access															
1	L2	All MCs	192	3.0	192	3.0	0.374	13.0	LOS B	1.6	11.6	0.71	0.94	0.93	47.7
Approach			192	3.0	192	3.0	0.374	13.0	LOS B	1.6	11.6	0.71	0.94	0.93	47.7
East: Riverlea Blvd															
4	L2	All MCs	144	3.0	144	3.0	0.466	5.7	LOS A	0.0	0.0	0.00	0.10	0.00	56.3
5	T1	All MCs	1633	3.0	1633	3.0	0.466	0.2	LOS A	0.0	0.0	0.00	0.04	0.00	59.2
Approach			1777	3.0	1777	3.0	0.466	0.6	NA	0.0	0.0	0.00	0.05	0.00	59.0
West: Riverlea Blvd															
11	T1	All MCs	762	3.0	762	3.0	0.199	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
12	R2	All MCs	56	3.0	56	3.0	0.710	86.1	LOS F	2.3	16.5	0.98	1.11	1.48	24.4
Approach			818	3.0	818	3.0	0.710	5.9	NA	2.3	16.5	0.07	0.08	0.10	54.5
All Vehicles			2786	3.0	2786	3.0	0.710	3.0	NA	2.3	16.5	0.07	0.12	0.09	56.7

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
 Vehicle movement LOS values are based on average delay per movement.
 Minor Road Approach LOS values are based on average delay for all vehicle movements.
 NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
 Two-Way Sign Control Capacity Model: SIDRA Standard.
 Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
 Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
 Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
 HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
 Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com
 Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Tuesday, 29 August 2023 11:25:17 AM
 Project:

Appendix E Intersection 5b SIDRA Summary

SITE LAYOUT

 **Site: 101 [Int5b_PAC-Base AMandPM (Site Folder: General)]**

Intersection: 5b
 Precinct 2 Volumes
 AM and PM Peak
 Site Category: (None)
 Pedestrian Crossing (Signalised) - EQUISAT (Fixed-Time/SCATS) Isolated

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

 Site: 101 [Int5b_PAC-Base AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5b

Precinct 2 Volumes

AM Peak

Site Category: (None)

Pedestrian Crossing (Signalised) - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 120 seconds (Site User-Given Cycle Time)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
East: Riverlea Blvd															
8	T1	All MCs	200	3.0	200	3.0	0.127	2.3	LOS A	2.3	16.7	0.22	0.19	0.22	57.8
Approach			200	3.0	200	3.0	0.127	2.3	LOS A	2.3	16.7	0.22	0.19	0.22	57.8
West: Riverlea Blvd															
2	T1	All MCs	552	3.0	552	3.0	* 0.349	3.0	LOS A	8.1	58.0	0.28	0.25	0.28	57.2
Approach			552	3.0	552	3.0	0.349	3.0	LOS A	8.1	58.0	0.28	0.25	0.28	57.2
All Vehicles			752	3.0	752	3.0	0.349	2.8	LOS A	8.1	58.0	0.26	0.23	0.26	57.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist] ped m		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
West: Riverlea Blvd												
P11	Stage 1	200	211	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96
P12	Stage 2	200	211	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96
All Pedestrians		400	421	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:45:35 PM

MOVEMENT SUMMARY

 Site: 101 [Int5b_PAC-Base PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5b

Precinct 2 Volumes

PM Peak

Site Category: (None)

Pedestrian Crossing (Signalised) - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 120 seconds (Site User-Given Cycle Time)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
East: Riverlea Blvd															
8	T1	All MCs	552	3.0	552	3.0	* 0.349	3.0	LOS A	8.1	58.0	0.28	0.25	0.28	57.2
Approach			552	3.0	552	3.0	0.349	3.0	LOS A	8.1	58.0	0.28	0.25	0.28	57.2
West: Riverlea Blvd															
2	T1	All MCs	200	3.0	200	3.0	0.127	2.3	LOS A	2.3	16.7	0.22	0.19	0.22	57.8
Approach			200	3.0	200	3.0	0.127	2.3	LOS A	2.3	16.7	0.22	0.19	0.22	57.8
All Vehicles			752	3.0	752	3.0	0.349	2.8	LOS A	8.1	58.0	0.26	0.23	0.26	57.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist] ped m		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
West: Riverlea Blvd												
P11	Stage 1	200	211	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96
P12	Stage 2	200	211	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96
All Pedestrians		400	421	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

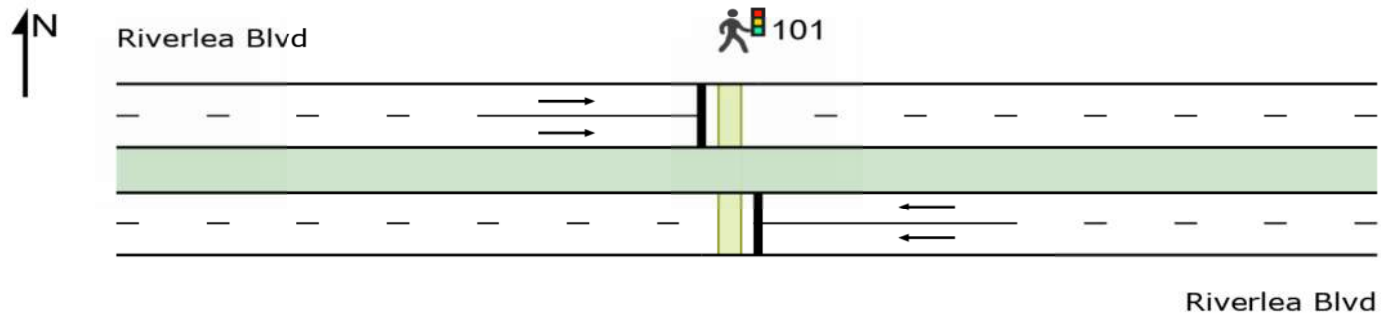
Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:45:43 PM

SITE LAYOUT

 **Site: 101 [Int5b_PAC-Ultimate AMandPM (Site Folder: General)]**

Intersection 5b
Ultimate Volumes
AM and PM Peak
Site Category: (None)
Pedestrian Crossing (Signalised) - EQUISAT (Fixed-Time/SCATS) Isolated

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

 Site: 101 [Int5b_PAC-Ultimate AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5b

Ultimate Volumes

AM Peak

Site Category: (None)

Pedestrian Crossing (Signalised) - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 120 seconds (Site User-Given Cycle Time)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
East: Riverlea Blvd															
8	T1	All MCs	563	3.0	563	3.0	0.178	2.5	LOS A	3.4	24.7	0.23	0.20	0.23	57.7
Approach			563	3.0	563	3.0	0.178	2.5	LOS A	3.4	24.7	0.23	0.20	0.23	57.7
West: Riverlea Blvd															
2	T1	All MCs	1865	3.0	1865	3.0	* 0.591	4.1	LOS A	18.9	135.7	0.39	0.35	0.39	56.2
Approach			1865	3.0	1865	3.0	0.591	4.1	LOS A	18.9	135.7	0.39	0.35	0.39	56.2
All Vehicles			2428	3.0	2428	3.0	0.591	3.7	LOS A	18.9	135.7	0.35	0.32	0.35	56.5

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol.	Dem. Flow	Aver. Delay	Level of Service	AVERAGE BACK OF QUEUE		Prop. Que	Eff. Stop Rate	Travel Time	Travel Dist.	Aver. Speed
						[Ped	Dist]					
		ped/h	ped/h	sec		ped	m			sec	m	m/sec
West: Riverlea Blvd												
P11	Stage 1	200	211	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96
P12	Stage 2	200	211	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96
All Pedestrians		400	421	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:45:53 PM

MOVEMENT SUMMARY

 Site: 101 [Int5b_PAC-Ultimate PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 5b

Ultimate Volumes

PM Peak

Site Category: (None)

Pedestrian Crossing (Signalised) - EQUISAT (Fixed-Time/SCATS) Isolated Cycle Time = 120 seconds (Site User-Given Cycle Time)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
East: Riverlea Blvd															
8	T1	All MCs	1768	3.0	1768	3.0	* 0.560	3.9	LOS A	17.1	122.7	0.37	0.34	0.37	56.4
Approach			1768	3.0	1768	3.0	0.560	3.9	LOS A	17.1	122.7	0.37	0.34	0.37	56.4
West: Riverlea Blvd															
2	T1	All MCs	762	3.0	762	3.0	0.241	2.6	LOS A	5.0	35.6	0.25	0.22	0.25	57.5
Approach			762	3.0	762	3.0	0.241	2.6	LOS A	5.0	35.6	0.25	0.22	0.25	57.5
All Vehicles			2531	3.0	2531	3.0	0.560	3.5	LOS A	17.1	122.7	0.33	0.30	0.33	56.7

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Green.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance												
Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped Dist] ped m		Prop. Que	Eff. Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
West: Riverlea Blvd												
P11	Stage 1	200	211	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96
P12	Stage 2	200	211	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96
All Pedestrians		400	421	54.6	LOS E	0.7	0.7	0.96	0.96	208.5	200.0	0.96

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Pedestrian movement LOS values are based on average delay per pedestrian movement.

Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:46:01 PM

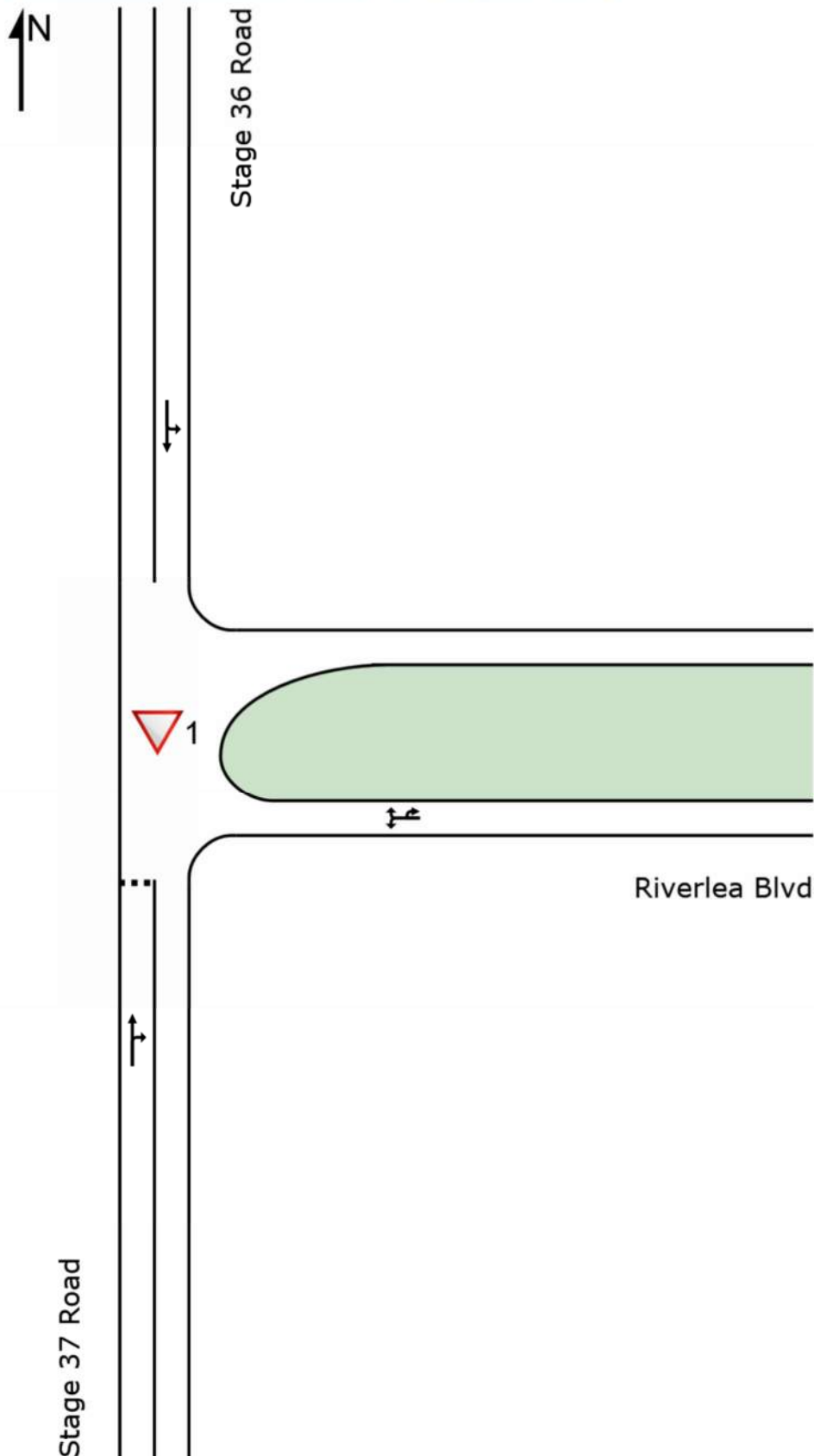
Appendix F Intersection 6 SIDRA Summary

SITE LAYOUT

▽ Site: 1 [Prec2_Int_6-AMandPM-Single Lane (Site Folder: General)]

Intersection 6
Precinct 2 Volumes
AM and PM Peak
Site Category: (None)
Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1 [Prec2_Int_6-AM-Single Lane (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 6
Precinct 2 Volumes
AM Peak
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 37 Road															
2	T1	All MCs	5	3.0	5	3.0	0.117	4.5	LOS A	0.5	3.6	0.54	0.66	0.54	44.8
3	R2	All MCs	108	3.0	108	3.0	0.117	7.2	LOS A	0.5	3.6	0.54	0.66	0.54	47.7
Approach			114	3.0	114	3.0	0.117	7.1	LOS A	0.5	3.6	0.54	0.66	0.54	47.6
East: Riverlea Blvd															
4	L2	All MCs	28	3.0	28	3.0	0.224	5.6	LOS A	1.1	7.5	0.08	0.58	0.08	48.1
6	R2	All MCs	92	3.0	92	3.0	0.224	5.7	LOS A	1.1	7.5	0.08	0.58	0.08	48.4
6u	U	All MCs	136	0.0	136	0.0	0.224	8.7	LOS A	1.1	7.5	0.08	0.58	0.08	51.7
Approach			256	1.4	256	1.4	0.224	7.3	NA	1.1	7.5	0.08	0.58	0.08	50.0
North: Stage 36 Road															
7	L2	All MCs	362	3.0	362	3.0	0.202	4.6	LOS A	0.0	0.0	0.00	0.52	0.00	45.9
8	T1	All MCs	5	3.0	5	3.0	0.202	0.1	LOS A	0.0	0.0	0.00	0.52	0.00	47.0
Approach			367	3.0	367	3.0	0.202	4.6	NA	0.0	0.0	0.00	0.52	0.00	45.9
All Vehicles			737	2.4	737	2.4	0.224	5.9	NA	1.1	7.5	0.11	0.56	0.11	47.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Monday, 28 August 2023 5:47:13 PM

MOVEMENT SUMMARY

Site: 1 [Prec2_Int_6-PM-Single Lane (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 6
Precinct 2 Volumes
PM Peak
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows		Arrival Flows		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			[Total	HV]	[Total	HV]				[Veh.	Dist]				
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 37 Road															
2	T1	All MCs	5	3.0	5	3.0	0.037	5.6	LOS A	0.1	1.1	0.55	0.65	0.55	44.8
3	R2	All MCs	28	3.0	28	3.0	0.037	7.4	LOS A	0.1	1.1	0.55	0.65	0.55	47.7
Approach			34	3.0	34	3.0	0.037	7.1	LOS A	0.1	1.1	0.55	0.65	0.55	47.2
East: Riverlea Blvd															
4	L2	All MCs	108	3.0	108	3.0	0.436	5.6	LOS A	2.8	19.9	0.06	0.55	0.06	48.7
6	R2	All MCs	362	3.0	362	3.0	0.436	5.6	LOS A	2.8	19.9	0.06	0.55	0.06	49.0
6u	U	All MCs	136	0.0	136	0.0	0.436	7.6	LOS A	2.8	19.9	0.06	0.55	0.06	52.4
Approach			606	2.3	606	2.3	0.436	6.1	NA	2.8	19.9	0.06	0.55	0.06	49.6
North: Stage 36 Road															
7	L2	All MCs	92	3.0	92	3.0	0.053	4.6	LOS A	0.0	0.0	0.00	0.50	0.00	46.1
8	T1	All MCs	5	3.0	5	3.0	0.053	0.0	LOS A	0.0	0.0	0.00	0.50	0.00	47.2
Approach			97	3.0	97	3.0	0.053	4.4	NA	0.0	0.0	0.00	0.50	0.00	46.1
All Vehicles			737	2.4	737	2.4	0.436	5.9	NA	2.8	19.9	0.08	0.55	0.08	49.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

SIDRA INTERSECTION 9.1 | Copyright © 2000-2023 Akcelik and Associates Pty Ltd | sidrasolutions.com

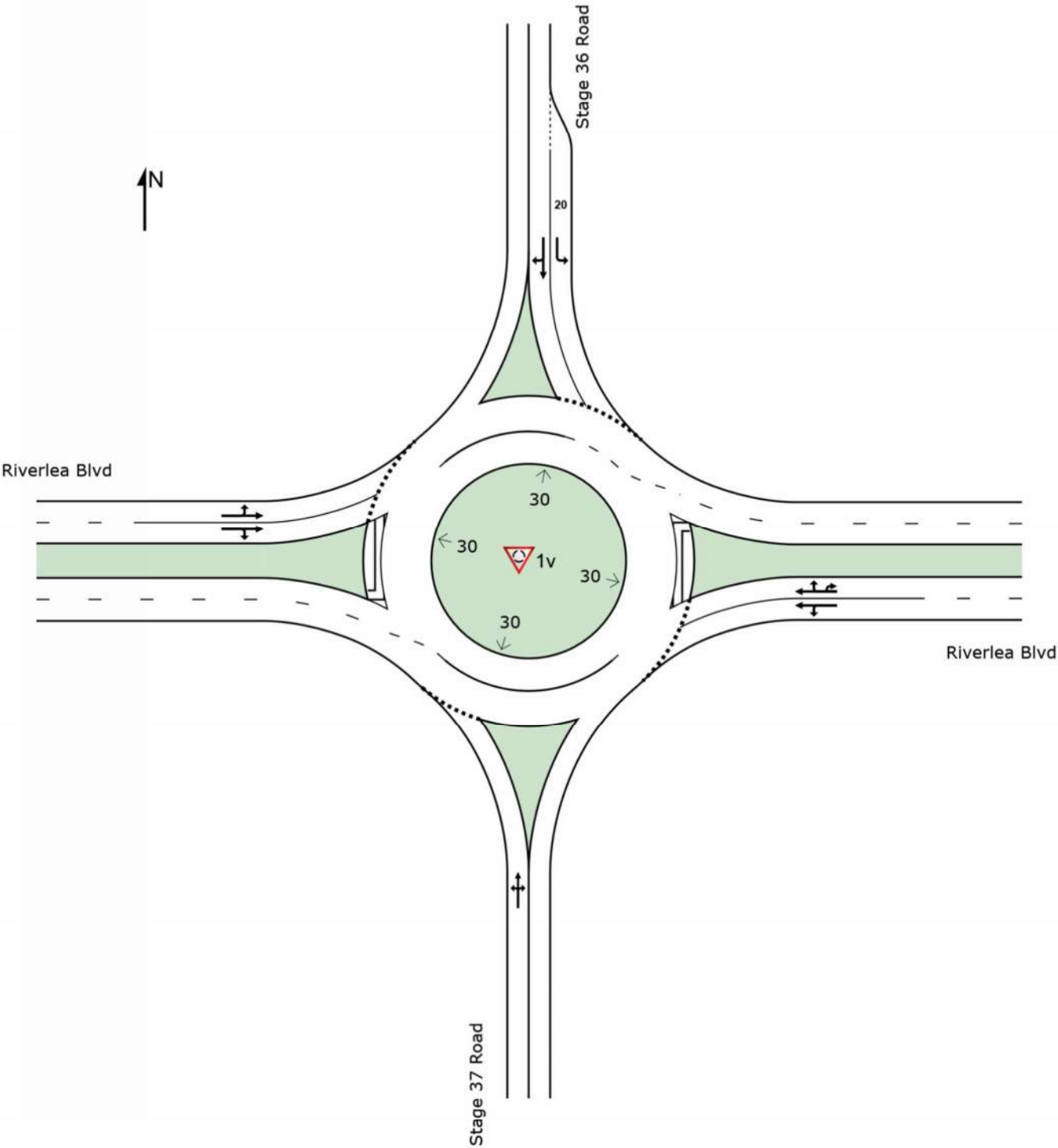
Organisation: EMPIRICAL TRAFFIC ADVISORY PTY LTD | Licence: PLUS / 1PC | Processed: Tuesday, 29 August 2023 11:32:05 AM

SITE LAYOUT

Site: 1v [Prec2_Int_6-Ultimate-AMandPM (Site Folder: General)]

Intersection 6
Ultimate volumes
AM and PM Peak
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1v [Prec2_Int_6-Ultimate-AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.3.210

Intersection 6
Ultimate volumes
AM Peak
Site Category: (None)
Roundabout

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 37 Road															
1	L2	All MCs	5	3.0	5	3.0	0.162	6.6	LOS A	0.7	4.9	0.57	0.73	0.57	46.8
2	T1	All MCs	5	3.0	5	3.0	0.162	5.2	LOS A	0.7	4.9	0.57	0.73	0.57	44.1
3	R2	All MCs	108	3.0	108	3.0	0.162	10.7	LOS A	0.7	4.9	0.57	0.73	0.57	46.3
Approach			119	3.0	119	3.0	0.162	10.2	LOS A	0.7	4.9	0.57	0.73	0.57	46.2
East: Riverlea Blvd															
4	L2	All MCs	28	3.0	28	3.0	0.189	3.6	LOS A	1.4	9.8	0.11	0.34	0.11	51.1
5	T1	All MCs	363	3.0	363	3.0	0.189	3.5	LOS A	1.4	9.8	0.11	0.38	0.11	54.9
6	R2	All MCs	92	3.0	92	3.0	0.189	9.2	LOS A	1.3	9.5	0.12	0.60	0.12	47.5
6u	U	All MCs	136	0.0	136	0.0	0.189	11.6	LOS A	1.3	9.5	0.12	0.60	0.12	50.8
Approach			619	2.3	619	2.3	0.189	6.1	LOS A	1.4	9.8	0.11	0.46	0.11	52.5
North: Stage 36 Road															
7	L2	All MCs	362	3.0	362	3.0	0.710	15.3	LOS B	5.6	40.0	0.94	1.12	1.45	43.6
8	T1	All MCs	5	3.0	5	3.0	0.036	10.5	LOS A	0.2	1.1	0.79	0.87	0.79	43.7
9	R2	All MCs	5	3.0	5	3.0	0.036	17.7	LOS B	0.2	1.1	0.79	0.87	0.79	45.9
Approach			373	3.0	373	3.0	0.710	15.3	LOS B	5.6	40.0	0.93	1.11	1.43	43.7
West: Riverlea Blvd															
10	L2	All MCs	5	3.0	5	3.0	0.563	6.0	LOS A	4.9	35.5	0.71	0.57	0.71	52.1
11	T1	All MCs	1314	3.0	1314	3.0	0.563	6.4	LOS A	5.0	36.0	0.72	0.59	0.74	52.4
12	R2	All MCs	5	3.0	5	3.0	0.563	12.7	LOS A	5.0	36.0	0.74	0.61	0.77	51.4
Approach			1324	3.0	1324	3.0	0.563	6.4	LOS A	5.0	36.0	0.72	0.59	0.74	52.4
All Vehicles			2435	2.8	2435	2.8	0.710	7.9	LOS A	5.6	40.0	0.59	0.64	0.68	50.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 1v [Prec2_Int_6-Ultimate-PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION **Version:** 9.1.3.210

Intersection 6
Ultimate volumes
PM Peak
Site Category: (None)
Roundabout

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Stage 37 Road															
1	L2	All MCs	5	3.0	5	3.0	0.092	11.5	LOS A	0.4	2.7	0.74	0.88	0.74	44.9
2	T1	All MCs	5	3.0	5	3.0	0.092	10.0	LOS A	0.4	2.7	0.74	0.88	0.74	42.4
3	R2	All MCs	28	3.0	28	3.0	0.092	15.6	LOS B	0.4	2.7	0.74	0.88	0.74	44.4
Approach			39	3.0	39	3.0	0.092	14.3	LOS A	0.4	2.7	0.74	0.88	0.74	44.2
East: Riverlea Blvd															
4	L2	All MCs	108	3.0	108	3.0	0.549	3.7	LOS A	6.1	44.1	0.16	0.33	0.16	50.9
5	T1	All MCs	1217	3.0	1217	3.0	0.549	3.5	LOS A	6.2	44.3	0.17	0.39	0.17	54.5
6	R2	All MCs	362	3.0	362	3.0	0.549	9.3	LOS A	6.2	44.3	0.18	0.52	0.18	48.3
6u	U	All MCs	136	0.0	136	0.0	0.549	11.6	LOS A	6.2	44.3	0.18	0.52	0.18	51.8
Approach			1823	2.8	1823	2.8	0.549	5.3	LOS A	6.2	44.3	0.17	0.42	0.17	52.7
North: Stage 36 Road															
7	L2	All MCs	92	3.0	92	3.0	0.114	5.1	LOS A	0.5	3.9	0.62	0.64	0.62	49.5
8	T1	All MCs	5	3.0	5	3.0	0.024	7.3	LOS A	0.1	0.7	0.64	0.72	0.64	45.4
9	R2	All MCs	5	3.0	5	3.0	0.024	14.5	LOS B	0.1	0.7	0.64	0.72	0.64	47.7
Approach			102	3.0	102	3.0	0.114	5.7	LOS A	0.5	3.9	0.63	0.65	0.63	49.2
West: Riverlea Blvd															
10	L2	All MCs	5	3.0	5	3.0	0.286	6.5	LOS A	2.0	14.4	0.68	0.58	0.68	52.2
11	T1	All MCs	562	3.0	562	3.0	0.286	6.8	LOS A	2.0	14.4	0.69	0.60	0.69	52.6
12	R2	All MCs	5	3.0	5	3.0	0.286	13.0	LOS A	1.9	13.5	0.70	0.62	0.70	51.5
Approach			573	3.0	573	3.0	0.286	6.8	LOS A	2.0	14.4	0.69	0.60	0.69	52.6
All Vehicles			2537	2.8	2537	2.8	0.549	5.8	LOS A	6.2	44.3	0.32	0.48	0.32	52.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Intersection and Approach LOS values are based on average delay for all vehicle movements.

Roundabout Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

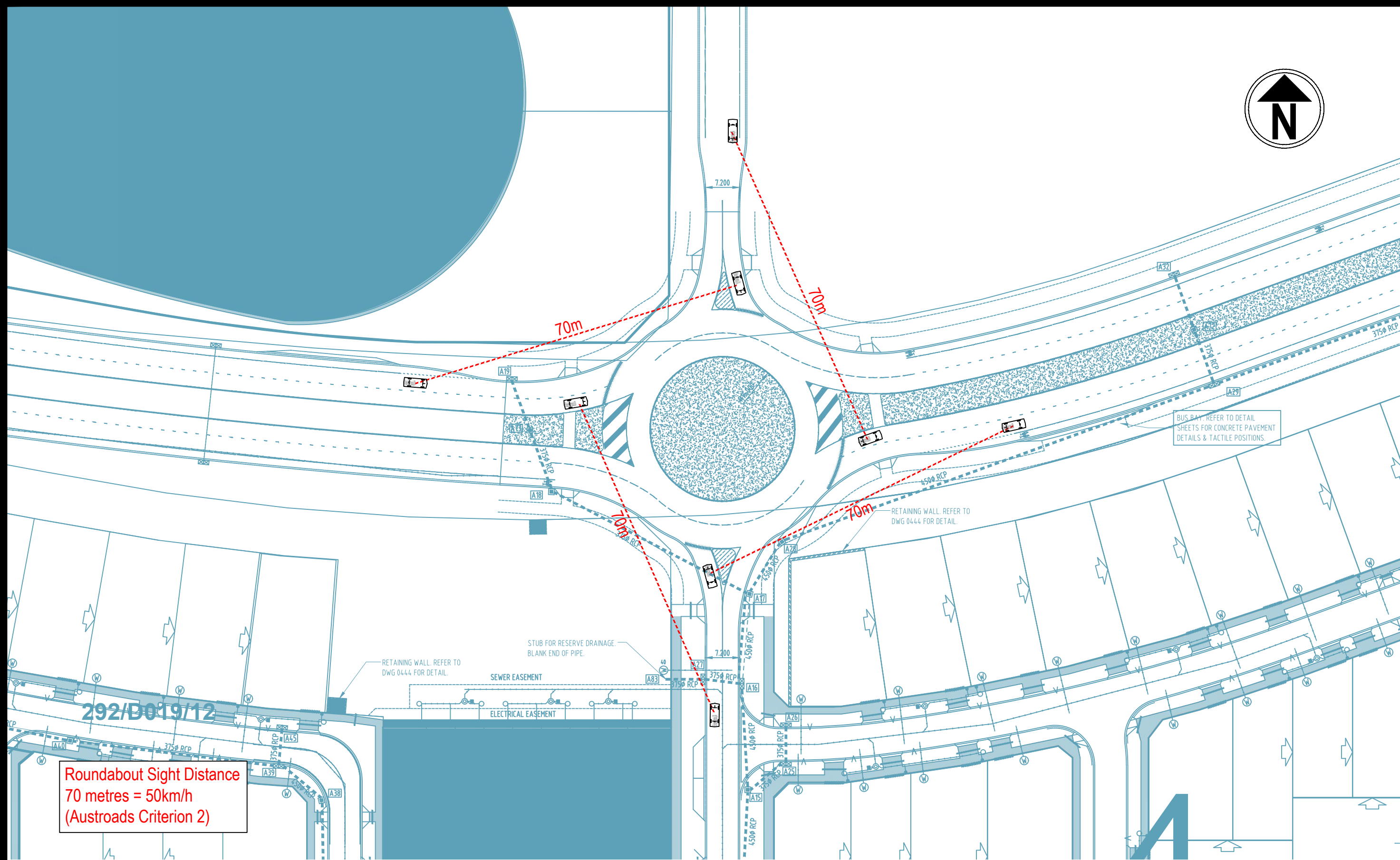
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

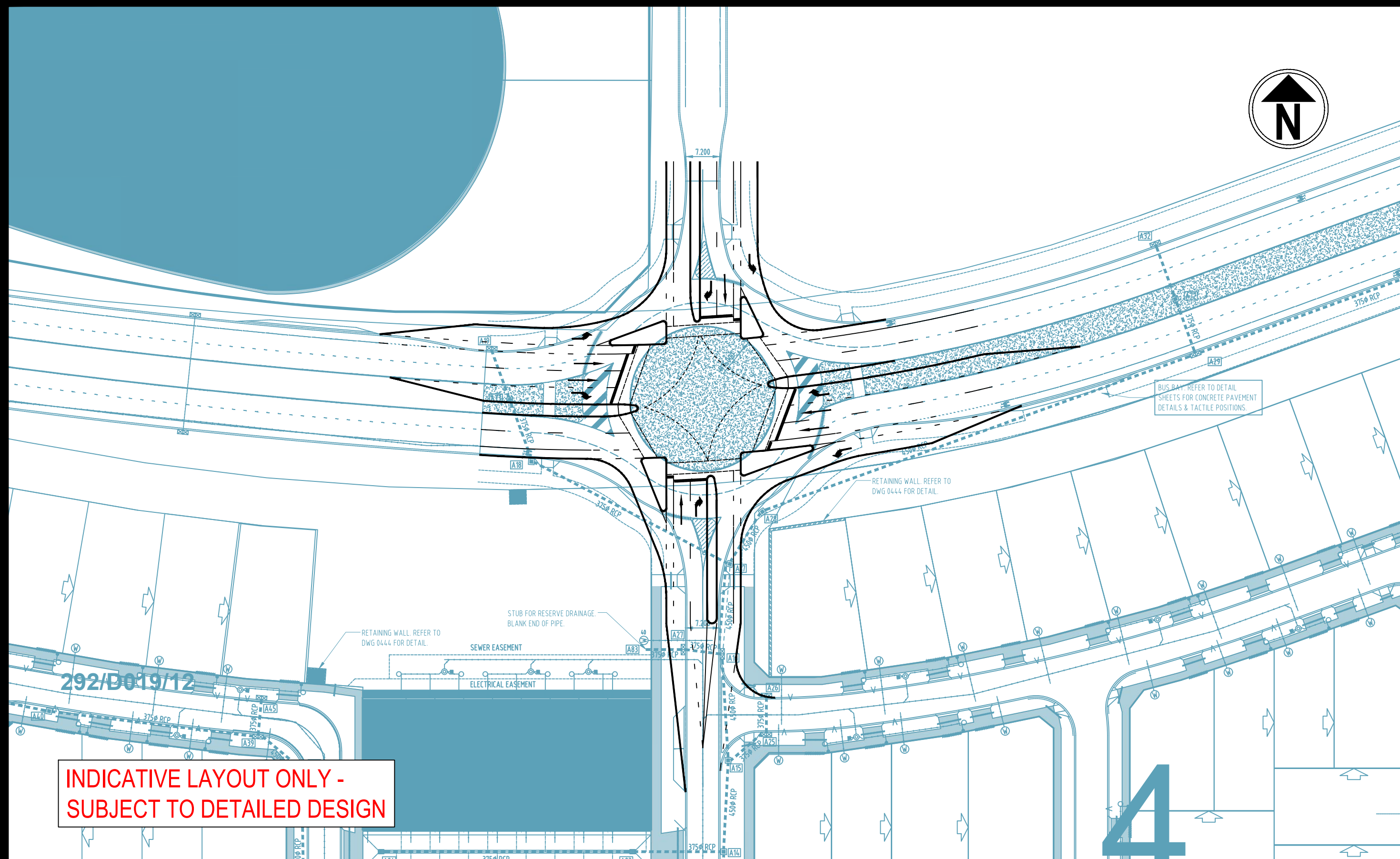
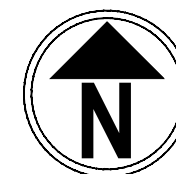
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Appendix G Concept Plans and Turn Path Diagrams





INDICATIVE LAYOUT ONLY -
SUBJECT TO DETAILED DESIGN

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER
The information presented in this drawing remains the property of Empirical Traffic Advisory Pty Ltd and is not to be copied, reproduced or provided to any third party without the written consent of ETA. ETA shall not be responsible for any modifications beyond the original information provided by ETA.

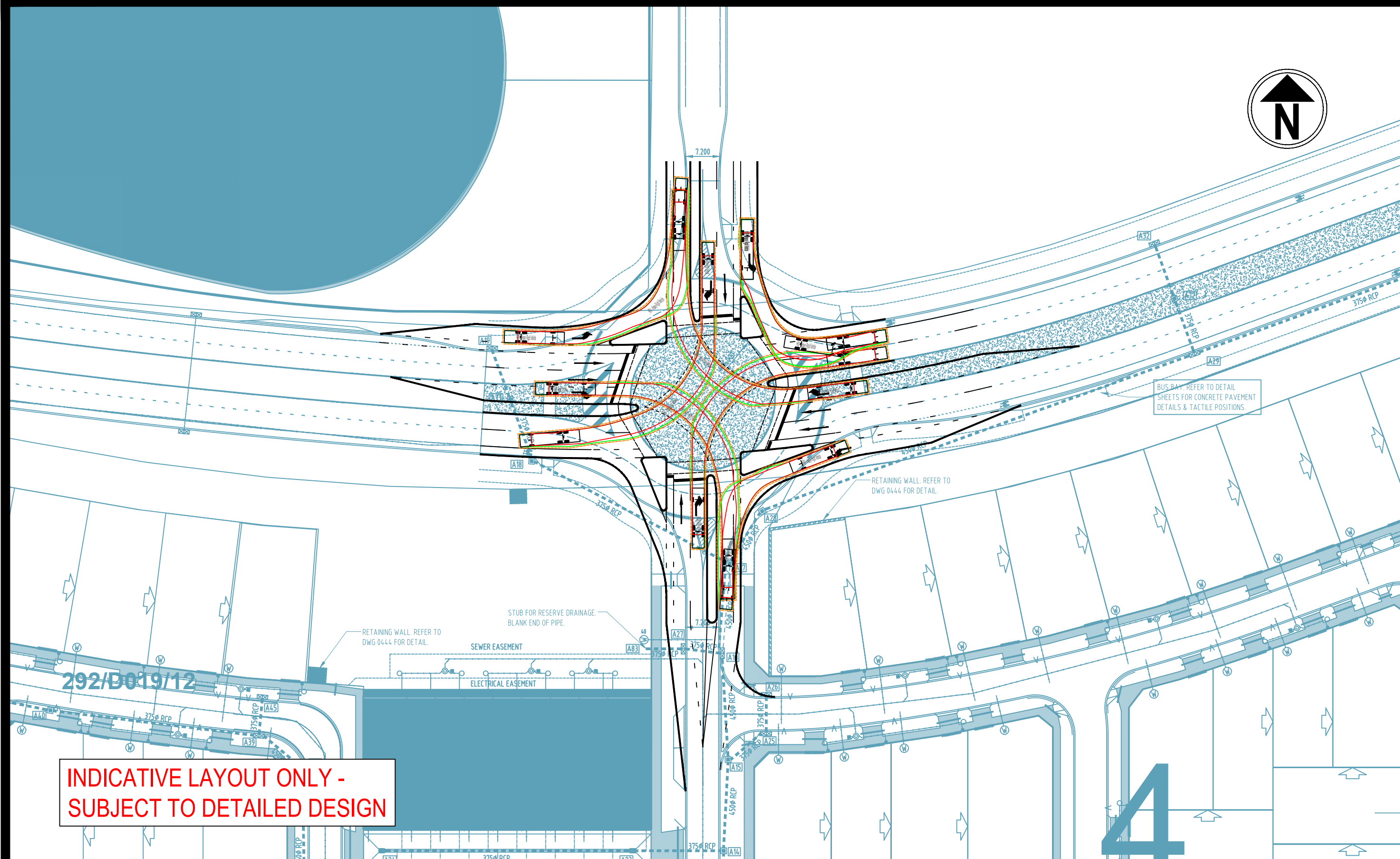
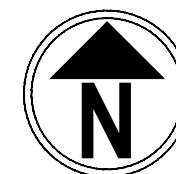


SCALE 1:750
0 7.5 15.0
metres

APPROVED: APP-NAME
DATE: 11 July 2023
FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 3 - SIGNAL OPTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-SK02



BUS BAY. REFER TO DETAIL SHEETS FOR CONCRETE PAVEMENT DETAILS & TACTILE POSITIONS.

RETAINING WALL. REFER TO DWG 0444 FOR DETAIL.

STUB FOR RESERVE DRAINAGE. BLANK END OF PIPE.

RETAINING WALL. REFER TO DWG 0444 FOR DETAIL.

SEWER EASEMENT

ELECTRICAL EASEMENT

INDICATIVE LAYOUT ONLY -
SUBJECT TO DETAILED DESIGN

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER
The information presented in this drawing remains the property of Empirical Traffic Advisory Pty Ltd and is not to be copied, reproduced or provided to any third party without the written consent of ETA. ETA shall not be responsible for any modifications beyond the original information provided by ETA.

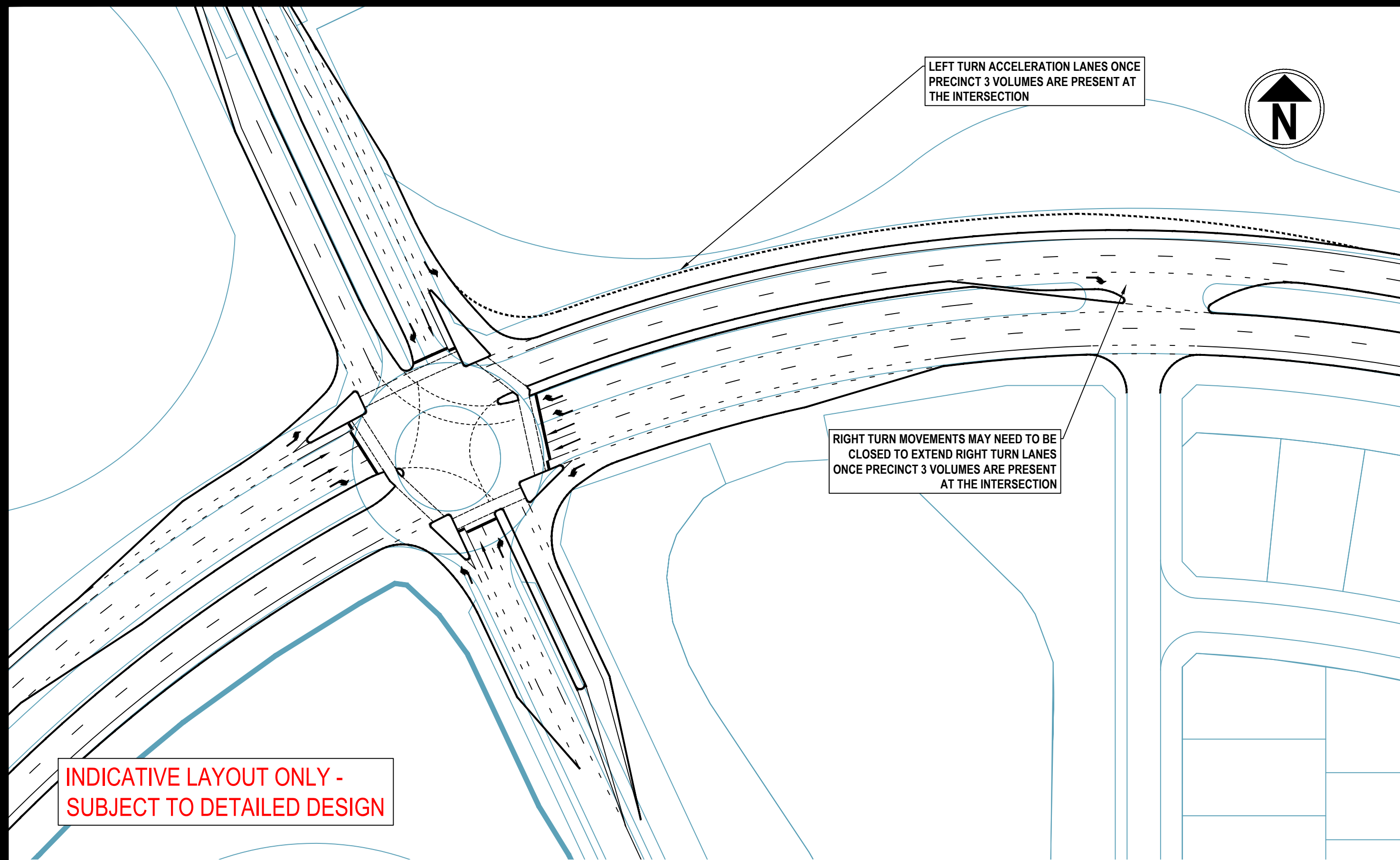


SCALE 1:750
0 7.5 15.0
metres

APPROVED: APP-NAME
DATE: 11 July 2023
FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 3 - SIGNAL OPTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-AT01



CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER
The information presented in this drawing remains the property of Empirical Traffic Advisory Pty Ltd and is not to be copied, reproduced or provided to any third party without the written consent of ETA. ETA shall not be responsible for any modifications beyond the original information provided by ETA.

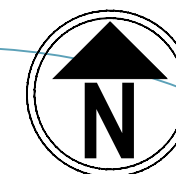


SCALE 1:750
0 7.5 15.0
metres

APPROVED: APP-NAME
DATE: 11 July 2023
FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 5 - SIGNAL OPTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-SK03



INDICATIVE LAYOUT ONLY -
SUBJECT TO DETAILED DESIGN

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER

The information presented in this drawing remains the property of Empirical Traffic Advisory Pty Ltd and is not to be copied, reproduced or provided to any third party without the written consent of ETA. ETA shall not be responsible for any modifications beyond the original information provided by ETA.



SCALE 1:750
0 7.5 15.0
metres

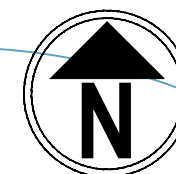
APPROVED: PSM

DATE: 11 July 2023

FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 5 - SIGNAL OPTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-AT02



SWEPT PATHS OF A 19m
ARTICULATED BUS

INDICATIVE LAYOUT ONLY -
SUBJECT TO DETAILED DESIGN

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER
The information presented in this drawing remains the property of
Empirical Traffic Advisory Pty Ltd and is not to be copied,
reproduced or provided to any third party without the written
consent of ETA. ETA shall not be responsible for any
modifications beyond the original information provided by ETA.



SCALE 1:750
0 7.5 15.0
metres

APPROVED: PSM
DATE: 11 July 2023
FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 5 - SIGNAL OPTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-AT03



DEDICATED U-TURN LANE
AND OPENING

RIGHT TURN ENTRY LANE TO
SCHOOL/SPORTS PRECINCT

MODIFIED T-INTERSECTION WITH
NORTH-EAST VEHICLE PRIORITY

INDICATIVE LAYOUT ONLY -
SUBJECT TO DETAILED DESIGN

48cp

18cp

Admin
2 storeys

Primary
2 storeys

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER

The information presented in this drawing remains the property of Empirical Traffic Advisory Pty Ltd and is not to be copied, reproduced or provided to any third party without the written consent of ETA. ETA shall not be responsible for any modifications beyond the original information provided by ETA.



SCALE 1:750
0 7.5 15.0
metres

APPROVED: PSM
DATE: 11 July 2023
FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 6 - INTERIM INTERSECTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-SK04



WIDTH MAINTAINS U-TURN
BY 10.5m WASTE VEHICLE

INDICATIVE LAYOUT ONLY -
SUBJECT TO DETAILED DESIGN

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER

The information presented in this drawing remains the property of Empirical Traffic Advisory Pty Ltd and is not to be copied, reproduced or provided to any third party without the written consent of ETA. ETA shall not be responsible for any modifications beyond the original information provided by ETA.



SCALE 1:750
0 7.5 15.0
metres

APPROVED: PSM

DATE: 11 July 2023

FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 6 - INTERIM INTERSECTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-AT04



SWEPT PATHS OF 19m
ARTICULATED BUS

INDICATIVE LAYOUT ONLY -
SUBJECT TO DETAILED DESIGN

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER

The information presented in this drawing remains the property of Empirical Traffic Advisory Pty Ltd and is not to be copied, reproduced or provided to any third party without the written consent of ETA. ETA shall not be responsible for any modifications beyond the original information provided by ETA.



SCALE 1:750
0 7.5 15.0
metres

APPROVED: PSM
DATE: 11 July 2023
FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 6 - INTERIM INTERSECTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-AT05



ADDITIONAL LEFT TURN LANE REQUIRED DUE
TO HIGH LEFT TURN VOLUMES IN AM PEAK

RIGHT TURN ENTRY LANE TO
SCHOOL/SPORTS PRECINCT

ROUNDAABOUT BASED ON INTERSECTION 3
INTERIM DESIGN

INDICATIVE LAYOUT ONLY -
SUBJECT TO DETAILED DESIGN

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER

The information presented in this drawing remains the property of
Empirical Traffic Advisory Pty Ltd and is not to be copied,
reproduced or provided to any third party without the written
consent of ETA. ETA shall not be responsible for any
modifications beyond the original information provided by ETA.



SCALE 1:750
0 7.5 15.0
metres

APPROVED: PSM
DATE: 11 July 2023
FILENAME: 230711_1000045_100B.DWG

RIVERLEA
PRECINCT 2
INTERSECTION 6 - ROUNDAABOUT OPTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-SK05



PROPERTY BOUNDARIES IMPACT
ON ROUNDABOUT SIGHT
DISTANCE REQUIREMENTS

CORNER CUT OFF REQUIRED ON
IMPACTED ALLOTMENT

70m

70m

70m

70m

PROPERTY BOUNDARIES IMPACT ON
ROUNDABOUT SIGHT DISTANCE
REQUIREMENTS

CORNER CUT OFF RECOMMENDED ON
IMPACTED ALLOTMENT

PROPERTY BOUNDARIES IMPACT ON
ROUNDABOUT SIGHT DISTANCE
REQUIREMENTS

CORNER CUT OFF RECOMMENDED ON
IMPACTED ALLOTMENT

Roundabout Sight Distance
70 metres = 50km/h
(Austroads Criterion 2)

CONCEPT PLAN ONLY
NOT FOR CONSTRUCTION

DISCLAIMER
The information presented in this drawing remains the property of
Empirical Traffic Advisory Pty Ltd and is not to be copied,
reproduced or provided to any third party without the written
consent of ETA. ETA shall not be responsible for any
modifications beyond the original information provided by ETA.



SCALE 1:750
0 7.5 15.0
metres

APPROVED: PSM
DATE: 11 July 2023
FILENAME: 230711_1000045_100B.DWG

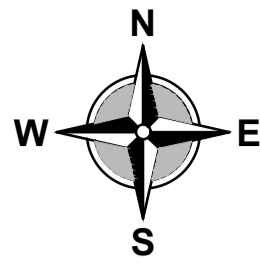
RIVERLEA
PRECINCT 2
INTERSECTION 6 - ROUNDABOUT OPTION
CONCEPT PLAN

DRAWING: 230711_1000045_100B-SK06



Empirical
Traffic
Advisory

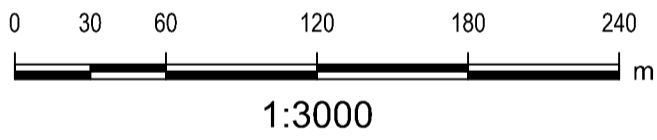
PO Box 268
Glenside SA 5063
contact@empiricaltraffic.com.au



LEGEND

Allotment Type	Width	Depth	Area m²
Affordable Housing Terrace	7-9	25-30	150-250
Affordable Housing Cottage	15	15	225
Affordable Housing Land Sales	12.5	25	312
Affordable Housing Apartment / Development Site*			

Apartment / Development Sites to deliver a component of affordable housing as part of the built form. (approximately 3 to 4 per site).



Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

Title

PRECINCT 2
Affordable Housing
Modification
(435 Allotments)
Sheet 1 of 2

Project

RIVERLEA

Project Code

21A3182

Drawing No.

21A3182AH

Rev

M

Revision Date

24 September 2024

Surveyor

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T

(08) 8130 1666

F

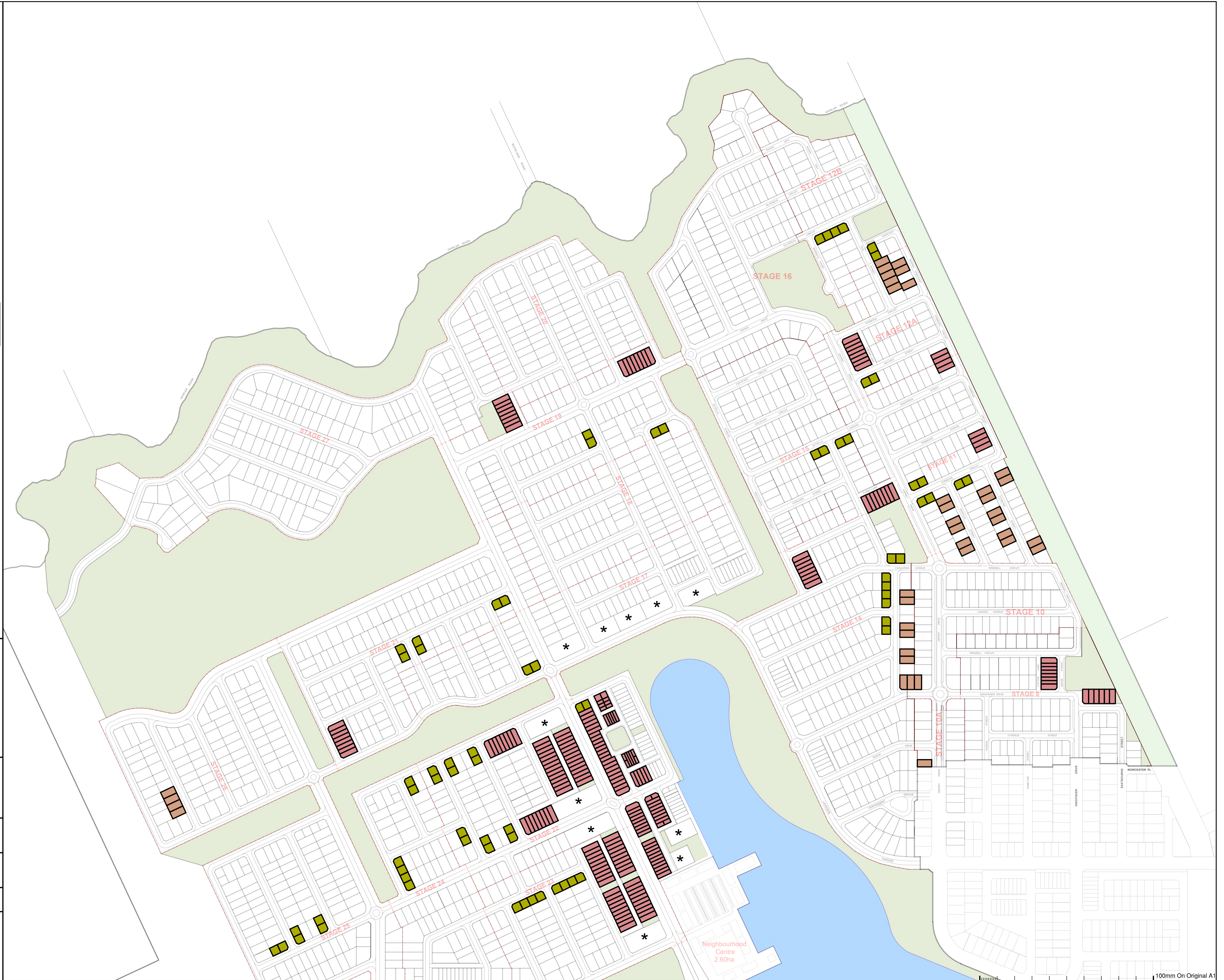
(08) 8362 0099

W

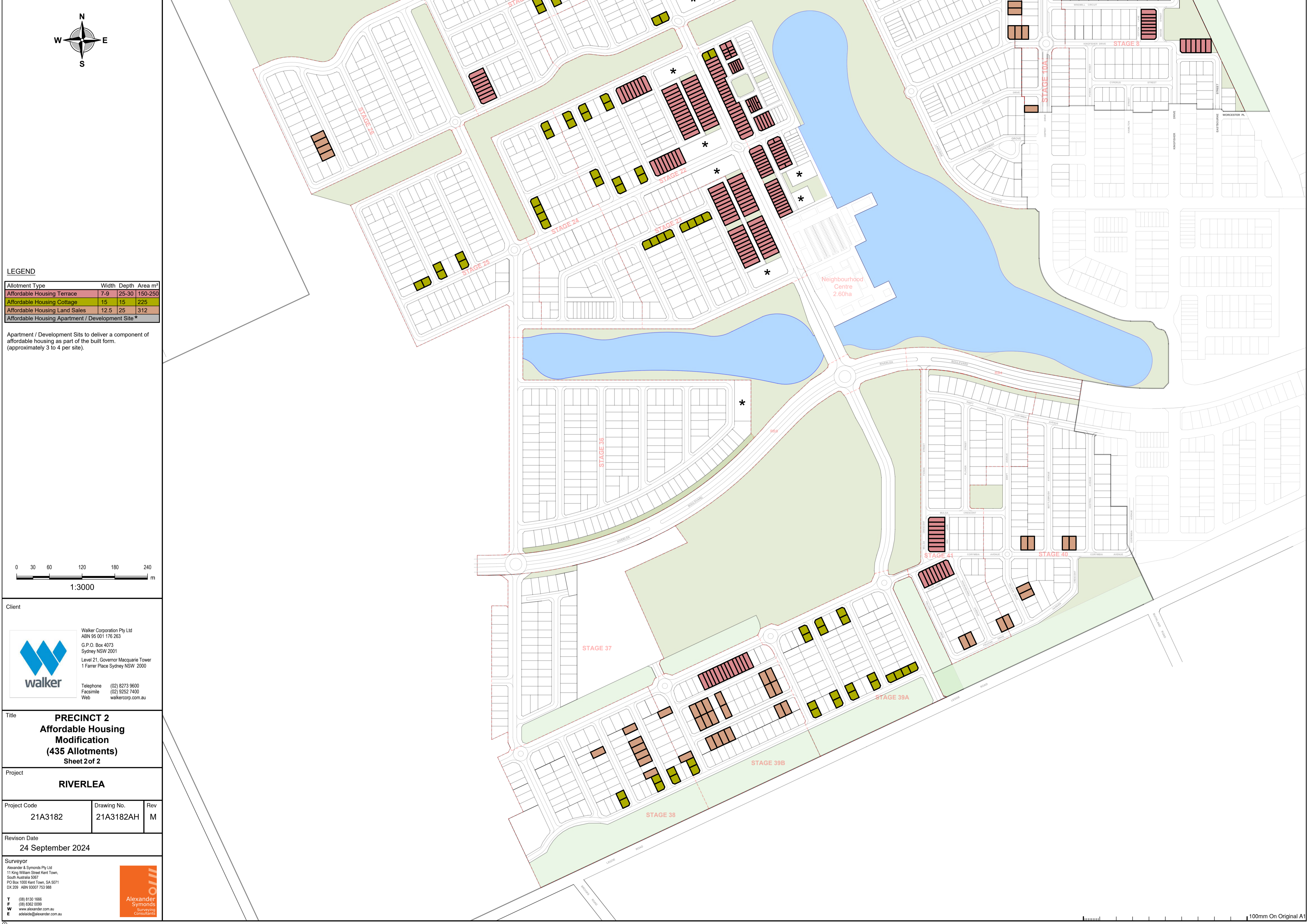
www.alexander.com.au

E

adelaide@alexander.com.au



100mm On Original A1



Allotment Type	Width	Depth	Area m ²
Affordable Housing Terrace	7-9	25-30	150-250
Affordable Housing Cottage	15	15	225
Affordable Housing Land Sales	12.5	25	312
Affordable Housing Apartment / Development Site*			

0 30 60 120 180 240 m

1:3000



Title

PRECINCT 2

Affordable Housing

Modification

(435 Allotments)

Sheet 2 of 2

Project Code	Drawing No.	Rev
21A3182	21A3182AH	M

Surveyor
Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988



Alexander
Symonds
Surveying
Consultants

100mm On Original A1

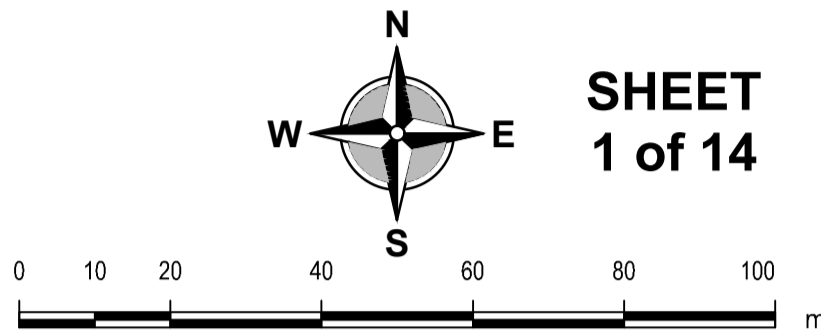
SHEET INDEX



Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429
Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Rod)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



1:1000 @ A1

RIVERLEA
PRECINCT 2

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12B	RHF	GIH	03.08.2022
G5	STAGE 12A	RHF	GIH	26.07.2022
G4	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	28.06.2022
G3	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G1	STAGE 10 AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.12.2021
E	STAGE 8 AMENDED	RHF	GIH	30.08.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013


Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments 2749

Total area 377.03ha
Developable area (less school & community) 274.64ha

Reserves (incl lake) 72.00ha
Drainage Reserves 14.03ha
Total Reserve area 86.03ha
Contributed Reserve (28.8%) 79.02ha
(total reserve less 50% of Drainage Reserves)

Length of new roads 41.89km

 Tree to be removed

Contour interval 1m. Datum AHD.
Road pavements shown are indicative only.
Dimensions and areas are subject to survey.

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1
Glenn Ian Hordacre
LICENSED SURVEYOR

REF 21A3182	
DWG No. 21A3182PROP(R)	
REVISION R	
RHF 24.09.2024	

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +



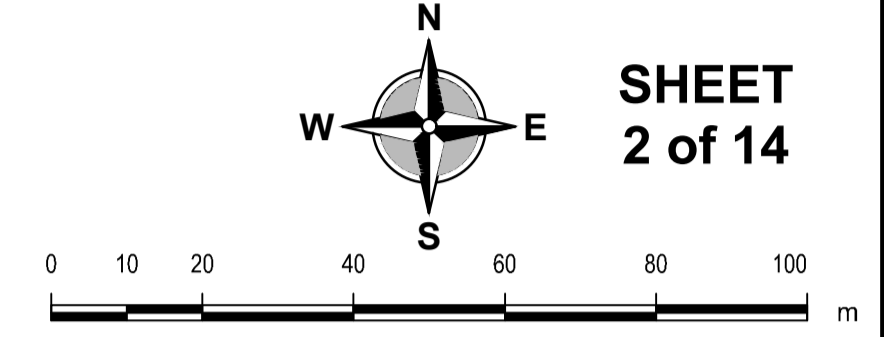


Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429

Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Road)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



1:1000 @ A1
**RIVERLEA
PRECINCT 2**

AMENDED PLAN	AMENDED PLAN	AMENDED PLAN
01.12.2022	02.02.2024	24.09.2024
AMENDED PLAN	AMENDED PLAN	
29.03.2023	22.05.2024	
AMENDED PLAN	AMENDED PLAN	
06.06.2023	5.09.2024	

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G6	STAGE 12A	RHF	GIH	03.08.2022
G5	STAGE 12B	RHF	GIH	26.07.2022
G4	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	28.06.2022
G3	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G1	STAGE 10 AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.12.2021
E	STAGE 8 AMENDED	RHF	GIH	30.08.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments	2749
Total area	377.03ha
Developable area (less school & community)	274.64ha
Reserves (incl lake)	72.00ha
Drainage Reserves	14.03ha
Total Reserve area	86.03ha
Contributed Reserve (28.8%)	79.02ha
(total reserve less 50% of Drainage Reserves)	
Length of new roads	41.89km
Tree to be removed	
Contour interval 1m. Datum AHD.	
Road pavements shown are indicative only.	
Dimensions and areas are subject to survey.	

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1

Glenn Ian Hordacre
LICENSED SURVEYOR

REF	21A3182
DWG No.	21A3182PROP(R)
REVISION	R
RHF	24.09.2024

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

Alexander Symonds
Surveying Consultants



Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429
Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Road)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769

1:1000 @ A1
RIVERLEA
PRECINCT 2

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client
Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G6	STAGE 12B	RHF	GIH	03.08.2022
G5	STAGE 12A	RHF	GIH	26.07.2022
G4	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	28.06.2022
G3	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G1	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 AMENDED	RHF	GIH	10.12.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
No. of proposed allotments	2749				
Total area	377.03ha				
Developable area (less school & community)	274.64ha				
Reserves (incl lake)	72.00ha				
Drainage Reserves	14.03ha				
Total Reserve area	86.03ha				
Contributed Reserve (total reserve less 50% of Drainage Reserves)	(28.8%) 79.02ha				
Length of new roads	41.89km				
Tree to be removed					
Contour interval 1m. Datum AHD. Road pavements shown are indicative only. Dimensions and areas are subject to survey.					

© ALEXANDER & SYMONDS PTY. LTD. Glenn Ian Hordacre
LICENSED SURVEYOR
Original Sheet Size A1

REF 21A3182 DWG No. 21A3182PROP(R) REVISION R RHF 24.09.2024	
---	--

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

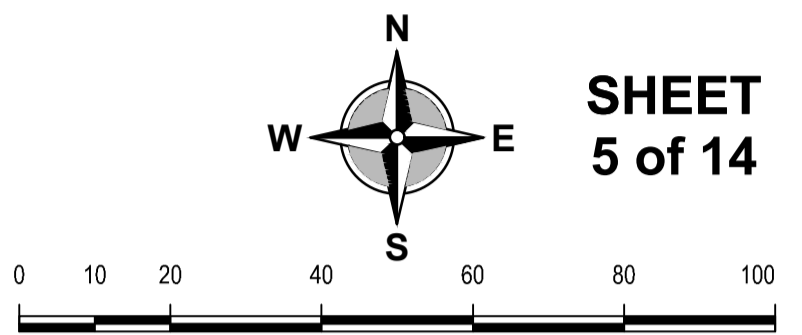
+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +



Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429
Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Rod)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



SHEET
5 of 14

1:1000 @ A1

RIVERLEA
PRECINCT 2

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12A	RHF	GIH	03.08.2022
G5	STAGE 12B	RHF	GIH	26.07.2022
G4	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	28.06.2022
G3	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G1	STAGE 10 AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.12.2021
E	STAGE 8 AMENDED	RHF	GIH	30.08.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

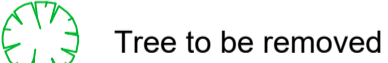
Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments 2749

Total area 377.03ha
Developable area (less school & community) 274.64ha

Reserves (incl lake) 72.00ha
Drainage Reserves 14.03ha
Total Reserve area 86.03ha
Contributed Reserve (28.8%) 79.02ha
(total reserve less 50% of Drainage Reserves)

Length of new roads 41.89km



Contour interval 1m. Datum AHD.
Road pavements shown are indicative only.
Dimensions and areas are subject to survey.

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1

Glenn Ian Hordacre
LICENSED SURVEYOR

REF 21A3182	
DWG No. 21A3182PROP(R)	
REVISION R	
RHF 24.09.2024	

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

Alexander
Symonds
Surveying
Consultants

F162492

GAWLER RIVER

STAGE 12B

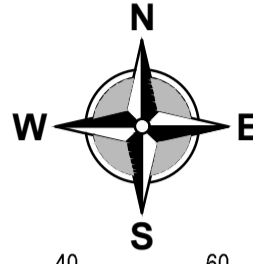
STAGE 16

STAGE 12A

Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429
Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Rod)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



SHEET
6 of 14

1:1000 @ A1

RIVERLEA
PRECINCT 2

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12A	RHF	GIH	03.08.2022
G5	STAGE 12A	RHF	GIH	26.07.2022
G4	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	28.06.2022
G3	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G1	STAGE 10 AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.12.2021
E	STAGE 8 AMENDED	RHF	GIH	30.08.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments 2749

Total area 377.03ha
Developable area (less school & community) 274.64ha

Reserves (incl lake) 72.00ha
Drainage Reserves 14.03ha
Total Reserve area 86.03ha
Contributed Reserve (28.8%) 79.02ha
(total reserve less 50% of Drainage Reserves)

Length of new roads 41.89km

Tree to be removed

Contour interval 1m. Datum AHD.
Road pavements shown are indicative only.
Dimensions and areas are subject to survey.

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1

Glenn Ian Hordacre
LICENSED SURVEYOR

REF 21A3182	
DWG No. 21A3182PROP(R)	
REVISION R	
RHF 24.09.2024	

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

Alexander
Symonds
Surveying
Consultants

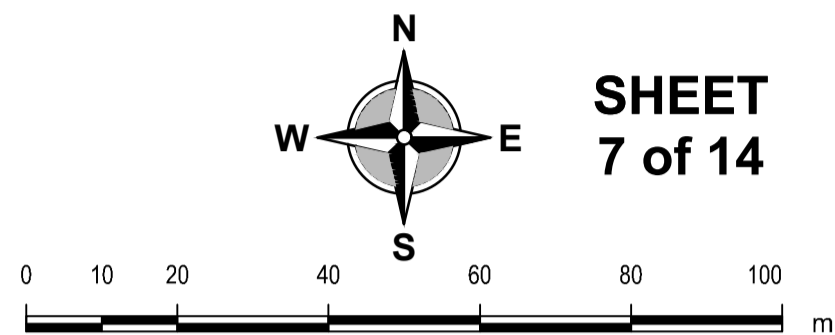


Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429

Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Road)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK


C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



1:1000 @ A1
RIVERLEA
PRECINCT 2

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000

Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12A	RHF	GIH	03.08.2022
G5	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	26.07.2022
G4	STAGE 11 AMENDED	RHF	GIH	28.06.2022
G3	STAGE 10A AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10 AMENDED	RHF	GIH	26.05.2022
G1	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.12.2021
F	STAGE 8 AMENDED	RHF	GIH	30.08.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments	2749
Total area	377.03ha
Developable area (less school & community)	274.64ha
Reserves (incl lake)	72.00ha
Drainage Reserves	14.03ha
Total Reserve area	86.03ha
Contributed Reserve (total reserve less 50% of Drainage Reserves)	(28.8%) 79.02ha
Length of new roads	41.89km
Tree to be removed	
Contour interval 1m. Datum AHD. Road pavements shown are indicative only. Dimensions and areas are subject to survey.	

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1
Glenn Ian Hordacre
LICENSED SURVEYOR

REF 21A3182	
DWG No. 21A3182PROP(R)	
REVISION R	
RHF 24.09.2024	

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

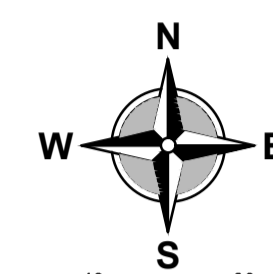
**Alexander
Symonds**
Surveying
Consultants



Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429
Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Rod)
Hundred of Port Adelaide
 in the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



SHEET
8 of 14



1:1000 @ A1

RIVERLEA
PRECINCT 2

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1641, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
Q	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
R	ROAD WIDTHS AMENDED	RHF	GIH	29.06.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	11.12.2022
J	TOTAL REDESION TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G	STAGE 12B	RHF	GIH	03.08.2022
G5	STAGE 12A	RHF	GIH	26.07.2022
G3	STAGE 11, LOTS 1108-112, 1134-1138	RHF	GIH	26.07.2022
G2	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G1	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G2	STAGE 10 AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.08.2021
E	STAGE 8 AMENDED	RHF	GIH	10.08.2021
D	3RD DRAFT AMENDMENTS	RHF	GIH	8.01.2021
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments	2749
----------------------------	------

Total area	377.03ha
Developable area (less school & community)	274.64ha

Reserves (incl lake)		72.00ha
Drainage Reserves		14.03ha
Total Reserve area		86.03ha
Contributed Reserve	(28.8%)	79.02ha
(total reserve less 50% of Drainage Reserves)		

Length of new roads	41.89km
---------------------	---------



Contour interval 1m. Datum AHD.
Road pavements shown are indicative only.
Dimensions and areas are subject to survey.

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1

Glenn Ian Hordacre
LICENSED SURVEYOR

REF 21A3182	
DWG No. 21A3182PROP(R)	
REVISION R	
RHF 24.09.2024	

Alexander & Symonds Pty Ltd
11 King William Street Kent Town
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
 + Construction + Mining +
 + Spatial Information Management +

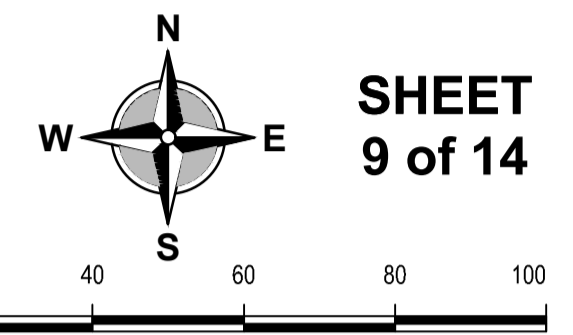
Alexander
Symonds
Surveying
Consultants



Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429
Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Rod)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK


C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



1:1000 @ A1
**RIVERLEA
PRECINCT 2**

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12A	RHF	GIH	03.08.2022
G5	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	26.07.2022
G3	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G1	STAGE 10 AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.12.2021
E	STAGE 8 AMENDED	RHF	GIH	30.08.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments 2749

Total area 377.03ha
Developable area (less school & community) 274.64ha

Reserves (incl lake) 72.00ha
Drainage Reserves 14.03ha
Total Reserve area 86.03ha
Contributed Reserve (28.8%) 79.02ha
(total reserve less 50% of Drainage Reserves)

Length of new roads 41.89km

 Tree to be removed

Contour interval 1m. Datum AHD.
Road pavements shown are indicative only.
Dimensions and areas are subject to survey.

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1

Glenn Ian Hordacre
LICENSED SURVEYOR

REF 21A3182
DWG No. 21A3182PROP(R)
REVISION R
RHF 24.09.2024

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

**Alexander
Symonds**
Surveying
Consultants



Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429
Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Road)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK
C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769

N
W
E
S

0 10 20 40 60 80 100 m

SHEET
10 of 14

1:1000 @ A1
RIVERLEA
PRECINCT 2

AMENDED PLAN
01.12.2022

AMENDED PLAN
02.02.2024

AMENDED PLAN
24.09.2024

AMENDED PLAN
29.03.2023

AMENDED PLAN
22.05.2024

AMENDED PLAN
06.06.2023

AMENDED PLAN
5.09.2024

Client

Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 8252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12A	RHF	GIH	03.08.2022
G5	STAGE 12A	RHF	GIH	26.07.2022
G4	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	28.06.2022
G3	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G1	STAGE 10 AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.12.2021
E	STAGE 8 AMENDED	RHF	GIH	30.08.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
No. of proposed allotments 2749					
Total area 377.03ha					
Developable area (less school & community) 274.64ha					
Reserves (incl lake) 72.00ha					
Drainage Reserves 14.03ha					
Total Reserve area 86.03ha					
Contributed Reserve (28.8%) 79.02ha (total reserve less 50% of Drainage Reserves)					
Length of new roads 41.89km					
Tree to be removed					
Contour interval 1m. Datum AHD. Road pavements shown are indicative only. Dimensions and areas are subject to survey.					

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1

Glenn Ian Hordacre

LICENSED SURVEYOR

REF 21A3182

DWG No. 21A3182PROP(R)

REVISION R

RHF 24.09.2024

Alexander & Symonds Pty Ltd,
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666

F (08) 8362 0099

W www.alexander.com.au

E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

Alexander Symonds

Surveying Consultants





Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429

Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Road)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769

N

W

E

S

SHEET

12 of 14

01000 @ A1

RIVERLEA
PRECINCT 2

AMENDED PLAN
01.12.2022

AMENDED PLAN
02.02.2024

AMENDED PLAN
24.09.2024

AMENDED PLAN
29.03.2023

AMENDED PLAN
22.05.2024

AMENDED PLAN
06.06.2023

AMENDED PLAN
5.09.2024

Client

Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12A	RHF	GIH	03.08.2022
G5	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	26.07.2022
G4	STAGE 11 AMENDED	RHF	GIH	28.06.2022
G3	STAGE 10A AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10 AMENDED	RHF	GIH	26.05.2022
G1	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 AMENDED	RHF	GIH	10.12.2021
E	3RD DRAFT AMENDMENTS	DEL	GIH	30.08.2021
D	2ND DRAFT AMENDMENTS	RHF	GIH	8.07.2015
C	1ST DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B		RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date

No. of proposed allotments

2749

Total area

377.03ha

Developable area (less school & community)

274.64ha

Reserves (incl lake)

72.00ha

Drainage Reserves

14.03ha

Total Reserve area

86.03ha

Contributed Reserve (total reserve less 50% of Drainage Reserves)

79.02ha (28.8%)

Length of new roads

41.89km

Tree to be removed

Contour interval 1m. Datum AHD.
Road pavements shown are indicative only.
Dimensions and areas are subject to survey.

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1

Glenn Ian Hordacre
LICENSED SURVEYOR

REF 21A3182

DWG No. 21A3182PROP(R)

REVISION R

RHF 24.09.2024

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

Alexander Symonds
Surveying Consultants

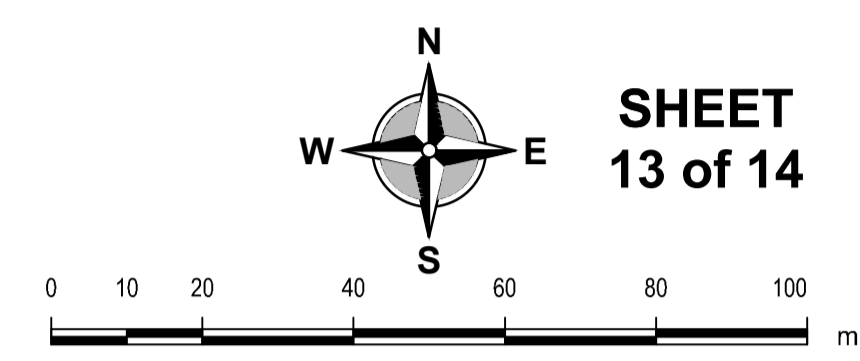


Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429

Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Rod)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



1:1000 @ A1
**RIVERLEA
PRECINCT 2**

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client

Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3791	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12A	RHF	GIH	03.08.2022
G5	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	26.07.2022
G4	STAGE 11 AMENDED	RHF	GIH	28.06.2022
G3	STAGE 10A AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10 AMENDED	RHF	GIH	26.05.2022
G1	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 AMENDED	RHF	GIH	10.12.2021
E	3RD DRAFT AMENDMENTS	DEL	GIH	30.08.2021
D	2ND DRAFT AMENDMENTS	RHF	GIH	8.07.2015
C	1ST DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B		RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments 2749

Total area 377.03ha
Developable area (less school & community) 274.64ha

Reserves (incl lake) 72.00ha
Drainage Reserves 14.03ha
Total Reserve area 86.03ha
Contributed Reserve (28.8%) 79.02ha
(total reserve less 50% of Drainage Reserves)

Length of new roads 41.89km

Tree to be removed

Contour interval 1m. Datum AHD.
Road pavements shown are indicative only.
Dimensions and areas are subject to survey.

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1
Glenn Ian Hordacre
LICENSED SURVEYOR

REF 21A3182	
DWG No. 21A3182PROP(R)	
REVISION R	
RHF 24.09.2024	

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

D1671

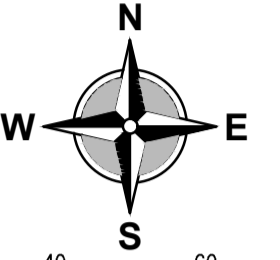
STAGE 26

STAGE 25

Development No. 292 / D027 / 15
City of Playford

Proposed Plan of Division
Allotment 91 in F174425
Allotment 92 in F174426
Allotment 93 in F174427
Allotment 95 in F174429
Blocks 58 to 60 & 67 to 69 in D1671
Allotments 5003 to 5006 in 292 / D019 / 12
Part Closed Road (Buckland Road)
Hundred of Port Adelaide
In the area named
BUCKLAND PARK

C'sT 5868/774, 5868/780, 5868/771, 5868/775, 5868/785, 5868/770,
5868/782, 5868/767, 5868/766, 5868/768
PT CT 5868/769



SHEET
14 of 14

0 10 20 40 60 80 100 m

1:1000 @ A1

RIVERLEA
PRECINCT 2

AMENDED PLAN 01.12.2022	AMENDED PLAN 02.02.2024	AMENDED PLAN 24.09.2024
AMENDED PLAN 29.03.2023	AMENDED PLAN 22.05.2024	
AMENDED PLAN 06.06.2023	AMENDED PLAN 5.09.2024	

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

R	STAGE 14 LOTS 1630-1644, 1651-1654, 1719-1721 & 2061-2066	DEL	GIH	24.09.2024
O	STAGE 14 LOTS 2061 TO 2066	DEL	GIH	05.09.2024
P	STAGES 37 TO 39, RB4 & RB5	RHF	GIH	22.05.2024
N	STAGE 14, LOTS 1631-1643 & 1707-1721	RHF	GIH	02.02.2024
M	STAGE 39, LOTS 3773-3781	RHF	GIH	06.06.2023
L	ROAD WIDTHS AMENDED	RHF	GIH	29.03.2023
K	STAGE 15, 16, 38, 39, 40, 41	RHF	GIH	01.12.2022
J	TOTAL REDESIGN TWEAKS	RHF	GIH	24.08.2022
H	TOTAL REDESIGN	RHF	GIH	08.08.2022
G8	STAGE 12B	RHF	GIH	03.08.2022
G5	STAGE 12A	RHF	GIH	26.07.2022
G4	STAGE 11, LOTS 1108-1112, 1134-1138	RHF	GIH	28.06.2022
G3	STAGE 11 AMENDED	RHF	GIH	15.06.2022
G2	STAGE 10A AMENDED	RHF	GIH	26.05.2022
G1	STAGE 10 AMENDED	RHF	GIH	16.05.2022
F	STAGE 8 STAGE BOUNDARY AMENDED	RHF	GIH	10.12.2021
E	STAGE 8 AMENDED	RHF	GIH	30.08.2021
D	3RD DRAFT AMENDMENTS	DEL	GIH	8.07.2015
C	2ND DRAFT AMENDMENTS	RHF	GIH	26.09.2013
B	1ST DRAFT AMENDMENTS	RHF	GIH	20.08.2013

Issue	Description	Drwn	Ckd.	Appd.	Date
-------	-------------	------	------	-------	------

No. of proposed allotments 2749

Total area 377.03ha
Developable area (less school & community) 274.64ha

Reserves (incl lake) 72.00ha
Drainage Reserves 14.03ha
Total Reserve area 86.03ha
Contributed Reserve (28.8%) 79.02ha
(total reserve less 50% of Drainage Reserves)

Length of new roads 41.89km

Tree to be removed

Contour interval 1m. Datum AHD.
Road pavements shown are indicative only.
Dimensions and areas are subject to survey.

© ALEXANDER & SYMONDS PTY. LTD. Original Sheet Size A1

Glenn Ian Hordacre
LICENSED SURVEYOR

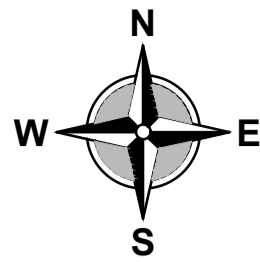
REF 21A3182	
DWG No. 21A3182PROP(R)	
REVISION R	
RHF 24.09.2024	

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

+ Property + Land Development +
+ Construction + Mining +
+ Spatial Information Management +

Alexander
Symonds
Surveying
Consultants



LEGEND

Allotment Type	Width	Depth	Area m²	Total	Total%
Terrace	7-9	25-30	150-250	345	12.6%
Cottage	15	15	225	105	3.8%
Small Courtyard	12.5	25	312	100	3.6%
Courtyard	14	25	350	58	2.1%
Villa	12.5	30	375	430	15.7%
Medium Courtyard	16	25	400	99	3.6%
Entry Traditional	14	30	420	494	18.1%
Large Villa	12.5	35	438	21	0.8%
Large Courtyard	18	25	450	31	1.1%
Small Traditional	16	30	480	528	19.2%
Entry Estate	14	35	490	30	1.1%
Grand Courtyard	20	25	500	23	0.8%
Medium Traditional	18	30	540	241	8.8%
Small Estate	16	35	560	34	1.2%
Large Traditional	20	30	600	132	4.8%
Medium Estate	18	35	630	25	0.9%
Large Estate	20	35	700	23	0.8%
Grand Estate			800+	17	0.6%
MD Site				12	0.4%
Total				2748	100%

0 30 60 120 180 240
m
1:3000

Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

Title

**PRECINCT 2
Residential Allotment Mix
Modification
Sheet 1 of 2**

Project

RIVERLEA

Project Code

21A3182

Drawing No.

21A3182LM

Rev

L

Revision Date

24 September 2024

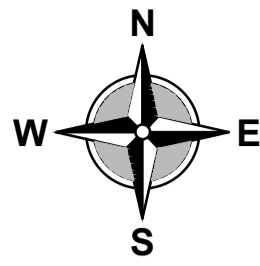
Surveyor

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
W www.alexander.com.au
E adelaide@alexander.com.au

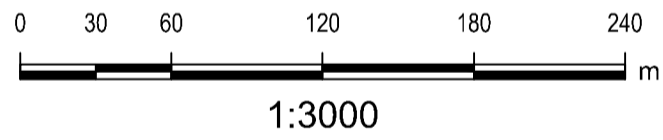


100mm On Original A1



LEGEND

Allotment Type	Width	Depth	Area m²	Total	Total%
Terrace	7-9	25-30	150-250	345	12.6%
Cottage	15	15	225	105	3.8%
Small Courtyard	12.5	25	312	100	3.6%
Courtyard	14	25	350	58	2.1%
Villa	12.5	30	375	430	15.7%
Medium Courtyard	16	25	400	99	3.6%
Entry Traditional	14	30	420	494	18.1%
Large Villa	12.5	35	438	21	0.8%
Large Courtyard	18	25	450	31	1.1%
Small Traditional	16	30	480	528	19.2%
Entry Estate	14	35	490	30	1.1%
Grand Courtyard	20	25	500	23	0.8%
Medium Traditional	18	30	540	241	8.8%
Small Estate	16	35	560	34	1.2%
Large Traditional	20	30	600	132	4.8%
Medium Estate	18	35	630	25	0.9%
Large Estate	20	35	700	23	0.8%
Grand Estate			800+	17	0.6%
MD Site				12	0.4%
Total				2748	100%



Client



Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000
Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

Title

**PRECINCT 2
Residential Allotment Mix
Modification
Sheet 2 of 2**

Project

RIVERLEA

Project Code

21A3182

Drawing No.

21A3182LM

Rev

L

Revision Date

24 September 2024

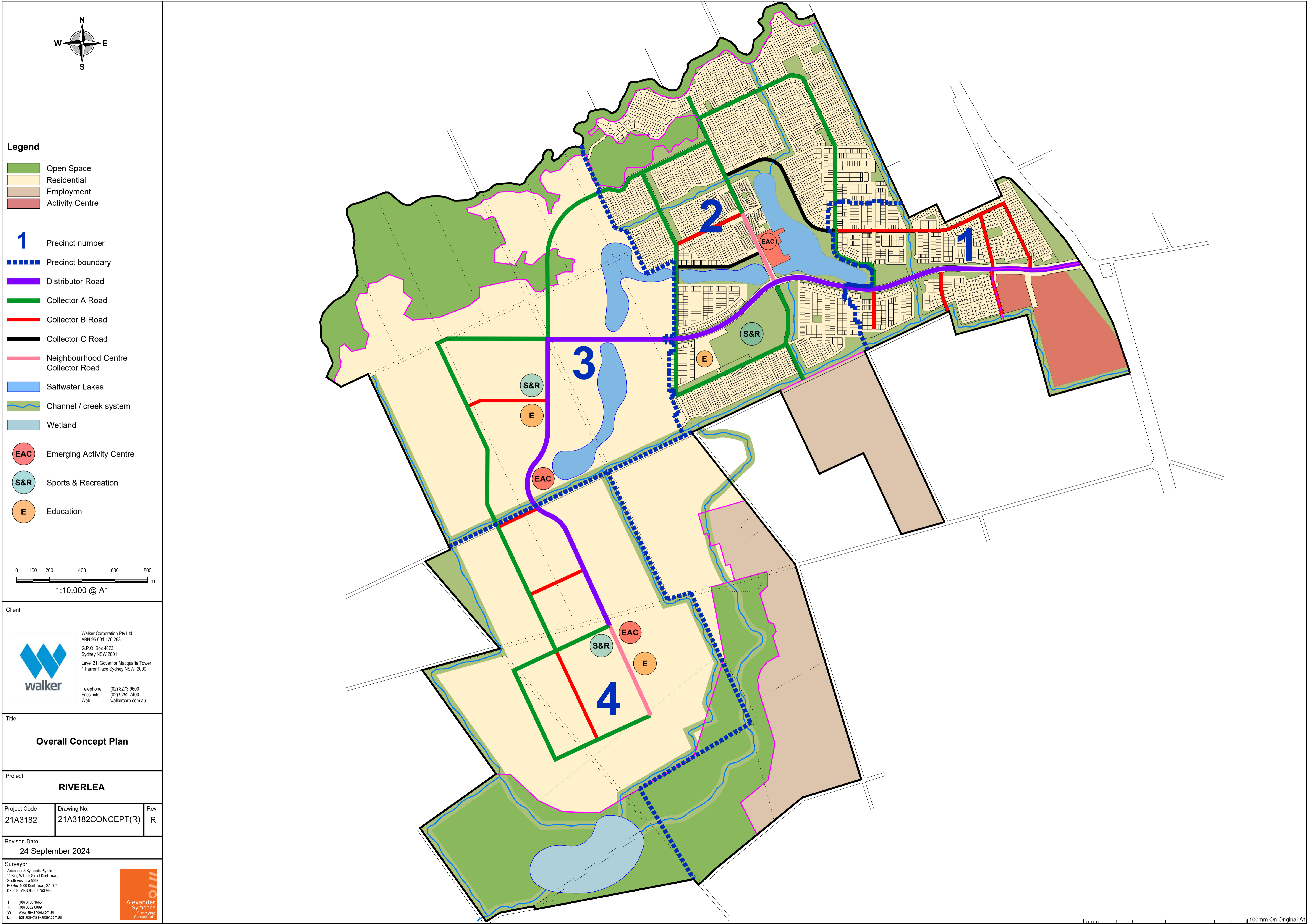
Surveyor

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

T (08) 8130 1666
F (08) 8362 0099
E www.alexander.com.au
alex@alexander.com.au



100mm On Original A1



Legend

- Open Space
- Residential
- Employment
- Activity Centre

1 Precinct number

- Precinct boundary
- Distributor Road
- Collector A Road
- Collector B Road
- Collector C Road
- Neighbourhood Centre Collector Road
- Saltwater Lakes
- Channel / creek system
- Wetland

- EAC** Emerging Activity Centre
- S&R** Sports & Recreation
- E** Education

0 100 200 400 600 800 m
1:10,000 @ A1

Client

walker

Walker Corporation Pty Ltd
ABN 95 001 176 263
G.P.O. Box 4073
Sydney NSW 2001
Level 21, Governor Macquarie Tower
1 Farrer Place Sydney NSW 2000

Telephone (02) 8273 9600
Facsimile (02) 9252 7400
Web walkercorp.com.au

Title

Overall Concept Plan

Project

RIVERLEA

Project Code	Drawing No.	Rev
21A3182	21A3182CONCEPT(R)	R

Revision Date

24 September 2024

Surveyor

Alexander & Symonds Pty Ltd
11 King William Street Kent Town,
South Australia 5067
PO Box 1000 Kent Town, SA 5071
DX 209 ABN 93007 753 988

Alexander Symonds
Surveying
Consultants

T (08) 8130 1666
F (08) 8362 0099
W www.alexandersymonds.com.au
E alexander@alexandersymonds.com.au

Riverlea Development,
Proposed Saltwater Lakes

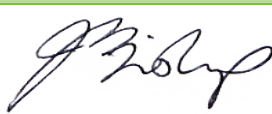
Saltwater Seepage Risk Assessment

For Walker Buckland Park
Developments Pty Ltd

Riverlea Development – Proposed Saltwater Lakes Saltwater Seepage Risk Assessment

Report for Walker Buckland Park Developments Pty Ltd

Document Control

File	231445-01 R02.docx
Revision	0
Date issued	23.10.2024
Author(s)	T O'Leary, J Bishop, J Larkin
Principal review	J Bishop
Approved for issue	

Distribution Record

		Revision No. and Date Issued
		0
Organisation	Contact Name	23.10.2024
Walker Buckland Park Developments Pty Ltd	Pat Mitchell	●

Table of Contents

Executive Summary	i
1 Introduction	1
1.1 Objectives	1
2 The Proposed Saltwater Lakes	3
2.1 Lake Properties	3
2.2 Liner Options	3
3 Background	5
3.1 Geology	5
3.2 Hydrogeology	5
3.3 Existing Use of Shallow Groundwater	6
3.4 Existing Salinity of Shallow Groundwater	7
4 Regulatory Framework	9
4.1 Water Quality Guidelines	9
4.1.1 Livestock drinking water	10
4.1.2 Aquaculture and human consumption of aquatic foods	10
4.1.3 Aquatic ecosystems	10
5 Potential Seepage and Migration Modelling for Saltwater	12
6 Discussion	13
6.1 Question 1	13
6.2 Question 2	14
6.3 Question 3	19
6.3.1 Users of groundwater	19
6.3.2 Environmental values of groundwater	19
6.3.3 Current or future ecological receptors	19
6.3.4 Built environment	23
6.3.5 Summary	24
6.4 Question 4	24
6.5 Question 5	27
6.5.1 Sea level rise	27
6.5.2 Drought	28
6.5.3 Flood	28
6.5.4 Reduced groundwater recharge	29
7 Risk Assessment for Saltwater Seepage into Groundwater	30
8 Conclusions and Recommendations	37
9 Limitations	39

List of Tables and Plates

Table 1	Saltwater Lake Properties	3
Table 2	Registered Use of Groundwater ≤ 15 mBGL and within 2 km of the Saltwater Lakes	6
Table 3	TDS concentrations in shallow groundwater at Riverlea and surrounds	7
Plate 1	Histogram for TDS Concentrations in Shallow Groundwater	8
Plate 2	ANZECC (2000) recommended salinity for livestock drinking water	10
Plate 3	Schematic of lake liner scenarios	13
Table 4	Predicted source zone TDS concentrations in groundwater beneath lakes	13
Plate 4	Anaqsim modelled particle tracking for 100 years	17
Plate 5	Anaqsim modelled particle tracking for 1,000 years	17
Plate 6	Anaqsim modelled particle tracking for 100 years, SWL2 level at 3 mAHD	18
Plate 7	Riverlea Concept Masterplan	21
Plate 8	BOM GDE map for aquatic ecosystems – Gawler River	22
Plate 9	BOM GDE map for terrestrial ecosystems – Gawler River	22
Table 5	High-level Sustainability Review of Liner Options	25
Plate 10	BOM GDE map for terrestrial ecosystems – Gawler River	28
Table 6	Likelihood Descriptor Matrix	30
Table 7	Consequence Descriptor Matrix	30
Table 8	Risk Ranking Matrix	32
Table 9	Risk Assessment	33

List of Appendices

- A Figures
- B Dewatering Modelling Report

Abbreviations

ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018
ASC NEPM	National Environment Protection (Assessment of Site Contamination) Measure 1999 (amended 2013)
BOM	Bureau of Meteorology
DEW	Department for Environment and Water, Government of South Australia
EPA	Environment Protection Authority, Government of South Australia
EP Act	<i>Environment Protection Act 1993 (SA)</i>
EP Regs	<i>Environment Protection Regulations 2023 (SA)</i>
EV	Environmental Value
GAR	Guidelines for the assessment and remediation of site contamination (EPA 2019)
GDE	Groundwater dependent ecosystem
GED	General Environmental Duty
GME	Groundwater monitoring event
HCL	Hydrogeology Consulting Ltd
HDPE	High density polyethylene
LBWco	LBW co Pty Ltd
LMP	Lake Management Plan
mAHD	metres Australian Height Datum
mBGL	metres below ground level
mg/L	milligrams per litre
NGL	Natural ground level
QA/QC	Quality assurance / quality control
RL	relative level
SA	South Australia
SWL	Standing water level
SWL1	Saltwater Lake 1
SWL2	Saltwater Lake 2
SWL3	Saltwater Lake 3
TDS	Total Dissolved Solids
TSS	Total suspended solids
Walker	Walker Buckland Park Developments Pty Ltd
WQP	<i>Environment Protection (Water Quality) Policy 2015 (SA)</i>

Executive Summary

Three saltwater lakes are proposed to be constructed at the Riverlea site and will provide a range of functions and benefits to the community, which have been set out in a revised masterplan submission by Walker to the State Planning Commission.

Dewatering investigations to assess construction impacts of the lakes were undertaken by LBWco for PART 1 of the saltwater lakes investigations during 2023 and 2024. Hydrogeological modelling by Hydrogeology Consulting Ltd (HCL) was included, and reported to Walker in:

LBWco 2024, Riverlea Development – *Proposed Saltwater Lakes Dewatering Investigation and Risk Assessment Report* (231445-01 R01), 15.10.2024.

PART 2 investigations, including solute transport modelling by HCL, is reported here. The assessment work was undertaken to predict properties of seepage of saltwater from the lakes into shallow groundwater, subsequent migration of saline groundwater downgradient of the lakes, and to assess potential environmental impacts. This report for PART 2 builds on environmental and hydrogeological characterisation work for the site in PART 1 and accordingly, both reports should be considered together.

Three different scenarios for lake construction were considered for this investigation: Unlined, clay-lined and geo-synthetic lined.

To address the objectives for this assessment, a set of questions were posed and responses developed by LBWco's team based on the findings of the site investigations and modelling work. The questions and concluding responses are set out below. Detailed information on the nature of the investigations, modelling and impact assessment is provided in the report.

Question 1 – If saltwater seeps into the shallow groundwater system, what concentration of salt above background conditions is added to the groundwater for:

- a) A clay-lined subgrade for lake construction?
- b) A geo-synthetic lined lake construction?

Saltwater seepage into the groundwater is expected for both a clay-lined and geo-synthetic lined lake. The salinity of the groundwater beneath the lakes varies based on the seepage rate of saltwater into the groundwater. Conservative modelling predicted added salinity as TDS ranging from 13,000 – 17,700 mg/L for clay-lined lakes and from 1,000 – 3,100 mg/L for geo-synthetic lined lakes.

Question 2 – What extent of migration is predicted for above-background saline groundwater that may emanate from the lakes over time?

Migration of saline groundwater, resulting from saltwater seepage from the lakes, was assessed using Bioscreen-AT, which is a widely used tool for modelling solute advection and dispersion in groundwater. Based on the conservative parameters applied to the modelling, the predicted migration of saline groundwater at 100 years after filling of the lakes, ranged from approximately 600 m (geo-synthetic lined) to 780 m (unlined) downgradient of the lakes. Figures 6A-C in Appendix A provide interpretive mapping to visually represent the modelling predictions.

Predicted salinity migration at 100 years was within the Riverlea development boundary.

Advective transport of salt will be limited by the transmissivity of the shallow saturated zone and accordingly the conservative approach to modelling may overstate the distance of downgradient migration of salt.

Solute transport was assessed separately by particle tracking using the Anaqsim groundwater model flow field, containing unlined lakes filled with water and hydraulically connected with the

groundwater. Particle tracking within this steady state simulation predicted a similar migration distance (to Bioscreen-AT) of a salt particle at 100 years.

Extension of the Anaqsim modelling to a period of 1,000 years, indicated that based on current conditions the saltwater plume in groundwater would remain within the downgradient area of Riverlea for a period ranging between 200-700+ years. Modelling predictions at these timeframes are low confidence as the future effects of climate change and site operations on the lakes and groundwater are unknown.

Question 3 – Will saltwater seepage from the lakes into the shallow groundwater cause an unacceptable impact to existing users of the shallow groundwater, to current or future ecological receptors or the built environment?

The seepage and transport modelling provided no indication of potential for unacceptable impact to existing users of the shallow groundwater, as no relevant registered users were identified in the vicinity of the proposed lakes or downgradient of the lakes.

Moderate to high salinity groundwater, representing ambient background conditions, is present at Riverlea within 1 km downgradient of the proposed saltwater lakes. Hypersaline groundwater, caused by the salt evaporation pans, is present within 1.5 km downgradient.

A potential for adverse impacts to ecological receptors and to the built environment from increased salinity in shallow groundwater was identified. However, these potential impacts can be mitigated via design and through planning and implementation of a suitable Lake Management Plan (LMP). Due to the very slow migration rate predicted for the saltwater plume, the time available between filling of lakes and any downgradient mitigation being required is expected to be decades.

Question 4 – Are there challenges or impacts of design, construction, monitoring, repair, maintenance or replacement for the different liner types that would make one liner type more sustainable than the others?

A high-level sustainability review was undertaken and considered a wide of aspects to the proposed saltwater lakes construction and operation. Based on the scoring system adopted, the preference rankings were assessed as followings:

1. No liner
2. Clay-lined
3. Geo-synthetic lined

However, the “no-liner” option appears to be challenged by non-compliance with the obligations of the general environmental duty at section 25 of the *Environment Protection Act 1993* (SA). On this basis the “clay-lined” scenario for lake construction was assessed as the preferred approach on sustainability grounds.

Question 5 – What external influences may cause change to the local groundwater system in the Riverlea area, and could these influences affect the assessment of risks posed by saltwater seepage from the proposed lakes?

Relevant external influences that could change the local groundwater system at Riverlea were identified as follows:

- Sea level rise induced by climate change
- Drought or flood
- Reduced groundwater recharge due to higher ground coverage by buildings and pavements and loss of runoff to evaporation and lakes.

Climate change induced increase in the groundwater table elevation is likely to have the most significant long-term influence. Groundwater salinity at Riverlea may increase substantially via sea water intrusion or mobilisation of deeper saltwater within the shallow aquifer. Material increase to groundwater salinity and or reduction in saline groundwater depth could occur, and could cause distress or death to a range of vegetation at the site, particularly deep-rooted vegetation such as the mature Eucalypt trees in the north west portion of the site.

The information in this report is subject to the limitations expressed in Section 9. The reader should make themselves aware of the limitations and how they relate to the conclusions provided above.

1 Introduction

LBW co Pty Ltd (LBWco) was engaged by Walker Buckland Park Developments Pty Ltd (Walker) to undertake environmental and hydrogeological investigations at Riverlea (the site) to support impact assessments for the proposed saltwater lakes. A site locality plan is presented on Figure 1 in Appendix A.

Three saltwater lakes are proposed to be constructed at the site and will provide a range of functions and benefits to the Riverlea development, which have been set out in the revised masterplan submission by Walker.

Walker advised that the three saltwater lakes are proposed to be constructed and filled from 2030 through to 2040. The lakes will be filled with saltwater pumped from nearby Chapman Creek, which is a local inlet of the Gulf St Vincent. The progression of lakes construction will be informed by the progression of the Riverlea development and the learnings from delivering each lake in sequence.

The environmental and hydrogeological investigations were focussed on:

PART 1 – Dewatering of groundwater during construction of the lakes

PART 2 – Potential for salinity impacts via seepage of salt water from the lakes into the surrounding groundwater

Dewatering investigations were undertaken by LBWco for PART 1 during 2023 and 2024, including hydrogeological modelling by Hydrogeology Consulting Ltd (HCL), and reported to Walker in:

LBWco 2024, Riverlea Development – *Proposed Saltwater Lakes Dewatering Investigation and Risk Assessment Report* (231445-01 R01), 15.10.2024.

Work by LBWco for PART 2, including solute transport modelling by HCL, is reported here. The PART 2 work was undertaken to predict properties of seepage of saline water from the lakes into shallow groundwater, subsequent migration of saline groundwater downgradient of the lakes, and assess potential environmental impacts. Several potential lake construction and liner scenarios were considered.

This report for PART 2 builds on environmental and hydrogeological characterisation work for the site in PART 1. Selected information from PART 1 is summarised in this report. Accordingly, both reports should be considered together.

In 2024, LBWco and HCL prepared a memo to Walker regarding “**Riverlea Saltwater Lakes – Modelling of Groundwater Salinity via Seepage from Saltwater Lake 1 and Assessment of Potential Environment Impact**” (231445-01 M02.1), dated 01.03.2024. The advice provided in the memo was for saltwater lake 1 only and has since been extended and superseded by the investigation, modelling and risk assessment presented in this PART 2 report.

1.1 Objectives

Intent to separate saltwater stored in the lakes from the surrounding shallow groundwater was a key design principle proposed by Walker for the lakes. On the advice of environmental experts and applying the precautionary principle, Walker accepted that environmental containment systems (liners) for the saltwater lakes have the potential to leak and release saltwater via a range of mechanisms.

The objective of this investigation was to assess risks to the environment at Riverlea and in the downgradient surrounding area, from potential seepage of saltwater from the proposed lakes.

The objective was met by seeking to answer the following questions:

Question 1 – If saltwater seeps into the shallow groundwater system, what concentration of salt above background conditions is added to the groundwater for:

- a) A clay-lined subgrade for lake construction?
- b) A geo-synthetic lined lake construction?

Question 2 – What extent of migration is predicted for above-background saline groundwater that may emanate from the lakes over time?

Question 3 – Will saltwater seepage from the lakes into the shallow groundwater cause an unacceptable impact to existing users of the shallow groundwater, to current or future ecological receptors, or to the built environment?

Question 4 – Are there challenges or impacts of design, construction, monitoring, repair, maintenance or replacement for the different liner types that would make one liner type more sustainable than the others?

Question 5 – What external influences may cause change to the local groundwater system in the Riverlea area, and could these influences affect the assessment of risks posed by saltwater seepage from the proposed lakes?

2 The Proposed Saltwater Lakes

2.1 Lake Properties

Three saltwater lakes (SWL1, SWL2 and SWL3) are proposed within Walker's revised Riverlea masterplan, which was submitted to the State Planning Commission for planning consent. The lakes will serve multiple purposes within the Riverlea development and community, including (but not limited to):

- Amenity and recreation waters for the community
- Stormwater management
- Local environment and biodiversity enhancement within a new urban mixed-use community
- Source of soil construction materials for Riverlea, reducing demand on external sources of fill material

Key details on the area, depth and design water levels for each of the lakes are summarised in Table 1. These details were taken from lake design information per Burchills Engineering Solutions drawing SK136 (version D), 24.02.2023, and information supplied by Walker.

Table 1 Saltwater Lake Properties

Item	SWL1	SWL2	SWL3
Lake footprint area (m ²)	146,428	141,606	115,131
Lake bed RL ^a (mAHD ^b)	1.5	1.0	0.0
Design standing water level (mAHD)	4.5	4.0	3.0
Lake volume (m ³)	404,360	384,083	316,193
Planned completion year	2030	2035	2040

a. RL – relative level

b. AHD – Australian Height Datum

2.2 Liner Options

Containment of saltwater within the lakes has been investigated by Walker. Options for clay and polymer liners are under consideration.

No environmental containment system on the scale proposed for the saltwater lakes can provide a guarantee of zero seepage or leakage of the fluid being contained. In the case of the saltwater lakes, seepage of saltwater across the potential liner systems may occur in several ways:

- Clay is a porous material. A well-constructed compacted clay liner would be expected to deliver a permeability of 1×10^{-9} m/s (Roger Grounds, WGA). While this is a very low permeability to water, it is not impermeable. Accordingly, water under head pressure will seep through a clay liner.

Substantial drilling and logging of the soil profile has been undertaken at Riverlea by LBWco and others. The soil profile within the depth range of the proposed lakes construction is comprised predominantly of bands of hard, high plasticity clay containing variable lenses of permeable sand, gravel and clayey sand (refer section 3.1). These permeable lenses are the key media through which groundwater is transmitted.

Due to the local geology at the site, construction of a clay should not be envisaged as the placement and compaction of 0.5 m thickness of new clay material over a subgrade level

designed to accommodate placement of this layer. Rather, and in simple terms, a clay liner would likely be constructed by:

- confirming density/permeability of existing in-situ clay at target lake bed depth
- providing additional compaction to in-situ clay where necessary
- selectively removing zones of permeable materials encountered at lake bed depth and replacing these with compacted clay won from the lakes bulk excavation
- Geo-synthetic liners may be constructed from a range of different materials and at different thicknesses as required for the liner application. Geo-synthetic liner materials are practicably impermeable to water, but may leak due to punctures or tears to the liner caused during construction, or due to post-liner construction activity penetrating the liner (e.g. pylon construction for a new jetty). Leakage rates across these liners are influenced by the frequency and size of holes/tears in the liner, the permeability of the underlying subgrade and the head of water above.

3 Background

Site investigations of the geology and hydrogeology of the Riverlea development were undertaken by others for the original environmental impact statement process, including:

- REM (2008), Aquifer Storage and Recovery Potential for Buckland Park, 30 October 2008
- REM-SKM (2008), Buckland Park EIS Groundwater Investigations, 17 December 2008
- SKM (2009), Further Groundwater Monitoring, Buckland Park Proposal, 6 March 2009
- Golder (2009), Preliminary Acid Sulphate Soil Investigation, Buckland Park, South Australia, Draft Report, 31 March 2009
- AGT (2011), Buckland Parks Drain Model, 4 May 2011.

LBWco carried out a review of the above reports prior to the additional hydrogeological assessment in 2023-24 for the PART 1 dewatering investigations for the saltwater lakes (LBWco 2024) and this PART 2 saltwater seepage risk assessment. A summary of the key information relating to site geology, hydrogeology, existing use and salinity of the shallow groundwater is provided in the sections below.

3.1 Geology

The ground surface is relatively flat in the vicinity of the site, with a gentle slope down towards the coast, which is located approximately 5-6 km west of the planned location of SWL1.

The near surface stratigraphy of the area is comprised of Quaternary sediments of the Pooraka Formation, with the St Kilda and Glanville Formations towards the coast. The Pooraka Formation is described as mottled clay and silt inter-bedded with sand, gravel and thin sandstone layers. The St Kilda formation is characterised by estuarine muds, sands, peats and shelly beds and often contains permeable sand lenses.

These Quaternary sediments overlie the older sediments of the Hindmarsh Clay, which is described as a layered sequence of mottled red-brown sandy clay with sand and gravel lenses.

Observations made during soil bore investigations at Riverlea by LBWco indicated that natural soils across the site generally comprised dark brown or grey-brown clay interbedded with bands of more permeable material such as sandy clays, clayey sands, sandy gravels and sands, ranging in thickness from 0.1 m to 2.7 m. Saturated zones were generally observed within the permeable lenses, separated by hard, high plasticity clay bands of variable thickness.

3.2 Hydrogeology

The REM (Oct 2008) report indicates that four Quaternary aquifers (Q1 to Q4) are generally present in the Northern Adelaide Plains region. The top three (Q1 to Q3) have thicknesses ranging from 3 to 15 m, and can be quite discontinuous with lateral extents often less than 2 km. The Hindmarsh Clay unit encloses these aquifers. Clay generally underlies the Q3 aquifer and forms a confining bed above the Q4 aquifer, which is a sandy, confined aquifer within the Carisbrooke Sand, with an average thickness of about 20 m. The Q4 near Buckland Park (and Riverlea) is interpreted to directly overlie the top Tertiary aquifer (T1), although the Q4 itself thins out towards the coast.

Groundwater investigations onsite by LBWco, which included the installation and sampling of 22 new monitoring wells, and 3 selected existing wells, identified the depth the groundwater onsite to range from approximately 2.2 – 4.9 m below ground level (BGL). Ground surface was modified by construction activity in several areas and was a key contributor to the range of variability observed in depth to groundwater measurements.

3.3 Existing Use of Shallow Groundwater

As reported in LBWco (2024), a search of the SA Government WaterConnect groundwater database was undertaken in November 2023 for a 2 km radius extending from the proposed location of SWL1. The groundwater bore search was subsequently updated to capture additional data for shallow groundwater bores within a 2 km search buffer around all three saltwater lakes and across the groundwater model domain.

Table 2 summarises the findings of the WaterConnect records of registered groundwater use from bores at depths ≤ 15 mBGL. This depth range was selected because:

- It was well below the maximum depth of the saltwater lake beds and below the inferred maximum depth of the perched and Q1 aquifers onsite, based on LBWco's drilling observations.
- REM-SKM (2008-09) reported that there is little, if any, hydraulic connection between the Q1 and Q2 aquifers in the area of Riverlea, so the data set would represent the groundwater depth range that may be impacted by saltwater seepage from the proposed lakes.

Table 2 Registered Use of Groundwater ≤ 15 mBGL and within 2 km of the Saltwater Lakes

Registered Use	Registered Wells	Notes
Domestic	-	No domestic use was identified for shallow groundwater within 2 km of the site or further downgradient of the proposed lakes
Town Water Supply	-	No town water supply bores were identified within 2 km of the site or further downgradient of the proposed lakes
Recreation / aesthetics	-	No bores listed for recreational purposes were identified within 2 km of the site or further downgradient of the proposed lakes
Industrial (general industry)	-	No bores listed for industrial purposes were identified within 2 km of the site or further downgradient of the proposed lakes. Bore 6528-3098 was incorrectly listed in the database for industrial purposes. Inspection of records on WaterConnect confirmed this bore was actually monitoring well SLMW09-P installed under supervision by LBWco.
Primary industry (irrigation)	6628-2290	Bore 6628-2290 was located approximately 1.7 km east from the eastern extent of SWL1 and was cross-gradient to the groundwater flow at the lakes. There was negligible potential for this bore to be impacted by saltwater seepage from the lakes onsite.
Primary industry (stock drinking water)	6628-1100	Bore 6628-1100 was located approximately 1.75 km north east from the eastern extent of SWL1 and was up-gradient to the groundwater flow at the lakes. There was negligible potential for this bore to be impacted by saltwater seepage from the lakes onsite.

Figure 3 in Appendix A presents a map of the site, saltwater lakes locations, modelled groundwater potentiometric surface¹ and registered shallow groundwater bores. Monitoring/investigation wells were excluded from the map presentation to support Figure 3's focus on existing extractive uses of groundwater.

The absence of existing use of the shallow groundwater onsite and within the area downgradient of Riverlea is evident from inspection of Figure 3.

¹ Steady-state groundwater surface modelled by HCL in Anaqsim with unlined saltwater lakes embedded in the aquifer as a high-permeability zone, adjusted for fit to observed groundwater RLs in onsite monitoring wells.

3.4 Existing Salinity of Shallow Groundwater

Total Dissolved Solids (TDS)

In the absence of any current saltwater storage onsite, or any other activities on the land (to LBWco's knowledge) that could have been an anthropogenic source of salinity to the shallow groundwater near the lakes, TDS monitoring results for groundwater at Riverlea and nearby surrounds were considered to reasonably represent the ambient background conditions for the shallow groundwater system.

TDS data was collated from several data sources to assess the range of groundwater salinity in the area of the proposed saltwater lakes. The data sources included:

- Two groundwater monitoring events at Riverlea by LBWco in 2023, which were reported in LBWco (2024)
- Groundwater monitoring events reported in REM-SKM (2008-09)
- WaterConnect records for shallow groundwater bores (<15 mBGL) onsite and in the vicinity of the site, within the groundwater model domain.

A series of salt evaporation pans are located to the west of Riverlea and the proposed saltwater lakes, down hydraulic gradient towards the coast, as shown on the site location plan in Figure 1 (Appendix A). These salt pans are known to have caused to high salt loading to the shallow groundwater beneath and near the salt pans, which has resulted in hypersaline conditions within the shallow groundwater.

Hypersalinity in groundwater is not representative of ambient background conditions relative to the Riverlea development.

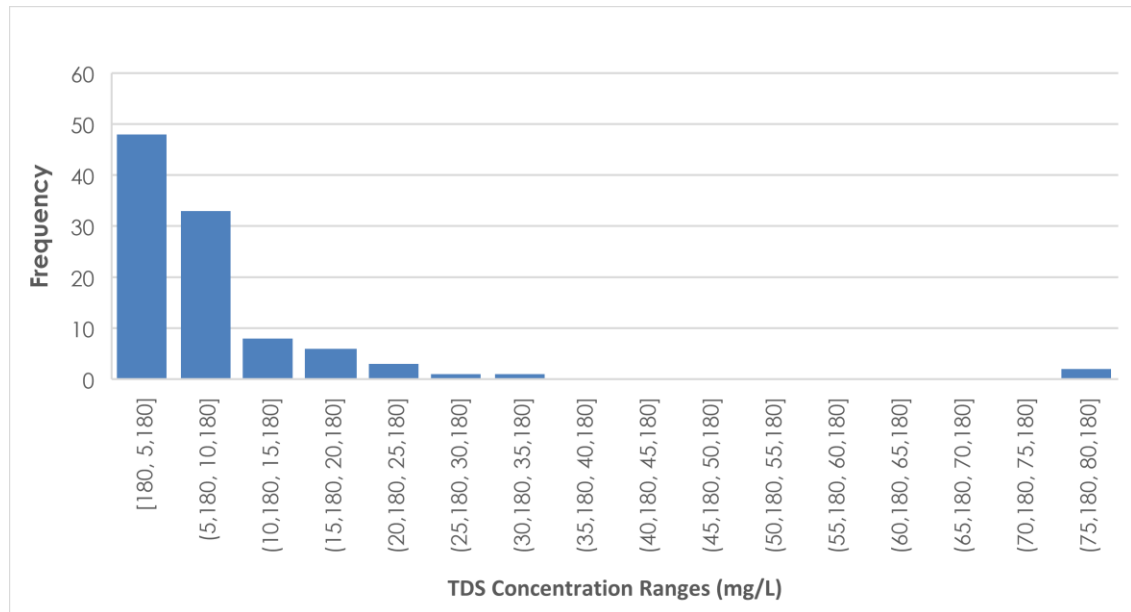
Summary statistics for the TDS concentrations in groundwater onsite and within the surrounding area are provided in Table 3 below.

Table 3 TDS concentrations in shallow groundwater at Riverlea and surrounds

Statistic	Result	Unit
Number of groundwater bores	102	-
Minimum TDS	180	mg/L
Maximum TDS	79,950	mg/L
Mean	8,753	mg/L
Median	6,605	mg/L
Standard deviation	11,803	mg/L
95% Upper confidence limit	11,254	mg/L

The statistics are significantly influenced by the skewed distribution of the TDS concentrations including wells containing hypersaline groundwater adjacent to the salt pans. Refer to the histogram in Plate 1 below for visual representation of the data.

Plate 1 Histogram for TDS Concentrations in Shallow Groundwater



The high concentrations of salt in groundwater at the evaporation pans and limited number of wells with TDS data at ≥ 1 km downgradient of the proposed lakes cause significant edge effects when attempting to contour the TDS data. Therefore, a TDS concentration contour map for the site has not been provided. Rather, LBWco mapped all the groundwater bores with TDS concentration data that was reviewed for the purpose of this assessment – refer to Figure 4 (Appendix A).

Shallow groundwater salinity in the area of the saltwater lakes ranges from approximately 5,000 mg/L to 18,000 mg/L.

Within a distance of approximately 1 km downgradient from proposed locations of SWL2 and SWL3, shallow groundwater salinity ranges from approximately 10,000 mg/L to 27,000 mg/L. The increased salinity in this area may be naturally occurring, may be influenced by the long-term presence of the salt pans, or a combination of both.

At approximately 1.5 km downgradient from the lakes, hypersaline groundwater is present at a salinity of approximately 80,000 mg/L.

4 Regulatory Framework

Protection of groundwater in South Australia is regulated by the:

- *Environment Protection Act 1993 (SA) (EP Act)*
- *Environment Protection Regulations 2023 (SA) (EP Regs)*, and
- *Environment Protection (Water Quality) Policy 2015 (SA) (WQP)*.

In accordance with Section 25 of the EP Act, there is a General Environmental Duty (GED) on all persons to ‘... **take all reasonable and practical measures to prevent or minimise any resulting environmental harm**’ resulting from an activity. The GED requires a person to take ‘reasonable and practical’ actions to prevent further environmental harm from any existing environmental harm.

The purpose of the WQP is to protect and maintain Environmental Values (EVs) of water resources and water protection areas in South Australia by regulating discharges to those waters. The WQP prescribes EVs for all inland, surface waters and groundwater.

By reference to the PART 1 report (LBWco 2024) and further consideration of the TDS data, the following prescribed EVs were determined to be applicable for the onsite shallow groundwater at and downgradient of the proposed lake locations:

- Primary industries – livestock drinking water
- Primary industries – aquaculture and human consumption of aquatic foods

Due to proximity of the site to surface water aquatic ecosystems, potential for groundwater-surface water interaction downgradient of the site, and application of the precautionary principle, LBWco assessed the following EVs to also be relevant for the shallow groundwater.

- Aquatic ecosystems (freshwater)
- Aquatic ecosystems (marine water)

Clause 9 of the WQP refers to the GED at section 25 of the EP Act, and requires (in part) that a person must:

- in the case of waters with an EV of aquatic ecosystems or primary industries, avoid activating a trigger value published in relevant Water Quality Guidelines
- follow standards, codes and guidelines prescribed in Schedule 4 of the WQP.

4.1 Water Quality Guidelines

The WQP prescribes Water Quality Guidelines as ANZECC 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

In 2018 these guidelines were revised and published online as the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018)². Nevertheless, the WQP contains a fixed reference to the ANZECC 2000 guidelines as relevant water quality criteria for application in South Australia.

Activation of trigger values for an indicator specified in the Water Quality Guidelines is described at Clause 7 of the WQP. For aquatic ecosystems a basis of 95% level of protection of species must be applied.

² <https://www.waterquality.gov.au/anz-guidelines>

For the purpose of this risk assessment regarding potential seepage of saltwater from lakes into the groundwater, LBWco has assessed the concentration of salt as TDS in groundwater as the primary indicator of potential for environmental harm. Other chemical concentrations may be present in the future lake water, but have not been included in this risk assessment.

4.1.1 Livestock drinking water

For the EV of Primary Industries – Livestock drinking water, the “loss of production” tolerance concentrations in ANZECC (2000) Table 4.3.1 were adopted as the applicable trigger values. A copy is provided in Plate 2 below.

Plate 2 ANZECC (2000) recommended salinity for livestock drinking water

Table 4.3.1 Tolerances of livestock to total dissolved solids (salinity) in drinking water^a			
Livestock	Total dissolved solids (mg/L)		
	No adverse effects on animals expected	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production	Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually
Beef cattle	0–4000	4000–5000	5000–10 000
Dairy cattle	0–2500	2500–4000	4000–7000
Sheep	0–5000	5000–10 000	10 000–13 000 ^b
Horses	0–4000	4000–6000	6000–7000
Pigs	0–4000	4000–6000	6000–8000
Poultry	0–2000	2000–3000	3000–4000

a From ANZECC (1992), adapted to incorporate more recent information
b Sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production

4.1.2 Aquaculture and human consumption of aquatic foods

For the EV of Primary Industries – aquaculture and human consumption of aquatic foods, the “physico-chemical stressor guidelines” in ANZECC (2000) Table 4.4.2 were adopted as the applicable trigger values. For salinity as TDS these values were:

Freshwater production <3,000 mg/L Saltwater production 33,000 – 37,000 mg/L

Background salinity of the shallow groundwater onsite and downgradient of Riverlea exceeds 3,000 mg/L and therefore precludes freshwater aquaculture production.

4.1.3 Aquatic ecosystems

For the EV of Aquatic ecosystems, ANZECC (2000) addresses the issue of changes in salinity at section 8.2.3.3 and states that salinity changes may affect aquatic organisms in two ways:

- direct toxicity through physiological effects — both increases and decreases in salinity can have adverse effects; and
- indirectly by modifying the species composition of the ecosystem and affecting species that provide food or refuge.

For freshwaters, it is recommended that salinity should not be allowed to increase above 1,000 mg/L.

Via the EPA website (https://www.epa.sa.gov.au/reports_water/c0021-ecosystem-2008), *Gawler River, Virginia Park 2008 Aquatic Ecosystem Condition Report* rated the Gawler River's condition as poor. Salinity of 1,100 mg/L was measured at Broster Rd, Virginia, a short distance upstream from Riverlea. Salinity downstream closer to the coast may be higher.

The water quality measured by EPA highlights that the ANZECC 2000 guideline for aquatic ecosystems is not likely to be achievable due to background conditions exceeding the guideline.

For estuarine and coastal waters, salinity changes should be less than 5% from background levels.

Naturally brackish or saline wetlands and streams may be affected by climate change induced sea level rise, depending on level of freshwater influence. Professional judgement may be used to derive less stringent values by agreement with stakeholders. Further site-specific assessment would be warranted to derive appropriate trigger levels for salinity.

5 Potential Seepage and Migration Modelling for Saltwater

HCL (Jonathan Larkin, Principal Hydrogeologist) was engaged to undertake seepage and migration modelling for saltwater from the lakes entering the surrounding shallow groundwater. This work was an extension to the dewatering groundwater modelling undertaken by HCL for LBWco for the PART 1 investigations at Riverlea, and was designed to inform LBWco's risk assessment. The modelling report prepared by HCL is provided as Appendix B.

Modelling work by HCL included:

- Assessment of salinity as TDS concentrations in groundwater directly beneath a saltwater lake source for three lake construction scenarios: Unlined, clay-lined and HDPE-lined³.
- Assessment of dispersion of saline groundwater from directly beneath SWL1, SWL2 and SWL3 using Bioscreen-AT and linear sources to represent each lake
- Applying the Anaqsim model for the site to assess the steady state groundwater flowfield with unlined lakes filled with saltwater, then review particle tracking over selected periods of time.

HCL consulted with LBWco, Mockinya and Walker prior to and during the modelling work to refine the approach, modelling assumptions and sensitivity analysis during the process. Based on our close involvement during the work, LBWco was satisfied that the modelling work and representations of outcomes present a conservative assessment of potential saltwater seepage and migration from the proposed lakes.

The findings by HCL were used to inform discussion on potential impacts of saltwater seepage in section 6 below.

³ A HDPE liner has been considered to assess performance, sustainability and risk of a high standard liner. Other material options may be appropriate from detailed assessment and design.

6 Discussion

Based on the outcomes of saltwater seepage modelling work by HCL, an assessment of potential impacts to the environment at Riverlea and in the surrounding area was considered by LBWco via this discussion. Potential impacts were considered by addressing the questions raised in the objectives in section 1.1.

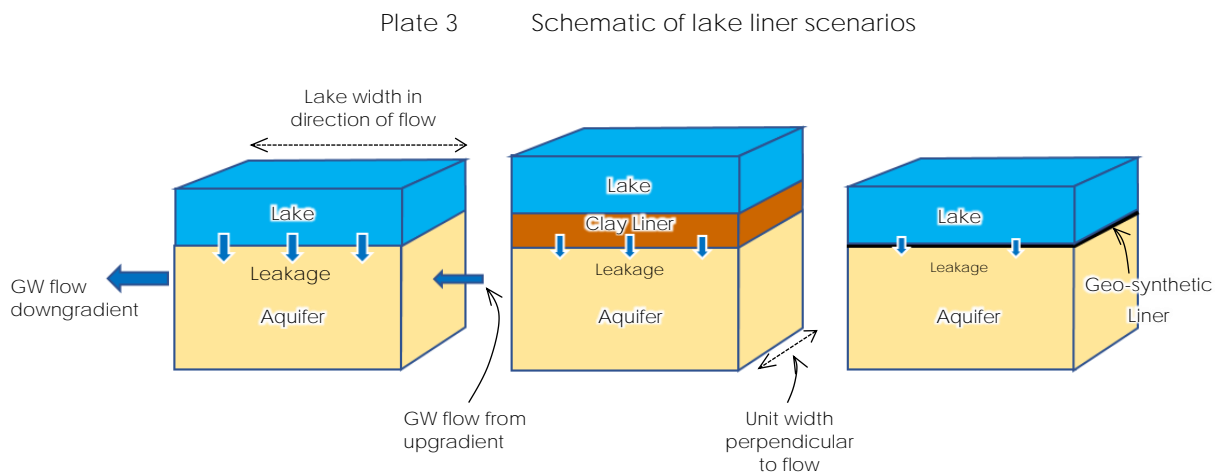
Key aspects addressed within this discussion have been summarised and incorporated in the risk assessment presented in section 7.

6.1 Question 1

If saltwater seeps into the shallow groundwater system, what concentration of salt above background conditions is added to the groundwater for:

- A clay-lined subgrade for lake construction?
- A geo-synthetic membrane lined lake construction?

Section 6.3 of HCL's report describes the use of initial mixing calculations, maintaining mass balance, to determine a representative average TDS concentration for the source zone in groundwater beneath each lake. Plate 3 provides a schematic representation of the three different lake liner scenarios assessed in the modelling.



For each scenario, it was assumed that the lake level was 0.4 m above the design lake water level, being 50% of the design freeboard. Based on the conservative input parameters adopted by HCL (refer HCL report Table 3), the predicted initial source zone salinity concentrations were reported per the summary in Table 4 below.

Table 4 Predicted source zone TDS concentrations in groundwater beneath lakes

Parameter	Units	SWL1	SWL2	SWL3 N & S
TDS of saltwater in lake	mg/L		35,000	
Background groundwater TDS	mg/L	5,400	6,000	7,000
Source TDS – Lake unlined	mg/L	29,600	29,000	28,000
Source TDS – Lake clay lined (10 ⁻⁹ m/s)	mg/L	21,800	23,700	20,000
Source TDS – Lake HDPE lined	mg/L	6,400	9,100	7,000

6.2 Question 2

What extent of migration is predicted for above-background saline groundwater that may emanate from the lakes over time?

Advection and dispersion of the source zone saltwater within the shallow groundwater was modelled using Bioscreen-AT to predict downgradient incremental TDS concentrations based on **uniform flow perpendicular to the linear source**. While uniform flow doesn't account for spatial and temporal variability of flow within the shallow groundwater, the modelling provides a conservative prediction of advection and dispersion due to the input parameters selected by HCL.

HCL Figures 6, 7, 8 and 9 show plots of predicted added TDS concentrations along the centre lines of saltwater plumes migrating downgradient from SWL1, SWL2 and SWL3 for time periods of 20-, 50-, 100-, 200- and 300-years post filling of the lakes.

If the TDS concentration in the saltwater lakes remains at 35,000 mg/L, groundwater gradient remains consistent with the current conditions, and no material change to leakage rates occurs over time, the concentration of additional TDS will vary approximately linearly between the source zone and predicted leading edge of the plume for the unlined lakes scenario.

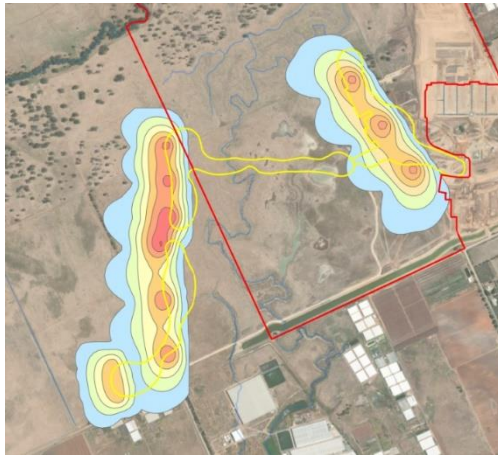
For the clay-lined scenario, modelling predicted the added TDS would remain below 10,000 mg/L within 250 m of the source zone for all three lakes across each of the time periods. For the HDPE-lined scenario, incremental TDS was predicted to remain below 4,000 mg/L within 250 m of the source zone.

The Bioscreen-AT modelling data files were provided to LBWco by HCL. LBWco prepared TDS concentration contour plots using Surfer™ software and mapped these relative to the proposed lake locations. Figures 5A-5C and 6A-6C (Appendix A) provide a representation of saltwater plume migration for unlined, clay-lined and HDPE-lined lakes at periods of 20 years and 100 years respectively. These representations of the Bioscreen-AT modelling are conservative in respect to dispersion distance based on the parameters and assumptions applied, including the assumption that the downgradient aquifer has the capacity to transmit the additional in-flow from the saltwater lakes.

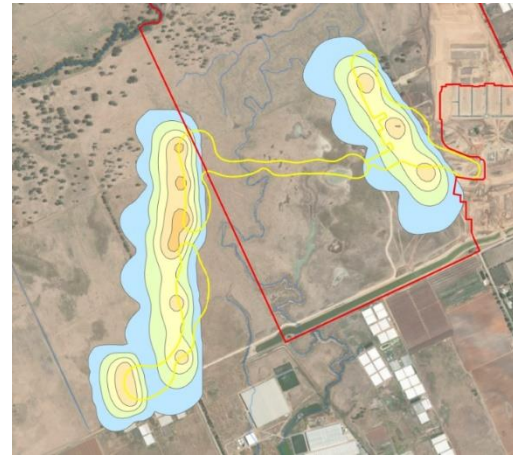
The leading edge of added saltwater was adopted as an increase of 500 mg/L TDS to minimise edge effects of the modelling.

HCL's Figure 10 (replicated below) shows the modelled salinity dispersion in the shallow groundwater for the unlined, clay-lined and HDPE-lined scenarios together at 20-years post filling of the lakes with saltwater (assuming all lakes are filled concurrently).

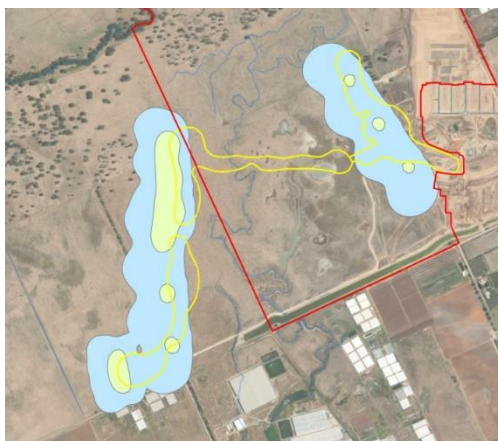
HCL Figure 10 – Salinity at 20 years



Lakes unlined



Clay-lined



HDPE-lined

Legend

Site boundary

Extent of proposed saltwater lakes

Watercourses

Increase in groundwater salinity (mg/L TDS)

500 - 5,000

5,000 - 10,000

10,000 - 15,000

15,000 - 20,000

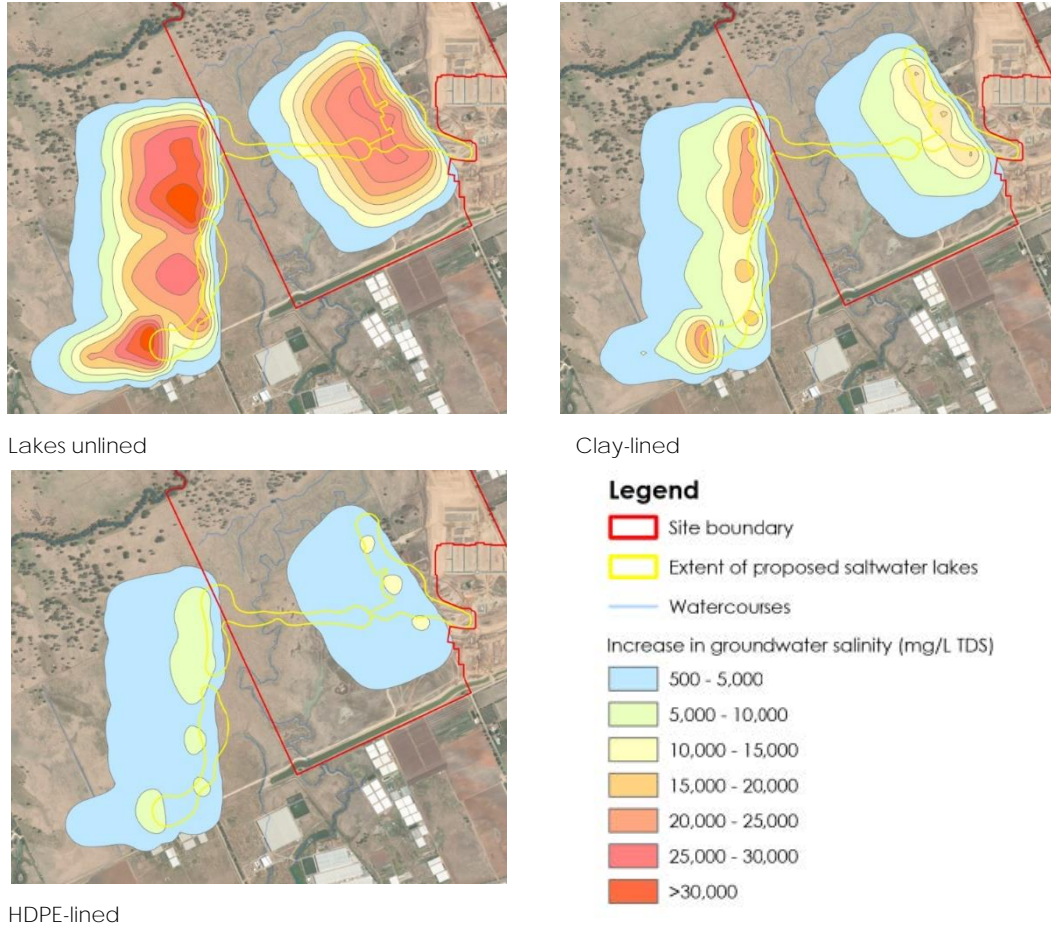
20,000 - 25,000

25,000 - 30,000

>30,000

HCL's Figure 11 (replicated below), presents the modelled salinity dispersion scenarios at 100-years post filling.

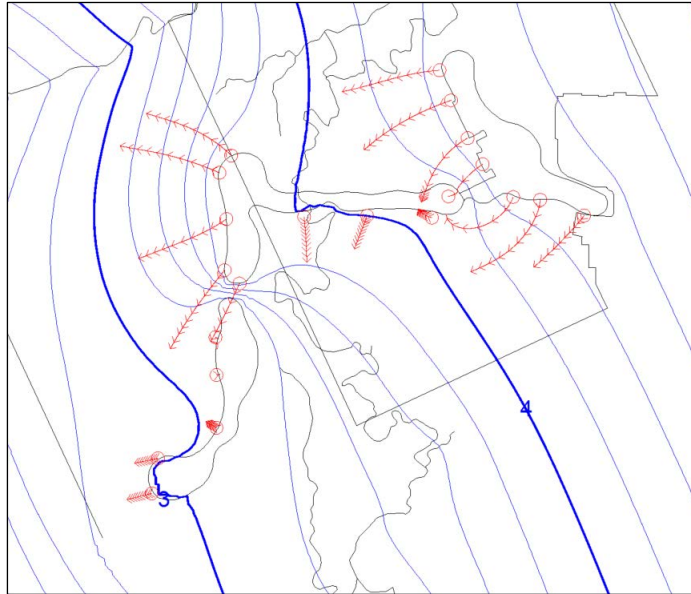
HCL Figure 11 – Salinity at 100 years



The actual groundwater flow field in the vicinity of the lakes and in the downgradient area will significantly influence the directions and distance of saltwater seepage in shallow groundwater. To assist with understanding advective flow directions, HCL was asked to investigate particle tracking from the saltwater lakes relative to the flow field modelled in Anaqsim.

Plate 4 presents Figure 3 from the HCL report. Red lines represent the predicted particle flowlines for unlined lakes over 100 years, with arrowheads depicting 10-year intervals. The enables visualisation of the influence that water level in unlined lakes has on the surrounding groundwater potentiometric surface and flow field.

Plate 4 Anaqsim modelled particle tracking for 100 years



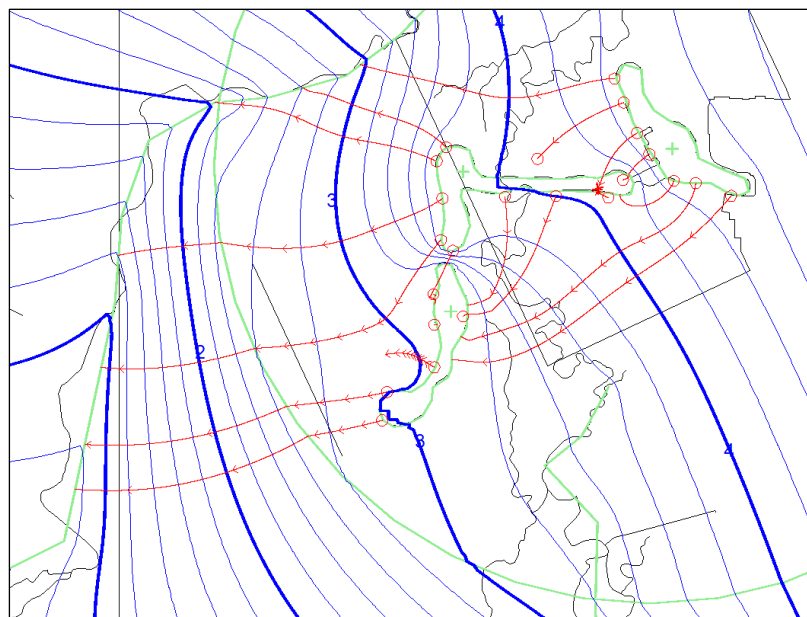
The particle tracking prediction via Anaqsim over 100 years indicated a migration distance marginally less than the prediction by Bioscreen-AT for uniform flow.

Based on the conditions modelled, is it evident that SWL2 will be a sink for some of the saltwater migrating from SWL1.

The reduced groundwater gradient around SWL3 limits downgradient migration of saltwater seepage, whereas seepage occurs more readily from SWL1 and SWL2.

Seepage of saltwater to the groundwater from a continuous source, such as the saltwater lakes, may drive the dispersion of saltwater in the shallow groundwater for much longer than 100 years. To investigate potential distant future impacts of saltwater seepage, HCL was asked to model particle tracking in Anaqsim out to a period of 1,000 years. The output for unlined lakes is represented in Plate 5.

Plate 5 Anaqsim modelled particle tracking for 1,000 years



1,000-year particle tracking shows flowlines reaching and terminating in the model at the Gawler River, which may represent:

- Discharge of groundwater into the river, if the groundwater level is higher than the invert level of the riverbed
- Discharge of groundwater into permeable sediments (sand, gravel, cobbles) beneath the base of the river, then travelling along the river flow direction
- Groundwater passing under the river if the groundwater level is lower than the riverbed and permeable sediments.

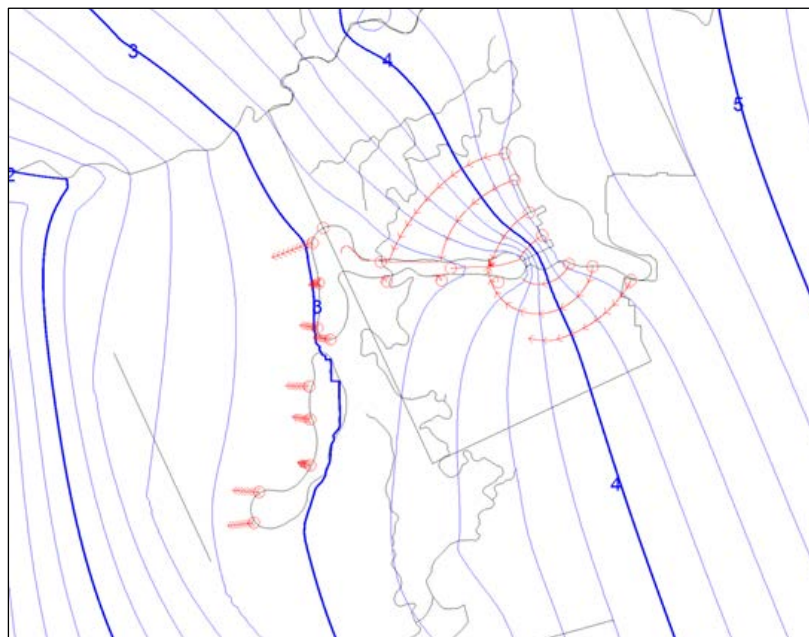
The time for particles to reach the Gawler River is predicted to range from approximately 200 years to 800+ years. Particle tracking for this 1,000-year timeframe presents a scenario representing flow lines from a modelling process applying a fixed set of assumptions over the entire time-period based on current site conditions. It is not possible to reliably predict impacts on groundwater levels due to climate change or whether the saltwater lakes will be operating in 1,000 years, so the particle tracking is relatively low confidence as a predictive tool over this timeframe. Visualisation of the behaviour in response to design and operating changes does however give insight into the effects of these changes and controls that may be applied to the system.

To support visualisation of the predicted 1,000-year flowlines within the wider context of the Riverlea site and surrounds, a GIS map was prepared as Figure 7 (Appendix A).

Observing predicted flowlines progressing from SWL1 into SWL2, and considering the groundwater potentiometric surface and saltwater lakes design within the shallow groundwater, it was apparent that lake locations, lake design water levels and applying controls to the lake water levels could materially influence the entire flow and saltwater dispersion regime at the site.

LBWco requested HCL prepare a revised scenario to the Anaqsim model to reduce the water level in SWL2 by 1 m to 3 mAHD, then assess particle tracking for 100 years for unlined lakes under this flow regime – refer to the output in Plate 6 below.

Plate 6 Anaqsim modelled particle tracking for 100 years, SWL2 level at 3 mAHD



The model output for SWL2 at a lake level of 3 mAHD predicts that more groundwater enters the model domain at SWL1 and leaves it at SWL2 as a sink. SWL2 captures more groundwater

emanating from SWL1 and the gradient west of SWL2 and SWL3 becomes very flat, causing a significant reduction in westerly dispersion of saltwater, particularly from SWL2.

The findings of the modelled dispersion scenarios indicate that for unlined lakes there is scope for adjusting design levels for lake water to control flows into and out of the lakes. Further, the modelling predicts that saltwater plumes would be contained within the Riverlea land, currently under Walker control, for 200-800+ years, indicating a significant time period for design and mitigation flexibility to Walker.

6.3 Question 3

Will saltwater seepage from the lakes into the shallow groundwater cause an unacceptable impact to existing users of the shallow groundwater, to current or future ecological receptors, or to the built environment?

6.3.1 Users of groundwater

Per the information presented in section 3.3, there are no existing registered users of the shallow groundwater in the vicinity of the proposed lakes or downgradient of the lakes. This includes the downgradient areas represented to be within the zone of the predicted 1,000-year particle flowlines, as indicated on Figure 7 in Appendix A.

Walker has no plans for extraction and use of the shallow groundwater within the future precincts of the Riverlea development, and due to moderate to high salinity groundwater within 1 km downgradient and hypersaline groundwater within 1.5 km downgradient of the saltwater lakes (refer section 3.4), there is no realistic future potential that the shallow groundwater will be used for a beneficial purpose.

It follows that there is no realistic potential for saltwater seepage to have an adverse impact on people via groundwater use, as there are no current or likely future users of the shallow groundwater.

6.3.2 Environmental values of groundwater

Background salinity of groundwater onsite and downgradient of Riverlea would preclude the use of the shallow groundwater for livestock drinking water for most of the livestock species listed in ANZECC 2000. Some use for livestock drinking water for horses, cattle and sheep may be possible in the northern portion of Riverlea where fresher groundwater exists, but suitability is marginal in the southern portion of the site downgradient of the lakes and closer to the coast.

Livestock drinking water use of the shallow groundwater is highly unlikely at Riverlea as the land uses that would support livestock and the need for livestock drinking water supply are not included in the current or revised masterplan for Riverlea by Walker.

The moderate to high background salinity within the area of the proposed lakes and downgradient of the lakes, together with the very low probability of livestock drinking water use within an urban setting, indicates low potential for an unacceptable impact on this EV due to saltwater seepage from the proposed lakes.

Aquaculture saltwater production using groundwater would not be adversely impacted by saltwater seepage from the proposed lakes. The development of an aquaculture industry is not intended within the current or revised masterplan proposed for Riverlea.

6.3.3 Current or future ecological receptors

To characterise risk to ecological receptors from dispersion of saltwater in shallow groundwater, it is important to understand:

- Context of historical agricultural land use progressively transitioning to urban master planned community
- Presence/absence of groundwater dependent ecosystems (GDEs)
- Connection between groundwater and aquatic ecosystems

The land use at and surrounding Riverlea has historically been broad-acre farming since post-colonial settlement. Some horticultural industry has also been present in the surrounding area. Recently, the land has been undergoing a rapid transformation following Riverlea's (formerly Buckland Park township) Major Development declaration. The entire site will undergo progressive land transition from broad-acre farming to a mixed-use urban setting over approximately 20 years, consistent with the Master Planned Neighbourhood Zone - refer to the Concept Master Plan in Plate 7 below.

The urban development front has commenced from the east of the site. It will progress in a staged approach, travelling west and southwest towards the Buckland Dry Creek salt evaporation pan operations that border Riverlea's western property boundary.

Native vegetation in the immediate vicinity of the proposed saltwater lakes is negligible, due to previous land clearing and grazing activities, and the introduction of exotic vegetation species. The area around SWL1 is under construction for urban development purposes, open space recreation, and stormwater management. However, there is an area of mature eucalypt trees to the west of SWL2, adjacent to the Gawler River, indicated via the inset on Plate 7.

The balance of the Riverlea land not currently under development is continuing to be used for stock grazing by the current owner.

Plate 7 Riverlea Concept Masterplan



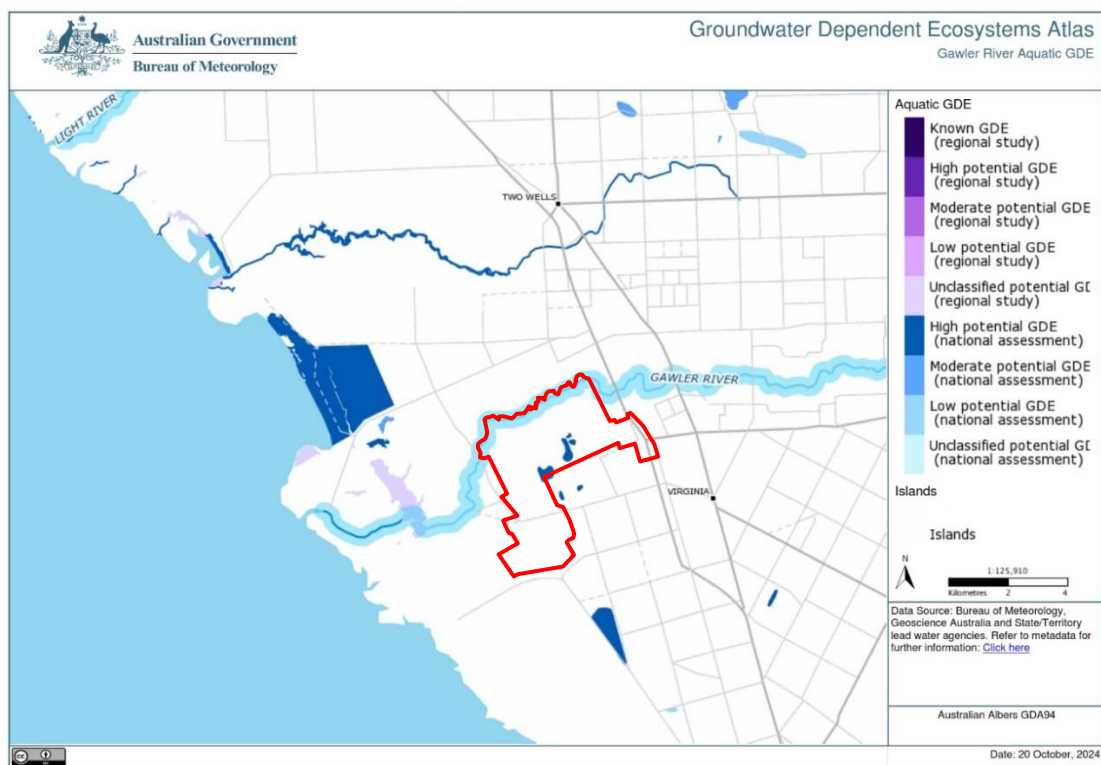
Riverlea's highest point (natural ground level – NGL) is in the northeast portion, at approximately 10+ mAHD. The site falls from the Gawler River towards the Thompson Outfall Channel, with NGL at around 3 m AHD.

Walker advised that the developable area downgradient of SWL1 has a design ground surface level of approximately 8.3 mAHD, which requires approximately 0.7-0.8 m on average of filling over the existing ground level. The design ground level will create a vertical separation distance of typically 3.8 - 4.5 m to the top of the shallow saturated zone (based on groundwater monitoring data obtained and reported by LBWco (2024)).

Groundwater Dependent Ecosystems

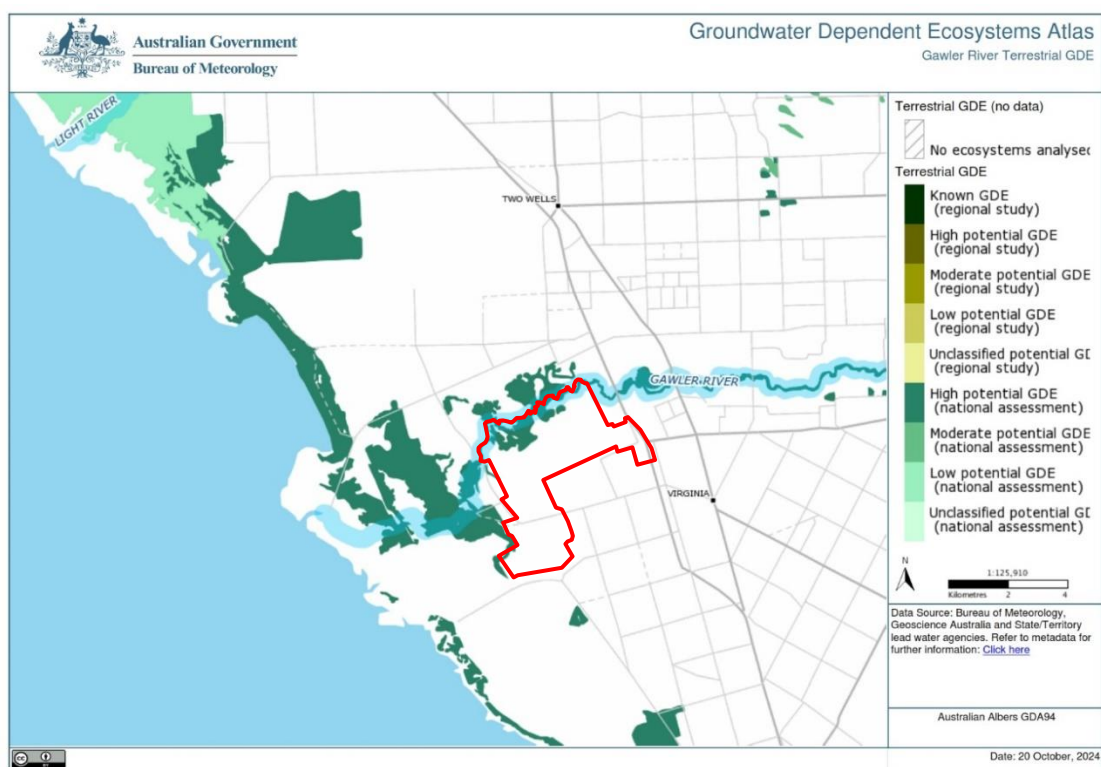
Mapping of GDEs was reviewed via the Bureau of Meteorology (BOM) GDE Atlas online (<http://www.bom.gov.au/water/groundwater/gde/>). The search revealed high potential GDEs for both aquatic (wetland) and terrestrial (vegetation) ecosystems mapped onsite. Refer to Plates 8 and 9 below for copies of the BOM maps with the approximate Riverlea site boundary added by LBWco.

Plate 8 BOM GDE map for aquatic ecosystems – Gawler River



The mapped high potential wetlands are in areas of the site subject to ephemeral water flows and subject to development approved under the current masterplan. Therefore, no potential for unacceptable impact to wetlands from seepage of saltwater from the proposed lakes is evident.

Plate 9 BOM GDE map for terrestrial ecosystems – Gawler River



The vegetation GDE shown in Plate 9 correlates to the location of mature Eucalypt trees shown in Plate 7 above, and another patch of trees to the north east along Gawler River.

Increased salinity due to saltwater seepage and dispersion in groundwater may have an adverse impact on the mapped vegetation areas. The timeframe for groundwater of materially increased salinity to reach these areas at Riverlea is predicted to be of the order of several decades for an unlined lakes scenario, which provides ample opportunity for monitoring, management and, if necessary, mitigation measures to be implemented to protect these environmental receptors.

As discussed in section 3.4, moderate to high salinities were measured in several groundwater wells downgradient of the saltwater lakes, including MWREM03 (TDS 8,145 mg/L) immediately adjacent to the Gawler River and within the mapped area of the vegetation GDE. It is possible that the mature Eucalypt vegetation is accessing a fresher water lens near the top of the saturated zone, resulting from rainfall recharge to the perched/Q1 aquifer and density stratification within the saturated zone.

New urban plantings within the public and private spaces of the Riverlea community may include lawns, grasslands, shrubs and trees. Most of the plantings will have root zone depths well above the groundwater-saturated zones at depths of 3.8 – 4.5 m below the design ground level and will source water primarily from shallow soil moisture and perched zones caused by rainfall infiltration and irrigation. However, trees planted across Riverlea may have deep roots that access the groundwater and could be adversely affected by current and/or increased salinity.

Risk to the health of future tree plantings could be managed via appropriate selection of tree species, including those with propensity for lateral root growth rather than deep vertical roots.

The creation of the new urban landscape within the Riverlea development, including the saltwater lakes, will bring a range of positive terrestrial ecological impacts to the area relative to the current degraded grazing landscape, including new and diverse vegetation in parks, gardens and street scapes.

Groundwater Discharge to Aquatic Ecosystems

Shallow groundwater at Riverlea flows generally westerly to south westerly and discharges at the coast into the Gulf St Vincent. The distance from the area of the saltwater lakes to the coast is approximately 5-6 km.

The Gawler River to the north and west of the proposed saltwater lakes is an ephemeral river system, often dry through the summer months. The ephemeral nature of the Gawler River suggests that groundwater does not discharge directly to the river on a permanent basis, but could occur on occasion. Groundwater may also discharge into permeable sediments within the river alignment, but below the invert level of the riverbed, or travel beneath the Gawler River.

Based on the conservative modelling of salinity dispersion by HCL, groundwater migration timeframe from the saltwater lakes to the Gawler River aquatic ecosystem is well in excess of 100 years and is impacted by design decisions that affect groundwater levels.

6.3.4 Built environment

The depth to groundwater below the finished ground level at Riverlea is expected to range from 3.8 – 4.5 mBGL. Impacts to deep below-ground infrastructure are possible from increased groundwater salinity downgradient from the saltwater lakes, and could be reasonably mitigated through infrastructure design. These impacts are expected to be similar to undertaking development in coastal locations with saline groundwater, which may be a consideration for Riverlea with respect to projected sea level rise.

6.3.5 Summary

The seepage and transport modelling provided no indication of potential for unacceptable impact to existing users of the shallow groundwater, as no relevant registered users were identified.

Potential for adverse impact to ecological receptors and the built environment from increased salinity in shallow groundwater was identified. The potential impacts can be mitigated via design and through planning and implementation of a suitable Lake Management Plan (LMP).

6.4 Question 4

Are there challenges or impacts of design, construction, monitoring, repair, maintenance or replacement for the different liner types that would make one liner more sustainable than the others?

A high-level relative sustainability review of the three liner options for the saltwater lakes was undertaken by applying a simple performance rating system of 1 – Highest; 2 – Middle; 3 – Lowest, to a series of aspects that can be used to assess relative differences between the options of unlined, clay-lined and HDPE-lined.

The aspects list developed by LBWco is not an exhaustive list. Other considerations are possible.

No weightings were applied to emphasise any one aspect over another, and a simple linear addition of the individual ratings was used to produce a total score. The intent was that the lowest total score could be used to support decision making on a preferred liner option based on a range of sustainability considerations, or a decision to undertake a more detailed assessment of one or more options as part of the design process to come.

Table 5 High-level Sustainability Review of Liner Options

Aspect	Unlined		Clay-Lined		HDPE-Lined	
Planning and design lead-time	Simplest planning and design requirements, so fastest to deliver.	1	Marginally more complex than the unlined scenario due to need for planning and design documentation for clay modification of permeable zones found during construction.	2	Longest and most complex planning and design process. Liner works are separate to bulk earthworks. Design decisions at lake edges and penetrations affect future development options.	3
Procurement lead-time	Shortest	1	Marginally longer than unlined scenario. Need to ensure appropriate work methods, clay specifications, and inspections.	2	Longest and most complex due to the extra contractors and work processes.	3
Construction time	Shortest	1	Middle	2	Longest	3
Construction QA supervision required	Simplest	1	Middle	2	Complex	3
Volume of groundwater dewatering wastewater produced	Lowest	1	Middle	2	Highest	3
Cost of construction	Lowest	1	Middle	2	Highest Timeframe, bulk earthworks + liner materials and construction, full time QA supervision additional steps.	3
Relative carbon emissions for construction	Lowest	1	Middle Marginally more machine time onsite relative to unlined.	2	Highest Liner manufacture, delivery and installation is extra to bulk earthworks and subgrade preparation for clay-lined scenario.	3
Employment for planning, design and construction	Lowest	3	Middle Perhaps marginally higher than unlined.	2	Highest	1
Repair and maintenance of liner required	None expected	1	None expected	1	None expected (potential liner punctures and tears from dredging and future development). Major repairs require draining the lake.	3

Aspect	Unlined		Clay-Lined		HDPE-Lined	
Replacement of liner	Not required	1	Not required	1	Not planned. Nominal service life (50% loss of strength) of HDPE with appropriate materials can exceed several 100 years. The service life (time at which containment fails) is expected to be substantially longer.	2
Relative carbon emissions for installation, repairs/maintenance/ replacement	None expected	1	None expected	1	HDPE is a hydrocarbon derived polymer	2
Liner performance at mitigating saltwater seepage from lakes into groundwater	Lowest Unlined lakes do not intervene to prevent or reduce saltwater seepage from lakes into the groundwater.	3	Improved Clay liner reduces the rate of seepage of saltwater into the groundwater relative to unlined. Results in lower TDS concentration than for unlined scenario, but not as low as HDPE-lined.	2	Highest A high standard of construction QA is required. Lowest predicted TDS increment in the groundwater.	1
Regulatory compliance	No intervention or control at lake-groundwater interface. Does not address general environmental duty obligation to take all reasonable and practicable measures to avoid causing harm to the environment.	3	Potentially viewed a reasonable and practicable approach to minimising adverse impacts with further design and operational controls, but not the best approach available.	2	Highest level of intervention and control.	1
Anticipated preference of community	Potentially least preferred as does not address requirement to take all reasonable and practicable measures to avoid causing harm to the environment.	3	Potentially viewed by the community as a reasonable and practicable approach to minimising adverse impacts with further design and operational controls.	1	Highest level of intervention and control. Issues of time, cost, maintenance and inflexibility in lake development. Any future works on liner require draining lake.	2
TOTAL SCORE		22		24		32

Based on the sustainability review, preferences were assessed in the following order:

1. No liner
2. Clay-lined
3. Geo-synthetic lined

Although the sustainability review identified “no-liner” as the apparent most sustainable solution, the unlined option does not appear to address the obligations of the GED at section 25 of the EP Act. On this basis the clay-lined scenario for lake construction was assessed as the preferred approach on sustainability grounds.

6.5 Question 5

What external influences may cause change to the local groundwater system in the Riverlea area, and could these influences affect the assessment of risks posed by saltwater seepage from the proposed lakes?

Relevant external influences that could change the local groundwater system at Riverlea were identified as follows:

- Sea level rise induced by climate change
- Drought or flood
- Reduced groundwater recharge due to higher ground coverage by buildings and pavements and loss of runoff to evaporation and lakes.

6.5.1 Sea level rise

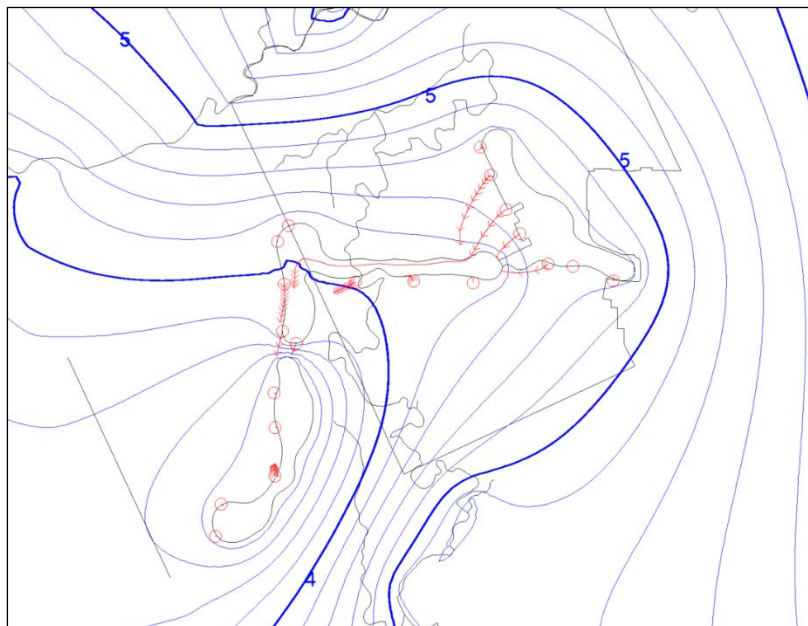
SA EPA reported the following on its website <https://soe.epa.sa.gov.au/environmental-themes/climate/climate-change-impact/seas> :

Sea levels along the South Australian coast have risen by an average rate of 2 mm per year from 1966 to 2022. The rate of sea-level rise is increasing, and from 1993 to 2022 was between 3 mm and 5 mm per year in some locations. Mean sea levels measured at tide gauges located at Port Adelaide, Thevenard and Victor Harbor have increased by 10–12 cm from 1965–69 to 2017–21.

At an increase of 3 mm per year, the sea level at Gulf St Vincent will rise by approximately 1.5 m after 500 years and 3.0 m after 1000 years. The increased sea level will cause gradual sea water intrusion into the groundwater, raising the elevation of the groundwater at the discharge point, which in turn will cause the upgradient groundwater to back up within the saturated zone.

The groundwater gradient between Riverlea and the coast would flatten out further, slowing the velocity of groundwater dispersion towards the coast and likely materially altering the groundwater flow regime. HCL prepared a revision to the Anaqsim model to reflect this scenario by setting sea level at 3 m, adjusting the fixed river levels then running a particle tracking simulation for 100 years – the outcome (refer to Plate 10) indicates all three saltwater lakes are net sinks for groundwater, particularly SWL3.

Plate 10 BOM GDE map for terrestrial ecosystems – Gawler River



Climate change induced increase in the groundwater table elevation may increase salinity at Riverlea and surrounds more generally via sea water intrusion or mobilising saltwater present deeper within the aquifer (long term density stratification). A material increase to groundwater salinity and or reduction in saline groundwater depth could occur and could cause distress or death to a range of vegetation at the site, particularly deep-rooted vegetation such as the mature Eucalypt trees in the north west portion of the site.

6.5.2 Drought

A prolonged period of drought in the Adelaide region, including the Riverlea area, could lead to the following changes to groundwater and lakes systems:

- Reduced freshwater recharge of shallow groundwater
- A decline in groundwater levels around the saltwater lakes, potentially affecting hydraulic control processes that seek to manage lake levels relative to surrounding groundwater level.

Declining groundwater levels, in absence of corresponding reduction in lake level, are likely to result in the saltwater lakes being in net loss of lake water to the groundwater due to the relative head difference between the water bodies.

- Increased salinity of the shallow groundwater through reduced recharge.
- Increased salinity of the shallow groundwater through increased irrigation to sustain landscape vegetation.

6.5.3 Flood

Flooding events of the Gawler River are usually in response to storm events and therefore can occur with very limited advance warning.

Flooding of the Gawler River would cause increased flows of freshwater through the stormwater system and flood mitigation channels at the Riverlea site, including the saltwater lakes, and would result in water ponding at the surface in surrounding areas where flood mitigation and drainage were not sufficiently designed or constructed.

Increased flows would likely result in short term increase in lake water level, causing the lakes to be in net loss of lake water. The shallow groundwater system would be recharged by seepage of the flood waters, and may become fully saturated and unable to transmit the recharge quickly.

Groundwater elevations may remain higher than the long-term average for an extended period of time, whereas the lake levels would likely be adjusted relatively quickly via discharge of surplus water to Thompson Creek. In this instance, the saltwater lakes could be a net sink for groundwater seepage into the lakes until the groundwater level recedes to near lake level.

6.5.4 Reduced groundwater recharge

Construction of many new dwellings, commercial and community buildings, roads, car parks, recreation facilities, paths and more, will disrupt the long-term average rainfall infiltration that has occurred through the predominantly unsealed surface.

The effects would be expected to be consistent with drought (refer section 6.4.2), but would occur over the life of the development, which would be a much longer timeframe than anticipated for typical drought cycles experienced in the Adelaide region.

Lower infiltration rates may reduce groundwater levels and the rate of change due to other affects that increase groundwater levels.

7 Risk Assessment for Saltwater Seepage into Groundwater

A risk assessment based on methodology presented in AS/NZS ISO31000:2018 – Risk Management, was undertaken to characterise risks posed by the hazards arising from the seepage of saltwater from the proposed lakes.

A risk ranking (low, medium, high, extreme) is assessed for each potential hazard identified, based on subjective ratings in terms of 'likelihood' of an adverse event occurring and a range of potential 'consequence' outcomes of an event.

Adopted descriptors for the 'likelihood' and 'consequence' components of the risk assessment for the proposed dewatering activity are presented in Tables 6 and 7, respectively. Consequence descriptors should be read as AND/OR statements.

Table 6 Likelihood Descriptor Matrix

Level	Descriptor	Comments
1	Virtually impossible	Has almost never occurred elsewhere in similar situations, is conceivable but not anticipated to occur within the project timeframe.
2	Unlikely	Has occurred a few times elsewhere in similar situations.
3	Possible	An occasional occurrence elsewhere in similar situations. May occur within a year.
4	Likely	A regular occurrence elsewhere in similar situations. Likely to occur within weeks to months.
5	Virtually certain	A very frequent occurrence elsewhere in similar situations. Expected to occur within days to weeks, or ongoing.

Table 7 Consequence Descriptor Matrix

Category	Level	Environmental/ Socio-economic	Community/Reputational	Legal
A	Negligible effect	Very short-term effects within the project area. Recovery will occur within days. No ecological or socio-economic consequences.	No media, regulator or community interest.	Minor non-compliance and/or breach of regulation. No legal consequences.
B	Minor effect	Short-term effects within the project area. Recovery will occur within weeks. Minor ecological or socio-economic consequences. No changes to biodiversity or ecological function.	Local media coverage. Some interest by regulator(s) and local NGOs. One or two community complaints.	Breach of regulation with investigation or report to authority with possible prosecution and fine.
C	Moderate effect	Medium-term effects within the project area. Recovery likely to occur within months to a year. Moderate ecological or socio-economic consequences. Local changes to biodiversity, but no changes to ecological function.	State media coverage. Investigation by regulator(s) and NGOs. Persistent community complaints.	Breach of regulation with litigation and moderate fine. Involvement of senior management.

Category	Level	Environmental/ Socio-economic	Community/Reputational	Legal
D	Major effect	Long-term effects, potentially extending beyond the project area. Recovery is likely to take years and complete recovery may not occur. Major ecological or socio-economic consequences. Significant local changes to biodiversity and measurable changes to ecological function.	National media coverage. Detailed investigation by regulator(s). Long term community unrest and outrage significantly impacting business.	Major breach of regulation with litigation and substantial fine . Possible suspension of operating licence.
E	Disastrous effect	Very long-term effects extending beyond the project area. Recovery is likely to take decades and complete recovery may not occur. Severe ecological or socio-economic consequences. Loss of biodiversity on a regional scale, and significant loss of ecological function.	International media coverage. Extensive investigation by regulator(s) involving government minister(s). Complete loss of trust by affected community threatening the continued viability of the business.	Major litigation or prosecution with very substantial fines . Possible cancellation of operating licence.

Table 8 presents the matrix for assessing risk based on the combination of consequence and likelihood. It was used to establish the overall risk level associated with a particular aspect of the dewatering activity before any control measure was applied, which identifies the level of potential risk.

The risk matrix shows risk levels from 'Low' to 'Extreme' and identifies where controls are required to mitigate potential impacts.

Walker is committed to implementing appropriate controls to manage and mitigate risks during the operational phase for the saltwater lakes. Development of controls will be undertaken through the detailed design phase of the saltwater lakes and documented in a comprehensive LMP.

Table 8 Risk Ranking Matrix

			Likelihood				
			1 Virtually Impossible	2 Unlikely	3 Possible	4 Likely	5 Virtually Certain
Consequence	1	Negligible effect	1	2	3	4	5
	2	Minor effect	2	4	6	8	10
	3	Moderate effect	3	6	9	12	15
	4	Major effect	4	8	12	16	20
	5	Disastrous effect	5	10	15	20	25
≥ 0			Low Risk		Low risks will be maintained under review. Simple controls expected to be sufficient.		
≥ 5			Medium Risk		Medium risks require appropriate management planning and controls that can be readily implemented as part of routine operations.		
≥ 10			High Risk		High risks demand comprehensive management planning and controls to avoid an impact where possible and to support rapid response.		
≥ 15			Extreme Risk		Extreme risks demand comprehensive management planning and controls to avoid an impact where possible and to support rapid response. Operations should not proceed, or must cease if already commenced, if the risk cannot be effectively controlled.		

The risk assessment based on the methodology outlined above is summarised in Table 9.

High level commentary on potential controls for risk mitigation is provided in the risk assessment in Table 9. The level of risk associated with each potential impact was re-evaluated on consideration of potential controls, which determined the level of 'residual' risk. Further consideration of risk characterisation and mitigation measures can be undertaken through the detailed design phase for the lakes.

Table 9 Risk Assessment

Item	Hazard (Environmental Aspect)	Potential impact – no mitigation	Consequence	Likelihood	Potential risk level	Comments on Assessment Findings and Mitigation measures	Consequence	Likelihood	Residual risk level – with controls
1	Constructed liner fails to meet specified permeability, resulting in greater than permitted loss of containment of saltwater	Seepage of saltwater to groundwater occurs at a faster rate than predicted. Repairs to liner required. Saltwater dispersion causes adverse impact to one or more receptors: <ul style="list-style-type: none">• Mature eucalypts• Trees planted during development• Wetlands• Water quality in Gawler River• Existing groundwater users	Major	Possible	High	LMP to specify environmental monitoring plan to support early identification of saltwater seepage and to assess rate of dispersion. Trigger, Action, Response Plan (TARP) to be included. LMP to address liner leak detection investigation and response plan. Transmissivity of the shallow aquifer is a key limiting factor to dispersion of salt water, so migration of saline groundwater front is reasonably expected to be very slow. Timeframe to identify, assess and manage/mitigate is expected to be decades. Mitigation options could include (but are not limited to): implementing hydraulic control over groundwater to prevent salinity dispersion reaching a receptor, or freshwater soakage/ injection to provide a dilution barrier to salinity progression.	Moderate	Unlikely	Medium
2	Dispersion of saltwater through the shallow groundwater is faster or more extensive than predicted due to preferential pathways or other factors	Saltwater dispersion causes adverse impact to one or more receptors: <ul style="list-style-type: none">• Mature eucalypts• Trees planted during development• Water quality in Gawler River• Existing groundwater users	Major	Possible	High	LMP to specify environmental monitoring plan to support early identification of saltwater seepage and to assess rate of dispersion. TARP to be included. Transmissivity of the shallow aquifer is a key limiting factor to dispersion of salt water, so migration of saline groundwater front is reasonably expected to be very slow. Timeframe to identify, assess and manage/mitigate is expected to be decades. Review of lake design and hydraulic control scenarios to be undertaken to find design and	Moderate	Unlikely	Medium

Item	Hazard (Environmental Aspect)	Potential impact – no mitigation	Consequence	Likelihood	Potential risk level	Comments on Assessment Findings and Mitigation measures	Consequence	Likelihood	Residual risk level – with controls
						operations solutions that reduce potential for saltwater seepage to groundwater to as low as practicable. Can be addressed in design phase. Develop mitigation contingencies including deep drainage to control groundwater levels and flow directions based on a risk assessment.			
3	Groundwater extraction for a beneficial purpose is unknowingly attempted in an area subject to increased salinity	If groundwater not suitable for the intended use, bore drilling and testing will be a sunk cost. Alternate water source (e.g. deeper groundwater, potable) to be found	Minor	Possible	Medium	Modelled salinity increase in groundwater is contained within the Riverlea development (Walker controlled land) for 200+ years, so new shallow groundwater extraction is unlikely. LMP action can include requirement to update DEW on groundwater salinity data for monitoring wells so current information is available in the WaterConnect database.	Minor	Unlikely	Low
4	As trees planted for the Riverlea development become sufficiently mature, their root system penetrates groundwater with increased salinity	Salinity has a toxic effect. Trees show declining health and potentially die off	Moderate	Possible	Medium	Investigate stratification of salinity with the shallow aquifer onsite to better understand salinity distribution and depth to saline waters in the Riverlea Development. Use the data to support an appropriate tree selection and planting plan. Consider plan for harvesting freshwater collected onsite for irrigation of trees	Minor	Unlikely	Low
5	Impact to built environment from saline groundwater	Corrosion damage occurs to structures penetrating the ground to sufficient depth to intersect saline groundwater or salt-affected vadose zone	Moderate	Unlikely	Medium	Building and development occurs widely in saline groundwater environments. Undertake sufficient site characterisation to understand the distribution of existing and potential future salinity. Implement administrative tools to ensure appropriate building design and materials selections are made for the site setting.	Minor	Unlikely	Low

Item	Hazard (Environmental Aspect)	Potential impact – no mitigation	Consequence	Likelihood	Potential risk level	Comments on Assessment Findings and Mitigation measures	Consequence	Likelihood	Residual risk level with controls
						Avoid installation of deep infrastructure comprising materials susceptible to salt corrosion			
6	Increase in sea level, resulting in higher groundwater levels	Changes hydraulic conditions at the site, causing shallower water table. Saltwater seepage regime from the lakes changes and becomes unpredictable Causes saline groundwater intrusion to the site	Major	Likely	Extreme	The long term future impacts of climate change are not in Walker's control . Riverlea development is in a location that will be affected hundreds of years into the future. LMP to monitor for and assess rate of changes to predict and identify when certain thresholds for action are met. TARP to be prepared for this hazard. Future saltwater intrusion at the coast and to the site in the future poses risk of harm or damage to receptors and infrastructure. Attempting to protect receptors or infrastructure now may be deemed futile. Efforts may be better focussed on adapting management and mitigation to a saline groundwater setting and long-term groundwater levels rather than effort, energy and cost on a lining system that ultimately won't prevent salinisation of the groundwater onsite and downgradient receptors.	Moderate	Possible	Medium
7	Decrease in groundwater levels resulting from drought and / or shadowing effect from the development	Increased seepage from lakes to groundwater due to increased head of water above the groundwater potentiometric surface, impacts as per Item 1	Moderate	Likely	High	LMP to monitor for these conditions and have TARP in place to respond. Hydraulic control over the lake water level to closely align with groundwater level will reduce saltwater seepage to the extent practicable. If not practicable to reduce lake water level accordingly, consider in LMP whether short term increased saltwater seepage is acceptable and be prepared for contingency/mitigation actions, such as hydraulic or freshwater dilution controls.	Minor	Possible	Medium

Item	Hazard (Environmental Aspect)	Potential impact – no mitigation	Consequence	Likelihood	Potential risk level	Comments on Assessment Findings and Mitigation measures	Consequence	Likelihood	Residual risk level – with controls
8	Increase in lake and groundwater levels due to flooding	Groundwater infiltration into saltwater lake	Moderate	Possible	Medium	<p>Concurrent increase in lake and groundwater levels will require short term management to reduce lake level to maintain freeboard for future rain/flooding event.</p> <p>Groundwater level will be slower to respond and will remain higher than lake level for a longer period, creating net gain conditions for the lake. LMP may require a response regarding management of:</p> <ul style="list-style-type: none"> • Bank stability/erosion • Lake water quality • Regulatory compliance 	Minor	Possible	Medium

8 Conclusions and Recommendations

The assessment work reported here was undertaken to predict properties of seepage of saltwater from the lakes into shallow groundwater, subsequent migration of saline groundwater downgradient of the lakes, and to assess potential environmental impacts.

Lake construction including unlined, clay-lined and geosynthetic-lined scenarios were considered.

With respect to the questions posed as the objectives for this assessment, LBWco concluded the following:

Question 1 – If saltwater seeps into the shallow groundwater system, what concentration of salt above background conditions is added to the groundwater for:

- c) A clay-lined subgrade for lake construction?
- d) A geo-synthetic lined lake construction?

Saltwater seepage into the groundwater is expected for both a clay-lined and geo-synthetic lined lake. The salinity of the groundwater beneath the lakes varies based on the seepage rate of saltwater into the groundwater. Conservative modelling predicted added salinity as TDS ranging from 13,000 – 17,700 mg/L for clay-lined lakes and from 1,000 – 3,100 mg/L for geo-synthetic lined lakes.

Question 2 – What extent of migration is predicted for above-background saline groundwater that may emanate from the lakes over time?

Migration of saline groundwater, resulting from saltwater seepage from the lakes, was assessed using Bioscreen-AT, which is a widely used tool for modelling solute advection and dispersion in groundwater. Based on the conservative parameters applied to the modelling, the predicted migration of saline groundwater at 100 years after filling of the lakes, ranged from approximately 600 m (geo-synthetic lined) to 780 m (unlined) downgradient of the lakes. Figures 6A-C in Appendix A provide interpretive mapping to visually represent the modelling predictions.

Predicted salinity migration at 100 years was within the Riverlea development boundary.

Advective transport of salt will be limited by the transmissivity of the shallow saturated zone and accordingly the conservative approach to modelling may overstate the distance of downgradient migration of salt.

Solute transport was assessed separately by particle tracking using the Anaqsim groundwater model flow field, containing unlined lakes filled with water and hydraulically connected with the groundwater. Particle tracking within this steady state simulation predicted a similar migration distance (to Bioscreen-AT) of a salt particle at 100 years.

Extension of the Anaqsim modelling to a period of 1,000 years, indicated that based on current conditions the saltwater plume in groundwater would remain within the downgradient area of Riverlea for a period ranging between 200-700+ years. Modelling predictions at these timeframes are low confidence as the future effects of climate change and site operations on the lakes and groundwater are unknown.

Question 3 – Will saltwater seepage from the lakes into the shallow groundwater cause an unacceptable impact to existing users of the shallow groundwater, to current or future ecological receptors or the built environment?

The seepage and transport modelling provided no indication of potential for unacceptable impact to existing users of the shallow groundwater, as no relevant registered users were identified in the vicinity of the proposed lakes or downgradient of the lakes.

Moderate to high salinity groundwater, representing ambient background conditions, is present at Riverlea within 1 km downgradient of the proposed saltwater lakes. Hypersaline groundwater, caused by the salt evaporation pans, is present within 1.5 km downgradient.

A potential for adverse impacts to ecological receptors and to the built environment from increased salinity in shallow groundwater was identified. However, these potential impacts can be mitigated via design and through planning and implementation of a suitable Lake Management Plan (LMP). Due to the very slow migration rate predicted for the saltwater plume, the time available between filling of lakes and any downgradient mitigation being required is expected to be decades.

Question 4 – Are there challenges or impacts of design, construction, monitoring, repair, maintenance or replacement for the different liner types that would make one liner type more sustainable than the others?

A high-level sustainability review was undertaken and considered a wide of aspects to the proposed saltwater lakes construction and operation. Based on the scoring system adopted, the preference rankings were assessed as followings:

4. No liner
5. Clay-lined
6. Geo-synthetic lined

However, the “no-liner” option appears to be challenged by non-compliance with the obligations of the general environmental duty at section 25 of the *Environment Protection Act 1993* (SA). On this basis the “clay-lined” scenario for lake construction was assessed as the preferred approach on sustainability grounds.

Question 5 – What external influences may cause change to the local groundwater system in the Riverlea area, and could these influences affect the assessment of risks posed by saltwater seepage from the proposed lakes?

Relevant external influences that could change the local groundwater system at Riverlea were identified as follows:

- Sea level rise induced by climate change
- Drought or flood
- Reduced groundwater recharge due to higher ground coverage by buildings and pavements and loss of runoff to evaporation and lakes.

Climate change induced increase in the groundwater table elevation is likely to have the most significant long-term influence. Groundwater salinity at Riverlea may increase substantially via sea water intrusion or mobilisation of deeper saltwater within the shallow aquifer. Material increase to groundwater salinity and or reduction in saline groundwater depth could occur, and could cause distress or death to a range of vegetation at the site, particularly deep-rooted vegetation such as the mature Eucalypt trees in the north west portion of the site.

The information in this report is subject to the limitations expressed in Section 9 The reader should make themselves aware of the limitations and how they relate to the conclusions provided above.

9 Limitations

Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between Walker Buckland Park Developments Pty Ltd (Walker) and LBW co Pty Ltd (LBWco) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

In preparing the report, LBWco has relied upon data, surveys, analyses, designs, plans and other information provided by Walker and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, LBWco has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. LBWco will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to LBWco.

Environmental Conclusions

In accordance with the scope of services, LBWco has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions.

Also, it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Walker Buckland Park Developments Pty Ltd

The report has been prepared for the benefit of Walker and no other party. LBWco assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of LBWco or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

LBWco will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Appendix A

Figures



FIGURE 1
Site Location Plan



Site: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Client: Precinct 2, Riverlea Park, SA

Legend

- Site boundary
- Watercourses
- Coastline
- Salt evaporation pans



low **co** | DELIVERING ENVIRONMENTAL SOLUTIONS

			
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (May 2024)		
Job No	231445-01	Scale at A3:	1:45,000
Drawn	TO	Rev	0
Approved	JB	Date	16/10/2024

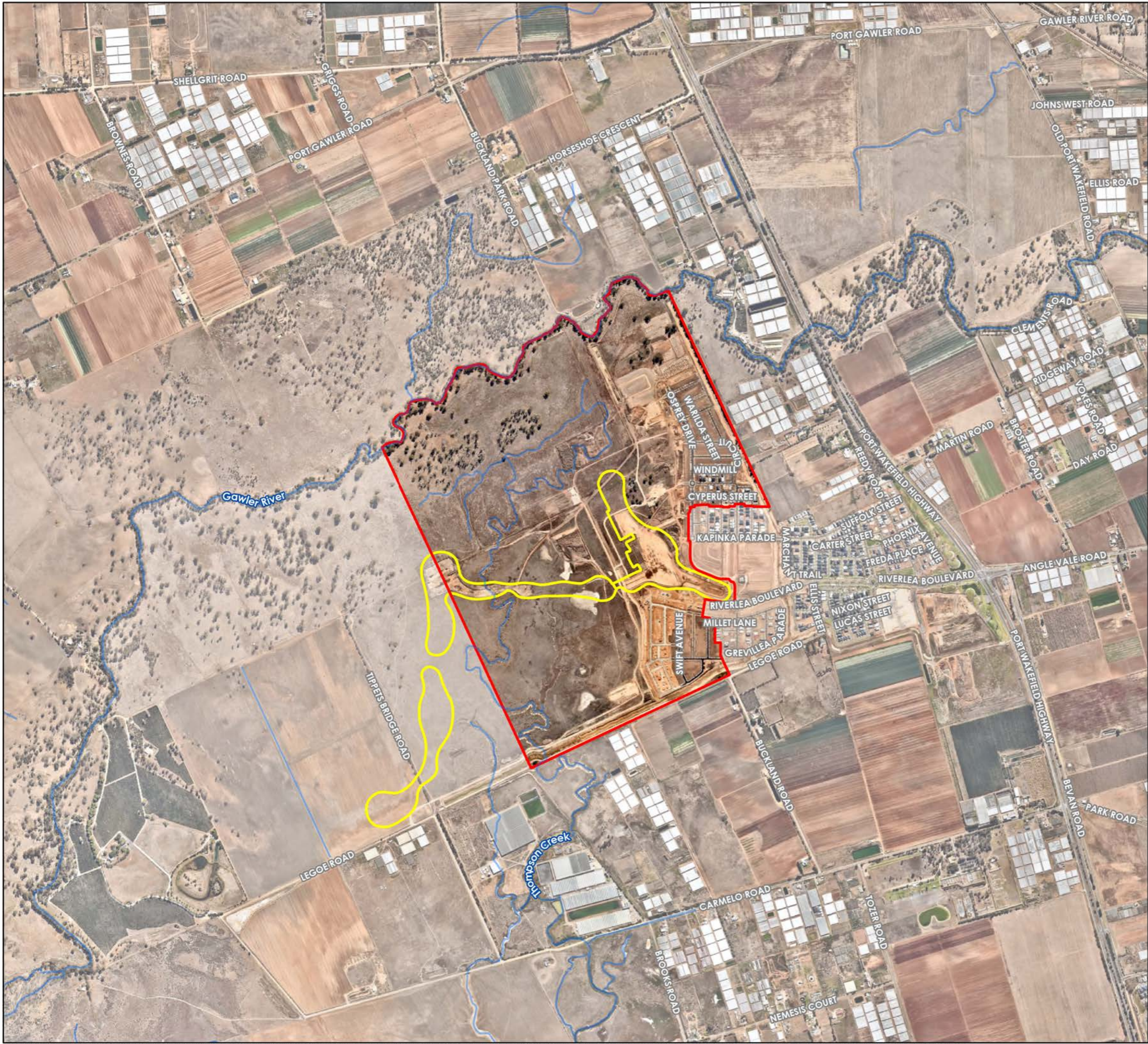


FIGURE 2
Site Layout Plan

Client: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Site: Precinct 2, Riverlea Park, SA

Legend

- Site boundary
- Extent of proposed saltwater lakes
- Watercourses



low co | DELIVERING
**ENVIRONMENTAL
SOLUTIONS**


	0 250 500 750 1,000 Meters		
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (April, 2023)		
Job No	231445-01	Scale at A3:	1:20,000
Drawn	TO	Rev	0
Approved	JB	Date	16/10/2024

FIGURE 4

Recorded Salinity of Shallow Groundwater

Client: Walker Buckland Park Development Pty Ltd

Project: Saltwater Seepage Risk Assessment

Site: Precinct 2, Riverlea Park, SA

Legend

- Site boundary
- Extent of proposed saltwater lakes
- 2 km from saltwater lakes
- Salt evaporation pans
- Domestic
- Irrigation
- Irrigation/stock
- Stock
- Drainage
- Environmental
- Industrial
- Observation
- Investigation/monitoring
- Unknown

6628-2553 Well ID / Unit No.
(1474) (TDS, mg/L)

low co | DELIVERING ENVIRONMENTAL SOLUTIONS


	<div>0 0.5 1 1.5 km</div>		
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (May 2024)		
Job No	231445-01	Scale at A3:	1:30,000
Drawn	TO	Rev	0
Approved	JB	Date	16/10/2024



FIGURE 5A
Modelled groundwater salinity
contours from a linear source:
Unlined Saltwater Lakes, 20 years

Client: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Site: Precinct 2, Riverlea Park, SA

Legend

Site boundary

Extent of proposed saltwater lakes

Watercourses

Increase in groundwater salinity (mg/L TDS)

500 - 5,000

5,000 - 10,000

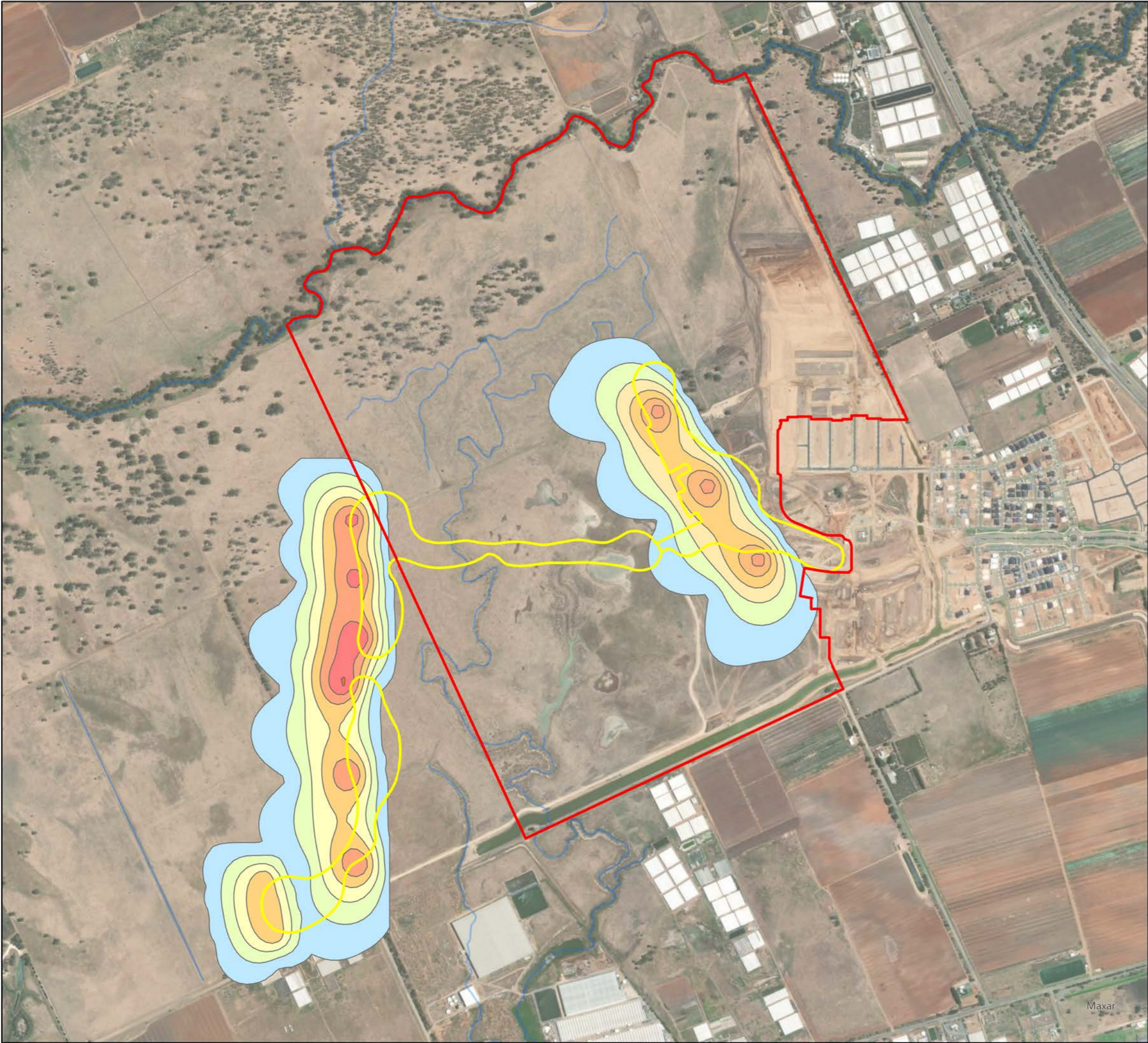
10,000 - 15,000

15,000 - 20,000


20,000 - 25,000

25,000 - 30,000

>30,000



low CO | DELIVERING
ENVIRONMENTAL
SOLUTIONS

	0300600 Meters		
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (6 Feb 2023)		
Proposal No	231445-01	Scale at A3:	1:12,500
Drawn	TO	Rev	0
Approved	JB	Date	16/10/2024

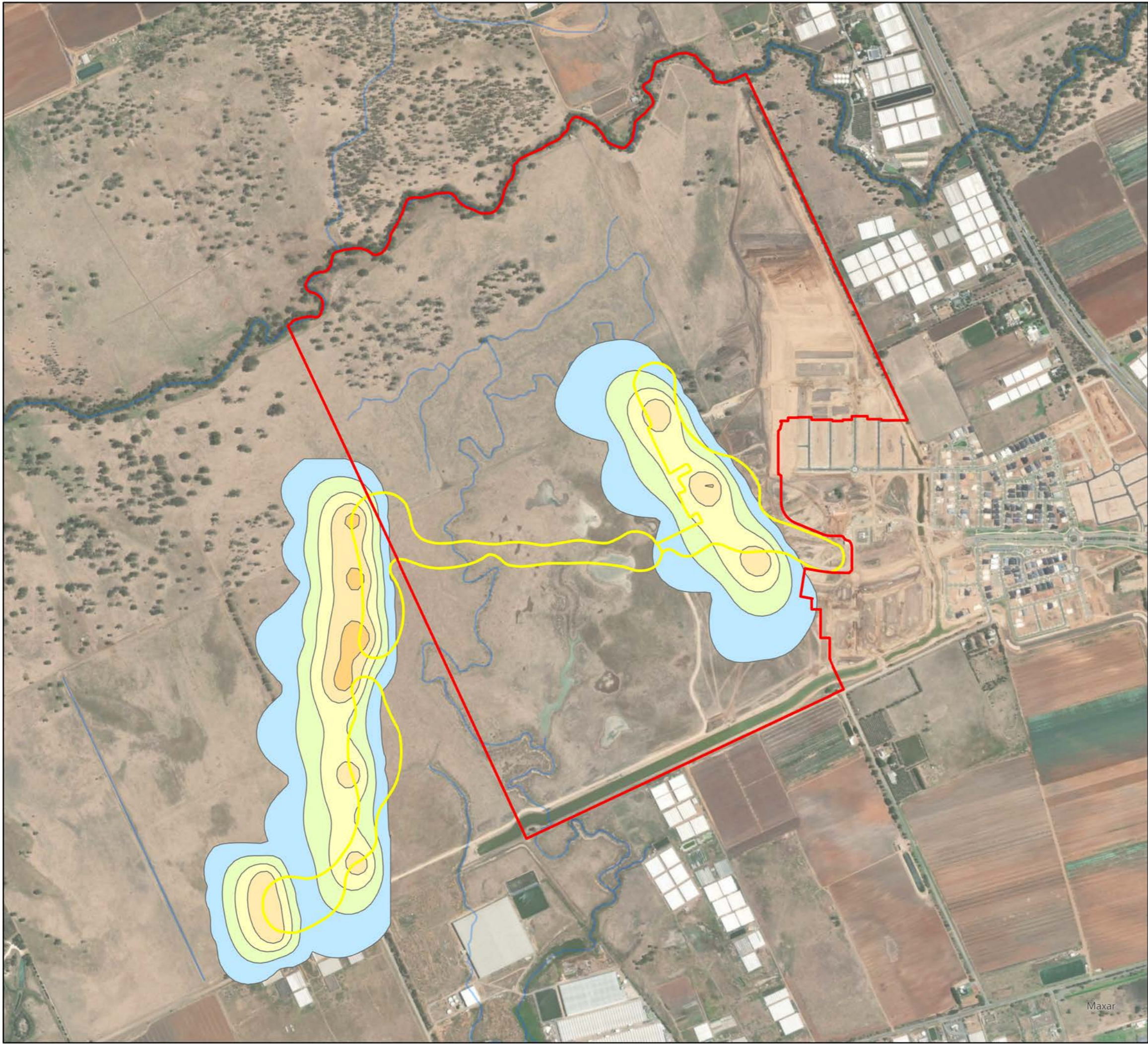


FIGURE 5B
Modelled groundwater salinity
contours from a linear source:
Clay Lined Saltwater Lakes, 20 years

Client: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Site: Precinct 2, Riverlea Park, SA


Legend

- Site boundary
- Extent of proposed saltwater lakes
- Watercourses

Increase in groundwater salinity (mg/L TDS)

- 500 - 5,000
- 5,000 - 10,000
- 10,000 - 15,000
- 15,000 - 20,000
- >20,000

low CO | DELIVERING ENVIRONMENTAL SOLUTIONS

	0 300 600 Meters		
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (6 Feb 2023)		
Proposal No	231445-01	Scale at A3:	1:12,500
Drawn	TO	Rev	0
Approved	JB	Date	16/10/2024

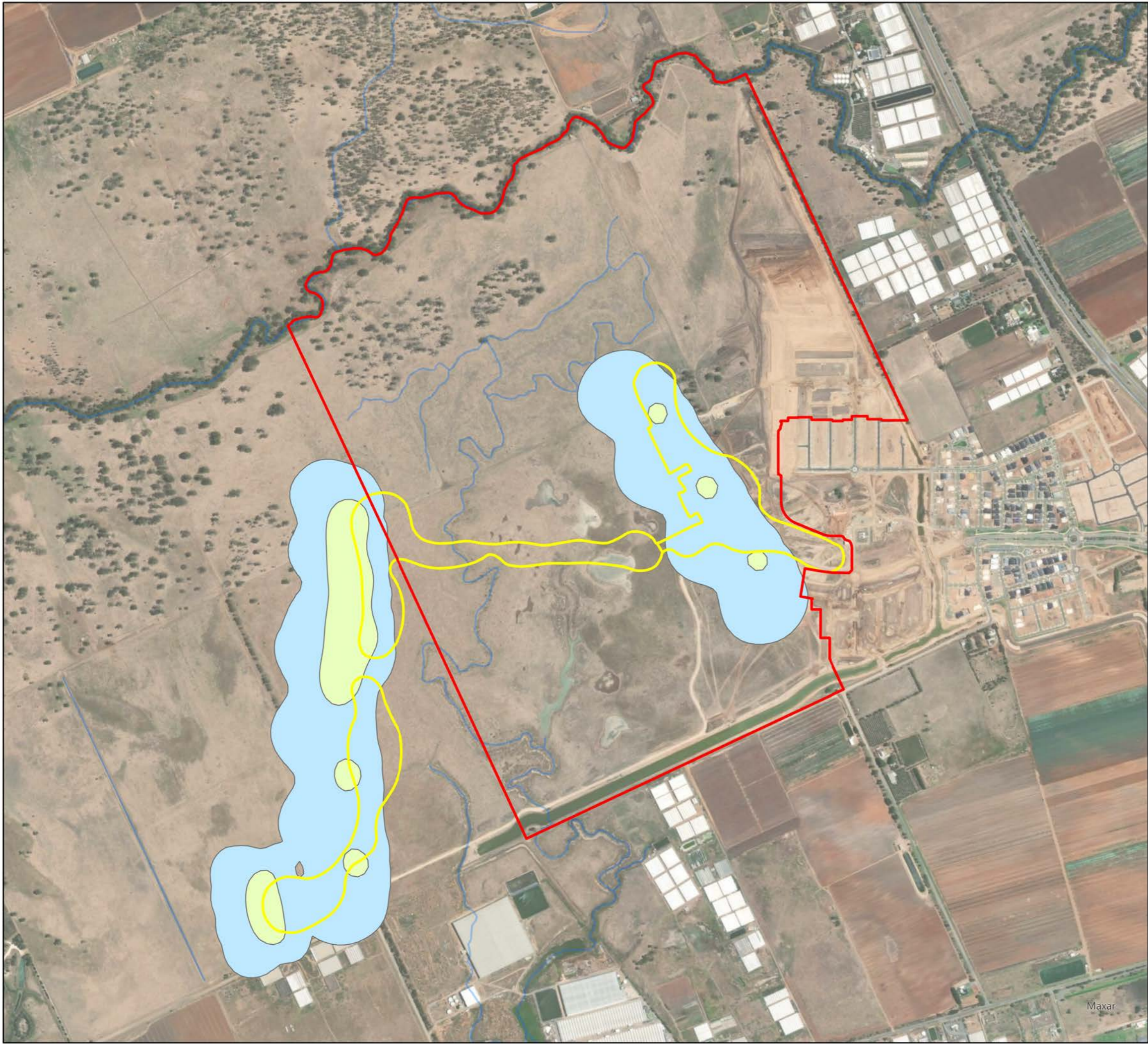



FIGURE 5C
Modelled groundwater salinity
contours from a linear source:
HDPE Lined Saltwater Lakes, 20 years

Client: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Site: Precinct 2, Riverlea Park, SA

- Legend**
- Site boundary
 - Extent of proposed saltwater lakes
 - Watercourses
- Increase in groundwater salinity (mg/L TDS)
- 500 - 5,000
 - 5,000 - 10,000

low CO | DELIVERING
ENVIRONMENTAL
SOLUTIONS

	0 300 600 Meters		
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (6 Feb 2023)		
Proposal No	231445-01	Scale at A3:	1:12,500
Drawn	TO	Rev	0
Approved	JB	Date	16/10/2024

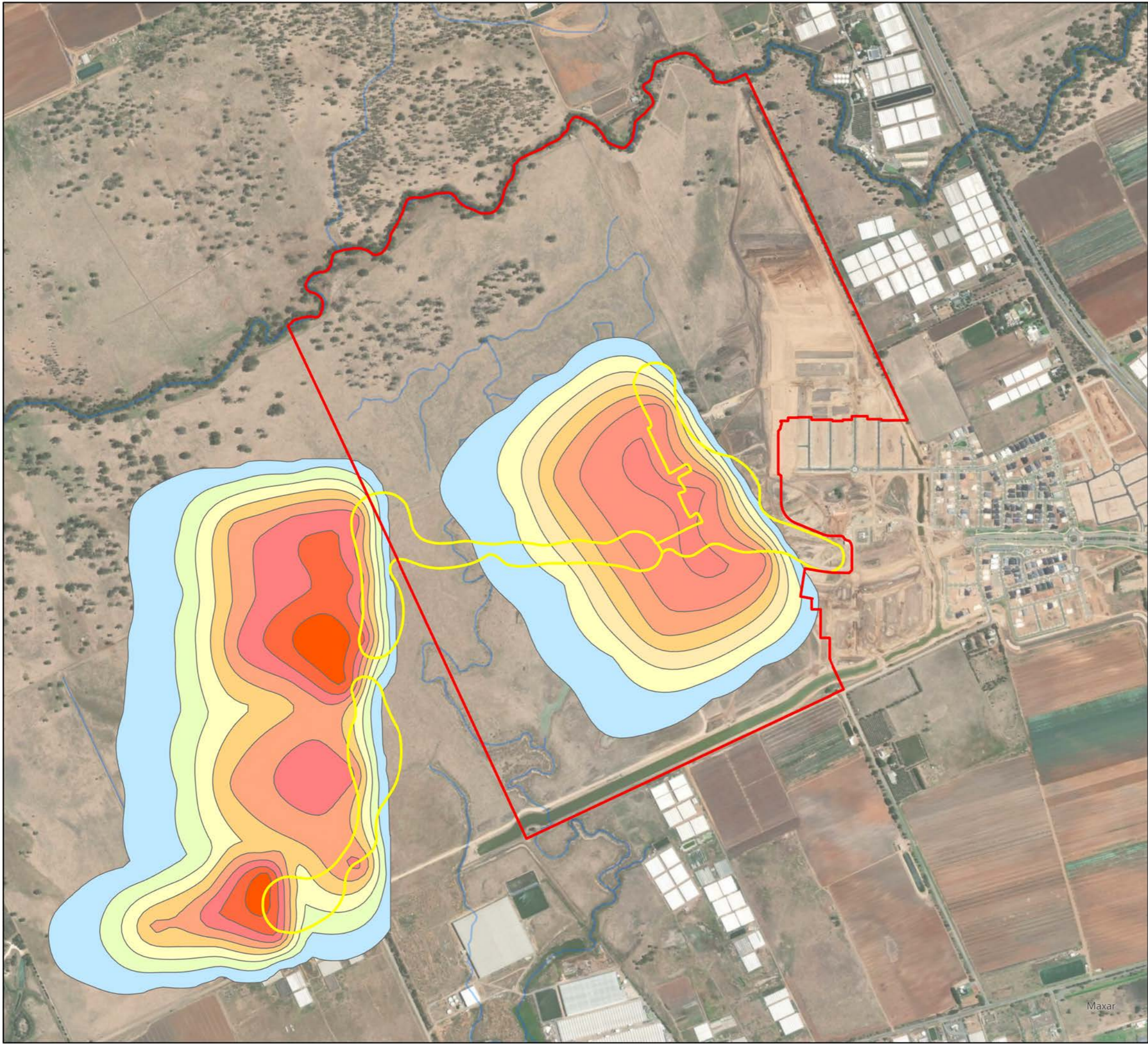



FIGURE 6A
Modelled groundwater salinity
contours from a linear source:
Unlined Saltwater Lakes, 100 years

Client: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Site: Precinct 2, Riverlea Park, SA

Legend

- Site boundary
 - Extent of proposed saltwater lakes
 - Watercourses
- Increase in groundwater salinity (mg/L TDS)
- 500 - 5,000
 - 5,000 - 10,000
 - 10,000 - 15,000
 - 15,000 - 20,000
 - 20,000 - 25,000
 - 25,000 - 30,000
 - 30,000 - 35,000
 - >35,000

low CO | DELIVERING
ENVIRONMENTAL
SOLUTIONS

	0 300 600 Meters		
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (6 Feb 2023)		
Proposal No	231445-01	Scale at A3:	1:12,500
Drawn	TO	Rev	0
Approved	JB	Date	16/10/2024

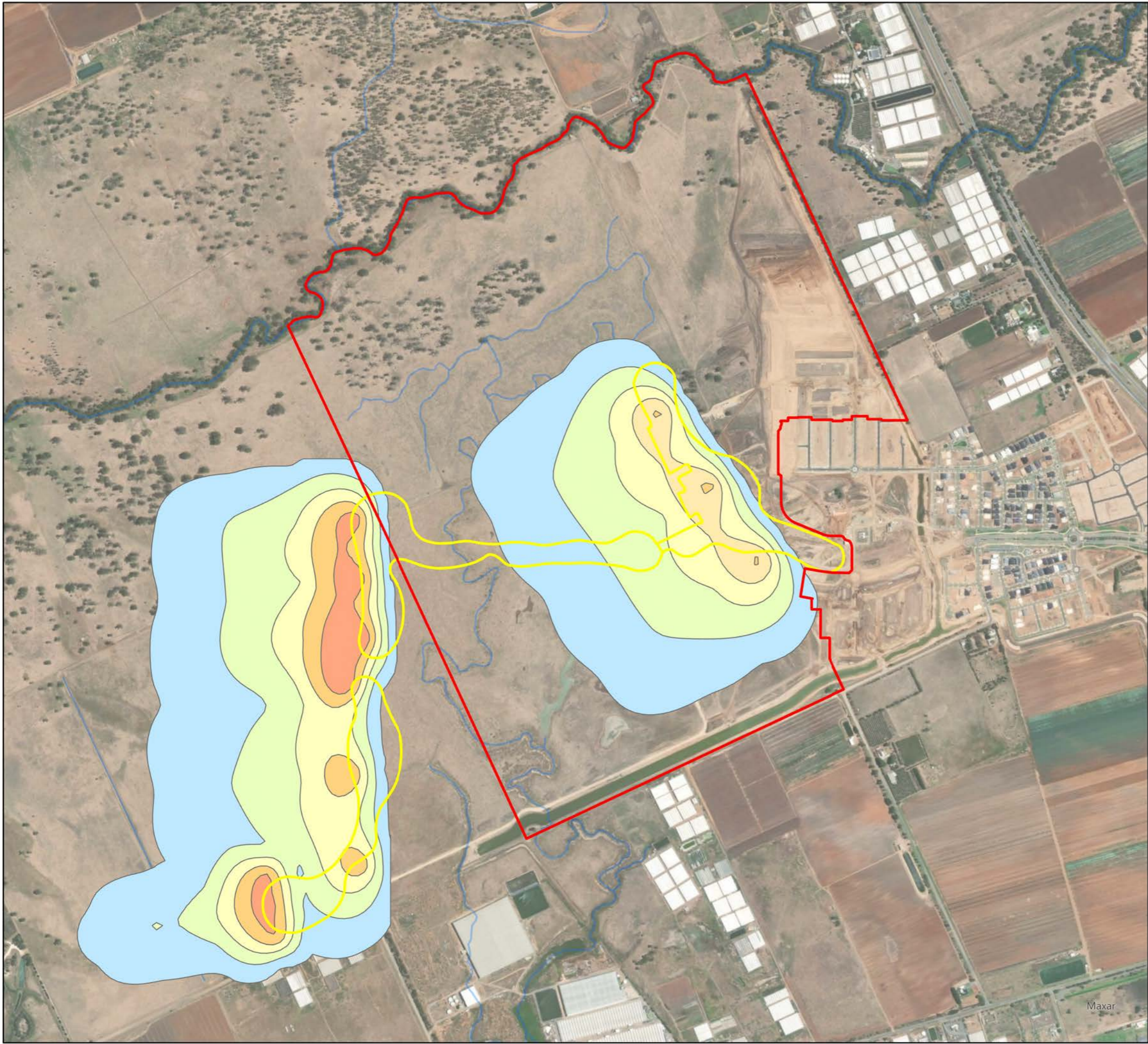


FIGURE 6B
Modelled groundwater salinity
contours from a linear source:
Clay Lined Saltwater Lakes, 100 years

Client: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Site: Precinct 2, Riverlea Park, SA


Legend

- Site boundary
- Extent of proposed saltwater lakes
- Watercourses

Increase in groundwater salinity (mg/L TDS)

- 500 - 5,000
- 5,000 - 10,000
- 10,000 - 15,000
- 15,000 - 20,000
- >20,000

low CO | DELIVERING ENVIRONMENTAL SOLUTIONS

	0300600 Meters		
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (6 Feb 2023)		
Proposal No	231445-01	Scale at A3:	1:12,500
Drawn	TO	Rev	0
Approved	JB	Date	16/10/2024

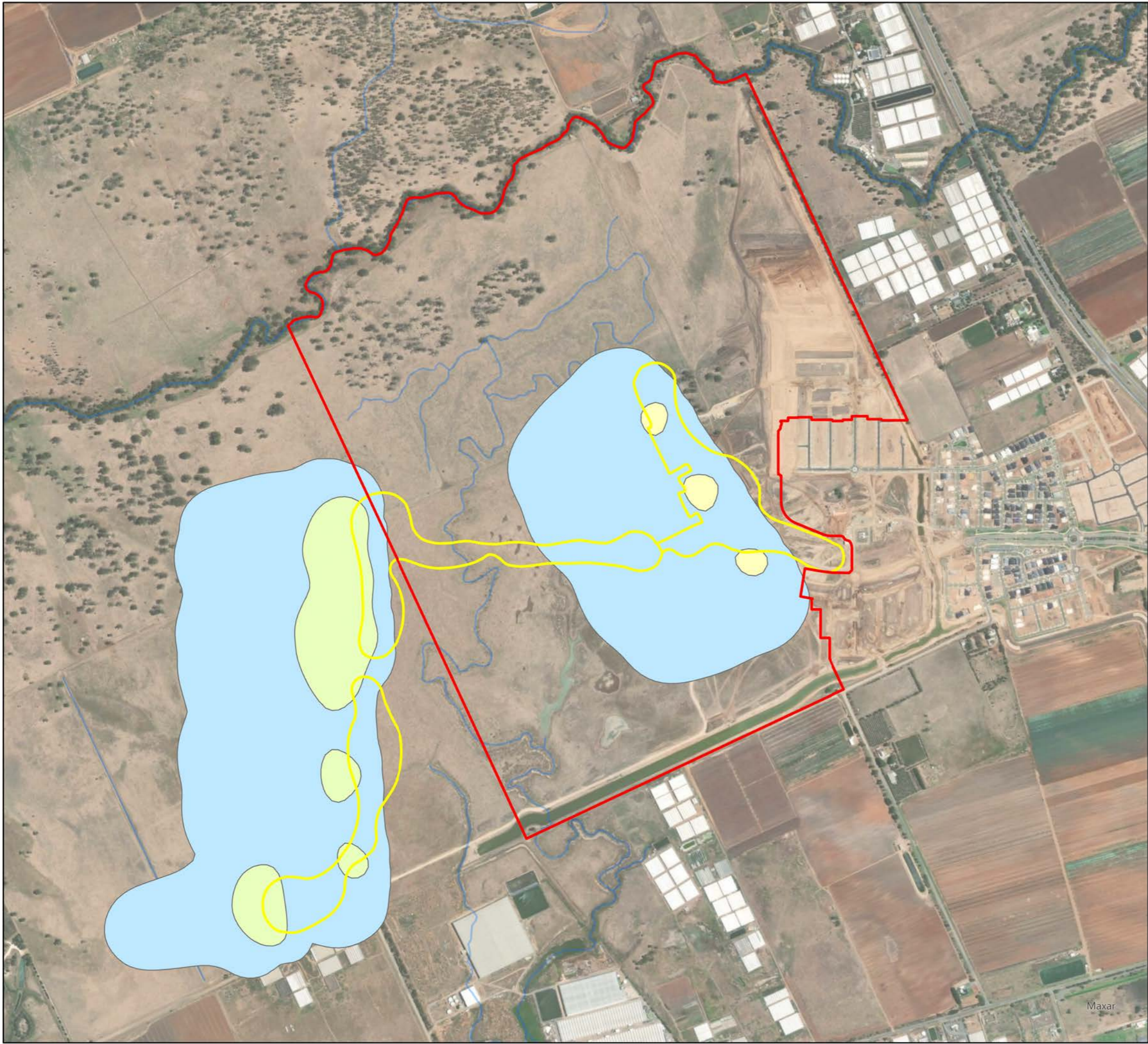


FIGURE 6C
Modelled groundwater salinity
contours from a linear source:
HDPE Lined Saltwater Lakes, 100 years

Client: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Site: Precinct 2, Riverlea Park, SA

Legend

- Site boundary
- Extent of proposed saltwater lakes
- Watercourses

Increase in groundwater salinity (mg/L TDS)

- 500 - 5,000
- 5,000 - 10,000

low CO | DELIVERING
ENVIRONMENTAL
SOLUTIONS

	0300600 Meters		
	Spatial Reference: GDA2020 MGA Zone 54		
	Source: Nearmap.com (6 Feb 2023)		
Proposal No	231445-01	Scale at A3:	1:12,500
Drawn	TO	Rev	0
Approved	JB	Date	18/10/2024

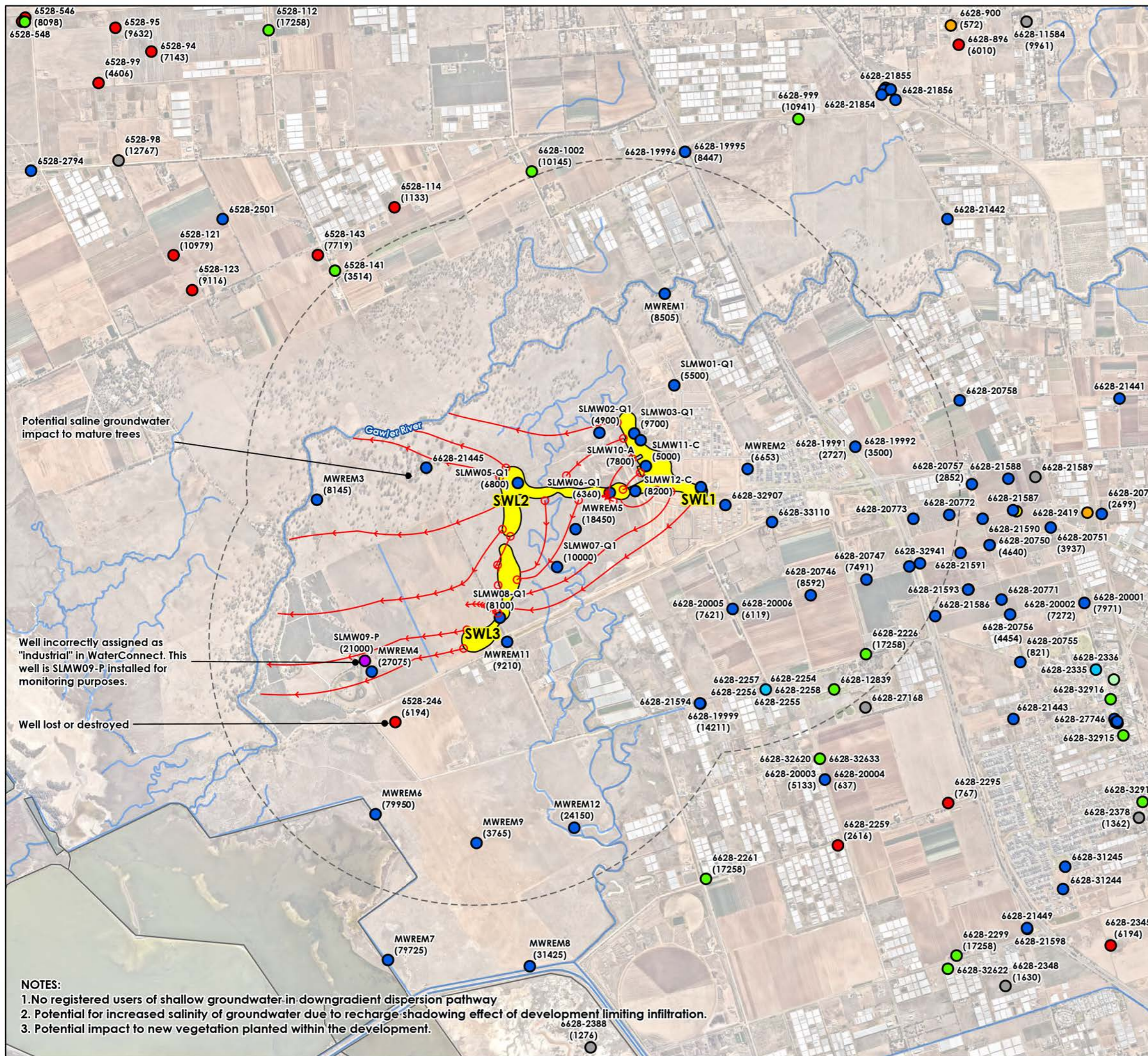


FIGURE 7
Potential impacts from saline groundwater

Client: Walker Buckland Park Development Pty Ltd
Project: Saltwater Seepage Risk Assessment
Site: Precinct 2, Riverlea Park, SA

- Legend**
- Watercourses
 - Extent of proposed saltwater lakes
 - 2 km from saltwater lakes
 - Salt evaporation pans
- Registered purpose
- Domestic
 - Irrigation
 - Irrigation/stock
 - Stock
 - Drainage
 - Environmental
 - Industrial
 - Observation
 - Investigation/monitoring
 - Unknown
- Modelled partial flow path, 100 year increments

low co | DELIVERING ENVIRONMENTAL SOLUTIONS

N

0 0.5 1 1.5 km

Spatial Reference: GDA2020 MGA Zone 54

Source: Nearmap.com (May 2024)

Job No	231445-01	Scale at A3:	1:30,000
Drawn	TO	Rev	0
Approved	JB	Date	23/10/2024

Appendix B

Dewatering Modelling Report



RIVERLEA SALTWATER LAKES POTENTIAL SEEPAGE AND MIGRATION OF SALINE WATER

REPORT STATUS: FINAL

REPORT PREPARED FOR:

LBW co Pty Ltd
184 MAGILL RD
NORWOOD
SA 5067
AUSTRALIA

Date issued: 17 October 2024

Table of Contents

1.	Introduction	3
2.	Objectives	3
3.	Background.....	4
4.	Water Seepage Rates.....	4
4.1.	Seepage from an unlined lake	4
4.2.	Seepage from a lined lake	6
4.3.	Conclusions about long-term seepage	7
5.	Groundwater Migration Directions	8
6.	Salinity Migration, Dispersion and Diffusion in Groundwater	10
6.1.	Migration and attenuation mechanisms	10
6.2.	Model assumptions	11
6.3.	Input parameters	12
6.4.	Salinity advection and dispersion model results	14
6.5.	Sensitivity of model results to input parameter values	18
7.	Conclusions	21
8.	Limitations.....	23

List of Figures

Figure 1. Modelled steady state net outflow from SWL1 (unlined) with varying water level	5
Figure 2. Calculated seepage from SWL1 (lined) with varying liner permeability	6
Figure 3. Modelled steady-state groundwater contours with SWL1-3 unlined.....	9
Figure 4. Modelled steady-state groundwater contours with SWL1-3 hydraulically isolated from aquifer.....	9
Figure 5. Locations of linear source lines used in salinity dispersion model.....	13
Figure 6. Simulated migration of increased salinity downgradient (lakes unlined)	14
Figure 7. Simulated migration of increased salinity downgradient (clay liner)	15
Figure 8. Simulated migration of increased salinity downgradient (HDPE liner)	16
Figure 9. Simulated migration of increased salinity downgradient of SWL1 (3 scenarios)	16
Figure 10. Simulated salinity distributions after 20 years	17
Figure 11. Simulated salinity distributions after 100 years	18

List of Tables

Table 1. Salinity migration model assumptions and limitations	11
Table 2. Dispersion model input parameters	12
Table 3. Dispersion model source parameters	13
Table 4. Model sensitivity to input parameters	19

1. Introduction

Thank you for asking Hydrogeology Consulting Ltd (HCL) to assess the potential migration of saline groundwater from the three planned saltwater lakes (SWL1 to SWL3) at Riverlea, South Australia.

SWL1 will be the first lake to be constructed, with saltwater to be introduced in approximately 2030, with the other two lakes following at 5-year intervals.

It is understood that SWL1 will have an area of approximately 14.6 ha. The lakebed will be at +1.5 mAHD and in normal circumstances the lake will be about 3.0 m deep, with a design water level of +4.5 mAHD. This is approximately the same as the ambient groundwater level at that location. The lake will have 0.8 m freeboard to provide temporary additional water storage following rainstorm events. The maximum water level in the lake will therefore be +5.3 mAHD but the average water level is expected to be close to the design level of +4.5 mAHD. Similar details will apply to SWL2 and SWL3 but at lower elevations because they will be located further west, where the land is lower.

The lakes will be filled with seawater pumped from the Gulf St Vincent. Some of this water will be lost to evaporation and some will seep from the sides and base of the lake to become groundwater. Design details for any liner are yet to be finalized. Water will be pumped into the lakes as needed, with overflow discharged back to the Gulf St Vincent (downgradient), both to maintain design water levels and to cause a total volume exchange within each lake on a cycle of approximately 80 days. This will prevent the lakes from drying out and will help promote good water quality.

When the water level in a lake equals the average surrounding groundwater level, there will be no net inflow of groundwater to the lake and no net outflow from the lake to groundwater. However, due to the background hydraulic gradient of the groundwater, and depending on the design and construction of the lakebed and sides, there will be some inflow of groundwater to the upgradient (eastern) half of the lake, and a corresponding outflow from the downgradient (western) half of the lake to groundwater.

After storm events, when lake water levels are temporarily higher due to influx of stormwater, there will be net outflows of water from the lakes to groundwater.

The general description of water flows provided above will be true whether the lakes are lined or not. The presence of a low permeability liner may reduce flow rates but would not fully prevent inflows and outflows from occurring.

2. Objectives

This work aims to provide preliminary answers to the following questions:

1. At what rate will water seep from the lakes to the groundwater?
2. How will this seepage affect the salinity of the groundwater adjacent to and downgradient of the lakes?
3. Over what timescale will groundwater of increased salinity migrate downgradient from the lakes?

It is envisaged that the results from this work will be used to help inform an assessment of the potential environmental impacts associated with leakage and migration of saltwater from the lakes.

Please note that this is a scoping study only. It aims to assess the potential water flows and migration of saline groundwater in an overview manner based on a generalised geometry. It does not provide a detailed representation or prediction of future conditions.

3. Background

This report follows on from the Hydrogeology Consulting Ltd report *Groundwater Dewatering Model, Riverlea Saltwater Lake 1*, dated 30 September 2024. That report presents background information on the environmental and hydrogeological setting of the lakes. It also provides details of a groundwater model that was constructed using the analytical element software Anaqsim¹, to estimate the potential amounts and effects of the dewatering that would be required to facilitate the construction of SWL1.

4. Water Seepage Rates

4.1. Seepage from an unlined lake

The rate of seepage of water from an unlined lake will depend partly on the following:

- The dimensions and geometry of the lake and its orientation with respect to the background hydraulic gradient of the groundwater.
- Differences in water level ('head') between the lake and the groundwater.
- The hydraulic conductivity of the aquifer adjacent to and beneath the lake (noting that the hydraulic conductivity of the shallow sediments at Riverlea is variable on a small scale, so is neither homogeneous nor isotropic).
- The hydraulic gradient, transmissivity and extent of the aquifer downgradient of the lake. These factors are important because water will not be able to seep from the lake unless it is able also to migrate away from the lake in the aquifer. Otherwise, the hydraulic resistance of the aquifer will limit the seepage rate.

The analytic element model Anaqsim, as used for the dewatering assessment, has been used to assess the potential long-term average leakage rate from SWL1 if it is unlined (i.e. in full hydraulic continuity with the shallow aquifer). To do this the calibrated steady-state Anaqsim model has been adapted as follows:

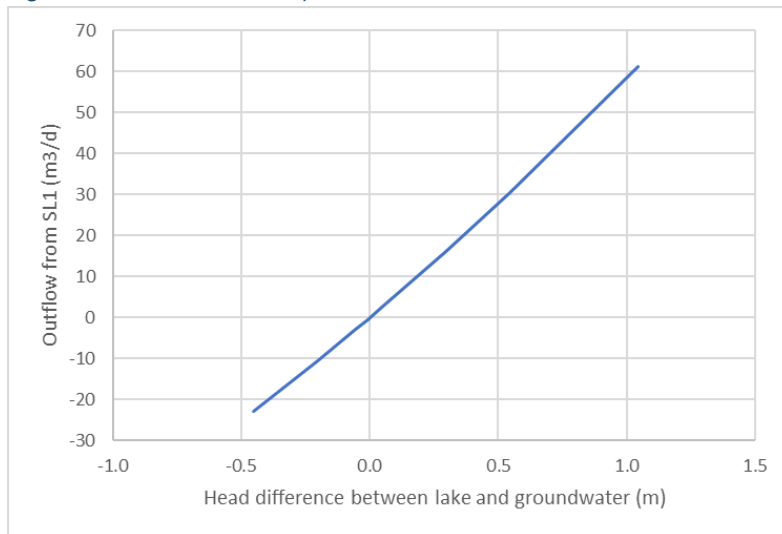
- SWL1 is included in the model as a zone of high hydraulic conductivity (1,000 m/d) across the extent of the lake, above the lakebed elevation of 1.5 mAHD. Lakes SWL2 and SWL3 are not included in this model.
- The water level in the lake is set by including in the model a fixed head 'well' at an arbitrary location within the high permeability zone that represents the lake.

The Anaqsim model was used to explore the modelled steady state net flow from the lake (i.e. the flow from the fixed head well in the lake) under a range of fixed head conditions. The results are illustrated in Figure 1. When there is zero head difference between the lake and groundwater, the model shows no net flow from the lake. When the lake level is 0.4 m above the groundwater level (i.e. when 50% of the design freeboard capacity is filled and assuming the groundwater level has not risen contemporaneously) the model indicates a net flow of approximately 22 m³/d from the lake to the

¹ <https://anaqsim.com/>

groundwater. The steady-state net outflow rate is not higher because it is limited by the hydraulic resistance of the aquifer.

Figure 1. Modelled steady state net outflow from SWL1 (unlined) with varying water level



Some simple calculations based on Darcy's Law can be used to check this result. First, for comparison, consider the background groundwater flow beneath the location of SWL1 and assume:

- The transmissivity of the shallow aquifer is $33 \text{ m}^2/\text{d}$ (geometric mean transmissivity estimated from the pumping tests conducted in December 2023)
- Hydraulic gradient is approximately 0.002 (2 m per 1 km)
- The length of SWL1 measured perpendicular to the hydraulic gradient is approximately 900 m.

Based on these parameter values, the background rate of groundwater flow in the shallow aquifer beneath SWL1 is approximately $60 \text{ m}^3/\text{d}$ ($33 \text{ m}^2/\text{d} \times 0.002 \times 900 \text{ m}$).

The lake will be located essentially within the aquifer (replacing some of its volume), rather than above it, and will have a head similar to that of the aquifer. This means that there will be relatively little scope for the groundwater flow rate to increase in the aquifer downgradient of the lake, because the water level, hydraulic gradient and transmissivity of the aquifer will not have changed. Some increase in flow can occur due to the average head difference between the lake and the groundwater but this head difference will be small and for much of the time will likely be close to zero.

Taking the example of when 50% of the freeboard capacity of SWL1 is filled, the water level in the lake would be 0.4 m above the groundwater level. The most by which this could increase the equilibrium groundwater level beneath the lake, if there is complete hydraulic connectivity, would also be 0.4 m, which would increase the level from say 4.5 mAHD to 4.9 mAHD. If this head dissipates over (say) 500 m distance downgradient, this would increase the average hydraulic gradient by 0.0008, which would represent an additional flow of approximately $24 \text{ m}^3/\text{d}$ ($33 \text{ m}^2/\text{d} \times 0.0008 \times 900 \text{ m}$), which is similar to the net steady-state outflow modelled by Anaqsim.

The example calculations above apply to SWL1 but similar calculations and results would apply to SWL2 and SWL3.

In the shorter term, where water levels are not at equilibrium, the rate of seepage from a lake could be higher, due to a higher hydraulic gradient near the lake and a smaller radius of influence (distance over which the head is dissipated). However, higher seepage rates and associated gradients could

only be temporary because in the long term, the aquifer would not have the capacity to transmit large additional flows of water away from the lake.

4.2. Seepage from a lined lake

If the lake is constructed with an engineered liner, the thickness and hydraulic conductivity of the liner may restrict the rate of seepage from the lake.

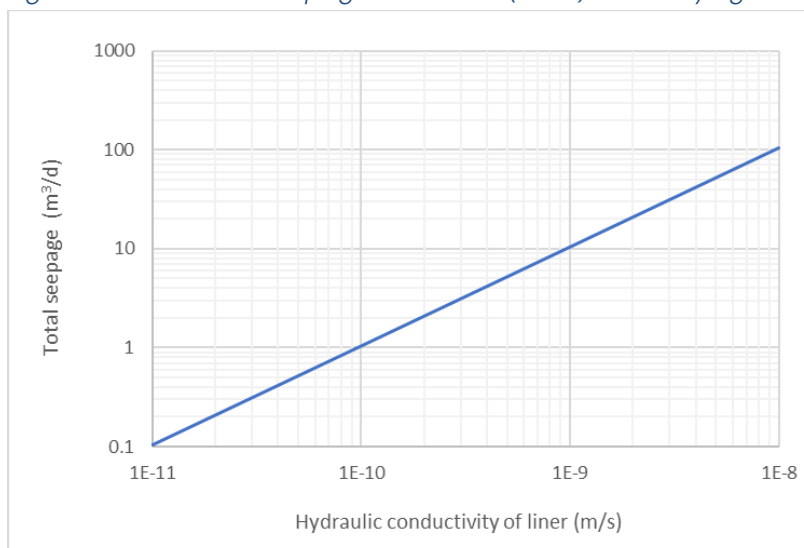
An initial estimate of seepage from a lined lake can be made as follows. This assumes that seepage occurs uniformly across the lake area, vertically through the basal liner and laterally through the liner at the sides of the lake. It also assumes that seepage water migrates away immediately and does not impede further seepage; this assumption is more valid for lower liner permeabilities than for higher because for higher permeabilities the transmissivity of the aquifer outside the liner becomes a limiting factor.

Leakage through the liner can be estimated from Darcy's Law. The chart in Figure 2 shows calculated seepage rates based on the following parameter values:

- Thickness of liner = 0.5 m
- Permeability of liner = variable between 1×10^{-11} m/s and 1×10^{-8} m/s, as shown on the chart
- Lake base area for seepage = 146,000 m² (SWL)
- Side area for seepage = 6,000 m² (3 m vertical x 2,000 m perimeter)
- Head difference between lake and groundwater = 0.4 m (50% of design freeboard). When this is applied across the liner thickness of 0.5 m, the resulting hydraulic gradient across the liner is 0.8.

For a liner permeability of 1×10^{-9} m/s (a value typically used to represent engineered clay for landfill liners), the estimated seepage rate from SWL1 is approximately 10 m³/d, assuming the rate is not impeded further by the hydraulic resistance of the aquifer. As liner permeability increases, the hydraulic resistance of the aquifer becomes increasingly the dominant factor. This can be seen by noting that the calculated seepage when the liner permeability is 1×10^{-8} m/s is 100 m³/d, which exceeds the estimated background rate of groundwater flow in the shallow aquifer beneath SWL1 (approximately 60 m³/d).

Figure 2. Calculated seepage from SWL1 (lined) with varying liner permeability



In the case of composite liners (e.g. those including geomembranes such as HDPE that are often used for landfills, dams and tailings applications), although the permeability of intact liner materials may be very low, global experience shows that some defects and perforations such as punctures and rips are typically present, and the number of defects is related to the level of construction quality assurance (CQA). Empirical data from double-lined systems indicates that leakage rates are small but non-zero and large areas of liner therefore have an equivalent average permeability higher than that of the geomembrane itself. Based on information provided by Mockinya Consulting, some illustrative seepage rates calculated from a geomembrane liner under 0.4 m head are approximately:

- 12 L/d if there are 10 defects (20 mm holes) per hectare
- 7 L/d if there are four seam failures of 5 m length per hectare
- 50 L/d if there is one 0.5 m diameter hole per hectare

Individually, these scenarios would imply overall seepage rates for SWL1 (14.6 Ha) of approximately 0.1 m³/d to 0.73 m³/d, but the defect scenarios are not mutually exclusive. An illustrative combined seepage rate of 1 m³/d has been used later in this report to provide a scoping assessment of the potential migration of saltwater seepage from an HDPE-lined lake.

4.3. Conclusions about long-term seepage

The key conclusions from the long-term seepage assessment are:

- The long-term average seepage rate from the lake will be limited by the hydraulic resistance of the receiving aquifer. This occurs because of the small head difference between the lake and groundwater, the low regional hydraulic gradient, and the relatively low transmissivity of the aquifer.
- The estimated long-term average net seepage rate from SWL1 if it is not lined and has a water level 0.4 m above the adjacent groundwater level, is 22 m³/d.
- Because the seepage rate is limited by the hydraulic resistance of the aquifer, the addition of a low permeability liner to the lake would not greatly reduce the long-term average net seepage rate. For a liner permeability of 1×10^{-9} m/s (a value typically used to represent engineered clay), the estimated seepage rate from SWL1 is approximately 10 m³/d, assuming the rate is not impeded further by the hydraulic resistance of the aquifer.
- Lower seepage rates can be obtained by using geomembrane liners, if they are installed under careful CQA, but zero seepage is not realistically achievable.
- The initial rate of seepage from an unlined lake would be higher than the calculated long-term average rate but would only occur until the hydraulic gradient has equilibrated. This is because there is less hydraulic resistance to filling local pore spaces as the water table rises, than there is to water migrating a long distance through the aquifer. However, the rise in water table will be limited because the design water level for the lake is approximately the same as the natural groundwater level, with net outflow occurring only when the lake water level is raised due to temporary storage of stormwater.

If the lake is unlined, there may be local areas with higher outflow along preferential flow paths where there is higher permeability. The potential for such flows could be mitigated by placing local low permeability barriers across any high permeability zones (e.g. sand and gravel) that are encountered during construction of the sides or base of the lake. This may also help mitigate potential sediment migration and associated geotechnical concerns.

5. Groundwater Migration Directions

Groundwater with increased salinity will migrate generally downgradient from each of the lakes. Some lateral spreading (dispersion) will also take place during migration, as discussed in Section 6. Dispersion occurs due to the differing pathways that individual molecules of water and associated ions such as chloride take as they migrate through the aquifer matrix.

The precise downgradient flow direction from each lake will depend on the regional flow direction (generally southwest) and on how each lake interacts with the groundwater, which depends in turn on the relative water levels and on whether the lake has a liner, as discussed previously.

For example, Figure 3 shows steady-state groundwater contours simulated by the Anaqsim model after all three lakes have been installed, for a scenario in which the lakes are in full hydraulic continuity with the aquifer (no liner). This simulation assumes:

- Each lake is represented by a high permeability zone ($k = 1,000 \text{ m/d}$)
- The water level in each lake is set at a location within the high permeability zone, with water elevations of 4.5, 4.0 and 3.0 mAHD for SWL1, SWL2 and SWL3, respectively.

In this simulation SWL1 and SWL3 have net gains of water from the aquifer (approximately $36 \text{ m}^3/\text{d}$ and $10 \text{ m}^3/\text{d}$) while SWL2 has a net loss of water to the aquifer (approximately $29 \text{ m}^3/\text{d}$). Different flow rates would be simulated for different lake water levels and under different ambient groundwater level conditions.

Across most of Figure 3 the groundwater level contours indicate a hydraulic gradient close to 0.001. At this gradient and with an average hydraulic conductivity of 4 m/d (as used for the shallow aquifer in the Anaqsim model) and an effective porosity of 30%, the average porewater migration rate would be approximately 5 m/y . Higher velocities would occur in areas where the gradients are steeper, such as in the zones between lakes SWL1 and SWL2 and between SWL2 and SWL3.

Figure 3 also shows in red a number of particle-tracking lines indicating the advective flow directions from various locations along the downgradient sides of each of the lakes. Each represents the advective migration distance over a 100-year period, with the arrowheads marked at 10-year intervals. In terms of flow direction, the particle traces and groundwater contours indicate:

- Groundwater seeping from much of the western side of SWL1 flows towards SWL2 and much of this would likely enter SWL2 towards its eastern end if the lake is unlined. Seepage from the northern end of SWL1 is indicated to migrate almost due west, while seepage from the southeastern end of SWL1 is indicated to migrate generally southwest towards SWL3.
- Water seeping from SWL2 would migrate in directions ranging from northwest at the lake's northern to southwest at its southern end. Some water seeping from the southern end of SWL2 may enter SWL3 if it is unlined and has a lower water level than SWL2.
- In this simulation the water level at SWL3 is similar to the steady-state water level across a wide area near SWL3. The small hydraulic gradients in this area mean there is very little groundwater movement simulated on the western side of SWL3, with some outflow to the west at its southern end, and potentially a small inflow from the west at its northern end.
- The longest particle traces for the 100-year simulation are approximately 450 m long, indicating an average advective porewater velocity of 4.5 m/y , which is consistent with the initial 5 m/y estimated presented above.

Figure 3. Modelled steady-state groundwater contours with SWL1-3 unlined

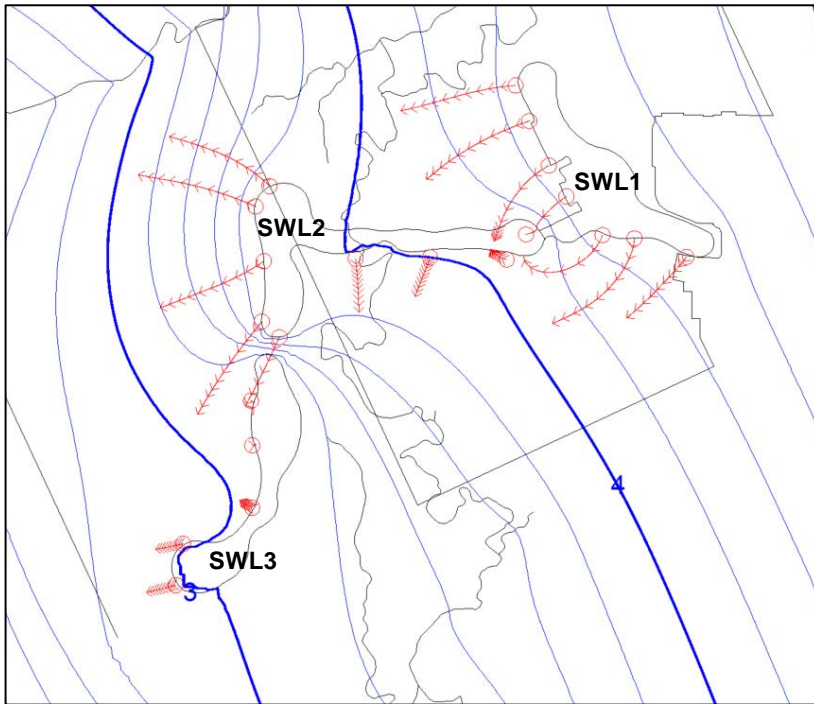
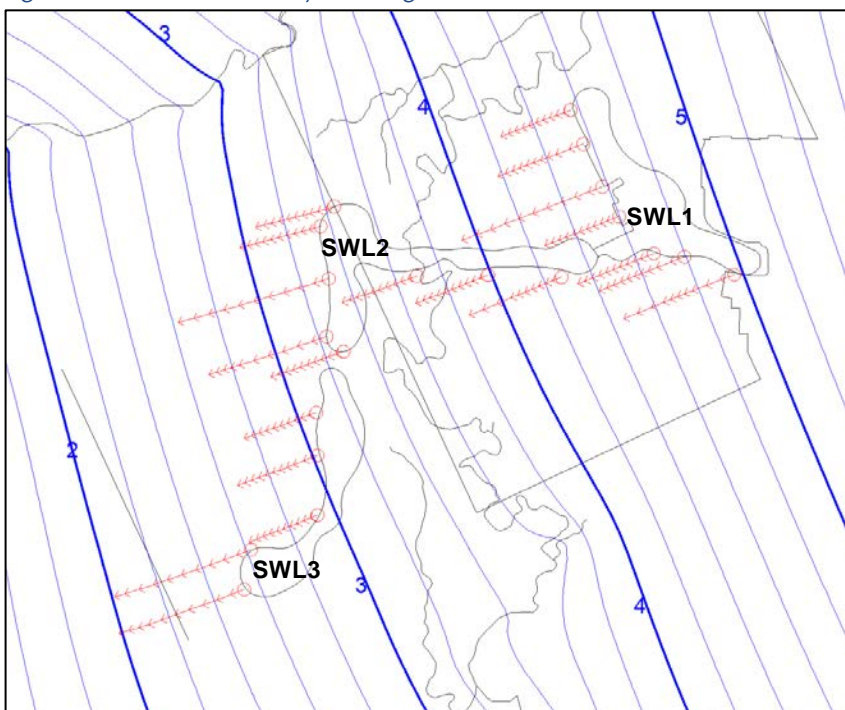


Figure 4 shows a similar plot for the opposite end-case scenario, in which the lakes are fully isolated from the aquifer. It indicates a more uniform flow field, with particle migration towards the west-southwest. This simulation does not take account of the fact that if the lakes have low permeability liners, part of the aquifer material would be replaced by a low permeability zone. Groundwater from upgradient would need to flow beneath or around this zone as it proceeds downgradient and this may cause some localised changes in groundwater levels and flow directions.

Whichever approach is adopted in respect of design and construction of the sides and base of the lakes, the advective pathways for groundwater flow would be expected to be intermediate between the two end-cases presented in Figure 3 and Figure 4.

Figure 4. Modelled steady-state groundwater contours with SWL1-3 hydraulically isolated from aquifer



6. Salinity Migration, Dispersion and Diffusion in Groundwater

6.1. Migration and attenuation mechanisms

Molecular dispersion takes place during solute migration in groundwater, due to the differing pathways that individual molecules of water and associated ions such as sodium and chloride take as they move downgradient through the aquifer matrix. This causes lateral spreading of the 'plume' of solute as it migrates. It also causes some molecules to migrate more quickly than others, so that as the leading edge of the solute front reaches a new downgradient, concentrations rise gradually over time, rather than abruptly.

Dispersion also takes place in groundwater over time, whether or not a solute is migrating by advection and dispersion. Ions and molecules diffuse in response to concentration gradients, moving (on average) from areas of higher to lower concentration. However, whereas diffusion can be the dominant process of solute spreading in clay soils, advection and dispersion dominate in sandy soils, where the effects of diffusion are negligible by comparison.

According to Rowe (1994)², diffusion dominates over advection if the average groundwater velocity (Darcy velocity) is less than 0.0002 m/y and advection dominates for Darcy velocities over 0.02 m/y, with both playing an important role for intermediate velocities. The estimated average Darcy velocity (porewater velocity multiplied by porosity) at Riverlea is approximately 1.5 m/y, so is clearly in the range where advection dominates and where diffusion is negligible by comparison. Although much clay is present within the shallow soil profile at Riverlea, the overall hydraulic behaviour of the strata, as indicated by the average transmissivity (33 m²/d) derived from the pumping tests, is consistent with sand or silty sand. Therefore, any spreading of salinity in the shallow aquifer by diffusion is expected to be negligible in comparison to migration and spreading due to advection and dispersion. Diffusion may play a role in determining the flux of salinity that migrates through a clay-based liner system. This would affect the rate at which salinity enters the groundwater but would not affect the subsequent migration and spreading of salinity within the groundwater.

The potential advection and dispersion of salinity within groundwater downgradient of the lakes has been assessed using the analytical solute transport model Bioscreen-AT³ (version 1.45). Bioscreen-AT is an enhancement of the US EPA screening-level model Bioscreen⁴, which was developed to simulate petroleum hydrocarbons in groundwater but can also be used to simulate other dissolved solutes such as chloride (representing salinity). Bioscreen-AT has been used because it gives an exact solution to the solute transport equation, rather than the approximate solution given by the Domenico equations in the original Bioscreen model, as discussed by West et al (2007)⁵.

For the purposes of this section, the Bioscreen-AT model has been used to assess the migration and dispersion of salinity with time downgradient of each of the lakes under the three scenarios discussed in the preceding section: lakes unlined, lakes with a low permeability clay liner, and lakes with an HDPE liner.

² R. Kerry Rowe (1994), 'Diffusive transport of pollutants through clay liners', in 'Landfilling of waste: barriers', eds. T H Christenson, R. Cossu and R. Stegmann, publ. Chapman & Hall, London.

³ <https://www.sspa.com/software/bioscreen>

⁴ <https://www.epa.gov/water-research/bioscreen-natural-attenuation-decision-support-system>

⁵ Michael R. West, Bernard H. Kueper, and Michael J. Unger (2007), *On the Use and Error of Approximation in the Domenico (1987) Solution*, Ground Water Vol. 45, No. 2, pp 126-135.

6.2. Model assumptions

The salinity migration model incorporates the assumptions and limitations listed in Table 1.

Table 1. Salinity migration model assumptions and limitations

Assumption or limitation	Justification
Steady state groundwater flow.	Although there will be short-term variations in groundwater levels and flows due to recharge events and seasonal fluctuations, solute transport over the longer term (<i>i.e.</i> years to decades) will be controlled by long-term average groundwater levels and flow conditions.
Homogeneous, isotropic, laterally extensive aquifer downgradient of the lakes.	Similar geological conditions have been encountered during drilling of the various monitoring wells across the area. Consistent with this, the results of pumping tests and borehole permeability tests ('slug tests') did not show a large variation in transmissivity. Also, the inferred groundwater elevation contours suggest relatively uniform aquifer conditions.
The modelling relates only to the upper part of the shallow aquifer	The Q1 aquifer is the one that will potentially interact directly with the lakes, via lateral and vertical seepage. Together with possible local areas of perched groundwater (not modelled), it is the zone from which any downgradient trees or other vegetation may extract groundwater. In reality, there is vertical stratification within the shallow aquifer, some of which is represented in the Anaqsim model developed for the dewatering assessment. The modelling of salinity migration considers only the upper part of the aquifer and assumes no mixing with deeper groundwater.
Water pressures are assumed to be vertically uniform	Reasonable assumption for the shallow aquifer based on the similarity of piezometric pressures in the multi-level monitoring wells installed around the location of SWL1.
Preferential flowpaths are not modelled	Some preferential flowpaths may be present. The degree to which they are interconnected is unknown. To reduce their significance if the lake is unlined, localised areas of sand or gravel encountered at the base or sides of the lake during construction could be covered with clay.
Aquifer recharge is not explicitly modelled.	This is a conservative assumption because the addition of rainwater recharge would dilute groundwater salinity. However, the hydraulic gradient and resulting groundwater velocities (as simulated in the model) are the result of the overall aquifer recharge and flow pattern.
Salinity migrates with groundwater.	Standard assumption for chloride, which is assumed not to be retarded by processes of adsorption and desorption.
No degradation or other mass loss.	Standard assumption for chloride, which acts as a conservative solute (no mass loss by degradation, volatilisation or chemical precipitation).
Density effects are not represented	Saline groundwater is denser than freshwater, but density-driven flows are complex and are not represented in the model. As noted above, there may be localised perched water above the aquifer downgradient of the lakes. There may also be fresh groundwater near the top of the aquifer due to local infiltration and recharge; this effect could progressively increase moving downgradient from the lakes. The additional vertical gradients that would be present due to salinity contrasts could increase the potential for mixing with groundwater lower in the aquifer as the salinity moves downgradient.

6.3. Input parameters

Model input parameters have been estimated from available site-specific data and from literature values and experience and are summarised in Table 2. These have been used to examine how a plume of varying widths would develop over time in these aquifer conditions.

Table 2. Dispersion model input parameters

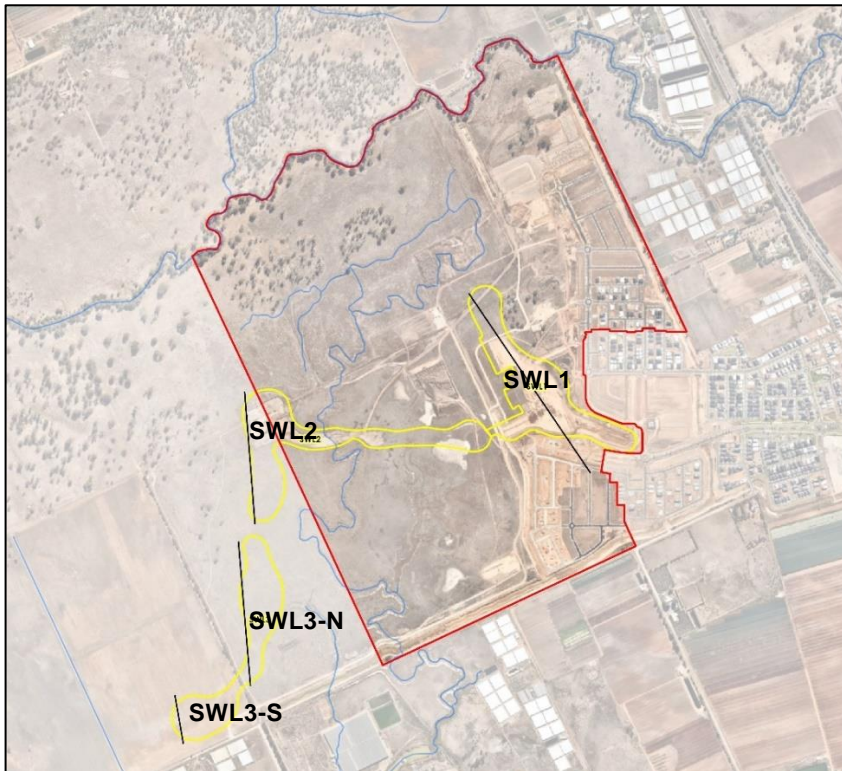
Parameter	Value	Source of data
Seepage velocity	5 m/year	This velocity applies to the shallow aquifer and is based on $k = 4 \text{ m/d}$, hydraulic gradient = 0.001, effective porosity = 30%.
Dispersivity longitudinal	9.1 m	Calculated from the estimated plume length using a 'modified Xu and Eckstein' correlation (Xu, M. and Y. Eckstein, 1995; Al-Suwaiyan, M., 1996), assuming a plume length of 500 m (the distance a 5 m/y plume would migrate in 100 years with no dispersion): $Dispersivity = 0.82 \times [\log_{10}(plume \ length)]^{2.446}$ The resulting dispersivity is about 2% of the estimated plume length. Due to the logarithm term in the equation, dispersivity is relatively insensitive to plume length (a plume length of 1000 m would give a dispersivity of 11.8 m).
Dispersivity transverse	10% of longitudinal	Lower (conservative) end of range 10% to 33% typically used for modelling (US EPA, 1986 & 2000; ASTM, 1995).
Dispersivity vertical	0.1% of longitudinal	Low value, allowing some dispersion but reflecting that vertical hydraulic conductivity is likely lower than horizontal.
Retardation	1.0	A retardation factor of 1.0 means the solute migrates at the same rate as porewater and is not retarded by sorption or other factors.
Decay rate	zero	The salinity is assumed to migrate as a conservative solute, with no mass loss due to precipitation or other mechanisms.

For this scoping assessment, the above parameters are taken to be reasonably reflective of aquifer conditions across the entire area of interest, and to apply to salinity 'plumes' as they migrate downgradient from all three lakes. In reality, there will be spatial and temporal differences in hydraulic gradient, porewater velocity and other factors. The sensitivity of results to parameter input values is discussed in Section 6.5.

For the purposes of the dispersion model, each lake is approximated simply as a linear source of salinity near its downgradient edge. The alignments of both SWL1 and SWL2 are such that, as a rough approximation, their downgradient edges are perpendicular to the inferred groundwater flow direction. However, the eastern 'arm' of SWL2 is not represented. The small cross section width of the 'arm' perpendicular to groundwater flow direction for the western part of the 'arm' length and the flatter groundwater gradient for the eastern part of the 'arm' length, indicated dispersion from the 'arm' section would be limited relative to the dispersion downgradient from SWL2 and SWL3. Accordingly, dispersion from the 'arm' portion of SWL2 was not modelled.

To simulate dispersion from SWL3, the lake has been divided into two portions (north and south) represented by lines extending approximately SSE-NNW direction, as indicated in Figure 5.

Figure 5. Locations of linear source lines used in salinity dispersion model



The modelled source characteristics are summarised in Table 3. The TDS concentrations used in the dispersion model represent additional salinity that is due to lake seepage. The total salinity of the groundwater at any location would therefore be the background salinity (e.g. 5,400 mg/L at SWL1) plus the salinity indicated by the model.

To model dispersion of seepage from unlined lakes, the source concentration is applied to a 4 m thickness of aquifer (3 m to represent the downgradient side of the lake, where there may be horizontal flow, plus 1 m to represent the top of the underlying zone where there may be lateral flow of water that seeps from the base of the lake). Initial dilution on mixing of seepage water into the ambient groundwater flow within this 4 m thickness is conservatively not represented.

To model dispersion from lined lakes (clay or HDPE), initial mixing calculations maintaining mass balance have been used to determine a representative average TDS concentration for the source zone. For the mixing calculation the seepage flows derived as described in Section 4 are mixed into the calculated groundwater throughflow for a 1 m thickness of aquifer (i.e. the 1 m beneath the base of the lake). The throughflow has been calculated based on the hydraulic conductivity of 4 m/d as used in the top layer of the Anaqsim model and a hydraulic gradient of 0.001.

Table 3. Dispersion model source parameters

Parameter	Units	SWL1	SWL2	SWL3 N	SWL3 S
Lake area	m ²	146,000	142,000	115,000	
Source width (lake length perpendicular to flow)	m	900	550	600	200
Salinity of water in lake (TDS)	mg/L	35,000			
Background groundwater salinity (TDS)	mg/L	5,400	6,000	7,000	
Aquifer throughflow for 1 m thickness below lake	m ³ /d	3.6	2.2	2.4	0.8

Parameter		Units	SWL1	SWL2	SWL3 N	SWL3 S
Lake unlined	Modelled source thickness	m	4	4	4	
	Modelled source TDS	mg/L	29,600	29,000	28,000	
Lake has clay liner (10 ⁻⁹ m/s)	Seepage through liner under gradient of 0.8	m ³ /d	10	10	5	3
	Modelled source thickness	m	1	1	1	
	Modelled source TDS (seepage mixed into throughflow)	mg/L	21,800	23,700	20,000	
Lake has HDPE liner	Seepage through liner (illustrative)	m ³ /d	1	1	1	
	Modelled source thickness	m	1	1	1	
	Modelled source TDS (seepage mixed into throughflow)	mg/L	6,400	9,100	7,000	

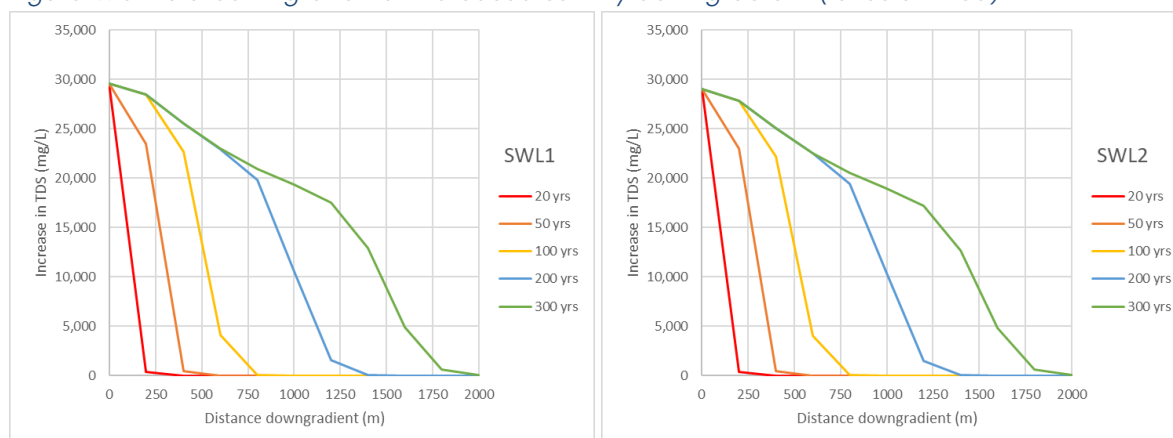
6.4. Salinity advection and dispersion model results

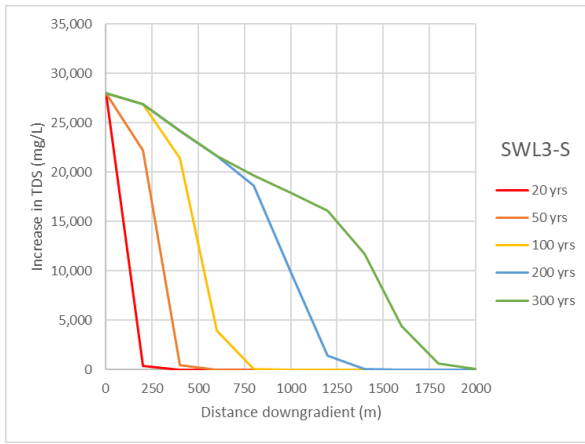
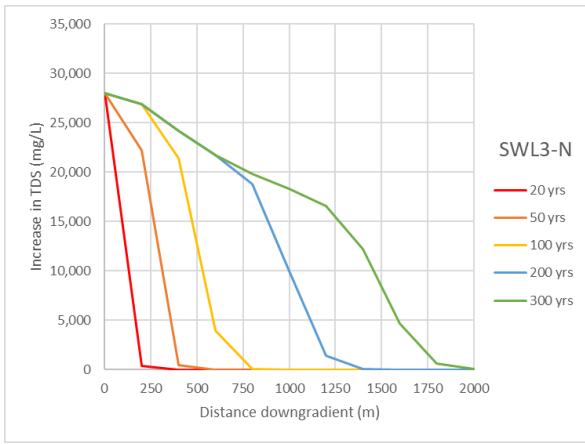
Figure 6 shows the simulated advancement of the salinity front downgradient of each lake over a period of 300 years if the lake is in direct hydraulic conductivity with the shallow aquifer. The salinities shown represent the additional TDS due to the lake seepage. These charts are very similar to each other because the advancement of the salinity front is controlled by the groundwater velocity in the aquifer. However, the width of the plumes will vary based on the different widths of the lakes perpendicular to the groundwater flow direction.

The peak salinity reached at any location depends on its distance downgradient from the lake and laterally (cross-gradient) compared to the source location. The highest salinity increases occur immediately downgradient of the lakes. The maximum salinity that is reached gradually decreases in the downgradient direction due to dispersion. Although not represented in the model, there would also be dilution downgradient due to mixing with infiltrating rainwater that reaches the aquifer.

Given the relatively slow porewater migration velocity, the intervals of 5 years between construction of one lake and the next are a relatively insignificant period of time compared to the long-term over which the lakes will be present.

Figure 6. Simulated migration of increased salinity downgradient (lakes unlined)





The corresponding plume centreline charts for the two lined scenarios (clay liner or HDPE liner) are plotted in Figure 7 and Figure 8. Note the reducing concentration scales on the y-axis between Figures 6, 7 and 8.

Figure 7. Simulated migration of increased salinity downgradient (clay liner)

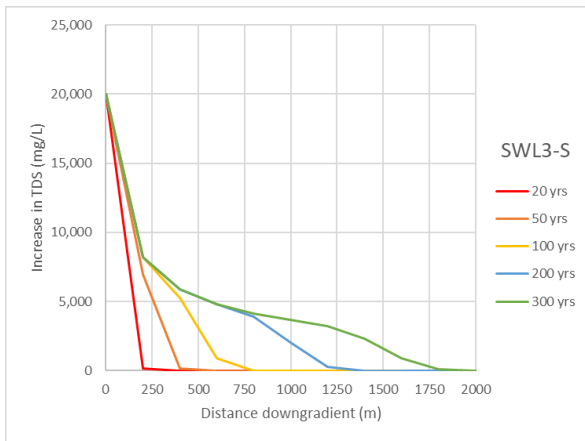
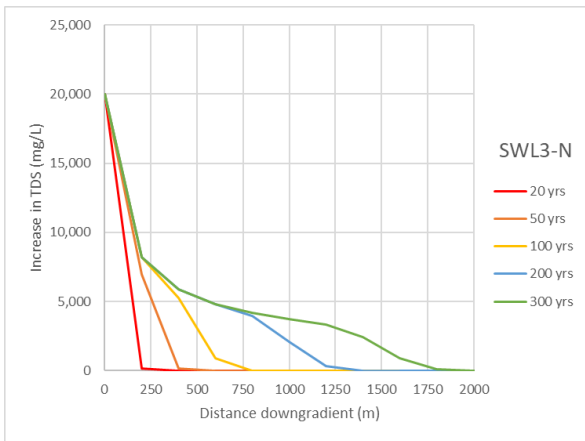
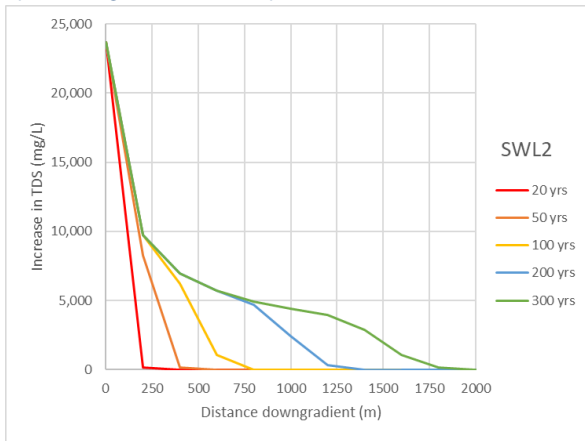
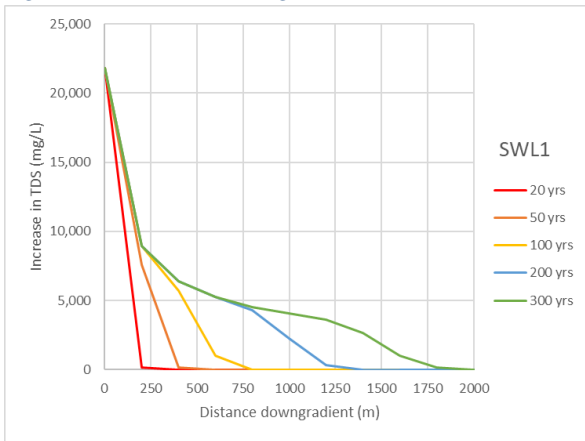


Figure 8. Simulated migration of increased salinity downgradient (HDPE liner)

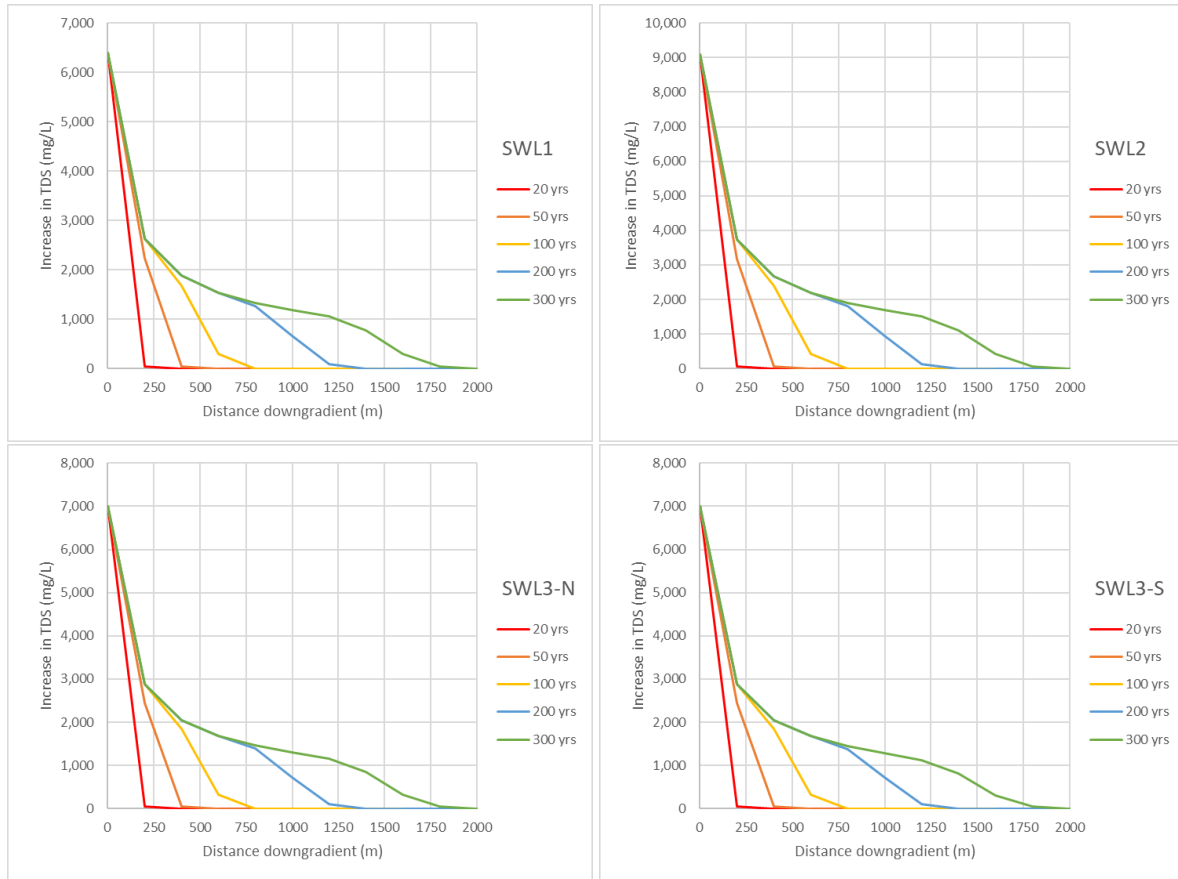
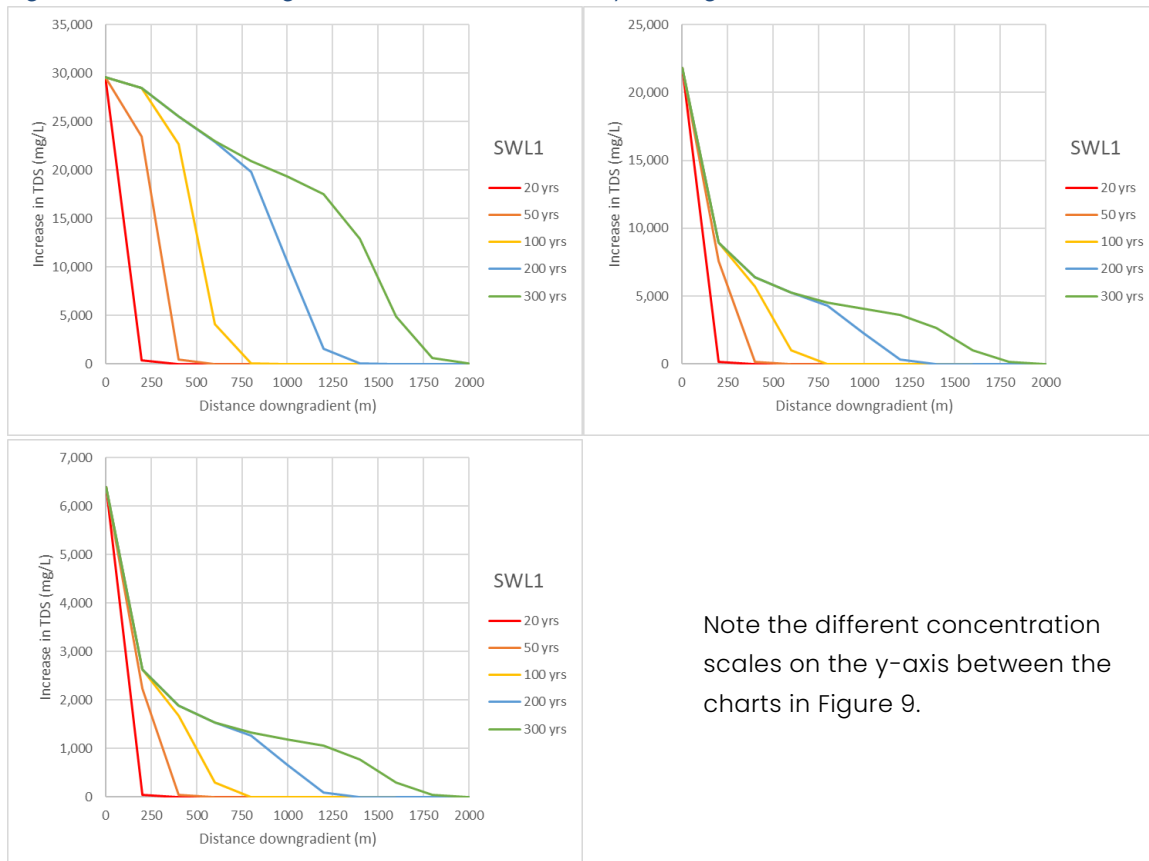


Figure 9 shows the plume centreline charts for SWL1 under the three scenarios. The main differences between the three scenarios are the simulated TDS concentrations at any particular place and time.

Figure 9. Simulated migration of increased salinity downgradient of SWL1 (3 scenarios)



Note the different concentration scales on the y-axis between the charts in Figure 9.

The maps below show interpolated salinity contours to help visualise the advection and dispersion of salinity from the lakes after 20 years (Figure 10) and 100 years (Figure 11) under the three lining scenarios modelled: no liner, clay liner and HDPE liner. In each case the maps show the simulated salinity plumes from the four linear sources (as per Figure 5). Seepage of salinity from other, irregularly-shaped portions of the lakes (e.g. the eastern ‘arm’ of SWL2) is not represented.

The BIOSCREEN-AT model assumes simple, uniform flow so the results do not account for spatial or temporal variability in groundwater flow directions. Nevertheless, they provide an indication of the potential migration of salinity from the lakes for the conditions simulated under the three scenarios. The salinities in the model represent additional salinity due to seepage from the lakes. The total salinity of the groundwater at any point would be its background salinity plus the salinity due to lake seepage.

As with the centreline charts in the preceding set of figures, these maps illustrate that the migration and dispersion of salinity depends primarily on the hydrogeology of the aquifer, not on assumptions relating to seepage. However, the seepage assumptions do affect the magnitude of increased salinity in the aquifer.

Figure 10. Simulated salinity distributions after 20 years

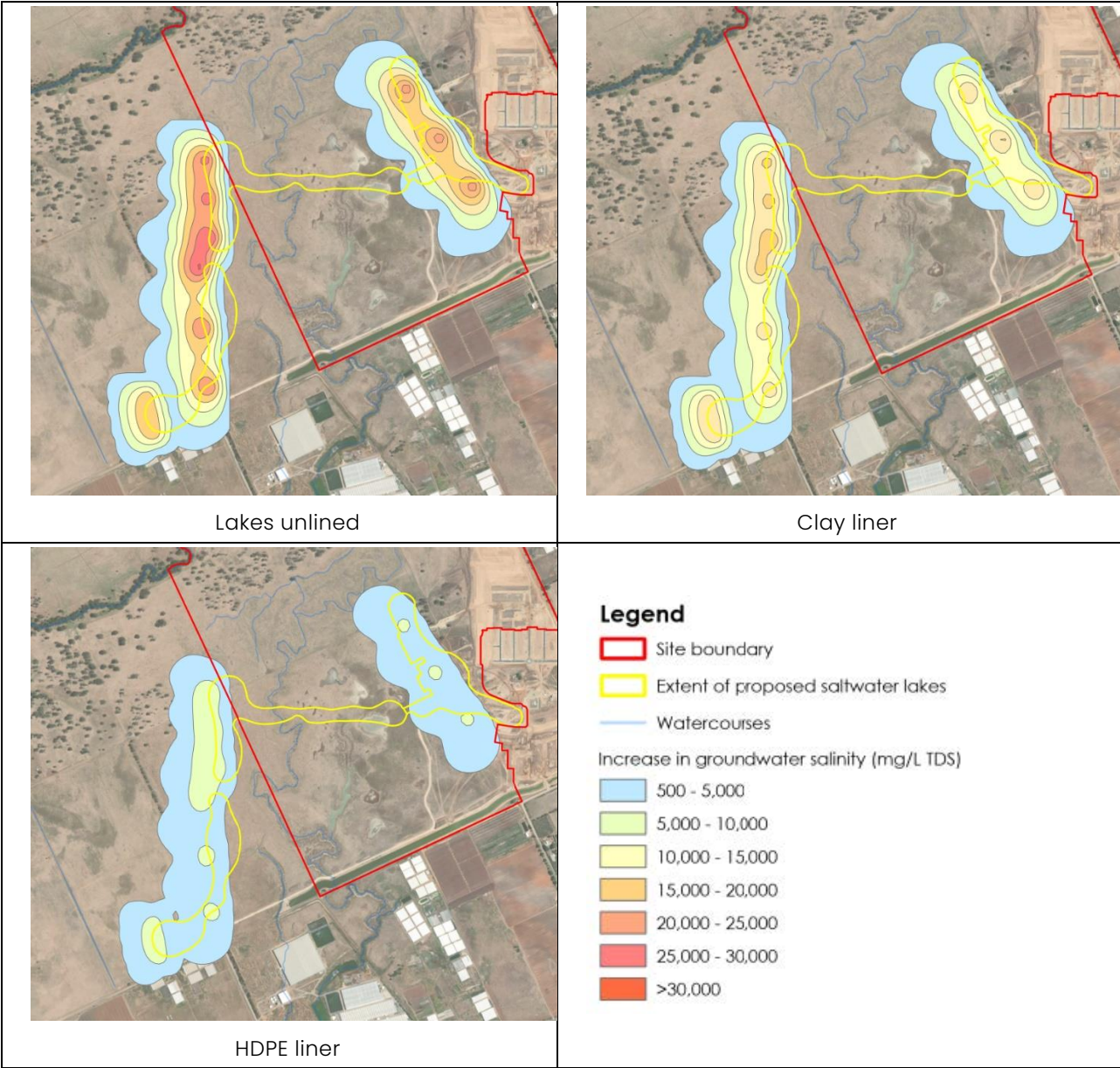
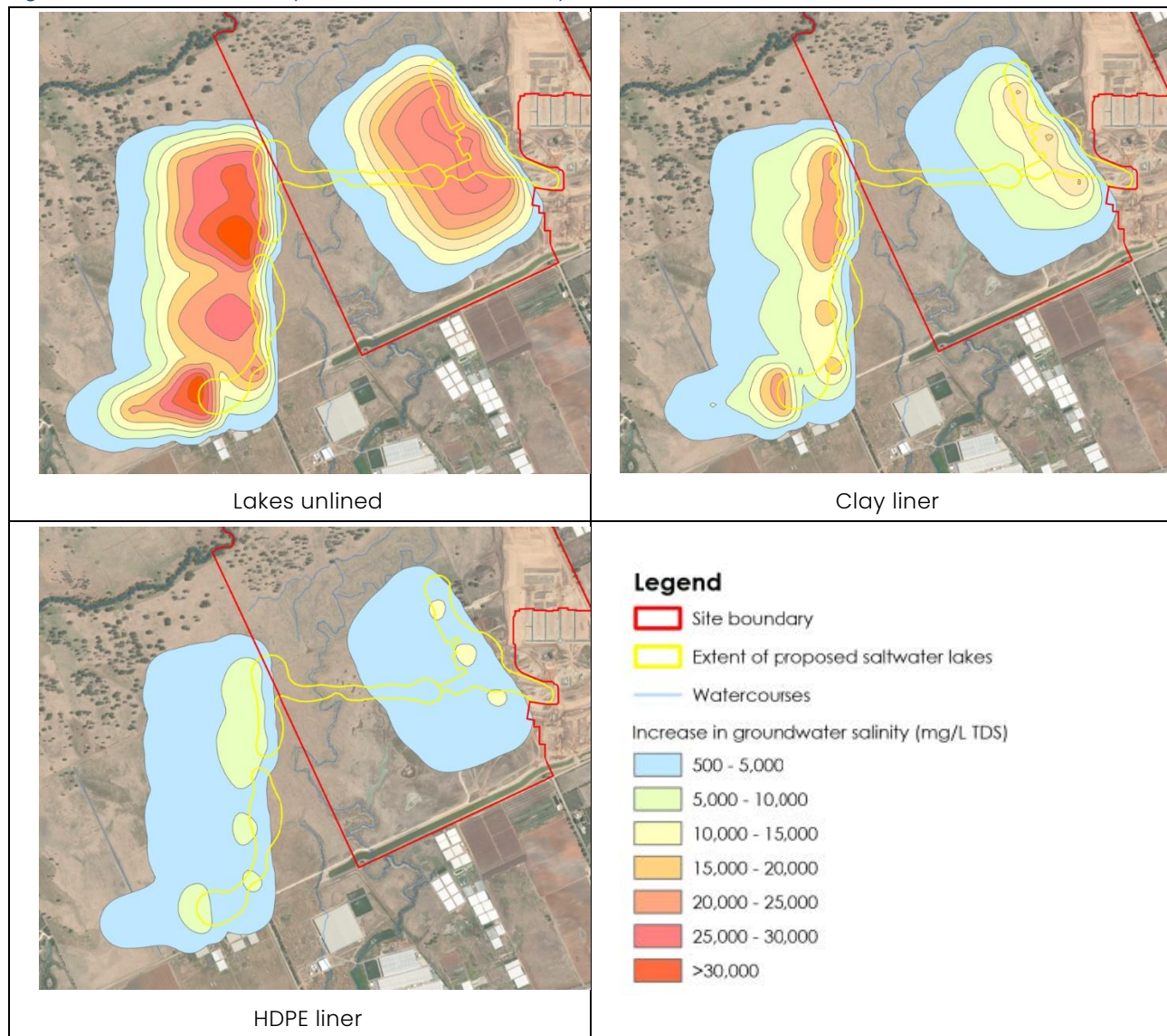


Figure 11. Simulated salinity distributions after 100 years



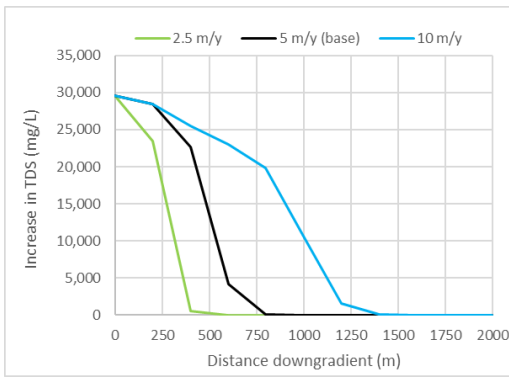
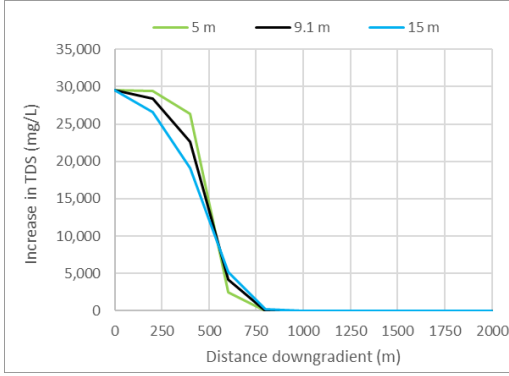
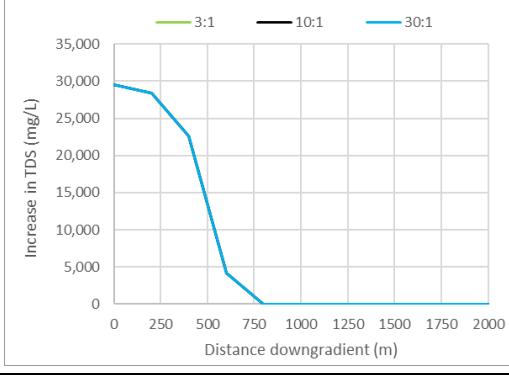
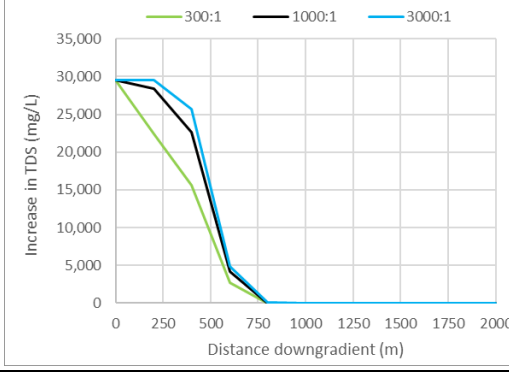
6.5. Sensitivity of model results to input parameter values

The main input parameters for the advection and dispersion model (BIOSCREEN-AT) are:

- Porewater velocity. In turn, this depends on the hydraulic conductivity, hydraulic gradient and effective porosity. The hydraulic conductivity and gradient are also dependent on each other.
- Dispersivity values (longitudinal, transverse, vertical)
- Source thickness (i.e. initial mixing depth)
- Source concentration. This has not been assessed further because any change in source concentration results in a directly proportional change in simulated plume concentrations.
- Source length. This is effectively the length of the lake when measured perpendicular to the groundwater flow direction, so is essentially fixed as part of the overall Riverlea design.

The sensitivity of the model results to changes in porewater velocity, dispersivity and source thickness has been assessed by reproducing the simulated plume centreline concentration profile for SWL1 at 100 years with the 'base' parameter value and with higher and lower parameter values for comparison, while keeping other input parameter values unchanged. The results are presented and summarised in Table 4.

Table 4. Model sensitivity to input parameters

Parameter	Values	Chart of results	Comments
Porewater velocity	2.5 m/y * 5 m/y 10 m/y		Changes in velocity result in proportional changes to the distance migrated with a specified time.
Dispersivity (long)	5 m * 9.1 m 15 m		Changes in longitudinal dispersivity affect the degree to which the plume spreads in the direction of travel.
Dispersivity ratio (long: transverse)	3:1 * 10:1 30:1		Changing the transverse dispersivity does not change the plume centreline. It would however change the lateral spreading of the plume.
Dispersivity ratio (long: vertical)	300:1 * 1000:1 3000:1		Decreasing the ratio of longitudinal to transverse dispersivity serves to increase the value of vertical dispersivity. This allows the plume to disperse (mix) vertically to a greater degree and so decreases the concentrations at any point.

Parameter	Values	Chart of results	Comments																																
Source thickness	2 m * 4 m 6 m	<table border="1"> <caption>Approximate data points from the TDS vs Distance graph</caption> <thead> <tr> <th>Distance downgradient (m)</th> <th>2 m Source TDS (mg/L)</th> <th>4 m Source TDS (mg/L)</th> <th>6 m Source TDS (mg/L)</th> </tr> </thead> <tbody> <tr><td>0</td><td>30,000</td><td>30,000</td><td>30,000</td></tr> <tr><td>250</td><td>25,000</td><td>28,000</td><td>28,000</td></tr> <tr><td>500</td><td>15,000</td><td>20,000</td><td>22,000</td></tr> <tr><td>750</td><td>5,000</td><td>10,000</td><td>15,000</td></tr> <tr><td>1000</td><td>0</td><td>5,000</td><td>10,000</td></tr> <tr><td>1250</td><td>0</td><td>0</td><td>5,000</td></tr> <tr><td>1500</td><td>0</td><td>0</td><td>0</td></tr> </tbody> </table>	Distance downgradient (m)	2 m Source TDS (mg/L)	4 m Source TDS (mg/L)	6 m Source TDS (mg/L)	0	30,000	30,000	30,000	250	25,000	28,000	28,000	500	15,000	20,000	22,000	750	5,000	10,000	15,000	1000	0	5,000	10,000	1250	0	0	5,000	1500	0	0	0	Changing the source thickness changes the mass of solute entering the model and so changes concentrations accordingly.
Distance downgradient (m)	2 m Source TDS (mg/L)	4 m Source TDS (mg/L)	6 m Source TDS (mg/L)																																
0	30,000	30,000	30,000																																
250	25,000	28,000	28,000																																
500	15,000	20,000	22,000																																
750	5,000	10,000	15,000																																
1000	0	5,000	10,000																																
1250	0	0	5,000																																
1500	0	0	0																																

* Value used in base model simulation

The sensitivity testing indicates the following:

- The only model parameter that affects significantly the distance that the plume will migrate in a specified time is the porewater velocity. This in turn depends on the hydraulic conductivity, hydraulic gradient and effective porosity. The hydraulic gradient is reasonably well known but hydraulic conductivity will vary spatially across the area, including on a small scale. The values used in the model are based on the best available information, which are the results of the test pumping conducted near SWL1 in December 2023, taking into account calibration of the groundwater flow model developed for dewatering assessment.
- Changes to other parameter values affect the modelled salinity concentrations at any downgradient location and time, but do not affect the migration rate. For the purposes of this scoping assessment and the associated consideration of potential groundwater impacts, the adopted values are considered reasonable, and it is unlikely that the selection of different parameter values would materially affect conclusions relating to groundwater impacts.

7. Conclusions

The main conclusions from this assessment are:

- Based on these parameter values, the average background rate of groundwater flow in the shallow aquifer beneath SWL1 is estimated at approximately 60 m³/d.
- The lakes will be constructed within the aquifer and will have water levels similar to those in the adjacent groundwater. This means:
 - For unlined lakes in direct hydraulic continuity with the aquifer, there will be little scope for groundwater flow rates to change. If lake water levels rise following storm events, the increased head may or may not increase seepage, depending on how local groundwater levels have also changed. Long-term average seepage rates will be limited by the hydraulic resistance of the aquifer. The estimated long-term average net seepage rate from SWL1 if it is not lined and has a water level 0.4 m above the adjacent groundwater level, is 22 m³/d.
 - At the other end of the scale, if the lakes are lined with a fully impermeable liner (although not achievable in practice), there would be no direct exchange of water between the lakes and the groundwater. However, the lakes would represent a physical low permeability barrier within the aquifer. This may affect groundwater levels and flow directions, although the effects are likely to be relatively local.
- If the lakes are unlined:
 - Initial rates of seepage from an unlined lake would be higher than the calculated long-term average rate but would only occur until the hydraulic gradient has equilibrated.
 - There may be local areas with higher outflow along preferential flow paths where there is higher permeability. The potential for such flows could be mitigated by placing local low permeability barriers across any high permeability zones (e.g. sand and gravel) that are encountered during construction of the sides or base of the lake. This may also help mitigate potential sediment migration and associated geotechnical concerns.
- The groundwater model Anaqsim was used to track the pathways for advective migration of particles from just outside the downgradient sides of the three lakes under steady flow conditions for the two end-cases of lake/groundwater interaction. with the following results:
 - If the lakes are lined such that they have no effect on groundwater levels, the particles migrate west-southwest at a rate consistent with the estimated porewater velocity (approximately 4.5 m/y, resulting in 450 m migration per century if the gradient remains the same)
 - If the lakes are unlined and in full hydraulic continuity with the groundwater, the modelled groundwater levels and particle tracking indicate:
 - Much of the groundwater seeping SWL1 would likely enter SWL2 towards its eastern end (if SWL2 unlined). Some seepage from the northern end of SWL1 may migrate west; seepage from the southeastern end of SWL1 is indicated to migrate generally southwest towards SWL3.
 - Water seeping from the west of SWL2 would migrate in directions ranging from northwest to southwest. Some water seeping from the southern end of SWL2 may enter SWL3 if it is unlined and has a lower water level than SWL2.

- The simulated hydraulic gradient near SWL3 is very low, such that there is very little groundwater movement simulated on the western side of SWL3.
- Illustrative modelling has been conducted using the analytical model BIOSCREEN-AT to simulate advection and dispersion of salinity within the shallow aquifer after seepage from the three lakes under three scenarios:
 - Lake unlined and in direct hydraulic continuity with the shallow aquifer.
 - Clay liner. Based on an example clay thickness of 0.5 m with a permeability of 1×10^{-9} m/s (typically used to represent engineered clay for landfill liners), the estimated seepage rate from SWL1 is approximately 10 m³/d, assuming the rate is not impeded by the hydraulic resistance of the aquifer.
 - HDPE liner, with an illustrative overall seepage rate of 1 m³/d for each lake, based on assuming the installed liner will have a limited number of perforations (holes and seam tears) and the rate is not impeded by the hydraulic resistance of the aquifer.
- The BIOSCREEN-AT model results indicate that the migration and dispersion of salinity depends primarily on the porewater velocity in the aquifer, not on assumptions relating to seepage. Assumptions relating to seepage affect the magnitude of increased salinity in the aquifer. For the purposes of this scoping assessment and consideration of potential groundwater impacts, the adopted values are considered reasonable, and it is unlikely that the selection of different parameter values would materially affect conclusions relating to groundwater impacts.
- The model does not account for some other features and mechanisms that will affect the migration of groundwater and salinity. These include:
 - Aquifer heterogeneity and the potential for preferential flowpaths of higher permeability, as well as clay-rich zones where the permeability is low and where very little migration occurs.
 - Density effects, which may cause saline water to gradually move downwards within the aquifer as it migrates, especially if there is freshwater recharge entering the top of the aquifer. This process may be important in terms of determining the suitability of any location for various types of vegetation, depending on root depths and salt tolerance.

8. Limitations

Hydrogeology Consulting Ltd has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of LBWco. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice and assessment included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the proposal.

Where this report indicates that information has been provided by third parties, Hydrogeology Consulting Ltd has made no independent verification of this information except as expressly stated in the report. Hydrogeology Consulting Ltd assumes no liability for any inaccuracies in or omissions to that information.

This report was prepared in October 2024 and is based on the information reviewed at the time of preparation, as detailed herein. Hydrogeology Consulting Ltd disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. Except as required by law, no third party may use or rely on this report unless otherwise agreed by Hydrogeology Consulting Ltd in writing. To the extent permitted by law, Hydrogeology Consulting Ltd expressly disclaims and excludes liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this Report.

This report does not give legal advice. Legal advice can only be given by qualified legal practitioners.

Our ref: 231445-01 L01 - DEW response DRAFT.docx

13 December 2024

Pat Mitchell
Walker Buckland Park Developments Pty Ltd
By email: Patrick.Mitchell@walkercorp.com.au



DELIVERING
**ENVIRONMENTAL
SOLUTIONS**

LBW co Pty Ltd
184 Magill Road, Norwood SA 5067
08 8331 2417 www.lbwco.com.au
ABN 58 126 992 274

Together with:



Dear Pat,

Riverlea Saltwater Lakes – Dewatering Investigation and Risk Assessment Report
Response to feedback from Department for Environment and Water (DEW)

1 Introduction

This document responds to comments by the Department for Environment and Water (DEW) relating to groundwater assessment for the Riverlea development. The numbering of the comments (in italics) and responses is the same as in DEW's Technical Memo dated 14 November 2024.

The following reports are referenced in these responses:

- "HCL report": '*Groundwater dewatering model, Riverlea Saltwater Lake 1*', report prepared for LBW co Pty Ltd by Hydrogeology Consulting Ltd, 30 September 2024
- "LBW report": '*Riverlea Development – proposed saltwater lakes dewatering investigation and risk assessment report*', report prepared by LBW co Pty Ltd for Walker Buckland Park Developments Pty Ltd, 15 October 2024.

2 Responses

1. *The potential for groundwater extraction associated with the dewatering effort to affect other groundwater users in the region has not been addressed adequately either by modelling or the provision of data such as a well audit of groundwater users within a nominal distance of the project.*

The HCL report was not intended to be read as a standalone report. It is an Appendix to the LBWco report, which contains details of registered bores in the area. The modelling report includes simulation of drawdown at three of the closest registered bores, with the drawdown at the end of pumping simulated to be less than 1 mm in each case.

LBWco detailed all registered shallow groundwater wells in the region and their purpose (stock, drainage, observation, etc.), presented a demarcated 2.0 km boundary from the saltwater lakes and showed the predicted extent of groundwater drawdown after the temporary pumping, as modelled by HCL.

LBWco concluded that there were no registered users for extraction of shallow groundwater within 2 km of the proposed saltwater lakes and that modelling indicated a low risk of unacceptable impact to nearby registered shallow groundwater users from dewatering activities.

The shallow aquifer matrix is mostly hard silty clay with some sand/gravel horizons/lenses. LBWco and HCL consider that the modelling is adequate for the purposes of the assessment of the temporary dewatering activity in a low permeability, discontinuous aquifer setting. The short duration of the proposed dewatering activity is not long enough for groundwater drawdown to propagate large distances.

2. *The current model indicates that significant groundwater discharge needs to occur into Gawler River and Thompson Creek for model calibration before extraction is initiated. If the model is correct, such a significant discharge may represent an adverse environmental impact to ecosystems and other dependencies on these surface water systems. This needs to be verified and investigated from a groundwater-surface water perspective as it may have significant ramifications if large amounts of water are extracted in the process of dewatering the site.*

There is no available data with which to prove or disprove the hypothesis that groundwater levels in the western part of the model domain are influenced by discharge associated with the creeks. The hypothesis is reasonable based on consideration of the sedimentary environment in which the shallow soils were deposited – i.e. throughout the depositional period there would have been fluvial systems crossing the area from east to west, and it is likely that sands and gravels would have been deposited in creek beds that are now buried.

Some of the hydrographs plotted by LBW for wells less than 15 m deep indicate that groundwater responds to river flood conditions. This can be seen most clearly in the hydrograph for well 6628-2219 in Figure A1 below, which also includes new hydrographs (refer also to Figure A7 in the response to comment 13). It is reasonable to suppose that the groundwater also discharges in the lower reaches of the creeks to provide baseflow.

The suggestion that dewatering may influence groundwater-dependent ecosystems (GDEs) is agreed in principle and would no doubt be an issue if long-term or permanent groundwater abstraction was proposed. However, for the limited planned period of dewatering (less than 6 months), the modelling results indicate that the creeks (and any potential GDEs near the creeks) are far enough from SWL1 that the hydraulic influence of dewatering does not reach them within the period of dewatering.

Please also see response to comments 11, 13 and 15.

Figure A1. Hydrographs for wells less than 15 m deep



3. Confirmation that there is no connection between surface and groundwater. Water samples from well number 6628-23298 (which is close to the Gawler River) and surface water from Gawler River Channel, Thompson Creek and Riverlea stormwater shows low value of pH ranging from 4.75 to 5.08 suggesting a potential connectivity between the groundwater and surface water. For example, water quality data from the Gawler River next to the well 6628-23298 should be obtained to confirm connection or otherwise.

See responses to comments 2 and 15. Further investigation is not warranted at this time as the dewatering modelling and risk assessment have demonstrated that for temporary dewatering for 6 months, no unacceptable risk to GDEs is predicted.

LBWco advises that the pH data referenced above appears to be field-measured data obtained with a pH probe that had suffered a calibration error. Laboratory-measured values for groundwater and surface samples collected within the same monitoring event ranged between pH 7-9. The pH data in isolation does not suggest connectivity between the groundwater and surface water.

4. Confirmation on the type of liner is required as well as confirmation of its leakage. In Appendix V, a permeability value of 1×10^{-9} was used for the calculation of leakage (using Darcy's law) from the base of the saltwater lake. In the LBW co's Technical Memo that was sent previously for comments, it was mentioned that using a synthetic geomembrane will achieve a permeability in the range of 1×10^{-12} to 1×10^{-15} m/d. This poses two questions – what is the actual permeability value of the liner and what is the volume and distribution (temporally and spatially) of this leakage? Also, a detailed 'Risk Management and Monitoring Plan' (RMMP) is required that identifies the hazards and risks related to lake liner leakage and/or liner failure and outlines how risks to existing groundwater users, groundwater-dependent ecosystems and the groundwater resource itself will be managed. The RMMP will detail a fit-for-purpose groundwater monitoring network that includes, but is not limited to, a plan outlining (1) the groundwater parameters that will be monitored, (2) the groundwater well locations where those parameters will be measured and the frequency of monitoring, (3) the measurement thresholds that will invoke a management response, (4) details of the type of management response

and (4) the conditions under which the management response will be revoked (i.e., a return to the status quo).

As the Response Document covers, the current investigations are considering two lining options for the SWL: a clay liner and/or a geosynthetic liner. In terms of the actual permeability value of the liners, Walker's engineering consultants advised that:

- they would only certify a clay liner to have a permeability of 1×10^{-9} m/s
- an engineered synthetic geomembrane could achieve a permeability in the range of 1×10^{-12} to 1×10^{-15} m/s

However, an independent containment expert considers there to be risks and challenges for even the best geomembrane lining solution, particularly issues concerning construction practicalities and operational flaws, given they are applied (typically) to more passive land use practices that are not vulnerable to active or frequent public recreational exposure.

Walker wanted to appreciate the volume and distribution of potential leakage (temporally and spatially), so LBWco undertook the saltwater seepage investigation and risk assessment, which was reported in *Riverlea Development, Proposed Saltwater Lakes - Saltwater Seepage Risk Assessment (October 2024)*. Like the LBWco - Dewatering Investigation and Risk Assessment Report, LBWco's - Saltwater Seepage Risk Assessment also includes a preliminary Risk Assessment for Saltwater Seepage into Groundwater (refer to Chapter 7).

5. The groundwater modelling is poor and cannot be used to make structural decisions regarding the dewatering sequence. If numerical modelling is to be used for impact assessment and risk management purposes, then the model needs to demonstrably address the issues above.

We do not agree that the modelling is poor. Most of DEW's comments appear to stem primarily from a lack of confidence in the assessment of historic groundwater levels. The groundwater level data used to assess the potentiometric surface within the model domain was taken from WaterConnect, LBWco's onsite groundwater monitoring in 2023 and 2024, REM/SKM's onsite and offsite groundwater monitoring in 2008 and 2009.

Following receipt of DEW's comments, LBWco and Hydrogeology Consulting undertook extensive additional review of the WaterConnect data for wells at depth ≤ 15 mBGL and obtained EPA Public Register reports to confirm several groundwater levels. The findings have confidently determined that the validation of the model is sound. The additional review work included:

- Checking source documents available via WaterConnect and selected environmental assessment reports available via EPA's Public Register.
- Incorporating additional data identified for observation wells and monitoring wells and updating the chart of hydrographs
- Identifying and correcting several data errors in WaterConnect (where supported by reliable sources). Corrections included replacing depth to groundwater entries incorrectly entered as the driller's reported water cut, with documented standing water level data.
- Preparing groundwater elevation contour plots for numerous subsets of the historical and recent groundwater level data to confirm consistency of groundwater levels over an extended time period, and comparing these with an updated version of the 2020-2024 contour plot, and also the model groundwater contours applied by REM (2008) and AGT (2012).
- Reviewing Gawler River flow data concurrently with groundwater hydrographs to assess correlation between high river flows (flooding events) and rapid increase in groundwater levels in wells adjacent to the river, then using the data to avoid contouring short-term groundwater levels that do not represent the long-term average conditions of the shallow aquifer.

Groundwater levels were collated for wells of depth ≤ 15 m below ground level (BGL), representing the shallow quaternary aquifer (well 6628-2219 located onsite was installed to depth 15.24 mBGL and was included following review of the driller's log and well construction details).

Please see responses to all other comments as relevant to these matters.

6. Figures 1 and 2 should have a scale and North arrow to provide definition.

The HCL report was not intended to be read as a standalone report. It is an Appendix to the LBWco report, which contains more detailed maps showing the site location, setting and lake design. Figure 2 of the HCL report notes that it shows a preliminary layout and is not to scale.

Figure A2 below is an updated version of Figure 1 from the HCL report.

7. Figure 1 must have a legend: what do the numbers mean? Locations of boreholes? And what do the different colours represent?

See response to comment 6.

Figure A2. Locations of SWL1 to SWL3

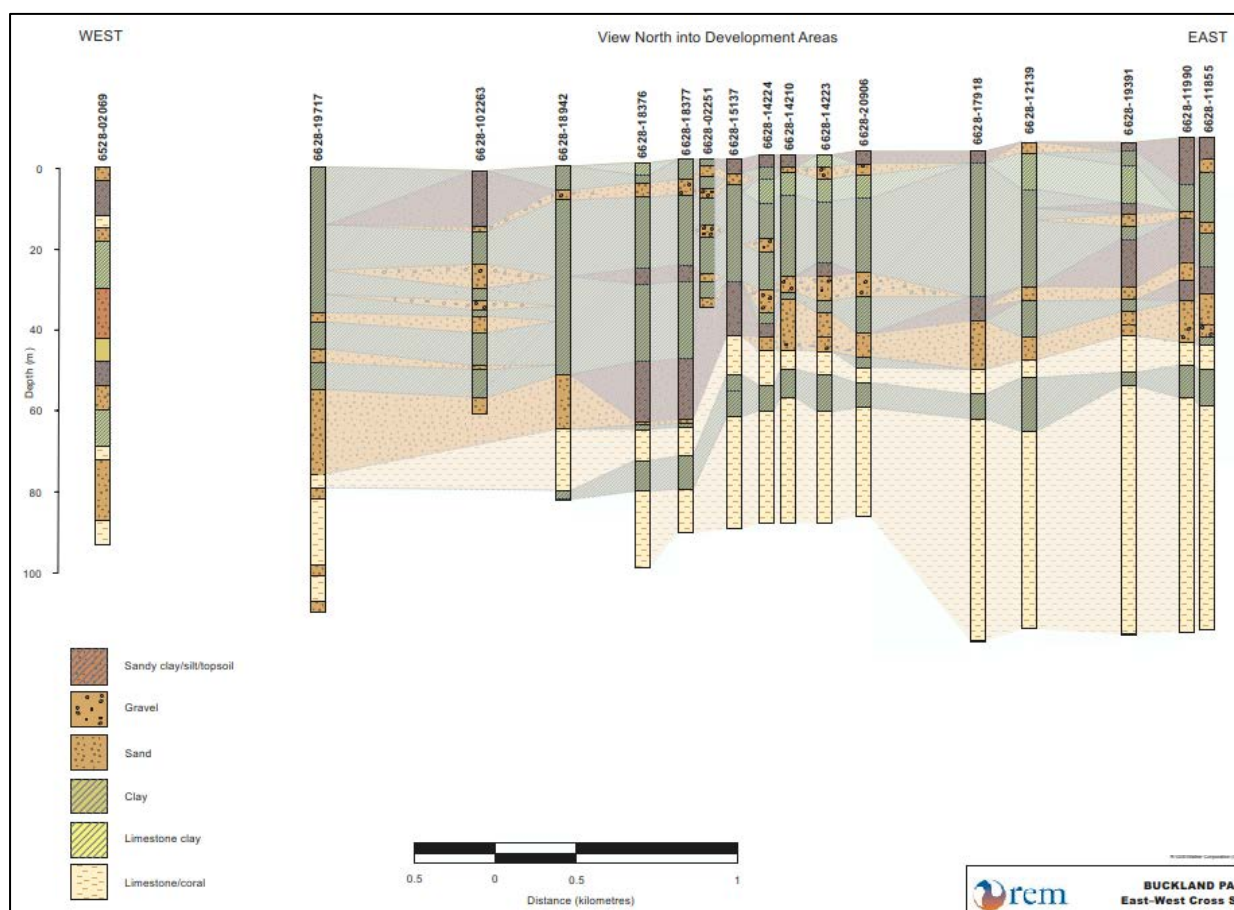


8. Section 2.3 and 2.4: the descriptions here really need some figures/cross-sections/stratigraphic columns to support what is being presented and, DEW presumes, what will be used to develop the groundwater flow model.

As noted above, the HCL report was intended to be read as an Appendix to the LBW report which contains more detailed information on the site setting and site investigations.

Figure A3 below shows a lithological cross-section prepared by REM (2008)¹. The section line is shown in Figure A4 and runs approximately 2 km south of SWL1. The cross-section illustrates the heterogeneity of the geology, both laterally and vertically. It also illustrates that there appears to be a near-continuous layer of permeable materials (sand, gravel) of a few metres thickness at shallow depth (typically less than 10 m), which is interpreted to represent the Q1 aquifer. It is separated by at least several metres thickness of clay from the underlying sands and limestones that form the deeper Quaternary and Tertiary aquifers in the area.

Figure A3. Lithological cross section (reproduced from REM, 2008)



9. Section 2.4: the locations of wells EX10, EX12 and EX13 need to be provided on a map (with a scale and North arrow).

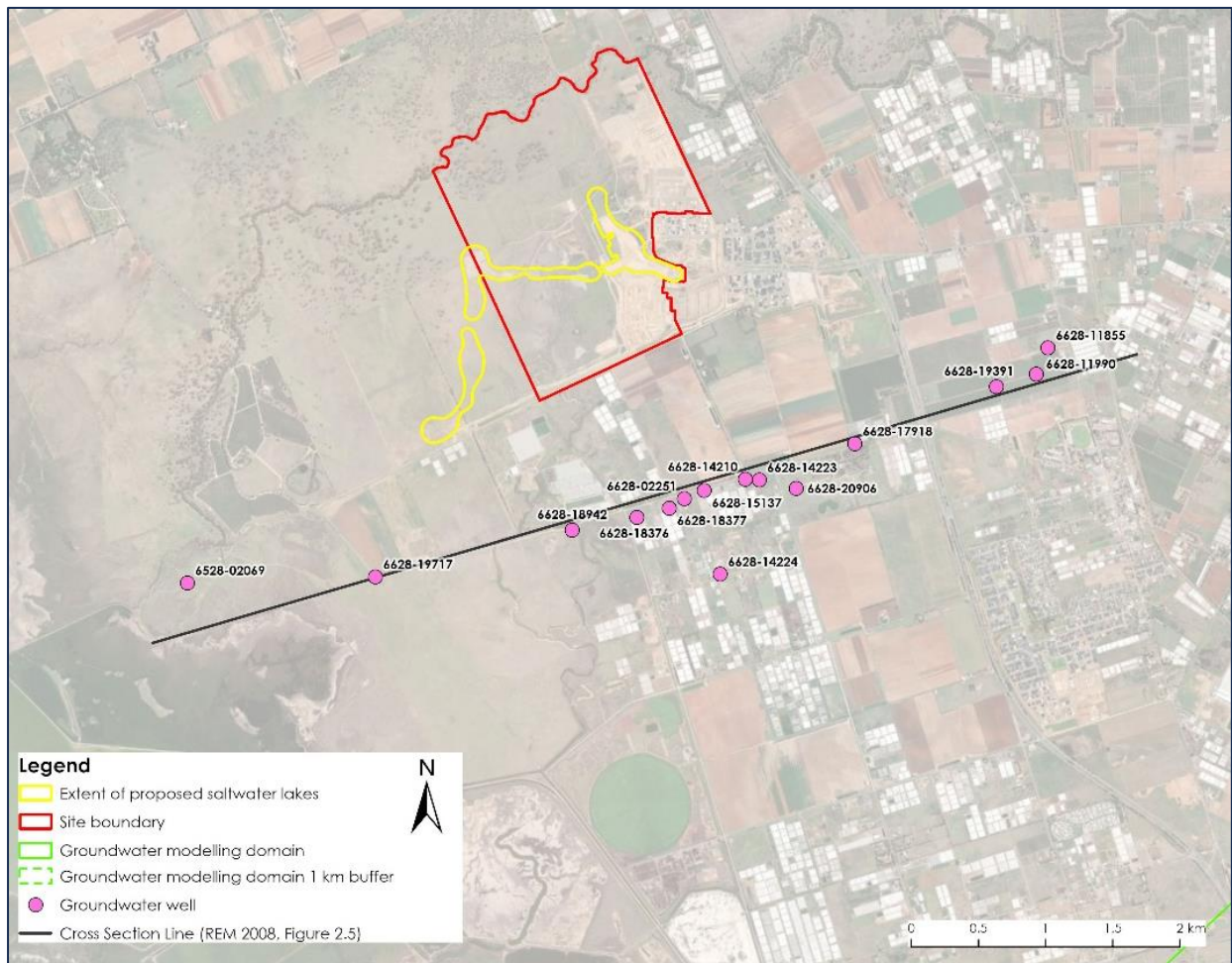
The locations of these wells are provided in the LBW report, to which the HCL report is an appendix. They are also shown in Figure A2 above.

¹ REM (2008) Buckland Park EIS Groundwater Investigations, Final Report, 17 December 2008.

10. Table 2: this Table would be greatly improved with the addition of a stratigraphic cross- sectional diagram.

The logs for the three test wells are included in the LBW report. Please also refer to Figure 3 of the HCL report and Figure A3, above.

Figure A4. Location of lithological cross section line



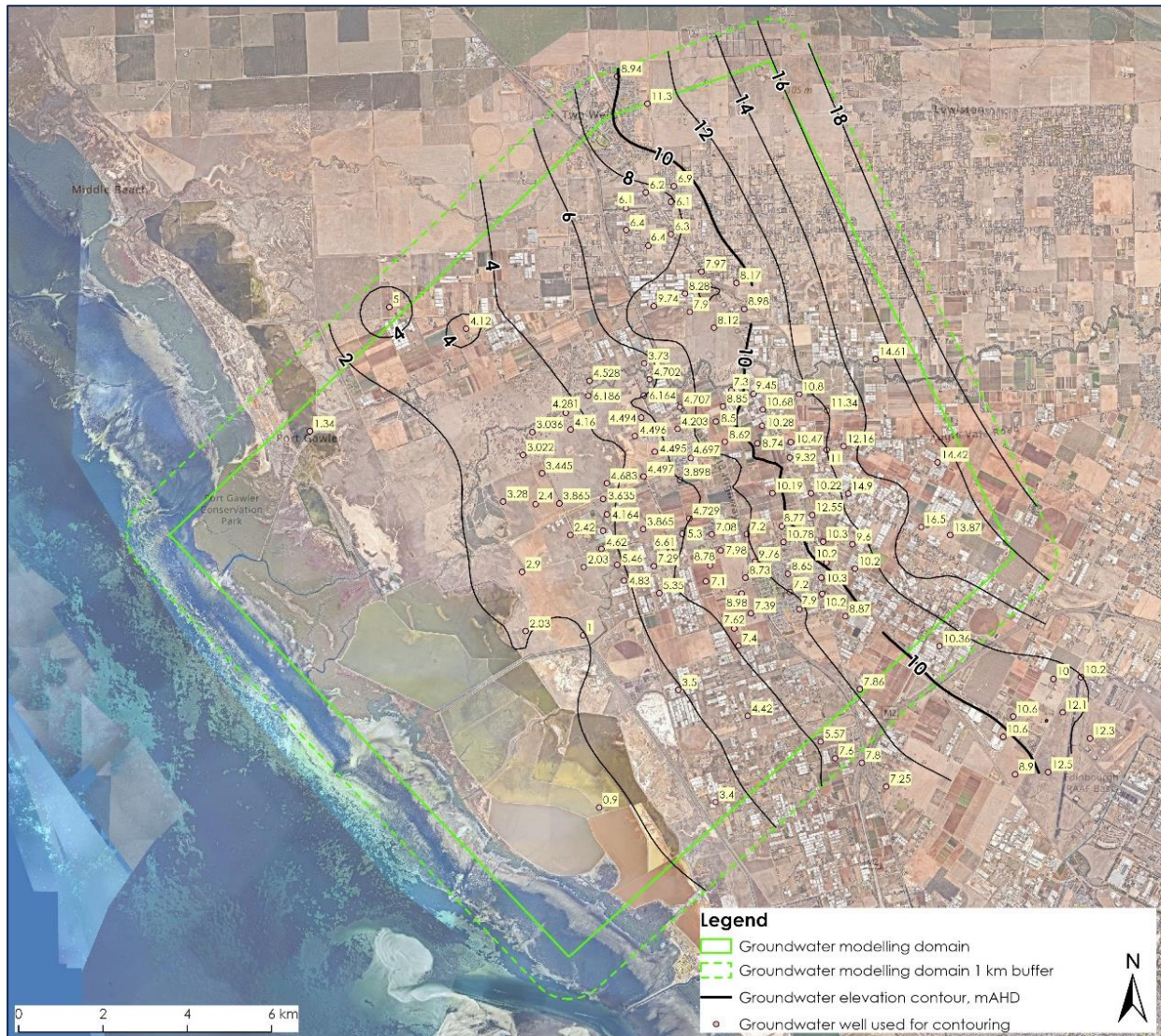
11. Figure 5: these figures are unacceptable. Potentiometric surface maps must be developed for a specific period of time for the same aquifer. These surfaces cover decades and no indication is given as to which aquifer has been measured.

The contours in Figure 5 are based on data for wells less than 15 m deep, representing the Q1 aquifer. This is clearer when the HCL report is read as intended, in the context provide by the LBW report.

There is no short period of time for which groundwater level information is available that has good lateral coverage across the full model domain. The approach adopted for Figure 5 made use of as much of the available water level information as possible and leads to groundwater level contours that are generally consistent with those interpolated based on smaller datasets for specific short periods of time.

A clearer version of the left-hand part of Figure 5 is provided as Figure A5 below. The contours are based on the most recent datapoint for every well for which groundwater level information is available since the year 2000.

Figure A5. Interpolated regional groundwater level contours

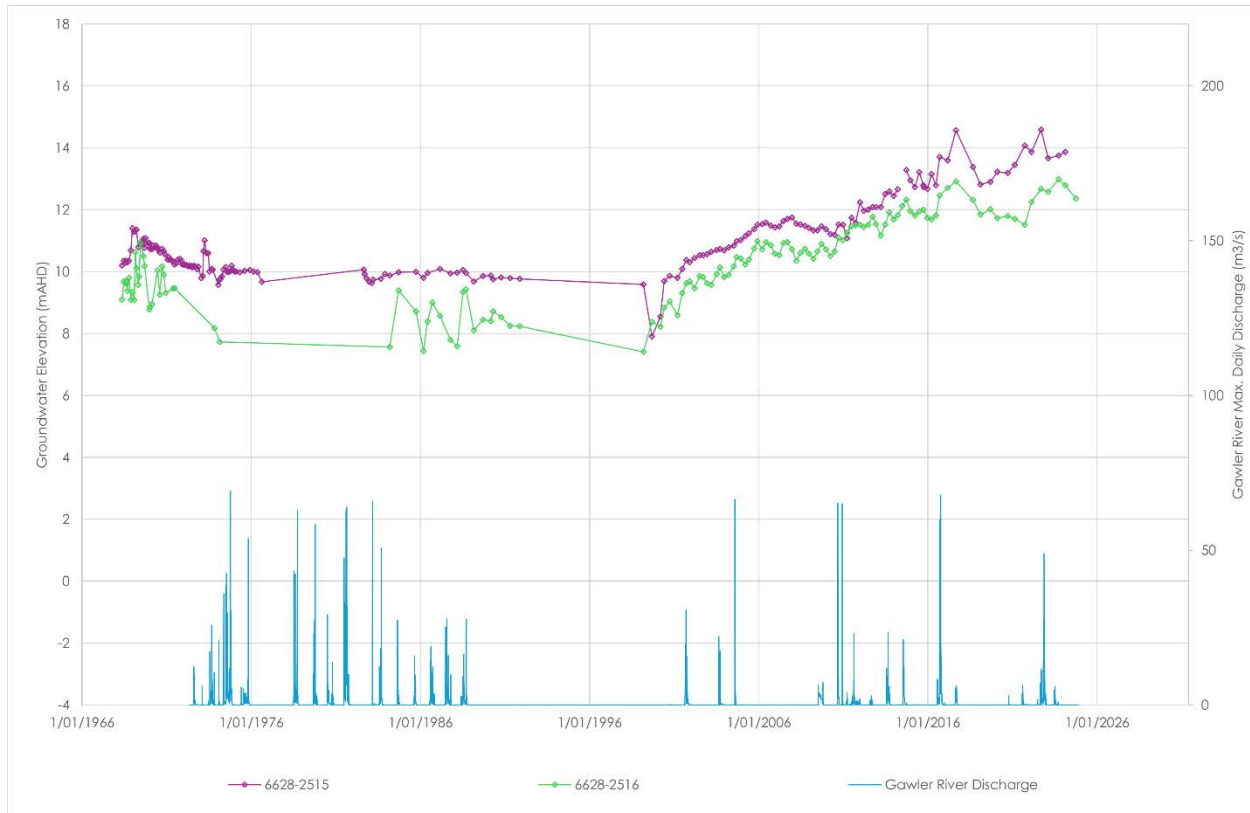


With one main exception (6628-2515, which is shown in purple on Figure A1), hydrographs for observation wells within the model domain indicate approximately stable groundwater levels over time, with fluctuations and in some cases possible slow trends that are small relative to the broad-scale differences in groundwater level across the domain.

Well 6628-2515 shows an increasing water level trend since approximately the year 2000, during which time it has risen from around 10 to 14 mAHd (average increase c. 0.17 m per year). Because no other wells show the same degree of increase, it is unclear whether these changes are very local to the well or whether they are representative of a wider area. The situation is complex because further investigation has showed that a nearby deeper well (6628-2616) that is reported to be screened in the Q3 aquifer shows a very similar trend – refer Figure A6. Both wells are within an area used for growing crops under cover and outdoors, so there is the potential for locally elevated groundwater levels due to either to leaking water pipes or excessive irrigation, as well as the potential for local vertical hydraulic connection between the different aquifer units.

LBWco recently inspected 6628-2515 and identified the well to be capped at ground level in a low-lying roadside area subject to inundation. The increasing water level trend may be influenced by local drainage of stormwater down this well, and other factors.

Figure A6. Hydrographs for adjacent wells 6628-2515 and 6628-2516

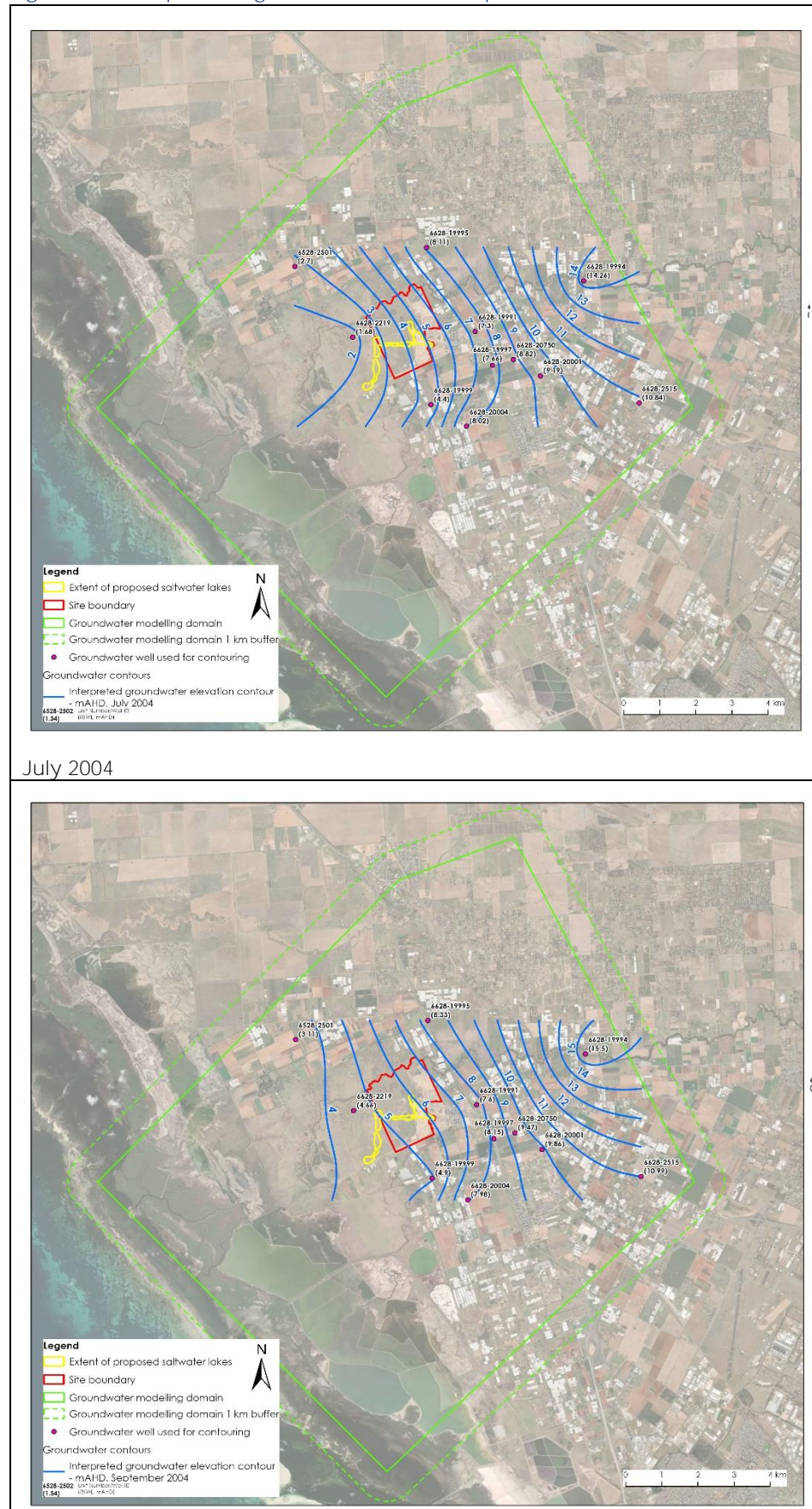


The groundwater level contours in HCL Figure 5 and in Figure A5 above are based on the most recent information for each well, so take account of the higher water level at 6628-2515.

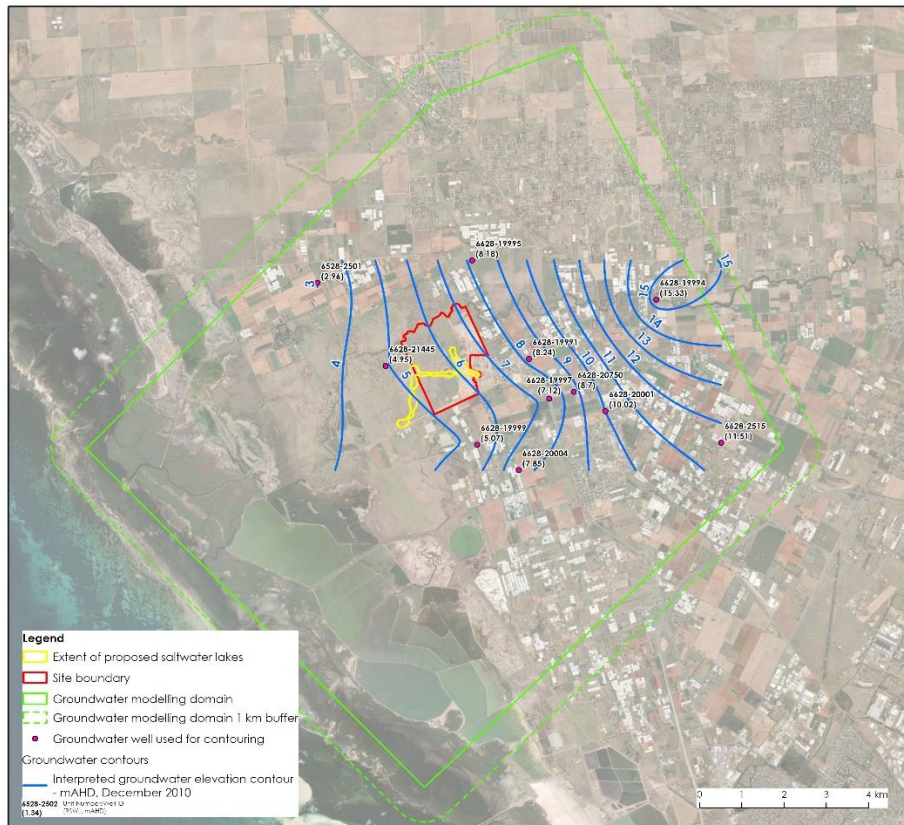
As noted above, there is no short period of time for which groundwater level information is available that has good lateral coverage across the full model domain. Figure A7 below provides interpolated groundwater level contours for the months for which the largest amounts of data are available. The best coverage is for December 2016 but none of the contour plots cover the full model domain. For that reason, taking into account the general stability of water levels over time, the decision was made to make best use of all the wells for which at least some data was available since the year 2000, by using the most recent water level information to construct the contours shown in Figure 5 of the HCL report and Figure A5 above. The interpolated contours for December 2016 show the same general picture as the contours in Figure A5. None of the contour plots include information near the northeast or southwest corners of the model domain.

REM (2008) reported that *"the steady state model was calibrated to a data set of 48 water level measurements from individual wells on and around the site. The data comprised a primary set of wells, including the new wells installed by REM and a selection of existing wells that were gauged on 7 February 2008, combined with a secondary set of wells that had been gauged in March 2007 to provide a broader coverage of data for interpretation"*. The approach adopted by REM was to prioritise spatial coverage of groundwater level data over short time-period data.

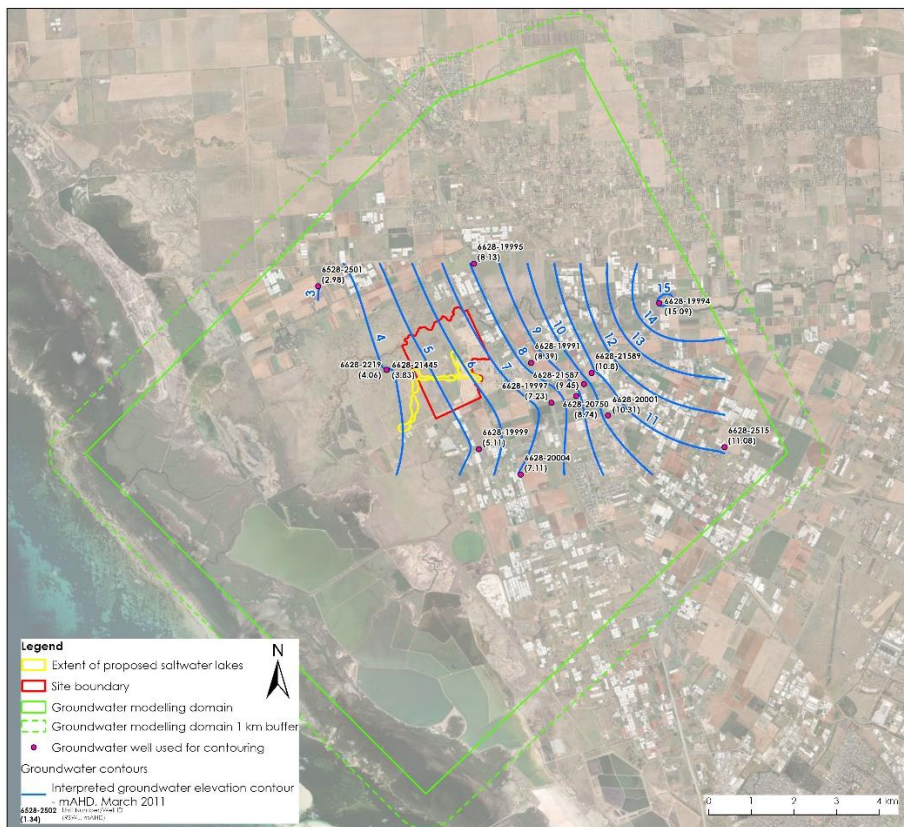
Figure A7. Interpolated groundwater level at specific times



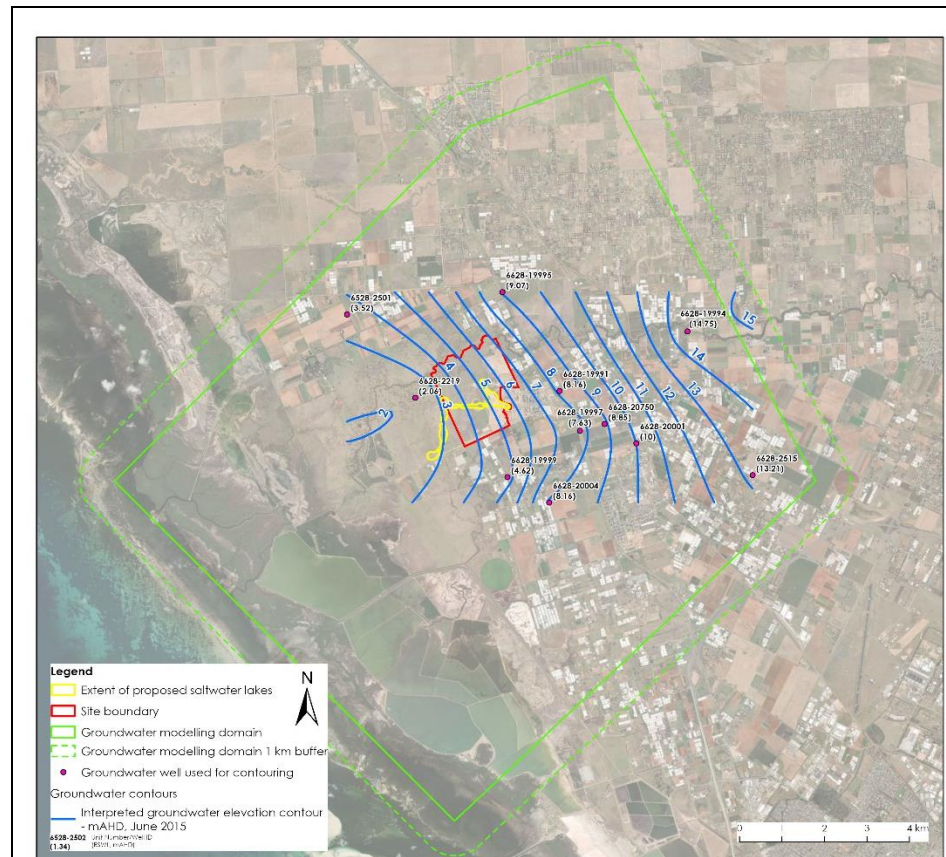
September 2004



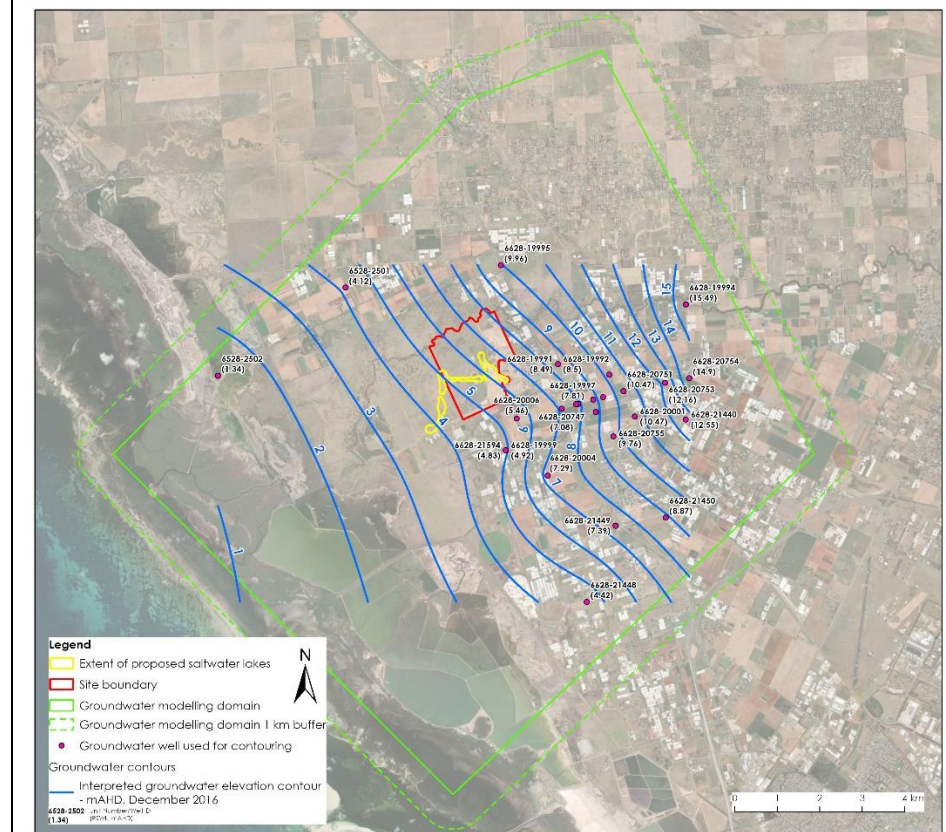
December 2010



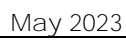
March 2011



June 2015



December 2016





When the model is updated, the baseline model can be calibrated against water level data for a short time period as DEW has requested. However, this will mean the model being calibrated against many fewer data points, and there will be data gaps across some large parts of the model domain. In those areas, a view on what groundwater levels are expected (and therefore on what boundary conditions are appropriate for the model) will need to be made based on the data that is available - i.e. the data for other periods of time. This is effectively what has been done in the modelling presented in the HCL report. HCL therefore expects the outcome of calibrating the model against a smaller dataset of water levels representing a short period of time would be similar to what has already been presented.

12. Figure 6: DEW are disappointed to see only 1 hydrograph that covers the period 1968 to 2000 and only 4 others since 2000. Furthermore, these hydrographs show quite significant increases since 2000, suggesting that the potentiometric surface in Figure 5 is unsupported.

LBW has undertaken additional collation of historic groundwater level data since the HCL report was prepared. Some additional hydrographs and sets of groundwater level contours have been developed as presented in Figures A1 and A7 above and discussed in the response to comment 11. The overall picture is similar to what was presented previously and indicates that the potentiometric surface in Figure 5 of the HCL report remains a reasonable approximation of the average groundwater level in the domain area.

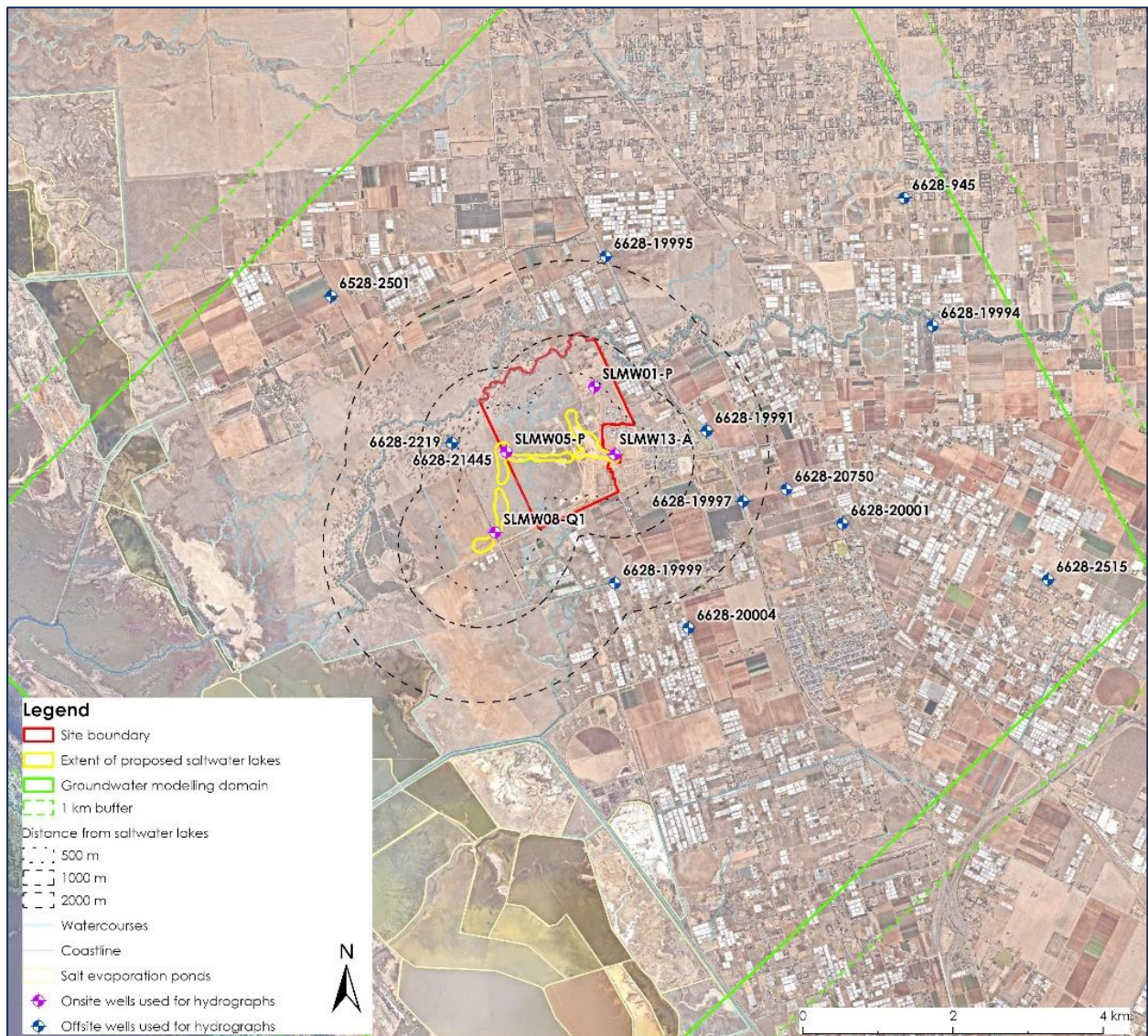
13. Figure 7: Please provide a caption. Do the green lines indicate the model boundaries? If so, bore 6628-2515 has risen 4.2m since 2000. This will affect whatever boundary condition is chosen for the model.

An updated version of Figure 7 is provided below as Figure A8.

As per previous responses, the HCL report was not intended to be read on a standalone basis and some of the requested information is in the LBW report to which it was appended.

As per response to comment 11, the model calibration and boundaries are based on the most recent data for the wells (including for 6628-2515). Any trends over time have been small in the context of the relatively short duration over which dewatering will be required.

Figure A8. Locations of wells used for hydrographs



14. Section 2.5: a stratigraphic cross-section is really needed to support this discussion. In addition, an investigation of water levels in deeper wells needs to be provided to support the statement: "deeper aquifers are assumed to be hydraulically separate from the shallow aquifer, and so are not relevant to this assessment". This is of major significance in light of the extraction rates that are considered later in the modelling.

The assumption that the Q1 aquifer is hydraulically separated from underlying aquifers is consistent with statements and assumptions made in previous modelling reports for the area (e.g. by REM and by AGT) and in published reports on the general hydrogeology of the area. See also the response to comment 8.

15. Section 2.5: please provide proof for these conjectures: "It is also influenced by discharge to low-lying creeks. Some of this discharge will be within creek bed gravels, some may emerge as surface water discharge, and some water will be lost by evaporation from low-lying ground and salt pans to the west and southwest, and by evapotranspiration from deep-rooted vegetation." This suggests that dewatering the site may influence GDEs. It also means that the aspect of groundwater-surface water interactions needs a far more significant analysis in the conceptual model development and in terms of model calibration.

Please see response to comment 2.

Inferred groundwater level contours lie further apart in the area west of the proposed SWL1 than in the upgradient area to the east. This means there must either be higher transmissivity in this area to allow water to move away downgradient, or there must be another means by which water discharges from this area (i.e. discharge associated with creeks, buried channels and/or evapotranspiration). A general higher transmissivity seems unlikely based on consideration of the depositional environment.

REM (2008) s5.2.4 – s5.2.6 reported the following:

“Baseflow of groundwater into the Gawler River, Thompson Creek and the various drainage channels on and around the site is likely to be an appreciable component of groundwater discharge from the site during times when the watertable is elevated above the bed elevations of these features. Field observations made by REM staff indicate that this condition occurs variably across the site and is most common in the low lying areas where groundwater is naturally very shallow.”

“The Gawler River is the main hydrological feature affecting groundwater conditions in the study area. The river is ephemeral and only flows following large sustained rainfall events through winter. During these times the river would act as a ‘losing stream’ meaning that water from the river would recharge into the shallow aquifers, the water levels of which are typically below the river bed. It is possible that there could be a period following sustained wet winter conditions that the river could become a ‘gaining stream’ for a short period as groundwater discharges from elevated levels in the shallow aquifer in the process of restoring the usual equilibrium.”

“Field observations also indicate that the Thompson Creek bed has been deepened and enlarged in places to act as more of a groundwater drain for the surrounding low lying land. This was observed on the south sector west and south sector of the site.”

When the HCL report is updated it could include additional discussion of this issue and could include an alternative model that assumes the creeks are hydraulically isolated from the groundwater. Review of results from both models could help assess the effect of this uncertainty on the modelled results.

16. Section 2.5: *“There will be variations in groundwater levels and flows over time, in response to seasonal fluctuations and variability in rates of precipitation, groundwater recharge and evapotranspiration. However, for the purposes of modelling the relatively short timescale required for construction dewatering, and as future climate events cannot be predicted, it is assumed that regional groundwater levels (away from the influence of dewatering) will be steady over time.”* Temporal variations can be ascertained from the hydrographs and need to be addressed in modelling. Future climate effects can also be ascertained through modelling. Assuming that regional groundwater levels will be steady over time is contradicted in the very few hydrographs that have been considered.

See response to comment 11.

The planned dewatering for SWL1 is for less than 6 months. The average water level rise during 6 months at the well with the clearest increasing trend (6628-2515) is approximately 0.09 m, which is smaller than the anticipated seasonal fluctuation. The model is not intended (and does not need) to simulate long-term water level changes due to climate effects, etc; it is intended only to assess the potential abstraction rates and drawdown influence caused by short-term pumping.

17. Section 3.1: *the discussion of model classification is interesting, but no longer used in most groundwater modelling projects in Australia. Further, it has no effect on DEW's review. Please ensure that modelling guidelines specific to the Australian context and regulatory requirements specific to relevant South Australian and Australian legislation are addressed both in model construction, and discussion of results.*

Section 3.1 was included specifically because DEW mentioned the 2000 and 2012 guidelines in the meeting on 9 September 2024 and requested that the modelling should follow those guidelines.

18. Section 3.2: *Again, somewhat interesting, but of little interest to DEW's review, which will be based on conceptual model development and application of the numerical model to the conceptual model. Please ensure that modelling guidelines specific to the Australian context and regulatory requirements*

specific to relevant South Australian and Australian legislation are addressed both in model construction, and discussion of results.

See response to comment 17.

19. Section 3.4: "This extent of domain was designed to be large enough that the effects of modelled dewatering for the saltwater lakes would not be significant at the model boundaries." This is what the model needs to assess. At present it does not achieve this.

On the contrary, the model results clearly indicate that the effects of dewatering do not reach the model boundaries. This is clear from the sensitivity testing results presented in Tables 8 and 10. In each row of these tables the simulated pumping from wells or wellpoints is matched by the simulated change in storage, with pumping having no effect on the simulated boundary flows or on flows associated with the creeks. The effects of pumping would take longer than 6 months to reach the creeks and a lot longer than 6 months to reach the domain boundaries.

Similarly, the simulated flows at the model boundaries and associated with the creeks for the full pumping scenario for SWL1 (6 bays) at the end of pumping (147 days) are the same as for Scenario C in Table 10.

20. Section 3.4: DEW assume the NE boundary condition of 16 mAHD fixed head is based on Figure 5, which is wrong. Figure 5 needs to be corrected, and a supportable boundary condition used. The no-flow conditions are probably supportable but would need to be reassessed once Figure 5 is corrected.

See responses to previous comments, particularly comments 11 and 15. Further assessment of observation well data indicates the NE boundary condition is reasonable, particularly towards its southern end. There is a gap in observation well data for the area near the northeast corner of the model domain.

This could be explored further when the model is updated, and the effects of the boundary condition on model results could be assessed in more detail. It is expected that because of the large distance of the NE boundary from SWL1 and the fact that dewatering will be conducted for a relatively short period, the precise manner in which the boundary is represented in the model will not have a material effect on the modelled influence of dewatering.

21. Section 3.4: the vertical structure of the model requires a graphical stratigraphic column.

Figure A9 provides a cross-section to illustrate the vertical layering that is incorporated in the groundwater model. The section line is shown on Figure A10.

Figure A9. Model cross-section

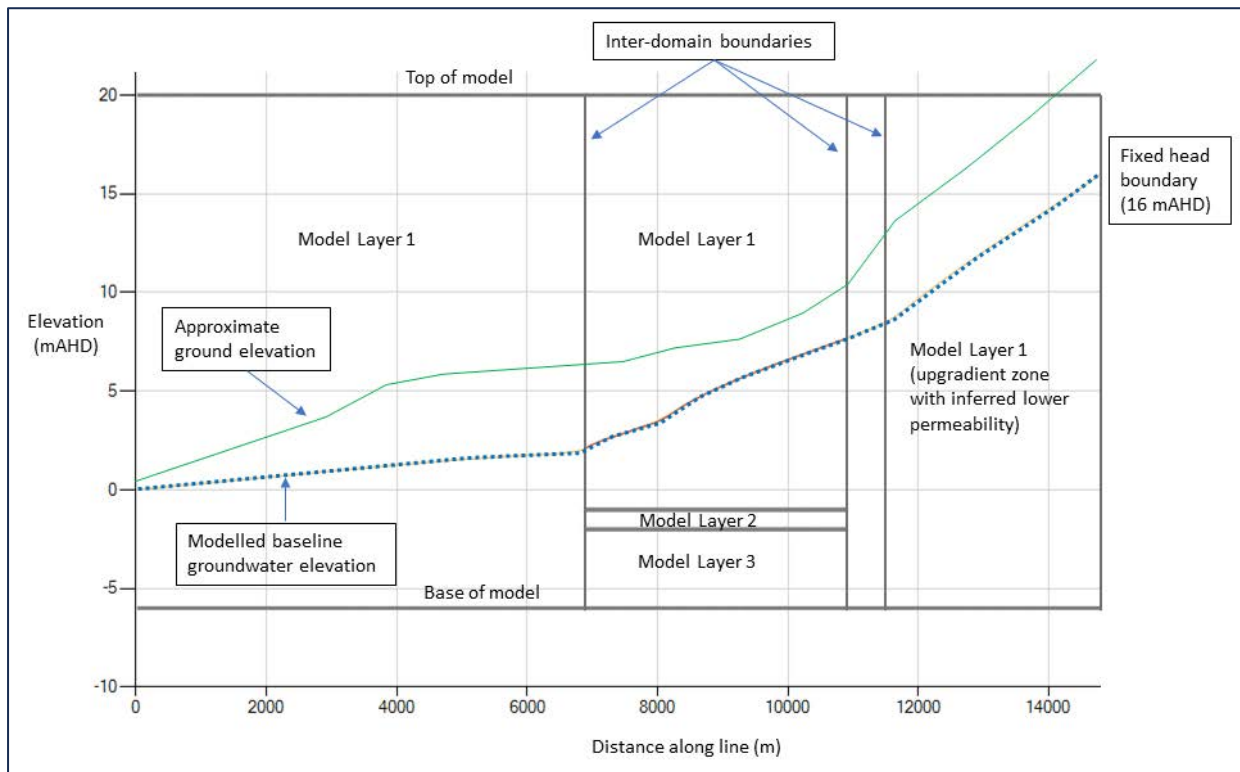
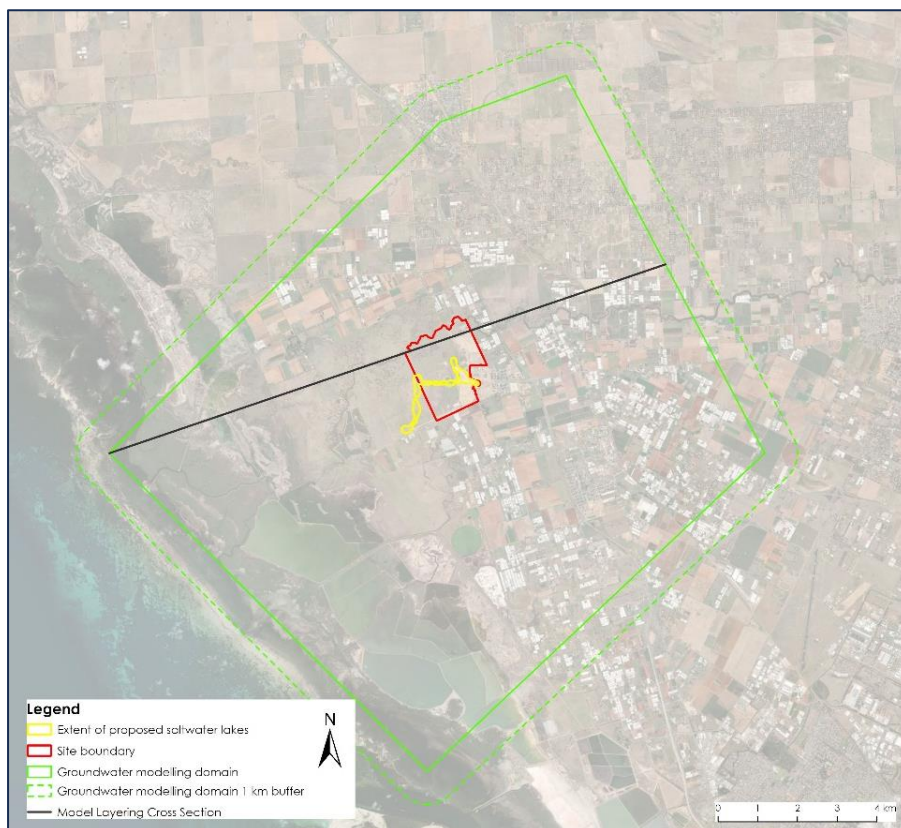


Figure A10. Location of model cross-section line



22. Section 3.4: "Across the more distant parts of the domain, away from the proposed lakes, the model was set up as a single layer." This assumption needs to be assessed once Figure 5 has been corrected by considering a specific time and specific contour plots for each of the vertical units.

See response to comments 11, 15, 20 and 21.

23. Figure 9: This figure very clearly identifies Gawler River and Thompson Creek as being within close proximity to the site. No mention of these very significant features has been discussed or incorporated into the conceptual model. DEW are very concerned about this lack of inclusion. Text later in the discussion suggests that the rivers have been included as a mechanism of removing 'unwanted' water with no data or physical basis for doing so. Furthermore, it appears that they are GDEs that need to be addressed formally.

On the contrary, in the context of a relatively low transmissivity setting with relatively low hydraulic gradients and the plan for relatively short duration pumping, the site is not in close proximity to the Gawler River or Thompson Creek. The shortest distance from SWL1 to the Gawler River is about 700 m, and the shortest distance to Thompson Creek is approximately 900 m.

The potential for groundwater discharge associated with the river and creeks is included in the conceptual model description in Section 2.5 of the HCL report.

DEW 2022, *Adelaide Plains Water Allocation Plan*, prescribes buffer distances around groundwater-dependent ecosystems. These buffer distances apply to wells and to open excavations such as dewatering pits and "are based on modelling and other numerical tools. These were used to test the drawdown of groundwater level associated with extraction from wells, resulting in the recommended buffer distances between pumping and groundwater-dependent ecosystems." The buffer distances specified for the unconfined Quaternary aquifer are 330 m for groundwater-dependent streams and 250 m for terrestrial vegetation. The WAP includes maps of streams and vegetation to be protected but the maps do not show any buffer zones around the Gawler River or Thompson Creek down gradient from Riverlea. In any case, the smallest distance between planned dewatering for SWL1 and the Gawler River is approximately 700 m and the distance to the Thompson Creek is even larger.

Also see response to comment 15.

24. Figure 9 and text: There really needs to be a stratigraphic diagram that show this 3-layered subset of the larger 1-layer model.

See response to comment 21

25. Section 3.4: "The resulting k estimates for the vertical intervals were then averaged between the four wells": arithmetic averaging is not an acceptable method within hydrogeologic spheres. What averaging was performed?

Section 3.4 describes how the decisions were made in relation to model layering. The averages in Table 3 are arithmetic averages used to compare how the hydraulic conductivity estimates from slug tests, vary vertically. From this it was concluded that the top part of the formation (above -1 mAHD) appears generally more permeable at SWL1 than the deeper part (from -1 to -6 mAHD). This is consistent with what can be seen on the borehole logs in Figure 3.

As indicated in Section 3.5 of the HCL report, the hydraulic conductivity values used in the model for the area around SWL1 are based on the geometric mean transmissivity obtained from the pumping tests.

26. Figure 11: This figure and the discussion surrounding it are out of place and require complete description of the calibration process and its results.

Figure 11 and the description in Section 3.5 present the parameters of the baseline model. The calibration process that resulted in the hydraulic conductivity distribution is described in Section 3.8.

27. Section 3.7: Justification is needed to support using zero values for recharge and evapotranspiration. In addition, an assessment needs to be performed and reported on as to whether there are any extraction wells within the model area.

The use of a zero value for areal recharge is conservative in that the model is more likely to overestimate (rather than underestimate) the simulated drawdown resulting from pumping. It also recognises the possibility that even though in reality there probably is a small rate of areal recharge, there could be zero recharge for the short time period during which dewatering takes place.

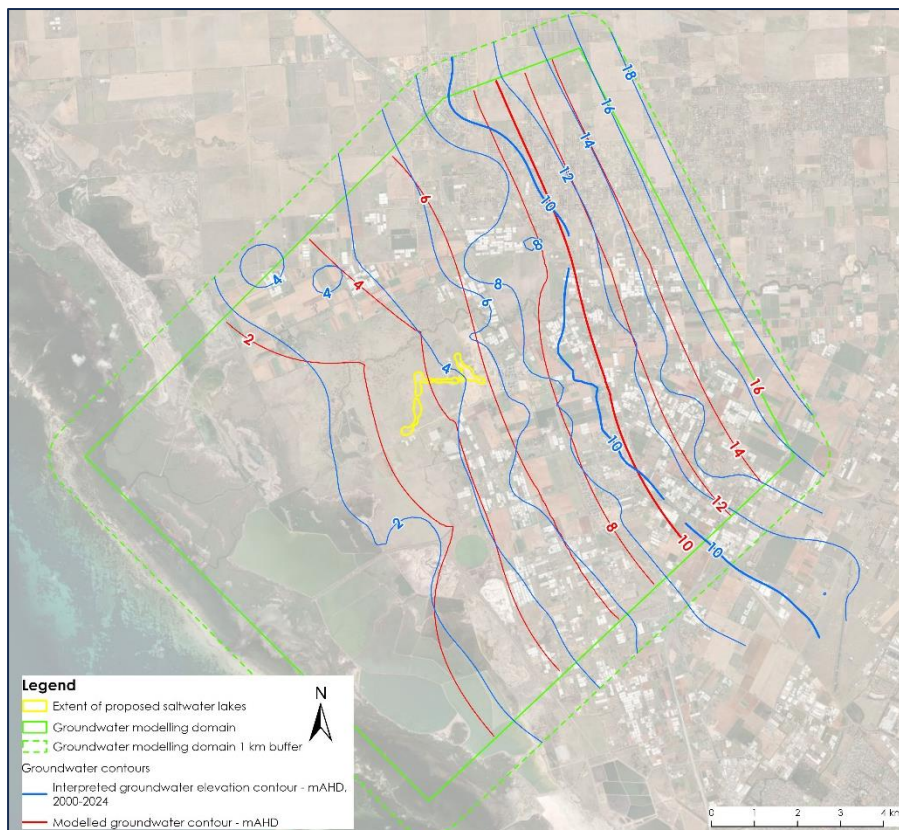
Evaporation from the groundwater table is unlikely to be significant unless the groundwater is relatively close to the ground surface (e.g. REM (2008) model used an evaporation extinction depth of 2.3 m. Evapotranspiration may occur locally but will depend on a range of factors including groundwater depth, vegetation type, presence/absence of perched groundwater. Over most of the model domain the depth to groundwater will be more than 2.3 m (see Figure A9), although some evapotranspiration from the water table may be occurring from low-lying land associated with the creeks and from low-lying land towards the coast.

The LBW report (to which the HCL report is appended) discusses the registered wells in the model domain area.

28. Figure 12: The figure is unacceptable: Please add a scale, North arrow, and labels to all contours. Despite the lack of these important details, the figure is far too busy to be comprehensible. Furthermore, Figure 5 needs to be corrected.

See earlier responses (especially 11) in relation to DEW comments on Figure 5. A clearer version of Figure 12 is provided in Figure A10 below.

Figure A11. Modelled and observed groundwater level contours (mAHD)



29. Section 3.8: 106 wells are available. That should be sufficient to develop potentiometric contours for a specific time for steady state model calibration. DEW requires this to be accomplished.

See response to comment 11. The calibration was based on information from all the wells, recognising that although the data was not all contemporaneous, it was based on the most recent information for each well and that any trends in groundwater level are relatively slow.

The graph of modelled vs observed groundwater levels (Figure 13 of the HCL report) is therefore based on data for all 106 wells, whereas any contour plot for a specific time period would be based on a much smaller number of wells because of the different timings of the various investigations and monitoring events from which the full dataset is comprised.

30. Figure 14: see comments on Figure 12. Without labels, these contours are meaningless.

An updated version of Figure 14 from the HCL report is provided as Figure A12 below. As noted in the HCL report, the average difference (across all 106 wells) between modelled and observed water levels is 0.013 m and the root mean square error (RMSE) is 0.998 m. This Figure (A12) shows the differences for a subset of wells, selected to provide geographic coverage across the model domain.

Figure A12. Differences between modelled and recorded groundwater levels



31. *Table 4: The flows to the rivers are very significant (compared with the coast) and need to be discussed and supported.*

See response to comment 15.

32. *Section 3.9, S1: This result is interesting: the aquifer is unconfined (based on "The top of the model was set at 20 mAHD, thus allowing the aquifer to be unconfined across the domain"), which means that groundwater flow is a (quadratic) function of saturated thickness. If the saturated thickness is almost doubled, DEW would expect that to have a significant effect on the groundwater level contours. This suggests errors in the numerical model. It may also be that the outflow to the rivers, which is suspect, may have an over-riding influence on these results.*

The groundwater level contours are controlled mainly by the fixed head boundaries at the northeast and southwest and by the fixed heads that are applied in the lower reaches of the Gawler River and Thompson Creek.

There are some differences in the simulated groundwater level contours between baseline and run S1, but the differences are relatively minor in the context of the overall model domain.

33. *Section 3.9, S2: See comment to S1.*

See response to comment 32.

34. *Section 3.9, S3: This indicates that the rivers have a very significant effect on water flow and balance within the groundwater system within the model area and in close proximity to the Lakes and require more investigation.*

See response to comment 15.

35. *Section 3.9, S5: The contours very clearly suggest a linear response for the groundwater system. It almost suggests that the model has been run under confined and not unconfined conditions?*

The model was run for unconfined conditions.

36. *Section 3.9, S6: non-zero recharge but zero ET is a questionable assumption that requires supportable justification. Please provide evidence for this assumption.*

Run S6 was a sensitivity test run, not an assumption. See also response to comment 27.

37. *Sections 3.8 and 3.9: Without a stratigraphic cross-section, it is difficult to assess whether any of these simulations cause groundwater levels to reach the land surface. Is this a possibility? If it is, then ET is no longer zero. Please provide a stratigraphic cross section that supports this conclusion.*

See Figure A9 and the response to comment 21. The only simulation from Sections 3.8 and 3.9 of the HCL report that results in some modelled groundwater levels about ground level is sensitivity run S6, which incorporates a uniform recharge rate of approximately 10 mm/year.

38. *Chapter 3: Overall, DEW believe the conceptual model is insufficient and acceptable calibration has not been achieved. In particular, the rivers need more investigation. Additionally, no attempt was made at transient calibration when at least some hydrographs are available (it is unclear how many).*

See responses to earlier comments, especially 11 and 15.

There would be little value in attempting transient calibration because there are so few wells with time-series data and there is no information on factors such as infiltration from irrigation or pumping from upgradient abstraction wells.

Note that the objective of the model is not to develop a tool for long-term water resources management of the area but to simulate potential pumping rates and drawdown from a limited duration of pumping (less than 6 months).

39. *Figure 17: This figure is indicative of results from a confined aquifer, not an unconfined aquifer. Additionally, DEW has previously requested that at least one figure is included out to the edges of the model area to demonstrate that the boundaries have no effect. Furthermore, please refer to the comments on all figures and fill in the gaps.*

The model was run for unconfined conditions. Figure 17 represents modelled groundwater level contours after 30 days of pumping for Bay 1 only.

Figure 31 of the HCL report provides modelled groundwater level contours for the entire model domain at the end of pumping for the full-scale dewatering scenario. The zoomed-in plots in Figure 32 show that the limited extent of area over which significant drawdown is simulated. For example, at the end of pumping (147 days) the maximum distance across the zone within which the drawdown is modelled to be at least 0.1 m is approximately 1,600 m. Approximately 950 m of this is the distance across SWL1 itself. The modelled radial distance from the edge of the excavation to the 0.1 m drawdown contour at the end of pumping is therefore approximately 350 m.

40. *Chapter 4: Combined rate of dewatering is 720 m³/d. Table 4 indicates that only 522.9 m³/d enters the model from the northeast boundary. DEW suggest that this level of dewatering at the site may influence the inflow across the boundary, and so puts into question the boundary condition and the model itself.*

The 720 m³/d is the simulated initial combined pumping rate for 9 wells. It is simulated to decrease to approximately 600 m³/d after 30 days. As indicated in Table 8 of the HCL report, Scenarios A, B and C do not change the simulated baseline inflows or outflows from the model. The simulated pumping from wells or wellpoints comes entirely out of storage.

It is agreed that if the pumping were to be long-term or permanent it would have an effect at the model boundaries. It does not do so because the boundaries are distant and the pumping is short term, such that the influence of pumping does not have time to reach the boundaries.

41. *Figure 19: these very clearly show a linear gradient, representative of a confined aquifer, not an unconfined aquifer.*

The top layer of the model is unconfined. The cross sections represent only a small part of the model domain, which extends 13,200 m from northeast to southwest and extends down to -6 mAHD.

42. *Figures 20 and 21: DEW does not believe that an extraction rate of 10,000 m³/d has so little effect on the groundwater contours. The modelling performed for this analysis is highly questionable. Please update the figure as necessary once related comments above are adequately addressed.*

The extraction rate in this simulation is 10,000 m³/d only in the first day. As stated in the text, the modelled extraction rate is 3,000 m³/d after 7 days and reduces to 1,400 m³/d by 30 days.

Please also note the scales involved. Bay 1 is about 270 m long and over 90 m wide; the groundwater level within this area needs to be drawn down by over 4 m. For a porosity of 30%, the water volume to be removed from this soil within the footprint of Bay 1 is close to 30,000 m³.

43. *Section 4.7, T1: "As in Scenario C, the pumped water is drawn entirely from storage (not from the model boundaries)." This statement is contradicted in Table 10. Please correct the contradiction.*

The statement is correct and is not contradicted. In each row of Table 10 the outflow rate from the wellpoints equals the rate of change in storage. And for each row the modelled inflow is balanced by the total of the outflows associated with the river and creek and the outflow at the coast.

44. Section 5.2: DEW expect that an initial pumping rate of 17,000 m³/d will have significant effects on many aspects of the conceptual and numerical models, just based on a simple mass balance within the model area. DEW believe the current analyses do not represent these aspects correctly and improved and corrected modelling needs to be performed.

This is similar to comment 42. The rate of 17,000 m³/d is simulated only in the first day of pumping, The modelled total volume pumped over the 147 days of dewatering is 436,000 m³, which gives an average rate of approximately 3,000 m³/d.

45. Section 6: DEW question whether these conclusions can be supported based on the modelling undertaken and the analyses performed. Please review the conclusions and edit accordingly once issues with modelling discussed above are addressed.

The conclusions are supported by the modelling results (see responses to previous comments). When the model is updated it would be possible to present the results of additional simulations to explore and demonstrate the effects of different boundary conditions, and if needed an alternate conceptualisation relating to the creeks. However, given the large extent of the model domain, the relatively low aquifer transmissivity and the limited duration of dewatering, it is unlikely that the results of such additional simulations would materially change the main conclusions. Note that the model is already conservative in a number of respects, in particular in having isotropic hydraulic conductivity (rather than lower in the vertical direction).

3 Moving Forward

LBWco and HCL acknowledge and welcome the comments provided by DEW to Walker via email (K Pryde – B Colmer) on 10 December 2024. We consider that a reserved matter or a condition that requires the Riverlea project to develop a surface and groundwater monitoring plan for implementation during dewatering of SWL1, is an appropriate pathway forward from here.

LBWco notes that the preparation and implementation of a comprehensive Dewatering Management Plan (DMP), including appropriate monitoring and response actions, has been the intention of LBWco and Walker since the commencement of the dewatering investigations. This intent was communicated to DEW and EPA in our early meetings.

The intent of the Riverlea project team to apply the learnings of the SWL1 modelling, approvals, dewatering and construction processes to the future development of SWL2 and SWL3 has also been communicated to DEW and EPA. The projected 5 year intervals between construction of each lake, will provide ample opportunity to undertake the necessary modelling and management planning updates based on the lived experience of SWL1.

It is recommended that Walker engage with PLUS and DEW on the wording of a reserved matter or condition, and understand how it relates to the next step of the approvals process and the likely timing for delivery of a DMP.

Please contact Jarrod Bishop for any questions on the matters addressed above.

Yours sincerely
For LBW co Pty Ltd



Jarrod Bishop
Director | Senior Principal



pp
Jonathan Larkin
Principal Hydrogeologist