

**PROPOSED REZONING FOR
RESIDENTIAL SUBDIVISION
RALSTON AVENUE, BELROSE**

***Assessment of Traffic
Implications***

December 2012

Reference 12085

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1. INTRODUCTION

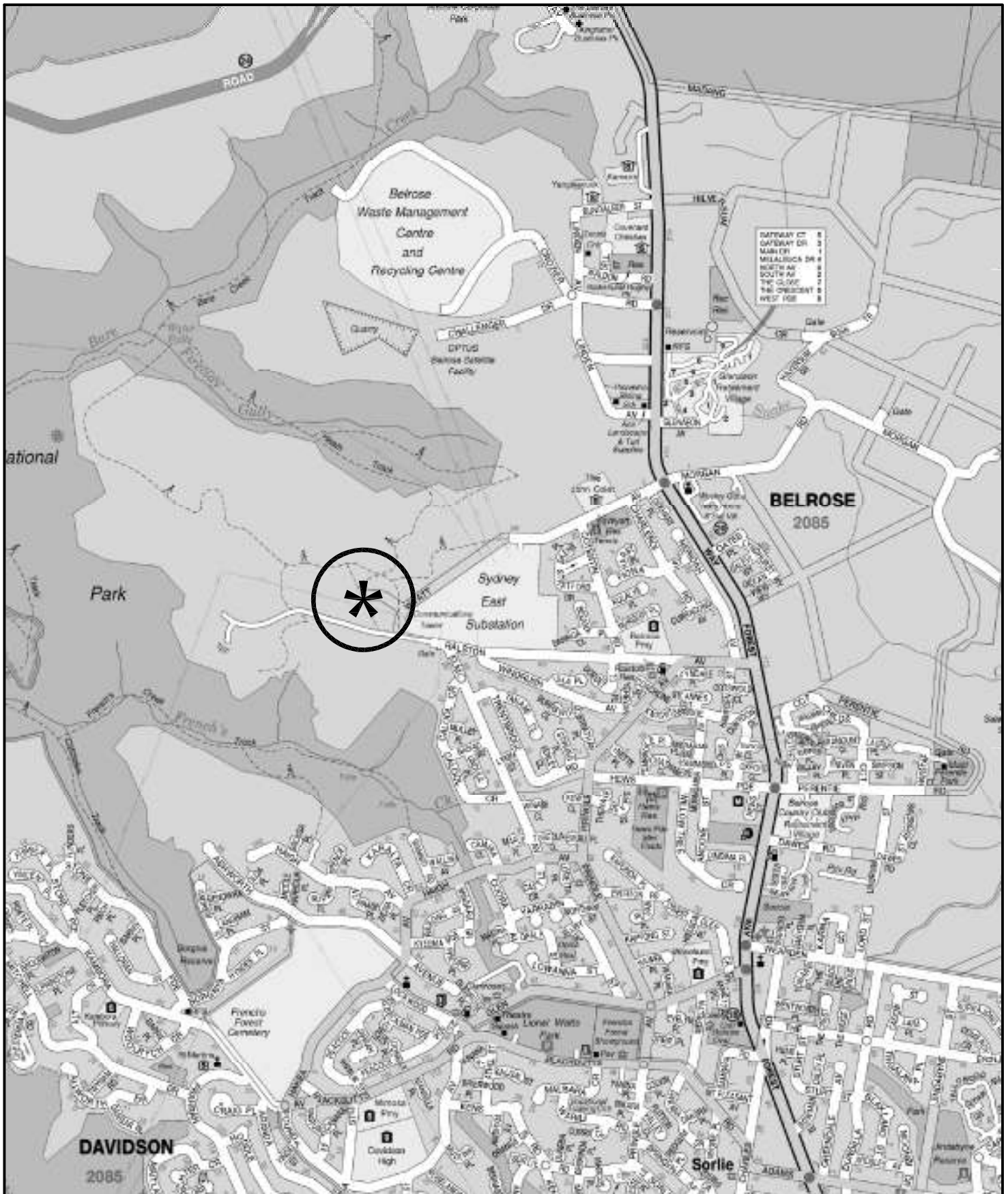
This report has been prepared to accompany a Draft Planning Proposal to Warringah Council for a proposed rezoning to permit a residential development on a site within the Metropolitan Local Aboriginal Land Council (MLALC) landholding located to the west of Forest Way at Belrose (Figure 1).

The Belrose area represents a highly desirable locality for residential development due to the convenient proximity to shopping facilities, public transport services and schools as well as sporting facilities, open space/bushland areas and the northern peninsula beaches. Subdivisions have been occurring in the area for the past 40 years and whilst this has slowed in the past decade or so there have been some developments along the eastern side of Forest Way in that time.

Virtually all available land zoned for residential development in the area has been exhausted while there are other areas which present logical and easy potential extensions to the existing urban development without adverse environmental implications. A section of the large MLALC landholding presents such an opportunity subject to rezoning.

The envisaged development which is the subject of the application represents a further small extension immediately to the west of the earlier subdivisions. The proposal will potentially provide approximately 169 low density residential lots with new roads, involving an extension of existing collector roads which link to the 'higher order' roads of Forest Way, Warringah Road and Mona Vale Road.

The purpose of this report is to provide an assessment of potential road and traffic related implications of the envisaged development.



LEGEND



LOCATION

FIG 1

2. ENVISAGED DEVELOPMENT

2.1 SITES AND CONTEXT

The development site (Figure 2) is part of Lot 1 DP602729 which occupies a large irregular shaped total landholding of 135.3 ha located to the west of Forest Way (see Deposited Plan reproduced overleaf). The undulating site is largely Hawkesbury sandstone shrub and bushland apart from some cleared areas and tracks. The landholding is bounded to the west by the large Garigal National Park which spans the upper reaches of Middle Harbour Creek and its off shoots Bare Creek, Frenchs Creek and Fireclay Gully.

The site is adjoined by the Sydney East Substation

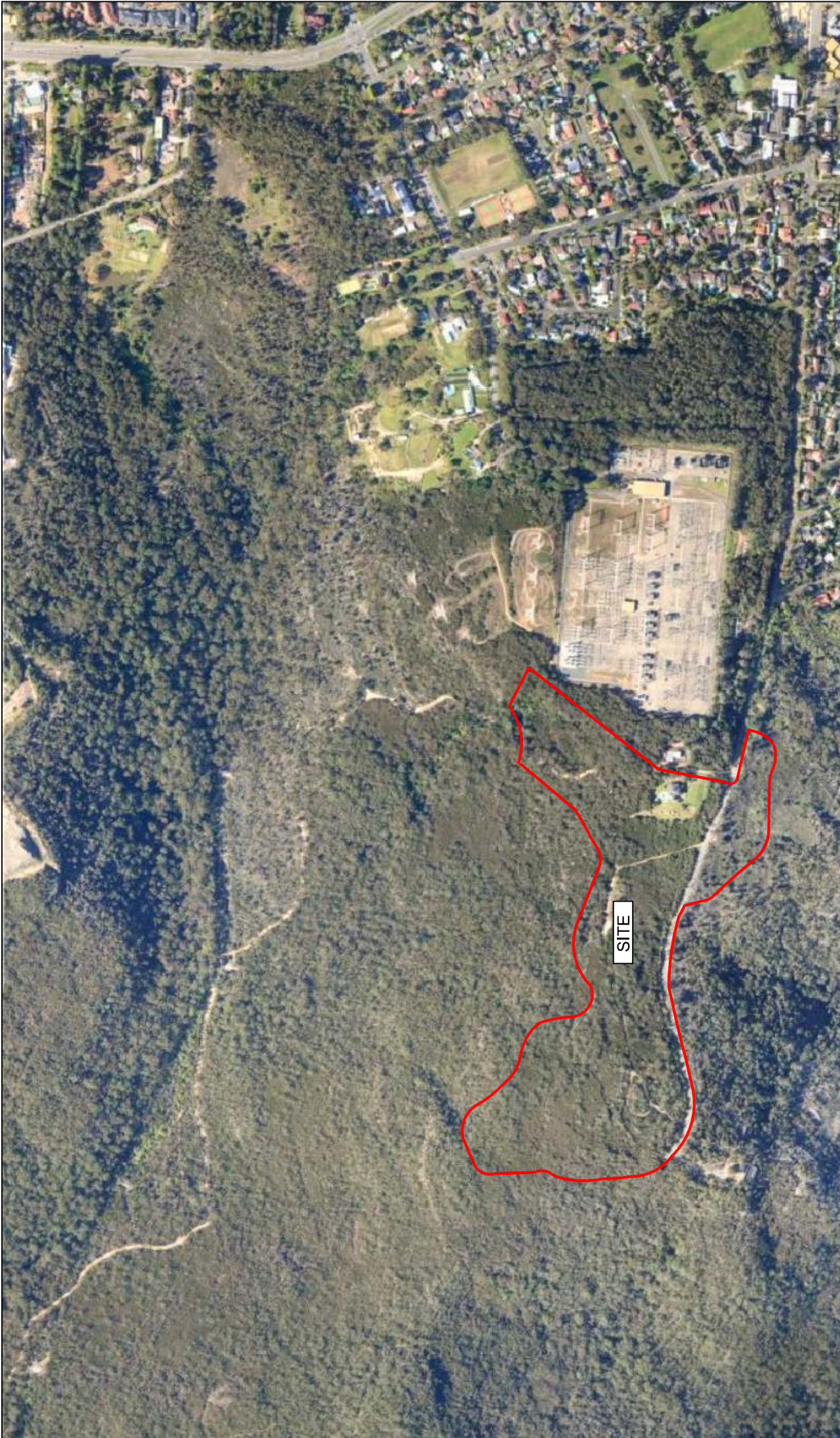
Also located in the vicinity are:

- The John Colet School
- The Belrose Satellite Facility
- Belrose Waste Management Centre

The existing urban development extending each side of Forest Way generally contain residential and rural residential properties together with aged persons accommodation and schools.

2.2 ENVISAGED SUBDIVISION

The envisaged development (subject to rezoning approval) would largely reflect the nature of the existing adjoining residential lands to the east with a road system including the construction of the existing unmade sections of Ralston Avenue and Wyatt Avenue.



LEGEND

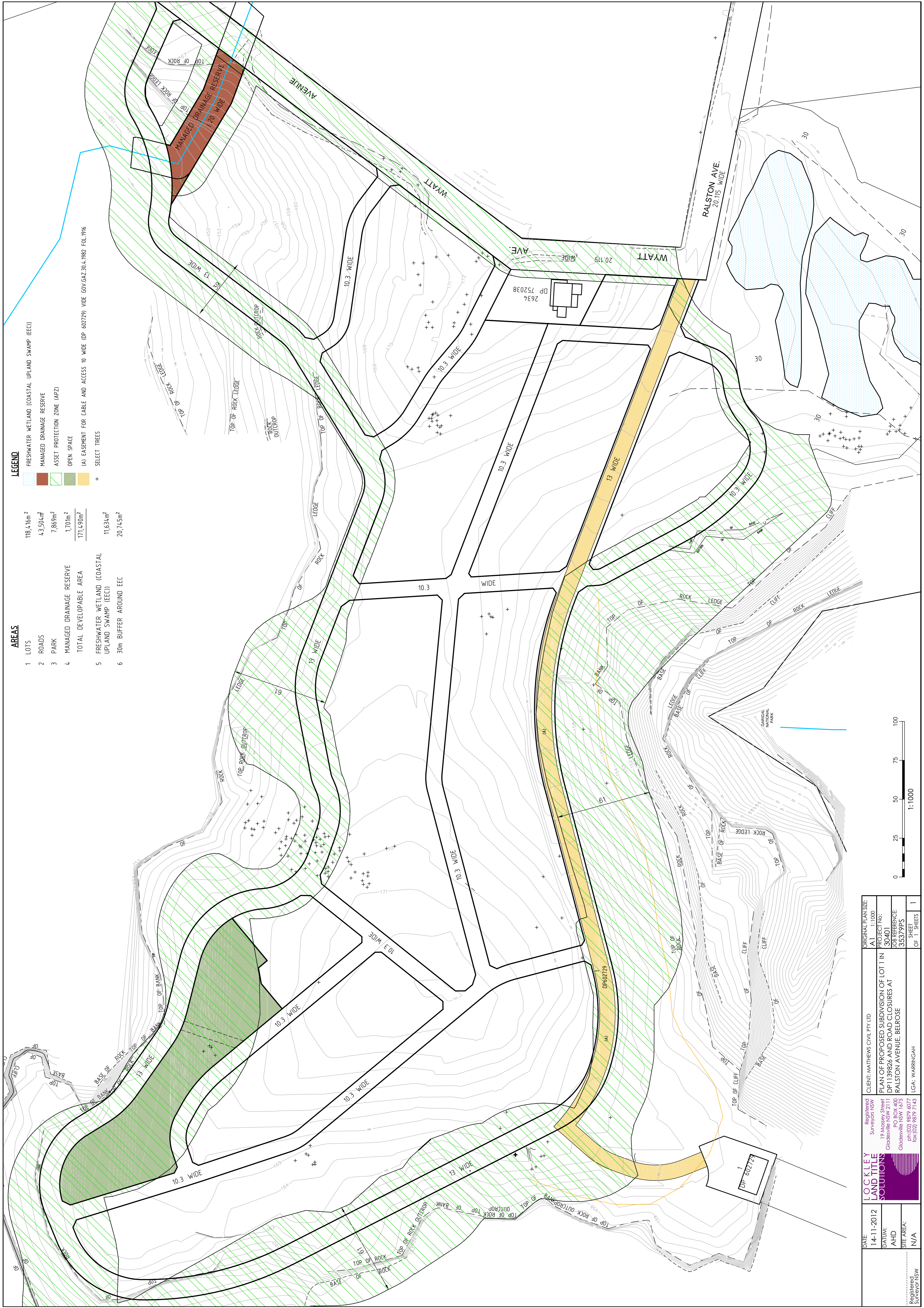


SITE

FIG 2

The proposed development will provide the potential for residential lots with normal frontage set back to the new road system. The site will retain significant open space areas in various forms along roads which will have a somewhat curvilinear alignment.

Details of the envisaged outcome are provided on the plan prepared by Lockley Land Title Solutions which accompany the Rezoning Application and are reproduced in part overleaf.



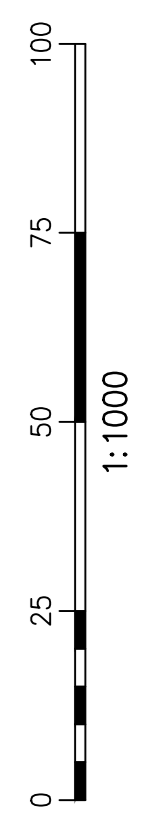
AREAS

1	LOTS	118,416m ²
2	ROADS	43,504m ²
3	PARK	7,869m ²
4	MANAGED DRAINAGE RESERVE	1,701m ²
	TOTAL DEVELOPABLE AREA	171,490m ²
5	FRESHWATER WETLAND (COASTAL UPLAND SWAMP) (ECC)	11,634m ²
6	30m BUFFER AROUND ECC	20,745m ²

LEGEND

	FRESHWATER WETLAND (COASTAL UPLAND SWAMP) (ECC)
	MANAGED DRAINAGE RESERVE
	ASSET PROTECTION ZONE (APZ)
	OPEN SPACE
	(A) EASEMENT FOR CABLE AND ACCESS 10 WIDE (DP 602729) VIDE GOV.GAZ.30.4.1982 FOL.1916
	SELECT TREES

DATE:	14-11-2012	Registered Surveyors NSW	LOCK KLEY LAND TITLE SOLUTIONS	ORIGINAL PLAN SIZE:	A1 1:1000
DATUM:	AHD	19 Messers Street Gladesville NSW 2111		PROJECT NO.:	30401
SITE AREA:	N/A	PO BOX 400 Gladesville NSW 1675		JOB REFERENCE:	35379PS
		ph:(02) 9879 6777		SHEET	1
		fax:(02) 9879 7143		OF 3 SHEETS	1
				LGA:	WARRINGAH
				CLIENT:	MATHEWS CIVIL PTY LTD
				PLAN OF PROPOSED SUBDIVISION OF LOT 1 IN	
				DP1198226 AND ROAD CLOSURES AT	
				RALSTON AVENUE, BELROSE	



3. ROAD NETWORK AND TRAFFIC CONDITIONS

3.1 ROAD NETWORK

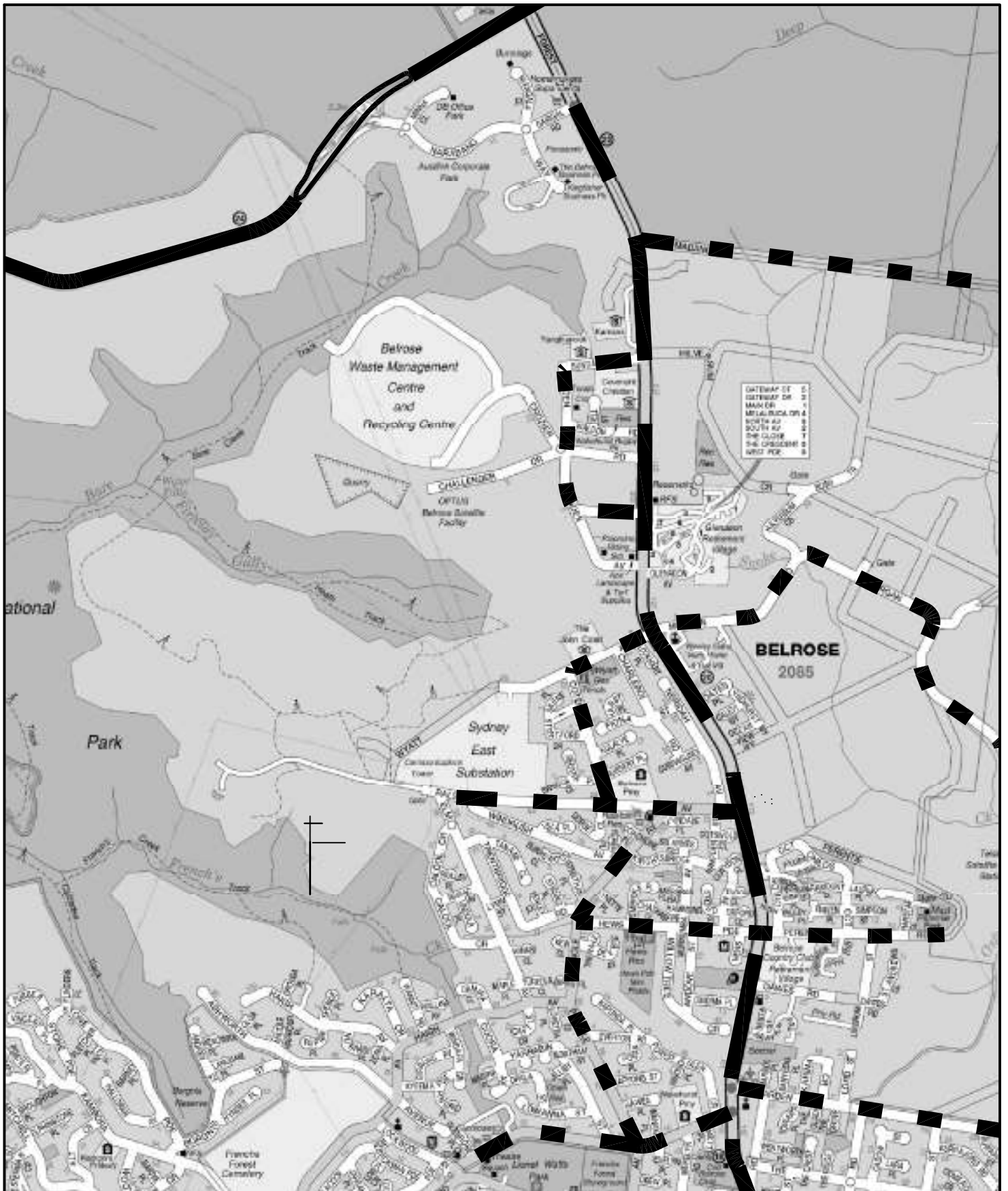
The road network serving the site (Figure 3) comprises:

- * *Warringah Road* – a State Road and arterial route connecting between Pittwater Road at Brookvale across Roseville Bridge to Pacific Highway at Chatswood
- * *Forest Way* – a State Road and sub-arterial route connecting between Warringah Road and Mona Vale Road
- * *Glen Street, Weardon Road, Hew Parade and Perentie Road* – collector road connecting off Forest Way to the east and west
- * *Ralston Road, Cotentin Road and Wyatt Avenue* – a collector road route connecting between Forest Way
- * *Crozier Road, Linden Avenue* – a minor collector road route connecting to Forest Way




3.2 ROAD GEOMETRY

The roadways in the vicinity of the sites have normal 20m wide road reservations however the form of the road carriageways varies as follows:

- Ralston Avenue – 12.8m wide roadway with kerb and gutter both sides except for the western end. The roadway is generally straight and level with a slight downgrade generally from west to east.



LEGEND

-  ARTERIAL
-  SUB-ARTERIAL
-  COLLECTOR



ROAD NETWORK

FIG 3

- Wyatt Avenue – 12.8m wide roadway with kerb and gutter both sides except for the section west of Cotentin Road where there is no northern kerb and the pavement reduces to 8.5m. The roadway is generally straight and level except for the western part which has a slight downgrade to the west

3.3 TRAFFIC CONTROLS

The traffic controls, which have been applied to the road system serving the site, (Figure 4) comprise:

- * the roundabout at the intersection of Ralston Avenue and Pringle Avenue
- * the traffic signal control at the of Forest Way/Wyatt Avenue and Morgan Road intersection including right arrow phasing (See Appendix A for details)
- * the traffic signals at the Forest Way/Crozier Road intersection including right turn arrow phasing (See Appendix A for details)
- * the traffic signals at the Forest Way/Hews Parade/Perentie Road intersection
- * the marked footcrossings on Ralston Road (wombat) and on Cotentin Road adjacent to the primary school
- * the traffic calming measures on Elm Avenue including roundabout and raised platforms controls
- * the roundabout at the Crozier Road/Linden Avenue intersection
- * the central median island along Forest Way restricting access movements at Linden Avenue to left turn IN/OUT (See Appendix A for details)
- * The GIVE WAY control on Ralston Avenue at Forest Way (See Appendix A for details) with partial 'seagull' treatment (ie centre storage for cars turning right out of Ralston Avenue)

- * the 50 kmph School Zone speed limit on the local and collector roads with 40 kmph limits in the vicinity of schools
- * the marked footcrossing on Wyatt Avenue at the John Colet School

3.4 TRAFFIC CONDITIONS

An indication of traffic conditions on the road system serving the area is provided by data¹ published by RMS and the results of surveys undertaken as part of this study. The data published by RMS is expressed in terms of Annual Average Daily Traffic (AADT) and the latest data is provided in the following:

	AADT
Forest Way north of Frenchs Forest Road	75,379
Warringah Road west of Hilmer Street	78,279
Wakehurst Parkway south of Frenchs Forest Road	19,798

Surveys have been undertaken at the principal access intersections along Forest Way relative to the sites during the morning and afternoon peak traffic periods in early August 2012. The results of those surveys are provided in the following and summarised in Figure 5.

		AM	PM
Forest Way	Northbound	1316	1248
	Left Turn	92	84
	Southbound	1284	1259
	Right Turn	120	204
Ralston Avenue	Right Turn	24	31
	Left Turn	252	136
<hr/>			
Forest Way	Northbound	1459	1352
	Right Turn	62	20
	Left Turn	47	12
	Southbound	1369	1439
	Right Turn	97	41
	Left Turn	124	44

¹ *Traffic Volume Data for Sydney Region
Roads and Traffic Authority of NSW*

Wyatt Avenue	Eastbound	25	8
	Right Turn	53	27
	Left Turn	68	36
Morgan Road	Westbound	35	11
	Right Turn	136	72
	Left Turn	43	57
Forest Way	Northbound	1735	1492
	Left Turn	28	32
	Southbound	1444	1524
	Right Turn	252	33
Crozier Road	Right Turn	145	108
	Left Turn	20	21

The operational performance of the intersections on Forest Way with the existing morning and afternoon peak volumes has been assessed using the SIDRA program. The results of that assessment are provided in Appendix B and summarised in the following while the criteria for interpreting the SIDRA results are provided overleaf.

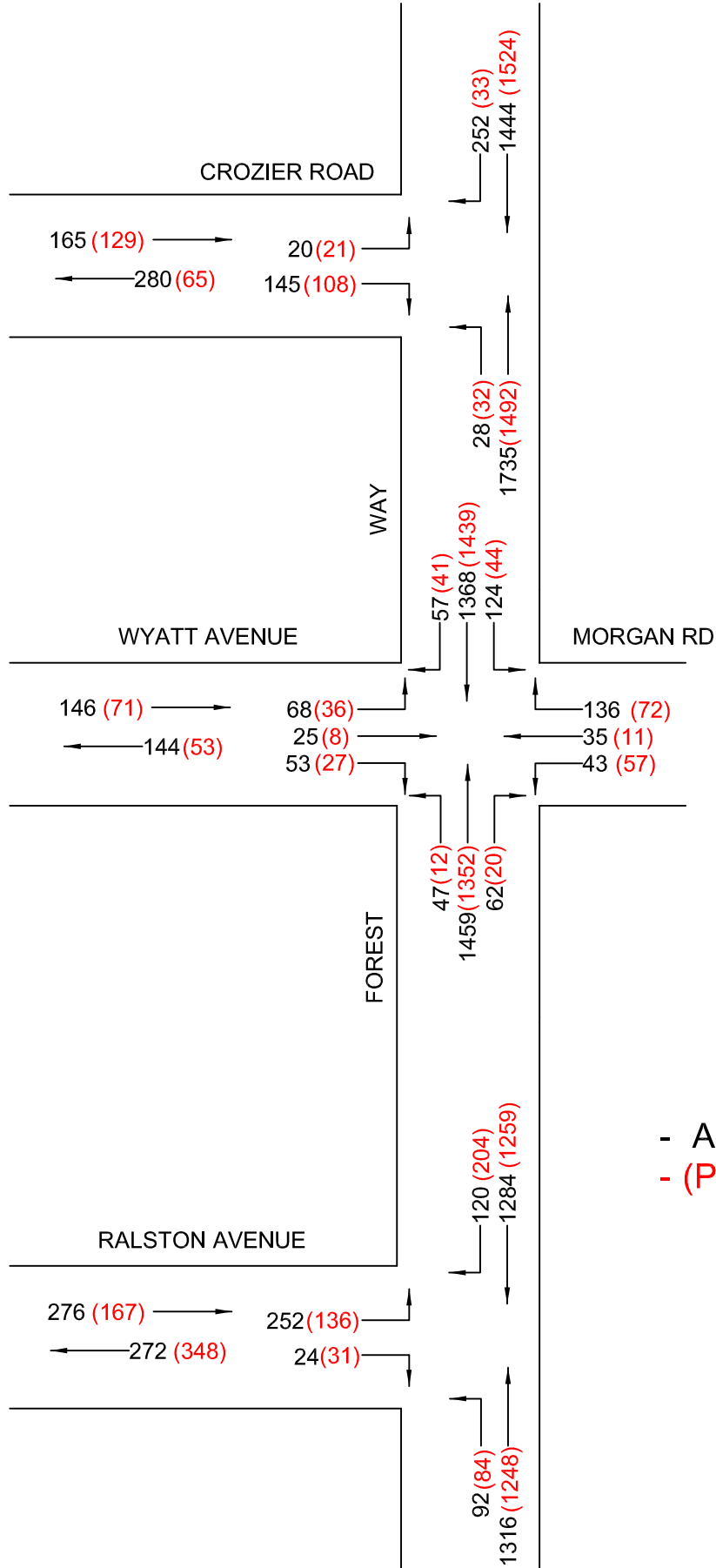
	AM		PM	
	LOS	AVD	LOS	AVD
Wyatt Avenue	A	12.5	A	11.3
Ralston Avenue	A-F	16.0	A-F	20.8

The results indicate that the Wyatt Avenue intersection operates satisfactorily but the Ralston Avenue intersection does not however the later results simply reflects the way that SIDRA models the delay for the right turn movement out of Ralston Avenue (which does not have full regard for the gaps provided by the adjacent traffic signals) and does not take account of the 'partial seagull' arrangement.

3.5 TRANSPORT SERVICES

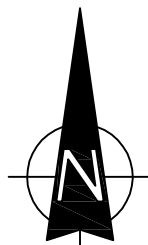
Public transport services in the vicinity of the site are provided by the bus routes operated by Forest Coach Lines, including:

- * Routes 270, L70 and 284 which run along Forest Way



- AM
- (PM)

LEGEND



EXISTING PEAK TRAFFIC VOLUMES

FIG 5

- * Routes 270, 283 and 282 which run along the Wyatt Avenue, Cotentin Road, Ralston Avenue and Pringle Avenue route

Criteria for Interpreting Results of SIDRA Analysis

1. Level of Service (LOS)

LOS	Traffic Signals and Roundabouts	Give Way and Stop Signs
'A'	Good	Good
'B'	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
'C'	Satisfactory	Satisfactory but accident study required
'D'	Operating near capacity	Near capacity and Accident Study required
'E'	At capacity; at signals incidents will cause excessive delays. Roundabouts require other control mode	At capacity and requires other control mode
'F'	Unsatisfactory and requires additional capacity	Unsatisfactory and requires other control mode

2. Average Vehicle Delay (AVD)

The AVD provides a measure of the operational performance of an intersection as indicated on the table below which relates AVD to LOS. The AVD's listed in the table should be taken as a guide only as longer delays could be tolerated in some locations (ie inner city conditions) and on some roads (ie minor side street intersecting with a major arterial route).

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabouts	Give Way and Stop Signs
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause excessive delays. Roundabouts require other control mode	At capacity and requires other control mode

3. Degree of Saturation (DS)

The DS is another measure of the operational performance of individual intersections.

For intersections controlled by **traffic signals**² both queue length and delay increase rapidly as DS approaches 1, and it is usual to attempt to keep DS to less than 0.9. Values of DS in the order of 0.7 generally represent satisfactory intersection operation. When DS exceeds 0.9 queues can be anticipated.

For intersections controlled by a **roundabout or GIVE WAY or STOP signs**, satisfactory intersection operation is indicated by a DS of 0.8 or less.

¹ the values of DS for intersections under traffic signal control are only valid for cycle length of 120 secs

4. ENVISAGED DEVELOPMENT ROAD SYSTEM

4.1 ROAD SYSTEM

The envisaged development road system reflects the objectives of permeability and ESD housing outcomes avoiding the characteristics of a standard 'grid' pattern. The proposed roadways will have a slightly curvilinear alignment reflecting the undulating terrain.

The envisaged road configurations will reflect the Auspec criteria as specified in Council's LEP.

- * Distributor/Collector Function – 20 metre wide reserve, 13 metre wide roadway with footway and verges
- * Perimeter Road Function – 13 metre wide reserve, 7 metre wide roadway with footway, verge and swale
- * Local Street/Access Function - 10.5 metre wide reserve, 6 metre wide roadway and verges

4.2 ACCESS CONNECTIONS

The access connections to the existing road system will comprise:

- * construction of Ralston Avenue from the existing termination to Wyatt Avenue
- * construction of Wyatt Avenue from the existing termination to Ralston Avenue

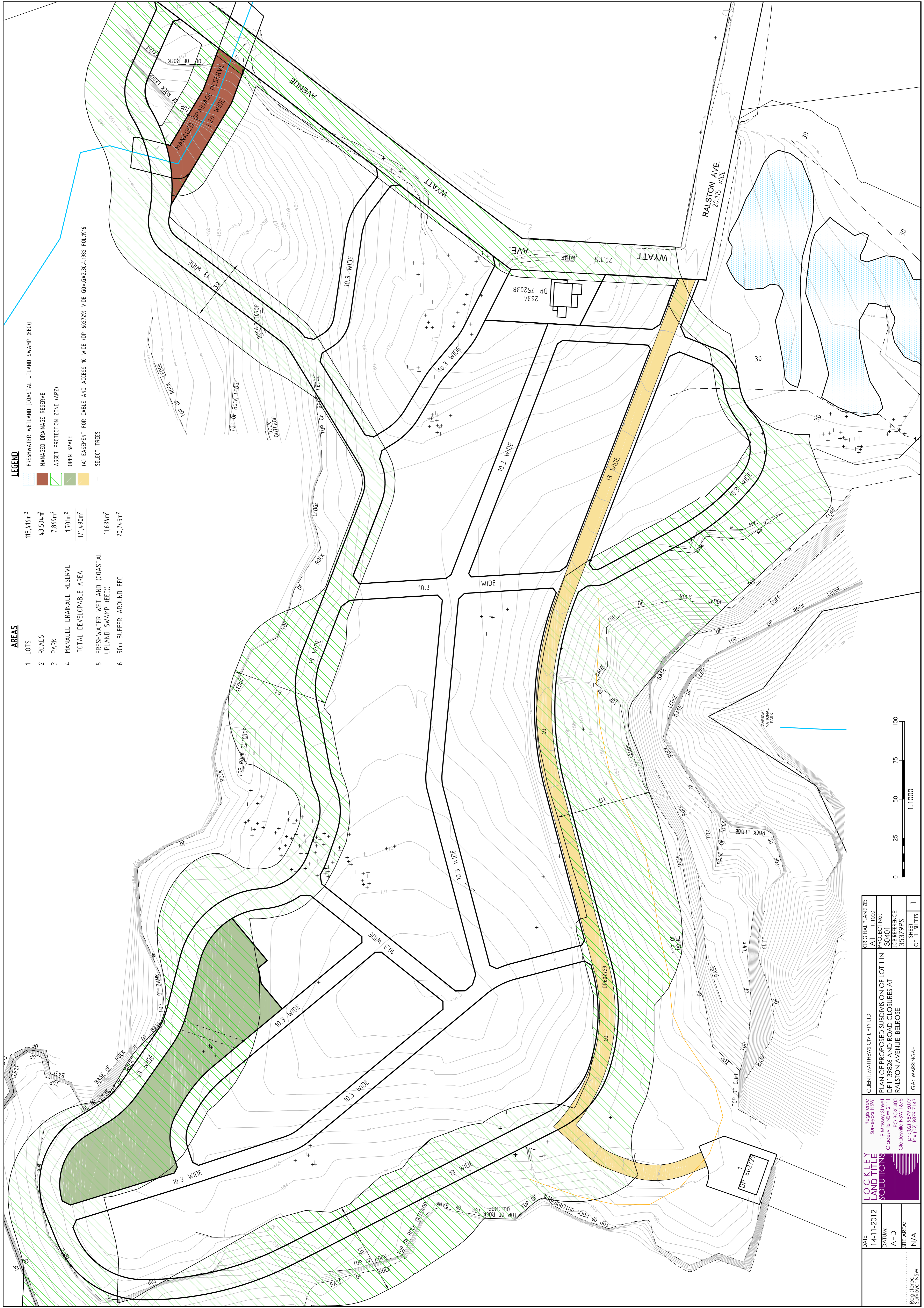
These access connections represents suitable, appropriate and easily understood road arrangements.

AREAS

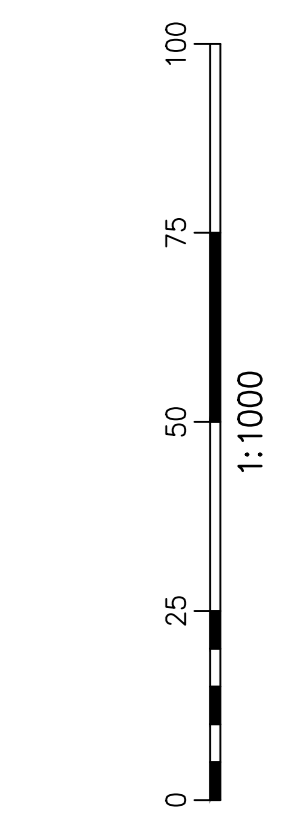
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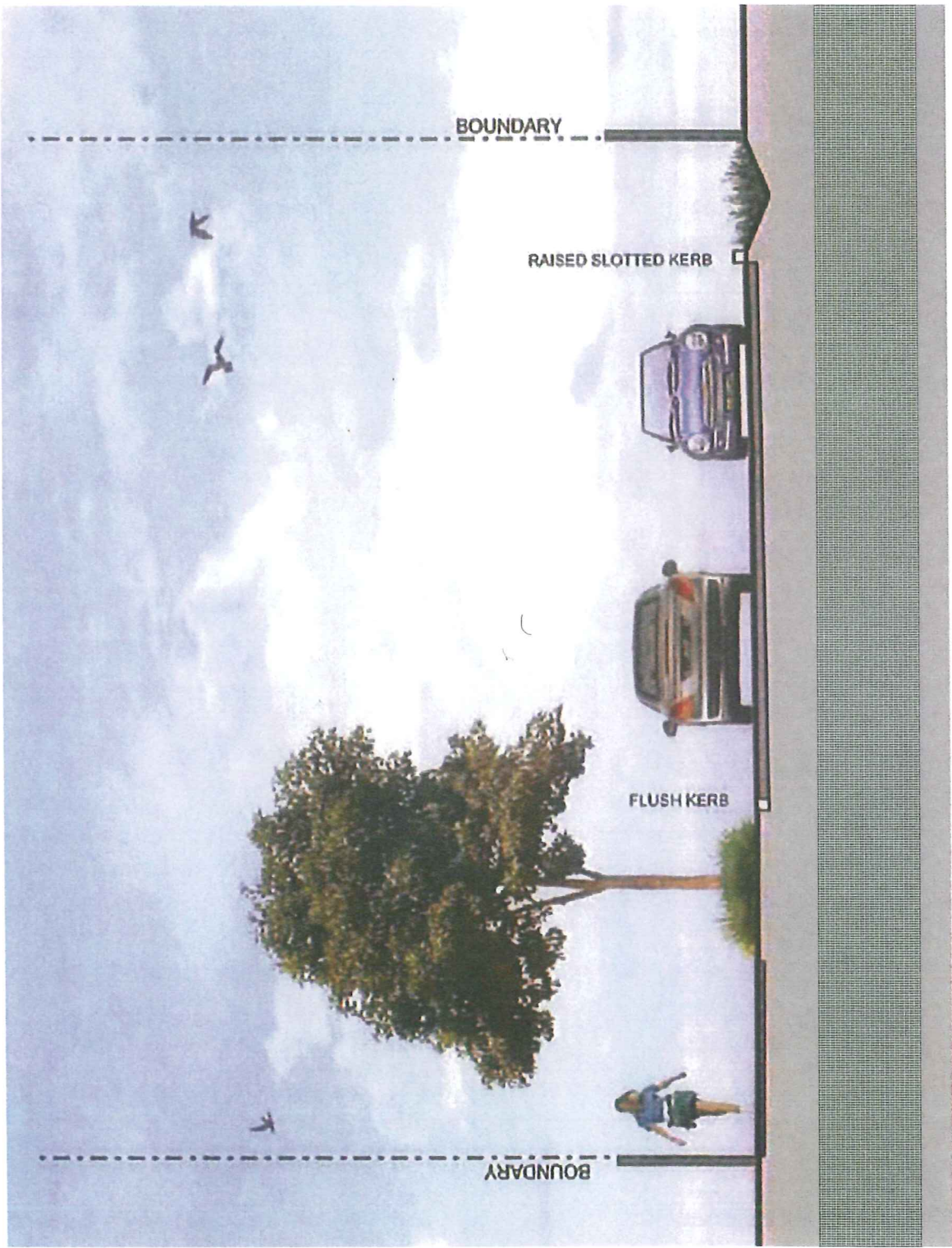
LEGEND

	FRESHWATER WETLAND (COASTAL UPLAND SWAMP (ECC))
	MANAGED DRAINAGE RESERVE
	ASSET PROTECTION ZONE (APZ)
	OPEN SPACE
	(A) EASEMENT FOR CABLE AND ACCESS 10 WIDE (DP 602729) VIDE GOV.GAZ.30.4.1982 FOL.1916
	SELECT TREES

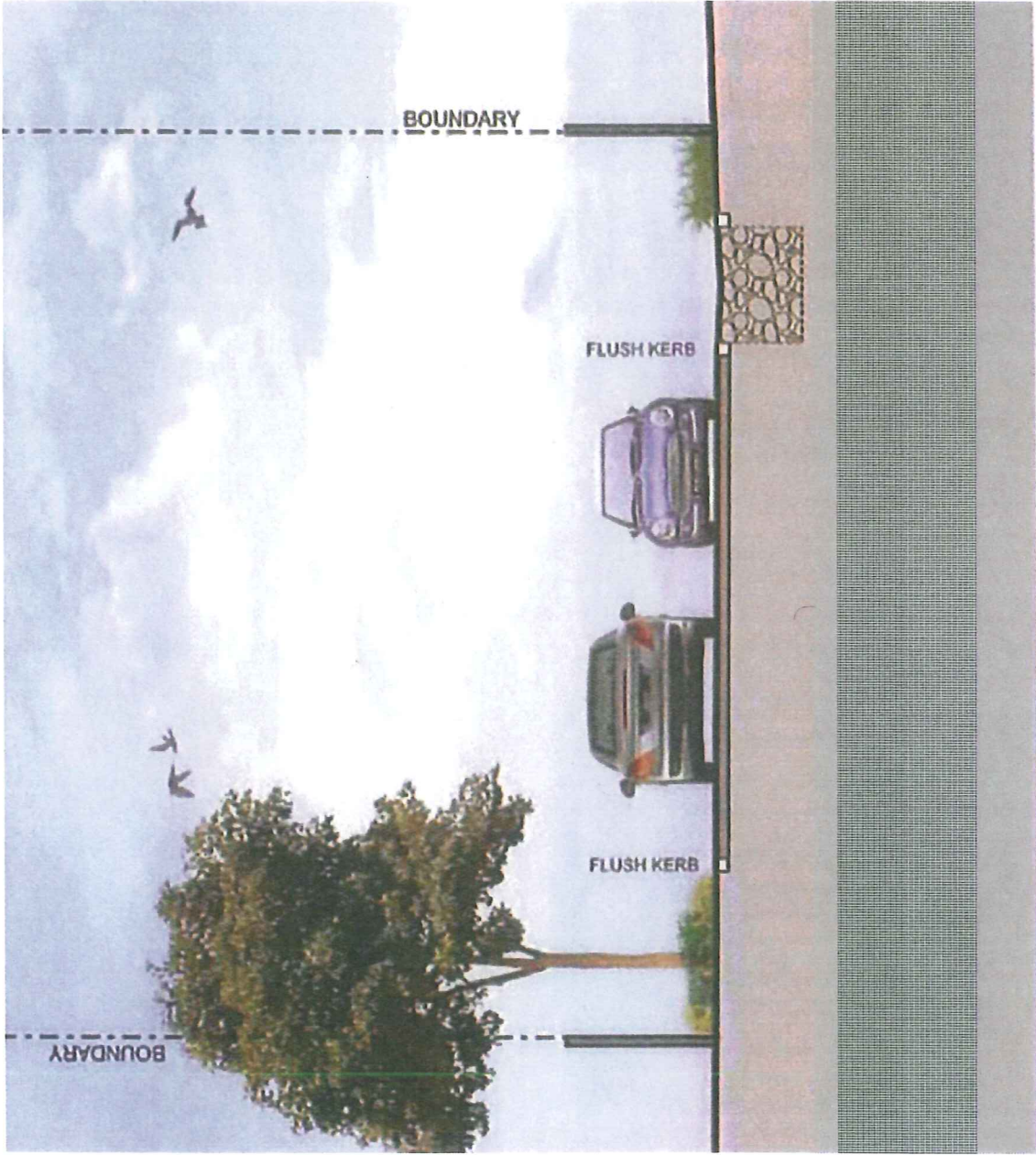


DATE:	14-11-2012
DATUM:	AHD
SITE AREA:	N/A
REGISTERED SURVEYOR NSW:	LOCKLEY LAND TITLE SOLUTIONS
REGISTERED SURVEYORS NSW:	19 Messers Street Gladstone NSW 4211
PROJECT NO.:	30401
JOB REFERENCE:	35379PS
CLIENT:	MATHEWS CIVIL PTY LTD
PLAN OF PROPOSED SUBDIVISION OF LOT 1 IN DP1159626 AND ROAD CLOSURES AT RALSTON AVENUE, BELROSE	
ORIGINAL PLAN SIZE:	A1 1:1000
SHEET	1
OF 3 SHEETS	





PERIMETER ROAD



LOCAL STREET

5. TRAFFIC IMPLICATIONS

5.1 TRAFFIC GENERATION

The RMS Development Guidelines* provide generic criteria in relation to the assessed traffic generation of single residential dwellings as follows:

Single Dwellings

'Outer Sydney area, new dwellings, large lots, poor public transport'

- 0.85 vtpH (peak hour)

Medium Density dwellings

'Villas, townhouse, semi-detached and other medium density

2 and 3 bed – 0.5 to 0.65 vtpH'

However unlike the other landuse categories dealt with in the Guidelines, and particularly the various forms of residential development, there is no supporting "Survey and Assessment" analysis to indicate where this longstanding Single Dwelling criteria was derived from. The RMS document also identifies that some 25% of residential subdivision trips are "internal" involving local shops, schools and local social/sporting visits.

TTPA have undertaken many of the studies commissioned by the former RTA to derive the traffic generation of various landuses for incorporation into the now RMS Development Guidelines. In 2003, TTPA undertook a major assessment of single dwelling residential development (Glenmore Park Stage 1) which comprised some 5,600 dwellings on the western outskirts of Sydney. An extract from that study is provided in Appendix C with the conclusion that the peak traffic generation of this very large existing residential precinct (which has geographical/transport similarities to the Belrose site) is some 0.65 vtpH per dwelling.

* *Guide To traffic Generating Development
RTA NSW December 2002*

It is also noted that road network assessments recently undertaken for the State Governments Growth Centres planning have adopted a peak traffic generation rate for single dwelling (ie North West Growth Centres) of 0.57 vtpd per dwelling. There are schools and shops located within the precinct (ie without need to access Forest Way which would indicate a moderate “internal” containment of generated trips however in order to assess the traffic generation implications for the access roadways and provide a robust assessment of the access intersection on Forest Way, a peak traffic generation rate of 0.65 vtpd per dwelling has been adopted (ie without internal discount) with peak directional splits of 80/20 and 25/75 (ie AM and PM). Thus the projected traffic generation outcome with completed development on the envisaged lots is as follows:

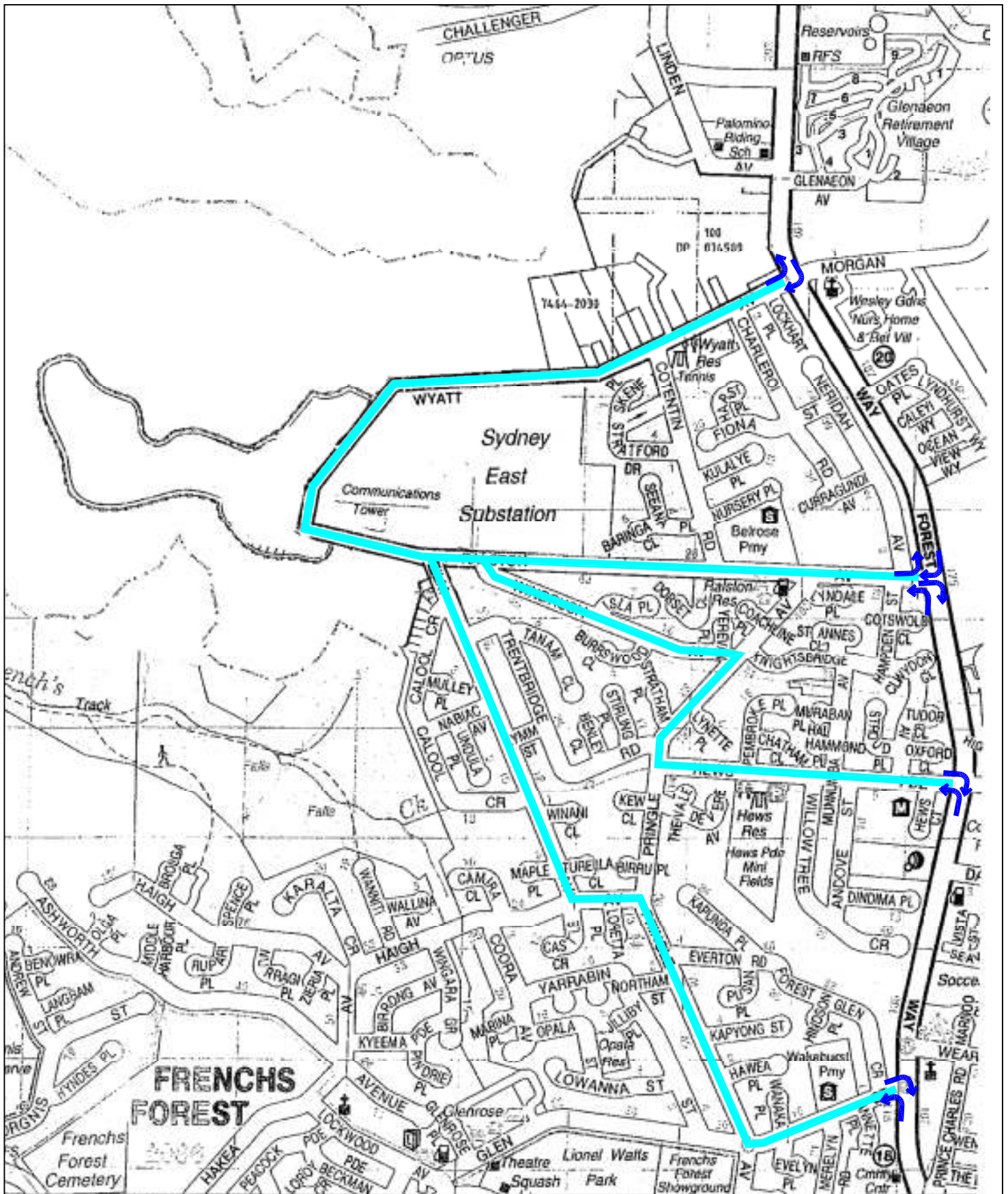
	AM		ON	
169 Lots @ 0.65-110 vtpd	20	90	82	28

However a +15% sensitivity factor has been applied to the projected peak generation to reflect a robust assessment (ie 125 vtpd).

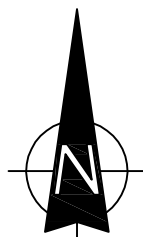
There are a number of routes available for the generated traffic movements to approach and depart the sites as indicated on Figures 6 however it is unlikely that any significant movements will result along the Elm Avenue/Pringle Avenue and Hews Parade/Pringle Avenue/Windrush Avenue routes due to:

- The relative indirectness
- The general free flowing movements on the relevant section of Forest Way and signal “green time” priority

The directional distribution can be gauged by the existing movement patterns at the access intersections (Figure 6) as follows:



LEGEND



PROJECTED TRAFFIC DISTRIBUTION

FIG 6

	AM		ON	
To the North	60%	(60)	60%	(19)
To the South	40%	(40)	40%	(14)
From the North	65%	(17)	75%	(69)
From the South	35%	(8)	25%	(23)

On this basis the projected additional movements at the access intersections consequential to development on the subdivision Lots during the peak periods is as follows:

Intersection with Forest Way		AM	PM
Wyatt Avenue	RT IN	10	69
	LT OUT	50	15
Ralston Avenue	RT IN	6	9
	LT IN	4	13
	RT OUT	10	10
	LT OUT	10	4
Hews Parade	RT OUT	15	1
	LT IN	2	5
Glen Street	RT OUT	15	1
	LT IN	2	5
Total		125	125

It is proposed to modify the Forest Way \ Ralston Avenue intersection to formalise a “seagull” island arrangement.

The operational performance of the Wyatt Avenue and Ralston Avenue intersections with these additional volumes has been assessed using SIDRA. The volumes distributed to the Hews Parade and Glen Street intersections are quite minor being less than 1vt each 2 cycles of the signals and therefore not perceptible in terms of traffic modelling. The results of that assessment are provided in Appendix B and summarised in the following:

	AM		ON	
	LOS	AVD	LOS	AVD
Wyatt Avenue	B	17.0	A	12.7
Ralston Avenue	A-D	6.6	A-D	8.4

5.2 TRAFFIC IMPACT

It is apparent that the projected traffic generation consequential to the proposed development will not have any adverse traffic implications.

5.3 TRAFFIC RELATED ENVIRONMENTAL IMPLICATIONS

Environmental Capacity

The RMS Guide to Traffic Generating Developments and the AMCORD Model Code specify the following 'Environmental Capacity Performance Standards' for residential streets:

	Max Speed	Max Vpd
Distributor/Collector Street	50 kmph	3000 (environmental goal) 5000 (max)
Local Street	40 kmph	2000 (environmental goal) 3000 (max)
Minor/Access Street	25 kmph	1000 (environmental goal)

Ralston Avenue and Wyatt Avenue (east of Cotentin Road) are minor collector roads and the projected traffic volume circumstances are as follows:

	EXISTING	FUTURE
Wyatt Avenue		
East of Cotentin Road	2070 vpd	2745 vpd
West of Cotentin Road	200 vpd	800 vpd
Ralston Avenue		
East of Cotentin Road*	5315 vpd	5645 vpd
West of Cotentin Road	500 vpd	830 vpd

* Consequential to location of school and shopping centre

It is apparent that the traffic generated by the proposed development will not result in any compromise to the environmental capacity of any existing roads in the area.

Road Geometry

The proposed road geometry reflects a contemporary subdivision which responds appropriately to the terrain, access for service vehicles and buses. It is noted that the Bush Fire Assessment which has been undertaken in relation to the proposed development has concluded that the nature, width and layout of the proposed road system is suitable and appropriate for any potential evacuation for a bush fire event.

Traffic Management

The principal issues of traffic management are:

* **Vehicle Speed**

A statutory 50 kmph speed limit will apply however the road geometry and traffic management measures will constrain speeds to approximately 40 kmph

* Management

The long curvilinear collector road through the Ralston Avenue Section will require speed control devices in the form of:

- roundabouts at major intersections (Wyatt Avenue/Ralston Avenue)
- mid block 'slow point' with raised platforms

* Conflict

Four way intersections and 'Y' junctions will require clarifying GIVE WAY signage

6. SERVICING, PEDESTRIANS AND CYCLISTS

6.1 SERVICING

The subdivision roads will facilitate the movements of service vehicles and particularly garbage removal.

The road widths and arrangement will accommodate the movements of 'large rigid trucks' and would accord with Council's design requirements.

6.2 PEDESTRIANS

Suitable and appropriate provision will be made for pedestrians in the design with:

- * footpath along the lot frontages
- * suitable sight distances
- * pathway system with linkages
- * suitable street lighting.

6.3 CYCLISTS

There is no existing bicycle facility which would connect to the development. The proposal will however make suitable and appropriate provision for cyclists with:

- * A 2.5m wide shared footway along the distributor/collector roads
- * suitable street lighting

6.4 BUS SERVICES

It could be anticipated that the existing bus service using Ralston Avenue, Cotentin Road and Wyatt Avenue would be extended by the service provider to encompass the full Ralston Avenue/Wyatt Avenue loop providing services within 400m of the new Lots.

7. CONSTRUCTION TRAFFIC MANAGEMENT

It is inevitable that the consent for the proposed development to be constructed will have a requirement for the preparation and submission of a detailed Construction Traffic Management Plan.

The basis to the management of construction vehicles will be to limit these movements to/from Forest Way via Ralston Avenue and Wyatt Avenue. These are existing minor collector roads which are suitable for the movement of construction vehicles.

Ralston Avenue and Wyatt Avenue are relatively straight and level and are of a suitable standard of construction to accommodate heavy vehicles. The existing traffic signals at the Forest Way and Wyatt Avenue intersection will assist with vehicle access while the roundabout and raised marked footcrossing on Ralston Avenue will suitably constrain vehicle speeds at the potential conflict points. Traffic Control Plans will be prepared and submitted in relation to any works requiring to be undertaken on Ralston Avenue or Wyatt Avenue and there is no other apparent need for mitigation measures.

8. CONCLUSION

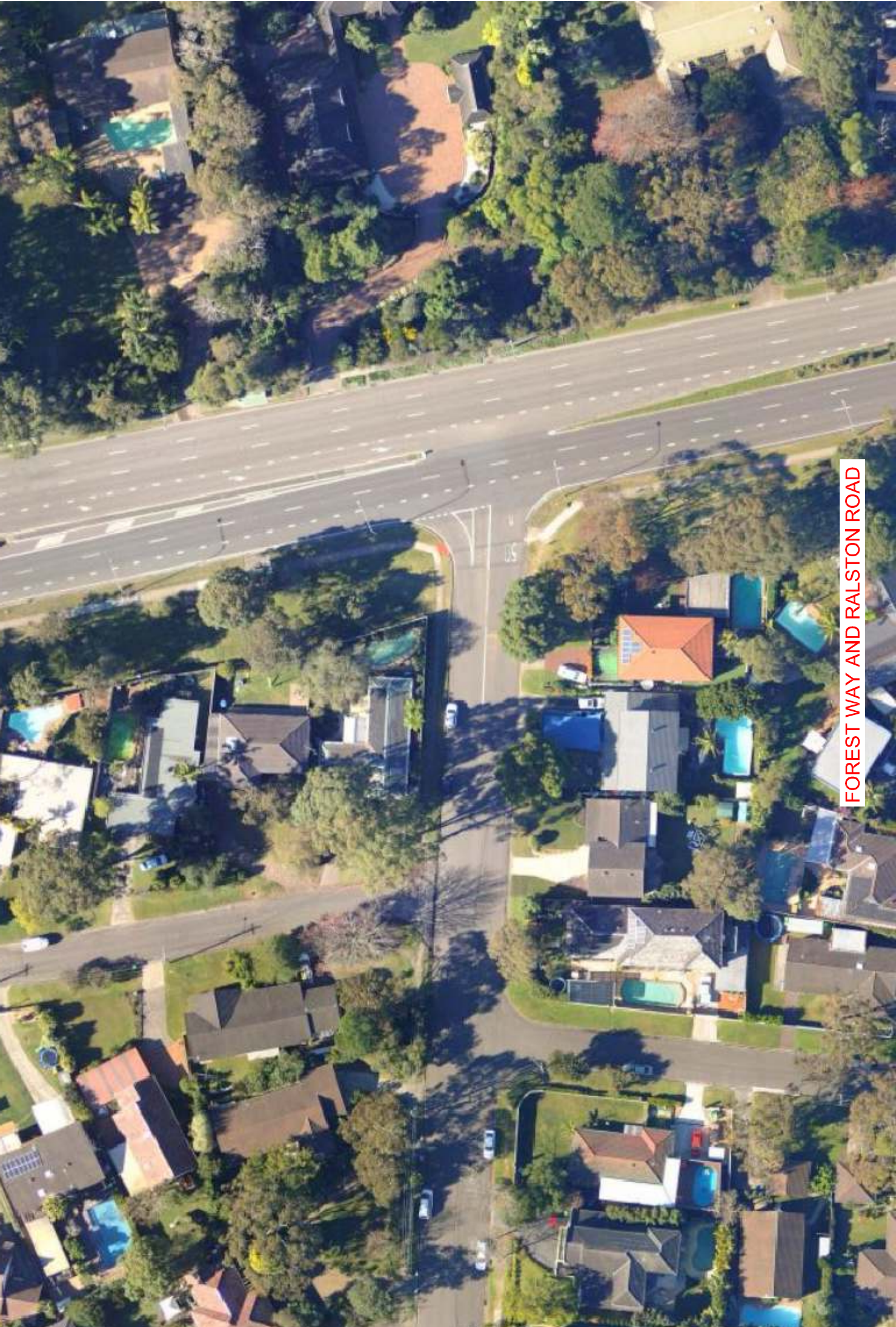
The proposed rezoning to permit a residential development at Belrose will provide for the of addition of high quality housing in a desirable location while retaining appropriate open space areas. The envisaged development will have an access road system which accords with Council's Development Design Specification.

The proposed development would comprise approximately 169 dwellings and the 'traffic outcome' will be satisfactory in relation to:

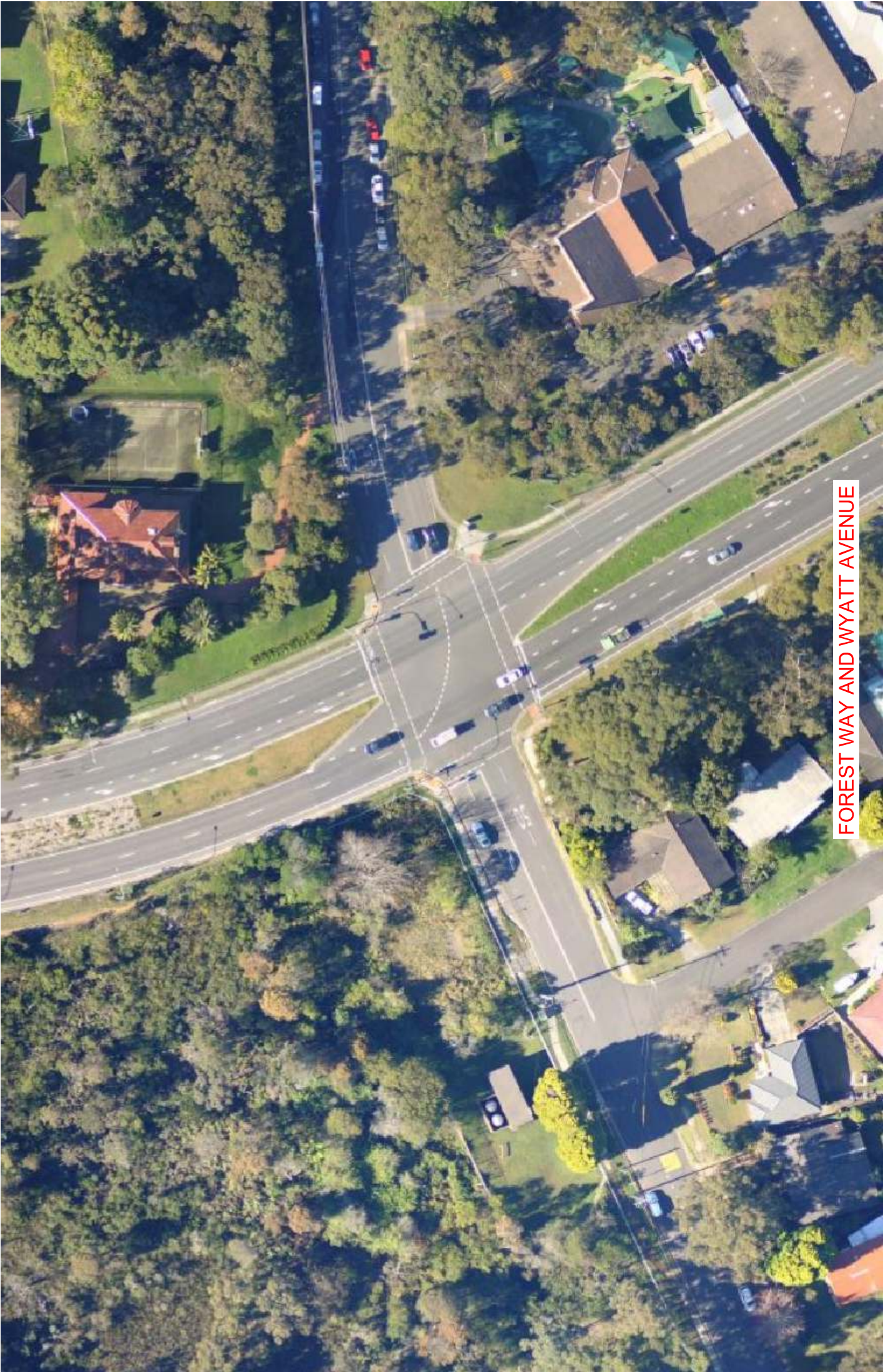
- * road/intersection capacity implications
- * traffic related environmental implications
- * traffic management and safety implications.

APPENDIX A

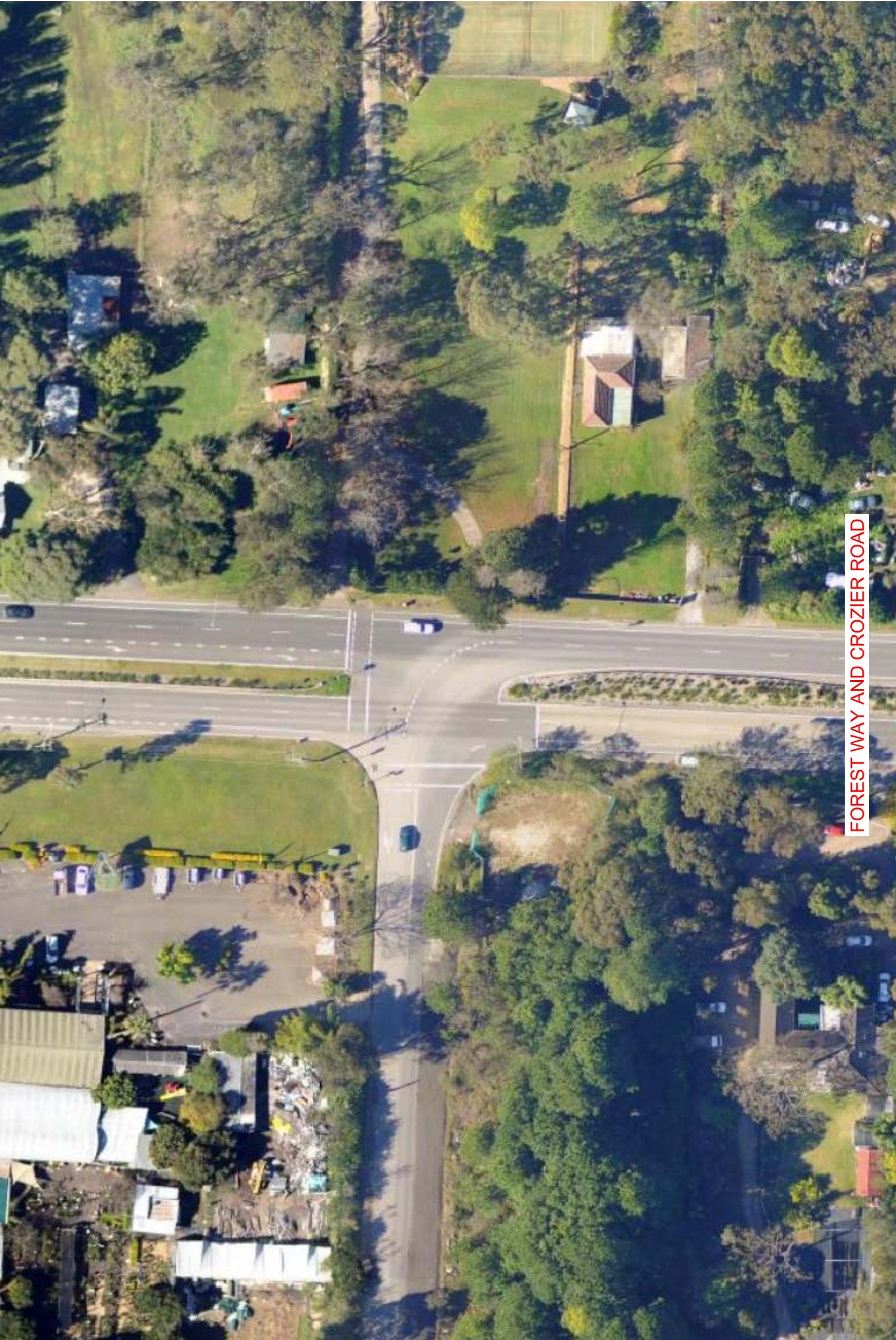
INTERSECTION IMAGES



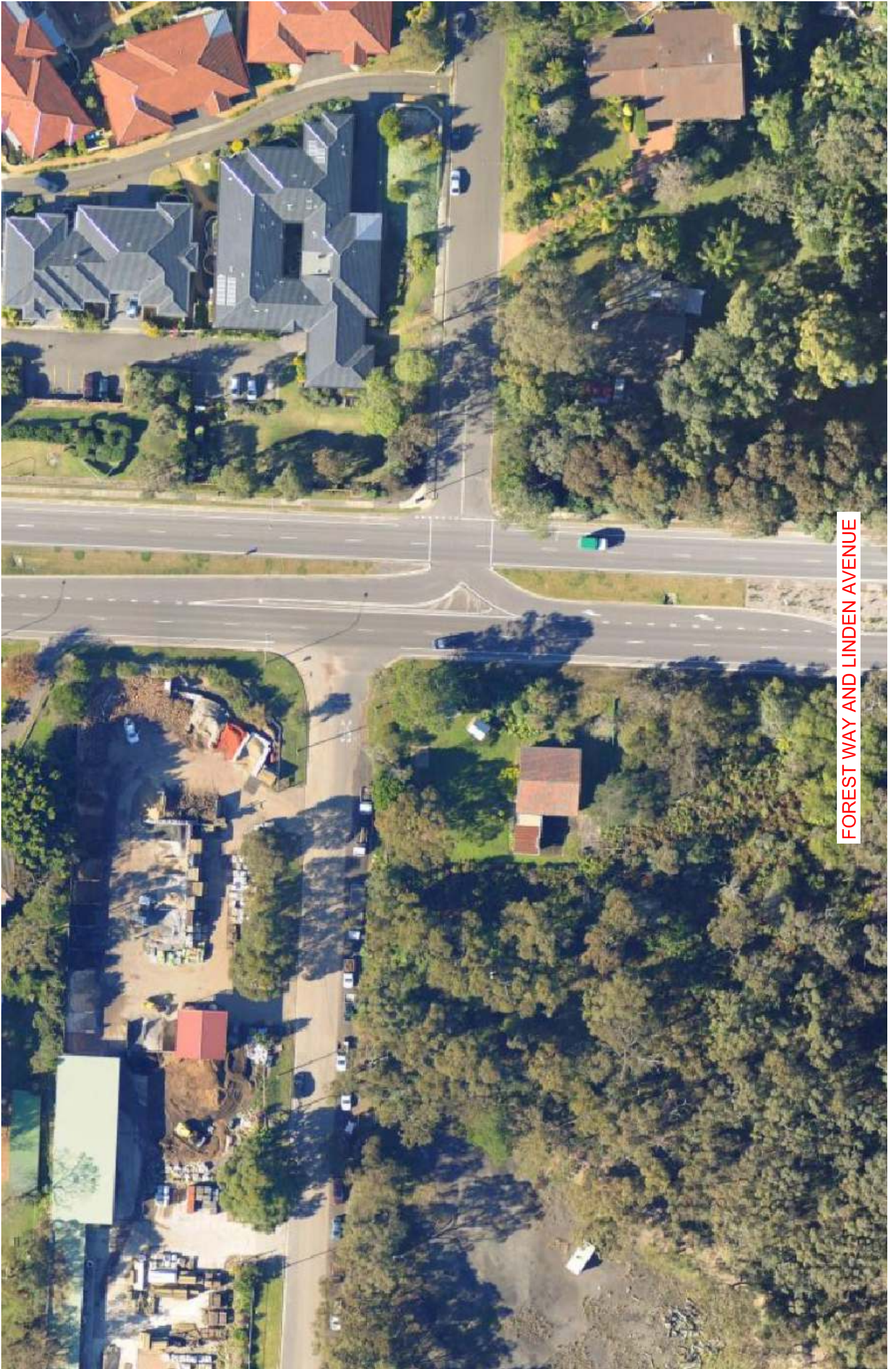
FOREST WAY AND RALSTON ROAD



FOREST WAY AND WYATT AVENUE



FOREST WAY AND CROZIER ROAD



FOREST WAY AND LINDEN AVENUE

APPENDIX B

SIDRA RESULTS

MOVEMENT SUMMARY

Site: Existing AM Peak

Ralston St x Forest Highway
Existing AM Peak
Giveaway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Forest Way (S)											
1	L	92	2.0	0.050	8.8	LOS A	0.0	0.0	0.00	0.68	53.1
2	T	1316	2.0	0.342	0.0	LOS A	0.0	0.0	0.00	0.00	70.0
Approach		1408	2.0	0.342	0.6	LOS A	0.0	0.0	0.00	0.04	68.7
North: Forest Way (N)											
8	T	1284	2.0	0.222	0.0	LOS A	0.0	0.0	0.00	0.00	70.0
9	R	120	2.0	0.506	29.3	LOS C	2.7	19.0	0.87	1.05	34.8
Approach		1404	2.0	0.506	2.5	LOS C	2.7	19.0	0.07	0.09	64.9
West: Ralston Ave											
10	L	252	2.0	0.609	21.8	LOS B	4.3	30.3	0.85	1.16	35.0
12	R	24	2.0	1.000 ⁴	1643.1	LOS F	7.0	49.9	1.00	1.63	1.4
Approach		276	2.0	1.000	162.8	LOS F	7.0	49.9	0.86	1.20	11.1
All Vehicles		3088	2.0	1.000	16.0	NA	7.0	49.9	0.11	0.17	46.2

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).

Approach LOS values are based on the worst delay for any vehicle movement.

⁴ x = 1.00 due to minimum capacity

MOVEMENT SUMMARY

Site: Existing PM Peak

Ralston St x Forest Highway
Existing PM Peak
Giveaway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Forest Way (S)											
1	L	84	2.0	0.046	8.8	LOS A	0.0	0.0	0.00	0.68	53.1
2	T	1248	2.0	0.324	0.0	LOS A	0.0	0.0	0.00	0.00	70.0
Approach		1332	2.0	0.324	0.6	LOS A	0.0	0.0	0.00	0.04	68.8
North: Forest Way (N)											
8	T	1259	2.0	0.218	0.0	LOS A	0.0	0.0	0.00	0.00	70.0
9	R	204	2.0	0.782	38.4	LOS C	6.0	43.1	0.93	1.27	30.2
Approach		1463	2.0	0.782	5.4	LOS C	6.0	43.1	0.13	0.18	60.0
West: Ralston Ave											
10	L	136	2.0	0.305	16.3	LOS B	1.6	11.2	0.74	0.96	38.2
12	R	31	2.0	1.000 ⁴	1638.5	LOS F	8.5	60.4	1.00	1.87	1.4
Approach		167	2.0	1.000	317.4	LOS F	8.5	60.4	0.79	1.13	6.3
All Vehicles		2962	2.0	1.000	20.8	NA	8.5	60.4	0.11	0.17	42.3

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).

Approach LOS values are based on the worst delay for any vehicle movement.

⁴ x = 1.00 due to minimum capacity

MOVEMENT SUMMARY

Site: Future AM Peak

Ralston St x Forest Highway
 Future AM Peak
 Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Forest Way (S)											
1	L	96	2.0	0.111	8.8	LOS A	0.0	0.0	0.00	0.95	53.1
2	T	1316	2.0	0.313	0.0	LOS A	0.0	0.0	0.00	0.00	70.0
Approach		1412	2.0	0.313	0.6	LOS A	0.0	0.0	0.00	0.06	68.7
North: Forest Way (N)											
9	R	126	2.0	0.534	30.2	LOS C	2.9	20.5	0.88	1.06	34.4
Approach		126	2.0	0.535	30.2	LOS C	2.9	20.5	0.88	1.06	34.4
West: Ralston Ave											
10	L	262	2.0	0.634	22.4	LOS B	4.6	32.6	0.86	1.18	34.7
12	R	34	2.0	0.318	48.3	LOS D	1.4	9.7	0.92	1.01	25.0
Approach		296	2.0	0.634	25.4	LOS D	4.6	32.6	0.87	1.16	33.2
All Vehicles		1834	2.0	0.634	6.6	NA	4.6	32.6	0.20	0.31	55.6

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS D. LOS Method for individual vehicle movements: Delay (RTA NSW).

Approach LOS values are based on the worst delay for any vehicle movement.

MOVEMENT SUMMARY

Site: Future PM Peak

Ralston St x Forest Highway
 Future PM Peak
 Giveway / Yield (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Forest Way (S)											
1	L	97	2.0	0.106	8.8	LOS A	0.0	0.0	0.00	0.93	53.1
2	T	1248	2.0	0.298	0.0	LOS A	0.0	0.0	0.00	0.00	70.0
Approach		1345	2.0	0.298	0.6	LOS A	0.0	0.0	0.00	0.07	68.6
North: Forest Way (N)											
9	R	213	2.0	0.829	43.3	LOS D	7.1	50.5	0.95	1.34	28.3
Approach		213	2.0	0.830	43.3	LOS D	7.1	50.5	0.95	1.34	28.3
West: Ralston Ave											
10	L	140	2.0	0.316	16.5	LOS B	1.7	11.8	0.75	0.96	38.1
12	R	41	2.0	0.414	55.9	LOS D	1.8	13.0	0.93	1.04	23.1
Approach		181	2.0	0.412	25.4	LOS D	1.8	13.0	0.79	0.98	33.2
All Vehicles		1739	2.0	0.830	8.4	NA	7.1	50.5	0.20	0.32	53.9

LOS (Aver. Int. Delay): NA. The average intersection delay is not a good LOS measure for two-way sign control due to zero delays associated with major road movements.

Level of Service (Worst Movement): LOS D. LOS Method for individual vehicle movements: Delay (RTA NSW).

Approach LOS values are based on the worst delay for any vehicle movement.

MOVEMENT SUMMARY

Site: Existing AM Peak

Wyatt x Forest Way
 AM Existing Peak
 Signals - Fixed Time Cycle Time = 140 seconds (Practical Cycle Time)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Forest Way (S)											
1	L	47	2.0	0.831	12.8	LOS A	15.0	106.6	0.29	1.27	50.2
2	T	1459	2.0	0.831	4.0	LOS A	15.0	106.9	0.29	0.26	60.5
3	R	62	2.0	0.790	83.1	LOS F	6.0	43.0	1.00	0.78	18.3
Approach		1568	2.0	0.831	7.4	LOS A	15.0	106.9	0.31	0.31	55.6
East: Wyatt Ave											
4	L	43	2.0	0.240	61.1	LOS E	6.1	43.6	0.90	0.78	22.1
5	T	35	2.0	0.240	53.4	LOS D	6.1	43.6	0.90	0.70	20.8
6	R	136	2.0	0.537	66.3	LOS E	10.3	73.2	0.96	0.80	20.9
Approach		214	2.0	0.536	63.1	LOS E	10.3	73.2	0.94	0.78	21.1
North: Forest Way											
7	L	124	2.0	0.825	12.7	LOS A	14.5	103.1	0.28	1.16	50.1
8	T	1368	2.0	0.826	3.9	LOS A	14.6	103.7	0.28	0.26	60.6
9	R	57	2.0	0.726	82.5	LOS F	5.6	39.7	1.00	0.76	18.4
Approach		1549	2.0	0.826	7.5	LOS A	14.6	103.7	0.31	0.35	55.5
West: Wyatt Ave											
10	L	68	2.0	0.585	39.4	LOS C	5.3	37.7	0.90	0.77	27.8
11	T	25	2.0	0.585	31.7	LOS C	5.3	37.7	0.90	0.70	26.5
12	R	53	2.0	0.184	63.1	LOS E	4.4	31.6	0.91	0.75	21.5
Approach		146	2.0	0.585	46.7	LOS D	5.3	37.7	0.90	0.75	24.9
All Vehicles		3477	2.0	0.831	12.5	LOS A	15.0	106.9	0.37	0.38	48.4

Level of Service (Aver. Int. Delay): LOS A. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
 Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
 Approach LOS values are based on average delay for all vehicle movements.

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	64.1	LOS F	0.2	0.2	0.96	0.96
P3	Across E approach	53	25.2	LOS C	0.1	0.1	0.60	0.60
P5	Across N approach	53	64.1	LOS F	0.2	0.2	0.96	0.96
P7	Across W approach	53	25.2	LOS C	0.1	0.1	0.60	0.60
All Pedestrians		212	44.7				0.78	0.78

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
 Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: Existing PM Peak

Wyatt x Forest Way
 PM Existing Peak
 Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Forest Way (S)											
1	L	12	2.0	0.814	18.2	LOS B	23.3	165.9	0.50	1.16	45.7
2	T	1352	2.0	0.818	9.4	LOS A	23.3	166.0	0.50	0.45	52.0
3	R	20	2.0	0.273	85.4	LOS F	2.2	15.7	0.97	0.70	18.0
Approach		1384	2.0	0.818	10.6	LOS A	23.3	166.0	0.50	0.46	50.7
East: Wyatt Ave (E)											
4	L	57	2.0	0.387	62.2	LOS E	5.6	40.1	0.88	0.76	21.7
5	T	11	2.0	0.387	54.5	LOS D	5.6	40.1	0.88	0.67	20.5
6	R	72	2.0	0.268	69.4	LOS E	6.3	44.6	0.93	0.77	20.3
Approach		140	2.0	0.387	65.3	LOS E	6.3	44.6	0.90	0.76	20.9
North: Forest Way (N)											
7	L	44	2.0	0.769	12.2	LOS A	9.7	69.0	0.20	1.47	50.2
8	T	1439	2.0	0.772	3.3	LOS A	11.8	83.8	0.20	0.25	61.6
9	R	41	2.0	0.198	66.2	LOS E	3.5	25.3	0.84	0.74	21.5
Approach		1524	2.0	0.772	5.3	LOS A	11.8	83.8	0.22	0.29	58.7
West: Wyatt Ave (W)											
10	L	36	2.0	0.186	39.6	LOS C	2.8	19.9	0.85	0.74	27.7
11	T	8	2.0	0.186	31.9	LOS C	2.8	19.9	0.85	0.64	26.5
12	R	27	2.0	0.101	67.4	LOS E	2.5	18.1	0.90	0.72	20.7
Approach		71	2.0	0.186	49.3	LOS D	2.8	19.9	0.87	0.72	24.4
All Vehicles		3119	2.0	0.818	11.3	LOS A	23.3	166.0	0.39	0.40	49.7

Level of Service (Aver. Int. Delay): LOS A. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
 Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
 Approach LOS values are based on average delay for all vehicle movements.

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	69.1	LOS F	0.2	0.2	0.96	0.96
P3	Across E approach	53	23.5	LOS C	0.1	0.1	0.56	0.56
P5	Across N approach	53	69.1	LOS F	0.2	0.2	0.96	0.96
P7	Across W approach	53	30.1	LOS D	0.1	0.1	0.63	0.63
All Pedestrians		212	48.0				0.78	0.78

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
 Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: Future AM Peak

Wyatt x Forest Way
 AM Future Peak
 Signals - Fixed Time Cycle Time = 140 seconds (Practical Cycle Time)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Forest Way (S)											
1	L	47	2.0	0.878	17.3	LOS B	25.9	184.2	0.51	1.17	46.7
2	T	1469	2.0	0.876	8.5	LOS A	25.9	184.7	0.51	0.48	53.0
3	R	62	2.0	0.677	80.2	LOS F	5.9	41.9	1.00	0.77	18.8
Approach		1578	2.0	0.876	11.6	LOS A	25.9	184.7	0.53	0.51	49.6
East: Wyatt Ave											
4	L	43	2.0	0.240	61.1	LOS E	6.1	43.6	0.90	0.78	22.1
5	T	35	2.0	0.240	53.4	LOS D	6.1	43.6	0.90	0.70	20.8
6	R	136	2.0	0.537	66.3	LOS E	10.3	73.2	0.96	0.80	20.9
Approach		214	2.0	0.536	63.1	LOS E	10.3	73.2	0.94	0.78	21.1
North: Forest Way											
7	L	124	2.0	0.869	16.9	LOS B	24.6	175.2	0.50	1.10	46.6
8	T	1374	2.0	0.868	8.1	LOS A	24.8	176.4	0.50	0.46	53.3
9	R	67	2.0	0.732	80.7	LOS F	6.3	45.1	1.00	0.77	18.7
Approach		1565	2.0	0.868	11.9	LOS A	24.8	176.4	0.52	0.53	49.2
West: Wyatt Ave											
10	L	118	2.0	0.868	48.5	LOS D	8.6	61.0	0.91	0.89	25.0
11	T	25	2.0	0.868	40.8	LOS C	8.6	61.0	0.91	0.82	23.7
12	R	53	2.0	0.169	61.1	LOS E	4.4	31.0	0.89	0.75	21.9
Approach		196	2.0	0.867	50.9	LOS D	8.6	61.0	0.90	0.84	23.9
All Vehicles		3553	2.0	0.876	17.0	LOS B	25.9	184.7	0.57	0.55	43.5

Level of Service (Aver. Int. Delay): LOS B. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
 Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
 Approach LOS values are based on average delay for all vehicle movements.

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	64.1	LOS F	0.2	0.2	0.96	0.96
P3	Across E approach	53	27.0	LOS C	0.1	0.1	0.62	0.62
P5	Across N approach	53	62.2	LOS F	0.2	0.2	0.94	0.94
P7	Across W approach	53	27.0	LOS C	0.1	0.1	0.62	0.62
All Pedestrians		212	45.1				0.79	0.79

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
 Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).

MOVEMENT SUMMARY

Site: Future PM Peak

Wyatt x Forest Way
 PM Future Peak
 Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Forest Way (S)											
1	L	12	2.0	0.814	18.2	LOS B	23.5	167.6	0.50	1.16	45.6
2	T	1356	2.0	0.820	9.4	LOS A	23.6	167.7	0.50	0.45	52.0
3	R	20	2.0	0.273	85.4	LOS F	2.2	15.7	0.97	0.70	18.0
Approach		1388	2.0	0.820	10.6	LOS A	23.6	167.7	0.51	0.46	50.7
East: Wyatt Ave											
4	L	57	2.0	0.193	62.2	LOS E	5.6	40.1	0.88	0.77	21.7
5	T	11	2.0	0.193	54.5	LOS D	5.6	40.1	0.88	0.68	20.5
6	R	72	2.0	0.303	69.4	LOS E	6.3	44.6	0.93	0.77	20.3
Approach		140	2.0	0.303	65.3	LOS E	6.3	44.6	0.90	0.76	20.9
North: Forest Way											
7	L	44	2.0	0.775	12.3	LOS A	9.9	70.4	0.21	1.47	50.3
8	T	1448	2.0	0.776	3.3	LOS A	12.0	85.4	0.21	0.25	61.6
9	R	110	2.0	0.530	69.0	LOS E	9.0	63.8	0.92	0.78	20.9
Approach		1602	2.0	0.776	8.1	LOS A	12.0	85.4	0.26	0.32	54.7
West: Wyatt Ave											
10	L	51	2.0	0.391	39.2	LOS C	3.7	26.0	0.86	0.74	27.8
11	T	8	2.0	0.390	31.5	LOS C	3.7	26.0	0.86	0.64	26.6
12	R	27	2.0	0.101	67.4	LOS E	2.5	18.1	0.90	0.72	20.7
Approach		86	2.0	0.391	47.3	LOS D	3.7	26.0	0.87	0.73	25.0
All Vehicles		3216	2.0	0.820	12.7	LOS A	23.6	167.7	0.41	0.41	48.2

Level of Service (Aver. Int. Delay): LOS A. Based on average delay for all vehicle movements. LOS Method: Delay (RTA NSW).
 Level of Service (Worst Movement): LOS F. LOS Method for individual vehicle movements: Delay (RTA NSW).
 Approach LOS values are based on average delay for all vehicle movements.

Movement Performance - Pedestrians								
Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	69.1	LOS F	0.2	0.2	0.96	0.96
P3	Across E approach	53	23.5	LOS C	0.1	0.1	0.56	0.56
P5	Across N approach	53	69.1	LOS F	0.2	0.2	0.96	0.96
P7	Across W approach	53	30.1	LOS D	0.1	0.1	0.63	0.63
All Pedestrians		212	48.0				0.78	0.78

Level of Service (Aver. Int. Delay): LOS E. Based on average delay for all pedestrian movements. LOS Method: Delay (HCM).
 Level of Service (Worst Movement): LOS F. LOS Method for individual pedestrian movements: Delay (HCM).

APPENDIX C

EXTRACT FROM TRAFFIC STUDY

**PROPOSED
GLENMORE PARK STAGE 2**

***Assessment of Traffic, Transport and
Parking Implications***

September 2003

Reference -0338

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5.2 EXISTING GLENMORE PARK

The 2001 Census established that there were some 5,447 occupied dwellings in the existing Glenmore Park development at the time of the survey.

Access to and from the surrounding Arterial Road network (ie The Northern Road and Mulgoa Road) from the existing development is restricted to the Glenmore Parkway and Garswood Road intersection. This circumstance and the circuitous internal road layout provides the relatively unique situation where it is possible to establish the vehicle trip generation rate of the estate without the complication of non-related external through movements. An assessment of the AM and PM peak hour movements at the 3 'access' intersections from the 'June' survey indicate the following IN/OUT movements from the Glenmore Park Estate.

	Total Movements	IN	OUT
AM Peak	3,278	835	2,443
PM Peak	3,645	2,636	1,009

(NB The earlier survey provided similar results to the June survey being within $\pm 2\%$ of the total movements)

On the conservative estimate that there have been some 200 dwellings built and occupied since the undertaking of the 2001 Census (ie 5,647 dwellings), the traffic movements indicated above translate to the following external trip generation rates for the estate and the peak period IN vs OUT ratios.

	Total (vtph)	IN (%)	OUT (%)
AM Peak	0.58	25	75
PM Peak	0.65	72	28

5.3 ORIOLE STREET CATCHMENT

The street layout within the existing Glenmore Park development provided an opportunity to undertake a 'sensitivity test' of the published RTA generation rate and the rates established in Section 5.2. To ascertain the traffic generation rate of residential only development, a survey was carried out of the vehicle movements in the AM (7.00 –9.00am) and PM (4.00 - 6.30pm) peak period travelling to/from Oriole Street at its intersection with Woodlands Drive. This intersection is the only means of vehicular access to some 340 residences and is an area of the estate which is fully developed with no new residential construction activity currently taking place.

The results of the survey indicate the following movements to/from Oriole Street.

**LOCATION: ORIOLE STREET/WOODLANDS DRIVE
(SURVEY PERIOD – 19TH MAY 2003)**

		AM Peak (7.45 – 8.45am)	PM Peak (5.15 – 6.15pm)
Oriole Street (OUT)	Left	24	11
	Right	118	51
Woodlands Drive (IN)	Left	8	35
	Right	34	132
Total		184	229

On the assumption that of the 340 residences within the surveyed area, approximately 6% (20 residences) were unoccupied, the traffic movements represent an AM and PM peak generation of 0.58 vehicle trips per hour per residence and 0.72 vehicle trips per hour per residence respectively.

From the assessment it is apparent that the RTA published trip generation rate for residential development of 0.85 vtpd is not a true reflection of the circumstances which prevail at Glenmore Park. On the basis that the trip generation rate attained from the Oriole Street assessment also includes a component of 'internal' trips (say 6%), the data from this analysis and that of the 'whole' of Glenmore Park would suggest that an external trip generation rate of 0.65 vtpd per dwelling in the peak periods is a far more accurate interpretation of the existing traffic activity generated by the Glenmore Park Estate.

Application of this rate to the various phases of the proposed development indicates the following likely AM and PM peak vehicle movements:

Phase	0.65 vtpd	AM Peak *		PM Peak *	
		OUT (80%)	IN (20%)	OUT (25%)	IN (75%)
1	144	115	29	36	108
2	150	120	30	37	113
3	165-199	132-159	33-40	41-50	124-149
4	135-142	110-114	25-28	34-35	101-107
5	124	120	96	24	30
6	135	108	27	34	101
Total	849-890	681-712	168-178	212-222	637-668

The modelling undertaken of the existing circumstances at the intersection of Mulgoa Road/Glenmore Parkway and The Northern Road/Glenmore Parkway (refer to Section 3.3) confirmed on-site observations that both intersections operate satisfactorily with spare capacity during the AM and PM peak periods.

To establish the impact of the proposed development on these two intersections an assessment was undertaken of the following 2 development scenarios: