Calderwood Road

Calderwood Road is a two-lane undivided carriageway linking Albion Park with a number of rural properties in the Calderwood area. Pavement width is generally 6 metres in the rural section, widening to 12 metres within Albion Park urban area. A speed limit of 50km/h applies within the Albion Park urban area and a speed limit of 80km/h in the rural area. A school zone also applies for 600 metres west from the intersection with North Macquarie Road.

Photograph 9 Calderwood Road

North Macquarie Road

North Macquarie Road is a two-lane undivided carriageway, generally 4-5 metres in width, linking Illawarra Highway with Calderwood Road along the northern side of Macquarie Rivulet. It has a signposted speed limit of 80km/h for the majority of the route, with a 60km/h limit applying in the vicinity of the small concrete ford over Macquarie Rivulet. The immediate southern approach to Macquarie Rivulet is only one-lane wide.

Photograph 10 North Macquarie Road at Macquarie Rivulet

Appendix 4C

Carriageway Capacity Performance Criteria

APPENDIX 4C - CARRIAGEWAY CAPACITY PERFORMANCE CRITERIA

ENVIRONMENTAL CAPACITY

Typically road hierarchy classifications are based purely on road function and capacity. Within more sensitive land use zones, such as residential zones, a more appropriate classification would be based on the environmental capacity concept. The RTA Guide to Traffic Generating Developments (October 2002) gives the guidance on the environmental capacity of residential streets, as detailed in Table 1 below.

Table 1 Environmental Capacity Performance Standards on Residential Streets

Road Class	Maximum Speed (kilometres/hour)	Maximum Peak Hour Volume (vehicle/hour)
Collector Street		
Environmental Goal	50	300
Maximum	50	500
Local Street		
Environmental Goal	50	200
Maximum	50	300

Source: RTA Guide to Traffic Generating Developments

URBAN ROADS MID-BLOCK CAPACITY

The typical capacity of urban lanes with interrupted flow is provided in Table 2 for each LoS, as defined in the RTA Guide to Traffic Generating Developments. These capacities may increase when priority is given to the major traffic flow at intersections or if there is flaring at intersections to accommodate more traffic. The spacing of intersections will differ with the hierarchy and function of the road.

Table 2 Mid-block Level of Service and Capacity

LoS	Description	Hourly Flow (vehicles)	
		1 Lane	2 Lane
A	Free flow - A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.	200	900
B	Stable flow (slight delays) - In the zone of stable flow and drivers still have the reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with LOS A.	380	1400
C	Stable flow (acceptable delays) - Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.	600	1800
D	Approaching unstable flow (tolerable delays) - Close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.	900	2200
E	Unstable flow (congestion; intolerable delays) - Occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause break-down.	1400	2800
F	Forced flow (jammed)	>1400	>2800

Source: RTA Guide to Traffic Generating Developments

A service volume, as defined by AUSTROADS, is the maximum number of vehicles that can pass over a given section of roadway in one direction during one hour while operating conditions are maintained at a specified LoS. It is suggested that ideally arterial and sub-arterial roads should not exceed service volumes at LoS C. At this level, whilst most drivers are restricted in their freedom to manoeuvre, operating speeds are still reasonable and acceptable delays experienced. However, in urban situations, arterial and sub-arterial roads operating at LoS D are still considered adequate. It is acceptable to provide road capacity at Level of Service 'D' in the peak hour since overprovision of road capacity is not conducive to promoting alternative transport modes to the car. The LoS for uninterrupted flow conditions along urban roads is identified in Table 3.

Table 3 Level of Service Uninterrupted Flow Conditions Along Urban Roads (One Way Hourly Volumes)

Road Description	LEVEL OF SERVICE (LoS)					
	A	B	C	D	E	F
2 Lane Undivided (2U)	760	880	1000	1130	1260	Forced Flows
2 Lane with Clearways and limited access (2CL)	1010	1170	1330	1500	1680	
4 Lane Undivided (13m) (4U)	1260	1470	1680	1890	2100	
4 Lane Undivided with Clearways (4UC)	1510	1760	2010	2270	2520	
4 Lane Divided with Clearways (4DC)	1600	1860	2130	2400	2660	
4 Lane Divided with Clearways, limited access and intersections(4DCI)	2250	2620	3000	3380	3740	
6 Lane Undivided (6U)	2020	2350	2690	3020	3360	
6 Lane Divided with Clearway (6DC)	2440	2840	3250	3660	4060	
6 Lane Divided with Clearways, limited access and intersections (6DCL)	3375	3930	4500	5070	5610	

Source: AUSTROADS *Guide to Traffic Engineering Guidelines – Part 2 - Roadway Capacity (1988)*

UNINTERRUPTED TWO-LANE RURAL ROAD CAPACITY

Uninterrupted Two-Lane Two-Way roads have one lane for use by traffic travelling in each direction. Overtaking of slower vehicles requires the use of the opposing traffic lane when sight distance and gaps in the opposing traffic stream permit. The term 'uninterrupted' describes the flow facilities where traffic flow conditions are the result of interactions between vehicles in the traffic stream, and between vehicles and the geometric and environmental characteristics of the road, and not the result of traffic controls. The Uninterrupted Two-Lane Two-Way roadway capacity is affected by factors such as, terrain, sight distance, lane widths, percentage of heavy vehicles, and directional distribution.

The roadway capacity for an uninterrupted two-lane two-way road is calculated using the following equation:

$$SFi = 2{,}800\,(v/c)I\,f_d\,f_w\,f_{HV}$$

Where:

SF_i	=	Total service flow rate in vehicles per hour in both directions under prevailing roadway and traffic conditions for level of service i
(v/c)	=	Maximum volume/capacity ratio which can be accommodated at level of service I for a given terrain and percent of length with no overtaking, from Table 3.1
f_d	=	Adjustment factor for directional distribution of traffic, from Table 3.2
f_w	=	Adjustment factor for narrow lanes and shoulders from Table 3.3
f_{HV}	=	Adjustment factor for heavy vehicles
P_T & P_B	=	The proportion of trucks and buses respectively in the traffic stream
E_T & E_B	=	The average passenger car equivalents for trucks and buses, from Table 3.4

The volume/capacity ratio is based on two factors, the type of terrain and the percent of length with sight distance less than 450m.

Reference: Austroads Guide to Traffic Engineering Practice, PART 2, Roadway Capacity, Section 3 Uninterrupted Two-Lane Two-Way Roads.

UNINTERRUPTED MULTI-LANE RURAL ROAD CAPACITY

Uninterrupted Multi-Lane roads have two or more lanes for use by traffic in each direction. They may be classified as either divided or undivided. Divided is when opposing direction of traffic are physically separated by a median. Undivided is when opposing directions of traffic are not physically separated. The Uninterrupted Multi-Lane roadway capacity is affected by factors such as, design speed, terrain, lane widths, number of lanes, percentage heavy vehicles, driver population, and development environment.

The roadway capacity for an uninterrupted multi-lane road is calculated using the following equation:

$$SF_i = C_j (v/c)_i N f_w f_{HV} f_e f_p$$

Where:

SF_i	=	Total service flow rate in one direction under prevailing roadway and traffic conditions for level of service *i*
C_j	=	Capacity per lane under ideal conditions for a multi-lane highway with a design speed *j*, i.e. 2,000 pc/h/lane for *j* = 100km/h or 110km/h and 1,900 pc/h/lane for *j* = 80km/h
N	=	Number of lanes in one direction
(v/c)	=	Maximum volume/capacity ratio which can be accommodated at level of service *i*, obtained from Table 4.1
f_w	=	Adjustment factor for lane width and/or lateral clearance restrictions, see Table 4.2
f_{HV}	=	Adjustment factor for heavy vehicles
	=	$1 / [1 + P_T(E_T - 1) + P_B(E_B - 1)]$
P_T & P_B	=	The proportion of trucks and buses respectively in the traffic stream
E_T & E_B	=	The average passenger car equivalents for trucks and buses, from Table 4.3
f_e	=	Adjustment factor for development environment and type of multi-lane road, obtained from Table 4.4
f_p	=	Adjustment factor for driver population, obtained from Table 4.5

Reference: Austroads Guide to Traffic Engineering Practice, PART 2, Roadway Capacity, Section 4 Uninterrupted Multi-Lane Roads

FREEWAY CAPACITY

A freeway is a divided road with two or more lanes for use by traffic travelling in each direction, with no at-grade intersections and with full control of access from abutting property. In addition to the factors affecting an uninterrupted multi-lane road, freeway capacity is also affected by ramps, and weaving areas.

The roadway capacity for a freeway is calculated using the following equation:

$$SF_i = C_j (v/c)_i N f_w f_{HV} f_p$$

Where:

SF_i	=	Total service flow rate in one direction under prevailing roadway and traffic conditions for level of service *i*
C_j	=	Capacity per lane under ideal conditions for a freeway with a design speed *j*, ie 2,000 pc/h/lane for *j* = 100km/h or 110km/h and 1,900 pc/h/lane for *j* = 80km/h
N	=	Number of lanes in one direction
(v/c)	=	Maximum volume/capacity ratio which can be accommodated at level of service *i*, obtained from Table 5.1
f_w	=	Adjustment factor for lane width and/or lateral clearance restrictions, see Table 4.2
f_{HV}	=	Adjustment factor for heavy vehicles
	=	$1 / [1 + P_T(E_T - 1) + P_B(E_B - 1)]$
P_T & P_B	=	The proportion of trucks and buses respectively in the traffic stream
E_T & E_B	=	The average passenger car equivalents for trucks and buses, from Table 4.3
f_p	=	Adjustment factor for driver population, obtained from Table 4.5

Reference: Austroads Guide to Traffic Engineering Practice, PART 2, Roadway Capacity, Section 5 Freeways

Appendix 4D

Intersection Performance Criteria

APPENDIX 4D - INTERSECTION PERFORMANCE CRITERIA

The existing intersection operating performance was assessed using the SIDRA software package to determine the Degree of Saturation (DS), Average Delay (AVD in seconds) and LoS at each intersection. The SIDRA program provides LoS Criteria Tables for various intersection types. The key indicator of intersection performance is LoS, where results are placed on a continuum from 'A' to 'F', as shown in Table 1.

Table 1 Intersection Level of Service

LoS	Traffic Signal / Roundabout	Give Way / Stop Sign / T-Junction control
A	Good operation	Good operation
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 & accident study required
E	At capacity, at signals incidents will cause excessive delays.	At capacity, requires other control mode
F	Unsatisfactory and requires additional capacity, Roundabouts require other control mode	At capacity, requires other control mode

The Average Vehicle Delay (AVD) provides a measure of the operational performance of an intersection as indicated below, which relates AVD to LOS. The AVD's should be taken as a guide only as longer delays could be tolerated in some locations (i.e. inner city conditions) and on some roads (i.e. minor side street intersecting with a major arterial route). For traffic signals, the average delay over all movements should be taken. For roundabouts and priority control intersections (sign control) the critical movement for LoS assessment should be that movement with the highest average delay.

Table 2 Intersection Average Delay (AVD)

LoS	Average Delay per Vehicles (seconds/vehicle)
A	Less than 14
B	15 to 28
C	29 to 42
D	43 to 56
E	57 to 70
F	>70

The degree of saturation (DS) is another measure of the operational performance of individual intersections. For intersections controlled by traffic signals both queue length and delay increase rapidly as DS approaches 1. It is usual to attempt to keep DS to less than 0.9. Degrees of Saturation in the order of 0.7 generally represent satisfactory intersection operation. When DS exceed 0.9 queues can be anticipated.

Intersection modelling has been completed using the SIDRA intersection modelling program. The 2008 base case scenarios for both the AM and PM peaks have been assessed as part of this study. The modelled volumes have been derived from the TRACKS model and reassigned into SIDRA. The intersections were analysed to determine the operating characteristics under the existing traffic conditions with existing traffic volumes. The intersections were analysed using the existing intersection layout. The analysis results are presented in the following sections.

Appendix 4E

Annual Average Daily Traffic (AADT) Volumes 1994 to 2005

APPENDIX 4E - Annual Average Daily Traffic (AADT) Volumes (vehicles per day)

	Years					
Location	**1994**	**1997**	**1998**	**2000**	**2003**	**2005**
Southern Freeway						
South of Fowlers Road	-	-	29,969	33,091	37,674	-
Princes Highway						
South of Huntley Road	9,656	10,322	10,416	10,692	11,954	12,681
At Macquarie Rivulet bridge	37,781	40,752	41,873	44,635	48,648	48,842
South of Illawarra Highway	33,644	34,575	35,687	37,869	41,413	41,595
North of Tongarra Road	37,781	40,752	41,873	44,635	48,648	48,842
East of Tongarra Road	42,204	37,472	39,401	40,689	31,749	38,290
Illawarra Highway						
South of Princes Highway	11,514	11,471	12,180	13,355	13,773	14,553
West of Terry Street	12,124	12,329	12,575	14,124	12,061	12,262
Tongarra Road						
West of Princes Highway	14,614	14,937	15,767	15,368	9,472	9,989
East of Illawarra Highway	11,678	13,800	14,302	15,421	11,562	12,322
Terry Street						
South of Illawarra Highway	11,846	13,347	13,699	17,404	12,547	12,648

Source: Roads and Traffic Authority of New South Wales, Average Annual Traffic Volume Data for Southern Region, 2006

Appendix 4F

Existing Mid-block Traffic Volumes & Carriageway Level of Service

Appendix 4F - Existing Mid-block Traffic Volumes & Carriageway LoS
AM Peak

Location			Peak Flow (Veh/hr)			LoS	
Street	Between	And	E/N bound	W/S Bound	Total	E/N bound	W/S Bound
Illawarra Highway	Tongarra Lane	North Macquarie	113	126	239	B	B
Illawarra Highway	North Macquarie	Tullimbar Lane	128	115	243	B	B
Illawarra Highway	Tullimbar Lane	Yellow Rock Road	131	123	254	B	B
Illawarra Highway	Yellow Rock Road	Broughton Avenue	173	136	309	B	B
Illawarra Highway	Broughton Avenue	Church Street	229	205	434	A	A
Illawarra Highway	Church Street	Calderwood Road	482	351	833	A	A
Illawarra Highway	Calderwood Road	Russell Street	526	428	954	A	A
Illawarra Highway	Russell Street	Terry Street	572	547	1,119	A	A
Illawarra Highway	Terry Street	Croome Lane	870	365	1,235	B	A
Illawarra Highway	Croome Lane	Princes Highway	960	427	1,387	C	A
Yallah Road	Marshall Mount	Princes Highway	61	32	93	A	A
Marshall Mount Road	Calderwood Road	North Marshall	36	36	72	A	A
Marshall Mount Road	North Marshall	Yallah Road	53	28	81	A	A
Marshall Mount Road	Yallah Road	Yallah TAFE	40	32	72	A	A
Marshall Mount Road	Yallah TAFE	Huntley Road	30	51	81	A	A
Calderwood Road	Calderwood valley	Marshall Mount	27	17	44	A	A
Calderwood Road	Marshall Mount	Illawarra Christian	44	34	78	A	A
Calderwood Road	Illawarra Christian	North Macquarie	69	108	177	A	B
Calderwood Road	CUDP	Mansons Bridge	69	99	168	B	B
Calderwood Road	Mansons Bridge	Illawarra Highway	142	133	275	A	A
North Macquarie Road	Illawarra Highway	Macquarie Rivulet	9	9	18	A	A
North Macquarie Road	Macquarie Rivulet	Calderwood Road	15	6	21	A	A
Huntley Road	Marshall Mount	Princes Highway	147	93	240	A	A
Tongarra Road	Terry Street	Stapleton Avenue	546	453	999	A	A
Tongarra Road	Stapleton Avenue	Croome Road	410	394	804	A	A
Tongarra Road	Croome Road	Station Road	500	396	896	A	A
Tongarra Road	Station Road	Ti-Tree Avenue	424	370	794	A	A
Tongarra Road	Ti-Tree Avenue	Ash Avenue	323	317	640	A	A
Tongarra Road	Ash Avenue	Princes Highway	445	356	801	A	A
Princes Highway	Woollybutt Drive	Tongarra Road	1,535	1,585	3,120	A	A
Princes Highway	Tongarra Road	Station Road	1,333	1,294	2,627	A	A
Princes Highway	Station Road	Airport Road	1,561	1,378	2,939	A	A
Princes Highway	Airport Road	Illawarra Highway	1,709	1,667	3,376	B	B
Princes Highway	Illawarra Highway	Yallah Bay Road	2,671	1,894	4,565	F	C
Princes Highway	Yallah Bay Road	Southern Freeway	2,610	1,894	4,504	E	C
Princes Highway	Southern Freeway	Huntley Road	491	571	1,062	A	A
Princes Highway	Huntley Road	Mount Brown Road	540	566	1,106	A	A
Southern Freeway On-Ramp	Cormack Avenue	Southern Freeway	-	1,229	1,229		C
Southern Freeway Off-Ramp	Southern Freeway	Princes Highway	994	-	994	C	
Southern Freeway	Princes Highway	Fowlers Road	1,643	1,092	2,735	B	B

Appendix 4F - Existing Mid-block Traffic Volumes & Carriageway LoS
PM Peak

Location			Peak Flow (Veh/hr)			LoS	
Street	Between	And	E/N bound	W/S Bound	Total	E/N bound	W/S Bound
Illawarra Highway	Tongarra Lane	North Macquarie	104	164	268	B	B
Illawarra Highway	North Macquarie	Tullimbar Lane	162	107	269	B	B
Illawarra Highway	Tullimbar Lane	Yellow Rock Road	173	131	304	B	B
Illawarra Highway	Yellow Rock Road	Broughton Avenue	172	140	312	B	B
Illawarra Highway	Broughton Avenue	Church Street	175	145	320	A	A
Illawarra Highway	Church Street	Calderwood Road	311	390	701	A	A
Illawarra Highway	Calderwood Road	Russell Street	383	418	801	A	A
Illawarra Highway	Russell Street	Terry Street	440	704	1,144	A	A
Illawarra Highway	Terry Street	Croome Lane	409	870	1,279	A	B
Illawarra Highway	Croome Lane	Princes Highway	459	843	1,302	A	B
Yallah Road	Marshall Mount	Princes Highway	34	33	67	A	A
Marshall Mount Road	Calderwood Road	North Marshall	19	16	35	A	A
Marshall Mount Road	North Marshall	Yallah Road	24	28	52	A	A
Marshall Mount Road	Yallah Road	Yallah TAFE	30	31	61	A	A
Marshall Mount Road	Yallah TAFE	Huntley Road	31	28	59	A	A
Calderwood Road	Calderwood valley	Marshall Mount	18	17	35	A	A
Calderwood Road	Marshall Mount	Illawarra Christian	26	28	54	A	A
Calderwood Road	Illawarra Christian	North Macquarie	39	23	62	A	A
Calderwood Road	CUDP	Mansons Bridge	50	33	83	A	A
Calderwood Road	Mansons Bridge	Illawarra Highway	71	101	172	A	A
North Macquarie Road	Illawarra Highway	Macquarie Rivulet	11	6	17	A	A
North Macquarie Road	Macquarie Rivulet	Calderwood Road	14	13	27	A	A
Huntley Road	Marshall Mount	Princes Highway	80	60	140	A	A
Tongarra Road	Terry Street	Stapleton Avenue	546	494	1,040	A	A
Tongarra Road	Stapleton Avenue	Croome Road	493	446	939	A	A
Tongarra Road	Croome Road	Station Road	401	511	912	A	A
Tongarra Road	Station Road	Ti-Tree Avenue	390	446	836	A	A
Tongarra Road	Ti-Tree Avenue	Ash Avenue	365	374	739	A	A
Tongarra Road	Ash Avenue	Princes Highway	408	466	874	A	A
Princes Highway	Woollybutt Drive	Tongarra Road	1,465	1,833	3,298	A	B
Princes Highway	Tongarra Road	Station Road	1,212	1,638	2,850	A	B
Princes Highway	Station Road	Airport Road	1,090	1,883	2,973	A	C
Princes Highway	Airport Road	Illawarra Highway	1,301	2,018	3,319	A	C
Princes Highway	Illawarra Highway	Yallah Bay Road	1,779	2,927	4,706	B	F
Princes Highway	Yallah Bay Road	Southern Freeway	1,785	2,873	4,658	B	F
Princes Highway	Southern Freeway	Huntley Road	495	557	1,052	A	A
Princes Highway	Huntley Road	Mount Brown Road	507	549	1,056	A	A
Southern Freeway On-Ramp	Cormack Avenue	Southern Freeway	-	1,159	1,159		C
Southern Freeway Off-Ramp	Southern Freeway	Princes Highway	968	-	968	C	
Southern Freeway	Princes Highway	Fowlers Road	816	1,714	2,530	A	B

Appendix 4G

2009 Existing Intersection Performance

Appendix 4G - 2009 Existing Intersection Performance

Intersection	Intersection Control	AM Peak			PM Peak		
		Degree of Saturation	Delays (sec)	LoS	Degree of Saturation	Delays (sec)	LoS
Illawarra Hwy/ Nth Macquarie Rd	Priority	0.009	13.1	A	0.056	13.1	B
Illawarra Hwy/ Tongarra Rd/Terry St	Signals	0.805	29.5	C	0.793	29.1	C
Illawarra Hwy/ Princes Hwy	Roundabout	1.000	88.2	F	0.362	15.6	B
Princes Hwy/ Tongarra Rd	Signals	0.637	16.3	B	0.780	17.5	B
Calderwood Road/ Nth Macquarie Road	Priority	0.016	15.1	C	0.014	16.2	C
Calderwood Road/ Marshall Mount Road	Priority	0.019	10.9	B	0.010	12.4	B
Marshall Mount Road/ Yallah Road	Priority	0.043	11.1	B	0.022	11.6	B
Huntley Rd/ Marshall Mount Rd	Priority	0.029	10.2	B	0.029	9.9	A
Princes Hwy/ Huntley Rd	Priority	0.294	30.3	D	0.107	22.0	C
Illawarra Hwy/ Calderwood Rd/Macquarie St	Signals	0.393	12.7	B	0.431	10.5	B
Illawarra Hwy/ Broughton Ave	Roundabout	0.138	11.8	B	0.004	11.6	B
Tongarra Rd/ Station Rd	Priority	0.290	14.7	B	0.294	13.7	B
Yallah Rd/ Princes Hwy on-ramp	Priority	0.057	10.0	A	0.057	10.0	A
Yallah Rd/ Haywards Bay Dr	Priority	0.061	8.8	A	0.039	8.9	A
Illawarra Hwy/ Yellow Rock Rd	Priority	0.044	15.5	C	0.013	15.7	C
Haywards Bay Drive/ Princes Highway southbound ramps	Roundabout	0.034	11.3	A	0.026	11.4	A
Princes Highway/ Southern Freeway (Tallawarra northbound off-ramp)	Priority	0.349	17.7	B	0.583	23.6	B
Princes Hwy/ Cormack Ave	Priority	0.674	20.2	B	0.999	36.7	C

Appendix 4H

Rail Infrastructure and Services

APPENDIX 4H - RAIL INFRASTRUCTURE AND SERVICES

The South Coast Railway Line is located approximately 3km east of the study area on a north-south axis, running parallel to, and east of, the Princes Highway. It is currently a single, electrified track with a number of at-grade and grade separated road crossings. Vehicular and pedestrian crossing opportunities within the study area are located at:

- Huntley Road (road overbridge).
- Princes Highway (road overbridge).
- Haywards Bay Drive (road overbridge)
- Windang Street (level crossing).
- New Lake Entrance Road (road overbridge).

Dapto, Albion Park and Oak Flats are the closest railway stations to the proposed development. Dapto Railway Station is located approximately 6-8 kilometres north and accessed via Marshall Mount Road and Princes Highway, whilst Albion Park is located approximately 4km to the east via Tongarra and Station Roads. Oak Flats station is located approximately 5km to the east.

A bus interchange is located at Dapto but is presently unused as most services do not deviate off the Princes Highway which is only a short walk away. There are currently no direct bus services between Albion Park and Dapto. Bus travel between Albion Park and Dapto would require a transfer on the Princes Highway at Albion Park Rail to one of the "Lake Loop" services for travel to or from Dapto or Wollongong. Bus/rail transfers at Albion Park Station are facilitated by bus stops located on Princes Highway near the station entrance. Limited commuter parking is provided at both stations.

Currently, services on the South Coast railway line generally operate as through services between Sydney Terminal and the end of the electrified track at Kiama, although some diesel services commence from Bomaderry and terminate at Dapto with connecting electric services commencing at Dapto and heading to Sydney.

Table 1 presents a guide to the frequency of rail services serving Albion Park and Dapto railway stations.

Table 1 Frequency of Rail Services serving Albion Park and Dapto Railway Stations

Direction	Weekdays				Weekends	
	AM Peak	Daytime	PM Peak	Evening	Daytime	Evening
Northbound	2tph	1tph	1-2tph	1-3tph	1tph	1tph
Southbound	1-2tph	1tph	1-2tph	2tph	1tph	1tph

Note: tph = trains per hour

The service frequency levels quoted in Table 1 are approximate only, as services do not operate to a consistent clock face timetable. The infrequency and irregularity of services is a disincentive to travel, as waiting times are significant and variable, requiring passengers to plan around the rail timetable. Infrastructure constraints, including the single track and at-grade road crossings, are impediments to any increase in service frequency.

As part of planning for the WDRA, a new railway station was proposed adjacent to the Huntley Road bridge over the South Coast railway line, 3km south of Dapto. The station was a long-term proposal, with the intention of forming the focus of a higher density residential node and assisting the provision of viable public transport services. Railcorp estimated that the critical point for determining whether the station would be provided or not would be reached in 10-15 years time. The Growth Centres Commission review of planning for the WDRA in November 2008 questioned the need for the provision of a railway station at Huntley, indicating that it was unlikely that development of the release area would produce sufficient patronage to justify the cost of the station and associated track amplifications.

Appendix 4I

Bus Services

APPENDIX 4I - BUS SERVICES

Premier Illawarra operates bus services in the Wollongong area, with routes stretching from Kiama in the south to Bellambi in the north. A network of three routes serves the greater Dapto area and a network of three local routes serves the Albion Park area. They function as the primary mode of public transport for local trips and trips within the Wollongong region, with the railway used predominately for longer trips.

Due to the rural nature of Calderwood, no bus routes presently serve the immediate area. The closest bus routes are located at Albion Park. Table 1 provides a summary of these nearby routes and the level of service provided.

Table 1 Summary of Bus Services in Calderwood Area

Route No.	Route	Frequency Guide (approximate headway in minutes)					
		Direction	Weekday			Saturday	Sunday
			Peak	Off-Peak	Night	Daytime	Daytime
31	Horsley – Dapto - Wollongong	Northbound	30*	60	60*	60	120
		Southbound	30*	60	60*	60	120
33	Penrose – Dapto – Horsley – Dapto – Koonawarra – Kanahooka – Wollongong	Northbound	30	60	1 service only	60	120
		Southbound	1 service only	60	60	60	120
37	LAKE LINK – ANTI-CLOCKWISE LOOP University – Wollongong – Warrawong – Shellharbour – Dapto – University	Southbound	60	60	120	60	60
43	Penrose – Dapto – Koonawarra – Kanahooka – Berkeley – Warrawong – Port Kembla	Northbound	60	60	No service	60	60
		Southbound	60	60	No service	60	120
51	Albion Park – Oak Flats – Shellharbour City Centre - Windang – Wollongong - University	Northbound	120	120	No service	No service	No service
		Southbound	120	120	No service	No service	No service
57	LAKE LINK – CLOCKWISE LOOP University – Dapto – Shellharbour – Warrawong – Wollongong – University	Northbound	60	60	120	60	60
70	Albion Park – Oak Flats – Shellharbour City Centre - Mt Warrigal – Barrack Point - Shellharbour Beach	Eastbound	1 service only	120	No service	120	1 service only
		Westbound	100	120	1 service only	120	No service
73	Albion Park – Oak Flats – Shellharbour City Centre – Mt Warrigal – Shell Cove – Shellharbour City Centre	Clockwise	No service	No service	No service	No service	120
		Anti-clockwise	No service	No service	No service	No service	120
76	Albion Park – Shellharbour City Centre	Eastbound	60	60	60	120	120
		Westbound	40	120	1 service only	120	120

Route No.	Route	Frequency Guide (approximate headway in minutes)					
		Direction	Weekday			Saturday	Sunday
			Peak	Off-Peak	Night	Daytime	Daytime
Cityrail Bus – Wollongong to Moss Vale		Eastbound	2 services only	1 service only	1 service only	4 services only	4 services only
		Westbound	1 service only	1 service only	No service	3 services only	3 services only

* Approximate average headway due to irregular service frequency

Whilst services are infrequent, most operate at, or close to, a clock face timetable (i.e. services arrive at the same time in each hour) at most times of the day. This format is easy to memorise and makes travel planning around a public transport timetable significantly easier.

However, as shown in **Error! Reference source not found.**, the routes are circuitous, which increases travel time significantly. Public transport information is poor, with network maps and timetables difficult to decipher. The interchange arrangements at Albion Park Railway Station are difficult to understand and it is not clear to potential users of the system whether Route 37/57 buses stop at Yallah.

Improvements to service frequency and fare structures would significantly increase the attractiveness of interchanging between bus and rail services, reducing journey time for longer distance trips. It would also increase the attractiveness of transferring between the different bus services, increasing the number of potential origin and destination combinations accessible by public transport.

Bus services will need to be extended or created to serve the Calderwood development. This is discussed further in Section **Error! Reference source not found.**.

Appendix 4J

Proposed Bus Network

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Figure 4J

Illawarra Bus Network Review - Proposed Bus Network

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Appendix 4K

City Of Wollongong Bicycle Plan 2006-11

APPENDIX 4K - CITY OF WOLLONGONG BICYCLE PLAN 2006-11

The *City of Wollongong Bicycle Plan 2006-11* provides a plan of action for the provision of bicycle facilities within Wollongong local government area. Maps are provided identifying existing and proposed cycleways, however whether these are provided as on or off-road facilities is not specified. The plan is reproduced in the following figure and key features are summarised below:

- Relevant existing cycleways include:
  - Princes Highway from Huntley Road to Macquarie Rivulet (on-road cycle lanes using the road shoulder, except across Macquarie Rivulet bridge where an off-road path is provided).
- Relevant proposed cycleways include:
  - Princes Highway and Marshall Street from Huntley Road to Dapto town centre.
  - Southern Freeway north of Princes Highway.

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Figure 4K

Wollongong Bicycle Plan 2006-2011

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- Cycleway
- Proposed Cycleway
- Wollongong LGA Boundary
- Learn To Ride Facility

Wollongong
City of Innovation

NCS International
CERTIFIED QUALITY MANAGEMENT SYSTEM
ISO 9001

N	GIS ref. gi05773-05
	Printed: 4/04/2006
	ArcGIS 9.1 - ArcMap - ArcInfo
	Scale 1:30,000

250 0 250 500 750 1,000
Meters

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Shaping the Future

Appendix 4L

Shellharbour Local Government Area Shared Use Path Strategy 2008

APPENDIX 4L - SHELLHARBOUR LOCAL GOVERNMENT AREA SHARED USE PATH STRATEGY 2008

The recent 2008 Shellharbour LGA Shared Use Path Strategy replaces the *Shellharbour Bike Plan 1996* and provides details of the cycle facilities to be implemented, along with design guidelines. Existing and proposed on and off-road facilities are defined, as well as proposed 'Preferred Routes' along quiet streets and 'Dismount Zones' through areas of high pedestrian activity. The plan is reproduced in the following figure and the key features are summarised below:

- Relevant existing on-road facilities include:
  - Tongarra Road between Albion Park and Albion Park Rail.
- Relevant existing off-road facilities include:
  - Terry Street shared path.
  - Tullimbar Village shared path.
  - Various sections of shared paths around Church Street area of Albion Park.
- Relevant proposed off-road facilities include:
  - Illawarra Highway from Russell Street to Tullimbar Village.
- Relevant proposed Preferred Routes include:
  - Taylor Road and Calderwood Road from Illawarra Highway to Mansons Bridge.
- Relevant proposed Dismount Zones include:
  - Illawarra Highway, Terry Street and Tongarra Road in the immediate vicinity of Albion Park town centre.

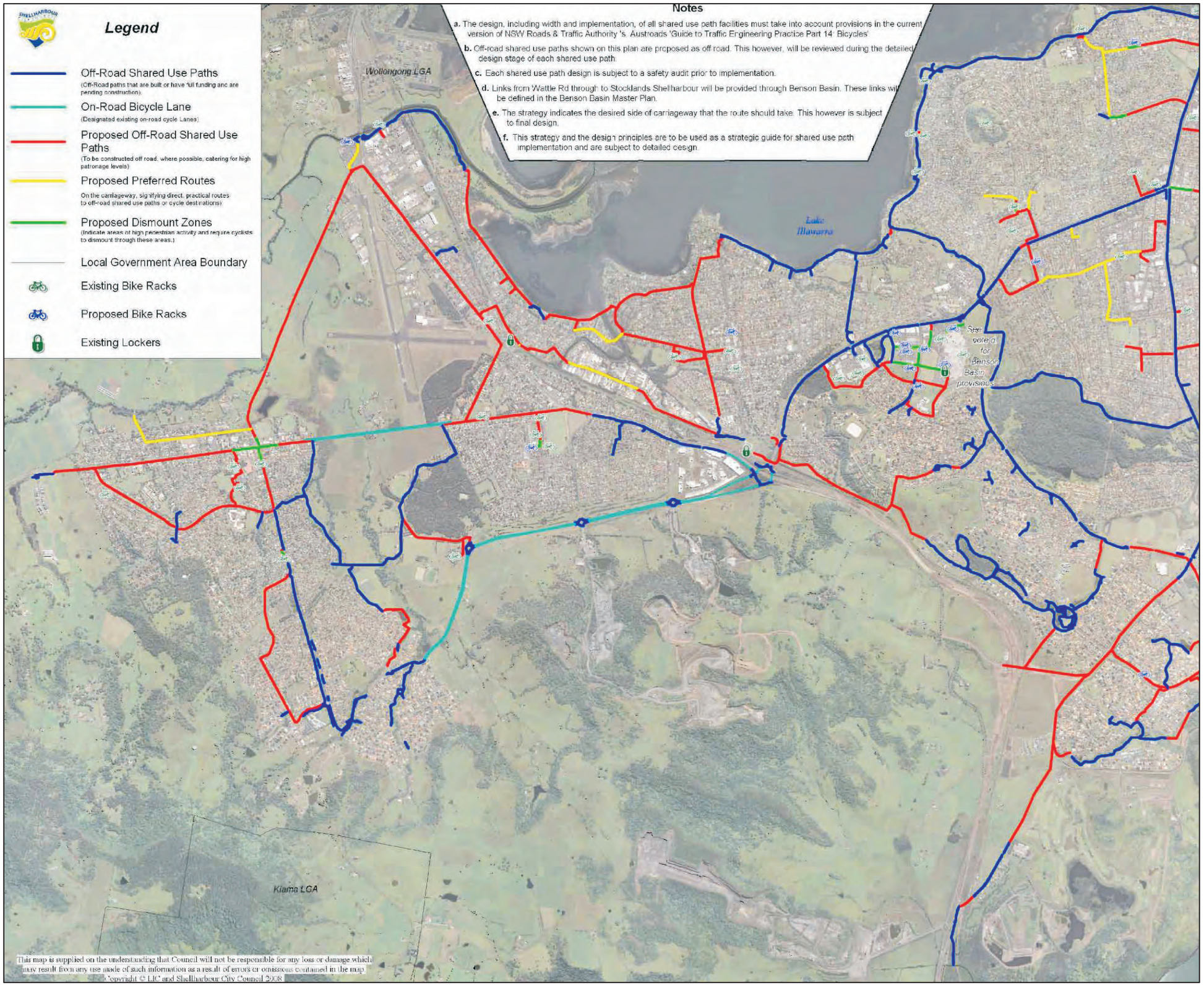

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Figure 4L

Shellharbour Shared Path Strategy 2008

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URBAN DEVELOPMENT PROJECT

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Appendix 4M

JTW Data Explanation

APPENDIX 4M - JTW DATA EXPLANATION

Before interpreting the JTW data provided in this section it is important to briefly describe what the data represents and its limitations and strengths to determine its reliability for making important decisions.

Journey to Work

Journey to Work data is collected by the Australian Bureau of Statistics as part of the Australian national census. Data consists of employment counts for specific locations and method of travel to work gathered via a completion Census form that is carried out every five years. All commuting trips are recorded. The data represents linked trips (explanation is provided below).

This dataset highlights one of the key trip generating purposes which is "commuting" (i.e. travel to or from a place of employment). This dataset is a good bench mark as it is a 100% sample dataset. As a result, it is ideal for estimating peak trip counts and to make comparisons between different years. However the dataset does not provide a comprehensive picture of travel modes used. Refer to discussion on mode hierarchy below.

Data Coverage

The 2006 JTW data covers the Greater Metropolitan Area (GMA) (made up of Sydney, Illawarra, and Newcastle Statistical Subdivisions (SD06s)) plus areas surrounding the GMA (as specified in the data).

Linked and Unlinked trips

An **unlinked trip** is each component of a linked trip, including each mode used. For example, a person living in Dapto and working in the Wollongong CBD travels by train with a walk trip at either end of the train trip. This would be one linked trip (mode=Train) and three unlinked trips as shown in Table 1.

Table 1 Example of linked and unlinked trips

Trip No.	Origin	Destination	Mode	Purpose
1	Home	Dapto Station	Walk	Change mode
2	Dapto Station	Wollongong Station	Train	Change mode
3	Wollongong Station	Workplace	Walk	Work

Mode Hierarchy

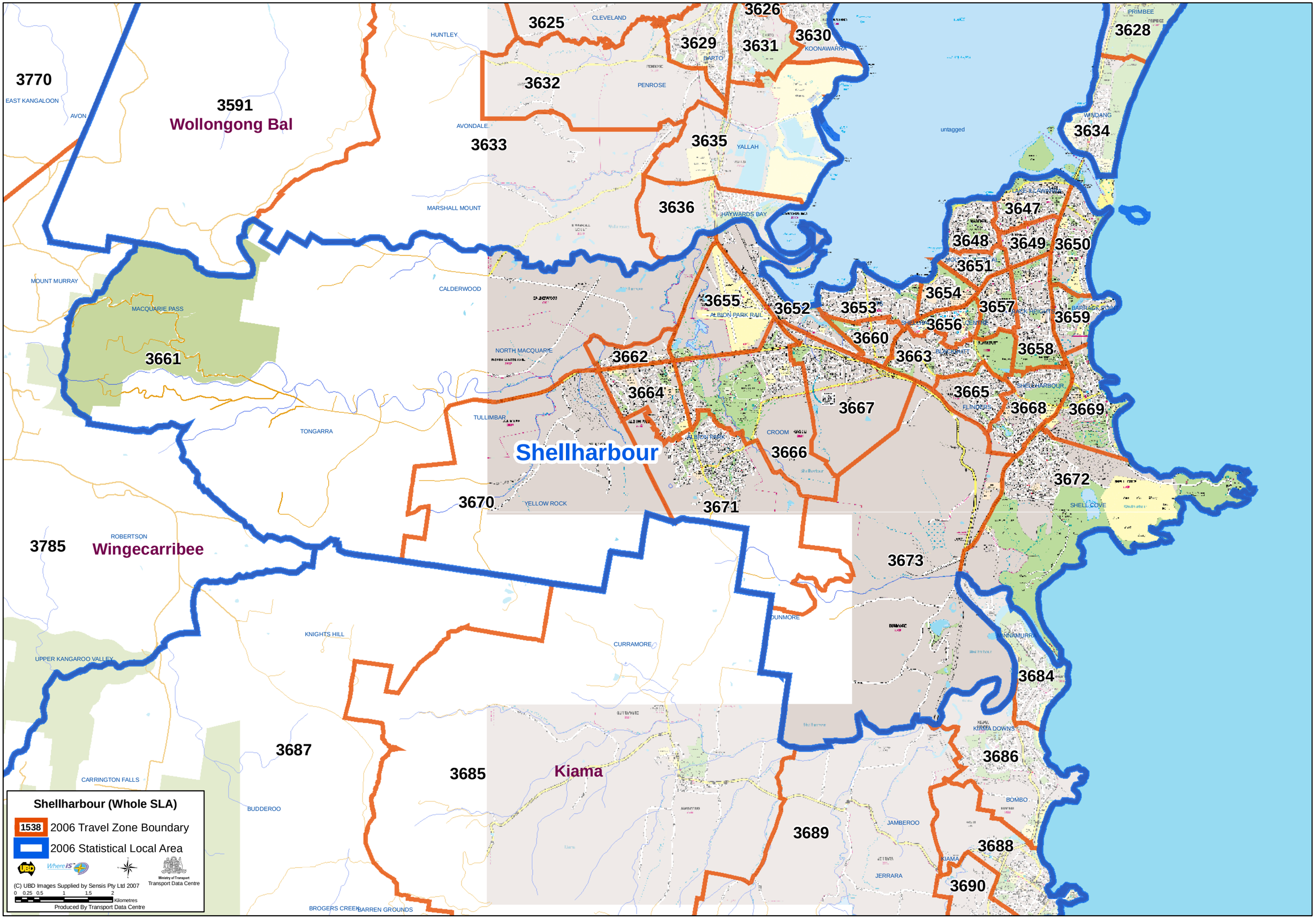
Travel data is aggregated based on a modal hierarchy that attributes the trip only to the highest-ranking mode in the hierarchy (shown in Table **Error! No text of specified style in document.**.2). For example, driving to a station and taking the train to work would is considered as a trip by train, as is catching the bus to the station and taking the trip to work. For this reason, some modes are unrepresented, especially bus trips, and the extent of intermodal transfer is not recognised.

Table Error! No text of specified style in document..**2 Journey to Work Mode Hierarchy**

Mode	JTW Priority
Train	**Highest**
Bus	
Ferry	
Light rail/tram	
Taxi	
Car driver	
Car passenger	
Truck	
Motorbike	
Bicycle	**Lowest**
Other	
Walk	

Zones

To identify the origin or destination of trips to/from different areas within LGAs, travel zones are used. These are defined in the following figures for the Wollongong and Shellharbour LGAs.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AVON
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Wollongong Bal
MOUNT MURRAY
MACQUARIE PASS
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ROBERTSON
Wingecarribee
HUNTLEY
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CLEVELAND
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PENROSE
AVONDALE
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MARSHALL MOUNT
CALDERWOOD
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YELLOW ROCK
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DUNMORE
KNIGHTS HILL
CURRAMORE
UPPER KANGAROO VALLEY
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KIAMA DOWNS
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CARRINGTON FALLS
BUDDEROO
BOMBO
JAMBEROO
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KIAMA
JERRARA
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BROGERS CREEK
BARREN GROUNDS
Shellharbour (Whole SLA)
1538 2006 Travel Zone Boundary
2006 Statistical Local Area
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Ministry of Transport
Transport Data Centre

Shellharbour (East)

1538 2006 Travel Zone Boundary

2006 Statistical Local Area

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Wollongong Bal

Shellharbour

3785 Wingecarribee

Kiama

3687

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AVON

MOUNT MURRAY

MACQUARIE PASS

AVONDALE

PENROSE

YALLAH

MARSHALL MOUNT

HAYWARDS BAY

Wollongong

CALDERWOOD

ALBION PARK RAIL

NORTH MACQUARIE

TULLIMBAR

ALBION PARK

YELLOW ROCK

TONGARRA

ROBERTSON

CARRINGTON FALLS

KNIGHTS HILL

BUDDEROO

JAMBEROO

CROOM

CURRAMORE

Shellharbour (West)

1538 2006 Travel Zone Boundary

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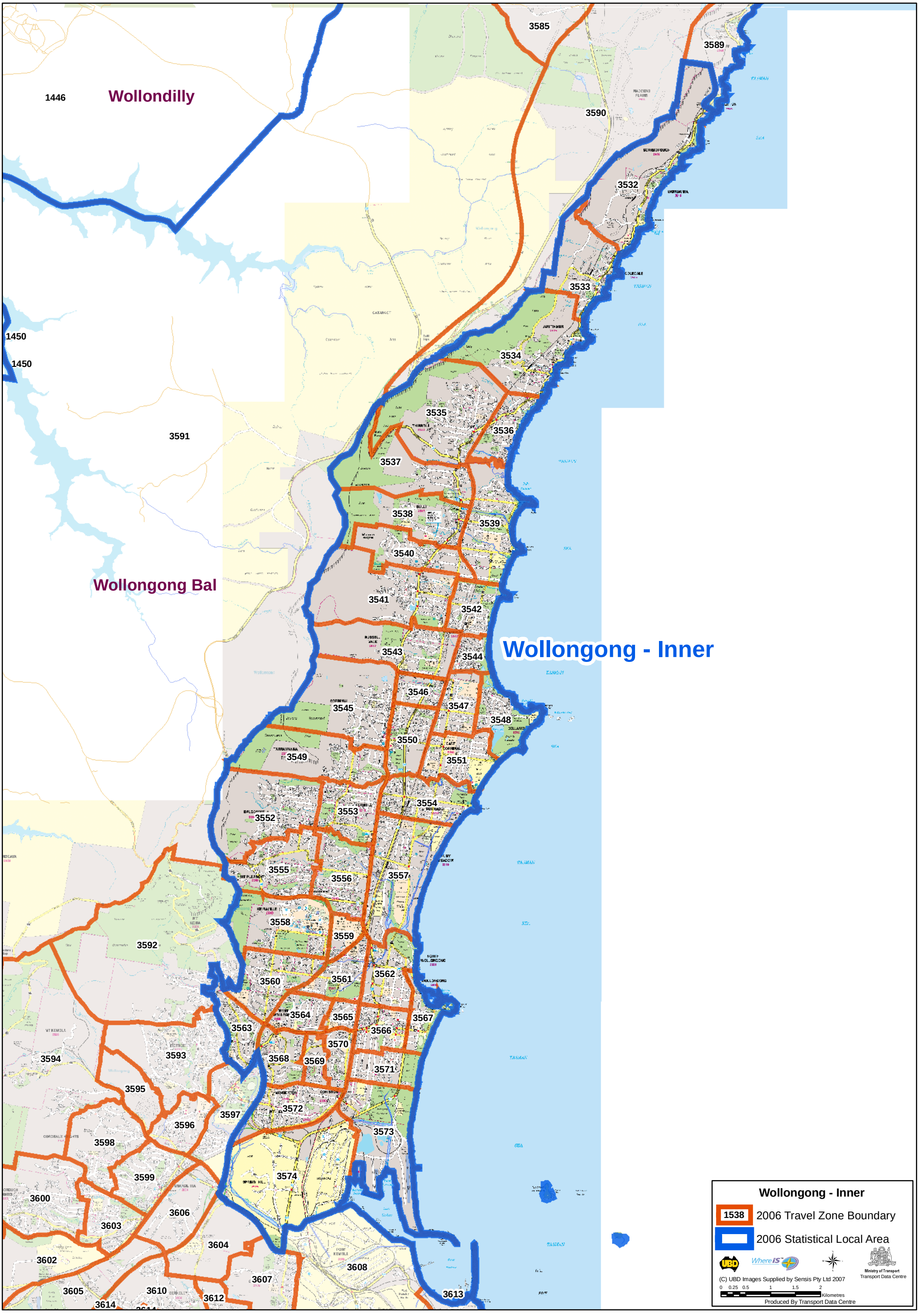
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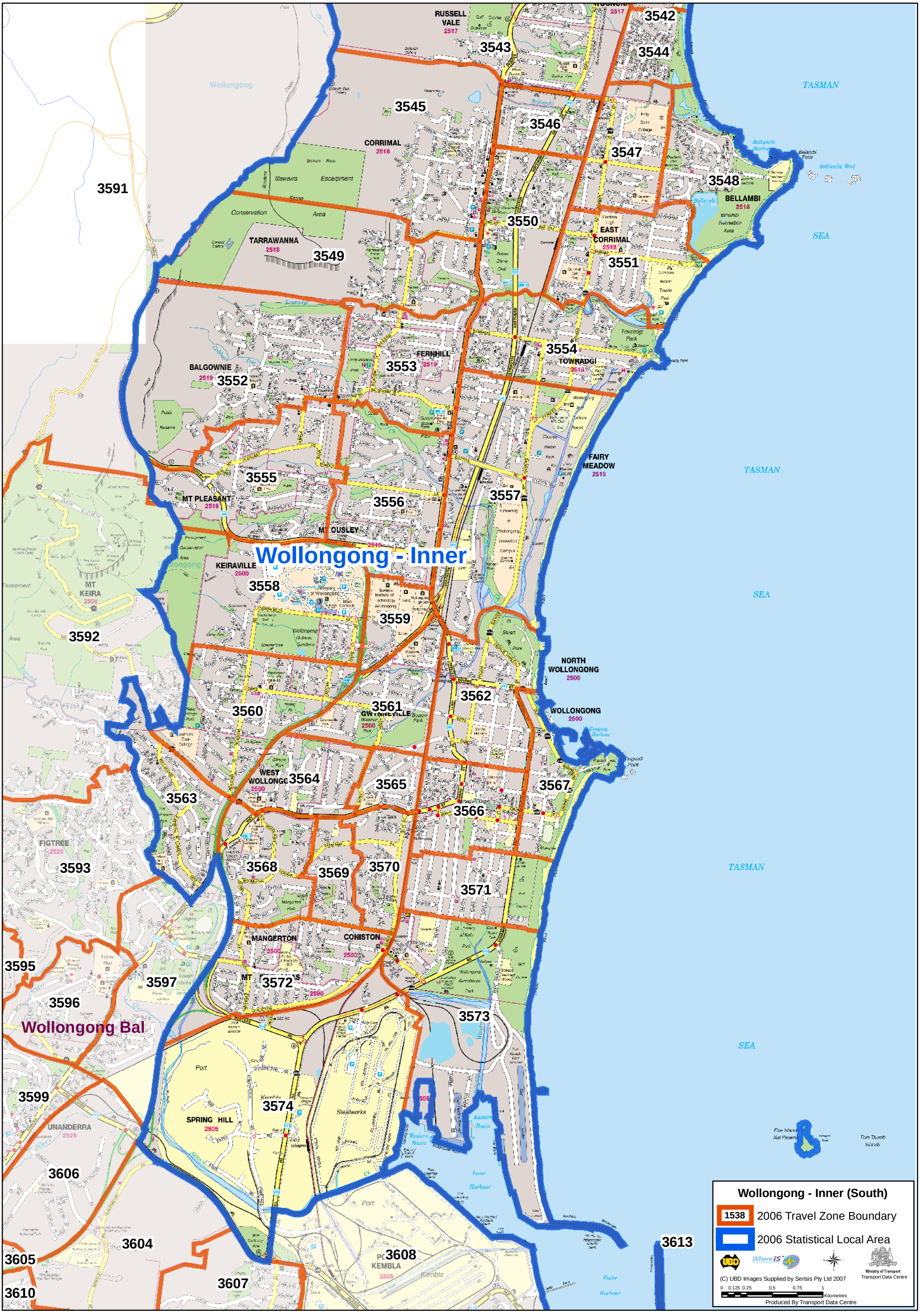
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Bellambi Harbour
Bellambi Reef
Belambi Point
Towradgi Park
Wollongong Botanic Gardens
Stuart Park
Tom Thumb Islands
Five Islands Nat Reserve
Port Kembla
Steelworks
Eastern Basin
Western Basin
Inner Harbour
Outer Harbour
Wollongong - Inner (South)
1538 2006 Travel Zone Boundary
2006 Statistical Local Area
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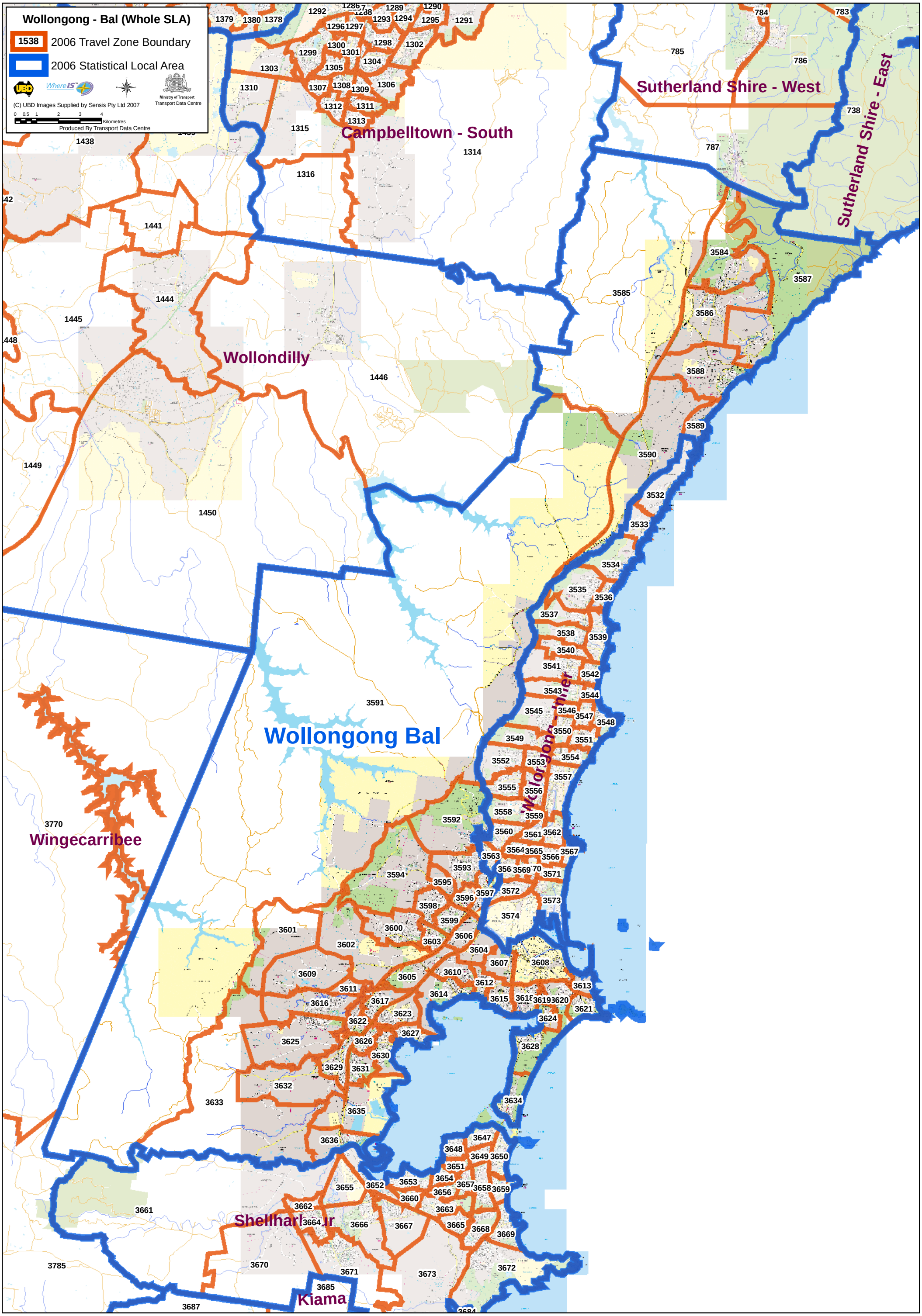
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