FIGURE 15 – COMPOSITE DEVELOPMENT CAPABILITY MAP, WARRIEWOOD VALLEY BUFFER AREAS

2.6 Definition of buffer areas

Between the 2001 review of the development capacity of the STP buffer areas and the most recent review in 2010, the Council revised the definition of the buffer areas (Figure 16 refers). The main areas of change were:

- The creekline corridors (including adjacent environmental areas) were removed;
- Part of Buffer Area 1 along Macpherson Street was relocated to Buffer Area 2 (now part of Buffer Area 2a);
- The ARV seniors housing development on Macpherson Street was removed from Buffer Area 2 which was renamed Buffer Area 2a;
- Buffer Area 3 was split into 2 comprising 14-18 Boondah Rd as Buffer Area 3a (8.114 hectares) and 5-7 Macpherson Street (2,996m^2) renamed to Buffer Area 3b.

A consequence of this review is that the total net developable area of the remaining Buffer Areas has been reduced in size to 17.4 hectares (further details set out in Table 4).

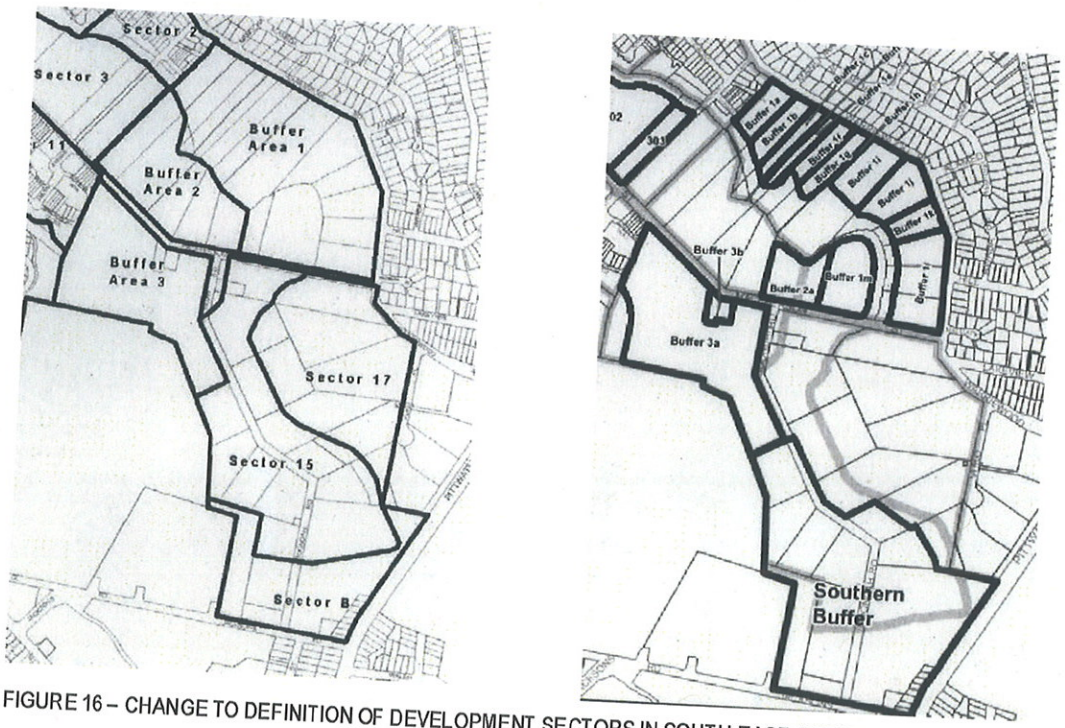


FIGURE 16 – CHANGE TO DEFINITION OF DEVELOPMENT SECTORS IN SOUTH-EAST CORNER OF RELEASE AREA

2.7 Note about dwelling density in Warriewood Valley and implications for the buffer areas

The maximum dwelling densities quoted in Council planning documents and statutory instruments relate to the dwellings permissible within the net developable areas remaining after flood prone and environmentally constrained land has been removed. The 2010 Planning Framework indicates the Council's assessment of the dwelling capacity of each of the buffer sites, which are summarised in Table 1.

This approach differs from the State Government's approach to setting targets for the density of release areas, which are based on gross development area, excluding regional land uses.

Table 1 – Development capacity of Buffer Areas (1997 and 2010)

Area	Gross Area (ha) (1997)	Land-uses	Net area	Assumed dwellings density/ ha	Potential dwellings 1997	Potential dwellings 2010
Buffer Area 1	15.7	Mixed residential Conservation	9.1 7.0	15 -	136	201
Buffer Area 2*	6.1	Medium density Conservation	5.0 1.4	25 -	125	20
Buffer Area 3	8.4	Medium density Conservation/ Recreation	6.0 1.7	25 -	151	193
TOTAL	**30.2**				**412**	**414**

Source: Warriewood Valley Planning Framework 2010 - Table 16: Development density and population projection as estimated in 1997 (updated in 2001), and Table 17: Projected dwelling yields for revised sectors.
Note *: Buffer Area 2 reduced in size due to removal of new development for seniors housing.

The brief for this assessment requires consideration of the density proposed on the 14-18 Boondah Road site, and quotes a density of 75 dwellings per hectare. It should be noted that the density of 75 dwellings per hectare reflects the gross density: that is the number of dwellings proposed in the concept plan (600), divided by the gross area (8.116 hectares).

Notwithstanding the information in Table 16 of the 2010 Strategy on the net area of Buffer Area 3, Council advised that the net developable land within 14-18 Boondah Road is around 7.4 hectares. Using Council's assessment of the net developable area for Buffer Area 3, the density of development would be calculated as 81 dwellings per hectare (600 dwellings/ 7.4 hectares). For consistency, we have adopted the Council's approach based on the density of development on the net developable land in the buffer areas, in this review.

3. FLOODING AND WATER MANAGEMENT IN WARRIEWOOD VALLEY

The primary guidance document for flooding and water management within Warriewood Valley is Pittwater Council's 2001 *"Warriewood Valley Urban Land Release Water Management Specification"* (WMS).

The WMS requires consideration of the following elements:

- Stormwater quantity management – including assessment of hydrology and implementation of above or below ground detention measures to meet base case conditions defined by Cardno Lawson & Treloar (CLT);
- Stormwater quality management – comprising assessment of water quality (including nutrients and other pollutants) and implementation of stormwater treatment measures to meet base case conditions;
- Water balance – including assessment of runoff volumes and implementation of measures to achieve pre development conditions;
- Stormwater conveyance - implementation of best practice stormwater drainage systems;
- Flooding – comprising assessment of existing flooding, post-development flooding, any flood impacts, flood risk, flood evacuation and implementation of flood impact amelioration measures; and
- Water quality monitoring - undertaking and reporting on water quality before, during and following development.

A number of precursor studies/reports have been undertaken to justify/support the requirements of the WMS, including the "*Integrated Water Management Strategy – Warriewood Valley*" by Lawson & Treloar, November 1997.

The Integrated Water Management Strategy and its accompanying models contain a range of key assumptions.

Critical among these is the assumed level of impervious areas (*or impervious fraction*) within each sector of the valley, which is generally capped at 50% of the gross site area. That is, the amount of impervious surface should not exceed 50% of the gross site area of the development parcel, including the area of creekline corridor, etc. Impervious surfaces include all hard surfaces - roofs, roads, paths, etc – across each development site.

CLT have also established a flood model and produced a detailed flood study report for Warriewood Valley. This model and report have been updated progressively as development has advanced throughout the valley.

The latest Flood Study report addendum was issued in July 2005.

The CLT flood model provides detailed predictions of flood levels throughout the Valley under the current development scenario for a range of storm frequencies, including the. 5yr, 20yr, 100yr flood event and the Probable Maximum Flood (PMF). It also tested a number of Climate Change scenarios.

Riparian corridors have been defined by Pittwater Council for each of the primary creeklines that traverse the valley. In the majority of cases this entails a 50m central section of creek dedicated as public space, with a further 50m landscape buffer (25m each side of the 50m central corridor) to be retained in private ownership resulting in a creekline corridor of 100m total width.

This creekline corridor is considered to be generous, and in most cases the first 50m (the publicly-owned creek corridor) fully contains the 1 in 100 year flood extents.

In summary, in respect of flooding, the key drivers behind the water management strategy for the valley are:

- The amount of impervious surfaces for all developments should be no more than 50% of the gross site area;
- Stormwater runoff volumes leaving the land should achieve pre-development levels; and
- Water quality should meet agreed standards for nutrients, etc.

4. STRATEGIC CONTEXT FOR WARRIEWOOD VALLEY

4.1 Sub-Regional Strategy

The North-east Sub-regional Strategy was published by the Department of Planning. It comprises a series of directions and targets for employment and housing in response to the forecast growth of the Sydney Region to 2031.

4.1.1 Housing

The key directions for housing in the NE Sub-Region include (a) increasing housing choice, (b) concentrating development and strengthening major centres through to small villages and neighbourhoods, and (c) enabling communities to "age in place".

The sub-regional strategy identified that 80% of the housing stock in Pittwater comprises detached dwellings, less than 15% in villas/ townhouses and the like, and less than 6% as units or apartments. The percentage of attached dwellings is significantly less than the remainder of north-east sub-region which includes Warringah and Manly. As a result housing choice in Pittwater is severely limited, with evidence that there is a significant demand for a broader mix of dwellings.

The Strategy also highlights the benefits of higher density housing in supporting the objectives for centres, transport objectives, and addressing housing affordability.

The specific target for additional dwellings to 2031 for the Pittwater Council area is 4,600 dwellings. The intent of the Sub-regional strategy is to set a target that is to be embodied in replanning for centres and localities within each local government area, and is to be reflected in new comprehensive local environmental plans.

4.1.2 Employment

Employment uses are identified at Warriewood Square shopping centre, as well as the Vuko Place precinct off Warriewood Road, and the business Park area at the northern end of Ponderosa Parade adjacent to Mona Vale Road.

The target for jobs in the north-east subregion to 2031 is for an additional 6,000 jobs.

4.2 Metropolitan Development Program (MDP)

The latest MDP for Sydney covers the 5 year period 2008/2009 to 2012/2013. For the Pittwater LGA the 5 year dwelling production estimate/ forecast is for an additional 1,580 dwellings approximately. This compares with around 1,375 dwellings produced over the previous 5 years, and 1,040 dwellings in the 5 years before that. Beyond the next 5 years an additional 925 dwellings are expected.

Of those 1,580 dwellings, around 470 are expected to be in infill areas, 130 at transit nodes (Warriewood Square and Mona Vale have been nominated as transit nodes in Pittwater) and 979 in release areas, such as Warriewood Valley. No major redevelopment sites (such as Dee Why Town Centre in Warringah LGA) have been identified under the MDP for Pittwater, with Ingleside being identified as the primary source of greenfield housing for the subregion.

5. SUMMARY OF PROPOSALS AT 14-18 BOONDAH ROAD

The proposed development at 14-18 Boondah Road (see Figure 17 and Figure 18) consists of the following, gleaned from the Part 3A documentation presently on public exhibition:

- A gross site area of 8.116 hectares, with frontage to Macpherson Street and Boondah Road;
- 13 residential buildings ranging in height from 3 storeys along Macpherson Street and Boondah Road to 5 storeys in the internal part of the site (see Figure 19 and Figure 20);
- Child care centre, retail shops, and swimming pool/ recreation centre/ gym;
- 600 apartment dwellings that will consist of a mix of studio, 1, 2 and 3 bedroom apartments;
- Stage 1 of 313 apartments to comprise 4% studios, 20% 1 bedroom, 71% 2 bedroom and 11% 3 bedroom apartments;
- Development density of around 75 dwellings per gross hectare, and gross floor area (GFA) of around 53,100m2 giving a floor space ratio of around 0.65:1;
- Internal streets, including one street to be dedicated to Council;
- Open space and creekline restoration works along Fern Creek, which forms the western and southern boundary of the site, in addition to on-site stormwater management and water quality ponds; and
- Pedestrian and cycle paths through the site and linking with existing and proposed pathways throughout the Valley.

FIGURE 17 – AERIAL OF THE 14-18 BOONDAH ROAD SITE

FIGURE 18 – AERIAL OF THE 14-18 BOONDAH ROAD SITE AND ADJOINING PROPERTIES

FIGURE 19 – CONCEPT PLAN FOR 14-18 BOONDAH ROAD

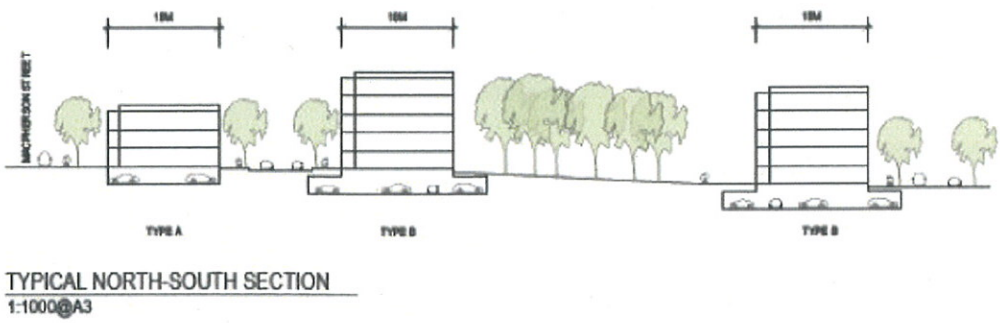


FIGURE 20 – NORTH SOUTH SECTIONS THROUGH PROPOSED DEVELOPMENT 14-18 BOONDAH ROAD

6. PRINCIPLES FOR CONSIDERING HIGHER DENSITY DEVELOPMENT

In addressing this strategic review, we have identified a number of planning criteria and associated principles relevant to any consideration of increasing the density of development in the Warriewood Valley. While most of the criteria relate to Warriewood specific issues (especially the implications of flooding and the environmental values of the riparian environment) they borrow from issues typically addressed in any density review:

- Site characteristics including development constraints and opportunities – soils and topography, flooding, environmental values;
- Locational characteristics;
- Availability of services and potential housing outcomes;
- Building placement and separation and compliance with agreed standards/ guidelines;
- Setback of buildings from creeklines/ overshadowing of creeklines and achievement of environmental outcomes;
- Building height and visual context;
- Site cover and deep soil planting; and
- Traffic and transport implications.

The application of these principles for Buffer Areas 1-3 is discussed below.

6.1 Site, location, utility services and housing outcomes

The establishment of a suitable density for areas should take into consideration a wide range of elements including:

- The development capacity of the land, in terms of site characteristics, risks, etc;
- Location relative to available urban services and amenities, including jobs, roads, public transport;
- The availability of suitable land areas (shape and size) for the intended development outcomes;
- The capacity of utility services (water, sewerage, power, etc), including the ability to augment those services;
- The ability to create an environment that is safe and attractive, and which contributes to community building; and
- The potential to increase housing choice, and the availability of more affordable housing.

While the physical site characteristics do not change over time, the value of those characteristics, the nature of the risks, and the surrounding context and broader objectives may change, which have the potential to justify reconsideration of the development capacity of an area.

The reviews of the Warriewood Valley undertaken by the Council since the late 1990s have addressed a number of these issues.

6.2 Flooding and water management

One of the key risks relates to flooding and water management. Council has carried out considerable technical analysis of the flooding on the area arising from its natural drainage conditions, and identifying measures to manage flood and water management impacts from urban development. Recent concerns about the effect of climate change on flood levels have also been built into the analysis for the Warriewood Valley. The water management approach has been reflected in land-use planning and development controls for the area. These measures augment the ecological outcomes sought for the area.

A robust framework has been established that is applied rigorously to development proposals within the valley.

6.3 Building height and visual context

It is relevant to consider building height in the context of the visual setting, created by existing landscape character and future landscape planting, topography, key view lines and vistas, especially from the public domain.

The visual character of the Warriewood Valley was the subject of assessment as part of the planning process, with an apparent focus on the implications of areas of visual interest on the identification of potential development areas.

6.4 Building separation

To date, the low-medium density of development has been managed through a series of controls that relate to built form, development density, site cover and minimum landscaped areas.

For higher density development comprising apartment buildings, the Residential Flat Design Code to SEPP 65 outlines standards for the separation required between buildings of different heights.

In a greenfields environment such as this, site planning for higher density development should seek to meet these standards where possible.

6.5 Site cover/ deep soil planting

Pittwater DCP 21 stipulates that site coverage for development within Warriewood Valley should not exceed 50%. This site coverage has been determined based on the need to minimise impervious surfaces as part of the response to flood management (see discussion at Section 3), as well as for amenity and the availability of land for deep soil planting to create suitable landscape outcomes.

Any increase in development density will need to ensure that it meets this strict criterion, so that the flood management objectives are not compromised in particular.

6.6 Building setback from creekline corridors

The planning framework for Warriewood Valley includes a requirement for development to be set back at least 25 metres from the designated creekline corridor. This landscaped creekline buffer is to be retained in private ownership, and is able to accommodate informal/ passive recreation facilities/ pedestrian and cycle pathways/ lighting, access roads for the adjacent development areas. In the case of Warriewood, it contributes to the visual character of the creeklines, and counts towards the public open space requirements for the area.

Any increase in density should include provision for the landscaped buffer.

6.7 Overshadowing of creekline corridors

The potential overshadowing of vegetation in the creekline corridors by adjacent buildings is a relevant consideration in assessing the scale of adjoining development.

Any assessment should ensure that new buildings do not adversely affect the creekline ecology.

6.8 Traffic and transport

The Warriewood Valley Roads Masterplan 2006 prepared by the Council identifies in detail the road works and traffic management measures, and facilities for buses, cyclists, and pedestrians required in the Warriewood Valley. It covers such aspects as road reserve widths, traffic volume limits for the types of roads within Warriewood, road design speeds, preferred designs for intersections, the location of roundabouts,

street cross-sections, the location and design of bus bays, the location and design of pedestrian paths and cycle paths, street lighting, and locations for road widenings and intersection modifications.

The masterplan has been updated as the development potential of the valley has been revised.

In addition to the masterplan, Pittwater DCP 21 identifies the preferred location of new streets within the buffer areas, notably, a new street network within Buffer Area 1, connecting Warriewood Road.

The traffic and transport implications of higher density development within the buffer areas should be assessed according to best practice guidelines for traffic impact studies, taking into account the latest masterplan. It should address all the relevant traffic and transport issues including traffic volumes, intersection performance, levels of service, degree of saturation and delay times. The analysis should identify suitable ameliorative measures such as intersection upgrades, street widening, and the like.

7. SUITABILITY OF REMAINING BUFFER AREAS FOR HIGHER DENSITY DEVELOPMENT

7.1 Review of environmental constraints across buffer areas

The characteristics of the buffer areas have been comprehensively reviewed, and key environmental and risk characteristics including flood risk, riparian values and vegetation/ fauna values have been taken into account in the original planning for the area to identify areas suitable for development, and those areas worthy of conservation and/ or risk areas that should be excluded from development. Local planning through the development control plan (Pittwater DCP 21) reflects these parameters. The approach overall appears a sound basis for land-use planning.

The planning framework for the Warriewood Valley revolves around the system of wetlands, riparian corridors, and an open space and vegetation conservation strategy focussed on Narrabeen Creek and Fern Creek.

The framework has established minimum width corridors for the riparian environment (50m wide or 25m either side of the creekline) and adjoining vegetation areas (defined by vegetation worthy of conservation), based on technical studies carried out as part of the planning process. In general the creekline corridors require substantial levels of rehabilitation to overcome historical uses which have degraded the soils and vegetation.

The riparian corridors overall are more generous than in other parts of Sydney, however, the development market has become accustomed to them, and a reasonable part (30%) of the riparian corridors are counted as open space due to their use for passive open space.

In addition to the creekline corridors the planning framework requires a 25m landscaped buffer adjacent to the creekline corridor.

The riparian corridor system has been planned to account for flood behaviour, and to manage the quantity and quality of stormwater discharging from the developed areas.

There do not appear to be any reasons why there should be any amendment to the riparian corridor/ environmental framework for the Warriewood Valley at this late stage in the development process.

7.2 Physical suitability – land capability, etc

7.2.1 Land capability

The land capability map prepared by Pittwater Council (February 2010) indicates that the majority of the buffer areas have a high development capability designation, indicated by the pink colour on Figure 21. Provided the development takes into account the valuable vegetation areas (red hatching) and the flood prone land (blue hatching), there do not appear to be any impediments to higher density development on the buffer areas.

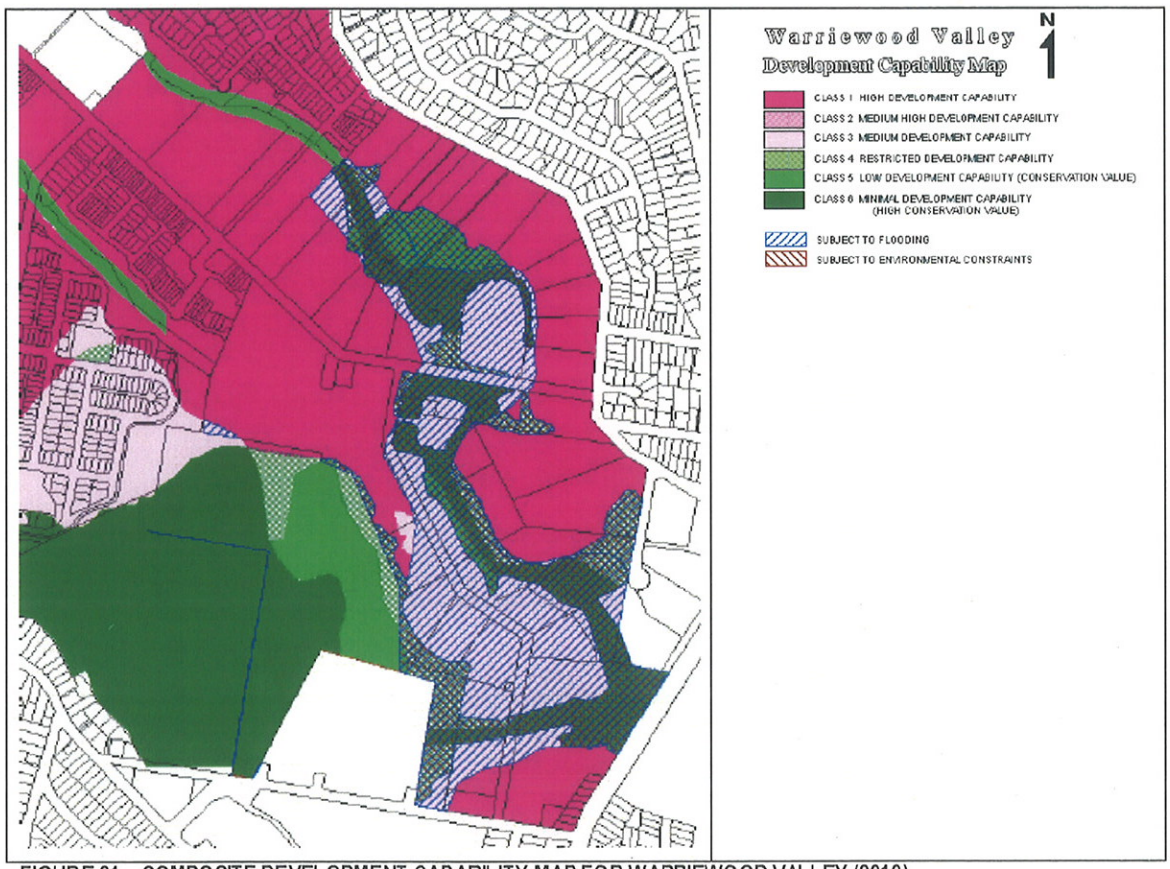


FIGURE 21 – COMPOSITE DEVELOPMENT CAPABILITY MAP FOR WARRIEWOOD VALLEY (2010)

7.2.2 Flooding and water management

Most of the elements of water management are sensitive to the impervious fraction of a catchment.

For example an increase in impervious area on a site generally leads to an increase in runoff, flooding and stormwater pollutants.

From a water management perspective in Warriewood Valley as long as the impervious fraction is kept to a level that all the background studies anticipated - 50% of gross site area - then in theory the increase in density could have minimal impact.

The two caveats to the above statement are carefully considering how an increase in the population may impact on (a) flood risk - the level of flooding would be the same but the number of people exposed to

flooding would increase; and (b) if the population increase would impact on water quality and pollutant export assumptions - whether litter and to a lesser extent sediment and nutrient concentrations would increase.

If these issues are addressed adequately and the impervious fraction capped at 50% then there is no reason, from a water management perspective, why the higher density could not be achieved on the buffer areas.

7.2.3 Topography

The topography of Buffer Area 1 slopes away from Warriewood Road towards Narrabeen Creek – the slope ranges from around 4% to 8%. The adjacent land on the northern side of Warriewood Road continues to rise up, with existing dwellings elevated above Warriewood Road and Buffer Area 1.

It is expected that the filling of land that has occurred in Sectors 1 and 2 to the west will occur on Buffer Area 1.

Provided the fall of the land away from Warriewood Road towards the creek is maintained, and not filled to the level of Warriewood Road, the fall will assist in the visual appearance of the buildings, allowing them to step down the slope.

Buffer Area 2 and 3 have a similar flat to gently sloping topography. Part of Buffer Area 3 has a small knoll in the vicinity of 5-7 Macpherson Street.

The slope of the land in the buffer areas is not considered sufficient to preclude higher density development.

7.2.4 Development area dimensions and road frontage

The depth of the developable land from external roads (Warriewood Road, Macpherson Street and Boondah Road) to the creekline/ landscaped buffer boundary for each of the buffer areas ranges from around 200m to about 80m.

These depths will enable the siting of a range of building types and heights. They also will enable areas of open space to be located between buildings and adjacent to the creekline corridor. The depth of land also appears to allow for an internal road system in accordance with the Warriewood Valley Planning Framework 2010 Road Network Plan.

All buffer areas have extensive external road frontages. This provides an opportunity to locate lower scale buildings along the external perimeter of the site.

7.2.5 Lot fragmentation

The land ownership map prepared by Pittwater Council (February 2010) indicates a range of frontages and areas for each of the parcels that make up the three buffer areas. Approximate frontages (scaled off a 1:4000 plan) are shown in Table 2.

We believe that narrower sites would have significant difficulty in creating reasonable urban form outcomes if developed independently. To avoid long narrow development sites, amalgamation of sites is recommended.

Table 2 – Buffer Areas and approximate frontage of property ownerships

Buffer Area/ ownerships	Approximate frontages
1a	66m
1b	48m
1c+1e	60m
1f+1g	84m
1i	86m
1j	120m
1k	70m
1l+1m*	230m + 100m
2a	120m
3a + 3b	330m + 290m

* Buffer area 1m is in the same ownership as area 1l. It is proposed as open space and has been excluded from frontage calculations and development potential calculations.

7.2.6 Setbacks to key external streets (Warriewood Road and Macpherson Street)

The setback required to external streets required under the Warriewood DCP is 6.5 metres. This is considered to be a reasonable setback which allows for appropriate planting and landscaping for 3 storey buildings.

7.2.7 Setbacks to creekline corridors

In view of the site dimensions within the remaining buffer areas, we are satisfied that the higher density of development need not compromise the required setbacks to the creekline corridor.

7.2.8 Overshadowing of creekline corridors

Given the similarity of the shape and dimensions of the remaining buffer areas, and the requirement to provide a landscaped buffer between the creekline corridor and adjacent development, it is expected that any overshadowing impacts can be suitably managed.

7.2.9 Building height

As outlined in the description of Warriewood Valley in Section 2, the effective height of existing residential buildings along parts of Macpherson Street nearing Buffer Areas 2 and 3 is over 2 storeys due to the recent construction of 2 storey buildings on filled land. Furthermore the seniors living development along Macpherson Street contains buildings of 3 storeys.

Along Warriewood Road, the fall of the land away from the older residential areas towards Narrabeen Creek reduces the scale of the existing 2 storey dwellings fronting that road.

The current height limit of 8.5m is identified in DCP 21.

In our opinion, the potential for increased building heights comprising for example 3 storey buildings fronting the external roads to the buffer areas, with higher buildings located within the interior of the buffer areas adjacent to the creekline corridors represents an acceptable built form and visual character for the buffer areas. It would appear that buildings up to about 5 storeys would be consistent with the height of the tree canopy throughout the Valley. However, taller built elements in strategic locations (such as on corner sites) would also not be objectionable.

Front street setbacks under current control documents are appropriate for suitable landscape treatment along external streets. Taller buildings in the interior of the buffer areas can be screened by the lower

buildings on the street. Landscaping comprising tall trees within developments will also contribute to the appearance of denser areas.

An increase in density enabled by larger footprints and taller building forms provide for good outcomes in relation to built-upon area and retention of deep soil areas. Maximum building heights that relate to the height of trees, and where the tallest buildings will sit at the valley floor, in our opinion, the taller buildings associated with the higher density will remain relatively inconspicuous across distant views.

A three storey street scale will establish a moderate change in character for this part of the valley.

These elements will also mean that the higher buildings are least visible from the public domain and will not disrupt the very strong scale and form of the main through-street (Macpherson Street).

As an impact on the neighbourhood, in our opinion, this scale change is relatively minor, and will have the effect of indicating an increase in density toward the "town centre" of Warriewood created by the shopping centre, employment area, Council depot and playing fields. This is consistent with well-established townscape principles. From the point of view of impacts on the quality of public spaces, the impacts will be minimal in our view.

In our view, the presentation of 3 storey buildings along Macpherson Street will also be satisfactory given the nature of development further west along Macpherson Street, and the setbacks and landscape requirements.

The landform along Warriewood Road with the fall away from the street towards the creek, required street setbacks and landscape treatment within the street setback will enable the buildings to present an appropriate scale in Buffer Area 1, notwithstanding the predominant existing dwelling scale in the surrounding area. This is illustrated in Figure 22 using similar building forms to those proposed in the 14-18 Boondah Road proposal, and based on the existing landform.

Building detail, materials, textures and colours remain important elements in achieving this relatively moderate change in character, particularly on the street facades, and will need to be sympathetic in terms of style and response.

7.2.10 Building separation

The building separation requirements of the SEPP 65 Residential Flat Design Code should be adhered to as far as possible. We believe that the shape and dimensions of the three buffer areas provide sufficient flexibility to achieve the required building separation.

7.2.11 Site cover/ deep soil planting

A site cover of no more than 50% appears to be achievable given the similarity in dimensions of the three buffer areas. This should address both the flooding criterion and the deep soil planting/ landscape criterion.

7.3 Locational suitability

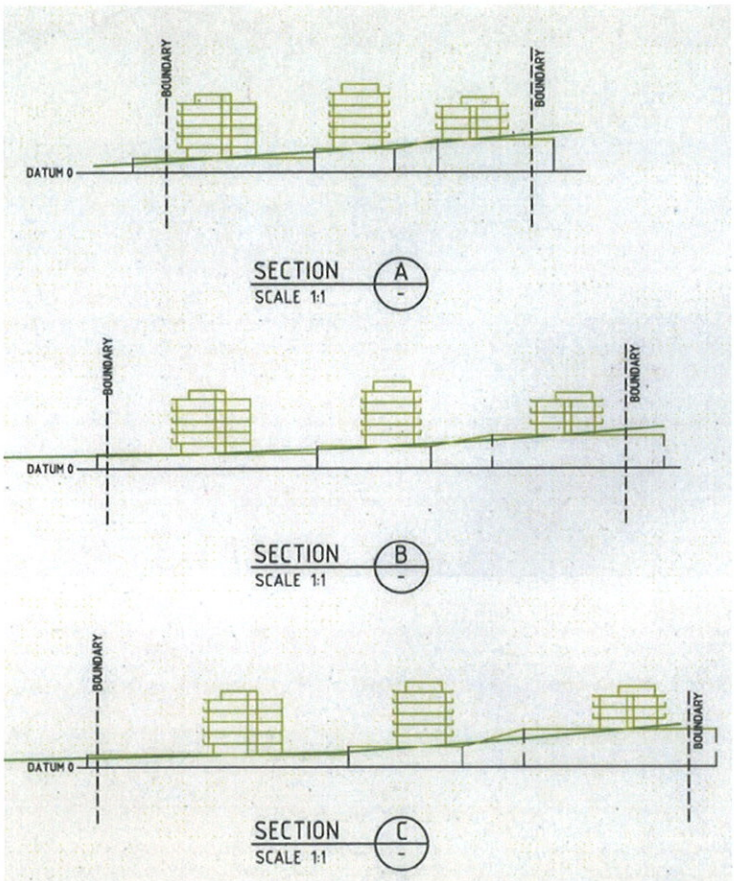
The buffer areas are well-located in respect of bus services, and are within easy walking distance of schools, community facilities, employment, shopping, recreation and entertainment facilities.

Pittwater Road, the main arterial road from the northern peninsula to Manly is less than 1 kilometre from the land. Additional retail and services are located along Pittwater Road.

This supports the principle of higher density development in proximity to these activities.

7.4 Visual analysis

As stated elsewhere we believe that the landform, and required landscape treatments will be capable of ensuring that higher density development is visually compatible with the area, especially with stepping of buildings from 3 storeys at the street to taller buildings beyond. The design and articulation of buildings, as well as materials and colours will assist in their appearance.



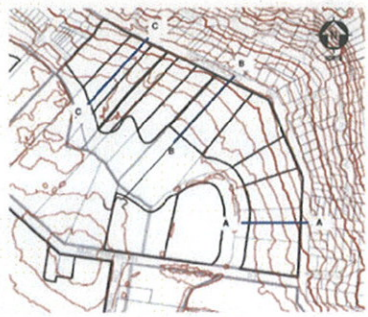


FIGURE 22 – SECTIONS THROUGH BUFFER AREA 1 WITH EXAMPLE OF 3-5 STOREY BUILDINGS

We do not believe that higher density development or taller buildings will overwhelm the locality, especially in view of the gradual increase in density and scale within the area over the past 2 decades, and the vegetation corridors that form a strong backdrop to the valley.

7.5 Possible servicing ramifications of higher density development in buffer areas

For this strategic review specific advice from the relevant utility service providers was unable to be obtained.

However, Sydney Water Corporation (SWC) was consulted to discuss the implications of increasing density within the buffer areas.

All utility services (power, wastewater, potable water, gas and telecommunications) will be impacted by an increase in population because there is a direct increase in load and demand. Typically the service providers will plan for this demand/ load based on approved planning strategies and associated population projections such as the MDP.

7.5.1 Dwelling and population calculations for the buffer areas

The population projections for the buffer areas that are currently part of Council's planning strategy compared with our estimate of the increase in population due to the 81 dwellings/ha proposal throughout the buffer areas are shown in Table 3.

For comparison the Pre-2010 Council dwelling projection for Warriewood Valley as a whole totalled 1,886 dwellings.

Council's 2010 Planning Framework increases marginally the total dwelling projection for Warriewood Valley to 2,012 dwellings.

If the higher density of development at 81 dwellings/ net ha is applied to the three buffer areas (and remaining undeveloped areas are developed according to current density assumptions), then the total dwelling yield for Warriewood Valley would be in the order of 3,000 dwellings (based on information from Council reports). This is approximately 1,000 dwellings more than would be the case under current densities.

Table 3 – Capacity of buffer areas for servicing assessment

Site	2010 Planning Framework - Council Dwelling Projections		Higher density potential	
	No.	Density Assumption	Approximate Dwellings	Density Assumption
Buffer Area 1	201	15 dwellings/ ha	750	81d/ha
Buffer Area 2	20	25 dwellings / ha	32	81d/ha
Buffer Area 3	193	25 dwellings / ha	624 *	81d/ha
Total	**414**		**1,406**	
Dwelling difference	***992***			
Additional Population in buffer areas (EP)	**1,242**	**3EP/dwelling**	**2,812**	**2EP/dwelling (Unit)**

Note to Table 3:
* The higher density figure for Buffer Area 3 assumes the yield in the current proposal for 14-18 Boondah Road, plus 81 dwellings/ hectare yield over 5-7 Macpherson Street.

7.5.2 Wastewater management and Warriewood STP

It is our understanding that the utility services most sensitive to an increase in population are wastewater and power supply.

Advice in the public domain from SWC for wastewater servicing indicates the following:

- SWC currently has a program to upgrade the Warriewood STP to accommodate developments within both Warriewood Valley and Ingleside South;
- The next upgrade is due to be completed in 2012 and will accommodate development in line with the 2007 MDP;
- SWC's initial assessment confirms that 600 dwellings can be catered for by the 2012 upgrade; and
- SWC also confirm that developments in excess of the 2007 MDP projections could possibly be catered for by bringing forward the planned 2031 upgrade.

Separate correspondence from SWC provides the following advice:

- There is current capacity at the Warriewood STP for the introduction of 858 new dwellings in Warriewood Valley between 2007 and 2012 based on SWC's 2009/ 10 Growth Servicing Plan;
- The 2009/ 10 Growth Servicing Plan is based on the 2007 MDP projections which also shows a total of 1,341 dwellings in Warriewood Valley between 2007 and 2017;

- SWC intends to upgrade the STP in 2012 to cater for the additional 483 (i.e. 1,341-858) dwellings in Warriewood Valley;
- Any increase in density above the MDP data will be considered in their next review of the Growth Servicing Plan in 2011/12;
- Should any increase in density beyond the 2017 MDP projection be required, Sydney Water may require the developer to fund the works; and
- No information is currently available on the planned 2031 upgrades.

It would appear that the total allowance of additional dwellings from Warriewood Valley that would be serviced by Warriewood STP is approximately 2,000 dwellings.

Any additional dwellings such as those generated by a change in density throughout the buffer areas are not currently part of the STP allocation. However depending on timing, spare capacity may be available from other allocations such as Ingleside South.

Based on the above it would appear that the capacity of the STP may be a constraint on application of the higher density throughout the buffer areas.

The implications on the STP, and the relationship to timing of alternative development areas should be the subject of ongoing rigorous review by Sydney Water.

7.5.3 Water and other utilities

Preliminary investigations indicate that no major obstacles exist in supply of potable water to meet higher densities, although additional lead-in works/ amplifications may be required, subject to detailed investigation.

A zone substation is located in relative proximity to the Valley (to the north of Mona Vale Road to the rear of Mona Vale cemetery). Preliminary investigations indicate that there is likely to be spare capacity to service the increased demand but this would need to be confirmed by detailed work. Extra high voltage feeders from the zone substation may need to be funded by developers.

An increase in both gas and telecommunication servicing will be influenced by commercial viability. However, an increase in population and customers without the need for major extensions of existing infrastructure is likely to be attractive to service providers

The above advice is preliminary, and is provided subject to detailed investigations.

Overall, it is not considered that the proposed increase in development density across the three buffer areas will result in an insurmountable obstacle for the utility service providers.

7.6 Other planning issues

7.6.1 Community facilities

The potential exists to incorporate community facilities into a project. This has the potential to meet the demand arising from the development, and reducing demand for facilities provided through Section 94.

Should the additional development potential be implemented, it would be prudent for the Council to review its Contributions Plan, and determine the additional community facilities that would be needed, including any extension/ expansion of existing or proposed facilities.

7.6.2 Housing choice and housing affordability

The Warriewood housing market is dominated by single dwellings and higher density forms of housing – apartments, etc – are relatively under-represented.

In reviewing available ABS data from the 2006 Census for Pittwater, we are of the opinion that an increase in density of the remaining buffer areas will provide for a greater diversity of housing in an area well-served by facilities and services for the future community within Warriewood and within Pittwater generally.

In respect of housing affordability the Housing NSW Rent and Sales Reports (published quarterly) provide data on the sales price and rent of dwellings and apartments within NSW. The most recent rental data for the March quarter 2010 indicate median rents for new bonds for 2 bedroom apartments 22% less than median rents for 2 bedroom houses. The difference is 33% when comparing the rent on a 3 bedroom house and a 2 bedroom flat.

In regard to dwelling sales data for the December quarter 2009, the median price for strata dwellings in Pittwater were 33% less than the median sale prices for separate dwellings.

The MDP also includes 2008 data on median sale prices for detached dwellings and multi-unit dwellings, which show a marked difference in the prices, with units 42% less than detached dwellings.

Therefore, on the basis of the MDP and the Rent and Sales Report data, we believe that the addition of apartment dwellings into the Warriewood Valley has the potential to have a significant beneficial impact on housing affordability.

7.7 Information for consultation with the Roads and Traffic Authority on local and regional traffic implications

7.7.1 Buffer area dwelling yield

Should the density of development within the three buffer areas be increased to equate with that proposed for 14-18 Boondah Road, the following development yield would result (see details of each buffer area parcel outlined in Table 4).

Table 4 – Potential development for Buffer Areas 1-3 at density equivalent to 14-18 Boondah Rd proposal

Sector	Council estimate net developable area (ha)	Dwellings on net residential area
Buffer 1	0.77 (Buffer 1a) 0.7504 (Buffer 1b) 0.5616 (Buffer 1c) 0.0447 (Buffer 1d) 0.4815 (Buffer 1e) 0.6512 (Buffer 1f) 0.7282 (Buffer 1g) 0.0292 (Buffer 1h) 1.2337 (Buffer 1i) 1.2359 (Buffer 1j) 0.6658 (Buffer 1k) 2.1194 (Buffer 1l) Total 9.2716	Total approx 750
Buffer 2	0.405	32 approx
Buffer 3	7.4427 (Buffer 3a) 0.2996 (Buffer 3b) Total 7.727	600 * 24 approx Total 624 approx
Total	**17.4032**	**1,406**

* Assuming yield currently proposed on 14-18 Boondah Road.

7.7.2 Development in other undeveloped sectors

In addition to the development outlined in Table 4, the Council estimate of the residential development potential of the other remaining undeveloped land in Warriewood Valley is shown in Table 5.

Table 5 – Potential development in other undeveloped sectors

Sector	Net developable area (residential)	Council estimate of dwellings on net residential area
1	0.1566	1
3	5.1962	131
5	3.105	75
8	1.1858	19
9	14.3912	245
10	3.167	42
Total	**30.183**	**513**

Source: Map and table of data provided by Pittwater Council, 15 June 2010

7.7.3 Dwelling mix by size

Given that the dwellings at the higher density would be in the form of apartments, and that the size of the apartments would play some role in determining traffic generation, the potential dwelling mix should be addressed.

While it is not possible to be definitive about the mix of apartment sizes, Table 6 provides 2 sets of estimates, based around the 2006 Census data for apartments for Pittwater, as well as the mix proposed within the 14-18 Boondah Road project.

Table 6 – Potential dwelling mix for Buffer Areas 1-3 for traffic assessment

Dwelling size	% in 2006 Census	% of total assumed capacity in buffer areas (1,595 dwellings)	% in 14-18 Boondah Rd proposal	Dwellings as % of total assumed capacity in buffer areas (1,595 dwellings)
Studio	3%	42	3%	42
1 Bedroom	24%	337	18%	253
2 Bedroom	54%	759	73%	1,026
3 Bedroom	19%	267	6%	84
Total		**1,406 (rounded)**		**1,406 (rounded)**

Source: Environmental Assessment Report for 14-18 Boondah Rd, Warriewood Valley; ABS 2006 Census Pittwater LGA – Basic Community Profile and Expanded Community Profile. 4% of the dwellings were "not stated". We have spread the not stated to each size category equally.

These figures could be provided to the RTA for the purpose of assessing the traffic implications of developing the buffer areas to a density that matches the density on 14-18 Boondah Road, with the addition of the 513 dwellings that Council has estimated for the other remaining Sectors in Warriewood Valley.

8. CONCLUSIONS

The undeveloped buffer areas around the Warriewood STP appear to be suitable for development at a higher density than is presently envisaged under the Council's Planning Framework for Warriewood Valley.

On the basis of the proposals for 14-18 Boondah Road and the similarity of that site with the other buffer areas, there do not appear to be any physical impediments to higher density development approximating 81 dwellings per net hectare of developable land.

The key criteria that have been used to determine the areas of developable land are well-established and appear to be defensible.

The built form for 81 dwellings per net hectare of developable land will require buildings of 3 storeys and over. With the lower building heights facing external streets, and taller buildings within the interior of sites, we believe that the additional height will not detract from the scenic and visual character of the area. Indeed over time the scale of buildings within Warriewood Valley has increased, with more recent developments of 3 storeys or similar. The fall of the land from Warriewood Road to Narrabeen Creek in Buffer Area 1 will reduce the apparent height of buildings when viewed from Warriewood Road.

As a result of the planning approach to Warriewood Valley, the landscape character of the creekline corridors has been substantially improved by rehabilitation works and new planting. This process has the potential to continue under a higher development density regime, meeting ecological objectives and visual character objectives.

The configuration of the buffer areas should not result in the key development criteria for the land – establishing the creekline corridors, and the adjacent buffer areas - to be compromised.

However, the current fragmentation of the land and the configuration of individual allotments (which have generally narrow frontages and long depths) would need to be addressed through setting a minimum lot frontage for development to occur. A number of existing ownerships would not be able to create suitable development layouts under their current configuration.

In respect of flooding and water management, the buffer areas are able to accommodate higher density development and address the critical water management objectives under the *Warriewood Valley Water Management Specification*, provided the 50% impervious surface control which is central to the water management strategy for the Warriewood Valley is met.

Any development proposal in excess of the 50% impervious fraction will require significant assessment and justification in all areas of water management. This is because all water management planning to date for the valley has been based on this premise.

Proposals must also be able to adequately address the water storage and water quality objectives.

In locational terms the land is appropriately sited in close proximity to the full range of urban services to justify higher density. The growth strategy for Pittwater envisaged in the Sub-regional strategy will require a comprehensive review of the supply of services and facilities required to meet this additional growth. The additional potential development within the Warriewood Valley should be included in this review.

A comprehensive review of the traffic implications of higher density of development within Warriewood is warranted. In assessing the potential impacts and necessary traffic management measures to meet additional development, a range of data are available on which to base that assessment.

More detailed investigations need to be undertaken with Sydney Water to determine if the STP can cater for the increased density.

Sydney Water has advised that the 2010/ 2011 Growth Servicing Plan (due for release in August, 2010) may assist in this regard. It is anticipated that the increased density could be catered for at developers' cost by bringing forward the 2031 upgrades, particularly if masterplanning for Ingleside South continues at its current pace.

Other services are also capable of being delivered.

Recent Census data and housing sales and rental data for the Pittwater LGA, demonstrate that there is a compelling argument in favour of higher density development within Warriewood Valley as a means of contributing to housing choice and housing affordability for Pittwater.

Warriewood Valley

Traffic Report

11 November 2010

Prepared for

NSW Department of Planning

Halcrow

Warriewood Valley
Traffic Report

Prepared for
NSW Department of Planning

This report has been issued and amended as follows:

Rev	Description	Date	Prepared by	Approved by
1	Draft for client review	29/10/10	PD	BM
2	Amended Draft	8/11/10	PD	BM
3	Final	11/11/10	PD	BM

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Contents

Executive Summary

This study has examined the traffic implications of three development scenarios for the "Buffer Areas" in the Warriewood Valley. The three scenarios are:

- Case 1 – development according to Council's Framework Plan, being 414 dwellings plus the ARV development, resulting in 333 vehicle trips being generated during the weekday morning and evening peak hours.
- Case 2 – higher density in the Buffer Areas than allowed for in the Framework Plan, being 1,406 dwellings plus the ARV development, resulting in 750 vehicle trips being generated during the weekday morning and evening peak hours.
- Case 3 – higher density in the Buffer Areas than Case 1, but lower than Case 2, being 900 dwellings plus the ARV development, resulting in 503 vehicle trips being generated during the weekday morning and evening peak hours.

The capacity of any road system is generally dictated by the operation of the intersections, where conflicting movements occupy the same road space. Analysis using the Sidra Intersection analysis program was used, assuming that intersections are upgraded in accordance with the Council's Roads Master Plan requirements. The analyses found that based on the RTA's Level of Service criteria, all intersections would operate at Level of Service C or better under all three future scenarios, with the exception of Warriewood Road and Pittwater Road, which would operate at Level of Service D during the evening peak under Case 2. Level of Service D is considered the limit of acceptable operation in urban conditions, and Level of Service C is satisfactory operation.

Further analysis considering Levels of Service based on the degree of saturation of intersections (the ratio of demand against capacity), showed that the intersection of Warriewood Road and Pittwater Road would reach an unacceptable Level of Service in the evening peak under Case 2. Should development Case 2 be pursued, additional upgrading of the intersection of Warriewood Road and Pittwater Road beyond that assumed here would need to be further investigated.

Weekday peak hour volumes on key roads in the Warriewood Valley Road system were compared against approximate upper limits set out in Pittwater Council's Roads Master Plan, noting that operationally, these roads may be able to carry higher volumes. Existing volumes on several roads including Jubilee Avenue, Ponderosa Parade, Macpherson Street, are close to exceed the approximate upper limits for their classifications in the road hierarchy described in the Master Plan. This suggests that it may be appropriate for Council to review the Master Plan hierarchy designations and upper limit traffic volumes. Future volumes would result in the approximate upper limits being exceeded to varying degrees on several roads, including Jubilee Avenue, Foley Street, Ponderosa Parade, Macpherson Street, Warriewood Road east of Macpherson Street, and Garden Street.

The acceptability of any exceedance of the traffic limits set by the Master Plan would depend on the design of each road. Potential measures to ameliorate adverse amenity or safety impacts of higher traffic volumes may include limiting the number or location of driveways, providing more pedestrian crossing facilities, or requiring buildings to meet noise guidelines.

Key Findings

In terms of the ability of the Warriewood Valley road system to accommodate the potential future traffic volumes, the operation of the intersections in and around the Valley would dictate this capacity. Sufficient capacity would need to be provided to allow for the forecast movement of vehicles in and out of the Valley under whichever land use scenario is adopted. The analysis indicates that the planned intersection upgrades described in the Roads Master Plan would provide this required capacity for all three cases, with the exception of the Warriewood Road intersection with Pittwater Road under Case 2, being the highest density option.

Assuming such intersection capacity is provided for whichever land use scenario is adopted, then the acceptability of the resulting volumes on roads within the Valley would need to be reviewed with respect to the Master Plan road hierarchy designations, and with respect to the design of the roads and surrounding environment to provide for the safe movement of all road users.

1 Introduction

This paper has been prepared on behalf of NSW Department of Planning (DoP) to present the results of an assessment of the traffic implications of several development scenarios within the Warriewood Valley. The study aims to review the traffic implications of increasing the density of currently undeveloped (or underdeveloped) lands in Warriewood Valley.

The scenarios were developed by the DoP, and are summarised below:

- Case 1 = Base Case, with full development in accordance with Pittwater Council's Framework Plan 2010. The Buffer Areas would contain some 414 medium density townhouse dwellings.
- Case 2 = with an increase in density in the "Buffer Areas" resulting in a total of 1,406 dwellings in the Buffer Areas.
- Case 3 = with a lesser increase in density in the "Buffer Areas" compared with Case 2, resulting in a total of 900 dwellings in the Buffer Areas.

The study has developed the Base Case traffic conditions though traffic surveys and an assessment of the likely impacts developments which were approved or under construction at the time of the surveys. The additional traffic generated by Cases 2 and 3 were added to the road system, and the effects on traffic conditions assessed.

The study has drawn on information compiled during assessments of Warriewood Valley traffic conditions on behalf of Pittwater Council for its Roads Masterplan update, and on behalf of Meriton Apartments regarding a Development Application for the Buffer Area 3 site. Relevant details from those studies are repeated in this assessment as required.

This study is not intended to draw conclusions from the analyses, nor present recommendations regarding appropriate level of development. It is intended to present the results of the analysis for the consideration of DoP.

2 Background Information

2.1 *Land Use Scenarios*

The additional dwellings for Cases 2 and 3 were assumed to be spread across the Buffer Areas according to the same distribution as Case 1. The number of dwellings per sector for each of the scenarios assessed in this report is as follows.

Table 2.1 – Land Use Scenarios: Proposed Dwellings by Sector

Sector/Area	Case 1 Framework 2010	Case 2	Case 3
1	1	1	1
3	131	131	131
5	75	75	75
8	19	19	19
9	245	245	245
10A	14	14	14
Buffer 1	201	683	437
Buffer 2	20	68	43
	379 ARV	379 ARV	379 ARV
Buffer 3	193	655	420

ARV = Anglican Retirement Village

The DoP provided information regarding the typical mix of dwellings to be assumed for the Buffer Areas in Cases 2 and 3. The following table sets out this mix, and the calculation of average peak hour traffic generation per dwelling, based on the RTA's rates for medium density dwellings.

Table 2.2 – Dwelling Mix and Peak Hour Traffic Generation (veh/hr/dwelling)

Dwelling	Proportion	RTA Generation Rate	Weighted Generation
Studio	3%	0.4	0.012
1 bedroom	18%	0.4	0.072
2 bedroom	73%	0.5	0.365
3 bedroom	6%	0.65	0.039
Total	**100%**		**0.488**

The assessment therefore assumes that new dwellings in the Buffer Areas under Cases 2 and 3 generate an average of 0.488 vehicle trips per dwelling during the morning and evening peak hours.

2.2 *Surveyed Traffic Volumes 2009*

Surveys of vehicle movements were undertaken at key intersections throughout Warriewood Valley as a means of quantifying existing traffic conditions. The surveys were conducted on Tuesday 8 September 2009, at the following intersections:

- Warriewood Road and Pittwater Road
- Boondah Road and Macpherson Street
- Macpherson Street and Warriewood Road
- Boundary Road and Ponderosa Parade
- Garden Street and Macpherson Street
- Boondah Road and Jacksons Road
- Jacksons Road and Pittwater Road
- Jubilee Avenue and Ponderosa Parade
- Ponderosa Parade and Mona Vale Road
- Jubilee Avenue, Foley Street and Vineyard Street
- Mona Vale Road and Foley Street
- Warriewood Road and Brands Lane.

The morning peak hour occurred between 8.00am and 9.00am, and the evening peak hour between 4.30pm and 5.30pm. The two way volumes are summarised in Table 2.3.

Table 2.3 – Surveyed Peak Hour Traffic Volumes September 2009 (veh/hr)

Road	Location	Morning Peak Hour	Evening Peak Hour
Boondah Road	South of Macpherson Street	117	114
	North of Jacksons Road	121	158
Casuarina Drive	South of Macpherson Street	86	74
Foley Street	South of Mona Vale Road	455	354
Forest Road	West of Macpherson Street	537	113
Garden Street	South of Macpherson Street	784	697
Jacksons Road	West of Boondah Road	762	1,060
	West of Pittwater Road	670	987
Jubilee Avenue	West of Ponderosa Parade	517	568
	East of Ponderosa Parade	537	435
Macpherson Street	South of Forest Road	905	792
	West of Garden Street	987	820
	East of Garden Street	335	297
	West of Boondah Road	260	267
	West of Warriewood Road	310	291
Mona Vale Road	West of Ponderosa Parade	1,484	1,581
	East of Ponderosa Parade	1,521	1,581
	West of Foley Street	1,468	1,498
	East of Foley Street	1,699	1,708
Pittwater Road	North of Warriewood Road	3,170	3,415
	North of Jacksons Road	3,568	3,884
Ponderosa Parade	South of Mona Vale Road	983	1,005
	South of Jubilee Avenue	1,045	858
Samuel Street	North of Mona Vale Road	396	393
Vineyard Street	East of Foley Street	204	187
Warriewood Road	South of Jubilee Avenue	421	493
	West of Brands Lane	342	409
	North of Macpherson Street	516	529
	South of Macpherson Street	606	618
	West of Pittwater Road	786	881

2.3 *2009 Intersection Operating Conditions*

As part of the previous work undertaken by Halcrow on behalf of Meriton Apartments, the operation of the majority of the surveyed intersections was analysed using Sidra Intersection. Although it is not directly relevant to the current study, for the sake of completeness, the results of those analyses of September 2009 conditions are repeated here. The 2009 operation of the intersections of Mona Vale Road and Foley Street, Warriewood Road and Brands Lane, and Warriewood Road, Foley Street, Jubilee

Avenue and Vineyard Street was not assessed as part of the study for Meriton. This was because the location of that development means that the likely approach and departure routes of vehicles would not be particularly reliant upon use of those intersections. Thus 2009 results for those intersections are not presented here.

Sidra Intersection is an analysis program which determines characteristics of intersections operating conditions including the degree of saturation, average delays, and levels of service. For the sake of completeness, the results of those analyses are repeated here. The degree of saturation, or x-value, is the ratio of the arrival rate of vehicles to the capacity.

The operating characteristics can be compared with the performance criteria set out in Table 2.4 below, which relate average delays per vehicle experienced at the intersection to Levels of Service. These performance criteria are those generally used by the RTA when assessing operational characteristics of intersections. It is noted that average delay per vehicle is expressed in seconds per vehicle and is measured over all movements at signalised intersections, and for the movement with the highest average delay at roundabout and priority intersections.

Table 2.4 – Level of Service Criteria

Level of Service	Average Delay per Vehicle (sec/veh)	Traffic Signals, Roundabout	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, requires other control mode
F	> 70	Extra capacity required	Extreme delay, traffic signals or other major treatment required

The results of the analysis are presented in Table 2.5.

Table 2.5 – Existing Intersection Operating Conditions (Sept 2009)

Intersection	Morning Peak Hour			Evening Peak Hour		
	X-value	AD	LOS	X-value	AD	LOS
Warriewood/Pittwater	0.78	23.3	B	0.90	31.2	C
Boondah/Macpherson	0.09	10.8	A	0.10	11.1	A
Macpherson/Warriewood	0.22	10.7	A	0.21	10.6	A
Macpherson/Ponderosa	0.38	13.7	A	0.36	11.2	A
Garden/Macpherson	0.47	9.8	A	0.40	8.9	A
Boondah/Jacksons	0.21	11.7	A	0.36	17.0	B
Jacksons/Pittwater	0.95	14.3	A	0.93	24.5	B
Jubilee/Ponderosa	0.51	14.9	B	0.52	14.1	A
Ponderosa/Mona Vale	0.60	19.2	B	0.83	30.5	C

The results indicate that the surveyed intersections currently operate at satisfactory levels of service, with spare capacity and short to moderate delays to vehicles. Delays at the roundabout at the intersection of Ponderosa Parade and Mona Vale Road lead to queuing on Mona Vale Road, typically westbound in the morning and eastbound in the evening.

It is noted that Sidra Intersection does not fully model the effects of co-ordination of signals along a route, as occurs on Pittwater Road. The analysis above assumes the current cycle length and phase splits, and includes some co-ordination benefits. The results indicate that both the Pittwater Road intersections operate at satisfactory levels of service, however some movements are close to capacity, with the right turn bays into Jacksons Road and Warriewood Road currently overflowing into the adjoining lane on occasions during the peak hours. The Sidra results suggest that the right turn lane into Jacksons Road overflows around 50 percent of cycles, or about 16 times per hour in the peak hours, and the right turn lane into Warriewood Road overflows around 9 to 10 percent of cycles, or about three times per hour during the peak hours. These overflow results have not been calibrated by observations onsite but are indicative of a current limitation on turning capacity.

The Level of Service criteria adopted for the assessment of intersection operation are based on general perceptions of a driver's experience in using an intersection under different levels of delay. In some cases, a driver may have a different perception from the average. In such cases, the Sidra analysis can be provide relativities between existing and future intersection performance, against which an individual driver could judge the

extent to which the operation of a particular intersection may be expected to improve or worsen.

2.4 *Incomplete Developments 2009*

At the time of the surveys, a number of developments in Warriewood Valley were under construction, or can be considered very likely to proceed. The traffic generated by these likely developments was assessed and added to the road system as part of the Base Case assessment of future traffic conditions. The assumptions regarding these "under-developed" lands were previously discussed with Pittwater Council officers.

The developments and their assumed peak hour traffic generation were as follows:

- Sector 7 rezoned, assuming FSR 0.7, 60% light industrial, and 40% commercial. Based on RTA rates, peak hour traffic generation is 227 vehicle trips per hour.
- Sector 8 – two Development Applications have been lodged, and the one with the higher likely generation has been used for this assessment, being for a 3,200m^2 supermarket and 750m^2 specialty shops. The DA traffic report to Council does not present a traffic generation estimate. This analysis uses RTA rates for Thursday evening peak giving 577 vehicle trips per hour, and assumes 80% of the traffic is generated from within Warriewood Valley. This internal traffic is likely to be drawn in part from the additional trips generated by the proposed developments, but no discount has been applied. The morning peak generation is assumes to be one-third of the evening peak, and no discount for multi-purpose or linked trips was applied.
- Sector 12 subdivision complete for 180 dwellings, under construction at the time of the surveys. This study assumes at the time of the surveys, this development was 50% complete. The remaining 50% yet to be completed assumes 65% detached dwellings and 35% medium density dwellings, and using RTA rates yields 70 vehicle trips per hour.
- Sector 20 subdivision for 63 dwellings complete, with Development Applications going to Council for construction of the dwellings at the time of the surveys. These are all detached dwellings, and applying RTA rates, peak hour traffic generation is 54 vehicle trips per hour.
- Buffer Area 2 – Anglican Retirement Village under construction. ARV advised that the first residents did not move in until late September 2009, after the traffic surveys

were conducted. Approval is for 260 self-contained dwellings and a 119-bed residential aged care facility. Applying RTA rates, the peak hour traffic generation is 64 vehicle trips per hour.

2.5 *Planned Infrastructure Upgrades*

Council's Roads Master Plan identifies planned upgrades to infrastructure in the Warriewood Valley area in response to the planned development. These include the following of relevance to the surveyed intersections:

- Roundabout at Boondah Road and Macpherson Street
- Roundabout at Garden Street and Macpherson Street
- Roundabout at Warriewood Road and Macpherson Street
- Roundabout at Macpherson Street and Brands Lane (access to Sector 11)
- Roundabout at Boondah Road and Jacksons Road
- Realignment of intersection of Warriewood Road and Macpherson Street
- New signals at Mona Vale Road and Ponderosa Parade
- New signals at Mona Vale Road and Foley Street (completed)
- Upgrade intersection of Warriewood Road and Pittwater Road
- Upgrade intersection of Jacksons Road and Pittwater Road.

The future scenario analyses of intersection operating conditions assume that the infrastructure upgrades above occur before realisation of the traffic generated by the potential new developments. It is noted that the Roads Masterplan does not necessarily provide design details for the upgrades, such as lengths of additional traffic lanes, as only concept sketches are presented. Appendix A of this report presents the intersection layouts, including lane lengths, assumed in this study for the signalised intersections. These are consistent with the Masterplan concept sketches, however assumptions have been made regarding the lengths of additional lanes, and the phasing of signals. New roundabouts were all assumed to have single circulating lanes, with single approach and departure lanes on all approaches.

3 Weekday Peak Hour Traffic Generation

3.1 Case 1 Traffic Generation

As described above, the Base Case (Case 1) scenario consists of the surveyed traffic conditions in 2009, plus traffic generated by the developments underway but not complete at the time of those surveys, plus the traffic generated by the land use forecasts in Council's Framework 2010. The following table summarises the land use and traffic generation added to the surveyed traffic conditions of September 2009.

Table 3.1 – Case 1 Land Use and Traffic Generation Above Surveyed

Sector	Land Use	Traffic Generation (vehicle trips/hour)	Notes
3	131 dwellings	98	50% detached @ 0.85 trips/dw 50% med density @ 0.65 trips/dw
5	75 dwellings	56	50% detached @ 0.85 trips/dw 50% med density @ 0.65 trips/dw
7	2.32ha light industrial	227	FSR 0.7 60% industrial @ 1 trip/100m² 40% commercial @ 2 trips/100m²
8	Retail	577 PM Peak 192 AM Peak	3,500m² supermarket @ 15.5/100m² 750m² specialty @ 4.6/100m²
9	245 dwellings	208	100% detached @ 0.85 trips/dw
10A	14 dwellings	11	50% detached @ 0.85 trips/dw 50% med density @ 0.65 trips/dw
12	90 dwellings	70	65% detached @ 0.85 trips/dw 35% med density @ 0.65 trips/dw
20	63 dwellings	54	100% detached @ 0.85 trips/dw
Sectors Subtotal		**1,301 PM Peak** **916 AM Peak**	
Buffer 1	201 dwellings	131	100% med density @ 0.65 trips/dw
Buffer 2	20 dwellings	13	100% med density @ 0.65 trips/dw
	ARV development	64	260 self-contained @ 0.2 trips/dw 119 aged care @ 0.1 trips/dw
Buffer 3	193 dwellings	125	100% med density @ 0.65 trips/dw
Buffer Areas Subtotal		**333**	

3.2 *Case 2 Buffer Areas Traffic Generation*

Table 3.2 summarises the dwellings and traffic generation of the Buffer Areas in Case 2. The total dwellings were distributed across the three Buffer Areas in proportion to the dwellings allowed for in the Framework Plan (see Table 2.1). The traffic generation is based on the RTA's rates for medium density developments and the dwelling mix supplied by DoP (see Table 2.2). The traffic generation for all other Sectors in Case 2 is the same as Case 1.

Table 3.2 – Case 2 Buffer Areas Land Use and Traffic Generation

Sector	Land Use	Traffic Generation (vehicle trips/hour)	Notes
Buffer 1	683 dwellings	333	DoP mix @ 0.488 trips/dw
Buffer 2	68 dwellings	33	DoP mix @ 0.488 trips/dw
	ARV development	64	As for Case 1
Buffer 3	655 dwellings	320	DoP mix @ 0.488 trips/dw
Total	**1,406 dwellings**	**750**	

3.3 *Case 3 Buffer Areas Traffic Generation*

Table 3.3 summarises the dwellings and traffic generation of the Buffer Areas in Case 3. The total dwellings were distributed across the three Buffer Areas in proportion to the dwellings allowed for in the Framework Plan (see Table 2.1). The traffic generation is based on the RTA's rates for medium density developments and the dwelling mix supplied by DoP (see Table 2.2). The traffic generation for all other Sectors in Case 3 is the same as Case 1.

Table 3.3 – Case 3 Buffer Areas Land Use and Traffic Generation

Sector	Land Use	Traffic Generation (vehicle trips/hour)	Notes
Buffer 1	437 dwellings	213	DoP mix @ 0.488 trips/dw
Buffer 2	43 dwellings	21	DoP mix @ 0.488 trips/dw
	ARV development	64	As for Case 1
Buffer 3	420 dwellings	205	DoP mix @ 0.488 trips/dw
Total	**900 dwellings**	**503**	

4 Weekday Peak Hour Traffic Volumes

The additional traffic was added to the road system and the resulting peak hour two way traffic volumes are summarised in the following tables for the morning and evening peak hours respectively.

Table 4.1 – Morning Peak Hour Traffic Volumes (veh/hr)

Road	Location	2009	Case 1	Case 2	Case 3
Boondah Road	South of Macpherson Street	117	206	274	234
	North of Jacksons Road	121	183	225	197
Casuarina Drive	South of Macpherson Street	86	86	86	86
Foley Street	South of Mona Vale Road	455	489	531	506
Forest Road	West of Macpherson Street	537	593	593	593
Garden Street	South of Macpherson Street	784	1,031	1,058	1,042
Jacksons Road	West of Boondah Road	762	988	1,019	1,000
	West of Pittwater Road	670	895	913	902
Jubilee Avenue	West of Ponderosa Parade	517	775	775	775
	East of Ponderosa Parade	537	544	544	544
Macpherson Street	South of Forest Road	905	1,256	1,311	1,279
	West of Garden Street	987	1,338	1,393	1,361
	East of Garden Street	335	602	684	636
	West of Boondah Road	260	595	673	627
	West of Warriewood Road	310	638	777	695
Mona Vale Road	West of Ponderosa Parade	1,484	1,634	1,693	1,658
	East of Ponderosa Parade	1,521	1,736	1,790	1,758
	West of Foley Street	1,468	1,647	1,675	1,658
	East of Foley Street	1,699	1,875	1,888	1,880
Pittwater Road	North of Warriewood Road	3,170	3,393	3,512	3,442
	North of Jacksons Road	3,568	3,869	3,994	3,920
Ponderosa Parade	South of Mona Vale Road	983	1,309	1,365	1,332
	South of Jubilee Avenue	1,045	1,340	1,395	1,362
Samuel Street	North of Mona Vale Road	396	450	450	450
Vineyard Street	East of Foley Street	204	204	204	204
Warriewood Road	South of Jubilee Avenue	421	448	489	465
	West of Brands Lane	342	407	449	424
	North of Macpherson Street	516	659	819	724
	South of Macpherson Street	606	963	1,207	1,063
	West of Pittwater Road	786	1,143	1,387	1,243

Table 4.2 – Evening Peak Hour Traffic Volumes (veh/hr)

Road	Location	2009	Case 1	Case 2	Case 3
Boondah Road	South of Macpherson Street	114	243	317	273
	North of Jacksons Road	158	232	240	219
Casuarina Drive	South of Macpherson Street	74	74	74	74
Foley Street	South of Mona Vale Road	354	386	426	402
Forest Road	West of Macpherson Street	113	201	201	201
Garden Street	South of Macpherson Street	697	1,123	1,145	1,132
Jacksons Road	West of Boondah Road	1,060	1,345	1,343	1,331
	West of Pittwater Road	987	1,257	1,266	1,257
Jubilee Avenue	West of Ponderosa Parade	568	856	856	856
	East of Ponderosa Parade	435	441	441	441
Macpherson Street	South of Forest Road	792	1,224	1,276	1,245
	West of Garden Street	820	1,252	1,304	1,273
	East of Garden Street	297	670	743	700
	West of Boondah Road	267	719	796	751
	West of Warriewood Road	291	706	849	764
Mona Vale Road	West of Ponderosa Parade	1,581	1,740	1,799	1,764
	East of Ponderosa Parade	1,581	1,791	1,841	1,811
	West of Foley Street	1,498	1,673	1,702	1,685
	East of Foley Street	1,708	1,879	1,890	1,883
Pittwater Road	North of Warriewood Road	3,415	3,668	3,791	3,718
	North of Jacksons Road	3,884	4,212	4,198	4,169
Ponderosa Parade	South of Mona Vale Road	1,005	1,335	1,387	1,356
	South of Jubilee Avenue	858	1,202	1,254	1,223
Samuel Street	North of Mona Vale Road	393	447	447	447
Vineyard Street	East of Foley Street	187	187	187	187
Warriewood Road	South of Jubilee Avenue	493	519	559	535
	West of Brands Lane	409	550	590	566
	North of Macpherson Street	529	750	912	816
	South of Macpherson Street	618	982	1,225	1,081
	West of Pittwater Road	881	1,245	1,379	1,270

The two way volumes were compared against the road hierarchy in Council's Roads Master Plan, which nominates subarterial and collector roads, with approximate upper limits of 10,000 and 5,000 vehicles per day respectively. Peak hour volumes are typically around ten percent of the daily flow, thus the limits set in the Master Plan are equivalent to around 1,000 vehicles per hour for the subarterial roads and 500 vehicles per hour for the collector roads.

In relation to the traffic limits specified for subarterial and collector roads, it is noted that these were desirable limits formulated at the time the plan was prepared. Operationally, higher traffic volumes can generally be carried, with the RTA's road hierarchy guide suggesting a limit of around 2,000 vehicles per hour for subarterial roads and 1,000 vehicles per hour for collector roads.

The RTA's general four-tier hierarchy classification is based on the functions that roads fulfil, giving higher priority to through traffic functions at the arterial and subarterial road levels, and higher priority to local access at the collector and local road levels. While the construction standard of a road does not necessarily define its road hierarchy classification, the RTA's guide suggests that subarterial roads typically have four or more traffic lanes, with signal or zebra crossing controls for pedestrians (noting however that zebra crossings are no longer provided on four lane roads), no parking permitted in peak periods, possibly parking in off-peak periods and possibly limits on midblock vehicular access directly to and from properties. By comparison, the majority of the subarterial roads in Warriewood as defined in the Master Plan have two traffic lanes only, with kerbside parking permitted, and existing and planned pedestrian facilities are typically pedestrian refuges rather than formal zebra crossings. Similarly, the RTA's guide suggests collector roads typically have two or more traffic lanes, with zebra crossing controls for pedestrians, parking permitted at all times of day, and bicycles only in marked lanes. The collector roads in Warriewood are generally two travel lanes, with bicycles sharing the road space, and pedestrian refuges.

Thus, while the construction standards are considered only as a guide to road classification, there are clearly differences between the typical road standards assumed in the RTA's classifications and those in the Warriewood Valley Roads Master Plan classifications. The appropriate traffic volumes described in the Master Plan and RTA guide should not be blindly applied to roads as strict limits without due consideration to the road standards and facilities. Higher traffic volumes are able to be accommodated with appropriate management of such design aspects as pedestrian crossings, bicycle facilities, orientation of buildings, and spacing and design of driveways.

Generally, the acceptability of any exceedance of the Master Plan limits would therefore depend on the design of each road, the provision of pedestrian facilities, and the orientation of dwellings towards the road.

In general, the Warriewood Valley Roads Master Plan road standards are more in keeping with a predominantly residential area with divided carriageways and embayed parking along the subarterial roads, making them easier for pedestrians to cross. Similarly, tighter collector road designs are more conducive to traffic speed regulation. There are no accepted traffic amenity limits on subarterial roads. However, the Master Plan target limit of 1,000 vehicles per hour is considered reasonable. Accordingly, in cases where this was to be exceeded then the design of the road should be reviewed to ensure that bicycle and pedestrian facilities and kerbside parking were appropriately provided.

In the case of collector roads, the RTA suggests an environmental limit of 500 vehicles per hour on residential streets. In a practical sense, it is not always possible to achieve such a limit, especially when the road carries traffic generated by non residential developments. In our experience, once a collector road carries in excess of about 750 vehicles per hour, residential amenity is significantly eroded and measures are required to divert traffic, slow traffic, or provide protected pedestrian crossing opportunities. In such cases, reconsideration of whether the road was really a subarterial road would be appropriate.

Master Plan Collector Roads – Approximate Upper Limit 500 vehicles per hour

Jubilee Avenue

- Existing volumes are close to or exceed the approximate upper limit.
- Future volumes under all three future cases would exceed the approximate upper limit by 275 to 360 vehicles per hour.
- Volumes on Jubilee Avenue would be the same under Case 1, Case 2 or Case 3.

Foley Street

- Morning peak volumes under Case 2 would reach around 530 vehicles per hour, slightly above the approximate upper limit.

Vineyard Street

- Volumes would remain well below the approximate upper limit under all future scenarios.

Overall, collector road traffic volumes would generally be appropriate for their function, noting that while the volumes on Jubilee Avenue exceed the general limit, it is not a residential street, so higher volumes can be tolerated without impacting on residential amenity. It may however be appropriate to reconsider its classification in the Master Plan, considering future volumes are expected to exceed the upper limit even under Case 1.

Master Plan Subarterial Roads – Approx. Upper Limit 1,000 vehicles per hour

Ponderosa Parade

- Existing volumes are close to or exceed the approximate upper limit.
- Future volumes would exceed the approximate upper limit under all three scenarios.
- For Case 1, the peak volume would exceed the limit by some 340 vehicles per hour.
- For Case 2, the peak volume would exceed the limit by some 400 vehicles per hour.
- For Case 3, the peak volume would exceed the limit by some 360 vehicles per hour.

Macpherson Street

- The existing morning peak volume on Macpherson Street between Garden Street and Ponderosa Parade is close to or exceeds the approximate upper limit.
- Future volumes would exceed the approximate upper limit under all three scenarios during both morning and evening peaks.
- For Case 1, the peak volume would exceed the limit by some 220-340 vehicles per hour.
- For Case 2, the peak volume would exceed the limit by some 275-400 vehicles per hour.
- For Case 3, the peak volume would exceed the limit by some 245-360 vehicles per hour.

Warriewood Road East of Macpherson Street

- Existing volumes are well below the approximate upper limit.

- For Case 1, the volumes would exceed the approximate upper limit by some 140-250 vehicles per hour immediately west of Pittwater Road during the morning and evening peak hours respectively.
- For Case 2, the volumes would exceed the upper limit by 200-380 vehicles per hour.
- For Case 3, the volumes would exceed the upper limit by 60-240 vehicles per hour.
- The higher traffic levels would be experienced close to the intersection with Pittwater Road.

Garden Street

- Existing volumes are well below the approximate upper limit.
- Future volumes would exceed the approximate upper limit under all three scenarios during both morning and evening peaks immediately to the south of Macpherson Street.
- For Case 2, the volume would exceed the upper limit by up to 150 vehicles per hour.
- It is noted though, that the vehicular access to Sector 8 is assumed to be from Garden Street south of Macpherson Street. The volume forecast between the access and Garden Street is higher than would occur to the south of the Sector 8 access point.

Boondah Road

- Existing and future volumes would be well below the approximate upper limit for all scenarios.

For the first four roads, a review of the Master Plan may be appropriate to examine the need for any mitigative works as the upper limits are exceeded in all three cases.

Master Plan Undefined Roads – No Volumes Limit Specified

Warriewood Road West of Macpherson Street

- Existing volumes slightly exceed the approximate upper limit for collector roads immediately west of Macpherson Street.
- Future volumes would exceed the approximate upper limit for collector roads between Foley Street and Macpherson Street in the evening peak, and immediately west of Macpherson Street during the morning peak.