northern beaches council

30 September 2021

Mr Malcolm McDonald
Executive Director, Eastern Harbour City
Department of Planning, Industry and Environment
Locked Bag 5022
PARRAMATTA NSW 2124

[redacted] Our Ref: 2021/684234

Dear Mr McDonald

Submission on the draft Frenchs Forest Place Strategy Planning Package

I refer to the public exhibition of the draft Frenchs Forest Place Strategy Planning Package, and I thank the Department of Planning, Industry and Environment (the Department) for the opportunity provided to Northern Beaches Council (Council) to comment on the exhibition material.

At their meeting on 28 September 2021, it was resolved:

That Council:

1. *Support the Submission to the NSW Department of Planning, Industry and Environment in relation to the draft Frenchs Forest Place Strategy Planning Package.*
2. *Acknowledge that the key issues raised in the Submission requiring resolution include:*
    - *A. Transport infrastructure provision.*
    - *B. Cost and funding of infrastructure.*
    - *C. Town centre open space and Police Station site dedication.*
    - *D. Delivery of the community hub.*
    - *E. Elevating the role of sustainability as a key feature to create a flagship precinct.*
    - *F. Statutory planning framework.*
    - *G. State Government coordination.*
    - *H. Support for affordable rental housing contribution.*

I. Development feasibility.

3. *Does not proceed with the Aquatic Reserve Masterplan for a state-of-the-art education and recreation precinct as this does not align with the NSW Government's draft Frenchs Forest 2041 Place Strategy.*

4. *Dissolve the Northern Beaches Hospital Precinct Consultation Committee, as the role and objectives of the Northern Beaches Hospital Precinct Consultation Committee have been realised with the Department's Frenchs Forest 2041 Place Strategy. Council thanks members of the Committee for their time and input to support the Northern Beaches Hospital Precinct Structure Plan process.*

5. *Acknowledge that a design excellence process is preferred over a design competition process for the Frenchs Forest Precinct as floor space or height bonuses are unavailable due to the traffic capacity of the precinct and carefully considered urban design principles.*

In accordance with the above resolution of Council, please find attached the submission from Council to the draft Frenchs Forest Place Strategy Planning Package.

Council is hopeful that the Department can continue its crucial coordination role and ensure a resolution to Council's issues.

Should you require any further information or assistance in this matter, please do not hesitate to contact Louise Kerr or myself on ph. 8495 6273.

Yours faithfully

Andrew Pigott
Executive Manager Strategic & Place Planning

Frenchs Forest Place Strategy

Submission to the NSW Department of Planning, Industry and Environment

September 2021

northern beaches council

Contents

Introduction

Northern Beaches Council (Council) welcomes the opportunity to provide a submission in response to the exhibition of the draft Frenchs Forest Place Strategy planning package (draft planning package) by the NSW Department of Planning, Industry and Environment (the Department).

Council supports the Department's role in coordinating the precinct planning for the area, as it is best placed to ensure that supporting infrastructure including schools, public transport, road infrastructure and open space are delivered to support the community's existing and future needs.

The Department's draft planning package delivers on important strategic land use policy outcomes, which is welcomed. Council is supportive of the need for urban renewal within Frenchs Forest to facilitate the delivery of Council's adopted Hospital Precinct Structure Plan and the designation of Frenchs Forest as a Strategic Centre and Health and Education Precinct by the NSW Government.

Council also acknowledges that the proposal aligns with the priorities contained in Council's Local Strategic Planning Statement (Towards 2040) and Council's Local Housing Strategy to deliver a sustainable health and education precinct and contribute to Council's six to ten-year housing target and beyond. The requirement to provide an affordable rental housing target of 15% in the town centre and 10% elsewhere in the precinct, in alignment with Council's Affordable Housing Policy, is commended.

Other matters identified throughout the draft planning package which Council supports include:

- the identification of 1.5 hectares of new public open space in the town centre.
- the delivery of grant funding to upgrade three local parks including Brick Pit, Akora and Rabbett Reserves, through the Department's Precinct Support Scheme.
- the confirmation of a site to accommodate the relocated High School to facilitate the delivery of the town centre.
- the commitment to design excellence for buildings that are over three storeys or 12 metres (noting this does not apply to the Karingal Crescent precinct), which requires applications to be referred to Council's Design and Sustainability Advisory Panel.
- the investigation of a 'platform park' that will link the town centre to Akora Reserve and become an iconic land bridge to those moving from the town centre to the southern side of Warringah Road, which could also double as a future bus interchange along Warringah Road.
- the application of a Special Infrastructure Contribution (SIC) levy for new development within the precinct to ensure that any value uplift provides a contribution towards the provision of State and regional infrastructure.
- the identification of a 'community hub' to provide social infrastructure, which will be required to support the needs of existing and future residents, workers, and visitors.
- revised statutory planning controls which consider the impact on transition zones, lot amalgamation patterns and implementation of the urban design masterplan.
- the identification of potential sustainability initiatives that could be applied at a precinct-scale.

Since the identification of Frenchs Forest as a State-led rezoning precinct in 2017, Council has worked with the Department to ensure that the rezoning of Frenchs Forest is supported by the provision of supporting infrastructure. Council is acutely aware that once the rezoning is finalised by the Department, it will be Council who will be left to manage the implementation phase.

It is therefore imperative that the recommendations in the draft planning package are reflected as firm commitments by relevant State Agencies and that the aspirations identified in the technical studies and draft Frenchs Forest Place Strategy are reflected in legislation. In this regard, Council remains concerned that the draft planning package lacks certainty in the delivery of a robust planning framework as well as the alignment of housing supply with infrastructure delivery.

This submission is divided into three parts as follows:

- a high-level overview on the strategic planning context and a summary of the Department's proposal.
- the identification of issues that require further consideration prior to the Department's finalisation of the statutory planning controls.
- commentary on the documents on exhibition and technical studies to support the rezoning of the precinct.

Council is hopeful that the Department can continue its crucial coordination role and ensure a resolution to Council's issues.

Background

Strategic planning context

Since the announcement of Frenchs Forest as the site for a new Northern Beaches Hospital in 2006, Frenchs Forest has been identified as an important precinct for investment by the NSW Government. This has influenced subsequent NSW Government policies, leading to the identification of Frenchs Forest as a Strategic Centre in 2014 and a Health and Education Precinct in 2018. Figure 1 illustrates the evolution of the Frenchs Forest precinct in government policy, dating back to 2006.

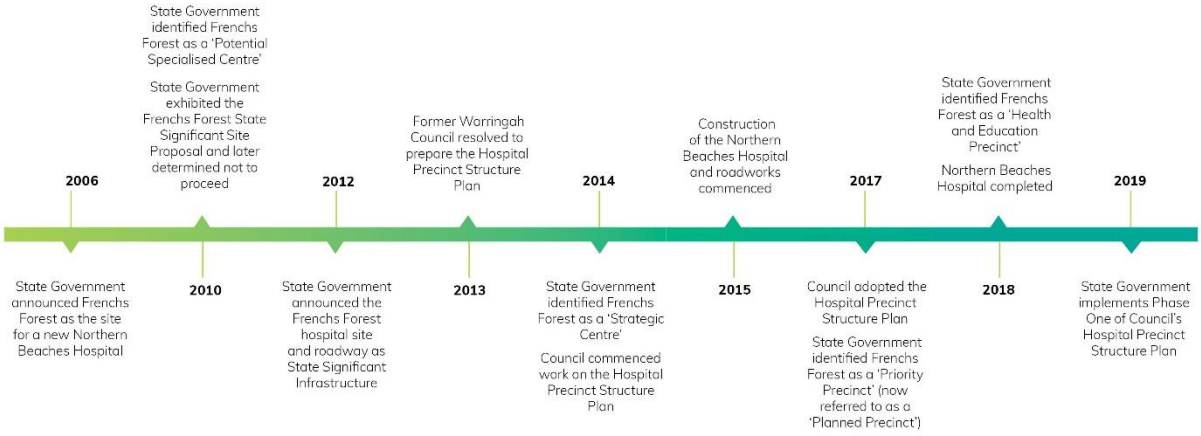


Figure 1: Timeline of the Frenchs Forest Hospital Precinct

The Department's draft planning package aligns with broader strategic directions that are identified for Frenchs Forest in Council's strategic land use policy documents, including the Local Strategic Planning Statement (Towards 2040*)*, Local Housing Strategy and Hospital Precinct Structure Plan (Structure Plan). Table 1 provides a summary and analysis of the Department's consistency with Council's strategic land use policy documents.

Table 1: Council's strategic land use policy documents

Document	Purpose	Consistency
Towards 2040	Establishes the land use planning framework for the Northern Beaches over a 20-year timeframe to 2040 and incorporates the recommendations of the Region Plan (A Metropolis of Three Cities*)* and the North District Plan.	Yes. The draft planning package supports the delivery of Priority 23 to deliver a sustainable health and education precinct, by encouraging new development with a variety of land uses alongside a new town centre to support the Northern Beaches Hospital.
Local Housing Strategy	Identifies the importance of Frenchs Forest in the delivery of Council's six to ten-year housing targets.	Yes. The draft planning package has been factored into the Local Housing Strategy's projected calculations on housing delivery to 2036.

Document	Purpose	Consistency
Structure Plan	Identifies how growth will occur over a 20-year timeframe between 2017 to 2037 and proposes a three-phased delivery of a new Strategic Centre, which is dependent on infrastructure delivery.	Yes. The draft planning package implements Phase One of Council's Structure Plan by providing approximately 2,000 new homes and 2,000 new jobs to 2041.

Generally, the Department's draft planning package is consistent with the vision for a vibrant, new town centre as outlined in Towards 2040 and the Structure Plan. The proposal delivers approximately 2,000 dwellings and 2,000 new jobs, which aligns with Council's Local Housing Strategy and Structure Plan (noting that Phases Two and Three will also need to be delivered).

The Department's draft planning package has strategic merit and aligns with the future directions set by the NSW Government and Council for Frenchs Forest.

The Department's draft planning package

The planning package will inform a rezoning of Frenchs Forest through a self-repealing State Environmental Planning Policy to amend Warringah Local Environmental Plan 2011. The draft planning package is accompanied by a comprehensive suite of documents including:

- draft Frenchs Forest 2041 Place Strategy
- draft Explanation of Intended Effect
- draft Frenchs Forest Green Plan
- draft Frenchs Forest Special Infrastructure Contribution Schedule
- nine background technical studies comprising an Aboriginal and Non-Aboriginal Heritage Assessment, Contamination Site Investigation, Flooding and Stormwater Study, Social Infrastructure Report, Sustainability Plan, Transport Strategy, Urban Tree Canopy Audit, Employment Strategy and Urban Design Report.

The draft Place Strategy proposes five 'big moves', which will be required to implement the full potential of the precinct. These are:

1. relocate and construct a new high school.
2. create a revitalised mixed use town centre.
3. strengthen an emerging health and education precinct.
4. establish a vibrant High Street.
5. build on the established character of Frenchs Forest to create a place for people.

To achieve the vision outlined above the draft planning package proposes the following outcomes:

- 2,000 new dwellings and 2,000 new jobs

- new public open space and green spaces in the town centre with a tree canopy cover of up to 30%
- the potential for the delivery of a ‘community hub’ in the town centre to provide social infrastructure for new and existing residents, visitors and workers
- a diversity of homes, including terraces, medium scale apartments and higher density apartments
- a range of building heights from 2 to 12 storeys, with taller buildings near the hospital, no building higher than the hospital and lower-scale housing in the north and south
- up to 15% affordable housing in the town centre and 10% in the surrounding areas
- the highest standard in architectural, urban design and sustainability outcomes through the application of a design excellence provision in the statutory planning controls
- commercial and retail uses, including a dedicated commercial core near the hospital through the identification of a B3 Commercial Core zone in the statutory planning controls
- a new neighbourhood centre on Bantry Bay Road.

Council commends the vision and master planning undertaken to support the proposed outcomes for Frenchs Forest. However, to make this vision a reality requires careful consideration with implementation. The importance of getting the planning legislation and statutory mechanisms right will be crucial to the long-term success of Frenchs Forest.

Key issues

Council has identified that the following issues require resolution, prior to finalisation of the rezoning of the Frenchs Forest precinct.

1. Transport infrastructure provision.
2. Cost and funding of infrastructure.
3. Town centre open space and Police Station dedication.
4. Delivery of the community hub.
5. Elevating the role of sustainability as a key feature to create a flagship precinct.
6. Statutory planning framework.
7. State government coordination.
8. Affordable rental housing contribution.
9. Development feasibility.

1. Transport infrastructure provision

Council is extremely concerned that the issue of traffic and transport infrastructure has not been adequately resolved. The Department's Transport Strategy prepared by Jacobs, includes modelling data that indicates that the local road network will reach its capacity following 70% development of the town centre site. In other words, once 70% of the town centre site is built, the impact on the traffic and transport network will become a serious issue. This is a major concern to Council as the draft planning package allows for the full delivery of Phase One to approximately 2,000 dwellings and 2,000 jobs, without any commitment as to how additional traffic and transport infrastructure will be funded to support the remaining 30% development capacity.

Council does not support the Department's proposed infrastructure solution to address only 70% development capacity for the town centre site and requires upfront commitment from the State Government to address the remaining 30% development capacity via the identification and commitment to the required infrastructure. Council seeks a commitment from the State Government to provide for an upfront infrastructure package that delivers the full development capacity (100%) of Stage 1.

The Department proposes to include a provision in the Warringah Local Environmental Plan 2011 to require the Developer to submit additional traffic impact assessments and consider further infrastructure upgrades once the 70% capacity is reached. This is not a viable outcome that provides commitment to the actual delivery of infrastructure and demonstrates a lack of forward planning. An extract of the Department's draft provision is provided below.

> *Transport infrastructure needs must be considered once the town centre reaches 70 per cent residential development capacity (approximately 700 dwellings or 56,000m² of residential floorspace) to ensure development does not have an adverse impact on the road network and is supported by adequate transport infrastructure. This will require:*
>
> - *a detailed traffic impact assessment to demonstrate sufficient capacity in the transport network to support the development; or*
> - *the provision of infrastructure upgrades required as part of the development.*
>
> Source: NSW Department of Planning, Industry and Environment 2021, Draft Explanation of Intended Effect, page 14

It is essential that the growth of Frenchs Forest is matched by the required transport infrastructure, given that the precinct has no access to heavy rail, light rail connections, or other suitable public transport solutions unlike other Strategic Centres in Greater Sydney. Council has consistently advocated for the resolution of this issue prior to the public exhibition of the draft planning package.

The road network around the precinct was recently upgraded to facilitate the requirements of access to the Northern Beaches Hospital and provided improved east-west capacity in peak periods. However, it is noted that this does not assist the future development of the Frenchs Forest precinct as far as ongoing delivery capacity. Council has noted that the high morning peak flows still results in significant queues westbound between Forest Way and Allambie Road. None of the proposed infrastructure in either the Department or Council's separately commissioned Transport Strategies will address these issues from existing flows, but improvements in Council's Transport Strategies for local precinct access from the state road network and improved public transport connectivity provides the initial direction in addressing the underlying network issues.

Whilst Council recognises the significant work undertaken by the Department to find feasible and practical solutions through the Transport Strategy by Jacobs, it is disappointing that an agreed outcome has not been reached. This has resulted in Council developing its own detailed transport model for the precinct, and the preparation of two independent traffic and transport reports by Arup and Arcadis, which are attached as part of Council's submission.

The report by Arup utilises Council's own transport model of the precinct and provides an overview of the transport infrastructure items needed to support the development of the Frenchs Forest precinct. Importantly, the Arup report concludes that these infrastructure requirements are only needed due to the additional development from the Department's draft Place Strategy. The report by Arcadis provides a peer review of both the Department and Council's transport reports and provides a set of recommendations that are a combination of the Arup and Jacobs reports.

Council's position regarding the provision of traffic and transport infrastructure to support the full delivery of the Frenchs Forest precinct is consistent with the peer review undertaken by Arcadis. Many of these infrastructure items are on state controlled roads and in Council's view, should be funded by the Special Infrastructure Contributions (SIC) levy.

The peer review by Arcadis concludes the following:

- *neither of the modelling processes can be represented as a wholistic, multi-modal transport study. Both models focus on finding and reporting solutions to traffic problems and neither model includes the modelling of public transport or active transport. On the other hand, the SIDRA models at least made some account of a shift to public transport as a response to improved bus services. The SIDRA modelling also includes the impact of pedestrians on traffic flow, while the AIMSUN model does not explicitly represent pedestrians or cycles*

- *the report to DPIE does not recommend substantial public transport projects, suggesting instead some minor improvements and further investigation of major projects. The report to Council provides recommendations for improved bus services and the addition of facilities to help the operation of buses.*

- *the report to DPIE has few recommendations for improving opportunities for active transport. The report to Council recommends the provision of a network of shared paths and on-road cycle paths in an area that represents a 20-minute walk from the town centre. Both reports recommend bridges for crossing Forest Way and Warringah Road.*

- *as a result of these findings, the modelling is almost irrelevant in the planning of a network system that offers a range of travelling modes.*

Source: Arcadis 2020, Frenchs Forest Town Centre Traffic Modelling Review, page 32

Council acknowledges that there are discrepancies between the traffic and transport infrastructure items identified by the Department and Council commissioned reports. It is recognised that the discrepancies are mainly due to the different scopes for the consultants, the different traffic models relied upon, and the different approach to the phasing of development across the precinct. Notwithstanding this, there are still outstanding items to be addressed to align the Department and Council's positions.

Council understands that the Department has committed to the delivery of six traffic and transport infrastructure items, which include:

- an additional right turn lane at Forest Way from the southern Forest Way leg into Naree Road (land and works)
- a signalised intersection at Frenchs Forest Road West/Sylvia Place (currently where the Police Station is located)
- investigation for a rapid bus service via Warringah Road between Dee Why and Chatswood
- a new stairway access to the existing pedestrian bridge over Warringah Road, west of Hilmer Street
- improving active transport and green connections to Manly Dam
- investigation for a 'Warringah Road Green Bridge'

As indicated in Table 2, Council is of the view that 16 traffic and transport infrastructure items will be required for the full delivery of the Frenchs Forest precinct. Most of these items will require delivery by Council. However, Council also notes that of the 16 items, there are five (5) which Council considers a requirement for delivery by State agencies as they are located on state-controlled roads. These items are not identified by the Department and therefore remain unfunded, and include:

- the section of Frenchs Forest Road West identified in the Jacobs report as a 'vibrant' street – widened footpaths, slower traffic speeds and drop off points for Mobility as a Service (MaaS) vehicles and safe crossing points for pedestrians.
- the extension of Naree Road to Grace Avenue.
- signalised intersections at Naree Road/Forest Way and Naree Road/Grace Avenue.
- connecting Holland Crescent to the intersection of Frenchs Forest Road West at Sylvia Place – whilst the Department have only committed to the provision of signals, the land acquisition component, construction of the road and relocation of the Police Station to the town centre is unfunded and requires a written commitment.
- the widening of Grace Avenue between the Naree Road extension and Fitzpatrick Avenue West to two lanes in each direction.

In addition to the above, the linear transport interchange (referred to as a Green Bridge in the Department's documents), is considered an integral part of the transport provision for the town centre to facilitate the modal shift required to mitigate the impact on network capacity caused by the precinct development. Council acknowledges that the linear transport interchange will not be required as an initial part of the infrastructure requirements to enable the Phase 1 development to proceed. However, it must be considered as part of the future full implementation of the east-west rapid bus project or as part of the Beaches Link project to provide improved connectivity through the precinct to the benefit of the overall network.

Table 2: Transport infrastructure items recommended by Council to support the full delivery of 2,000 dwellings and 2000 jobs in Frenchs Forest (Phase 1)

	Timing	Infrastructure item	Delivery	Proposed Funding
1	**Initial/early**	Walking and shared path network (as identified by Arup). Additional paths on the south that link to other recommended paths and to the bridges across Warringah Road should also be provided. The cycle network should be expanded significantly to allow safe cycling between Frenchs Forest, Chatswood and Dee Why and other coastal areas, which are within a comfortable half-hour cycle ride. This should include provision of the pedestrian overpass linking the southern town centre gateway to Warringah Road bus stops as recommended by Jacobs, and the Green Bridge recommended by both.	Council	Development Contributions Plan (Section 7.11)
			Department of Planning, Industry and Environment	SIC levy
2		A high frequency express bus service between Frenchs Forest, Dee Why and Chatswood with stops on Warringah Road will play an important part in reducing traffic volumes through, into and out of Frenchs Forest and needs to be prominent and visible early in the development period.	Transport for NSW	SIC levy – investigation only Transport for NSW project
3		Road access to the town centre is needed to start the development and the two access points to the town centre recommended by Arup are preferable to those recommended by Jacobs, which would result in three signalised intersections within a few hundred meters of one another: • Frenchs Forest Road West/ Bluegum Crescent/ New Internal Road – Item 1A in Arup's Report	Developer of the town centre site (Item 1A)	Developer of the town centre site
			Council (Item 1B)	Development Contributions Plan (Section 7.11)

	Timing	Infrastructure item	Delivery	Proposed Funding
		• Holland Crescent Extension to Town Centre – Item 1B in Arup's report		
4		Treat the section of Frenchs Forest Road identified in Jacobs Report as a Vibrant Street with widened footpaths, slower traffic speeds and drop off points for Mobility as a Service (MaaS) vehicles and safe crossing points for pedestrians.	Undetermined Recommendation: Transport for NSW	Unfunded Recommendation: SIC Levy or Transport for NSW project
5	**50% of Phase 1**	The widening of Frenchs Forest Road and Naree Road from Bluegum Crescent to Forest Way and the installation of signals at Sylvia Place.	Transport for NSW	Development Contributions Plan (Section 7.11) – widening of Frenchs Forest Road and Naree Road from Bluegum Crescent to Forest Way SIC levy - signals at Sylvia Place
6		The provision of a 24-hour bus-only lane between the southern end of Holland Crescent to the intersection of Forest Way and Rabbett Street intersection will be needed.	Council	Development Contributions Plan (Section 7.11)
7	**70% of Phase 1**	Extend Naree Road to Grace Avenue	Undetermined Recommendation: Transport for NSW	Unfunded Recommendation: SIC Levy or Transport for NSW project
8		Signalise the intersections of – Naree Road and Forest Way	Undetermined Recommendation:	Unfunded Recommendation:

	Timing	Infrastructure item	Delivery	Proposed Funding
		– Naree Road and Grace Avenue	Transport for NSW	SIC Levy or Transport for NSW project
9		Connect Holland Crescent to the intersection of Frenchs Forest Road West at Sylvia Place	Dedication from State Government Note: there is no certainty on how land acquisition is to occur	No cost
10		Upgrade the intersections of: – Adams Street and Forest Way – Adams Street and Rabbett Street.	Council	Development Contributions Plan (Section 7.11)
11		Provide a bus priority system from Rabbett Street onto Warringah Road	Council	Development Contributions Plan (Section 7.11)
12		Relocate the bus stops on Frenchs Forest Road East to prevent blockages in the roadway when buses stop and vehicles need to turn right into driveways	Council	Development Contributions Plan (Section 7.11)
13	**Full Phase 1 and 20% of Phase 2**	In Forest Way, northbound, provide an additional right turn lane into Naree Road, either by widening Forest Way or be reducing the number of through-lanes. Prioritise the turns into Naree Road to improve access to the town centre	Transport for NSW	SIC levy
14		Widen Grace Avenue between Naree Road extension and Fitzpatrick Avenue West to two lanes in each direction	Undetermined Recommendation: Transport for NSW	Unfunded Recommendation: SIC Levy or Transport for NSW project
15		Upgrade the intersection of Fitzpatrick Avenue West and Warringah Road	Council	Development Contributions Plan (Section 7.11)

	Timing	Infrastructure item	Delivery	Proposed Funding
16		Provide traffic calming infrastructure in Wareham Crescent, Dundilla Road, Greendale Avenue, Sturt Street to discourage rat-running.	Council	Development Contributions Plan (Section 7.11)

Recommendation:

1. The Department commits to the delivery of the required six (6) transport infrastructures items either through a SIC levy or identified in relevant State Agency budgets.
2. The Department commits to the delivery (not investigation) of the linear transport interchange (Warringah Road Green Bridge), as part of the Beaches Link project to enhance the public transport component of the project.
3. The Department commits to engaging with Transport for NSW to develop a significant public transport uplift to provide services to meet the needs of the precinct as it develops, inclusive of the reallocation of services toward North Sydney and the CBD via Beaches Link.

2. Cost and funding of infrastructure

Council raises two (2) concerns regarding the cost and funding of infrastructure. The first concern relates to the timing of the rezoning and impact on Council's Development Contributions Plan (Section 7.11). The second concern relates to the SIC levy, regarding the identification of infrastructure items and distribution of funds.

Timing of the rezoning and impact on Council's Development Contributions Plan (Section 7.11)

The draft planning package identifies several infrastructure items which will require delivery by Council. To ensure that these items are funded and delivered, Council is preparing a draft Development Contributions Plan (Section 7.11), which will identify the local infrastructure items and apportionment attributable to the development from the draft planning package. It is expected that the draft section 7.11 contributions plan will be exhibited later in the year.

Given the nature and number of infrastructure items required, it is likely that the residential contribution rate will greatly exceed the $20,000 per dwelling cap imposed by the Government, necessitating a review process and final approval by the Independent Pricing and Regulatory Tribunal (IPART). Based on the experience observed from other precincts who have been through the IPART process, this will create an additional delay with the approval of the Development Contributions Plan (Section 7.11).

To address the above timing issues, Council acknowledges that the Department have included a provision in the Explanation of Intended Effect to mitigate this issue. The provision proposes to ensure that development applications cannot approved unless there is a contributions plan in place. However, Council raises concern that the proposed wording is not strong enough. The specific current reference is:

> *The preparation of a contributions plan will be led and prepared by Northern Beaches Council and will set out local infrastructure works and location, proposed staging, and estimated costs per item.*
>
> *An amendment to the EP&A Regulation 2000 will require a contributions plan to be prepared prior to the determination of any development applications in Site A, Site B, Site C and Site D in the Frenchs Forest precinct that are not minor in nature. This provision will apply to ensure the implementation of infrastructure consistent with the draft Frenchs Forest Place Strategy.*
>
> Source: NSW Department of Planning, Industry & Environment 2021, Explanation of Intended Effect, page 16

Council requests that the drafting of this clause specifically refer to the preparation and adoption of a Development Contributions Plan (Section 7.11). There is a risk that if the rezoning for the precinct proceeds and the amendment to the Local Environmental Plan comes into effect before the Development Contributions Plan (Section 7.11) is approved by IPART, the current Development Contributions Plan (Section 7.12) would apply. This is a significant concern to Council who have committed to working on a Development Contributions Plan (Section 7.11) to deliver the required infrastructure for the precinct. Levying under the current Development Contributions Plan (Section 7.12) can only achieve 1% of the development value, which will not be enough to deliver the identified infrastructure.

SIC Levy – identification of infrastructure items and distribution of funds

Council welcomes the inclusion of a Special Infrastructure Contributions (SIC) levy applying to the precinct, to ensure that funding is captured to contribute towards the delivery of state or regional infrastructure. However, Council has several concerns relating to the identification of the items and distribution of funds. Figure 2 identifies these items and the distribution of funds proposed to be allocated towards each item.

Reference	Infrastructure	Contribution
	Education	**$19,519,791**
E1	Contribution towards the provision of additional primary and secondary school facilities	$19,519,791
	Roads	**$5,329,626**
R1	Forest Way additional right turn lane from southern Forest Way leg into Naree Road (land and works)	$4,789,626
R2	Signalised intersection at Frenchs Forest West Road/Sylvia Place	$540,000
	Public Transport	**$1,000,000**
PT1	PT1 Supporting infrastructure for rapid bus services via Warringah Road between Dee Why and Chatswood (investigation)	$1,000,000
	Active Transport and Green Links	**$10,915,608**
P1	Southern Gateway – new stairway access to the pedestrian bridge over Warringah Road, west of Hilmer Street	$443,866
P2	Manly Dam Regional Connection	$8,000,000
P3	Investigation into Warringah Road Green Bridge	$2,471,742
	Planning and delivery	**$551,475**
	Total	**$37,316,500**

Figure 2: NSW Department of Planning, Industry & Environment 2021, Proposed SIC Frenchs Forest, page 10

Generally, Council observes that the SIC levy proposes to fund a potential list of studies, a set of traffic lights, an additional right turn lane, improvements to walking and cycling connections to Manly Dam and education infrastructure. Council observes that 52% of SIC levy is proposed to be allocated towards education.

Contrastingly, only 37% of the SIC levy funds will deliver actual infrastructure works. The remainder is for 'investigation' purposes which is of concern to Council as construction costs for investigation items of state and regional infrastructure are unfunded. This creates a high level of uncertainty that some of the key SIC levy infrastructure works will or can be delivered in the future.

Council requests that the Department reconsider the allocation of funds towards certain infrastructure items, as well as the inclusion of additional items that support the recommendations from Council's Transport Study by Arcadis.

Council recommends that any review of the SIC levy should address the following issues:

1. Clarification on why the SIC levy is being applied to all three phases of Council's Hospital Precinct Structure Plan area when there is only certainty that Phase One will be rezoned at this stage in the process?

2. There is no certainty on when the funds from the SIC levy will be spent and what the infrastructure priorities will be. A priority expenditure list appears to be a missing gap. Therefore, there is a risk that most of the income from Phase One will go to the Department of Education, rather than physical infrastructure.

3. Clarification is sought on how the contribution for education facilities was determined. This is significantly greater than any other SIC levy within NSW. For example, Bayside West 19.4%, North West Growth Area 6.3%, Warnervale 0%, Gosford City Centre 6.9%, St Leonards-Crows Nest 19.4%, Illawarra Shoalhaven 16.5%.

4. Why does the SIC levy only apply to residential development? Non-residential development contributes to significant infrastructure demand. This is supported by the Department's Transport Strategy by Jacobs, which identifies a traffic generation apportionment of approximately 55% to non-residential development. Accordingly, Council is of the view that it is most appropriate to levy non-residential development under the SIC levy.

5. The total value of the SIC levy is misleading as it applies to all three phases of Council's Structure Plan, when there is no certainty that Phases Two and Three will proceed. Further, the SIC levy does not apply to affordable housing. The SIC levy also credits existing development (approximately 102 dwellings to a value of $663,000). Therefore, the total possible SIC levy for Phase One is $21,762,000 (this excludes affordable housing and credits for existing dwellings).

In relation to the draft Environmental Planning and Assessment (Special Infrastructure Contribution – Frenchs Forest) Determination 2021, the following concerns are raised regarding the drafting of the clauses:

6. Clause 13(3) on page 8 – clarification is required on the proposed wording: *For the purpose of determining the number of dwellings that have been demolished: a dwelling that is not residential accommodation is to be included in the number.* Shouldn't a dwelling that is not used for residential accommodation be excluded from a credit to the SIC levy?

7. Clause 19 on page 11 – this clause provides a reduction in the SIC by 50% or 25% if it is paid by 1/7/22 or 1/7/23 respectively. Council requests that this clause is deleted as no reductions should be provided to ensure that all infrastructure requirements are fully funded.

Recommendation:

4. The Department refine the proposed clause relating to the 'Requirement to prepare a Contributions Plan', so that there is specific reference to the preparation of a Development Contributions Plan (Section 7.11).

5. The Department reconsider the infrastructure items identified in the SIC levy and associated contribution.

6. The Department undertake a thorough review of Council's concerns including, but not limited to, the application of the SIC levy to non-residential development, preparation of a priority expenditure list, consider the discounts available and impact on the total value of the SIC levy, and the drafting of specific clauses.

3. Town centre open space and Police Station dedication

Town Centre

Council supports the identification of approximately 1.5 hectares of land in the town centre to be utilised for open space purposes. Council has consistently requested that this parcel of land be dedicated to Council, free of cost. To date, Council has only received verbal reassurance from the Department that this dedication, free of cost would be supported.

Council seeks the Department's assistance with confirmation of this position in writing from Property NSW (who will be leading the sale of the school site) and the Department of Education (who are the land owners). This commitment must be confirmed in writing to ensure that Council is able to remove the significant cost to acquire the land from Council's Development Contributions Plan (Section 7.11), so as not to result in an inflated contribution rate due to the uncertainty around this matter.

The 1.5 hectare open space land on the town centre site is a pivotal part of the precinct. The town centre open space will deliver on a strong community desire to retain existing vegetation and mature trees and is of a size that will be well utilised. Further, Council supports the retention of remnant and planted trees west of the existing school. It is therefore crucial that this land is dedicated to Council, free of cost, to ensure the vision for the town centre is achieved.

Police Station

To facilitate the delivery of the new road which connects Holland Crescent to the intersection of Frenchs Forest Road West at Sylvia Place, Council seeks the dedication of No. 137-139 Frenchs Forest Road West (Frenchs Forest Police Station) to Council free of charge. Council requests that the Department investigate an appropriate mechanism to allow certainty and ensure that the land can be dedicated to Council at the appropriate time.

Recommendation:

7. The Department provide Council with written confirmation from Property NSW and the Department of Education that the land required for the town centre open space and the land on which the police station is located will be dedicated to Council, free of cost.

4. Delivery of the community hub

The draft planning package identifies that a 'community hub' will be located within the town centre site, positioned towards the south-western corner of the town centre. The community hub will overlook the new open space and be near the proposed piazza area, where outdoor dining and cafes are expected. It will also be adjacent to a 10-storey residential apartment development (on the eastern side of the community hub site) and close to the six storey commercial buildings which front Warringah Road. If the Green Bridge for a future bus interchange at Warringah Road proceeds, then the community hub will also be near the future bus service.

Council supports the identification of the community hub in the Department's plans, however, advises that Council has no way of delivering the full extent of the community hub land uses with the current rules governing Development Contributions Plans (Section 7.11) in place. In relation to community buildings, councils can collect funds for the land on which they are located but not for the construction of the building itself. It is noted that the State Government is currently considering changes to Development Contribution legislation. These changes are silent on any proposed changes to the essential infrastructure list that may include a review of the ability to collect for the floorspace for community centres or not.

Whilst Council intends to deliver community facilities within the town centre site on land that is expected to be dedicated to Council, free of cost, the range of facilities to be provided is likely to be limited due to funding constraints. Some of the uses such as a child care centre and indoor recreation facility could be provided by the private market. To date, no funding source has been identified for the construction of the community hub, making this an unfunded project.

Recommendation:

8. The Department include reference to a 'community hub' in the Place Strategy documents but remove reference to building footprint size and total floor space related to the 'community hub' building.

5. Elevating the role of sustainability as a key feature to create a flagship precinct

Council is pleased to see that a Sustainability Plan, prepared by Flux Consultants (Flux), has been prepared for the precinct. The report by Flux considers how sustainability could be implemented at a precinct-wide level, with the town centre site playing a crucial role in the achievement of a sustainable precinct. This is a great step forward and Council invites the Department to build on Flux's recommendations in order to elevate the role of sustainability as a key feature for the entire precinct.

A tremendous opportunity exists for Frenchs Forest to become a carbon neutral and sustainable precinct which considers climate change and resilience. Council has spoken up about the effects of climate change and in August 2019, resolved to 'declare that we are in a state of climate emergency that requires immediate action by all levels of government'.

Following this, in December 2019, Council adopted the Protect. Create. Live - Northern Beaches Environment and Climate Change Strategy 2040 (E&CCS). The E&CCS sets out clear and ambitious commitments to accelerate action on climate change. These commitments are aligned to the Paris Climate Agreement 'to limit global temperature rise to well below 2 degrees Celsius above pre-industrial levels and to strive for 1.5 degrees' and include:

- a 50% reduction in community emissions by 2040 and net zero emissions by 2050.
- 50% of suitable premises with solar panels installed by 2030.
- an aspiration to achieve net zero emissions by 2030 with all new buildings net zero by 2030.

Council's Local Strategic Planning Statement (Towards 2040) also includes actions relevant to climate change mitigation and adaption. These are:

- to deliver the Frenchs Forest Strategic Centre as a low-carbon, high-efficiency precinct, and a Green Star Community.
- to develop Local Environmental Plan and Development Control Plan controls to improve energy, water and waste efficiencies in new developments and require developments in strategic centres, employment hubs and areas subject to urban intensification to provide an independent sustainability certificate such as the Green Star Rating Tool, Passive House or a recognised equivalent (threshold to be developed).
- to prepare a Climate Change Action Plan for the Northern Beaches and a Climate Change Adaptation Plan for the Frenchs Forest Strategic Centre.

The NSW Government also has similar commitments to achieve net zero emissions by 2050, and a 35% reduction in emissions by 2030 compared to 2005 levels.

The latest Intergovernmental Panel on Climate Change report (IPCC) further identifies that we will need to reach 'at least net zero CO_2 emissions, along with strong reductions in other greenhouse gas emissions' (IPCC 2021). The global nature of climate means that we are already experiencing change and it is critical that we prepare for the changes already locked into the system. We can do this by adapting the way we design and build structures today as these structures will stand for the next 50 to 100 years. As such, it is essential that our planning framework and mechanisms ensure that best practice is included.

The draft Explanation of Intended Effect (EIE) outlines proposed provisions to guide the delivery of sustainable development. Whilst Council supports the inclusion of these objectives, Council notes that these controls apply only to the town centre site and do not specify targets or standards. An extract of the proposed mechanism is below.

- *Objectives for the future development of the town centre will aim towards a low-carbon precinct where carbon emissions are reduced, energy, water and waste is efficiently managed, and a genuine mix of land uses support Frenchs Forest as a strategic centre with more jobs and space for employment uses, higher quality public areas and new open space.*

- *Environmental sustainability must be considered in commercial and non-residential development, which includes consideration of energy consumption, water efficiency, thermal comfort and sustainable design. Note, BASIX will apply to residential development.*

  Source: NSW Department of Planning, Industry and Environment 2021, Draft Explanation of Intended Effect, page 14

There are three (3) matters that Council would like to see resolved prior to finalisation of the statutory planning controls. These are:

1) the application of sustainability objectives to the entire precinct.

2) increasing the targets for residential development under State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004 (BASIX SEPP).

3) applying sustainability targets for non-residential development.

This is not the first time that Council has raised sustainability issues with the Department. It is imperative that the Department demonstrate leadership in delivering best practice outcomes for sustainability, despite the challenges that may be involved in amending the 'back-end' of BASIX or, the complexities involved with the inclusion of innovative statutory requirements in the Local Environmental Plan. This has been done for other precincts and Council cannot see why this would be different for the Frenchs Forest Precinct. Council urges the Department to undertake more work to elevate the role of sustainability as a key feature to create a flagship precinct.

The application of sustainability objectives to the entire precinct

As mentioned previously, Council is concerned that the proposed provision in the EIE applies only to the town centre site. Council requests that the provision is extended to all lots within the precinct.

Extending the sustainability objectives to the entire precinct will ensure that the same design and sustainability standards apply. It will also prevent a potential two-tier development outcome, where high quality, sustainable buildings are provided only within the town centre site and stock standard apartment or mixed-use buildings are delivered elsewhere.

Increasing the targets for residential development under State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004 (BASIX SEPP)

Council acknowledges that the BASIX SEPP will be the primary mechanism to enforce sustainability for residential development. Unfortunately, the BASIX SEPP is preventing Council from going beyond the standard requirements to implement higher performance sustainability targets, which have also been identified by Flux.

Whilst Council acknowledges the ambitious recommendations identified by Flux, Council raises concern with a potential gap in the analysis relating to implementation associated with fragmented land ownership patterns, particularly for the lots outside of the town centre site.

Council engaged Kinesis to undertake a Sustainability Strategy (see attached) to fill this gap by meeting the same environment performance outcomes of the Flux Sustainability Strategy, while responding to the fragmented land ownership patterns. Based on modelling outcomes, the recommendations from Kinesis highlighted that increasing BASIX targets was the most efficient and realistic way to deliver high performance sustainable buildings. Further, Kinesis concluded that if these solutions were implemented, it would estimate an additional marginal capital cost of $4,100 per dwelling, saving households close to $600 per year in utility bills.

The targets recommended were:

- higher BASIX targets
    - Energy 55 for all new apartments
    - Water 55 for all new apartments
- higher Performance for non-residential buildings
    - NABERS 5.5 Energy for offices and hotels
    - NABERS 3-star Water for offices and hotels
    - minimum Green Star Design & As Built ratings 4-star
- higher Performance requirements for the community hub, including minimum solar photovoltaic (PV) requirement of 30% of the roof area or 0.5 megawatts, with an aspiration to meet net zero emissions
- require all new off-street parking to include electric vehicle (EV) charge points
- investigate the potential for unbundled and decoupled parking and the opportunities for car share within the precinct.

Alluvium was commissioned by Council to prepare a Water Sensitive Urban Design Strategy for the precinct (see attached). The Alluvium Strategy identified a recommendation to increase the requirement for BASIX tank size by 50% to manage stormwater discharges to the existing creeks. Due to the steep terrain in many areas of the precinct, increasing the minimum size of rainwater tanks (either permanent storage or temporary detention storage) to manage hydrology was recommended as a cost-effective option.

Applying sustainability targets for non-residential development

Council is concerned that the proposed provisions in the EIE do not capture targets for non-residential development, therefore relying on Council's Development Control Plan. It is well recognised that controls within a Development Control Plan provide guidance only and accordingly, should not be the mechanism to be relied on to enforce sustainable development outcomes.

Council requests that the sustainability targets as identified by Kinesis for non-residential buildings are included in the Local Environmental Plan. This will ensure that non-residential development also delivers a sustainable outcome.

Recommendation:

9. The Department amend the BASIX SEPP to include higher targets for Energy (55) and Water (55), increase the BASIX tank size by 50% to manage stormwater discharges to the existing creeks and adopt net zero targets for multi-residential developments and office, hotel, mixed use and shopping centres as defined in 'Planning for net zero energy buildings' (City of Sydney 2021).

10. The Department include sustainability requirements for non-residential buildings in the precinct in the Local Environmental Plan, requiring NABERS 5.5 Energy for offices and hotels, NABERS 3-Water for offices and hotels and a minimum 4-star Green Star Design & As Built rating, to reflect the recommendations from the Kinesis Strategy.

11. The Department work with Council to include additional sustainability requirements in the Local Environmental Plan to reflect the recommendations from the Flux and Kinesis Strategies. This includes:

    A. the requirement for a water reuse target of at least 50% in the town centre commercial core precinct.

    B. ensuring all new buildings are EV ready.

    C. the requirement for all new development to submit a Green Travel Plan.

    D. the requirement to unbundle parking provision from dwellings to enable choice to purchase or lease parking.

    E. higher performance requirements for the community hub, including minimum solar PV requirements of 30% of the roof area or 0.5 megawatts, and an aspiration to meet net zero emissions or even a carbon positive building (i.e. buildings that create a net environmental benefit).

12. The Department implement the following actions from Council's Local Strategic Planning Statement – Towards 2040 and other State government policies, strategies and plans including:

    A. delivering a carbon neutral, high efficiency precinct and a Green Star Community through integrated sustainability initiatives. This could be achieved by ensuring the precinct incorporates high passive design performance, is electric vehicle ready, supports a diverse and integrated system of renewal energy supply (including solar, green hydrogen, bio-energy and the like), banning fossil fuel gas from new buildings, sustainable and resilient construction materials. Also, the precinct should incorporate high levels of resilience by ensuring continuous energy, water, data supply even during extreme events like drought, heat waves or pandemics.

    B. designing a flagship circular economy precinct to enable the efficient collection and sharing of used materials, water and energy between business for beneficial reuse in other businesses. This will include infrastructure to efficiently collect 'clean' used materials to enable recycling (such as waste vacuum systems or other technology for efficient transfer). The planning controls should facilitate reuse and repair of circulated materials, energy and water.

    C. driving precinct-scale efficiencies by integrated measures into the planning framework that support sharing electricity generation, consumption, harvesting and recycling

	across multiple buildings or land uses. For example, this includes incorporating embedded energy networks, dual reticulation water systems and energy storage systems to facilitate power sharing.
D.	developing and integrating planning controls that deliver net zero, resilient and health homes that meet requirements of ratings tools such as Green Star Homes.
E.	consistency with the NSW Waste and Sustainable Materials Strategy 2041 by ensuring planning controls provide opportunities for complementary businesses to co-locate where they beneficially re-use each other's by-products, reducing their waste and carbon footprints.

6. Statutory planning framework

Achieving a robust and clear statutory planning framework is key to implementing the vision contained within the Department's draft planning package. Council understands that the primary mechanism will be through a self-repealing state environmental planning policy to amend the current Warringah Local Environmental Plan 2011. This is supported by Council and is the most effective mechanism to achieve the intended outcome.

Council provides additional comments for further consideration by the Department. This includes:

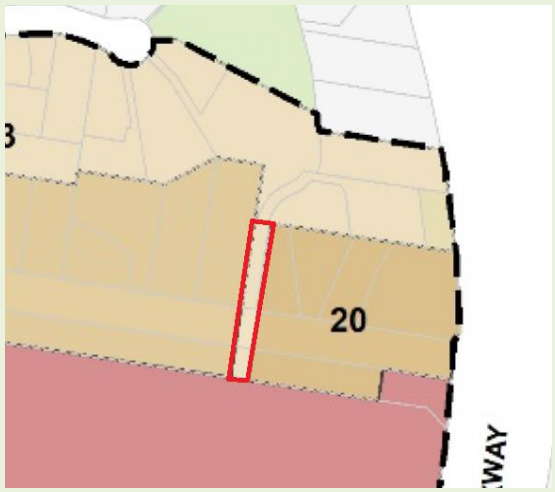
1. suggested improvements to the draft Explanation of Intended Effect
2. the application of a Ministerial Direction to implement the draft Frenchs Forest Place Strategy
3. the preparation of additional information to meet Planning for Bushfire Protection 2019 and Ministerial Direction 4.4 – Planning for Bushfire Protection

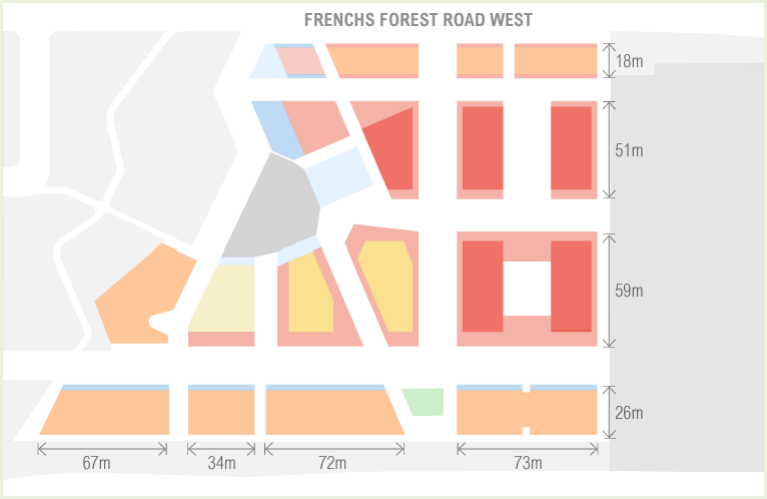
Suggested improvements to the draft Explanation of Intended Effect

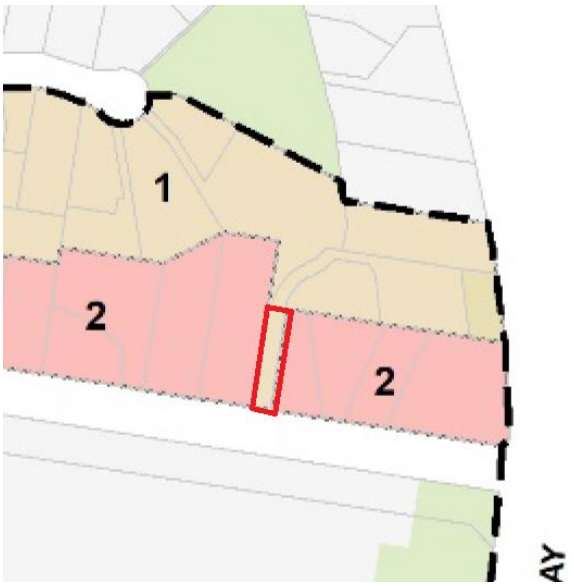
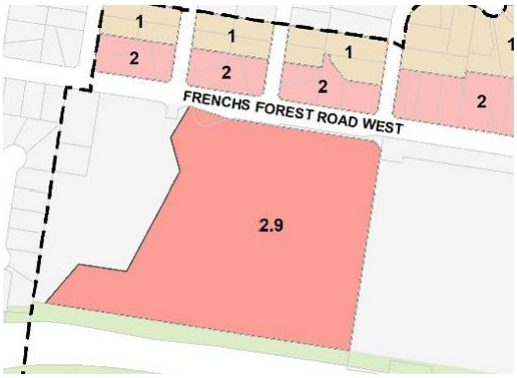
Council generally supports the statutory planning framework identified in the draft Explanation of Intended Effect to implement the draft Frenchs Forest Place Strategy. Table 3 identifies additional comments for consideration.

Table 3: Suggested improvements to the draft Explanation of Intended Effect

Proposed mechanism	Comment
Land Zoning Map	Council raises no issue with the proposed land use zones, which are generally consistent with the land uses envisaged under Council's Structure Plan. However, there is one site which Council requests for review. **1. Northern Beaches Hospital** An SP2 Infrastructure zone is proposed to be applied across the entire site. Council advises that parts of the site are currently zoned RE1 Public Recreation, which reflect the native vegetation conditions that currently exists on site and the conditions of development approval for the Hospital to maintain these areas. Council recommends rezoning the eastern portion of the Hospital site currently zoned RE1 to E2 Environmental Conservation, and the southern portion of the site currently zoned RE1 to E3 Environmental Management for the following reasons: • the State Significant Infrastructure approval included a requirement to retain a portion of land for vegetation and any remaining Duffys Forest endangered ecological community (EEC). This included a "retained green space" at the eastern portion of the site adjoining Wakehurst Parkway. Council considers an E2 zone appropriate to reflect this environmentally sensitive area containing Duffys Forest EEC. • to continue the landscaped setting along Warringah Road and Wakehurst Parkway, which is a key feature of the precinct. Both the

Proposed mechanism	Comment
	southern and eastern boundaries of the site contribute to the overall landscaped corridor along main roads. Whilst the southern boundary has been cleared of mature vegetation, this area has been replanted to reflect the requirement under the approved plans for native grass batter and dense native screening. The existing RE1 zoned land also provides a natural setback to Warringah Road and Wakehurst Parkway. If the zoning of this part of the land changes, it is considered that an E3 zone is appropriate to reflect the objective to protect, manage and restore aesthetic values by promoting bushland buffers adjacent to major traffic thoroughfares. • to reflect the approved plans for the Northern Beaches Hospital site. Rezoning the entire site to SP2 Infrastructure will permit future expansion of the hospital towards the eastern and southern boundaries. The approved plans identify that retaining these areas in combination with the biodiversity offsets are considered suitable mitigation measures in managing any potential environmental impacts.
Height of Buildings Map	In relation to the Bantry Bay Track and the portion of land that fronts Frenchs Forest Road West, Council recommends that the 20-metre height limit is extended west to include this portion of the site (see red outline below). This will allow future flexibility for this site and align with development to the east, given the number of constraints applicable to this site. 

Proposed mechanism	Comment
	 In relation to the Frenchs Forest High School site, the current height of building map shows the height as 40m across the entire site. It is requested that the height be amended to reflect the height of buildings identified in the urban design study that shows differentiated heights in the town centre with a maximum height of 12 storeys (40m) only in specific locations.  
Floor Space Ratio (FSR) Map	In relation to the Bantry Bay Track and the portion of land that fronts Frenchs Forest Road West, Council recommends that the 2:1 FSR is extended west to include this portion of the site (see red outline below). This will allow future

Proposed mechanism	Comment
	flexibility for this site and align with development to the east, given the number of constraints applicable to this site.  In relation to the Frenchs Forest High School site, the current FSR map shows a consistent FSR of 2.9 across the entire site. It is requested that the FSR be amended to reflect the differentiated built form identified in the urban design study that shows differentiated FSR in the town centre. 

Proposed mechanism	Comment
	
Land Reservation Acquisition Map	Council refers to its comments in relation to required transport and traffic infrastructure for the precinct. Council is of the view that further acquisitions will be required once the town centre site reaches 70% capacity. These properties are not reflected on the Land Reservation Acquisition Map and Council requests that an agreed approach with relevant state agencies is reached.
Additional Permitted Uses Map	Council raises no issues with the additional permitted uses proposed. However, in relation to the Bantry Bay Track and the portion of land that fronts Frenchs Forest Road West, Council recommends that Area 24 is extended west to include this portion of the site (see red outline below). This will allow future flexibility for this site and align with development to the east, given the number of constraints applicable to this site.

Proposed mechanism	Comment
	
Extend exceptions to development Standards	Council supports the extension of clause 4.6 exceptions to development standards to add clause 6.7 relating to residential flat buildings in the B4 Mixed Use zone for Site A and confirmation that the floor space ratios within the precinct are unable to be varied. Regarding clause 6.7, Council requests that this is also extended to Site B, as this precinct also includes a B4 zone for part of the site fronting Frenchs Forest Road West. This will ensure that non-residential development is mandated and not treated as a development standard, which will contribute to the overall vision for activation at the street level. Regarding the inclusion of floor space ratios, Council reiterates that the traffic modelling of the entire precinct has considered the level of floor space proposed under the FSRs identified. Any change to the modelled capacity (including variations to FSRs which would result in incremental increases to floor space) would result in impacts to the precinct's overall transport and traffic network and potentially require additional traffic and transport infrastructure upgrades that are beyond what has been identified.
Site specific provisions	Council refers to its previous comments raising issues associated with the inclusion of a development cap for the town centre, lack of sustainability targets and specific reference to the inclusion of a Development Contributions Plan (Section 7.11). Council supports the inclusion of site-specific provisions. Comments on certain provisions are discussed below.
Design excellence	Council supports a design excellence process for Sites A, B and D. Council understands that a design competition process is unable to be achieved for the precinct as floor space or height bonuses are unavailable. Council suggests that the design excellence process also include reference to the integration of circular economy principles, to demonstrate consistency with the NSW Waste and Sustainable Materials Strategy 2041 and the

Proposed mechanism	Comment
	forthcoming State Environmental Planning Policy – Design and Place. This could include the prioritisation of the use of recycled material and modular building design together with material passports, to enable reuse of materials.
Minimum subdivision lot size for attached dwellings and semi-detached dwellings in limited circumstances	Council supports the inclusion of this provision to allow subdivision of attached dwellings and semi-detached dwellings. Council understands that there may be an administrative error regarding the reference to Site B in this provision, which should be referenced as Site C. Council requests that this reference is corrected.
Affordable housing	Council supports the identification of affordable housing targets of 10% to 15% of residential floor space. This aligns with Council's draft Affordable Housing Contributions Scheme. Council acknowledges that inclusion of this provision would enable the implementation of Council's Affordable Housing Contributions Scheme.
Undergrounding existing powerlines	Council supports the inclusion of this provision however understands that the outcome to underground the 33kV powerlines along Frenchs Forest Road West may not be practical if undertaken in a piecemeal and site-specific manner. Council has investigated potential delivery outcomes with Ausgrid. The advice concluded that whilst undergrounding of the powerlines was possible, the precinct contained several constraints, which required specific design solutions. This included routing of the powerlines within the centre median of Frenchs Forest Road West due to the presence of other underground utilities (e.g. gas lines) underneath the footpath. As a result, any undergrounding works were required to be undertaken in a single event and within specific time periods. Council has been advised by Ausgrid that this matter is a priority for the Strategic Centre. Ausgrid have advised that the undergrounding cannot be undertaken on a site by site basis due to construction difficulties with a gas line located underground and compliance with Ausgrid's own guidelines. Council understands that the issue may not be resolved unless there is a single authority who is willing to undertake the works. Therefore, the current proposal is to ensure that new development along Frenchs Forest Road West is set back at least 3.5 metres to address safety requirements. This is proposed to be enforced through Council's Development Control Plan.

The application of a Ministerial Direction to implement the draft Frenchs Forest Place Strategy

Council requests that the Department consider the application of a Ministerial Direction to implement the draft Frenchs Forest Place Strategy. This will ensure that the interim period between exhibition of the draft planning package and publishing of the statutory planning controls allows statutory weight to be placed on the draft Frenchs Forest Place Strategy.

Council is aware that the Department has included other Place Strategies as Ministerial Directions. This includes plans applying to the North West Growth area, Greater Parramatta, Wilton, Glenfield to Macarthur, Western Sydney Airport, Bayside West, Cooks Cove, St Leonards/Crows Nest, Greater Macarthur, and the Pyrmont Peninsula regions.

A Ministerial Direction is a relevant matter for consideration in the assessment of planning proposals and offers an increased level of protection when assessing planning proposals that don't conform to the place strategy.

The preparation of additional information to meet Planning for Bushfire Protection 2019 and Ministerial Direction 4.4 – Planning for Bushfire Protection

As part of the Hospital Precinct Structure Plan, Council commissioned a Bushfire Constraints and Opportunities Assessment including assessment of vegetation, slope and bushfire requirements required by the NSW Rural Fire Service and the then applicable Planning for Bushfire Protection 2006. It provided several recommendations, which Council understands have been incorporated into the Department's draft plans.

Given that the precinct is situated on bush fire prone land identified in the Northern Beaches Bush Fire Prone Land Map 2020, Council is of the view that a Strategic Bush Fire Study is required to be prepared in accordance with the requirements of the new Planning for Bush Fire Protection 2019. The Strategic Bush Fire Study provides the opportunity to assess whether new development is appropriate in the bush fire hazard context. It also provides the ability to assess the strategic implications of future development for bush fire mitigation and management. Council also notes that consideration of bushfire matters is a Ministerial Direction under Direction 4.4. Direction 4.4 advises that consultation with the Commissioner of the NSW Rural Fire Service is required.

Recommendation:

13. The Department amend the draft Explanation of Intended Effect to reflect the following outcomes:

A. rezone the eastern portion of the Hospital site currently zoned RE1 to E2 Environmental Conservation, and the southern portion of the site currently zoned RE1 to E3 Environmental Management.

B. amend the planning maps (Height of Building, Floor Space Ratio, Additional Permitted Uses) relating to the portion of land at Bantry Bay Track that fronts Frenchs Forest Road West, to provide flexibility for this site and align with future development to the east, given the number of constraints applicable to this site.

C. amend the planning maps (Height of Buildings, Floor Space Ratio) relating to the Frenchs Forest Hight School site, to reflect the differentiated built form identified in the

urban design study that shows differentiated heights and FSR in the town centre with a maximum height of 12 storeys (40m) and FSR of 2.9:1 only in specific locations.

D. discuss with relevant state agencies regarding land acquisition required beyond 70% development of the town centre site and include this in the Land Reservation Acquisition Map.

E. amend clause 4.6 exceptions to development standards to include Site B as part of clause 6.7 relating to residential flat buildings in the B4 Mixed Use zone.

F. consider the inclusion of circular economy principles as part of the design excellence process.

G. clarify that the minimum subdivision lot size for attached dwellings and semi-detached dwellings apply to Site C (not Site B).

14. The Department apply a Ministerial Direction to implement the Frenchs Forest Place Strategy to ensure that the outcomes of the Strategy are not compromised through the planning proposal process.

15. The Department prepare a Strategic Bush Fire Study to meet requirements under Planning for Bush Fire Protection 2019 and consult with the Commissioner of the NSW Rural Fire Service under Ministerial Direction 4.4 – Planning for Bushfire Protection.

7. State Government coordination

Council supports the Department's role in coordinating the precinct planning for the area, as it is best placed to ensure that supporting infrastructure including schools, public transport, road infrastructure and open space are delivered to support the community's existing and future needs.

We have identified several matters requiring coordination with various state agencies. We are hopeful that the Department can continue its crucial coordination role and ensure a resolution to the identified issues.

Department of Education and School Infrastructure NSW

Council is pleased to see that agreement has been reached with the Department of Education on the relocation of The Forest High School to 187 Allambie Road, Allambie Heights. Council understands that the new school is a state significant project, requiring the preparation of an Environmental Impact Statement and public exhibition.

Property NSW

Council understands that Property NSW are the lead agency in dealing with the divestment of the Forest High School site. Council requests that the Department liaise with Property NSW to guide the proposed divestment strategy and special conditions within the Contract of Sale.

Council understands that the divestment strategy may include several options such as selling the site as a single parcel to a single developer, the subdivision of the site and subsequent sale of different parcels of the site, or redevelopment of the site by a government agency such as Landcom. Council requests that the Department is involved with determining the preferred divestment strategy to ensure a suitable outcome for the development of the town centre site.

Regarding the Contract of Sale, Council requests that the Department advocate for special conditions to be applied to ensure that there is a contractual agreement to secure sustainable urban fabric including green procurement practices for the construction and/or operations of buildings and infrastructure. The town centre site represents a significant opportunity to deliver a world class and sustainable town centre and the contract of sale is key to ensuring that the right developer with a shared vision is procured.

Transport for NSW

Council is continuing to work with Transport for NSW to ensure that development at Frenchs Forest is accompanied by appropriate infrastructure to support the new population. As identified in the submission, Council is of the view that there are several transport infrastructure items which require commitment from Transport for NSW as they are on state-controlled roads.

Council requests that the Department liaise with Transport for NSW to ensure that commitment is provided to deliver Council's required traffic and transport upgrades. Council has recommended in the submission that there may be opportunity to identify these upgrades as part of future regional transport projects for the Northern Beaches including the proposed east-west B-Line service or the Beaches Link Tunnel project.

Separately, Council requests that the Department include in the draft Place Strategy the identification of a future pedestrian and cyclist bridge across Wakehurst Parkway (either graphically or captured in text) which has been agreed in consultation with Council and Schools Infrastructure NSW. This will ensure consistency and acknowledgement of this important pedestrian and cycle connection to the new School location.

Recommendation

16. The Department liaise with Property NSW to ensure that special conditions are applied to the sale of the Forest High School site relating to the delivery of sustainable and green infrastructure.

17. The Department liaise with Transport for NSW to ensure that commitment is provided to deliver Council's required traffic and transport upgrades, noting the opportunities available to identify these works as part of future regional transport projects for the Northern Beaches.

18. The Department liaise with Transport for NSW to identify the future pedestrian and cyclist bridge across Wakehurst Parkway in the draft Frenchs Forest Place Strategy.

8. Support for affordable rental housing contribution

Council strongly supports the proposed affordable housing targets of 15% for the town centre site and 10% elsewhere. This position aligns with Council's adopted Affordable Housing Policy, which applies to the Northern Beaches local government area. This position also aligns with Council's draft Affordable Housing Contributions Scheme, which was placed on exhibition by Council concurrently with the Department's draft planning package.

Council sees that the Frenchs Forest Hospital precinct provides the best opportunity to deliver affordable housing and be one of the first precincts to include a clause in Warringah Local Environmental Plan 2011 to implement State Environmental Planning Policy No. 70 – Affordable Housing (Revised Schemes). Council requests that the Department's Eastern Harbour City Team continue to liaise with the Housing Policy team to ensure that all relevant statutory requirements have been met in order to implement the 10% and 15% affordable rental housing target in the Warringah Local Environmental Plan 2011.

Recommendation

19. The Department's Eastern Harbour City Team continue to liaise with the Housing Policy team to ensure that all relevant statutory requirements have been met to implement the 10% and 15% affordable rental housing target in the Warringah Local Environmental Plan 2011.

9. Development feasibility

The Department's exhibition material does not include work to determine development feasibility. Council remains concerned that the feasibility of the proposed height and floor space ratios do not have regard for the cost of the SIC levy and local infrastructure contributions, which are likely to go well beyond the $20,000 per dwelling cap.

Further, Council advises that affordable housing contributions and sustainability inclusions should be treated as business-as-usual requirements. Council does recognise that this may not be a shared view with the development industry. Therefore, Council suggests that these items are separately itemised.

Council requests that an updated feasibility assessment is undertaken, which accounts for the infrastructure contributions likely to be imposed on development. Council is aware that the Northern Beaches property market has had an upward trajectory since the adoption of Council's Structure Plan in 2017, which may have had an impact on feasibility. An updated feasibility assessment is recommended to ensure that the proposed height and floor space ratio controls can be delivered.

Recommendation

20. The Department prepare an updated feasibility assessment, which accounts for the infrastructure contributions likely to be imposed on development.

Conclusion

Council welcomes the exhibition of the Department's draft planning package and appreciates the consultation undertaken during the preparation of the draft reports and strategies.

Council provides the following recommendations to assist with the finalisation of the draft planning package:

1. The Department commits to the delivery of the required six (6) transport infrastructures items either through a SIC levy or identified in relevant State Agency budgets.
2. The Department commits to the delivery (not investigation) of the linear transport interchange (Warringah Road Green Bridge), as part of the Beaches Link project to enhance the public transport component of the project.
3. The Department commits to engaging with Transport for NSW to develop a significant public transport uplift to provide services to meet the needs of the precinct as it develops, inclusive of the reallocation of services toward North Sydney and the CBD via Beaches Link.
4. The Department refine the proposed clause relating to the 'Requirement to prepare a Contributions Plan', so that there is specific reference to the preparation of a Development Contributions Plan (Section 7.11).
5. The Department reconsider the infrastructure items identified in the SIC levy and associated contribution.
6. The Department undertake a thorough review of Council's concerns including, but not limited to, the application of the SIC levy to non-residential development, preparation of a priority expenditure list, consider the discounts available and impact on the total value of the SIC levy, and the drafting of specific clauses.
7. The Department provide Council with written confirmation from Property NSW and the Department of Education that the land required for the town centre open space and the land on which the police station is located will be dedicated to Council, free of cost.
8. The Department include reference to a 'community hub' in the Place Strategy documents but remove reference to building footprint size and total floor space related to the 'community hub' building.
9. The Department amend the BASIX SEPP to include higher targets for Energy (55) and Water (55), increase the BASIX tank size by 50% to manage stormwater discharges to the existing creeks and adopt net zero targets for multi-residential developments and office, hotel, mixed use and shopping centres as defined in 'Planning for net zero energy buildings' (City of Sydney 2021).
10. The Department include sustainability requirements for non-residential buildings in the precinct in the Local Environmental Plan, requiring NABERS 5.5 Energy for offices and hotels, NABERS 3-Water for offices and hotels and a minimum 4-star Green Star Design & As Built rating, to reflect the recommendations from the Kinesis Strategy.
11. The Department work with Council to include additional sustainability requirements in the Local Environmental Plan to reflect the recommendations from the Flux and Kinesis Strategies. This includes:

A. the requirement for a water reuse target of at least 50% in the town centre commercial core precinct.

B. ensuring all new buildings are EV ready.

C. the requirement for all new development to submit a Green Travel Plan.

D. the requirement to unbundle parking provision from dwellings to enable choice to purchase or lease parking.

E. higher performance requirements for the community hub, including minimum solar PV requirements of 30% of the roof area or 0.5 megawatts, and an aspiration to meet net zero emissions or even a carbon positive building (i.e. buildings that create a net environmental benefit).

12. The Department implement the following actions to align with outcomes in Council's Local Strategic Planning Statement – Towards 2040 other NSW State Government policies, strategies and plans.

A. delivering a carbon neutral, high efficiency precinct and a Green Star Community through integrated sustainability initiatives. This could be achieved by ensuring the precinct incorporates high passive design performance, is electric vehicle ready, supports a diverse and integrated system of renewal energy supply (including solar, green hydrogen, bio-energy and the like), banning fossil fuel gas from new buildings, sustainable and resilient construction materials. Also, the precinct should incorporate high levels of resilience by ensuring continuous energy, water, data supply even during extreme events like drought, heat waves or pandemics.

B. designing a flagship circular economy precinct to enable the efficient collection and sharing of used materials, water and energy between business for beneficial reuse in other businesses. This will include infrastructure to efficiently collect 'clean' used materials to enable recycling (such as waste vacuum systems or other technology for efficient transfer). The planning controls should facilitate reuse and repair of circulated materials, energy and water.

C. driving precinct-scale efficiencies by integrated measures into the planning framework that support sharing electricity generation, consumption, harvesting and recycling across multiple buildings or land uses. For example, this includes incorporating embedded energy networks, dual reticulation water systems and energy storage systems to facilitate power sharing.

D. developing and integrating planning controls that deliver net zero, resilient and health homes that meet requirements of ratings tools such as Green Star Homes.

E. consistency with the NSW Waste and Sustainable Materials Strategy 2041 by ensuring planning controls provide opportunities for complementary businesses to co-locate where they beneficially re-use each other's by-products, reducing their waste and carbon footprints.

13. The Department amend the draft Explanation of Intended Effect to reflect the following outcomes:

A. rezone the eastern portion of the Hospital site currently zoned RE1 to E2 Environmental Conservation, and the southern portion of the site currently zoned RE1 to E3 Environmental Management.

B. amend the planning maps (Height of Building, Floor Space Ratio, Additional Permitted Uses) relating to the portion of land at Bantry Bay Track that fronts Frenchs Forest Road West, to provide flexibility for this site and align with future development to the east, given the number of constraints applicable to this site.

C. amend the planning maps (Height of Buildings, Floor Space Ratio) relating to the Frenchs Forest Hight School site, to reflect the differentiated built form identified in the urban design study that shows differentiated heights and FSR in the town centre with a maximum height of 12 stories (40m) and FSR of 2.9:1 only in specific locations.

D. discuss with relevant state agencies regarding land acquisition required beyond 70% development of the town centre site and include this in the Land Reservation Acquisition Map.

E. amend clause 4.6 exceptions to development standards to include Site B as part of clause 6.7 relating to residential flat buildings in the B4 Mixed Use zone.

F. consider the inclusion of circular economy principles as part of the design excellence process.

G. clarify that the minimum subdivision lot size for attached dwellings and semi-detached dwellings apply to Site C (not Site B).

14. The Department apply a Ministerial Direction to implement the Frenchs Forest Place Strategy to ensure that the outcomes of the Strategy are not compromised through the planning proposal process.

15. The Department prepare a Strategic Bush Fire Study to meet requirements under Planning for Bush Fire Protection 2019 and consult with the Commissioner of the NSW Rural Fire Service under Ministerial Direction 4.4 – Planning for Bushfire Protection.

16. The Department liaise with Property NSW to ensure that special conditions are applied to the sale of the Forest High School site relating to the delivery of sustainable and green infrastructure.

17. The Department liaise with Transport for NSW to ensure that commitment is provided to deliver Council's required traffic and transport upgrades, noting the opportunities available to identify these works as part of future regional transport projects for the Northern Beaches.

18. The Department liaise with Transport for NSW to identify the future pedestrian and cyclist bridge across Wakehurst Parkway in the draft Frenchs Forest Place Strategy.

19. The Department's Eastern Harbour City Team continue to liaise with the Housing Policy team to ensure that all relevant statutory requirements have been met to implement the 10% and 15% affordable rental housing target in the Warringah Local Environmental Plan 2011.

20. The Department prepare an updated feasibility assessment, which accounts for the infrastructure contributions likely to be imposed on development.

Appendix

Detailed comments - documents on exhibition and technical studies

Document	Comment
Draft Frenchs Forest Place Strategy	• Community hub – Whilst Council is supportive of the provision of community facilities in the town centre site, Council is concerned that there are a range of uses and floor space identified, which may not be able to be fully delivered by Council due to limited funding opportunities to construct and deliver a community facility. Notwithstanding this, it is acknowledged that there are several Council adopted strategies that support the provision of community facilities in Frenchs Forest e.g. Community Centres Strategy, Children's Services Strategy, Art and Creativity Strategy, Public Art Policy and Guidelines. • Retirement and respite day care - this is listed on page 19 with an allocation of 9,200sqm. Council advises that it will be difficult to mandate the provision of this land use, unless it is identified as a requirement in the statutory planning controls. • Flooding and stormwater – whilst the Strategy has been informed by a Stormwater Study, there is minimal discussion on flooding in the document. The Strategy states that mainstream flooding is unlikely, with potential for only minor flooding of residential properties north of Frenchs Forest Road, and that the existing draining easement will need to be maintained as well as that stormwater pipe upgrades may be needed. The Strategy mentions rainwater tanks, but nowhere in the document does it mention onsite detention (OSD) or detention basins. • Biodiversity - The broader area covered by the various elements of the Strategy includes areas with high biodiversity values such as threatened ecological communities and threatened species and habitat connectivity (e.g. wildlife corridors). Whilst the Strategy has been informed by various technical studies, the assessment of biodiversity values appears to be limited to that of tree canopy. It is acknowledged that most important biodiversity values are located outside of the precinct area (town centre) but close to and within areas identified for the future school site, embellished open spaces and jobs growth areas. It is recommended that a more detailed consideration of biodiversity values is included in the planning process in order to demonstrate consistency with relevant legislation including (but not limited to) the NSW Biodiversity Conservation Act 2016 (BC Act 2016) and associated NSW Biodiversity Conservation Regulation 2017. As a minimum, biodiversity values should be assessed and documented by following Stage 1 of the Biodiversity Assessment Method, established under the BC Act 2016. • Greener Places Design Guide - the draft plans do not refer to the latest NSW Government draft Greener Places Design Guide (2020). Section three of the current Greener Places Design Guide provides for an improved 'strategic urban biodiversity framework' including strategies

Document	Comment
	designed to be integrated into land use planning such as that currently advertised for Frenchs Forest. It is recommended that future consideration and finalisation of the Strategy includes implementation of strategies identified in Section three of the draft Greener Places Guide (2020). • Trees - The precinct area incorporating the existing Forest High School, Northern Beaches Hospital and immediate surrounds is proposed for substantial intensification. Within this area, the retention of remnant and planted trees west of the existing school is supported. Further, remnant native vegetation between the Hospital and Wakehurst Parkway must continue to be protected and managed. It is noted that two large remnant trees with significant hollows are located on Frenchs Forest Road West and would be removed for the proposal. One of the hollow bearing trees was formerly used for nesting by the threatened Powerful Owl. The owls are not thought to have returned to the nest tree for many years and the location is now less suitable to the nesting due to clearing of adjoining areas for road upgrades and the likes. Where possible, large trees especially those which provide wildlife habitat, should be retained and conserved within the precinct. • Crime risk – Council suggests that the Strategy refers to principles that mitigate crime risks from activities such as illegal dumping, graffiti, adequate lighting and pedestrian safety, assault and robbery (especially noting activity is expected at all hours of the day and night) • Waste management – Council notes that the Strategy does not include any reference to waste or the circular economy. This is a major omission for a significant new precinct and is inconsistent with both the NSW Government's clear direction to promote the circular economy and Council's own commitments in Towards 2040. The Frenchs Forest precinct presents an ideal opportunity to embed circular economy principles at a precinct level for these new mixed land uses.
Draft Explanation of Intended Effect	Refer to Key Issue 6 – Statutory planning framework
Draft Frenchs Forest Green Plan	• Platform Park - The platform park is a good innovation and the proposed facility mix is supported. Council notes that detailed design will need to consider the wind impact on its usability. Council welcomes further discussions with state agencies to progress the investigation of this item. • Forestville Park - The Plan refers to Nandi Reserve and Lionel Watts as being open space to support the precinct, however there is no mention of Forestville Park, which Council is planning to embellish through the Development Contributions Plan (Section 7.11) to increase capacity of

Document	Comment
	nearby active open space. Nandi Reserve will effectively be a bushland reserve with walking trails and is not considered appropriate for active open space. • Stormwater management – The Plan fails to consider stormwater management, downstream watercourses, receiving waters or catchment management principals. Council notes that the town centre drains to three catchments, including the high priority Curl Curl Creek catchment which drains to Manly Dam. There are several watercourses within reserves in the study area and future investigations areas which have not been considered in the Plan, mentioned in key projects or included in any mapping. These include: o Rabbett Reserve – Middle Creek, Narrabeen Lagoon Catchment o Brick Pit Reserve – Curl Curl Creek, Manly Dam and Manly Lagoon Catchment o Meredith Place Reserve – Bantry Bay tributary, Bantry Bay Catchment Council recommends consideration of water sensitive urban design, stormwater impacts and receiving waters under Principal 6 - Nature and Culture. Council recommends including the catchment boundaries, stormwater network and watercourses in the Plan's maps. • Off road cycle routes – the Plan identifies off road cycle routes through areas of intact native vegetation including mapped threatened ecological communities. Additional threatened species values and habitats are also known from these areas. Appropriate survey and assessment of trail alignment is recommended. The final alignment of such trails should seek to avoid and minimise impacts to biodiversity including threatened species values. • Green vision statement and overarching principles - to achieve the overarching principles, section 4.3 of the Plan identifies more detailed guiding principles, none or which appear to include the creation or enhancement of biodiversity corridors. The guiding principles are focused on increasing public access to local bushland and include limited content. It is recommended that the guiding principles also include provision for the protection and enhancement of biodiversity corridors. • Northern Beaches Hospital site – Council recommends that the existing RE1 Public Recreation zoned lands on the site that apply to the areas of native vegetation communities and native trees to the east and south of the Hospital (including an area of Duffys Forest endangered ecological community (EEC) along Wakehurst Parkway) is mapped. By including this in the map, these areas can be effectively protected, ensuring that

Document	Comment
	they will significantly contribute to the overarching Green Vision Principle of 'Open Spaces for Biodiversity'. • Access to bushland areas – increasing access to bushland areas will inevitably result in impacts (e.g. edge effects such as weed invasion) to natural areas. New tracks, trails and pathways through bushland (including any new pedestrian crossings of Wakehurst Parkway to Aquatic Reserve) should be designed to first avoid impacts, before identifying mitigation measures, and then potential offsetting. It is recommended that management of these impacts is accounted for in the Plan and appropriately funded and resourced to allow for more sustainable recreational access into the future. • Figure 16 – this identifies initiatives including a new open space over existing bushland (refer to numbered item 9) at the corner of Wakehurst Parkway and Warringah Road linking to Aquatic Drive. This bushland is now one of the last north south bushland linkages in the locality and is highly recommended for retention as bushland.
Draft Frenchs Forest Special Infrastructure Contribution	Refer to Key Issue 2 – Cost and funding of infrastructure
Aboriginal and non-Aboriginal Heritage Assessment	No issues raised
Contamination Site Investigation	No issues raised
Flooding and Stormwater Study	• Modelling – the modelling covers all three phases, is standard and adequate for the purpose. Whilst the Frenchs Forest Phase 1 area is at the top of the catchment, the report identifies a number of areas in the general vicinity which are currently subject to flooding in a 1% AEP event. Existing and developed conditions are modelled. It is found that the rezoning will reduce flooding downstream, assuming that onsite detention (OSD) is applied to each development site to restrict proposed flows to natural state flows. The Flood Development Control Plan (DCP) Clause quoted in this report is the 2017 version, which was superseded in January 2021. A detention strategy was developed to determine the location and size of the detention basins, but these details have not been provided. Detention basins were not physically modelled in the proposed condition model. A flow analysis was simply undertaken at the outlet for each catchment in its natural state and in the proposed conditions with OSD.

Document	Comment
	• Infrastructure improvements - the Study identifies further measures which could be implemented to improve the conveyance of stormwater flows and reduce flood depths, including: 1) upgrading pipes located downstream of the sag pit on Frenchs Forest Road; 2) upgrading pipes between sag pits on Holland Crescent and sag pits on Frenchs Forest Road; 3) construction of a defined channel in a drainage easement through private properties in Phase 3; and 4) provision of additional OSD in the catchment upstream of Frenchs Forest Road/Holland Crescent. The report says there is 'provision' to increase pipe capacities, but it is unclear exactly what this means. Does it mean that the Developer will undertake these works? Or that these improvements have been included in the modelling? Or that Council could undertake these works separately? Details of the flood mitigation measures should be identified in the Study.
Social Infrastructure Report	• Population data - The demographics have a very high percentage of young professionals 25-34 (approximately 40% of population) and 35-49 year old's (20%) but a relatively small percentage of children aged 0-4 is 4.7% and 5-11 is 2.4%. The local government area wide percentage of children 0-4 is 6.2% and 5-11 is 9.8%. If Dee Why is used as a comparison where 21% of the population are 25-34 and 25% are 35-49, the percentage of the population aged 0-4 is 7.3% and 5-11 is 6.7%. Noting the comparison between Dee Why and Frenchs Forest isn't perfect, but a guide that suggests the number of children assumed in the Report is on the low end. • Children services – the findings align with Council's Children's Services Strategy, as demand for childcare is predicted to grow with a forecast population increase of 98.9% in Frenchs Forest. • Libraries – the need for additional library floor space is noted. Libraries are known to be social anchors attracting people into a local area. Council notes there is an opportunity to co-locate the library with other community facilities such as community centres and indoor recreation centres.
Sustainability Plan	Refer to Key Issue 5 – Elevating the role of sustainability as a key feature to create a flagship development
Transport Strategy and Addendum letter	Refer to Key Issue 1 – Transport infrastructure provision
Urban Tree Canopy Audit	No issues raised
Employment Strategy	No issues raised

Document	Comment
Urban Design Report	No issues raised

Council commissioned technical reports

1. Arup 2021, Frenchs Forest Town Centre Transport Strategic Design
2. Arcadis 2020, Frenchs Forest Town Centre Traffic Modelling Review
3. Kinesis 2019, Frenchs Forest Precinct Sustainability Report
4. Alluvium 2019, Frenchs Forest Planning Precinct WSUD Strategy

Northern Beaches Council

Frenchs Forest Town Centre

Transport Strategic Design

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Job number 237921-06

Arup Pty Ltd ABN 18 000 966 165

Arup
Level 5
151 Clarence Street
Sydney NSW 2000
Australia
www.arup.com

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Contents

Appendices

Appendix B

Jacobs - Option Scenarios Modelling Results

Appendix C

SIDRA Modelling Results

1 Introduction

1.1 Background

The Northern Beaches Council (Council) commissioned Arup Pty Ltd to prepare a transport strategic design report to support the Frenchs Forest Town Centre project. This report aims to inform the development of a Special Infrastructure Contribution (SIC levy) and a Local Infrastructure Contribution Plan.

A SIC levy is a levy paid by developers to share the cost of delivering state and regional infrastructure required to support a growing community. SIC levies are utilised for all planned precincts and growth areas in Sydney and support infrastructure such as construction or upgrade of state and regional roads or transport facilities such as bus shelters and interchanges.

A Local Infrastructure Contribution (S7.11) Plan is paid by developers to share the cost of delivering local infrastructure within a catchment area.

This report outlines the transport infrastructure items needed to support the strategic development of the precinct and provides indicative cost estimates which aim to inform the development of both a SIC levy and a S7.11 contribution.

The aims of this report will be to:

- Provide an overview of traffic and active travel infrastructure items
- Identify land parcels for the purpose of land acquisition and land uptake for land acquisition
- Outline traffic related infrastructure works required to support the development of the catchment area
- Outline active travel related infrastructure works required to support the development of the precinct
- Provide indicative cost estimates for each infrastructure item for the SIC Levy and S7.11 Plan.

1.2 Subject Area

The subject area of this study is the local area which borders the proposed Frenchs Forest Town Centre. The location of the town centre is shown in Figure 1.

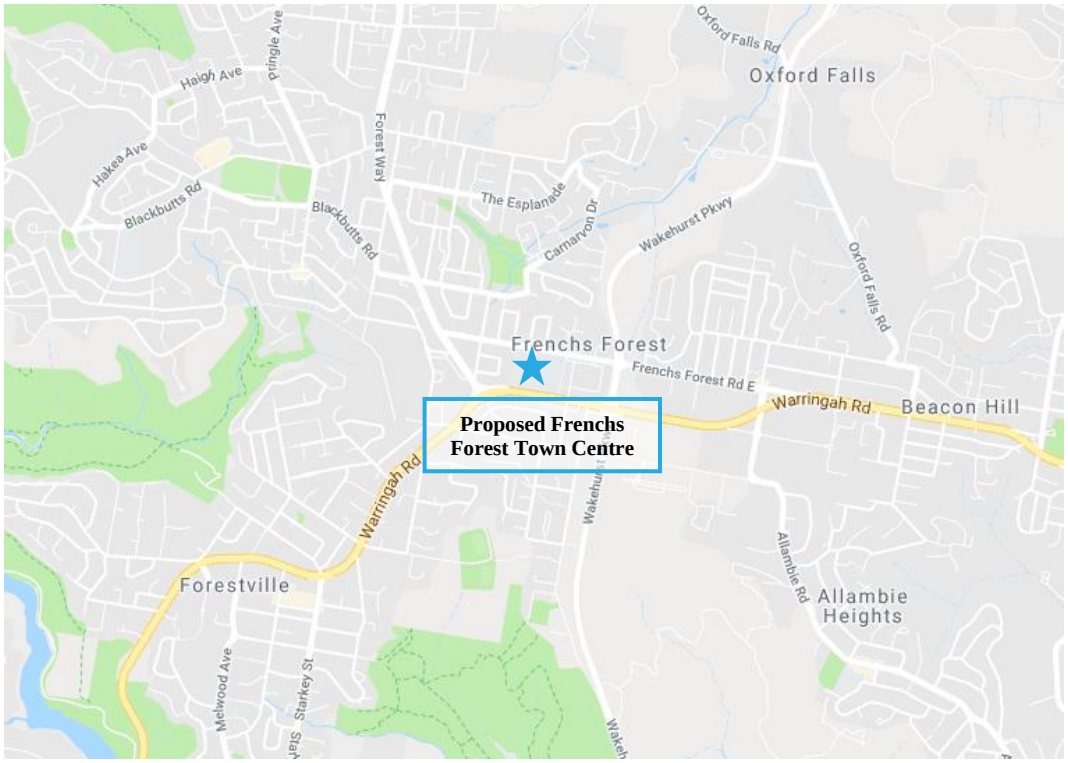


Figure 1: Proposed Frenchs Forest Town Centre

1.3 Report Structure

Section 1 provides an introduction to the aims and purpose of this report.

Section 2 provides an overview of the existing transport conditions in the vicinity of the precinct.

Section 3 provides an overview of the proposed development.

Section 4 outlines the traffic related infrastructure requirements such as new roads and intersection upgrades which would be required to support the development.

Section 5 outlines the active travel related infrastructure requirements such as new off-road shared paths and pedestrian facilities which would be required to support the development.

Section 6 provides the transport network performance

Section 7 provides indicative cost estimates for each of the infrastructure items, including for the SIC levy and for the S7.11 contribution.

Section 8 provides a conclusion of the findings of this report.

2 Existing Conditions

2.1 Road Network

The town centre is bounded by Frenchs Forest Road West to its north and Warringah Road to its south. These roads provide east-west connectivity for the entire precinct, while Wakehurst Parkway and Forest Way provide north-south connectivity.

2.1.1 Frenchs Forest Road West

Frenchs Forest Road West runs to the north of the hospital precinct and is a collector road with two lanes in each direction. It has been upgraded as a part of the Northern Beaches Hospital works. Frenchs Forest Road West will serve as the primary road for town centre access.

2.1.2 Warringah Road

Warringah Road runs to the south of the hospital precinct and is classified as a state road that runs between Roseville and Dee Why. It currently has three lanes in each direction in the vicinity of the precinct and is being upgraded to provide an underpass for through traffic and surface roads for local access as a part of the Northern Beaches Hospital works. Warringah Road will be one of the main roads connecting the precinct to the rest of Sydney.

2.1.3 Wakehurst Parkway

Wakehurst Parkway runs in a north-south direction and is classified as a state road connecting Balgowlah and Narrabeen. It generally has one lane in each direction for most of its length and will be one of the main roads connecting the precinct to the rest of Sydney.

2.1.4 Forest Way

Forest Way runs in a north-south direction and is classified as a state road connecting Frenchs Forest to Belrose. It generally has three lanes in each direction in the vicinity of the precinct and is also the location of the Forestway Shopping Centre, an existing focal point for retail activities in the Frenchs Forest area.

2.2 Public Transportation

The precinct is serviced by a number of bus routes which help connect it to the wider Sydney Area including Dee Why, Chatswood and Wynyard. The nearest bus stops and bus routes in the vicinity of the precinct are shown in Figure 2.

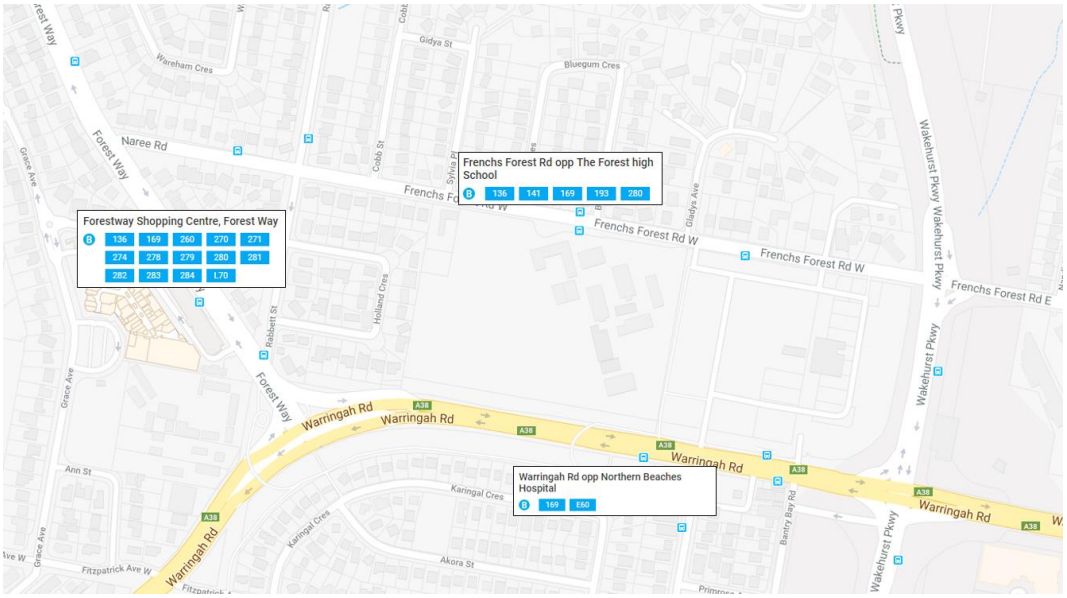


Figure 2: Existing bus services serving the precinct
Base map Source: Google Maps

2.3 Cycling and Walking Network

The road network surrounding the precinct has a well-developed walking network with footpaths generally provided on both sides of the street. The current cycling network in the vicinity of the precinct is shown in Figure 3. It is noted that this map includes cycling network upgrades which are a part of the Northern Beaches Hospital upgrade works and may currently be in the construction phase.

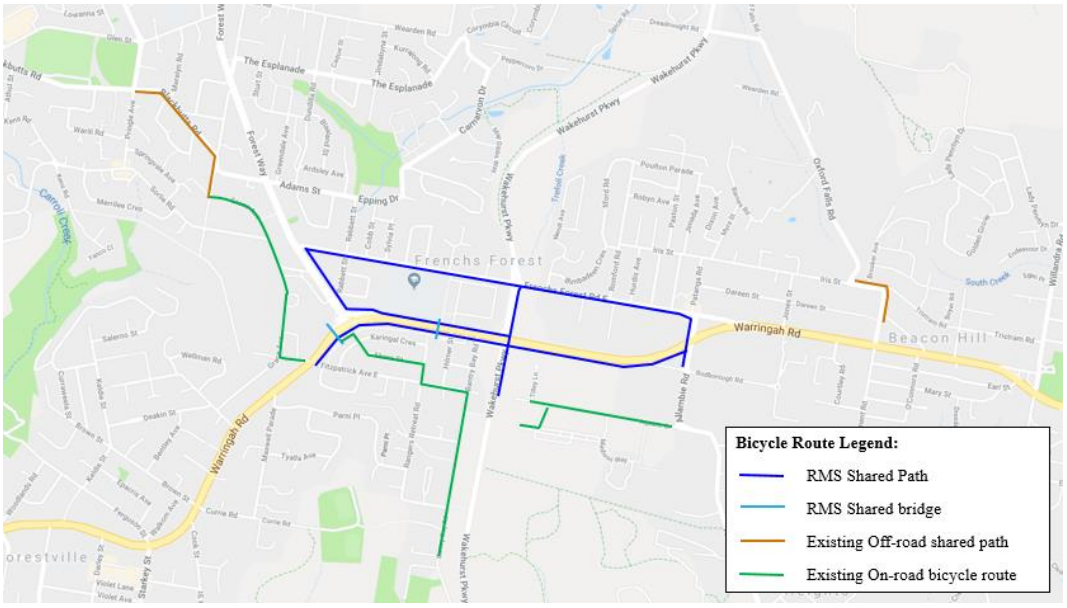


Figure 3: Cycling network overview
Base map source: Google Maps

3 Development Phases

The precinct will be developed over 3 phases. Phase 1 includes the core town centre development as well as some additional developments along Karingal Crescent and Frenchs Forest Road. The total residential yield for Phase 1 is 1,930 dwellings accommodating 4,246 residents.

Phases 2 and 3 involve the wider development of the precinct bringing the total residential yield to 4,360 dwellings. Phase 2 would include an additional 1,115 dwellings accommodating 2,453 residents, while Phase 3 would accommodate 1,315 dwellings accommodating 2,893 residents.

The plans for the Precinct Development infrastructure delivery also needs to consider the potential for future growth across the employment lands located directly to the southeast of the precinct around Aquatic Drive, Rodborough Road and Frenchs Forest Road (east), which under current development controls has significant potential to contribute to meeting the long-term employment growth targets of the Northern Beaches.

The Frenchs Forest Business Park is one of nine major business parks across greater Sydney. Given it does not have height restrictions and would benefit from spectacular regional views, its capacity for future growth is significant. This is further strengthened by its proximity to the planned beaches link tunnel and East-West rapid bus network which will significantly improve accessibility to Sydney CBD, Sydney airport and the eastern economic corridor.

The proximity to the Belrose and Terrey Hills Business and Industry development areas and the link to the A3 – Mona Vale Road/Lane Cove Road Corridor should also be considered as ancillary service provision areas to support the Hospital and Education Precinct. These areas could provide improved freight servicing opportunities such as vertical warehousing and consolidation centres to support the Precinct.

Consideration should be given to removing several pinch points along the Forest Way corridor to the north of the designated precinct boundaries to connect the precinct to the A3 corridor.

The phases of the precinct are shown in Figure 4 and Figure 5.

Figure 4: Geographical Phases of Precinct

Figure 5: Precinct Breakdown

4 Traffic Infrastructure Requirements

4.1 Overview

To support the development of the Frenchs Forest Town Centre, several upgrades to traffic infrastructure are proposed. Transport modelling has been used to test the infrastructure items and to confirm their need to support the development of the precinct.

The modelling was also used to determine the timing for delivery of each infrastructure item to support the level of development in each phase. Development occurring in Phase 1 was assumed to be more car dependant, as public transport improvements were assumed to occur during Phases 2 and 3. This resulted in the traffic generation for Phase 1 being 75% of the ultimate Phase 3 traffic generation, and hence the majority of the infrastructure upgrade works occur early in the development of the precinct.

The modelling undertaken by Jacobs for Phase 1 on behalf of the Department of Planning, Industry and Environment, with supplementary modelling for Phases 2 and 3 undertaken by Council is described in Section 6.

As shown in the table below, all infrastructure is required to be completed by the 20% build out of stage 2 or equivalent as from that point in time it is not about building additional traffic and transport infrastructure, but how the existing capacity within the network is utilised and a shift in transport modes is achieved across the network. At this point the impact on the Warringah Road corridor needs to be mitigated through Forestville in the west and Beacon Hill in the east.

Table 1 and Figure 6 outline the traffic related infrastructure requirements to support the project.

Table 1: Traffic Infrastructure Requirements

Development Phase	Infrastructure	Item Number	Location	Report Section	Type
Initial Delivery	New Signals	1A	Frenchs Forest Road West/ Bluegum Crescent East/ New Internal Road	Section 4.2.1	Delivered as the primary access to the Precinct
	New Road	1B	Holland Crescent Extension to Town Centre	Section 4.2.2	S7.11
50% Build Out of Phase 1	Road Widening	2A	Frenchs Forest Road West/ Naree Road Widening from Bluegum Crescent to Forest Way	Section 4.3.1	Potential SIC Levy or State Funded
	New Signals	2B	Frenchs Forest Road West/ Sylvia Place	Section 4.3.2	S7.11
	New Road	2C	New Road from Holland Crescent to Frenchs Forest Road West/ Sylvia Place	Section 4.4.9	S7.11
	Bus Infrastructure	2C	Southern End of Holland Crescent to Forest Way/	Section 4.3.3	S7.11

			Rabbett St Intersection		
70% Build Out of Phase 1	New Signals	3A	Naree Road/ Forest Way	Section 4.4.1	Potential SIC Levy or State Funded
	New Signals	3B	Naree Road/ Grace Avenue	Section 4.4.2	Potential SIC Levy or State Funded
	New Road	3C	Naree Road Extension	Section 4.4.3	Potential SIC Levy or State Funded
	Green Bridge	3D	Green Bridge over Warringah Road	Section 4.4.4	Potential SIC Levy or State Funded
	Intersection Upgrade	3E	Adams Street/ Forest Way	Section 4.4.5	S7.11
	Intersection Upgrade	3F	Adams Street/ Rabbett Street	Section 4.4.6	S7.11
	Bus Infrastructure	3G	Forest Way/ Warringah Road Intersection	Section 4.4.7	S7.11
	Bus Infrastructure	3H	Frenchs Forest Road East	Section 4.4.8	S7.11
	New Road	3I	New Road from Holland Crescent to Frenchs Forest Road West/ Sylvia Place	Section 4.3.3	S7.11
Completion of Phase 1 and 20% Build Out of Phase 2	Road Widening	4B	Forest Way Widening	Section 4.5.2	Potential SIC Levy or State Funded
	Traffic Calming	4C	Wareham Crescent, Dundilla Road, Greendale Avenue, Sturt Street	Section 4.5.3	S7.11
	Intersection Upgrade	4D	Fitzpatrick Avenue West/ Warringah Road	Section 4.5.4	S7.11
	Road Widening	4E	Grace Avenue Widening	Section 4.5.5	Potential SIC Levy or State Funded

Figure 6: Traffic Infrastructure Requirements Map

4.2 Initial Delivery

The following items are proposed as a part of the initial delivery of the town centre.

4.2.1 (Item 1A) Frenchs Forest Road West/ Bluegum Crescent/ New Internal Road

It is proposed that the intersection of Bluegum Crescent (eastern end) and Frenchs Forest Road West be upgraded to a signalised intersection to accommodate the new internal road which would provide access to the town centre. This would require relocation of the traffic signals from Bluegum Crescent (western end) to the new location. This would allow safe construction access to the precinct with minimal impact on access to the hospital. This item is considered a SIC Levy item as it would provide strategic access into the town centre.

The upgrade of the Frenchs Forest Road West/ Bluegum Crescent intersection is shown in Figure 7.

Without the infrastructure proposed this intersection performs at a Level of Service F with queues lengths of up to 348 metres and delays of up to 218 seconds. With the infrastructure proposed, the queue lengths reduce to 203 metres and delays reduce to 188 seconds.

Figure 7: Frenchs Forest Road West/ Bluegum Crescent/ New Internal Road

4.2.2 (Item 1B) Holland Crescent Extension to Town Centre

It is proposed that Holland Crescent be extended to provide a direct connection into the town centre from the local precinct to the west. This extension would be approximately 40 metres from the current southern part of Holland Crescent through to the town centre. It would improve road access to and from the town centre and it is expected that it would entail the acquisition of one residential property: 26 Holland Crescent.

It is a separate item to the extension of Holland Crescent to connect to Frenchs Forest Road. The works would also require modifying the existing road environment along the southern leg of Holland Crescent and the priority at the Rabbett Street intersection. There may need to be controls put in place to reduce impacts of increased traffic on the residents that live within the Phase 2 release area.

To provide a secondary access to the Town Centre to improve the level of service at the main access point from Frenchs Forest Road (West) which operates at a LoS F at 70% phase 1 delivery and provides for improved access options from the north and west prior to that point.

Without the infrastructure proposed, the other primary access to the town centre performs at a Level of Service F with queue lengths of up to 148 metres and delays of up to 218 seconds.

With this proposed infrastructure, the intersection will operate at a Level of Service A with queue lengths of 11 metres and delays of 7 seconds. The other primary access to the town centre will also benefit and operate at a Level of Service F with queue lengths of up to 203 metres and delays of up to 188 seconds.

The Holland Crescent Extension is shown in Figure 8.

Figure 8: Holland Crescent Extension to Town Centre

4.3 50% Build Out of Phase 1

The following items are proposed prior to the 50 percent build out of Phase 1.

4.3.1 (Item 2A) Frenchs Forest Road West/ Naree Road Widening from Bluegum Crescent to Forest Way

It is proposed that Frenchs Forest Road West/ Naree Road be widened from Bluegum Crescent to Forest Way. This would require the acquisition of approximately 3.5 metres of all properties on the southern road boundary and a portion of the properties on the Rabbett Street and Frenchs Forest Road/ Naree Road intersection. It may also be prudent to acquire the necessary portions of 2 & 4 Naree Road and 23 Forest Way for the eastbound lane upgrade as well.

This widening would be carried out in order to provide a third lane on Frenchs Forest Road as an extension to the bus lane from Bluegum Crescent to Rabbett Street. West of Rabbett Street, this additional westbound lane would operate as a dedicated left turn lane.

The east bound side of the Frenches Forest Road West will also need to be considered for minor widening, which will not require additional acquisition of property, but will require the overhead 33KV powerlines to be relocated. Due to the technical requirements from Augrid in relation to these lines to only viable solution is to place these lines underground between Rabbett Street and Wakehurst Parkway. This will allow the additional works to be undertaken without the need for property acquisition and allow full access to the development area north of Frenchs Forest Road West without the hazards of power poles in the middle of the high pedestrian/active transport corridor.

The widened Frenchs Forest Road West/ Naree Road is shown in Figure 9.

Figure 9: Frenchs Forest Road West/ Naree Road Widening

This work is required to allow for network optimisation and improved bus on time running through the precinct. As this provides a regional transport network benefit for services running through the precinct this would be an item for the SIC levy. The additional lane west of Rabbett Street provides additional storage for vehicles head west from the precinct and entering the Forest Way Corridor heading south towards Forestville and north towards Belrose. Not providing this infrastructure item will have adverse impacts on all intersections identified in Appendix C.

This infrastructure item will improve bus priority capacity as shown in the SIDRA results in Appendix C. This will also provide additional bus priority capacity to allow the high frequency services to support the town centre and drive modal shift to support further growth.

4.3.2 (Item 2B) Frenchs Forest Road West/ Sylvia Place

It is proposed that the intersection of Frenchs Forest Road West and Sylvia Place be upgraded to a signalised intersection in order to accommodate the new road connecting Frenchs Forest Road West to the extended Holland Crescent. This intersection would help mitigate traffic impacts from the expected growth in traffic volumes due to the town centre development and also allow the primary access to have the final state restrictions put in place.

This intersection upgrade is required to provide a second access to the town centre development. Without this infrastructure improvement, the intersection at the primary access to the town centre will operate at a Level of Service F with queue lengths of 348 metres and delays of 218 seconds.

With this infrastructure improvement, the intersection will operate at a Level of Service F with queue lengths of 221 metres and delays of up to 155 seconds. This will reduce the queue length and delays at the primary entrance to the town centre.

The upgrade of the Frenchs Forest Road West/ Sylvia Place intersection is shown in Figure 10.

Figure 10: Frenchs Forest Road West/ Sylvia Place/ New Road

4.3.3 (Item 2C) Southern End of Holland Crescent to Forest Way/ Rabbett Street Intersection

The Rabbett Street intersection with Forest Way currently operates as an exit only movement out of Rabbett Street. This intersection is restricted for usage by buses only between 6am and 10am. It is proposed that this restriction is increased to a 24-hour restriction on all days in order to prevent this location from becoming a point of congestion due to the increased traffic as a result of the town centre. This should be accompanied by painting of the roadway and increased signage, such as at the Rabbett Street/ Holland Crescent (southern end) intersection to reduce incidents of cars using this roadway.

The Forest Way/ Rabbett Street intersection is shown in Figure 11.

Figure11: Forest Way/ Rabbett Street Intersection

4.4 70% Build Out of Phase 1

The following items are proposed prior to the 70 percent build out of Phase 1.

4.4.1 (Item 3A) Naree Road/ Forest Way Intersection

It is proposed that the Naree Road and Forest Way intersection be upgraded to provide a number of new lanes to improve performance if the Warringah Road Town Centre Access Tunnel is not provided. These works would help enable the closure of Russell Avenue at Forest Way. The works will include a short left turn slip lane on the eastern approach and a new western leg in the form of the new Naree Road extension to Grace Avenue.
A right turn bay from the northern approach of Forest Way could be implemented within the large central median. It is expected that the upgrade of this intersection would not entail property acquisition, however, the upgrade of Naree Road and Forest Way would entail property acquisition. These are shown as separate items in Section 4.4.3 and Section 4.5.2.

This item is considered a potential SIC Levy item as it would provide strategic access for the precinct from the arterial road network. It is also an upgrade to a state road which provides primary access to Phases 2 and 3 of the development.

The upgrade of the Naree Road/ Forest Way intersection is shown in Figure 12.

Figure 12: Naree Road/ Forest Way

The intersection upgrade is required to provide access to the precinct from Warringah Road as there is no direct connection for the main east/west corridor into the precinct. Additional storage is required for the vehicles turning right from Forest way into Naree Road, as the current road configuration only allows storage of 10-12 vehicles prior to impacting the through traffic in lane 3 northbound.
With the demand increased without the upgrade the LoS was F and queue length 2256 metres (northbound) and a delay of 283 seconds, and with the proposed upgrade the LOS

was F and the queue length was reduced to 1070 metres (northbound) and a delay of 290 seconds.

4.4.2 (Item 3B) Naree Road/ Grace Avenue Intersection

It is proposed that a new intersection be constructed at Grace Avenue and the extended Naree Road. This would be a signalised T-intersection with two approach lanes and three exit lanes on the eastern side, two approach and exit lanes on the southern side and one approach and exit lane on the northern side.

This item is considered a potential SIC Levy item as it would provide strategic access for the precinct from the arterial road network as a secondary access route from Warringah Road.

The upgrade of the Naree Road/ Grace Avenue intersection is shown in Figure 113.

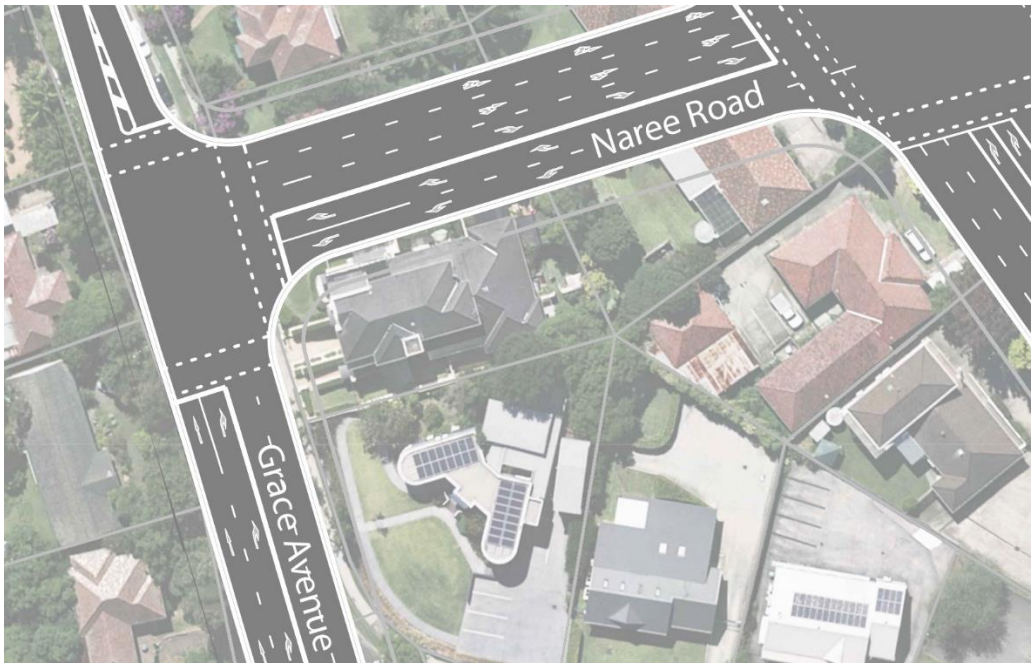


Figure 113: Naree Road/ Grace Avenue

This link would allow the road network to function as per the final configuration with traffic able to access the precinct from Warringah Road via the Fitzpatrick Avenue (East). The Naree Road extension will also provide a connection to assist in the local community accessing the town centre precinct without using the State Road Network. This upgrade removes an accident blackspot that would be made significantly worse given the increase in traffic predicted as part of the uplift across the three phases of the precinct.

4.4.3 (Item 3C) Naree Road Extension

It is proposed that Naree Road be extended from its intersection with Forest Way to provide a connection through to Grace Avenue. This extension would be approximately 100 metres in length and would connect the town centre to the local area to the west of Forest Way, including the existing Forestway Shopping Centre. It is expected that the extension of the road would entail the full acquisition of four residential properties. These include 28 and 30 Forest Way and 41 and 43 Grace Avenue.

The access is considered a potential SIC item as it would be an upgrade to an RMS operated roadway and provide strategic access for the precinct from the arterial road network.

Without this infrastructure item, there are adverse impacts on the intersections at Forest Way/Warringah Rd and Forest Way/Adams St. Impacts on the functionality of Russell Ave and Forest Way will create a safety impact on queue length. The queue length results in a safety impact to the state road.
With this proposed infrastructure item, the modelling results demonstrate improvements at the above intersections.

The construction of the Naree Road extension would allow for the closure of Russell Avenue at Forest Way. The Naree Road Extension is shown in Figure 14.

Figure 14: Naree Road Extension

The connection between Grace Avenue and Naree Road removes the current road link at Russell Avenue, which is an accident blackspot under current loading and will become a significant network issue as the current configuration allows only 4 vehicles into the

protected storage. This additional provides an improved connection to the State Road Network for the community directly to the west of the precinct and for traffic heading south on Forest Way.

4.4.4 (Item 3D) Green Bridge/Linear Transport Interchange over Warringah Road

The green bridge/linear transport interchange is considered a SIC item as it is a strategic project that would provide benefit to the larger community. It would also be beneficial in providing a direct connection to both sides of the Warringah Road Corridor if an express bus service were provided along Warringah Road. This express bus service could serve the town centre by providing a high-frequency public transport service to Chatswood or the Sydney CBD. This would also include vertical transport solutions to access the bus interchange facilities from the green bridge.

It is proposed that a green bridge be constructed over Warringah Road, providing a direct pedestrian connection between the town centre and Karingal Crescent. This green bridge could be 30 metres in width and could serve as an urban landmark, as well as a movement corridor, between the town centre and development on Karingal Crescent which would be entirely separated from the roadway below.

The bridge would require the acquisition of 36 and 38 Karingal Crescent to allow for continuous connection with the existing reserve in Karingal Crescent.

The location of the green bridge over Warringah Road is shown in Figure 15.

Figure 15: Green Bridge over Warringah Road

4.4.5 (Item 3E) Adams Street/ Forest Way

It is proposed that the Adams Street/ Forest Way intersection be upgraded to provide an additional traffic lane on the eastern approach on Adams Street. This would help to improve intersection performance and reduce the queue lengths on this approach by providing additional holding capacity. This is currently an observed problem and would be expected to become significantly worse due to the development of the precinct.

The upgrade of the Adams Street/ Forest Way intersection is shown in Figure 16.

Figure 16: Adams Street/ Forest Way

The volume of traffic that is generated through the delivery of the 3 phases of the project but especially Phase 1 and Phase 2 will require this intersection to be upgraded to allow for improved storage. This significant network optimisation outcome benefits both local and regional traffic flows. This infrastructure also provides enhanced connectivity for the residents on the northern periphery of the precinct to access the regional recreational facilities to the west of Forest Way.

Without this infrastructure improvement, this intersection will operate at Level of Service F with queue lengths of 421 metres and delays of 73 seconds.

With this infrastructure improvement, the intersection will operate at a Level of Service F with queue lengths of 229 metres and delays of up to 87 seconds.

4.4.6 (Item 3F) Adams Street/ Rabbett Street

It is proposed that the intersection of Adams Street and Rabbett Street be upgraded to a roundabout to accommodate increased traffic volume and improve performance. This would include construction of a mountable roundabout and the construction of pedestrian splitter islands on all three approaches and exits of the new roundabout, improving both the vehicle flow and pedestrian amenity of the intersection. It is not expected that any additional land acquisition would be required.

The upgrade of the Adams Street/ Rabbett Street intersection is shown in Figure 17.

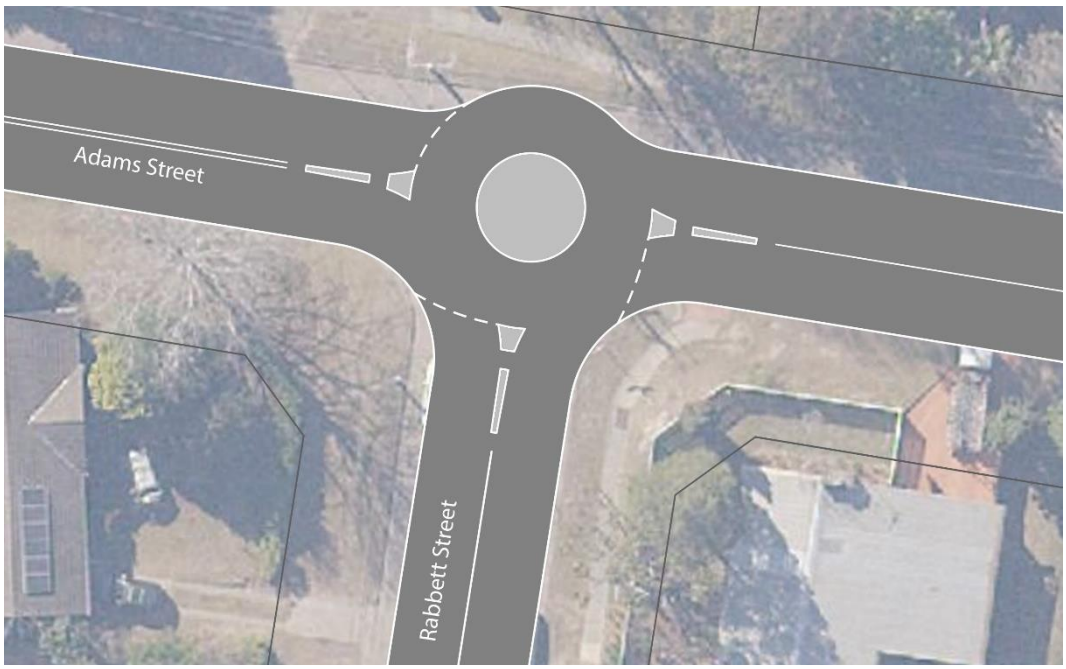


Figure 17: Adams Street/ Rabbett Street

This location will see volumes double (400vPH) at the end state project delivery and as such to optimise the traffic flows through the secondary route to Forest Way. This item is a 7.11 funded item as it has local network benefits by reducing the queue length on all legs during peak periods.

Without this infrastructure improvement, this intersection will not function with the correct priority allocation and cause additional delays both along Rabbett Street into Frenchs Forest Road (west) and into Epping Drive for residents coming out of the residential precinct.

4.4.7 (Item 3G) Forest Way/ Warringah Road Intersection

It is proposed that a bus priority system from Rabbett Street onto Warringah Road be implemented to allow for buses to exit out of Rabbett Street and manage the movement conflicts at this location. This would consist of a traffic light which would hold traffic travelling southbound on Forest Way in order to provide for buses to exit Rabbett Street. These traffic lights would be co-ordinated with the Forest Way/ Warringah Road traffic lights and would have minimal negative impact on the southbound traffic.

It is proposed that this upgrade be delivered in conjunction with a shared pedestrian bridge over Forest Way. This could be designed as an extension to the existing shared bridge over Warringah Road. This shared bridge would allow a direct connection between the town centre, Karingal Crescent and the existing Forestway Shopping Centre. It would also enable the removal of a signalised midblock crossing currently located on Forest Way approximately 200 metres north from the intersection, improving traffic flow.

The shared pedestrian bridge would require partial acquisition of 500C Warringah Road. Taking a set of signals away will improve level of service. Removal of the pedestrian phased signalling will increase green time for vehicles hence, improving network performance.

The location of the shared pedestrian bridge over Forest Way is shown in Figure 18.

Figure 18: Shared Pedestrian Bridge over Forest Way

4.4.8 (Item 3H) Relocation of Bus Stops on Frenchs Forest Road East

It has been observed that, during the morning peak hour, traffic becomes blocked due to eastbound bus operations on Frenchs Forest Road East. This can occur where buses stop at the bus stop in the left lane of the roadway, while vehicles queue to turn right into the driveways, causing a blockage in the roadway where vehicles going through on the road are not able to get past and must wait for the bus to continue moving or the right turn queue to clear. This is shown in Figure 19.

Figure 19: Bus stops on Frenchs Forest Road East

It is recommended that both bus stops be relocated to such locations where buses would not stop parallel to the right turn queue. Further investigation should be carried out to determine the most appropriate and cost-effective locations for this.

Without this infrastructure improvement, significant delays will occur along Frenchs Forest Road East, which will be exacerbated by the traffic resulting from all three phases of the development.

4.4.9 (Item 3I) New Road from Holland Crescent to Frenchs Forest Road West/ Sylvia Place

It is proposed that a new road be constructed from Frenchs Forest Road West to Holland Crescent. This new road would be approximately 130 metres in length from the current intersection of Frenchs Forest Road West and Sylvia Place through to Holland Crescent. It would improve road access to and from the town centre and it is expected that it would entail the full acquisition of the existing Frenchs Forest Police Station and 16 Holland Crescent. The road has been designed with a 90º turn to facilitate future development parcels of land.

The new road between Holland Crescent and Frenchs Forest Road West is shown in Figure 20.

Figure 20: New Road from Holland Crescent to Frenchs Forest Road West

As network demand increases additional access was needed to provide tertiary egress from the precinct during peak load periods along the Frenchs Forest Road corridor. Whilst not improving the level of service at adjoining intersections, this did reduce the queue length from 147 metres to 73 metres at the Rabbett Street and Frenchs Forest Road (west). This infrastructure allows the load to be shared across the several intersections to provide improved network performance.

4.5 Completion of Phase 1 and 20% Build Out of Phase 2

The following items are proposed prior to the 20 percent build out of Phase 2.

4.5.1 (Item 4A) Warringah Road Town Centre Access

Four options were considered for improved town centre access to meet traffic demands from the Warringah Road Corridor.

The first option is a surface option which involves relying on western access from Frenchs Forest Road West, as shown in Figure 12. This would require additional turning capacity in Forest Way at the Naree Road intersection. The improvements required to the Forest Way/ Naree Road intersection are included as Item 3A and the widening of Forest Way to allow for an extension of the right turn bay is included as Item 4B. This is the most cost effective option and provides the best outcome from an ongoing network viability and performance perspective. **That is why this option forms part of the infrastructure requirements for the Precinct. For the purposes of the SIC Levy costing, the surface option has been adopted.**

The second option is a new tunnel constructed from the road underpass on Warringah Road to feed traffic directly into the town centre. This tunnel could include an approximately 60 metre deceleration lane, a 140 metre tunnel segment and a 120 metre ramp up to the surface level and would help to feed traffic in from areas west of the town centre, such as Chatswood, directly into the town centre. The tunnel would considered a SIC item as it would be a significant upgrade to an RMS operated roadway. In contrast to the first surface option, the tunnel would take significant load off Forest Way northbound, as well as the Forest Way/ Naree Road intersection. **This option is a nice to have from a network performance perspective, however it has been discounted on the basis of cost ($60m + contingencies), the impact on the adjoining network during the construction, significant construction challenges that would need to be overcome, and a cost – benefit ratio that rendered it not feasible**.

The third option considered was the use of the existing Hospital entrance intersection at Hilmer Street to provide some form of access and egress to the eastern portion of the Phase 1 area. This would have a benefit to improve access from Warringah Road directly into the precinct, however this would need to overcome several challenges including, current contractual issues between Health Infrastructure and the Hospital operators, traffic movement point of conflict approaching the signals at Hilmer Street, and the existing infrastructure (both road and underground services) which would add to the cost of this option. **This item is marked for further investigation.**

The fourth option assessed was a surface connection at the western end of the Phase 1 Town Centre development between Forest Way and the eastern pedestrian overpass. This would require removal of significant trees along the southern boundary of the precinct. There would also a significant safety hazard due to a three-way traffic movement point of conflict between the eastbound acceleration lane from Forest Way, traffic moving across to the Town Centre entry and traffic moving towards the right turn at Hilmer Street. In future development stages it would also create a hazard for linear bus services along the Warringah Road Corridor. **This item was discounted due these risks that cannot be overcome through engineering solutions without an undesirable network impact on Forest Way. The option was also deemed unacceptable due to the further removal of the group trees along the Warringah Road frontage of the site.**

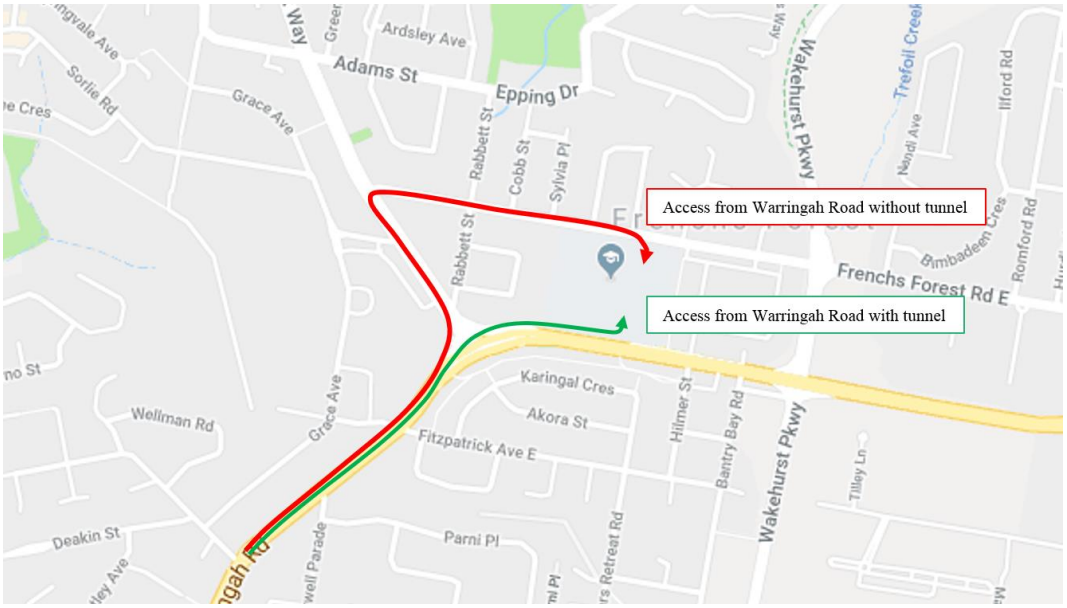


Figure 12: Warringah Road Access

The Warringah Road Town Centre Access Tunnel is shown in Figure 13.

Figure 13: Warringah Road Tunnel Option

4.5.2 (Item 4B) Forest Way Road Widening

It is proposed that Forest Way be widened in order to provide additional access capacity to allow vehicle access from the south and west of the precinct. The widening of Forest Way would be required if Item 4A, the Warringah Road access tunnel, is discounted.

The widening of Forest Way would include the construction of an additional turning lane northbound into Naree Road, including an additional lane approximately 225m back towards the Warringah Road intersection. It is expected that the widening of Forest Way would entail the partial acquisition of a number of properties along Forest Way, as follows:

- Property acquisition on Forest Way (24, 26, 32, 34, 46-38, 40, 23), Russell Avenue (2A) and Naree Road (2, 4). It is expected that property consolidation and resale would be possible with these lots.
- Partial property acquisition on Forest Way (42, 44, 44a, 17, 19, 21, 25, 27, 29) and 3.5 metres along the frontage of the Shopping centre property provide improved road geometry or partial acquisition of 1-15 Forest Way of approximately 4 metres.

The widening of Forest Way would also upgrade the Forest Way/ Naree Road intersection to have a double right turn lane on the southern approach. This item is considered a SIC Levy item as it would provide strategic access for the precinct from the arterial road network.

Without this infrastructure item, there are major impacts on all intersections, especially on the state roads between Beacon Hill Road and Roseville Bridge. The queue length going into Naree Road/Forest Way would be almost 2km.

With this proposed infrastructure item, all intersections above will be improved

The Forest Way road widening is shown in Figure 14.

Figure 14: Forest Way Road Widening

4.5.3 (Item 4C) Traffic Calming

To support the development of the town centre, it is proposed that traffic calming devices, such as speed humps, midblock road closures or chicanes be constructed to improve safety and discourage vehicles from accessing the town centre via residential streets in place of main roads. It is proposed that traffic calming be implemented on the following streets:

- Three flat top concrete speed humps along Wareham Crescent to discourage drivers from skipping the queue on the eastern leg of the Forest Way/ Adams Street intersection.
- Three flat top concrete speed humps along Dundilla Road to discourage drivers from using Dundilla Road to avoid Forest Way and to reduce vehicle speeds and improve safety.
- Two flat top concrete speed humps along Greendale Avenue to discourage drivers from using Greendale Avenue to avoid Forest Way and to reduce vehicle speeds and improve safety.
- Two flat top concrete speed humps along Sturt Street to discourage drivers from using Sturt Street to avoid Forest Way and to reduce vehicle speeds and improve safety.

The locations for the proposed traffic calming measures are shown in Figure 15.

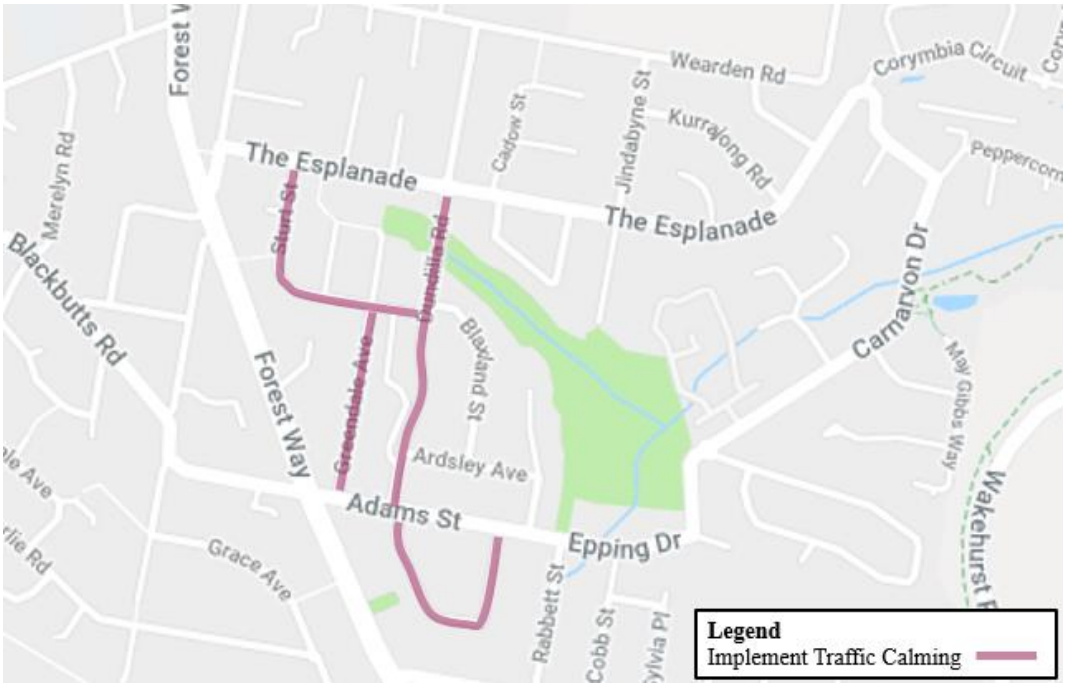


Figure 15: Traffic Calming Locations

These items are required to maintain traffic on the dedicated collector roads and make the rat-run less attractive to vehicles with destinations outside of the local roads. These items will be delivered when 7.11 funding allows or demand requires them based on local need but funded through 7.11 collections.

4.5.4 (Item 4D) Fitzpatrick Avenue West/ Warringah Road Intersection

It is proposed that an additional point of access into the western side of the precinct be provided through the provision of a dedicated slip lane at Fitzpatrick Avenue West. This would require the acquisition of approximately 170 m^2 land from 520 and 524 Warringah Road. This would require the construction of a retaining wall along the Warringah Road frontage of the property. The intersection of Grace Avenue and Fitzpatrick Avenue West would also require upgrade to allow for priority access from Warringah Road.

The Fitzpatrick Avenue West/ Warringah Road slip lane is shown in Figure 16.

Figure 16: Fitzpatrick Avenue West/ Warringah Road intersection

This item is required to service Phase 2 & 3 by taking load off Forest Way at Naree Road and provides additional connectivity for both Phases 2 & 3 via Grace Avenue.

Without this infrastructure item, there are adverse impacts at Warringah Rd and Forest Way. This infrastructure provides a secondary access to the phase 3 area, taking pressure off Forest Way for traffic coming from the west and Warringah Road.

With this proposed infrastructure item, the following improvements can be seen at these intersections at the above intersections.

4.5.5 (Item 4E) Grace Avenue Widening

It is proposed that Grace Avenue be widened between the extended Naree Road and Fitzpatrick Avenue West to provide two lanes in each direction. An allowance has been made for a small amount of property acquisitions in select locations of the alignment, however, it is assumed that the majority of the widening would be accommodated within the existing road reserve.

The widening of Grace Avenue is shown in Figure 17.

Figure 17: Grace Avenue Widening

The item allows for improved network flow between the Fitzpatrick Avenue west intersection and the Naree Road extension. This will assist in local network operations around both Phase 2 and Phase 3.

5 Active Transport Infrastructure Requirements

5.1 Overview

In order to support the development of Phase 1, 2 and 3 of the Hospital Precinct Structure Plan, a number of upgrades to the active transport network are proposed. Active transport infrastructure would help promote non-car modes to access the precinct, such as walking and cycling, and would be essential to ensuring a liveable outcome for the precinct. Good active travel infrastructure can improve the health of the users of the precinct, reduce pollution and help reduce traffic congestion. Table 2 and Figure 18 outline the active transport infrastructure requirements to support the project.

It is important to produce a cohesive network of cycle routes which provide access between the town centre and its surrounding precinct, attracting travellers to choose active travel as a sustainable alternative to private vehicle travel.

Table 2: Overview of Active Transport Infrastructure Requirements

Infrastructure	Item Number	Location	Report Section	Type
Off-road shared path	5	Forest Way	Section 5.3.1	S7.11
		Adams Street	Section 5.3.2	
		Naree Road Extension	Section 5.3.3	
		Rabbett Street	Section 5.3.4	
		Allambie Road (Completed – removed from costings)	Section 5.3.5	
		Warringah Road	Section 5.3.6	
		Aquatic Drive	Section 5.3.7	
		Epping Drive/ Carnarvon Drive/ The Esplanade	Section 5.3.8	
		Dundilla Road	Section 5.3.9	
		Patanga Road/ Dareen Street	Section 5.3.10	
		Grace Avenue to Woodlands Road	Section 5.3.11	
		Peppercorn Drive to Dreadnought Road Connection	Section 5.3.12	
		Dreadnought Road	Section 5.3.13	
		Peppercorn Drive	Section 5.3.14	
On-road cycling friendly treatment	6	Wakehurst Parkway	Section 5.4.1	
		Oxford Falls Road	Section 5.4.2	

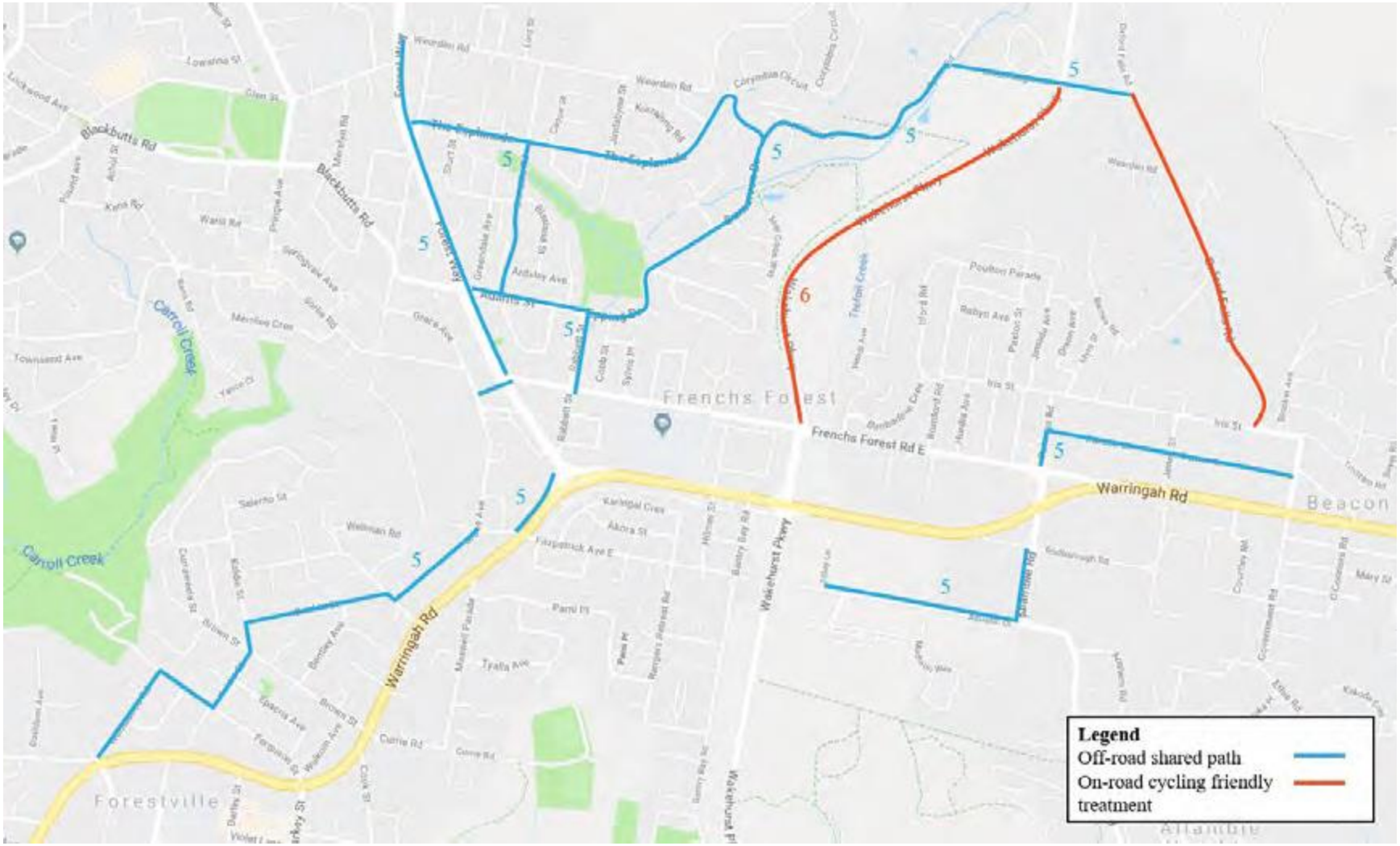


Figure 18: Active Transport Infrastructure Requirements Map

The active transport requirements have not been grouped into phases of the development. The active transport connections should be delivered on a priority basis with the primary delivery to be scheduled to provide connections to the bus priority network, between the areas of increased residential density and recreational facilities and between existing low density residential areas and the town centre precinct. These items should be delivered in line with available funding collected through infrastructure contributions.

5.2 Northern Beaches Hospital Works

Roads and Maritime Services, as a part of the Northern Beaches Hospital project, are delivering a number of active transport works including new and redeveloped footpaths and cycling paths. These are shown in Figure 19.

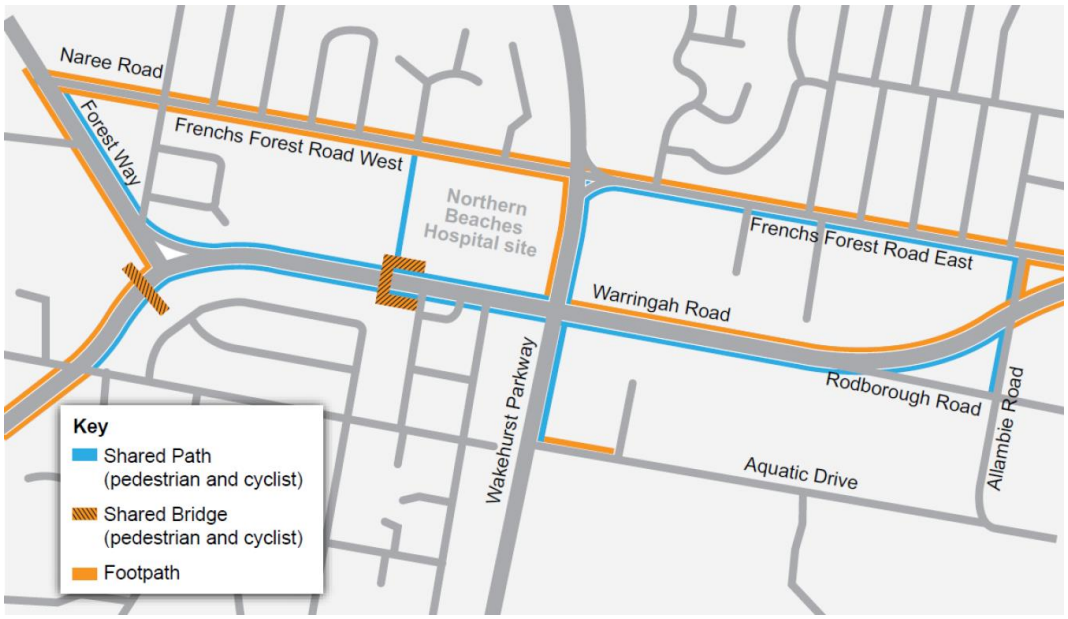


Figure 19: Northern Beaches Hospital active transport upgrades

5.3 Off-Road Shared Paths

As a part of the town centre works, a number of shared paths are required which will help connect the precinct to the larger area. Shared paths help facilitate more walking and cycling journeys and are best suited to busier roads or roads with high speeds and narrow geometries where cyclists may feel unsafe riding on the road. Shared paths can help improve liveability and reduce congestion through providing an attractive alternative to car usage. An example of an off-road shared path is shown in Figure 20.

It is noted that these shared paths should be constructed at the standard width of between 2.5 and 3 metres wide.

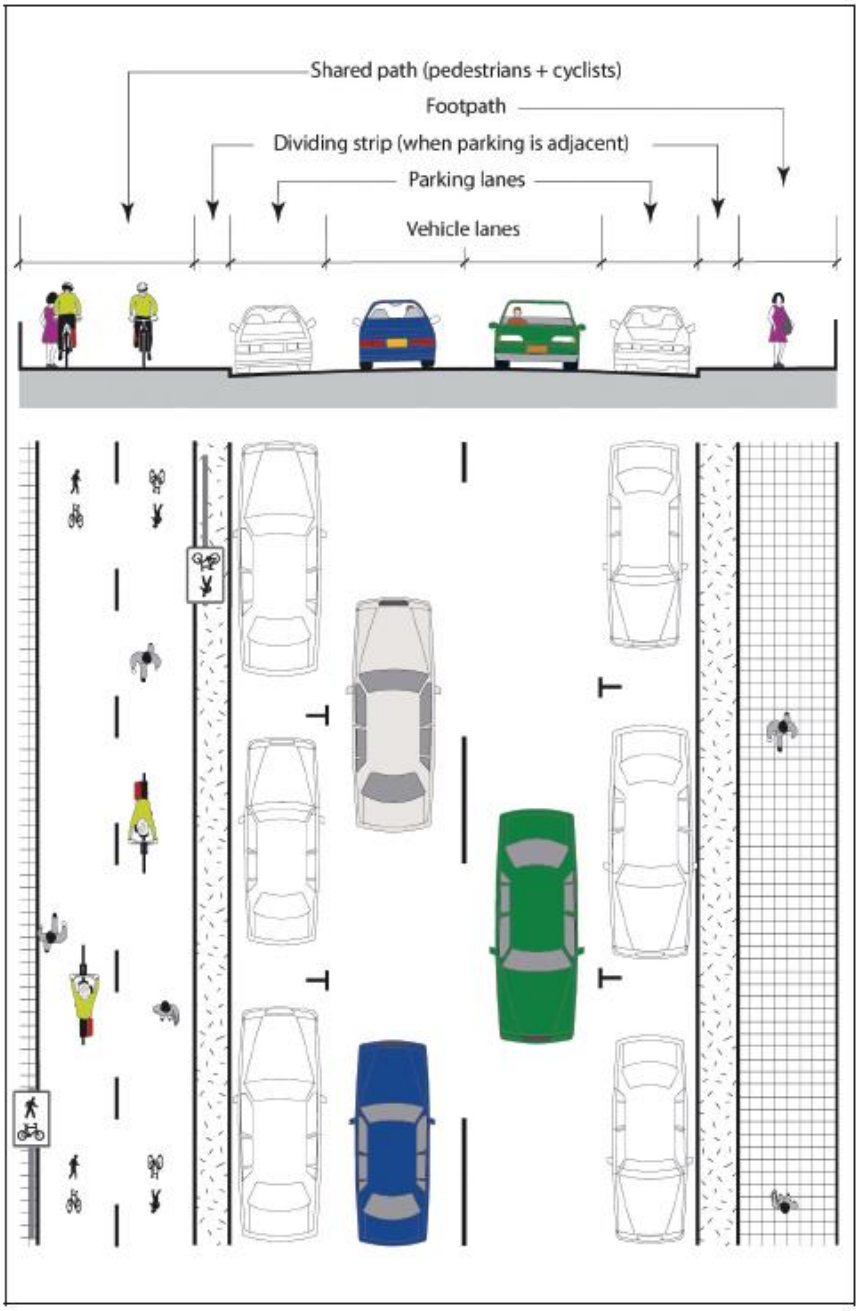


Figure 20: Road with shared path cross section
Source: RTA (2005)

5.3.1 Forest Way

It is proposed that an approximately 1200 metre shared path be constructed along Forest Way from the intersection of Forest Way and Naree Road to the intersection of Wearden Road. In order to align with the current cycling infrastructure on Forest Way, this shared path should be constructed on the eastern side of the road. It is assumed that no additional property acquisition would be required.

This shared path would help provide a pedestrian and cyclist connection between the residential areas and the town centre, as well as also better connecting Wakehurst Public School to the town centre.

The Forest Way shared path is shown in Figure 21.

Figure 21: Forest Way Shared Path

5.3.2 Adams Street

It is proposed that an approximately 420 metre shared path be constructed along Adams Street from the intersection of Adams Street and Rabbett Street to the intersection of Forest Way. In order to avoid destroying trees on the south side of Adams Street, the shared path should be constructed on the north side of the street through upgrading the existing footpath. It should be designed to connect with the shared path currently being delivered by the Northern Beaches Council on the south side of Adams Street east of the Forest Way intersection.

This shared path would help connect the town centre and residential areas to the north-west, and also provide a direct active transport link between the town centre and Lionel Watts Reserve/ Frenchs Forest Showground.

The Adams Street shared path is shown in Figure 22.

Figure 22: Adams Street Shared Path

5.3.3 Naree Road Extension

It is proposed that an approximately 90 metre shared path be constructed along the proposed Naree Road Extension, outlined in Section 5.3.3. In order to align with current cycling infrastructure on Naree Road, this shared path should be constructed on the southern side of the road.

This shared path would help connect Grace Avenue to the town centre and provide a link between the town centre and residential areas to the west and north-west.

The Naree Road Extension shared path is shown in Figure 23.

Figure 23: Naree Road Extension Shared Path

5.3.4 Rabbett Street

It is proposed that an approximately 250 metre shared path be constructed along Rabbett Street from the intersection of Rabbett Street and Frenchs Forest Road W to Epping Drive. As the eastern side of Rabbett Street has an existing footpath while the western side lacks a footpath, it is recommended that the shared path should be constructed on the eastern side of the street through upgrading the existing footpath. This would help remove the need to destroy trees on the western side of the street.

This shared path would help connect the town centre to the residential areas to the north through providing a link between the proposed shared path on Adams Street and on-street cycling on Epping Drive.

The Rabbett Street shared path is shown in Figure 24.

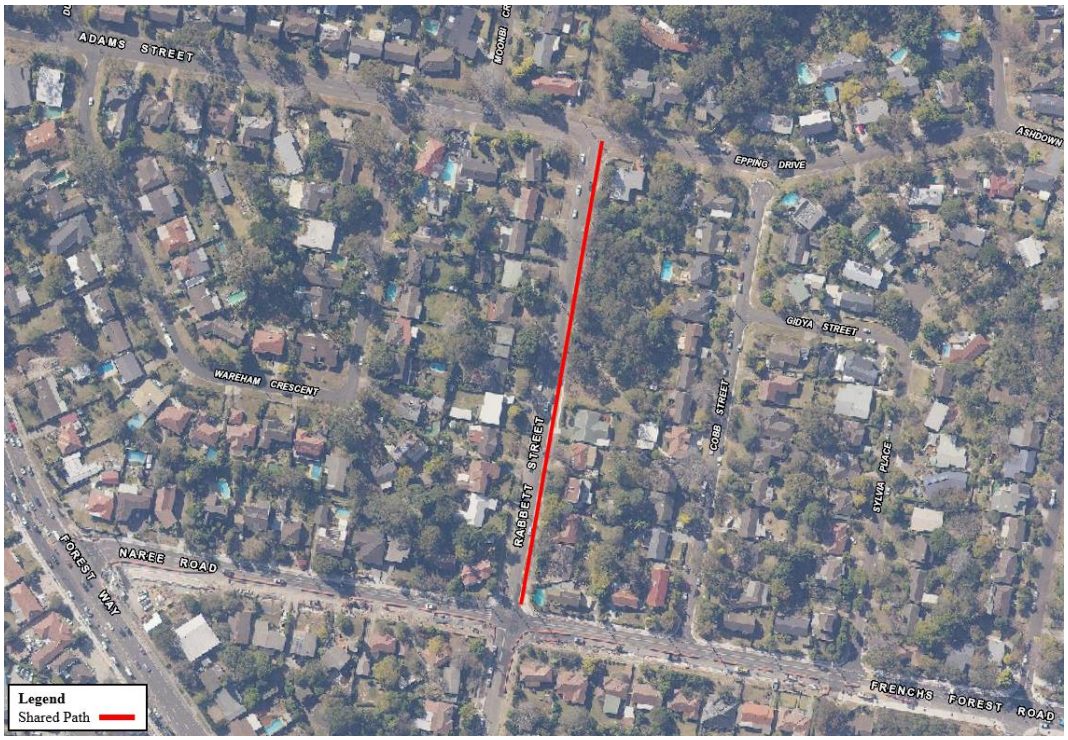


Figure 24: Rabbett Street Shared Path

5.3.5 Allambie Road

It is proposed that an approximately 250 metre shared path be constructed along Allambie Road from the intersection of Allambie Road and Rodborough Road to the intersection with Aquatic Drive. In order to align with current cycling infrastructure on the northern end of Allambie Road, it is recommended that the shared path should be constructed on the western side.

This shared path would help connect the existing cycling friendly facilities on Aquatic Drive to the larger cycling network in the area and provide an active transport link between the town centre and the recreational facilities at Aquatic Reserve. This would also enhance the connectivity of the New High School Precinct with the safe cycling network.

This section has now been completed under TfNSW funded program and removed from the costings.

The Allambie Road shared path is shown in Figure 25.

Figure 25: Allambie Road Shared Path

5.3.6 Warringah Road

It is proposed that an approximately 210 metre shared path be constructed along Warringah Road from the intersection of Warringah Road and Fitzpatrick Avenue and the shared overpass over Warringah Road near the Forest Way intersection. This should be constructed on the western side of the road to provide a connection for vehicles on Fitzpatrick Avenue to the shared bridge.

This shared path would help connect Grace Avenue and Fitzpatrick Avenue to the larger cycling network and help connect residential areas to the south-west to the town centre.

The Warringah Road shared path is shown in Figure 26.

Figure 26: Warringah Road Shared Path

5.3.7 Aquatic Drive

It is proposed that an approximately 660 metre shared path be constructed along Aquatic Drive from the intersection of Aquatic Drive and Allambie Road to Tilley Lane. In order to align with existing infrastructure on Fitzpatrick Avenue East and Allambie Road, it is recommended that the shared path should be constructed on the northern side, taking place of an existing informal but well utilised pedestrian path.

This shared path would replace the existing on-road cycleway on Aquatic Drive, which may be unsafe for cyclists such as school students at the future high school near this area. This can include vehicles turning in or out of the parking spaces conflicting with cyclists on the cycleway, as well as parked vehicles opening their doors into the path of cyclists. The shared path would also provide an active transport link between the town centre and the recreational facilities at Aquatic Reserve.

The Aquatic Drive shared path is shown in Figure 27.

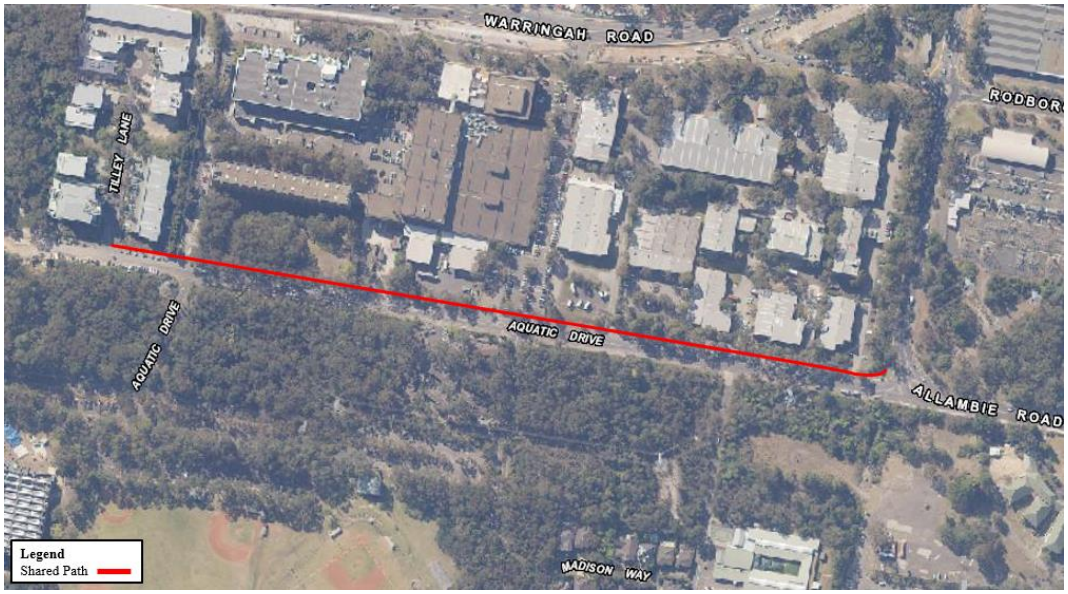


Figure 27: Aquatic Drive Shared Path

5.3.8 Epping Drive/ Carnarvon Drive/ The Esplanade

It is proposed that a shared path be constructed along Epping Drive/ Carnarvon Drive and The Esplanade to provide better cycling conditions and improve cycling connections between the precinct and the residential areas to the north of the precinct. This shared path would help connect the residential areas to the north of the town centre as these roads serve as collector roads for this area.

The location of the shared paths on Epping Drive, Carnarvon Drive and The Esplanade are shown in Figure 37.

Figure 37: Epping Drive/ Carnarvon Drive/ the Esplanade Shared Path

5.3.9 Dundilla Road

It is proposed that a shared path be constructed on Dundilla Road between Adams Street and The Esplanade. This would provide a connection between the proposed shared paths on Adams Street and The Esplanade, helping connect the precinct to the residential areas to the north of the precinct. This shared path would help make this road, which operates as a collector road for the residential areas to the north of the precinct, more appealing to cyclists.

The location of the shared path on Dundilla Road are shown in Figure 38.

Figure 38: Dundilla Road Shared Path

5.3.10 Patanga Road/ Dareen Street

It is proposed that a shared path be constructed on Patanga Road between Frenchs Forest Road East and Dareen Street, as well as on Dareen Street between Patanga Road and Ellis Road. This would provide a connection between the shared paths recently constructed on Frenchs Forest Road East and the shared path on Ellis Road and Oxford Falls Road. This shared path would help provide a connection between the precinct and the residential areas to the east of the precinct.

The location of the shared path on Patanga Road and Dareen Street is shown in Figure 39.

Figure 39: Patanga Road/ Dareen Street Shared Path

5.3.11 Grace Avenue to Woodlands Road

It is proposed that a shared path be constructed on the roads between Grace Avenue (at the Grace Avenue/ Fitzpatrick Avenue West intersection) and Woodlands Road (at the Woodlands Road/ Warringah Road intersection).

This shared path would formalise an existing commonly used cycle route and help provide a connection between the precinct and the residential areas to the south-west of the precinct. Furthermore, this cycling route would also provide a connection to the existing cycleway on Warringah Road and the pedestrian/cyclist bridge over Warringah Road.

The location of the shared path from Grace Avenue to Woodlands Road is shown in Figure 40.

Figure 40: Grace Avenue to Woodlands Road Shared Path

5.3.12 Peppercorn Drive to Dreadnought Road Connection

It is proposed that an approximately 425 metre shared path be constructed, potentially along an existing unpaved trail between Peppercorn Drive along Spicer Road and the proposed shared path on Dreadnought Road.

This shared path would provide an active transport shortcut between the Carnarvon Drive shared path and the Oxford Falls area which includes Oxford Falls Grammar School. Furthermore, it would also help link the cycling friendly Wakehurst Parkway north of Dreadnought Road to the town centre. This shared path would formalise an existing pedestrian trail at this location, shown in Figure 41.

Figure 41: Existing pedestrian trail from Spricer Road to Peppercorn Drive

The Peppercorn Drive to Dreadnought Road connection is shown in Figure 42.

Figure 42: Peppercorn Drive to Dreadnought Road Shared Path

5.3.13 Dreadnought Road

It is proposed that a shared path be constructed on Dreadnought Road between the intersection of Dreadnought Road and Oxford Falls Road to the intersection with Spicer Road.

This shared path would provide a connection between Wakehurst Parkway, the proposed shared path connecting to Peppercorn Drive via Spicer Road and the Oxford Falls area which includes Oxford Falls Grammar School. Furthermore, it would also help better link the cycling friendly Wakehurst Parkway north of Dreadnought Road to the town centre.

The location of the shared path on Dreadnought Road is shown in Figure 43.

Figure 43: Dreadnought Road Shared Path

5.3.14 Peppercorn Drive

It is proposed that a shared path be constructed on Peppercorn Drive. This shared path would provide a connection between the proposed shared paths on Carnarvon Drive and connecting to Dreadnought Road via Spicer Road, providing a connection between the town centre and the Oxford Falls Area.

The location of the shared path on Peppercorn Drive are shown in Figure 44.

Figure 44: Peppercorn Drive Shared Path

5.4 (Item 6) On-Road Cycling Friendly Treatment

As a part of the town centre works, a number of on-road cycling friendly treatments are proposed which aim to help improve cycling conditions in the vicinity of the town centre. These treatments may include:

- Dedicated on-road cycling lane on busier or faster roads
- Expanding road shoulder width to accommodate cyclists.
- Bicycle markings and signage to remind drivers to share the road with bicycles
- Bicycle arrows (such as existing on Grace Avenue)
- Speed humps with cyclist bypass
- Partial road closure with cyclist bypass
- Green painted bicycle lanes or bicycle “jumps” at intersections

Examples of on-road cycling infrastructure are shown in Figure 45.

Figure 45: On-road cycling friendly treatment examples

5.4.1 Wakehurst Parkway

It is proposed that on-road cycling friendly treatments be implemented on Wakehurst Parkway between the intersection of Wakehurst Parkway and Frenchs Forest Road and the intersection with Dreadnought Road. This could be in the form of widening the road shoulder where it is not sufficient in order to allow cyclists to cycle safely along the shoulder. These on-road cycling facilities would provide a connection to the town centre and the Oxford Falls area which includes Oxford Falls Grammar School. Furthermore, it would also help link Wakehurst Parkway north of Dreadnought Road to the town centre.

The location of the cyclist friendly treatments on Wakehurst Parkway are shown in Figure 46.

Figure 46: Wakehurst Parkway Cycle Friendly Treatment

5.4.2 Oxford Falls Road

It is proposed that on-road cycling friendly treatments be implemented on Oxford Falls Road between the intersection of Oxford Falls Road and Dreadnought Road and the intersection of Iris Street and Oxford Falls Road. This could be in the form of widening the road shoulder where it is not sufficient in order to allow cyclists to cycle safely along the shoulder.

These on-road facilities would help link the town centre and the cycling network on Dareen Street and Frenchs Forest Road to the Oxford Falls area which includes Oxford Falls Grammar School. Furthermore, it would also help link Wakehurst Parkway north of Dreadnought Road to the cycling network.

The location of the cyclist friendly treatments on Oxford Falls Road are shown in Figure 47.

Figure 47: Oxford Falls Road Cycle Friendly Treatment

6 Transport Network Performance

6.1 Introduction

Sections 4 and 5 of this report provided a list of traffic and active travel infrastructure items which would be required in order to support the delivery of the project. This section provides an overview of the performance of the network for different levels of development, with and without the proposed infrastructure items in place.

It is noted that Arup has not been involved in the most recent modelling for this project but are reporting on outputs based on modelling undertaken by Jacobs for Phase 1 on behalf of the Department of Planning, Industry and Environment, with supplementary modelling for Phases 2 and 3 (applied on top of Phase 1) undertaken by Council.

The transport modelling was used to test the infrastructure items and to confirm their need to support the development of the precinct. The modelling was also used to determine the timing for delivery of each infrastructure item to support the level of development in each phase.

6.2 Transport Modelling Methodology – Phase 1

Modelling for Phase 1 of the precinct was undertaken by Jacobs for the Department of Planning, Industry and Environment. The traffic generation modelled by Jacobs is shown in Table 3.

Table 3: Phase 1 Traffic Generation

Land Use	AM Rate	PM Rate	Phase 1		
			Yield (Phase 1)	AM Trips/ Hour	PM Trips/ Hour
Resi dwellings (high density)	0.4 per dwelling	0.45 per dwelling	1,901	760	855
Resi dwellings (med density)	0.5 per dwelling	0.55 per dwelling	231	116	127
Commercial	1.6 per 100m2	1.2 per 100m2	5,852 m²	94	71
Retail (supermarket)	4.3 per 100m2	12.3 per 100m2	5,891 m² GLFA	254	725
Retail (other)	2.7 per 100m2	7.6 per 100m2	8,660 m2 GLFA	233	658
Hotel	0.3 per 100m2	0.3 per 100m2	11,300 m2	34	34
Education	0.8 per 100m2	0.8 per 100m2	24,450 m2	196	196
Aged care/community	1.0 per 100m2	1.6 per 100m2	15,375m2	154	246
Total				**1,841**	**2,912**

The impacts of the Phase 1 development traffic have been assessed through the use of an Aimsun traffic model with the aim of identifying constraints in the network and testing possible infrastructure improvements to support the development of Phase 1 of the precinct.

The distribution of traffic generated by the Frenchs Forest Planned Precinct has been derived from an analysis of origin-destination patterns from the strategic Sydney Motorway Project Model (SMPM) modelling provided by RMS.

Modelling outputs are provided in Appendix D.

6.3 Transport Modelling Methodology – Phase 2 & 3

6.3.1 Basis of additional modelling

As part of the Planned Precinct Development at Frenchs Forest, Council's Transport Network Team has looked at several additional access options as a response to the work undertaken by Jacobs on behalf of the Department of Planning, Industry and Environment, with concerns raised regarding the suitability of the access to the Phase 1 release area from Frenchs Forest Road (West). Upon detailed assessment of the initial proposed access intersection, Council determined that the proposed configuration, when modelled, did not function with a suitable level of service (LoS). In particular, once the development yield approached the threshold of 70% of the stage 1 delivery, the service level became an issue.

Arup was commissioned by Council to develop some concept designs and preliminary cost estimates to provide alternative and/or additional access options for not only the full delivery of Phase 1 but to assist with the full delivery of all three current planned redevelopment stages. The options Arup developed included additional surface connections to service the town centre, dedicated public transport options and infrastructure, and two options for access directly into the Phase 1 delivery area from the eastbound Warringah Road corridor.

The additional surface connections are designed to spread the traffic load along Frenchs Forest Road (West) at Bluegum Crescent (East), Sylvia Place, and Rabbett Street. By restricting some movements at these intersections network performance is optimised to maintain an acceptable level of service. Additional road capacity along the Naree and Frenchs Forest Road corridor is required to provide for bus service enhancements for local and express services, and provide improved state road network performance at the Forest Way/ Naree Road intersection.

To provide pedestrian connectivity between the Town Centre and the south precinct, a new green pedestrian bridge is proposed to be constructed and will also provide a means to deliver an express bus connection for the town centre on the Warringah Road corridor. This can include vertical transport options to the surface road without the need for extensive compliant ramps, like those constructed for the existing pedestrian bridges across the corridor.

To assist with overall network performance along Warringah Road and Forest Way Arup investigated an option for a direct connection from the bypass slot, currently under construction as part of the Northern Beaches Hospital connectivity enhancement project, to allow eastbound traffic to enter the precinct and relieve the increased traffic load on the Warringah Road and Forest Way intersection and the Forest Way and Naree Road intersection. The construction would require

demolition of newly built road assets and may have an adverse impact on network performance if the methodology for the construction is not carefully considered and staged to minimise this impact. The initial cost benefit ratio (CBR), when assessed in pure infrastructure terms, is not a preferred option and does not comply with current guidance. However, when a whole of project approach is looked at, the cost of the alternate options, including additional property acquisition spend, the political and community issues that will invariably arise and the potential network impact in the later delivery phases, need to be considered. Whilst not required on day 1 of the project, the route needs to be considered as part of the development plan to not prohibit the connection in the future. When modelled, using the network model validated by RMS for the project, this option produces a reduction in eastbound travel time along Warringah Road in the AM peak by a minimum of 45 seconds or 12% improvement on the worst infrastructure combination, and only an increase of 8 seconds on the current (no additional development scenario).

Jacobs modelled 7 infrastructure options as part of the extension of the work they previously carried out for Department of Planning, Industry and Environment, however the optimisation of the network has not been fully assessed and does not take into account full delivery of all 3 phases and the potential additional impacts of out of scope development that will provide additional load to the state and local road transport network. The proposed infrastructure delivery schedule and timing is based on the proposed infrastructure Council believes is required to secure the most feasible transport outcomes for the priority precinct over the proposed structure plan delivery timeframe. The timing is derived from the assumptions contained in the Jacobs report modelling and has been extrapolated to take into account the overall development yield and generation across all three phases of the precinct under the Council adopted Structure Plan.

6.3.2 Modelling inputs

Modelling for Phases 2 and 3 of the precinct was undertaken by Council using the SIDRA Intersection 8 microsimulation software. The AM and PM traffic generation rates for Phase 2 and 3 assume that a Bus Rapid Transit (BRT) style service would be operational connecting the precinct to the larger public transport network, including to key destinations such as Chatswood and the Sydney CBD. The provision of higher density residential within the precinct with good public transport access leads to a higher level of containment of trips within the precinct and hence a reduction in the traffic generation rates.

Two development outcomes were modelled being 4360 and 5360 dwellings. The infrastructure requirements for each scenario were found to be the same, that is, development greater than 3,000 dwellings would have an adverse impact on the traffic and transport network. The bulk of the additional dwellings are delivered in the Phase 2, when the containment and public transport servicing allow for the additional yield. This would best be defined as worst-case impact modelling and shows the network can cope with the increased demand provided the transport infrastructure and servicing is provided.

The traffic generation modelled by the council is shown in Table 4.

Table 4: Phase 2 and 3 Traffic Generation

Land Use	AM Rate	PM Rate	Phase 2			Phase 3		
			Yield (Phase 2)	AM Trips/ Hour	PM Trips/ Hour	Yield (Phase 3)	AM Trips/ Hour	PM Trips/ Hour
Resi dwellings (high density)	0.29 per dwelling	0.29 per dwelling	3685	1069	1069	5000	1450	1450
Resi dwellings (med density)	0.29 per dwelling	0.29 per dwelling	360	105	105	360	105	105
Commercial	1.2 per 100m2	1.2 per 100m2	5,852 m²	71	71	6,680 m²	81	81
Retail (supermarket)	2.24 per 100m2	5.19 per 100m2	5,891 m² GLFA	132	305	13,406 m² GLFA	300	696
Retail (other)	2.24 per 100m2	5.19per 100m2	8,660 m2 GLFA	194	450	22,738m2 GLFA	509	1180
Hotel	0.3 per 100m2	0.3 per 100m2	11,300m²	34	34	11,300m²	34	34
Education	0.8 per 100m2	0.8 per 100m2	22,450m²	196	196	22,450m²	196	196
Aged care/community	1.0 per 100m2	1.6 per 100m2	15,375m²	154	246	15,375m²	154	154
Total				**1,955**	**2,476**		**2,829**	**3,896**

The SIDRA Intersection network modelled by Council is shown in Figure 48.

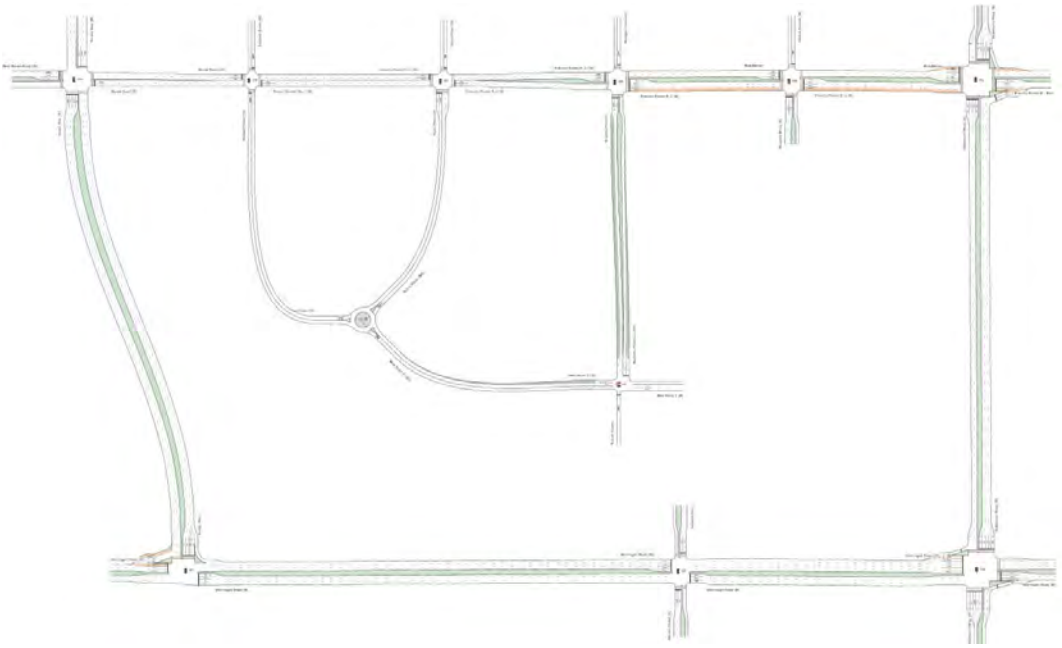


Figure 48: SIDRA Intersection Network

6.3.3 Modelling assumptions

It has been assumed that the Beaches Link project would be operational by Phases 2 and 3 of the precinct. Therefore, the project has resulted in a change to the traffic generation, however, the journey patterns of travellers have not been redistributed to take into account any changes that may occur due to the project.

For the Sidra 8 Network model, the incremental network load has been applied in the logical travel paths. These are based on local traffic flow and volumes taken from the SCATS system in the current network configuration and extrapolated to model the expected network impacts of the dynamic traffic distribution. This approach will also allow agility in response to changes over time to emerging technology and changes in transport expectation by the community.

The staging of works has considered the construction time to be included prior to the deemed point of need for each infrastructure item being reached. However, this is a guidance based on the concept design only, and detailed design and schedule will need to be programmed to provide the infrastructure in a timely fashion as development proceeds.

Modelling outputs are provided in Appendix C.

6.4 Public Transport Improvements

From the point of 50% of Phase 2 delivery or precinct wide equivalent, additional implementation of bus lanes on Warringah Road and other network enhancements along the Warringah Road Corridor outside the delivery precinct will be required, along with investigation of additional public transport service options to ensure the full delivery of the three phases of the project.

This will include dedicated bus lanes including priority signalling at all intersections from Beacon Hill to Roseville. This would result in modal change (potentially forced) from single private car to public transport through the re-purposing of existing traffic lanes, enhanced bus service timing and traffic signal phasing to favour the state road through traffic over local traffic. Council will need to investigate reclassification of local roads to sub-arterial roads and removal of traffic calming in some locations to assist in managing local traffic efficiently in partnership with TfNSW (RMS) to limit the impact of some intersection signalisation to reduce congestion.

7 Indicative Cost Estimates

7.1 Special Infrastructure Contributions (SIC Levy)

Table 5 outlines the indicative cost estimates for the Special Infrastructure Contribution items. It is noted that these cost estimates have been prepared at a strategic level for indicative purposes only, and a quantity surveyor should be engaged to prepare detailed cost estimates for the project. Further details of the cost estimates are shown in Appendix A.

Table 5: SIC Infrastructure Cost Estimates

Item Number	Name	Acquisition Cost	Infrastructure Cost (includes contingency)	Estimated Cost (Rounded to nearest $10,000)
1A	Frenchs Forest Road West/ Bluegum Crescent East/ New Internal Road	$0	$6,680,000	$6,680,000
3A	Naree Road/ Forest Way	$0	$7,280,000	$7,280,000
3B	Naree Road/ Grace Avenue	$760,000	$1,350,000	$2,110,000
3C	Naree Road Extension	$7,872,000	$12,298,000	$20,170,000
3D	Green Bridge over Warringah Road	$3,164,000	$57,306,000	$60,470,000
4B	Forest Way Widening	$17,778,000	$25,512,000	$43,290,000
4E	Grace Avenue Widening	$132,000	$8,848,000	$8,980,000
Total SIC Levy Items		**$29,706,000**	**$119,274,000**	**$148,980,000**

7.2 Local Infrastructure Contribution (S7.11 Contribution)

Table 6 outlines the indicative cost estimates for the Local Infrastructure Contribution items. It is noted that these cost estimates have been prepared at a strategic level for indicative purposes only, and a quantity surveyor should be engaged to prepare detailed cost estimates for the project. Further details of the cost estimates are shown in Appendix A.

Table 6: S7.11 Cost Estimates

Item Number	Name	Acquisition Cost	Infrastructure Cost (includes contingency)	Estimated Cost (Rounded to nearest $10,000)
1B	Holland Crescent Extension to Town Centre	$1,764,000	$2,854,000	$4,618,000
2A	Frenchs Forest Road West/ Naree Road Widening from Bluegum Crescent to Forest Way	$7,953,000	$17,512,000	$25,465,000
2B	Frenchs Forest Road West/ Sylvia Place	$0	$540,000	$540,000
2C	Southern End of Holland Crescent to Forest Way/ Rabbett St Intersection	$0	$10,000	$10,000
3E	Adams Street/ Forest Way	$0	$660,000	$660,000
3F	Adams Street/ Rabbett Street	$0	$250,000	$250,000
3G	Forest Way/ Warringah Road Intersection	$540,000	$2,160,000	$2,200,000
3H	Frenchs Forest Road East	$0	$80,000	$80,000
3I	New Road from Holland Crescent to Frenchs Forest Road West/ Sylvia Place	$9,072,000 ($6,792,000)	$12,928,000	$22,000,000
4C	Wareham Crescent, Dundilla Road, Greendale Avenue, Sturt Street	$0	$640,000	$640,000
4D	Fitzpatrick Avenue West/ Warringah Road	$408,000	$1,592,000	$2,000,000
5	Off-Road Shared Paths	$0	$2,550,000	$2,550,000
6	On-Road Cycle Friendly Treatments	$0	$200,000	$200,000
Total S7.11 Items		**$19,737,000**	**$41,976,000**	**$61,713,000**

8 Conclusions

This report has been prepared to outline the transport strategic design to support all three phases of the Frenchs Forest Town Centre project and addresses both traffic and active travel related infrastructure.

Traffic infrastructure items which have been outlined include new roads, widening of existing roads, upgrades to signalised and unsignalised intersections, new bus bays and traffic calming works. Active travel related infrastructure items which have been outlined include off-road shared paths, on-road cycling friendly treatment and pedestrian/shared bridges.

This report also provides indicative cost estimates for each infrastructure item to inform the development of a SIC Levy and S7.11 contribution. These contributions allow developers to share in the cost of delivering the infrastructure required to support new developments or shield the existing community from negative impacts as a result of the new development. The cost estimates shown in Appendix A have been prepared for indicative purposes only and a quantity surveyor should be engaged to prepare detailed cost estimates for the project.

Appendix A

Indicative Costings

Item Number	SIC Levy Item	Cost (rounded to nearest $10,000)
1A	Frenchs Forest Road West/ Bluegum Crescent East/ New Internal Road	$ 6,680,000
3A	Naree Road/ Forest Way	$ 7,280,000
3B	Naree Road/ Grace Avenue	$ 2,100,000
3C	Naree Road Extension	$ 19,570,000
3D	Green Bridge over Warringah Road	$ 59,660,000
4B	Forest Way Widening	$ 43,290,000
4E	Grace Avenue Widening	$ 8,260,000
	Total SIC Levy Items	**$ 146,840,000**
4A	Optional - Warringah Road Town Centre Access Tunnel	$ 53,270,000

Item Number	S7.11 Item	Cost (rounded to nearest $10,000)
1B	Holland Crescent Extension to Town Centre	$ 4,620,000
2A	Frenchs Forest Road West/ Naree Road Widening from Bluegum Crescent to Fores	$ 25,470,000
2B	Frenchs Forest Road West/ Sylvia Place	$ 540,000
2C	New Road from Holland Crescent to Frenchs Forest Road West/ Sylvia Place	$ 10,000
3E	Adams Street/ Forest Way	$ 660,000
3F	Adams Street/ Rabbett Street	$ 250,000
3G	Forest Way/ Warringah Road Intersection	$ 2,020,000
3H	Frenchs Forest Road East	$ 80,000
3I	New Road from Holland Crescent Extension to Frenchs Forest Road West	$ 21,990,000
4C	Wareham Crescent, Dundilla Road, Greendale Avenue, Sturt Street	$ 640,000
4D	Fitzpatrick Avenue West/ Warringah Road	$ 2,000,000
5	Off-Road Shared Paths	$ 14,570,000
6	On-Road Cycle Friendly Treatments	$ 120,000
	Total S7.11 Items	**$ 72,970,000**

Item 1A

Estimated cost: Town centre access point

	Item	Rate Value	Per	Amount	$ Cost
1 Concept Development	EIS (50m-150m)		**5.0% of construction cost**	$ 3,158,577.15	**$ 157,928.86**
	Project Management		**10.0% of total stage cost**	$ 157,928.86	**$ 15,792.89**
	Client Representation		**10.0% of project management cost**	$ 15,792.89	**$ 1,579.29**
	Total Stage Cost				**$ 175,301.03**
2 Detailed Design & Documentation	Investigation & Design		**6.0% of construction cost**	$ 3,158,577.15	**$ 189,514.63**
	Project Management		**10.0% of total stage cost**	$ 189,514.63	**$ 18,951.46**
	Client Representation		**10.0% of project management cost**	$ 18,951.46	**$ 1,895.15**
	Total Stage Cost				**$ 210,361.24**
3 Property Acquisitions	Assumed $/Sqm	**$ 2,400**	**per sqm**	**0**	$ -
	Professional Services for Property		**7.0% of property acquisition cost**	$ -	$ -
	Project Management		**10.0% of total stage cost**	$ -	$ -
	Client Representation		**10.0% of project management cost**	$ -	$ -
	Total Stage Cost				**$ -**
4 Utility Adjustments	Adjust Utilities		**25.0% of infrastructure cost**	$ 3,158,577.15	**$ 789,644.29**
	Project Management		**10.0% of total stage cost**	$ 789,644.29	**$ 78,964.43**
	Client Representation		**10.0% of project management cost**	$ 78,964.43	**$ 7,896.44**
	Total Stage Cost				**$ 876,505.16**
5 Infrastructure Construction	New Signals	**$ 350,000**	**per signal**	1	**$ 350,000.00**
	New Town Centre Access (60m)	**$ 4,000,000**	**per lane km**	0.12	**$ 480,000.00**
	Intersection civil/ kerb/ linemarking	**$ 2,000,000**	**per signal**	1	**$ 2,000,000.00**
	PA Insurance		**0.55% of costs**	$ 2,830,000.00	**$ 15,565.00**
	Project Management		**10% of total stage cost**	$ 2,845,565.00	**$ 284,556.50**
	Client Representation		**10% of project management cost**	$ 284,556.50	**$ 28,455.65**
	Total Stage Cost				**$ 3,158,577.15**
6 Finalisation	Project Data & Post Completion Review		**1.0% of infrastructure cost**	$ 3,158,577.15	**$ 31,585.77**
	Project Management		**10.0% of total stage cost**	$ 31,585.77	**$ 3,158.58**
	Client Representation		**10.0% of project management cost**	$ 3,158.58	**$ 315.86**
	Total Stage Cost				**$ 35,060.21**

Contingency	50%	**$ 2,227,902.39**
	TOTAL COST	**$ 6,683,707.18**

Element:	**Traffic & Transport**
Item Number	**1B**
Item Description	**Holland Crescent Extension to Town Centre**

Explanation of Item

Extend Holland Crescent to Town Centre

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Land Acquisition	735	m2	$ 2,400.00	Council	$ 1,764,000.00
Demolition of existing structures	271	m2	$ 267.00	IPART 3.1	$ 72,357.00
New 3 lane sub-arterial road	40	m	$ 8,814.00	IPART 1.1	$ 352,560.00
Street Lighting	2	each	$ 15,367.00	IPART 1.17	$ 30,734.00
New 1.2m footpath on both sides	80	m	$ 226.00	IPART 1.10	$ 18,080.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 2,237,731.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 4,617,418.06**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Payment of full waste levy for solid waste or restricted special waste
Road and footpath closures
Contaminated materials
Surplus excavation of materials
Import of fill required for site levlling

Element:	**Traffic & Transport**
Item Number	**2A**
Item Description	**Frenchs Forest Road West/ Naree Road from Bluegum Crescent to Forest Way**

Explanation of Item

Widen Frenchs Forest Road West/ Naree Road
Additional Lane at Rabbett Street

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Sub-Arterial Road Widening	500	m	$ 6,422.00	IPART 1.2	$ 3,211,000.00
2.5m wide shared cycleway/ pedestrian footpath	500	m	$ 669.00	IPART 1.10	$ 334,500.00
Street Lighting	13	each	$ 15,367.00	IPART 1.17	$ 199,771.00
Land Acquisition	3314	m2	$ 2,400.00	Council	$ 7,953,600.00
Rabbett Street Turning Lane	100	m	$ 6,422.00	IPART 1.2	$ 642,200.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 12,341,071.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 25,465,028.69**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Payment of full waste levy for solid waste or restricted special waste
Additional excavated material requiring disposal off-site
Imported fill required for site levelling

Element:	**Traffic & Transport**
Item Number	**2B**
Item Description	**Sylvia Place/ Frenchs Forest Rd West/ New Road**

Explanation of Item

New Signals due to new road from Holland Crescent

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
New Signalised Intersection	1	signal	$ 260,680.00	IPART 1.13	$ 260,680.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 260,680.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 537,896.89**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities

Element:	**Traffic & Transport**
Item Number	**2C**
Item Description	**Southern End of Holland Crescent to Forest Way/ Rabbett St Intersection**

Explanation of Item

Upgrading restriction to Bus Only 24 Hour, requiring painting of surface

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Road Pavement Resurfacing/ Painting	70	m2	$ 97.00	IPART 1.21	$ 6,790.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 6,790.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 14,010.74**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities

All or part of works to be completed at night

Element:	**Traffic & Transport**
Item Number	**3A**
Item Description	**Naree Rd/ Forest Way**

Explanation of Item

Intersection upgrade to accommodate additional turn lanes and include land aquisiton

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
New intersection slip lane and other works	150	m	$ 19,266.00	3*IPART 1.2	$ 2,889,900.00
New Signals	1	signal	$ 260,680.00	IPART 1.13	$ 260,680.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 3,150,580.00**

Adjustment Factors	Factor
Congestion (Heavy)	1.4
Total Adjustment Factors	**1.4**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 7,281,147.91**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Payment of full waste levy for solid waste or restricted special waste
Road and footpath closures
Contaminated materials
Surplus excavation of materials
Import of fill required for site levlling

Element:	**Traffic & Transport**
Item Number	**3B**
Item Description	**Naree Road/ Grace Avenue**

Explanation of Item

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Land Acquisition	316	m2	$ 2,400.00	Council	$ 758,400.00
New Signals	1	signal	$ 260,680.00	IPART 1.13	$ 260,680.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 1,019,080.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 2,102,807.89**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities

Element:	**Traffic & Transport**
Item Number	**3C**
Item Description	**Naree Rd Extension**

Explanation of Item

Extend Naree Road through to Grace Avenue

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Land Acquisition	3280	m2	$ 2,400.00	Council	$ 7,872,000.00
Demolition of existing structures	1031	m2	$ 267.00	IPART 3.1	$ 275,277.00
New 4 lane sub-arterial road	100	m	$ 10,235.00	IPART 1.1	$ 1,023,500.00
Additional Lane	100	m	$ 2,000.00	assumed	$ 200,000.00
Street Lighting	6	each	$ 15,367.00	IPART 1.17	$ 92,202.00
New 1.2m footpath on one side (cycleway on other side costed later)	100	m	$ 226.00	IPART 1.10	$ 22,600.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 9,485,579.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 19,572,899.42**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Payment of full waste levy for solid waste or restricted special waste
Road and footpath closures
Contaminated materials
Surplus excavation of materials
Import of fill required for site levlling

Item 3D

Estimated cost: Green bridge (30m)

	Item	Rate Value	Per	Amount	$ Cost
1 Concept Development	EIS (50m-150m)	**5.0%**	**of construction cost**	$ 25,949,441.25	**$ 1,297,472.06**
	Project Management	**10.0%**	**of total stage cost**	$ 1,297,472.06	**$ 129,747.21**
	Client Representation	**10.0%**	**of project management cost**	$ 129,747.21	**$ 12,974.72**
	Total Stage Cost				**$ 1,440,193.99**
2 Detailed Design & Documentation	Investigation & Design	**6.0%**	**of construction cost**	$ 25,949,441.25	**$ 1,556,966.48**
	Project Management	**10.0%**	**of total stage cost**	$ 1,556,966.48	**$ 155,696.65**
	Client Representation	**10.0%**	**of project management cost**	$ 155,696.65	**$ 15,569.66**
	Total Stage Cost				**$ 1,728,232.79**
3 Property Acquisitions	Assumed $/Sqm	**$ 2,400.00**	**per sqm**	**1110**	**$ 2,664,000.00**
	Professional Services for Property	**7.0%**	**of property acquisition cost**	$ 2,664,000.00	**$ 186,480.00**
	Project Management	**10.0%**	**of total stage cost**	$ 2,850,480.00	**$ 285,048.00**
	Client Representation	**10.0%**	**of project management cost**	$ 285,048.00	**$ 28,504.80**
	Total Stage Cost				**$ 3,164,032.80**
4 Utility Adjustments	Adjust Utilities	**25.0%**	**of infrastructure cost**	$ 25,949,441.25	**$ 6,487,360.31**
	Project Management	**10.0%**	**of total stage cost**	$ 6,487,360.31	**$ 648,736.03**
	Client Representation	**10.0%**	**of project management cost**	$ 648,736.03	**$ 64,873.60**
	Total Stage Cost				**$ 7,200,969.95**
5 Infrastructure Construction	Lifts	**$ 250,000**	**per lift**	1	**$ 250,000.00**
	Green Bridge	**$ 5,000**	**per m2**	4500	**$ 22,500,000.00**
	Escalator	**$ 500,000**	**per escalator**	1	**$ 500,000.00**
	PA Insurance	**0.55%**	**of costs**	$ 23,250,000.00	**$ 127,875.00**
	Project Management	**10%**	**of total stage cost**	$ 23,377,875.00	**$ 2,337,787.50**
	Client Representation	**10%**	**of project management cost**	$ 2,337,787.50	**$ 233,778.75**
	Total Stage Cost				**$ 25,949,441.25**
6 Finalisation	Project Data & Post Completion Review	**1.0%**	**of infrastructure cost**	$ 25,949,441.25	**$ 259,494.41**
	Project Management	**10.0%**	**of total stage cost**	$ 259,494.41	**$ 25,949.44**
	Client Representation	**10.0%**	**of project management cost**	$ 25,949.44	**$ 2,594.94**
	Total Stage Cost				**$ 288,038.80**

Contingency	50%	**$**	**19,885,454.79**
	TOTAL COST	**$**	**59,656,364.36**

Element:	**Traffic & Transport**
Item Number	**3E**
Item Description	**Adams Street**

Explanation of Item

Widen Adams Street

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Sub-arterial road widening	50	m	$ 6,422.00	IPART 1.2	$ 321,100.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 321,100.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 662,569.78**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities

Payment of full waste levy for solid waste or restricted special waste

Additional excavated material requiring disposal off-site

Imported fill required for site levelling

Element:	**Traffic & Transport**
Item Number	**3F**
Item Description	**Adams Street/ Rabbett Street**

Explanation of Item

New roundabout construction + Pedestrian Refuges

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
New Roundabout	1	roundabout	$ 100,069.00	IPART 1.14	$ 100,069.00
New Pedestrian Refuges	4	crossings	$ 5,490.00	IPART 1.15	$ 21,960.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
			Total Base Cost		**$ 122,029.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 251,799.21**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities

Element:	**Traffic & Transport**
Item Number	**3G**
Item Description	**Forest Way/ Warringah Road Intersection**

Explanation of Item

Add bus priority to manage movement conflicts at this location
Upgrade pedestrian bridge

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
New Signalised Intersection (Rabbett St/Forest Way)	1	each	$ 260,680.00	IPART 1.17	$ 260,680.00
Co-ordinating signals for priority system (Forest Way/ Warringah Rd)	1	each	$ 50,000.00	Assumed	$ 50,000.00
Cycle Overbridge (84m)	3	28m span	$ 31,973.00	IPART 1.19	$ 95,919.00
Modify Original Bridge	1	each	$ 31,973.00	assumed	$ 31,973.00
Land Acquisition	225	m2	$ 2,400.00	Council	$ 540,000.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
			Total Base Cost		**$ 978,572.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 2,019,222.16**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
All or part of works to be completed at night

Element:	**Traffic & Transport**
Item Number	**3H**
Item Description	**Bus Stop Relocation**

Explanation of Item

Relocate bus stops to fix blockage issue

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Bus Shelters	2	shelters	$ 17,515.00	IPART 1.16	$ 35,030.00
Demolition of existing shelters (20m2 each)	20	m2	$ 267.00	IPART 3.2	$ 5,340.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 40,370.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 83,300.97**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Payment of full waste levy for solid waste or restricted special waste
Road and footpath closures
Contaminated materials
Surplus excavation of materials
Import of fill required for site levlling

Element:	**Traffic & Transport**
Item Number	**3I**
Item Description	**New Road from Holland Crescent Extension to Frenchs Forest Road West**

Explanation of Item

Connect Holland Crescent to Frenchs Forest Rd West

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
New 3 lane sub-arterial road	130	m	$ 8,814.00	IPART 1.1	$ 1,145,820.00
Demolition of existing structures	1071	m2	$ 267.00	IPART 3.1	$ 285,957.00
Street Lighting	6	each	$ 15,367.00	IPART 1.17	$ 92,202.00
New 1.2m footpath on both sides	260	m	$ 226.00	IPART 1.10	$ 58,760.00
Land Acquisition	3780	m2	$ 2,400.00	Council	$ 9,072,000.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 10,654,739.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 21,985,388.01**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Payment of full waste levy for solid waste or restricted special waste
Road and footpath closures
Contaminated materials
Surplus excavation of materials
Import of fill required for site levlling

Item 4A

Estimated cost: Warringah Road access point (tunnel option)

	Item	Rate Value	Per	Amount	$ Cost
1 Concept Development	Planning	5.0%	of construction cost	$ 25,173,748.28	$ 1,258,687.41
	Project Management	10.0%	of total stage cost	$ 1,258,687.41	$ 125,868.74
	Client Representation	10.0%	of project management cost	$ 125,868.74	$ 12,586.87
	Total Stage Cost				**$ 1,397,143.03**
2 Detailed Design & Documentation	Investigation & Design	6.0%	of construction cost	$ 25,173,748.28	$ 1,510,424.90
	Project Management	10.0%	of total stage cost	$ 1,510,424.90	$ 151,042.49
	Client Representation	10.0%	of project management cost	$ 151,042.49	$ 15,104.25
	Total Stage Cost				**$ 1,676,571.64**
3 Property Acquisitions	Assumed $/Sqm	$ 2,400	per sqm	0	$ -
	Professional Services for Property	7.0%	of property acquisition cost	$ -	$ -
	Project Management	10.0%	of total stage cost	$ -	$ -
	Client Representation	10.0%	of project management cost	$ -	$ -
	Total Stage Cost				**$ -**
4 Utility Adjustments	Adjust Utilities	25.0%	of infrastructure cost	$ 25,173,748.28	$ 6,293,437.07
	Project Management	10.0%	of total stage cost	6293437.069	$ 629,343.71
	Client Representation	10.0%	of project management cost	629343.7069	$ 62,934.37
	Total Stage Cost				**$ 6,985,715.15**
5 Infrastructure Construction	Ramp Construction	$ 10,000,000	per km	0.12	$ 1,200,000.00
	Additional Auxiliary Deceleration Lane (Use Tunnel Rate)	$ 100,000,000	per km	0.06	$ 6,000,000.00
	Tunnel Construction	$ 100,000,000	per km	0.14	$ 14,000,000.00
	Retaining Wall	$ 1,500.00	per m2	750	$ 1,125,000.00
	CCTV	$ 30,000.00	total	1	$ 30,000.00
	VMS	$ 200,000.00	total	1	$ 200,000.00
	PA Insurance	0.55%	of costs	$ 22,555,000.00	$ 124,052.50
	Project Management	10%	of total stage cost	$ 22,679,052.50	$ 2,267,905.25
	Client Representation	10%	of project management cost	2267905.25	$ 226,790.53
	Total Stage Cost				**$ 25,173,748.28**
6 Finalisation	Project Data & Post Completion Review	1.0%	of infrastructure cost	$ 25,173,748.28	$ 251,737.48
	Project Management	10.0%	of total stage cost	251737.4828	$ 25,173.75
	Client Representation	10.0%	of project management cost	25173.74828	$ 2,517.37
	Total Stage Cost				$ 279,428.61

Contingency		50%	**$ 17,756,303.35**
		TOTAL COST	**$ 53,268,910.04**

Element:	**Traffic & Transport**
Item Number	**4B**
Item Description	**Forest Way Widening**

Explanation of Item

Widen Forest Way

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Sub-Arterial Road Widening	400	m	$ 6,422.00	IPART 1.2	$ 2,568,800.00
2.5m wide shared cycleway/ pedestrian footpath	400	m	$ 669.00	IPART 1.10	$ 267,600.00
Street Lighting	10	each	$ 15,367.00	IPART 1.17	$ 153,670.00
Land Acquisition	7408	m2	$ 2,400.00	Council	$ 17,779,200.00
Bus Stop Indented Bay	30	m	$ 6,422.00	IPART 1.2	$ 192,660.00
Bus Shelter	1	each	$ 17,515.00	IPART 1.16	$ 17,515.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 20,979,445.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 43,289,773.54**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities

Payment of full waste levy for general solid waste or restricted special waste

Additional excavated material (over and above that stated in the basis of cost) requiring disposal off-site

Imported fill required for site levelling

Contaminated materials

Surplus excavated material requiring disposal off-site

Imported fill required for site levelling

Element:	**Traffic & Transport**
Item Number	**4C**
Item Description	**Traffic Calming**

Explanation of Item

Construct flat top road humps

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Flat top road humps - Dundilla Road	3	each	$ 30,885.00	IPART 1.9	$ 92,655.00
Flat top road humps - Wareham Crescent	3	each	$ 30,885.00	IPART 1.9	$ 92,655.00
Flat top road humps - Greendale Avenue	2	each	$ 30,885.00	IPART 1.9	$ 61,770.00
Flat top road humps - Sturt Street	2	each	$ 30,885.00	IPART 1.9	$ 61,770.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 308,850.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 637,292.67**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Element:	**Traffic & Transport**
Item Number	**4D**
Item Description	**Fitzpatrick Avenue West/ Warringah Road Slip Lane**

Explanation of Item

New Slip Lane & Deceleration Lane from Warringah Road into Fitzpatrick Avenue West

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
New Sub-Arterial Road (Slip Lane)	50	m	$ 2,231.00	IPART 1.5	$ 111,550.00
Sub-Arterial Road Widening (Deceleration Lane)	70	m	$ 6,422.00	IPART 1.2	$ 449,540.00
Land Acquisition	170	m2	$ 2,400.00	Council	$ 408,000.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 969,090.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 1,999,656.65**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Contaminated materials
Surplus excavated material requiring disposal off-site
Imported fill required for site levelling
Payment of full waste levy for general solid waste or restricted special waste
Additional excavated material (over and above that stated in the basis of cost) requiring disposal off-site
Imported fill required for site levelling

Element:	**Traffic & Transport**
Item Number	**4E**
Item Description	**Grace Avenue Widening**

Explanation of Item

Widening of Grace Avenue to 2 lanes in each direction between the extended Naree Road and Fitzpatrick Avenue West

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Land Acquisition	55	m2	$ 2,400.00	Council	$ 132,000.00
Sub-Arterial Road Widening	550	m	$ 6,422.00	IPART 1.2	$ 3,532,100.00
Street Lighting	14	each	$ 15,367.00	IPART 1.17	$ 215,138.00
New 1.2m footpath on both sides	550	m	$ 226.00	IPART 1.10	$ 124,300.00
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
			Total Base Cost		**$ 4,003,538.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 8,261,050.44**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Payment of full waste levy for solid waste or restricted special waste
Road and footpath closures
Contaminated materials
Surplus excavation of materials
Import of fill required for site levlling

Element:	**Traffic & Transport**
Item Number	**5**
Item Description	**Off-road shared path**

Explanation of Item

Demolition of existing footpath, construction of 2.5m shared cycleway

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Forest Way	1200	m	$ 690.00	IPART 1.11	$ 828,000.00
Adams Street	420	m	$ 690.00	IPART 1.11	$ 289,800.00
Naree Road Extension	90	m	$ 669.00	IPART 1.10	$ 60,210.00
Rabbett Street	250	m	$ 690.00	IPART 1.11	$ 172,500.00
Allambie Road	250	m	$ 690.00	IPART 1.11	$ 172,500.00
Warringah Road	210	m	$ 690.00	IPART 1.11	$ 144,900.00
Aquatic Drive	660	m	$ 669.00	IPART 1.10	$ 441,540.00
The Esplanade, Carnarvon, Epping	2400	m	$ 690.00	IPART 1.11	$ 1,656,000.00
Dundilla Road	520	m	$ 669.00	IPART 1.10	$ 347,880.00
Patanga Road/ Dareen Street	900	m	$ 669.00	IPART 1.10	$ 602,100.00
Grace Avenue to Woodlands Road	1800	m	$ 669.00	IPART 1.10	$ 1,204,200.00
Dreadnought Road	650	m	$ 690.00	IPART 1.11	$ 448,500.00
Peppercorn Drive	350	m	$ 690.00	IPART 1.11	$ 241,500.00
Peppercorn Drive to Dreadnought Road Connection (Path)	425	m	$ 669.00	IPART 1.10	$ 284,325.00
Peppercorn Drive to Dreadnought Road Connection (Vegetation Clearing, 5m width)	2125	m	$ 3.81	IPART 3.2	$ 8,096.25
Peppercorn Drive to Dreadnought Road Connection (Security lighting, 50m distance)	43	each	$ 3,146.00	IPART 3.22 (L)	$ 135,278.00
Bike racks in key places	20	each	$ 1,121.00	IPART 1.22	$ 22,420.00
				Total Base Cost	**$ 7,059,749.25**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 14,567,351.34**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities
Payment of full waste levy for solid waste or restricted special waste
Road and footpath closures
Contaminated materials
Surplus excavation of materials
Import of fill required for site levelling

Element:	**Traffic & Transport**
Item Number	**6**
Item Description	**On-road cycleway**

Explanation of Item

Cycle Friendly Treatment

Financial Year Work to be commenced	
Financial Year Work to be completed	

Cost Estimate

Component	Quantity	Unit	Rate	Source	Amount
Wakehurst Parkway	1700	m	$ 20.00	Average Cost for signage & linemarking	$ 34,000.00
Oxford Falls Road	1300	m	$ 20.00	Average Cost for signage & linemarking	$ 26,000.00
Bike racks in key places	5	each	$ 20.00	Average Cost for signage & linemarking	$ 100.00
			$ 20.00	Average Cost for signage & linemarking	$ -
			$ 20.00	Average Cost for signage & linemarking	$ -
			$ 20.00	Average Cost for signage & linemarking	$ -
			$ 20.00	Average Cost for signage & linemarking	$ -
			$ 20.00	Average Cost for signage & linemarking	$ -
			$ 1,121.00	IPART 1.22	$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
				Total Base Cost	**$ 60,100.00**

Adjustment Factors	Factor
Congestion (Moderate)	1.25
Total Adjustment Factors	**1.25**
Contingency	**1.5**
ABS Producer Price Indicies Adjustment	**1.1005** (Index 3101, Jun 2013 to Jun 2018)
Total Cost Estimate	**$ 124,012.59**

Prepared by Arup

Notes

Key identified risks (excluded from costs but allowed for in contingency)

Relocation/diversion of existing utilities

All or part of works to be completed at night

Appendix B

Land Acquisitions

ARUP

Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Introduction

The land acquisition requirements for the SIC Levy and S7.11 infrastructure items have been identified.

Item Number	SIC Levy Item	Land needed
1A	Frenchs Forest Road West/ Bluegum Crescent East/ New Internal Road	No
2A	Frenchs Forest Road West/ Naree Road Widening from Bluegum Crescent to Forest Way	Yes
3A	Naree Road/ Forest Way	No
3B	Naree Road/ Grace Avenue	Yes
3C	Naree Road Extension	Yes
3D	Green Bridge over Warringah Road	Yes
4B	Forest Way Widening	Yes
4E	Grace Avenue Widening	Yes
Item Number	**S7.11 Item**	
1B	Holland Crescent Extension to Town Centre	Yes
2B	Frenchs Forest Road West/ Sylvia Place	No
2C	Southern End of Holland Crescent to Forest Way/ Rabbett St Intersection	No
3E	Adams Street/ Forest Way	No
3F	Adams Street/ Rabbett Street	No
3G	Forest Way/ Warringah Road Intersection	Yes
3H	Frenchs Forest Road East	No
3I	New Road from Holland Crescent to Frenchs Forest Road West/ Sylvia Place	Yes
4C	Wareham Crescent, Dundilla Road, Greendale Avenue, Sturt Street	No
4D	Fitzpatrick Avenue West/ Warringah Road Slip Lane	Yes
5	Off-road shared path	No
6	On-road cycleway	No

Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Item Number 2A

141, 143, 145, 147, 149, 151, 153 and 155 Frenchs Forest Road – 574sqm

1, 1A, 3, 5, 7 and 9 Naree Road + 21A Forest Way – 2,726sqm

15 Rabbett Street – 14sqm

Total – 3,314sqm

Subject Land Acquisition Mapping

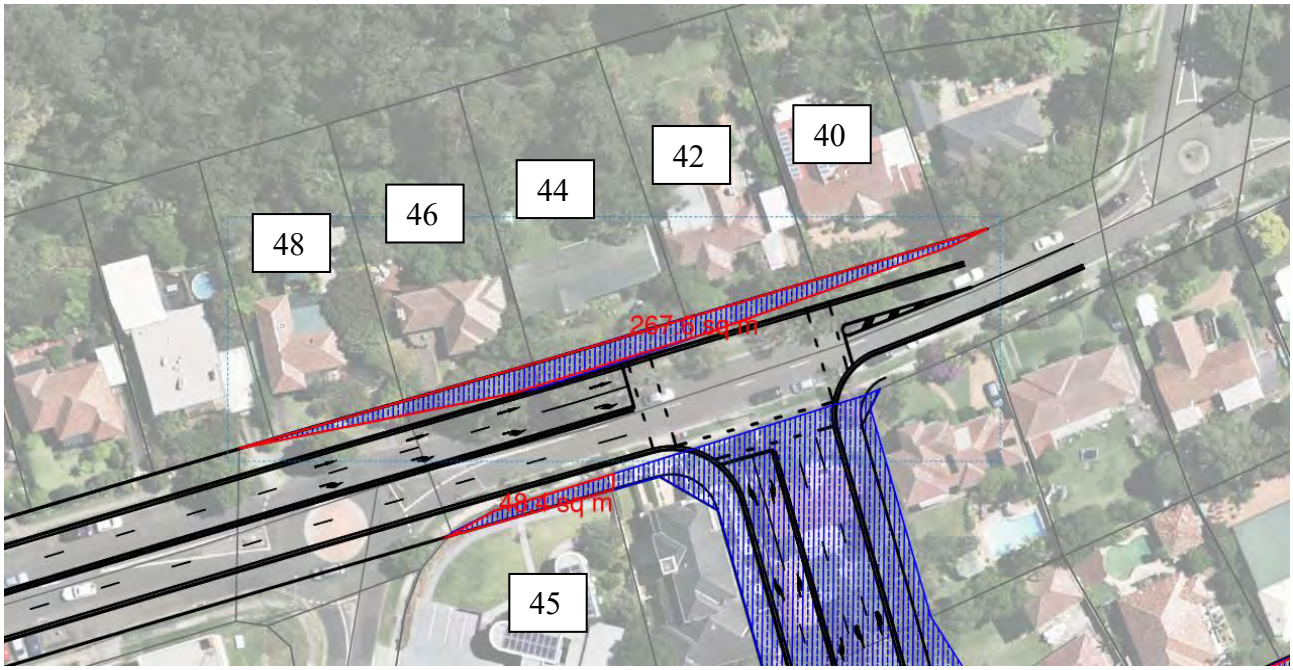
Date 6 September 2019 **Job No/Ref** 237921

Item Number 3B

40, 42, 44, 46 and 48 Grace Ave – 267.6sqm

45 Grace Ave – 48.4sqm

Total - 316sqm



Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Item Number 3C

28 Forest Way – 800sqm

30 Forest Way – 850sqm

41 Grace Ave – 800sqm

43 Grace Ave – 830sqm

Total – 3,280sqm

Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Item Number 3D

36 Karingal Crescent – 550sqm

38 Karingal Crescent – 560sqm

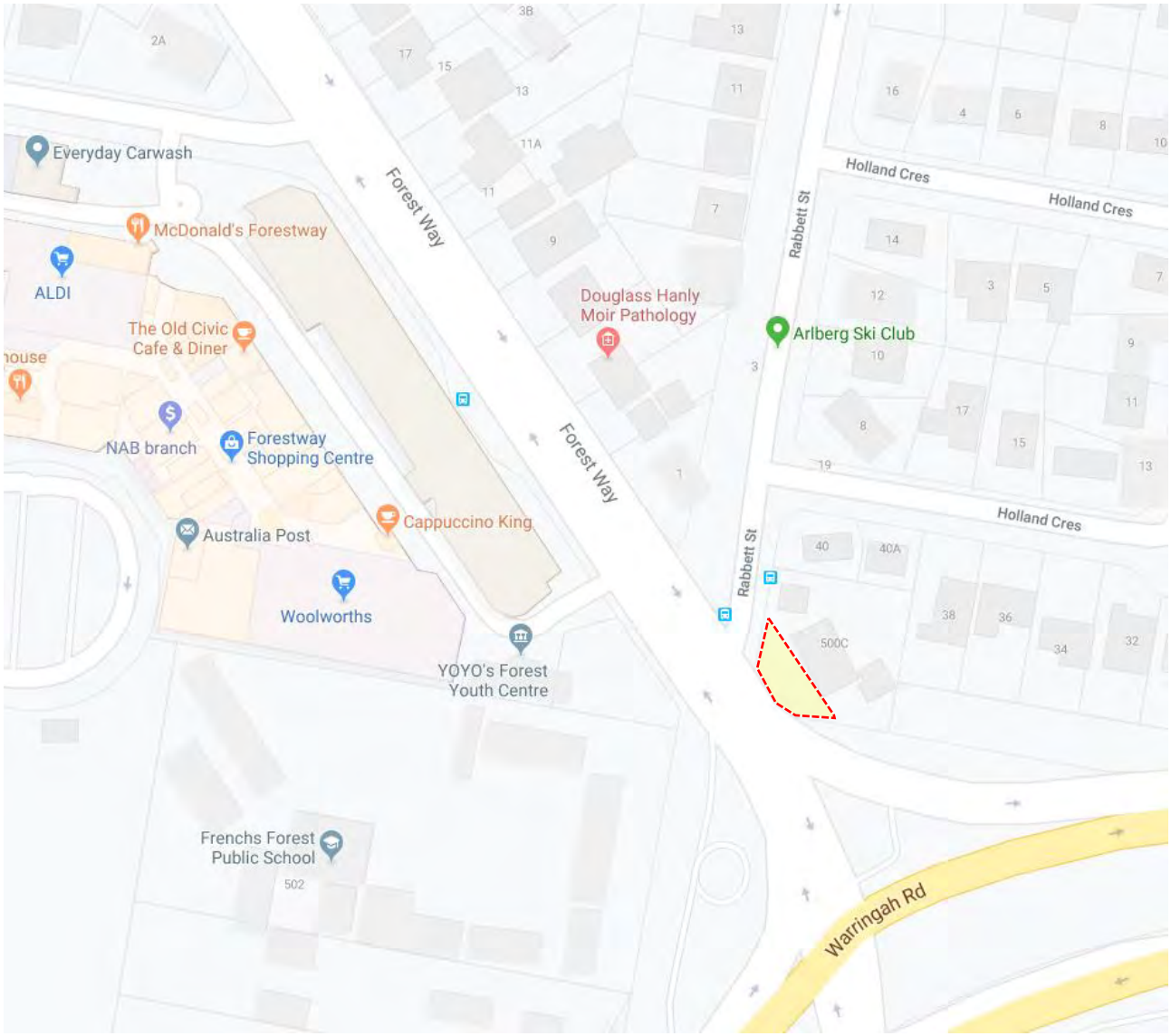
Total – 1,110sqm

Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Item Number 3G

500C Warringah Road (Partial acquisition) – 225sqm



Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Item Number 4B

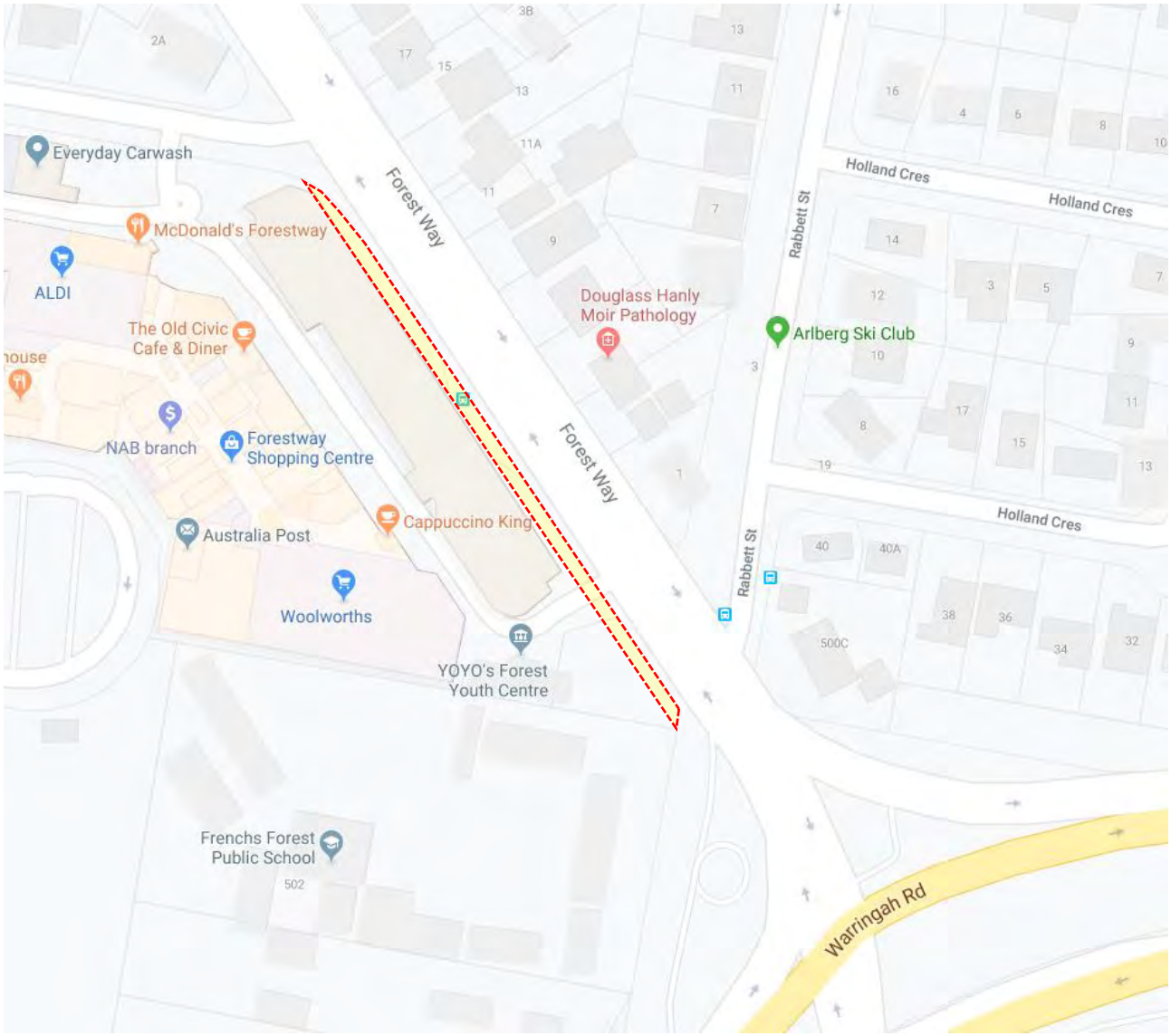
Address	Requirement	Area (sqm)
2a Russell Avenue	Full acquisition – reconsolidate and sell	1181
17 Forest Way	Partial acquisition	62
19 Forest Way	Partial acquisition	64
21 Forest Way	Partial acquisition	70
23 Forest Way	Partial acquisition	77
25 Forest Way	Partial acquisition	53
27 Forest Way	Partial acquisition	74
29 Forest Way	Partial acquisition	74
Forestway Shopping Centre	Partial acquisition	714
24 Forest Way	Full acquisition – reconsolidate and sell	888
26 Forest Way	Full acquisition – reconsolidate and sell	860
28 Forest Way	Item 3C	
30 Forest Way	Item 3C	
32 Forest Way	Full acquisition – reconsolidate and sell	781
34 Forest Way	Full acquisition – reconsolidate and sell	763
38 Forest Way	Full acquisition – reconsolidate and sell	771
40 Forest Way	Full acquisition – reconsolidate and sell	847
42 Forest Way	Partial acquisition	65
44 Forest Way	Partial acquisition	37
44a Forest Way	Partial acquisition	27
Total		**7,408**

Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921



Subject Land Acquisition Mapping

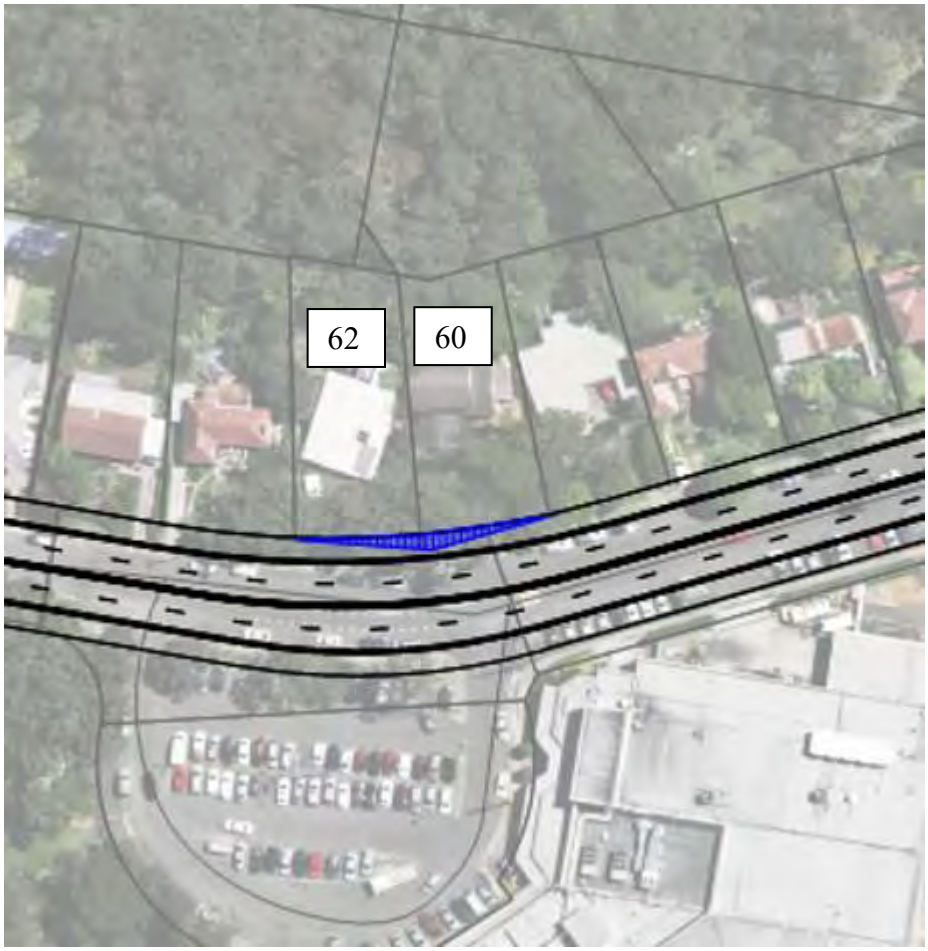
Date 6 September 2019 **Job No/Ref** 237921

Item Number 4E

60 Grace Ave – 30sqm

62 Grace Ave – 25sqm

Total – 55sqm



Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Item Number 1B

26 Holland Crescent – 735sqm

Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Item Number 3I

137 Frenchs Forest Road West – 2,830sqm

16 Holland Crescent – 950sqm

Total – 3,780sqm

Subject Land Acquisition Mapping

Date 6 September 2019 **Job No/Ref** 237921

Item Number 4D

520 -522 Warringah Road – 150sqm

524 Warringah Road – 21sqm

Total – 171sqm

Appendix C

Council - SIDRA Modelling Results Overview

Location		Phase 1 - Infrastructure required to enable development of Town Centre and peripheral development - Residential Yield of 1938.			Phase 2 - Additional 1900 Dwellings + Phase 1 infrastructure and new provision to cater for growth, including East-West BRT - Total Residential Yield 3838.			Phase 3 - Additional 1350 Dwellings and additional retail/commercial development on Forest Way site + Phase 2 infrastructure (more employment containment and corridor capacity redeployment) - Total Residential Yield of 5188			Phase 0 - Full development yield with no additonal infrastructure		
		Queue Length	Delay	LoS	Queue Length	Delay	LoS	Queue Length	Delay	LoS	Queue Length	Delay	LoS
Frenchs Forest Road (West) and Precinct primary entry	OVERALL	405.0m (worst lane)	126.6 sec (average)	F	271.6m (worst lane)	188.7 sec (average)	F	203.1m (worst lane)	188.2 sec (average)	F	347.8m (worst lane)	217.6sec (average)	F
	north leg	6.2m	51.9	D	16.6m	88.5	F	38.7m	65.1	E	299.5m	334.7	F
	south leg	180.0m	184.8	F	180m	146.2	F	180m	182.8	F	160.3m	319.9	F
	east leg	251.5m	155.1	F	267.4m	623	F	203.1m	130	F	395.7m	301.2	F
	west leg	405m	119.9	F	58.6m	80.8	F	33.6m	73.7	E	338m	273	F
Wakehurst Parkway and Frenchs Forest Road	OVERALL	212.2m (worst lane)	87.2 sec (average)	F	213.4m (worst lane)	78.1 sec (average)	E	116.2m (worst lane)	52.9 sec(average)	D	2369.5m (worst lane)	941.0 sec (average)	F
	north leg	159m	172.1	F	140.9m	98.7	F	86.9m	61.3	E	424.4m	185.2	F
	south leg	22.3m	57.7	E	213.4m	97.8	F	19m	42.3	D	2369.5m	180.2	F
	east leg	3.7m	83.9	F	28.7m	62.5	E	3.7m	83.9	F	623.3m	178.9	F
	west leg	212.2m	144.9	F	37.2m	76.5	E	71.2m	77.2	E	222.7m	136.1	F
Forest Way and Naree Road (Phase 0 and 1 without Naree Rd extension)	OVERALL	2256.0m (worst lane)	160.4 sec (average)	F	1755.4m(worst lane)	176.2 sec (average)	F	1675.0m (worst lane)	289.8 sec (average)	F	2255.6m (worst lane)	283.1sec (average)	F
	north leg	1559.3m	185.2	F	1356.0m	209.9	F	1122.2m	197.6	F	3510.6m	552.1	F
	south leg	2256m	131.6	F	748.4m	194.3	F	1070.6m	191.9	F	4608.6m	514.3	F
	east leg	215m	201.7	F	215.0m	165	F	215m	145.2	F	215m	186.7	F
	west leg	-	-	-	-	-	-	399.7m	201.2	F	-	-	-
Town Centre to Rabbett Street	OVERALL	454.4m (worst lane)	5.9 sec (average)	N/A	2.2m (worst lane)	5.4sec (average)	N/A	1.8m (worst lane)	5.3 sec (average)	N/A	1.0m (worst lane)	4.6 sec (average)	N/A
	north leg	1.4m	7.2	A	2.2m	9.4	A	1.8m	9	A	1m	7.8	A
	south leg	-	-	-	-	-	-	-	-	-	-	-	-
	east leg	454.4m	3.8	A	0.9m	4.7	A	0.9m	4.4	A	0.1m	4.1	A
	west leg	0m	4.6	A	0m	4.6	A	0m	4.6	A	0m	4.6	A
Frenchs Forest Road (West) and Naree Road and Rabbett Street	OVERALL	204.1m (worst lane)	56.4 sec (average)	F	73.9m (worst lane)	40.1 sec (average)	D	159.6m (worst lane)	52.5 sec (average)	D	405.0m (worst lane)	607.6 sec (average)	F
	north leg	16.1m	73.6	E	12.7m	48.4	D	67.3m	119.3	F	291.3m	283.8	F
	south leg	56.2m	118.1	F	61.4m	49.5	D	70m	74.4	E	39.7m	57.8	E
	east leg	178m	109.6	F	73.1m	47.6	D	18m	74.6	E	147.3m	281.8	F
	west leg	37.5m	82.8	F	73.9m	52.6	D	112.5m	58.5	E	215m	397.9	F
Holland Crescent and access to the Town Centre	OVERALL				12.9m (worst lane)	8.1 sec (average)	A	11.1m (worst lane)	7.3 sec (average)	A			
	north leg				1.2m	5.3	A	1.1m	5	A			
	south leg				12.9m	6.6	A	11.1m	6.7	A			
	east leg				-	-	-	-	-	-			
	west leg				8.1m	12.2	B	3.6m	10.2	B			
Frenchs Forest Road and Sylvia Place	OVERALL				205.0m (worst lane)	149.9 sec (average)	F	221.0m (worst lane)	155.3 sec (average)	F			
	north leg				14.8m	88.8	F	221m	129.7	F			
	south leg				85m	167.2	F	85m	129.2	F			
	east leg				205m	100.8	F	205m	186.4	F			
	west leg				175m	195.3	F	175m	181.4	F			
Adam Street and Forest Way	OVERALL	744m (worst lane)	313 (average)	F	705m (worst lane)	293 (average)	F	746m (worst lane)	334 (average)	F	621m (worst lane)	796 (average)	F
	north leg	744m	184	F	705m	172	F	746m	187	F	621m	831	F
	south leg	82m	52	D	108m	50	D	50m	55	E	43m	34	C
	east leg	325m	118	F	133m	108	F	229m	87	F	421m	73	E
	west leg	501m	252	F	376m	239	F	367m	303	F	327m	1964	F

Appendix D

Jacobs - Modelling Outputs

JACOBS

Memorandum

Level 7, 177 Pacific Highway
North Sydney NSW 2060 Australia
PO Box 632 North Sydney
NSW 2059 Australia
T +61 2 9928 2100
F +61 2 9928 2444
www.jacobs.com

Subject	**Option Scenarios**	**Project Name**	Frenchs Forest Priority Precinct
Attention	Patrick Bastawrous	**Project No.**	IA179100
From	Iwan Smith		
Date	1 May 2019		
Copies to			

1. Introduction

Jacobs has been engaged by Northern Beaches Council to undertake additional model runs for the Frenchs Forest Priority Precinct. The scope of study includes modelling of various scenarios of the precinct and the surrounding road network. These scenarios were run using the Frenchs Forest Priority Precinct traffic model in Aimsun 8.2.1.

This memorandum summarises the model outputs (intersection level of service, travel times and network statistics) for the above options and compares the Level of Service of access intersections with the Department of Planning and Environment's (DPE) preferred option.

2. Modelled scenarios

The following seven scenarios were modelled:

1. Current scenario (no precinct or precinct upgrades and standard background growth)
2. Option A: new accesses via Frenches Forest Road at Bluegum Crescent only
3. Option B: Option A and new proposed tunnel access (in only) via Frenches Forest Road at Bluegum Crescent
4. Option C: Option A and two additional signalised access points via Frenches Forest Road at Rabbett Street and Sylvia Place
5. Option D: Options A, B and C
6. Option E: Option D and Naree Road extension to Grace Avenue
7. Option F: Option E and Slot along Warringah Road

3. Model Outputs

3.1 Intersection Level of Service

The delay and Level of Service of the above options for the two access intersections in the preferred option, Bluegum Crescent and Hilmer Street, are shown below in Table 3.1. More detailed intersection level of service for other intersections in the model area are provided in Appendix A.

Table 3.1 Access delay and LoS

Option	Bluegum Crescent (West) Access				Hilmer Street Access			
	AM		PM		AM		PM	
	Delay (s)	LoS	Delay (s)	LoS	Delay (s)	LoS	Delay (s)	LoS
Current scenario	3	A	4	A	26	B	24	B
Option A	28	B	29	C	28	B	36	C
Option B*	20	B	21	B	26	B	36	C
Option C*	20	B	21	B	29	B	34	C
Option D*	20	B	21	B	26	B	36	C
Option E*	20	B	21	B	27	B	35	C
Option F*	20	B	21	B	26	B	37	C

*No access from the Priority Precinct proved at Bluegum Crescent West in these options

In each option, the delays at the access intersections change but do not substantially improve as more accesses are added to the development. This indicates that the performance of these intersections is largely governed by minimum phase times at each intersection and that these intersections all generally have sufficient capacity irrespective of the number of accesses to and from the precinct.

3.2 Travel time

Travel time comparisons for each option are provided for the following routes:

- Frenchs Forest Road between Forest Way and Allambie Road
- Warringah Road between Davidson Park and Cornish Avenue

A summary of travel times on these routes for each option is provided in Table 3.2 and Table 3.3.

Table 3.2: Frenchs Forest Road travel time

Option	2026 AM travel time (mm:ss)		2026 PM travel time (mm:ss)	
	Eastbound	Westbound	Eastbound	Westbound
Current scenario	03:03	04:09	03:03	04:04
Option A	03:37	04:38	04:04	05:53
Option B	06:55	06:10	09:25	05:53
Option C	06:45	06:07	09:21	05:56
Option D	07:03	06:06	09:23	05:55
Option E	06:52	06:09	09:28	06:00
Option F	06:44	06:07	09:18	05:53

Table 3.3: Warringah Road travel time

Option	2026 AM travel time (mm:ss)		2026 PM travel time (mm:ss)	
	Eastbound	Westbound	Eastbound	Westbound
Current scenario	06:35	06:14	08:01	05:38
Option A	06:50	06:07	09:13	05:58
Option B	07:38	06:09	09:14	05:54
Option C	06:55	06:08	09:31	05:55
Option D	07:24	06:01	09:17	05:51
Option E	07:06	06:09	09:08	05:46
Option F	06:43	06:07	09:20	05:54

Analysis of travel time along Frenchs Forest Road shows that those options with a higher number of accesses along French Forest Road generally have higher travel times, reflecting the additional delays associated with the traffic signals at these new access locations.

Modelled travel times on Warringah Road generally show little difference in travel times between options, except in the morning peak eastbound, where the additional demand associated with the access directly from Warringah Road leads to higher delays associated with greater demand on Warringah Road to use this left-in access.

3.3 Network statistics

A summary of the overall network statistics for each option is provided in Table 3.4.

Table 3.4: Summary of network statistics

Option	2026 AM			2026 PM		
	VKT	VHT	Av Network Speed	VKT	VHT	Av Network Speed
Current scenario	98,718	2,752	35.9	105,011	2,870	36.6
Option A	104,999	3,185	33.0	113,118	3,469	32.6
Option B	105,207	3,173	33.2	113,235	3,485	32.5
Option C	105,400	3,215	32.8	113,217	3,486	32.5
Option D	104,822	3,210	32.7	113,219	3,484	32.5
Option E	105,396	3,207	32.9	113,204	3,566	31.7
Option F	104,567	3,127	33.4	113,900	3,481	32.7

Analysis of the overall network statistics shows very small differences in average network speed across the options, with the exception of those associated with the left in access on Warringah Road. This is a result of the additional traffic travelling along Warringah Road to use this access.

4. Conclusions

The six option scenarios run in the Frenches Forest Priority Precinct traffic model showed very minor improvements in the Level of Service over DPE's preferred option. As the number of vehicles accessing and leaving the development is relatively small, additional accesses do not substantially improve the Level of Service of the proposed access intersections.

The inclusion of a left in access from Warringah Road would increase the traffic travelling eastbound on Warringah Road that would otherwise turn left into Forest Way and access the precinct from French Forest Road. This would increase traffic on Warringah Road and increase delays along the surface sections of the road.

Appendix A

1. Current scenario

1.1 Delay and LoS

Intersection	AM peak			PM peak		
	Volume (veh)	Delay (s)	LoS	Volume (veh)	Delay (s)	LoS
Warringah Road/Forestville Ave	6779	22	B	6839	29	C
Warringah Road/Darley St	6511	14	B	6796	12	A
Warringah Road/Starkey St	6689	25	B	7242	24	B
Warringah Road/Currie Road	6486	28	B	6960	11	A
Warringah Road/Forest Way	2658	47	D	3091	50	D
Warringah Road/Hilmer Street	2764	26	B	3644	24	B
Warringah Road/Wakehurst Parkway	4279	61	E	4621	59	E
Warringah Road/Allambie Road	4961	40	C	5223	37	C
Warringah Road/Government Road	4778	27	B	5232	40	C
Frenchs Forest Road/Wakehurst Parkway	3302	46	D	3187	47	D
Frenchs Forest Road/Gladys Avenue	1846	6	A	1555	21	B
Frenchs Forest Road/Bluegum Crescent West	1460	3	A	1047	4	A
Frenchs Forest Road/Rabbett Street	1452	28	B	1039	13	A
Frenchs Forest Road/Forest Way	3620	19	B	4254	17	B
Frenchs Forest Road/Bluegum Crescent East	1488	6	A	1352	4	A
Frenches Forest Road/Sylvia Place	1348	1	A	1031	1	A

1.2 Travel times

Road	Direction	2026 AM	2026 PM
Warringah Road	EB	06:35	08:01
	WB	06:14	05:38
Frenchs Forest Road	EB	03:03	03:03
	WB	04:09	04:04

1.3 Network statistics

Statistic	AM peak	PM peak
Vehicle kilometres travelled (VKT)	98,718	105,011
Vehicle hours travelled (VHT)	2,752	2,870
Average speed (km/h)	35.9	36.6
Delay (s)	55	55
Unreleased vehicles	0	0

2. Option A

2.1 Delay and LoS

Intersection	AM peak			PM peak		
	Volume (veh)	Delay (s)	LoS	Volume (veh)	Delay (s)	LoS
Warringah Road/Forestville Ave	7053	19	B	7309	42	C
Warringah Road/Darley St	6812	14	B	7276	18	B
Warringah Road/Starkey St	7114	21	B	7815	29	C
Warringah Road/Currie Road	6822	23	B	7475	12	A
Warringah Road/Forest Way	3068	63	E	3373	76	F
Warringah Road/Hilmer Street	3028	28	B	4152	36	C
Warringah Road/Wakehurst Parkway	4710	63	E	5370	54	D
Warringah Road/Allambie Road	5436	47	D	5651	42	C
Warringah Road/Government Road	5040	30	C	5525	40	C
Frenchs Forest Road/Wakehurst Parkway	3554	48	D	3721	44	D
Frenchs Forest Road/Gladys Avenue	2085	6	A	1991	16	B
Frenchs Forest Road/Bluegum Crescent West	1833	28	B	2113	29	C
Frenchs Forest Road/Rabbett Street	1716	22	B	2006	34	C
Frenchs Forest Road/Forest Way	4528	52	D	5146	38	C
Frenchs Forest Road/Bluegum Crescent East	1877	22	B	2195	35	C
Frenches Forest Road/Sylvia Place	1564	0	A	1830	1	A

2.2 Travel times

Road	Direction	2026 AM	2026 PM
Warringah Road	EB	06:50	09:13
	WB	06:07	05:58
Frenchs Forest Road	EB	03:37	04:04
	WB	04:38	05:53

2.3 Network statistics

Statistic	AM peak	PM peak
Vehicle kilometres travelled (VKT)	104,999	113,118

Statistic	AM peak	PM peak
Vehicle hours travelled (VHT)	3,185	3,469
Average speed (km/h)	33.0	32.6
Delay (s)	66	69
Unreleased vehicles	1	177

3. Option B

3.1 Delay and LoS

Intersection	AM peak			PM peak		
	Volume (veh)	Delay (s)	LoS	Volume (veh)	Delay (s)	LoS
Warringah Road/Forestville Ave	7065	19	B	7281	46	D
Warringah Road/Darley St	6821	14	A	7256	18	B
Warringah Road/Starkey St	7126	20	B	7793	28	B
Warringah Road/Currie Road	6824	23	B	7467	12	A
Warringah Road/Forest Way	3210	72	F	3598	72	F
Warringah Road/Hilmer Street	2891	26	B	3977	36	C
Warringah Road/Wakehurst Parkway	4536	60	E	5252	57	E
Warringah Road/Allambie Road	5418	48	D	5590	43	C
Warringah Road/Government Road	4990	28	B	5493	50	D
Frenchs Forest Road/Wakehurst Parkway	3499	49	D	3581	46	D
Frenchs Forest Road/ Gladys Avenue	2039	7	A	1881	15	B
Frenchs Forest Road/Bluegum Crescent West	1265	1	A	1457	1	A
Frenchs Forest Road/Rabbett Street	4354	48	D	4789	34	C
Frenchs Forest Road/Forest Way	1842	20	B	1937	21	B
Frenchs Forest Road/Bluegum Crescent East	1309	6	A	1340	5	A
Frenches Forest Road/Sylvia Place	7065	19	B	7281	46	D

3.2 Travel times

Road	Direction	2026 AM	2026 PM
Warringah Road	EB	07:38	09:14
	WB	06:09	05:54
Frenchs Forest Road	EB	06:55	09:25
	WB	06:10	05:53

3.3 Network statistics

Statistic	AM peak	PM peak
Vehicle kilometres travelled (VKT)	105,207	113,235
Vehicle hours travelled (VHT)	3,173	3,485
Average speed (km/h)	33.2	32.5
Delay (s)	65	70
Unreleased vehicles	1	108

4. Option C

4.1 Delay and LoS

Intersection	AM peak			PM peak		
	Volume (veh)	Delay (s)	LoS	Volume (veh)	Delay (s)	LoS
Warringah Road/Forestville Ave	7061	19	B	7282	44	D
Warringah Road/Darley St	6809	14	B	7261	18	B
Warringah Road/Starkey St	7114	21	B	7805	29	C
Warringah Road/Currie Road	6822	24	B	7472	12	A
Warringah Road/Forest Way	3165	56	D	3387	81	F
Warringah Road/Hilmer Street	3104	29	B	4188	34	C
Warringah Road/Wakehurst Parkway	4755	64	E	5406	59	E
Warringah Road/Allambie Road	5445	46	D	5627	43	D
Warringah Road/Government Road	5073	30	C	5517	42	C
Frenchs Forest Road/Wakehurst Parkway	3571	49	D	3708	45	D
Frenchs Forest Road/ Gladys Avenue	2057	7	A	1979	14	B
Frenchs Forest Road/Bluegum Crescent West	1387	0	A	1671	1	A
Frenchs Forest Road/Rabbett Street	4535	35	C	5129	38	C
Frenchs Forest Road/Forest Way	1842	20	B	1937	21	B
Frenchs Forest Road/Bluegum Crescent East	1309	6	A	1340	5	A
Frenches Forest Road/Sylvia Place	7061	19	B	7282	44	D

4.2 Travel times

Road	Direction	2026 AM	2026 PM
Warringah Road	EB	06:55	09:31
	WB	06:08	05:55
Frenchs Forest Road	EB	06:45	09:21
	WB	06:07	05:56

4.3 Network statistics

Statistic	AM peak	PM peak
Vehicle kilometres travelled (VKT)	105,400	113,217
Vehicle hours travelled (VHT)	3,215	3,486
Average speed (km/h)	32.8	32.5
Delay (s)	66	70
Unreleased vehicles	1	138

5. Option D

5.1 Delay and LoS

Intersection	AM peak			PM peak		
	Volume (veh)	Delay (s)	LoS	Volume (veh)	Delay (s)	LoS
Warringah Road/Forestville Ave	7062	19	B	7285	44	D
Warringah Road/Darley St	6820	14	A	7264	18	B
Warringah Road/Starkey St	7122	20	B	7805	28	B
Warringah Road/Currie Road	6835	23	B	7472	12	A
Warringah Road/Forest Way	3423	76	F	3618	62	E
Warringah Road/Hilmer Street	3129	26	B	3967	36	C
Warringah Road/Wakehurst Parkway	4839	64	E	5217	57	D
Warringah Road/Allambie Road	5343	45	D	5694	43	C
Warringah Road/Government Road	5084	29	C	5560	60	E
Frenchs Forest Road/Wakehurst Parkway	3551	53	D	3579	46	D
Frenchs Forest Road/ Gladys Avenue	2049	10	A	1878	14	B
Frenchs Forest Road/Bluegum Crescent West	1159	0	A	1245	1	A
Frenchs Forest Road/Rabbett Street	4386	61	E	4875	34	C
Frenchs Forest Road/Forest Way	1842	20	B	1937	21	B
Frenchs Forest Road/Bluegum Crescent East	1309	6	A	1340	5	A
Frenches Forest Road/Sylvia Place	7062	19	B	7285	44	D

5.2 Travel times

Road	Direction	2026 AM	2026 PM
Warringah Road	EB	07:24	09:17
	WB	06:01	05:51
Frenchs Forest Road	EB	07:03	09:23
	WB	06:06	05:55

5.3 Network statistics

Statistic	AM peak	PM peak
Vehicle kilometres travelled (VKT)	104,822	113,219
Vehicle hours travelled (VHT)	3,210	3,484
Average speed (km/h)	32.7	32.5
Delay (s)	68	69
Unreleased vehicles	1	120

6. Option E

6.1 Delay and LoS

Intersection	AM peak			PM peak		
	Volume (veh)	Delay (s)	LoS	Volume (veh)	Delay (s)	LoS
Warringah Road/Forestville Ave	7059	19	B	7291	45	D
Warringah Road/Darley St	6813	15	B	7261	18	B
Warringah Road/Starkey St	7118	22	B	7810	28	B
Warringah Road/Currie Road	6823	25	B	7480	12	A
Warringah Road/Forest Way	3116	59	E	3684	65	E
Warringah Road/Hilmer Street	2883	27	B	3900	35	C
Warringah Road/Wakehurst Parkway	4635	72	F	5163	60	E
Warringah Road/Allambie Road	5441	47	D	5676	44	D
Warringah Road/Government Road	5041	30	C	5560	51	D
Frenchs Forest Road/Wakehurst Parkway	3637	48	D	3652	44	D
Frenchs Forest Road/ Gladys Avenue	2165	7	A	2007	13	A
Frenchs Forest Road/Bluegum Crescent West	1204	1	A	1354	1	A
Frenchs Forest Road/Rabbett Street	4445	35	C	5255	46	D
Frenchs Forest Road/Forest Way	1842	20	B	1937	21	B
Frenchs Forest Road/Bluegum Crescent East	1309	6	A	1340	5	A
Frenches Forest Road/Sylvia Place	7059	19	B	7291	45	D

6.2 Travel times

Road	Direction	2026 AM	2026 PM
Warringah Road	EB	07:06	09:08
	WB	06:09	05:46
Frenchs Forest Road	EB	06:52	09:28
	WB	06:09	06:00

6.3 Network statistics

Statistic	AM peak	PM peak
Vehicle kilometres travelled (VKT)	105,396	113,204
Vehicle hours travelled (VHT)	3,207	3,566
Average speed (km/h)	32.9	31.7
Delay (s)	65	71
Unreleased vehicles	1	147

7. Option F

7.1 Delay and LoS

Intersection	AM peak			PM peak		
	Volume (veh)	Delay (s)	LoS	Volume (veh)	Delay (s)	LoS
Warringah Road/Forestville Ave	7068	19	B	7312	44	D
Warringah Road/Darley St	6817	15	B	7285	18	B
Warringah Road/Starkey St	7125	21	B	7824	29	B
Warringah Road/Currie Road	6827	24	B	7485	11	A
Warringah Road/Forest Way	2990	56	D	3370	49	D
Warringah Road/Hilmer Street	2846	26	B	3858	37	C
Warringah Road/Wakehurst Parkway	4516	64	E	5057	62	E
Warringah Road/Allambie Road	5299	45	D	5590	42	C
Warringah Road/Government Road	4980	27	B	5522	43	C
Frenchs Forest Road/Wakehurst Parkway	3564	46	D	3616	45	D
Frenchs Forest Road/ Gladys Avenue	2181	8	A	2081	14	A
Frenchs Forest Road/Bluegum Crescent West	1139	1	A	1338	1	A
Frenchs Forest Road/Rabbett Street	4482	37	C	5215	44	D
Frenchs Forest Road/Forest Way	1842	20	B	1937	21	B
Frenchs Forest Road/Bluegum Crescent East	1309	6	A	1340	5	A
Frenches Forest Road/Sylvia Place	7068	19	B	7312	44	D

7.2 Travel times

Road	Direction	2026 AM	2026 PM
Warringah Road	EB	06:43	09:20
	WB	06:07	05:54
Frenchs Forest Road	EB	06:44	09:18
	WB	06:07	05:53

7.3 Network statistics

Statistic	AM peak	PM peak
Vehicle kilometres travelled (VKT)	104,567	113,900
Vehicle hours travelled (VHT)	3,128	3,481
Average speed (km/h)	33.4	32.7
Delay (s)	65	66
Unreleased vehicles	58	62

ARCADIS Design & Consultancy for natural and built assets

FRENCHS FOREST TOWN CENTRE TRAFFIC MODELLING REVIEW

23 OCTOBER 2020

CONTACT

ANTHONY FRANSOS
Principal Transport Engineer

T 61 3 8623 1219
M 614 37 469 313
E Anthony.Fransos@arcadis.com

Arcadis
L32/140 William Street
Melbourne 3000

NICOLE VUKIC
National Manager Transport Planning and Traffic Engineering

T 61 2 8907 3932
M 614 17 233 935
E Nicole.Vukic@arcadis.com

Arcadis
580 George Street
Sydney 2000

FRENCHS FOREST TOWN CENTRE

Traffic Modelling Review

Authors Anthony Fransos

Checker Nicole Vukic

Approver Nicole Vukic

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REVISIONS

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1	10/09/20	Draft for client review	T Fransos	N Vukic
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CONTENTS

EXECUTIVE SUMMARY

The NSW Department of Planning, Industry and Environment (DPIE) commissioned Jacobs to model the traffic and transport impacts of the development of the Frenchs Forest Priority Precinct and to recommend plans for the transport in the area. Northern Beaches Council (Council) developed their own detailed model of the planned Frenchs Forest Town Centre and commissioned Arup to develop a set of recommendations that addresses the results of both models. With two separate sets of modelling estimates of traffic, there is the potential for misinterpretations and conflicts that weaken the intent and conclusions of both studies. In particular, there is the potential for reducing the credibility of the Local Infrastructure Contribution (LIC) and Special Infrastructure Contribution (SIC) plans. Council is seeking to review the content, assumptions and methods associated with both modelling studies. Arcadis was commissioned by Council to perform this review, which aims to:

- Examine the assumptions and the infrastructure provision in the DPIE study compared to those associated with the modelling report commissioned by Council
- Compare the modelling commissioned by Council to that of the DPIE study
- Provide a departure report and make recommendations for infrastructure delivery to advise plans aimed at raising infrastructure funding.

Approach

Arcadis reviewed four reports, including:

- *Frenchs Forest Planned Precinct: Transport Strategy*, Jacobs, 12 September 2019, Jacobs
- *Frenchs Forest Town Centre: Transport Strategic Design*, Arup, 23 October 2019, Arup
- *Frenchs Forest Precinct: Urban Design Report and Public Domain Strategy, CHROFI and architectus*, 2020
- *Northern Beaches Hospital, Stage 2 EIS - Network Enhancement Works: Traffic and Transport Impact* GTA Consultants, 2015. This report provided context around the work.

Arcadis has assessed the relative strengths of the two models and the reliability of their outputs. In particular, we have looked at the way they consider a wholistic, multi-modal approach to modelling and the subsequent use of the modelling results in formulating the recommended plan of infrastructure provision that accords with a vision for the town centre.

Key Review Findings

There is not enough evidence in the materials we have reviewed to make a definitive conclusion about the veracity of the AIMSUN modelling forecasts. Our concern is that the model may not model delays properly, because it is not calibrated correctly, and no evidence has been provided to show that that it complies with TfNSW Guidelines requirements. Our reasons for concern are that:

- The network statistics are extremely different from an older model of the same network
- The future matrices appear to contain too few trips. fewer than in the 2016 matrix
- The modelling fails to account for any change of modes
- The model does not include pedestrian flows and impacts
- Public transport demand has been treated as a target than as an evaluated performance.

SIDRA Network modelling focussed on all three phases of the development. The main issue with the SIDRA Network modelling is that it is limited to the town centre's internal network and the roads that surround it. It provides no information about further flung issues of transport demand.

Recommendations

After review of the modelling and recommendations in the two studies for DPIE and Council, and the urban design and public domain strategy, Arcadis has developed a set of recommendations that are a combination of those of Arup and Jacobs and set into the context of the stated Vision for the Frenchs Forest town centre. The aim of the recommendations is to aid in the vision for the town centre by:

- Providing facilities for alternative modes to car to maximise the opportunity for reducing car use
- Providing those facilities early in the development so that the potential change from car begins early
- Promoting ease of access to the town centre and diverting through-traffic away from Frenchs Forest Road.

1 INTRODUCTION

The Department of Planning, Industry and Environment (DPIE) commissioned a modelling study that aimed to assess the existing transport opportunities and constraints associated with the Frenchs Forest Planned Precinct, of which the Northern Beaches Hospital is the first part. It provides a detailed assessment of transport impacts of the proposed Frenchs Forest Planned Precinct development and outline the infrastructure and servicing required to support the precinct.

Northern Beaches Council (Council) commissioned a study that informs the development of a Local Infrastructure Contribution (LIC) Plan and identifies the transport infrastructure that Council requires to successfully deliver the Frenchs Forest Planned Precinct. A transport model is central to this study and underpins plans for raising funding for provision of the infrastructure through LIC and Special Infrastructure Contributions (SIC).

1.1 Overview

With two separate sets of modelling estimates of traffic, there is the potential for misinterpretations and conflicts that weaken the intent and conclusions of both studies. In particular, there is the potential for reducing the credibility of the LIC and SIC plans. Council now want to review the content, assumptions and methods associated with both modelling studies. This review is required to

- Examine the assumptions and the infrastructure provision in the DPIE study compared to those associated with the modelling report commissioned by Council
- Compare the modelling commissioned by Council to that of the DPIE study
- Provide a departure report and make recommendations for infrastructure delivery to advise plans aimed at raising infrastructure funding.

1.2 Aim of this review

The review of the two documents aims to:

- Evaluate and compare the modelling processes used for the two studies
- Evaluate and compare the transport issues identified by each of the studies
- Evaluate and compare the infrastructure that the two reports recommended
- Assess and recommend a preferred program of action.

1.3 Our approach

In our review of the modelling completed for the planning of Frenchs Forest Town Centre, we reviewed three reports, including:

- *Frenchs Forest Planned Precinct: Transport Strategy*, Jacobs, 12 September 2019, Jacobs
- *Frenchs Forest Town Centre: Transport Strategic Design*, Arup, 23 October 2019, Arup
- *Frenchs Forest Precinct: Urban Design Report and Public Domain Strategy*, CHROFI and architectus 2020
- *Northern Beaches Hospital, Stage 2 EIS - Network Enhancement Works: Traffic and Transport Impact* GTA Consultants, 2015.

The last of these is not part of the traffic modelling for Frenchs Forest Planning but has been used as a benchmark against which to compare the modelling completed specifically by Jacobs.

The microsimulation models developed by Jacobs and the SIDRA models developed by Council were supplied for review. These files and the outputs were examined to assess the impact of any issues

identified. In this assessment, we did not run any new modelling; we simply retrieved the results that were included in the files supplied.

The review of the documents focusses on issues that include:

- The source of trip data
- The modes included in the model
- The paths and routes onto which trips are assigned
- The way demand is contained by capacity
- The way travel times are calculated and used in the modelling
- The location of congestion or crowding and how they are treated in the modelling.

Arcadis has assessed the relative strengths of the two models and the reliability of their outputs. In particular, we have looked at the way they consider a wholistic, multi-modal approach to modelling and the subsequent use of the modelling results in formulating the recommended plan of infrastructure provision.

This report is structured along the same way as our approach:

- **Section 2** reports on a review and comparison of the modelling and modelling processes in the two studies
- **Section 3** compares the recommendations that were made in the two studies
- **Section 4** reports on a re-evaluation of the modelling in the context of the modelling of both studies
- **Section 5** sets out updated recommendations that accord with the context of both models and the vision stated in the urban design report
- **Section 6** summarises the findings and concludes the report.

2 TRAFFIC MODELLING REVIEW

Jacobs developed their model in AISMUN 8.2.1. It is a micro-simulation of the road network around the Northern Beaches Hospital complex. The model includes the east-west corridor along Warringah Road from west of Forest Way to East of Allambie Road, and the length of Frenchs Forest Road. North-south roads include Forest Way, Wakehurst Parkway and Allambie Road.

Jacobs reports that they have imported the demands for the model without any amendment from the NHBCaNE model. The processes of development of this model are unclear. NHBCaNE is run on a VISSIM platform and converted to AIMSUN for the Frenchs Forest modelling. It appears that there was no further calibration or validation work on the model. A current year was not modelled.

Traffic conditions on the roads were forecast for scenarios without development in the town centre and with various options for development. The scenarios modelled include:

- **Do Minimum case** for 2026 and 2036
- **Project Case** without Beaches Link for 2026 and 2036. This scenario includes traffic generated by the Frenchs Forest Planned Precinct, relocation of Forest High School and an additional northbound right turn lane into Naree Road
- **Project Case with Beaches Link** for 2036. This scenario adds the Beaches Link to the previous project case.

Council appointed Jacobs to run seven additional scenarios to test options for access to the town centre. Council planners were concerned that the modelling suggested that access to the town centre does not operate at an acceptable level of service. To examine this issue on more detail, Council developed a traffic model of the town centre road network using SIDRA Network 8. This model is based on local traffic flow and volumes taken from SCATS. These volumes were then extrapolated to future years to model the expected network impacts of the traffic distribution.

2.1 Frenchs Forest Planned Precinct Model (Jacobs)

After reviewing the AIMSUN Model, the associated report and the model files, Arcadis has concerns that:

- The model is not properly calibrated
- The study is focused on transport by car to the detriment of other modes
- The AIMSUN model has been developed using data from incompatible sources
- There are inconsistencies in the model's outputs
- The modelling processes are opaque and not reported fully.

Calibration of the model

The Transport for NSW (TfNSW) Traffic Modelling Guidelines set out requirements for the calibration and validation of traffic models. It is most likely that the NHBCaNE VISSIM model was developed to these standards. Jacobs report that the travel demand matrices were taken from this model and used in AIMSUN unaltered. They report that because the VISSIM model was calibrated, the AIMSUN model was deemed suitable for the purposes of modelling Frenchs Forest. Examination of the AIMSUN model files shows that although 2016 demand matrices are included, there is no evidence of any calibration or validation.

It is a mistake to assume that just because the traffic demand from one model is copied into another, the second model is also calibrated. There is no guarantee that the matrices imported into the model from a VISSIM model are appropriate and the individual cars in the model may behave fundamentally differently to those in the VISSIM model. It is not clear from the Jacobs reporting, how the model's road network was constructed. The network would affect substantially the performance of the model; the capacity of the lanes,

length of short lanes, signal timings and phases all need to be examined in detail. Even within a model, there are parameters that alter flows, queues, delays and other measures of performance.

AIMSUN and VISSIM work quite differently in their assignment algorithms. For example, the car-following models implemented in AIMSUN are based on an algorithm in which vehicles accelerate to a desired speed and decelerate to avoid a collision while trying to maintain the desired speed. This is known as the Gipps model.

VISSM uses a more complex, psycho-physical car-following algorithm in which a faster moving vehicle decelerates while approaching a slower vehicle and follows the slower vehicle at a safe distance. A rule-based model is used for lane change to occur only if it is safe to do so. Also, a vehicle will change lanes if it is approaching a required turn or if the lead vehicle is traveling at a slower speed than the vehicle following is traveling. The user can set some of the car following model parameters to reflect a customised driver behaviour model. VISSIM assumes that some travellers do not choose shortest paths.

There are other parameters in each of the software that control the way the model simulates behaviour like changing lane, merging, aggression of following and gap-acceptance. These will all affect the credibility of the modelling outputs.

Consequently, while the VISSIM model was calibrated to measures like delay, queue lengths and travel speeds, there is no certainty that the AIMSUN model will produce the same level of calibration. As a result, it is unlikely that the model conforms to the requirements of the TfNSW Modelling Guidelines. At the very least, there should be some demonstration that the model reproduces travel speeds, delays and queue lengths in 2026 and 2036 as the VISSIM models do. Unless they are similar, the results of the AIMSUN model cannot be afforded sufficient credibility on which to base the transport plans for the precinct.

Focus on car transport

The AIMSUN Model files include references to public transport, walking and cycling. For example, vehicle types for walk and cycling are defined, but no demand is included. Public transport routes have been defined, but the only purpose for its inclusion appears to be for including buses in the model's traffic stream; no public transport demand has been included.

When estimating the town centre's traffic generation, rates have been used that are associated with a level of public transport accessibility. In this case, the assumption is that there is a poor level of accessibility. However, to test the impact of improved public transport service, the TPA's Public Transport Project Model (PTPM) was used, but the expected change in car traffic demand was not tested. Walking and cycling demand were not modelled at all and were accounted for qualitatively. In general, because there are few sources of information about the drivers of walking and cycling demand, this would be understandable. However, the Roads and Maritime Services trip generation guidelines state that generally, 25 per cent of trips generated by a development do not leave that development. This statistic could have been used as an indication of the numbers that might walk or cycle for the assessment of the planned active transport infrastructure.

From our examination of the model, it appears pedestrians are not accounted for in the modelling. This may have a significant impact on the outputs of the model because pedestrian demand would affect signal timing and increase the delays experienced by travellers in cars.

Incompatibilities in data sources

There are potential incompatibilities between the traffic demand data taken from the NHBCaNE model and the networks. The potential impact of this is described broadly in the second on calibration. More broadly, the study refers to several different models and other sources of information:

- Trip generation rates are broadly based on rates from Roads and Maritime Services guidelines, modified and supplemented in consultation with TfNSW (formerly Roads and Maritime Services).

- A bus rapid transit (BRT) and a rail option were tested in PTPM to examine the impact on car travel demand. This is problematic because it is not clear whether the highway outputs from PTPM and outputs of the AIMSUN model are compatible or consistent.
- The Sydney Motorway Project Model (SMPM) was used to distribute trips generated by the town centre to destinations. Again, the impact of public transport involved on the SMPM has not been assessed. A plot of the difference between the Do Minimum and the Project Cases shows where Frenchs Forest town centre's trips travel (See Figure 1) and the plot suggests that some of the origins and destinations are quite close together and the trips they represent are short, generally no longer than three kilometres. These may not be typical car trips.

Inconsistencies in modelling outputs

The demand in matrices for 2026 and 2036 is lower than in 2016. This depends on the veracity of the 2016 model files supplied and further examination of the detail of the matrices. Table 1 compares the total number of trips in the two-hour peak periods. As can be seen the totals in 2016 are substantially higher than those of 2026 and 2036.

Table 1: Traffic demand for 2-hour periods (trips) in demand matrices

Case	2-hr Period	2016	2026	2036
Base Year	**AM**	38,300	-	-
	PM	43,900	-	-
Do Minimum	**AM**	-	32,700	34,200
Project	**AM**	-	36,000	37,600
Do Minimum	**PM**	-	34,400	35,500
Project	**PM**	-	38,800	39,800

Detailed documentation of the NBHCaNE VISSIM model was not available for this review. However, the processes and outcomes of the VISSIM model used in the Northern Beach Hospital EIS was reviewed with the aim of gauging the potential impact of the non-calibration of the Frenchs Forest Planned Precinct AIMSUN model.

A comparison of network statistics is shown below. The model extents for the two studies appear to be the same. It may also be that the model used for the EIS was a forerunner of the NBHCaNE model. While we would expect there to be differences, perhaps even substantial differences, the scale of the differences are extreme. The number of trips (three-hour compared to two-hour durations) are roughly comparable. The average speed (ringed in green) in the Jacobs model is more than double that of the NBH EIS. Even more extreme, the average delay for vehicles (ringed in orange) in the Jacobs model is 90 per cent lower than that of the NBH EIS model.

Table 6.3 provides a comparison of the modelling results between the Stage 1 Project and Project Case against the 2028 Do Minimal scenarios for the 2028 three hour AM peak period.

Table 6.3: Network Performance Results – 2028 Project Case (AM Peak Period)

Network Measure (3 hours)	Do Minimal	Stage 1	Project Case
Total traffic demand (vehicles)	45,346	44,952 (-0%)	45,341 (+0%)
Number of vehicles that have left the network (vehicles)	36,582	38,465 (+5%)	40,489 (+11%)
Number of vehicles that remain in the network (vehicles)	4,011	3,606 (-10%)	2,717 (-32%)
Unreleased demand (vehicles)	4,753	2,881 (-39%)	2,135 (-55%)
Proportion of vehicles unreleased	10%	6%	5%
Total distance travelled in network (km)	116,143	124,178 (+7%)	128,181 (+10%)
Total time travelled in network (hr)	7,533	6,074 (-19%)	5,406 (-28%)
Average speed (km/h)	15.4	20.4 (+32%)	23.7 (+54%)
Average delay time per vehicle(sec)	503	349 (-31%)	279 (-45%)
Average number of stops per vehicle	7.4	5.5 (-26%)	4.5 (-39%)
Total delay time including unreleased time (hr)	9,132	6,603 (-28%)	6,109 (-33%)

Source: NBH Roadworks VISSIM Model (GTA, 2014).

Table 5.4: Network statistics for 2026 scenarios

	2026			
	AM Do Minimum	AM Project	PM Do Minimum	PM Project
Vehicle kilometres travelled	99,064	106,184	105,068	113,492
Vehicle hours travelled	2,771	3,278	2,896	3,427
Average speed (km/h)	35.8	32.4	36.3	33.1
Delay (sec)	55	67	56	65
Unreleased vehicles	0	1	29	121

These figures show that density of traffic across the network is less than 20 vehicles per kilometre – this is correctly reported from the model. However, we have not been able to reconcile the densities with the volumes and speeds. For example, a section of Warringah Road that reportedly carries around 2,570 vehicles in the two-hour period has a speed of 45 km/hr. The density is reported to be lower than 20 vehicles per kilometre (veh/km), but elementary traffic flow theory suggests that for these values, the density would be 29 veh/km.

We exported the traffic statistics for all sections in the model and used a GIS to plot some of the network measures. A plot of the difference between the Do-Minimum and the Project Case gives an indication of the routes used by trips to and from the town centre and is in indication of the way the trips were distributed. The result is shown in Figure 1. One of the issues we believe needs additional explanation are the sections of the network where there appear to be significant reductions in volume. It may be that these reductions are the result of the re-location of the High School, but we have not yet been able to verify this. Some of the reductions appear to be associated with changes in the demand at specific zones.

Figure 1: Travel paths of trips associated with the Frenchs Forest Town Centre in 2026 morning peak period

Figure 2 shows the level of service categorised by the average delay per vehicle for the morning peak period in 2026. It is broadly similar to those provided in the Jacobs report and shows few problems in the network.

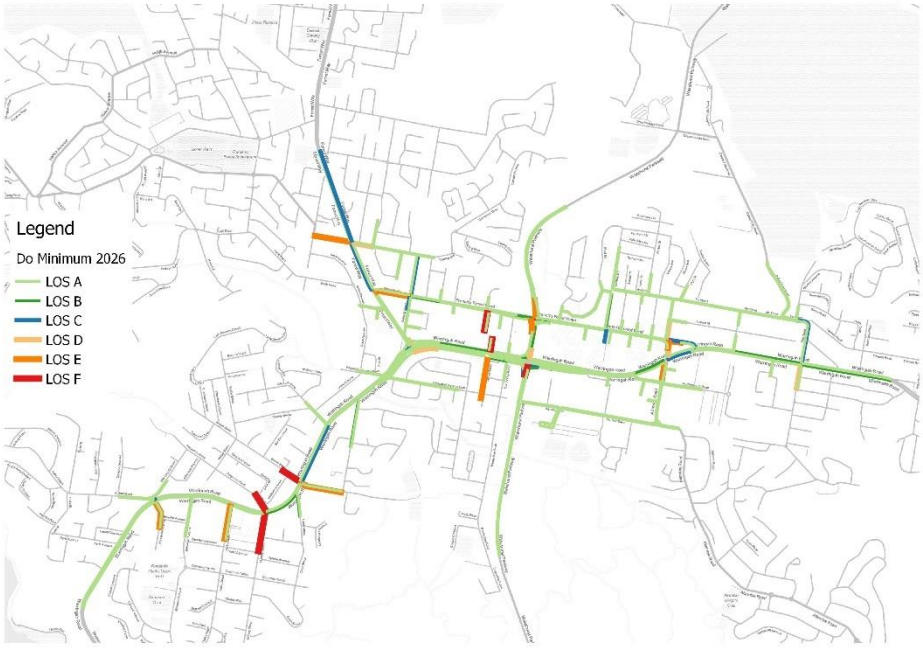


Figure 2: Level of Service categorised by delay for Do Minimum 2026

Figure 3 shows the levels of service based on volume/capacity ratio in the morning peak period of the Do Minimum case in 2026. It appears to show significantly more congestion than does the density plot in the report and the plot of delay level of service (LOS). However, the volumes reported are for two hours and the capacities are for one hour. This means that where the plot indicates LOS F, the actual LOS would be B or C. Nevertheless, this measure can be used to identify the worst congested sections more easily.

Figure 3:Level of Service categorised by V/C Ratio for Do Minimum 2026

Figure 4 shows plot of traffic speeds from the Google Maps traffic layer at 8:05am on Tuesday, 1 September 2020. It is reasonably similar to the plot in Figure 3. This suggests that the volume/ capacity measure is a better indicator of congestion in the AIMSUN Model than density. It also suggests that because the model's 2026 volumes produce congestion that looks like congestion on a 2020 network impacted by the Covid-19 pandemic, the model's volumes may be low.

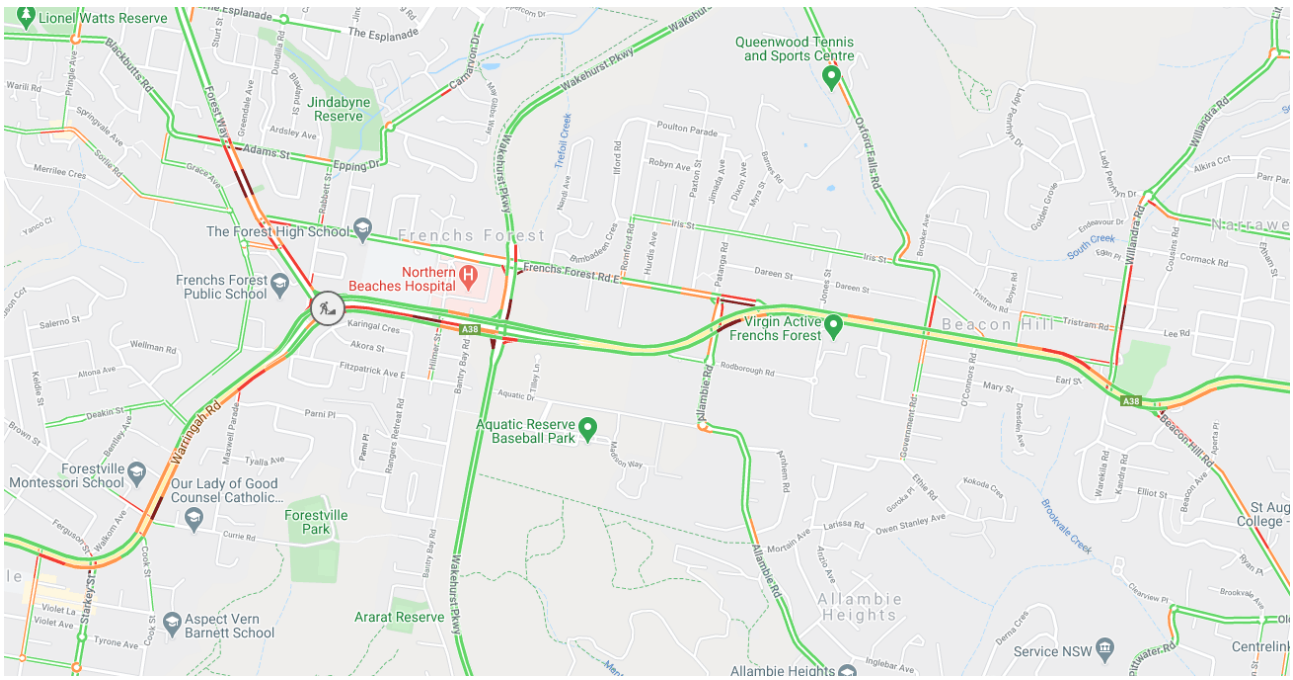


Figure 4: Traffic congestion plat from Google during the morning peak period on a Wednesday in September (affected by the COVID pandemic)

In Table 2 the AIMSUN morning peak matrix for 2026 is compared to a matrix derived from the 2016 census place of work for SA2. This comparison is not definitive because the AIMSUN matrix includes non-work trips while the census only shows a table of where people live and work. The census data provides no information about the route taken to work. However, the table shows that the east-west (both directions) movement is by far the largest demand and that the north-south (both directions) movement is a small demand, Both matrices also show that the demand in the model's town centre zones for travel to and from the west is also a large demand. The two matrices disagree with the spread of traffic to and from the town centre. This is understandable because there are likely to be many more residents, employment opportunities and non-work destinations in the town centre in 2026 that in 2016.

Table 2:A comparison of the AIMSUN 2026 AM Peak matrix with 2016 Census Place of Work matrix

Movement	Census	AIMSUN
East-West	69%	57%
North-South	3%	2%
Town Centre - North	0%	5%
Town Centre - South	6%	17%
Town Centre - East	4%	14%
Town Centre - West	18%	4%
Internal	0%	2%

Summary

There is not enough evidence in the materials we have reviewed to make a definitive conclusion about the veracity of the modelling forecasts. Our concern is that the model may not modelling delays properly, possibly because it is not calibrated correctly, and no evidence has been provided to show that that it complies with TfNSW Guidelines requirements. Our reasons for concern are that:

- The network statistics are extremely different from an older model of the same network.
- The future matrices appear to contain too few trips. There are fewer trips in the future demand matrices than in the 2016 matrix
- The modelling fails to account for any change of modes
- The model does not include pedestrian flows and impacts
- Public transport demand has been treated as a target than as an evaluated performance. A bus and a rail connection to Chatswood and Dee Why were modelled separately in PTPM, a model that is unrelated to the AIMSUN model.

2.2 Frenchs Forest Town Centre Model

Council identified several alternative schemes aimed at improving movement around the network in Frenchs Forest and commissioned Jacobs to use the Frenchs Forest Priority Precinct model to test their efficacy. These alternative scenarios are:

- Current scenario (no precinct or precinct upgrades and standard background growth)
- Option A: new accesses via Frenchs Forest Road at Bluegum Crescent only
- Option B: Option A and a proposed tunnel access via Frenchs Forest Road at Bluegum Crescent
- Option C: Option A and two new signalised accesses to Frenchs Forest Road at Rabbett Street and Sylvia Place

- Option D: Options A, B and C
- Option E: Option D and Naree Road extension to Grace Avenue
- Option F: Option E and Slot along Warringah Road.

These tests were based only on Phase 1 development.

Council developed a SIDRA Network model to extend the modelling to test the impacts of Phases 2 and 3 of the precinct. SCATS turning movement volumes are the basic input into the SIDRA model. Future movements were forecast by extrapolating existing volumes using estimated growth rates. The model was then used to test incremental stages of the development and to identify impacts of intermediate stages of development.

With this model, Council tested several options in separate potential scenarios, that included combinations of development stages and road network options, which included:

- Phase 1 development, No business precinct
- Do minimum (Business precinct only)
- New access and tunnel
- Access, tunnel and new access points for the town centre
- Road, tunnel, new access points and a Grace Avenue Link
- Full network upgrade and a slot option
- Three access points to town centres no access via Warringah Road.

Figure 5 shows the network of one of the scenarios in this model as an example.

The model was also used to test the impact of a BRT service through the centre, but not the operations and efficacy of the BRT itself. To account for the potential diversion of trips to public transport, Council adjusted the vehicle trip generation for input into the SIDRA model to reflect the movement to BRT. The modelling also assumed that Beaches Link will be open by the time that Phases 2 and 3 of the precinct are developed.

Further options were tested, with different internal layouts for the town centre road network and a range of access arrangements. For these options, only the internal road network and Frenchs Forest Road between Forest Way and Wakehurst Parkway were modelled.

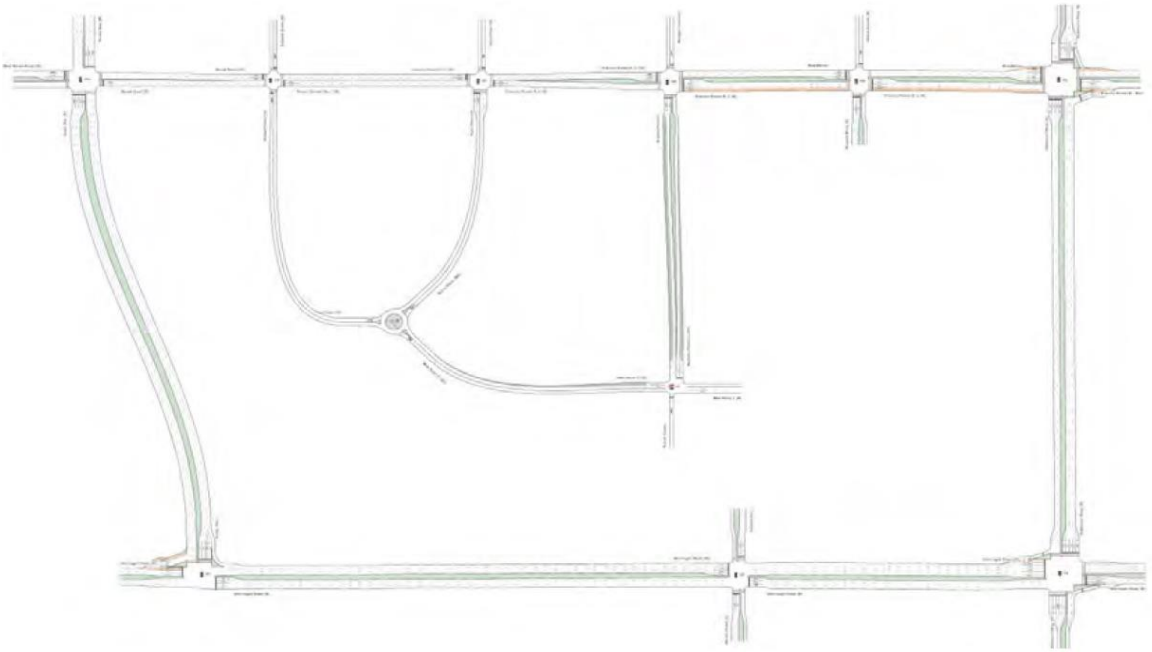


Figure 5: A SIDRA schematic showing an example network modelled in SIDRA

Modelling processes

In general, the SIDRA modelling has the same issue has the Jacobs modelling regarding mode choices and interchanges. However, the trip generation rates used have been adjusted to account for the attraction of a BRT operation, which is an improvement on neglecting public transport.

There are some potential issues when dealing with SCATS counts. Lanes that are shared by more than one turning movement are counted together. As a result, it is not possible to separate the exact volumes into the different turning movements. Another issue is that lanes that accommodate continuous flowing traffic seldom have a detector to count the traffic volumes. Consequently, for many intersections the exact turning movements are not uniquely determined.

Technical issues with detectors also result in counting errors; they have a tendency to under-count the number of vehicles at a rate of around two per cent. The size of these errors is affected by different operating factors of intersections, which were categorised and evaluated in a study in 2010[1]. The factors are:

- Traffic volume: there is a general undercounting error that is particularly pronounced (nearly 5%) for volumes of less than 200 vehicles per hour, but is less than two per cent for volumes larger than 800 vehicles per hour
- Road Pavement condition: a pavement in poor condition is associated with five per cent more of an undercount than one in good condition
- Lane type: errors in counting are larger in left and right turning, with left-turns undercounted by more than six per cent and tight turns by nearly five per cent
- Traffic composition: the percentage of heavy vehicles appears to affect the accuracy of the detector counts, though there is no discernible pattern to the scale of the error. However, for vehicle content of greater than six per cent, the undercounting error can increase to more than five per cent.

[1] Samuels and Briedis, Accuracy of inductive loop detectors, ARRB 24th Conference, 2010

While these issues need to be kept in mind, they also need to be kept in context. Traffic flows can vary by more than 10 per cent through a week, so there is not really a single “accurate” set of weekly volumes. The errors associated with detectors are not out of scale compared to the variation volumes over the week.

Forecasting through extrapolation risks future growth that is not tempered by the capacity of the road network. Generally, a model of any type will highlight areas where demand exceeds capacity, but it remains an issue that can affect conclusions. In this case, the general network appears to be operating at close to capacity, given the low growth rates in the demand matrices.

One other concern is there is no evidence of validation for this model either. This tends to be less of an issue with models like SIDRA, whose determinist theory is more robust than DUE in micro-or meso-simulation.

SIDRA model issues

In the version of SIDRA files provided, the turning movements at the intersection of Wakehurst Parkway and Frenchs Forest Road appear to be set at a default, with all three movements on each of the northern and eastern approaches being 100 vehicles per hour each. It is not clear why these values have been assigned to these movements.

One other issue with the networked intersections is that the exit volumes of intersections do not always total the entering volumes at the downstream intersection. SIDRA does mitigate this issue in its networking algorithms, so that this may not be a significant issue.

Diagnostic messages are generated for all network runs. These indicate that the model did not converge to a solution that is within desired mathematical limits. The impact of these has not been investigated in detail, but these generally indicate an over-congested network.

Modelling outcomes

The Council’s model produces a picture that is significantly different to that of Jacob’s modelling. It shows a road network around the town centre that is highly congested, with an overall Level of Service of F estimated by the SIDRA modelling.

Generally, all of the options show that Warringah Road, Forest Way and sections of Frenchs Forest Road will be extremely congested by the time all phases of the development have been completed, which has been assumed to be 2036 in the modelling. A diagram of the degree of saturation for one of the modelling outputs is shown in Figure 6. Most of the SIDRA modelling show similar results, with variations only in the sections of Frenchs Forest Road that are congested.

One of the reasons for this may be that the AIMSUN model focusses on Phase 1 on the development. Another reason may be that the SIDRA model includes estimates of pedestrians, who impact on the timings of signals and increase the delays experienced by people in cars. The AIMSUN model has no explicit inclusion on pedestrians.

2.3 Differences between the models

Apart from the obvious difference that they were run in different software packages, there are other areas where the models differ, which may explain the differences in their outputs.

Extent of models

Jacobs’ AIMSUN model extent takes in the length of Warringah Road from around Davidson Park in the south west to Beacon Hill in the west and Wakehurst Parkway from around Manly Creek in the south to around Trefoil Creek in the north. The SIDRA model is confined to the road surrounding the Frenchs Forest town centre: Forest Way in the West, Wakehurst Parkway in the east, Frenchs Forest Road in the north and Warringah Road in the south.

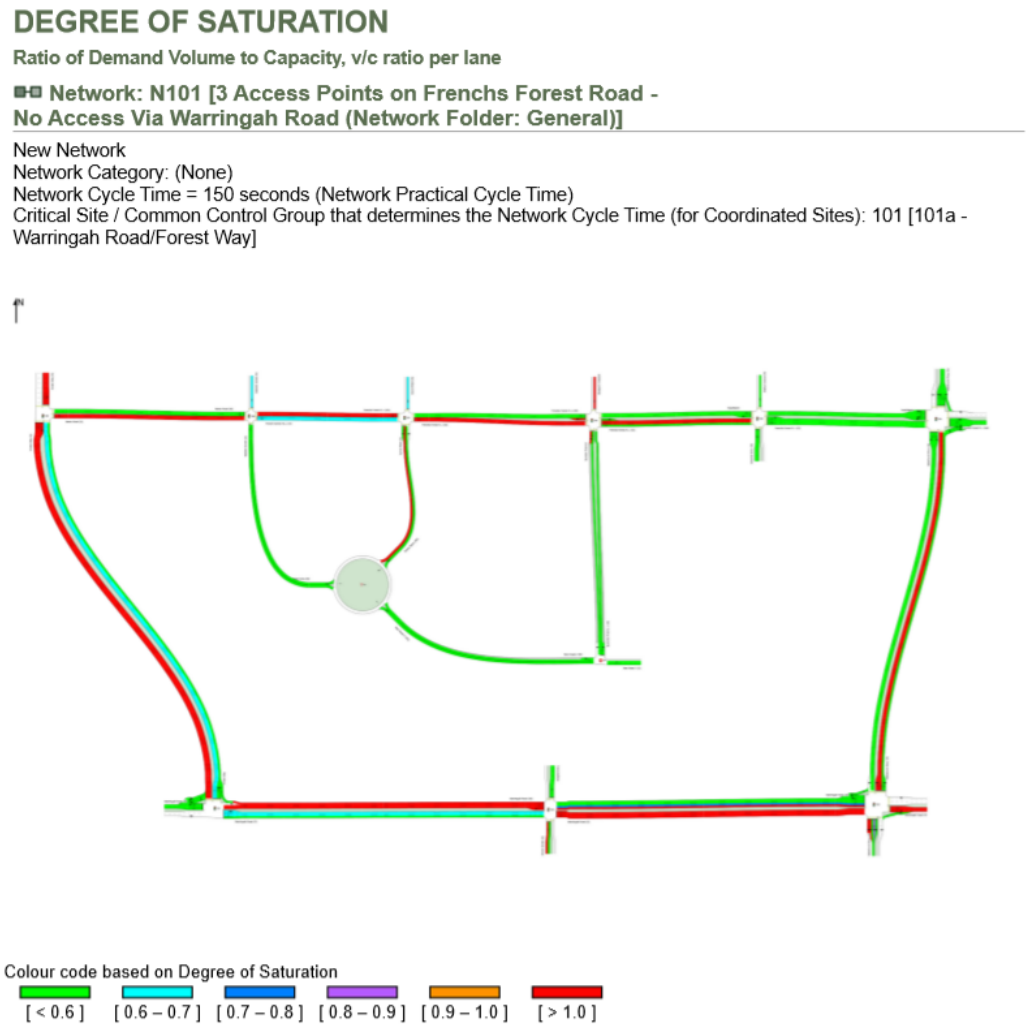


Figure 6: SIDRA output for Morning Peak hour in 2036 with three accesses to the town centre on Frenchs Forest Road and none on Warringah Road

The SIDRA modelling includes sensitivity modelling in smaller sections of the model with the attention on the internal road network and Frenchs Forest.

Figure 7 compares the extents of the AIMSUN and SIDRA models.

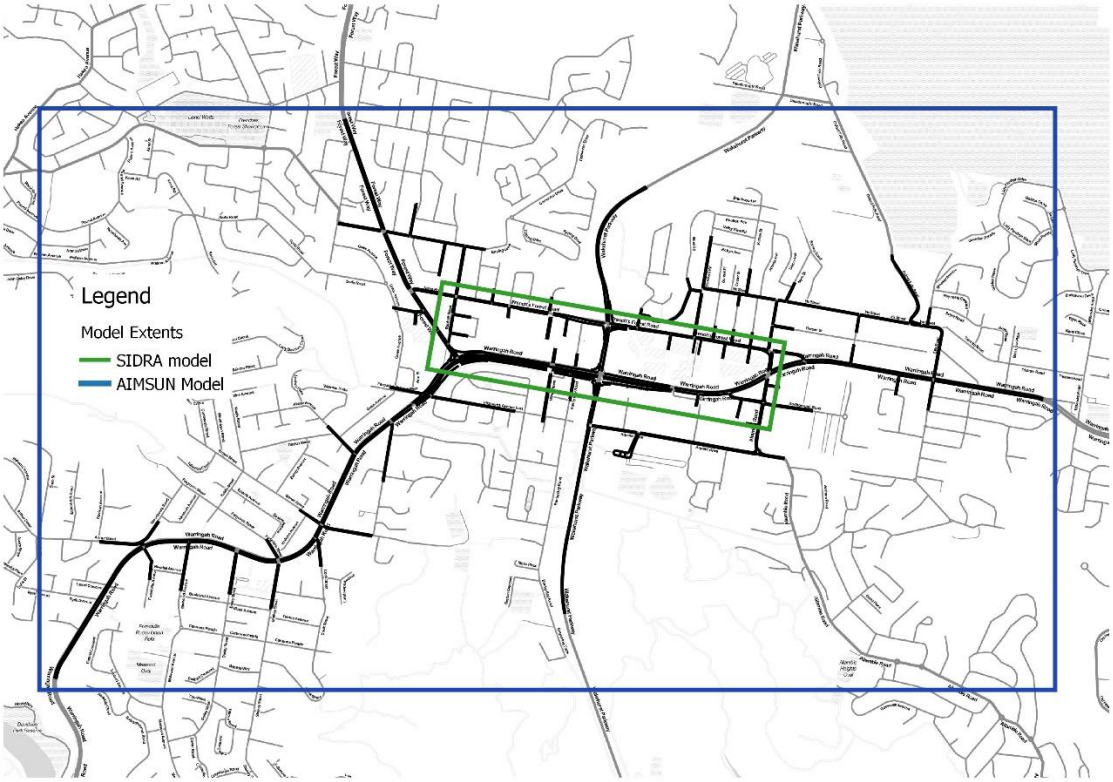


Figure 7: Approximate spatial extents of the models

Years and phases

The fundamental focus of the AIMSUN model is Phase 1 of the development of the town centre, though sensitivity tests included Phase 2 and 3. The model forecasts to two horizons: 2026 and 2036.

The SIDRA model has 2036 as its primary focus, and incudes Phases 2 and 3 in the modelling.

Source of inputs

AIMSUN demand matrices were taken from the NBHCaNE model that was used to model the road infrastructure required around the Northern Beaches Hospital.

The SIDRA model has its base, SCATS detector counts at signalised intersections and SCATS signal plans. The counts were then factored by observed growth rates to derive movements of background traffic at intersection in 2036.

Both models use estimated land use yields and traffic generation rates to estimate the traffic generated by the development of the town centre which were added to the background traffic to model a project case that includes the development traffic.

Components of the models' demand

The basic assumption of the AIMSUN model transport network inclusions was that the Beaches Link would not be provided by 2036, but the impact of its inclusion was tested with a sensitivity scenario. The SIDRA model assumes that the Beaches link and a BRT is included in the network. The impact on the mode shares was estimated by adjusting the vehicle trip generation rates used in the forecasting of traffic generated by the three phases of development.

The AIMSUN mode comprises only road traffic that contains cars, heavy vehicles and buses. There are references to pedestrians and cycles, but no demand matrices for these modes were included in the model. Public transport and active transport were accounted for using mode share targets and strategic modelling with PTPM was used to determine the potential impact of introducing a bus rapid transport system or a heavy rail system. Active transport was not accounted for apart from recommending some paths.

The SIDRA model comprises only road traffic (it has no capability for other modes) but pedestrian demand was estimated and included in the model so that the pedestrian phases of the signals were accounted for. The impact of a BRT was accounted for by adjusting the vehicle trip generation rates used in estimating the traffic generated by the town centre.

3 RECOMMENDATIONS ARISING FROM MODELLING

The two studies each recommended several infrastructure projects that are aimed to improve the ease and efficiency of transport.

The Jacobs report is focussed on road traffic, possibly because most of the effort involved in the project has been around traffic modelling. Active transport and public transport infrastructure recommendations are more high level likely to have a smaller impact and are not based on substantial evidence in the report. They are also aimed more at the Phase 1 development. Phases 2 and 3 have not been included in the model in any detail.

The Arup report has a more detailed and more substantial set of recommendations and include more detailed active transport and public transport projects. The road infrastructure projects are backed up by the outputs of the road traffic modelling, but there is still a relative lack of evidence that supports the provision of other transport infrastructure.

In the following sections, these recommendations are listed for completion and for a ready set of comparisons. For full details please refer to the original reports.

3.1 Road Infrastructure

Jacobs

These recommendations are mostly the result of investigating Phase 1 of the Town Centre development and do not take account of further development. There are three main recommendations for road infrastructure:

- Provision of the town centre road network with a new signalised intersection for access onto Frenchs Forest Road: no specific recommendations have been made.
- Provision of a new access to the town centre at Bluegum Crescent, aimed at reducing demand on the main access to the town centre further east. This needs to be provided by the time Phase 1 is 70 per cent developed.
- An investigation (not provision) into the worth of providing an additional right turn lane from Forest Way (southern approach) into Naree Road. This seems to be a minimal response to the traffic issues on Forest Way.

The analysis of movement and place identifies Frenchs Forest Road West north of the Phase 1 development as a Vibrant Street but provides no recommendations on how this is to be achieved.

Arup

Arup have recommended 19 new items of road infrastructure, of which 14 will be required before the full development of Phase 1. Their recommendations include:

- For Initial action:
  - Provide a new signalised intersection at Bluegum Crescent East, for access to the development's internal road network
  - Extend Holland Crescent to provide a second access to the development's internal road network
- By 50 per cent development of Phase 1
  - Widening of Frenchs Forest Road West and Naree Road from Bluegum Crescent to Forest Way
  - Signalise the intersection of Frenchs Forest Road West/ Sylvia Place
- By 70 per cent development of Phase 1
  - Extend Naree Road to Grace Avenue

  - Signalise the intersections of
    - Naree Road and Forest Way
    - Naree Road and Grace Avenue
  - Connect Holland Crescent to the intersection of Frenchs Forest Road West/ Sylvia Place
  - Upgrade the intersections of:
    - Adams Street and Forest Way
    - Adams Street and Rabbett Street
- By complete Phase 1 development and 20 per cent Phase 2 development
  - Add a northbound lane on Forest Way between Waringah Road and Naree Road, with an additional right turn lane into Naree Road
  - Widen Grace Avenue between Naree Road extension and Fitzpatrick Avenue West to two lanes in each direction
  - Upgrade the intersection of Fitzpatrick Avenue West and Warringah Road
  - Provide traffic calming infrastructure in Wareham Crescent, Dundilla Road, Greendale Avenue, Sturt Street to discourage rat-running.

An option to connect Warringah Road to the Town Centre via tunnel has been suggested but discounted on the basis of cost.

3.2 Public transport

Jacobs

There are three recommendations for public transport, including:

- New high-quality bus stop facilities on Frenchs Forest Road West to the west of town centre access road
- Investigation (not provision) of high quality, direct bus services via bus stops in Warringah Road between Northern Beaches and Chatswood. This recommendation is from Future Transport 2056 and has not been investigated in this study in as much details as has the traffic.
- A pedestrian overpass linking the southern town centre gateway to Warringah Road bus stops. The provision of this bridge would be dependent on the provision of the bus link to Chatswood.
- Consideration (not provision) of a heavy rail line linking Frenchs Forest to Chatswood and the eastern coastal settlements like Dee Why.

Of these four recommendations, the only actual provision suggested is the new bus stops in Frenchs Forest Road.

Arup

Arup provided three specific recommendations for public transport:

- By 50% development of Phase 1:
  - Provide a 24-hour bus-only lane between the southern end of Holland Crescent to the intersection of Forest Way and Rabbett Street Intersection
- By 70% development of Phase 1:
  - Provide a bus priority system from Rabbett Street onto Warringah Road
  - Relocate the bus stops on Forest Way West eastwards.

3.3 Active transport

Jacobs

There are no recommendations specific to the Frenchs Forest Priority Precinct study. The following are included as recommendations:

- A logical network of accessible pedestrian routes throughout the town centre, based on desire lines, legibility, connecting places of interest, and utilising existing green spaces. Desire lines have not been identified, neither have potential places of interest and green spaces. This recommendation actually requires the town centre to be substantially developed in order to plan their locations.
- A network of shared paths and new footpaths on sections of Warringah Road, Wakehurst Parkway, Forest Way, Aquatic Drive, and Allambie Road. These are already under construction.
- Modification of existing pedestrian bridge over Warringah Road west of Wakehurst Parkway to link with existing demand and to provide a gateway to the development from the south. The existing demand referred to is most likely to be associated with the Northern Beaches Hospital.

Arup

Arup recommended a large number of cycle and shared paths as well as two recommendations for bridgeworks. These are:

- By 70 per cent development of Phase 1:
  - Green Bridge over Warringah Road
  - Upgrade the current pedestrian bridge to a shared bridge across Warringah Road to cross Forest Way and connect to the town centre

Arup's extensive recommendations for cycle paths are most easily shown diagrammatically, as in Figure 8.Figure 1

Figure 8: Location of recommended active transport infrastructure (extracted from Arup's report) with superimposition of currently constructed facilities

3.4 Transport demand management

Jacobs

Jacobs has recommended three ways of managing transport demand, including:

- Car sharing: This would reduce car ownership and their recommendation is to set a requirement for share cars to be provided as a proportion of the car parking spaces provided
- Travel choices: This provides a framework that advises people to improve their journey times and reliability by changing mode, changing the route they travel on, changing the time that they travel or choosing not to travel at all.
- Establishing a Transport Management Association to manage and monitor travel associated with the precinct, including personalised travel planning, travel information, and liaison with transport providers.

Arup did not recommend any transport management actions.

3.5 Summary

Table 3 contains a summarised comparison of the recommendations made by Jacobs and Arup

Table 3: Summary of recommendations by Jacobs and Arup

JACOBS	ARUP
Town centre road network with a new signalised intersection	Town Centre road network with signalised intersection at Bluegum Crescent East
Provide a new access to the town centre at Bluegum Crescent	Holland Crescent extension to the town centre road network
	Frenchs Forest Road West and Naree Road widening from Bluegum Crescent to Forest Way
	Signals at the intersection of Frenchs Forest Road West/Sylvia Place
	Naree Road extension to Grace Avenue
	Signals at Naree Road and Forest Way
	Signals at Naree Road and Grace Avenue
	Holland Crescent extension to Frenchs Forest Road West/ Sylvia Place
	Adams Street and Forest Way upgrade
	Adams Street and Rabbett Street upgrade
Investigate additional right turn lane from Forest Way (southern approach) into Naree Road	New north bound lane on Forest Way with an additional right turn lane into Naree Road
	Widen Grace Avenue between Naree Road extension and Fitzpatrick Avenue West
	Upgrade the intersection of Fitzpatrick Avenue West and Warringah Road
	Provide traffic calming infrastructure to discourage rat-running
New high-quality bus stop facilities on Frenchs Forest Road West west of town centre access road	Relocate the bus stops on Forest Way West eastwards.
Investigate high quality, direct bus services between Northern Beaches and Chatswood	
A pedestrian overpass linking the southern town centre gateway to Warringah Road bus stops	
Consider a heavy rail line linking Frenchs Forest to Chatswood and the Northern Beaches	
	24-hour bus-only lane between Holland Crescent and Forest Way / Rabbett St
	Provide a bus priority system from Rabbett Street onto Warringah Road
A logical network of accessible pedestrian routes throughout the town centre	

JACOBS	ARUP
The network of shared paths and new footpaths currently under construction.	
Modification of existing pedestrian bridge over Warringah Road west of Wakehurst Parkway	Upgrade pedestrian bridge to a shared bridge across Warringah Road to cross Forest Way and connect to the town centre
	Green Bridge over Warringah Road
Car sharing to reduce car ownership	
Travel Choices	
Transport Management Association to manage and monitor travel associated with the precinct	

4 RE-EVALUATION OF THE FORECASTS

In reviewing the modelling for this project, the outputs of the modelling were re-evaluated in the light of the Vision statement and the broader requirements for the development of the town centre. It is unfortunate that the modelling is detailed and limited to the precinct area, so that it is difficult to highlight the overall patterns of current and future demands.

To illustrate, Table 4 shows the broad numbers of workers who live in ABS SA2s on one side of the modelling area and work in an SA2 on another side of the modelling area. These are only broadly descriptive numbers, but they show quite clearly that there is a large east-west movement through Frenchs Forest. This is obviously a known demand because the infrastructure currently under construction caters for the east-west traffic demand. The table also shows that public transport share is substantial. The active transport mode shares may be overstated, because of the extents of SA2s whose extremes are close together.

Table 4: Census Place of Work and Mode to work data aggregated to broad movements

		Persons				Mode Share			
		Car	Public Transport	Active	Total	Car	Public Transport	Active	Total
Through Trips	**East-West**	12,830	3,600	3,200	19,690	65%	18%	16%	100%
	North-South	560	300	340	1,200	47%	25%	28%	100%
Frenchs Forest Trips	**North**	60	10	-	70	86%	14%	0%	100%
	South	1,060	1,100	50	2,210	48%	50%	2%	100%
	East	760	150	10	920	83%	16%	1%	100%
	West	3,390	460	380	4,220	80%	11%	9%	100%
Internal trips		55	-	-	55	100%	0%	0%	100%

In the Jacobs study, a scenario was tested that included the Beaches Link with Phases 2 and 3 of the development. The movements through and into the Frenchs Forest town centre were extracted from the demand matrix for this scenarios and the result is shown in Table 5 . The east-west through demand dominates the matrix, while trips travelling to or from the town centre are destined for the south and west or come from there.

Table 5: Vehicle demand in 2036 forecast matrix in AIMSUN model

Direction	Demand (Vehicles)
East-West	8,140
North-South	290
North	700
East	2,370
West	1,930
South	530
Internal	250
Total	14,210

These figures show that the issue of planning for the demand extends well beyond the bounds of Frenchs Forest and there are actions in areas east and west of the town centre that can optimise the movement of people in and through the area.

Figure 9 is a plot from the AIMSUN scenario that includes the Beaches Link and Phases 2 and 3 of the development. It shows clearly that the Warringah Road/Forest Way corridor is critical.

Figure 9: AIMSUN forecast of level of service in 2036 with Beaches Link and Phases 2 and 3 of the development

A typical outcome of SIDRA modelling is shown in Figure 10. SIDRA modelling shows that in each scenario tested, Warringah Road is highly congested along most of its length, as is Forest Way northbound, Wakehurst Parkway southbound and most of the length of Frenchs Forest Road.

While active transport infrastructure was recommended in both studies, little, if any, analysis of the active transport demand was made. However, the public domain strategy expresses the aim of providing a 20-minute town centre. An estimate of the areas included within a 20-minute walk and cycle ride is shown in Figure 11. This shows that anywhere within the modelled area is within a 20-minute walk of the town centre and much of the Northern Beaches and Lindfield/ Roseville areas are within a 20-minute bike ride.

Based on these broad observations, the recommendations contained in both reports were reviewed and a program of delivery was drawn up.

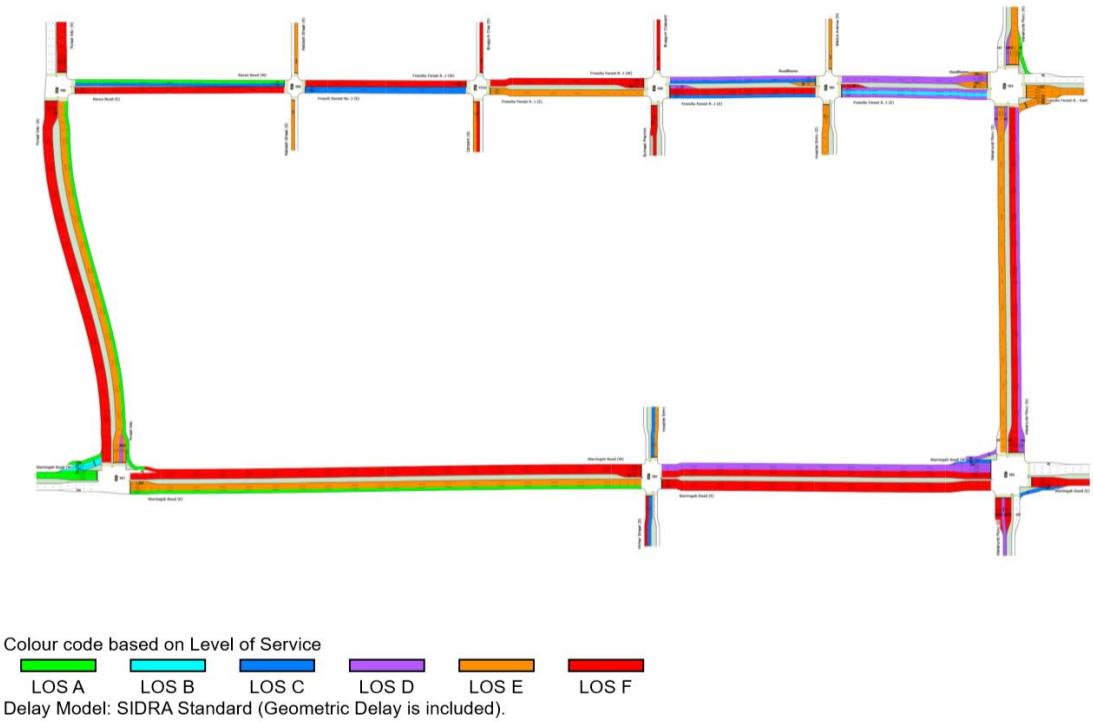


Figure 10: Typical result from SIDRA modelling

Figure 11: Approximate areas within 20 minutes travel on foot or by bicycle

5 REVIEWED RECOMMENDED ACTIONS AND CONCLUSION

The review of the two transport modelling forecasts has focussed on their completion and the differences between the models. Ultimately, the aim of the review is to determine which of the recommendations need to be followed. Based on the review of the modelling, associated reports and results, we have formulated a set of recommendations for provision of infrastructure that will provide the best possible transport connections for the Frenchs Forest town centre. In the following sections, these recommendations are listed along with the rationale behind them and their expected impact.

5.1 Principles for reviewed recommendations

In our view, a study of the need for transport infrastructure would ideally promote development of the town centre towards a vision. No statement of vision is made in either study, possibly because the vision was formulated after the completion of the studies.

In the urban design and public domain strategy (CHROFI and architectus, 2020), the following are components of the vision:

- A Meeting Place: destinations for families, events, friends, visitors, and colleagues
- A Lively Place: open for business around the clock and always safe and friendly
- A Place for Walking: a 20-minute neighbourhood with many services and attractions near your job or home
- Affordable and Diverse: housing diversity and affordability, emerging and diverse jobs anchored by the Hospital
- A Healthy Place: for people and the environment
- A Connected Place: connected to the neighbourhood, to nature and an integrated bus network

The place of the town centre in the community needs to be part of its time as well as its space and would be well-served by consideration of the opportunities that may be afforded in the future. In this location, the transport networks will play a crucial role in achieving the vision. Good access to the town centre will be critical for to build a lively, healthy and connected place that will be a safe meeting place. A healthy environment is specifically mentioned and to this end, public transport, active transport, mobility as a service (MaaS) and micro-mobility facilities should be promoted ahead of the use of cars.

Local traffic and traffic that originates from or destined for the town centre should be provided priority over other traffic. Frenchs Forest Road between Wakehurst Parkway and Forest Way will best serve traffic accessing the town centre and discourage other traffic.

5.1.1 The need for early action

To achieve the vision for the Frenchs Forest town centre changes in travel behaviour will be needed, mostly around choice of transport mode and a move away from private vehicles. To be successful in this, the alternative facilities need to be provided and visible in good time so that potential residents, investors and businesses are aware of them from day one and can plan for choices away from cars.

Pedestrian and cyclist facilities have been proposed for the future. The risk is that if these are provided after the area has developed significantly, it will be more difficult to persuade travellers out of their cars and onto the cycleways and pedestrian paths. Earliest provision of these facilities will encourage locals to use them and increasing use by locals will increase the visibility of cycling and walking alternatives for new residents and workers in the area.

A similar argument can be made for earlier provision of bus services. High frequency express services along with strong distribution of information about the service will persuade locals to use the service and will make the service more visible as an alternative to the private vehicle. Early provision and adoption of the service will facilitate changing travel habits more quickly and more easily that coaxing people out of cars.

With road network alterations it helps to provide the changes earlier to prevent potential frustration of motorists in the future and also to show new residents and workers how the roads work rather than changing the road network after new residents and workers have moved to the area.

In summary, early provision of the recommended infrastructure is required to change established travel behaviour and encourage a greater shift towards walking, cycling and public transport for the future residents, workers and visitors to the area. Early provision of transport network facilities will be instrumental in shaping travel behaviour into the future.

For these reasons, it is recommended that some of the recommendations that are slated for provision further into the future are brought forward to the early stage of development.

5.2 Summary of the facts driving the recommendations

Planning for the Frenchs Forest Precinct would be improved if it were broadened to examine the transport demand to a more regional scope. Even in 2036, when the town centre is substantially developed, traffic travelling through the precinct on Forest Way and Warringah Road dominates the roads. Both roads detract from the stated vision for the Town Centre and, because of the dominance of the through-traffic, through-traffic is prioritised by the traffic control systems in the area.

There is a demonstrated demand for movement between the coastal settlements east of Frenchs Forest, like Dee Why, and those west of Frenchs Forest, such as Chatswood. There may also be an element of the traffic that travels between north-south corridors (Pacific Highway and Condamine Road/S pit Road) as a preferred route to North Sydney or Sydney. Improved transport options that service these needs will benefit areas far wider that Frenchs Forest.

5.3 Recommendations

Our recommendations, based on the review, principles and facts driving the recommendations are listed below.

Initial/ early

The following infrastructure is recommended for early provision:

- The walking and shared path network recommended by Arup is important for early provision. Additional paths on the south that link to other recommended paths and to the bridges across Warringah Road should also be provided. The cycle network should be expanded significantly to allow safe cycling between Frenchs Forest, Chatswood and Dee Why and other coastal areas, which are within a comfortable half-hour cycle ride. This should include provision of the pedestrian overpass linking the southern town centre gateway to Warringah Road bus stops as recommended by Jacobs, and the Green Bridge recommended by both.
- A high frequency express bus service between Frenchs Forest, Dee Why and Chatswood with stops on Warringah Road will play an important part in reducing traffic volumes through, into and out of Frenchs Forest and needs to be prominent and visible early in the development period
- Road access to the town centre is needed to start the development and the two access points to the town centre recommended by Arup are preferable to those recommended by Jacobs, which would result in three signalised intersections within a few hundred meters of one another
  - Frenchs Forest Road West/ Bluegum Crescent/ New Internal Road – Item 1A in Arup's Report
  - Holland Crescent Extension to Town Centre – Item 1 B in Arup's report
- Treat the section of Frenchs Forest Road identified by Jacobs as a Vibrant Street accordingly, with widened footpaths, slower traffic speeds and drop off points for MaaS vehicles and safe crossing points for pedestrians

50 per cent Phase 1

Arup recommends at this stage the widening of Frenchs Forest Road and Naree Road from Bluegum Crescent to Forest Way and the installation of signals at Sylvia Place. While we do not disagree with this, it will not be compatible with the vision for the Frenchs Forest Town Centre. A more appropriate approach may be to close the accesses of Sylvia Place and Cobb Street onto Frenchs Forest Road and extend Cobb Street to Epping Drive to allow access to those areas from Epping Drive rather than from Frenchs Forest Road.

At this stage the provision of a 24-hour bus-only lane between the southern end of Holland Crescent to the intersection of Forest Way and Rabbett Street Intersection will be needed.

70 per cent Phase 1

On the road network, the Arup recommendations at this stage are appropriate:

- Extend Naree Road to Grace Avenue
- Signalise the intersections of
  - Naree Road and Forest Way
  - Naree Road and Grace Avenue
- Connect Holland Crescent to the intersection of Frenchs Forest Road West at Sylvia Place
- Upgrade the intersections of:
  - Adams Street and Forest Way
  - Adams Street and Rabbett Street.

The public transport actions should include the those described for this stage by Arup and include:

- Provide a bus priority system from Rabbett Street onto Warringah Road
- Relocate the bus stops on Forest Way West eastwards.

Full Phase 1 and 20 per cent Phase 2

For this stage, the following are recommended according to Arup's specifications:

- In Forest Way, northbound, provide an additional right turn lane into Naree Road, either by widening forest way or be reducing the number of through-lanes. Prioritise the turns into Naree Road to improve access to the town centre
- Widen Grace Avenue between Naree Road extension and Fitzpatrick Avenue West to two lanes in each direction
- Upgrade the intersection of Fitzpatrick Avenue West and Warringah Road
- Provide traffic calming infrastructure in Wareham Crescent, Dundilla Road, Greendale Avenue, Sturt Street to discourage rat-running.

Transport demand management

Jacobs made three recommendations regarding the management of transport demand. In the case of the Frenchs Forest Town Centre development, the primary need for demand management is for car travel. Their recommendations include car sharing and travel choices and include a requirement for developers to provide spaces for storing share cars.

A better way to manage car travel demand and to help with travel choices, would be to require developers to provide with residential developments, bicycles, scooters, e-bikes and e-scooters at a rate specified by Council. This would provide additional mobility choices and would reduce not only car ownership, but car travel.

5.4 Overall

After review of the modelling and recommendations in the two studies for DPIE and Council, and the urban design and public domain strategy, we have developed a set of recommendations that are a combination of those of Arup and Jacobs. The aim of the recommendations is to aid in the vision for the Frenchs Forest Town Centre by:

- Providing facilities for alternative modes to car to maximise the opportunity for reducing car use
- Providing those facilities early in the development so that the potential change from car begins early
- Promoting ease of access to the town centre and diverting through-traffic away from Frenchs Forest Road.

6 SUMMARY AND CONCLUSION

After a review of the modelling and recommendations that came out of the reports by Jacobs to DPIE and Arup to Council, the recommendations from each report were also reviewed in the context of the vision stated in the urban design and public domain strategy. This statement may not have been available to Jacobs and Arup at the time of their studies.

The findings of the review can be summarised as follows:

- Neither of the modelling processes can be represented as a wholistic, multi-modal transport study. Both models focus on finding and reporting solutions to traffic problems and neither model includes the modelling of public transport or active transport. On the other hand, the SIDRA models at least made some account of a shift to public transport as a response to improved bus services. The SIDRA modelling also includes the impact of pedestrians on traffic flow, while the AIMSUN model does not explicitly represent pedestrians or cycles
- The report to DPIE does not recommend substantial public transport projects, suggesting instead some minor improvements and further investigation of major projects. The report to Council provides recommendations for improved bus services and the addition of facilities to help the operation of buses.
- The report to DPIE has few recommendations for improving opportunities for active transport. The report to Council recommends the provision of a network of shared paths and on-road cycle paths in an area that represents a 20-minute walk from the town centre. Both reports recommend bridges for crossing Forest Way and Warringah Road.
- As a result of these findings, the modelling is almost irrelevant in the planning of a network system that offers a range of travelling modes.

The results of both models were reviewed, along with the recommendations made. Some broad principles were set for evaluating the recommendations and the recommendations from both reports were then set into the context of providing a multi-modal transport network that aims to fulfil the vision statement and to fit into an environment that the future might resemble. The principles that the revised set of recommendations are founded on are:

- Provide active transport facilities in a pro-active way so that travel choices of residents and workers of the area can be make early in the development process
- Protect Frenchs Forest Road as the major access to the Frenchs Forest Town Centre
- Because of the impact of travel from outside of the area, aim to influence travellers to or from the Northern Beaches and Chatswood areas to change modes of travel away from cars.

REFERENCES

ARUP (2019). Report to Northern Beaches Council: *Frenchs Forest Town Centre - Transport Strategic Design*

CHROFI and architectus (2020) Frenchs Forest Precinct: Urban Design Report And Public Domain Strategy

GTA (2015) Northern Beaches Hospital, Stage 2 EIS - Network Enhancement Works: Traffic and Transport Impact

Jacobs (2019). Frenchs Forest Planned Precinct: Report to Department of Planning, Industry and Environment. Transport Strategy – Final

ARCADIS Design & Consultancy for natural and built assets

KINESIS

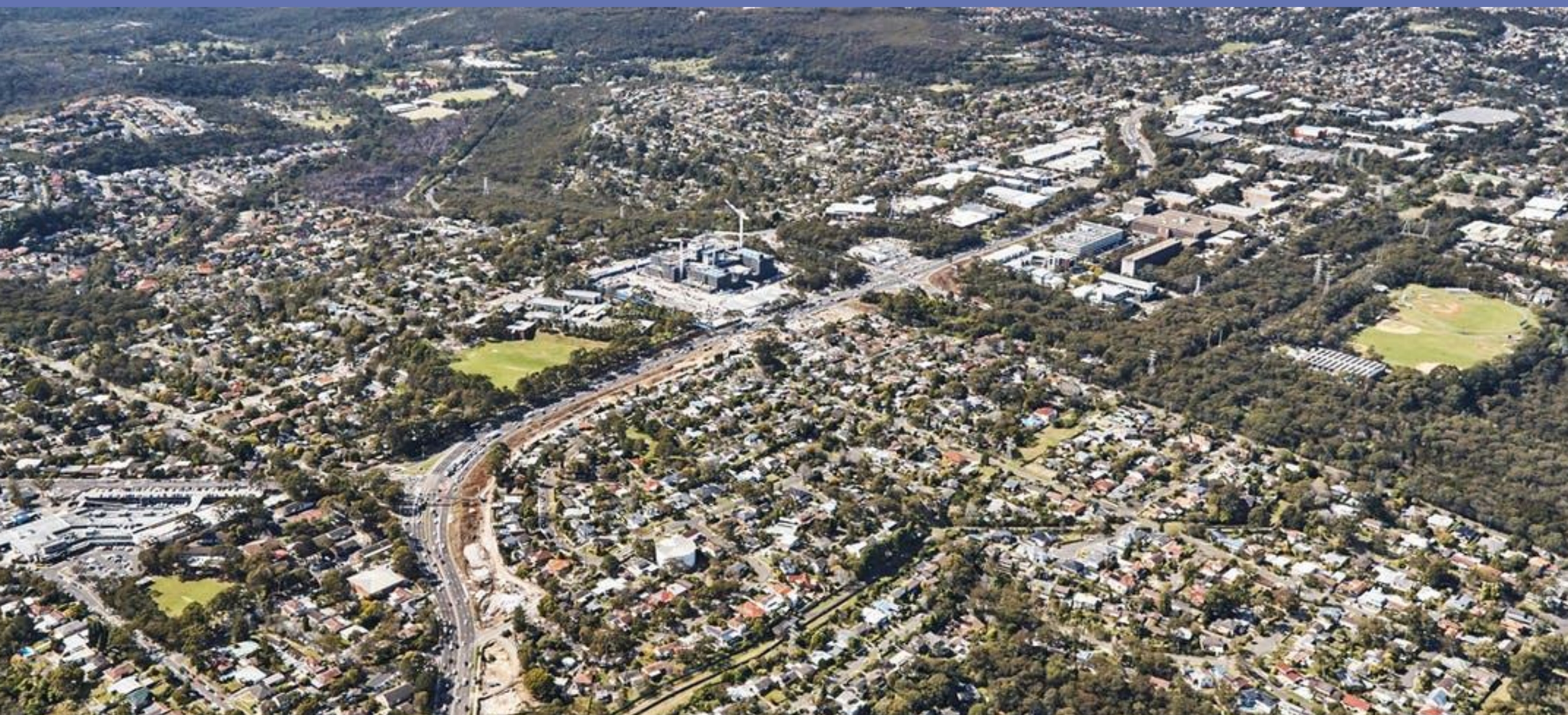
northern beaches council

FRENCHS FOREST PRECINCT

SUSTAINABILITY REPORT

PREPARED BY KINESIS FOR NORTHERN BEACHES COUNCIL

1 MAY 2019



Prepared by Kinesis
Level 6, 155 Clarence Street
Sydney, 2000 NSW
P.O. Box Q164
Queen Victoria Building
NSW 1230
admin@kinesis.org

Document Version
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Authors
David Holden, Director
Tu Tu, Energy Engineer
Harish Moro, Analyst

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Note: This report is provided subject to some important assumptions and qualifications:

The results presented in this report are modelled estimates using mathematical calculations. The data, information and scenarios presented in this report have not been separately confirmed or verified. Accordingly, the results should be considered to be preliminary in nature and subject to such confirmation and verification.

Energy, water and greenhouse consumption estimates are based on local climate and utility data available to the consultant at the time of the report. These consumption demands are, where necessary, quantified in terms of primary energy and water consumptions using manufacturer's data and scientific principles.

Generic precinct-level cost estimates provided in this report are indicative only based on Kinesis's project experience and available data from published economic assessments. These have not been informed by specific building design or construction plans and should not be used for design and construct cost estimates.

The Kinesis software tool and results generated by it are not intended to be used as the sole or primary basis for making investment or financial decisions (including carbon credit trading decisions). Accordingly, the results set out in this report should not be relied on as the sole or primary source of information applicable to such decisions.

CONTENTS

EXECUTIVE SUMMARY

Kinesis were engaged by Northern Beaches Council to review a suite of completed studies and strategies for the Frenchs Forest Precinct and provide a refined sustainability strategy that meets the aspirations of Council while responding to the fragmented land ownership and development staging.

KEY FINDINGS

DPE has previously prepared a Sustainability Strategy for the Frenchs Forest Precinct. This strategies relies heavily on the delivery of **precinct wide energy and water infrastructure. T**he build-out of the Frenchs Forest Precinct, however, is expected to be incremental, with multiple land owners, reflecting the existing fragmented ownership across the precinct. As a result, precinct wide infrastructure will be more challenging to deliver, as it requires coordination across the entire precinct.

This report has developed a suite of sustainability strategies for the Frenchs Forest Precinct that seeks to meet the same environmental performance outcomes of the original Sustainability Strategy, while responding to the fragmented land ownership and development staging and enabling strategies to be delivered at a site by site, or building by building level.

These strategies include building energy and water efficiency, significant solar PV and building level water reuse. The combination of these strategies is expected to deliver:

- Approximately 35% reduction in precinct wide greenhouse gas emissions
- Approximately 30% reduction in mains water consumption

To deliver on these outcomes, it is recommended that the project team for the precinct pursue the following:

- Higher BASIX targets
  - Energy 55 for all new apartments
  - Water 55 for all new apartments

- Higher Performance for non-residential buildings
  - NABERS 5.5 Energy for offices and hotels
  - NABERS 3-star Water for offices and hotels
  - Minimum Green Star Design & As Built ratings 4-star

- Higher Performance requirements for the Community Hub, including minimum solar PV requirements, with an aspiration to meet net zero emissions.

- Require all new off-street parking include EV charge points.

- Investigate the potential for unbundled and decoupled parking and the opportunities for car share within the precinct.

HIGHER BASIX COSTS & BENEFITS

A key implementation mechanism for Council and DPE is to establish higher BASIX targets (Energy and Water) across the precinct. This will ensure residential dwellings meet the performance outcomes outlined in this report but provide developers with the design and technology choice on how these performance outcomes are met. To determine whether the BASIX Energy and Water targets proposed for the Frenchs Forest Precinct are appropriate, a cost-benefit analysis has been undertaken and is outlined below.

Based on analysis by Kinesis, it is expected that these outcomes can be achieved for a marginal capital cost (or cost premium above the Base Case) of approximately $4,100 per dwelling, saving households close to $600 per year in energy and water bills.

GREEN STAR COMMUNITIES

Accreditation under the Green Star Communities rating tool is being targeted for Ingleside, aimed towards a Four Star (Australian Best Practice) Green Star rating. The combination of the above strategies will assist in the delivery of this rating across a number of targeted strategies, including:

- Credit 25 (Greenhouse Gas Strategies) - ~3 points
- Credit 24 (Integrated Water Cycle) - ~2.5 points

BACKGROUND

The purpose of this document is to provide a review of existing studies and strategies for the Frenches Forest Planned Precinct as they relate to sustainability, across energy, water, transport and cost of living. Further, this document outlines preliminary recommended strategies for Council review that provide a practical, high performance outcome as the planned precinct develops over time.

Based on the existing studies provided by council, Kinesis undertaken a review of the following documents:

- CHROFI. (2018). Frenchs Forest Precinct GFA Calculations.
- CHROFI. (2019). Spatial Feasibility Study - University Study Within Frenchs Forest Town Center.
- FLUX. (n.d.). Frenchs Forest Planned Precinct Sustainability Plan.
- Greater Sydney Commission. (2018). North District Plan - Connecting Communities.
- Jacobs Group. (2018). Frenchs Forest Planned Precinct Transport Startegy.
- Mott MacDonald. (2018). Frenchs Forest Planned Precinct Flooding & Stormwater Assessment.
- Mott MacDonald. (2018). Frenchs Forest Planned Precinct Utility Capacity Assessment.

The main document that was most relevant to this review was the Frenchs Forest Planned Precinct Sustainability Plan. This memo documents the key relevant outputs from this report and recommended revised sustainability strategies based on our analysis.

Precinct Details & Assumed Land Use

The Frenchs Forest Precinct is expected to deliver significant growth in residential and non-residential floor space. An estimate of this growth is provided in Table 1 and has been extracted from CHROFI (2018) Frenchs Forest Precinct GFA Calculations. These estimates include the estimated use of gross floor space, the allotted use of car parking spaces and the estimated occupancy for the development.

In Table 1 the GFA and dwelling estimation was extracted from CHROFI (2018) Frenchs Forest Precinct GFA Calculations. Occupancy prediction was provided by Northern Beaches Council.

These parameters have been used as the basis for any calculations undertaken by Kinesis.

Frenchs Forest Precinct Estimated Land Use

Category	Quantity
Non-residential Floor Area - m^2 GFA	**71,264**
Estimated total Roof Area - m^2	**43,101**
University	9,117
Aged Care	9,532
Hotel	8,124
School	8,897
Retail	13,539
Non-retail	736
Underground parking	5,891
Library	1,127
Community Centre	2,155
Childcare	680
Indoor Sport	2,301
Commercial	9,166
Residential - Dwellings	**5,360**
Phase 1 Dwellings	1,930
Phase 2 Dwellings	2,115
Phase 3 Dwellings	1,315
Parking Rates – Spaces/dwelling	**-**
1-bedroom dwelling	0.6
2-bedroom dwelling	0.9
3-bedroom dwelling	1.4
Visitor parking	0.2
Population (Estimated based on Dwellings)	**11,792**
Phase 1	4,246
Phase 2	4,653
Phase 3	2,893

Table 1: Dwelling yield, floor space and estimated population for the Frenchs Forest Planned Precinct

REVIEW OF SUSTAINABILITY OUTCOMES

Outlined in the Greater Sydney Commission North District Plan - Priority N21[1], the Frenchs Forest Planned Precinct will adopt precinct-wide energy, water and waste strategies, aiming to deliver on the three key objectives:

- Reducing carbon emission and contribute to net-zero emission by 2050
- Water reuse
- Waste recycling

Kinesis has reviewed relevant documents[2] relating to and impacting the sustainability design of Frenchs Forest Planned Precinct. The key document outlining sustainability strategies and plans for the precinct are outlined in the FLUX Sustainability Plan.

In this document the performance of Frenchs Forest Planned Precinct was analysed under three scenarios:

- **Reference Scenario-** reflects the future performance of the precinct under minimum uptake of potential technologies and compliance with sustainability initiatives.

- **Current Best Practice Scenario-** reflects the impact of utilising current technologies and adopting best practice strategies currently available.

- **Future Best Practice Scenario-** reflects the performance of the precinct incorporating all potential technologies and initiatives to deliver the greatest possible emissions reduction for the precinct[3].

The energy, water and transport strategies outlined for the Frenchs Forest Planned Precinct full build-out (Future Best Practice Scenario) and extracted from the FLUX Sustainability Plan are outlined below:

Energy/Greenhouse Gas Emission Strategies

- Total of 2 MW on-site solar PV
- District Thermal plant for space heating and cooling
- Private wire network with potential of battery storage installations

Water Strategies

- Water sensitive urban design to reduce stormwater runoff
- 560 kL/day recycled water
- 300 kL Centralized rainwater tank

Transport Strategies

- Car share
- Electric vehicles

The energy and water strategies are heavily reliant on **precinct wide infrastructure**, including precinct heating and cooling systems (district thermal), precinct level solar PV distributed through a private wire network and battery storage, and a precinct scale recycled water scheme. This strategy also assumed the inclusion of the new Northern Beaches Hospital.

The build-out of the Frenchs Forest Precinct is expected to be incremental, with multiple land owners, reflecting the existing fragmented ownership across the precinct. As a result, precinct wide infrastructure will be more challenging to deliver, as it requires coordination across the entire precinct.

In addition, since the preparation of the FLUX Sustainability Plan, the Northern Beaches Hospital has been completed. At the time of this review, Kinesis is not aware of the sustainability strategies implemented at the Northern Beaches Hospital, but it is unlikely that the precinct wide infrastructure solutions have been implemented at the hospital, making it even more difficult to deliver these strategies across the entire precinct.

[1] Greater Sydney Commission – North District Plan
[2] FLUX - Frenchs Forest Planned Precinct Sustainability Plan & Mott MacDonald - Frenchs Forest Planned Precinct Flooding & Stormwater Assessment

[3] The performance and technology assumptions for both the Reference Scenario and Future Best Practice Scenario were obtained from the Sustainability plan by Flux Consultants

ENERGY & WATER STRATEGIES

Given the implementation challenges of the energy and water strategies outlined in the FLUX Sustainability Plan (reflected in the fact that we don't believe these strategies have been implemented at the hospital site), Kinesis has undertaken preliminary analysis to determine a suite of strategies more in line with the expected implementation and build-out of the Frenchs Forest Precinct, **while seeking to deliver an equivalent standard in environmental performance**.

According to the FLUX Sustainability Plan, the precinct wide infrastructure strategies are estimated to achieve:

Energy / Greenhouse Gas Emission Outcomes

- 55% reduction in precinct wide greenhouse gas emissions[4]
- BASIX Energy score of 50
- NABERS 5-star Energy for offices and hotels
- 25% GHG reduction in other non-residential buildings

Water Outcomes

- 44% reduction in mains water consumption[3]
- BASIX Water score of 60
- NABERS 5-star Water for offices and hotels
- 25% water consumption reduction in other non-residential buildings

Based on the assumed land use growth outlined in Table 1, Kinesis analysed and calculated the opportunities for **building scale strategies under the same vision of reducing energy and water use.**

These potential strategies are outlined in Table 2 and include:

- Efficient residential building design, lighting and appliances
- Efficient non-residential building design, lighting and appliances
- Significant solar PV on both residential and non-residential buildings
- Building level rainwater reuse for external irrigation and internal uses

This suite of building level strategies are not reliant on precinct wide infrastructure and allow for fragmented ownership and build-out of the precinct as it occurs over time.

Frenchs Forest Precinct Revised Sustainability Strategies

	Technology	Potential Strategy
Residential Dwellings Car Park	**ENERGY**	
	Hot water system	Gas Instantaneous
	Thermal Design (NatHERS)	6-star average
	Space heating and cooling	5-Star reverse cycle A/C
	Lighting	Efficient (LED)
	Appliances	Dishwasher – 4-star Energy Washing machine – 4-star Energy Dryer – 2-star Energy Fridge – 3-star Energy
	Cooking	Electric cook-top Gas oven
	Renewables	PV Panels – 0.2 kW/dwelling
	WATER	
	Fixtures	Toilet – 4-star WELS Tapware – 5-star WELS Showerhead – 3 plus-star WELS
	Appliances	Washing machine – 4-star Energy Dishwasher – 4.5-star Water
	Rainwater tanks	0.5 kL per dwelling with connection to: • Irrigation, toilet, laundry
	Car parking ventilation	Natural ventilation with CO sensor
	Car parking lighting	Fluorescent with lighting motion sensor
Non-Residential Buildings	**ENERGY**	
	Thermal Design	Efficient
	Lighting	Efficient (LED)
	Space heating and cooling	Water-cooled system Average System COP 6
	Renewables	PV Panels – 920 kW
	WATER	
	Efficiency Setting	High Efficiency
	Water reuse	Rainwater reuse for amenities and irrigation

Table 2: Potential building level strategies investigated by Kinesis.

[4] Note: when the FLUX Sustainability Plan was prepared, the Reference Case (building code and BASIX compliance) delivered a lower performance outcome than now. Recent increases in BASIX targets means that the overall percent reduction delivered by the Frenchs Forest Precinct will be less than estimated by FLUX.

The results of these building level strategies are outlined in Figure 1.

Figure 1 outlines the potential energy related greenhouse gas emissions (electricity and gas) and water reductions achieved by these building level strategies across the Frenchs Forest Planned Precinct. Importantly, these strategies are expected to deliver similar energy and water performance outcomes as the precinct-wide solutions outlined in the original Sustainability Plan for the precinct:

Energy / Greenhouse Gas Emission Outcomes

- 34% reduction in precinct wide greenhouse gas emissions
- BASIX Energy score of 55
- NABERS 5-star Energy for offices and hotels
- 32% GHG reduction in other non-residential buildings

Water Outcomes

- 29% reduction in mains water consumption
- BASIX Water score of 55
- NABERS 3-star Water for offices and hotels
- 39% water reduction in other non-residential buildings

Note - recent increases in BASIX targets means that the overall percent reduction delivered by the Frenchs Forest Precinct will be less than estimated in the original Sustainability Plan.

A note on renewable energy

The FLUX Sustainability Plan recommends the installation of 2 MW solar PV as a precinct wide strategy. This was proposed to be delivered via a private wire network across the precinct.

This strategies has modelled delivering the same level of solar PV but at a building level, not reliant on private wire network, but simply using the delivered solar PV within the building. Based on our analysis, the proposal building level solar PV is expected to be equivalent to 2 MW across the entire precinct, or approximately 30% of the roof space.

In addition, the utility and benefit of solar PV extends beyond building scale energy use. Combined with the increasing electrification of future urban transportation (EVs), solar PV would become a key initiative in reducing the transport related emissions. This will be vital to achieving an objective of net-zero emission by 2050.

A note on water reuse

The FLUX Sustainability Plan recommends the implementation of precinct-wide recycled water to deliver significant water reductions.

Without precinct scale recycled water, water reuse is limited to rainwater and stormwater collection at the building level. This is limited by the amount of roof and surfaces available to collect water, as well as the patterns of rainfall in the local climate.

Kinesis modelled rainwater tanks for residential dwellings, connecting to irrigation, toilet and laundry. Due to the typical rainfall of the area and the high water demands from connected end-uses, the rainwater system would experience shortages throughout the year, where domestic water top-up would be required (see Figure). As a result the water reduction outcomes of the strategies outlined in Table 2 fall short of achieving same water reduction outcomes outlined in the original Sustainability Plan.

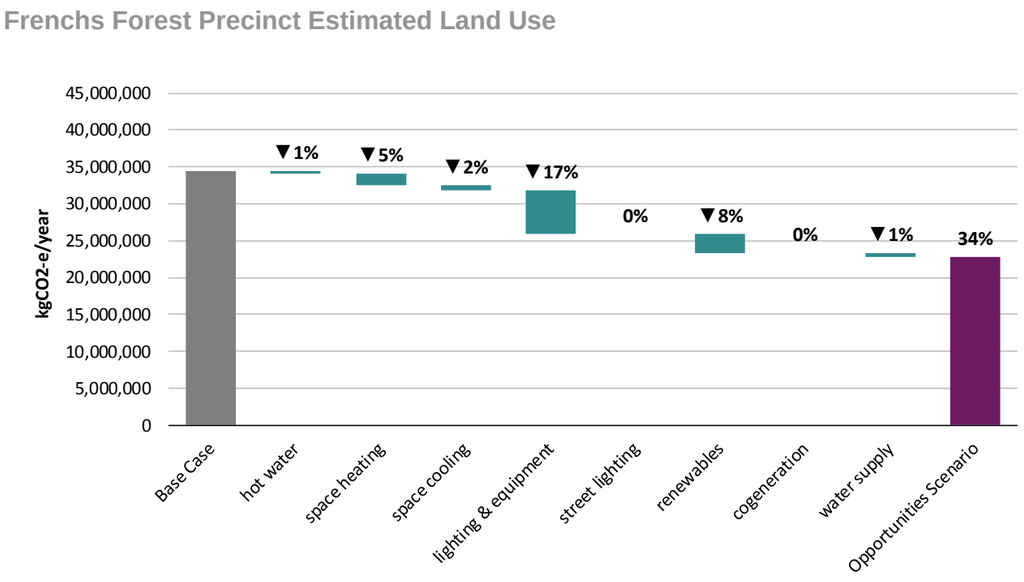

Figure 1: Frenchs Forest Planned Precinct full build out emission reduction due to strategies in Table 1

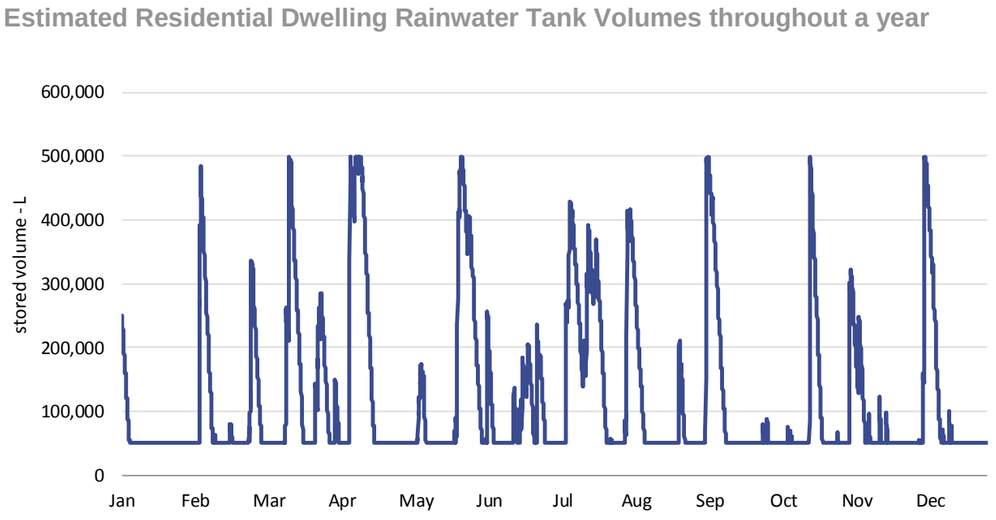

Figure 2: Residential dwelling rainwater tank remaining volume, showing periods of top-up when rainfall is low.

DELIVERING HIGH PERFORMANCE FOR THE COMMUNITY HUB

As part of the development the council has explored a program to develop a combined facility located adjacent to the central piazza, including various essential public facilities and 8,000 m2 of university floor space[5], known as the Community Hub. The estimated Community Hub floor space is shown in Table 2.

Kinesis analysed the impact of the above building level strategies, and investigated pathways that would deliver a higher performance outcomes for the Hub, with a goal of delivering a net zero emissions outcome.

Under a Reference Scenario (built to building code), the Community Hub is expected to have an annual greenhouse gas emission of 7,870 tonnes.

Following the strategies for the non-residential buildings outlined in Table 1, including the inclusion of 0.5 MW of solar PV (approximately 30% of the roof area), the Community Hub would see a 29% reduction in greenhouse gas emission reduction, down to 5,760 tonnes, shown in Figure 2.

A stretch scenario was also investigated (Figure 3) which outlines the greenhouse gas emission projection from increased solar PV at the Community Hub (1.5 MW) as well as accounting for changes to the grid. The national electricity grid has been showing its commitment towards a greener grid, from the control and future shutdown of existing coal-fired power generation, and the increased up-take in renewable power generation and energy storage[6]. As the national electricity grid becomes greener, the overall greenhouse emission of the council owned community hub is expected to decrease. As observed from Figure 3, with the forecasted future emission factors of the electricity grid, the community hub is expected to be net carbon neutral by 2040 with 1.5 MW of PV. However, it is advised that council audit and review the performance and policies of assets on an annual basis. This will help council to monitor progress, identify issues in the programme and adjust priorities accordingly.

Community Hub Estimated Land Use

Category	Quantity
Non-residential Floor Area - m^2 GFA	**14,850**
Estimated total Roof Area - m^2	**11,700**
University	8,000
One Stop Shop	500
Community Centre	2,000
Wellness Centre	700
Indoor Sport	2,000
Childcare Centre	1,650

Table 2: Estimated floor space and for the Frenchs Forest Planned Precinct Community Hub

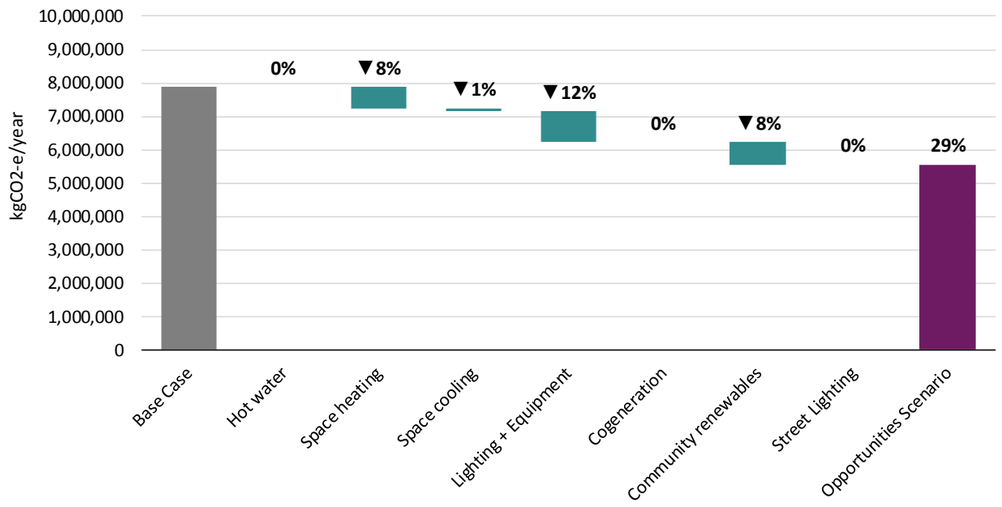

Figure 2: Frenchs Forest Community Hub greenhouse gas emission comparison

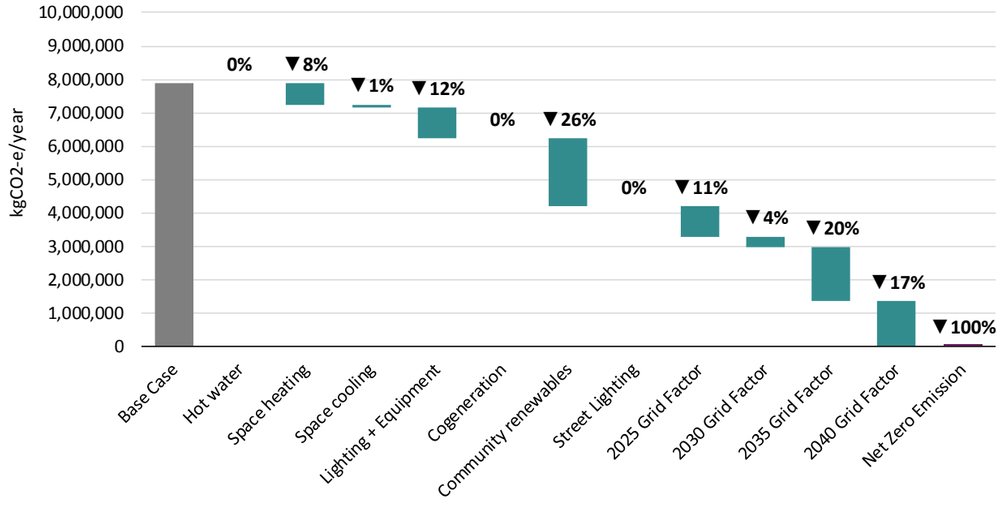

Figure 3: Frenchs Forest Community Hub greenhouse gas emission projection with renewables and improved grid

[5] CHROFI – Spatial Feasibility Study – University Study Within Frenchs Forest Town Centre

[6] Australian Energy Market Operator – Integrated System Plan

TRANSPORT STRATEGIES

The newly announced East-West B-Line route from Dee Why to Chatswood is being developed for the Northern Beaches region. This new service aims to improve local bus service and make the regional bus network operate more effectively for customers. Kinesis expects the improved bus services to reduce the average walk/wait time in the French Forest Planned Precinct. Kinesis expects this to result in a future decrease in the car ownership rate for the upcoming residential dwellings in Frenchs Forest Planned Precinct.

In addition, car ownership is changing and the delivery of parking needs to be flexible to response to this change. Parking should be flexible to allow people's preferences to change as the need for private car ownership and therefore parking changes. As the use of ride share, car share and the emergence of autonomous vehicles increase, owning a car becomes less desirable and the need for individuals to accommodate it in a private parking space becomes redundant. Therefore, council could consider potential parking strategies that work alongside the projection of reduced car ownership, for the Frenchs Forest Planned Precinct. Some potential strategies are presented below.

Unbundled Parking: Residents have the choice to purchase/lease parking rather than it being bundled in the cost of housing. As such, residents have the choice of more affordable homes. The other benefit is that the amount of parking is responsive to residents who can afford and require parking, limiting the risk of excess parking provision.

Decoupled Parking: In addition to the benefits of unbundled parking, council or privately owned and operated parking stations at the periphery of the community hub would address short term parking needs and reduce the potential requirement for individual developments to supply car parking on-site. This would also minimise the impact of traffic within the precinct and help support a gradual change in travel behaviour and patterns. This could be funded by a development fee in lieu of providing parking on-site, if considered appropriate.

If both unbundled parking and decouple parking strategies are implemented, Kinesis expects a 10%-30% reduction in residential parking space demand, which translates to a saving in fuel use and improved household affordability (Figure 4).

Through lower and more strategic parking delivery, coupled with more accessible public transport, the Opportunities Scenario is expected to deliver:

1. 21% reduction in car use (compared to the Base Case), shown in Figure 4.
2. 13% reduction in transport household costs (compared to the Base Case), equivalent to approximately $2,640 per year.
3. Lower construction costs associated with excavation and construction of underground parking.
4. Less energy demands for parking lighting and ventilation equates to lower compliance costs with
5. BASIX Energy Targets and lower energy costs for an apartment body corporate.

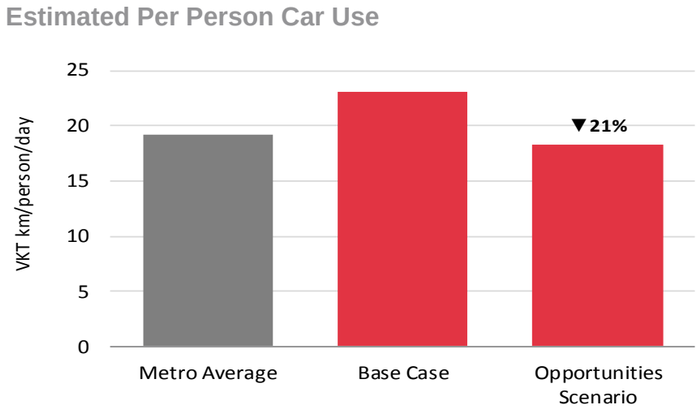

Figure 4: Estimated car use per person per day under the Base Case and the Opportunities Scenario[7]

[7] *Note: Percent reductions are shown as a reduction against the Base Case (building code compliance)

IMPLEMENTATION

While the estimated performance outcome from the building scale strategies did not surpass the results from the precinct-wide solutions outlined in the Sustainability Plan, particularly in water consumption, it is expected that the solutions outlined above can be delivered through the current planning and approvals processes, and be reviewed frequently as the precinct develops to ensure they remain best practice.

Table 3 below outlines the key implementation strategies that can be applied by Council to deliver on the outcomes outlined above. It is expected that these strategies will require Council to work closely with the NSW Department of Planning and Environment to establish requirements through both state policy as well as LEP and DCP controls. Note: the targets outlined in this table are preliminary only.

A key implementation mechanism for Council and DPE is to establish higher BASIX targets (Energy and Water) across the precinct. This will ensure residential dwellings meet the performance outcomes outlined in this report but provide developers with the design and technology choice on how these performance outcomes are met. To determine whether the BASIX Energy and Water targets proposed for the Frenchs Forest Precinct are appropriate, a cost-benefit analysis has been undertaken and is outlined below.

Strategy	Potential Implementation Mechanisms	Next Steps
Residential dwelling: Building efficiency Renewable energy Water reuse	**BASIX targets** BASIX Energy 55 (draft) BASIX Water 55 (draft)	• Cost benefit analysis to determine applicability of targets for Frenchs Forest Precinct (see next section of this report) • Work with DPE to amend BASIX for Frenchs Forest Precinct.
Non-Residential buildings: Building efficiency Renewable energy Water reuse	**NABERS Commitments** (office & hotels) 5.5-star Energy, 3-star Water. **Minimum Green Star** Design & As Built ratings 4-star for all other non-residential building types. **Minimum** water reuse and renewable energy requirements for non-residential buildings for key new assets (i.e. school, library, community centre)	• Review with Council other example LEP and DCP controls for non-residential buildings to determine appropriate inclusions for Frenchs Forest Precinct.
Electric Vehicles	LEP - all off-street parking is EV ready	LEP review to include EV charging.
Parking Controls	**Choice** to purchase parking with sale of apartment (unbundled parking) **Build** separate parking facility where spaces can be purchased or leased by residents (decoupled parking)	• Develop LEP requirements that could allow for decoupled and unbundled parking across the Frenchs Forest Precinct. • Review and revised parking rates based on new LEP requirements.
Car Share	Car share policy	• Develop car share policy for Northern Beaches Council and Frenchs Forest Precinct in particular. • Review parking rates in relation to this policy. • Approach car share provider to understand potential car share solution for the precinct.

Table 3: Potential implementation mechanisms available to Council to deliver on the building level strategies investigated by Kinesis.

BASIX COST-BENEFIT ANALYSIS

The following cost-benefit analysis was undertaken to determine the additional capital costs and household savings associated with increasing BASIX targets for the Frenchs Forest Precinct.

Under current compliance, new residential apartments at Frenchs Forest are required to deliver the following:

Current BASIX Compliance:

	BASIX Energy	BASIX Water
High-rise apartment (6+ storeys)	25	40

Proposed BASIX Targets for Frenchs Forest:

	BASIX Energy	BASIX Water
High-rise apartment (6+ storeys)	55	55

Tables 4 and 5 incorporate technology and infrastructure measures that vary between the Base Case (BASIX Minimum Compliance) and Kinesis' modelled opportunities scenario which reflects what is expected to be required to achieve BASIX Energy 55 and BASIX Water 55.

Based on analysis by Kinesis, it is expected that these outcomes can be achieved for a marginal capital cost (or cost premium above the Base Case) of approximately $4,100 per dwelling[8], saving households close to $600 per year in energy and water bills.

Estimated Higher BASIX Requirements Costs & Benefits

Marginal Capital Cost	Energy Saving - $	Water Saving - $	Total Saving - $	Simple Payback - (years)
$4,100	510	70	580	7.1

Table 4: Potential implementation mechanisms available to Council to deliver on the building level strategies investigated by Kinesis.

Estimated Higher BASIX Requirements and Estimated Capital Costs

	Technology	Base Case	Opportunities Scenario	Marginal Capital Cost ($)
ENERGY (estimated strategies to achieve BASIX Energy 55 for +6 storey apartments)				
	Hot water system	Gas Instantaneous	Gas Instantaneous	$0
	Thermal Design (NatHERS)	5-star average	6-star average	$370
	Space heating and cooling	2-Star reverse cycle A/C	5-Star reverse cycle A/C	$360
	Lighting	Standard (Halogen/CFL)	Efficient (LED)	$560
	Dishwasher	2.5-star Energy 2.5-star Water	4-star Energy 4-star Water	$200
	Washing machine	2.5-star Energy 2.5-star Water	4-star Energy 4-star Water	$280
	Dryer	1-star Energy	2-star Energy	$500
	Fridge	1.5-star Energy	3-star Energy	$390
	Cooking	Electric cook-top Gas oven	Electric cook-top Gas oven	$0
	Renewables	None	Solar PV - 0.2 kW/dwelling	$220
	Ventilation	Standard	CO2 Sensor	$100
	Lighting	Standard	Motion sensor	$100
WATER (estimated strategies to achieve BASIX Water 55 for +6 storey apartments)				
	Toilet	3-star WELS	4-star WELS	$130
	Tapware	4-star WELS	5-star WELS	$200
	Showerhead	3-star WELS	3 plus-star WELS	$80
	Rainwater tanks	0.2kL per dwelling with connection to Irrigation	0.5kL per dwelling with connection to Irrigation, toilet & laundry	$600
TOTAL MARGINAL CAPITAL COST				**$4,100/dwelling**

Table 5: Estimated capital cost of higher BASIX targets

[8]Capital costs outlined above are indicative only, and should not be considered appropriate for a regulatory impact statement, but simply an estimate based on high level cost estimates.

GREEN STAR COMMUNITIES

Accreditation under the Green Star Communities rating tool is being targeted for the Frenchs Forest Precinct. The combination of the opportunities and strategies identified above will assist in the delivery of this rating across a number of targeted strategies.

Green Star Communities requires the establishment of a Reference Case development which is calculated based on:

- The local conditions of the standard energy and water supply available to the site;
- Construction of all non-residential and residential buildings to achieve minimal compliance with the NCC provisions;
- Construction of all residential buildings to achieve a minimum BASIX compliance

This report establishes and calculates a transparent Reference Case for the Frenchs Forest Precinct which meets this criteria to allow comparison for performance based analysis across the following key credits areas.
When compared to the Reference Case, French Forest Planned Precinct, with the recommended building scale strategies outlined in the prior sections, is expected to:

- Reduce greenhouse gas emissions by ~35%, and
- Reduce mains water demand by ~30%

With these results, when assessed through the performance pathway under Green Star Communities, the precinct is expected to achieve will achieve:

- Credit 25 (Greenhouse Gas Strategies) - ~3 points
- Credit 24 (Integrated Water Cycle) - ~2.5 points

These results will be reviewed and fully documented for Green Star Communities submission as the strategies for the precinct are refined.

As noted above, the FLUX Sustainability Plan estimates the strategies recommended in the plan would deliver a 55% reduction in precinct wide greenhouse gas emissions and a 44% reduction in mains water consumption. However, when the FLUX Sustainability Plan was prepared, the Reference Case (building code and BASIX compliance) delivered a lower performance outcome than now. Recent increases in BASIX targets means that the overall percent reduction delivered by the Frenchs Forest Precinct will be less than estimated by FLUX.

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FINAL REPORT

Frenchs Forest Planning Precinct WSUD strategy

December 2019

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Contact:

Name	Alluvium Consulting Australia Pty Ltd
ABN	76 151 119 792
Contact person	Mark Wainwright
Ph.	0417 208 130
Email	mark.wainwright@alluvium.com.au
Address	Suite 9, 744 Hunter Street, Newcastle West

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Contents

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Tables

1 Introduction

The NSW government has identified Frenchs Forest as a Planned Precinct within the North District Plan. The Frenchs Forest Planning Precinct (FFPP) includes the Northern Beaches Hospital property, the proposed Frenchs Forest Town Centre (FFTC) and surrounding future medium density residential / mixed use development. FFPP is to be developed over the next 20 years in three phases and will ultimately provide over 4,360 new dwellings and support 3,093 jobs. The extents of each development phase within the FFPP is shown in Figure 1-1.

Figure 1-1 *Frenchs Forest Planning Precinct Phasing Strategy (NBC, 2017 – Structure Plan)*

The Phase 1 precinct including the FFTC is the primary focus of this WSUD strategy. The Draft Frenchs Forest Town Centre Urban Design Report and Public Domain Strategy (CHROFI, 2018) outlines the 'masterplan' for development in the FFTC and includes the design vision and principles that inform the urban design. The FFTC is being planned to include a range of dwelling types, cafes, restaurants, retail shops, public buildings, commercial and health based uses and a large open space area referred to as the village green.

Land within the FFPP is highly valued for a range of future urban land uses. Council is seeking to minimise the land required to be dedicated exclusively to stormwater management, whilst ensuring that stormwater runoff quality and quantity can be managed to protect sensitive receiving environments. The FFTC masterplan does not include dedicated land parcels for managing stormwater quality and other areas in the FFPP have limited potential for centralised stormwater quality management measures.

The FFTC masterplan includes some discussion on future stormwater quality management controls, but to date no specific WSUD strategy has been prepared for the FFPP. Council is seeking a WSUD strategy that focuses on distributed source-based measures that can be strategically positioned within private development lots, private road reserves, public road reserves and public footways. Council intends that road reserves within the FFTC are retained in private ownership. The FFPP also includes three public reserves that are to be improved for the community's use and these upgrades are expected to provide an opportunity to incorporate WSUD measures at a larger sub-catchment scale.

The recommended WSUD strategy is outlined in the following sections of this report:

- Section 2 outlines the existing and planned future development characteristics in the FFPP.
- Section 3 summarises some of the key site characteristics that influence selection of the types and locations of WSUD measures.

- Section 4 summarises key state and local government planning legislation, policies, strategies and guidelines that include objectives that would be supported through the implementation of WSUD.
- Section 5 summarises Council's current stormwater quality management objectives and targets that would apply to development in the FFPP. Recommendations are provided in this section on opportunities to update these objectives and targets.
- Section 6 outlines WSUD measures considered for the FFPP and their suitability based on the objectives, targets, development characteristics and site constraints.
- Section 7 outlines the recommended base WSUD strategy for the FFPP. The base WSUD strategy represent the fundamental components that would be required to achieve the targets.
- Section 8 provides conceptual sketches of base WSUD strategy measures.
- Section 9 outlines the MUSIC modelling completed to evaluate the conceptual configuration and extents of WSUD measures within the base WSUD strategy.
- Section 11 outlines preliminary cost estimates for the measures.

2 Development planning

2.1 Existing development

The Northern Beaches Hospital that was recently constructed adjacent to the existing Forest High School is a major development in the area. Major roads including Warringah Road, Wakehurst Parkway, Forest Way and Frenchs Forest Road traverse the FFPP. Historically, the Forest High School site was a large orchard where loquats, persimmons, lemons and other fruit were grown. Remnants of this orchard exist adjacent to the Forest High School grounds. Other existing major developments in the FFPP include the Forestway Shopping Centre, Frenchs Forest Public School and Frenchs Forest Police Station. A number of other businesses front Forest Way. The remaining land is primarily low density residential comprising individual detached dwellings.

2.2 Future development

The Northern Beaches Hospital was constructed over the 2015 to 2018 period. During construction of the Northern Beaches Hospital, the NSW government announced that Frenchs Forest would be included as a Planned Precinct in the North District Plan. The Frenchs Forest Planning Precinct (FFPP) was delineated to incorporate the Northern Beaches Hospital site, the adjacent Frenchs Forest Town Centre (FFTC) and surrounding increased density residential and mixed use development. The proposed LEP land zoning incorporated into the FFPP structure plan is shown in Figure 2-1.

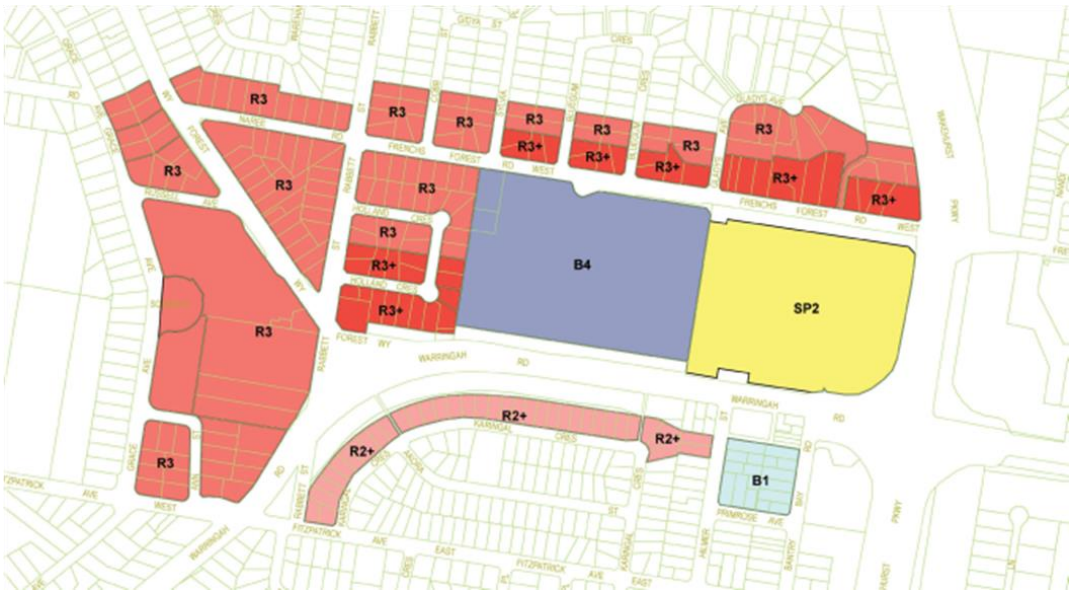


Figure 2-1 *Frenchs Forest Planning Precinct – Proposed land uses (NBC, 2017 – Structure Plan)*

The FFPP is to be developed over the next 20 years in 3 phases including Phase 1 (immediate), Phase 2 (< 10 years) and Phase 3 (> 10 years). The extents for each development phase are shown in Figure 1-1 and discussed further below.

2.3 Phase 1 precinct

Phase 1 of the FFPP includes the Northern Beaches Hospital, the proposed Frenchs Forest Town Centre (FFTC) (the current Forest High School site), a neighbourhood centre and a proportion of the low and medium density residential development. The Phase 1 precinct is the primary focus of this WSUD strategy.

Phase 1 will provide over 1,930 of the planned 4,360 new dwellings, and 2,981 of the planned 3,093 new jobs. The FFTC is being planned to include a range of housing types, cafes, restaurants, retail shops, public buildings, commercial and health based uses, and a large central open space area.

Figure 2-2 *Frenchs Forest Planning Precinct – Phase 1 extents (source: NSW Department of Planning and Environment)*

The Frenchs Forest Town Centre Urban Design Report and Public Domain Strategy (CHROFI, 2018) outlines the 'masterplan' for development in the FFTC and includes the design vision and principles that inform the urban design.

The masterplan promotes the inclusion of a large central park or village green (area exceeding 6,000 m^2) in the FFTC development to provide a significant space that supports a diverse range of passive and active recreational uses for the community. It is envisaged that the village green would be utilised by office and retail workers, university students and residents. Initial concepts indicate this area would include a high proportion of level grassed open space. We understand that the design intent for this area is to keep the village green open and relatively free of obstructions that may impede views across the space.

The masterplan includes provision for retention of remnant mature urban forest for utilisation as an informal exercise and play area that enhances community well-being and social interactions. This space would be adjacent to the village green area.

The FFTC includes a number of key public domain areas that are intended to have different functions and landscaping objectives. The key public domain areas are described below and shown in Figure 2-3.

1. Piazza – Hard paved landscaped area central to the town centre.
2. Village green – Large open lawn park for exercise and potentially events including outdoor cinema and weekend markets.
3. Remnant forest and orchard – Remnant urban forest and orchard providing space for community gardens, exercise and picnics.
4. Fresh food court – Forecourt near access to retail areas including water features and lush planting.
5. Hospital connector – Linear pedestrian connection from the piazza to the hospital.
6. High street – Frenchs Forest Road footway.
7. Southern gateway – Existing pedestrian link and bridge over Warringah Road.
8. Future overpass - New pedestrian bridge over Warringah Road.
9. Neighbourhood centre – Retail centre separated from the main FFTC site by Warringah Road.

Figure 2-3 *Public domain and landscaping spaces (CHROFI, 2018)*

Major roads surrounding the hospital are currently being upgraded to support the hospital and urban renewal in Frenchs Forest.

Residential units are planned for multi-storey buildings ranging in height from 2 storeys up to 12 storeys throughout the FFPP.

2.4 Phase 2 precinct

The Phase 2 precinct includes land between the FFTC and Forest Way. The existing land is primarily low density detached residential dwellings with the exception of the Frenchs Forest Police Station and some small businesses with frontages to Forest Way. All existing low density residential development in this precinct is planned to be converted to medium and high density housing.

Multi-storey high density residential apartment buildings are planned in the elevated parts of this precinct adjacent to the Forest Way / Warringah Road intersection. Residential units will be included in multi-storey buildings ranging in height from 2 storeys up to 12 storeys.

Opportunities for centralised management of stormwater runoff within this precinct are limited by steep terrain and with the exception of Rabbett Reserve, limited availability of appropriately zoned land. It is likely that distributed source based treatment of stormwater will necessarily be a key focus for the area.

2.5 Phase 3 precinct

The Phase 3 development precinct includes land between Forest Way, Warringah Road and the riparian areas in the upper reaches of Carroll Creek. A large proportion of the Phase 3 precinct is currently occupied by the Forestway Shopping Centre, Frenchs Forest Public School and surrounding mixed business and low density residential uses. All land in this precinct is planned to be converted to medium density housing. Residential units will be included in multi-storey buildings ranging in height from 2 storeys up to 12 storeys.

2.6 Preliminary stormwater management strategy

The masterplan outlines a preliminary stormwater management strategy for the FFTC. Preliminary ideas for management of stormwater quality within FFTC were suggested for that site. Key themes include providing permeable paving in the piazza, bioretention tree bays along streets, stormwater gardens/bioretention basins in the village green, green roofs, linear ponds, rainwater tanks, gross pollutant traps and OSD/drainage infrastructure. Many of the ideas included in this preliminary strategy are considered applicable to FFTC.

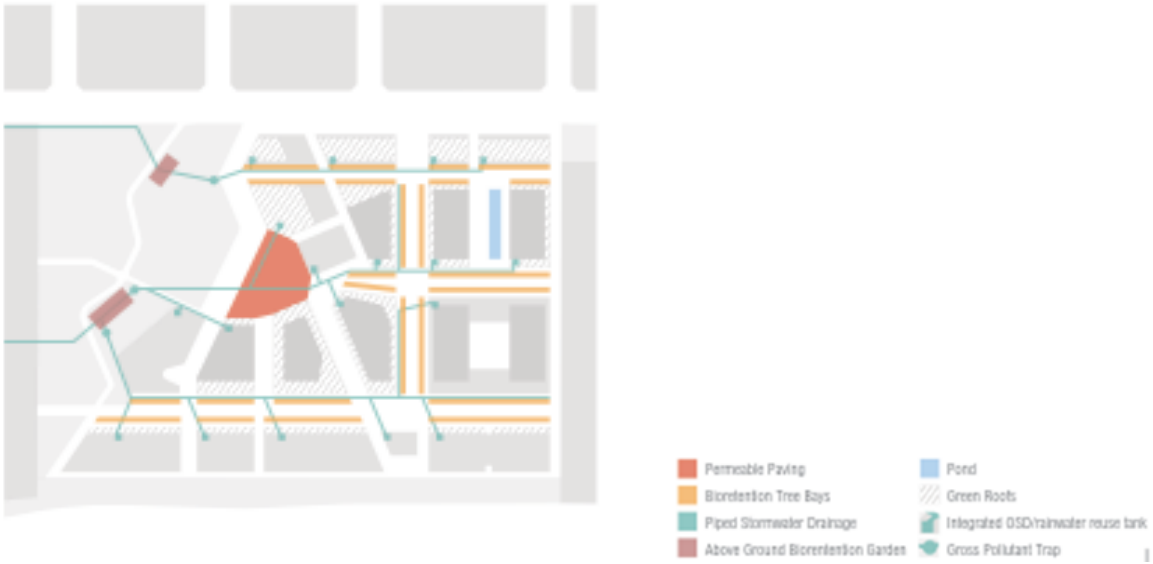


Figure 2-4 *Preliminary WSUD strategy (CHROFI, 2018)*

3 Site analysis

3.1 Drainage and overland flooding

The FFPP follows a ridgeline that separates the precinct into upper catchment areas for multiple receiving environments including Narrabeen Lagoon, Manly Dam, Bantry Bay and Middle Harbour. The majority of planned re-development areas within the FFPP will drain in a northerly directly to Narrabeen Lagoon. The sub-catchment extents for particular receiving waterways are shown on Figure 3-1.

The existing stormwater drainage system in the FFPP is generally aligned with public roads. The main exception is an existing piped drainage system through private residential land between the FFTC site and Rabbett Reserve. This drainage system follows what previously would have been a natural creek. It is apparent that this creek has been infilled and residential development constructed over. Review of contours and available flood mapping (Mott McDonald, 2018) indicate that extensive overland flow would occur through these properties during large flooding events and periods where the existing drainage system is blocked, or the flow capacity of the drainage system exceeded. Ideally, re-development of land in this existing residential area located within the Phase 2 Precinct would include redefining an overland flow path through public land. WSUD measures in this precinct should be provided outside overland flow paths to avoid impacts on flooding behaviour or redistribution of flows.

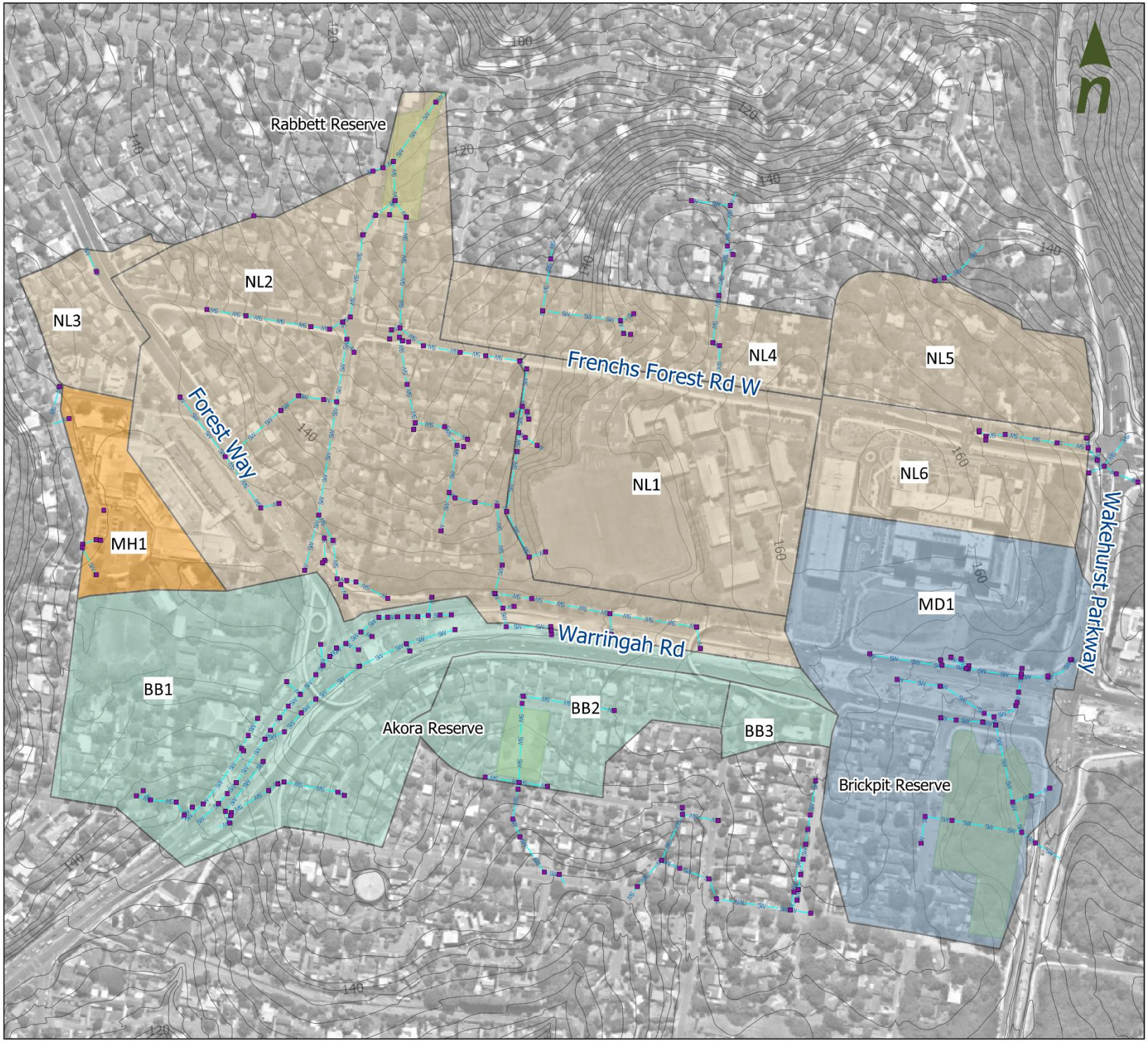
3.2 Terrain

The existing terrain is typically a key challenge to WSUD in any development area. Typical gradients across the FFPP are show in Figure 3-2. Within the FFPP there are distinctive differences in gradient across the future development areas.

The Phase 1 precinct aligns with a ridge that separates the Narrabeen Lagoon and Middle Harbour catchments. The Phase 1 precinct will primarily be gently grading except in the proposed residential areas on the northern side of Frenchs Forest Road and within a remnant urban forest area adjacent to the future FFTC. The existing terrain in this precinct is likely to be amenable to a range of source, street and precinct scale WSUD measures.

The Phase 2 precinct includes relatively steep land with gradients exceeding 10% over a high proportion of the precinct. The steep gradients in this precinct form a major constraint to a range of WSUD measures. There is potential that stormwater treatment of minor flows could be incorporated into the downstream Rabbett Reserve, although the size of the upstream catchment is likely to result in minor treatment outcomes. The steep gradients are likely to restrict WSUD measures to lot scale source based controls in planned residential development lots and localised street scale measures in locations where road gradients are amenable.

The Phase 3 precinct straddles a ridge separating the Narrabeen Lagoon and Carroll Creek catchments. Similarly, to the Phase 1 precinct, the land is primarily gently grading and would be appropriate for a range of source, street and precinct scale WSUD measures.



French's Forest Precinct

Figure 3-1 - Subcatchments and drainage

Legend

Stormwater assets

- Pits
- Drainage pipes

Cadastral

- Reserves
- Contours (2m)

Receiving waters

- Carroll Creek to Middle Harbour
- Manly Creek to Manly Dam
- Unnamed Creek to Bantry Bay
- Middle Creek to Narrabeen Lagoon

0 100 200 m

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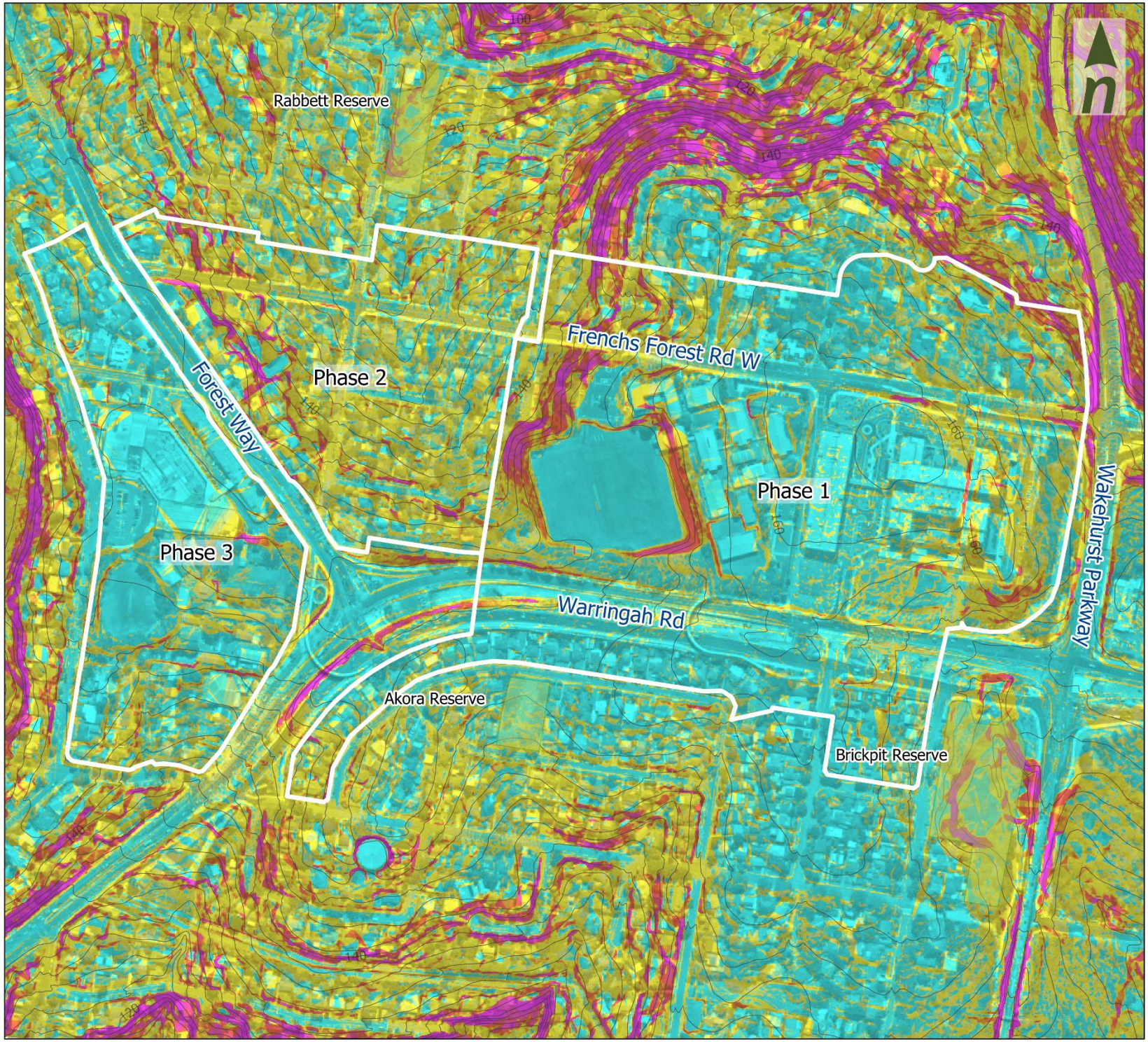

French's Forest Precinct

Figure 3-2 - Terrain

Legend

- 2m Contours

Slope gradient (%)

- 0-5%
- 5-10%
- 10-25%
- 25-50%
- > 50%

0 100 200 m

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3.3 Soils and groundwater

The soil landscapes found across the FFPP are shown on Figure 3-4 . As can be observed, most of the FFPP aligns with the Lucas Heights (lh) soil landscape formed along an undulating plateau where gradients less than 10% are typical. Lucas Heights soils typically comprise a loose fine grained sandy loam (lh1) layer up to 0.3m overlying a 0.1 to 0.3m layer of stony hard setting fine grained sandy clay loam (lh2). The sandy clay loam layer is typically underlain by a sandy to heavy clay layer (lh4) with a depth up to 1m. The depth to shale bedrock is typically less than 1m. On the edges of the plateau, soils may lie directly on Hawkesbury sandstone bedrock. The typical soil profile is show in Figure 3-3.

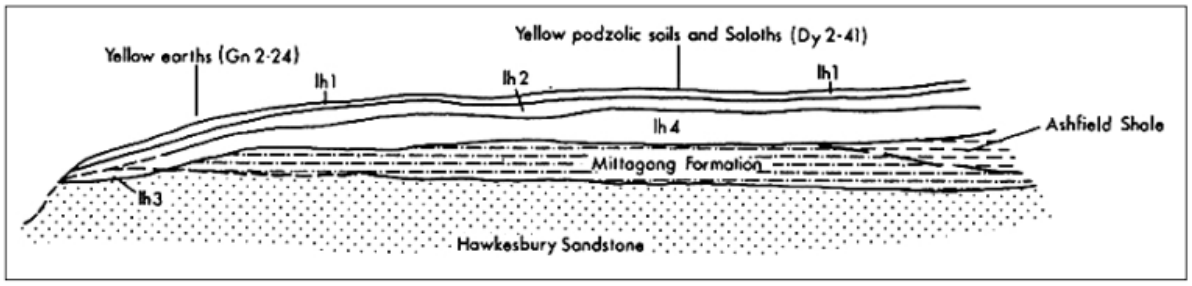

Figure 3-3 *Typical Lucas Heights soil landscape cross section (Chapman and Murphy, 1989)*

Along the western and northern fringes of the FFPP the land transitions to steeper gullies and the soils change to typical Hawkesbury soils. These soils are typically discontinuous in the areas with sandstone outcrops and boulders covering over 50% of the surface. On rock benches, shallow sandy soil layers have formed with the total soil depth typically less than 0.7m.

The upper Lucas Heights soil layers typically have high permeability and would be suitable for shallow infiltration of stormwater. Sandy loam soils are ideal for a range of biofiltration measures including tree pit filters, stormwater gardens, biofiltration swales and basins. The total soil depth of around 1m is relatively shallow and requires consideration when designing treatment measures. As gradients increase above 5% there would be increased risk of erosion where stormwater is concentrated across these soils.

Hawkesbury soils will typically be unsuitable for many WSUD measures due to the widespread presence of sandstone outcrops and boulders. The shallow depth to bedrock would be a key constraint in these areas.

It is expected that shallow groundwater would be recharged by local rainfall and move along the interface between the sandy and clay soils layers during large recharge events. It is envisaged that groundwater would emerge as baseflow at the interface between the bedrock and soils in gullies and creeks that drain the area, and potentially through springs along the hillslopes. Ensuring that concentrated infiltration of stormwater at particular locations in the development area does not increase seepage into existing downslope properties is an important consideration for the WSUD strategy.

3.4 Existing services and infrastructure

Existing services and infrastructure have been identified through a dial-before-you-dig enquiry focusing on the public reserves where consideration is being given to constructing centralised stormwater treatment measures. Indicative locations of services are shown on concept figures for the reserves.

French's Forest Precinct

Figure 3-4 - Soil landscapes

Legend

Soil Landscapes

- DISTURBED TERRAIN
- GYMEA
- HAWKESBURY
- LAMBERT
- LUCAS HEIGHTS
- OXFORD FALLS

Phases

- Phase 1
- Phase 2
- Phase 3

0 100 200 m

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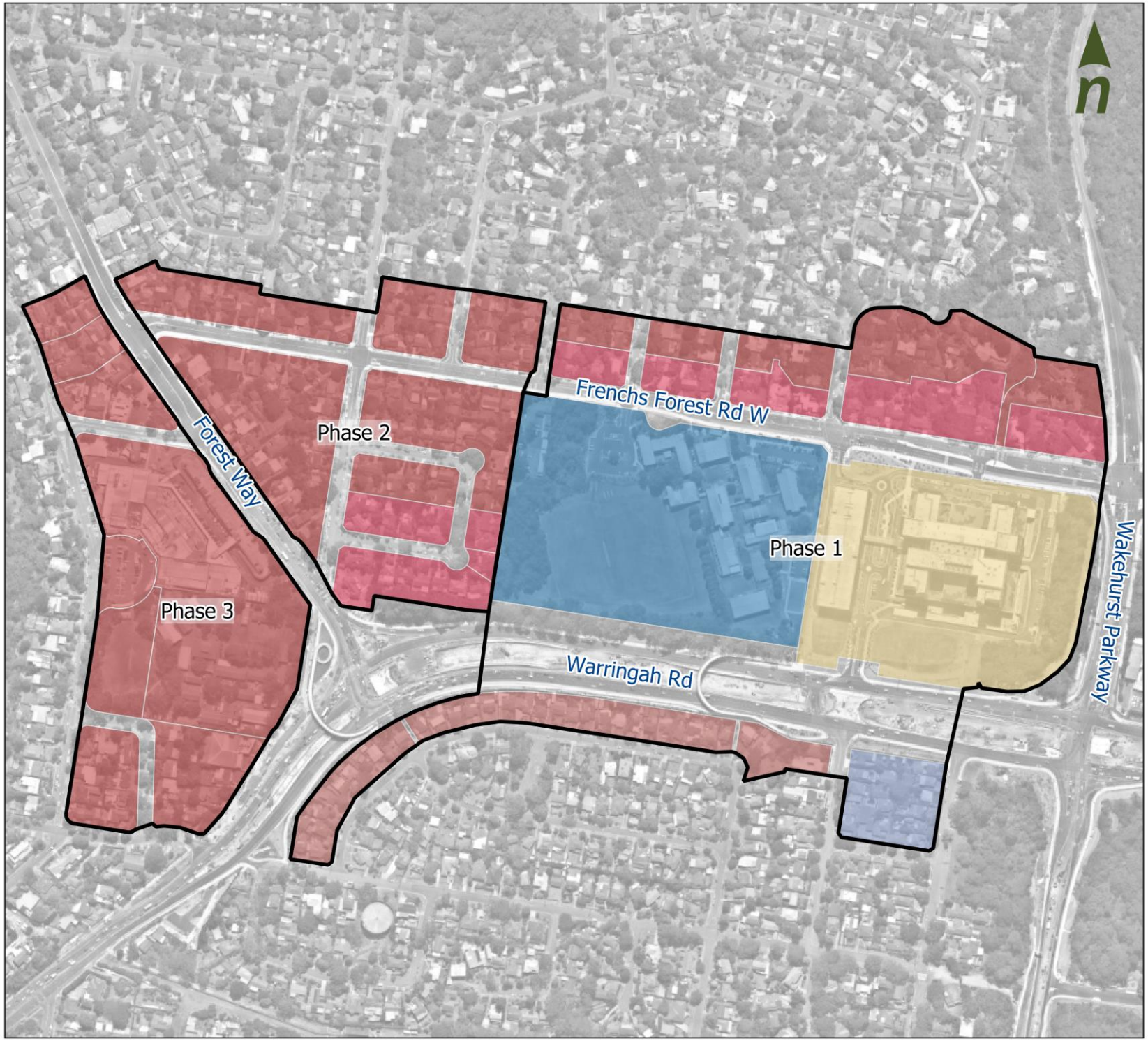

French's Forest Precinct

Figure 3-5 - Anticipated land zoning

Legend

LEP land zoning

- B1
- B4
- R2+
- R3
- R3+
- SP2
- Phases

0 100 200 m

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3.5 Receiving environments

The receiving environments that accept stormwater runoff from the FFPP are shown in Figure 3-6 and briefly discussed below.

The FFPP straddles a ridge aligned with Warringah Road and Forest Way that traverses the precinct. The Phase 1 precinct includes the FFTC and future residential development initially draining north to Middle Creek prior to flowing into Narrabeen Lagoon. The Phase 1 precinct also includes future residential development south of Warringah Road that drains south to an unnamed creek and then into Bantry Bay. The existing Northern Beaches Hospital within the Phase 1 precinct and a small area of future business and residential development south of Warringah Road drains through Brickpit Reserve to Curl Curl Creek and then into Manly Dam.

The initial receiving environments for stormwater runoff from FFPP are all ephemeral creeks that are typically steep due to their location in the upper reaches of each catchment. Management of both runoff quality and quantity from the development areas will be important to mitigate potential impacts on these creeks. Protection of these creeks will assist to protect water quality in downstream receiving environments including Narrabeen Lagoon, Middle Harbour and Manly Dam that are highly valued by the community.

The Warringah Creeks Study (Warringah Council, 2004) identified a number of key threats to the creeks that receive runoff from the FFPP. A large portion of the FFPP drains to Middle Creek, and the upper reaches of Middle Creek downstream of the FFPP were observed to have bank erosion issues due to altered flow conditions associated with urban development. It was recommended that bank stabilisation in the steeper upper reaches be planned to reduce weed transfer and sediment supply to lower reaches of the creek and Narrabeen Lagoon.

The western portion of the FFPP drains to Carroll Creek comprising steep headwater reaches draining to narrow gorge upstream of Middle Harbour. Management of runoff quality from urban development was identified as particularly critical for this creek. The southern parts of the FFPP drain to an unnamed creek that drains into Bantry Bay. Bank stabilisation and weed removal were identified as priorities for this creek. A minor proportion of the FFPP including part of the new Northern Beaches Hospital and land south of Warringah Road drains to the uppermost reach of Curl Curl Creek flowing to Manly Dam. Curl Curl Creek was identified as being highly impacted by weeds and high concentrations of water pollutants were detected.

3.6 Improved liveability

In addition to managing stormwater quality and quantity, sensitive integration of the stormwater quality management elements into the urban landscape can support a range of physical health, mental health and social co-benefits. Some key benefits that can be supported by WSUD include:

- Urban cooling benefits through the provision of increased vegetation canopy and reduced impervious surfaces.
- Improved amenity through the integration of stormwater management facilities with landscaping treatments.
- Increased opportunities for social interactions through the creation of attractive landscaped public open spaces that merge stormwater quality management with passive recreation.
- Integration of physical exercise equipment into enhanced urban forest areas.

French's Forest Precinct

Figure 3-6 - Frenchs Forest receiving environments

Legend

- Watercourses
- Receiving environment
- Frenchs Forest precinct

0 1 2 km

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4 Planning policies and guidelines

4.1 NSW environmental planning hierarchy

The current NSW environmental planning hierarchy is shown in Figure 4-1. The relevance of the various planning instruments to the management of stormwater from new development in the FFPP is discussed below.

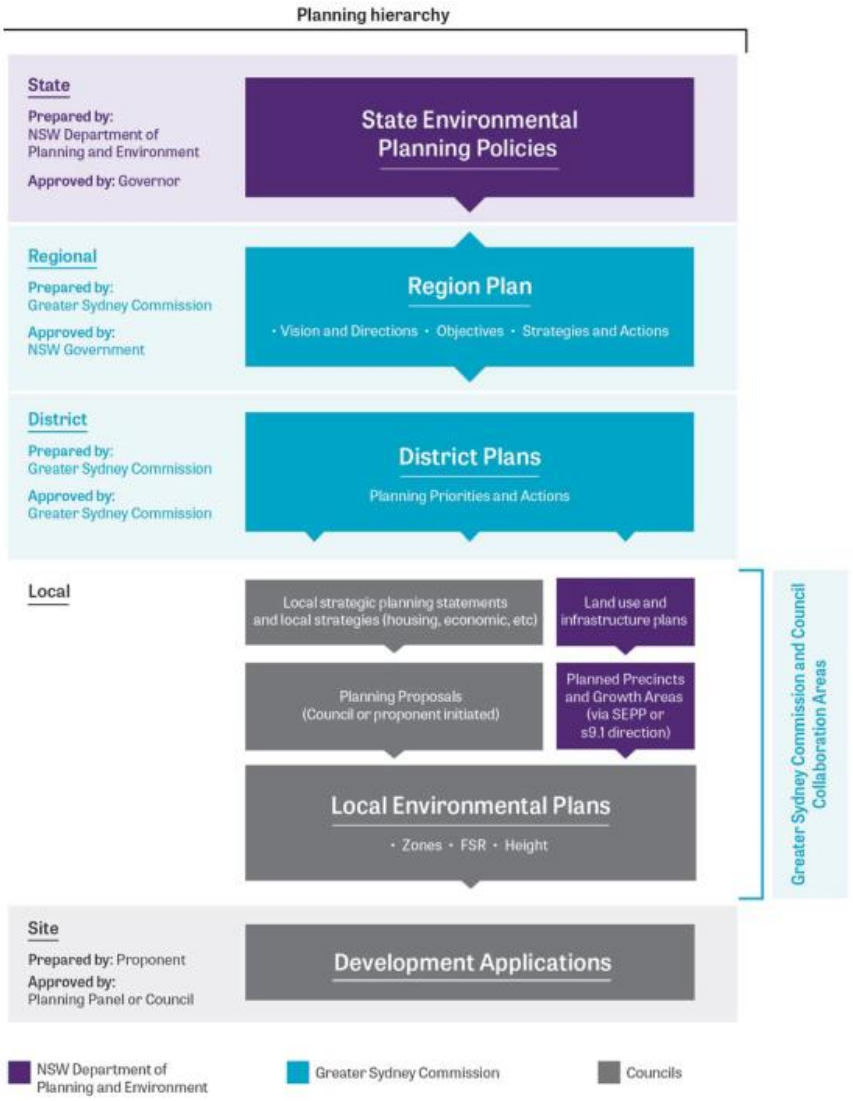


Figure 4-1 *NSW environmental planning hierarchy*

4.2 State Environmental Planning Policies

SEPP (Coastal Management) 2018

This SEPP combines three repealed SEPPs (coastal wetlands, littoral rainforests and coastal protection)

The FFPP lies outside (but is close to) the mapped Coastal Environment Area in SEPP (Coastal Management) 2018 and other mapped coastal wetland and littoral rainforest areas. At this stage, no mapping is available for coastal vulnerability areas. The SEPP requires that development consent for development located with the mapped Coastal Environment Area shall not be granted unless the consent authority has considered whether

the development is likely to cause an adverse impact on a range of issues, include a number that are relevant to urban stormwater management including:

- *the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,*
- *coastal environmental values and natural coastal processes,*
- *the water quality of the marine estate (within the meaning of the Marine Estate Management Act 2014), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,*
- *marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,*
- *Aboriginal cultural heritage, practices and places,*

Although the FFPP lies just beyond the mapped Coastal Environment Area extents, the principles outlined in the SEPP are also relevant to future development in this area as stormwater from the FFPP also drains to these protected areas.

4.3 Regional Plan - The Greater Sydney Region Plan – A Metropolis of Three Cities

This document outlines the Greater Sydney regional plan for the next 40 years. The regional plan provides a vision for the city that includes directions for future infrastructure, liveability, employment and sustainability.

The plan includes 40 objectives. *Objective 25 - The coast and waterways are protected and healthier* is the main objective that would be addressed through management of urban stormwater runoff in the FFPP. Other objectives relevant to stormwater management include:

- *Objective 27 – Biodiversity is protected, urban bushland and remnant vegetation is enhanced.*
- *Objective 30 – Urban tree canopy cover is increased.*
- *Objective 31 – Public open space is accessible, protected and enhanced.*
- *Objective 32 – The green links parks, open spaces, bushland and walking and cycling paths.*

Key strategies linked to Objective 25 include protecting environmentally sensitive waterways and coastal environments, enhancing liveability and improving the health of catchments and waterways. Strategy 25.3 has a specific target to improve the health of catchments and waterways through a risk-based approach to managing the cumulative impacts of development. DPIE promotes the use of a risk-based framework across catchments to help improve the health of catchments and waterways through a structured approach that:

- Considers the effects of land use change, development and the management of public land on waterways;
- Shows how better management of development can help meet environmental targets for waterways; and
- Provides options for appropriate management responses across entire catchments.

Whilst the risk-based approach promoted by DPIE has not specifically been progressed for the catchments impacted by future development in the FFPP, consideration of the potential impacts on the creeks, lagoons and estuaries receiving stormwater runoff from the FFPP has been included in preparation of this WSUD strategy.

4.4 District Plan - North District Plan

The North District Plan (NDP) sets out planning priorities and actions for improving the quality of life for residents as urban areas change and development progresses in the district. The NDP includes Frenchs Forest as key strategic centre and planned precinct. Frenchs Forest is an emerging strategic centre supporting employment growth associated with the recently constructed Northern Beaches Hospital.

The NDP outlines infrastructure, liveability, productivity and sustainability planning priorities for areas within the Sydney Metropolitan Area north of the Parramatta River, east of Castle Hill and south of the Hawkesbury River. Key planning priorities that are relevant considerations for WSUD in the FFPP include:

N6 – Creating and renewing great places and local centres and respecting the District's heritage.

This involves improving community access to open spaces. From a stormwater management perspective, it could involve creating shared spaces that function for community recreation during dry weather that can also function to support stormwater runoff management during wet weather.

N15 – Protecting and improving the health and enjoyment of Sydney Harbour and the District's waterways.

Waterways are identified as a key contributor to green infrastructure for cooling urban areas, providing a recreational destination and supporting a range of ecological communities reliant on water. The waterways also form a key component of the stormwater drainage system for urban catchments including French Forest.

The NDP identifies that urban development in Frenchs Forest will significantly increase impervious area and this has the potential to significantly increase stormwater runoff, leading to reduced water quality, discharge of contaminants into the waterways and loss of habitat. The WSUD strategy for the FFPP should assist to prevent impacts in existing waterways and enhance their values wherever possible.

The NDP aims to integrate the waterway objectives set out in legislation, policies and plans by prioritising the management of waterways and green infrastructure by:

- Reconceptualising waterways as an infrastructure asset;
- Integrating protection of waterways with other urban infrastructure; and
- Addressing the cumulative impacts of development and land use management across the catchments on the waterways

N16 – Protecting and enhancing bushland and biodiversity.

Many urban bushland areas are susceptible to edge effects from stormwater pollution.

N19 – Increasing urban tree cover and delivering Green Grid connections.

A key objective is to increase urban tree canopy. Tree lined streets have a significant impact on mitigating the urban heat island effect. It is recognised that urban renewal and transformation projects such as the FFPP have a critical role to play in increasing urban tree cover. Whilst opportunities for planting large trees may be limited in highly built up areas such as FFPP, provision of smaller trees, ground covers and native grasses can play a significant role through incorporation into stormwater gardens, green roofs and green walls. This planting can also perform a dual role of treating stormwater quality by filtering out pollutants.

N20 – Delivering high quality open space.

Urban renewal in areas such as FFPP creates opportunities to increase and improve the quality of open space areas. For the FFPP, local open space areas will be highly valuable spaces for workers to relax and for residents to meet and socialise. Ensuring that a large proportion of these areas is not exclusively dedicated to stormwater treatment and can serve multiple uses will be important.

N21 – Reducing carbon emissions and managing energy, water and waste efficiently.

Stormwater harvesting from roofs and potentially ground level paved areas can support many of the water efficiency approaches to be incorporated into sustainable building design.

N22 – Adapting to the impacts of urban and natural hazards and climate change.

Local overland flooding in FFPP will need to be managed to avoid exposing the community to high hazard flooding or increased flooding impacts. Development in FFPP should aim to cool the landscape by retaining water and increasing urban tree canopy.

4.5 Northern Beaches Council

Shape 2028 (Northern Beaches Community Strategic Plan 2018 – 2028)
Shape 2028 outlines the Northern Beaches Communities 10-year plan that identifies the main priorities and aspirations of the community for their local government area. Shape 2028 represents the highest level of strategic planning undertaken by Council. Whilst Council has the responsibility to prepare and maintain the community strategic plan, responsibility for implementing the plan is shared by state agencies, community groups and individuals within the community.

Shape 2028 clearly outlines the communities desire to see protection of the natural environment from the risks and impacts of local pressures. Key goals include that bushland, coast and waterways are protected to ensure safe and sustainable use for present and future generations; and that the built environment is developed in line with best practice sustainability principles. Strategies proposed to achieve this include:

- Protect and restore local biodiversity and bushland.
- Protect and improve ecological conditions in catchments, creeks and lagoons.
- Protect sustainable access to the natural environment, whilst recognising and protecting its cultural and heritage value.
- Ensure integrated land use planning balances the environmental, social and economic needs of present and future generations.
- Create green and resilient urban environments by improving tree cover, native vegetation, landscaping and water management systems.
- Promote the savings and benefits of ecologically sustainable development.
- Continually improve environmental standards and compliance in new and existing developments.

Local Strategic Planning Statement
The Environmental Planning and Assessment Act 1979 (EP&A Act) was amended in 2018 to introduce new requirements for councils to prepare and make local strategic planning statements (LSPS). An LSPS outlines a 20-year vision for land use in the local area including:

- the special characteristics which contribute to local identity;
- shared community values to be maintained and enhanced; and
- how growth and change will be managed into the future.

Councils will need to illustrate how their vision gives effect to the regional and district plans, based on local characteristics and opportunities, and the council's own priorities in the community strategic plan prepared under the Local Government Act 1993. The local area may be an entire local government area or could be based on separate wards in each LGA. They differ to community strategic plans which have a broader focus on social, environmental and economic aspirations of the community.

Once implemented, the LSPS will be the key resource to understand how strategic and statutory plans will be implemented at the local level. It will be important that the LSPS includes statements supporting the implementation of a WSUD strategy in the FFPP.

Warringah Local Environment Plan 2011
Northern Beaches Council is progressing the consolidation of the Warringah LEP, Pittwater LEP and Manly LEP into a new Northern Beaches LEP. The Warringah LEP 2011 currently applies to development in the FFPP.

The Warringah LEP 2011 does not include any specific miscellaneous or local provisions directly addressing the protection and management of water quality. We understand that specific clauses relevant to water quality are being considered for incorporation into the new Northern Beaches LEP.

Warringah Development Control Plan 2011
Similarly to the LEP, Northern Beaches Council is currently progressing with consolidating existing DCPs for the merged Councils into one Northern Beaches DCP.

The Warringah DCP 2011 currently applies to development in the FFPP. Section C4 Stormwater within the Warringah DCP 2011 outlines objectives and requirements applicable to the management of stormwater within the FFPP. The objectives of Section C4 of the DCP include:

- To protect and improve the ecological condition of Warringah's beaches, lagoons, waterways, wetlands and surrounding bushland.
- To minimise the risk to public health and safety.
- To reduce the risk to life and property from flooding.
- Integrate Water Sensitive Urban Design measures into the landscape and built form to maximise amenity.
- To manage and minimise stormwater overland flow, nuisance flooding and groundwater related damage to properties.
- To protect Council's stormwater drainage assets during development works and to ensure Council's drainage rights are not compromised.
- To minimise the quantity of stormwater runoff from new development discharged to Council's drainage system.

The requirements for new developments include:

- Stormwater runoff must not cause downstream flooding and must have minimal environmental impact on any receiving stormwater infrastructure, watercourse, stream, lagoon, lake and waterway or the like.
- The stormwater drainage systems for all developments are to be designed, installed and maintained in accordance with Council's Water Management Policy.

Warringah Council PL 850 Water Management Policy (Version 3) 2017
This policy outlines specific objectives and targets for new development in the former Warringah Council LGA. These objectives and targets remain relevant to development in Frenchs Forest. The objectives and targets relevant to stormwater quality management are discussed further in Section 5.

4.6 Other NSW government policies and plans

Marine Estate Management Act 2014, Draft Marine Estate Management Strategy 2018-28 (Marine Estate Management Authority, 2018)
The Marine Estate includes the coastal waters, estuaries, lakes, lagoons and coastal wetlands of NSW. This Strategy was developed by the NSW Government to coordinate marine estate management in accordance with the objectives of the Marine Estate Management Act 2014 and the NSW Government's vision for the marine estate.

The strategy identified water pollution as the highest threat to the environmental, social, cultural and economic benefits of the marine estate. Litter, oil spills and catchment runoff contributing to water pollution were identified as the greatest environmental threat to the marine environment.

Greener Places Draft Policy (NSW Government Architect, 2017)
The policy objectives include providing liveable and resilient places for the NSW community by promoting healthy living, encouraging exercise, social activities and enhancing wellbeing. These liveable places would comprise a network of well-designed green spaces through urban communities that address environmental challenges that occur as urban communities grow.

Greater Sydney Local Strategic Plan 2016-2021 (Greater Sydney Local Land Services, 2016)
Local Land Services (LLS) has a primary function to deliver local land services that are necessary to support productive agriculture and other land managers to achieve benefits for their economies, environments and communities. In the Greater Sydney area, Greater Sydney Local Land Services (GSLLS) has prepared the Greater Sydney Local Strategic Plan 2016-2021 (GSLSP) to address local land management.

The GSLSP was developed following extensive community consultation. A key objective of the GSLSP is to achieve healthy harbours, rivers and waterways. Strategies identified in the GSLSP to achieve this include improving the condition of urban waterways to enhance amenity value, ecosystem health and the quality of receiving waters to support recreational, commercial and environmental values.

Flood Prone Land Policy (NSW Government, 2005)
The primary objective of this policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property. Minimising private and public losses from floods is a key focus, and the policy emphasises that ecologically positive flood mitigation measures should be adopted wherever possible.

Flood prone lands are categorised into floodway, flood storage and flood fringe areas. The appropriate category is confirmed through floodplain risk management and associated flood studies. A key principle of the policy is that flood prone land is managed in a manner that is consistent with the flood risk and does not cause undue future distress or unduly increase potential flood liability for individuals or the community.

Existing overland flow paths and waterways typically form a key element of the flood management system in urban catchments. We understand that flooding behaviour in the FFPP is being investigated separately by others. It is envisaged that a key area for consideration will be the existing overland flow paths through residential development upstream of Rabbett Reserve.

NSW Water Quality and River Flow Objectives (NSW government, 1999)
The NSW Government established the NSW Water Quality and River Flow Objectives in 1999 for most NSW catchments (the Hawkesbury-Nepean catchment was one exception).

These include high level water quality and river flow objectives for each catchment to address issues that were identified by the community. These objectives are intended to be considered by local councils, catchment management organisations and state agencies when completing strategic, catchment and land use planning activities. Water quality objectives are provided for aquatic ecosystems, visual amenity, secondary recreation, primary recreation, aquatic foods.

River flow objectives are provided for the protection of pools, low flows, high flows (i.e. water rises), wetland and floodplain inundation, drying in temporary waterways, natural flow variability, groundwater, effects of weirs and other structures, and effects of dams.

Water Management Act 2000 (WMA) & 'Controlled activities on waterfront land - Guidelines for riparian corridors on waterfront land' (Natural Resources Access Regulator (NRAR), 2018)
These guidelines recommend appropriate minimum riparian corridor widths for protection of waterways. The riparian corridor includes the channel and banks of a watercourse, and land immediately adjacent to the banks on either side of the watercourse. Riparian corridors provide a range of functions including bed and bank stability, water quality protection, aquatic and terrestrial habitat, flood conveyance, buffering to development and passive recreation.

These guidelines list activities that are allowable within the riparian corridor with a controlled activity approval. Guidance is provided on appropriate locations for cycleways, paths, dry detention basins, stormwater outlets, realignment, bridges and culverts. Construction of stormwater quality treatment measures in riparian corridors is not allowed under these guidelines.

The guidance relates specifically to functions of watercourses covered by the WMA. Whilst public authorities do not require approval for planning interventions within riparian corridors, principles outlined in guidance provided by NRAR remain relevant.

This legislation and policy are most applicable within the FFPP to the provision of stormwater management measures within existing public reserves that include potential riparian corridors (i.e. Rabbett and Brickpit Reserves).

5 Water management objectives and targets

5.1 Water Management Policy objectives

The Warringah Council PL 850 Water Management Policy (Version 3) 2017 (the "Water Management Policy") outlines specific objectives and targets for new development in the former Warringah Council LGA. These objectives and targets remain relevant to development in Frenchs Forest. The Water Management Policy aims to protect and improve the health of Council's waterways through the appropriate planning, design and operation of stormwater treatments measures for urban development. The outcomes Council seeks include:

- The integration of water sensitive urban design measures in new developments to address stormwater and floodplain management issues.
- Improve the quality of stormwater from urban development.
- Mimic natural stormwater flows by minimising impervious areas, reusing rainwater and stormwater and providing treatment measures that replicate the natural water cycle.
- Preserve, restore and enhance riparian corridors as natural systems.

Key elements of the current Water Management Policy that are particularly relevant to stormwater quality management in the FFPP are summarised below.

5.2 Stormwater runoff quality

The location of a proposed development in the former Warringah Council LGA determines if Council's stormwater quality objectives or general stormwater quality requirements apply to the development site.

Middle Creek, Carroll Creek, Curl Curl Creek and Bantry Creek are categorised as Group C creeks in the Warringah Creeks Study (2004). Section 8.1 of the Water Management Policy indicates that stormwater quality management requirements for catchments draining to Group C creeks are Council's "General Stormwater Requirements". The general stormwater quality requirements that are relevant to development in the FFPP are summarised in Table 5-1.

Table 5-1 *Northern Beaches Council general stormwater runoff quality targets*

Pollutant	Target
Total Suspended Solids	85% reduction in the mean annual post development (untreated) load
Total Nitrogen	45% reduction in the mean annual post development (untreated) load
Total Phosphorous	65% reduction in the mean annual post development (untreated) load
Gross Pollutants	90% reduction in the mean annual post development (untreated) load (for pollutants greater than 5mm in diameter)
pH	6.5 - 8.5

The Water Management Policy also outlines a range of criteria relevant to stormwater quality management including:

- All stormwater treatment measures must be designed in accordance with the requirements of this Policy and the Water by Design Technical Guidelines and modified for local conditions as appropriate.
- Stormwater treatment measures must be sited on private land. Council will not accept the ownership or maintenance responsibilities of any stormwater treatment devices.
- For alterations and additions and the like, the stormwater quality targets only apply to the new works.

- Stormwater treatment measures must not be sited within riparian zones or within remnant vegetation.
- All stormwater treatment measures must be sited in an area which is easily and safely accessible (e.g. roadside) and have wet weather access.

To demonstrate compliance with the stormwater performance targets, Council prefers that a MUSIC model (or equivalent widely accepted model) be prepared and provided. The policy requires MUSIC modelling to be undertaken in accordance with the Northern Beaches WSUD Technical Guide unless alternative modelling parameters are justified on the basis of local studies.

5.3 Stormwater runoff quantity

Stormwater runoff quantity management for new development is required to achieve the target outlined in Table 5-2.

Table 5-2 *Northern Beaches Council stormwater runoff quantity target*

Pollutant	Target
Hydrology	The post-development peak discharge must not exceed the pre-development peak discharge for flows up to the 2 year ARI

5.4 Other

Whilst the focus of this WSUD strategy is on the management of stormwater quality and quantity during frequent storm events, there are a range of other water management elements that required consideration under Council's Water Management Policy. These elements will typically need to be integrated with the WSUD measures and can be complimentary. Some key considerations are outlined below:

- Stormwater drainage – WSUD measures installed in the streetscape can assist with reducing the number of drainage inlet pits required and can assist to pre-treat stormwater to minimise the potential for the drainage system inlets to become blocked by litter, organic debris and sediment.
- On-site detention (OSD) – WSUD measures provided to harvest stormwater and manage frequent flows, can be integrated with OSD systems to reduce costs and land requirements for separate systems. Many individual commercial and residential developments in FFPP will require OSD and identifying an appropriate standard arrangement for these systems would be important.
- Potable water conservation – WSUD can provide stormwater as an alternative water source for many non-potable uses including toilet flushing and irrigation. By harvesting stormwater, impacts on natural waterways can be reduced.
- Flooding and overland flow – WSUD measures encourage the management of stormwater close to the source including retention and infiltration opportunities. This can help to reduce the frequency of overland flow events (particularly for more frequent design storms) and function as distributed passive detention systems.
- Groundwater management – WSUD measures can assist to increase groundwater recharge in urban areas through distributed infiltration to assist with restoring hydrology closer to natural conditions.
- Erosion and sediment controls – WSUD measures can perform a temporary erosion and sediment control function during construction phase. WSUD measures can be staged to ensure that construction activities do not damage the required final post building condition of the measure.

6 WSUD measure selection

6.1 Targeted stormwater pollutants

A primary consideration in the selection of appropriate WSUD measures for any development is that the measures selected are capable of capturing the targeted stormwater pollutants.

Between the initial source of the stormwater within the FFPP and the creeks receiving the runoff, a series of WSUD measures should be provided to manage runoff quality and quantity to achieve Council's objectives. The upstream and typically source control WSUD measures should aim to intercept larger pollutants (e.g. litter, organic debris and coarse sediment) with WSUD measures capable of removing finer and dissolved pollutants introduced after the larger pollutants have initially been removed. In some catchments, separate WSUD measures in series may be achievable, whilst in more constrained areas all WSUD measures may be required in close proximity or as one integrated treatment measure with multiple functions.

In some circumstances, compromises may be required in the treatment series due to site constraints and availability of land. This may result in some measures requiring increased maintenance to ensure that the WSUD measures continue to function as designed. An example of this would be a stormwater garden installed within a public street. It would be expected that these measures would capture litter for either stormwater flows, wind-blown or from littering by the community. Frequent manual maintenance would be expected for these measures to remove this litter.

6.2 Urban design integration

There are a number of urban design factors that require consideration when selecting appropriate locations for WSUD measures within a development. Some of the key considerations when confirming appropriate locations include:

- The characteristics of the development surfaces to be treated by the WSUD measure.
- Compatibility of the scale of the WSUD measure with the catchment being treated.
- The availability of sufficient land to position the WSUD measure.
- Compatibility with other private and community uses of the space.
- Compatibility with visual, acoustics and heritage considerations.
- Compatibility with pedestrian and vehicular traffic at the location.
- Opportunity to integrate the WSUD measure into landscaping.
- Opportunity to support and improve liveability conditions for the community.
- Financial sustainability of long term maintenance requirements of the WSUD at the location.

6.3 Physical site characteristics

The physical characteristics of the development site will have a large influence on the types of WSUD measures that are suitable. A range of environmental considerations that potentially form constraints to WSUD within the site including:

- Flooding.
- Terrain and drainage.
- Soils and groundwater.
- Tides.

- Existing land uses and potential contamination.
- Adjacent land uses.
- Watercourses and riparian corridors.
- Vegetation and protected habitats.
- Existing services and infrastructure.

An appreciation of the downstream receiving environments (e.g. creek, wetland, lagoon, river, estuary, beach) will assist with focusing on key water management objectives.

Table 6-1 *Potential locations of WSUD measures in the Frenchs Forest Planning Precinct*

WSUD Measure	Residential building/dwelling lot	Multi-residential common property	Commercial building lot	Commercial forecourt	Paved pedestrian areas	Open carpark	Commercial roads and parking bays	Residential roads and parking bays	Road reserve footway	Riparian corridor	Parklands and public reserves
Rainwater tank	✓		✓								
Pit insert							✓				
Gross pollutant trap							✓				✓
Sediment forebay											
Vegetated filter strip					✓				✓		
Vegetated swale											✓
Permeable paving	✓	✓			✓						
Sand filter											
Tree pit filter					✓		✓				
Stormwater garden		✓			✓		✓	✓			
Biofiltration swale		✓			✓		✓	✓			
Infiltration measure	✓	✓			✓						
Retention basin											
Constructed wetland											
Biofiltration basin											✓
Green roof	✓		✓								
Urban forest											✓
Stormwater harvesting basin											
Stormwater harvesting tank											✓
Proprietary devices											✓

	High potential
	Moderate potential
	Low potential
✓	Appropriate for FFPP

Table 6-2 *Stormwater pollutants targeted by WSUD measures*

WSUD Measure	Targeted stormwater pollutants							
	Litter and organic debris	Coarse sediment	Total suspended solids	Heavy metals	Total phosphorus	Total nitrogen	Runoff volumes	Runoff flow rates
Rainwater tank								
Pit insert								
Gross pollutant trap								
Sediment forebay								
Vegetated filter strip								
Vegetated swale								
Permeable paving								
Sand filter								
Tree pit filter								
Stormwater garden								
Biofiltration swale								
Infiltration measure								
Retention basin								
Constructed wetland								
Biofiltration basin								
Green roof								
Urban forest								
Stormwater harvesting basin								
Stormwater harvesting tank								
Proprietary devices								

	Pre-treatment to remove pollutant preferred to optimise maintenance
	Targeted stormwater pollutants
	Potential to manage a minor proportion of the stormwater pollutant

Table 6-3 *Site constraints for WSUD measures*

WSUD Measure	Steep terrain (>5%)	Flat terrain (<1%)	Shallow bedrock	Clay soils	Sandy soils	High groundwater	High sediment load	Highly dispersive or erodible soils	Saline or sodic soils	Riparian land	Services or infrastructure
Rainwater tank	✓		✓		✓						✓
Pit insert	✓		✓		✓						✓
Gross pollutant trap	✓		✓		✓						✓
Sediment forebay	✓		✓		✓						✓
Vegetated filter strip	✓		✓		✓						✓
Vegetated swale	✓		✓		✓						✓
Permeable paving	✓		✓		✓						✓
Sand filter	✓		✓		✓						✓
Tree pit filter	✓		✓		✓						✓
Stormwater garden	✓		✓		✓						✓
Biofiltration swale	✓		✓		✓						✓
Infiltration measure	✓		✓		✓						✓
Retention basin	✓		✓		✓						✓
Constructed wetland	✓		✓		✓						✓
Biofiltration basin	✓		✓		✓						✓
Green roof	✓		✓		✓						✓
Urban forest	✓		✓		✓						✓
Stormwater harvesting basin	✓		✓		✓						✓
Stormwater harvesting tank	✓		✓		✓						
Proprietary devices	✓		✓		✓						

	Low constraint
	Moderate constraint
	High constraint

7 WSUD options

7.1 Mechanical sweeping

Mechanical sweeping involves vehicles with sweeping and suction capabilities removing litter, organic debris and sediment from paved surfaces. Typically, larger vehicles would be utilised in trafficable areas and smaller, lighter and more manoeuvrable vehicles in pedestrian areas. Sweeping would typically target larger solid pollutants.

Regular mechanical sweeping of road pavement and pedestrian areas would be an important control for minimising the potential for blockage of permeable pavements and filter media in other measures distributed throughout the development areas.

Figure 7-1 *Mechanical street sweeper (LHS) and footpath sweeper (RHS)*

Suitable applications for FFPP include:

- All public streets and paved pedestrian areas in the FFTC.
- All public streets in other areas of the FFPP.

7.2 Community education

On-going education of the community focused around the FFTC can be an effective source control to assist with reducing the volume of litter generated in highly pedestrianised areas. Ideally the education activities would focus on reducing the volume of materials such as cigarettes, glass, cans, sediment, paper, cardboard and plastics that could be conveyed into the conventional drainage system.

Incorporation of recycling facilities within the development and utilising recycled materials as mulch (e.g. crushed glass) within treatment measures are options that could be considered. The provision of explanatory signage adjacent to selected stormwater measures in highly used public spaces can also be an effective education tool for the community.

Figure 7-2 *Container recycling facility (LHS) and recycled glass biofilter mulch (RHS)*

Suitable applications for FFPP include:

- Areas with the FFTC that will be a focus for community uses.

7.3 Reduce directly connected impervious areas

The efficient drainage of urban areas is typically undertaken to minimise nuisance flooding for the community and minimise the potential for overland flooding damage. Whilst this approach is effective for these objectives, it is now recognised that efficient drainage of urban areas results in significant impacts on the ecology and physical condition of natural waterways that receive runoff from these areas.

Increasingly WSUD approaches are being applied across urban areas to reduce the drainage efficiency during frequent smaller rainfall events that cumulatively generate a high proportion (often over 90%) of stormwater runoff volume discharged from urban areas to waterways. The function of conventional minor drainage systems (i.e. pits and pipes) is retained for infrequent larger storm events, with modern stormwater management systems designed to retain, filter, infiltrate and divert runoff during the many smaller storm events.

Suitable applications for FFPP include:

- Green roof feasibility to be considered for multi-storey buildings.
- All impervious roof areas to be connected to rainwater tanks or drain to a centralised stormwater harvesting tank.
- Road carriageways to be the minimum width required to achieve the traffic planning requirements.
- Permeable paving to be encouraged in parking bays and other low traffic load areas.
- Paved pedestrian areas to be constructed from permeable concrete/asphalt/pavers where feasible.
- Surface runoff and infiltrated runoff from paved pedestrian areas to be directed to perimeter swales, stormwater gardens and distributed tree pit filters where feasible.
- Road pavement runoff to be initially drained to a stormwater garden or biofiltration swale prior to overflow to a conventional stormwater drainage system.
- Vegetated filter strips to be provided adjacent to footpath areas to encourage filtration and infiltration.

7.4 Green roofs

Green roofs should be encouraged within the FFPP where these are financially sustainable to construct and maintain. Within the FFPP, the total roof area is likely to represent approximately 50% of the potential directly

connected impervious area and therefore management of rainfall on roofs will be important. In many areas within the FFPP, steep terrain will form a key constraint to the provision of appropriate WSUD infrastructure at ground level. Green roofs provide the opportunity to manage roof runoff close to the source and provide additional private open space area for use by residents and building occupants.

Figure 7-3 *Green roofs*

Suitable applications for FFPP include:

- Multi-storey commercial and residential buildings.

7.5 Rainwater tanks

Rainwater tanks are typically installed within private lots in urban areas to capture roof runoff (rainwater) for internal and external uses. Benefits of harvesting rainwater include potable water conservation, stormwater detention and water quality improvement. Retaining and using rainwater reduces reliance on potable water supply systems in urban areas and as such can assist with deferring upgrades of potable water systems. Distributed rainwater harvesting across urban areas also assists with maintaining dam storages at higher levels than otherwise would occur without tanks. This provides additional drought resilience in the water supply system and can delay the introduction of drought management measures.

The retention of roof runoff can also contribute to reducing the duration of elevated stream flows from urban catchments. Rainwater tanks will typically have limited influence on water quality concentrations, although retention and diversion of stormwater to the sewer and garden areas reduces the volume of stormwater pollutants discharging to watercourses in the catchment of the development.

Rainwater tanks are more efficient when the retained water is used to supply multiple water demands within a development. Within urban residential areas, rainwater can typically supplement/replace potable water demands including toilet flushing, garden watering, laundry, hot water and pool filling. Typically, a potable water service connection is still required for situations where the rainwater tank is empty, and water is unable to be accessed from another source. Rainwater tanks are typically required for many residential developments to achieve BASIX criteria. In these circumstances, rainwater tanks will also form a part of the treatment series.

Whilst rainwater tanks are often considered in isolation, they actually form one element in a rainwater supply system comprising:

- A rainwater catchment and drainage system (i.e. roof, roof gutters, downpipes, rainheads and drainage lines).
- A rainwater treatment system (i.e. screens, first flush device, filters, disinfection).
- A rainwater tank (i.e. storage, inlets, outlets).
- A rainwater distribution system (i.e. pumps, pressure tanks, mains supply control switches and valves, trickle top-up, backflow prevention).

- Rainwater supplied fixtures (i.e. toilets, outdoor taps, washing machines, hot water systems).

Suitable applications for FFPP include:

- All future residential developments required to achieve BASIX targets.
- Future commercial buildings where sufficient non-potable demands are available for rainwater use considering other water sources available to achieve an integrated water cycle management solution for each building (e.g. grey water and black water sources).
- Increasing the required minimum BASIX rainwater tank size by 50% is recommended to assist with managing stormwater discharges to the existing creeks. Due to the steep terrain in many areas, increasing the minimum size of rainwater tanks (either permanent storage or temporary detention storage) to manage hydrology would be a cost effective option.

7.6 Permeable paving

Permeable paving comprises a semi-permeable surface layer overlaying a depth of granular material. The surface layer is typically formed from modular concrete pavers, concrete/plastic grids or porous asphalt. More recently concrete paving products are being designed with increased porosity that enable stormwater to infiltrate directly through the surface layer. The surface layer incorporates voids that enable water to infiltrate into the lower granular layer. The lower granular layer functions to filter, detain and retain stormwater, and also provide structural support to transfer surface loads to the underlying soils.

Permeable paving filters stormwater during frequent runoff events to remove fine sediment and associated particulates. Detention and retention of stormwater is achieved by storage on the surface and within the granular base. During infrequent high runoff events the infiltration capacity of the voids is exceeded, and the excess rainfall is converted to runoff. During these events runoff is directed to an appropriate minor or major drainage system and conveyed to the receiving environment.

Permeable paving is typically positioned close to the source of pollutant generation. Permeable paving provides an option in urban areas for disconnecting impervious surfaces from receiving environments. Typically. permeable paving is provided in pedestrian areas, plazas, residential driveways, shared accesses and car parking spaces where traffic loadings are relatively low. Permeable paving can be relatively simple and efficient to maintain provided appropriate pre-treatment of surface runoff is undertaken.

Stormwater that is retained in the permeable pavement base/drainage layer can either infiltrate to underlying soils where conditions are appropriate or be collected by sub-surface drainage and directed to a biofiltration measure, stormwater harvesting facility for use or a conventional drainage system. The drainage layer will hold a proportion of infiltrated water within the voids between adjacent gravel stones and this water would be available for evaporation through the permeable concrete. Even without stormwater harvesting or extensive infiltration, significant stormwater volume reductions can be achieved by evaporation from the base layer. A major benefit of permeable paving is that the retention provided can assist with reducing large flow pulses of stormwater discharged to a waterway to assist with reducing erosion potential.

Figure 7-4 *Pervious concrete (LHS) and permeable pavers (RHS)*

Suitable applications for FFPP include:

- Driveways, shared accesses and paths within residential development.
- Footpaths, plazas and other pedestrian areas.
- Car parking bays and other low traffic areas.
- Areas where infiltrated stormwater can be managed to prevent impacts on infrastructure including underground carparks and building basement areas.

7.7 Vegetated filter strips

Vegetated filter strips typically comprise a grassed or otherwise vegetated strip of land directly adjacent to a paved area. Vegetated filter strips can be effective as a pre-treatment measure for intercepting litter, organic debris, coarse to medium sized sediment particles and attached pollutants. Filter strips can also assist with shallow infiltration of stormwater runoff.

Filter strips are typically provided directly adjacent to road pavements or other paved areas for filtering of sheet flow runoff from these impervious surfaces. Runoff from paved areas is typically able to flow as unconcentrated sheet flow onto the filter strip. The sheet flow is distributed across the filter strip and treatment occurs through friction with the grasses which slows the flow and enables sedimentation to occur.

The vegetation is typically maintained at around 150mm to provide effective filtration. This height may be varied as a catchment becomes more stabilised and coarse sediment loads reduce. Low growing tufted native grasses could also be planted to achieve a similar function.

Typically, a vertical step is provided between the paving edge and filter strip to reduce edge trimming requirements and minimise sediment accumulation on the paved area.

Figure 7-5 *Grassed roadside filter strips*

Suitable applications for FFPP include:

- Adjacent to paved areas in FFTC that drain runoff as sheet flow into a biofiltration measure. Typically provide around the perimeter of large paved areas.
- Short sections at inlets to biofiltration measures.

7.8 Pit inserts

Pit inserts are a form of source control gross pollutant trap installed within individual drainage pits. These devices are primarily designed to intercept litter, organic debris and coarse sediment. Well planned, designed, constructed and maintained pit inserts can be very effective at capturing these pollutants.

Conventional proprietary stormwater treatment devices can efficiently capture these larger pollutants where space is highly constrained and the potential for litter loads is elevated (i.e. commercial or industrial developments) above other land uses that typically generate lower volumes of litter (e.g. residential development).

Pit inserts should only be used to target hot spot locations in highly impervious commercial and carparking areas where litter generation potential is high. The devices are generally not appropriate in residential streets where the maintenance costs can exceed the benefits able to be achieved. In commercial areas pit inserts can generally be maintained using a mechanical footpath sweeper.

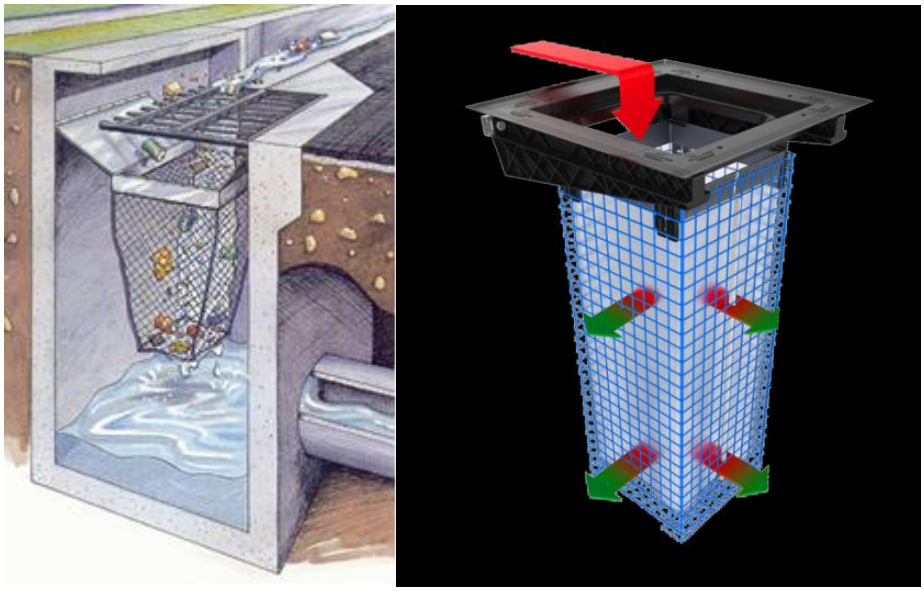


Figure 7-6 *Pit inserts*

Suitable applications for FFPP include:

- Localised areas in the FFTC with high pedestrian and traffic volumes.

7.9 Biofiltration measures

Biofiltration measures are ephemeral treatment measures that assist with achieving stormwater quality and stormwater retention objectives. All biofiltration measures comprise an extended detention storage and below ground filter media. The extended detention storage enables settling of sediment and other particles which is a function of the hydraulic residence time. The below ground filter intercepts finer particles including heavy metals. Nutrients are removed through interception and uptake by appropriate vegetation planted within the measure. Biofiltration measures assist with disconnecting impervious areas from urban streams by retaining stormwater for an extended period. Biofiltration measures are generally suitable in areas where gradients are typically less than 2%.

Biofiltration measures include tree pit filters, stormwater gardens, biofiltration swales and biofiltration basins. These measures all perform a similar function, although at different scales including:

- **Tree pit filters** – Close to source biofiltration measure typically accepting runoff from road pavement through a kerb inlet directing runoff to an individual tree incorporated into a footway area.
- **Stormwater gardens** – Close to source biofiltration measure comprising a shallow (typically 150 mm) above ground extended detention. Usually formed in a pod or cell arrangement directly adjacent to an impervious surface.
- **Biofiltration swales** – Typically a trapezoidal shaped biofiltration measure with a large length to width ratio. May accepts runoff from multiple stormwater drainage outlets in a gently grading area.

- **Biofiltration basin** – Typically a larger end-of-line biofiltration measure with a larger catchment area. Measure may have a deeper extended detention and incorporate flood detention. Important to include a dedicated pre-treatment measure for larger catchments.

Some examples of these measures are shown in Figure 7-7.

Figure 7-7 *Biofiltration measures (top left clockwise) - Tree pit filter, stormwater garden, biofiltration basin, biofiltration swale*

Suitable applications for FFPP include:

- Tree pit filters could be distributed throughout large paved footpaths or plazas in the FFTC. Individual tree pit filters will only treat a minor volume of stormwater sufficient to sustain tree growth. Tree pit filters can assist with providing increased shade for the community in otherwise continuous hard and hot paved areas.
- Stormwater gardens are often provided close to a runoff source and are typically small retention cells/basins within the streetscape. Suitable locations would be within the FFTC precinct behind kerb returns at road intersections co-ordinated with the stormwater inlet pits.
- Biofiltration swales could be provided as linear biofiltration measures between road pavement areas and footways to function as a combined flow and water quality management measure. Biofiltration swales can assist to control road crossing locations for pedestrians by forming a barrier and also to separate footway dining areas from roads. Biofiltration swales can also be used to prevent unauthorised vehicle access to high use pedestrian areas. Suitable locations for biofiltration swales would include adjacent to road pavement in FFTC and around the perimeter of the piazza area.

- Biofiltration basins are typically provided as large end-of-line measures that may be combined with other community functions (e.g. detention basins, sporting fields, parks). Smaller biofiltration basins may also be distributed throughout a development precinct. It is envisaged that biofiltration basins could be incorporated into re-development of existing parks and reserves that receive stormwater runoff from the FFPP.

7.10 Gross pollutant traps

Conventional proprietary gross pollutant traps (GPTs) include a range of pit inserts, in-line gross pollutant traps and end-of-line gross pollutant traps. These devices are primarily designed to intercept litter, organic debris, and sediment. Well planned, designed, constructed and maintained proprietary GPTs can be effective at capturing these pollutants.

Conventional proprietary GPTs can efficiently capture larger stormwater pollutants where space is highly constrained and the potential for litter loads is elevated (i.e. commercial or industrial developments) above other land uses that typically generate lower volumes of litter (e.g. residential development).

GPTs that store captured sediment, organic debris and litter in a dry state are preferable. GPTs that store and decompose organic debris in a wet sump between runoff events characteristically have low dissolved oxygen conditions that contribute to the release of nutrients into the water column within the device. Capturing increased loads of dissolved nutrients (nitrogen and phosphorus species) conveyed by stormwater is a key focus for coastal waterways and minimising the potential for GPTs to create conditions conducive to the release of nutrient rich waters should be avoided.

GPTs should be easily accessible for maintenance using machinery that Council has access to and have acceptable ongoing maintenance costs.

Any proposed proprietary devices should be comprised of materials that have sufficient strength and are resistance to fatigue failure. Screens, filtration mechanisms and other key elements required to sustain forces from stormwater flows and the weight of debris shall not be constructed from plastics. GPTs should also not have small inlets that are prone to regular blockage from organic debris and litter.

Suitable applications for FFPP include:

- Pre-treatment of stormwater runoff draining to centralised biofiltration systems positioned in Council parks or reserves.
- Pre-treatment of stormwater runoff draining to stormwater harvesting tanks.

7.11 Stormwater harvesting system

Stormwater harvesting provides an alternative water source to potable water for irrigation of public recreational land. A stormwater harvesting system typically comprises a number of elements including diversion structures, pipes, pre-treatment devices, pumps, storage tanks/ponds, biological treatment, filtration, disinfection and a distribution system.

Maintaining public recreation areas in a good condition is a high priority for many urban communities. This maintenance requires the availability of appropriate water sources for irrigation. Many Council recreational areas have conventionally been irrigated using potable water. As water restrictions have come into play during periods of drought and falling water storages, increased awareness of the need for improved water efficiency and potable water conservation has occurred. This has resulted in changes to policies on potable water use. These changes and increased water charges have driven a response to find alternative water sources to potable water for irrigation of recreational areas.

Suitable applications for FFPP include:

- A centralised stormwater harvesting system within the Village Green area of the FFTC to reduce potable water use and reduce stormwater runoff volumes from the FFPP. Treated stormwater could be utilised for irrigation of the Village Green and potentially interpretation area of the historical orchard in the adjacent urban forest area. A stormwater harvesting system would require closer consideration of other water sources within the FFPP including rainwater harvesting, grey water and blackwater treatment and re-use to confirm the optimum integrated water cycle management solution for the area.

7.12 Integrated water cycle management

The optimum solution for stormwater management within the FFTC precinct is influenced by interactions with the drinking water supply and wastewater management systems. Runoff from building roofs can readily be captured in rainwater tanks, treated and utilised as a water source for non-potable uses within the buildings. Internal building uses for non-potable water can also be supplied by recycled wastewater treated to an appropriate standard.

The stormwater management strategy for FFTC assumes that non-potable uses within the buildings will be managed by a combination of drinking water, recycled wastewater and water conservation measures. It is assumed that the provision of green walls on the buildings would be irrigated using recycled wastewater.

For this strategy, it is assumed that any roof runoff will be drained through the buildings drainage system and connected to a public piped drainage system that directs stormwater to a centralised stormwater tank for harvesting and re-use.

7.13 Green Star Communities (Credit 24A IWCM)

The Green Star rating system comprises four rating tools available for certification; Communities, Design and as built, Interiors and Performance. Each tool assesses a set of credits containing specific criteria to determine the overall Green Star score.

The Communities rating tool is applicable to precinct-wide developments and is the assessment tool applicable to the FFPP. Credit 24A (Integrated Water Cycle Management) is listed under the Environment category, and the elements to be considered under this category focus on stormwater drainage, stormwater quality, potable water conservation, flow regimes and climate change mitigation (water related elements of).

A successful claim of points for each credit is determined by the evidence and justifications outlined in a credit submission. The Green Star website provides a submission template for 24A outlining the requirements to be met. These requirements range from explicit targets and objectives to descriptions of the overall behaviour and management of the water cycle.

The submission template states that in order to be eligible for points for this pathway, the project must meet the following minimum stormwater requirements:

1. 75% of the total annual stormwater runoff is evaporated or retained within the project site, via both harvesting and infiltration;
2. The post-development peak 1-year Average Recurrence Interval (ARI) event discharge from the project site does not exceed the pre-development peak 1-year ARI event discharge; and
3. The quantity of key pollutants discharged in site stormwater is limited, based on the percentage reduction of sediment, phosphorus, nitrogen, and litter in project runoff when compared to untreated runoff.

The first requirement will be challenging to achieve across the FFPP and particularly for runoff from footways and roads. MUSIC modelling of the base WSUD strategy indicates that a reduction of 20% in stormwater runoff volume could be achieved through stormwater harvesting and evapotranspiration. The feasibility of large scale infiltration would be constrained in some part of the FFPP by the steep terrain.

8 Base WSUD strategy

8.1 Overview

The WSUD strategy for the Frenchs Forest Planning Precinct is summarised in Table 8-1. The WSUD options and potential locations outlined in Section 7 were reviewed to identify a base WSUD strategy for the FFPP that would address Council's targets and appropriately responds to the constraints and opportunities identified from the site analysis. The base WSUD strategy elements are highlighted in Table 8-1. The other non-highlighted WSUD elements are considered relevant for consideration as planning progresses and these potentially could be included as components of a WSUD+ strategy that facilitates the optimisation of base WSUD strategy measures. The WSUD+ strategy elements are discussed further in Section 9.

The base WSUD strategy was modelled in MUSIC to confirm appropriate scales and sizes of WSUD measures (refer Section 10). Preliminary cost estimates were also completed to provide an indication of the costs associated with constructing and maintaining the base WSUD strategy measures (refer Section 11).

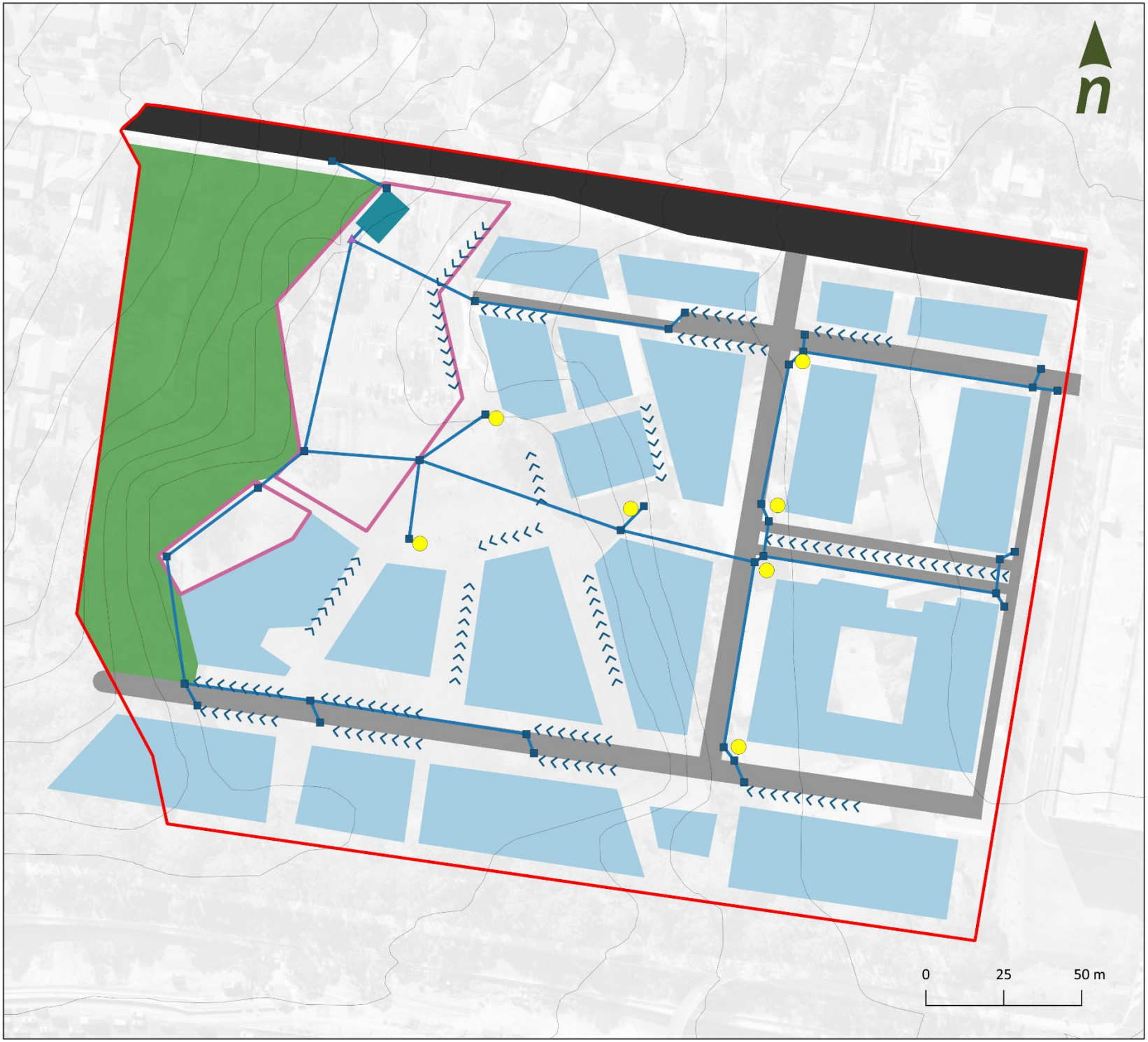
Conceptual figures outlining the base WSUD strategy configuration for FFTC, Brickpit Reserve and Akora Reserve are shown on Figure 8-1, Figure 8-2 and Figure 8-3 respectively.

It is considered that the base WSUD strategy would represent the likely maximum footprint within the development layout to assist with further development planning.

Table 8-1 *Summary of WSUD strategy for the Frenchs Forest Planning Precinct*

Scale	WSD measure	Conceptual treatment measure options/arrangement
FFTC precinct	Education	On-going education of the community focused around the FFTC.
Street	Mechanical street sweeper	Regular street sweeping as a source control to reduce volumes of litter, organic debris and coarse sediment exposed to stormwater. Would be important in areas where other options for trapping gross pollutants would not be cost effective.
Footways	Mechanical footpath sweeper	Regular footpath sweeping of pedestrian areas would be an important control for minimising the potential for blockage of permeable pavements and filter media in other measures distributed throughout the development areas.
Residential roofs	Rainwater tank	Base WSUD strategy measure to be provided in multi-dwelling residential lots to address BASIX targets and reduce potable water consumption. Base WSUD strategy includes capturing roof runoff from multi-dwelling residential developments for irrigation use. WSUD+ strategy could include supplying internal non-potable uses and consideration of increasing BASIX tanks size by 50% to manage hydrology in steep land.
Multi-storey commercial and residential buildings	Green roofs	Green roof feasibility to be considered as a component of a WSUD+ strategy for individual multi-storey commercial and residential buildings in the FFPP. Steep terrain in many of the future residential lots will challenge the provision of vegetated treatment systems in some sites.
Commercial building lot	Rainwater tank	Rainwater tanks to be considered as a component of a WSUD+ strategy for all future commercial buildings to confirm an optimal integrated water cycle management solution considering all available sources of non-potable water to reduce potable water consumption.
Residential lot	Permeable paving	The feasibility of permeable paving to be considered as a component of the WSUD+ strategy for driveways, shared accessways and parking spaces in low traffic areas and within private multi-dwelling residential lots.
Footways	Pervious concrete	The feasibility of pervious concrete to be considered for all public footway, plaza and other pedestrian areas as a component of a WSUD+ strategy. It is likely to be feasible to connect sub-surface drainage collecting the infiltrated stormwater to Base WSUD strategy measures including tree pit filters, stormwater gardens and biofiltration swales.

Scale	WSD measure	Conceptual treatment measure options/arrangement
Multi-storey residential building lots	Terraced stormwater gardens	Base WSUD strategy measure to be provide in multi-residential developments to treat runoff prior to site discharge. Terraced measures utilising retaining walls likely to be necessary to respond to the steep terrain.
Footways	Vegetated filter strips	Base WSUD strategy measure for pre-treatment of sheet flow from paved footways that drain to biofiltration swales or stormwater gardens.
Street	Vegetated filter strips	Vegetated filter strips to be considered adjacent to road pavements in gently grading residential streets to pre-filter runoff and intercept coarse sediment prior to the runoff draining to a biofiltration swale or stormwater garden.
Street	Pit insert	Pit inserts to be considered for installation at localised areas within the FFTC where planning indicates pedestrian and traffic volumes will be high and litter would not initially be intercepted by a filter strip or biofiltration measure.
Footways	Tree pit filters	Base WSUD strategy measure to be distributed throughout large pedestrian and plaza areas in the FFTC to treat runoff from footway areas.
Street	Stormwater gardens	Base WSUD strategy measure to be provided adjacent to stormwater pits in gently grading streets at locations where biofiltration swales would be impractical or where the measures could be utilised to form a feature in the urban landscape.
Street	Biofiltration swales	Base WSUD strategy measure to be provided in gently grading streets at locations where these linear measures can be co-ordinated with pedestrians and traffic. Biofiltration swales can assist to control pedestrian road crossing locations, separate dining areas from roads and prevent unauthorised vehicle access to footways.
Piazza	Biofiltration swales	Base WSUD strategy measure to be provided around the perimeter of plaza areas.
Precinct/sub-catchment	Gross pollutant traps	Base WSUD strategy measure to pre-treat runoff draining to biofiltration basins or stormwater harvesting tanks.
Precinct/sub-catchment	Biofiltration basin	Base WSUD strategy measure to be incorporated into the re-development of Brickpit Reserve to treat stormwater runoff draining to Curl Curl Creek from the new Northern Beaches Hospital, future business development, major roads and existing residential development.
Precinct	Stormwater harvesting tank	Base WSUD strategy measure to be located underground within the Village Green area. Treated stormwater from the FFTC precinct to be harvested for irrigation use and to reduce stormwater runoff volumes draining to Middle Creek and Narrabeen Lagoon.



Frenchs Forest Precinct

Figure 8-1 - Frenchs Forest Town Centre - Base WSUD strategy

Legend

- 2m contour
- Sub-catchment NL1
- Existing sealed road
- Future sealed road
- Buildings
- Urban forest
- Village green
- Stormwater garden
- Biofiltration swale
- Stormwater inlet pit
- Gross pollutant trap
- Stormwater drainage pipe
- Stormwater harvesting tank

NOTE: LOCATIONS OF EXISTING SERVICES NOT SHOWN. LOCATIONS TO BE CONFIRMED PRIOR TO FINALISING WSUD MEASURE LOCATIONS.

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Frenchs Forest Precinct

Figure 8-2 - Brickpit Reserve WSUD concept

Legend

- Existing stormwater pipe
- Existing stormwater pit
- New stormwater pit
- New headwall
- New stormwater pipe
- Spillway
- Low flow swale
- Brickpit Reserve extents
- New zoning (B1)
- Telecommunication
- Gas main
- Sewer PVC
- Water CICL
- Biofilter

NOTE: EXISTING SERVICE LOCATIONS ARE INDICATIVE ONLY AND MAY BE INCOMPLETE. LOCATIONS SHOULD BE CONFIRMED BEFORE FINALISING TREATMENT

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Frenchs Forest Precinct

Figure 8-3 - Akora Reserve WSUD concept

Legend

- SW — Existing stormwater pipe
- Existing stormwater pit
- New stormwater pit
- New headwall
- New stormwater pipe
- Spillway
- Flow bypass
- Akora Reserve extents
- New zoning (R2+)
- Biofilter
- Stormwater garden
- T — Telecommunication
- G — Gas main
- S — Sewer PVC
- W — Water CICL

NOTE: EXISTING SERVICE LOCATIONS ARE INDICATIVE ONLY AND MAY BE INCOMPLETE. LOCATIONS SHOULD BE CONFIRMED BEFORE FINALISING TREATMENT

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8.2 WSUD elements

Rainwater tanks

The base WSUD strategy assumes that rainwater tanks would be provided in multi-residential lots to capture stormwater from roofs for irrigation use only. For the base WSUD strategy, it was assumed that BASIX water conservation targets would be achieved for multi-residential developments by including other options that reduce potable water consumption (i.e. low demand showerheads, taps and appliance, native landscaping etc). A typical arrangement of a rainwater tank is shown in Figure 8-4.

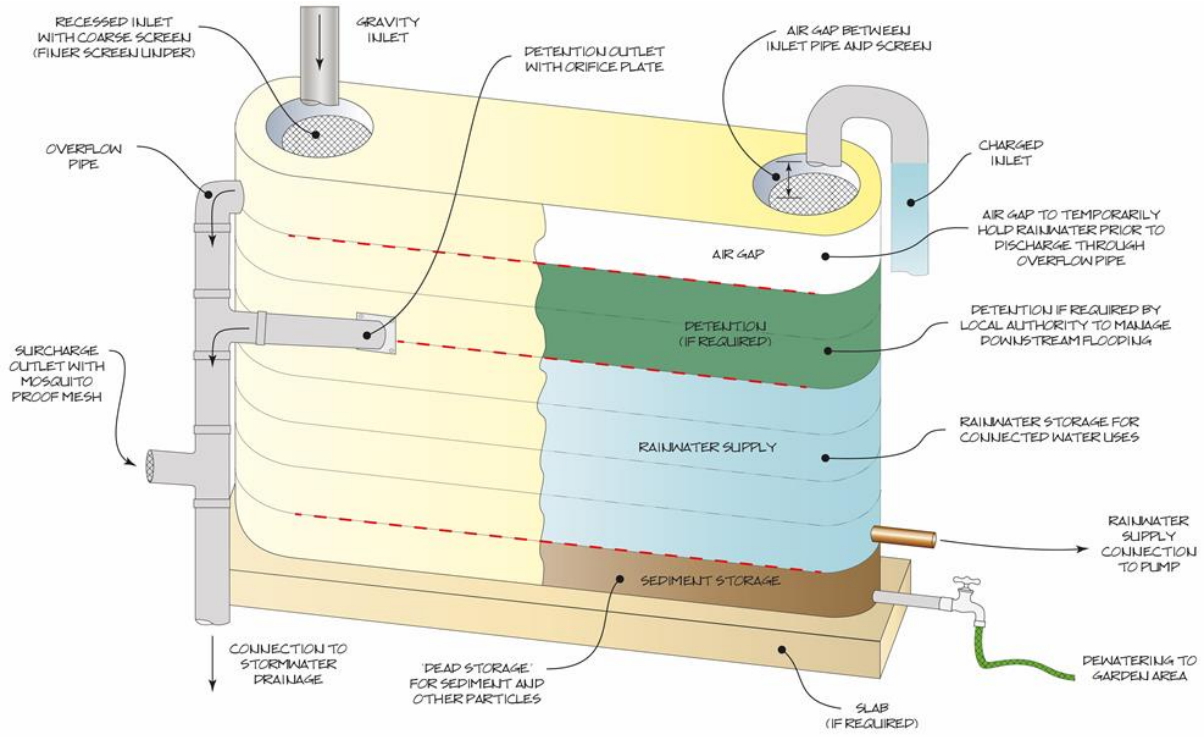

Figure 8-4 *Example rainwater tank configuration*

Tree pit filters

The base WSUD strategy includes tree pit filters distributed throughout large paved pedestrian areas in the FFTC. Conceptual sketches of the typical configuration of tree pit filters are shown in Figure 8-5 and Figure 8-6.

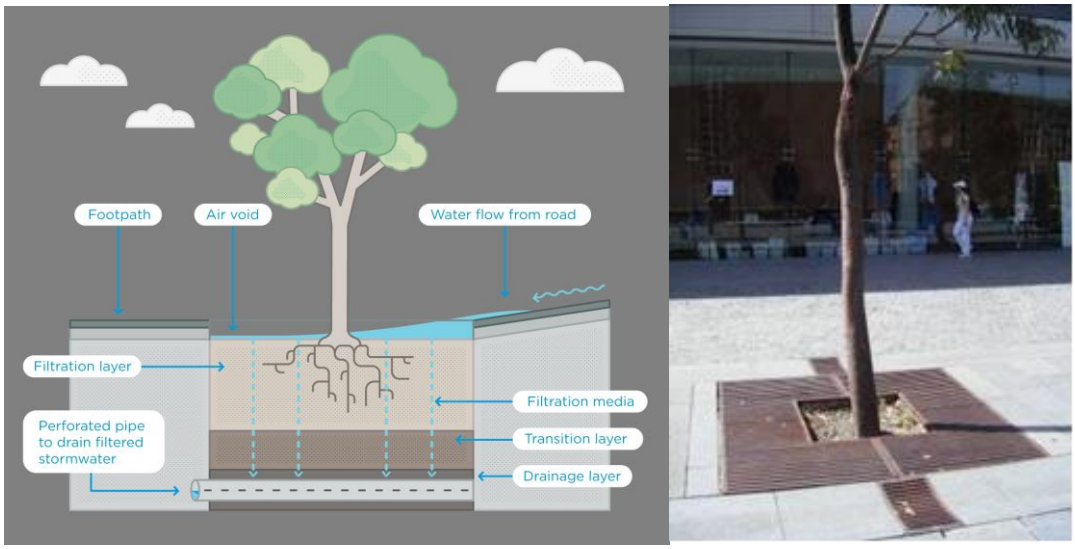

Figure 8-5 *Example tree pit filter configuration (LHS image source: http://urbanwater.melbourne.vic.gov.au)*

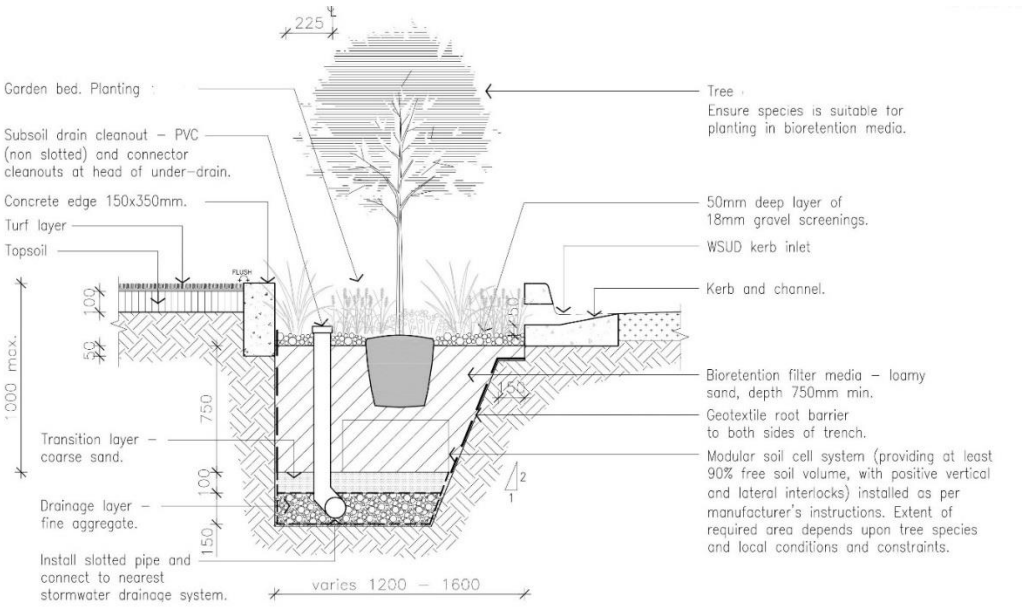

Figure 8-6 *Typical tree pit filter detail (adapted from Brisbane City Council, 2010)*

Tree pit filters typically have vertical sides with open grates covering the extended detention storage. The extended detention temporarily stores runoff prior to filtration through the media filter. During events that exceed the available volume in the extended detention storage, excess runoff typically overflows into a minor drainage system through structures positioned within the measure.

The media filter typically consists of a biofilter layer and drainage layer. The biofilter layer is the upper layer and incorporates soil that has a reasonable water holding capacity that is capable of sustaining vegetation growth. The biofilter layer must also have a reasonable saturated hydraulic conductivity to enable steady percolation of runoff when the water holding capacity is exceeded. The lower layer comprises fine gravel that typically surrounds slotted agricultural drainage pipe and captures the filtered stormwater before directing it to a constructed drainage system.

Biofiltration swales

The base WSUD strategy includes recommendations to provide linear biofiltration swales between road pavement areas and footways across the FFTC precinct. Biofiltration swales would function as a source control treating runoff from road surfaces and footways. A goal would be to ensure that all surface runoff from roads and footways within the FFTC initially passes through a biofiltration system prior to discharge into a conventional stormwater pit or infiltration to the natural soils where appropriate.

In addition to providing stormwater quality and quantity management, biofiltration swales would assist with managing road crossing locations for pedestrians by forming a barrier and also to separate footway dining areas from roads. The biofiltration swales can also be utilised to prevent unauthorised vehicle access to high use pedestrian areas.

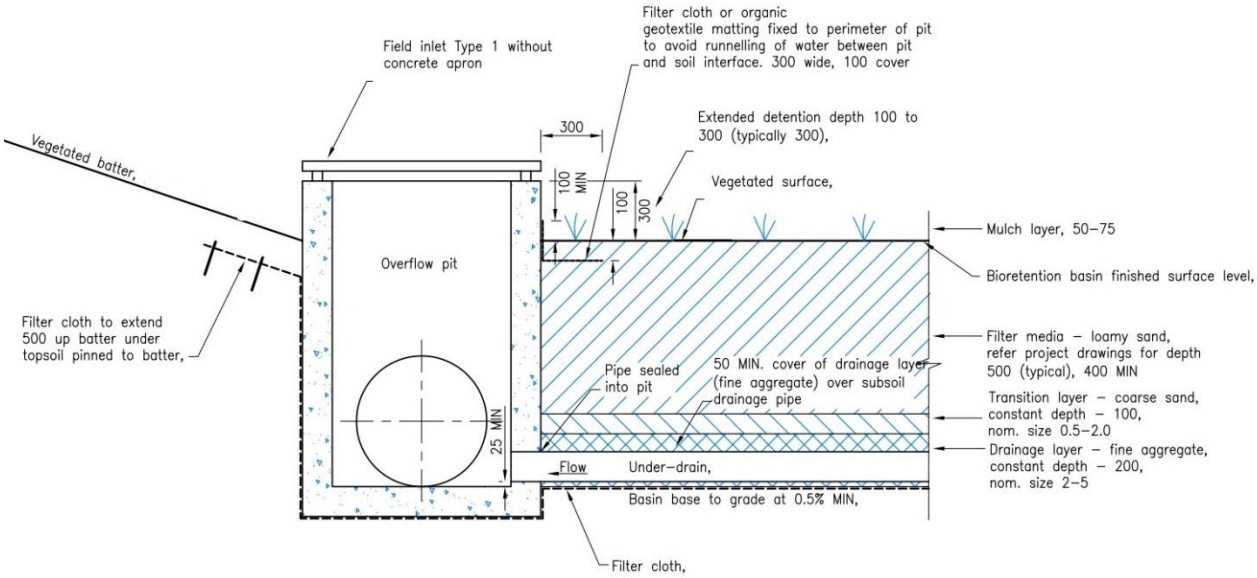

Figure 8-7 *Example biofiltration swale configuration (source: adapted from Water by Design, 2010)*

Stormwater gardens

The base WSUD strategy includes stormwater gardens positioned within the FFTC. Stormwater gardens are recommended to be located behind kerb returns at road intersections with locations co-ordinated with the stormwater inlet pits. An example concept sketch for a typical stormwater garden and installed example is shown in Figure 8-8.

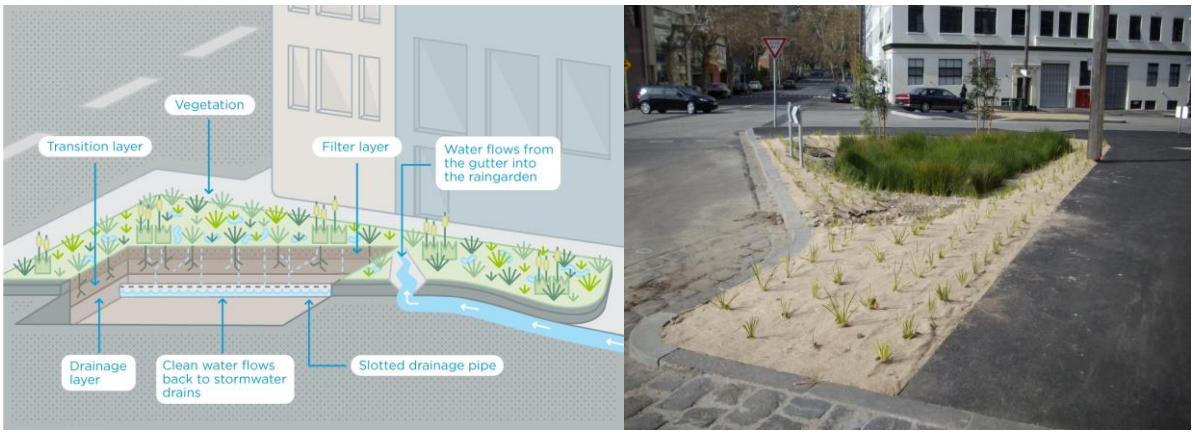

Figure 8-8 *Example stormwater garden configuration (source: http://urbanwater.melbourne.vic.gov.au)*

Pit inserts and gross pollutant traps

Pit inserts are not included in the base WSUD strategy and it is recommended these only be considered in localised areas where pedestrian or vehicular traffic is high. It is envisaged that most footway areas in FFTC would be drained to flush grates that would be effective at excluding most gross pollutants. Typically pit inserts would be most effective in kerb inlet pits installed in road reserves. The base WSUD strategy assumes that most road pavement areas would initially be drained to a biofiltration swale or raingarden, and therefore litter would be intercepted by these measures before entering a piped drainage system. Pit inserts would therefore only be applicable to a small proportion of the FFTC, and where provided, these would be maintained by private owners of the road reserve in FFTC (rather than Council).

Provision of a biofiltration basin in Brickpit Reserve downstream of the hospital and major roads in a larger urban catchment warrants consideration of a central pre-treatment GPT to intercept litter prior to it mixing with vegetation in the biofiltration basin. This will typically be more important in circumstances where a high proportion of litter is not able to be effectively intercepted in FFTC close to the source (e.g. pit inserts, flush grates or similar exclusion measures). Selection of an appropriate GPT for Brickpit Reserve would need to be undertaken in close consultation with Council. Key considerations would include:

- ensuring an appropriate all-weather access is feasible to the GPT for cleaning; and
- that sufficient independent monitoring data is available supporting the long-term effectiveness of the GPT.

Biofiltration basins

The base WSUD strategy includes recommendations to provide biofiltration basins within Akora and Brickpit Reserves as a component of future redevelopment of these community assets. An example of a biofiltration basin integrated with a public park is shown in Figure 8-9. In this example, the park functions to manage stormwater flows during low flows (biofiltration basin activates) and higher overland flooding flows (detention basin activates). The configuration of the biofilter is similar to that shown in Figure 8-7.

Figure 8-9 *Example biofiltration basin integrated within community park (source: Lake Macquarie City Council, 2013)*

Vegetated filter strips

The base WSUD strategy incorporates vegetated filter strips adjacent to road pavements, carparking and footways areas for filtering of sheet flow runoff from these impervious surfaces. Vegetated filter strips typically perform a primary treatment function and also assist with shallow infiltration of stormwater runoff.

Filter strips provide pre-treatment by removing a high proportion of coarse matter to reduce the potential for blockage of following measures designed to manage finer and dissolved pollutants. Filter strips would be provided adjacent to stormwater gardens or biofiltration swales in appropriate locations to provide pre-treatment of flows draining to these WSUD measures.

Vegetation in the filter strips is typically maintained at around 150mm or higher to provide effective filtration. This height may be varied as a catchment becomes more stabilised and coarse sediment loads reduce. Low growing tufted native grasses could also be planted to achieve a similar function.

Stormwater harvesting system

The base WSUD strategy includes a recommendation to incorporate a stormwater harvesting system into the Village Green area. Stormwater initially treated within biofiltration systems would be directed through a piped stormwater drainage system to a below ground stormwater tank positioned adjacent to the Village Green. Pre-treatment of runoff draining to the tank would be achieved through the provision of a below ground GPT.

The base WSUD strategy includes allowance for the stormwater to be filtered and treated prior to application as irrigation water within the Village Green area. The focus of the stormwater harvesting system would be to conserve potable water. Overflow from the stormwater harvesting tank would be connected into the existing stormwater drainage system in Frenchs Forest Road for discharge to Middle Creek.

Private residential lots

Residential development in the FFPP outside of the FFTC is proposed in areas where centralised management of stormwater quality is unlikely to be feasible considering natural drainage paths, existing steep terrain and limited availability of land in appropriate locations. It is likely that distributed treatment measures within private land will be required as a component of individual developments to address Council's water quality objectives to overcome this lack of available centralised land.

The base WSUD strategy assumes that lot scale WSUD treatment systems comprising rainwater tanks, permeable paving, stormwater gardens and vegetated filter strips would be required within private residential lots to address Council's targets. It is envisaged that these measures would be incorporated into the landscape design with common areas of multi-dwelling residential developments.

It is likely that many of the multi-dwelling residential lots will be highly constrained by steep terrain and this may require terraced and retained stormwater gardens to be constructed to fit in with the landscape (refer example for an individual dwelling shown in Figure 8-10).

Figure 8-10 *Example of a terraced biofiltration system for an individual residential lot (source: MidCoast Council)*

It is also likely to be impractical to drain 100% of the lot area to a stormwater garden, leading to a portion of the site draining across the boundary untreated (e.g. part of driveways). This has been allowed for in evaluating typical WSUD provisions for future residential development.

In some circumstances, stormwater treatment of future residential development and business developments can be achieved through the provision of stormwater treatment in public land (e.g. FFTC, Akora Reserve and Brickpit Reserve). In these circumstances, Council could progress the implementation of a mechanism for future developers to contribute to the cost of constructing these facilities. The base WSUD strategy measures within Akora Reserve and Brickpit Reserve have been sized to achieve Council's targets including consideration of future development in the catchment draining to each reserve.

9 WSUD+ strategy

The base WSUD strategy includes WSUD measures that provide some flexibility for integration within the future development as planning of the final development layout and staging progresses. A number of additional WSUD measures summarised in Table 8-1 warrant further consideration as development planning progresses and further details of the development configuration are resolved. Where feasible, incorporation of these other elements into the WSUD strategy could assist to reduce the footprint and cost of the base WSUD strategy measures.

WSUD measures including commercial building rainwater harvesting, green roofs, permeable paving and pervious concrete have the potential to significantly reduce runoff volumes. A WSUD strategy incorporating these additional measures (referred to here as the WSUD+ strategy) would reduce runoff volumes and along with other source control activities including street sweeping would assist to reduce the size of base WSUD measures. For example, permeable paving or porous concrete can provide significant detention and retention capability of stormwater by storage on the surface and within the granular base.

Permeable paving typically comprises a semi-permeable surface layer overlaying a depth of granular material. The surface layer is typically formed from modular concrete pavers, concrete/plastic grids, porous asphalt and porous concrete. The surface layer incorporates voids that enable water to infiltrate into the lower granular layer. The lower granular layer functions to filter, detain and retain stormwater and can also provide structural support to transfer vehicular loads (light vehicles only) to the underlying soils.

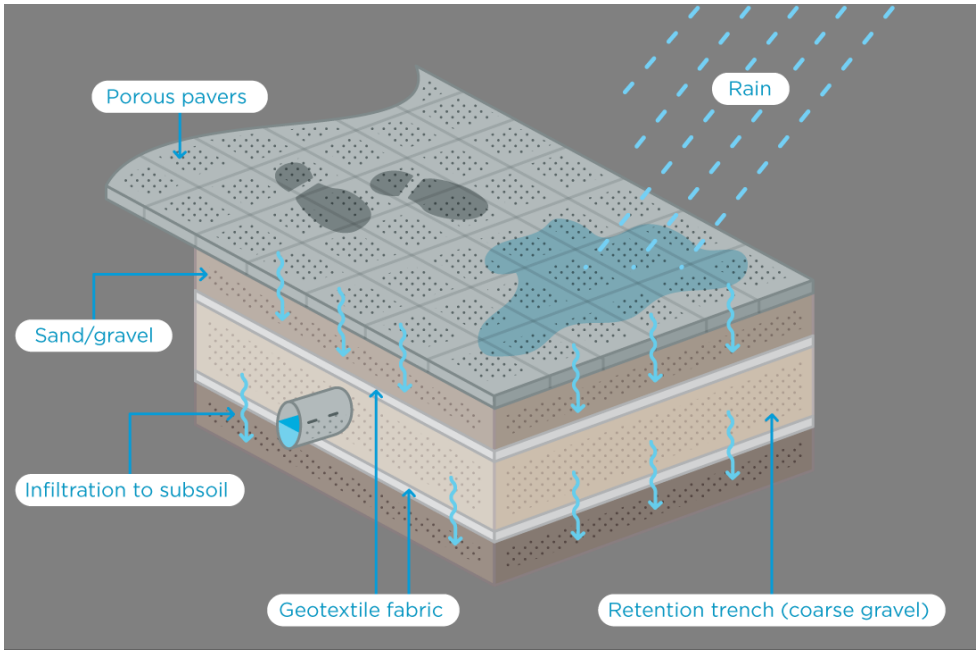

Figure 9-1 *Example permeable/porous paving configuration (source: http://urbanwater.melbourne.vic.gov.au)*

Permeable paving is not included in the base WSUD strategy and is not recommended in areas that will be owned/maintained by Council. Permeable paving is included for consideration as a source control option in private multi-dwelling residential lot scale developments where traffic loads would be low (e.g. shared driveways, visitor parking bays).

Pervious concrete is suggested for consideration in non-trafficable footway areas to assist with disconnecting large areas of paving from the drainage system. This material differs from typical permeable paving as it has a surface appearance similar to standard concrete paving. Pervious concrete is designed to enable rain to permeate the surface into an underlying gravel media. This material has the advantage that infiltrated stormwater could be harvested close to the source and used for landscape irrigation and other uses to assist with conserving potable water.

10 MUSIC modelling

10.1 Modelling Approach

Stormwater quantity and quality modelling was undertaken using the Model for Urban Stormwater Improvement and Conceptualisation (MUSIC) to estimate runoff volumes and loads of common stormwater pollutants including Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN).

MUSIC includes algorithms to evaluate the hydrology and concentrations / loads of common stormwater pollutants (i.e. TSS, TP and TN) from urban catchments and estimate the performance of WSUD measures at capturing these pollutants.

MUSIC was designed to continuously simulate urban stormwater systems over a range of temporal and spatial scales utilising historically representative rainfall data. MUSIC is considered within the industry to be an appropriate conceptual design tool for the assessment and sizing of stormwater treatment measures.

The hydrologic algorithm in MUSIC is based on the model developed by Chiew & McMahon (1997). The model simplifies the rainfall-runoff processes and requires input of the following variables to perform the hydrological assessment:

- Rainfall data (time steps varying from 6 minutes to 1 days);
- Potential evapotranspiration rates;
- Catchment parameters (area, % impervious and pervious areas);
- Impervious and pervious area parameters (rainfall threshold, soil and groundwater parameters) and
- Storm event and base flow stormwater pollutant concentrations.

MUSIC can be utilised for comparison of alternative scenarios that adopt the same base inputs. Although the magnitude of the estimates may not be equivalent to actual site conditions (due to limitations in available data for a particular site), the relative differences between scenarios is expected to be appropriate for supporting decision making. MUSIC can also be applied to evaluate the performance of stormwater treatment measures against load-based objectives. The MUSIC modelling approach applied to derive estimates catchment loads for the FFPP is described in the following sections.

10.2 Meteorological Input Data

The meteorological template includes the rainfall and areal potential evapotranspiration data. It forms the basis for the hydrologic calculations within MUSIC.

Rainfall data were sourced from Bureau of Meteorology (BoM) Station 66062 Sydney (Observatory Hill). Data were available for the 1914 to 2015 period. Interpolated data were also sourced from the SILO database for comparison with Stn. 66062.

Review of the rainfall data indicated that a 20 year period between 1966 to 1985 was relatively free of data gaps. The mean annual rainfall for this period is 1220mm which is similar to the long term mean of 1216mm for this station. The long term average calculated from the SILO data is similar. Council's MUSIC guidelines recommend utilising rainfall for a 5 year period between 1981 and 1985 for stormwater quality modelling. This period provides a mean annual rainfall of 1240mm which is also close to the long term average. The 1981 to 1985 period was adopted for modelling stormwater quality.

Monthly average potential evapotranspiration (PET) rates are often input to MUSIC utilising average values for the 1961 to 1990 period sourced from the Bureau of Meteorology's Climatic Atlas of Australia (BoM, 2001). For the MUSIC modelling, daily estimates of areal potential evapotranspiration rates were sourced from the SILO database for the same period as the rainfall data (i.e. 1981 to 1985). Morton wet environment daily areal potential evapotranspiration rates were adopted as being appropriate for the modelling.

The adopted average monthly PET values (based on the daily values) for Frenchs Forest are presented in Table 10-1 along with BoM averages for the 1961 to 1990 period. The areal PET values for the 1981 to 1985 period indicate that potential evapotranspiration during this period was higher than long term averages.

Table 10-1 *Monthly Average PET Rates for Frenchs Forest*

	Areal PET (mm/month)	
Scale	**1961 - 1990 averages (BoM, 2001)**	**1981 – 1985 averages (based on daily SILO estimates)**
January	176	170
February	132	135
March	121	125
April	80	84
May	52	56
June	39	41
July	41	46
August	57	73
September	80	99
October	126	128
November	150	152
December	158	170
Annual total	1212	1278

A 6-minute model time step was adopted for the MUSIC modelling.

10.3 Catchment Parameters

Sub-catchments were estimated considering the existing terrain and constructed drainage system. The sub-catchments are shown on Figure 3-1. Sub-catchment areas are summarised in Table 10-2.

Phase 1 Precinct - Frenchs Forest Town Centre (Sub-catchment NL1)

There is currently no detailed road and super lot layout available for the future development in FFTC. The MUSIC models were prepared based on digitising of the masterplan layout (CHROFI, 2018). The future configuration of development surfaces in Sub-catchment NL1 (the sub-catchment including the future FFTC, refer Figure 3-1) was estimated based on the masterplan layout and these are summarised in Table 10-2.

Table 10-2 *Modelled surfaces for FFTC (Sub-catchment NL1)*

Surface type	**Area ha**	**% effective imperviousness**
Village green	0.567	0%
Building roofs	2.244	100%
Existing sealed road	0.382	100%
New sealed road	0.529	100%
Public footways including piazza	2.354	75%
Urban forest	0.840	0%
Total	6.916	

Phase 1 Precinct – Brickpit Reserve (Sub-catchment MD1)

The sub-catchment draining to Brickpit Reserve was modelled considering the existing catchment characteristics allowing for increased imperviousness associated with the planned commercial area in rezoned residential land on the southern side of Warringah Road. The modelled configurations of surfaces within this sub-catchment is summarised in Table 10-3.

Table 10-3 *Modelled surfaces for Brickpit Reserve sub-catchment (Sub-catchment MD1)*

Surface type	Area ha (% of total)	% effective imperviousness
Hospital roof	0.800	100%
Hospital remnant urban forest	0.630	0%
Hospital landscaping	1.640	5%
Existing sealed road and carparking	3.080	100%
New business area	0.880	80%
Existing low density residential	1.850	65%
Brickpit Reserve	1.320	0%
Total	10.200	

Phase 1 Precinct – Akora Reserve (Sub-catchment BB2)
The sub-catchment draining to Akora was modelled considering the existing catchment characteristics and allowing for increased imperviousness associated with the planned higher density residential land along Karingal Crescent to the north of the reserve. The modelled configurations of surfaces within this sub-catchment is summarised in Table 10-4.

Table 10-4 *Modelled surfaces for Akora Reserve sub-catchment (Sub-catchment BB2)*

Surface type	Area ha (% of total)	% effective imperviousness
Future R2+ land on Karingal Cr	1.170	70%
Existing low density residential	1.300	65%
Existing sealed roads	0.280	100%
Akora Reserve	0.310	100%
Total	3.06	

Phase 1 Precinct – Rabbett Reserve (Sub-catchments NL1, NL2 and NL3)
Rabbett Reserve in located in the northern portion of the FFPP and includes a steep upper reach of Middle Creek that drains to Narrabeen Lagoon. Compared to the other public reserves in the FFPP, the upstream sub-catchment area draining to Rabbett Reserve is relatively large with related runoff volumes being significantly higher. The typical terrain in this reserve has gradients exceeding 10%. The reserve is effectively bisected by the existing creek and constrained by road embankments and residential lot on either side of the riparian zone.

The potential for incorporating WSUD measures to manage stormwater quality in this reserve is considered low due to the site constraints. There would be some potential to divert very small flows into stormwater gardens or similar measures on the eastern side of the reserve for treatment, although it is considered that any benefits are likely to be far exceeded by the costs.

It is recommended in this strategy that the focus should be on positioning closer to source WSUD measures within the upslope catchment areas either within public land or private lots.

Phases 1, 2 and 3 Precincts - R3 and R3+ Residential
A large proportion of planned residential development corresponds with terrain exceeding 10% in gradient with no feasible locations available for positioning centralised WSUD measures to treat runoff from multiple development lots. Therefore, the residential building lots in Phases 1, 2 and 3 are likely to each require the provision of a lot scale treatment system to manage stormwater runoff quality and quantity. It is assumed that any on-site detention requirements would be integrated with the stormwater quality treatment measures.

To evaluate future WSUD treatment measures for residential development in locations where lot scale treatment is likely to be the only feasible option, example lot configurations have been modelled in MUSIC considering the masterplan and associated proposed development controls. Within the future residential precincts there will be a range of different residential buildings varying in height and number of units.

For the WSUD strategy, treatment requirements have been estimated and modelled based on example residential development scenarios derived from the masterplan including consideration of floor space ratios, proposed building heights and number of dwellings for the following scenarios:

- Three storey residential building including 12 units.
- Five storey residential building including 40 units.
- Six storey residential building including 72 units.

MUSIC modelling of each of the residential scenarios adopted the following assumptions:

- Residential units would have an average floor area of 80 m^2 with a roof area equivalent to 100 m^2 for each unit on the upper level.
- The roof area would cover up to 40% of the lot considering the proposed floor space ratios and building heights. The remaining lot area would comprise driveways, carparking, paths, lawns, patios, pools, vegetated landscaping and other common residential surfaces. It was assumed that the non-roof area within the lot would be up to 50% impervious.
- All roof areas would be directed to a shared rainwater tank for each building. Non-potable water demands from the tanks would be for outdoor irrigation of common property.
- Overflow from the rainwater tank and surface runoff from 80% of paved and landscaping areas within the lot would be directed to a biofiltration system. The biofilters would have a minimum biofilter area equivalent to 3% of the total lot area.
- It may be impractical to drain up to 20% of the paved and landscaping areas within each lot to the biofiltration system due to terrain constraints. 80% of this bypassing area would be treated through landscaped buffers adjacent to the bypassing paved areas (nominally a 0.5m wide indigenous grass buffer strip).

10.4 Rainfall-runoff parameters

Modelling of the rainfall-runoff process in MUSIC requires the definition of two impervious surface parameters and eight pervious surface parameters. These parameters can be determined through a calibration and validation exercise where concurrent stream flow, rainfall and evapotranspiration data are available for the catchment being considered.

Rainfall-runoff parameters for the FFPP were adopted from the 2015 NSW MUSIC Modelling Guidelines based on a characteristic sandy clay loam soil across the precinct indicated from a review of available soil landscape mapping data (refer Section 3.3). The adopted rainfall runoff parameters are summarised in Table 10-5. These parameters were adopted for developing the MUSIC models.

Table 10-5 ***Adopted MUSIC rainfall-runoff parameters***

Parameter	Adopted value
Impervious Area Parameters	
Rainfall Threshold (roofs, mm)	0.5
Rainfall Threshold (road pavement, mm)	1.5
Rainfall Threshold (mixed urban surfaces, mm)	1.5
Pervious Area Parameters	
Soil Storage Capacity (mm)	108
Initial Storage (% of capacity)	25
Field Capacity (mm)	73
Infiltration Capacity Coefficient – a	250
Infiltration Capacity Exponent - b	1.3
Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	60
Daily Baseflow Rate (%)	45
Daily Deep Seepage Rate (%)	0

10.5 Runoff quality parameters

The MUSIC input stormwater constituent concentrations were based on those recommended in the 2015 NSW MUSIC Modelling Guidelines. The adopted log_{10} values are summarised in Table 10-6 and

Table 10-7.

Table 10-6 *Storm flow concentrations for MUSIC modelling in NSW (mg/L - log_{10})*

	TSS		**TP**		**TN**	
	mean	std. dev	mean	std. dev	mean	std. dev
Residential landscaping	2.15	0.32	-0.60	0.25	0.30	0.19
Public open space	2.15	0.32	-0.60	0.25	0.30	0.19
Paved footways	2.15	0.32	-0.60	0.25	0.30	0.19
Hard roof	1.30	0.32	-0.89	0.25	0.30	0.19
Road pavement	2.43	0.32	-0.30	0.25	0.34	0.19

Table 10-7 *Base flow concentrations for MUSIC modelling in NSW (mg/L - log_{10})*

	TSS		**TP**		**TN**	
	mean	std. dev	mean	std. dev	mean	std. dev
Residential landscaping	1.20	0.17	-0.85	0.19	0.11	0.12
Public open space	1.20	0.17	-0.85	0.19	0.11	0.12
Paved footways	1.20	0.17	-0.85	0.19	0.11	0.12
Hard roof	n/a	n/a	n/a	n/a	n/a	n/a
Road pavement	1.20	0.17	-0.85	0.19	0.11	0.12

10.6 Modelled treatment measures

The configuration of the modelled treatment measures is summarised in Table 10-8.

Table 10-8 *Modelled treatment measures*

Treatment measure	Locations	Modelled configuration
Rainwater tanks	Multi-dwelling lots	Volume = 5 to 15 kL Water demands = irrigation only
Tree pit filters	Public footways in FFTC	Surface area = 30 x 2m^2 (total across FFTC) Biofilter area =30 x 2m^2 (total across FFTC) Extended detention = 0.15m Biofilter depth = 0.45m
Stormwater gardens	Intersections in FFTC	Surface area = 290m^2 (total across FFTC) Biofilter area =290m^2 (total across FFTC Extended detention = 0.15m Biofilter depth = 0.45m
Biofiltration swales	Public streets in FFTC	Surface area = 690m^2 (total across FFTC) Biofilter area =690m^2 (total across FFTC Extended detention = 0.15m Biofilter depth = 0.45m
GPT	Village Green	Not modelled
Stormwater harvesting tank	Village Green	Storage volume = 150 kL Water demand = 2150 kL/year
GPT	Brickpit Reserve	Not modelled
Biofiltration basin	Brickpit Reserve	Surface area = 850m^2 Biofilter area =700m^2 (total across FFTC Extended detention = 0.45m Biofilter depth = 0.45m
Vegetated swale	Brickpit Reserve	Length = 100m, Slope = 3% Top width = 4m Base width = 1m Depth = 0.3m
Biofiltration basin	Akora Reserve	Surface area = 390m^2 Biofilter area =350m^2 (total across FFTC Extended detention = 0.30m Biofilter depth = 0.45m
Stormwater gardens	Akora Reserve, Akora St	Surface area = 2 x 15m^2 Biofilter area =2 x 15m^2 (total across FFTC Extended detention = 0.15m Biofilter depth = 0.45m

10.7 MUSIC modelling results

The MUSIC modelling results for the FFTC, Brickpit Reserve and Akora Reserve are summarised in Table 10-9, Table 10-10 and Table 10-11 respectively. The modelling results indicate that the base WSUD strategy for each location would achieve Council's targets.

Table 10-9 *Phase 1 Precinct Frenchs Forest Town Centre*

Stormwater quality parameter	Source load	Treated load	% reduction
Flow (ML/yr)	63.6	59.2	7.1%
Total Suspended Solids (kg/yr)	9590	1350	85.9%
Total Phosphorus (kg/yr)	18.2	6.29	65.4%
Total Nitrogen (kg/yr)	136	63.4	53.3%
Gross Pollutants (kg/yr)	1490	0.00	100.0%

Table 10-10 *Brickpit Reserve sub-catchment*

Stormwater quality parameter	Source load	Treated load	% reduction
Flow (ML/yr)	86.1	84.5	1.8%
Total Suspended Solids (kg/yr)	17500	2480	86.1%
Total Phosphorus (kg/yr)	31.6	8.69	71.8%
Total Nitrogen (kg/yr)	177	86.2	51.7%
Gross Pollutants (kg/yr)	1790	0.00	100%

Table 10-11 *Akora Reserve sub-catchment*

Stormwater quality parameter	Source load	Treated load	% reduction
Flow (ML/yr)	26.7	25.9	3.1
Total Suspended Solids (kg/yr)	4860	706	85.5
Total Phosphorus (kg/yr)	8.30	2.66	68.0
Total Nitrogen (kg/yr)	56.1	26.6	52.6
Gross Pollutants (kg/yr)	667	0.00	100.0

11 Preliminary cost estimates

Preliminary cost estimates have been prepared for base WSUD strategy measures within pedestrian areas, road reserves and public open space within the FFTC, Brickpit Reserve and Akora Reserve. These estimates are summarised in Table 11-1, Table 11-2 and Table 11-3. We understand that Council's preference will be for all road reserves within the FFTC (including WSUD measures) to be privately owned and maintained.

The preliminary cost estimates were derived from detailed cost estimates prepared by Alluvium for the ACT government in 2015 for over 25 WSUD and stormwater harvesting projects. The ACT rates were adjusted for inflation and NSW conditions for this project. Costs were also compared with $/ha estimates derived for similar development categories that are outlined in the publication "A Business Case for Best Practice Urban Stormwater Management" (waterbydesign, 2010).

The preliminary cost estimates are based on (but not limited to) the following key assumptions:

- Adjustments to existing services would not be required.
- Site establishment and clearance costs required for all works would be costed separately by others (including items such as tree removal, demolition of concrete, removal of debris/waste, fencing, erosion and sediment control etc).
- Only minimal excavation in rock would be required.
- Conventional pit and pipe stormwater drainage system elements required to achieve Council's design standards for drainage would be available to connect new WSUD infrastructure to.
- We have assumed that the capital, operation and maintenance costs of new stormwater drainage infrastructure associated with the WSUD infrastructure will be evaluated separately by others.
- Excavated soil within the site would be uncontaminated and excavated soil would be utilised as fill with the site.
- Additional landscaping outside the extents of the WSUD measures to integrate the measures into the urban landscape would be costed separately by others.

Table 11-1 *Preliminary cost estimate for FFTC WSUD measures*

Treatment measure	Unit	Quantity	Rate	Capital	Annual O&M
Biofiltration swales	m2 of biofilter	690	$515	$355,350	$8,900
Stormwater gardens	m2 of biofilter	290	$515	$149,350	$3,800
Tree pit filters	each	30	$4,000	$120,000	$6,000
Below ground GPT	item	1	$110,000	$110,000	$5,500
Stormwater harvesting system	item	1	$550,000	$550,000	$27,500
			Contingency (30%)	$385,400	$15,500
			Total	**$1,670,100**	**$67,200**

Table 11-2 *Preliminary cost estimate for Akora Reserve WSUD measures*

Treatment measure	Unit	Quantity	Rate	Capital	Annual O&M
Diversion pit on existing drainage line	item	1	$10,000	$10,000	
Drainage diversion pipe	m	15	$550	$8,250	
Biofilter inlet headwall	item	1	$1,100	$1,100	
Local regrading and landscaping of overland flowpath	m2	150	$50	$7,500	

Biofiltration basin	m2 of biofilter	350	$515	$180,250	$4,500
Street stormwater gardens	m2 of biofilter	30	$750	$22,500	$1,150
Outlet pit on existing drainage line	item	1	$5,000	$5,000	
			30% contingency	$70,380	$1,700
			Total	**$304,980**	**$7,350**

Table 11-3 *Preliminary cost estimate for Brickpit Reserve WSUD measures*

Treatment measure	Unit	Quantity	Rate	Capital	Annual O&M
Diversion pit on existing drainage line	item	1	$7,500	$7,500	
Modify existing drainage pit to incorporate diversion weir	item	1	$5,000	$5,000	
Drainage diversion pipe	m	60	$550	$33,000	
Biofilter inlet headwall	item	1	$1,100	$1,100	
GPT	item	1	$30,000	$30,000	$1,500
Low flow landscaped swale	m2	300	$50	$15,000	$1,500
Biofiltration basin	m2 of biofilter	700	$515	$360,500	$9,000
Biofiltration spillway	item	1	$10,000	$10,000	$300
Drainage outlet line	m	25	$550	$13,750	
Headwall outlet	m	1	$1,100	$1,100	
			30% contingency	$143,085	$3,700
			Total	**$620,035**	**$16,000**