Northern Beaches Hospital

Stage 1: Concept Design, Site Clearance & Preparatory Works

Appendix I

Stormwater Management Strategy & Plan

Health Infrastructure NSW Health

Northern Beaches Hospital Campus Project

Stormwater Management Strategy and Plan

Issue 2 | 11 July 2013

Job number 225990

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ARUP

Document Verification

ARUP

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Appendices

1 Introduction

The Northern Beaches Hospital involves the development of a parcel of land bounded by Frenchs Forest Road to the north, Wakehurst Parkway to the east, Warringah Road to the south and The Forest High School to the west. Bantry Bay Road currently crosses the site from north-south, providing access to several houses (which have been acquired and subsequently demolished as part of the development). The remainder of the existing site is predominantly bushland. The approximate size of the site is 6.3 ha. The site is located within the Warringah Council local government area (LGA).

It is proposed to develop the site into a hospital with associated infrastructure including car parking, administration, utility services and soft and hard landscaping.

This report has been provided in response to the Director General's Requirements (DGRs) for the Environmental Assessment received on 19th June 2013. The DGRs requires a Stormwater Management Strategy and Plan be prepared that addresses the drainage associated with the proposal. The specific requirements for the stormwater design which shall be addressed in this management plan are:

- Stormwater and drainage infrastructure
- Water sensitive urban design (WSUD)
- Water harvesting
- On site retention/ detention
- Avoiding impacts on downstream properties.

In addition to addressing these requirements, this report also provides a summary of the stormwater drainage requirements and the outcomes from discussions/ meetings held with Council (13/11/12 and 10/12/12). Copies of meeting minutes are provided in Appendix A.

2 Existing Stormwater Drainage Network

The site is located on a high-point which sheds runoff to two separate drainage catchments. According to the Warringah Council *"Northern Beaches Stormwater Management Plan"*, July 1999, the north of the site sheds to the north east and contributes to the Narrabeen Lagoon Catchment. The remainder of the site sheds to the south east and to Manly Lagoon Catchment.

The majority of the existing site is bush landscaping, with a relatively small impermeable proportion, in the form of Bantry Bay Road and residential properties.

Stormwater runoff from the site currently sheet flows to the surrounding road network where the water is captured by a pit and pipe network. These networks are Council and RMS owned assets.

3 Proposed Stormwater Drainage Strategy

The proposed stormwater drainage system would be designed in accordance with the procedures outlined by the Department of Planning and Infrastructure (DP&I) and the relevant design standards (eg Australian Standards, Australian Rainfall and Runoff (AR&R)). The appropriate authorities, including Roads and Maritime Services (RMS) and Council will be consulted during the design phase to establish/ confirm the design strategy to be adopted.

The following sections summarise the key requirements for the design of the stormwater drainage network.

3.1 Rainfall/ intensity frequency duration (IFD)

Site runoff calculations would be determined in accordance with the procedures outlined in AR&R and based upon Council's IFD table (reference: Glen Street Theatre, Frenchs Forest). A copy of the IFD table is provided in Appendix B.

3.2 On-site detention/ retention and permissible site discharge

On-site detention is required to mitigate the increase in runoff from the site. The design shall be provided in accordance with Council requirements. Council generally requires OSD to be designed using their *"On-site Stormwater Detention Technical Specification*".

In response to the DGRs to avoid impact on downstream properties, it is proposed to 'limit the proposed peak site discharge to that of the existing site for storm durations ranging from 5 minutes to 3 hours and for recurrence intervals of 5, 20 and 100 years'. This criterion eliminates any adverse impacts of the proposed development but is not intended to resolve any pre-existing deficiencies in the downstream network. It is noted that the proposed criteria differs to that required by Council and has been based upon a review of what feasibly can be achieved by the project development.

3.2.1 Storage Requirements

A preliminary review of the site has been completed to understand the OSD requirements with regard to the anticipated maximum level of development. A comparison between the existing and proposed concept design is provided in Table 1. The results indicate a significant increase in the impermeable proportion of the site as a result of the development that will require detention to achieve the permissible site discharge (PSD) as outlined in Section 3.2.

Table 1 – Existing and developed site properties

	Total Area (ha)	**Permeable Area (ha)**	**Impermeable Area (ha)**
Existing Site	6.3	5.4 (85%)	0.9 (15%)
Proposed Site	6.3	1.9 (30%)	4.4 (70%)

It is noted that Council policy requires the assumption that the predevelopment condition for the site is 100% permeable for developments other than a single dwelling. This is not representative of the existing site conditions and the assumption would result in increased storage and "betterment" to the existing drainage network. This requirement was discussed with Council and copies of meeting minutes are provided in Appendix A.

The storage volumes required as part of the development will depend on the final impermeable area of the development and the consultation process with Council.

Opportunities should be explored during the detailed design to optimise the storage requirements. This may include the incorporation of high early discharge, infiltration, rainwater reuse and variable/ staged outlets.

3.2.2 Storage Opportunities

The detailed design should explore opportunities for providing storage below or above ground, or a combination of both. Below ground options include proprietary storage devices or bespoke cast in-situ tanks. Above ground storage may be incorporated into car parks and/ or soft landscaping by appropriate grading. Alternatively, rooftop storage is an option that may be explored further.

The option for rooftop OSD storage has been discussed with Council and has been deemed acceptable on the condition that the depth of ponding does not exceed 200mm and that the hydraulic design can be proven effective. An assessment has been carried out to determine its viability. The major constraints for this option are the potential uses for the space, including rooftop plant, helipads etc. that would need to remain clear of any ponded water. The option is also further constrained by the limited catchment area which can contribute to the storage via gravity. Based upon the anticipated roof catchment area of 1.0 ha, an estimated volume of storage which may be reasonably provided upon the building roof is 700m^3.

Opportunity for the retention of stormwater for reticulation and reuse throughout the site would be investigated during the detailed design phase. Potential uses for the harvested stormwater include landscape irrigation and grey water reuse within the building development. The viability of such a scheme would need to be determined by a water reuse study, including a water balance assessment during the detailed design stage. This is further discussed in Section 3.6.1.

Council standards for residential development permit a 50% discount/offset for water used for reticulation within the building. No policy currently exists for commercial/ hospital developments. The opportunity for an offset would be discussed with Council during the consultation process if recycled water reticulation is to be pursued for the development.

Council requires that surface storage be provided in landscaped and/or driveways and car park areas. The grading of the site is such that the opportunity to provide storage above ground is limited without terracing/ benching which could introduce complications for vehicle and pedestrian access. Therefore it is more than likely that the majority of the storage requirements would need to be provided below ground. Early concept designs for the site indicated that a large proportion of the site would be occupied by basements. Therefore scope for providing below ground OSD storage would be limited. An inquiry has been

made to Council regarding the acceptability of providing the storage requirements off site, however this was deemed unacceptable. Further exploration for suitable storage locations will be necessary during detailed design.

3.3 Discharge locations

Council's technical specification states that it is unacceptable to divert flows from one catchment to another. Council has since clarified that the redistribution of the site's two catchment areas is acceptable on the condition that the PSD for each catchment is not exceeded.

Due to the predominantly undeveloped nature of the existing site, stormwater runoff currently sheet flows to the surrounding road network where it is intercepted by the local pit and pipe network.

Discharge for the proposed development may be provided by either direct connections to the in-ground drainage network in the surrounding road network or outlets directly to the kerb and gutter.

3.4 Major/ minor design criteria

Council's major (overland) and minor (piped) drainage design standards are the 100 year average recurrence interval (ARI) and 20 year ARI respectively. A 100% blockage factor is to be applied to the piped drainage network for the design of the major drainage flow path.

The standard RMS minor drainage design criteria is the 10 year ARI. Council has agreed to adopt the RMS minor design (10 year ARI) standard where connections are made from the Council to the RMS drainage network. This is conditional that the agreed PSD is not exceeded.

3.5 Stormwater quality

Reference should be made to Warringah Council's *"Northern Beaches Stormwater Management Plan"* for determining the water quality requirements for stormwater runoff. During the meetings held with Council representatives, it has been identified that the key pollutants for design and treatment consideration are total suspended solids (TSS), gross pollutants and hydrocarbons. The generation of total phosphorous (TP) and total nitrogen (TP) pollutants are anticipated to be low and are of lesser concern to Council.

3.6 Water sensitive urban design (WSUD)

WSUD has been defined by the Australian governmental agreement of the National Water Initiative (COAG 2004) as being *"the integration of urban planning with the management, protection and conservation of the urban water cycle that ensures that urban water management is sensitive to natural hydrological and ecological processes"* (www.wsud.org).

Techniques and devices for WSUD are continually developing and improving. Several possibilities for consideration include:

- Roof water and stormwater harvesting systems

- Bioretention systems, tree pits and rain gardens
- Proprietary Stormwater Quality Improvement Devices (SQIDs)
- Gully baskets/ pit inserts
- Permeable pavements

The viability of each of these options depends upon criteria including anticipated demand for recycled water, available footprint, water quality treatment targets, ground conditions and tie-in levels with existing drainage networks. The suitability of each of these devices/ techniques would require assessment in conjunction with the development of the hospital's detailed design, however a brief summary of each is provided in the subsequent sections.

Examples of WSUD devices are shown in Figure 1.

Figure 1 - WSUD techniques [Clockwise from top left: raingarden scheme in Cremone Street, Melbourne (wsud.org 2012), permeable pavement in a Sutherland car park (wsud.org, 2012), Humes JellyFish, tree pit (Auckland Council 2012)]

3.6.1 Roof water and stormwater harvesting

Roof water and stormwater harvesting provides opportunity to capture, store and reticulate stormwater for non-potable reuse. Harvesting systems assist in reducing potable water demands and discharge volumes to stormwater drainage networks. Due to its requirement for a dedicated pipe network its viability would need to be considered against the initial and long-term cost requirements.

3.6.2 Bioretention systems, tree pits and rain gardens

It is unlikely that bioretention and rain gardens would be the most suitable devices for the site considering the large footprint areas required for treatment. They are also ideally suited to the treatment of phosphorus and nitrogen which have been identified through consultation with Council to be of less significance for treatment. However, due to their aesthetic appeal and ability to be integrated into landscaping, they may be a suitable method of treatment in conjunction with alternate techniques.

3.6.3 Proprietary Stormwater Quality Improvement Devices

SQIDs provide the opportunity to provide an 'all in one system' for the removal of a range of pollutant types. They provide a consolidated location for capture and removal of pollutants during maintenance. The type of device/s adopted can be tailored to suit the anticipated pollutant types. SQIDs often occupy a significant below-ground footprint which requires coordination with other services and basement footprints during the detailed design.

3.6.4 Gully baskets/ pit inserts

Gully baskets/ pit inserts are effective methods of capturing at-source gross pollutants and are often used as retro-fitted treatment solutions. The limitations of such WSUD solutions are the maintenance requirements. Each individual basket/ pit requires periodic maintenance to remove trapped material to avoid a reduction in the hydraulic performance of the drainage network. Alternate WSUD techniques may be provided to achieve the same water quality benefits with a reduced maintenance requirement.

3.6.5 Permeable pavements

Permeable pavements allow for the effective removal of fine sediment, TSS, TP and TN, however they do not provide for the removal of litter or gross pollutants. Other limitations of permeable pavements is that they are suitable for pedestrian and occasional light traffic only and are most efficient on relatively flat sites. Therefore the opportunity to be integrated into the proposed development would be dependent upon the site layout and grading, including heavy vehicle access routes.

3.7 Frenchs Forest Road West drainage

Should the development of the hospital site include the widening of Frenchs Forest Road West. Council require that the road stormwater network be upgraded to suit the new kerb alignment and increased runoff. The existing drainage network is estimated to be 30-40 years old. Council has requested that pipes which are intended to be retained and potentially affected by construction traffic are to be inspected by CCTV.

Council has confirmed that the site's OSD calculations do not need to incorporate the impacts of the widening of Frenchs Forest Road West.

4 Conclusion

The detailed design for the stormwater drainage will need to be undertaken in accordance with the relevant standards and the various discussions held with Council. It is recommended that the two existing points of discharge be retained to limit the OSD volume. Water quality treatment will be necessary to treat the anticipated pollutant types and loadings. It is likely that further discussions with Council and RMS will be required to agree on an acceptable design solution and layout.

Appendix A

Council Meeting Minutes

Minutes

ARUP

Project title	Northern Beaches Hospital	Job number	225990
Meeting name and number	Stormwater and OSD	File reference	
Location	Warringah Council	Time and date	14:00 13 November 2012
Purpose of meeting	Discuss On-site Detention (OSD) strategy and requirements		
Present	Karen Seeto (Arup) James Holbrook (John Staff) Stephen Watson (WC) Paul David (WC)		Claire Moore (Arup) Sean Khoo (WC)
Apologies			
Circulation	Those present Peter Macdonald Colin Robertson		

Action

James Holbrook and Claire Moore provided a summary of the project status and site layout including descriptions of site entrances and building/basement extents.

1. Clarifications sought with regards to Council's *"On-site Stormwater detention Technical Specification"*:

"Diverting flows from one catchment to another is not permitted". WC confirmed that this did not apply on the condition that the Permissible Site Discharge (PSD) for each discharge location was not exceeded.

WC clarified that "discharge off the site is to be restricted to the "state of nature"" refers to an impermeable fraction of 0% and roughness coefficient of 0.33 to be applied to the existing site. Therefore imposing a requirement for betterment. Arup/ John Staff challenged this requirement given the existing site has a road (Bantry Bay Road) and various properties which are impervious. The requirement for betterment is increasing the size of OSD storage required to meet these targets. This may make the project unviable.

To be discussed at next meeting.

WC confirmed that the proposed pipe flow from site is limited to the 5 year pre-development runoff, unless RMS can confirm that their infrastructure has greater than a 5 year capacity. In this instance, additional flow may be directed to the pipe network on the condition that

Prepared by	Karen Seeto
Date of circulation	15 November 2012
Date of next meeting	tbc

		Action
	the total site discharge (pipe and overland) does not exceed the PSD. Arup sought clarification of how the 5 year ARI design criteria can efficiently be applied to a site outlet when the additional flows generated in major storms will produce increased head and therefore an increased flow in the pipe network. Further discussion of this design criterion is requested at the next meeting.	To be discussed at next meeting.
2.	**Design elements**	
	Arup advised that the area for the potential, future Private Hospital would be graded and cleared. However, as this part of the site will remain pervious in nature the OSD design for the hospital buildings will exclude this area. If/when the private hospital is built; a separate OSD strategy will need to be included by the developer.	
	OSD on roof areas was proposed by Arup. WC has no policy for the detention of rainwater on roofs and requested details of how the scheme would operate in order to confirm acceptance. After discussion WC agreed that if this option is developed by design team and agreed with HI, a maximum storage depth of 200mm would apply and that an overflow route would be required. Arup explained that an overflow route would be provided and that the storage on the roof would exclude critical elements including helipad and plant. The roofs would be graded for drainage (with and without OSD).	
	Arup requested clarification from Council to assist in establishing tailwater conditions. Arup proposed the adoption of 150mm below and 150mm above pit surface level at the connection point to the external network for the minor and major storms respectively. WC's preference was to model the downstream network to establish the tailwater level at the point of connection. This item requires further discussion. Arup's opinion is that given the grade of the site that the tailwater levels proposed by WC are conservative and that further modelling of the network would still require the establishment of tailwater conditions at the network outlet.	To be discussed at next meeting.
	WC confirmed that High Early Discharge (HED) is acceptable.	
	WC put forward a proposal to provide OSD on the pitch of the adjacent Forest High School. However this was not considered appropriate as it would be diverting flows to another catchment.	
	WC queried whether OSD storage in landscaping was being investigated by the project. Arup explained the inefficiencies of aboveground storage considering the site's steep gradient.	
	Arup advised that rainwater tanks were possibly being considered however NSW HI did not intend to reticulate recycled water throughout their facilities. An alternate proposal was to provide irrigation to the adjacent Forest High School. WC advised that no offset in OSD volume would be provided for water stored for irrigation. Council standards for residential development permit a 50% discount for water used for reticulation within the building. No policy exists for commercial/ hospital	To be discussed at next meeting.

		Action
	developments. Arup requests further discussion regarding the applicable discount if rainwater storage is to be pursued for the project.	
	WC requested details of the project's velocity x depth design criteria. Arup advised that this would be something to be addressed at detailed design stage but that the use of the site as a hospital would be considered and appropriate limits set to minimise risk to public and staff.	To be discussed at next meeting.
	A discussion was had regarding off site detention of stormwater within Council land. A further discussion of this matter is required if it is to be pursued as a viable design solution. SW to check ownership and zoning of the land south of Warringah Road.	SW
3.	**Items not discussed during meeting and requiring further clarification:**	
	Does council have a specific IFD table to be adopted in the design?	To be discussed at next meeting.
	A discussion is requested by Arup regarding the apparent requirement for undertaking cctv survey and upgrading of existing Council drainage networks.	

Minutes

ARUP

Project title	Northern Beaches Hospital	Job number	225990
Meeting name and number	Stormwater and OSD Meeting 2	File reference	
Location	Warringah Council	Time and date	14:30 10 December 2012
Purpose of meeting	Discuss On-Site Detention (OSD) and water quality strategy and requirements		
Present	Karen Seeto (KS - Arup) Nikki Akbari (NA - Arup) Sean Khoo (SK – Warringah Council) Claire Moore (CM - Arup) Robert Barbuto (RB – Warringah Council)		
Apologies			
Circulation	Those present James Holbrook Peter Macdonald Colin Robertson		

Action

1. Introduction

CM provided a summary of the project status and site layout including a description of the proposed site plan including public, staff, and heavy vehicle entrances as well as an overview of the proposed service easement and the strip of Duffy's Forest being retained.

2. Stormwater and OSD

As discussed at the previous meeting, Arup advised that the opportunity for providing OSD on the site is limited without impacting the retained Duffy's Forest area which is considered undesirable. All agreed that with basement extents required for parking there is limited scope for providing detention within site.

2.1 Permissible Site Discharge (PSD)

Arup wish to challenge the need for the PSD to be 'state of nature' and instead requested an alternative PSD to meet the existing site discharge and not increase existing runoff. Council agreed to consider such a scheme and have requested that figures be provided as validation.

Arup to issue PSD calculations to Council by 15/01/13

Arup requested a site specific IFD table to be adopted in the design. Post meeting note – this has been provided.

Council (SK)

Council agreed that high early discharge could be adopted.

Prepared by	Nikki Akbari
Date of circulation	11 December 2012
Date of next meeting	TBC

Action

2.2 Water Harvesting

The previous proposal to provide irrigation to the adjacent Forest High School was further discussed. Council requested that Arup provide a Water Balance Model if this option were to be pursued.

Arup to review with hydraulic engineer.

2.3 Roof Storage

Council queried whether roof storage would be implemented. Arup advised that this is being investigated as part of the schematic design. As previously agreed this would be limited to 200mm as rainfall intensities do not generate sufficient volumes to warrant a depth of ponding greater than 200mm.

Council advised that multiple kerb outlets would be acceptable to Council if it were an option that the project wished to consider.

3. Water Quality

Council referred Arup to the Northern Beaches Stormwater Management Plan for determining water quality requirements. Council confirmed that phosphorous and nitrogen pollutants reduction targets are not relevant due to the anticipated low generation rates for the development. However total suspended solids, gross pollutants and hydrocarbons etc must be reduced in accordance with the Northern Beaches Stormwater Management Plan. Arup are to review the water quality requirements for the project.

Arup to review plan

Council was not keen on the option of providing off-site OSD due to the impact on natural vegetation etc. Council referred Arup to Natural Environment Manager, Adam Burrows for further discussion on this item.

4. Frenchs Forest Road Drainage

Council confirmed that future road widening of Frenchs Forest Road is not to be included in the sites area to be counted for OSD, however part of the road's stormwater network should be upgraded to suit new kerb alignments and increased runoff. Council advised that Frenchs Forest Road drainage has no current condition assessment available and the pipes could be 30-40 years old. Council requested CCTV of pipe networks which would be retained and potentially affected by construction traffic.

Council advised that the minor storm criteria for Council's drainage networks in public roads is a 20 year ARI. Arup suggested that using the Council standard of 20 years would be ineffective as the pipe flow is limited to the capacity of the surrounding roads which comply with

Action

the RMS standard 10 year capacity. Council confirmed they will accept RMS standard of 10 years where this situation applies, for example Frenchs Forest Road drainage connects to RMS network at Wakehurst Parkway.

Council advised that their standard requirements for the design of drainage are to check the 5, 20 and 100 year ARIs. Arup may also model the 10 year ARI and provide a pipe connection with a 10 year capacity on the condition that the agreed PSD is not exceeded.

5. AOB

Next meeting to be in the new year.

Appendix B

Council IFD Table

LOCATION [illegible] * NEAR. [illegible] ISSUED [illegible] REF. [illegible]

GLEN ST THEATRE FRENCHS FOREST

LIST OF COEFFICIENTS TO EQUATIONS OF THE FORM [illegible]

$$\ln(I) = a + b*(\ln(T)) + c*(\ln(T))**2 + d*(\ln(T))**3 + e*(\ln(T))**4 + f*(\ln(T))**5 + g*(\ln(T))**6$$

I = INTENSITY IN MILLIMETRES PER HOUR

T = TIME IN HOURS

RETURN PERIOD (YEARS)	a	b	c	d	e	f	g
1	3.4599	-0.5778	-0.0306	0.00728	0.000585	-0.0001595	-0.0000244
2	3.7214	-0.5719	-0.0318	0.00733	0.000703	-0.0001771	-0.0000257
5	3.9955	-0.5558	-0.0335	0.00764	0.000744	-0.0002592	-0.0000121
10	4.1289	-0.5474	-0.0345	0.00766	0.000808	-0.0002798	-0.0000110
20	4.2785	-0.5407	-0.0353	0.00799	0.000800	-0.0003398	0.0000003
50	4.4474	-0.5326	-0.0362	0.00789	0.000880	-0.0003501	-0.0000003
100	4.5600	-0.5274	-0.0367	0.00792	0.000892	-0.0003659	0.0000025

RAINFALL INTENSITY IN MM/HR FOR VARIOUS DURATIONS AND RETURN PERIODS

DURATION (HOURS)	RETURN PERIOD 1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
0.083	102.	131.	164.	184.	209.	243.	268.
0.100	95.8	122.	155.	173.	197.	229.	253.
0.167	78.5	101.	128.	144.	164.	192.	212.
0.333	57.4	73.9	95.3	108.	124.	146.	162.
0.500	46.7	60.4	78.4	89.1	103.	121.	135.
1.000	31.8	41.3	54.4	62.1	72.1	85.4	95.6
2.000	21.1	27.4	36.5	41.9	48.9	58.2	65.3
3.000	16.4	21.4	28.7	33.0	38.6	46.1	51.8
6.000	10.7	14.0	18.9	21.8	25.6	30.7	34.7
12.000	7.02	9.21	12.5	14.5	17.1	20.5	23.2
24.000	4.62	6.09	8.29	9.65	11.4	13.7	15.5
48.000	3.00	3.95	5.40	6.29	7.43	8.96	10.2
72.000	2.26	2.98	4.09	4.75	5.64	[illegible]	[illegible]

DESIGN RAINFALL INTENSITY DIAGRAM

LOCATION [illegible] * NEAR. [illegible]

* [illegible]

ISSUED [illegible] REF. [illegible]

[illegible]

PREPARED BY -- HYDROLOGY BRANCH -- BUREAU OF METEOROLOGY -- MELBOURNE