City & Southwest – Chatswood to Sydenham

Maximisation of Spoil Removal by Non-Road Methods – Investigation Report (Part 1)

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Unclassified

Revision	Revision Date	Status	Brief Reason for Revision	Author Company / Position	Approver Company / Position
1	27 Sep 2018	Final	Compliance with Chatswood to Sydenham Condition of Approval E84 prior to commencement of tunnel spoil generation	Sydney Metro / Sustainability Officer	Sydney Metro / Director of Planning, Environment & Sustainability, City & Southwest

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1. Terminology

All terminology in this document is taken to mean the generally accepted or dictionary definition. Other acronyms, terms and jargon specific to Sydney Metro are defined within SM QM-FT-435 Integrated Management System (IMS) Glossary and/or in the table below.

	Definitions
ASS	Acid Sulphate Soils
C2S	Chatswood to Sydenham
CBD	Central Business District
CoA(s)	Condition(s) of Approval
CSM	Central Station Main (known publicly as Central Walk and Metro Station)
CSSI	Critical State Significant Infrastructure
EIS	Environmental Impact Statement
EP&A	*Environmental Planning and Assessment Act 1979* (NSW)
EPA	Environment Protection Authority (of NSW)
ER	Environmental Representative
REF	Review of Environmental Factors
Secretary	The Secretary of the NSW Department of Planning and Environment
TBM	Tunnel Boring Machine
TSE	Tunnels and Station Excavation (known publically as Metro tunnelling contract)
VENM	Virgin Excavated Natural Material

2. Introduction

2.1. Purpose of this Report

The Chatswood to Sydenham (C2S) component of the Sydney Metro City & Southwest project includes the boring of 15.5 kilometres of underground twin tunnels and excavation of multiple construction site boxes. These activities are expected to generate approximately 2.4 million cubic metres of spoil along the alignment's construction sites.

This report has been prepared to document Sydney Metro's investigation into opportunities to maximise spoil removal by non-road methods under the C2S planning approval. This investigation was required as part of Condition E84 of the C2S planning approval.

Sydney Metro is complying with Condition of Approval (CoA) E84 in accordance with the approach outlined in Table 1. This approach is consistent with the allocation of CoA E84 in the *Sydney Metro City & Southwest Chatswood to Sydenham Staging Report*.

Table 1: Sydney Metro's Compliance Approach to CoA E84

CoA E84 Component Number	CoA E84 Component Description	Sydney Metro Compliance Approach
1	**Notwithstanding the above [CoA E83], the Proponent must investigate opportunities to maximise spoil removal by non-road methods**	This is currently addressed in this report.
2	**And [investigate opportunities to] schedule final track laying as soon as practicable following completion of tunnelling with a view to transporting materials and equipment for station fit-out, systems and commissioning by rail to minimise truck movements in town centres and the Sydney CBD.**	This will be addressed in a revised version of this report or in a separate report.
3	**The findings of the investigation must be reported to the Secretary before commencement and before completion of tunnel spoil generation as relevant.**	This will be complied with in two parts: - CoA E84 Component 1 will be complied with by submitting this report to the Secretary for information prior to the commencement of tunnel spoil generation (currently planned no earlier than 12 October 2018). - CoA E84 Component 2 will be complied with by submitting a revised version of this report or a separate report to the Secretary for information prior to the completion of tunnel spoil generation (currently planned for March 2020).
4	**A decision to not adopt spoil haulage or materials delivery by non-road methods must be demonstrated to the satisfaction of the Secretary.**	Any comments received by the Secretary in relation to CoA E84 will be addressed by Sydney Metro to the satisfaction of the Secretary.

2.1.1. Environmental Representative Endorsement

In accordance with CoA A24(d) of the C2S planning approval, this report will be endorsed by the Environmental Representative (ER) for suitability for submission to the Secretary prior to submission to the Secretary. The ER endorsement of this report is provided in Appendix A.

2.2. Sydney Metro Background

The NSW Government is implementing Sydney's Rail Future (Transport for NSW, 2012a) – a plan to transform and modernise Sydney's rail network so that it can grow with the city's population and meet the needs of customers in the future.

Sydney Metro is a new standalone rail network identified in Sydney's Rail Future. This 21st century network will deliver new metro stations and more than 88km of new metro rail for Australia's biggest city – revolutionising the way Sydney travels.

Sydney Metro currently comprises of three projects, all of which have been identified by the NSW Government as priority projects:

- **Northwest** (formerly North West Rail Link) – a 36 kilometre project currently under construction and opening in the first half of 2019 with a metro train every four minutes in the peak. Tunnelling has finished and construction is progressing.
- **City & Southwest** – a 30 kilometre metro line extending metro rail from the end of Sydney Metro Northwest at Chatswood, under Sydney Harbour, through new Central Business District (CBD) stations and southwest to Bankstown. The project is due to open in 2024 with ultimate capacity to run a metro train every two minutes in the peak.
- **West** – the next significant railway infrastructure investment proposed to be delivered by the second half of the 2020s. This project would link the CBDs of Parramatta and Sydney and communities in between.

Figure 1 provides a map of the three Sydney Metro project alignments.

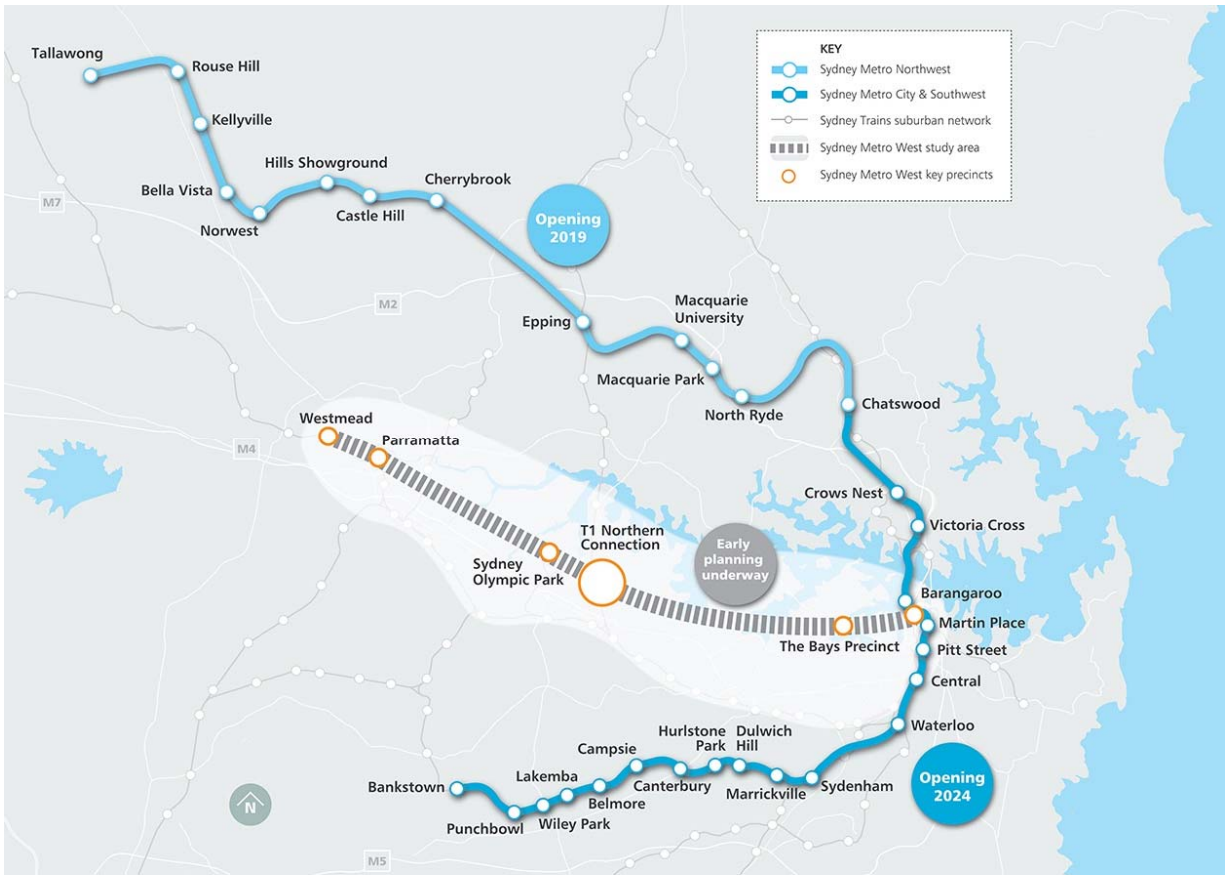


Figure 1: Sydney Metro Project Alignments

2.3. City & Southwest Project

The City & Southwest project has generally been declared as a Critical State Significant Infrastructure (CSSI) project by the NSW Minister for Planning.

2.3.1. Project Planning Approvals

Projects declared as a CSSI require CSSI planning approval under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). Works outside the declaration require separate planning approval under the EP&A Act.

The City & Southwest project comprises two core components that are each subject to the CSSI planning approval pathway:

- **Chatswood to Sydenham** – which covers the construction and operation of the Sydney Metro railway between Chatswood and Marrickville. This includes the delivery of seven new metro stations and 15.5 kilometres of twin railways tunnels from Chatswood, beneath Sydney Harbour and the Sydney CBD, to Marrickville. The C2S component was subject to the *Chatswood to Sydenham Environmental Impact Statement* (EIS) and was granted planning approval on 9 January 2017.

- **Sydenham to Bankstown** – which covers the construction and operation of the Sydney Metro railway between Marrickville and Bankstown Stations. This includes the upgrading of 13.5 kilometres of the Sydney Trains T3 Bankstown Line between the Marrickville and Bankstown Stations. This component is subject to the *Sydenham to Bankstown Upgrade EIS* and *Sydenham to Bankstown Submissions and Preferred Infrastructure Report* and is expected to be determined in late 2018.

Over-station developments are subject to separate State Significant Development planning approval processes.

2.3.2. Project Delivery, Staging and Timing

Refer to the *Sydney Metro City & Southwest Chatswood to Sydenham Staging Report* for the latest information on the project delivery strategy, staging and timings. This document is available from the Sydney Metro website.

3. Spoil Management

Spoil management on the City & Southwest project is guided by the *City & Southwest Sustainability Strategy*. The Sustainability Strategy outlines Sydney Metro's performance targets, initiatives and outcomes that will be adopted throughout the design, construction and operation of the City & Southwest project across key policy areas, including spoil management.

A key spoil management objective of the strategy is to beneficially reuse 100% of reusable spoil. This objective is further supported by Revised Environmental Mitigation Measure WM2 of the Chatswood to Sydenham planning approval:

> *100 per cent of spoil that can be reused would be beneficially reused in accordance with the project spoil reuse hierarchy.*

3.1. Spoil Reuse Hierarchy

The spoil reuse hierarchy is outlined in the *City & Southwest Sustainability Strategy* and is provided in Table 2.

All spoil generated by the project will classified to determine the most appropriate reuse option. Spoil that cannot be reused (e.g. contaminated spoil) will be disposed at appropriately licensed facilities.

Table 2: Spoil Reuse Hierarchy

Ranked Preference	Reuse Option	Examples
1	**Within the Project**	• Reuse in the project to fill embankments and mounds within a short haulage distance from the source. • Restoration of any pre-existing contaminated sites within the project boundaries. • Reuse as a feed product in construction materials (e.g. concrete).
2	**Environmental Works**	• Reuse in coastal protection works (e.g. beach nourishment, land raises). • Reuse in flood mitigation works and other restoration works.
3	**Other Development Projects**	• Reuse for filling embankments and mounds on projects within an economic transport distance from site. • Reuse for land reclamation or remediation works. • Reuse for manufacturing with sand in concrete or shale in bricks/tiles.
4	**Land Restoration**	• Reuse to fill disused facilities (e.g. mines and quarries, to enable either future development or ecological rehabilitation).
5	**Landfill Management**	• Reuse to cap completed landfill cells. • Reuse in daily covering of landfill waste.

3.2. Applicable Contracts

Almost all spoil generated under the C2S planning approval will be generated under one of two contracts:

- **Tunnels and Station Excavation** (TSE) contract – this contract includes all construction site box excavations (except at Central Station) and the boring of 15.5 kilometres of underground twin tunnels approximately six metres in diameter from Chatswood to Marrickville. This contract was awarded to John Holland CPB Ghella Joint Venture on 22 June 2017. The TSE contract comprises of approximately 89.9% of the total spoil generation under the C2S planning approval (refer to Table 3).
- **Central Station Main** (CSM) contract – this contract includes the excavation of the Sydney Metro station platform box at Central Station and the excavation of Central Walk. This contract was awarded to Laing O'Rourke on 7 March 2018. The CSM contract comprises of approximately 10.1% of the total spoil generation under the C2S planning approval (refer to Table 3).

3.2.1. Commercial Risks and Limitations

During the tender phases for both the TSE and CSM contracts, Sydney Metro considered mandating a portion of all spoil removal to be undertaken via non-road methods. However from a commercial perspective and to provide value for money to NSW tax-payers, Sydney Metro decided not to mandate any removal of spoil via non-road methods due to the significant costs that would have been added by the tenderers to compensate for uncertainties. Instead, Sydney Metro encouraged tenderers to consider spoil removal by non-road methods.

Factors of uncertainty that were likely to have generated increased tender costs include:

- Final spoil compositions and qualities, which would affect the final reuse and destination options for the spoil,
- The commencement of other large tunnelling projects in Sydney that remain subject to planning approval (such as WestConnex stages, Western Harbour Tunnel, F6 Extension and other Sydney Metro projects), which would apply significant pressure on the final spoil destination facilities to accept spoil, and
- The ability for individual facilities to legally accept differing qualities and quantities of spoil at the time of generation.

Post contract award dates, Sydney Metro determined that mandating contractors to undertake spoil removal via non-road methods would pose significant commercial and financial risk to the contracts. This would have been caused by requesting the successful contractors to price the contract variation request in an uncompetitive environment, leading to significantly inflated costs. Again, Sydney Metro encouraged the successful contractors to consider spoil removal by non-road methods.

4. Spoil Generation

4.1. Classification

The majority of spoil generated by the project is likely to be classified as Virgin Excavated Natural Material (VENM). Non-VENM material will be classified as one of the following categories:

- Excavated Natural Material,
- Acid Sulphate Soils (ASS) or potential ASS,
- General soil waste,
- Restricted soil waste, or
- Hazardous waste.

4.2. Suitability for Reuse

The suitability for reuse of spoil generated by the project is dependent on the spoil composition. Three primary types of spoil compositions are anticipated to be generated by the project – sandstone, shale and marine sediment. The general suitability of spoil reuse for each of these composition types is as follows:

- **Sandstone** – Relatively high engineering end use potential for spoil generated by hydraulic breakers, road headers and Tunnel Boring Machines (TBMs). Possible reuse options include road-base material, reinforced earth backfill, reclamation fill and general fill for road embankments.
- **Shale** – Relatively low engineering end use potential for weathered shales (and possibly fresh shales) given the lower compressive strengths of these materials compared to sandstone. This type of composition is expected to be suitable as general fill and possibly for high-value brick-making purposes.
- **Marine Sediment** – Very low engineering end use potential for spoil generated by the TBM tunnelling beneath Sydney Harbour between the Blues Point and Barangaroo Station sites. The marine sediment slurry may need to be disposed of to landfill due to the potential presence of ASS.

The *Spoil Transport Options Paper* provides further details on anticipated spoil compositions and suitability for reuse. This report is provided in Appendix B.

The type of reuse for spoil will be determined by the project's contractors following confirmation of the spoil compositions and qualities. This will then determine options for the final destination of the spoil.

4.3. Compositions and Volumes

Table 3 provides anticipated spoil compositions and indicative volumes to be generated and extracted from each site along the project alignment. The indicative spoil volumes in Table 3 have been sourced from the applicable contractor's Spoil Management Plan (2018) and therefore differ slightly from the estimations in Appendix B (2016).

Table 3: Anticipated Spoil Compositions and Indicative Volumes

Site	Contract	Anticipated Spoil Composition	Indicative Spoil Volumes (m^3)	% Total Spoil Generation
Chatswood Dive	TSE	Sandstone	521,224	19.96%
Artarmon Substation	TSE	Sandstone	233	0.01%
Crows Nest Station	TSE	Shale / Sandstone	146,789	5.62%
Victoria Cross Station	TSE	Sandstone	255,937	9.80%
Blues Point *	TSE	Sandstone	5,987	0.23%
Barangaroo Station	TSE	Sandstone / Marine Sediment	314,467	12.05%
Martin Place Station	TSE	Sandstone	168,430	6.45%
Pitt Street Station	TSE	Sandstone	145,450	5.57%
Central Station	CSM	Shale / Sandstone	263,000	10.07%
Waterloo Station	TSE	Shale / Sandstone	132,195	5.06%
Marrickville Dive	TSE	Shale / Sandstone	657,049	25.17%
		Total	**2,610,761**	**99.99%** *(does not equal 100% due to rounding)*

** Whilst the Blues Point site is a temporary site only (i.e. no net spoil removal), spoil will need to be removed from the site during construction due to the limited capacity to store spoil onsite (approximately 50 cubic metres only can be stored onsite).*

5. Non-Road Method Options Analysis

Sydney Metro analysed two feasible non-road methods for removing spoil at each site:

- Rail (freight) transportation, and
- Marine transportation (i.e. barging).

The advantages and disadvantages of each of these methods are outlined in Table 4. This table demonstrates that the advantages of both rail and marine transportation are very similar, however there are significantly more disadvantages associated with rail transportation as there are for marine transportation.

Table 4: Advantages and Disadvantages of Non-Road Methods Analysed

Non-Road Method	Advantages	Disadvantages
Rail	• Operational expenditure is generally more cost effective than removal by road (i.e. generally transporting more spoil per 'movement'). • Limits the impacts on the local and arterial road networks. • Generally has lower environmental and community impacts than removal by road.	• Capital expenditure is generally less cost effective than removal by road. • May require 'double' or 'triple' handling of spoil in some circumstances, generally leading to higher costs and program/logistical inefficiencies. • Availability limited to sites that have close proximity to the rail network. • Requires sufficient land area adjacent to the rail corridor for rail sidings and loading/unloading activities (in the context of significantly constrained available land surrounding the existing Sydney rail network). • Time, cost and planning approval impacts associated with constructing new rail infrastructure and spoil loading/unloading activities. • Limits spoil disposal options (as required) to sites within close proximity to the rail network. • Movements generally limited to overnight shutdown periods between passenger services (leading to increased impacts on the community during more sensitive work hours) and subject to Sydney Trains rail possession periods. • Greater coordination and logistical constraints with the freight rail industry in order to schedule movements without impacts to existing freight rail movements.
Marine	• Limits the impacts on the local and arterial road networks. • Generally has lower environmental and community impacts than removal by road.	• May require 'double' or 'triple' handling of spoil in some circumstances, generally leading to higher costs and program/logistical inefficiencies. • Availability limited to sites that have close proximity to a marine environment. • Requires sufficient land area for barge loading/unloading facilities.

Table 5 provides a list of considerations that were taken into account in determining the suitability of each non-road method at each site.

Table 5: Considerations in Determining the Non-Road Method Suitability at each Site

Theme	Considerations
Site Proximity to Transport Infrastructure	• Does the site have access to the required transport infrastructure? • Is the transport infrastructure rated for freight transportation? • How far is the site from the associated transport infrastructure?
Capacity of Existing Infrastructure	• Does the transport infrastructure have the capacity to support spoil removal activities? • What is the scope of any additional construction works required to improve the infrastructure to meet the required capacity? • What are the constraints and implications of any improvement works? • Is there enough space available onsite to improve infrastructure if required? • What are the community, environmental and planning approval implications of any improvements works?
Community Impacts	• What are the additional community impacts (e.g. noise, passenger train services)? • Will any improvement works need to be undertaken during Sydney Train rail possession periods? • Are the additional community and environmental impacts consistent with the applicable planning approvals?
Planning Approval	• Are the activities covered under the existing planning approvals? • What are the implications of seeking any additional required planning approvals?
Timing	• What are the impacts on the project delivery timeframes? • Is the rate of spoil removal greater than the rate of spoil generation? • Is there enough space to stockpile spoil if the rate of spoil removal is less than the rate of spoil generation? • What would be the impacts of any changes to the project delivery strategy and/or scope?
Cost	• What are the impacts on the project costs? • Would the additional costs provide value to the NSW tax-payers?

5.1. Rail Transportation

Rail transportation would involve the removal of spoil from site via Sydney's freight rail network. Under certain circumstances, this could involve using a limited section of track normally dedicated to passenger services. A map of Sydney's freight rail network is provided in Figure 2.

Sections 5.1.1 to 5.1.4 discuss the feasibility of removing spoil by rail from each site with direct access to the rail network:

- Chatswood Dive,
- Martin Place Station,
- Central Station, and
- Marrickville Dive – This is the only site within close proximity to Sydney's freight rail network (refer to Figure 2). This option is discussed in Section 5.1.4.

Furthermore, Sydney Metro has identified and investigated the feasibility of transporting spoil by road to two locations on the Sydney rail network for removal by rail. These two locations are discussed in Sections 5.1.5 and 5.1.6 and include:

- St Leonards Station, and
- The Sydney Modal Transfer Facility in Chullora.

5.1.1. Chatswood Dive

The Chatswood Dive Site was determined to be unsuitable for spoil removal by rail due to a combination of factors, including:

- Lack of freight rail lines in close proximity to the site,
- Lack of space adjacent to the North Shore Line for loading operations and construction of new rail sidings and other related rail infrastructure,
- Scheduling of construction of new rail infrastructure being mostly restricted to Sydney Trains rail possession periods,
- Noise impacts on nearby residential dwellings caused by construction of rail infrastructure mostly restricted to night time hours due to Sydney Trains rail possession periods,
- Cost and time impacts of constructing new rail infrastructure, and
- Operations restricted to periods outside of passenger services (and potential impacts to passenger services).

Refer to Section 5.2 of Appendix B for further discussion.

5.1.2. Martin Place Station

The Martin Place Station site was determined to be unsuitable for spoil removal by rail, primarily due to:

- Lack of freight rail lines in close proximity to the site,
- Lack of space for loading operations, construction of new rail infrastructure and spoil haulage logistics,

- Significant impacts on commuters (being one of Sydney's busiest commuter railway stations), and
- Operations restricted to periods outside of passenger services (and potential impacts to passenger services).

5.1.3. Central Station

Whilst some rail siding space is available on the former Darling Harbour freight line, spoil removal from Central Station was determined to be unsuitable due to a combination of factors, including:

- The required lengthening of the existing rail siding to accommodate a spoil train,
- Lack of freight rail lines in close proximity to the site,
- Space constraints within Sydney Yard to construct additional rail infrastructure,
- Scheduling of construction of new rail infrastructure being mostly restricted to Sydney Trains rail possession periods,
- Cost and time impacts of constructing new rail infrastructure, and
- Operations restricted to periods outside of passenger services and the high impacts this would cause to the rail lines within Central Station.

Refer to Section 5.2 of Appendix B for further discussion.

5.1.4. Marrickville Dive

The Marrickville Dive Site is the only project construction site within close proximity to Sydney's freight rail network. New track could be constructed and used as a rail siding for loading spoil in the rail corridor to be transported via the freight rail network. Spoil removal by rail is estimated to eliminate the need for up to 60% of the total anticipated truck movements to removal spoil by road at the site.

The area surrounding the Marrickville Dive Site is largely industrial. This would provide considerable noise attenuation for the closest residential dwellings.

Ultimately, the feasibility of removing spoil from the Marrickville Dive Site by rail is dependent on:

- Construction of the required spoil-loading and other associated rail infrastructure (including the impact this would have on project delivery timeframes and cost),
- Logistical interrelationship between the rate of spoil removal by rail and the rate of spoil generation by excavation and tunnelling activities, and
- The lack of planning approval to cover these activities (likely to require a modification to the C2S planning approval).

Upon further investigation and consultation with the NSW Freight Industry Group, the site was found to have insufficient stockpiling capacity or space available to offset the imbalance between the rate of spoil generation and the rate of removal by rail. This has the potential to constrain the TBM productivity rates, which is a critical risk to the project delivery timeframes.

Furthermore, the capacity of the freight rail network to transport spoil would be heavily dependent on Sydney Trains rail possession periods west of Sydenham Station. These possession periods, however, are planned to be used extensively for the Sydenham to

Bankstown component of the project. As a result, spoil removal by rail from the Marrickville Dive Site was determined to be unsuitable due to a combination of these factors.

5.1.5. Utilising St Leonards Station

St Leonards Station was investigated as a potential location to transport spoil generated from nearby construction sites via the rail network. These included sites at Chatswood Dive (approximately two kilometres away), Crows Nest Station (approximately one kilometre away) and Victoria Cross Station (approximately five kilometres away).

This option was investigated due to the existing availability of rail sidings immediately north of St Leonards station. These could potentially be used for the loading of spoil during the day and removal during the night time shutdown period (allowing one train movement per night). However after further detailed consideration, this option was determined to be unsuitable due to the following reasons:

- Lack of freight rail lines in close proximity to the site,
- Requirement to upgrade and extend the existing siding and associated rail infrastructure (including possible construction of an acoustic enclosure), including associated construction impacts such as noise, cost and project delivery timeframe delays,
- Scheduling of construction of new rail infrastructure being mostly restricted to more sensitive work hours due to Sydney Trains rail possession periods,
- The 'double-handling' of spoil (i.e. spoil would need to be loaded onto trucks, transported via the road network, unloaded onto the rail siding and then loaded onto rail carriages for removal via the rail network),
- Noise impacts on nearby residential dwellings (as well as the Royal North Shore Hospital) caused by loading of spoil during Sydney Trains rail possession periods, and
- Operations restricted to periods outside of passenger services (and potential impacts to passenger services).

5.1.6. Utilising the Spoil Management Project

Transport for NSW has prepared a Review of Environmental Factors (REF) for its proposed Spoil Management Project. The Spoil Management Project involves the construction and operation of a facility at Chullora (the 'Sydney Modal Transfer Facility') and Port Kembla (the 'Illawarra Modal Transfer Facility') that would be used to transfer spoil between Sydney and the Illawarra region by freight rail. These facilities would be designed to have the capacity to handle 9,000 tonnes of spoil per day. Material would be brought to the Sydney Modal Transfer Facility by truck, loaded onto trains and then transported to the Illawarra Modal Transfer Facility, for distribution by truck to construction projects in the region.

This option has the potential to apply to Sydney Metro projects, however it would still require significant transportation by road from the project construction sites to Chullora (located almost 20 kilometres from the Sydney CBD) and require significant 'double-handling' of spoil. Furthermore, despite being self-determined by Transport for NSW in December 2017, the project is yet to commence construction. As a result, this option was not determined to be suitable for use on the City & Southwest project in the immediate term. However, Sydney Metro will continue to monitor the progress of this project for possible utilisation in the future.

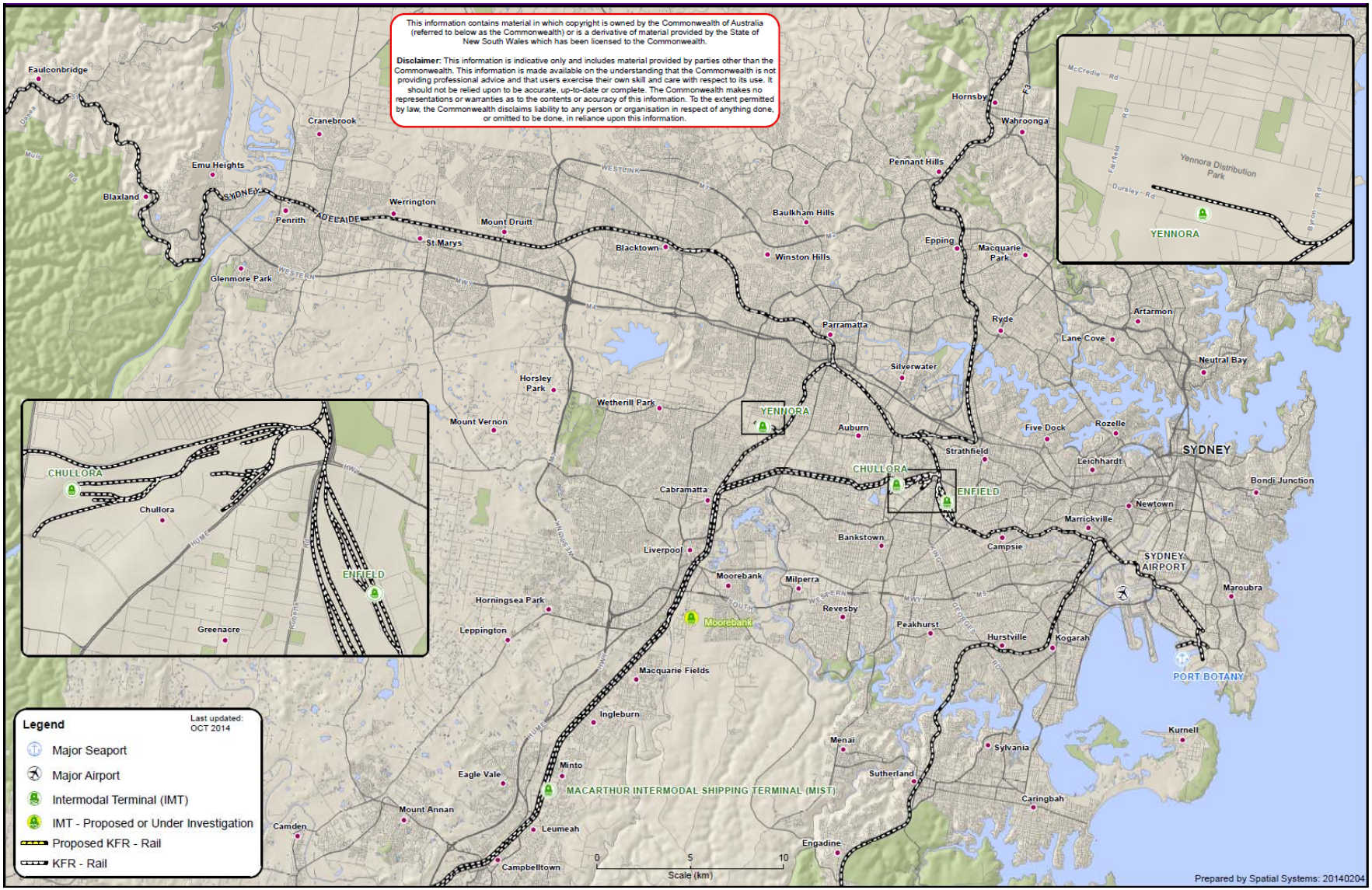


Figure 2: Sydney Freight Rail Network Map (Source: Transport and Infrastructure Council)

5.2. Marine Transportation (Barging)

Marine transportation would involve the removal of spoil by barge from sites within close proximity to a marine environment. The Blues Point and Barangaroo Station sites are the only sites that meet this criterion (both sites with direct access to Sydney Harbour waters).

Investigations into the feasibility of barging spoil from the Blues Point and Barangaroo Station sites have been undertaken by Sydney Metro throughout the various phases of the C2S planning approval, including:

- Preparation of the *Environmental Impact Statement*,
- Preparation of the *Submissions and Preferred Infrastructure Report*, and
- Post-approval through Consistency Assessments.

These investigations have been consolidated into the *Condition E84 Barging Report*, which is provided in Appendix C. This report was prepared by the TSE contractor.

Sections 5.2.1 and 5.2.2 discuss the option of removing spoil by barge from the Blues Point and the Barangaroo Station sites. Section 5.2.3 discusses the use of the Clyde Barging Facility.

Dumping of spoil at sea has not been considered due to its inconsistency with the *City & Southwest Sustainability Strategy* objective to beneficially reuse 100% of reusable spoil.

5.2.1. Blues Point

Consideration of spoil removal by barge from the Blues Point Site was heavily influenced by the decision to barge TBM equipment and material to and from the site. This decision required some improvement works to be undertaken on the existing Blues Point Wharf to increase its width and strength. Refer to Appendix C for further details.

The decision to undertake Blues Point Wharf improvement works provides capacity at the site to enable spoil removal by barge. As a result, spoil removal from the Blues Point Site will be undertaken by barge and will require approximately 35 barge movements to remove approximately 8,000 cubic metres of spoil. Spoil removed from the Blues Point Site will be barged to the Clyde Barging Facility. Refer to Section 5.2.3 for further detail on the Clyde Barging Facility.

Spoil removal by barge from the Blues Point Site is expected to eliminate the need for over 1,000 truck arrivals onsite over a three month period. Community benefits resulting from the removal of spoil by barge from site include:

- Significantly reduced traffic impacts on the local road network,
- Significantly reduced noise impacts caused by reduced number of truck movements,
- Increased site amenity, and
- Increased community safety on the local road network caused by the reduced number of truck movements.

5.2.2. Barangaroo Station

Barging operations from the Barangaroo Station Site would utilise existing wharf facilities, with no improvement works required. Due to site establishment and traffic management constraints, some spoil will need to be trucked from site until safe access from the excavations to the wharf can be established.

The Barangaroo Station Site has the potential to remove approximately 235,000 cubic metres of spoil by barge, including:

- VENM from the Barangaroo Station excavations, and
- Slurry material generated by the TBM operations between the Barangaroo Station and Blues Point sites beneath Sydney Harbour. This material would comprise of VENM and very small volumes of additives (such as bentonite). The TSE contractor would seek to obtain a resource recovery exemption from the NSW Environment Protection Authority (EPA) to maximise beneficial reuse of this material. If the EPA is unable to issue an exemption, this material would need to be removed from site via truck movements.

Given the existing barging infrastructure accessibility, availability and suitability at this site, spoil removal from the Barangaroo Station site will be undertaken by barge and transported to the Clyde Barging Facility. Refer to Appendix C for further information on the Barangaroo Station Site barging activities and Section 5.2.3 for further information on the Clyde Barging Facility.

5.2.3. Clyde Barging Facility

The Clyde Barging Facility is a temporary facility located on the Parramatta River in Clyde, in an existing industrial area. The facility will receive spoil removed by barge from the Blues Point and Barangaroo Station sites, and transfer the spoil onto trucks to be transported to other residential and commercial development projects across wider Sydney. The Clyde Barging Facility was subject to an REF and self-determined by Transport for NSW under the EP&A Act.

The use of the Clyde Barging Facility will reduce impacts to the local community and remove approximately 22,000 trucks from the traffic-congested environments of the North Sydney and Sydney CBD road networks. Furthermore, 100% of reusable excavated material will be reused in accordance with the Sydney Metro spoil reuse hierarchy.

6. Investigation Findings

The findings of Sydney Metro's investigation into opportunities to maximise spoil removal by non-road methods are as follows:

- There are two primary methods available on the City & Southwest project to remove spoil by non-road methods:
    - Rail (freight) transportation, and
    - Marine transportation (i.e. barging).
- Both methods have similar advantages, however there are significantly more disadvantages associated with rail transportation as there are for marine transportation.
- Options to implement rail transportation are limited to sites that have close proximity to the rail network. These are:
    - Chatswood Dive,
    - Martin Place Station,
    - Central Station, and
    - Marrickville Dive.
- Of the sites that rail transportation is an option, none of the sites were determined to be suitable for spoil removal by rail. The primary reasons for this are:
    - Lack of freight rail lines in close proximity to the site,
    - Lack of available space needed to construct rail sidings and other related rail infrastructure,
    - Lack of stockpiling areas to accommodate for the difference between the rate of spoil production and the rate of spoil removal by rail,
    - Noise, cost, program and planning approval impacts associated with constructing new rail sidings and other related rail infrastructure,
    - Limited availability to undertake work during Sydney rail passenger services and increased noise and community impacts associated with undertaking works during non-passenger service periods (i.e. night time), and
    - Potential impacts on existing freight services.
- Options to implement marine transportation are limited to sites that have close proximity to marine environments. These are:
    - Blues Point, and
    - Barangaroo Station.
- Spoil generated from both the Blues Point and Barangaroo Station sites will be removed by barge (i.e. a non-road method). This represents removal of spoil by non-road methods comprising of approximately 12.3% of total spoil removal under the C2S planning approval.

Appendix A – Environmental Representative Endorsement

HBI Healthy Buildings International Pty Ltd
A.C.N. 003 270 693 A.B.N. 39 003 270 693

Suite 2.06, Level 2
29-31 Solent Circuit
Baulkham Hills NSW 2153

Tel: 61 (02) 9659 5433
e-mail: hbi@hbi.com.au
Web: www.hbi.com.au

Stuart Hodgson
Director
Program Sustainability Environment & Planning
Sydney Metro
Transport for NSW
PO Box K659
HAYMARKET NSW 1240

28 September 2018

Ref: 170108(a)_E84

Dear Stuart

RE: Endorsement of Sydney Metro City & Southwest – Chatswood to Sydenham Maximisation of Spoil Removal by Non-Road Methods – Investigation Report (Pt 1)

Thank you for providing the following documents for Environmental Representative (ER) review and endorsement as required by the Condition of Approval A24 (d) of the Sydney Metro City & Southwest project (SSI – 15_7400 January 9 2017).

- Sydney Metro City & Southwest Chatswood to Sydenham Maximisation of Spoil Removal by Non-Road Methods – Investigation Report (Pt 1) Rev 1.2, 27 September 2018.

This investigation report has been prepared to address the following requirements of Condition E84 of the Infrastructure Approval:

- *"investigate opportunities to maximise spoil removal by non road methods"*
- "*The findings of the investigation must be reported to the Secretary before commencement [and completion] of tunnel spoil generation as relevant.*

The second component of Condition E84 related to the scheduling of track laying to facilitate alternative transport for material and equipment for station fit out is to be addressed in a subsequent report.

As an approved ER for the Sydney Metro City & Southwest project, I have reviewed and provided comment on this report and now consider it appropriate to report to the Secretary for information.

Yours sincerely

Jo Robertson
Environmental Representative – Sydney Metro – City and South West

Appendix B – Spoil Transport Options Paper

JACOBS ARCADIS RPS

Sydney Metro City & Southwest – Chatswood to Sydenham
Environmental Planning Studies

Spoil Transport Options Paper

Draft 2 – 30 August 2016

Project Team Office

Level 10, 100 Christies Street, St Leonards, NSW, 2065

T +61 02 9928 2100 **F** +61 02 9928 2500 **E** SRT@jacobs.com.au

DOCUMENT STATUS

Version	Purpose of Document	Prepared by	Reviewed by	Review Date
Draft 1	Initial draft	Steven Rosin and Beth Laurenson	Peter Rand	15/09/2015
Draft 2	General update	Steven Rosin and Beth Laurenson	Peter Rand	30/8/2016

APPROVAL FOR ISSUE

Name	Signature	Date
Peter Rand		30/08/16

Contents

1 Introduction

This report presents the results of a spoil transport options assessment for the Chatswood to Sydenham component of the Sydney Metro City and Southwest project.

This component of Sydney Metro would include substantial works in inner Sydney, within a normally congested road traffic environment. The project is expected to generate large volumes of spoil during tunnelling and excavation of new stations at various locations along the route.

This options paper considers various alternative methods of transporting spoil to reuse and/or disposal locations. Alternative transport methods include road, rail or barge (either on their own or in combination).

The ultimate feasibility of the various transport methods will be influenced by the destinations of the spoil. As these destinations will not be identified until the detailed construction planning phase of the project, alternative transport methods are described in terms of potential feasibility, with additional investigations being necessary before final decisions are made.

The followings tasks have been undertaken in the preparation of this paper:

- A general description of construction aspects of the project
- Identification of the anticipated spoil volumes and type of soil and rock materials generated from the project
- Presentation of a spoil management hierarchy of end use from most preferred to least preferred
- Potential for contaminated spoil and likely volumes to be encountered during the project
- Likely engineering properties of the spoil generated from the project as a function of material type and excavation methods at each location
- A review of off-site transport options to include a transport ranking system and overall initial ranking for the project
- Discussion on the justification for the initial transport ranking
- Recommendations for further investigations to better understand of spoil properties and refinement of the initial off-site transport ranking provided.

1.1 Documents reviewed and meetings held

The following key documents were reviewed in the preparation of this report:

- *Sydney Metro City & Southwest Information Pack,* SRT Design JV [Transport for NSW, Parsons Brinckerhoff, Cox, Hassell and AECOM] (12 June 2015)
- *Sydney Rapid Transit –Technical Services; Interim Constructability Report* (30 April 2015)
- *Sydney Harbour Metro Crossing Environmental Planning Studies-Desktop Contamination Investigation,* Jacobs Group Australia for Transport for NSW (4 June 2015)

In addition to the above, relevant documents from other past Sydney infrastructure projects were reviewed.

The project team and Sydney Metro Delivery Office (SMDO) staff engaged in various meetings and correspondence to assist in the preparation of the report as follows:

- A meeting with representatives of TfNSW in July 2015 for appreciation of the overall project issues and objectives.

- A meeting with representatives of Sydney Trains in July 2015 for consideration of spoil disposal by rail. Subsequent discussions with Sydney Trains, TfNSW Freight Strategy & Planning Team and TfNSW Infrastructure and Strategy Team between May and July 2016.
- Various internal meetings with the wider EIS team to discuss construction, traffic and related issues.

1.2 Project description

The New South Wales (NSW) Government is implementing *Sydney's Rail Future* (a plan to transform and modernise Sydney's rail network so that it can grow with the city's population and meet the needs of customers in the future.

Sydney Metro is a new standalone rail network identified in *Sydney's Rail Future*. The Sydney Metro network consists of Sydney Metro Northwest (previously known as the North West Rail Link) and Sydney Metro City & Southwest. The proposed Sydney Metro network is shown in Figure 1.

The proposed Sydney Metro City & Southwest comprises two core components:

- The Chatswood to Sydenham project (the project), which is the subject of report. The project would involve construction and operation of an underground rail line, about 15.5 kilometres long, and new stations between Chatswood and Sydenham.
- The second core component would involve upgrading the 13.5 kilometre rail line and existing stations from Sydenham to Bankstown which will be subject to a separate environmental assessment process.

Figure 1 Sydney Metro project overview

The project involves the construction and operation of a metro rail line between Chatswood Station and just north of Sydenham Station. The key operational components include:

- About 15.5 kilometres of twin rail tunnels (that is, two tunnels located side-by-side) between Mowbray Road, Chatswood and Bedwin Road, Marrickville. The tunnel corridor would extend about 30 metres either side of each tunnel centre line and around all stations
- About 250 metres of aboveground metro tracks between Chatswood Station and the northern dive structure
- A northern dive structure (about 400 metres in length) and tunnel portal south of Chatswood Station and north of Mowbray Road, Chatswood
- A southern dive structure (about 400 metres in length) and tunnel portal north of Sydenham Station and south of Bedwin Road, Marrickville
- New metro stations at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street and Waterloo, as well as new underground platforms at Central Station
- Underground pedestrian links and connections to other modes of transport (such as the existing suburban rail network) and surrounding land uses
- Realignment of T1 North Shore Line surface track within the existing rail corridor between Chatswood Station and Brand Street, Artarmon, including a new rail bridge for a section of the 'down' (northbound) track to pass over the proposed northern dive structure
- Permanent closure and demolition of the road bridge on Nelson Street, Chatswood,
- Signalisation of the Mowbray Road / Hampden Road intersection at Chatswood
- Modification (including protection) of the road bridge on Mowbray Road, Chatswood to accommodate the reconfigured T1 North Shore Line track arrangement
- Services within each of the stations, including mechanical and fresh air ventilation equipment and electrical power substations
- A permanent power supply from Pyrmont or Surry Hills to Pitt Street Station
- Alterations to pedestrian and traffic arrangements and public transport infrastructure around the new stations and surrounding Central Station
- Signalisation of the Edinburgh Road / Edgeware Road / Bedwin Road intersection at Marrickville
- A substation (for traction power supply) at Artarmon
- A services facility (for traction power supply and an operational water treatment plant) adjacent to the southern dive structure
- Installation and modification of existing Sydney Trains rail systems including overhead wiring, signalling, access tracks / paths, rail corridor fencing and noise walls, within surface sections at the northern end of the project at Chatswood
- Removal of the existing Sydney Trains maintenance access point from Hopetoun Avenue, Chatswood and modifications to the existing access point from Drake Street, Artarmon
- Provision of a maintenance access point from Brand Street, Artarmon on the 'down' (western) side of the T1 North Shore Line
- Provision of maintenance access stairs from Albert Avenue, Chatswood.

The proposed alignment, stations and operational ancillary infrastructure are shown in Figure 2.

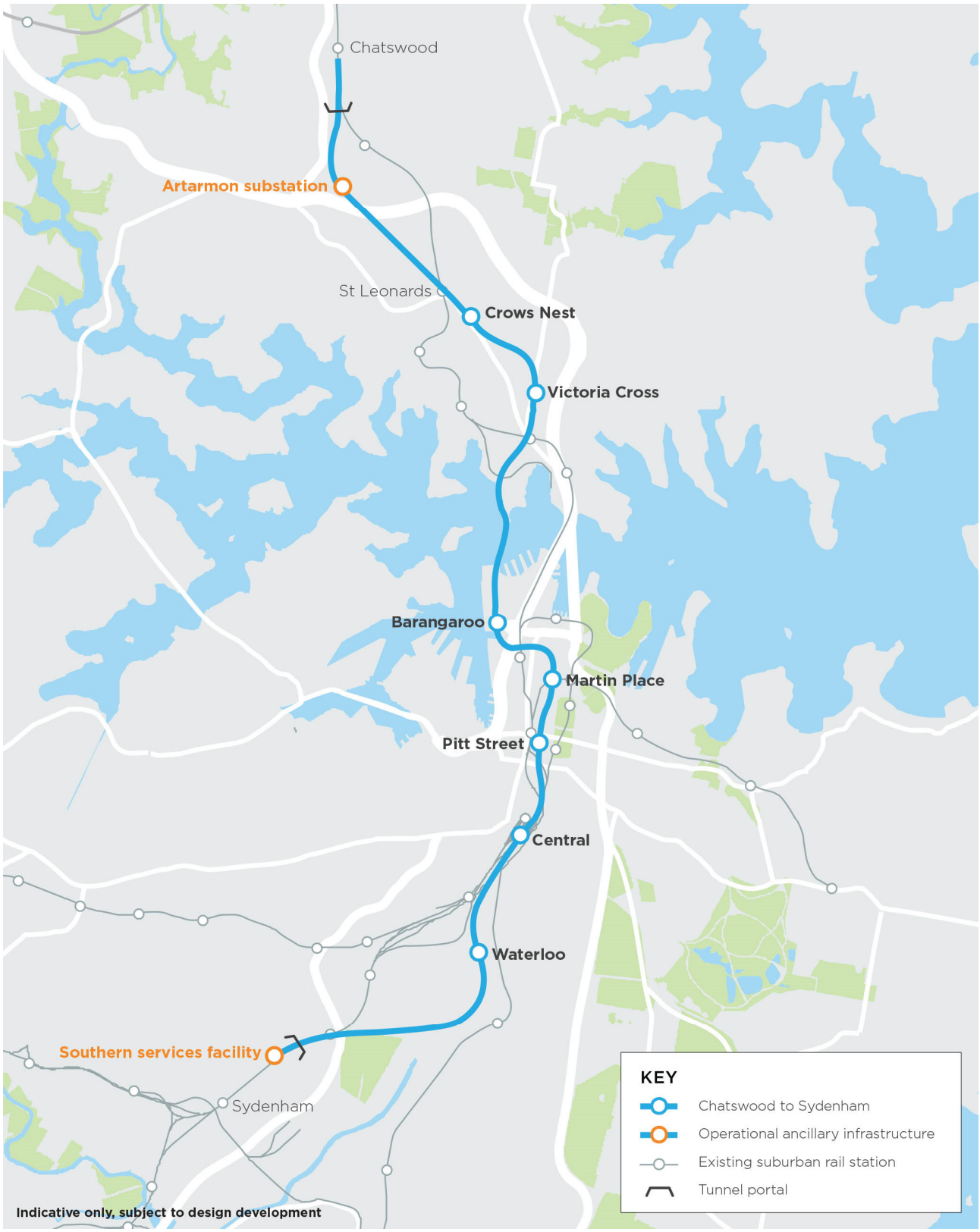


Figure 2 Sydney Metro Chatswood to Sydenham tunnelling project Location and Layout

2 Spoil production

2.1 Station and tunnel construction methods

Tunnel boring machine (TBM) operations would occur from three sites including:

- A northern TBM launch and support site in Chatswood (south of Chatswood Station and north of Mowbray Road), referred to as the Chatswood dive site
- A southern TBM launch and support site north of Sydenham Station (south of Bedwin Road), referred to as the Marrickville dive site
- A TBM launch and support site at the proposed Barangaroo Station construction site for the crossing of Sydney Harbour

Two TBMs from the northern and southern dive sites would be used to create twin tunnels, with the northern TBMs to be extracted at the Blues Point temporary site and the southern TBM to be extracted from the station excavation at Barangaroo. A slurry type TBM crossing under Sydney Harbour would drive from Barangaroo to the Blues Point temporary site where the cutter heads and shields would be retrieved and transported back to Barangaroo to be reassembled and undertake the excavation of the other twin tunnel under Sydney Harbour.

Each tunnel would be constructed with segmental lining as fully tanked structures. The various station excavations, caverns and shaft structures would be constructed using a range of excavation methods. Each of the various structures would occur within varying ground conditions which, when combined with the various methods of excavation, would produce spoil material of varying properties.

2.1.1 Station excavation

The stations would be excavated concurrently with the TBM drives. Station excavations would be undertaken using conventional rock breakers, excavators and road headers, to create the underground openings for the station caverns, shafts and adits. Explosives would be used at some stations.

With the exception of Central Station, the station excavations would be completed before the arrival of the TBMs. Initial consideration was given to possible innovations in materials handling to alleviate road congestion in the CBD, such as in-tunnel spoil conveyance from station sites to TBM portal dives at the north and south ends of the project for subsequent off-site transport. Given this construction programming constraint, such methods of spoil transportation would not be feasible and consequently has not been considered further in this report.

For the most part, station excavations would be undertaken in Hawkesbury Sandstone. Based on data from past projects (such as the Cross City Tunnel project), the spoil generated from road header methods of excavation is expected to be a well-graded gravelly sand with a high silt content. Such material is likely to be suitable for re-use as relatively high-quality engineering-type material compared to spoil generated by TBM tunnelling which is typically of a finer grading. Excavation by excavator with a hydraulic hammer is expected to produce a relatively coarse spoil material with a lower fine content than road header material provided the sandstone is of good quality rock. This method would possibly produce some over-sized materials requiring treatment but, in general, would also be considered a higher-quality engineering-type material. Likely material re-use opportunities are discussed in Chapter 4 of this report. Where shales are encountered in station excavations they are likely to be more deeply weathered and weaker rock and thus are expected to produce lower quality engineering materials likely to be only suitable as general fill or possibly for clay brick making as a high value commercial opportunity.

2.1.2 Tunnel construction

For the northern and southern TBM drives (Chatswood to Blues Point and Sydenham to Barangaroo), the general tunnelling conditions are expected to be favourable with no likely soft ground conditions. Although high groundwater conditions and localised poor rock conditions (such as in shear zones) are expected, advance would also be within medium to high strength more massive sandstone. Hence, a conventional hard rock TBM (double shield) machine such as those used for the Sydney Metro Northwest would likely be used. The only chemicals that are likely to be used would be those to reduce the rate of the cutter wheels from wearing (due to the high strength and abrasive qualities of the rock mass conditions) which would not impact on the quality of the spoil. Thus the spoil produced from the southern drives is expected to have similar gradings and material properties to spoil generated from the Sydney Metro Northwest which has been re-used for a range of beneficial uses. From an engineering re-use perspective, this spoil would likely be of intermediate quality: between higher-quality materials generated from road header construction and low-end quality materials from the harbour crossing.

The TBM excavating beneath Sydney Harbour would be required to advance through soft ground associated with the presence of a deep soil in-filled paleo channel. The material is likely to be comprised of saturated clays and sands of variable consistency and density respectively with tunnelling to be carried out under high hydrostatic heads conditions. It is currently proposed that a slurry TBM machine would be used for the harbour crossing. Under these tunnelling conditions, the hydraulically removed soils are pumped to a slurry treatment plant, where the liquids are separated from the solids and the supporting fluids are recycled back into the slurry circuit. Bentonite admixtures may be used for face support for the slurry TBM machine. Given the fine grained nature of the natural soils and the addition of admixtures to enable slurry TBM methods to be adopted, it is expected that the resulting spoil would be of relatively low beneficial end use compared to the other materials generated from the project.

2.2 Material volumes and type

Table 1 provides the material volume and type anticipated to be excavated from tunnelling activities, station excavation and associated facilities. It should be noted that the project is still in the early design stage and spoil quantities may be subject to change during detailed design and construction.

Table 1 Estimated spoil generation by construction site

Site	Volume of spoil (m^3)	Rock Type
Chatswood dive site (dive excavation)	60,000	Sandstone
Chatswood dive site (tunnelling)	460,000	Sandstone
Artarmon Substation	2,000	Sandstone
Crows Nest Station	150,000	Shale/sandstone
Victoria Cross Station	175,000	Sandstone
Blues Point temporary site	8,000	Sandstone
Barangaroo (tunnelling)	90,000	Sandstone/marine sediment
Barangaroo Station	145,000	Sandstone
Martin Place Station	175,000	Sandstone
Pitt Street Station	160,000	Sandstone
Central Station	230,000	Sandstone

Waterloo Station	115,000	Sandstone
Marrickville dive site (dive excavation)	70,000	Shale
Marrickville dive site (tunnelling)	560,000	Sandstone
TOTAL	2,400,000	

3 Spoil composition

3.1 Classification

Spoil generated by the project would primarily be derived from sandstone and to a lesser extent shales excavated during tunnelling and station excavations. It is likely that this material would predominantly be classified as Virgin Excavated Natural Material (VENM). The Protection of the Environment Operations Act 1997 (POEO Act) and the NSW EPA Waste Classification Guide (2014) defines VENM as "natural material (such as clay, gravel, soil or rock fines):

- that has been excavated or quarried from areas that are not contaminated with manufactured chemicals or processed residues, as a result of industrial, commercial, mining or agricultural activities; and
- that does not contain any sulfidic ores or soils or any other waste".

Where spoil cannot be classified as VENM, it would need to be classified into one of the following categories:

- Acid sulphate soils or potential acid sulphate soils
- General soil waste
- Restricted soil waste
- Hazardous waste.

Where spoil cannot be re-used in accordance with the spoil management end-use hierarchy outlined in Chapter 4 of this report, it would be disposed of at an appropriate landfill. Disposal sites would be selected in accordance with the Waste Classification Guidelines – Part 1: Classifying Waste and Part 2: Immobilisation of Waste (2014).

A classification system would be used to control the excavation, stockpiling and disposal of all potentially contaminated materials. Soils would be classified in situ prior to excavation/tunnelling activities, or when stockpiling during excavation, depending on available time and room for stockpiling areas. The classification system would be compliant with the POEO Act and the NSW EPA guidelines.

3.2 Potential contaminated spoil types

3.2.1 Acid Sulphate Soils

Acid Sulphate Soil (ASS) may be encountered at Barangaroo, given its location close to the original harbour shoreline. There may also be ASS associated with alluvial soils in the vicinity of the southern dive at Sydenham/Marrickville. The natural soft ground spoil derived from the harbour crossing tunnelling works may also include ASS given their depth and likely reducing environment of deposition.

Given the general topography and locations of other construction sites (relative to estuarine environments, the risk of encountering ASS (actual and/or potential) at these sites is considered to be low.

3.2.2 Contaminated industrial fill and associated soils

There is the potential for contaminated spoil to be excavated during construction of the project. Potential sources of contamination include:

- Various service station sites
- Various contaminated fills and soils used in the vicinity of railway lines

- A gas work site at Hickson Road, Millers Point (near Barangaroo)
- Reclaimed land at Barangaroo
- Surface fill in current and former industrial areas, including Barangaroo and Marrickville dive site.

3.3 Engineering properties of spoil

Testing of in-ground soil and excavated spoil materials is required to fully assess the suitability of spoil for various re-uses and recycling methods. At the time of writing, geotechnical test results were not available for the project. In the absence of test results, research undertaken by Parsons Brinckerhoff (2013) as part of the Maldon to Dombarton rail line feasibility study has been used. This study compiled information on sandstone tunnel spoil from other local projects, specifically the Epping to Chatswood Rail Link and the Cross City Tunnel.

3.3.1 Epping-Chatswood Rail Link Tunnel

The Epping to Chatswood Rail Link (ECRL) tunnel was excavated preliminarily by TBMs. All underground stations, declines and small sections of tunnel were excavated using road headers. Figure 4 shows the particle size distribution of the spoil derived from road header excavation in sandstone from the ECRL (shaded in red). This graph also shows the recommended range of particle size distribution for road-base material to compare the tunnel spoil extracted (shaded in grey) and the limits of particle size distribution between suitable and unsuitable road surface material (blue dotted line). The best roadbed surfacing materials have some plasticity and are well-graded. The curve indicated that the tunnel spoil material was reasonably well-graded and easy to reuse with minor modifications.

Laboratory test results also indicated that the Liquid Limit (LL) of the spoil varied from 20-25% and the moisture content was about 9%. The resistivity varied from 22-30 ohm-m. The pH value varied from 7.3 to 8 and chloride content was less than 0.02% by weight.

The spoil from shale/claystone may cause some handling problems in wet conditions as the plasticity index is high in a wet state. Shale/claystone spoil may be platy and poorly graded. If so, it may not be suitable for compaction. However, these materials can be added to sandstone spoil material in smaller proportions to improve the cohesiveness of the spoil.

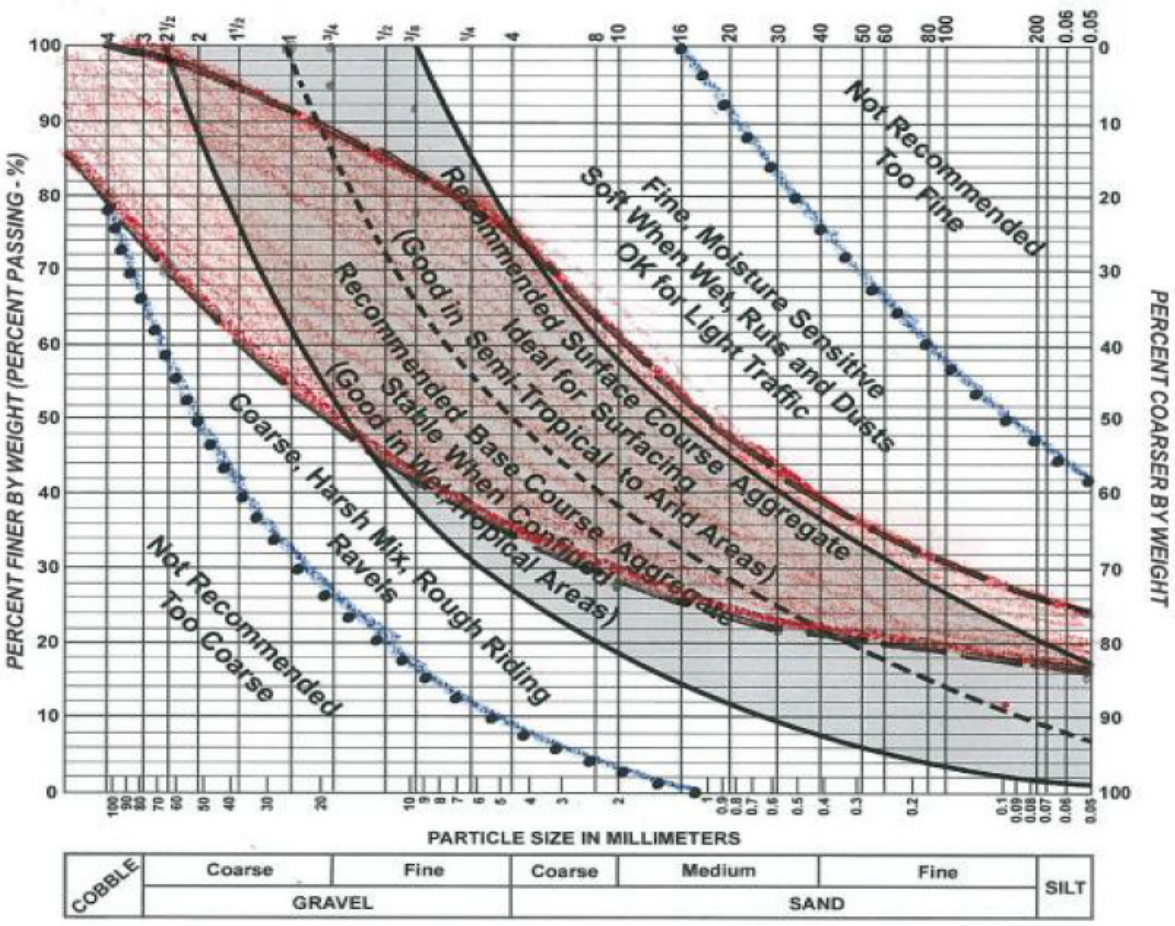


Figure 3 Epping to Chatswood Rail Link particle size distribution chart from the ECRL

(Source: Engineering and Operational Services Technical Memo: Tunnel Spoil Management Strategy, Maldon to Dombarton Rail Link, 2013)

3.3.2 Cross City Tunnel

Anecdotal advice was received by Parsons Brinckerhoff (2013) from construction staff that Hawkesbury Sandstone spoil from road header excavations on the Cross City Tunnel was used in the embankment and reinforced soil wall construction for the WestLink (M7) project. It was advised that the material was delivered and placed without treatment or moisture conditioning directly into stockpiles and then into the reinforced soil blocks. Some 80 suites of laboratory tests have been undertaken on the material in the period up to 2013 and the material has met R57 and R58 specifications (specifications for reinforced soil walls). The designers (The Reinforced Earth Company) advised that an effective friction angle of 31° was used on the design and that regular tests on the spoil have met the design criteria.

3.3.3 Summary of Engineering End Use

In summary, the following conclusions are made with regard to engineering end use depending on spoil types and methods of excavation anticipated for the project:

- Potentially relatively high engineering end use for good quality sandstone for both hydraulic breakers and road header generated spoil. End use may include road base material, reinforced earth backfill, reclamation fill and general fill for road embankments.

- Weathered shales and possibly fresh shales with relatively lower end use given the lower strengths of such materials are expected to be suitable as general fill and possibly high value brick making purposes
- Relatively low end use for the harbour crossing slurry TBM spoil possibly required to be disposed of to landfill given the ASS potential and slurry admixtures.

The above assessments should be reviewed once more detailed relevant information is available for the project.

4 Reuse and disposal

4.1 Spoil management end-use hierarchy

A key objective of spoil management for the project is to maximise its re-use. Spoil would be used in the most beneficial and sustainable way possible, in accordance with a suitable spoil management end-use hierarchy.

The project is anticipated to generate large quantities of reusable sandstone and shale spoil of varying quality. Depending on the quality of the materials there would be a potential for re-use of some of this material within the wider construction industry. The material would be subject to classification to determine the most appropriate re-use.

The spoil management hierarchy that has been adopted for the project is shown in Table 2.

Table 2 Chatswood to Sydenham spoil management hierarchy

Rank	Re-use options	Example of option
1	Within the project	▪ Reuse in the project to fill embankments and mounds within short haulage distance of source. ▪ Restoration of any pre-existing contaminated sites within the project boundaries. ▪ Reuse as a feed product in construction materials (e.g. concrete).
2	Environmental works	▪ Reuse in coastal protection works such as beach nourishment and land raise. ▪ Reuse in flood mitigation works.
3	Other development projects	▪ Reuse for fill embankments and mounds on projects within an economic transport distance from site. ▪ Reuse for land reclamation or remediation works. ▪ Reuse sand for manufacturing concrete and reuse shale for manufacturing bricks/ tiles.
4	Land restoration	▪ Reuse to fill disused facilities e.g. mines and quarries to enable either future development or ecological rehabilitation.
5	Landfill management	▪ Reuse to cap completed landfill cells. ▪ Reuse in daily covering of landfill waste.

Spoil that cannot be re-used (such as contaminated spoil) would be disposed at appropriately licensed landfill sites. Other disposal options, such as dumping at sea are not deemed to be environmentally acceptable and have not been evaluated in this report.

4.2 Potential reuse and disposal sites

The Reference Design Construction Staging and Sequencing Report (August, 2016) identified three potential options for landside spoil disposal within the Sydney Metropolitan locations to the north and west of the project construction sites. These options include land management and reclamation activities at the following sites:

- Schofields Quarry
- Horsley Park Quarry
- Hornsby Quarry

These sites are referred to in Chapter 5 of this report as the 'primary' potential spoil disposal sites for the project. As spoil from the project would not begin to be generated for several years the availability of these sites for spoil disposal cannot currently be determined. Given the concurrent and competing spoil disposal activities by other large infrastructure projects in Sydney, the capacity and availability of these quarries would need to be confirmed.

It is also noted that the use of these sites would occur only in the event that spoil cannot feasibly be reused in accordance with the options higher on the spoil reuse hierarchy (Table 2).

Other potential spoil reuse and disposal sites have been identified as part of more recent investigations (between May and July 2016) undertaken by SMDO. An opportunity exists for rail transport of spoil to the Port Kembla Coal Terminal (PKCT), where it could be temporarily stored then distributed to several sites around the area which require fill, including:

- Port Kembla Harbour reclamation works
- Illawarra Regional Airport at Albion Park
- Residential development sites in the Shoalhaven area
- Shellharbour sand mine
- Dunmore Quarry
- Bombo Quarry (owned by Sydney Trains, planning approval would be required to dispose of spoil at this location)

PKCT is currently operating at a low capacity due to the downturn in coal production, therefore it has available capacity to handle spoil.

Badgery's Creek Airport could also provide an opportunity for spoil reuse. Based in information in the EIS (2015), the development of the airport site is a cut / fill balance, but some fill is needed as gravel. The total quantity of gravel (or other suitable materials such as sandstone) used during construction for base and sub-base material would be approximately three million tonnes (or about 3,500 tonnes per day over around 33 months of the indicative construction schedule - site preparation works start mid-2016 and end early 2023).

The selection of final spoil reuse and disposal sites would also take into consideration the sites being utilised by other major projects in construction and operation during the project spoil production period.

Contaminated spoil would be disposed of at licensed secure waste facilities.

Offshore disposal of spoil, such as sea dumping in waters surrounding Australia's coastlines is managed by the *Environment Protection (Sea Dumping) Act 1981* (the Sea Dumping Act). The Sea Dumping Act regulates the loading and dumping of waste at sea. Permits from the Commonwealth Department of the Environment are required for all sea dumping operations. Offshore disposal of spoil is not regarded as an appropriate solution for this project and is not evaluated further in this report.

5 Transportation options

There are a number of off-site transport options available for removing spoil from the station excavation and dive sites associated with tunnelling. Options that have been considered for the project are as follows:

- **Road:** considered for all sites due to their location directly adjacent to the existing road network
- **Rail**: considered for the northern dive, Central Station and southern dive sites only due to the proximity of these sites to the freight rail network
- **Barge**: considered for the Barangaroo and Blues Point sites due to the proximity of Sydney Harbour and the potential for spoil loading.

5.1 Road

Spoil transportation by road is currently the base case for the purposes of project planning and impact assessment. Road transportation via the metropolitan highway/motorway system (refer to Figure 5) was identified to access spoil disposal sites, including the following hauling routes:

- Pacific Highway and M1/M2 (Chatswood dive site, Crows Nest, Victoria Cross)
- Eastern Distributor/M1 and Western Distributor (CBD station excavations)
- City West Link and Parramatta Road and M1 (Central, Waterloo)
- Princes Highway and M1 (Marrickville dive site).

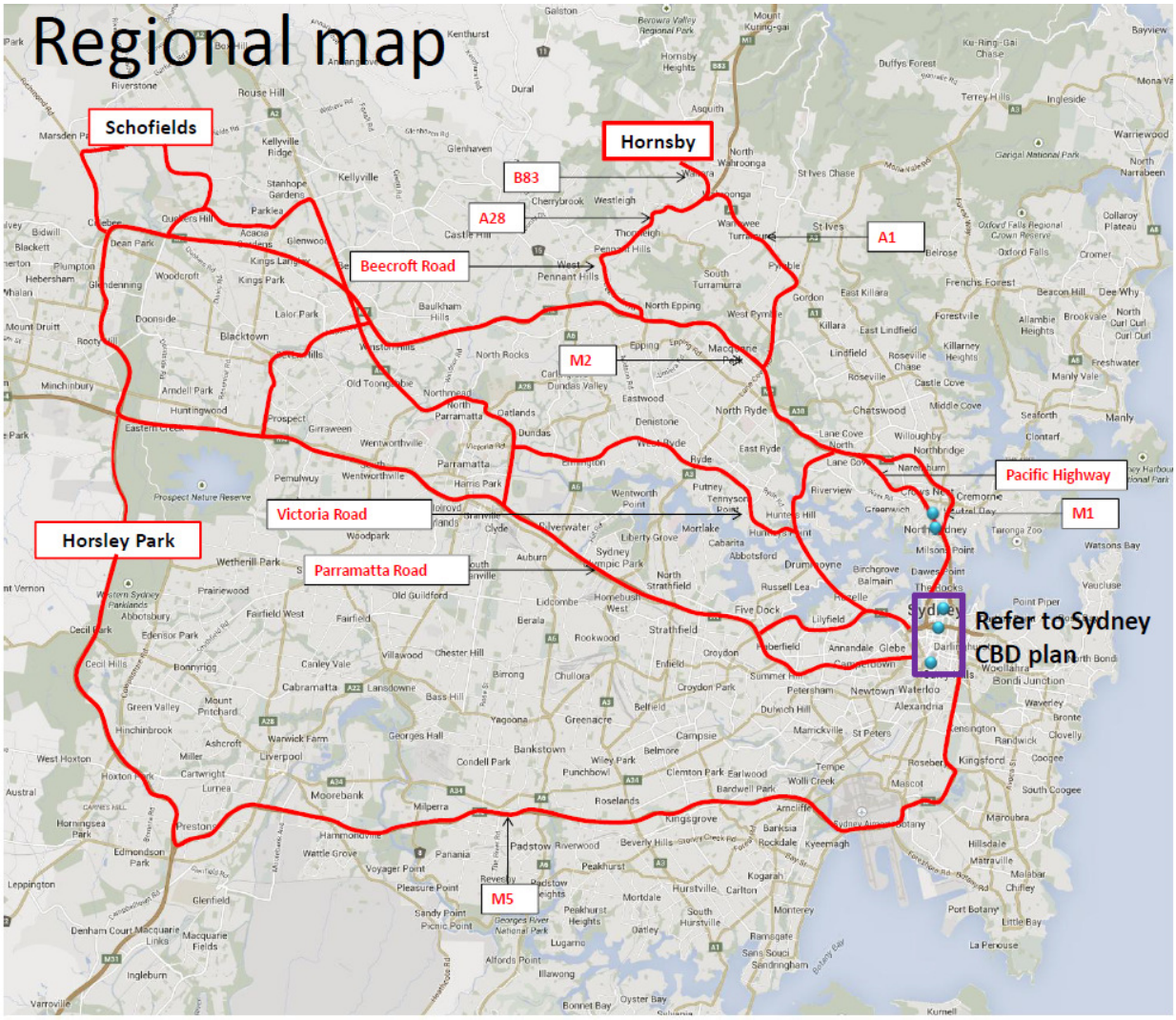


Figure 4 Sydney Metropolitan Road Network map showing primary potential spoil disposal sites.

Proposed primary and secondary haulage route maps for individual construction sites are included in Appendix A1.

Truck removal would provide the most flexibility in terms of disposal sites and route selection, and would be the most responsive transport mode to changes in project timing and scope.

Key constraints on spoil removal from Sydney CBD and North Sydney sites involve high traffic volumes, both in general and on individual streets surrounding the work sites. Sydney CBD streets are also subject to ad hoc restrictions and closures due to special events. Traffic flows are further constrained by the traffic impacts from other major projects in the vicinity of the work sites, including the following:

- CBD and South East Light Rail
  - Closure of George Street, Sydney to traffic
  - Limited east-west movement in the vicinity of George Street, Sydney
  - Limited access to Eddy Avenue and Chalmers Street in the vicinity of Central Station
  - Possible night and weekend closures of South Dowling Street (Eastern Distributor)

- Associated changes to bus movements – increased bus volumes on Elizabeth Street and Castlereagh Street in the vicinity of Martin Place and Pitt Street station boxes and likely time restrictions on truck movements in the area.

- Central Barangaroo
  - Increased construction traffic and potential road closures around Hickson Road, Millers Point.
- WestConnex Stages 2 and 3
  - Potential road closures and high construction traffic volumes around the proposed WestConnex St Peters Interchange, in the vicinity of the Sydenham dive site.
  - Potential limited access to and/or use of the M5 as a secondary haulage route.

5.2 Rail

Rail haulage is often regarded as more cost effective over longer distances and with lower environmental impacts than road haulage. Any rail transportation of spoil from the project construction sites would require access to the Metropolitan Freight Network, the Southern Sydney Freight Line and/or the Northern Sydney Freight Corridor (Appendix A2), although access to the freight network could in certain circumstances, involve using a limited section of track normally dedicated to passenger rail.

Any use of the rail network would require adequate train storage at (or very close to) the construction site. This would include a siding of sufficient length to store 1-2 trains (depending on the throughput required). Loading would occur most efficiently if it was via a conveyor/overhead loading system. Loading could also occur via front end loaders, in which case stockpiles would be required close to the train siding.

Rail haulage has been considered for three construction sites, (northern dive, Central Station and southern dive), on the basis of their proximity to the existing rail network.

Northern dive

At the northern dive, space would need to be found off the main North Shore line for loading operations, which would likely necessitate the construction of new rail sidings and related infrastructure during scheduled track possessions. The operation of the loading facility and spoil transport would need to work around regular night time maintenance on the North Shore line and may impact passenger rail operations, reducing the flexibility of spoil removal. The northern dive is in close proximity to residential dwellings and there would be potentially substantial noise impacts on local residents. The North Shore line is not currently rated for freight transport and includes steep grades and tight curves in the vicinity of the dive site. While none of the above reasons fully preclude the use of rail for spoil transport at this site, when they are viewed in combination it is not likely to be feasible at this site.

Central

At Central, some siding space is available on the former Darling Harbour freight line, located on the western side of Central Station. The length of the siding is unlikely to be adequate to accommodate a spoil train and additional siding infrastructure would likely be required in the context of limited space in the Sydney Yard. Spoil transport by rail at Central is likely to impact passenger services due to the existing high volume of track use. The closest potential alternative siding location would be at North Eveleigh, which is about 1.2 kilometres south of the Central construction site. Transporting spoil to North Eveleigh would require extensive infrastructure construction, such as a conveyor system. The North Eveleigh sidings are also in close proximity to residential dwellings and there would be potentially substantial noise impacts on local residents. For the above reasons, rail is not likely to be feasible at Central.

Southern dive

New track could be constructed and used as a siding for loading spoil in the rail corridor at the southern dive site. The siding would have ready access to the Main Illawarra Line and Metropolitan Freight Network. Depending on the number of trains (e.g. 3 night train paths available), up to 60% of the spoil truck movements could be removed from this site.

The surrounding area is largely industrial, providing a buffer to the nearest residential dwellings. Feasibility would be reliant on the installation of appropriate spoil-loading infrastructure at the site, which would likely include a conveyor system to transport the spoil across the rail corridor. The removal of spoil by train from the southern dive site is not within the current Chatswood to Sydenham planning approval structure and would therefore require likely require an approval modification if it was to be implemented.

5.3 Barge

Barge transportation would require a potential barge loading site in close proximity to a construction site. A conveyor system for loading of barges would likely be required, however loading via front end loader could also be considered. There is also a possible scenario where spoil is trucked from a stockpile to a nearby barge loading site, with loading of the barge occurring from a truck loading ramp. For barging to be feasible, a spoil receival site that is in close proximity to a facility suitable for unloading spoil barges would be required.

The one construction site that is in close proximity to the harbour and has large volumes of soil proposed to be extracted is Barangaroo. The Barangaroo site would generate spoil from the station excavation, as well as via the harbour tunnelling activities.

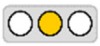
A concept has been developed that involves wharf infrastructure immediately south of the North Cove, and an associated conveyor that could transport soil from the TBM drive and the station excavation. This is currently being assessed as part of the Chatswood to Sydenham Submissions Report/Preferred Infrastructure Report with the intention that the project approval would include the ability to barge spoil from Barangaroo. It is understood that there are ongoing discussions with Barangaroo Development Authority regarding this option.

An alternative to barging from the Barangaroo development site would be barging from Moores Wharf. Moores Wharf which is the closest existing facility potentially capable of loading barges is Moores Wharf and is located immediately to the east of Barangaroo Headland Park. This facility is operated by the Port Authority of New South Wales and is the base for the Authority's emergency operations. For the site to be feasible, it would require suitable spoil to be transported via conveyor or truck 400-500m from the Barangaroo construction site and for appropriate loading infrastructure (such as a truck ramp) to be installed at the wharf. Agreement with the Port Authority of New South Wales regarding the use of the wharf for this purpose would also be required.

5.4 Summary evaluation of options

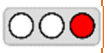
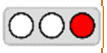
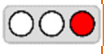
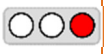
A summary *traffic light* evaluation is provided in Table 3 below for each construction site and in terms of each the spoil transport option.

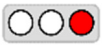
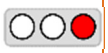
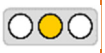
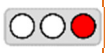
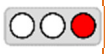
Table 3 Mode of transport ranking for spoil

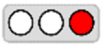
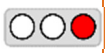
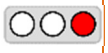
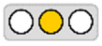
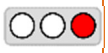
	Description
	Option is feasible.
	Option may potentially be feasible, but significant issues would need to be addressed.
	Option is not considered feasible and therefore not worthy of further consideration at this stage.

On the basis of Table 2, each site has been ranked in Table 3 below.

Table 4 Mode of transport assessment for each site

Site	Location	Road	Rail	Barge	Key Considerations
Northern Dive (Chatswood)	South of Chatswood Station and north of Mowbray Road partially within the North Shore rail corridor.				The site is directly adjacent to the Pacific Highway. The North Shore line is not currently rated for freight rail transport and the site is unlikely to have adequate space for train storage, therefore rail transport is not likely to be feasible at this site. No harbour access at the site.
Artarmon traction substation	Butchers Lane directly adjacent to Gore Hill Freeeway in Artarmon				The site is directly adjacent to the Gore Hill Freeway. No direct access to freight rail corridor. No harbour access at the site.
Crows Nest Station	Between Pacific Highway, Hume Street, Oxley Street and Clarke Lane in Crows Nest.				The site is directly adjacent to the Pacific Highway. No direct access to freight rail corridor. No harbour access at the site.
Victoria Cross Station	On Miller Street between Berry and McClaren streets in North Sydney				The site is in close proximity to the Pacific Highway. No direct access to freight rail corridor. No harbour access at the site.

Site	Location	Road	Rail	Barge	Key Considerations
Blues Point construction site	In Blues Point Reserve adjacent to Blues Point Road and Henry Lawson Ave				The site has access via Blues Point Road and Millar Street to the Pacific Highway. No direct access to freight rail corridor. Blues Point Reserve is directly located on the foreshore of the Sydney Harbour, however, the volume of spoil to be removed from this is not of a magnitude that would render barge transport feasible.
Barangaroo Station	Adjacent to Central Barangaroo on Hickson Road.				The site has access via Hickson Road and Sussex Street to the Western Distributor which is a primary route option for spoil transport to potential disposal sites. No direct access to freight rail corridor. The site is close to Sydney Harbour. There are barge loading location options in the general vicinity, with a concept under development and proposed to be included in the project approval.
Martin Place Station	Two entrance locations between Castlereagh and Elizabeth streets, one entrance south of Hunter Street and the other entrance north of King Street at Martin Place in the Sydney CBD.				The site has access via King Street to the Western Distributor or via Hunter and Macquarie Streets to the M1. A challenge for spoil removal via trucks through the Sydney CBD would be the cumulative impacts associated with CBD and South East Light Rail project in a congested CBD environment. No direct access to freight rail corridor. No harbour access at the site.
Pitt Street Station	Two entrance locations between Castlereagh and Pitt streets, one entrance north of Park Street and the other entrance south of Bathurst Street in the Sydney CBD.				The site has access via Park and Bathurst streets to the Western Distributor or the M1 which are both primary route options for spoil transport to potential disposal sites. A challenge for spoil removal via trucks through the Sydney CBD would be the cumulative impacts associated with CBD and South East Light Rail project in a congested CBD environment. No direct access to freight rail corridor. No harbour access at the site.

Site	Location	Road	Rail	Barge	Key Considerations
Central Station	New underground platforms would be located underground between intercity rail platforms and suburban rail platforms at Central Station.				The site has a number of access and egress routes to Parramatta Road, the M1 and the Western Distributor. A challenge for spoil removal via trucks through the Sydney CBD would be the cumulative impacts associated with CBD and South East Light Rail project in a congested CBD environment. Some siding space is available on the former Darling Harbour freight line, located on the western side of Central Station. The length of the siding is not likely to be adequate to accommodate a spoil train. The addition of freight transport at Central is likely to impact passenger services due to the existing high volume of track use. Rail transport is not likely to be feasible at this site. No harbour access at the site.
Waterloo	Between Botany Road, Cope Street, Raglan Street and Wellington Street at Waterloo				The site has access via Botany and Gardeners roads to the M1. No direct access to freight rail corridor. No harbour access at the site.
Southern Dive (Sydenham)	Within the rail corridor northeast of Sydenham Station.				The site has access via Bedwin Road and Campbell Street to the Princes Highway which is a primary route option for spoil transport to potential disposal sites. A limitation for spoil removal via trucks would be the cumulative impacts associated with WestConnex Stages 2 and 3. Rail haulage may be feasible if new track was constructed and used as a siding for loading spoil in the rail corridor at the southern dive site. The siding would have ready access to the Main Illawarra Line and Metropolitan Freight Network. The surrounding area is largely industrial, providing a buffer to the nearest residential dwellings. Feasibility would be reliant on the installation of appropriate spoil-loading infrastructure at the site, which would likely include a conveyor system to transport the spoil across the rail corridor. No harbour access at the site

6 Recommendations

Spoil transportation by road is the most realistic method for the northern and CBD construction sites, however there is the opportunity for spoil transportation by barge at Barangaroo Station and spoil transportation by rail at the southern dive site.

There are significant concurrent construction activities underway in NSW, and cumulative impacts associated with truck movements. Recently, the Secretary for TfNSW issued a directive to move spoil by train where possible to reduce truck congestion on roads, in the face of all of the upcoming infrastructure construction projects which will be occurring in Sydney over the next 5 years and beyond. It is therefore recommended to:

- Progress the ongoing feasibility study of constructing a rail siding and spoil loading facility at Sydenham and further explore opportunities for rail transport of spoil to the PKCT, where it could be temporarily stored then distributed to several sites in the Illawarra region which require fill.
- Continue strategic discussions with TfNSW Freight Strategy & Planning Team and TfNSW Infrastructure & Strategy Team to explore spoil disposal locations, spoil reuse options, long-term use for spoil loading infrastructure and train path availability.
- Undertake additional environmental impact assessment work for the construction of a rail siding and operation of a spoil loading facility at Sydenham. Once planning approval is obtained for the Chatswood to Sydenham project (likely in December 2016), a modification to the approval could be lodged with the Department of Planning and Environment.

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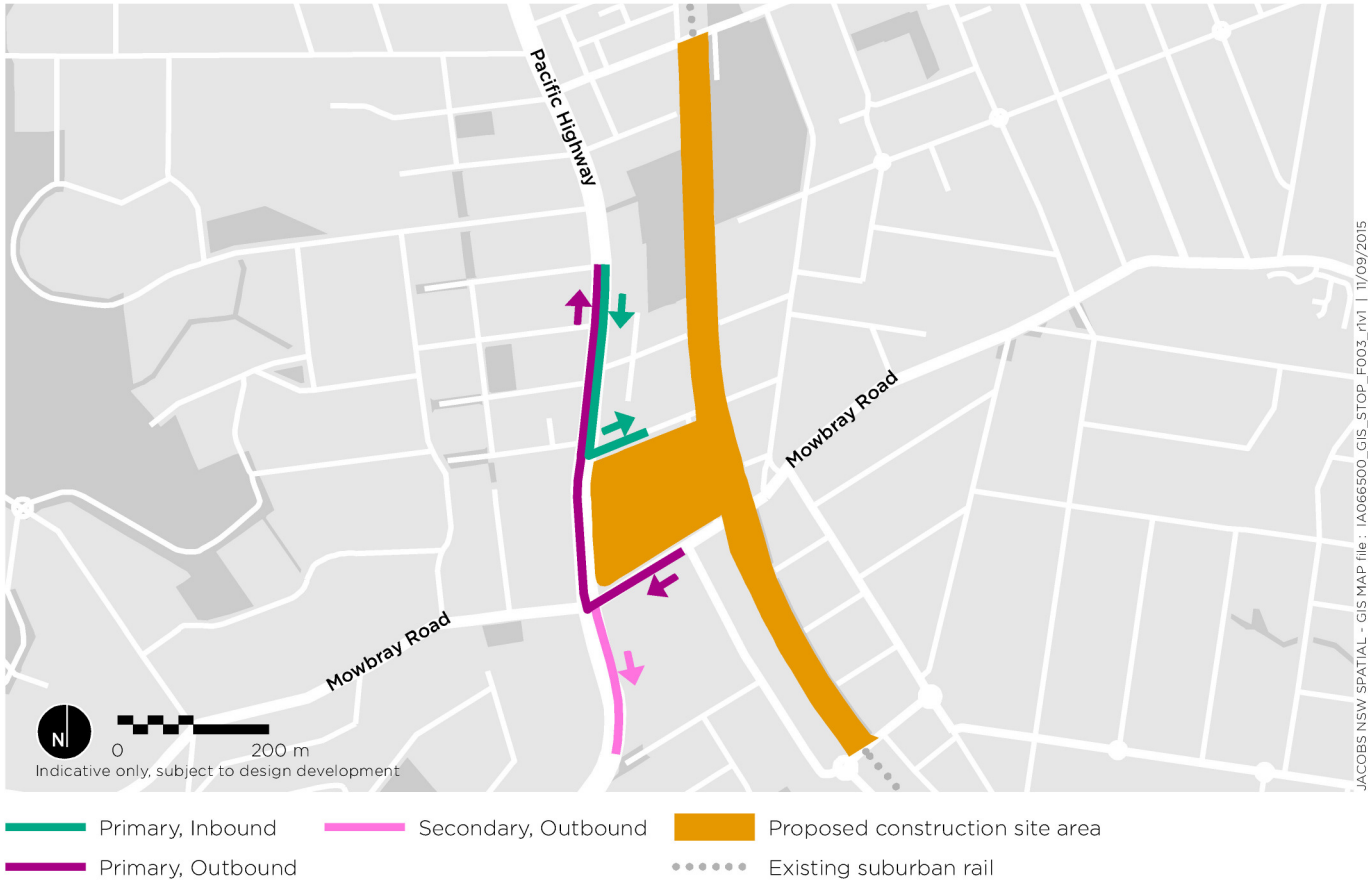
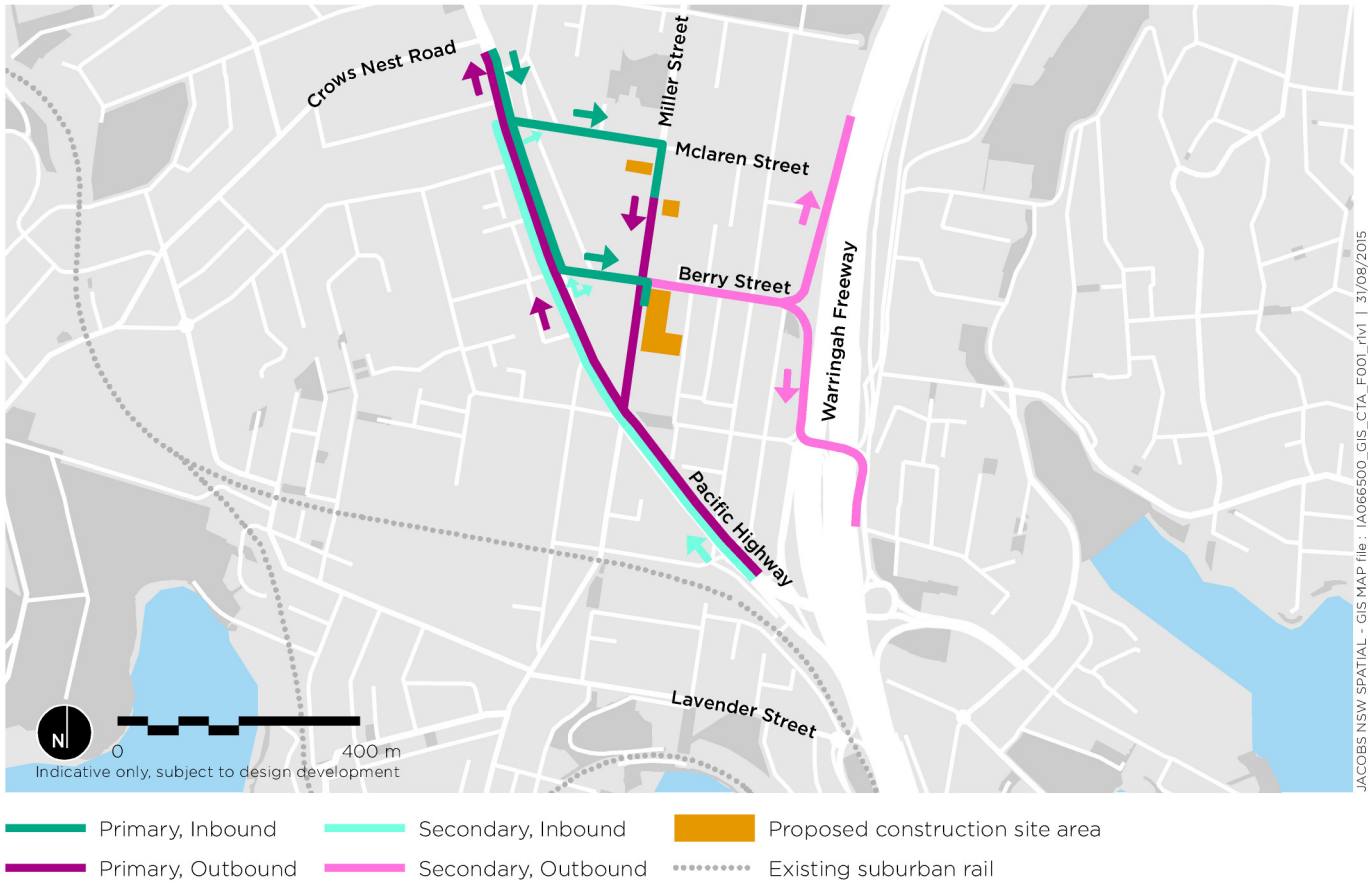
A1 Construction site road access routes



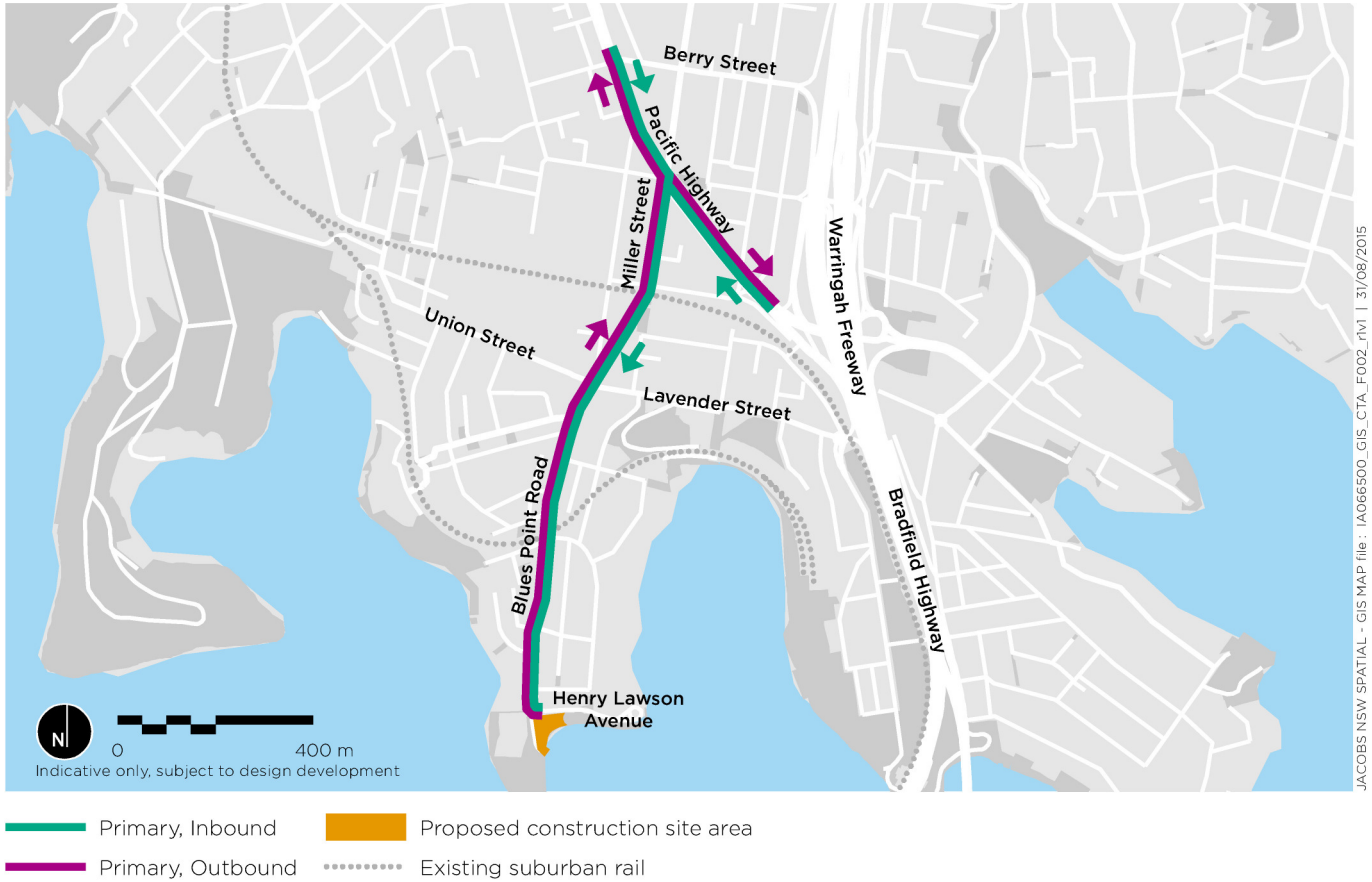
Northern dive –construction road access

Artarmon traction substation - construction road access

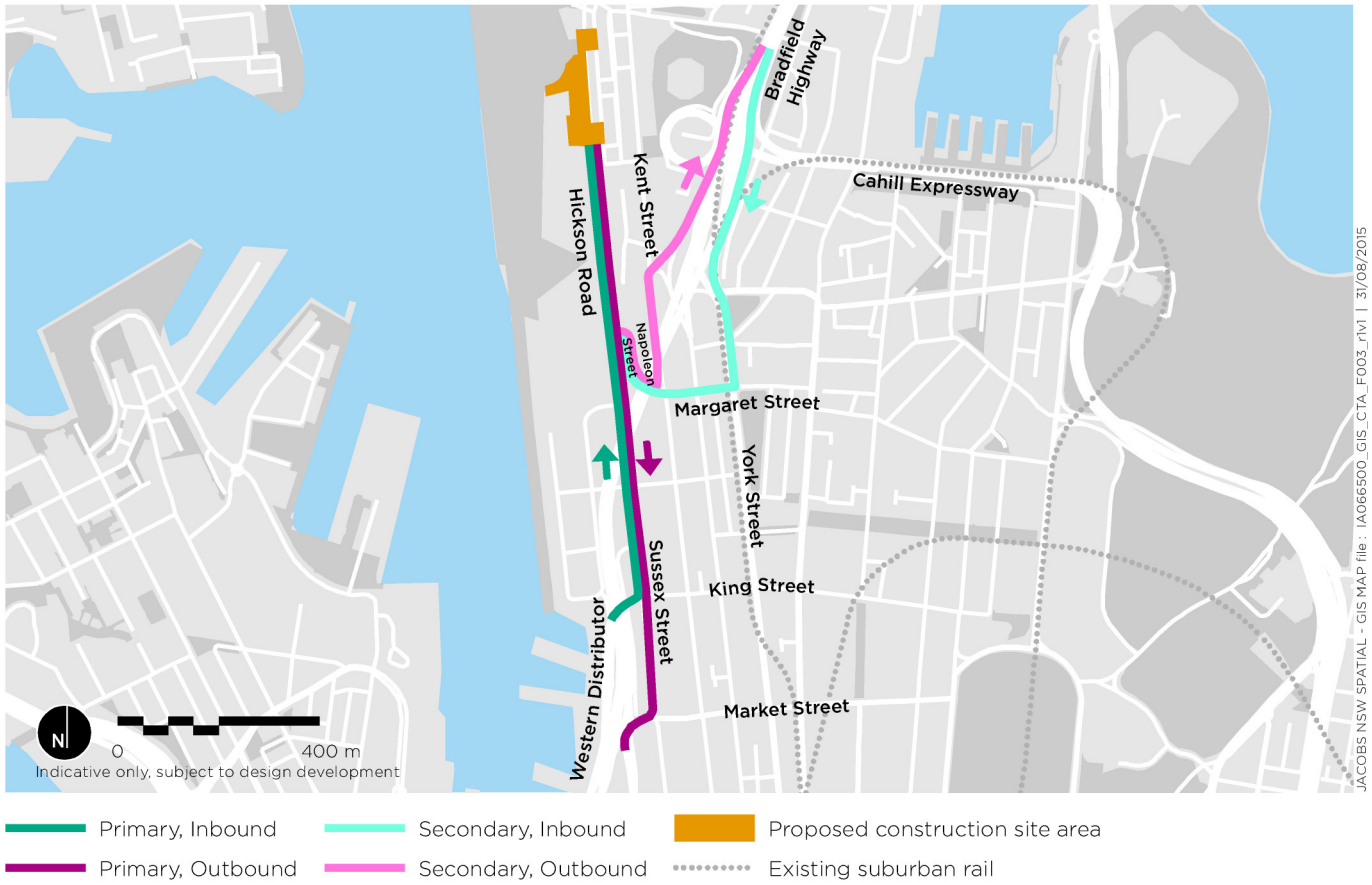
Crows Nest Station - construction road access



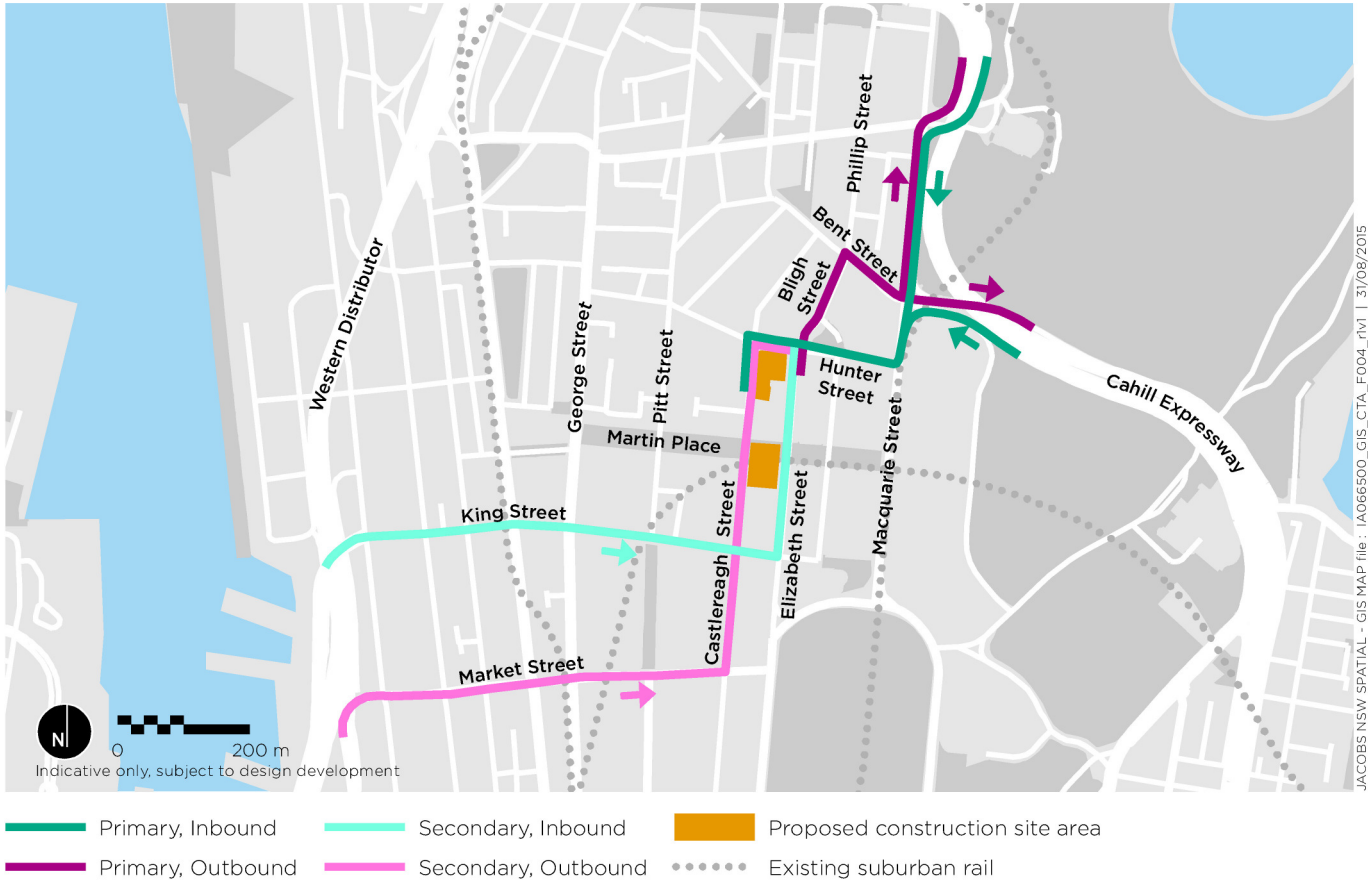
Victoria Cross station - construction road access



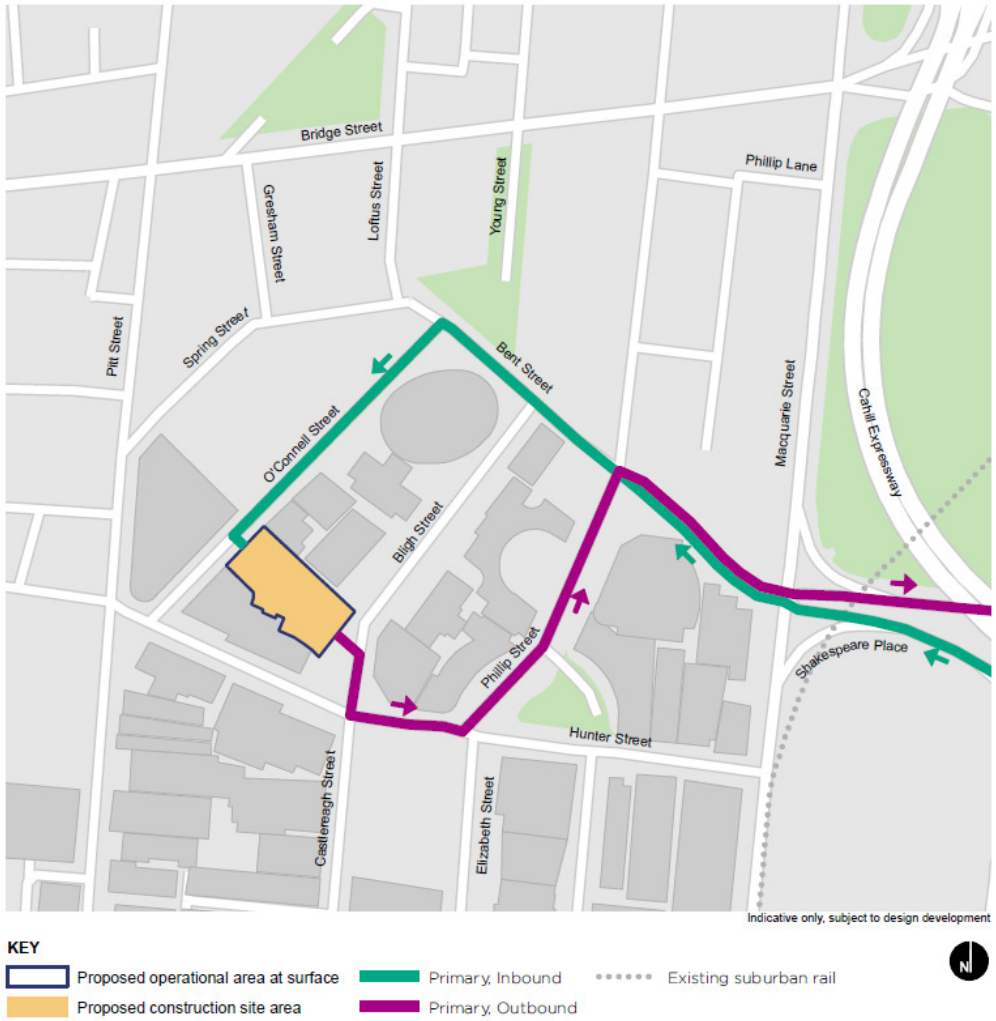
Blue Point - construction road access



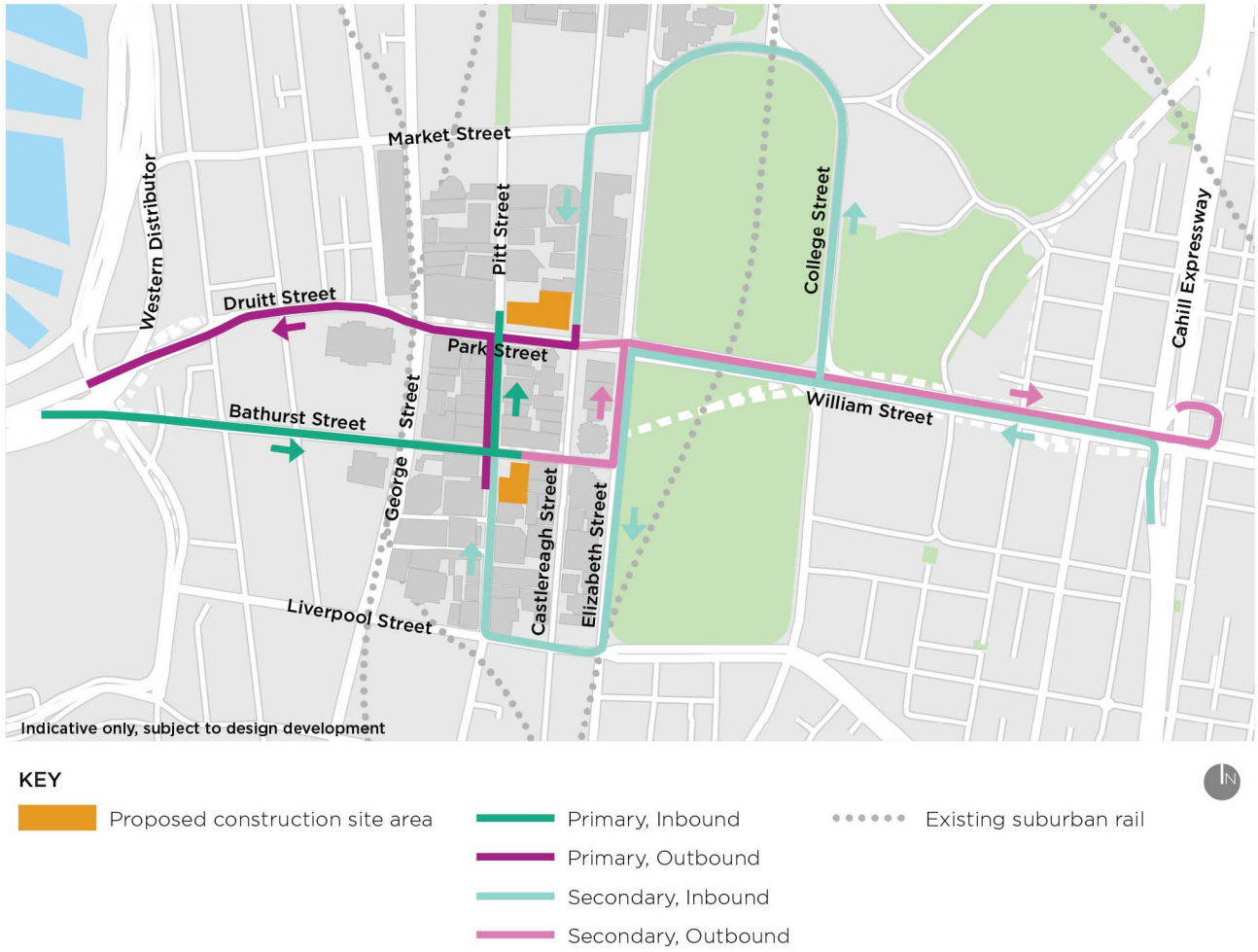
Barangaroo station - construction road access



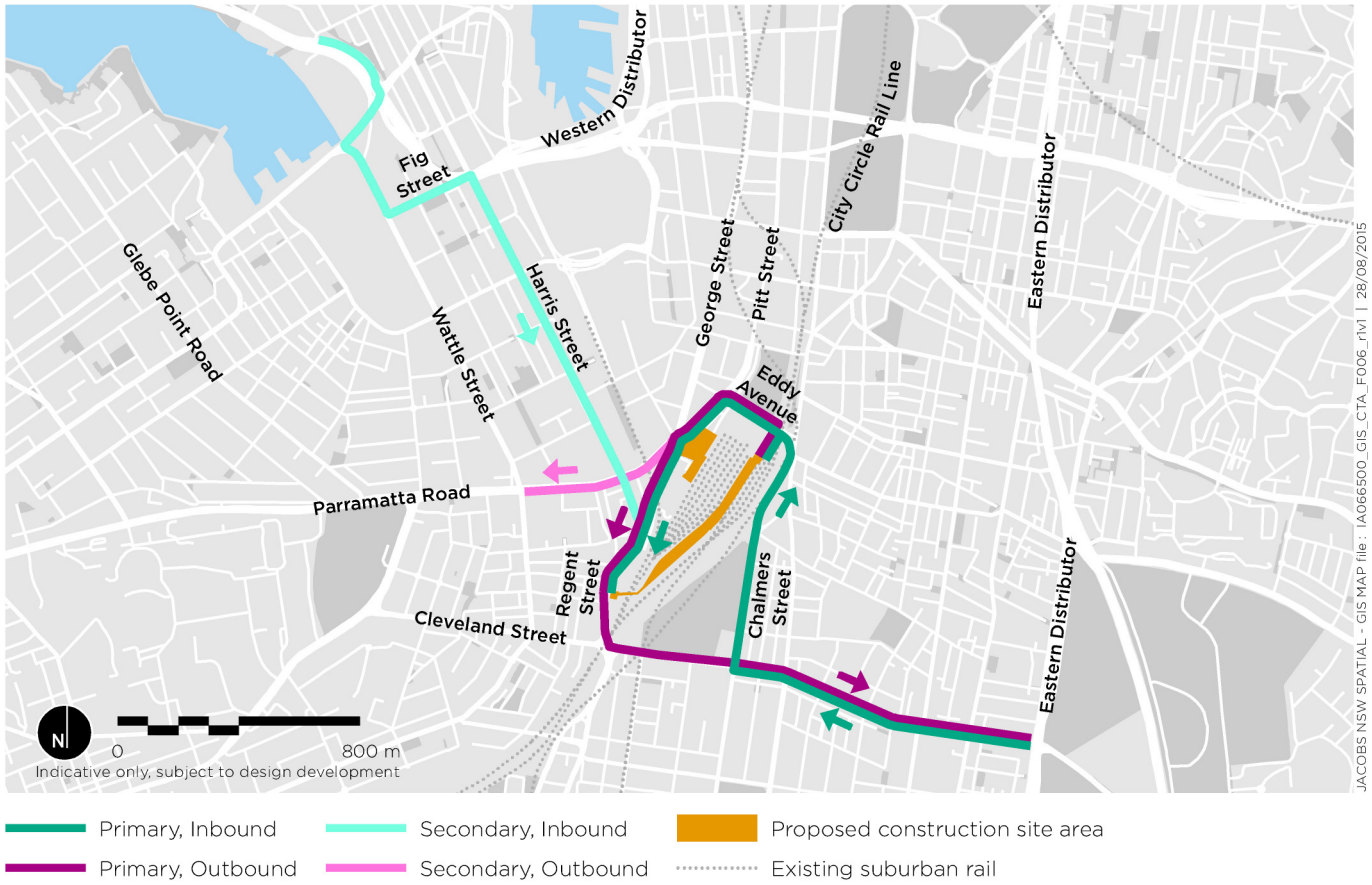
Martin Place station - construction road access



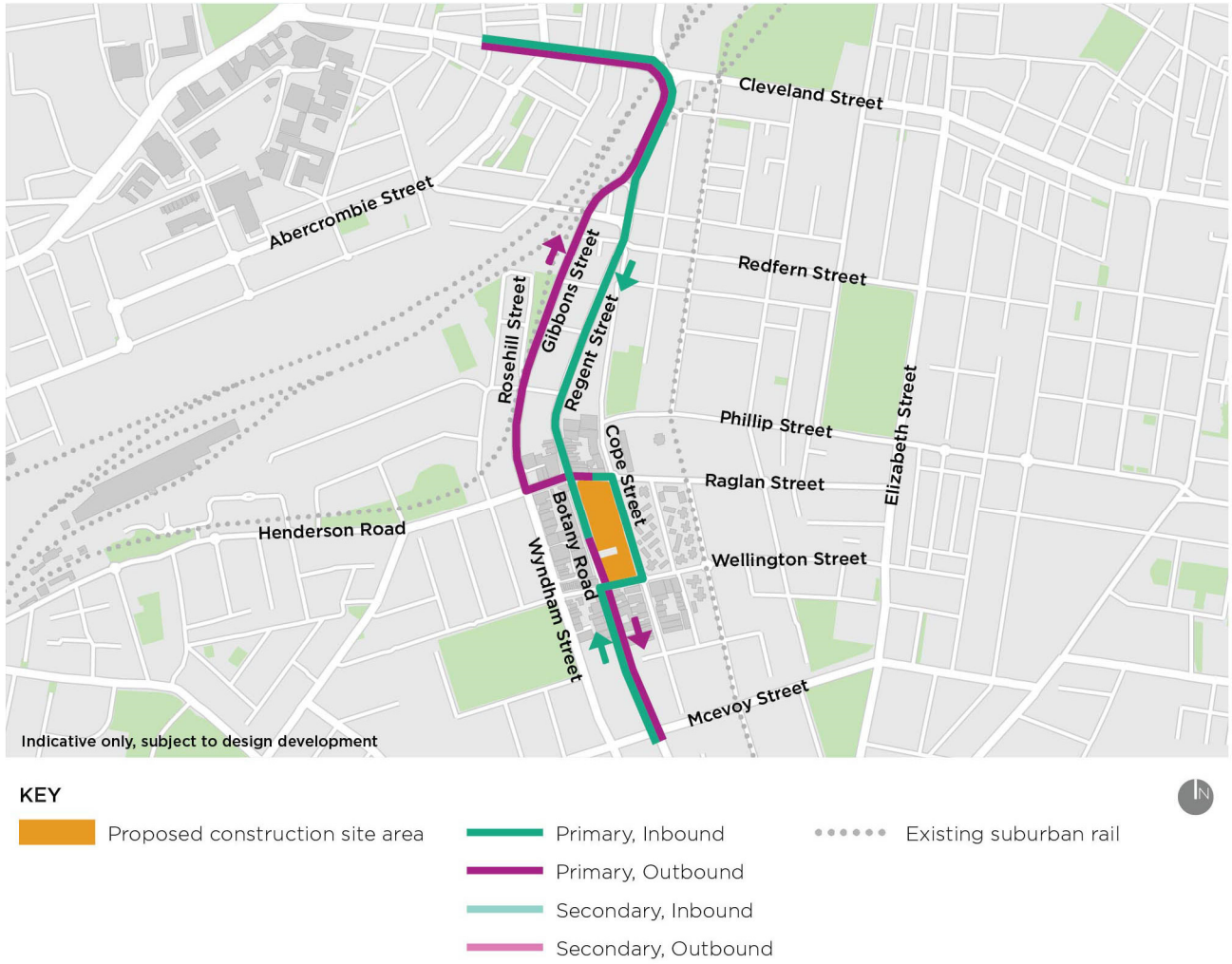
Martin Place station (O'Connell Street site) - construction road access



Pitt Street station - construction road access



Central station - construction road access



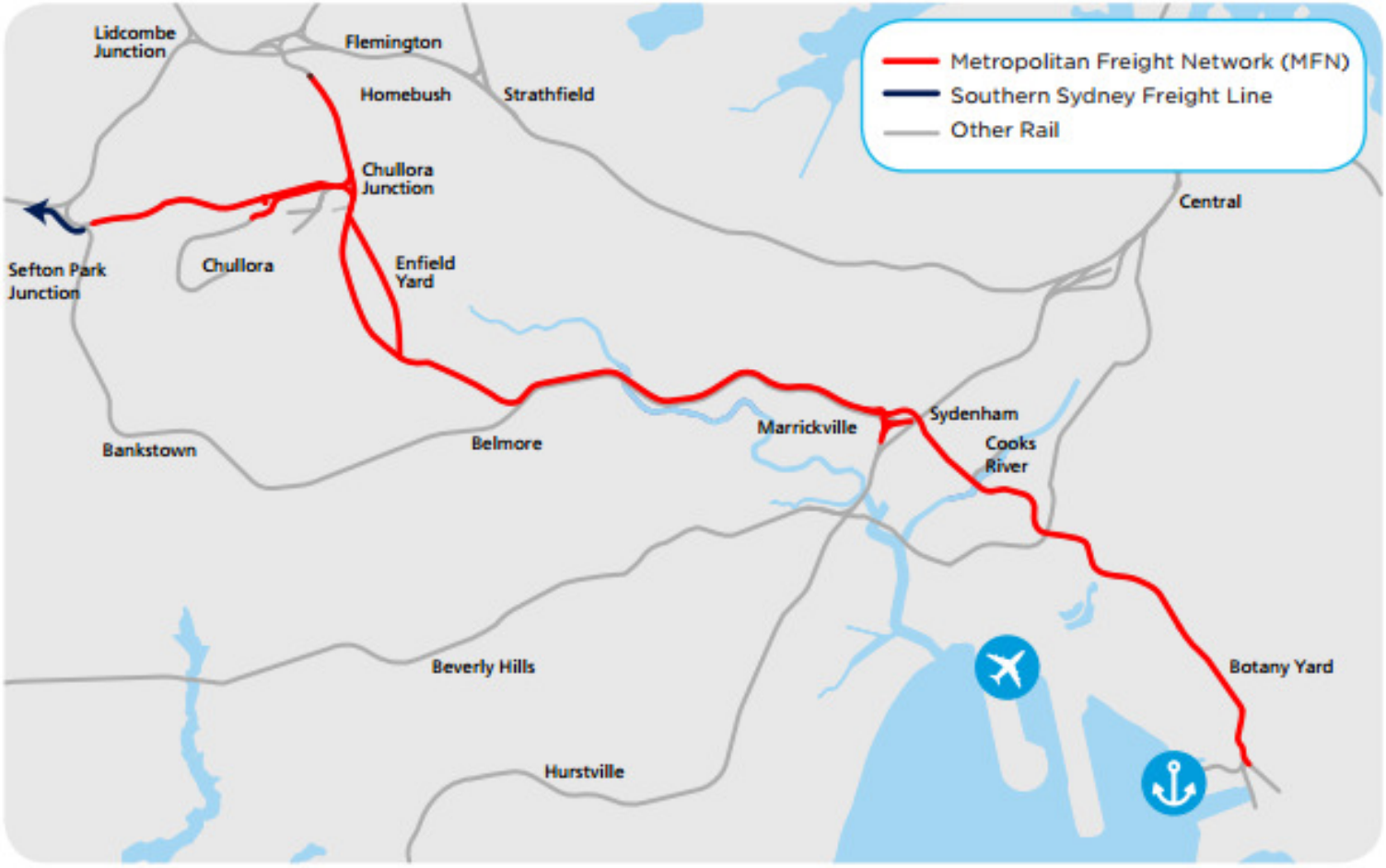
Waterloo station - construction road access

Southern dive - construction road access

A2 Rail infrastructure network maps

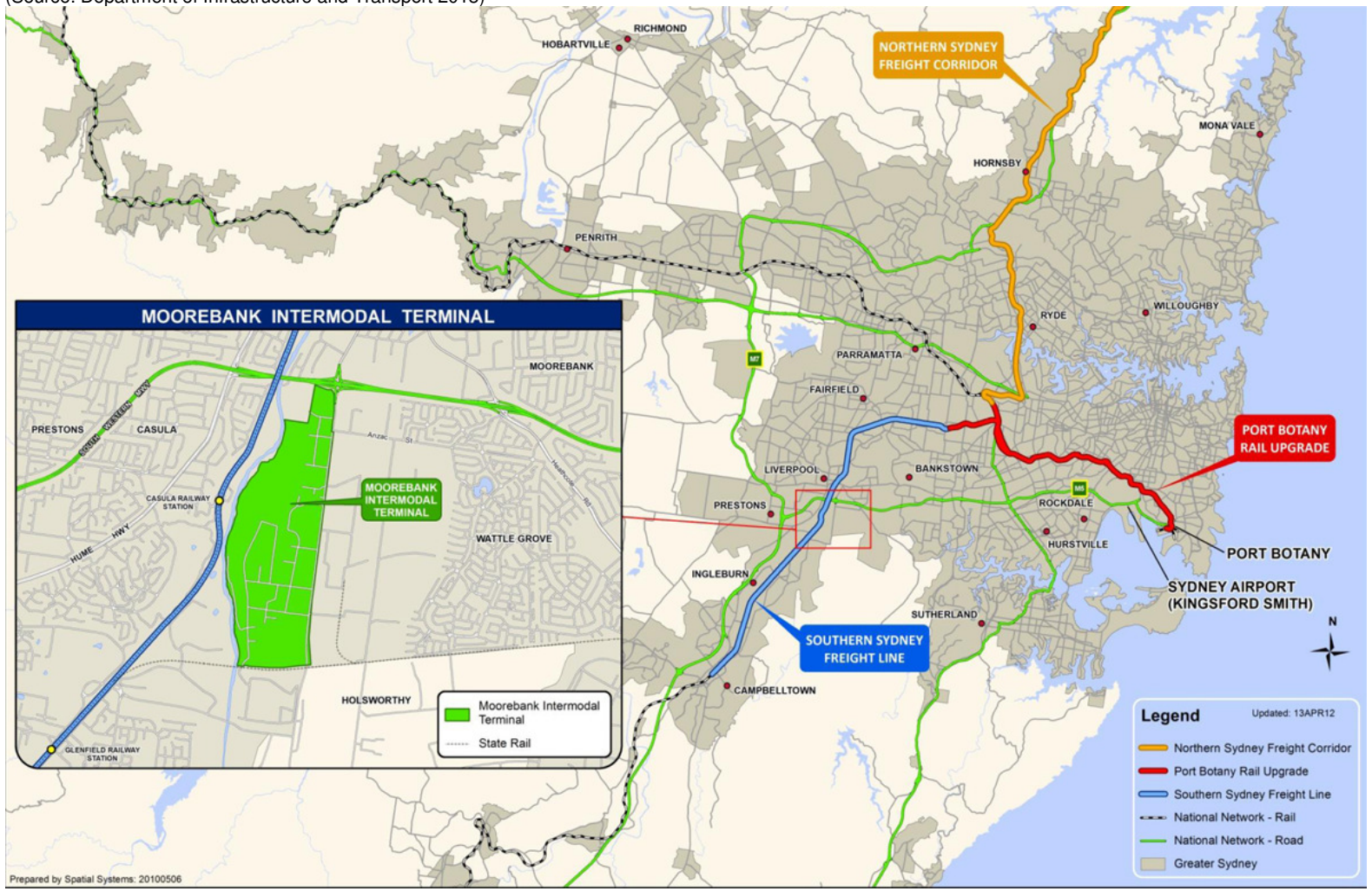
Metropolitan Freight Network

(Source: NSW Freight and Ports Strategy, 2013)



The Metropolitan Freight Network (red), the Southern Sydney Freight Line (blue) and the Northern Sydney Freight Corridor (yellow)

(Source: Department of Infrastructure and Transport 2013)



A3 Meeting Minutes (Sydney Metro and TfNSW Infrastructure and Strategy, 18 July 2016)

Meeting Minutes

Sydney Metro

Sydney Metro C&SW opportunities to transport spoil by train

Date:	Monday 18 July 2016	**Time:**	930 am
Venue:	18 Lee St		
Chairperson:	Trish McClure	**Prepared by:**	Jo Haggerty
Invitees:	Trish McClure – TM – Service Delivery and Performance, I&S, TfNSW David Spiteri – DS – Service Delivery and Performance, I&S, TfNSW Maya Das – MD – Service Delivery and Performance, I&S, TfNSW Alex Daly – AD – Service Delivery and Performance, I&S, TfNSW Ian Whitton – IW – City & Southwest, Sydney Metro, TfNSW Daniel Armstrong – DA – City & Southwest, Sydney Metro, TfNSW Matt Errington – ME – City & Southwest, Sydney Metro, TfNSW Jheeno Olidar – JO – City & Southwest, Sydney Metro, TfNSW Jo Haggerty – JH – City & Southwest, Sydney Metro, TfNSW Arnab Roy – RA – City & Southwest, Sydney Metro, TfNSW Samiha Najem – SN – Service Delivery and Performance, I&S, TfNSW Carolyn Riley – CR – Service Delivery and Performance, I&S, TfNSW Conrad Fonseca – CF – City & Southwest, Sydney Metro, TfNSW		
Apologies:	Alex Daly – AD – City & Southwest, Sydney Metro, TfNSW Roy Arnab – RA – Service Delivery and Performance, I&S, TfNSW Samiha Najem – SN – Service Delivery and Performance, I&S, TfNSW Carolyn Riley – CR – City & Southwest, Sydney Metro, TfNSW		

Item		Action by	Due date
1.	**Review of Minutes from Previous Meeting** No previous meetings	N/A	N/A
2.	**Review of Actions from Previous Meeting** No previous meetings	N/A	N/A
3.	**Topics this Meeting**	N/A	N/A
3.1	<u>Background</u> Trish McClure's team is working to realise the Secretary's directive to move spoil by train where possible to reduce truck congestion on roads, in the face of all of the upcoming infrastructure construction projects which will be happening in Sydney over the next 5 years and beyond. They are currently working on: • Identifying all of the potential spoil disposal sites, focussing in the southern area of Sydney, and further south (being done by Cardno, due in 4 to 6 weeks). Have a strategic map of southern / Illawarra sites which are looking for spoil - eg. Intermodal MacArthur. • Working with the M4 / M5 project to develop a rail solution for spoil, which would involve : Trucking spoil to Chullora Transportation via coal trains to Port Kembla Coal Terminal (PKCT). Plenty of train paths available. TfNSW would hire coal trains and pay PKCT for handling.	N/A	N/A

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	PKCT transferring to trucks, with final disposal in one of many sites in the south which have been earmarked (capacity 3 to 5 years), The rail solution would address approx 25% of spoil from M4 / M5 (15 million tonnes altogether). Looking at TfNSW filling Bombo quarry as a longer term option, train paths are more complicated and planning approval is needed.		
3.2	<u>Potential options for transport of spoil from the Sydney Metro project</u> • Truck transport to Chullora; and / or • Loading to train from a new siding at Sydenham (on either up or down side); and / or • Loading at central for metro box excavation spoil. • Then, train transport to either PKCT (8 train paths available) or Bombo quarry. No options for spoil from Chatswood dive end evident, unless it could be trucked to Hornsby.	N/A	N/A
3.3	<u>Sydney Metro information</u> 2.4 million M3 altogether. Most of spoil coming out at Chatswood and Sydenham. Smaller quantities at central and individual station boxes / shaft. Tunnelling starts late 2018 Further information available on production rates / types, if needed by I&S.	N/A	N/A
3.4	<u>Benefits of rail transport over road</u> PKCT operating at 15% capacity, has a lot of capacity available. Truck resources may be stretched. M4 / M5 indicate they will use half of the trucks available in the city. May be de-risking the Metro project by moving to trains. Trucks off road - congestion benefits When comparing road vs rail, risk and delay needs to be factored into cost comparison - Sydenham dive rail solution could help lower risk of delays if spoil is being generated at a high rate; and economic benefit of easing congestion should also be considered.	N/A	N/A
3.5	<u>Chullora</u> Planning approvals being worked through Some double handling, but could be used to supplement a direct rail (eg Sydenham) solution. Plenty of train paths available	N/A	N/A
3.6	<u>Sydenham siding</u> On the Down side: • TfNSW land available, but not enough for the full length of a coal train, possibly half. Conveyor and side loading using an excavator would be required. • Sydney Metro has done some work looking at the feasibility of this solution. It makes more sense if it can be then passed on to other users (eg waste transfer station), rather than being a temporary installation. • Plenty of train paths available - up to 8 paths / day for 45 wagon train. On the Up Side: • A portion of the land available for the dive / construction side could be used (Syd Metro to do further work to look at whether this is possible). It is likely that there won't be sufficient room for the full coal train. • Potentially a better solution as Syd Metro will ultimately be building sidings in that area for stabling. • Plenty of train paths available	N/A	N/A

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	• Not covered in the current EIS / planning application		
3.7	Central Train paths more limited, train paths at night and in the day during off peak.	N/A	N/A
3.8	Sydney Metro Tunnelling contract Currently preparing RfT. Going to market in September 2016, contract signed by May 2017. Contractors will likely be assuming the cheapest option for spoil transport - truck Sydney Metro should make a provision in the process to enable negotiating with them for potentially transporting spoil by train. It may be useful to request spoil transport and disposal unit rates from the contractors as part of the bid.	N/A	N/A
3.9	Contacts and information sources: RMS Easing Sydney's congestion document for economic indicators M5 - Cooks Cove - conveyor use Ken Reynolds - West Connex Con Lambous - RMS Hornsby quarry Shoal Harbour Council Marina development - potential reuse of spoil Carrie McIntyre contact person.	N/A	N/A
3.10	I&S timelines Planning approval Bombo underway 4 to 6 weeks spoil study in terms of locations where spoil can be disposed. 4 to 6 months - business case in place and infrastructure in place for M4/M5	N/A	N/A
4.	**Next Steps** Trish McClure to send Sydney Metro formal confirmation of available paths - what times of day they may be available. Sydney Metro to look at the Up side Sydenham option more closely. Meet again in 4 weeks time. Trish McClure to set up meeting.	TM IW/DA TM	5/8/16 Before next meeting 5/8/16
5.	**Next Meeting** To be scheduled by I&S	TM	5/8/16

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Appendix C – Condition E84 Barging Report

Condition E84 Barging Report

Project: Sydney Metro City & Southwest – TSE Works

Document No: SMCSWTSE-JCG-TPW-EM-RPT-097231

DOCUMENT APPROVAL

REVISION	DATE	PREPARED BY	REVIEWED BY	APPROVED BY	REMARKS
00	01/08/2018	Anne Andersen	Steve Kotevich	Terry Sleiman	For DP&E Submission
Signature:					

Table of Contents

Glossary

Term/ acronym	Definition
CEMF	Construction Environmental Management Framework (Appendix B of the Submissions and Preferred Infrastructure Report)
CEMP	Construction Environmental Management Plan
EIS	Sydney Metro City & Southwest Chatswood to Sydenham Environmental Impact Statement, May 2016
EMS	Environmental Management System
JHCPBG	John Holland CPB Ghella
Project	Sydney Metro City & Southwest
Project Planning Approval	Critical State Significant Infrastructure Sydney Metro & Southwest Chatswood to Sydenham Infrastructure Approval dated 9 January 2017 (Application no. SSI 15_7400)
REMM	Revised Environmental Mitigation Measures (Chapter 11 of the Submissions and Preferred Infrastructure Report).
SWTC	Scope of Work and Technical Criteria
TfNSW	Transport for New South Wales
TSE Works	Tunnels and Station Civil Works for the Sydney Metro City & Southwest Project

1.0 Plan Overview

1.1 Purpose

This Report documents John Holland CPB Contractors Ghella's (JHCPBG's) investigation of opportunities to use barges to transport construction materials and tunnel spoil for the Tunnel and Station Excavation Works (TSE Works) of the Sydney Metro City & Southwest Project (the Project). Transport for NSW (TfNSW) is delivering the Project on behalf of the NSW Government.

1.2 Roles and Responsibilities for Condition E84

The Chatswood to Sydenham section of the Project was approved on 9 January 2017 (SSI 15_7400) (Project Planning Approval). Condition E84 of the Project Planning Approval states:

> *"Notwithstanding the above, the Proponent must investigate opportunities to maximise spoil removal by non-road methods and schedule final track laying as soon as practicable following completion of tunnelling with a view to transporting materials and equipment for station fit-out, systems and commissioning by rail to minimise truck movements in town centres and the Sydney CBD. The findings of the investigation must be reported to the Secretary before commencement and before completion of tunnel spoil generation as relevant. A decision to not adopt spoil haulage or materials delivery by non-road methods must be demonstrated to the satisfaction of the Secretary."*

Project Deed Schedule D3 Clause 3 (a) (xlix) sets out roles and responsibilities for Project Planning Approval Condition E84 by stating that the Principal (Transport for NSW) will:

> *"be responsible for, under E84, preparing and obtaining approval for the report on the scheduling of final track laying as soon as practicable following completion of tunnelling with a view to transporting materials and equipment for station fit-out, systems and commissioning by rail prior to the commencement of rail fit out work. The TSE Contractor* [JHCPBG] *will prepare a report on the use of barges to transport construction materials and tunnel spoil before commencement of tunnel spoil generation and seek all necessary approvals for these works."*

As such TfNSW's Staging Report (Version 3.1 dated 15 February 2018) prepared under Condition A12 notes that Condition E84 is held by the TSE Contractor "Partial – To the extent of commencement of tunnel spoil generation only."

Section 5.9 of the Construction Environmental Management Plan (SMCSWTSE-JCG-TPW-EM-PLN-002010) approved by the Department of Environment and Planning on 22 December 2017 states that:

> *"JHCPBG is responsible for preparing a report on the use of barges to transport construction materials and tunnel spoil before commencement of tunnel spoil generation. This report will address barging operation at both Barangaroo and Blues Point for delivery and removal of TBM components, and the management of the spoil receival site. The Clyde receival site will be assessed and determined under a Review of Environmental Factors."*

As such this Report documents JHCPBG's investigation of opportunities to use barges to transport construction materials and tunnel spoil for the TSE Works.

1.3 Structure of this Report

This report is structured as follows:

- Background to the requirement to investigate barging options is provided in Section 2
- Analysis of various barging options are provided in Section 3
- JHCPBG's preferred barging strategy is provided in Section 4
- Conclusions are provided in Section 5

2.0 Background

2.1 EIS

The Environmental Impact Statement (EIS) for the Project noted in Section 7.10.5 in describing the Blues Point worksite that:

> *"It may also be feasible to remove the tunnel boring machines via barge using the wharf at the end of Blues Point Road. This opportunity would be further investigated during detailed design."*

In Section 7.10.6 in describing the Barangaroo Worksite the EIS also notes:

> *"It may also be feasible to remove some of the spoil generated through this site by barge using wharf facilities around Barangaroo. This opportunity would be further investigated during detailed design in consultation with Barangaroo Delivery Authority."*

Section 8.2 of the EIS assesses construction traffic and transport impacts and notes that:

> "For the purposes of this assessment, it has been assumed that all spoil would be transported from the construction site by truck. The use of other methods of transport, such as train or barge, maybe possible subject to further investigation. This would reduce the potential road traffic impacts as described in this chapter."

Section 8.2.3 of the EIS assessed spoil transport options. With respect to barging it stated:

> *"Barge transport options were investigated for the Blues Point temporary site and the Barangaroo Station construction site due to their proximity to Sydney Harbour.*
>
> *Blues Point temporary site*
>
> *The site has ready access to potential barge loading facilities via the existing wharf at the end of Blues Point Road. The use of a barge from this location may require strengthening works to the wharf and potentially dredging of the harbour bed to ensure sufficient depth.*
>
> *Additionally, the volume of spoil proposed to be transport from this site is relatively minor and the establishment of barging facilities at this site may not be a feasible solution.*
>
> *Barge transport of spoil may be feasible at this site subject to further investigations.*
>
> *Barangaroo Station construction site*
>
> *Barging of spoil at this site could potentially be achieved by using existing wharf areas at Barangaroo (to the south of the newly created 'Northern Cove') or to the north at Moore's Wharf (a Port Authority of NSW facility to the east of Barangaroo Reserve).*
>
> *The use of wharf space at Barangaroo could result in disruption to the construction of the adjacent Barangaroo development. However, barge transport of spoil from this location may be feasible subject to further investigation and agreement with Barangaroo Delivery Authority.*
>
> *The use of Moore's Wharf would require the transport of spoil from the Barangaroo Station construction site to the wharf through the use of a conveyor system or by road. Moore's Wharf is currently used by the Port Authority of NSW for various functions including emergency response. Barge transport of spoil may be feasible at this site subject to further investigations, agreement of the Port Authority of NSW and the*

development of a solution which ensured the existing functions supported by Moore's Wharf are not impacted."

The EIS found that, subject to further feasibility analysis, barge transport may be possible from the Barangaroo Station construction site and from the Blues Point temporary site. However, as there are substantial constraints to these options that would need to be overcome. The EIS therefore concluded that further consideration of barge options would be carried out during the detailed design phase of the project. EIS concluded that in the event that barging is adopted this is likely to result in a reduction to the road-based construction traffic impacts.

With respect to TBM retrieval the EIS noted at Section 8.4.10 that:

"The removal of the tunnel boring machine components is anticipated to be via Blues Point Road however the option of transporting these large components by barge using the existing wharf facilities at the end of Blues Point Road would be further investigated during detailed construction planning."

2.2 Submissions and Preferred Infrastructure Report

The Submissions and Preferred Infrastructure Report (SPIR) for the Project noted that since exhibition of the EIS, additional investigations have been carried out into:

- Barangaroo Station barging – the potential barging arrangements (in the event this solution is adopted) have been described and assessed
- Blues Point temporary site – description of the potential barging of the tunnel boring machine components, if this is determined to be a feasible solution.

Section 2.2 of the SPIR set out the following assessment addresses barging at Blues Point:

"Chapter 7 of the EIS identifies that the opportunity to transport tunnel boring machine components from Blues Point by barge (as an alternative to truck transport), would be further investigated. This section provides a description of the potential barging arrangements if this is determined to be a feasible solution.

Figure 2-2 shows the potential barging arrangements at Blues Point. Indicatively, a barge would be moored at or close to the existing wharf at the end of Blues Point Road. The water is around four metres deep at this location, which provides sufficient depth without the need for any dredging.

A crane would be established at the end of Blues Point Road (within the expanded site area) to lift the tunnel boring machine components onto the barge. Alternatively, a crane mounted on a barge could be used.

No further assessment of this activity is considered necessary as:

- *A maximum of four barge trips would occur within the harbour as a result of this activity*
- *(if adopted), which would not result in any additional impacts on marine traffic in the harbour*
- *The extraction and lifting of the tunnel boring machine components is included in the construction noise assessment presented in the Environmental Impact Statement*
- *The visual assessment in the Environmental Impact Statement identifies the potential for cranes to be present at the site, and the short term occupation of*

the expanded site area during the extraction of the tunnel boring machine. It concludes that the impact of construction activity at this temporary site would have a high visual landscape impact, and a high adverse visual impact in areas around Blues Point and McMahons Point. The temporary addition of barges would be consistent with the visible construction elements assessed in the Environmental Impact Statement and would have negligible additional impact

- *There would be no additional impact on Aboriginal or non-Aboriginal heritage items to that described and assessed in the Environmental Impact Statement. In particular, the work would be undertaken in a manner that would not have an impact on the waterfront wall, which forms part of the Blues Point Waterfront Group, a local heritage item under North Sydney Local Environmental Plan 2013*
- *The barging activities would not result in any change to the social and community infrastructure impacts as described and assessed in the Environmental Impact Statement.*

Overall, it is expected that using a barge to transport tunnel boring machine components would result in negligible changes in impacts when compared with those assessed in the Environmental Impact Statement."

Figure 1 is a reproduction of Figure 2-2 from the SPIR showing the location of potential barging arrangements at Blues Point temporary site.

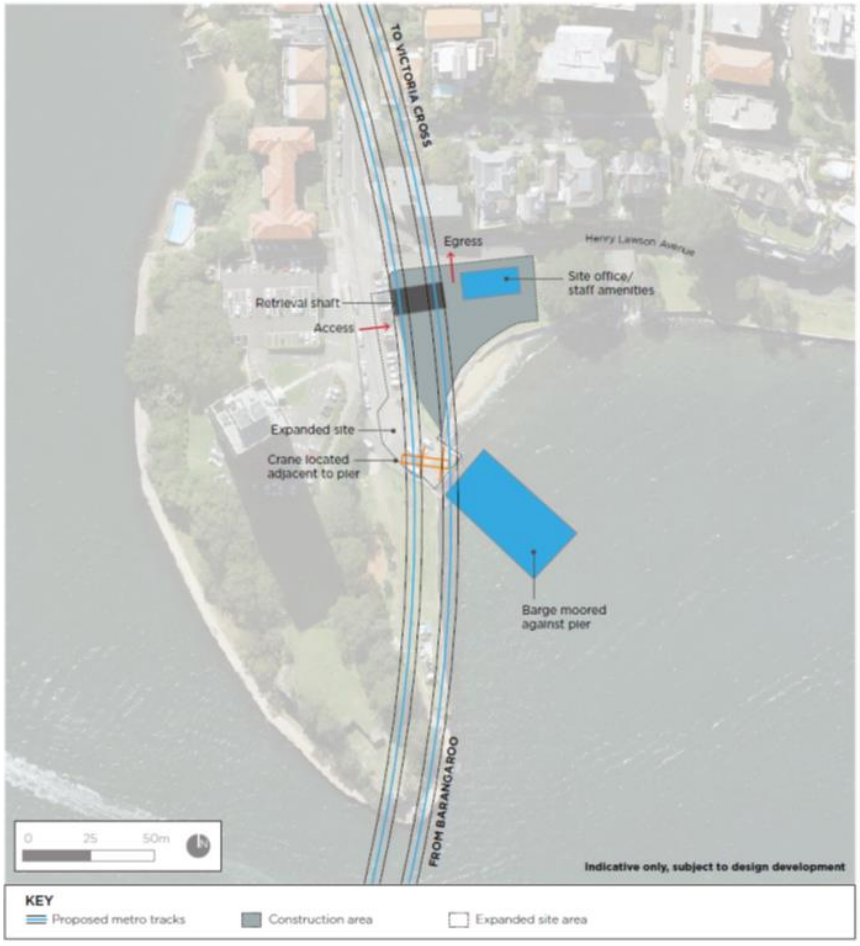

Figure 1: Potential barging arrangements at the Blues Point temporary site (extracted from the SPIR)

Section 3.2 of the SPIR noted that:

> *"Chapters 7 and 9 of the EIS identify that it may be feasible to transport some of the spoil generated at the Barangaroo Station construction site by barge.*
>
> *Further investigations have been carried out to identify a feasible solution for barging in the event this is adopted as a transport method. Further investigations also identified that barges could be used to deliver materials to the Barangaroo Station construction site.*
>
> *This section provides a description of the work required to enable barging to and from Barangaroo Station, and an assessment of the potential impacts of this activity."*

Section 3.2.1 of the SPIR set out the following description:

> *"If barging is adopted as a transport method, barging facilities would likely be established to the south of the Nawi Cove. This would include around 200 metres of wharf frontage, with one section used to load spoil barges and another used as a berth for deliveries. A materials storage area would be provided adjacent to the delivery berth. A maximum of seven barge trips per day (one-way) would be generated for spoil removal and deliveries.*
>
> *A conveyor system would transport spoil from the main construction site to the wharf and a haul road would be established adjacent to the conveyor to transport material deliveries from the wharf to the construction site. The location and layout of the barging infrastructure is shown on Figure 3-8.*
>
> *It is expected that the barging area would operate after hours. This would require lighting on the barges to facilitate a safe working platform while berthed, and lighting within the adjacent construction sites."*

Figure 2 is a reproduction of Figure 3-8 from the SPIR showing the location of potential barging arrangements at the Barangaroo site.

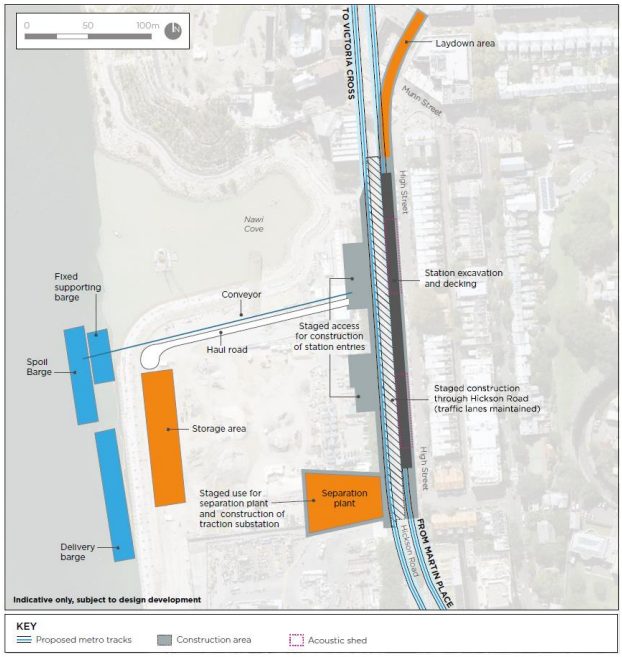

Figure 2: Potential barging arrangements at the Barangaroo site (extracted from the SPIR)

Table 1 is a reproduction of Table 3-4 from the SPIR which sets out an environmental screening assessment of barging from Barangaroo.

Table 1: Barangaroo barging environmental screening assessment

Aspect	Potential change in impact	Description
Construction traffic and transport	Yes	Barging would result in additional marine movements and would impact on pedestrian and cyclist movements. If the option were implemented, it would have major benefits in the reduction of construction vehicle movements on the surrounding road network. A further assessment is provided in Section 3.2.3 of the SPIR.
Operational traffic and transport	Yes	Barging would occur during the construction phase only and would not alter the operational transport arrangements at Barangaroo Station. No further assessment is considered necessary.
Construction noise and vibration	Yes	The barging facilities would introduce new infrastructure and new noise sources during the construction phase at Barangaroo Station. A further assessment is provided in Section 3.2.4 of the SPIR.
Operational noise and vibration	No	Barging would occur during the construction phase only and would not alter any operational arrangements at Barangaroo Station. No further assessment is considered necessary.
Land use and property	Yes	Additional land would be required for the barging facilities, mainly within the Barangaroo Delivery Authority area. A further assessment is provided in Section 3.2.5 of the SPIR.
Business impacts	No	Barging would not result in any additional impacts to businesses. No further assessment is considered necessary.
Non Aboriginal heritage	No	Barging would not result in any impacts to known non-Aboriginal heritage items. There may be views of barging activities from heritage items or the heritage conservation area. However, these would not be significantly different from the views of the current construction activity at Barangaroo. Further, there would be no impact to potential archaeology as excavation is not proposed. With the restriction of rock breaking to only standard construction hours, there would be no change to vibration levels from those predicted in the Environmental Impact Statement for heritage items. No further assessment is considered necessary.

Aspect	Potential change in impact	Description
Landscape character and visual amenity	Yes	The barging facilities would introduce temporary infrastructure adjacent to the wharf near Barangaroo Station. A further assessment is provided in Section 3.2.6 of the SPIR.
Groundwater and geology	No	Barging would not result in any additional groundwater and geology impacts as excavation is not proposed. No further assessment is considered necessary.
Soils, contamination and water quality	No	Barging would not result in any change to the potential soils, contamination or water quality impacts. No further assessment is considered necessary
Social impacts and community infrastructure	No	Barging would not result in additional impacts to community infrastructure or additional social impacts. No further assessment is considered necessary.
Biodiversity	No	Barging would not require the clearing of any vegetation, or the removal or any potential habitat. The fixed barge would be fixed to the adjoining land, and would not involve work to the harbour bed at this location. There is the potential for overshadowing impacts, but any impact on fauna (if present) would not be permanent. There is potential for the spread of marine pests (particularly the marine alga (Caulerpa taxifolia) from the transport of materials and spoil in the harbour (eg barges). However, C.taxifolia is not known to occur in the Barangaroo area. Mitigation measure B4 would be in place to avoid transportation of marine pests from other locations. Therefore, no impact is expected. No further assessment is considered necessary.
Flooding and hydrology	No	Barging would not result in any changes to flooding and would not alter existing stormwater systems. No further assessment is considered necessary.
Air quality	No	Without the implementation of adequate mitigation measures, barging would pose additional risks to local air quality. However, these risks would be readily managed through standard mitigation measures. No further assessment is considered necessary.
Hazards and risk	No	Barging would not include the storage and use of any additional hazardous substances and dangerous goods, or be located within a bushfire prone area. No further assessment is considered necessary.

Aspect	Potential change in impact	Description
Waste management	No	Barging would not result in the generation of any different and increased volumes of waste materials. No further assessment is considered necessary.
Sustainability	No	Barging would not change the climate risk profile of the project, and would not result in a substantial change to the generation of greenhouse gases or the use of resources. No further assessment is considered necessary.
Cumulative impacts	No	Barging would not result in any additional cumulative impacts. No further assessment is considered necessary.

In relation to construction traffic and transport Section 3.2.3 of the SPIR stated that:

- Network performance:

  "If barging to and from Barangaroo is adopted, there would be a benefit to the surrounding road network due to a reduction in construction vehicles transporting spoil or materials to the site.

  This would result in a reduction in potential impact and therefore no further quantification of the change in network performance was carried out.

  As the internal haulage route would be restricted to construction vehicles only, this would have no impact on the surrounding network."

- Maritime traffic impacts:

  "Given the anticipated low volume of barge movements (a maximum of 2 movements per day- 1 per tide), there would be minimal impacts to maritime services, including services to and from the planned ferry hub at Barangaroo, and the water taxi wharf at Rowntrees Wharf in Nawi Cove.

  To minimise potential navigational safety impacts, warning signals and demarcation would be provided for the fixed supporting barge and for the barges moored at the designated loading / unloading areas.

  The Port Authority of NSW (Harbour Master), Roads and Maritime Services and Sydney Ferries would be consulted in relation to all barge movements within Sydney Harbour to avoid impacts on the safety of other harbour users."

- Active transport impacts:

  "Wulugul Walk, which will eventually provide foreshore access for pedestrians and cyclists to King Street Wharf and Darling Harbour, is presently closed as part of the construction of Central Barangaroo. It is anticipated that the walk will be re-opened as construction activities for Barangaroo progress. At present, it terminates around 300 metres south of Nawi Cove, and provides no through access.

To allow for the infrastructure associated with the barge activities, Wulugul Walk would need to be closed for safety requirements at the point where the conveyor belt passes over the shared paths.

As the walk presently does not provide access to the south, any temporary closure would not have a significant impact on pedestrians or cyclists, with pedestrians and cyclists having to use Hickson Road to travel to / from areas further south of Barangaroo Point Reserve.

The completion of the Central Barangaroo precinct is expected to occur in 2024. If the remaining sections of Wulugul Walk within Central Barangaroo are completed while construction of the project is underway, alternative paths would be available for north–south movements (such as Hickson Road).

Any changes to Wulugul Walk would be subject to mitigation measures as proposed in Chapter 11 (Revised environmental mitigation measures and environmental performance outcomes), such as directional signage (mitigation measure T3) and advanced community notifications (mitigation measure T5).”

In relation to construction noise and vibration, Section 3.2.4 of the SPIR states:

- *“The addition of the barging activities would not increase exceedances of noise management levels as presented in the Environmental Impact Statement. While barging within Barangaroo would introduce a new source of airborne noise, it would not be to a level that would cause an increase in the category of exceedance. This is in part due to the restriction of rock breaking activities to standard construction hours, which has lowered the predicted noise contribution from excavation activities”*
- *“Barge movements would be within the noise management levels for all receiver areas.”*
- *“LAmax noise levels associated with barge support activities would exceed the sleep disturbance screening level by up to 10 dB at residential receivers in area A”*

In relation to land use and property impacts, Section 3.2.5 of the SPIR states:

“Subject to detailed construction sequencing, the barging option and associated infrastructure would be partially located within the foreshore areas of Barangaroo Reserve, referred to as Wulugul Walk, and partially within the construction footprint of Central Barangaroo precinct.

Central Barangaroo is currently under development and is scheduled to be completed in stages by 2024. It is currently a construction site that supports the construction of Barangaroo South and will continue to be a construction site as the Central Barangaroo precinct is developed.

Central Barangaroo covers 5.2 hectares. It will effectively become the cultural heart of Barangaroo, and will include a combination of civic and cultural attractions along with recreational, residential, retail and commercial uses. The proposed restaurants and cafes to be located at Wulugul Walk at Central Barangaroo have not yet commenced construction.

The barging option would require the temporary occupation of foreshore areas and parts of the Central Barangaroo precinct (subject to more detailed construction sequencing of both projects) for a storage area, internal haulage route and elevated conveyor system. The majority of this infrastructure would be within the Central

Barangaroo precinct. The use of the land would be secured by way of lease or a Memorandum of Understanding with Barangaroo Delivery Authority.

The temporary occupation of open space areas would have a minor land use impact associated with the removal of foreshore access. This would impact on a limited section of the Wulugul Walk, which currently terminates around 100 metres south of the barging area footprint.

The temporary occupation of construction areas of Central Barangaroo could have impacts on the staging of that development. To manage these impacts, the final configuration of construction activities within Central Barangaroo would be determined in consultation with the Barangaroo Delivery Authority with the objective of minimising disruption to construction staging for the precinct."

With respect to visual impacts, Section 3.2.6 of the SPIR states that during construction, there would be:

- *"A high adverse landscape impact on Wulugul Walk due to the restriction of access to the foreshore and proximity of construction activities to remaining accessible foreshore areas. This would reduce the attractiveness of this space*
- *A moderate adverse landscape impact on Sydney Harbour and foreshore areas. The presence of the barges and supporting infrastructure would result in a noticeable reduction in the landscape quality of this area."*

2.3 Relevant Consistency Assessments prepared by TfNSW

Since the Minister for Planning approved the Project on 9 January 2017, TfNSW has prepared the following consistency assessments relevant to barging operations:

- Consistency Assessment Barangaroo Traction Substation (TfNSW 7, approved 9 May 2017) which revised the Barangaroo worksite footprint to ensure barging minimised impacts on the Central Barangaroo development (see Figure 3 which is a reproduction of Figure 2 from TfNSW 7) and did not identify any additional mitigation measures specific to barging.
- Consistency Assessment Barangaroo Temporary Additional Land (TfNSW 23, approved 11 October 2017) addresses minor temporary additional land extensions required to facilitate the safe passage of pedestrians around the construction site and increase the laydown area available for the storage of machinery and equipment associated with the construction of the Barangaroo Station (see Figure 4 which is a reproduction of Appendix A from TfNSW 23). TfNSW 23 did not identify any additional mitigation measures specific to barging.
- Consistency Assessment Barangaroo Northern Shaft (TfNSW 20, approved 14 March 2018) which noted that the norther shaft spoil (approximately 6000 m3) would be transported from site by road truck and trailers, including some out of hours works. It would not be possible for the shaft spoil to be transported from the worksite via barges. This is expected to be in the order of 450 truck and trailer departures over the period of 2 months of excavation. TfNSW 20 did not identify any additional mitigation measures specific to barging.

Figure 2: Revised indicative layout of the Barangaroo Station construction site for north entry and barging activities

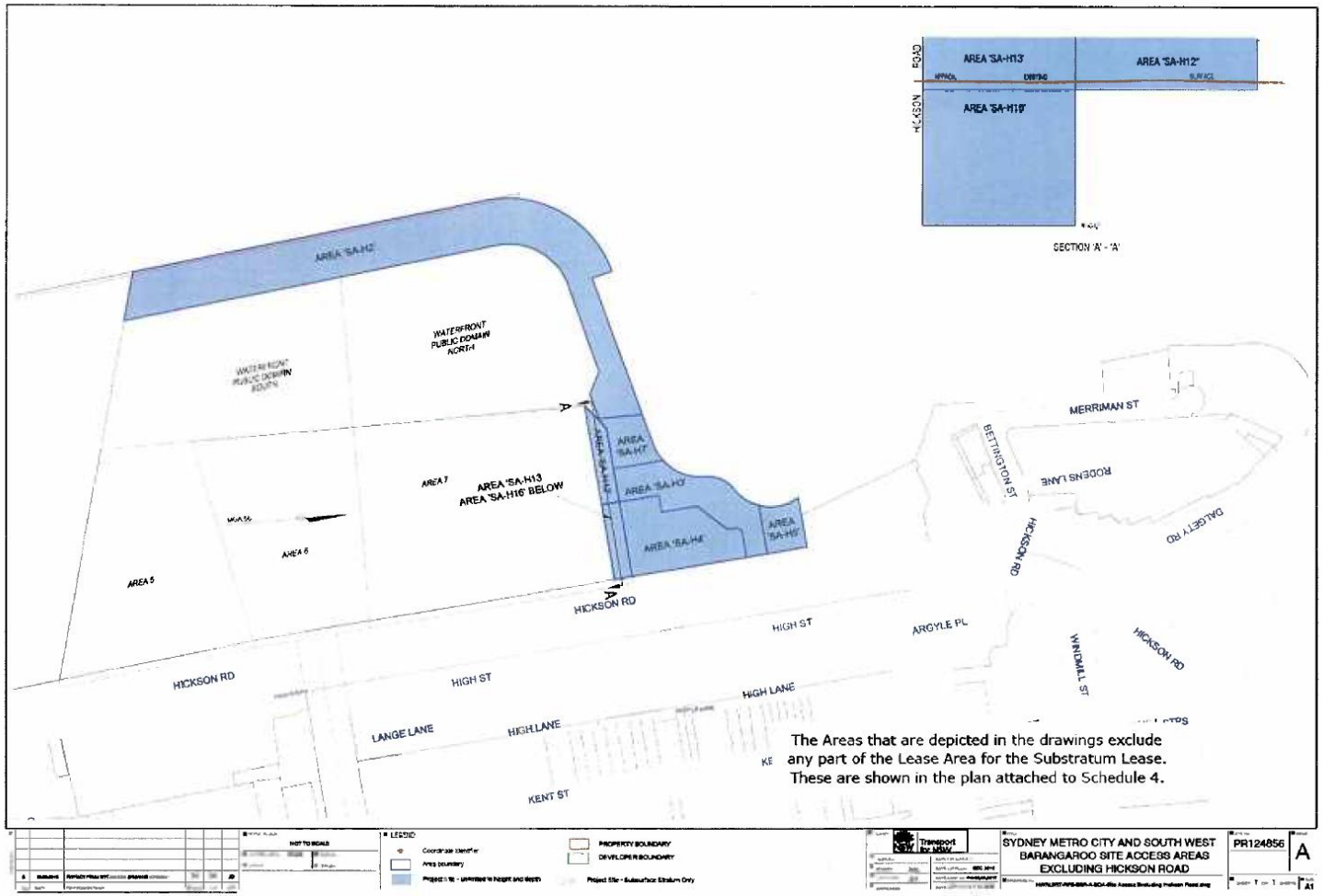

Figure 3: Additional land to facilitate barging at Barangaroo (extracted from TfNSW 7)

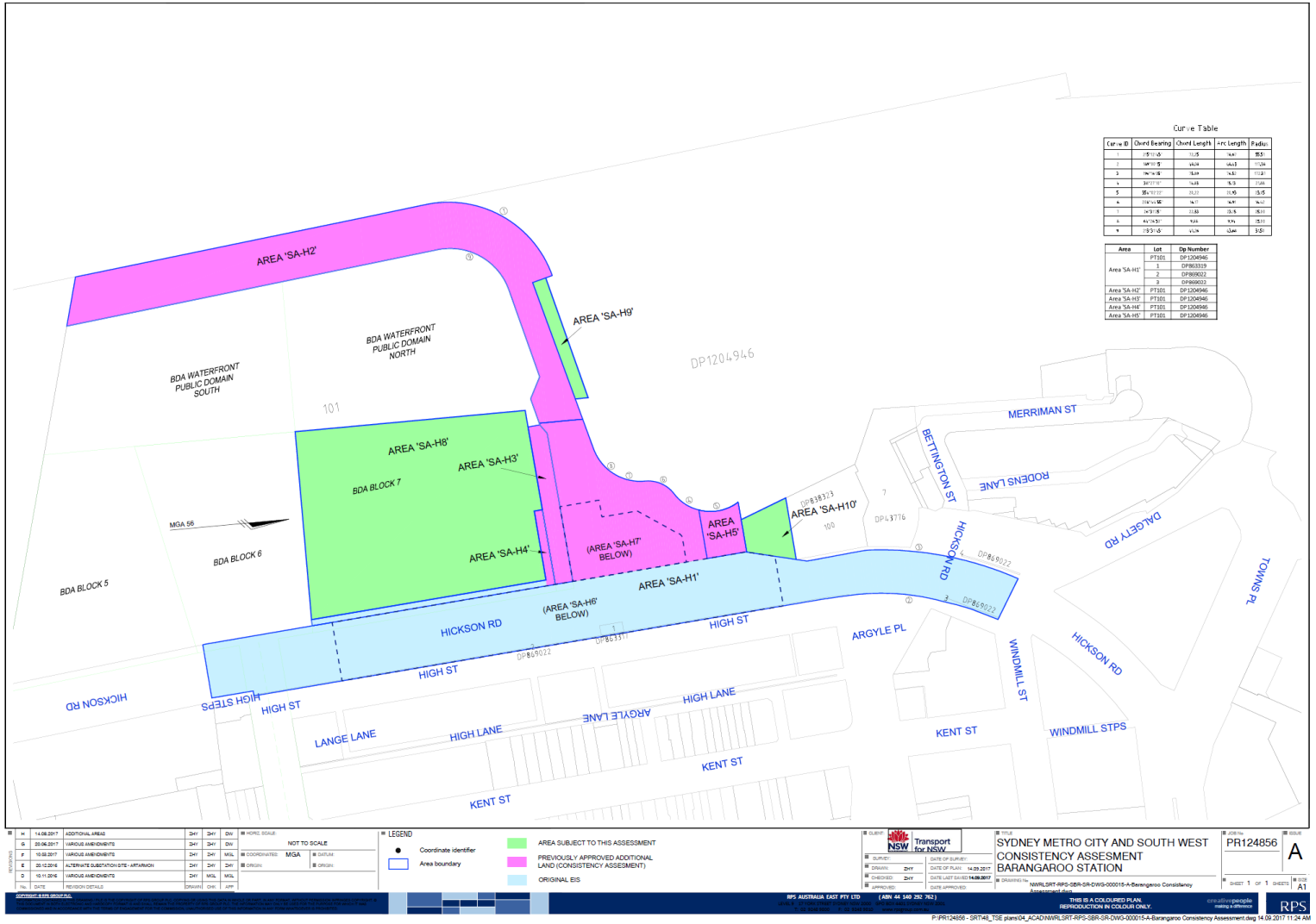

Figure 4: Additional land to facilitate barging at Barangaroo (extracted from TfNSW 23)

3.0 Barging opportunities analysis

3.1 Barging on previous projects

3.1.1 Sydney Harbour Tunnel

Transfield (now John Holland) Kumagai constructed the Sydney Harbour Tunnel which opened in 1992. Barging was used extensively to construct this project including:

- 700,000 m3 of spoil was dredged from the harbour seabed was barged for dumping at sea 12 km south-east of the heads to form an artificial reef
- To transfer 120 metre long precast tunnel sections from Port Kembla to the harbour for submerging and putting into place.

Three grab dredges were used to dig a 12-metre-deep trench for the precast tunnel segments to be placed at the bottom of Sydney Harbour. Figure 5 shows one of the grab dredges lifting spoil from the seabed and loading a barge ready for its journey out to sea.

Figure 5: – Dredging in Sydney Harbour (source: National Geographic, photographer: Mark Zvirblis)

A 320m by 100 m casting basin was constructed at Port Kembla to enable the tunnel sections to be cast, submerged and floated into Port Kembla ready for towing to Sydney Harbour. The 12-metre-deep basin was resealed, drained and cleaned for reuse. Figure 6 shows a tunnel segment being towed out of the Port Kembla casting basin.

Figure 6: – A tunnel segment being towed out of the Port Kembla casting basin (source: National Geographic, photographer: Margaret Rush)

The first tunnel section being towed by Tug to Sydney Harbour is shown in Figure 7.

Figure 7: – tug towing the first segment from Port Kembla to Sydney Harbour (source: National Geographic, photographer: Margaret Rush)

To enable shore-based surveyors to correctly position the tunnel sections two 26 metre towers were temporarily bolted to each segment prior to installation. Tugs were used to tow each precast concrete section into position (see Figure 8). The segments were flooded by the controlled release of valves causing them to be submerged into the harbour. Two pontoons fitted with winches lowered the segments into place, based on instructions from the shore -based surveyors.

Figure 8: – Tugs manoeuvre the fourth section into position for sinking (source: National Geographic, photographer: Margaret Rush)

3.1.2 North Side Storage Tunnel

Removal of 1,860,000 tonnes of spoil from tunnelling operations via barge was undertaken by Transfield (now John Holland) on the North Side Storage Tunnel Project. Because of the location of the sites in highly developed residential areas, an alternative to spoil haulage by road transport was required. The final arrangement entailed spoil removal from the Tunnel Boring Machines (TBMs) by conveyors and removal from the underground works by a combination of inclined, vertical and horizontal conveyors to barge loading points on the harbour side.

2000t barges were used to transport the spoil 18 km across Sydney Harbour to White Bay. Figure 9 shows a spoil barge being towed and manoeuvred by two tug boats near the Sydney Opera House. From White Bay the spoil was transported to points on the western outskirts of Sydney where it was used for industrial development earthworks.

Figure 9: – Barging 2000t barges through Sydney Harbour

The barge loading point for the works at North Head was located at the end of a 1.4km long conveyor tunnel at Little Manly Point Reserve in Spring Cove, North Harbour. Spring Cove is the habitat for Sydney Harbour's only colony of Little Penguins. Problems to be overcome at this site were the prevention of disturbance to the penguin colony and the avoidance of damage to sea grasses in the dedicated marine park area. After completion of the spoil conveyor tunnel, the wharf and noise shielded barge loading facilities were constructed at Little Manly Point and the spoil conveyor from North Head was installed in the tunnel.

A similar spoil handling facility was installed at the other main construction site at Tunks Park, Cammeray, within an environmentally sensitive residential area, adjacent to parkland and a public recreational reserve (see Figure 10). Stringent noise and space constraints had to be overcome to allow the project to proceed. Two underground caverns were constructed for storage of TBM spoil overnight and to allow tunnelling to continue 24 hours per day. Offices and amenities buildings were constructed on piles over the bay and all surface workshops and barge loading facilities were totally enclosed within buildings lined with acoustic suppression cladding designed to minimise noise transmission and disturbance to the local community.

Figure 10 – North Side Storage Tunnel Barge Loading Shed at Tunks Park

Figure 11 includes photographs showing, clockwise from top left:

- A conveyer loading a barge with spoil
- A barge being manoeuvred near the ANZAC Bridge
- Two barges being successfully manoeuvred in Fort Denison
- An excavator on a loaded spoil barge being towed by two tugs
- A loaded barge being manoeuvred to a wharf.

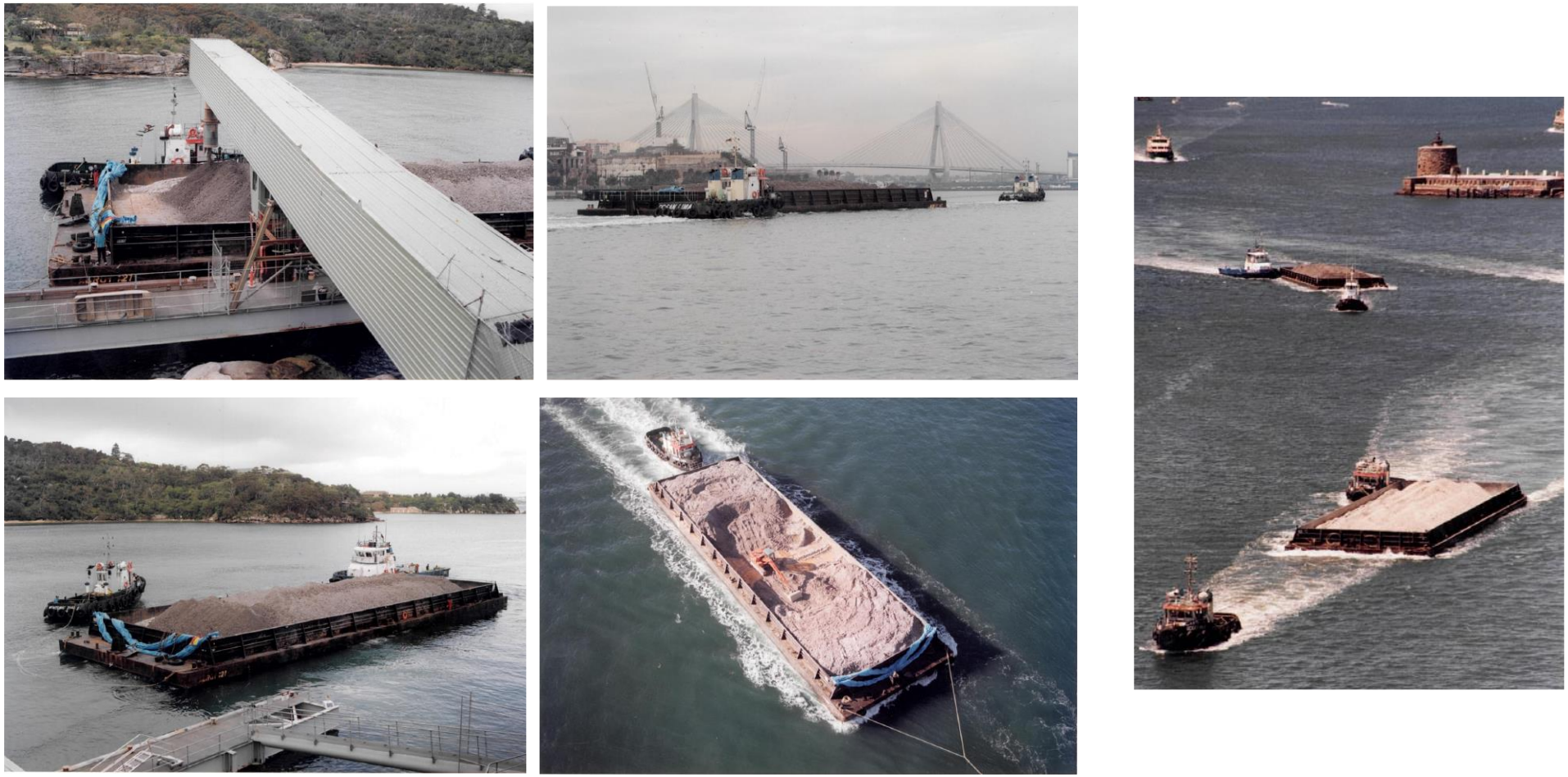

Figure 11 - North Side Storage Tunnel Barging

3.2 TSE Operations and barging potential

As noted in Sections 2.1, 2.2 and 2.3, TfNSW has already completed extensive investigation into barging from Barangaroo and Blues Point which identified the potential for both:

- Spoil barging from Barangaroo
- Barging of TBM cutter head and shields from Blues Point

JHCPBG confirms that there is potential for spoil barging and barging of TBM cutter heads and shields identified by TfNSW. In addition, JHCPBG has confirmed the potential for the following additional barging operations:

- Spoil barging from Blues Point
- Barging of entire TBMs from Barangaroo and Blues Point

The ability to barge spoil is governed by the confirmation of a suitable barge receival facility and it is noted that the EIS, SPIR and subsequent consistency assessments are silent on the destination of the barges. JHCPBG's assessment of barging spoil receival sites options is therefore set out in Section 3.3 below.

3.3 Barging receival sites options considered

JHCPBG completed a review of available barging infrastructure and identified the following potential barge destination options:

1. Port Kembla – Outer Harbour development
2. Camelia Industrial Precinct– Private development applications
3. White Bay – Industrial wharfs
4. Clyde - Viva Energy Australia's Clyde Terminal

To assess these options, advantages and disadvantages were identified and compared. This analysis is summarised in Table 2.

Table 2: Barging receival site options analysis

Option	Advantages	Disadvantages
1. Port Kembla – Outer Harbour development	• Existing mooring facilities	• Approximately 50 nautical miles from Barangaroo • Rough seas may restrict operations • Development consent for spoil receival has not been obtained and redevelopment timelines are uncertain
2. Camelia Industrial Precinct – Private development applications	• Approximately 11 nautical miles from Barangaroo	• There are not currently any sites that have existing mooring facilities • Would require extensive clearing of mangroves to establish wharf • Not easily trafficable due to low bridges and draft restrictions
3. White Bay – Industrial wharfs	• Approximately 0.74 nautical miles from Barangaroo • Existing mooring facilities	• Limited available space because of other significant projects and industrial uses • Rail infrastructure previously utilised on the North Side Storage Project has been removed • No potential for spoil to be reused in close proximity to this barge receival site • Still requires the spoil to be trucked through surrounding suburban streets and areas • Suitable for receipt and direct transfer of barged TBM components to ships docked at the wharf
4. Clyde - Viva Energy Australia's Clyde Terminal	• Approximately 9.5 nautical miles from Barangaroo • Existing wharf and mooring facilities • Adjacent land uses are industrial	• Existing wharf facilities would require upgrading • Potential for impacts on adjacent fuel infrastructure need to be considered during detailed design

Option	Advantages	Disadvantages
	• Access to arterial road network avoids traffic on local streets • Viva Energy Australia is currently consolidating its operational footprint at Clyde. This activity will liberate a significant area as surplus to operational needs which has the potential to require reuse of spoil as part of any future development activity.	
5. Newcastle Port	• Existing mooring facilities	• Approximately 71 nautical miles from Barangaroo • Rough seas may restrict operations • No immediate redevelopment proposed • Suitable for receipt, storage and/or direct transfer of barged TBM components to ships docked at the wharf

3.4 Conclusions

Option 4, use of Viva Energy Australia's Clyde Terminal was identified as the preferred option for spoil receival as it would utilise an existing wharf facility, located in an industrial area with ready access to the arterial road network and site establishment works and operations are not expected to have significant environmental impacts.

Option 3, use of White Bay and/or Option 5, use of Newcastle Port could also be necessary to maximise barging of TBM components.

JHPCBG's preferred barging strategy is detailed in Section 4.0.

4.0 Preferred barging strategy

4.1 Overview

JHCPBG's preferred barging strategy entails:

- Blues Point:
    - Removal of spoil from the excavation of the Blues Point shaft
    - Removal of the entire slurry TBM from the first harbour tunnel drive from Barangaroo to Blues Point
    - Removal of the entire two hard rock TBMs driven from Chatswood to Blues Point (not just cutter heads and shields)
    - Removal of the entire slurry TBM from the second harbour tunnel drive from Barangaroo to Blues Point.
- Barangaroo:
    - Removal of the spoil from the station box, cross over cavern and under harbour driven tunnels
    - Receival of slurry TBM
    - Removal of the entire two hard rock TBMs driven from Marrickville including gantries and support infrastructure from Barangaroo
    - Receival of the slurry TBM from first harbour tunnel drive.
- Clyde:
    - Receival of spoil barged from Blues Point and Barangaroo
    - Receival of TBM components for temporary storage
    - Removal of TBM components for transfer overseas via the existing White Bay port facilities.
- White Bay/Newcastle Port:
    - Receival of slurry TBM from overseas for direct transfer from moored ship to barge for transport to Barangaroo
    - Receival of TBM components via barge from Clyde for direct transfer from barges to moored ships for transportation oversea.

TBMs will be delivered to Barangaroo via barge in place of road transport. Once the TBMs have completed tunnelling operations, each TBM will be removed from its site (Blues Point or Barangaroo) by barge as set out above. The TBMs will then be returned to the manufacturer for reconditioning and reuse on other projects. The final initial TBM receival facilities from overseas and the TBM barging destination for overseas transfer have yet to be determined and could entail one or a combination of the following options:

1. TBM components could be barged to the Clyde barging facility and then transported via road to a storage location or directly to Newcastle Port.

2. TBM components could be barged directly to the Newcastle Port for temporary storage and/or direct transfer to moored ships for transportation to manufacturers overseas.
3. Given the limited space available at White Bay, TBM components could be temporarily stored at the Clyde barging facility and then barged back to White Bay for direct transfer from barges to moored ships for transportation to manufacturers overseas.

Barges of up to 55 metres in length would be utilised. Required barge movements would depend on the size and load capacity of the barges and an indicative summary is provided in Table 3. These barge weights and numbers have been determined to take into consideration detailed survey of the Parramatta River bed near the Clyde barging facility.

Table 3: Barge sizes and indicative numbers

Barge size	Maximum Cargo Weight	Average Cargo Weight Transported (Tide)
55 metres long and 18 metres wide	2000 tonnes	1450 Tonnes

Barge operations would be dependent on tides and therefore need to be undertaken 24 hours per day. Total barge numbers and potential reductions in truck volumes in the CBD and North Sydney are as follows:

- Total barge arrivals Blues Point – 55 (approximately 35 for spoil and between 15 and 20 for TBM components). This would remove approximately 1,150 single trucks arrivals for spoil haulage and approximately 100 oversize loads which would otherwise have used Blues Point Road.
- Total barge arrivals Barangaroo – 460 (approximately 440 for spoil and 20 for TBM components). This would remove approximately 21,000 truck and trailer arrivals for spoil haulage and approximately 100 oversize loads using Blues Point Road.
- Total barge arrivals Clyde – 535 (approximately 475 for spoil and up to 60 for TBMs and other plant and equipment (including the 20 being transferred back to White Bay/ Newcastle Port).
- Total barge arrivals White Bay/Newcastle Port – up to 30 for TBM Components. No truck access to White Bay would be required but depending on the selected TBM overseas receival and transfer back arrangements adopted, some road transport of TBMs from Clyde to the Newcastle Port could be required.

These indicative barge numbers are summarised in Table 4. These numbers are approximate and may change.

Table 4: Indicative barge numbers per site

Worksite	Spoil barge arrivals	TBM barge arrivals	Total barge arrivals	Maximum daily barge arrivals
Blues Point	35	20	55	1
Barangaroo	440	20	460	2
Clyde	Approximately 475	Approximately 60	Approximately 535	3
White Bay/ Port of Newcastle*	N/A	Up to 30	Up to 40	6

*Note final initial TBM receival facilities from overseas and the TBM barging destination for overseas transfer have yet to be determined.

Note also that there are no planning implications for the potential use of either White Bay or Newcastle Port which is a component of the preferred barging strategy. These existing facilities can be used without the need for any upgrade works and have the relevant planning and environmental approvals in place to receive the TBMs.

The following subsections provide an overview of site establishment requirements and operations at each of the barging sites to be utilised for the TSE Works.

4.2 Barangaroo

Barging operations from Barangaroo would utilise existing wharf facilities and no construction work would be required to the existing wharf. Due to site establishment and traffic management constraints some Virgin Excavated Natural Material (VENM) from the station box and northern shaft will need to be trucked from Barangaroo until safe access from the shaft area and the station box to the wharf area is established. As noted in Sections 2.2 and 2.3, a spoil conveyor would be used to load the barges and a haul road would be established adjacent to the conveyor to allow transfer of spoil to barges and transportation of material for deliveries. An indicative layout of the wharf and conveyor arrangement is provided in Figure 12.

Figure 12 – Indicative Barangaroo wharf

Contaminated spoil will not be barged as there is no way to segregate material on the conveyor system or barges. Attempting to transport this material by barge lead to mixing of different waste streams, meaning that the VENM component could not be beneficially reused as engineering fill in approved residential and industrial projects. Up to 275,321 m^3 of spoil could be barged from Barangaroo including:

- VENM from the Barangaroo station box and cross over cavern
- Material generated from the slurry TBM slurry treatment plant. This would be VENM with very small volumes of additives such as bentonite. JHCPBG would seek a resource recovery exemption from the NSW Environment Protection Authority (EPA) Waste Branch to maximise beneficial reuse. If the EPA does not issue this exemption this material would not be barged.

Barging of spoil from Barangaroo was addressed in the EIS, SPIR and consistency assessments referenced in Sections 2.0. Barging of the TBM components from Barangaroo work to reduce the extent of oversize road haulage from Barangaroo and no additional environmental assessment is required.

Impacts of barging at Barangaroo will be addressed in site specific documentation including:

- Site Environmental Plan
- Construction Noise and Vibration Impact Statement
- Erosion and Sedimentation Control Plan.

These documents will be finalised in consultation with expert consultants and endorsed by the Environmental Representative and, where relevant, the Acoustic Advisor prior to implementation.

4.3 Blues Point

As noted in Section 2.2, the SPIR assessed only the removal of TBM cutter heads and shield from the temporary Blues Point access shaft and assumed that existing wharf at the end of Blues Point Road could be utilised for barging and therefore included very limited environmental assessment of this proposal. While the SPIR contemplated use of the existing wharf, JHCPBG has completed a detailed survey of this structure and confirmed that it would not be suitable for use in its current state. It would need extensive works to increase both width and strength to enable the roll on roll off TBM transfer operations. Barge mooring to the existing wharf would also be difficult and require installation of facilities outside of the worksite boundaries such as bollards. Due to tides, dredging would also be required to use this facility.

A consistency assessment has therefore been prepared and will shortly be submitted to TfNSW addressing the following changes required to facilitate barging:

- That the location of the temporary wharf be moved to directly adjacent to the worksite. This scope of work consists of:
    - A ramp (approximately 6 m wide and 38 m long, plain steel), supported by six piles set in the seafloor, allowing access to the barge and safe docking;
    - Approximately two mooring piles set in the seafloor securing the barge during loading activities; and

- The existing boat mooring points to the north of the relocated wharf will also need to be removed to allow space for the barge to manoeuvre for the duration of the temporary barging operation and this work would be undertaken by Roads and Maritime Services in accordance with their standard management protocols.

- Removal of clean spoil via barge instead of trucks. This spoil would be barged to the Clyde barging facility. This would require approximately 35 additional barge arrivals.
- Barging operations would be 24 hours per day, 7 days per week with most likely one barge movement per day. Barges will be docked at Blues Point for up to 2 days at a time and approximately 55 barge arrivals would be required to transport spoil and Tunnel Boring Machine components (compared to the 4 barge movements assessed in the SPIR).

An indicative layout of the relocated wharf arrangement is provided in Figure 13

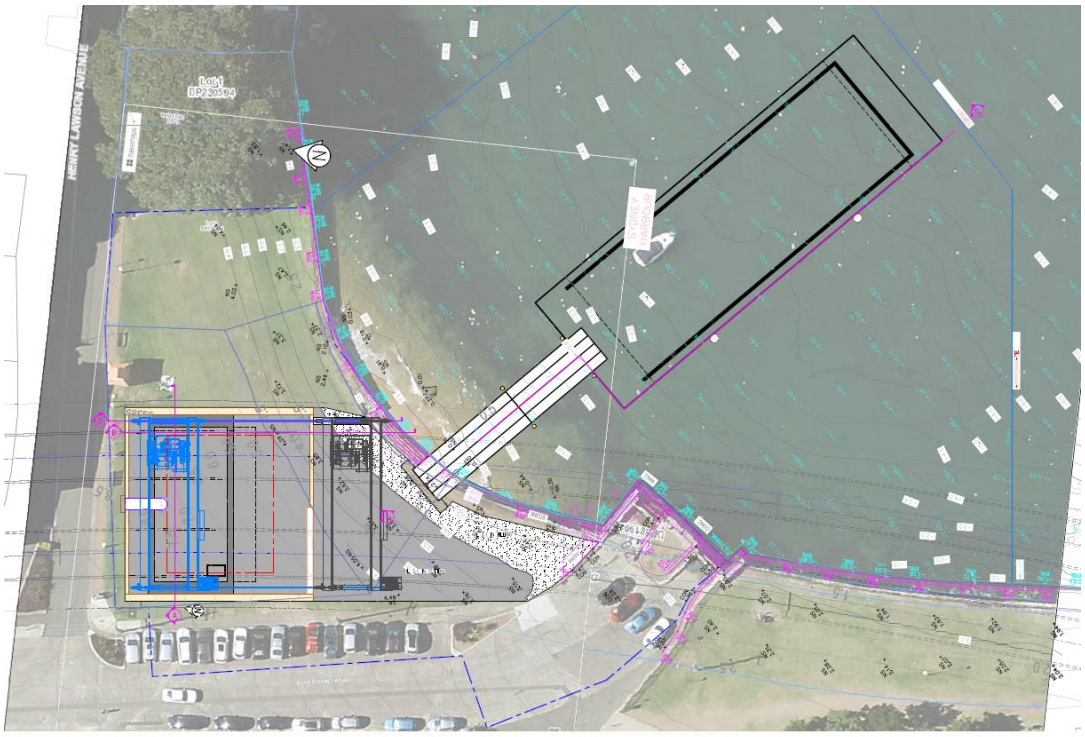

Figure 13 – Indicative Blues Point wharf

The consistency assessment identifies the following key potential environmental impacts associated with these changes:

- Flora and fauna – there is a seagrass bed composed principally of Zostera capricorni and Halophila sp. in the survey area, including under the footprint of the proposed wharf. No threatened seagrass Posidonia australis has previously been mapped in the survey area and none was observed during the marine survey. One individual Pipefish (Syngnathiformes) was found in the survey area. Subject to additional specific mitigation measures, construction and installation of the ramp and barge

facilities is considered to have a minor short-term impact on marine assemblages including seagrasses, macroalgae, fish and benthic invertebrates, which should all recover once the project is completed.

- Water and soils - there is the potential for water pollution as a result of materials handling, spills and leaks. Water pollution may also occur during transportation of materials to and from the wharf during construction. Increased water turbidity may occur during construction due to the removal and installation of piles and the operation of construction vessels, especially in shallow waters. The impact on water quality would be minimised through the implementation of the approved TSE Works Construction Soil Water and Groundwater Management Plan (SMCSWTSE-JCG-TPW-EM-PLN-002014) and associated Environmental Procedures.
- Noise and vibration - while wharf construction would occur during standard daytime hours, the proposed TBM retrieval operations would require approximately 3 months of evening and night works to be scheduled in accordance with TBM arrivals at Blues Point. This represents an intensification of the impact of hour of hours works assessed in the EIS and SPIR, which was limited to TBM cutter head and shield retrieval only. The indicative noise mitigation included in Appendix C of the TSE Works Construction Noise and Vibration Management Plan (SMCSWTSE-JCG-TPW-EM-PLN-002012-06) approved by the Department of Environment and Planning on 22 December 2017 shows an acoustic shed over the temporary shaft (see Appendix C of this Report) which would minimise noise impacts. The construction of a temporary acoustic shed is currently the subject of a Modification to the Project Planning Approval as detailed below.
- Historic heritage - A detailed heritage assessment prepared by Casey and Lowe concludes that impacts of the proposal would be mitigated by:
    - The preparation of a specific Archaeological Method Statement for Blues Point in accordance with the Project Planning Approval Condition E17
    - Protection of the seawall in consultation with and as approved by Casey and Lowe
    - Visual impacts on surrounding heritage items including the Sydney Opera House would be significant but temporary and the selection of an appropriate colour palette would assist in reducing this impact.
- Traffic management - Spoil barging from Blues Point would remove approximately 1,150 truck arrivals (singles) over a period of 3 months and would have significant amenity and safety benefits compared to road transport. While barging would remove the bulk of construction traffic, there would still be a need for some truck movements during site establishment and for deliveries, including materials and concrete. As the Clyde barging facility is only permitted to receive clean spoil, top soil and any contaminated spoil would need to be transported to appropriately licenced facilities in single bodied trucks. Similarly, as the barging facility at Blues Point is designed to remove spoil from the site onto barges it would not be possible for the backfill material to remediate the site to be barged to the site. As such approximately 1000 single bodied truck arrivals would be required to facilitate this operation. Where permits/licences are required, these would be obtained prior to commencement of works, in accordance with the TSE Works Construction Traffic Management Plan (SMCSWTSE-JCG-TPW-EM-PLN-002013).

- Visual impacts - The topography of the Blues Point Worksite slopes south from Henry Lawson Drive to the Sydney Harbour foreshore. The site layout, including the shaft collar and proposed acoustic shed, have been designed to minimise the height of the proposed shed and hence reduce the visual impact. The height of the proposed acoustic shed is approximately 19 metres (the concept design indicates 17m in height from Henry Lawson Avenue and 21m in height from the waterfront). This treatment would work to reduce the height of the proposed shed when viewed from residences and apartment buildings located to the north of the worksite. The temporary installation of an acoustic shed (subject to approval) over the access shaft is required to provide noise mitigation. This structure is proposed to be temporary and would be in place for less than 2 years. Its temporary visual impact would be significant, but the proposed shed would also work to shield gantries and crane infrastructure required for both shaft excavation and the TBM retrieval operations. Expert urban and landscape consultant KI Studio has been engaged to select a colour palette for the proposed acoustic shed to reduce its visual impact (subject to approval of the Modification as detailed below).

Subject to TfNSW's determination of the consistency assessment, the relocated wharf and additional barging operations will be managed in accordance with Project Planning Approval and the following site specific documentation including:

- Site Environmental Plan
- Construction Noise and Vibration Impact Statement
- Erosion and Sedimentation Control Plan.

These documents will be finalised in consultation with expert consultants and endorsed by the Environmental Representative and, where relevant, the Acoustic Advisor prior to implementation.

The following activities are currently subject to a proposed Modification to the Project Planning Approval that has been submitted by TfNSW to the Department in August 2018 (and has recently been on public exhibition 5 to 19 September 2018):

- Removal of the entire two hard ground TBMs driven from Chatswood and the slurry TBM driven twice from Barangaroo (not just cutter heads and shields) including gantries and support infrastructure from Blues Point for transportation by barge. This would necessitate approximately three months of out of hours work to be scheduled in accordance with TBM arrivals at Blues Point and approximately 15 to 20 barge arrivals.
- Installation and temporary use of an acoustic shed approximately 19 metres in height over the shaft to allow for essential out of hours works associated with TBM retrieval works (the design indicates 17m in height from Henry Lawson Avenue and 21m in height from the waterfront). The construction of the proposed shed is currently scheduled for January 2019 and will be decommissioned immediately following the completion of TBM retrieval works (a period of approximately 18 months).

4.4 Clyde barge receival site

The establishment and operation of the Clyde barge receival site was assessed in the Clyde Barging Facility Review of Environmental Factors (SMCSWTSE-JCG-TPW-EM-RPT-097239) (the REF) and Clyde Barging Facility Submissions Report (SMCSWTSE-JCG-TPW-EM-RPT-097256). This proposal was approved by TfNSW 14 April 2018.

The site is located on industrial land accessed off Grand Avenue and would comprise an area of approximately 8000 m2. The site is fenced and largely clear, with sparse vegetation. An indicative layout of the facility is provided in Figure 14.

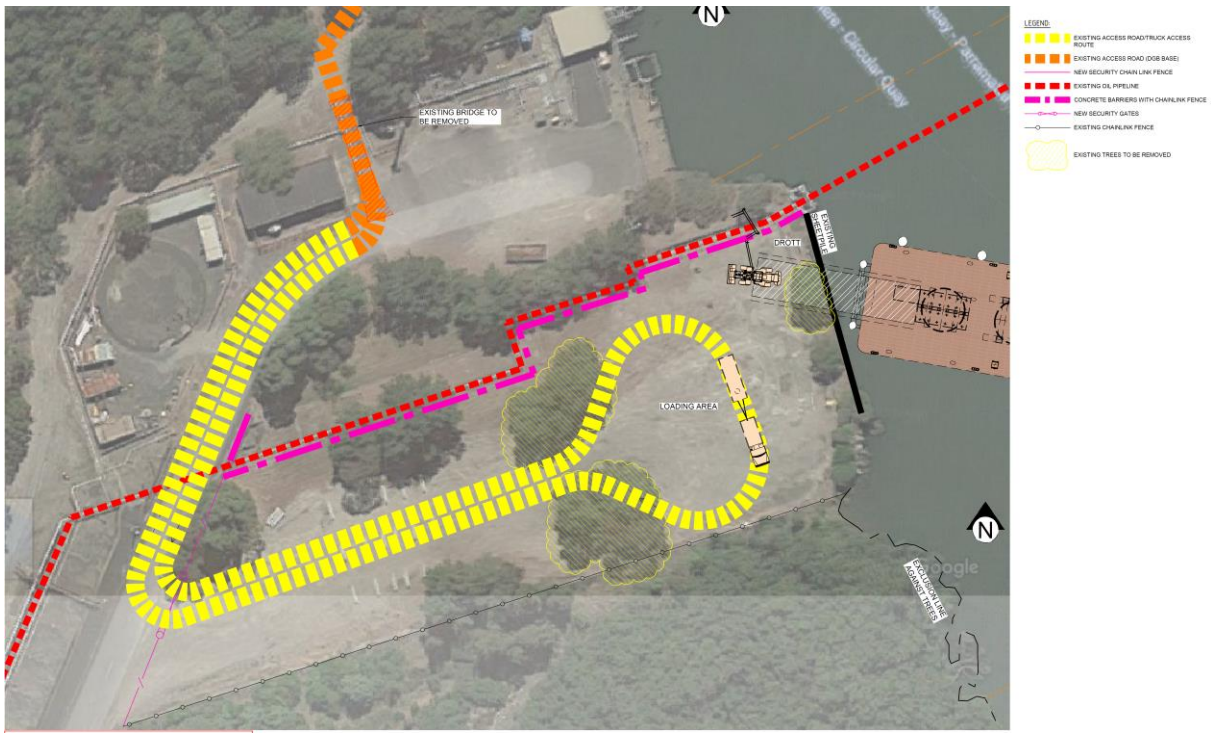

Figure 14 – Clyde Barging Facility indicative site layout

The existing access road between the wharf and Grand Avenue requires minor upgrading and extension to allow for heavy vehicle movements to connect directly to Grand Avenue. The exiting wharf would also require upgrading as follows:

- A ramp system will span from the shore to the Barge to allow unloading of the material via Front loaders.
- The upgrade of the wharf would involve piling. Additional piles would be installed within Parramatta River to provide additional protection for the existing pipeline and allow for the barges to be moored safely.

The REF and Submissions Report detailed the following key potential environmental impacts associated with the facility:

- Construction traffic and transport - Approximately 63 truck and trailers would be required per day on average to remove spoil off-site via Grand Avenue. During peak spoil generation periods there would be up to 161 truck and trailers per day:
    - During peak traffic periods five truck and trailers would depart the site per hour at peak traffic times between 6am and 10am and between 4pm and 7pm (a total of 35 truck and trailer departures)

- 15 truck and trailers would depart the site per hour between 10am to 4pm (a total of 90 truck and trailer departures)
- This would result in being able to move 125 trucks over the period between 6am to 7pm, however is dependent on traffic approvals
- Up to four truck and trailers departing the site per hour during the evening and night time between 7pm to 6am (a total of 36 truck and trailer departures). This may be required to reduce traffic congestion during peak traffic periods and would also be dependent on the availability of spoil receival sites.

Increased vehicle movements resulting from the temporary operation of the facility are not expected to impact on the safety and operation of the adjacent road network.

- Construction noise and vibration - The proposal is located in an industrial area and the nearest residential receiver is on the opposite side of the Parramatta River, approximately 350 metres from the wharf. Site establishment and operational noise is predicted to comply with construction noise criteria, except:
  - during piling which would occur intermittently over a two-month period.
  - At the nearest residential receivers in NCA_03, noise levels are predicted to be up to 4 dB(A) above the Noise Management Levels (NMLs) during the evening period and up to 9 dB(A) above the NMLs during the night time period. The above exceedances are predicted during periods when spoil from the barge is being loaded into trucks and removed off-site.
  - Noise levels are predicted to comply with the NMLs during periods when the barge is idling at the wharf.

  Where practicable, these activities would be undertaken during the day and evening time periods to minimise potential noise impacts at sensitive receivers. However, night time activities would be required due to tides, to coordinate with other vessel movements and to minimise impacts on the road network.
- Flora and Fauna – site establishment requires minor vegetation removal adjacent to a wetland known to contain Green and Golden Bell Frogs, a threatened species. Impacts on flora and fauna have been assessed in detail, and comprehensive mitigation and management measures set out in TfNSW's Determination Report. the REF and Submissions Report concluded that the establishment and temporary operation of the facility is not likely to have a significant impact on matters of national environmental significance or the environment of Commonwealth land within the meaning of the Environment Protection and Biodiversity Conservation Act (EPBC Act). A referral (EPBC Ref: 2018/8140) was submitted to the commonwealth Department of Environment and Energy (DEE) on 3 January 2018 to determine that it is not a controlled action. On 20 March 2018 DEE determined that the proposal was not a controlled action (EPBC Ref: 2018/8140).
- Soil and water - Site establishment would involve minor earthworks and the wharf upgrade works will need to be carefully planned and managed to reduce potential for disturbance of the river bed. During barge unloading operations, there is potential for spoil to be dropped into the Parramatta River. Suitable controls would be identified as part of detailed construction planning, and a site-specific Erosion and Sediment Control Plan would be prepared, implemented, and updated as construction progresses.

- Air quality - Site establishment, operations and decommissioning works all have the potential to generate dust and would generate vehicle emissions. A range of mitigation measures will be implemented to minimise air quality impacts.

The revised proposal would be managed in accordance with the conditions set out in TfNSW's Determination Report and under the systems and tools set out in Part B of the CEMP including:

- Leadership, accountability and culture
- Governance and planning
- Legal and other compliance monitoring
- Risk and opportunity management
- Change management
- Communication and consultation
- Training and competency
- Subcontractor management
- Incident management
- Emergency planning and response
- Document and record management
- Reporting, auditing, review and improvement

It is noted that Section 5.9 of the CEMP references the REF approval process and that updating the CEMP would not be required to implement the proposal.

The CEMP Sub Plans and Aspect specific management plans referenced in the CEMP would not apply to the proposal as the following site-specific documentation would be prepared to set out required environmental mitigation measures and controls:

- Site Environmental Plan
- Construction Noise and Vibration Impact Statement
- Erosion and Sediment Control Plan
- Construction Traffic Management Plan for road based transport
- Traffic Management Plan(s) and Communication Plan(s) for barging
- Construction Flora and Fauna Management Plan.

These documents will be finalised in consultation with expert consultants and endorsed by the Environmental Representative and, where relevant, the Acoustic Advisor prior to implementation.

5.0 Conclusion

Project Planning Approval Condition E84 requires that opportunities to maximise spoil removal be non-road transport be considered. TfNSW has already completed extensive investigation into barging from Barangaroo and Blues Point in the EIS and SPIR and a number of consistency assessments which identified the potential for both:

- Spoil barging from Barangaroo
- Barging of TBM cutter head and shields from Blues Point

JHCPBG has significant previous experience barging spoil and plant and equipment in Sydney Harbour. This Report documents JHCPBG's investigation of opportunities to use barges to transport construction materials and tunnel spoil for the TSE Works. JHCPBG confirms that there is potential for spoil barging and barging of TBM cutter heads and shields and spoil identified by TfNSW. In addition, JHCPBG has confirmed the potential for the following additional barging operations:

- Spoil barging from Blues Point
- Barging of entire TBMs from Barangaroo and Blues Point

The ability to barge spoil is governed by the confirmation of a suitable barge receival facility and JHCPBG has worked collaboratively with Viva Energy Australia (the owner of the majority of the Clyde site) and TfNSW to assess the impacts of establishing and operating a temporary facility at Clyde. This facility was approved under Part 5 of the Environmental Planning and Assessment Act by TfNSW in April 2018.

While barging arrangements from Barangaroo are as set in the EIS and SPIR and do not require any additional assessment, a resource recovery exemption is required from the EPA Waste Branch to allow spoil from the slurry TBM to be transported by barge and beneficially reused.

To facilitate barging from Blues Point, a temporary wharf needs to be constructed adjacent to the temporary worksite and an acoustic shed installed to minimise noise impacts from the required night time TBM retrieval works. JHCPBG has prepared a consistency assessment to address these changes to the wharf location and a Modification is being prepared for the acoustic shed installation. These documents will be submitted to TfNSW for relevant approval in the coming weeks.

Wharf construction at Clyde and Blues Point also requires land owner consent from the Roads and Maritime Services and need to address the requirements of Ports and Maritime Administration Act 1995, the Marine Safety Act 1998, and the Marine Pollution Act 2012. A marine works licence is currently being finalised between RMS and TfNSW to detail the requirements of the marine construction and operation of the facilities.

In accordance with Project Planning Approval Condition E84, this report will be submitted to the Secretary of the Department of Environment and Planning for Approval.

As such, the barging operations set out in this Report will be implemented, subject to the receipt of all necessary approvals. JHCPBG's barging strategy will remove in the order of 22,000 trucks from the congested CBD and North Sydney road network.

As noted in Section 1.2, TfNSW will prepare a separate report on the scheduling of final track laying as soon as practicable following completion of tunnelling with a view to transporting materials and equipment for station fit-out, systems and commissioning by rail prior to the commencement of rail fit out work.