ATTACHMENT B

ASHMORE PRECINCT FLOOD MITIGATION – TRUNK DRAINAGE OPTIONS REVIEW (REDACTED VERSION)

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Ashmore Precinct Flood Mitigation – Trunk Drainage Options Review

Final Report

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Executive Summary

Sydney Water and City of Sydney are seeking to initiate a collaborative project to reduce flood risk within the Munni Street sub-catchment of the Alexandra Canal. This work has been necessitated by the proposed residential development within the Ashmore Precinct in Erskineville and the existing flood risk context within this area.

The purpose of this report is to assist Sydney Water in reviewing trunk stormwater amplification options, costs and risks needed to arrive at a "most likely" project cost for an option, as well as holistic project risks going forward. The information derived from this report will be used to give confidence that the project can achieve the program benefits and outcomes within the program budget, as well as inform an initiation business case.

AAJV have reviewed the previous options considered by AECOM under the "Downstream Trunk Drainage Constructability Review, 2015" report in addition to those considered by City of Sydney under the "Ashmore Stormwater Drain Project Need and Rational" paper in 2016. Six Options including one sub option were developed for this study.

A full day workshop with AAJV, Sydney Water and City of Sydney was used to discuss and identify the merits and associated risks with each of the options considered. The workshop used a Multi Criteria Assessment (MCA) to identify the key selection criteria, associated percentage weighting and to ultimately identify the preferred option for further detailed analysis.

It was concluded that Option 1 (Maddox Street – Sheas Creek) may be desirable, however with the feasibility being reliant on the hydraulic performance of Sheas Creek open channel which has not been assessed in sufficient detail at this stage in the project it is not suitable for selection as the preferred option at this stage. The option is however retained within the assessment as the substantial cost benefits associated with it warrant further consideration of the hydraulic performance as part of future work.

It was agreed at the workshop that Option 6 (Mitchell Rd – Sydney Park Oval) would be taken forward as the preferred option and considered in a greater level of detail. Discussion of Option 6 at the workshop noted several benefits over options 2 to 5 including:

- The alignment through Sydney Park Oval allows flexibility for further development before settling on the final alignment.
- Widening the existing open channel allows minimum disturbance to the existing Ausgrid 132kV oil filled Transmission cables at the crossings of Euston Road and Burrows Road. Based on early discussions with Ausgrid and utility tracing works undertaken by City of Sydney, it is possible that only localised protection measures may be required where an interface between the proposed works and the 132kV cables occurs.
- Option 6 has the shortest length of micro-tunnelling. The risk for micro-tunnelling and unforeseen ground conditions consequentially becomes more manageable. Where clashes in Sydney Park Oval occur this would be directly accessible via open cut construction methods with minimum utility diversions, adjacent property disruption and significant traffic management and associated delay costs.
- It is likely that permanent land acquisition would not be required to facilitate the works. Widening of existing easements would however be required for the channel extension works between Euston Road and Burrows Road.
- Option 6 has minimum reliance on the programing of parallel construction projects such as Ashmore Precinct development and WestConnex.

The key risk item with both the feasibility and cost estimate developed for Option 6 is the scope of utility enabling/diversion works. In particular, existing sensitive 132kV Ausgrid feeders in Euston Road, Burrows Road and Mitchell Road represent a particular issue, with the proposed scope of work to interface with these assets based on limited discussions with Ausgrid and services tracing only at this stage. Further consultation and site investigations will be required to confirm the scope of work associated with these feeders and other services infrastructure impacted by the route.

The proposed works assume that the new drainage infrastructure can be micro tunnelled through the upper sections, in particular Mitchell Road & Sydney Park to minimise the services impacts, traffic management requirements and volume of spoil generated. The feasibility of this construction approach will require further geotechnical and technical assessment as part of future stages of work.

While one of the benefits of Option 6 is that it is generally located within existing public roads and/or parks, [redacted]

Based on the design developed for this study and the associated limitations discussed therein, a cost estimate of [redacted] has been estimated for the works including contingencies appropriate for this stage of project development.

The design proposals presented in this study will require substantial development through subsequent stages of work including additional site investigations and further detailed design assessment.

1 Introduction

1.1 Background

The Ashmore Precinct is situated within the Munni Street sub-catchment of the wider Alexandra Canal Catchment and is currently subject to significant flooding in storm events. There are substantial residential developments being constructed and planned for the 17 hectare Ashmore Precinct, with a forecast population of over 6,000 residents,

The existing flooding includes locations of deep ponding and high flood risk that will have an increased risk of property damage and injuries following the extensive residential development planned.

Drainage infrastructure within the Munni Street sub-catchment is owned and managed by both Sydney Water (trunk) and City of Sydney (local). Both parties are now seeking to initiate a collaborative project to reduce flood risk.

Mitigation options have previously been assessed as part of the Ashmore Precinct Public Infrastructure Concept design works undertaken by AECOM for the City of Sydney, in which four trunk drainage amplification options and associated costs were identified. Section 1.4.1 provides a summary of the previous report and its findings.

This study reviews previous investigations and considers potential trunk drainage augmentation options in more detail with an aim of informing an initiation business case and Council report.

1.2 Purpose

The purpose of this study is to assist Sydney Water in reviewing trunk stormwater amplification options for the Munni Street sub-catchment, including costs and risks needed to arrive at a "most likely" project cost for a preferred option, as well as risks going forward. The information derived from this work will be used to give confidence that the project can achieve the required program benefits and outcomes within the program budget, as well as inform an initiation business case and Council report.

In line with this purpose, this report includes the following:

- Summary of work previously undertaken;
- Outline context to inform option development;
- Identification of options for stormwater amplification;
- Summary of workshop held between Sydney Water, City of Sydney and AAJV on the 2nd of May 2016 and associated Multi Criteria Analysis;
- Development of the identified preferred solution and associated cost estimate; and
- Next steps.

1.3 Project Objectives

The overall project objectives, as outlined in the Ashmore Stormwater Drain Project Need and Rational paper (City of Sydney), are as follows:

- To augment existing infrastructure from the perimeter of the Ashmore Estate to the Alexandra Canal that will provide drainage capacity to:
    - Permit removal of high hazard flooding in the catchment.
    - Aim to provide up to a 5% Annual Exceedance Probability (AEP) event service capacity to customers.
- To ensure no adverse impacts to property by meeting the City's Interim Policy for Floodplain Management.

- To ensure high water quality by making any incoming side connections to new trunk drain infrastructure meet a suspended solids reduction target of 85% for a 3 month ARI (Average Recurrence Interval) .
- To ensure the continuance of base flows for stormwater harvesting in Sydney Park.
- To commence the works by mid-2019.
- To deliver the project for an agreed capital expenditure (excluding land access costs) and with whole of life costs minimised.
- To minimise community impacts during the works, particularly for property access, public safety, noise, vibration, night work, dust and traffic disruption.
- To ensure project environmental impacts are minimised, including sediment mobilisation to the Alexandra Canal and removal of trees.

1.4 Previous Studies

A number of previous investigations have considered the flooding and drainage context within the Munni Street sub-catchment and the Ashmore Precinct. These investigations are referenced throughout this paper, with recent studies specifically focussed on the amplification options available to mitigate flood risk within the Ashmore Precinct summarised below.

1.4.1 Downstream Trunk Drainage Constructability Review (AECOM, 2015)

This constructability review by AECOM identified 4 alignment options for the downstream trunk drain to relieve stormwater issues within the Ashmore Precinct. City of Sydney identified three alignment options to be investigated and through the investigation process AECOM identified a fourth option.

The constructability review focused on utilities interfaces, contamination, ground conditions, traffic management, land acquisition, construction methodology and cost estimate.

The study assumed an “open cut” technique would be adopted for the trunk drain construction methodology. As such, the risk analysis, cost estimates and constructability for each option were analysed in this context and did not consider methods such as micro-tunnelling or pipe jacking. Based on experience with the Green Square Trunk Drain project, these methods of construction may be a viable and potentially cost effective option.

The principal utilities risk identified in the constructability review was the Ausgrid 132kV cables that pass between the Alexandra Canal and the Ashmore Precinct. These run alongside or across elements of the proposed route for all options. These assets are critical to Sydney's power supply and should any modification to them be required as a result of the alignment, the associated costs are difficult to quantify but likely to be substantial. This is because each 132kV route contains many individual oil filled cables, and as these are disconnected to allow relocation, the associated load would have to be distributed to elsewhere on the network. This redistribution for each cable would require a design and potentially significant works.

The report recognised that a key element of investigating any option further would be to liaise with Ausgrid to determine feasibility of working around these cables rather than relocation. Indicative risk levels and cost estimates for each option were also provided but it was noted that the cost figures should be considered as conservative values until the full extent of Ausgrid relocation works is determined.

The review concluded that ‘Option 1’ (alignment running down Maddox Street then parallel to the existing Sydney Water channel) was the preferred option in terms of constructability and risk.

1.4.2 Ashmore Stormwater Drain: Project Need and Rationale (City of Sydney, 2016)

The Ashmore Stormwater Drain Project Need and Rationale report prepared by City of Sydney discusses the need for new trunk drainage infrastructure to alleviate flood risk in the Ashmore Precinct, as well as the rationale moving forward.

The report indicates that the average annual damage as a result of flooding in the Alexandra Canal catchment is [redacted]. It is also noted that this is a minimum cost figure as the cost of damages

2 Challenges and Constraints

2.1 Hydrologic and Hydraulic Context

2.1.1 Previous Investigations

A number of previous studies have investigated the hydrologic and hydraulic context of the study area including the following:

- Munni Street SWC 74 Capacity Assessment, Sydney Water 1998
- Alexandra Canal Flood Study, Cardno 2014
- Alexandra Canal Floodplain Risk management Study, Cardno 2014
- Downstream Trunk Drainage Constructability Review, AECOM 2015
- Ashmore Drainage Model, AECOM 2015
- Ashmore Stormwater Drain: Project Need and Rationale, City of Sydney 2016

2.1.2 Catchment and Flow Rates

The study area comprises the downstream section of the Munni Street sub-catchment which forms part of the broader Alexandra Canal Catchment. The Munni Street sub-catchment comprises an area of approximately 220 ha, extending from King Street, Newtown, in the north and west and Mitchell Road/McEvoy Street in the east. The catchment discharges to the top of the Alexandra Canal just south of Huntley Street.

The Munni Street sub- catchment is presented in Figure 1.

To facilitate assessment of the various trunk drainage augmentation options, contributing catchments and peak discharge has been assessed at a number of locations as follows:

- Within the existing trunk culverts north of Sydney Park Road;
- Within the open channel through Sydney Park; and
- Within the open channel downstream of Euston Road to the Alexandra Canal Outlet.

Catchment areas to the above key points within the study area have been taken from the Munni Street SWC 74 Capacity Assessment study. These have been compared with the catchment areas presented in the Alexandra Canal Flood Study which was issued subsequent to the Capacity Assessment study. The flood study estimates the size of the overall Munni Street sub-catchment at 213.6 ha, which aligns well with the 220 ha estimated in the Capacity Assessment study. The adopted sub-catchment areas are presented in Table 1.

Peak discharge from the Munni Street sub-catchment is assessed at a number of locations within the Sydney Water 1998 Capacity Assessment for the 5 year ARI storm event. These have been supplemented by desktop calculations using the rational method to estimate peak flow rates for the 20 year and 100 year ARI design storm events. The additional desktop rational method calculations have been calibrated to those presented in the Munni Street SWC 74 Capacity Assessment to ensure consistency. The peak flow rates calculated through this approach are presented in Table 1.

It is noted that the above approach will be conservative as it assumes all runoff from the catchment is contributing to the peak discharge and does not take account of the substantial informal storage within the upstream catchment (with much of the pipe drainage network having around a 5 year ARI capacity). However, the approach has been adopted here as it provides an indication of the peak discharge that would need to be accommodated if the drainage network within the upper catchment is improved to 20 year ARI standard.

To understand the level of conservatism, the discharges calculated using the above approach have been compared with the DRAINS modelling undertaken as part of the Ashmore Precinct design.

These values are the sum of the pipe and overland flow discharge within the DRAINS model, however does not account for other overland flow from higher up the catchment.

These comparison values are also presented in Table 1 and confirm that the flows derived using the rational method are conservative, being 70% to 100% higher than estimated by the DRAINS model. Reflecting the fact that discharge from the upper catchment is constrained by the limited pipe drainage capacity, the flow rates from the DRAINS model show limited increase in flow between the 20 year ARI and 100 year ARI storm events.

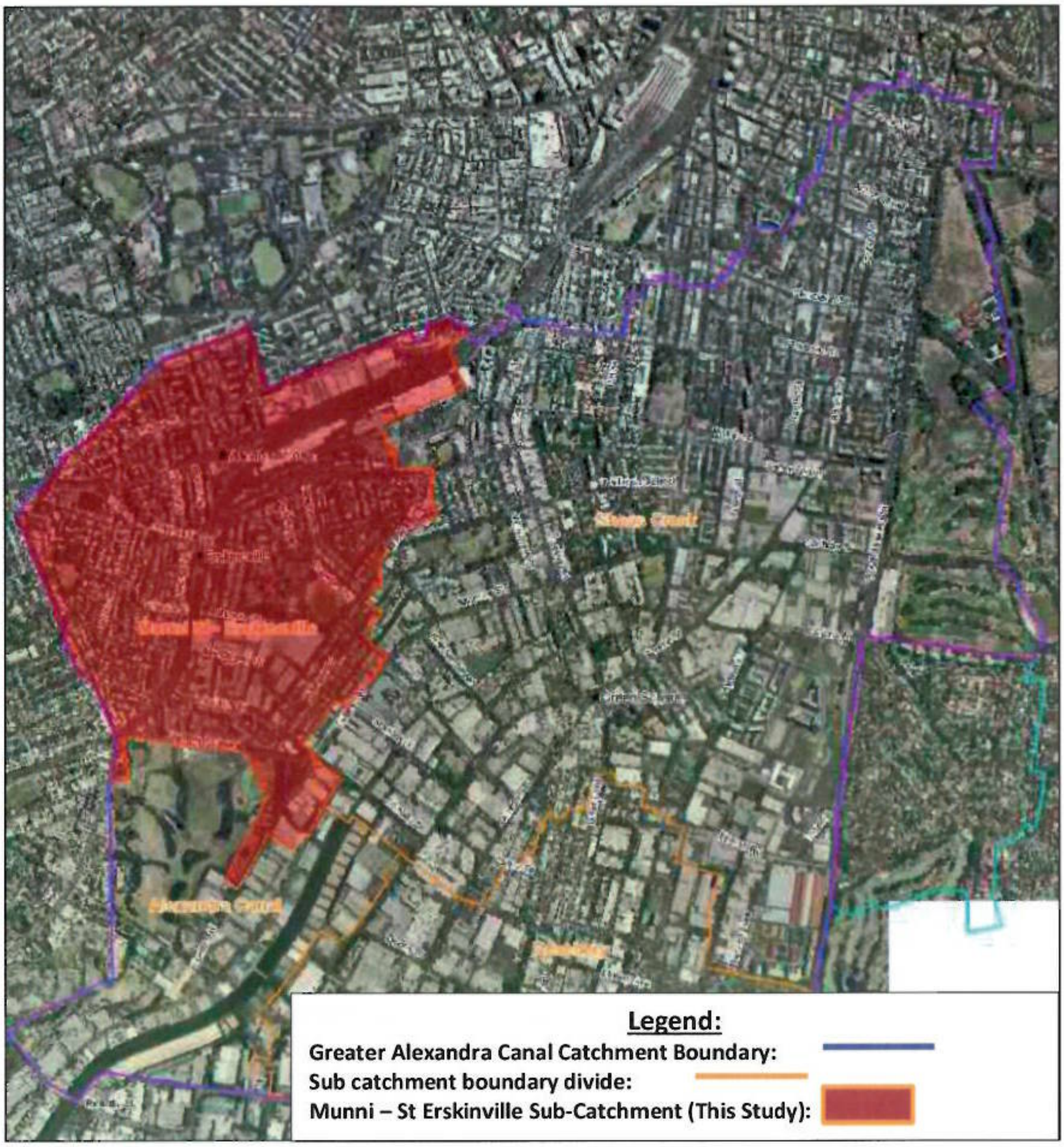


Figure 1 Munni Street Sub-Catchment Layout (source Alexandra Canal Flood Study)

Table 1 Peak discharge from the Munni Street Sub-Catchment

Location	Contributing Catchment (ha) [1]	5 year ARI (m^3/s) [1]	20 year ARI (m^3/s)	100 year ARI (m^3/s)	Notes
Outlet to Alexandra Canal	220	34.92	48.8	68.6	Rational Method and Capacity Assessment Reference A to B
		-	-	-	DRAINS
Open Channel downstream of Sydney Park Road	211	34.16	46.8	65.8	Rational Method and Capacity Assessment Reference E to D
		-	33.9	44.0	DRAINS [2]
Main Channel at Mitchell Road	88.7	14.11	19.7	27.6	Rational Method and Capacity Assessment Reference G to H
		-	-	-	DRAINS
Amplification Line at Mitchell Road	101.9	17.64	22.6	31.8	Rational Method and Capacity Assessment Reference E1 to E
		-	-	-	DRAINS

1. Contributing catchment and 5 year ARI discharge have been taken from the Munni Street SWC 74 Capacity Assessment, Sydney Water 1998
2. Combined upstream pipe and overland flow

2.1.3 Existing Munni Street Trunk Culverts and Open Channel

To understand the additional drainage infrastructure required to achieve a 20 year ARI capacity in the trunk drainage, the capacity of the existing critical infrastructure within the Munni Street sub-catchment has been assessed using desktop calculations. The drainage elements assessed are presented in Figure 2.

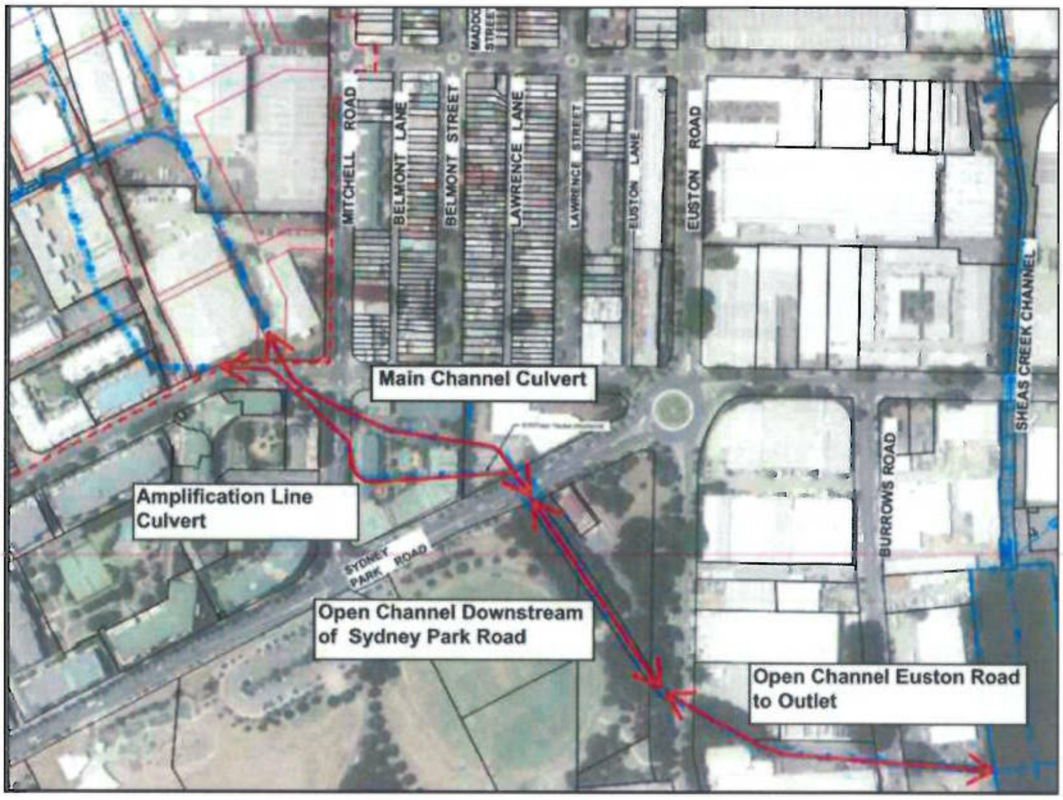


Figure 2 Key Existing Drainage Infrastructure within the Munni Street Sub-Catchment

The desktop hydraulic assessment has considered tailwater levels in the Alexandra Canal adopted from the Alexandra Canal Flood Study (Cardno, 2014) which are presented in Table 2.

Table 2 Alexandra Canal Tailwater Levels

Design Event	Tailwater Level (m AHD)
PMF	3.95
100 year ARI	2.50
20 year ARI	2.15
5 year ARI	2.00
1 year ARI	1.65

Review of previous studies indicates that the upper section of the Alexandra Canal near the study area is not impacted by tidal influence.

The existing trunk drainage immediately downstream of the Ashmore Precinct comprises two existing culverts, referred to as the Main Channel and Amplification Line in previous studies. The size and capacity of these existing culverts as calculated using high level desktop methods is presented in Table 3. The capacity is compared with the peak flow rates presented in Table 1 to understand the approximate drainage standard achieved by the existing infrastructure.

Table 3 Existing Munni Street Sub-Catchment Trunk Culverts

Section	Dimensions (mm)	Longitudinal Grade	Estimated Capacity (m^3/s) [1]	Estimated Capacity (m^3/s) [2]	Approximate ARI Storm Event Capacity
Main Channel	3,200 x 1,980	0.60%	19.3	13.7	~5 year ARI
Amplification Line	3,350 x 1,830	0.20%	16.8	13.6	<5 year ARI

1. From the Munni Street SWC 74 Capacity Assessment, Sydney Water 1998
2. From the Ashmore Drainage Model, AECOM 2015

Downstream of Sydney Park Road, the existing trunk culverts discharge to an open channel. As-built details of the open channels have been provided by Sydney Water and the adopted details of the open channels and approximate capacity are presented in Table 4.

Table 4 Existing Munni Street Catchment Open Channels

Section	Munni Street Report Reference	Dimensions (w x d) (mm)	Longitudinal Grade	Hydraulic Capacity (m^3/s)	Approximate ARI Storm Event Capacity
Sydney Park Road to Euston Road	D to E	4,570 x 2,895	0.33%	63.0	100 year ARI
Euston Road to Burrows Road	B to D	3,735 x 2,285	0.33%	36.0	5 year ARI
Burrows Road to Alexandra Canal	A to B	3,735 x 2,285	0.33%	30.0	5 year ARI

2.1.4 Existing Sheas Creek Open Channel

While the existing Munni Street Sub-Catchment trunk drainage discharges directly to the Alexandra Canal, augmentation options may include discharge to the existing open channel upstream of the canal. This open channel forms part of the Sheas Creek sub-catchment and drains an area of 775ha (from the Alexandra Canal Flood Study). The Sheas Creek catchment is presented in Figure 3.

An existing major trunk drainage upgrade project is underway within this catchment, involving construction of a new trunk drainage line from the Green Square section of the catchment through to the Alexandra Canal. The Green Square sub-catchment comprises approximately 265 ha as presented in Figure 4.

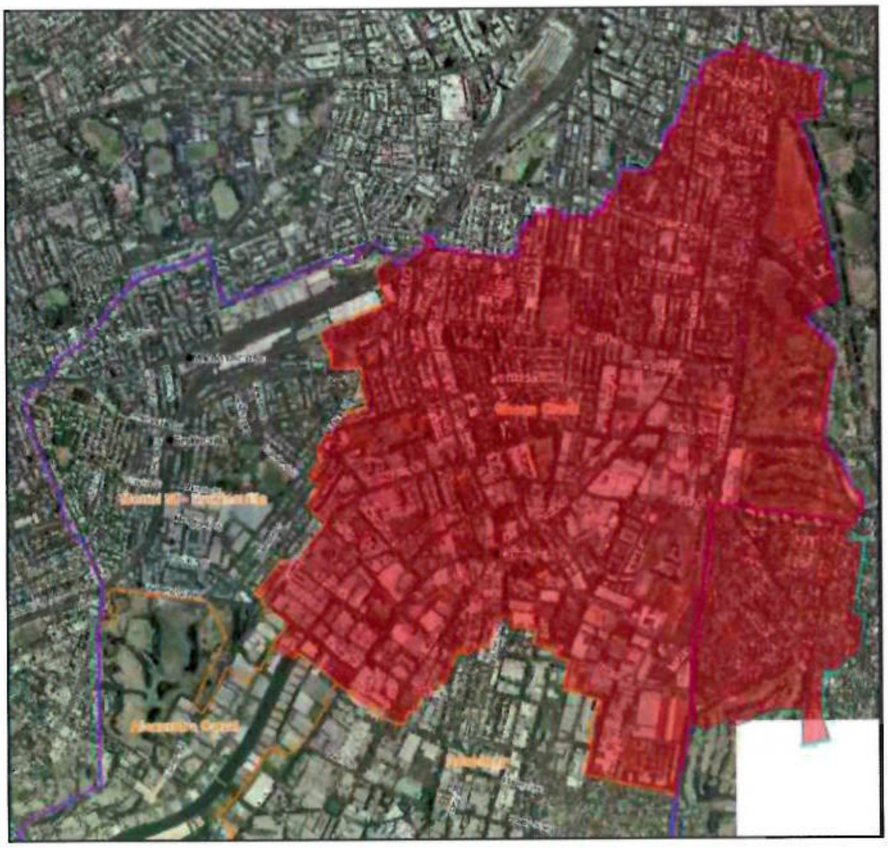


Figure 3 Sheas Creek Catchment (source Alexandra Canal Flood Study)

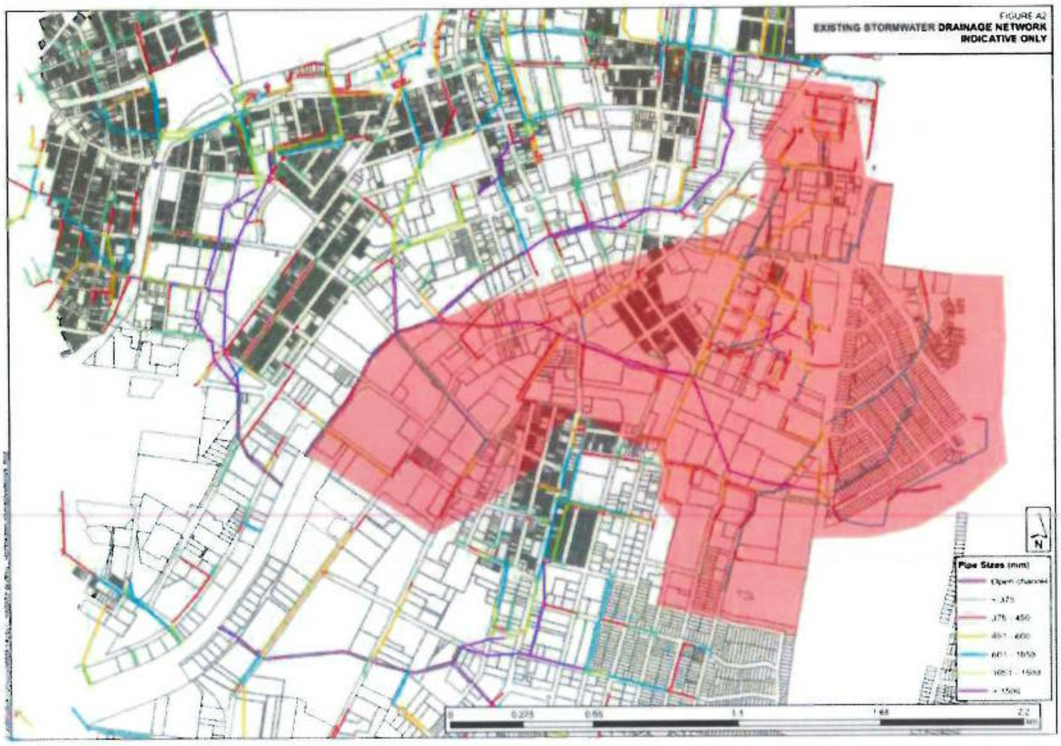


Figure 4 Green Square Trunk Drain Catchment (source Green Square Trunk drain – Hydraulic and Flood Modelling report)

Indicative runoff from these catchments has been calculated using the rational method. Similar to the assessment discussed in Section 2.1.2, this approach has been used for preliminary planning processes rather than outputs from the flood model to understand the magnitude of runoff from the catchment should the upstream drainage network be upgraded, noting that the existing catchment contains a number of trapped low points which will currently be mitigating the peak flow.

The estimated discharge from these catchments is presented in Table 5.

Table 5 Discharge from the Sheas Creek Catchment

Catchment	5 year ARI (m^3/s)	20 year ARI (m^3/s)	100 year ARI (m^3/s)
Overall Sheas Creek Catchment	76.2	112.1	157.3
Green Square branch Catchment	25.6	37.6	52.8

The flow conveyed by the new Green Square Trunk Drainage in the 100 year ARI design storm within the 3 x 1800mm diameter culverts immediately upstream of the open channel section is 27.47 m^3/s (taken from Sheas Creek Amplification Drawings SWC89AMP SP4, 90% detailed design drawings dated March 2016). This represents approximately 50% of the overall discharge from the sub-catchment.

The capacity of the open channel under existing conditions and following the widening to be undertaken as part of the Green Square trunk drainage project has been assessed using cross sections taken from the Sheas Creek Amplification Drawings (March 2016). The sections assessed are presented in Figure 5 and Figure 6, the red hatched area being the existing section (with minimum 0.5m freeboard, approximately 1.85m depth) and the blue hatched area being the additional area provided by the widening. The red line presents the capacity prior to spill into the adjacent properties (approximately 2.35m depth).

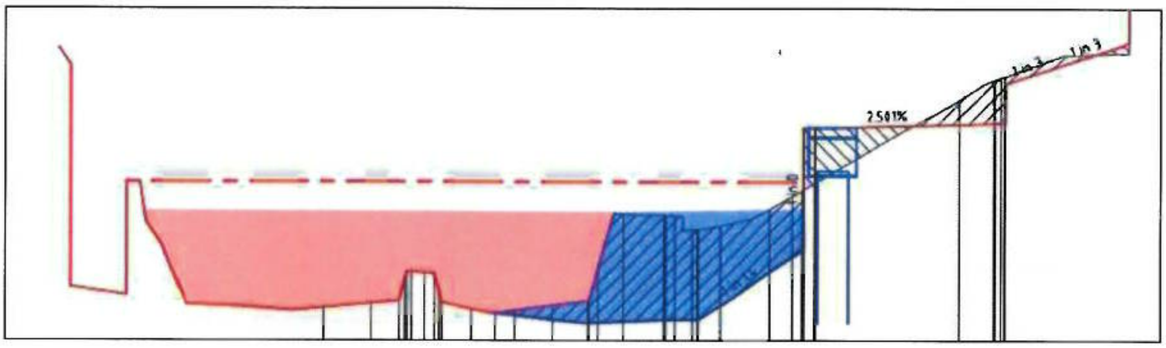


Figure 5 Sheas Creek Open Channel Cross Section Downstream of Huntley Street (taken at CH 60)

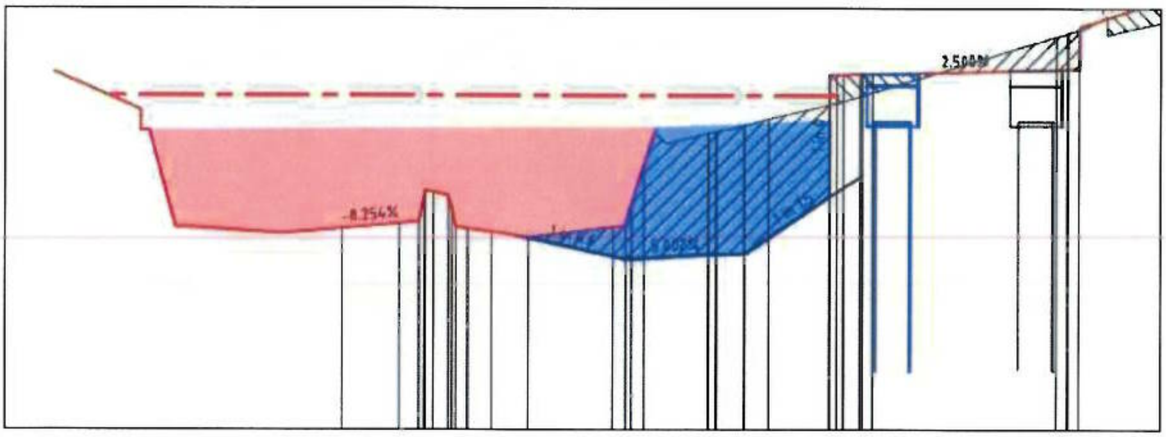


Figure 6 Sheas Creek Open Channel Cross Section Upstream of Huntley Street (taken at CH 220)

The channel areas and grades are presented in Table 6.

Table 6 Details of the Sheas Creek Open Channel upstream of the Alexandra Canal

Section	Cross Sectional Area pre GSTD (m^2)		Cross Sectional Area post GSTD (m^2)		Grade	Notes
	1.85m Depth	2.35m Depth	1.85m Depth	2.35m Depth		
Maddox Street to Huntley Street	13.85	19.0	21.05	27.7	0.51%	Gradient based on: RL 1.354 @ CH.150 RL2.224 @ CH.320
Huntley Street to Outlet	13.97	19.0	20.78	27.7	0.34%	Gradient based on: RL 0.802 @ CH.10 RL 1.176 @ CH 120

The capacity of the Sheas Creek open channel has been assessed using a simple HEC-RAS model (using the cross sections presented in Figure 5 and Figure 6 and the tailwater level presented in Table 2). The cross sections have been simplified to a rectangular cross section with the same waterway areas as those in Table 6.

The resultant capacities calculated are presented in Table 7.

Table 7 Indicative Capacity of the Sheas Creek Open Channel upstream of the Alexandra Canal

Section	Existing Capacity (m^3/s)		Approximate ARI Storm Event Capacity	Proposed Capacity (m^3/s)		Approximate ARI Storm Event Capacity (m^3/s)
	1.85m Depth	2.35m Depth		1.85m Depth	2.40m Depth	
Maddox Street to Huntley Street	70	105	5 to 20 year ARI	105	160	20 to 100 year ARI
Huntley Street to Outlet	70	105	5 to 20 year ARI	105	160	20 to 100 year ARI

Based on this simple assessment, the widening of the channel as part of the Green Square project appears to increase the capacity by between 35 m^3/s and 55 m^3/s depending on the depth of flow and freeboard adopted.

As noted above, the proposed Green Square trunk culverts will contribute 27.5 m^3/s in the 100 year ARI storm event. This will include a proportion of flow which was previously contributed by the existing GSTD culverts. Assuming that the 20 year ARI capacity is approximately the same as the 100 year ARI capacity with respect to pipe capacity and that the existing Green Square trunk drain discharge remains approximately as existing, this indicates that it may be possible to convey an additional 7.5 m^3/s (35 m^3/s – 27.5 m^3/s) within the Sheas Creek open channel without increasing flooding above existing. This is further supported by the fact that based on the overall flow from the Sheas Creek catchment, the open channel appears to have 20 year ARI capacity (with freeboard) and 100 year ARI capacity (without freeboard).

Note that this desktop assessment should be considered indicative only and that substantially more detailed assessment including flood modelling will be required before the feasibility of discharging part of the Munni Street catchment to the Sheas Creek open channel without further augmentation can be confirmed. Furthermore, Sydney Water has advised that the new Green Square Trunk drainage is very sensitive to tailwater levels in the

Alexandra Canal. As such, this initial desktop assessment should be considered as identifying an opportunity for further assessment only.

2.1.5 Indicative Infrastructure Requirement

As discussed in Section 2.1.2, the 20 year ARI discharge from the Munni Creek sub-catchment is estimated at approximately 48.8 m^3/s if the constraints in the upstream network are removed. The existing trunk culverts have a combined capacity of approximately 27.3 m^3/s, meaning that an additional capacity of 21.5 m^3/s is required.

This estimate aligns well with the 24 m^3/s advised as being required by City of Sydney as part of the Downstream Trunk Drainage Constructability Review (AECOM, 2015).

To achieve the 21.5 m^3/s required capacity, adopting a typical grade of 0.4%, this could be achieved through:

- A box culvert with dimensions 4.4 x 1.8m
- Triple pipe culverts at 1.8m diameter

It should be noted that the above figures are derived from a pro rata approach based on the existing capacities and cross-sectional areas of the existing Main Channel and Amplification Line. They should be considered as indicative at this stage for comparison purposes, the final sizing will require substantial additional detailed hydraulic analysis.

The downstream open channels currently have a capacity of around 30 m^3/s at the most downstream end (noting that the section through Sydney Park has substantially more capacity). This indicates that an additional 18.8m^3/s of capacity is required to achieve a 20 year ARI capacity.

Based on the existing channel grade and depth being maintained, this would require the channel to be widened by approximately 2.34m from Euston Road to the outfall at Alexandra Canal.

2.2 Traffic Context

2.2.1 Previous Investigations

A number of previous studies have investigated the traffic context of the study area including the following:

- Ashmore Precinct Traffic and Parking Assessment, AECOM 2013
- WestConnex New M5 Environmental Impact Statement – Technical Working Paper: Traffic and Transport, AECOM 2015

2.2.2 Traffic Volumes

A summary of the traffic volumes in the main streets within the study area for the AM and PM peaks are presented in Figure 7 and Figure 8 (these are taken from the background studies referenced in Section 2.2.1).

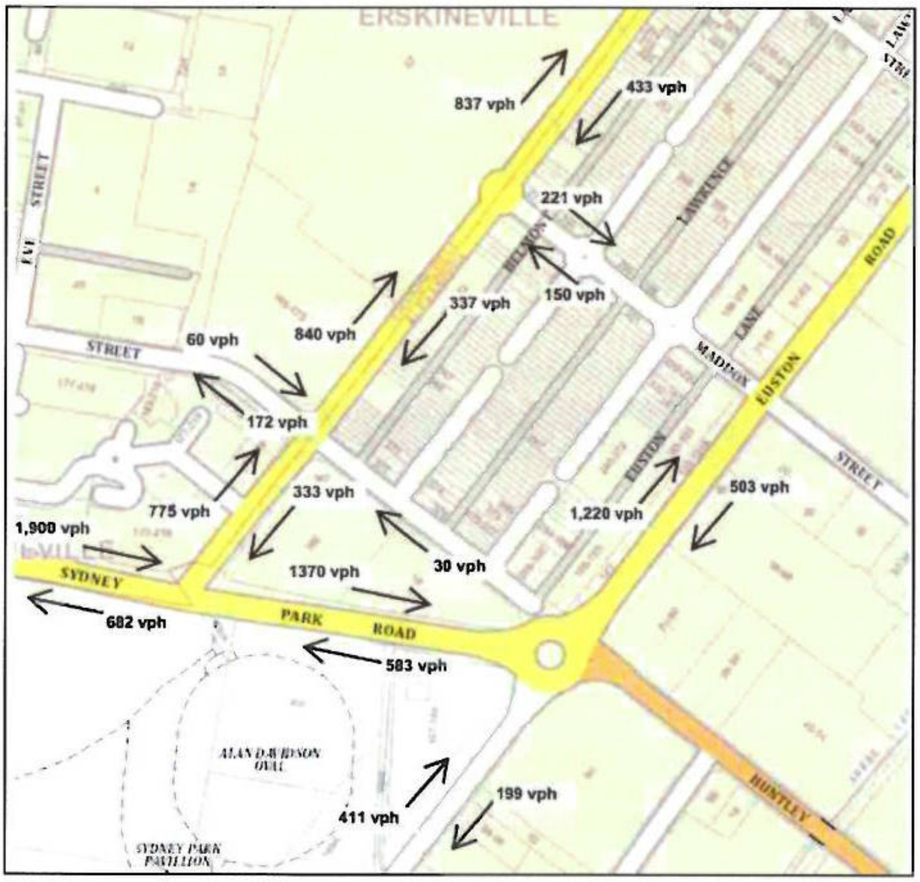


Figure 7 Existing AM Peak Hourly Traffic Volumes

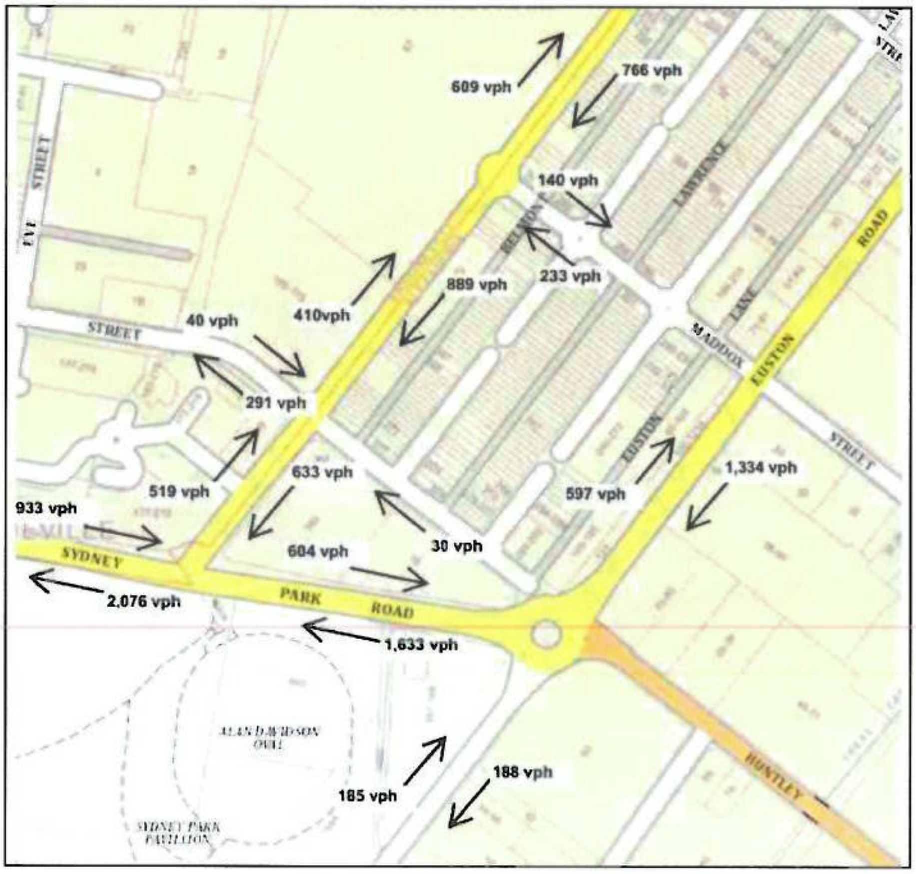


Figure 8 Existing PM Peak Hourly Traffic Volumes

The traffic context in the AM peak is characterised by a heavy movement along Sydney Park Road in an easterly direction and northerly movements along Euston Road and to a lesser extent Mitchell Road.

In the PM peak this movement is reversed with a heavy southbound traffic flow along Euston Road and Mitchell Road and a westerly movement along Sydney Park Road.

2.2.3 Key Intersections

Key intersections in the study area and their level of performance under existing conditions are as presented in Table 8.

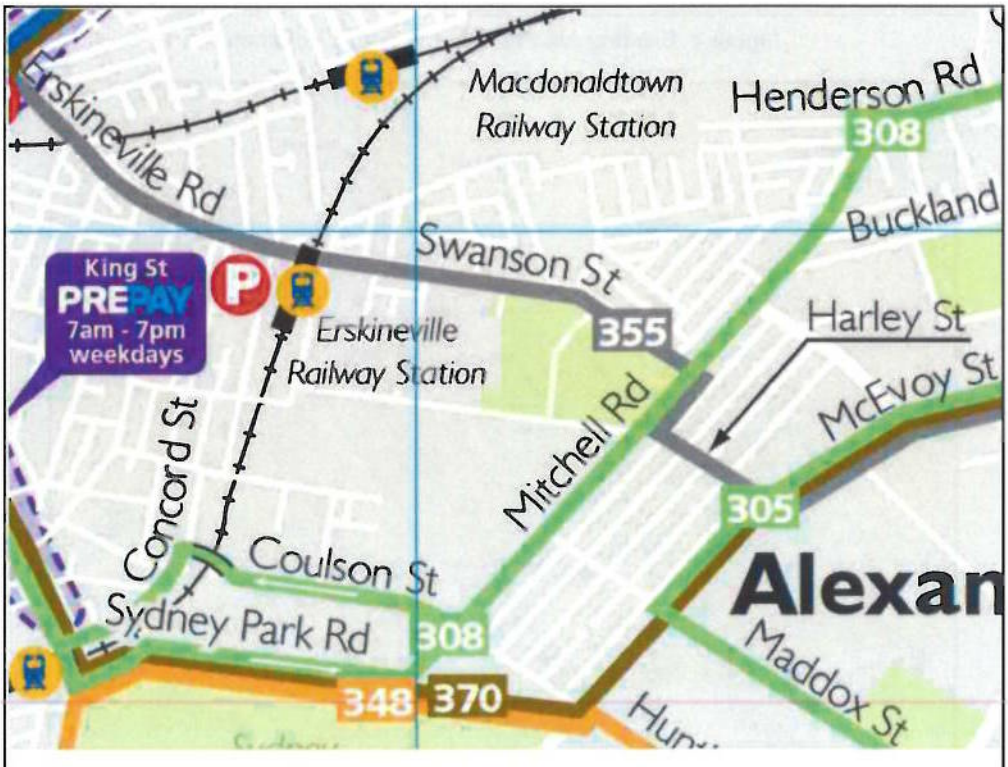
Table 8 Existing Level of Service for Key Intersections

Intersection	LOS (AM)	LOS (PM)
Sydney Park Road – Mitchell Street	B	B
Sydney Park Road – Euston Road	A to D[1]	A to D[1]
Mitchell Road – Coulson Street	C	A
Mitchell Road – Maddox Street	F	A

1. Westconnex Traffic and Transport Technical Working Paper only provides a range

2.2.4 Bus Routes

There are a number of existing bus routes that pass through the study area and may require temporary diversion depending on the alignment and construction methodology adopted (and associated traffic management requirements). This includes the 305, 308, 348 and 370, as presented in Figure 9.



Source: Sydney Buses, 2013

Figure 9 Existing Bus Routes within the Study Area

2.3 Major Services Infrastructure

The site is constrained by various existing utility assets which potentially require relocation or temporary protection works to facilitate the construction of the proposed drainage infrastructure. In particular there are several critical services assets within the study area which will require detailed investigation works to be undertaken to understand the interface with the proposed trunk drainage options.

The following presents a summary of the major utilities within the vicinity of the study area based on Dial-Before-You-Dig (DBYD) information and utilities modelling using 12D Model. Note that smaller type assets have not been reviewed as part of this study.

Further discussion of the critical assets interfacing with the preferred option based on more detailed site investigations and discussions with the relevant authorities is presented in Section 7.

2.3.1 Ausgrid Transmission Lines (132kV & 33kV)

Figure 10 below shows the approximate alignment of the transmission lines within the site area (orange alignments). The transmission lines are present on Huntley Street, Burrows Road, Euston Road and Sydney Park Road. The depth of the transmission lines varies throughout the site with typical depths in the region of 1.2m lowering to 3m in places along Huntley St.

The most critical of these assets are the 132kV feeders which comprise oil filled transmission cables and will be difficult to relocate and are sensitive to vibration during construction. Early discussions with Ausgrid have revealed that the minimum clearances required for this type of infrastructure are reviewed on a case by case scenario and require a more detailed review of the assets to understand the implications. It is noted that Ausgrid generally require very little or no disturbance of the backfill material around these feeders, and the joints in these cables are of particular importance. Any proposed construction methods would require zero settlement of their 132kV assets.

Previous experience has indicated that a minimum clearance of 0.5m is required for open cut construction and 1m for micro tunnelling. Note that this has not been confirmed with Ausgrid for this project and further consultation will be required to confirm the clearances required for this project. It is likely that concrete encasement and or localised ground stabilisation measures will be required in addition to inspection trial pits to identify the in-situ obvert level of the bored culvert either side of transverse utility crossings.

Relocation of these lines may be required for options considered in Huntley Street and for crossings at Burrows Road. Other alignments are generally deeper than the existing Ausgrid assets and may be constructible without impacting the existing feeders.

Details of further investigations and consultation with Ausgrid for specific locations within the study area are presented in Section 7.

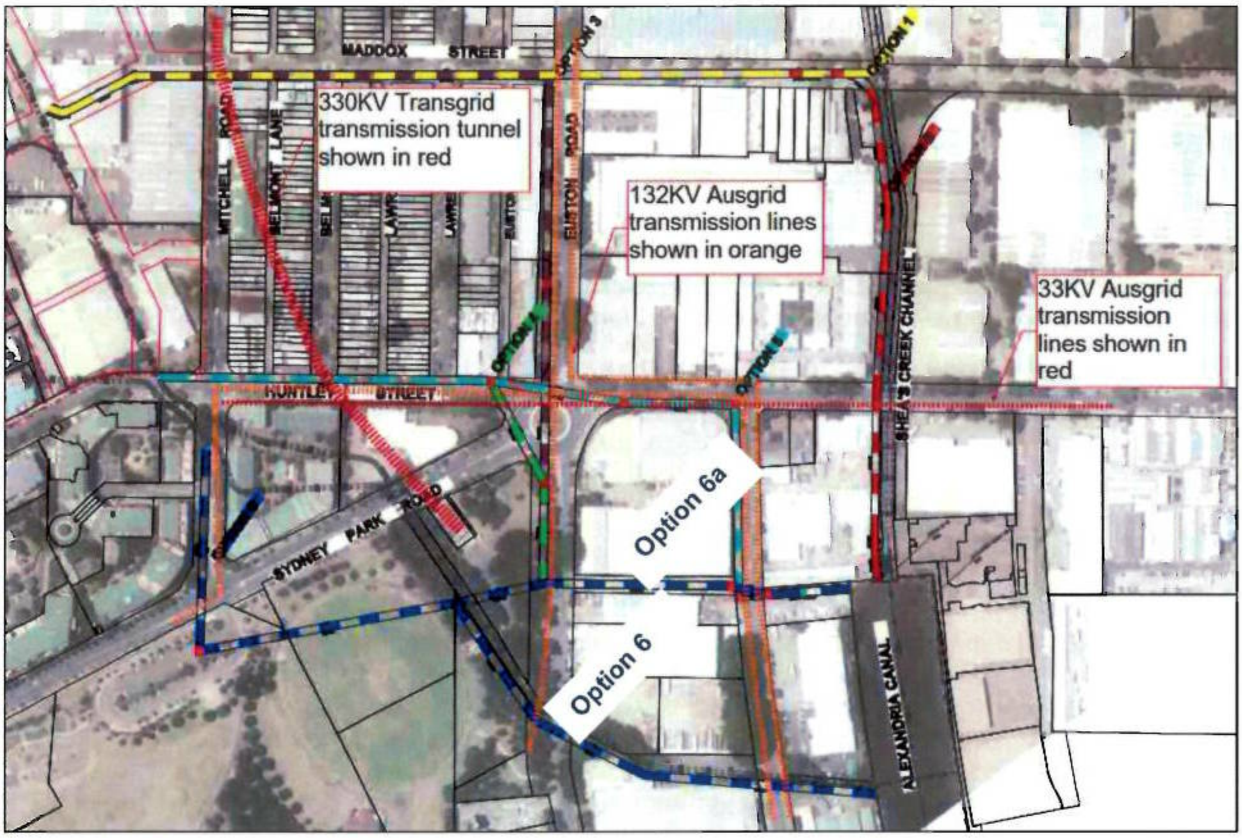


Figure 10 Ausgrid & Transgrid Transmission Lines

2.3.2 Transgrid Transmission Tunnel (330kV)

A TBM tunnel containing 330kV Transgrid transmission cables runs from the Transgrid building near the Sydney Park Road / Euston Road intersection towards Haymarket to the North. The tunnel alignment runs under Sydney Park Road and Huntley Street, under a residential area, and then continues parallel to Mitchell Road (see Figure 10, red line).

The asset is located approximately 10m below surface level (see Figure 11 below) based on archive drawings provided by Transgrid. Due to the depth of the service it is assumed that the proposed works will not directly interface with this service.

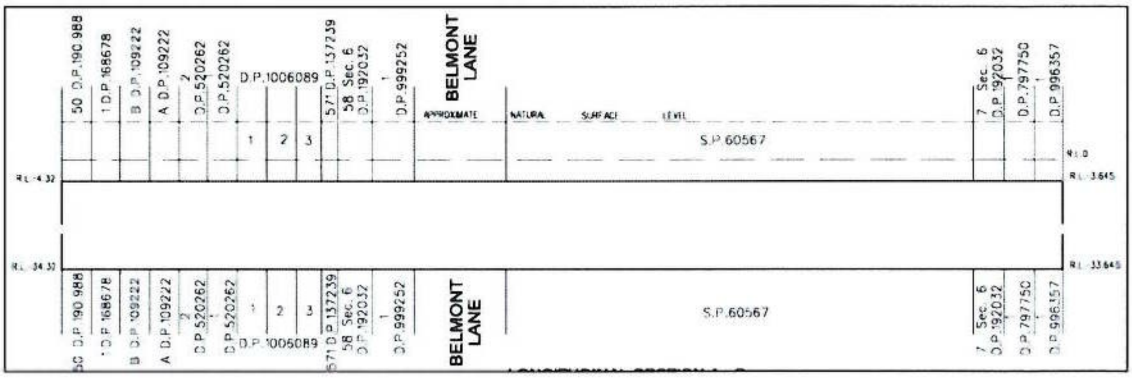


Figure 11 Extract from Transgrid 330KV Tunnel (section from Huntley Street to Mitchell Road)

2.3.3 Secondary Gas Mains (1050kPa)

Figure 12 below shows the approximate alignment of the 1050 kPa Secondary Gas Mains within the study area. The size of main varies from DN150 to DN250.

The Secondary Gas Mains are generally located to within 2m from the Boundary Line as indicated on the DBYD plans. The depth of cover to the gas mains is not shown on the plans and is assumed to be at depths less than 1.2m.

The Secondary Gas Mains are present on Euston Road, Huntley Street, Maddox Street and Burrows Road. Relocation of these lines is likely to be required for open cut solutions and for construction of launch/receptor pits where interfaces occur.

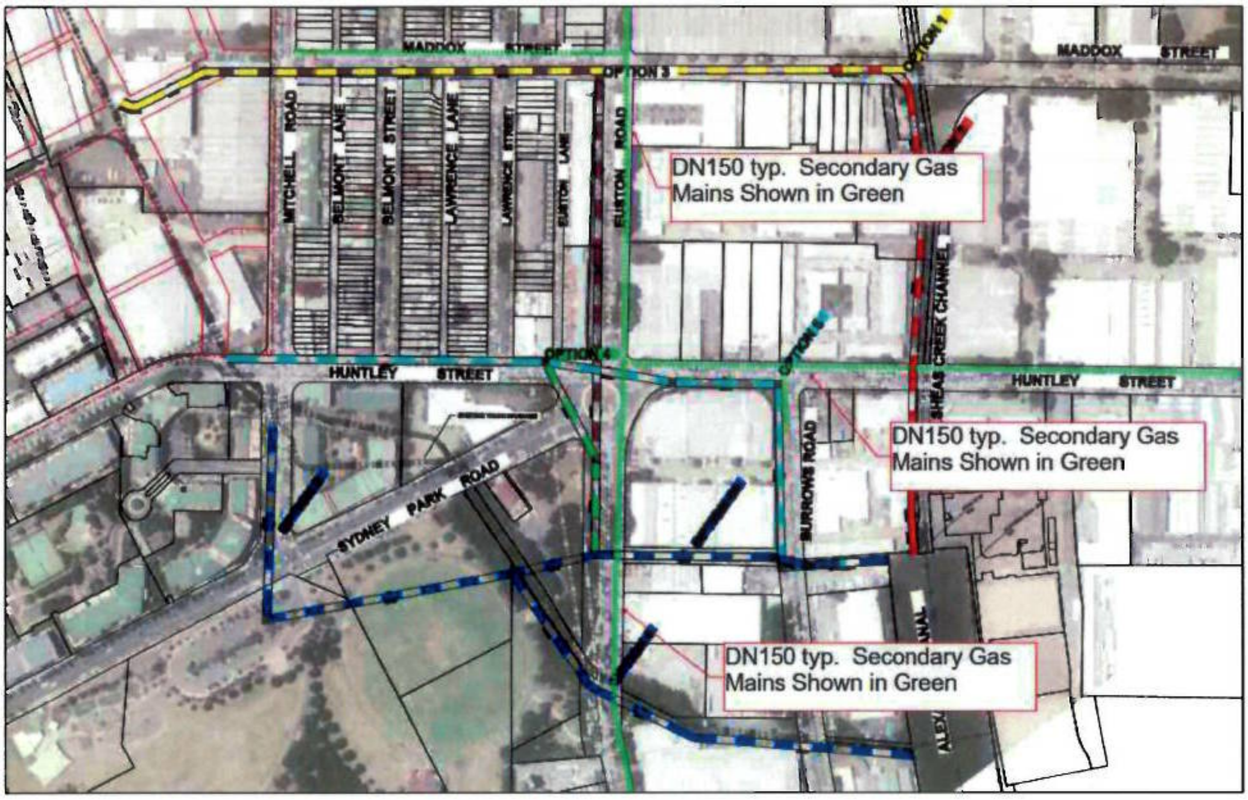


Figure 12 Jemena Secondary Gas Main Alignments

2.3.4 Fibre Optic Cables (including Southern Cross Cable)

Figure 13 below shows the approximate alignment and interpretation of the Fibre Optic Cable routes within the vicinity of the study area.

It is noted that a major fibre optic "Southern Cross" cable has been identified along Burrows Road and Huntley Street. Relocation of this cable is likely to be a significant task. It has been assumed that the cable is located at less than 1.2m from surface level.

Other fibre optic cables have been located in the vicinity of the site also as shown in Figure 13. Relocation of these lines is likely to be required for open cut solutions and for construction of launch/receptor pits where interfaces are likely to occur.

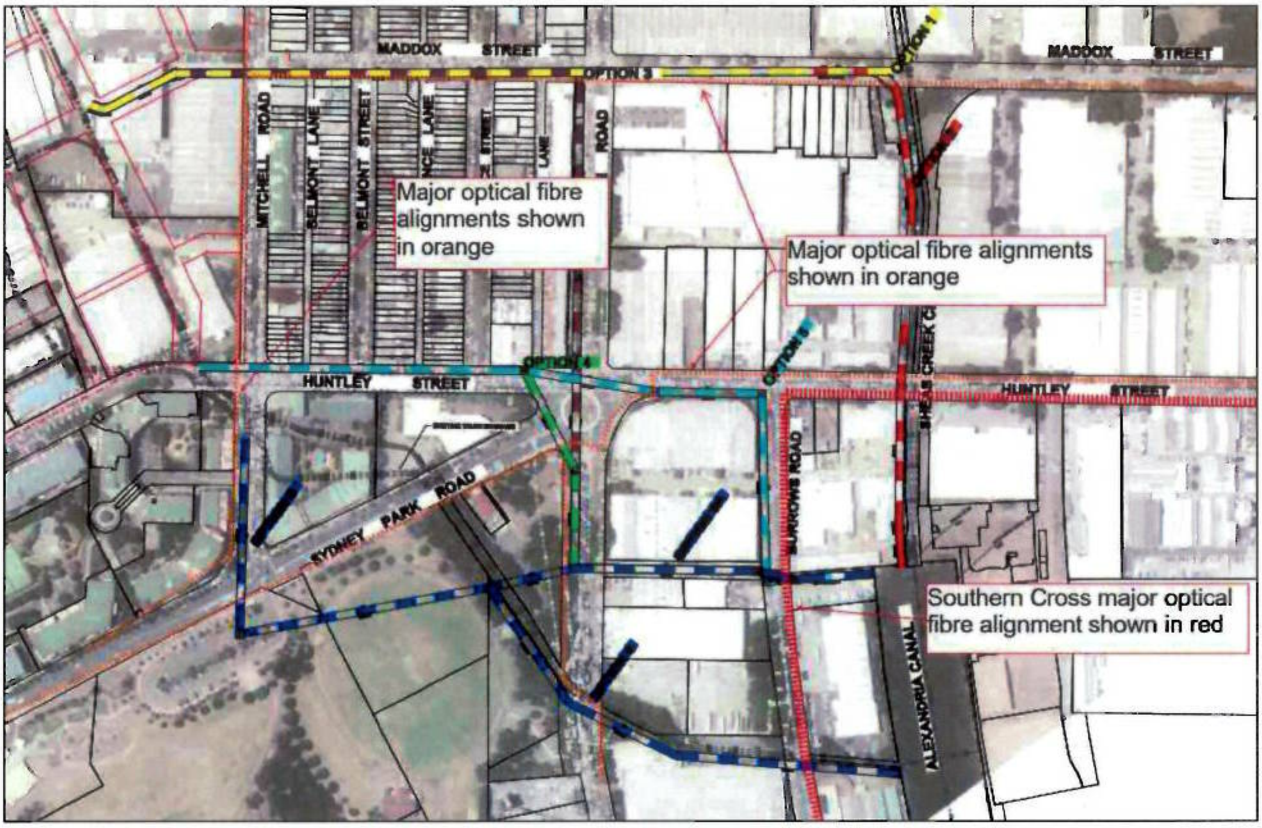


Figure 13 Typical DBYD Fibre Optical Alignments

2.3.5 Major Water Assets (Larger than DN500)

Figure 14 below shows the indicative alignment for the major water asset locations for the study area.

A major Sydney Water DN900 water main exists along Mitchell Road and Huntley Street. The DN900 transitions in size to a DN750 south of the intersection with Euston Road and Huntley Street. Temporary relocations to facilitate installation of culverts/launch pits are likely to be unfeasible due to the size of asset, where interfaces with the proposed trunk drainage occur, a permanent relocation upfront of the works would likely be required.

The depth of the asset is not known at this stage and further investigations are recommended to understand the potential interfaces. A major Sydney Water DN500 water main exists along Euston Road. The depth of this asset has been assumed to be less than 1.2m below ground level as part of this initial investigation.

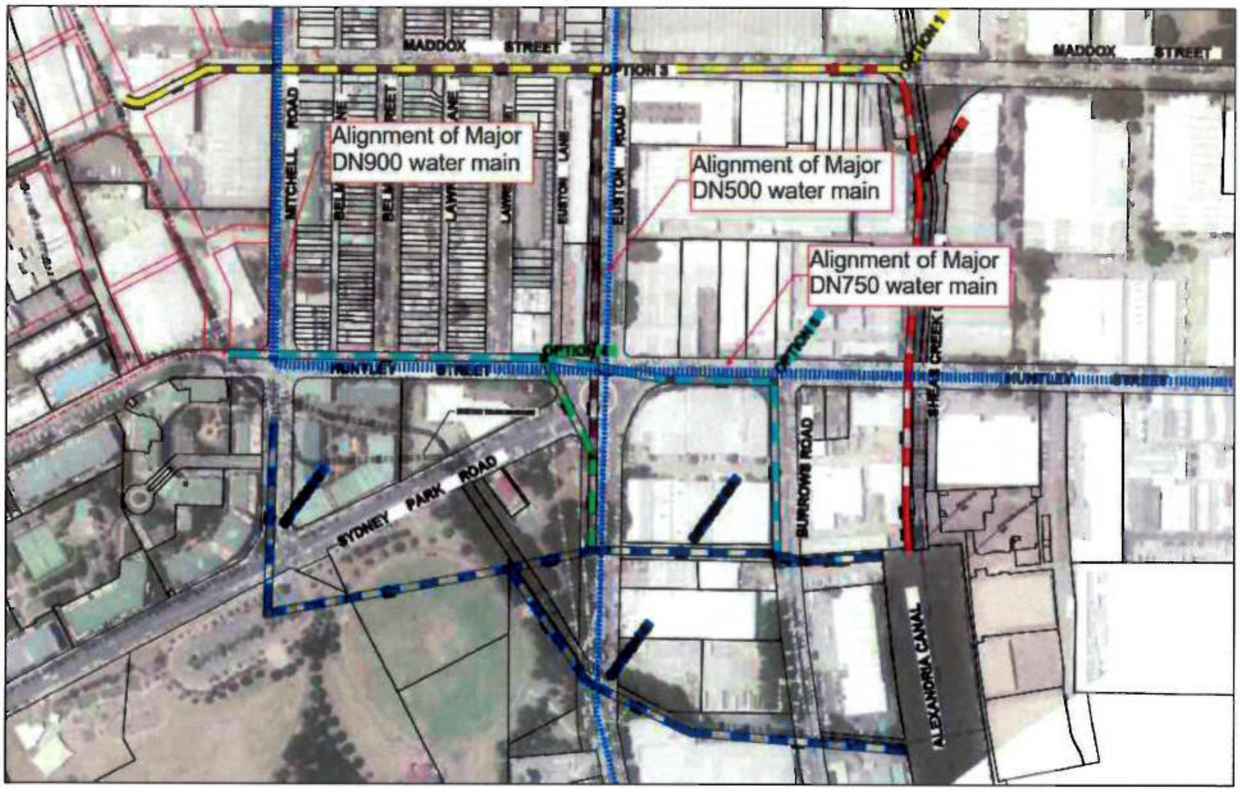


Figure 14 Typical DBYD Major Water (>DN500) Alignments

2.3.6 Sewer Mains

Figure 15 below shows the indicative alignment for the Sewer asset locations for the site.

A Sydney Water Sewer Pumping Station (SP0039) is located on the corner of Huntley Street and Burrows Road. A DN450 gravity main connects from Huntley Street. Two rising mains outlet from the SPS onto Huntley Street; DN450 and DN375. The DN450 main continues east along Huntley Street, crossing the existing Sydney Water Channel while the DN375 follows the alignment of the existing Sydney Water Channel on the western side.

Due to the size of these sewer mains, it is unlikely to be feasible to use temporary methods to redirect flows while undertaking relocation works. Any relocation will require the construction of a new main prior to redirection of flows.

A DN225 sewer main is located in Huntley Street between Euston Lane and Mitchell Road. This sewer and 3 number Manholes are likely to require relocation to facilitate the works.

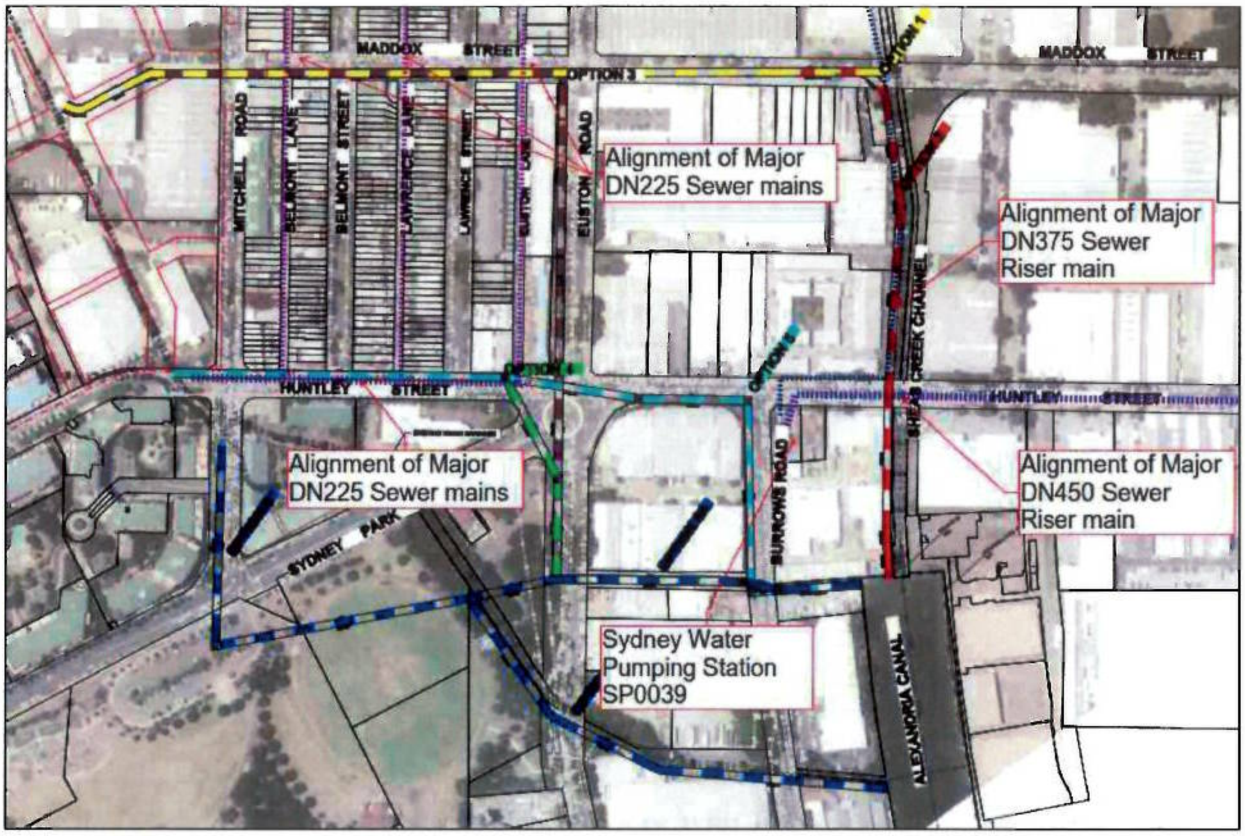


Figure 15 Typical DBYD Sydney Water Sewer alignments

2.4 Ground Conditions

2.4.1 Site Geological Profile

The typical geological conditions in this area are fill, Aeolian sands and alluvial material (including peats and clays). Rock level tends to vary significantly and is generally siltstone and shales (as shown in Figure 16).

Borehole logs taken from geotechnical investigation undertaken previously within the Ashmore Precinct show typically fill, varying density sands (Aeolian), firm to hard clays and generally weathered shale. Ground water table in this area appears to be around 2.8 to 3.2m depth from surface.

Borehole logs from the geotechnical investigation as part of the Green Square Trunk Drain (GSTD) east of the Shea's Creek channel indicated fill, sandy clay, peat and varying density clays (alluvial soils) were typically encountered. Bore-holes were generally terminated before any bedrock was encountered (greater than 10m depth). The ground water table in this area is approximately 2 to 2.4 m from surface level.

Ground conditions generally appear to be poor, and may limit the suitability of micro-tunnelling in many cases. A high water table will also pose problems to the construction methodology – especially in terms of groundwater infiltration into trenches and excavations.

Further detailed geotechnical investigations will be required as part of future stages of work to confirm ground conditions and the feasibility of different construction methods.

Figure 16 Extract from CoS geological GIS data

2.4.2 Contamination

Based on a review of current and historical land uses for the general area, contaminants of concern including asbestos, heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs) and Total Petroleum Hydrocarbons (TPHs) have been identified as potentially being present in fill materials.

Sydney Park is known to have operated as a quarry and later, as a landfill. An environmental site assessment for the park prepared by A. D. Envirotech Australia indicates that elevated concentrations of hydrocarbons such as Benzo(a)pyrene, as well as PAHs were detected in samples from within the park. It is also noted that sub-surface methane was detected at a concentration greater than 1.25% which may pose a significant risk to workers for alignments which pass through Sydney Park, which could be mitigated by Safe Work Method Statements (SWMS) as part of an Occupational Health and Safety (OH&S) Plan.

2.5 Land Ownership

Land ownership will potentially have a significant impact on the ability to construct additional drainage infrastructure outside existing road reserves. The following discusses opportunities and constraints for construction of alignments outside the existing road reserves.

Where land is not currently in public ownership, Sydney Water has advised that obtaining easements for additional infrastructure, rather than acquisition of land is preferred.

Road widening as part of the WestConnex project on the western side of Euston Street may allow additional space for culvert alignment. Refer to the area shaded orange in Figure 17 which indicates the location of the widening reservation (note the proposed road widening continues south down Euston Street – refer to section 2.7.2 for the extent of WestConnex work in this area). This road widening reserve is relatively unencumbered by existing services and would have substantially fewer traffic management requirements than many other locations.

[redacted]

Depending on the extent of any widening required to the Sheas Creek open channel, land acquisition or easements may be required along the west bank. There appears to be some scope to widen without extending into the adjacent properties, further investigations will therefore be required to confirm the extent of any property impacts. [redacted]

[redacted]

DELETED

Figure 17 General arrangement of potential alignments showing road widening, land acquisition, and easement opportunities

2.6 Construction Methodology

The method of construction for proposed trunk drain may involve micro-tunnelling/pipe-jacking, open cut, or a combination of both.

While potentially efficient, micro tunnelling or trenchless installation methods may only be considered where the ground conditions are suitable. These methods allow for the road or the majority of the road to remain open while the works are underway which is beneficial from a traffic and utilities diversion perspective.

This construction method has been adopted for the Green Square Trunk Drain, Sydney Water Desal Line and Transgrid 330kV tunnel.

It is noted that the method may present significant risk to the project where unsuitable ground conditions are encountered. Based on previous works in the Ashmore Precinct it is noted that ground water has generally been observed at 2-3m below ground level with the upper 3-5m below ground level consisting of Aeolian silty sands. These ground conditions may make mirco-tunnelling challenging and it is noted that the Desal & Transgrid tunnel have been micro tunnelled at greater depths than the proposed drainage works, typically 10m below ground level.

These methods can also only be used where there is sufficient cover to the culvert from the surface and also clearance to existing services which will limit the suitability for these methods along Huntley Street in particular.

The following key considerations have been noted for micro tunnelling solution:

- Typical Launch pit dimensions for a triple 1800Ø bore would be 12m x 12m (or 12m diameter). Receptor pits are likely smaller and dual launch/receptor pits should be considered.
- Intervals between launch and receptor pits should be limited to a typical spacing of 100m owing to the likely poor ground conditions to help facilitate grade and alignment.
- Specialist methods such as GBM (Guided Boring Machine) and use of steel envelopers can assist with accuracy and alignment.
- Grades of 0% upwards can be achieved; however the ground conditions generally dictate the probability of achieving the required grades. Consequentially, contractors cannot always guarantee the grades that will be achieved. To reduce this risk, launch/receptor pit spacing would need to be reviewed.
- Reinforced concrete pipes (RCPs) are difficult to install in displaceable water charged ground, as due to their weight they have a tendency to settle over longer distances. However, in stand up clays/shale and rock, RCPs are favourable to install. In displaceable wet ground a Guided Boring Machine (GBM) can be used to install a 110mm pilot tube which may guarantee +/- 25mm accuracy up to 150m and once the pilot tube is installed a conventional auger boring machine could be used to install a steel enveloper. As the enveloper progresses the GBM is used to pull the pilot tubes from the receipt to negate any rod sag which will ensure the steel enveloper is installed on grade and follows the pilot tube without any deviation. When the steel enveloper is installed, the RCP is jacked to replace the steel enveloper which is cut off in sections from the receipt pit and removed. This process only occurs in stable/stand up ground, in soft wet ground to avoid sag or drop the RCP is jacked within the steel enveloper on centralisers.

Generally, micro-tunnelling/GBM pipe-jacking has been assumed where possible for the proposed works. This method has been selected over open cut solutions where excessive cover (>3m), difficult traffic management and/or congested utility corridors exist. However, in line with the discussion above, further consideration of the ground conditions will be required as part of future project stages to confirm the feasibility of this approach, in addition further consideration will be required to identify methods for mitigating settlement in particular within the vicinity of the 132kV infrastructure.

Open cut/trenching has been assumed where tunnelling methods are not considered viable. Conventional trench boxes should be suitable for the support of trenches for widths of up to 3.6 m. Other excavation supports include; battered excavations, shotcreting, sheet piles or piled retaining walls. Excavation support would also be required for launch pit construction in the case of micro-tunnelling/pipe-jacking.

The following key considerations have been noted for open cut section of works:

- Requirement to temporarily/permanently relocate utilities to facilitate excavation and installation.
- Additional spoil generated compared to the micro tunnelling segments.
- Additional backfilling and compaction works compared to the micro tunnelling segments which are likely to cause additional traffic disruption depending on the location of the works.
- It is assumed that the majority of the excavated material would be suitable for backfill material. Where this is not suitable a significant cost would be incurred for exporting and importing new fill material (assumed to require disposal as General Solid Waste, GSW).

- It is assumed that the open cut segments could be installed with a 150te crawler crane or city crane.
- Temporary stockpiles would also be required to facilitate the excavated fill material, this is likely to have an impact on the traffic management and allocated working space.

2.7 Parallel Construction Projects

2.7.1 Green Square Trunk Drain (GSTD)

The GSTD separable portion SP4 is currently under construction and involves amplification of the Sheas Creek open channel from Maddox Street up to the head of the Alexandra Canal. This is the fourth stage of the GSTD running from the eastern side of Botany Road to the Alexandra Canal. Figure 17 shows the land use for the GSTD upstream of the Alexandra Canal.

The overall GSTD runs from Link Road, Zetland and is being constructed to address the flooding issues within the new Green Square Town Centre (GSTC) as well as to enable development within the broader Green Square Redevelopment Area.

The GSTD provides a precedent to the construction methodology likely to be implemented in this project – especially in terms of micro-tunnelling through similar ground conditions and the cost effectiveness of this method in the area. This will be taken into account when determining the costs and risks associated with each alignment option.

Part of the GSTD SP4 work includes re-building and widening of the Huntley Street bridge over the Sheas Creek open channel. It is unlikely that this bridge would be reconstructed for the purposes of the Ashmore Trunk Drainage Project, so consideration must be given to diverting any alignments in this area around the bridge, which may involve a significant cost.

2.7.2 WestConnex

Local road upgrades within the Study Area have been proposed as part of the WestConnex New M5 works. Refer to Figure 18 and Figure 19 for full extent of relevant roadworks.

The works in the immediate vicinity of the study area include:

- Upgrade and widening of Euston Road, from Campbell Road / Euston Road intersection and extend up to the Maddox Street / Euston Road intersection. Euston Road upgrades involve widening to 3 northbound and 3 southbound traffic lanes.
- The widening along Euston Road will also involve relocation of existing 132kV Ausgrid cables.
- Widening of the existing bridge over Munni Street SW channel on Euston Road.
- The Euston / Sydney Park Road / Huntley Street intersection is to be upgraded to a signalised intersection including works on Sydney Park Road and Huntley Street to provide additional turning lanes.

Further coordination with WestConnex will be required however; the proposed works down Euston Road may mitigate space issues for alignment options in this road, as well as potentially minimise traffic impacts given proper coordination between the two projects.

However, where timing of the works does not align, WestConnex construction is likely to form a constraint to the construction of the proposed trunk drainage, potentially limiting the ability to utilise the road widening corridor for this purpose.

As the trunk drainage works will inevitably interface with the WestConnex works it is essential that coordination between the projects be commenced at the earliest opportunity.

Figure 18 Extract from WestConnex New M5 EIS: Vol 1A - Chapter 05 (Fig. 5-30)

Figure 19 Extract from WestConnex New M5 EIS: Vol 1A - Chapter 05 (Fig. 5-29)

2.7.3 Ashmore Precinct

The development within the 17 hectare Ashmore Precinct will occur over the next 10 years. Public works in the area include construction of new road alignments, as well as drainage and other utility infrastructure.

The current status of completion within the Ashmore Precinct is presented in Figure 20. The precinct is expected to be fully developed in 2025 with a forecast population of around 6,300.

Figure 20 Extract from the City of Sydney Ashmore Precinct Infrastructure Plan (Ashmore indicative staging of development to 2025)

With the level of development expected within the Ashmore Precinct, an opportunity exists to improve the trunk drainage infrastructure in the area in order to mitigate the current significant flood hazard in the precinct which may affect the ability for both public infrastructure and private developments to take place. Part of the long-term strategy presented in the Alexandra Canal Flood Risk Management Plan, is to provide an overall 20 year ARI design capacity of the drainage system.

Two options have been proposed for the upstream trunk drainage strategy within the Ashmore Precinct to effectively split the precinct into western and northern sub-catchments. The first option comprises an additional trunk drain down the proposed Kooka Walk, parallel to the existing, as well as a connection point at Coulson Street near Mitchell road. The second option comprises a new trunk drain down the proposed Kooka Walk, and then heads east providing a connection point at the Maddox Street / Mitchell Road intersection.

The western sub-catchment may not require additional downstream capacity and is expected to be served by the existing Sydney Water trunk drain. The northern sub-catchment will require additional downstream capacity and is the subject of this study.

3 Stormwater Augmentation Options

Prior to the workshop with Sydney Water and City of Sydney, a range of potential alignments for the drainage augmentation were identified and considered as part of this study. These options were selected following consideration of those presented in the previous Downstream Trunk Drainage Constructability Review (AECOM, 2015) and the Ashmore Stormwater Drain – Project Need and Rational (CoS, 2016) and discussions with Sydney Water and City of Sydney.

Following review, six options were identified for further consideration and discussion at the workshop. These options are displayed in Figure 21, with detailed plans and long sections for each option presented in Appendix A.

The options consider two upstream connection points to the existing trunk drainage infrastructure:

- At the new Kooka Walk intersection to the north; and
- At the existing intersection of Coulson Street and Mitchell Road to the south.

The options also consider three downstream outlet points :

- At the existing Sheas Creek open channel from Maddox Street (Option 1);
- At the head of the Alexandra Canal – one adjacent to the existing Sheas Creek Channel (Option 2); and three to the west bank of the canal (Options 3, 4, 5 and 6A); and
- At the existing connection point of the Munni Street channel (Option 6).

The general alignments for each option are summarised in the sections below. A summary of all options including discussion against the key assessment criteria is also presented in Table 9.

Figure 21 Indicative trunk drain alignment options

3.1 Option 1

The Option 1 alignment comprises a new trunk drainage culvert connection from the new Kooka Walk intersection down Maddox Street with a connection to the existing Shea's Creek open channel.

Feasibility of this option would require confirmation that the existing Sheas Creek open channel has capacity to accept the additional inflow from the Munni Street sub-catchment without adverse impact on flood levels. As noted previously, insufficient investigations have been undertaken at this stage to allow the feasibility of this arrangement to be confirmed. As such, while this option was taken forward, being potentially desirable pending further hydraulic investigations, the uncertainty over feasibility means that this Option may not be appropriate for forming the basis of the business case at this stage.

3.2 Option 2

The Option 2 alignment comprises a new trunk drainage culvert connection from the new Kooka Walk intersection down Maddox Street. This option can be further broken into two components, (a) connection to the Sheas Creek open channel (as in option 1) and (b) extension to the head of Alexandra Canal.

This option would apply where the existing Sheas Creek open channel is shown to not have capacity to accept the additional inflow form the Munni street sub-catchment.

3.3 Option 3

The Option 3 alignment comprises a new trunk drainage culvert connection from the new Kooka Walk intersection down Maddox Street and Euston Road, turning east [redacted], and discharging at the head of the Alexandra Canal.

This option would take advantage of the road widening reserve along Euston Road [redacted]

Where constraints are imposed through WestConnex construction, this option could alternatively use Lawrence Street and the eastern edge of Sydney Park to avoid works in Euston Road.

3.4 Option 4

The Option 4 alignment comprises a new trunk drainage culvert connection from the intersection of Coulson Street and Mitchell Road down Huntley Street and Euston Road, turning east [redacted], and discharging at the head of the Alexandra Canal.

[redacted]

Where WestConnex presents a constraint to works in Euston Road, the alignment could be moved into the eastern edge of Sydney Park.

3.5 Option 5

The Option 5 alignment comprises a new trunk drainage culvert connection from the intersection of Coulson Street and Mitchell Road down Huntley Street and Burrows Road, turning east [redacted], and discharging at the head of the Alexandra Canal.

3.6 Option 6

The Option 6 alignment comprises a new trunk drainage culvert connection from the intersection of Coulson Street and Mitchell Road down Mitchell Road into the Sydney Park carpark. The alignment then runs east under Sydney Park.

Two sub-options are then proposed downstream of Sydney Park:

- **6** which comprises an amplified Munni Street open channel to the outlet at the Alexandra Canal (this may be able to utilise the existing open channel within Sydney Park without augmentation which appears to currently have sufficient capacity) , and
- **6A** which comprises a new line which passes under the existing Munni Street open channel within Sydney Park and discharges at the Alexandra Canal outlet as per Options 3, 4 and 5. **This option has been deemed to be not feasible due to the clash with the existing open channel.**

ATTACHMENT B

Table 9 Summary of Options

Options	Easement Requirements (ER)	Traffic Management (TM)*	Construction Method	Major** Utility Interfaces	Approx. Length & Cover ***(m)	Comments
1	[redacted]	Alignment primarily along Maddox Street, single lane with footpath closure likely to be achievable. Road Width approx. 20m including footpaths Major crossing at Mitchell & Euston Road. Bridge modifications at outfall are likely	Due to the depth of cover extending up to 5m and various intersections, micro-tunnelling is the favoured option. Localised open cut works required at connection points and launch/receptor pits. Up to 6 launch/receptor pits will be required for the length	Mitchell Road: 330kV, DN900 Water Maddox St: Secondary Gas, DN1800 Desal line, Fibre Optic Euston Lane: DN1800 Desal Euston Rd: 132kV & 11kV, DN500 Water, Secondary Gas	Length: 610m Min Cover: 3m Max Cover: 5m	• Capacity of the Sheas Creek Open Channel is may not be suitable to receive discharge in the current arrangement. (see option 2 for upgrade) • Modifications to the Maddox Street bridge at discharge location likely to be required • Suitability of micro – tunnelling subject to detailed utility & ground suitability assessment. • Launch/receptor pits at less than 100m intervals to maintain accuracy in grade • Utility adjustments required to facilitate launch/receptor pits including Fibre Optic • A detailed hydraulic capacity assessment of Sheas Creek open channel and upstream/downstream flood impact assessment would need to be undertaken
2	[redacted]	Alignment primarily along Maddox Street, single lane with footpath closure likely to be achievable. Road Width approx. 20m including footpaths Major crossing at Mitchell & Euston Road. Bridge modifications at outfall are likely	Refer to Option 1. Widening of Shea's Creek Open Channel is likely to be open cut due to minimal depth of cover & potential Sewer relocation works	Mitchell Road: 330kV, DN900 Water Maddox St: Secondary Gas, DN1800 Desal line, Fibre Optic Euston Lane: DN1800 Desal line Euston Rd: 132kV & 11kV, Secondary Gas, DN500 Water Shea's Creek: DN375 Sewer Huntley St: 33kV & 11kV, Fibre Optic, Secondary Gas, DN450 Sewer, DN375 Sewer, DN750 Water,	Length: 975m Cover: See Option 1. Cover is less than 1m along Shea's Creek Channel upgrade works	• See Option 1 comments • Modifications to the Maddox Street & Huntley Street Bridges are likely to be required • Significant number of utility relocation/bridging works required at Huntley Street Bridge • Land acquisition/easement requirements for widening of the Sheas Creek Open Channel need to be considered • Upgrading Sheas Creek Open Channel will be beneficial for current and future drainage improvement schemes
3	[redacted]	Alignment primarily along Maddox Street (20m wide) & Euston Road (28m wide). Potential for alignment of culvert in verge (11m wide) along Euston Road. Alignment crosses a major roundabout at Euston Road, Sydney Park & Huntley Street. Potential to synchronise works with Westconnex TM.	Due to the depth of cover extending up to 5m and various intersections, micro-tunnelling is the favoured option. Final 100m likely to be open cut due to minimum cover & utilities within Burrows Road. Localised open cut works required at connection points and launch/receptor pits.	Mitchell Road: 330kV,DN900 Water Maddox St: Secondary Gas, DN1800 Desal line, Fibre Optic Euston Lane: DN1800 Desal line Euston Rd: 132kV & 11kV, DN 500 Water, Secondary Gas, Fibre Optic Huntley St: 132kV,33kV & 11kV, Fibre Optic, Secondary Gas, DN450 Sewer, DN375 Sewer, DN900 Water Burrows Road: 132kV,33kV & 11kV, Fibre Optic, DN375 Sewer,	Length: 970m Min Cover: 0.3m at Burrows Rd Max Cover: 5.5m along Euston Rd	[redacted] • Burrows Road utility relocations are almost certain to be required to facilitate the culvert crossing. • Suitability of micro – tunnelling subject to detailed utility & ground suitability assessment. • Synchronising the WestConnex construction works may not be achievable to facilitate coordination of the works and mitigate traffic & utility disruption in Euston Road. Utility relocations as part of this project would need to be coordinated. • This alignment contains significant changes in direction which are likely to induce hydraulic inefficiencies within the design.

ATTACHMENT B

Options	Easement Requirements (ER)	Traffic Management (TM)*	Construction Method	Major** Utility Interfaces	Approx. Length & Cover ***(m)	Comments
4	[redacted]	Alignment primarily along Huntley Street (20m wide) & Euston Road (32m wide to lot boundary). Alignment crosses a major roundabout at Euston Road, Sydney Park & Huntley Street. Potential to synchronise works with Westconnex TM.	Due to the depth of cover extending up to 5.5m and various intersections & utilities, micro-tunnelling is the favoured option. Final 100m likely to be open cut due to minimum cover & utilities within Burrows Road. Localised open cut works required at connection points and launch/receptor pits.	Mitchell Road: DN900 Water Euston Lane: DN1800 Desal line Euston Rd: 132kV & 11kV, DN 500 Water, Fibre Optic Huntley St: 330kV, 132kV,33kV & 11kV, Fibre Optic, DN900 Water Burrows Road: 132kV,33kV & 11kV, Fibre Optic, DN375 Sewer,	Length: 630m Max Cover: 5.5m (Huntley) Min Cover: Mitchell Road: 3.4m Min Euston Rd: 3.5m Min Huntley St: 3.4m Min Burrows Road: 0.5m Min	• [redacted] • Burrows Road utility relocations are almost certain to be required to facilitate the culvert crossing. • Suitability of micro – tunnelling subject to detailed utility & ground suitability assessment. • Synchronising the WestConnex construction works may not be achievable to facilitate coordination of the works and mitigate traffic & utility disruption in Euston Road. Utility relocations as part of this project would need to be coordinated. • Due to the magnitude of utilities within Huntley Street, micro-tunnelling would be the only feasible option here to avoid excessive utility relocation costs for major and minor utility diversions. However spacing of launch/receptor pits along this length will need to be considered. • This alignment contains significant changes in direction which are likely to induce hydraulic inefficiencies within the design.
5	[redacted]	Alignment primarily along Huntley Street (20m wide) & Burrows Road (20m wide). Alignment crosses a major roundabout at Euston Road, Sydney Park & Huntley Street. Potential to synchronise works with Westconnex TM.	Due to the depth of cover extending up to 4.8m and various intersections & utilities, micro-tunnelling is the favoured option. Final 100m likely to be open cut due to minimum cover & utilities within Burrows Road. Localised open cut works required at connection points and launch/receptor pits.	Mitchell Road: DN900 Water Euston Lane: DN1800 Desal line Euston Rd: 132kV & 11kV, DN 500 Water, Fibre Optic, Secondary Gas Huntley St: 330kV, 132kV,33kV & 11kV, Fibre Optic, DN900 Water Burrows Road: 132kV,33kV & 11kV, Fibre Optic, DN375 Sewer, Secondary Gas	Length: 645m Max Cover: 4.8m (Huntley) Min Cover: Mitchell Road: 3.4m Min Euston Rd: 4.9m Min Huntley St: 1.4m Min Burrows Road: 0.5m Min	• [redacted] • Burrows Road utility relocations are almost certain to be required to facilitate the culvert crossing. • Suitability of micro – tunnelling subject to detailed utility & ground suitability assessment. • Synchronising the WestConnex construction works may not be achievable to facilitate coordination of the works and mitigate traffic & utility disruption in Euston Road. Utility relocations as part of this project would need to be coordinated. • Due to the magnitude of utilities within Huntley Street, micro-tunnelling would be the only feasible option here to avoid excessive utility relocation costs for major and minor utility diversions. However spacing of launch/receptor pits along this length will need to be considered.
6 and 6A	[redacted]	Alignment primarily along Mitchell Road (23m wide) & Sydney Park Oval. Works within Mitchell Road are likely to be achievable under single lane TM and footpath closure.	Due to the depth of cover extending up to 4.8m under Sydney Park Road micro - tunnelling is proposed between Mitchell Road and Sydney Park Oval. From Sydney Park to the existing channel, open cut is likely to be the preferred option due to this location being a landfill previously, traffic management constraints are of less concern within the oval also. The remaining downstream alterations are expected to be open cut channel widening operations	Mitchell Road: DN900 Water , 132kV & 11kV Cables Euston Rd: 132kV & 11kV, DN 500 Water, Fibre Optic, Secondary Gas , DN1800 Desal line Burrows Road: 132kV,33kV & 11kV, Fibre Optic, DN375 Sewer, Secondary Gas	Length: **6:** 340m culvert installation & 260m widening of existing channel downstream of Euston Road if included] **6a:** 630m culvert installation Cover: **6:** Max Cover: 6m (Sydney Park Car Park) Min Cover:	• Burrows Road & Euston Road temporary utility relocation works required to widen existing Channel • Modifications to Burrows Road & Euston Road existing bridge/culvert structures • Suitability of micro – tunnelling subject to detailed utility & ground suitability assessment. • Contamination within Sydney Park Oval & ground suitability may be an issue. • Segments of the existing channel within Sydney Park may have sufficient capacity. • The upstream connection is likely required to have a bifurcation structure to relieve both upstream existing trunk mains benefiting the entire upstream network. This may result in a large structure needing to be constructed in Mitchell Road. • **Note option 6A does not have sufficient cover under the existing channel within Sydney Park to facilitate a 2m deep structure. Maximum culvert diameter would be 500mm with 0.15% grades. A significant number of culverts would be required to facilitate the required discharge in addition to associated hydraulic losses from changes to the channel cross section.**

Options	Easement Requirements (ER)	Traffic Management (TM)*	Construction Method	Major** Utility Interfaces	Approx. Length & Cover ***(m)	Comments
					Mitchell Road: 2m Min Sydney Park: 4.2m Min Euston Rd: 1.1m Min Burrows Road: 0.7m Min **6a:** Not achievable under existing channel	

* Dimensions of Road are indicative only measured using Six Maps from edge of building on lot boundary line unless otherwise noted

** Major utilities considered to be as follows: **Water:** DN500 or greater, **Elec:** 330kV, 132kV, 33kV, 11kV, **Sewer:** DN 375 or greater, **Comms:** Fibre optic cables, **Gas:** Secondary Gas Mains

*** Min. cover values between assumed upstream connection point and 30m from Downstream connection at Canal/Channel

ATTACHMENT B

4 Indicative Cost Budget

4.1 Indicative Cost Budget Methodology

To facilitate discussion and MCA analysis at the Workshop and identification of a single option for development, a indicative cost budget was developed for each of the options. It should be noted that the values represented in the indicative cost budget were developed for comparison purposes only and do not reflect final lump sum cost to undertake the works. The method compares indicative rates with proposed quantities to understand which option is more favourable by like for like comparison.

The cost budgets identified through this process should not be used for any purpose other than the MCA analysis. Following identification of the preferred option, formal cost estimates have been prepared by a Quantity Surveyor as discussed in Section 7.

The following forms an outline of cost elements considered to inform the indicative cost budget:

- New culvert (Open Cut);
- New culvert (Micro – tunnelled);
- New open channel/widening of existing;
- Major structures;
- Traffic management;
- Relocation of services;
- Protection/temp relocation of services; and
- Land/Easement Acquisition lump sum (by SW & CoS).

4.2 Rates and Quantities

Typical industry rates were applied for each of the items above. For items 1 to 3 above, an indicative lump sum rate will be developed to include typical costs per m for each of the options including:

- Material Cost;
- Installation duration;
- Labour; and
- Excess disposal (assumed majority of excavated material is suitable for backfill).

Traffic Management rates were derived using a qualitative (High, Medium, Low) assessment and typical industry rates applied to assess the indicative overall cost budgets.

Relocation of services were based on a typical rate per metre of relocation for standard utilities with an extra over item for relocation of major assets i.e 132kV, 33KV, 11kV power. Major Fibre optic cables, major water sewer and gas mains.

Easement acquisition costs were included based on advice from the City of Sydney and Sydney Water property teams.

The costs produced for this purpose were direct costs only and did not include overheads, profit or contingencies.

The output and comparison of the options based on this Cost Budget Estimate approach is discussed in Section 6.

5 Multi Criteria Assessment (MCA)

5.1 MCA Procedure

A Multi Criteria Assessment (MCA) was undertaken at the Workshop to assist with defining the preferred option which best informs the project goals from a capital cost/business case perspective. This option was subsequently refined in more detail to help provide a higher level of cost certainty and ultimately inform a business case to undertake the works.

The following procedure was identified as the methodology for application of the MCA to the Options at the Workshop.

1

- **Objectives**
  - Define the project goals and identify key risk items to all stakeholders

2

- **Options Review**
  - Summarise site context and associated opportunities and constraints

3

- **Sustainability Criteria**
  - Identify and quantify the key performance criteria from a qualitative and quantitative perspective

4

- **Selection of Preferred Option**
  - Identify concept options for achieving the project goals
  - Perform a Multi Criteria assessment for each of the options based on a percentage weighting for each of the key performance criteria to identify the preffered solution

5.1.1 Phase 1: Objectives

The objectives of the assessment were agreed by the workshop participants and are summarised as follows:

- Identification of a cost effective solution;
- Effective in minimising construction impact to nearby residents;
- Protecting worker and public safety during construction and operation; and
- Protecting the quality of receiving waters during and after construction.

5.1.2 Phase 2: Options Review

The list of options presented in Section 3 was discussed during the workshop and refined or expanded as necessary.

This included consideration of the site context and the associated opportunities and constraints as summarised in Section 2.

5.1.3 Phase 3: Sustainability criteria

Preliminary MCA criteria were identified around ten categories:

- Constructability;
- Public disturbance;
- Safety;

- Environmental impact;
- Hydraulic performance;
- Program;
- Indicative Cost Budget;
- Operation & Maintenance;
- Land acquisition; and
- 3rd Party Approvals.

The criteria listed above and percentage weighting were discussed and developed further at the workshop. This focussed on narrowing the list of categories to allow the key factors to have a meaningful impact on the assessment. Further, criteria that essentially assessed the same issue were removed to avoid this influencing the outcome of the process.

The following list was the final adopted criteria and agreed percentage weighting:

- C1: Constructability (20%)
- C2: Public Disturbance (10%)
- C3: Indicative Cost Budget (45%)
- C4: 3rd Party utility impact/approvals (15%)
- C5: Ground Conditions (10%)

5.1.4 Phase 4: Selection of Preferred Option

After agreement on Phases 1 to 3 by the workshop participants, the MCA procedure was applied to score options and identify the preferred option. The following steps were undertaken:

1. Discuss and agree the assessment objectives, the criteria to be applied and the short list of options to be assessed;
2. Weight criteria;
3. Apply a overall weighting to each category totalling 100%;
4. Apply a weighting to each sub criteria in each category where applicable; and
5. Complete a detailed options assessment by filling out the performance matrix. Participants should discuss the merits of each option against each criterion.

Each option was assessed using a numerical "strength of preference" scale for each criterion, with a range of numerical scores (1 to 5), with a low score indicating poor relative performance against the specific criteria and a high score indicating good relative performance.

The results of the MCA process at the workshop are provided in Table 10.

Table 11 demonstrates a post workshop sensitivity analysis which scores the indicative cost budget as a more accurate rating in relation to the highest scoring option to assess the influence of cost. The results from Table 11 are discussed in Section 6.

The minutes from the workshop meeting are provided in Appendix B.

Table 10 MCA Workshop Results

GENERAL RANKING CRITERIA		CRITERIA WEIGHTING	Option 1		Option 2		Option 3		Option 4		Option 5		Option 6	
			Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score
C1	Constructability	20.00%	4.33	17.32%	1.67	6.68%	2.33	9.32%	2	8.00%	1.67	6.68%	3	12.00%
C2	Public disturbance	10.00%	3.67	7.34%	2.67	5.34%	2	4.00%	2.33	4.66%	2.33	4.66%	3	6.00%
C3	Indicative Cost Budget	45.00%	5	45.00%	2	18.00%	3.5	31.50%	3.5	31.50%	2	18.00%	4	36.00%
C4	3rd Party utility impact/approvals	15.00%	4	12.00%	2.33	6.99%	1	3.00%	1.33	3.99%	1	3.00%	3	9.00%
C5	Ground conditions	10.00%	4	8.00%	1.67	3.34%	3	6.00%	2.67	5.34%	2.67	5.34%	1.33	2.66%
		100.00%	21.0	89.66%	10.3	40.35%	11.8	53.82%	11.8	53.49%	9.7	37.68%	14.3	65.66%
TOTAL WEIGHTED SCORE (1 to 100%)			-	89.66%	-	40.35%	-	53.82%	-	53.49%	-	37.68%	-	65.66%
RANK		#	1		5		3		4		6		2	

Table 11 Post Workshop Meeting – Sensitivity Analysis

GENERAL RANKING CRITERIA		CRITERIA WEIGHTING	Option 1		Option 2		Option 3		Option 4		Option 5		Option 6	
			Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score	Raw Score (1 to 5)	Weighted Score
C1	Constructability	20.00%	4.33	17.32%	1.67	6.68%	2.33	9.32%	2	8.00%	1.67	6.68%	3	12.00%
C2	Public disturbance	10.00%	3.67	7.34%	2.67	5.34%	2	4.00%	2.33	4.66%	2.33	4.66%	3	6.00%
C3	Indicative Cost Budget	45.00%	5	45.00%	1.86	16.74%	3.59	32.31%	3.75	33.75%	2.08	18.72%	4.46	40.14%
C4	3rd Party utility impact/approvals	15.00%	4	12.00%	2.33	6.99%	1	3.00%	1.33	3.99%	1	3.00%	3	9.00%
C5	Ground conditions	10.00%	4	8.00%	1.67	3.34%	3	6.00%	2.67	5.34%	2.67	5.34%	1.33	2.66%
		100.00%	21.0	89.66%	10.2	39.09%	11.9	54.63%	12.1	55.74%	9.8	38.40%	14.8	69.80%
TOTAL WEIGHTED SCORE (1 to 100%)			-	89.66%	-	39.09%	-	54.63%	-	55.74%	-	38.40%	-	69.80%
RANK		#	1		5		4		3		6		2	