

Memorandum

To	David Ward	Page	1
CC	Belinda Petersen / Peter Roan / Zahni Hefferon		
Subject	CI - S41C Response - Technical Considerations Lyon Ave MAGS Alternative Rev D		
From	John Q Cooper		
File/Ref No.	60102004 3.5	Date	20-Sept-2013

David, Belinda

1. Introduction

Watercare is preparing a response to the Central Interceptor Main Project Works Hearing S41C which will include a comparison of the proposed Lyon Avenue site and an alternative site in the Mount Albert Grammar School (MAGS) grounds. This memo provides a commentary of design, construction and operational issues associated with the MAGS Alternative site.

There are two methods available for connecting the existing Lyon Avenue overflow to the shafts at the MAGS Alternative site; pipejacking or trenching. These two methods dictate the extent of the works and influence the access requirements as shown on the Drawing No's LYON-SK1001 Rev C and LYON-SK1101 Rev C (attached).

The Commissioners have also requested a more detailed risk assessment of the potential for ground settlement adversely affecting the SLGA buildings during construction for the proposed Lyon Avenue site and the MAGS Alternative.

Existing geotechnical information has been assessed by Tonkin & Taylor (T&T) to help define the extent of basalt in this area, which is a key influence on the arrangements to connect the existing Lyon Avenue overflow to the MAGS Alternative site. The geology also affects the assessment of settlement risk. Figures 1 and 2 (attached) summarise the interpretation of the local geology.

2. MAGS Alternative

2.1 Design

The attached drawings show the access and drop shaft arrangements within the MAGS Alternative site. The configuration is similar to the proposed Lyon Avenue site, with a connecting de-aeration tunnel at depth. The drop shaft must be connected to the existing Lyon Avenue overflow and across Meola Creek. We have considered two options for this: trenching across Meola Creek or connecting at a greater depth below the stream using a jacked pipe; both options are technically feasible from an engineering point of view.

In using a jacked option it is necessary to lower the connection pipe below the basalt which requires an intermediate drop structure between the diversion chamber at the Lyon Avenue overflow and the main drop shaft. This shaft will also serve as a reception pit to receive the pipejack advancing uphill from the MAGS Alternative site. For the trenched option the pipe would be set higher and would require excavation in basalt, temporary diversions of the stream and an additional connection chamber to redirect the flows across to the MAGS drop shaft.

The following points highlight the permanent works design issues associated with the MAGS Alternative site compared with Watercare's proposed Lyon Avenue site:

1. An additional diversion chamber or drop structure is introduced with associated changes in flow direction, adding to the complexity of the hydraulics and gate configuration. If pipe jacked, the initial drop structure must be deep enough for the pipejack to pass under the basalt.
2. For the pipejack option, flows enter the main drop shaft at greater depth, adding complexity to the design of the drop structure.
3. The main CI tunnel alignment will be moved laterally at Lyon Ave. by approximately 110m resulting in a reduction in tunnel length of about 65m.
4. The alternative shaft location in the MAGS sports fields is in an area that is known to flood, and as such the shaft lids will need to be lifted to an appropriate elevation and / or made watertight. The surrounding area could also be raised so that the lids remain flush with the ground if desirable.

2.2 Construction

Connecting the Lyon Ave overflow to the MAGS Alternative site via a pipe laid in trench would require a 2.7m diameter pipe to cross Meola Creek. The envisaged method for this would entail diverting the stream to one side in a new channel, probably formed using sheet piles, and putting the stream back to its original course over the top of the laid pipe. The Roy Clements Treeway walkway would also have to be temporarily diverted. The working area to lay the pipe and accommodate the diversions has been included in the extent of the MAGS Alternative site area and required tree removal.

Two access options are shown on the attached drawings (LYON-SK1001 Rev. C & LYON-SK1101 Rev. C); it is possible to undertake construction works for the two options involving works in the MAGS site from Alberton Ave. via MAGS Gate 1 which passes beside the school hostel. This would require a bridge across the Meola Creek, likely designed as a single lane, say 3.5m wide and set high enough so as not to impede flows.

The pipejack option does not require the two work sites to be connected to undertake the works. Using Alberton Ave. to access both sites for the pipejack connection arrangement would add additional costs for a bridge and increase the size of the land needed compared with the pipejack option layout shown on LYON-SK1001 Rev. C.

The main drop shaft and access shafts for the MAGS Alternative site would be of similar size to the proposed Lyon Avenue site but are now located outside the edge of the surface layer of basalt which does not extend to the west of the Meola Creek, making them easier to construct.

Sinking of the two main shafts at the MAGS Alternative site will not require blasting as the basalt is absent here. Sheet pile cofferdams are the most likely form of construction, with associated noise generation. Installation of piles by vibration rather than hammers is likely to be needed to manage noise.

Works will be required in the stream bank immediately adjacent to the sports field fence to provide sufficient separation of the two shafts and to keep the MAGS Alternative site away from the existing cricket nets. The current access roadway through MAGS is too narrow for two way construction traffic without widening. The school dormitories are located immediately adjacent to the existing access track and the clearance between existing dormitories and the top of the stream bank ranges from 5m to 7m. Approximately 9m is preferred for a two way road.

The widening of the track will require removal of trees and installation of retaining walls on the stream side using gabions or more likely timber pole walls, possible without narrowing the watercourse. It will also need to be resurfaced. Due to the close proximity of dormitories to the road, there is risk of damage to the dormitories from heavy construction traffic impacting the walls or repeated vibrations affecting the footings.

There is insufficient space to allow a separate walkway alongside these buildings and there are a number of parking bays and side roads off the existing road. It is likely that Gate 1 access road will need to be shared with school vehicles going to the parking area by the residents, the service roads and the school

fields. As well as noise and traffic impacts, this creates a risk for pedestrians and students and would require safety measures be put in place.

It is possible to put a 2m fence alongside the road and hard up against the residence buildings on the western side of the access road. This will serve to reduce noise. Steel posts will be used to provide protection for the dormitory buildings adjacent the access road, as well as providing separation between pedestrians and the access road.

Any fencing would also need to ensure emergency vehicles can access the school buildings.

Use of the MAGS Alternative site effectively splits the construction activities into two areas for both a pipejack and a trenched option. This will make scheduling the work more difficult and lead to some increase in costs. The quantities of work for the MAGS Alternative site would take approximately 6 months longer than the preferred Lyon Avenue site works if all activities were sequential. To offset this increase in construction period more activities can be scheduled to be concurrent but this can increase costs. We would recommend that the allowed construction time for the MAGS Alternative site is increased by 2 months, to 14 to 20 months, compared with 12 to 18 months for the preferred Lyon Avenue site. The total occupation time would remain the same, 3 years.

2.3 Costs

Table 1 presents a summary of the likely cost differential for the MAGS Alternative compared with the proposed Lyon Avenue site. The unit rates for this cost comparison are taken from the current Engineer's estimate and are hence directly comparable.

Table 1: Estimated cost differential for the MAGS Alternative site compared with the proposed Lyon Avenue site

MAGS Alternative site Items	Direct costs (NZ\$)
Increase to P&G's for split sites and more extensive site (+20%).	+\$25,000
Additional length of connection pipeline (trenched) including stream diversions and access bridge. (60m @ \$7400 + diversion @ \$40,000).	+\$480,000
Additional costs associated with pipejack connection. (60m @ \$8900).	+\$538,000
Connection chamber (trenched).	+\$160,000
Intermediate drop structure (pipejack).	+\$330,000
Saving on basalt excavation at main drop and access shafts.	-\$60,000
Additional operational access and inspection provisions.	+\$50,000
Additional costs for site and access road widening.	+\$150,000
Allowance for additional hydraulic (possibly physical) modelling.	+\$90,000
Cost differential for MAGS Alternative 1 – Pipe jack option.	+\$1,123,000
Cost differential for MAGS Alternative 2 - Trenched option.	+\$895,000
Saving from reduced length of Main tunnel (65m @ \$18,000).	-\$1,170,000
Additional operating costs (annual inspection would take approx. twice as long and access difficulties would require remote camera usage).	\$20,000 pa

Note. Direct costs only, based on Engineers estimate Aug. 2011.

The table indicates that the additional direct costs of constructing at the MAGS Alternative site are in the range of \$0.9M to \$1.1M using the current estimates rates. However, this is entirely offset by the saving in length of the tunnel resulting from shifting it westwards by 110m on the inside of a curve. On this basis

Watercare may assume that cost is not a factor in comparing the proposed Lyon Avenue site to the MAGS Alternative, given the level of accuracy of cost estimating at this stage.

2.3 Operational

The introduction of a deep connection from the spillway to a drop structure in the MAGS Alternative 1 – pipe jack introduces new operational and maintenance issues for Watercare. An additional drop structure would be introduced to the arrangement requiring inspection and maintenance down to about 12m deep. It also means that the main drop shaft enters the shaft at a similar depth, well below ground level and requiring additional provisions for entry to inspect the structure. Confined space entries for drop shaft structures create an additional safety hazard.

An all-weather trafficable access road will be required across MAGS playing fields for occasional inspection and maintenance activities at the two shafts. This will need to be sufficiently large to allow a mobile crane access to remove lids and place equipment into the shafts.

3. SLGA Ground Settlement Risk Assessment

A qualitative assessment of ground movements associated with the construction works has been completed by T&T. This assessment estimates ground settlement as a result of changes in groundwater levels and associated with deformation around shafts and underground openings.

Estimating the settlement profile around the proposed Lyon Avenue site works allows the response of the existing buildings to be considered with knowledge of the types of building foundations and nature of the structures. As-built foundation drawings have been obtained from Council records for SLGA blocks A, B and C. These records are dated April 2003, and our assessment of potential ground settlement effects is made on the basis of their original condition. We have not undertaken a detailed condition assessment or inspection of the SLGA blocks as part of this assessment.

Proposed Lyon Avenue site

Table 3 of T&T's letter (Ref. 29200 19th Sept. 2013) estimates settlements generated by a combination of consolidation of the Puketoka soils, elastic deformation of the construction shaft walls and volume loss from the main tunnel below. The content of this report is not repeated here, however, the estimated settlement contours have been overlain onto the building (Blocks A to C) footprints in Figure 3 attached. The settlement estimates assume a substantially watertight shaft excavation method. These values are a worse case as the assumptions do not allow for additional mitigations measures to control groundwater levels such as groundwater recharge between the shaft location and the SLGA blocks, nor does it account for the bridging effect of the basalt which lies between the consolidating Puketoka layer and the block foundations.

Block C is the closest to the Lyon Avenue site shaft location (25m at the closest point). The building is founded on pads which support columns through the basement car park and precast concrete panels above with a lift shaft constructed from blockwork. In terms of tolerance to movements this form of construction is a less tolerant than say a concrete frame, steel frame or timber building but more flexible than a blockwork or brick structure. Areas of possibly greater sensitivity are likely to be along the join of the two legs of the L Shape configuration and at the interface with the lift shaft.

The differential movements between pads are estimated to be less than 5mm, equivalent to a distortion of less than 1:3000; well below the commonly applied limit of 1:2000 and highly unlikely to be noticeable or cause anything other than minor cosmetic effects, even at the more sensitive parts of the building. This estimated settlement would be within the limits of the proposed Consent Conditions as follows:

“The Consent Holder shall use all reasonable endeavours to ensure that the exercise of this consent does not cause:

- (a) Greater (steeper) than 1:1,000 differential settlement (the Differential Settlement Limit) between any two adjacent settlement monitoring points required under this consent: or
- (b) Greater than 50mm total settlement (the Total Settlement Limit) at any settlement monitoring point required under this consent”.

Estimated settlements of this order would, however, trigger other requirements of the consent conditions relating to the building condition assessments, detailed analysis, monitoring, the implementation of trigger levels and contingency planning all required by the proposed consent conditions.

MAGS Alternative site

The main drop shaft and access shaft on the MAGS playing fields are far enough away from the SLGA buildings so as to cause no settlement risk to SLGA buildings. Similarly construction of the diversion chambers and trenching between the outfall and the MAGS Alternative site are shallow and will have no significant impacts on the deeper groundwater or cause settlement to the SLGA buildings.

The settlement effects of constructing an intermediate drop shaft near the existing Lyon Avenue overflow for the pipejack option will be similar to the shafts on the Lyon Avenue site as discussed earlier, on page 4. Because the shaft will need to extend below the basalt it will draw down groundwater in the Puketoka Formation and give rise to contours of estimated settlement in millimetres, as shown in Figure 4. The effects of this drop structure on Block B and Block C area will be similar to the proposed Lyon Avenue site; i.e. negligible.

4. Conclusion

The design, construction, cost and operational issues associated with the MAGS Alternative site have been considered.

Construction access to the MAGS Alternative site would be via Alberton Avenue. Works will be needed to widen and surface the school access road, which passes very close to the MAGS residences, and requiring some tree removal and safety measures to ensure protection to dormitories and regulation of vehicles and school children on the access road. The additional construction cost of the MAGS Alternative site is offset by the savings in a shorter main tunnel.

The MAGS Alternative site requires a longer connection to the Lyon Avenue overflow via a trench or pipejack. Trenching would require temporary diversion of Meola Creek and the Roy Clements Treeway walkway way footway and require further tree removal. Pipejacking would require an intermediate drop structure.

The time required to construct the MAGS Alternative site would be approximately two months longer than the proposed Lyon Avenue site. Additional measure would be required to facilitate operation and maintenance access to this alternative.

The risk of settlement of the SLGA blocks as a result of the works has also been assessed. The MAGS Alternative 2 – trenched option, will not cause a settlement risk to these buildings. The current design and construction methods for both the proposed Lyon Avenue site and the MAGS Alternative 1 – pipe jack option, give rise to similar estimated settlements of the buildings footings; 5mm vertical displacement difference and 1:3000 angular distortion between adjacent footings, well below the normally accepted limit and unlikely to be noticeable.

This estimated settlement would be within the limits of the proposed Consent Conditions:

“The Consent Holder shall use all reasonable endeavours to ensure that the exercise of this consent does not cause:

- (a) Greater (steeper) than 1:1,000 differential settlement (the Differential Settlement Limit) between any two adjacent settlement monitoring points required under this consent: or
- (b) Greater than 50mm total settlement (the Total Settlement Limit) at any settlement monitoring point required under this consent”.

Estimated settlements of this order would, however, trigger other requirements of the consent conditions relating to the building condition assessments, detailed analysis, monitoring, the implementation of trigger levels and contingency planning all required by the proposed consent conditions.



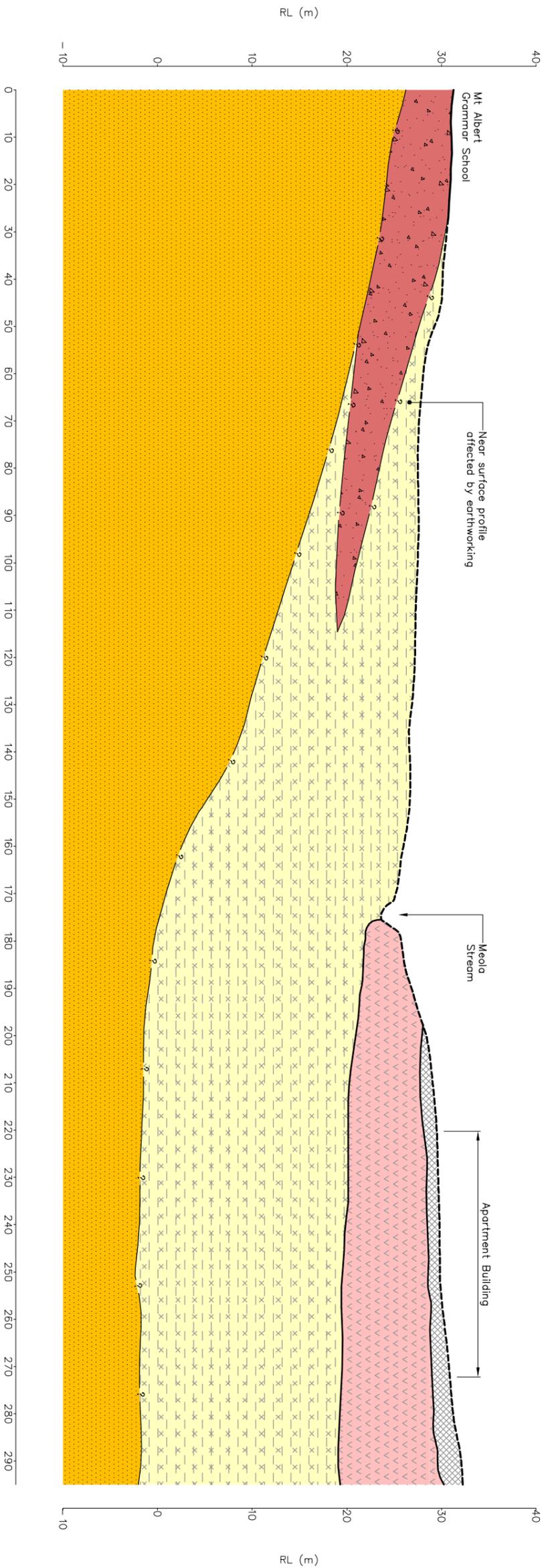
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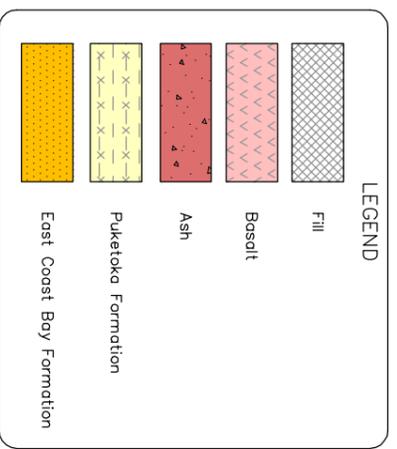
Site Plans - LYON-SK1001 Rev. C & LYON-SK1101 Rev. C, LYON-DSK401_OA Rev. B
Figures 1 and 2 - Geological Interpretation
Figure 3 and 4 - Settlement contours

WEST
A

EAST
A



SECTION A
SCALE 1:500(H)
1:250(V)



A3 SCALE 1:500
A1 SCALE 1:250
0 10 20 30 (m)



INFORMATION ONLY
September 2013

ISSUE	DATE	AMENDMENT	BY	APPD.	DESIGNED	KJH	08/13	OPERATIONS	ASSET MANAGER
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					DRAWN	AGI	08/13		
					DWG. CHECKED				
					REV'D P.MGR				
					APP'D P.DJR				

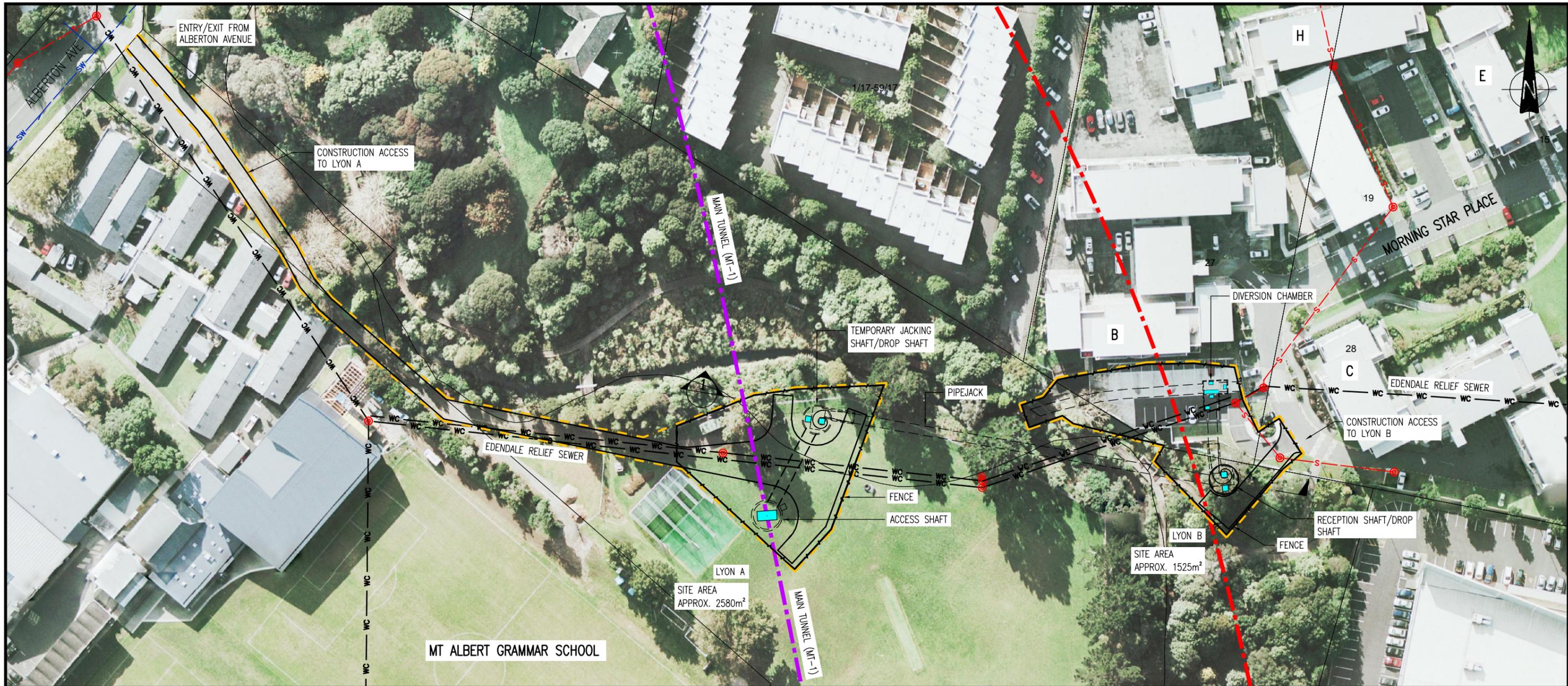


CENTRAL INTERCEPTOR AND ASSOCIATED WORKS
GEOTECHNICAL CONDITIONS

CAD FILE 29200-F02
ORIGINAL SCALE A1
AS SHOWN
DRAWING No. **FIGURE 2**
DATE 1-Jun-12
CONTRACT No.
ISSUE



FIGURE 4 – ESTIMATED SETTLEMENT CONTOURS
 NOT TO SCALE **MAGS ALTERNATIVE SITE**

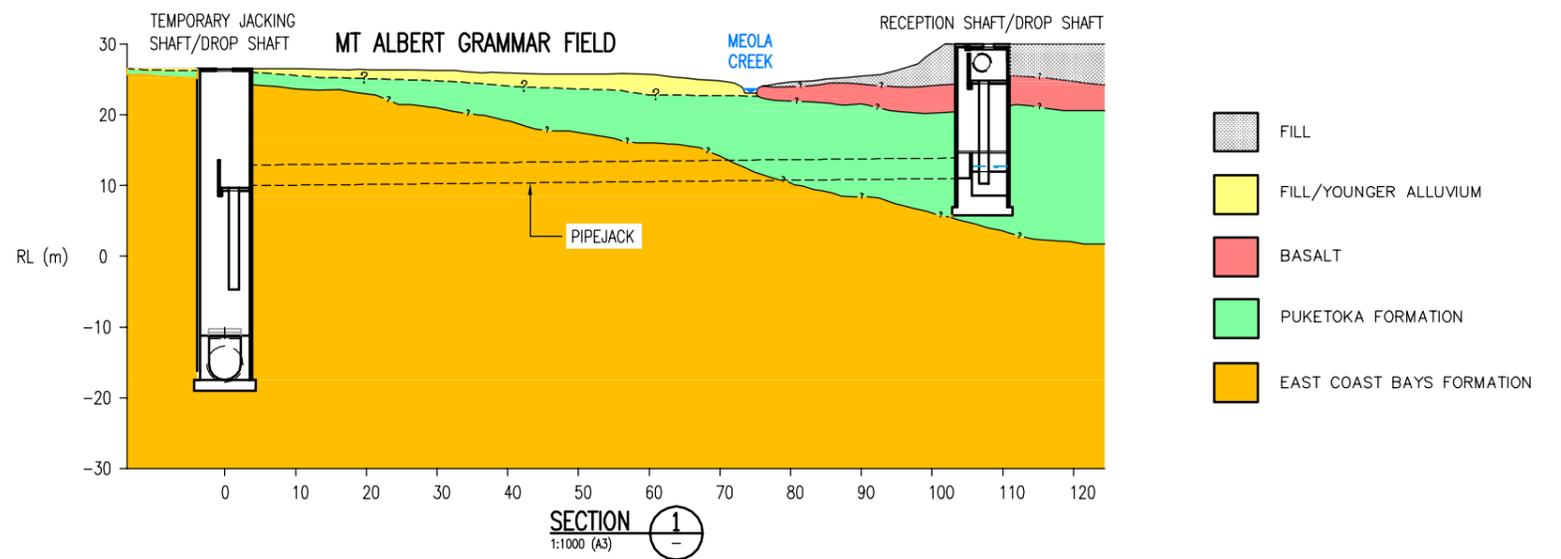


LEGEND

- - - PROPOSED TUNNEL ALIGNMENT
- - - MAGS ALTERNATIVE TUNNEL ALIGNMENT
- = = = CONNECTION PIPELINE
- S - EXISTING RETICULATION SEWER
- WC - EXISTING TRUNK SEWER
- SW - EXISTING STORMWATER
- - - PROPOSED SITE BOUNDARY
- LID/STRUCTURE FLUSH WITH GROUND
- LID/STRUCTURE ABOVE GROUND

NOTES:

1. SEE DRAWING LYON-SK401_OA FOR PLAN OF TUNNEL ALIGNMENTS FOR LYON AVE SITE OPTIONS.



Plot Date: 19-Sep-13 9:26 a.m.
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ISSUE	DATE	AMENDMENT	BY	APPD.	DESIGNED	DES. CHECKED	DRAWN	DWG. CHECKED	REV'D P.MGR	APP'D P.DIR	BY	DATE
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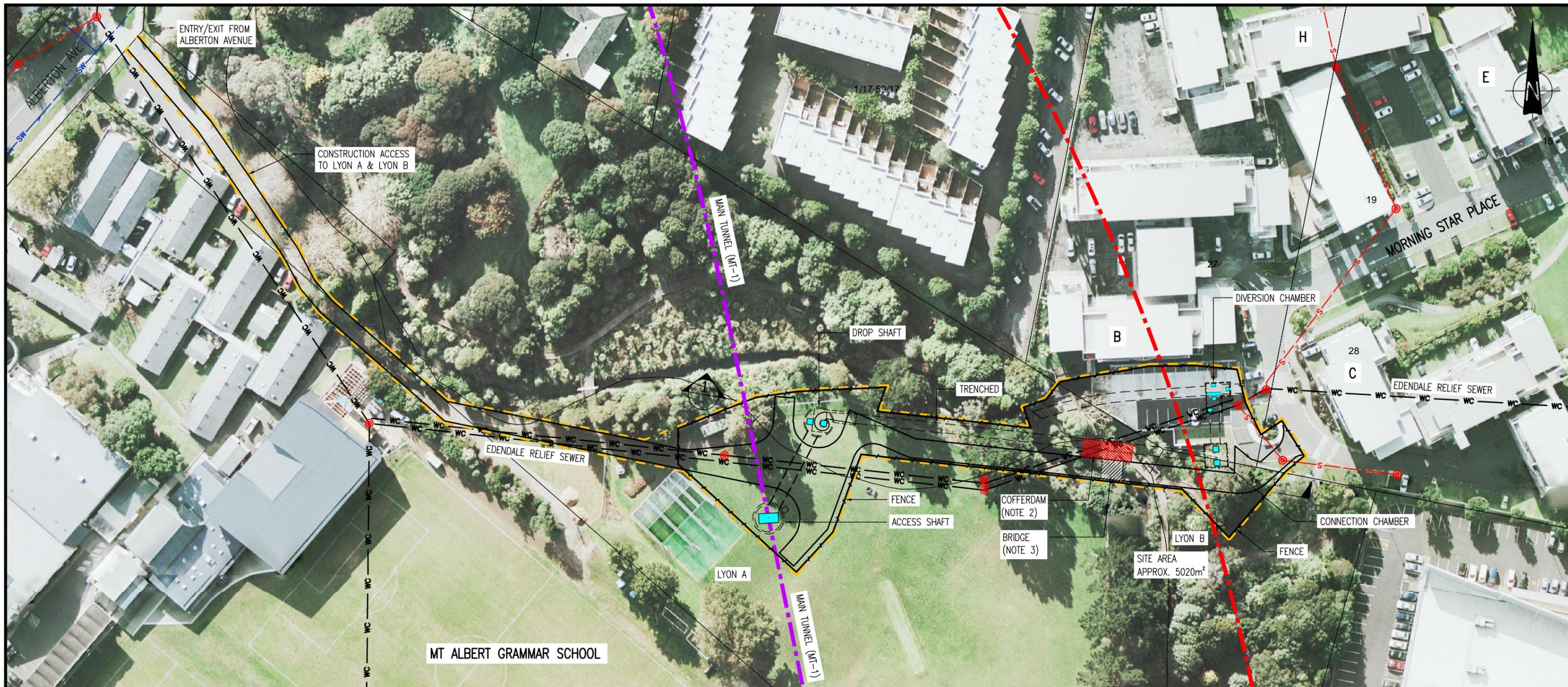
OPERATIONS
 ASSET MANAGER
 SITE LAYOUT AND DESIGNS INDICATIVE ONLY AND SUBJECT TO CHANGE DURING DETAILED DESIGN DEVELOPMENT
FOR INFORMATION



CENTRAL INTERCEPTOR
GENERAL - MT ALBERT GRAMMAR SCHOOL ALTERNATIVE 1
LYON AVENUE (AS2) - SEPARATE CONSTRUCTION ACCESS (PIPEJACK OPTION)

CAD FILE LYON-SK1001	DATE 19-Sep-13
ORIGINAL SCALE A1	CONTRACT No. 0538
1:1000 A3	
DRAWING No. LYON-SK1001	ISSUE C

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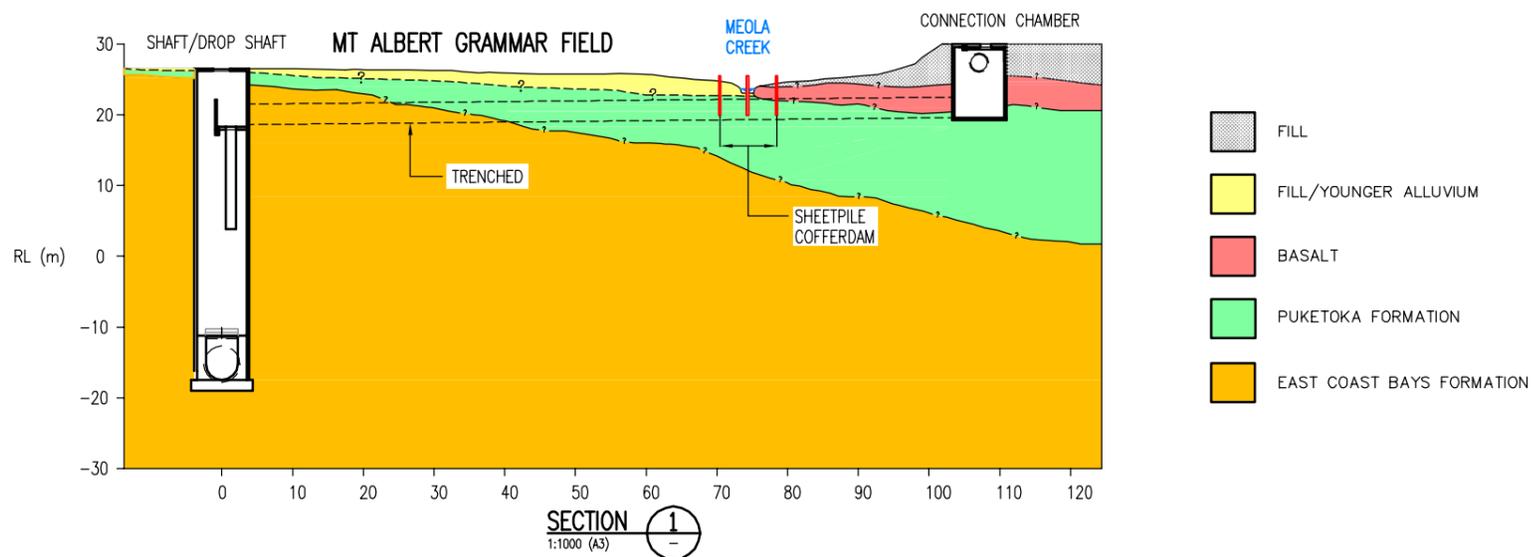


LEGEND

- - - - - PROPOSED TUNNEL ALIGNMENT
- - - - - MAGS ALTERNATIVE TUNNEL ALIGNMENT
- = = = = = CONNECTION PIPELINE
- - - - S - - - - EXISTING RETICULATION SEWER
- WC - EXISTING TRUNK SEWER
- SW - EXISTING STORMWATER
- - - - - PROPOSED SITE BOUNDARY
- LID/STRUCTURE FLUSH WITH GROUND
- LID/STRUCTURE ABOVE GROUND

NOTES:

1. SEE DRAWING LYON-SK401_OA FOR PLAN OF TUNNEL ALIGNMENTS FOR LYON AVE SITE OPTIONS.
2. MEAOLA STREAM TO BE DIVERTED LEFT AND THEN RIGHT WITHIN SHEETPILE COFFERDAM TO ALLOW CONSTRUCTION OF TRENCH AND PIPE LAYING. FOOTPATH TO BE DIVERTED.
3. BRIDGE REQUIRED FOR ACCESS ACROSS STREAM (EITHER PERMANENT OR TEMPORARY, DEPENDING ON ACCESS ARRANGEMENTS).



ISSUE	DATE	AMENDMENT	BY	APPD.	DESIGNED	DES. CHECKED	DRAWN	DWG. CHECKED	REV'D P.MGR	APP'D P.DIR	BY	DATE
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B	17/09/13	FOR INFORMATION	AP	JQC	NL	JQC	AP	NL	-	-		
A	-	DRAFT	AP	PR	NL	JQC	AP	NL	-	-		

OPERATIONS

SITE LAYOUT AND DESIGNS INDICATIVE ONLY AND SUBJECT TO CHANGE DURING DETAILED DESIGN DEVELOPMENT

ASSET MANAGER

FOR INFORMATION



CENTRAL INTERCEPTOR
GENERAL - MT ALBERT GRAMMAR SCHOOL ALTERNATIVE 2
LYON AVENUE (AS2) - CONSTRUCTION ACCESS FROM MAGS (TRENCHED OPTION)

CAD FILE LYON-SK1101	DATE 19-Sep-13
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DRAWING No. LYON-SK1101	ISSUE C



LEGEND

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- ==== CONNECTION PIPELINE
- - - - - CORRIDOR

Plot Date: 17-Sep-13 9:55 a.m.
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DES. CHECKED	JQC				
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DWG. CHECKED	NL				
REV'D P.MGR	JQC	AP	JQC		
APP'D P.DIR	CC	AP	PR		
ISSUE	DATE	AMENDMENT	BY	APPD.	BY DATE

OPERATIONS
ASSET MANAGER

SITE LAYOUT AND DESIGNS INDICATIVE ONLY AND SUBJECT TO CHANGE DURING DETAILED DESIGN DEVELOPMENT
FOR INFORMATION



**CENTRAL INTERCEPTOR
MT ALBERT GRAMMAR SCHOOL ALTERNATIVE
LYON AVENUE (AS2) - TUNNEL DISPLACEMENT**

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