Where the tests did not extend far enough to intersect the RESIDUAL CLAY or SHALE units, the depth is shown as a greater than the base of the hole.

7.3. Access road condition

Based on the results of the test pit investigation completed on the access road, including the laboratory testing programme we consider the access road subsurface profile to be as tabulated in Table 2.

TABLE 2
ACCESS ROAD SUBSURFACE PROFILE

START DEPTH (m)	END DEPTH (m)	UNIT	DESCRIPTION
0.00	0.02	SEAL	Asphalt
0.02	0.30 to 0.45	BASE COURSE	Sandy GRAVEL, 20 mm, subangular, Assessed field CBR = ~ 50%
0.30 to 0.45	0.70 to 0.80	FILL	Sand, fine to medium grained, well compacted Assessed field CBR = ~ 15%
0.70 to 0.80	N.A.	SUBGRADE	Residual clay stiff to hard Assessed field CBR = ~ 2%

Furthermore, the pavement was observed to be in good condition.

8. GROUNDWATER

With regards to groundwater the following observations were made:

1. During the fieldwork, groundwater was observed in test pit TP03 and TP05 at approximately 0.6 m below the ground level. It is our opinion that this represented perched groundwater associated with surface infiltration.
2. During borehole drilling, groundwater was observed at approximately 1.5 to 2.5 m below the ground level. It is our opinion that this represented a perched water table associated with surface infiltration.
3. On 2 July 2010, PSM measured the groundwater levels at the standpipe piezometers installed in BH02 and BH04. The readings showed the water levels were at depths of 3.54 m and 4.63 m respectively. We note that on 17 June 2010 during the fieldwork, BH02 was drilled with NMLC coring method which involved supplying water into the hole to enable coring. On this basis the water measurement in BH02 is likely to be affected by the drilling.

9. RECOMMENDATION

9.1. Excavation conditions

Based on our understanding of the project and the results of the investigation, we understand that remediation of the contaminated materials on site is likely to require excavation of the FILL and RESIDUAL CLAY units. We expect that excavation in these units will require the use of conventional earth moving equipment.

Minor excavation may be required in the SHALE unit. It is possible that some rock breaking using excavators fitted with rock hammers may be required in some of the stronger shale layers.

It is our experience that excavatability is heavily dependant on the work method, the operator and the plant used. The earthworks contractor should satisfy itself with regard to excavatability.

9.2. Permanent and Temporary Batters

As stated, we understand that remediation of the site will require excavation within the FILL and RESIDUAL CLAY units. The estimated typical excavation depth is less than 4.0 m with some deeper excavation, up to 8.0 m likely to be required in the vicinity of the northern gas holder and the tar wells.

The proposed excavations are likely to extend to the boundaries of the site. We have therefore considered the potential for the proposed excavation to impact on the following structures:

1. Rail tracks on the Illawarra rail line. The rail tracks are at least 10.0 m from the proposed extent of excavation. The overhead wire structures are at least 7.0 m from the proposed extent of excavation.
2. Noise wall along southern boundary. Excavation adjacent to the noise wall is proposed.
3. Rail tracks and buildings within the Stabling Yard. The rail tracks in the stabling yard are at least 10 m from the extent of the proposed excavation. The buildings in the stabling yards are at least 8.0 m from the proposed excavation. Pavement and services that may be located below the pavement are located adjacent to the proposed excavation.
4. The existing southern gasholder. Excavation adjacent to the gasholder is proposed.
5. Services on the western embankment. Excavation adjacent to these services is proposed.
6. Residential dwellings on Burren Street. The rear of the dwellings is set back at least 3.0m from the proposed extent of the excavation. The rear of the residential block may actually be closer to the excavation and could be adjacent to the excavation if the excavation was undertaken up to the boundary of the site.

In order to provide useful advice with regards to recommended batter slopes we have varied the recommended batter slope based on the maximum batter height and the presence of structures or adjacent properties such as those listed above in the vicinity of the batter crest.

The batter slope angles shown in Table 3 are recommended for the design of temporary cut batters. These batter slope angles assume a horizontal surface above the batter, and that no surcharge load (permanent i.e. structures or transient i.e. plant) is present at the crest of the batter.

All batters should be protected from erosion. Temporary batters should not be left unsupported for more than 1 month.

TABLE 3
TEMPORARY BATTER SLOPES

DISTANCE BETWEEN CREST AND STRUCTURE OR PROPERTY BOUNDARY	GEOTECHNICAL UNIT	**MAXIMUM BATTER HEIGHT**			
		<4 m	**<6 m**	**<8 m**	**<10 m**
More than the batter height	FILL	1H:1V	1.5H:1V	2H:1V	2H:1V
	RESIDUAL CLAY	1H:1V	1H:1V	1.5H:1V	2H:1V
Less than the batter height	FILL	2H:1V	2H:1V	2.5H:1V	2.5H:1V
	RESIDUAL CLAY	2H:1V	2H:1V	2H:1V	2.5H:1V

For excavations deeper than 10 m specific advice should be sought.

Permanent batters should be drained and battered at 3H:1V in FILL and 2.5H:1V in RESIDUAL CLAY.

All permanent batters should be inspected by a suitably qualified geotechnical engineer upon completion. Temporary batters where structures or adjacent properties are located within 1.0 m of the crest should be inspected by a suitably qualified geotechnical engineer during excavation. Furthermore, temporary batters higher than 6.0 m should be inspected by a suitably qualified geotechnical engineer during excavation.

We note that the above advice does not relieve the contractor of its responsibilities with regards to worker safety when working below the temporary batters.

Staging of construction to limit the plan extent of the excavation may be able to be adopted to result in localised steeper batter slopes. If such steeper slopes are required additional specific advice should be sought.

With regards to excavations adjacent to the existing southern gas tank, it is recommended that all water and fill within the tank be removed prior to undertaking any excavation adjacent to the tank. Prior to removing water from the tank, advice should be sought from the structural engineer regarding the effect of loss of hydrostatic pressures within the tank on the gas holder structure, including any potential loss of stability.

9.3. Retaining structures

Cuts in FILL and RESIDUAL CLAY steeper than the batter slopes in Section 9.2 will need to be supported by some form of retaining structure.

The design of these structures should be based on the following effective soil strength parameters:

- FILL - c'= 0 kPa and ϕ' = 25°
- RESIDUAL CLAY – c' = 5 kPa and ϕ' = 25°

We note that we have not provided earth pressure coefficients as these are dependent on the wall type and geometry, the batter angle, the backfill angle, the flexibility of the wall, the construction sequence, the acceptable deformation, surcharge etc. The retaining wall designer should consider all the above as part of the design.

Note that design of retention systems may be based on K_a or K_o pressures or some other distribution. Design using active earth pressures provides the minimum lateral earth pressure that must be supported to avoid failure and requires a wall that can rotate or translate to allow the pressures to reduce to these values (vertical and lateral movements up to 2% of height may occur, typical movements will be much less).

If there is concern regarding movement due to excavation affecting adjacent structures or in ground services, it is recommended that the design and construction be based on K_o pressures and construction be carefully controlled to avoid unwanted effects. It should be noted that designing for K_o pressures does not, of itself, ensure that movement does not occur. Movements are controlled by construction method, especially sequence. The proximity of the neighbouring buildings to the boundaries will need to be considered when designing the basement retaining structure.

9.4. Monitoring of structures during excavation works

9.4.1. Dilapidation surveys

Where a structure is located within two (2) batter heights of the crest of an excavation it is recommended that a dilapidation survey be undertaken prior to commencement of excavation.

In particular it is recommended that dilapidation surveys of the following structures be undertaken:

1. Noise wall along southern boundary.
2. Rail tracks and buildings within the Stabling Yard including the pavement and services located adjacent to the proposed excavation.

3. The existing southern gasholder.
4. Services on the western embankment.
5. Residential dwellings on Burren Street.
6. OHWS along the Illawarra rail line.

9.4.2. Monitoring of rail tracks on the Illawarra rail line and other structures

The contractor undertaking the excavation works shall prepare a Ground Movement Monitoring Plan (GMMP) setting out the proposed monitoring requirements for the Illawarra rail line and other structures during the excavation works. The GMMP shall be presented to RailCorp for approval prior to commencement of excavation works. The GMMP shall consider the requirements in RailCorp SPC207 "*Track monitoring requirements for undertrack excavation*". We note that at this stage undertrack excavation is not proposed.

The GMMP shall consider the adopted excavation depths, temporary batter angles, retaining structures, distance from the crest of the excavation to the rail line/structure and the distance from the toe of the excavation to the rail line/structure and propose a suitable monitoring schedule including:

- Monitoring locations,
- Monitoring frequency,
- Monitoring methodology, and
- Notification and intervention levels.

It is our opinion that monitoring of the rail line or structure is not required, where the rail line or structure is located at a distance at least twice the batter height from the crest of the excavation provided that the excavation has been battered or supported as per the recommendations in this report.

Nevertheless it is recommended that baseline surveys of all structures and rail line within 30 m of the crest of the proposed excavation be undertaken prior to commencement of the excavation. This would allow the effect of the excavation on the structure to be checked at a later date if required. Requirements for this baseline surveys should be included in the GMMP.

9.5. Reuse of materials as engineered fill

This section does not address the suitability of the material on site for reuse as fill from a contamination/environmental perspective. We have however assessed the suitability of the material for reuse as engineered fill.

With the exception of topsoil material, and any organic material present within the FILL unit, it is our opinion that an earthworks specification could be developed to allow placement of the majority of the excavated and remediated material as engineered fill.