



Douglas Partners

Geotechnics • Environment • Groundwater

Integrated Practical Solutions

REPORT

on

GEOTECHNICAL INVESTIGATION

PROPOSED PACIFIC NATIONAL DEPOT

MANSFIELD STREET, GRETA

Prepared for

SINCLAIR KNIGHT MERZ PTY LTD

on behalf of

PACIFIC NATIONAL

Project 39129.01

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TABLE OF CONTENTS

	Page
1. INTRODUCTION.....	1
2. SITE DESCRIPTION AND REGIONAL GEOLOGY	2
3. PREVIOUS INVESTIGATION BY DP	3
3.1 Inspection of Alleged Shafts and Subsidence Troughs.....	3
3.2 DP Comments on Alleged Shafts and Troughs.....	6
3.3 Information from Newcastle Regional Museum.....	7
4. INFORMATION PROVIDED BY MSB.....	8
5. FIELD WORK.....	9
5.1 Methods.....	9
5.2 Results.....	11
6. PROPOSED DEVELOPMENT	14
7. ANALYSIS.....	15
7.1 Record Trace RT 288	15
7.2 Depth of Cover	16
8. COMMENTS	17
8.1 Alignment of the RT	17
8.2 Evidence of Pothole Subsidence	17
8.3 Crush	18
9. REMEDIAL MEASURES AND RESTRICTIONS ON DEVELOPMENT	18
9.1 Subsidence Potholes	18
9.2 Shafts	19
10. RECOMMENDED ADDITIONAL INVESTIGATION.....	20
10.1 Pothole Subsidence between Sawyers Creek and the Great Northern Railway.....	20
10.2 “Shafts” and “Subsidence Troughs” Identified by the Surveyor	20
11. LIMITATIONS.....	21
REFERENCES.....	21

ATTACHMENTS

Notes Relating to this Report
 Borehole Logs 1 to 4
 Core Photographs
 Drawing 1 – Test Location Plan
 CCTV Camera Records – Bore 3 (DVD)

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27 October 2009

**MINE SUBSIDENCE RISK ASSESSMENT
PROPOSED PACIFIC NATIONAL DEPOT
MANSFIELD STREET
GRETA**

1. INTRODUCTION

This report presents the results of a Mine Subsidence investigation at the proposed rail facility to be constructed on the south-western side of the Great Northern Railway at Greta. The assessment was carried out at the request of Sinclair Knight Merz Pty Ltd (SKM) on behalf of Pacific National Pty Ltd (PN).

The purpose of the investigation was to determine a depth of cover to the coal seam at four borehole locations across the site in order to obtain information on the dip of the Greta Seam beneath the site and on the stability of the shallow mine workings.

The proposed development is a railway siding off the main northern line for the routine maintenance of PN trains together with several structures housing maintenance facilities.

The site is underlain by the abandoned workings of the Anvil Creek Colliery which by subsequent change of ownership also operated under the names of New Anvil Creek Colliery and Central Greta Colliery. Details of all these collieries are shown on the record trace RT 288, obtained from DPI - Minerals

DP previously conducted a preliminary study of mine subsidence hazard which is presented in DP Report 39129-04 dated 14 December 2004 (Ref 1). That study comprised a desk study and brief walk over to inspect depressions identified as “shafts” by the project surveyor.

For the purposes of the mine subsidence investigation, the client supplied a concept plan of the proposed rail maintenance facility by SKM and a report on the Geotechnical Assessment of Mine Workings, F3 Minmi to SH9 Branxton, Section Buchanan to Branxton, prepared for the NSW Roads & Traffic Authority by RCA Australia, ref 5102-003/0, January 2006, and a follow-up report on Additional Geotechnical Assessment of Mine Workings for the same area, ref 5102a-002/0, September 2007.

2. SITE DESCRIPTION AND REGIONAL GEOLOGY

The Greta PN site (“the site”) is identified as Lot 1 on an application for subdivision of Lot 300 in DP 1117342.

The proposed development is bordered on the north-east by the Great Northern Railway and to the south-west by the proposed Hunter Expressway from the F3 to Branxton.

The site extends about 2.4 km north from the southern boundary of the lot, near Greta Railway Station, and is about 0.5 km wide at its greatest width. Site access for road vehicles is proposed to be from Mansfield Street, Greta.

The approximate location of the site is shown on Drawing 1 attached.

Reference to the Newcastle Coalfields Regional Geology 1:100,000 Sheet indicates that the site is within the area of outcrop of the Maitland Group and underlain by the Greta Coal Measures. The Greta Coal Measures typically comprise sandstone, conglomerate, siltstone and coal. The Branxton Formation overlies the Greta Coal Measures and typically comprises conglomerate, sandstone and siltstone. The geology encountered while drilling was consistent with this description.

Although the Greta Coal Measures consists of four seams, the site is underlain by shallow workings in the Greta Seam which is known to consists of two splits in the vicinity of Greta.

3. PREVIOUS INVESTIGATION BY DP

Ref 1 presents the results of a preliminary geotechnical risk assessment undertaken by DP in 2004. That study covered mine subsidence hazard at this site and comprised a desk study and brief walk over to inspect depressions identified as “shafts” by the project surveyor. For full details of the results of that investigation reference should be made to the DP report.

Some relevant information is reproduced below.

3.1 Inspection of Alleged Shafts and Subsidence Troughs

A number of the alleged shafts had been identified by the surveyor. These were located, observed and photographed by the senior engineering geologist from DP. These features were generally round holes of about 2 m to 3 m diameter and were generally of shallow depth (Plate 1). The depth of one was obscured by vegetation and some had been partly filled with rubbish. The holes had distinct edges and appeared to have been purposefully excavated. Rock and soil fragments were observed around the top of many of the ‘shafts’. A number of the ‘shafts’ had walls of dry-placed stone (Plate 2). Another ‘shaft’ was excavated adjacent to, or possibly through, medium to high strength sandstone which formed two walls of this feature.



Plate 1 - Typical "Shaft" Without Lining



Plate 2 - "Shaft" with Dry Stone Lining

In addition to the 'shafts', two elongated shallow trough features were observed. These correspond to the 'subsidence' indicated on the plan provided by SKM. These features had their long axis aligned in a north south direction. The southernmost of these, at approximate Chainage 212 090 was about 8 m wide and 50 m in length (Plate 3). Approximately 7 m from the northern end of this trough, a circular 'shaft' of about 3.4 m diameter had been excavated through or adjacent to a sandstone outcrop.

The second of these features, at approximate Chainage 212 120 was about 4 m in width, 31 m in length and about 1.5 m deep (Plate 4). This trough was about 21 m north-west of a rock lined 'shaft', and also had a 3 m to 4 m diameter 'shaft' approximately 20 m from the northern end of the trough and on the projection of this feature. A number of stones had been placed to form a wall like structure on part of the western side of this feature. In the floor of the trough an old dead tree trunk was observed with a severe lean to the vertical. The tree did not appear to be in its growth position and was suggestive of possible filling in the base of the trough.

The locations of these surface features are indicated on Drawing 1.



Plate 3 - North South Trending "Trough"



Plate 4 - Second North South Trending Trough

3.2 DP Comments on Alleged Shafts and Troughs

The 'shafts' and associated troughs observed on site are somewhat enigmatic. The number and spacing of these is closer than is normally observed even where collieries were operating at shallow depths. It is extremely unlikely that such a large number of shafts would have been sunk through generally strong sandstone and conglomerate to such depths.

The elongated troughs observed during the site inspection appear, to the writer, to have the form of purposeful excavation rather than subsidence. In view of the large depth of cover in these areas, mine subsidence would not be expected to have such a localised expression.

There are two possible alternative explanations for the 'shafts'. The 'shafts' could be wells or cisterns associated with an abandoned town in this area as suggested by the landholder. Alternatively there may have been unrecorded workings of the upper split of the Greta Seam in this area. In that case the trough like depressions could be abandoned adits or possible pit falls over shallow workings. The latter is certainly possible but in the view of the writer not likely because:

- A shaft log on the RT does not indicate the present of any coal seam at a higher level;
- The number of 'shafts' is still very high, even for shallow workings.

Notwithstanding the above, it is recommended that investigation should be undertaken to determine if unrecorded shallow abandoned mines are present in an upper split.

3.3 Information from Newcastle Regional Museum

- The original shaft of Anvil Creek Colliery is reported as being 500 yards south-west of Greta Station and 105 feet deep. Some 170 yards south-east of that shaft an airshaft of 50 ft depth was sunk. Other shafts were subsequently sunk, and adits (tunnel entrances) excavated;
- The 1884 annual report of the Geological Survey of NSW indicates that the seam was generally 14 ft 4 $\frac{1}{2}$ " thick. This is similar to contemporary newspaper articles which indicate that the seam was 14 ft 2" to 14 ft 6 $\frac{1}{2}$ " (4.4 m) thick with a dip of 1 in 8 (about 7°) to the west. Newspapers also allude to a second seam of 4 ft 2" below the main seam;
- In 1871 and 1876/77 the mine was affected by fires which reportedly destroyed 1200 tonnes of coal between the main shaft and air shaft. It should be noted that the Main Shaft and Air shaft shown on the RT may relate to later operations and may not be the locus of the fire. The mine did not reopen until 1881;
- A crush in 1876 is reported to have closed some districts of the mine. It is not clear from the data if this was related to the mine fire;
- In the 1912 publication "Coalfields of Australia", it was reported that in the Greta Colliery (Central Greta) there were two seams 14 ft apart (4.3 m). The top seam was 14 ft 6" thick, whereas the bottom seam was on average 3 ft 7". Greta Colliery is believed to have only worked the top seam which was worked in two passes to the full seam thickness.

4. INFORMATION PROVIDED BY MSB

Information provided by the MSB indicated that a large pothole developed towards the southern end of the site, near the north western boundary of Lot 3 in DP 882276, in February 2009. As well as the large hole there were also four other smaller holes running south away from the large hole. It is understood that the MSB backfilled the pothole without undertaking survey to establish its exact location or dimensions. However the district officer of the MSB indicates that the hole was probably about 30 m long by 15m wide by 3 m to 4 m deep at the shallow end sloping down to 10m deep at the deep end. A photo of the large pothole provided by the MSB is reproduced as Plate 5. The District Officer also indicated “There have been two previous issues in the same immediate area as the big February pothole, in 2005 and 2008, making a total of four claims. I can’t explain why the subsidence history only started in 2005 but the board (MSB) was formed in 1961. Surface water running back towards the shallower areas seems to play a big role in the problems in this area. Maybe any previous subsidence was repaired by the colliery or a previous owner.”



Plate 5 - Large pothole towards southern end of the site, February 2009
Photo provided by the MSB

During a site inspection by the district officer, the DP Site Engineer was shown the approximate location of the pothole subsidence relative to the fence lines. The approximate location of the large pothole was plotted by the DP Engineer based on site features, offsets from fence lines and readings taken with a recreational grade GPS. It is shown on Drawing 1.

5. FIELD WORK

Given the magnitude of the pothole reported by the MSB, the mine subsidence hazard was considered to be a potential risk to the drill rig. To mitigate this risk it was decided to conduct a walk over inspection in the section of the site to be drilled to identify any areas of possible pothole subsidence.

A number of possible pothole subsidence features were observed between Sawyers Creek and the Great Northern Railway. The approximate locations of these features are shown on Drawing 1. Inquires to the MSB indicated that subsidence occurred in the same area in September 2007. The latter subsidence had been backfilled with material scraped from the bottom of the site dam.

Based on the above, it was decided to restrict drilling to areas without surface expressions of pothole subsidence and where the depth of cover over the workings exceeds 20 m.

5.1 Methods

5.1.1 Core Drilling

Core drilling was undertaken in the period 10 August 2009 to 24 August 2009 and comprised the following:

- Drilling of 4 bores (Bores 1 to 4) to depths ranging from 27.15 m to 71.9 m;
- The bores were generally advanced by auger drilling with standard penetration testing (SPT) in soils and HQ3 coring in the underlying rock;
- On-site logging by a geotechnical engineer, including core photography.

The bores were set out by a DP Engineer using surface features shown on the site plan and a recreational grade GPS. The accuracy of the latter was adversely affected by site vegetation in some locations. After completion of drilling the bores were surveyed for location and level by Monteath and Powys Surveyors (MPS) and the locations are shown on Drawing 1.

5.1.2 Down Hole Assessment of Bores

The Greta Colliery workings in the Greta Seam were intersected in Bore 3 and collapsed rubble material was encountered in Bore 2. Down hole camera and sonar methods were used to map the voids encountered to allow confirmation of the workings shown on the record trace.

The assessment comprised the following:

- Monitoring of gas prior to commencement;
- Confirmation of the depth to the roof and floor of the void in Bore 3 using a down-hole video camera in axial mode;
- Viewing of the void in Bore 3, using a tilt up down-hole CCTV camera. The orientation of the camera was obtained by viewing a magnetic card compass with the camera in vertical orientation prior to tilting up. The camera was rotated at approximately 45° increments (eg, N, NE, E, SE etc) prior to tilting up for viewing. The video was recorded to DVD,
- Measurement of the distance from the bore to the walls/obstructions within the void using a Sonar. The sonar measurements were taken for full revolutions with a built in compass allowing correlation with the video camera assessment. The camera data was used in conjunction with the sonar to distinguish between clear readings of the wall of the void and obstructions such as rubble.

5.2 Results

5.2.1 Core Drilling

Detailed test bore logs are attached and should be read in conjunction with the “Notes Relating to This Report”, which defines descriptive terms and classification methods.

The cored bores generally indicated a clay soil cover in the range 0.1 m to 2.0 m underlain by inter-bedded very fine grained sandstone and siltstone. The weathered rock was typically extremely low to low strength, but generally increased to medium or high strength between about 4 m and 10 m depth. The depth to the top of the Greta Seam was obtained in each bore with drilling continuing to the base of the seam/void or earlier termination due to ground conditions. The depths and levels of the top of the seam are summarised in Table 1 below.

Table 1 - Coordinates and Surface Level of Bore Locations, Depth and RL of the Top of Seam

Bores	Easting	Northing	Surface RL AHD	Seam Depth (m)	Seam RL AHD
Bore 1	348153.44	6382720.88	67.18	66.9	0.28
Bore 2	348334.15	6382747.72	56.91	33.25	23.66
Bore 3	348130.2	6382500.11	59.37	48.73	10.64
Bore 4	348297.2	6382577.79	53.84	24.4	29.44

Bore 1 was terminated within the Greta Seam at a depth of 71.9 m due to caving of the bore.

Bore 2 encountered a small void within the Greta Seam between the depths of 36.2 m and 36.55 m below which a rubble filled void extended to a depth of about 39.3 m (i.e. 2.75 m rubble and 0.35 m void). Some coke fragments were observed within the rubble suggesting that heating or, possibly, fires occurred in this area during the operating life of the mine. Bore 2 was terminated at a depth of 42.5 m in sandstone and siltstone, probably the interburden between the top and bottom split of the Greta Seam.

Bore 3 encountered an open void between the depths of 48.96 m and 52.88 m (3.92 m void) with rubble extending to a depth of about 53.9 m (total working section of about 4.94 m). Bore 3

was terminated at a depth of 54.85 m within a claystone unit of the Greta Seam because of the risk of rubble entrapping the core barrel and because clay material within the tuff was blocking water flow through the bit.

Bore 4 was terminated within the Greta seam at a depth of 27.15 m due to cave-in of the borehole wall in the coal seam and blockage of the water flow through the bit.

5.2.2 Groundwater

Groundwater levels measured in the four bores on 18 August 2009 are shown in Table 2 below.

Table 2 - Groundwater

Bore	Depth to Water (m)	Groundwater Level (AHD)
1	23.5	43.7
2	14.5	42.4
3	15.8	43.6
4	10.4	43.4

5.2.3 Axial CCTV Inspection

Because of turbid conditions below the standing water level, only limited visibility was available. Nevertheless the axial camera inspection confirmed the presence of rubble in Bore 2. and the top and bottom of the open void in Bore 3.

The bores were allowed to settle for about 1 week after which the bores were reinspected with the axial CCTV camera. No improvement in the clarity of the water had occurred during the intervening period. Bore 2 was found to be obstructed by a rock at about 33.36 m depth, near the top of the coal seam.

5.2.4 Tilt Up CCTV Inspection of Void in Bore 3

The void in Bore 3 was inspected using CCTV camera in conjunction with DP's side looking tilt up head. The inspection confirmed the presence of rubble on the floor possibly ranging from less than 50 mm diameter to in excess of 0.5 m.

The CCTV inspection also revealed the presence of 3 mine props (timbers) to the north of the bore. Two of the props were vertical and one leaned at an acute angle to the vertical. A possible fourth prop was lying on the floor of the workings. There appeared to be a vertical face extending upward from the top of the props suggesting that the timbered area had a lower roof height than the area of the workings intersected by the bore. This suggests that the timbered area may lie within a cut-through or alternatively could be an area of the workings with a reduced working section.

A pillar face was observed to the east of the bore.

MPEG images from the CCTV Inspection are included as a DVD in the attachments.

5.2.5 Sonar Inspection of Voids in Bore 3

The Sonar profiling identified an intersecting system of bords about 5 to 7 m in width. Reflections were observed from faces up to about 16 m to 18 m from the bore.

A sonagram is presented as Figure 1.

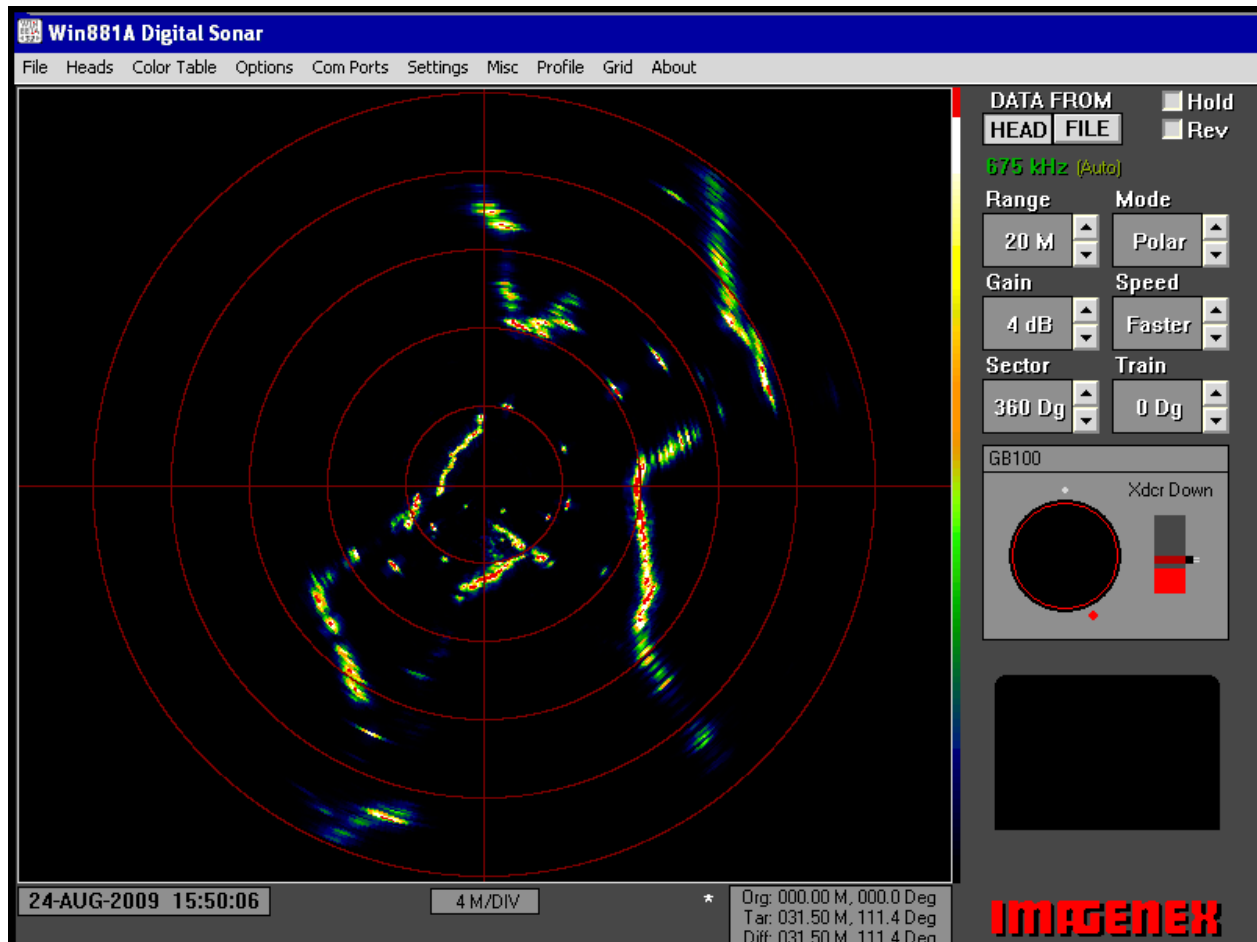


Figure 1 - Sonagram recorded in the void in Bore 3 at a depth of 51.5 m

6. PROPOSED DEVELOPMENT

It is understood that the proposed development is a facility for servicing coal trains. A rail siding will leave the Great Northern Railway near the southern end of the site and will bifurcate to form 6 tracks running approximately parallel to the existing railway.

An internal access road will enter from the southern boundary of the site and extend the length of the development approximately parallel to the western site boundary.

Other facilities are yet to be finalised but will probably include an administration building, fuel storage area and buildings to accommodate maintenance and refuelling operations.

7. ANALYSIS

7.1 Record Trace RT 288

An electronic copy of RT 288 was obtained from DPI-Minerals. Information obtained from the RT are described in the following paragraphs.

A number of mine shafts with depth annotations (sometimes several depths for the one shaft) were recorded on the RT. In the case of some shafts (such as the B and C Pits) the depth of the shaft is recorded as part of the original ink work. On other shafts depths are recorded in pencil and are of uncertain origin and accuracy.

The plan indicates that at least two generations of mining have occurred under the site. The older workings appear to occupy the northern and western areas of the site while the newer workings were located between the old workings and the subcrop of the coal seam in the south eastern area of the site.

The older mine workings include anomalous small unworked areas within the mine. No explanation for the coal being left in place is shown on the RT. It is also noted that the adjacent bords are sometimes open ended, suggesting that the RT may have been incomplete in these areas when the relevant mine district was abandoned.

The RT shows surface features such as Anvil Creek and Sawyers Creek and some of the older cadastre for Greta. It was initially attempted to align the RT to the modern cadastre using these features as recorded on historic Parish Maps. The resulting alignment produced a reasonable fit for the railway alignment shown on the RT and current cadastre at the northern part of the site but was a very poor fit for the southern half of the site. It was also significantly different from the MSB Model.

The RT was then georeferenced to a position similar to the MSB model. This was based on the MSB model coordinates for a number of shafts and other features interpolated from the MSB model. It should be noted that these coordinates are not based on actual survey data for the shafts and hence are indicative only. The resulting alignment of the RT to the modern cadastre is shown Drawing 1.

7.2 Depth of Cover

The RL of the top of the Greta Seam was calculated at each bore site from the depth measured in the bore and the surface RL at the bore collar measured by MPS. The coordinates of these bores were also provided by MPS.

The RL to the top of the seam for 4 bores previously drilled by the RTA was also calculated from the RL and depth to the top of seam at each bore given in Table 2 of Ref 3, provided by the Client. The bore locations were interpolated by DP from the Drawings in Ref 3 which showed the position of the bores relative to the mine workings. The geo-referenced RT was used in this process.

The seam RL and bore locations were used to extrapolate a Digital Elevation Model (DEM) of the seam RL using the MAPINFO DISCOVER module.

A DEM of the existing surface topography was interpolated from the 2 m site contours provided by the client was generated by DP with the MAPINFO-DISCOVER MODULE.

The DEM of the depth of cover over the top of the Greta Seam was determined using the MAPINFO-DISCOVER MODULE by subtracting the DEM of the RL of the top of the coal seam from the DEM of the surface RL for each cell of the DEM.

The DEM of depth of cover was then contoured in the MAPINFO-DISCOVER MODULE to produce the isopachs of the depth of cover over the seam given in Drawing 1.

It should be noted that the Isopachs of depth of cover are based on borehole data only and are independent of the assumptions made to align the RT to the modern cadastre.

8. COMMENTS

8.1 Alignment of the RT

Comparison of the position of the workings shown in Drawing 1 to the isopachs indicates a general consistency of the extent of mined areas with the depth of cover. The depths of cover were also compared to the depths given on the RT for the B and C Shafts and found to be generally consistent with these.

8.2 Evidence of Pothole Subsidence

As noted above there appears to be evidence of ongoing pothole formation in the southern areas of the site where cover over the workings is relatively low.

It is understood that a large pothole with plan dimensions of about 15 m by 30 m and a depth of up to 10 m was observed on the site near the north west corner of Lot 3 in DP 8822276 in February 2009. The location of this pothole is shown on Drawing 1. Reference to this drawing indicates that the pothole is in an area with about 12 to 15 m cover over the seam. The RT indicates that the site is underlain by first workings with a bord width of about 5 m although at some nearby locations bords intersect at an acute angle and form voids of up to 9 m width at the intersection.

Potholes over first workings of these dimensions typically have a surface expression of around 5 m width hence the size of the pothole is inconsistent with the layout of the workings as shown on the RT .

The dimensions of the pothole which developed in February 2009, therefore, suggest either:

- (1) unrecorded pillar extraction was undertaken in this area, or
- (2) the pillars were destroyed or severely weakened by fires in the underground workings which are known to have occurred in this mine, or

- (3) internal piping and erosion resulting in lateral undermining with subsequent collapse of the surface bridging layer.

As discussed above there is evidence of possible active potholing in the area between Sawyers Creek and the Great Northern Railway. The location of this area is shown on Drawing 1. Paradoxically the potholing appears to extend east of the workings to the contour of zero cover.

8.3 Crush

The historical data records a crush event in the workings. The location of that event is not clear but possibly coincides with the area of surface cracking which is marked on the RT to the west of the site. The depth of cover in that area ranges from about 100 m to 25 m. This area does not extend onto the PN Site.

8.3.1 Evidence of Fires

As noted above, historical records indicate that this colliery was affected by underground fires. The presence of coke observed in samples of coal rubble recovered from Bore 2, confirms that fires occurred under some areas of the site notwithstanding that there is no annotation in relation to fires in that area recorded on the RT.

9. REMEDIAL MEASURES AND RESTRICTIONS ON DEVELOPMENT

9.1 Subsidence Potholes

In view of the abnormally large dimension of potholes which have occurred on the site, together with the uncertainty as to the extent of pillar damage by underground fires, it is not considered feasible to adopt pothole subsidence design (where structures are designed to span possible potholes) on this site. The large size of the February 2009 pothole and its depth relative to the likely working section also suggests that future pothole subsidence may propagate to a height

exceeding the depth of 20 m commonly assumed to be the limit of pothole subsidence over first workings in the Newcastle CoalFields. Because of these uncertainties, it is suggested that a conservative value of 40 m cover should be adopted as the limit of pothole risk on this site.

It is therefore recommended that buildings, hard stands and fuel storage areas should be restricted to areas of the site with greater than 40 m cover over the coal seam. This is the area to the north west of the 40 m isopach indicated in red on Drawing 1.

In the area of the site with less than 40 m cover it is suggested that development be restricted to the proposed access road and rail spur. In areas of less than 40 m cover the mine workings below the footprint of the road and rail embankment should be fully grouted. The grouting should also extend laterally beyond the footprint of the road/rail embankment for a horizontal distance equivalent to one half of the depth of cover over the top of seam. (e.g. If the depth to the top of seam is 30 m then the grouting should extend at least 15 m beyond both sides of the footprint of the road/rail embankment).

Except for the access road and railway embankment, pedestrian and vehicular traffic should be restricted from areas of the site with less than 40 m cover unless a specific risk assessment is undertaken for the proposed access.

9.2 Shafts

At least two abandoned shafts are shown on the RT as being situated on the site and are indicated on Drawing 1.

The shafts are relatively remote from the proposed development areas and are expected to be included in the fenced-off area with high pothole subsidence risk.

It is unlikely that additional precautionary methods will be required unless development is planned closer to the shaft locations, in which case the precise locations of the shafts will need to be identified and they will need to be concrete-capped to the satisfaction of DPI-Minerals.

10. RECOMMENDED ADDITIONAL INVESTIGATION

10.1 Pothole Subsidence between Sawyers Creek and the Great Northern Railway

As discussed above possible pothole subsidence features were observed in the area believed to be outside the footprint of the mine workings between Sawyers Creek and the Great Northern Railway. Additional investigation is therefore required to confirm if these features are actually pot holes and if the mine workings extend further east than was inferred from the drilling and the RT. In view of the shallow depth to the seam at this area excavator test pits may be a suitable means of investigation.

10.2 “Shafts” and “Subsidence Troughs” Identified by the Surveyor

As noted above the surveyor previously identified a number of “shafts” and “subsidence troughs” in the northern area of the site. The “shafts” are too numerous to be credible as mine shafts associated with the deep workings in the Greta Seam shown on the RT. Similarly the depth of cover is too great for the “subsidence troughs” to be associated with subsidence in the underlying workings shown on the RT.

A possible alternative explanation could be that these shafts are associated with uncharted workings associated within a seam at shallow depth. While this is considered unlikely, it is imperative that subsurface investigation be undertaken to confirm the presence or absence of such workings in a shallow seam.

If the ‘shafts’ are not potholes associated with shallow workings, then additional investigation should be undertaken to determine the depth and nature of the backfill in these features to facilitate the design of remedial measures for these features.

11. LIMITATIONS

Conditions on site different to those identified during this assessment may exist. Therefore DP cannot provide unqualified warranties nor does DP assume any liability for site conditions not recorded in the data available for this study.

This report and associated documentation and the information herein have been prepared solely for the use of Pacific National and Sinclair Knight Merz Pty Ltd. Any reliance assumed by other parties on this report shall be at such party's own risk. Any ensuing liability resulting from use of the report by other parties cannot be transferred to DP.

DOUGLAS PARTNERS PTY LTD

Reviewed by:

Greg Hawkins
Senior Associate

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Principal

REFERENCES

1. DP, *Geotechnical Assessment of Mine Subsidence Risk, Proposed Rail Facility, Greta*, and DP Report 39129-04 dated 14 December 2004.
2. Newcastle regional Museum, *A History of the Greta Coal Measures (1861 to 1998)*, CD ISBN 0 6463 44 64 1.
3. RCA Australia; *Mine Stability Assessment; F3 to Branxton, RCA ref 5102a-002/0 September 2007*.

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing with a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole is advanced using 90—115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water

table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" — Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7
as 4, 6, 7
N = 13
- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm
as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6) N \text{ (blows per 300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

$$q_c = (12 \text{ to } 18) c_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. Normally, there is a depth limitation of 1.2 m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Bore Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be

the same at the time of construction as are indicated in the report.

- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section

is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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AN ENGINEERING CLASSIFICATION OF SEDIMENTARY ROCKS IN THE SYDNEY AREA

This classification system provides a standardized terminology for the engineering description of the sandstone and shales in the Sydney area, but the terms and definitions may be used elsewhere when applicable.

Under this system rocks are classified by Rock Type, Degree of Weathering, Strength, Stratification Spacing, and Degree of Fracturing. These terms do not cover the full range of engineering properties. Descriptions of rock may also need to refer to other properties (e.g. durability, abrasiveness, etc.) where these are relevant.

ROCK TYPE DEFINITIONS

Rock Type	Definition
Conglomerate:	More than 50% of the rock consists of gravel sized (greater than 2mm) fragments
Sandstone:	More than 50% of the rock consists of sand sized (.06 to 2mm) fragments
Siltstone:	More than 50% of the rock consists of silt-sized (less than 0.06mm) granular particles and the rock is not laminated
Claystone:	More than 50% of the rock consists of clay or sericitic material and the rock is not laminated
Shale:	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. clayey sandstone, sandy shale.

DEGREE OF WEATHERING

Term	Symbol	Definition
Extremely Weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately Weathered	MW	Rock substance affected by weathering to the extent that staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is no longer recognisable.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fs	Rock substance unaffected by weathering, limonite staining along joints.
Fresh	Fr	Rock substance unaffected by weathering.

STRATIFICATION SPACING

Term	Separation of Stratification Planes
Thinly laminated	<6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	>2 m

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics (Reference).

Strength Term	Is(50) MPa	Field Guide	Approx. qu MPa*
Extremely Low:	0.03	Easily remoulded by hand to a material with soil properties	0.7
Very Low:	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.	2.4
Low:	0.3	A piece of core 150 mm long x 50 mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	7
Medium:	1	A piece of core 150 mm long x 50 mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.	24
High:	3	A piece of core 150 mm long x 50 mm dia. cannot be broken by unaided hands, can be slightly scratched or scored with knife.	70
Very High:	10	A piece of core 150 mm long x 50 mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	240
Extremely High:		A piece of core 150 mm long x 50 mm dia. is difficult to break with hand held hammer. Rings when struck with a hammer.	

* The approximate unconfined compressive strength (qu) shown in the table is based on an assumed ratio to the point load index of 24:1. This ratio may vary widely.

DEGREE OF FRACTURING

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude known artificial fractures such as drilling breaks

Term	Description
Fragmented:	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than the core diameter.
Highly Fractured:	Core lengths are generally less than 20 mm - 40 mm with occasional fragments.
Fractured:	Core lengths are mainly 30 mm - 100 mm with occasional shorter and longer sections.
Slightly Fractured:	Core lengths are generally 300 mm - 1000 mm with occasional longer sections and occasional sections of 100 mm - 300 mm.
Unbroken:	The core does not contain any fracture.

REFERENCE

International Society of Rock Mechanics, Commission on Standardisation of Laboratory and Field Tests, Suggested Methods for Determining the Uniaxial Compressive Strength of Rock Materials and the Point Load Strength Index, Committee on Laboratory Tests Document No. 1 Final Draft October 1972

GRAPHIC SYMBOLS FOR SOIL & ROCK

SOIL

	BITUMINOUS CONCRETE
	CONCRETE
	TOPSOIL
	FILLING
	PEAT
	CLAY
	SILTY CLAY
	SANDY CLAY
	GRAVELLY CLAY
	SHALY CLAY
	SILT
	CLAYEY SILT
	SANDY SILT
	SAND
	CLAYEY SAND
	SILTY SAND
	GRAVEL
	SANDY GRAVEL
	CLAYEY GRAVEL
	COBBLES/BOULDERS
	TALUS

SEDIMENTARY ROCK

	BOULDER CONGLOMERATE
	CONGLOMERATE
	CONGLOMERATIC SANDSTONE
	SANDSTONE FINE GRAINED
	SANDSTONE COARSE GRAINED
	SILTSTONE
	LAMINITE
	MUDSTONE, CLAYSTONE, SHALE
	COAL
	LIMESTONE

METAMORPHIC ROCK

	SLATE, PHYLITTE, SCHIST
	GNEISS
	QUARTZITE

IGNEOUS ROCK

	GRANITE
	DOLERITE, BASALT
	TUFF
	PORPHYRY



BOREHOLE LOG

CLIENT: Pacific National C/- Sinclair Knight Merz Pty Ltd
PROJECT: Proposed Pacific National Depot
LOCATION: Mansfield Street, Greta

SURFACE LEVEL: 67.18 AHD
EASTING: 348153.44
NORTHING: 6382720.88
DIP/AZIMUTH: 90°/-

BORE No: 1
PROJECT No: 39129.01
DATE: 10-13/8/09
SHEET 1 OF 8

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint D - Drill Break	Type
67	0	SANDSTONE - Extremely low strength, extremely weathered, orange-brown fine grained sandstone, behaves like clayey sand to 0.75m then increasing resistance to 1.0m (almost tc-bit refusal)																A			
66	1																				
65	1.6	SANDSTONE - Medium to high strength, highly to moderately weathered, orange-brown with pale grey bands, fine grained sandstone, irregular bedding From 1.74m to 1.78m, clay seam, grey																C	100	85	PL(A) = 1.04MPa PL(A) = 0.45MPa
64	2																				
63	3																				
62	4																				
61	4.18	SANDSTONE - High to very high strength, fresh stained, grey fine to very fine grained sandstone, trace coarse sand and pebbles, irregular bedding																C	100	89	PL(A) = 1.83MPa
60	5																				
59	6																				
58	7	At 6.92m, conglomerate 70mm thick From 7.0m, fresh																C	100	94	PL(A) = 4.69MPa PL(D) = 2.64MPa
57	8																				
56	9																	C	100	100	
55																		C	100	100	

RIG: Scout 2

DRILLER: Ground Test (Simon)

LOGGED: Bear

CASING: HW - 4.3m

TYPE OF BORING: Solid flight auger to 1.0m, HQ coring from 1.6m to 71.9m

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: 50% water loss at 58.5m, 100% water loss at 59.37m, 80% to 100% water loss from 60m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U	Tube sample (x mm dia.)	PL	Point load strength ls(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	Δ	Water seep
		≡	Water level

CHECKED
Initials:
Date:



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BOREHOLE LOG

CLIENT: Pacific National C/- Sinclair Knight Merz Pty Ltd
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LOCATION: Mansfield Street, Greta

SURFACE LEVEL: 67.18 AHD
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NORTHING: 6382720.88
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 39129.01
DATE: 10-13/8/09
SHEET 2 OF 8

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength				Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing			Test Results & Comments				
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low		Low	Medium	High	Very High	Ex High	0.01	0.05	0.10	0.50		1.00	B - Bedding S - Shear	J - Joint D - Drill Break	Type
57	10.0	SANDSTONE - High to very high strength, fresh, grey fine to very fine grained sandstone, trace coarse sand and pebbles																								
56	11																					C	100	100		
55	12																									
54	13																			13.1m: J, 60°, pl, ro		C	100	100		
53	14																									
52	15	At 14.8m, rock fragment, subrounded, > 70mm																								PL(A) = 2.74MPa PL(D) = 2.22MPa
51	16																			15.2m: P, 5°, pl, sm, open 15.37m: P, 5°, pl, sm						
50	17																					C	100	100		
49	18																			17.81m: J, 15°, pl, sm, open 18.36m: J, 30°, pl, sm						
48	19																					C	100	100		

RIG: Scout 2

DRILLER: Ground Test (Simon)

LOGGED: Bear

CASING: HW - 4.3m

TYPE OF BORING: Solid flight auger to 1.0m, HQ coring from 1.6m to 71.9m

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: 50% water loss at 58.5m, 100% water loss at 59.37m, 80% to 100% water loss from 60m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U	Tube sample (x mm dia.)	PL	Point load strength ls(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	Δ	Water seep
		≡	Water level

CHECKED
Initials:
Date:



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BOREHOLE LOG

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LOCATION: Mansfield Street, Greta

SURFACE LEVEL: 67.18 AHD
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NORTHING: 6382720.88
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 39129.01
DATE: 10-13/8/09
SHEET 3 OF 8

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing							
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint D - Drill Break	Type	Core Rec. %	RQD %	Test Results & Comments
47		SANDSTONE - High to very high strength, fresh, grey fine to very fine grained sandstone, trace coarse sand and pebbles <i>(continued)</i>																										
21																												
46																												
22																												
45																												
23																												
44																												
24																												
43																												
25																												
42																												
26																												
41																												
27																												
40																												
28		At 27.93m, pebbly band with some calcite, 70mm thick																										
39		From 28.5m to 29.37m, pebbly bands with some irregular calcite blebs																										
29																												
38																												
29.32		CORE LOSS																										
29.35																												

RIG: Scout 2

DRILLER: Ground Test (Simon)

LOGGED: Bear

CASING: HW - 4.3m

TYPE OF BORING: Solid flight auger to 1.0m, HQ coring from 1.6m to 71.9m

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: 50% water loss at 58.5m, 100% water loss at 59.37m, 80% to 100% water loss from 60m

SAMPLING & IN SITU TESTING LEGEND		
A	Auger sample	pp Pocket penetrometer (kPa)
D	Disturbed sample	PID Photo ionisation detector
B	Bulk sample	S Standard penetration test
U	Tube sample (x mm dia.)	PL Point load strength ls(50) MPa
W	Water sample	V Shear Vane (kPa)
C	Core drilling	▷ Water seep
		↕ Water level

CHECKED
Initials:
Date:



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BOREHOLE LOG

CLIENT: Pacific National C/- Sinclair Knight Merz Pty Ltd
PROJECT: Proposed Pacific National Depot
LOCATION: Mansfield Street, Greta

SURFACE LEVEL: 67.18 AHD
EASTING: 348153.44
NORTHING: 6382720.88
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 39129.01
DATE: 10-13/8/09
SHEET 4 OF 8

RL	Depth (m)	Description of Strata	Degree of Weathering				Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing							
			EW	HW	MW	SW		FS	FR	Ex Low	Very Low	Low			Medium	High	Very High	Ex High	B - Bedding S - Shear	J - Joint D - Drill Break	Type	Core Rec. %	RQD %	Test Results & Comments
37		At 29.98m, coarse gravel/cobble sized inclusions SANDSTONE - High to very high strength, fresh, grey fine to very fine grained sandstone, trace coarse sand and gravel inclusion, irregular bedding, some light grey laminations (<i>continued</i>) From 30.3m, pyrite flecks and blebs up to 35mm At 30.45m, off white coloured subangular inclusion, possibly feldspar																C	100	100	PL(D) = 1.82MPa PL(A) = 2.54MPa			
31																								
36																			C	100		100		
32																								
35																								
33																								
34																			C	100		100		
34																								
33																		C	100	100				
35																								
32																								
36																								
31																								
37																		C	100	100				
30																								
38																								
29																								
39																		C	100	100				
28																								

RIG: Scout 2

DRILLER: Ground Test (Simon)

LOGGED: Bear

CASING: HW - 4.3m

TYPE OF BORING: Solid flight auger to 1.0m, HQ coring from 1.6m to 71.9m

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: 50% water loss at 58.5m, 100% water loss at 59.37m, 80% to 100% water loss from 60m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	Δ	Water seep
		≡	Water level

CHECKED
Initials:
Date:



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BOREHOLE LOG

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NORTHING: 6382720.88
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 39129.01
DATE: 10-13/8/09
SHEET 5 OF 8

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities			Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		Ex Low	Very Low	Low	Medium	High	Very High					Type	Core Rec. %	RQD %	Test Results & Comments
40.0		SANDSTONE - High to very high strength, fresh, grey fine to very fine grained sandstone, trace coarse sand and gravel, irregular bedding, some light grey laminations																				
27																						
41																						
26																						
42		From 48.15m to 48.65m, calcite blebs, and some pebbles At 48.5m, 60mm pale grey band																				
25																						
43																						
24																						
44		From 48.15m to 48.65m, calcite blebs, and some pebbles At 48.5m, 60mm pale grey band																				
23																						
45																						
22																						
46		From 48.15m to 48.65m, calcite blebs, and some pebbles At 48.5m, 60mm pale grey band																				
21																						
47																						
20																						
48		From 48.15m to 48.65m, calcite blebs, and some pebbles At 48.5m, 60mm pale grey band																				
19																						
49																						
18																						

RIG: Scout 2

DRILLER: Ground Test (Simon)

LOGGED: Bear

CASING: HW - 4.3m

TYPE OF BORING: Solid flight auger to 1.0m, HQ coring from 1.6m to 71.9m

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: 50% water loss at 58.5m, 100% water loss at 59.37m, 80% to 100% water loss from 60m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	Δ	Water seep
		≡	Water level

CHECKED
Initials:
Date:



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BOREHOLE LOG

CLIENT: Pacific National C/- Sinclair Knight Merz Pty Ltd
PROJECT: Proposed Pacific National Depot
LOCATION: Mansfield Street, Greta

SURFACE LEVEL: 67.18 AHD
EASTING: 348153.44
NORTHING: 6382720.88
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 39129.01
DATE: 10-13/8/09
SHEET 6 OF 8

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint D - Drill Break	Type	Core Rec. %
17		SANDSTONE - High to very high strength, fresh, grey fine to very fine grained sandstone, trace coarse sand and gravel, irregular bedding, some light grey laminations <i>(continued)</i>																								
51		From 50.38m, pebbly with some calcite																				C	100	100	PL(A) = 2.37MPa PL(D) = 0.92MPa	
16																										
52																						C	100	100		
15																										
53																										
53.1		CONGLOMERATE - High strength, fresh, grey conglomerate																								
14																										
54																										
54.0		SANDSTONE - High to very high strength, fresh, grey fine grained sandstone with trace carbonaceous laminations, slightly fractured, bedding appears massive, conglomerate bands																								
13		At 54.36m, conglomerate, 120mm thick																				C	100	100		
55																										
12																										
56		At 56.42m, conglomerate, 40mm thick																							PL(A) = 4.05MPa PL(D) = 4.42MPa	
11																										
57																										
10																										
58		At 57.95m, conglomerate, 100mm thick																				C	100	100		
9																										
59																										
8																										

RIG: Scout 2

DRILLER: Ground Test (Simon)

LOGGED: Bear

CASING: HW - 4.3m

TYPE OF BORING: Solid flight auger to 1.0m, HQ coring from 1.6m to 71.9m

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: 50% water loss at 58.5m, 100% water loss at 59.37m, 80% to 100% water loss from 60m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U _x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	Δ	Water seep
		≡	Water level

CHECKED

Initials:

Date:



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BOREHOLE LOG

CLIENT: Pacific National C/- Sinclair Knight Merz Pty Ltd
PROJECT: Proposed Pacific National Depot
LOCATION: Mansfield Street, Greta

SURFACE LEVEL: 67.18 AHD
EASTING: 348153.44
NORTHING: 6382720.88
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 39129.01
DATE: 10-13/8/09
SHEET 7 OF 8

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint D - Drill Break	Type
7		SANDSTONE - High to very high strength, fresh, grey fine grained sandstone with trace carbonaceous laminations, slightly fractured, bedding appears massive, conglomerate bands (<i>continued</i>) At 60.60m, conglomerate, 470mm thick														59.9m: P, sh, pl, sm, cy 60.08m: J, 70°, pl, he, calcite 60.32m: J, 35°, pl, he, calcite	C	100	100	PL(A) = 5.3MPa PL(D) = 5.03MPa PL(D) = 6.94MPa	
61																					
6		At 61.8m, conglomerate 100mm thick														61.14m: J, 45°, pl, he, ca 61.42m: P, sh, un, ro 61.58m: P, 5°, un, ro	C	100	100		
62																					
5																					
62.81		CONGLOMERATE - High to very high strength, fresh, grey conglomerate																			PL(A) = 2.24MPa PL(D) = 1.14MPa PL(A) = 1.6MPa
63																					
63.45		SANDSTONE - High to very high strength, fresh, grey fine grained sandstone with trace carbonaceous laminations, slightly fractured, bedding appears massive, conglomerate bands At 64.26m, conglomerate, 108mm thick																			
64																63.89m: P, 10°, pl, sm, cy					PL(A) = 2.69MPa
65																					
66																					
66.0		CONGLOMERATE - High to very high strength, fresh, grey conglomerate At 66.53m, sandstone, 70mm thick																			PL(A) = 3.63MPa PL(D) = 3.86MPa PL(A) = 3.95MPa PL(D) = 3.71MPa
67																					
66.9		COAL - Medium to high strength, slightly weathered, black and dark brown coal, fractured to highly fractured with subvertical cleating, bands and nodules of pyrite. Bright and dull banded														From 67m, sv cleats, 200mm to 440mm in length	C	100	65		
68																					
68.2		At 68m, brown sandstone/tuff, 50mm From 68.05m, black coal														67.77m: J, pl, sm (67.55m to 67.99m)					
68.5		CORE LOSS														68.2m: CORE LOSS: 300mm From 68.5m, sv cleats					
69		COAL - Medium to high strength, slightly weathered, black highly fractured to fragmented, bright coal At 69.75m, brown sandstone/tuff,															C	88	0		

RIG: Scout 2 **DRILLER:** Ground Test (Simon) **LOGGED:** Bear **CASING:** HW - 4.3m
TYPE OF BORING: Solid flight auger to 1.0m, HQ coring from 1.6m to 71.9m
WATER OBSERVATIONS: No free groundwater observed during drilling
REMARKS: 50% water loss at 58.5m, 100% water loss at 59.37m, 80% to 100% water loss from 60m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	Δ	Water seep
		≡	Water level

CHECKED
Initials:
Date:



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BOREHOLE LOG

CLIENT: Pacific National C/- Sinclair Knight Merz Pty Ltd
PROJECT: Proposed Pacific National Depot
LOCATION: Mansfield Street, Greta

SURFACE LEVEL: 67.18 AHD
EASTING: 348153.44
NORTHING: 6382720.88
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 39129.01
DATE: 10-13/8/09
SHEET 8 OF 8

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing				
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint D - Drill Break	Type
-3		110mm COAL - Medium to high strength, slightly weathered, black highly fractured to fragmented, bright coal <i>(continued)</i>																C	88	0	
71																		C	100	20	
71.9		Bore discontinued at 71.9m, bore terminated due to cave in																			
72																					
73																					
74																					
75																					
76																					
77																					
78																					
79																					

RIG: Scout 2

DRILLER: Ground Test (Simon)

LOGGED: Bear

CASING: HW - 4.3m

TYPE OF BORING: Solid flight auger to 1.0m, HQ coring from 1.6m to 71.9m

WATER OBSERVATIONS: No free groundwater observed during drilling

REMARKS: 50% water loss at 58.5m, 100% water loss at 59.37m, 80% to 100% water loss from 60m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	Δ	Water seep
		≡	Water level

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Initials:
Date:



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BOREHOLE LOG

CLIENT: Pacific National C/- Sinclair Knight Merz Pty Ltd
PROJECT: Proposed Pacific National Depot
LOCATION: Mansfield Street, Greta

SURFACE LEVEL: 56.91 AHD
EASTING: 348334.15
NORTHING: 6382747.72
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 39129.01
DATE: 13-17/08/09
SHEET 1 OF 5

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint D - Drill Break	Type	Core Rec. %
56 1	0.4	SILTY CLAY - Dark brown silty clay																								200 - 250 kPa 11,14,20 N = 34 > 600 kPa
		CLAY - Very stiff, brown clay with some silt and sand, M>Wp																				pp				
	0.8	SANDSTONE - Extremely low strength, extremely weathered, light grey and red clayey sandstone																					S, pp			
55 2																										
54 3																										
53 4	3.25	SANDSTONE - Very low strength, highly weathered red and orange-brown, fine grained sandstone with bands of extremely low strength, extremely weathered light grey clayey sandstone																								PL(A) = 0.41MPa PL(A) = 0.38MPa
		From 4.3m, orange-brown and grey low to medium strength, highly to moderately weathered sandstone																								
52 5																										
51 6	5.75	SANDSTONE - Medium strength, slightly weathered to fresh, grey sandstone with irregular bedding, very fine to fine grained with some carbonaceous laminations																								PL(A) = 0.63MPa
50 7																										
49 8																										
48 9		From 8.5m, high strength, fresh																								
47																										

RIG: Scout 2 **DRILLER:** Ground Test (Simon) **LOGGED:** Bear **CASING:** HW - 2.9m
TYPE OF BORING: Solid flight auger to 2.5m, HQ coring from 3.25m to 42.5m
WATER OBSERVATIONS: No free groundwater observed during drilling
REMARKS: Water loss at 17.81m

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	Δ	Water seep ∇ Water level

CHECKED
Initials:
Date:



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