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PRELIMINARY CONTAMINATION AND GEOTECHNICAL ASSESSMENT

PROPOSED RESIDENTIAL SUBDIVISION MINMI AND LINK ROAD

Prepared for

COAL AND ALLIED OPERATIONS PTY LIMITED

Project 39663C

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PRELIMINARY CONTAMINATION AND GEOTECHNICAL ASSESSMENT PROPOSED RESIDENTIAL SUBDIVISION MINMI AND LINK ROAD

1. INTRODUCTION

This report presents the results of a preliminary contamination and geotechnical assessment for a proposed residential subdivision at Minmi and Link Road. The assessment was carried out at the request of Coal and Allied Operations Pty Limited, in consultation with Catylis Pty Ltd.

The assessment comprised the following components:

- Desktop review of regional geology, hydrogeology, and acid sulphate soils;
- Review of previous mining operations beneath the subject site;
- History review including a review of aerial photos since 1955 and interviews with local residents;
- Site walkover survey to describe the current site condition and surface features;
- Subsurface investigation by test pit and drilling;
- Soil sampling and chemical testing;
- Comments on actual and anticipated development constraints and opportunities including the following:
    - Potential contamination;
    - Depth, extent and nature of filling, including the presence of potentially combustible material;

- Depth of groundwater;
- Presence of soft alluvial soils and acid sulphate soils;
- Likely founding conditions;
- Presence of aggressive soil conditions with respect to buried structures;
- Presence of shallow rock;

* General recommendations for further investigation.

The contamination assessment was being carried out in general accordance with the NSW EPA "Guidelines for Consultants Reporting on Contaminated Sites" (Ref 1) and SEPP 55 "Remediation of Land" (Ref 2).

A mine subsidence investigation of the site was conducted in conjunction with this report (DP Project No 39663D, Ref 3).

2. SITE IDENTIFICATION

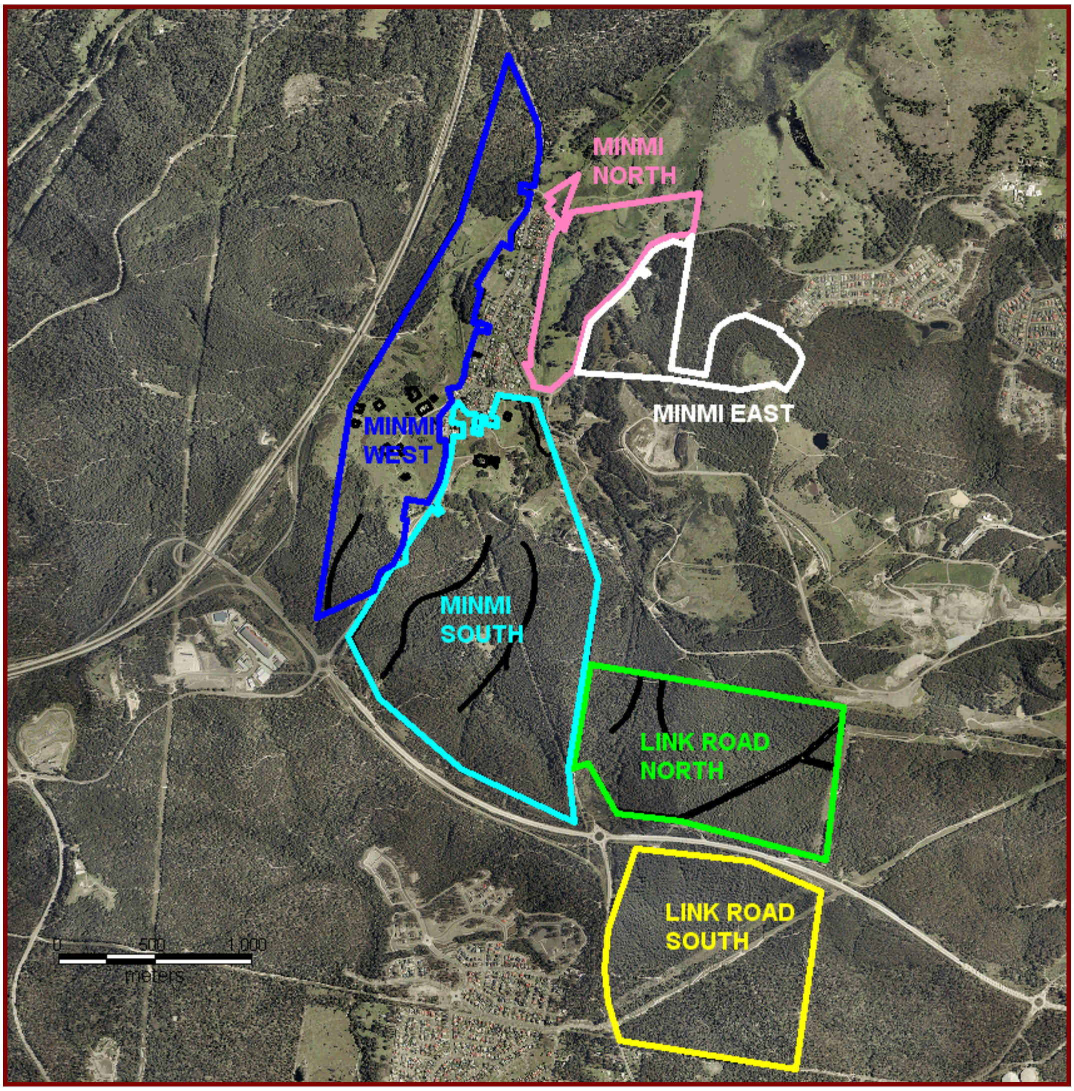
The Minmi site is identified as Lot 71 DP 1065169, Lot 351 DP 1108608 (formerly Lot 35 DP 800036), within the Newcastle City Council (NCC) area Lot 6 DP 1044574, Lots 2 and 3 DP 877349 within the Lake Macquarie City Council (LMCC) area.

Within the NCC area the land is zoned 2(a) Residential in the immediate vicinity of Minmi and south of Fletcher, 7(b) Environmental Protection Zone, and 7(c) Environmental Investigation Zone. Within the LMCC area the land is zoned 7(2) Conservation (Secondary) and the south – west corner zoned 10 Urban Conservation, with a small area between the two, zoned 5 Infrastructure.

For purposes of this assessment, the site has been divided into six areas. The extent of each of the potential development areas is shown on Figure 1 below. Each area is described as follows:

* ***Minmi West:*** This area is between Woodford Street, which bisects the Minmi village in a north-south direction, and the F3 freeway to the west. The area has an irregular shape with an overall area of about 100 hectares;

- ***Minmi North***: This area is to the east of the Minmi township and to the north/west of Minmi Road. The area is generally low lying and has an area of about 40 ha;
- ***Minmi East***: This area is to the east of Minmi Road and north of the Summerhill Waste Disposal Centre. The area has an irregular shape with two sub areas, one to the west and one to the east. The overall surface area is about 45 ha;
- ***Minmi South***: This area is between the Minmi Township and the Newcastle Link Road to the South, it has an area of about 170 ha;
- ***Link Road South***: This is an approximately square area to the south of the Newcastle Link Road and East of Minmi Road with an area of about 100 ha;
- ***Link Road North:*** This area is also approximately square and immediately north of the Link Road. It has an area of about 100 ha.



Locality Plan

Adjacent land use comprised the following:

- Low lying farm land and sewage treatment works north and downslope of Minmi North Area;
- Township of Minmi between Minmi North and West areas, generally upslope;
- Bushland and F3 freeway to west of Minmi West area, generally upslope of site;
- Bushland and Newcastle Link Road to the south of Minmi South area;
- Bushland to the south of Link Road North area;
- Bushland to east of Link Road North and South areas;
- Bushland and residential development west and south of Link Road South, generally downslope of the site;
- Summerhill Waste Facility between Minmi East and Link Road North and east of Minmi South areas;
- Minmi Cemetery immediately east of Minmi South area.

3. DESKTOP REVIEW

3.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

The 1:100,000 scale Newcastle Coalfield Regional Geology map indicates the site is generally underlain, from north to south, by the Tomago Coal Measures (siltstone, sandstone, claystone, coal, tuff), the Newcastle Coal Measures Waratah Sandstone, and the Newcastle Coal Measures Lambton Subgroup (sandstone, siltstone, claystone, coal and tuff). The mapping does not indicate the presence of alluvial sediments, however as discussed below, alluvial soils are expected on the northern portions of Minmi West and Minmi North, as mapped on Drawing 4 attached.

Reference to the CALM soil landscape map for Gosford-Lake Macquarie indicates the soils at the site fall into three typical landscapes as follows:

Killingworth: The majority of the site soils including most of the Link Road sites, Minmi South and the southern portions of Minmi West are mapped as the Killingworth Landscape and typical limitations include the following:

- High erosion hazard;
- Mine subsidence;
- Localised foundation hazard;
- Shallow soils;
- Sodic/dispersive soils;
- Strongly acidic.

Bobs Farm: Alluvial soils on the northern parts of Minmi North and Minmi West are mapped as the Bobs Farm Landscape and typical limitations include the following:

- Permanently high water table;
- Seasonal waterlogging;
- Foundation hazard;
- Acid sulphate potential.

Beresfield: The eastern portions of Minmi North as well as undisturbed parts of Minmi East are mapped as the Beresfield Landscape and typical limitations include the following:

- Water erosion hazard;
- Localised foundation hazard;
- Strongly acidic.

Disturbed: The landscape associated with the open cut pits, mostly in Minmi West and Minmi East areas are mapped as disturbed landscapes. Possible limitations include the following:

- Mass movement hazards;
- Foundation hazard;
- Unconsolidated low wet bearing strength;
- Poor drainage;
- Erosion hazard;
- Toxic materials.

Reference to the Beresfield and Wallsend Acid Sulphate Soil Risk Maps prepared by the Department of Land & Water Conservation indicates that there is an area of acid sulphate soil (ASS) at the northern end of the Minmi North and Minmi West areas. The acid sulphate soils are within alluvial soils and mapped as being within 1 m and between 1 m and 3 m below the ground surface. This is consistent with the presence of iron staining in shallow surface water on the northern parts of the site. The ASS Risk Map indicates that there is no known occurrence of acid sulphate soil materials across the remainder of the site.

The regional groundwater flow regime is expected to be controlled by the presence of coal workings and flow is likely to be to the south away from the Hexham Swamp Nature Reserve, which is approximately 0.5 km from the site, and is considered to be the nearest sensitive receptor. It should be noted that groundwater levels are affected by factors such as climatic conditions and soil permeability and will therefore vary with time.

The nearest registered groundwater wells are located in the vicinity of Summerhill Landfill, to the east of the site. The wells are registered for monitoring purposes, and are described below:

- GW079055: Water bearing zone from 4.4 to 15m depth;
- GW079056: Water bearing zone from 4.4 to 15m depth;
- GW079057: Water bearing zone from 12.6 to 14.65m and 35 to 50 m;
- GW079058: Water bearing zone from 12.6 to 14.65m;
- GW078201: Water bearing zone from 28 to 31m;
- GW079065, 079066, 079061, 079063, 078161: No bore details published.

It should be noted that the above wells are probably up gradient or cross gradient of the site.

4. SITE HISTORY

4.1 Overview

The brief review of site history comprised the following:

- Review of historical records regarding mining at the site including mine record traces, newspaper articles and historical reference books;
- Interview with local resident and former mine employee, Mr Ron Perry;
- Review of historical aerial photos;
- Searches with NSW EPA.

The site is underlain by coal mine workings in two seams, the Young Wallsend and the Borehole seams.

4.2 History of Mining

4.2.1 Underground Mining

A, B and C Pits – RT 497

Mining in Minmi commenced with the A, B and C pits starting about 1953. The workings were in the Borehole Seam and comprised bord and pillar workings. The locations of shafts for Pits A, B and C are shown on Drawing 1.

A report by Smith & Moore to the provisional directors of the Melbourne and Newcastle Minmi Coal Company, dated 1862, indicated the following:

- Coal measures exceedingly regular;
- Seam was discovered by outcrops;
- The seam dips southward and eastward at 2^{o};

- The thickness of the seam averages 8'10'' (2.7 m) of which 2' (0.6 m) is left in the roof and 1 foot (0.3 m) in the floor leaving a net thickness mined of 5'6" (1.7 m);
- Coal worked on the pillar and stall system;
- Trucks drawn by horses;
- C Shaft is 92' (28.0 m) deep and 14' (14.3 m) diameter lined with sandstone for the upper 20' (6.1 m);
- B Pit is 56' (17.1 m) deep, 10'7" (3.2 m) diameter and lined with timber;
- An air upcast shaft with fire at its base provided ventilation;
- A water shaft was sunk 39 chains (785 m) from C pit;
- Steam driven winding engines.

The pit infrastructure was mostly on the southern half of the Minmi West area, and included a rail line and Coke Ovens, which appear to have been to the west of Pit B as indicated by the following sketches presented in Figures 1 and 2 below.

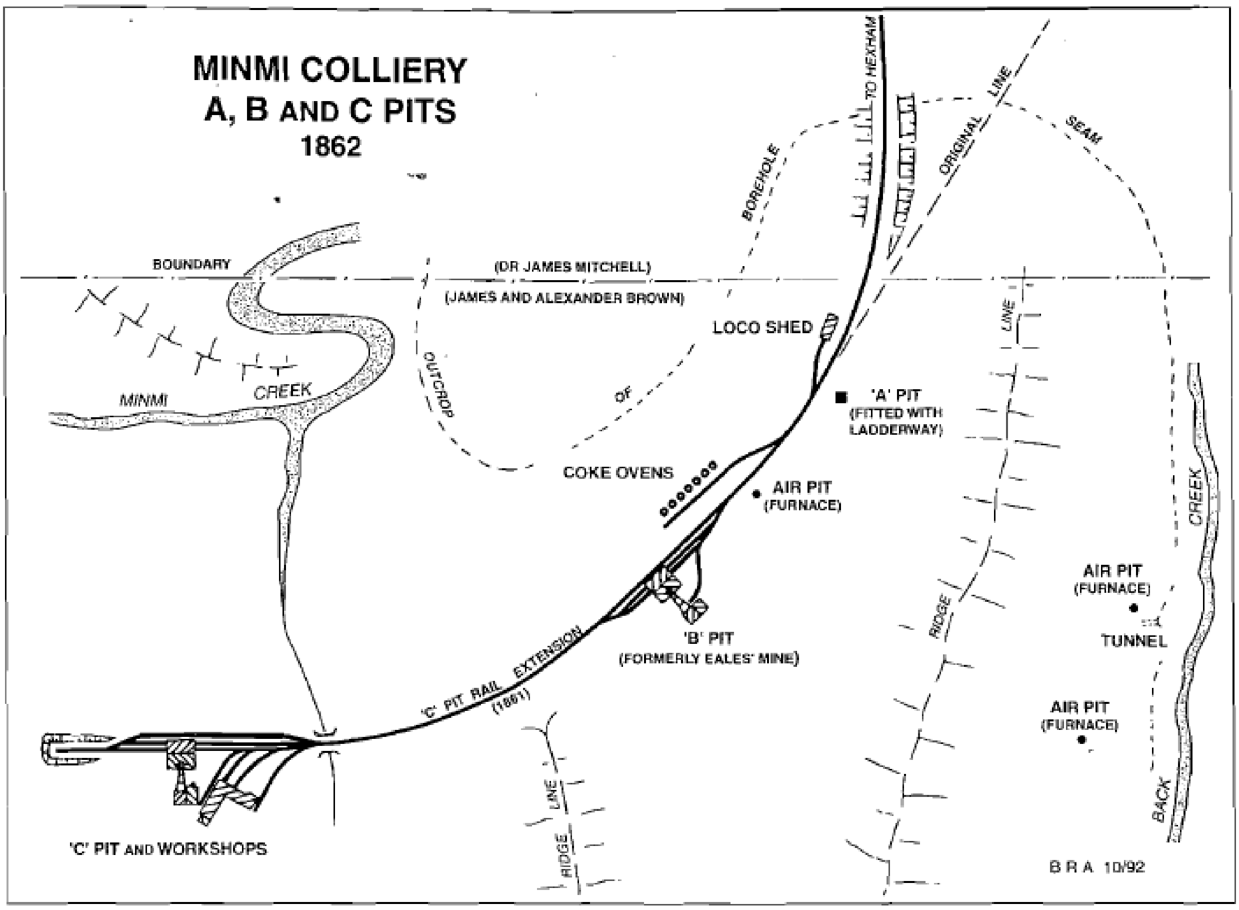


Figure 1 – Layout of Pits A, B and C, 1862 (Andrews, Ref 4)

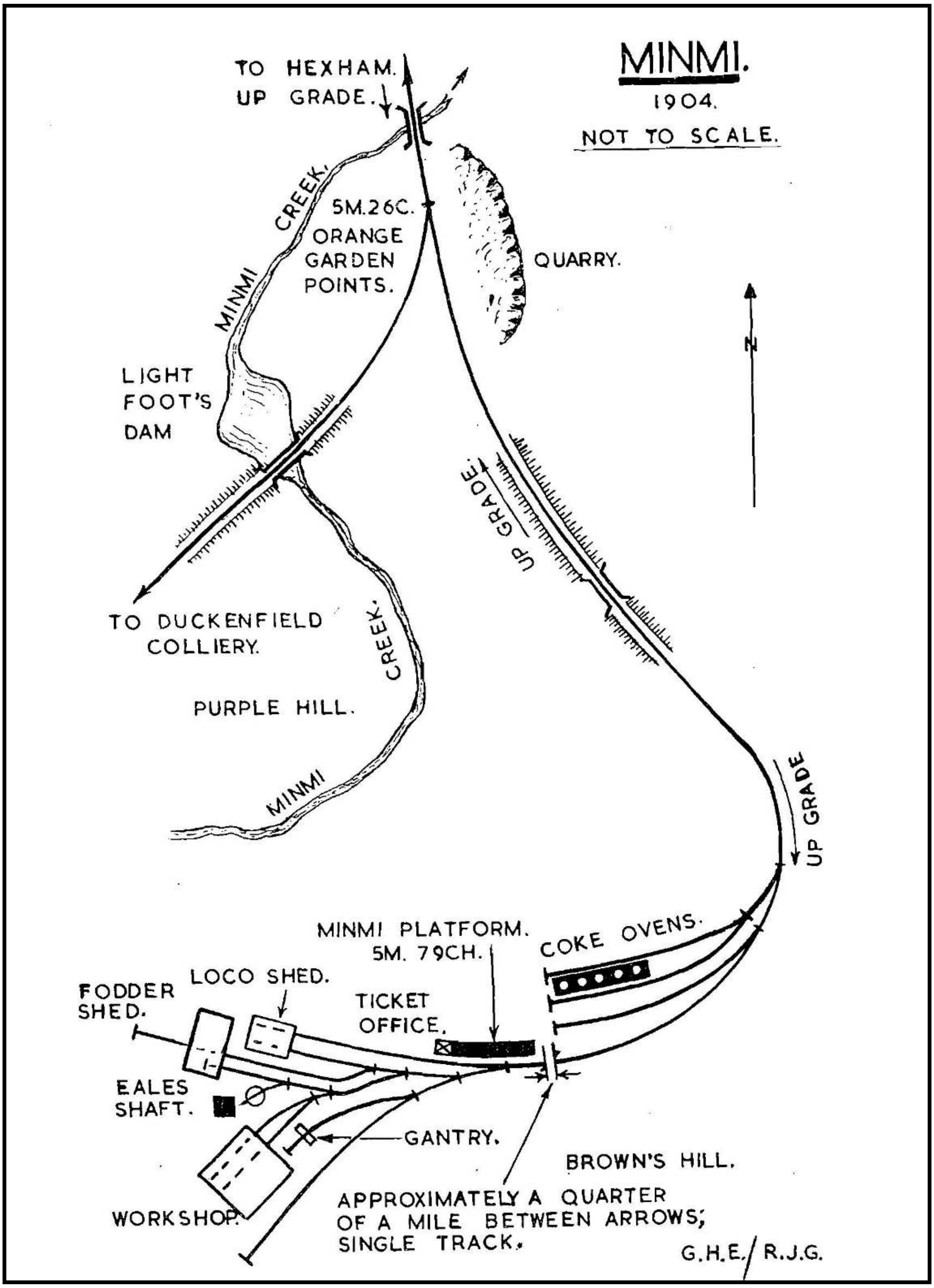


Figure 2 – Layout of Rail Lines, 1905, showing line to Duckenfield (Earley – Ref 5)

In 1859 the coke ovens were expanded to 32 in number and in 1861 a large workshop was also constructed near the C – Pit winding boilers, as shown in Photo 1 below.

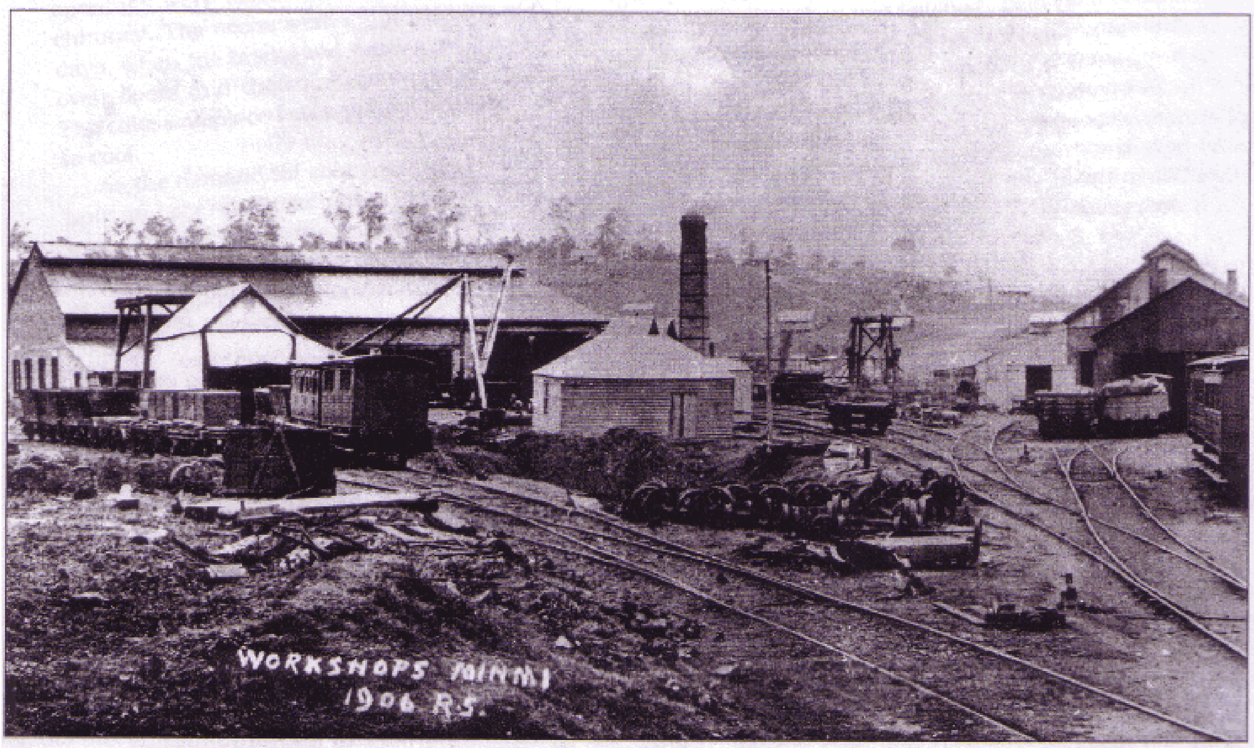


Photo 1 – Workshops near Pit C, 1906 (Andrews – Ref 4)

The workings extended below much of the Minmi West and Minmi South areas. The workings were discontinued in 1871 due to flooding of the workings. The railways and workshops remained in operation servicing the Duckenfield Colliery, located to the west of the site

A typical seam section shown on RT 497 indicated a workings section of 5'3" (1.6 m) with 10" (0.25 m) not worked.

Browns Colliery – RT 257

Browns colliery was opened in 1876, with the pit top located on the northern parts of Minmi South area. Tunnel entries No 2 and No 4 are shown on Drawing 1. The arrangement at the pit top is shown on Figures 3 to 5 below (Ref 4) and included the following:

- Stables;
- Cabins;
- Screens;
- Rail lines and sidings;
- Boiler.

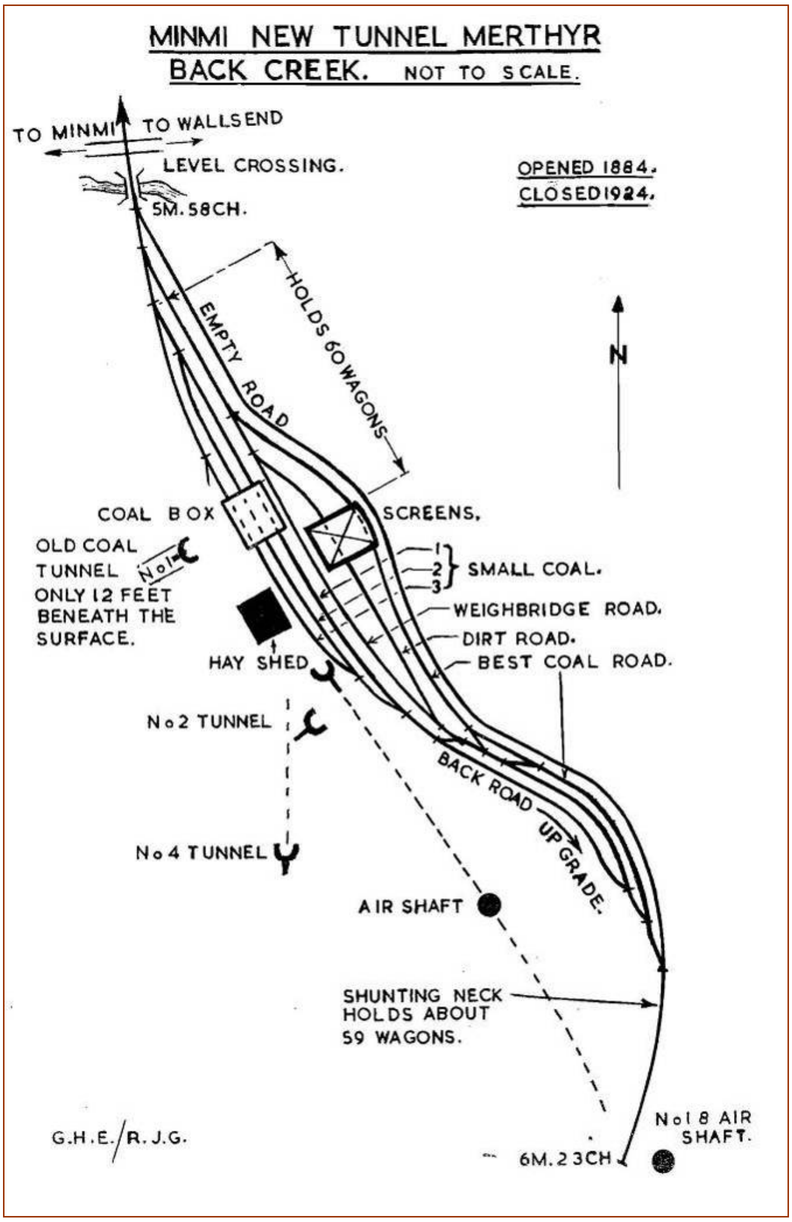
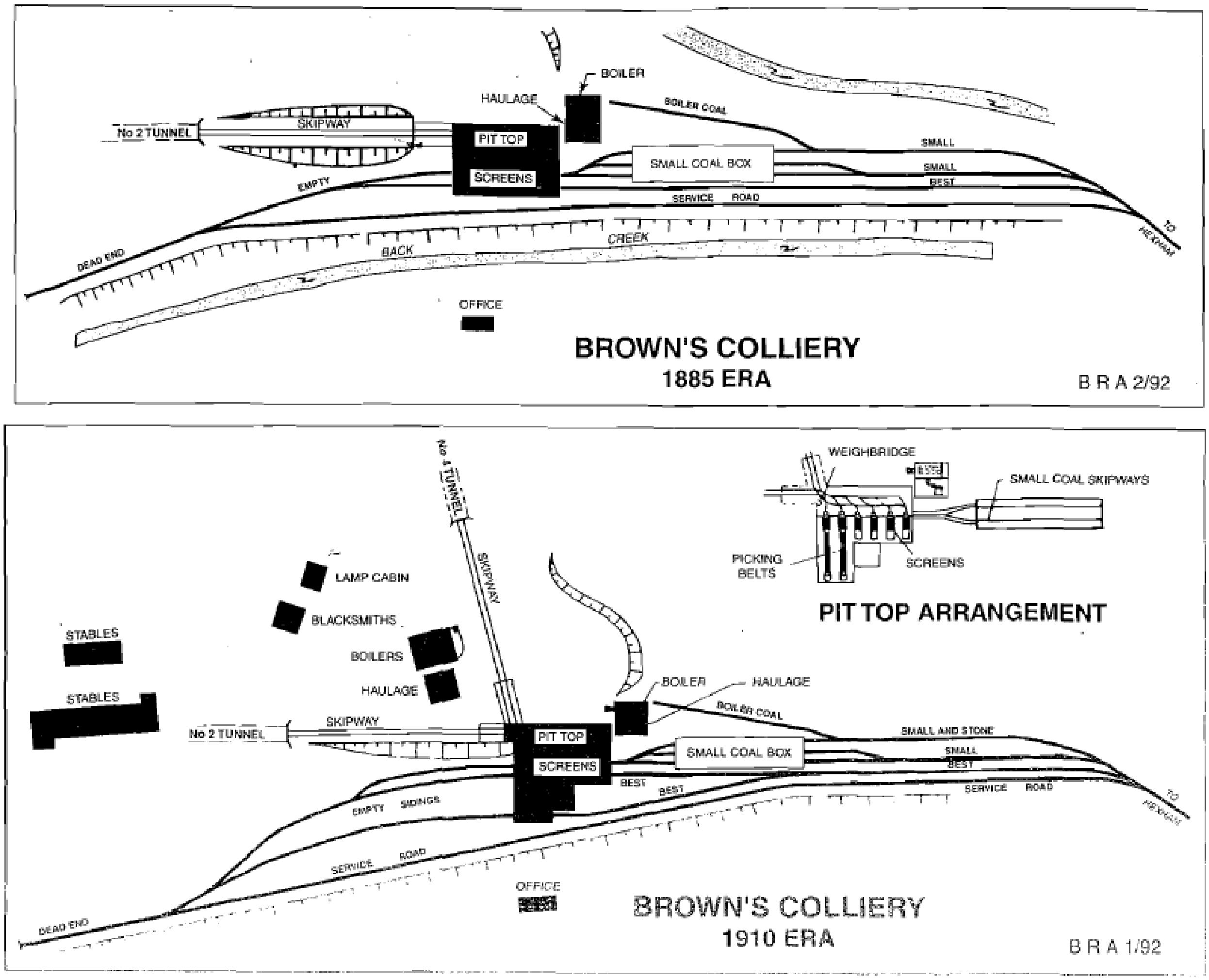


Figure 3 – General Arrangement of rail lines relative to Browns Colliery tunnel entries 1924 era (Earley – Ref 5)



Figures 4 and 5 – Showing arrangement of Browns Colliery Facilities in 1885 and 1910 (Andrews – Ref 4)

A photo of Browns Colliery from late in the 1800s is shown below (Photo 2), probably taken from the southern end of the Minmi township, looking south west.

J F Webber collection

Another view of Brown's Colliery commonly referred to as Back Creek Colliery.

Photo 2 – Browns Colliery in Back Creek (Andrews – Ref 4)

A second tunnel (Tunnel 4) was driven in 1888. Workings of the Browns Colliery, as shown on RT 257 extended under most of Minmi South as well as Link Road North. The workings were bord and pillar with some pillar extraction on the southern parts of the site.

Minmi East

The eastern section of the Minmi East area is underlain by the following workings in the Borehole seam:

- Co-operative Colliery – RT 527;
- Cramp Colliery – RT 282;
- Wentworth Colliery – RT 305.

The workings were undertaken in the late 1800s and comprised Bord and Pillar workings. Numerous shafts and entries are shown on the RTs, as mapped on Drawing 1 attached.

The RTs indicate seam thicknesses in the order of 6' (1.8 m). The workings sections are not shown.

Young Wallsend Seam – RT 701 and 574

Workings in the Young Wallsend seam were undertaken by the Wallsend Borehole Colliery (RT 701) under the southern parts of Minmi West and most of Minmi South. The Link Road South and North are underlain by workings in the Gretley Colliery (RT574). Record traces indicated workings on the northern parts of the site in the 1970s. The workings comprised bord and pillar workings, typically with 5 m wide bords, and pillar extraction in some areas.

An entry to the Young Wallsend Seam was located in Minmi South in a former open cut pit as shown on Drawing 3. A wash plant was located to the east, partly encroaching onto Blue Gums National Park.

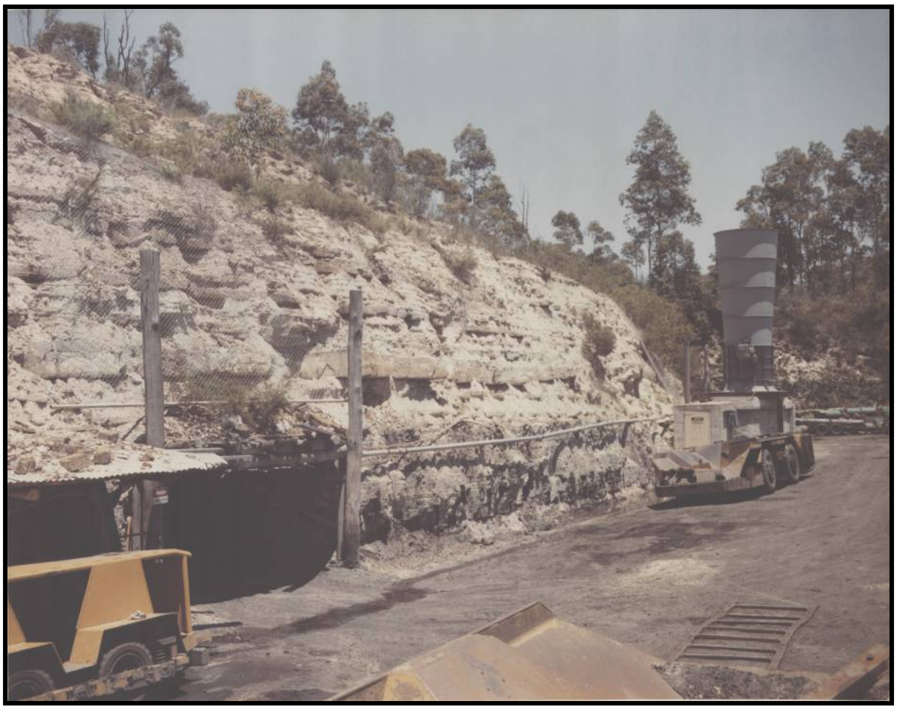


Photo 2a – Wallsend Borehole Colliery Entry No 2

4.2.2 Open Cut Pits – RT 621

Four open cut pits have been identified on the site as follows:

Purple Hill Open Cut. Located on the central western parts of the Minmi West area and continues to the west of the site. The cut was in the Borehole Seam, with the mining undertaken in the period 1948 to 1954. Underground workings were broken into on the south side of the cut.

Back Creek Open Cut. This is located on the north eastern boundary of Minmi South. The cut was in the Borehole Seam and was undertaken in 1949. The open cut continues to the south and east of the site. The thickness of coal as shown on the RTs ranges from 5' (1.5 m) to 7'6" (2.3 m).

Old Workings in Young Wallsend Seam: There are two smaller open cuts shown on the central parts of the Minmi South area, where there were workings of the Young Wallsend Seam. The workings were undertaken in 1953. No details of the seam or working depth are shown. One of these workings was later used as the No 2 Entry to the Wallsend Borehole Colliery (Photo 2a).

Browns Colliery: A continuation of the Back Creek open cut extended to encroach onto the south western part of Minmi East. The workings were in the Borehole Seam and were undertaken in 1950 and 1951. The workings broke into the Browns Colliery underground workings.

Wallsend Borehole Colliery (Young Wallsend Seam) : Open cut workings of the Wallsend Borehole Colliery extended onto the eastern part of the Minmi East area. The workings were undertaken in 1984 and did not extend to the outcrop. Base of seam contours are shown on Drawing 1.

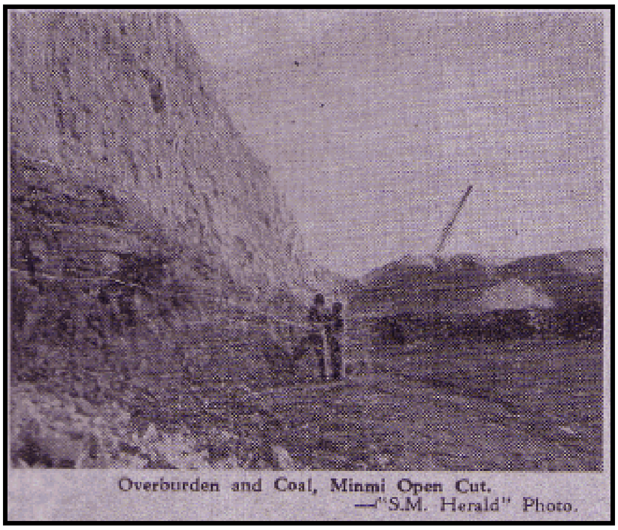
A Newcastle Herald article from 1950 and an article in Australian Coal, Shipping, Steel and The Harbour, dated 1 August 1949, indicated the following regarding the Purple Hill and Back Creek mining operations:

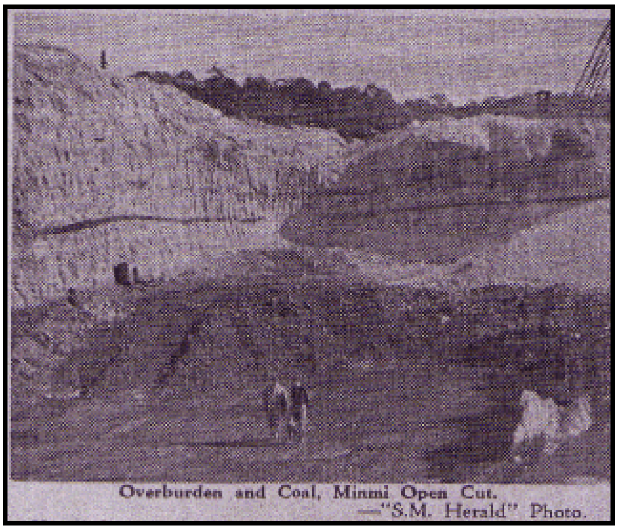
- Cuts in the order of 30‘ (9.1 m) to 45’ (13.7 m) (about 9 m to 14 m);
- Cuts fringed with ‘peaks of earth’;
- 14’ (4.3 m) of water in open cut;
- Diesel shovel used in places (see Photo 3 below);
- Blasting used, as well as bulldozers and drag lines;
- Coal seams 7’6’’ (2.3 m) thick;
- Overburden taken with scrapers to surrounding land which is not coal bearing;
- Old workings broken into : “although in old mines very accurate maps of workings were not made, and the layout was not set down with such mathematic precision of today, the present operators have a general idea of the size, direction and depth of the workings”.

With respect to the old underground workings the Newcastle Herald article indicated the following:

> “an experienced eye can gain a very good idea on the points from the depressions left when the old abandoned workings caved in. The fall-ins are plainly discernable in many places where new workings will be over old. The bords and pillars of half a century ago were much smaller than those of today. An old miner at Minmi informed me that his father had often told him he had driven a cut through in a day. The main headings were kept fairly even but driving was done by sound and it was left to the deputies to preserve some semblance of a line and to tell the miners where to put the bords and cut throughs”.

Typical photos of the open cuts from 1949 are shown below.





Photos 3 and 4 – Photos of typical open cut mines - 1949

For the Purple Hill and Back Creek open cuts a screening plant was constructed on the Minmi West area, near the base of a ridge. An access road was constructed to the west of the rail line to service the Purple Hill Mine and a loop road was constructed off Woodford Road, presumably to accept trucks from the Back Creek Mine via Minmi Road. The general arrangement is shown on Figure 6 below and a photo of the screening plant is shown on Photo 5.

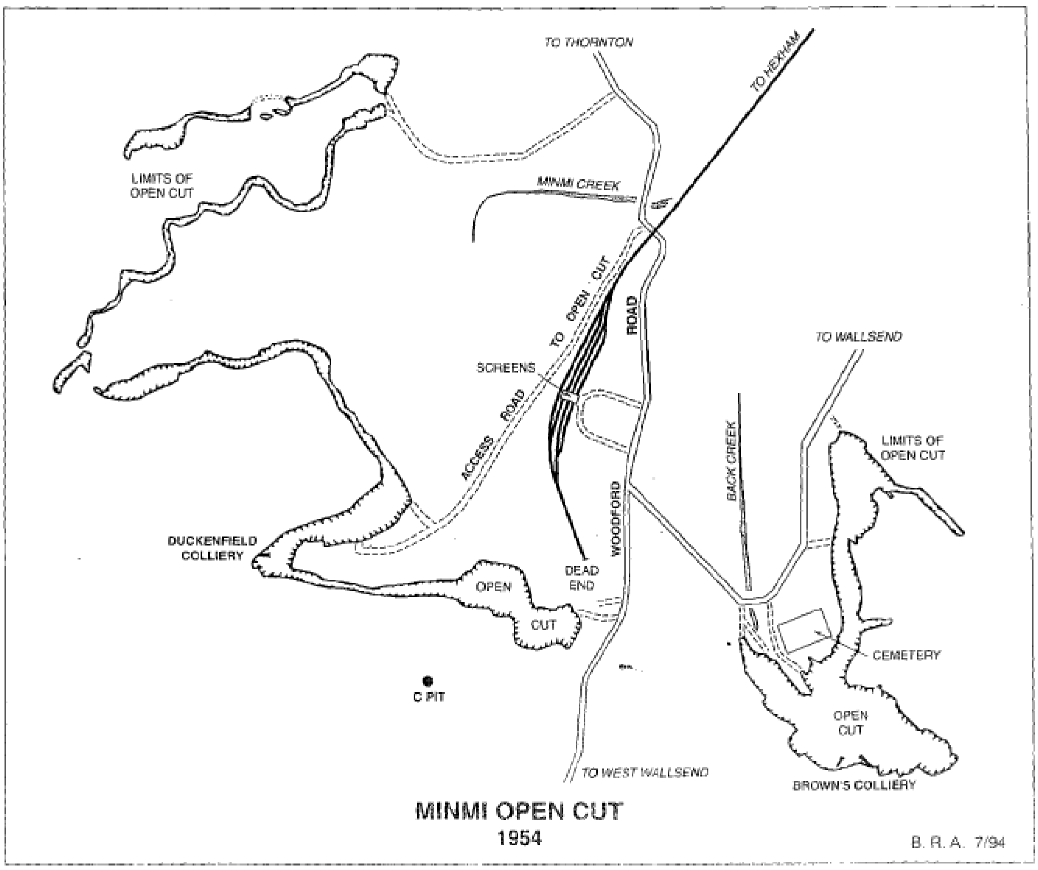


Figure 6 – Arrangement of rail lines and road loops relative to open cuts (Andrews – Ref 4)

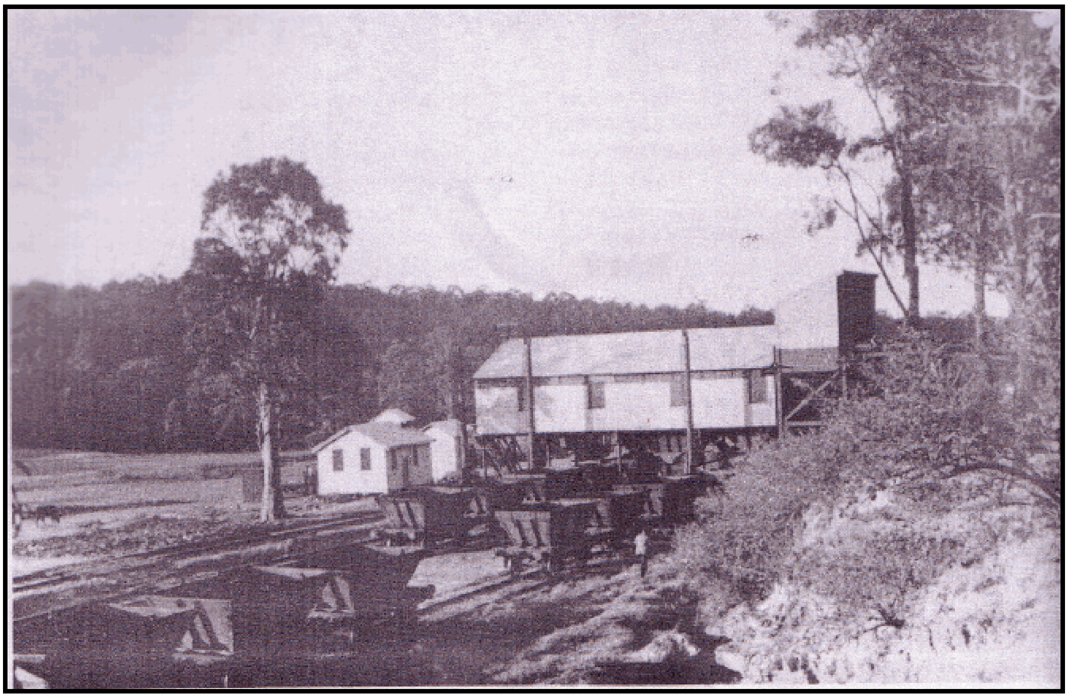


Photo 5 – Rail siding screening plant for open cuts, on east side of Minmi West (Eardley – Ref 5)

4.3 Interviews with Personnel Familiar with the Site

As most of the mining-related activities at the site occurred over 50 years ago, it is difficult to find people who have direct knowledge of operations on site.

Discussions were undertaken with the following:

Ron Perry, Local Resident

Ron is a local amateur historian buff and indicated the following:

- John Eales commenced mining;
- J & A Brown bought out Eales in the mid 1850s;
- There was a furnace shaft for ventilation;
- A railway was constructed to Hexham initially with the aid of horses and then steam locomotives;
- Underground workings near Minmi closed in 1923;
- Useful information to be found in publications of railways of J A Browns by Gifford Eardley (Ref 5) and Andrews (Ref 4);
- Open cut mines started in 1949 during a seven week strike. During this time, the army commenced open cut operations.

Bill Freeman

Bill Freeman is a long time resident and amateur historian and artist. Bill indicated that there were coke ovens located on the site and provided a schematic plan showing the approximate location, to the west of former Pits A and B. The approximate location is shown on Drawings 1 to 4.

Kerry Hindes

Kerry is a long time resident and amateur historian. She provided a number of historical photographs of Minmi in the late 1800s and early 1900s. She indicated the following:

- There were scattered residences across many of the areas now used for pasture/agistment and this accounts for much of the undulating surface in these areas. Many of the houses had brick cisterns dug into the ground for storage of water. These areas included the pasture in Minmi West and Minmi North;
- The majority of the former Browns Colliery infrastructure was to the east of the site in Blue Gum Hills National Park;
- The coke ovens were located in Minmi West, to the north of Railway Street and to the west of the houses on Woodford Street. She provided a photograph indicating the approximate location.

Additional interviews were undertaken with respect to mine subsidence issues and these are summarised in the Mine Subsidence Risk Assessment (Ref 3).

4.4 Review of Historical Aerial Photos

The following historical aerial photos were reviewed:

Table 1 – Aerial Photo Review

Year	Approximate Scale	Black and White/Colour
1954	1:40000	Black and White
1966	1:38000	Black and White
1975	1:40000	Black and White
1984	1:40000	Black and White
1996	1:50000	Colour
2006	1:25000	Colour

1954 Aerial Photograph

- Purple Hill Open Cut;
- No obvious infrastructure near C Pit;
- Haul road and rail lines evident in Minmi East;
- Road loop to open cut rail siding screens evident, screen not clearly visible;
- Back Creek workings;
- Various cleared areas and tracks on Minmi South;
- Most existing homes in Minmi present;
- Surface disturbance around former Browns Colliery (Back Creek) pit head.

1966 Aerial Photograph

- Open cut rail siding screens evident;
- Possible dam at north end of Minmi North;
- Browns Open Cut mine, including present surface water feature;
- Heavy disturbance around Browns Colliery (Back Creek) pit head;
- Some additional clearing in Minmi South;
- Disturbance near shaft at south end of Minmi South;
- Transmission line on Link Road South.

1975 Aerial Photograph

- Dam on northern part of Minmi South evident with surrounding surface disturbance;
- Track to dam and shaft at south end of Minmi South;
- Open cut rail siding screens still present;
- Additional clearing on northern end of Minmi West.

1984 Aerial Photograph

- Borehole Colliery open cut present on western part of Minmi East;
- Open cut rail siding screens removed.

1996 Aerial Photograph

- F3 Freeway to west of site;
- Link Road present;
- Surface disturbance in former Purple Hill Open cut area on Minmi West;
- Surface disturbance on Minmi South around Young Wallsend open cuts;
- Surface disturbance around shaft at south end of Minmi South.

Information obtained from aerial photos was limited by the relatively small scale and poor resolutions.

NSW Environmental Protection Authority (DECC)

A property information inquiry with the NSW EPA indicated that the site has no statutory notices issued under the provision of the Contaminated Land Management Act.

4.5 Summary of Site History

Underground mining commenced at Pits A, B and C in Minmi West in mid 1800s. Infrastructure included the following:

- A rail line along the eastern side of Minmi West with cutting/quarry on west side;
- A rail line running diagonally across the north end of Minmi West to Duckenfield Colliery;
- Boilers;
- Screens;

- Workshops;
- Coke ovens;
- Locomotive sheds.

Underground mining at Browns Colliery (Back Creek) at the northern end of Minmi South in the late 1800s. Infrastructure included the following:

- Rail line running north crossing Minmi Road and continuing along the western side of Minmi North, connecting with the lines from Minmi West at the northern tip of Minmi North;
- Numerous sidings;
- Screens;
- Stables;
- Various tunnels and shafts.

Mining occurred also at the eastern end of Minmi East in the later 1800s (Cooperative, Cramp and Wentworth Collieries), with numerous tunnels and shafts marked on the RT. Limited information is available regarding surface infrastructure.

Open cut mining commenced at Purple Hill (Minmi West) and Back Creek (north end of Minmi South) and Browns Colliery (west side of Minmi East) in the mid 1900s. The workings ranged up to about 10 m to 15 m deep. The coal was transferred by truck to a rail siding on the eastern side of Minmi West.

Open cut mining as part of the Wallsend Borehole Colliery occurred on the western part of Minmi East in 1984. It is likely that coal was trucked out using an access track to Minmi Road.

The No 2 Entry to Wallsend Borehole Colliery was located in a former open cut pit at Minmi South.

4.6 Minmi West

Most of the Minmi West area is grassed and used for grazing horses. There are some scattered houses off Railway St on the southern parts of the site and there is dense bushland at the northern and southern ends of the site, as well as the western fringes. Surface levels range from about 40 m AHD at the northern end to 4 m AHD on the lower central portions and then rise to 50 m AHD at the southern end.

A creek winds across the site from the western boundary on the southern parts of the site to the eastern boundary on the northern parts of the site.

Specific features include the following:

- Numerous horse paddocks (Photo 6);
- Mounded filling on the north eastern parts, to the east of the former rail line, including building rubble and fibro sheeting (Photos 7 to 9);
- A cut into rock on the central western parts of the site, probably to form the rail line route. (Photo 10) This is also near the likely location of the screening siding for the open cut;
- Fill embankment along western part of site to south of cut, again likely to have been constructed for the rail lines to A, B and C pits (Photo 11);
- Former Purple Hill Open Cut which has been partly filled and appears to have mounded filling around the perimeter (Photos 12 and 13, 18 and 19) , in particular the eastern and northern sides. There is still a valley feature in the former pit, running west to east and this contains concrete weir structures, probably associated with the control of stormwater from the F3 freeway (Photo 14);
- Undulating ground with shallow rock on the southerly trending slopes to the south of the open cut, probably from collapse of shallow mine workings (Photos 16 and 17);
- Fill embankments and slight cuttings on the western side of the site, north of the open cut, associated with the rail line to Duckenfield Colliery and the haul road to the open cut. Culverts were observed through the fill embankment where the former road/rail lines cross the creek;
- Low lying land to the north west of the former Duckenfield Rail;

- Undulating grassed ground which appears to have been disturbed in the area surrounding the scattered houses associated with Railway Street. This is the area of the former B and C pits (Photos 20 and 21) and associated infrastructure including rail siding, boilers, workshops and coke ovens and locomotive sheds. Little direct evidence of the former structures was observed;
- The southern parts of the site are densely vegetated with a number of tracks, one of which leads to a former water shaft. The shaft has been capped;
- There is a cleared area off Woodford St, immediately to the south of the site, where significant dumping has occurred, including filling and fibro (Photo 21a).

Photo 6 – Horse paddocks

Photo 7 – Mounded filling including building rubble

Photo 8 – Filled batter on western side of former railway, to the east of the open cut screens

Photo 9 – Fibro waste

Photo 10 - Cut batter on eastern side of former rail line

Photo 11 – Fill embankment from former rail line

Photo 12 – Creek with former Purple Hill Open cut in background

Photo 13 - Battered filling on northern side of former Open Cut

Photo 14 – Drainage structure in former open cut

Photo 15 – Former rail embankment


Photos 16 and 17 – Undulating surface to south of open cut – probable potholes


Photos 18 and 19 – Filled area north of open cut near existing access track to F3

Photo 20 – Former B Pit location

Photo 21 - Former C Pit location

Photo 21 a – Fly tipping at southern boundary of Minmi West

4.7 Minmi North

Most of the Minmi North area is grassed and used for grazing horses (Photo 22). There is bushland along the eastern boundary beside Minmi Road. Surface levels range from about 2 m AHD in the lower northern parts to 30 m AHD in the south eastern parts.

Back creek winds to the north close to the eastern boundary toward low lying areas on the northern parts of the site which contained surface water at the time of the assessment. The northern parts of the creek, where it meets Minmi Road, were dry at the time of the assessment (Photo 23).

Specific features include the following:

- Former rail alignment along the western boundary which appears to be benched into the hillside (Photos 24 and 25), however also contains sections cut into rock (Photo 26, Photo 28) and embankments (Photo 27);
- There is a Sewage Pump Station and a small cattle yard near the north western corner of the site, however it appears that these may not be on the subject site (Photo 29);

- There is a triangular area at the north western corner which is bounded on the east and west sides by rail embankments from the former rail lines to Back Creek and Pit C. The embankments meet at the northern tip of the site and continue to the north of the site. (Photo 30). This is the former rail line to Hexham. The area between the embankments is low lying and contained reeds and shallow surface water with iron staining (Photo 31);
- The eastern slopes of the site fall to the west. An area on the northern boundary of the slopes has been cleared and there are signs of cut and fill, including a benched area of cut and a fill mound and ramp. The area to the north is low lying and may have been cut as suggested by the review of aerial photographs (Photos 32 and 33);
- The eastern slopes show signs of shallow soil erosion and associated slope instability in the form of slumping. The erosion may have been initiated by rabbit warrens. (Photos 34 to 36);
- A stone lined well was noted on the lower eastern slopes, close to the creek (Photos 37 and 38);
- The grassed slopes on the southern part of the site are undulating with some chitter apparent at the surface, suggesting prior disturbance. A possible pothole feature was observed near Minmi Road.

Photo 22 – Grazing land to north of Minmi Road

Photo 23 – Back Creek where it meets Minmi Road

Photos 24 and 25 – Former Rail Line to Back Creek

Photo 26 – Cut into rock for former rail line

Photo 27 - Embankment along former rail line

Photo 28 – Rock exposed at northern end of access track

Photo 29 – Cattle Yard near sewer pump station

Photo 30 – Fill embankments where former rail lines meet

Photo 31 – Iron staining in low lying wet area at north of site

Photo 32 – Area of cut at north east corner of site

Photo 33 – Fill ramp in foreground and possible area of cut in background

Photo 34 – Slumping/erosion of slopes on western side

Photo 35 – Piping erosion of slope

Photo 36 – Piping erosion of slope

Photo 37 – Stone lined well

Photo 38 – Stone lined well / cistern

4.8 Minmi East

Minmi East can be divided into two district areas, the western and the eastern. Both areas contain former open cut mines. Ground surfaces are typically between 8 m to 50 m AHD on the western area and up to 70 m AHD on the eastern area.

Eastern Parts

The eastern parts contain the former Wallsend Borehole Colliery open cut in the Borehole Seam. The open cut was undertaken on the crest of the hill and the current landform is a bowl type shape at the top of the hill with steep natural slopes to the east, north and west and backfilled open cut rising to the south.

The former open cut area contains grass and bushes and there is a low lying reeded area in the south western corner (Photos 39 and 40). The open cut is surrounded on the east, north and west by bushland which slopes away from the open cut, typically at about 20^{o}, but locally up to about 40^{o} on the western side (Photo 41) . The lower slopes have a heavily undulating surface which is likely to be from collapse of shallow Borehole Seam workings (Photo 42).

There is a mound of overburden with some smaller mounds of building rubble, including fibro sheeting near the north east access to the site (Photo 43).

Photos 39 and 40 – Former Wallsend Borehole Colliery Open Cut


Photos 41 and 42 – Steep slopes and pothole subsidence around former Wallsend Borehole Colliery Open Cut


Photos 43 and 44 – Mounds of overburden and building rubble including fibro sheeting

Western Parts

The eastern side of the western area is mostly bushland. There is a track along the eastern boundary which contains significant fly tipping (opportunistic tipping) including car wrecks, batteries, fibro sheeting (Photos 45 to 47). The bushland contains an eroded gully with steeply sloping and slumping banks, as shown on Drawing 1.

The western area contains the former Browns Colliery Open Cut, much of which has been backfilled, with mine spoil battered around the perimeter (Photo 48). There is a water body located within the backfilled area (Photos 49 and 50).


Photos 45 and 46 – Fly Tipping

Photo 47 – Fly Tipping

Photo 48 – Overburden fill from Brown Colliery Open Cut


Photo 49 and 50 - Surface water in former Browns Colliery Open Cut

4.9 Minmi South

Minmi South is the site of the former Browns Underground Colliery and Back Creek Open Cut as well as two smaller open cuts into the Young Wallsend Seam. The northern areas of the site are heavily disturbed. The southern parts are mostly bushland with scattered tracks and clearings, mostly associated with shafts to the Browns Colliery workings. There is scattered residential development, mostly on the north western parts.

The topography is moderately to steeply undulating. Surface levels range from about 10 m at the northern end to 70 m AHD at the southern end. Back Creek initiates in the southern parts of the site and passes north through the former Back Creek Open cut, before passing below Minmi Road and continuing into the Minmi North Area, as described above. There are numerous upslope gullies which feed into Back Creek, however they were dry at the time of the assessment.

Specific site features include the following:

- North western parts of the site are grassed with scattered residential development and disturbed surfaces (Photos 51, 52 and 58) including shallow slumping of some steeper slopes (Photos 53 and 54);
- Areas of filling and cutting on the north western parts, probably associated with the former Browns Colliery (Back Creek) (Photos 55 and 56);
- Narrow cuts into the hillside, possibly former mine entries for Browns Colliery (Photo 57);
- Open cut pit into the Young Wallsend seam, containing surface water (Photos 59 and 60);
- Filled ground to south of Reservoir Road;
- Extensive areas of filling associated with the former open cuts in the Young Wallsend seam (shown in Blue on Drawing 3) (Photos 73 and 76);
- Several concrete capped shafts, one at the northern end of the bushland and one at the southern end, near the Link Road (Photos 62 and 69). The capped shafts are shown on Drawings 2 and 3;
- Masonry walled dam, concrete footings and shallow rock with scattered surface chitter and fibro near the southern capped shaft. (Photos 67, 70, 71, 72);

- Several cleared areas within the bushland with disturbed surfaces, one containing a stone lined shaft or well.(Photo 66);
- Eroded gully between two cleared areas with remnant timber bridge structure (Photos 64 and 65);
- Former Back Creek Open Cut has been backfilled and includes a timber stairway leading up to a walking track. Parts of the former open cut are relatively low lying and contain surface water and reeds. The western batters of the former open cut are steep and heavily vegetated.

Photo 51 – Undulating area north of Neal Close

Photo 52 – Gully falling towards Back Creek

Photo 53 and 54 – Disturbed and slumping slopes near former Browns Colliery

Photo 55 – Caravan on fill mound

Photo 56 – Cut bench into hillside, probably associated with Browns Colliery

Photo 57 - Narrow Bench cut into hillside, possible entry for Browns Colliery

Photo 58 – Undulating grassed hillside

Photo 59 and 60 – Young Wallsend Open Cut with surface water

Photo 61 – Filled ground near Reservoir Road

Photo 62 – Capped Shaft

Photo 64 – Erosion on gully banks

Photo 65 – Remnant Timber Bridge

Photo 66 – Stone lined well/shaft

Photo 67 – Masonry Walled Dam

Photo 69 – Capped Shaft

Photo 70 – Concrete Footing next to capped shaft

Photo 71 – Shallow rock with chitter at surface

Photo 72 – Fibro fragments on side of track

Photo 73 – Filled area on central site over former Young Wallsend Open Cut

Photo 74 – Dam cut in to rock

Photo 75 – Fill associated with former Young Wallsend Open Cut

Photo 76 – Grassed Fill Mound in Former Back Creek Open Cut

Photo 77 – Low lying reeded area in Former Back Creek Open Cut

4.10 Link Road North and South

The Link Road sites are primarily bushland with moderately to steeply undulating terrain. Surface levels range from about 20 m AHD at the northern and southern boundaries to about 90 m AHD at the Link Road. Slopes are typically in the order of 10^{o} to 20^{o} and locally up to around 30^{o} (Photo 79), mostly on gully slopes, which typically contained loose surface boulders, suggesting potential shallow instability.

There are scattered access tracks and transmission line easements running diagonally through each allotment. Shafts No. 12 and 14 were located on the Link Road North. Inspection of the shaft sites indicated that both shafts have been capped and that there are remnants of previous structures including a number of old slabs and footings. The site were both heavily overgrown and were inaccessible except by foot. There appears to be a fill embankment running along the site boundary from near the Link Road / Minmi Road roundabout towards Shaft No 14 to the north. The filling generally appears to be rock and chitter filling with numerous conglomerate boulders at the northern end. The toe of the embankment appears to extend onto the site in places. This was probably a former access track to the shaft however is now inaccessible to vehicles due to the presence of extensive vegetation growing on it (Photos 80 and 81).

Photo 78 – Track across Link Road South

Photo 79 – Steep Slopes in Link Road South Area

Photos 80 and 81 – Filling on Boundary near Shaft No. 14s

5. SURFACE FEATURE MAPPING

Various site surface features described in the preceding sections above have been mapped on Drawings 1 to 4. The general categories of surface condition are described below.

Disturbed Ground

As outlined above, much of the site includes mining infrastructure and as a consequence the associated land has been heavily disturbed. The original ground surface in many areas is expected to have been reworked and in many places filled. The estimated extent of disturbed ground is shown on Drawings 1 to 4.

Mounded Filling

Significant areas of filling were observed on the site as shown in purple on Drawings 1 to 4. The filling can be divided into the following categories:

- Mine spoil from open cut pits;
- Railway/ road embankments;
- Localised mounds of filling;
- Surface fly tipping.

Mine Spoil From Open Cut Pits

The areas of open cut mining are generally surrounded by spoil from the excavations. In most instances the open cut pits have only been partly backfilled, with depths of filling ranging up to about 12 m.

Embankments

Several rail embankments were identified on the site. There are two in Minmi West, one running in an approximate north south direction through the eastern part of the site, servicing the C and B Pits and the open cut mine. There is another rail line embankment which runs off the one described above to the western boundary and formerly serviced the Duckenfield Colliery to the west of the site. The embankments are generally grassed and elevated between 1 m and 4 m above surrounding ground with batters in the order of 1.5H:1V to 2H:1V. Chitter was observed at the surface in some places. The main rail alignment passes through an area of steep cut in places, shown in red on Drawing 2 and discussed below.

An embankment on the western side of Minmi North serviced the Browns Colliery in Back Creek (Minmi South). This embankment is similar to the one described above with heights ranging up to about 5 m in places and batter slopes in the order of 1.5H:1V to 2H:1V. In places, the embankment has been formed from cut to fill, however significant amounts of chitter was observed at the surface. This alignment also passes through an area of steep cut shown in red on Drawing 2. The two embankments meet at the northern end of the site where they adjoin a small low lying triangular area.

Mounded Filling and Surface Fly Tipping

Numerous relatively small mounds of filling were observed across the site. These piles often contained building rubble and in places fibro sheeting which is likely to contain asbestos. Numerous instances of fly tipping was observed across the site. The tipped material included paint tins, fuel cans, and fibro sheeting.

Potential Slope Instability

No signs of gross deep seated slope instability were observed on the site, however a number of localised slumping slopes were observed, often associated with erosion from concentrated surface water flows. These areas are shown in red on Drawings 1 to 4, and included the following:

- Steep gully sides;
- Mine fill batters;
- Deforested slopes;
- Cuts for rail lines.

Wells / Shafts

A number of brick lined cisterns were identified and it is likely that there are others on the site, mostly in areas mapped as disturbed ground. The cisterns which have been identified are shown on Drawings 1 to 4 in white. They have generally been backfilled with building rubble and other waste.

The site contains numerous former mine shafts and entries, the details of which are provided in the mine subsidence risk assessment (Ref 3).

Dams

A number of dams were identified on site as follows:

- Masonry walled dam on the southern part of the site (Minmi South) near the Link Road. This is at the head of a steep gully and appears to retain up to about 4 m depth of water. The dam had a notch cut into the crest for low flow spilling and it appeared that spilling over the main crest of the dam would occur during high flows;
- A cut to fill dam was observed to the east of the southernmost area of open cut. This dam appears to have been cut into natural ground with wall heights ranging up to about 3 m to 4 m. The dam had no significant catchments and no spillway was observed;
- Several minor farm dams were also located across the site.

6. FIELD WORK

6.1 Sampling Rationale

A systematic and judgemental sampling procedure was conducted for the current assessment to address the potential sources of contamination identified in the desktop and walkover assessments.

A total of 158 pits and six boreholes were sampled and analysed as part of the current assessment.

Samples were selected for analysis on the basis of the likely presence of contamination, based on material type, visual or olfactory evidence of possible contamination (i.e. odour or staining), proximity to a potential source of contamination, and whether generally representative of soil/fill conditions.

6.2 Methods

The field work was undertaken between the 31 July 2007 and 18 September 2007 and comprised the following:

- Excavation of 158 test pits to depths of up to 3.7 m using a backhoe as follows:
  - Minmi West: Pits 1 to 19, 50 to 86, 61A, 77A and 77B;
  - Minmi South: Pits 20 to 49, 23A and 23B;
  - Minmi East: Pit 87 to 96, 131 to 133, 135 to 137;
  - Minmi North: Pits 99 to 130, 134, 138;
  - Link Road North: Pits 153 to 158;
  - Link Road South: Pits 147 to 157;
  - Note: Pits 122 and 139 were not excavated due to access restrictions.
- Drilling of six boreholes (Bores 23B, 57, 91, 94, 97 and 98) to depths of up to 8.6 m, in areas of former open cut mines where relatively deep filling was expected.

The test locations were set out by an environmental engineer from DP who also logged the subsurface profile in the pits and boreholes and collected samples for identification and testing purposes. The test pits were pegged on completion and then surveyed by Monteath & Powys Pty Ltd. The locations of the pits and boreholes are shown on Drawings 1 to 4, Appendix D and co-ordinates are listed in Table 3, Section 7.5.

Samples for environmental purposes were generally collected from the near surface, and at regular depth intervals or changes in strata within each pit and borehole. Soil samples were collected directly from the side walls of the test pits or bores or from the excavator bucket or auger using disposable gloves. Care was taken to remove any extraneous material deposited on the sample.

All sampling data was recorded on DP chain of custody sheets, and the general sampling procedure comprised:

- Decontamination of all sampling equipment using a 3% solution of phosphate free detergent (Decon 90) and tap water prior to collecting each sample;
- The use of disposable gloves for each sampling event;
- Transfer of samples into laboratory-prepared glass jars, and capping immediately;
- Collection of 10% replicate samples for QA/QC purposes;
- Collection of replicate soil samples in zip-lock plastic bags at each depth for PID screening;
- Labelling of sample containers with individual and unique identification, including project number, sample location and sample depth;
- Placement of the sample jars and replicate sample bags into a cooled, insulated and sealed container for transport to the laboratory;
- Use of chain of custody (C-O-C) documentation ensuring that sample tracking and custody could be cross-checked at any point in the transfer of samples from the field to the laboratory.

The process of obtaining samples and their transportation, storage and delivery to laboratories for analysis was documented on a DP standard chain-of-custody form. Copies of completed forms are contained in Appendix C.

Replicate samples for each sample were screened for the presence of volatile organic compounds (VOCs), using a Photovac 2020 photo-ionisation detector (PID) with a 10.6 eV lamp, calibrated to 100 ppm Isobutylene. The PID is capable of detecting over 300 VOCs.

Samples collected for the assessment of acid sulphate soil conditions were wrapped in plastic wrap and plastic bags to exclude air, and stored and transported on ice. Samples were then refrigerated in the DP laboratory.

The work was undertaken in accordance with the DP quality system and procedures for contamination assessments as presented in the company's field procedures manual. A list of the procedures used and other information on quality assurance and quality control, including analysis of replicate samples, is found in Appendix C.

6.3 Data Quality Objectives (DQOs)

Table 2 summarises data quality objectives (DQOs) and the procedures designed to enable achievement of the DQOs.

Table 2 – Data Quality Objectives

DQO	Achievement Evaluation Procedure
Documentation completeness	Completion of field and laboratory chain of custody documentation, completion of borehole logs.
Data completeness	Analysis of appropriate determinants based on site history and on-site observation.
Data comparability	Use of NATA certified laboratory, use of consistent sampling technique.
Precision and accuracy for sampling and analysis	Achievement of 50% RPD for replicate analysis, acceptable levels for laboratory QC criteria.

6.4 Results

The subsurface conditions are presented in detail in the test pit and borehole logs, Appendix A. These should be read in conjunction with the general notes preceding them, which explain definitions of the classification methods and descriptive terms.

6.5 Minmi West

South of Railway Street (Pits 1 to 19)

The areas of Minmi West, south of Railway Street generally comprise scattered houses and grazed paddocks with an undulating surface due to previous development comprising a workshop as well as numerous houses on the slopes to the south.

Subsurface conditions on the slopes generally comprised silty filling ranging in thickness from 0.2 m to 1.9 m overlying very stiff to hard clay and siltstone/claystone at depths in the range 0.5 m to 2.5 m.

A number of former buried cisterns/pits were located on the site, as marked in white on Drawing 2. These were found to be localised pits, often brick lined, containing building rubble, sheet iron and other waste material such as plastic and glass. They were generally full of water.

In the area of the former workshops (Pits 8 to 15), the filling typically comprised sand and silt soils, including chitter and ash in places, as well as other deleterious materials such as metal and bricks. The filling in this area generally directly overlaid weathered claystone at depths in the range 0.25 m to 1.9 m.

Railway Street to Purple Hill Open Cut Mine (Pits 50 to 53)

Only limited investigation was undertaken in the area between Railway Street and the former Purple Hill Open Cut mine, comprising Pits 50 to 53 excavated near the approximate location of the former coke ovens. These pits encountered filling, comprising gravely clayey silt with coal chitter to depths in the range 0.35 m to 2.0 m underlain by clay and clayey sand with refusal occurring on conglomerate at depths in the range 1.9 m to 3.6 m. Groundwater seepage was observed in Pit 51 at 2.1 m depth.

Purple Hill Open Cut Mine and Slopes to the North
(Pits 54 to 59, 61 to 64, 66 to 69, 72, 73, and Bores 57 and 97)

Variable filling including coal chitter was encountered in these pits to depths in the range 0.4 m to greater than 3.1 m. Bores 57 and 97 encountered filling to 6.6 m and 6.7 m respectively. Pit 67 encountered metal and fibro sheeting between 0.3 and 0.5 m depth. No filling was encountered at Pit 68.

Where the base of the filling was encountered, the filling was underlain by clays, silts and sands with refusal generally occurring on sandstone, siltstone and conglomerate between 0.7 and 8.5 m depth. Pit 54 encountered clayey gravelly sand beneath the filling to termination at 3.4 m depth.

Groundwater was encountered in Pit 58 at 2.3 m depth, and in Bore 97 at 6.6 m depth.

Former Rail Embankments and Screens (Pits 60, 65, 67, 70, 71, 74 to 80, 82, 85, 86)

These test pits were excavated along former rail lines, many of which comprise an embankment elevated above the creek line as well as areas of cut to fill, such as where the sidings were near the former screens.

The pits encountered variable filling including coal chitter to depths between 0.2 m and at least 3.2 m, underlain by clays, silts and sands, with refusal generally on sandstone between 0.25 m to greater than 3.7 m depth.

Groundwater was observed in Pit 60 at 3.3 m, and Pit 85 at 2.85m. Seepage was observed in Pits 81 and 83 at 1.9 and 1.7 m depths respectively.

Low Lying Northern Parts (Pits 81, 83 and 84)

These pits encountered topsoil underlain by silts, clays, and sands to termination at 3.0 m in Pits 83 and 84, and possible refusal on rock in Pit 81 at 3.1 m depth.

Groundwater seepage was observed in Pits 81 and 83 at 1.9 m and 1.7 m depth respectively.

6.6 Minmi North

Former Rail Line (Pits 103, 108, 112, 113, 121, 130)

These test pits were excavated along a former rail lines, much of which comprises embankment elevated above the creek line as well as areas of cut to fill.

Filling, including coal reject, clay, silt and concrete, was encountered to depths of 0 m to 0.9 m, underlain by clays and silts. Claystone or siltstone was observed from 0.6 m to 2.4 m in all pits except Pit 130. Groundwater observed in Pit 58 from 2.3 m in Bore 97 from 6.6 m.

Gully Line and Low Lying Northern Areas (Pits 109, 110, 117, 119, 123, 129)

Pits 109 and 110 encountered filling to 0.45 m and 1.05 m respectively, underlain by clayey silt and silty clay to termination at 2.2 m depth.

The remaining pits comprised clay, silty clay and clayey silt, underlain in Pits 123 and 129 by silty sands, and siltstone from 2.2 m depth in Pit 129.

Groundwater was observed in Pits 123 and 129 at 2.45 m and 1.6 m respectively. Seepage was observed in Pit 117 at 0.7 m and Pit 129 at 0.4 m depth.

Southern Cleared Area (Pits 99, 100 to 102, 104, 105 to 107)

This area formerly contained numerous mining cottages and the current surface is moderately undulating.

These pits generally comprised variable filling including clay, ash, coal, brick and metal, from 0 m to greater than 2.0 m depth. In Pits 99, 100 to 102, 104 and 106, the filling was underlain by clays and siltstone or claystone to refusal between 1.2 and 2.7 m depth.

Perched groundwater was observed in Pit 107 at 0.5 m.

Northern Elevated Area (Pits 111, 114, 115, 118, 120, 124 to 128, 138)

This area is elevated above the adjacent low lying land. Much of the area is forested and only lightly disturbed, however clearing and cut and filling has been undertaken on the northern portions.

Pits 124, 128 and 138 encountered filling to 0.4 m to 1.35 m depth. Residual soil generally comprised clays and silts to termination in Pits 124 to 126 and 128, and underlain by claystone or siltstone in the remaining pits from 0.5 m to 2.0 m depth to termination.

6.7 Minmi East

Former Browns Open Cut Mine (Pits/Bores 87 to 96)

This is the former site of an open cut mine in the Borehole Seam.

The majority of pits encountered filling, including clay, sand, coal, coal chitter, sandstone and siltstone to termination. Pit 88 encountered filling to 0.3 m underlain by sandy clay and refused on sandstone at 0.9 m depth. Pits 87 and 96 refused on sandstone at 1.9 m and 2.3 m respectively.

Bores 91 and 94 encountered filling to 5.1 m and 8.2 m depth respectively, underlain by siltstone and laminite.

Seepage was observed in Bores 94 and 98 at 8.0 m and 3.2 m respectively. Groundwater was observed from 6.6 m depth in Bore 97.

Mid Eastern Parts (Pits 131 to 137)

This area is generally forested with the exception of a clearing and some access tracks where the test pits were undertaken. Significant opportunistic tipping has been undertaken in this area.

These pits encountered variable filling to between 0.1 m and 0.55 m depth, underlain by clayey sand, silty clay and refusing on sandstone between 0.45 m and 0.8 m depth. No filling was observed in Pits 135 and 136.

Far Eastern Area

No investigation was undertaken in the far eastern area.

6.8 Minmi South

Northern Cleared Areas (Pits 20 to 31)

These areas are generally used for pasture, however previously contained miners cottages and the surface is highly undulating.

The pits generally encountered variable filling to between 0.45 m and 2.5 m depth, generally underlain by clay and claystone / siltstone / coal. Pit 23A was located within a cesspit / well and encountered filling including clay, coal, ash, brick, glass, and timber to greater than 2.0 m depth. No filling was observed in Pits 25, 26 or 29.

Perched groundwater was observed in Pits 23A and 23B at 1.0m and 2.0m respectively.

Former open cut pit and entry to Wallsend Borehole Colliery (Pits 38 to 47 and Bore 98)

The Browns Underground Colliery once extended onto the very eastern parts of this site. This area was then used as an open cut mine to the Young Wallsend Seam, which was later used as an entry point for the Wallsend Borehole Colliery underground operations.

These pits generally encountered variable filling including coal, ash and coke to termination. Pit 40 encountered firm to stiff gravelly clay from 2.6m. Pit 42 encountered claystone from 1.9m and a timber column coated with coal tar was observed adjacent to the edge of the pit. Pits 43 and 44 and 47 encountered clay, coal and / or claystone from 0.8 m depth.

Bore 98 encountered variable filling to 3.2m depth underlain by soft to firm silty clay to 5.3 m depth, and stiff to very stiff silty clay to termination at 5.95 m depth. Seepage was observed at 3.2 m depth.

Southern Areas (Pits 32 to 37, 48, 49, 140 to 146)

These pits generally encountered silts underlain by stiff to hard clays to termination. Pits 32, 33, 37, 48, 140 to 143 and 145 encountered variable filling to between 0.25 m and 1.5 m depth.

Pits 32 to 34, 37, 48, 49, and 140 to 146 were terminated in siltstone, sandstone, claystone or conglomerate from 0.8 to 3.1 m depth.

6.9 Link Road North (Pits 153 to 158)

These pits generally comprised silts, clays and gravels underlain by sandstone, siltstone, claystone, coal and conglomerate, with refusal occurring between 0.75 m and 3.1 m depth. Pit 153 encountered gravel filling (possibly natural) to 0.4 m depth.

6.10 Link Road South (Pits 147 to 152)

These pits generally comprised silts, clays and gravel underlain by sandstone, siltstone and conglomerate, with refusal occurring between 0.8 m and 3.0 m depth. Deleterious filling was observed in Pit 149 to 0.2 m depth. In Pit 150 seepage was observed at 0.45 m and groundwater observed from 1.9 m depth.

6.11 Summary

A summary of the depth of filling, depth to rock and depth of groundwater is presented in Table 3, below.

Table 3 – Summary of Depth of Filling, Rock and Groundwater

Location	Area	Easting	Northing	Surface Level (AHD)	Depth of Fill (m)	Depth to Rock (m)	Depth of Backhoe/Auger Refusal (m)	Depth of Groundwater (m)
Pit 1	Minmi West	370105	6360262	61.1	0.35	0.8	1.6	NE
Pit 2	Minmi West	370039	6360488	44.0	0.9	2.4	>3.0	NE
Pit 3	Minmi West	369783	6360645	35.2	0.5	1.4	2.3	NE
Pit 4	Minmi West	370010	6360567	36.1	1.8	1.8	2.7	NE
Pit 4A	Minmi West	369985	6360657	25.6	>2.7	>2.7	>2.7	NE
Pit 5	Minmi West	370172	6360539	34.4	0.7	1.7	1.7	NE
Pit 6	Minmi West	370299	6360576	42.6	1.0	1.3	1.8	NE
Pit 6A	Minmi West	370238	6360569	33.6	0	0.9	2.5	NE
Pit 7	Minmi West	370088	6360727	25.4	0.5	0.5	2.1	NE
Pit 8	Minmi West	370072	6360692	28.2	0	0.3	2.1	NE
Pit 9	Minmi West	370800	6360372	19.6	1.3	1.3	>2.1	NE
Pit 10	Minmi West	370113	6360705	26.0	0.8	0.8	1.9	NE
Pit 11	Minmi West	370015	6360704	25.3	0.6	1.0	1.9	NE
Pit 12	Minmi West	370062	6360727	25.4	1.9	1.9	>3.0	NE
Pit 13	Minmi West	370103	6360740	24.6	0.5	1.0	2.2	NE
Pit 14	Minmi West	370014	6360734	22.2	0.2	1.4	>3.0	NE
Pit 15	Minmi West	370043	6360753	22.9	1.0	1.0	1.7	NE
Pit 16	Minmi West	370092	6360768	23.0	0	1.3	2.6	NE
Pit 17	Minmi West	370259	6360676	31.9	0.7	2.5	>3.0	NE
Pit 18	Minmi West	370259	6360676	31.9	0	1.6	>3.0	NE
Pit 19	Minmi West	370201	6360769	23.9	0.7	1.4	2.7	NE
Pit 20	Minmi Sth	370254	6360796	24.4	1.2	1.2	>1.8	NE
Pit 21	Minmi Sth	370310	6360834	23.1	1.0	2.0	2.5	NE
Pit 22	Minmi Sth	370451	6360794	26.2	0.7	1.4	>3.4	NE
Pit 23	Minmi Sth	370424	6360784	27.3	1.4	>3.0	>3.0	NE
Pit 23A	Minmi Sth	370645	6360881	34.2	>2.0	>2.0	>2.0	Perched 1.0
Pit 23B	Minmi Sth	370671	6360737	27.4	2.6	2.6	4.2	Perched 2.0
Pit 24	Minmi Sth	370669	6360751	28.2	0.9	0.9	>3.0	NE
Pit 25	Minmi Sth	370671	6360753	28.3	0	1.4	2.6	NE
Pit 26	Minmi Sth	370798	6359511		0	0.5	>3.0	NE
Pit 27	Minmi Sth	370605	6360692	39.2	2.1	2.6	>3.0	NE
Pit 28	Minmi Sth	370747	6360611	32.4	1.9	2.3	2.6	NE
Pit 29	Minmi Sth	370500	6360475	34.9	0	1.6	>2.5	NE
Pit 30	Minmi Sth	370709	6360499	29.8	1.3	1.25	1.5	NE

Table 3 – Summary of Depth of Filling, Rock, and Groundwater (continued)

Location	Area	Easting	Northing	Surface Level (AHD)	Depth of Fill (m)	Depth to Rock (m)	Depth of Backhoe/Auger Refusal (m)	Depth of Groundwater (m)
Pit 31	Minmi Sth	370619	6360449	30.8	0.5	1.1	>2.7	NE
Pit 32	Minmi Sth	370646	6360388		0.6	1.7	>2.3	NE
Pit 33	Minmi Sth	370302	6360288	53.8	0.4	0.7	1.0	NE
Pit 34	Minmi Sth	370473	6360062		0	1.4	>2.5	NE
Pit 35	Minmi Sth	370525	6360525		0	>2.5	>2.5	NE
Pit 36	Minmi Sth	370534	6359944		0	>2.2	>2.2	NE
Pit 37	Minmi Sth	370513	6360016		1.5	2.9	>3.1	NE
Pit 38	Minmi Sth	370762	6360357	16.7	≥2.4	2.4?	2.4	NE
Pit 39	Minmi Sth	370823	6360398	18.9	>3.1	>3.1	>3.1	NE
Pit 40	Minmi Sth	370890	6360423	22.5	2.6	>3.0	>3.0	NE
Pit 41	Minmi Sth	370793	6360285	19.7	>3.3	>3.3	>3.3	NE
Pit 42	Minmi Sth	370862	6360313	24.6	1.9-2.5	1.9	2.8	NE
Pit 43	Minmi Sth	370912	6360333	26.3	1.0	1.0	2.5	NE
Pit 44	Minmi Sth	370954	6360388	26.6	1.1	2.1	>3.0	NE
Pit 45	Minmi Sth	370809	6360251	21.0	>3.1	>3.1	>3.1	NE
Pit 46	Minmi Sth	370856	6360262	25.5	>3.5	>3.5	>3.5	NE
Pit 47	Minmi Sth	370750	6360294	16.5	0.8	0.8	>3.0	NE
Pit 48	Minmi Sth	371043	6360238	40.0	0.8	0.8	>3.0	NE
Pit 49	Minmi Sth	371016	6360144	46.3	0	0.6	2.2	NE
Pit 50	Minmi West	370348	6360939	17.4	0.4	1.9	1.9	NE
Pit 51	Minmi West	370317	6360890	17.2	1.9	3.6	3.6	Seepage at 2.1 m
Pit 52	Minmi West	370312	6360935	16.2	0.7	>3.0	>3.0	NE
Pit 53	Minmi West	370352	6360911		2.0	2.4	2.4	NE
Pit 54	Minmi West	370356	6360994	14.4	2.0	>3.4	>3.4	NE
Pit 55	Minmi West	370397	6360976	17.8	1.4	≥2.7	≥2.7	NE
Pit 56	Minmi West	370413	6361032	16.8	0.5	1.3	1.5	NE
Bore 57	Minmi West	370274	6361090	16.3	6.6	6.6	6.7	>6.7
Pit 58	Minmi West	370199	6361127	16.8	3.1	3.1	3.1	2.3
Pit 59	Minmi West	370392	6361110	12.6	0.4	1.7	1.8	NE
Pit 60	Minmi West	370451	6361130	17.5	2.4	>3.7	>3.7	3.3
Pit 61	Minmi West	370110	6361163	21.6	>1.4	>1.4	>1.4	NE
Pit 61A	Minmi West	370123	6361162	21.6	>2.1	>2.1	>2.1	NE
Pit 62	Minmi West	370319	6361188	18.3	0.5	2.4	2.4	NE
Pit 63	Minmi West	370161	6361249	29.6	2.1	3.1	3.1	NE

Table 3 – Summary of Depth of Filling, Rock, and Groundwater (continued)

Location	Area	Easting	Northing	Surface Level (AHD)	Depth of Fill (m)	Depth to Rock (m)	Depth of Backhoe/Auger Refusal (m)	Depth of Groundwater (m)
Pit 64	Minmi West	370253	6361319	22.4	1.9	2.7	2.7	NE
Pit 65	Minmi West	370440	6361271	16.4	2.6	>3.7	>3.7	NE
Pit 66	Minmi West	370363	6361322	12.8	0.6	1.1	1.1	NE
Pit 67	Minmi West	370273	6361482		0.7	0.7	0.7	NE
Pit 68	Minmi West	370299	6361386	14.7	0	≥1.35	1.4	NE
Pit 69	Minmi West	370364	6361411	8.9	0.7	2.9	2.9	NE
Pit 70	Minmi West	370218	6361432	18.7	1.9	1.9	1.9	NE
Pit 71	Minmi West	370437	6361423	17.0	0.7	0.7	0.8	NE
Pit 72	Minmi West	370358	6361488	12.2	>2.9	>2.9	>2.9	NE
Pit 73	Minmi West	370346	6361524	13.7	>3.0	>3.0	>3.0	NE
Pit 74	Minmi West	370485	6361525	17.9	1.0	1.0	1.5	NE
Pit 75	Minmi West	370493	6361599	16.7	1.8	>2.7	>2.7	NE
Pit 76	Minmi West	370439	6361599	12.4	3.2	>3.2	>3.2	NE
Pit 77	Minmi West	370552	6361579	23.7	1.5	1.5	1.8	NE
Pit 77A	Minmi West	370543	6361560	24.3	>0.3	>0.3	>0.3	NE
Pit 77B	Minmi West	370544	6361561		0.4	0.4	0.6	ME
Pit 78	Minmi West	370501	6361575	16.7	0.2	0.2	0.3	NE
Pit 79	Minmi West	370577	6361649	15.4	0.3	1.6	1.6	NE
Pit 80	Minmi West	370619	6361685	15.8	0.7	>2.8	>2.8	NE
Pit 81	Minmi West	370521	6361727	8.7	0	3.1	3.1	Seepage from 1.9m
Pit 82	Minmi West	370656	6361723	14.7	0.65	1.2?	1.2?	NE
Pit 83	Minmi West	370483	6361803	5.8	0	>3.0	>3.0	Seepage at 1.7m
Pit 84	Minmi West	370588	6361804	9.5	0	>3.0	>3.0	NE
Pit 85	Minmi West	370659	6361784	12.6	>3.2	>3.2	>3.2	2.9
Pit 86	Minmi West	370725	6360847	23.9	0.5	>2.7	>2.7	NE
Pit 87	Minmi East	371112	6361052	25.4	1.8	1.8	1.9	NE
Pit 88	Minmi East	371255	6361044	48.8	0.3	0.8	0.9	NE
Pit 89	Minmi East	371366	6361039	37.3	>3.2	>3.2	>3.2	NE
Pit 90	Minmi East	371149	6361126	30.2	>3.6	>3.6	>3.6	NE
Bore 91	Minmi East	371275	6361093	42.8	5.1	5.1	>7.2	>7.15
Pit 92	Minmi East	371314	6361143	39.8	0.7?? >3.2	>3.2	>3.2	NE
Pit 93	Minmi East	371153	6361185	35.7	≥3.7	≥3.7	3.7	NE
Bore 94	Minmi East	371245	6361196	37.2	8.2	8.2	8.6	Seepage at 8.0m

Table 3 – Summary of Depth of Filling, Rock, and Groundwater (continued)

Location	Area	Easting	Northing	Surface Level (AHD)	Depth of Fill (m)	Depth to Rock (m)	Depth of Backhoe/Auger Refusal (m)	Depth of Groundwater (m)
Pit 95	Minmi East	371254	6361257	35.6	>3.7	>3.7	>3.7	NE
Pit 96	Minmi East	371217	6361321	31.3	2.1	2.2	2.3	NE
Bore 97	Minmi West	370220	6361203	23.4	8.5	8.5	8.5	6.6
Bore 98	Minmi Sth	370800	6360372	19.6	3.2	6.0	6.0	Seepage at 3.2m
Pit 99	Minmi Nth	370824	6361003	11.4	1.2	1.9	2.2	NE
Pit 100	Minmi Nth	370889	6360985	10.5	0.9	1.6	1.8	NE
Pit 101	Minmi Nth	370790	6361062	14.5	0.3	1.3	1.4	NE
Pit 102	Minmi Nth	370940	6361090	13.0	0	1.6	2.0	NE
Pit 103	Minmi Nth	370818	6361184		0.3	0.6	0.8	NE
Pit 104	Minmi Nth	370888	6361172	10.2	0.4	0.8	1.2	NE
Pit 105	Minmi Nth	370951	6361148	16.4	>2.0	>2.0	>2.0	Perched at 0.4m, possible shaft
Pit 106	Minmi Nth	371030	6361176	23.6	0.3	2.2	2.7	NE
Pit 107	Minmi Nth	370933	6361244	14.1	0	>1.8	>1.8	Perched at 0.5m, possible pothole or well
Pit 108	Minmi Nth	370826	6361119	10.4	0.6	1.1	1.3	NE
Pit 109	Minmi Nth	370910	6361335	5.2	0.5	>2.2	>2.2	NE
Pit 110	Minmi Nth	370958	6361511	4.8	1.1	>2.2	>2.2	NE
Pit 111	Minmi Nth	371204	6361716	10.9	0	0.7	>2.0	NE
Pit 112	Minmi Nth	370995	6361422	8.7	0.2	1.0	3.0	NE
Pit 113	Minmi Nth	370887	6361552	7.8	0.95	2.4	2.6	NE
Pit 114	Minmi Nth	370993	6361626	3.3	0	2.0	2.2	Seepage at 2m
Pit 115	Minmi Nth	371248	6361581	25.6	0	0.5	1.8	NE
Pit 117	Minmi Nth	371326	6361654	17.4	0	>3.0	>3.0	Seepage at 0.7m
Pit 118	Minmi Nth	371111	6361754	2.3	0	1.8	>2.5	NE
Pit 119	Minmi Nth	371410	6361780	7.2	0	>3.0	>3.0	NE
Pit 120	Minmi Nth	370950	6361854		0	0.5	1.5	NE
Pit 121	Minmi Nth	371085	6361870	2.4	0	0.8	1.2	NE
Pit 123	Minmi Nth	371314	6361143	39.8	0	>3.0	>3.0	2.5
Pit 124	Minmi Nth	371367	6361851	2.3	1.1	>3.0	>3.0	NE
Pit 125	Minmi Nth	371447	6361841	8.6	0	>3.0	>3.0	NE
Pit 126	Minmi Nth	371438	6361920	0.9	0	>3.0	>3.0	NE
Pit 127	Minmi Nth	371358	6361704	13.2	0	1.2	1.5	NE
Pit 128	Minmi Nth	371517	6361917	1.2	0.4	>2.5	>2.5	1.7

Table 3 – Summary of Depth of Filling, Rock, and Groundwater (continued)

Location	Area	Easting	Northing	Surface Level (AHD)	Depth of Fill (m)	Depth to Rock (m)	Depth of Backhoe/Auger Refusal (m)	Depth of Groundwater (m)
Pit 129	Minmi Nth	370930	6361924	2.7	0	2.2	>3.0	1.6 (seepage at 0.4)
Pit 130	Minmi Nth	371034	6362048	3.1	0.9	>2.5	>2.5	0.6
Pit 131	Minmi East	371273	6361374	29.8	0.1	0.3	0.5	NE
Pit 132	Minmi East	371329	6361369	24.4	0.2	0.3	0.6	NE
Pit 133	Minmi East	371301	6361420		0.5	0.7	0.7	NE
Pit 134	Minmi Nth	370928	6361024	14.6	0.3	0.3	0.7	NE
Pit 135	Minmi East	371528	6361201		0	0.3	0.5	NE
Pit 136	Minmi East	371563	6361392	31.8	0	0.5	0.6	NE
Pit 137	Minmi East	371582	6361513	24.6	0.6	0.6	0.8	NE
Pit 138	Minmi Nth	371593	6361844	3.7	1.4	2.2	>2.6	NE
Pit 140	LR North	370505	6359691		0.3	0.9	1.5	NE
Pit 141	LR North	370578	6359711		0.3	0.8	1.5	NE
Pit 142	LR North	370578	6359620		0.5	1.4	>3.0	NE
Pit 143	LR North	370029	6359456		1.5	2.0	2.4	NE
Pit 144	LR North	370220	6359383		0	0.9	1.4	NE
Pit 145	LR North	370956	6359114		0.3	0.5	0.8	NE
Pit 146	LR North	370794	6359506		0	0.7	1.0	NE
Pit 147	LR South	371817	6357519		0	2.9	3.0	NE
Pit 148	LR South	371820	6357510		0	0.9	1.0	NE
Pit 149	LR South	372079	6357488		0.2	0.6	1.0	NE
Pit 150	LR South	371243	6357903		0	2.0	2.1	1.9 (seepage at 0.45)
Pit 151	LR South	371555	6357967		0	0.5	>2.0	NE
Pit 152	LR South	371849	6358134		0	0.7	0.8	NE
Pit 153	LR North	372125	6358461		0.4	0.6	0.75	NE
Pit 154	LR North	372284	6358527		0	2.5	2.6	NE
Pit 155	LR North	371277	6359497		0	1.4	2.3	NE
Pit 156	LR North	371585	6358846		0	0.9	>1.2	NE
Pit 157	LR North	372030	6358980		0	0.5	1.6	NE
Pit 158	LR North	372370	6359220		0	1.3	3.1	NE

Notes to Table 3:

NE – Not Encountered
Note: Entries with no surface level shown are approximate coordinates from hand held GPS.

Very soft to firm possible alluvial soil was encountered in Bore 97 from 6.7 to 8.45m depth

Groundwater seepage was also observed emanating from a localised point in the upper reached of a gully in the northern part of Link Road South.

The presence of potentially combustible material (coal and chitter) was noted on the borehole and test pit logs, and is summarised in Table 4 below.

Table 4 – Potentially Combustible Material within Test Bores and Pits

Test Pit / Bore	Depth (m)	Approx % (1)	Test Pit/ Bore	Depth (m)	Approx % (1)
Pit 9	0.7-1.0	5	Pit 72	0-0.2, 0.4-2.4	5
Pit 15	0.1-0.95	50	Pit 73	0.6-3.0	70
Pit 17	0.4-0.7	15	Pit 74	0-0.3	10
Bore 23B	0-2.5	5-10	Pit 74	0.65-1.0	5
Pit 32	0-0.55	5	Pit 76	0-0.25	10
Pit 39	0.65-1.45	30	Pit 78	0-0.2	50
Pit 44	0-0.05	10	Pit 79	0-0.3	30
Pit 44	0.35-1.1	15	Pit 85	0-0.55	10
Pit 46	1.5-2.0	20	Pit 86	0-0.5	10
Pit 47	0-0.25	60	Pit 87	0-1.8	5-10
Pit 47	0.35-0.65	90	Pit 90	0.05-1.6	10-15
Pit 48	2.0		Pit 90	1.6-1.7	40-50
Pit 51	0.7-1.9	50	Pit 90	1.7-2.7	15
Pit 53	0.2-0.6	80	Pit 90	2.7-2.8	40-50
Pit 55	0-0.4	50	Pit 90	2.8-3.6	5-10
Pit 55	0.4-1.4	5-10	Bore 91	0-3.7	5-10
Bore 57	0-6.6	5-10	Bore 94	0-7.6	10
Pit 58	2.3-3.1	80	Bore 94	7.6-8.2	20-50
Pit 59	0-0.4	70	Bore 97	0-5.3	10
Pit 60	0-1.3	20	Bore 98	0.7-3.2	
Pit 60	1.3-1.9	90	Pit 99	0.4-0.85	85
Pit 61	0.6-1.3	10	Pit 104	0-0.15	20-40
Pit 63	0-0.7	5	Pit 108	0-0.3	65
Pit 65	0-0.25	40	Pit 113	0.4-0.6	30
Pit 65	0.25-1.2	40	Pit 130	0.35-0.9	60
Pit 66	0-0.6	50-60	Pit 142	0-0.2	50
Pit 70	1.4-1.6	20	Pit 142	0.2-0.45	50
Pit 71	0.2-0.65	90	Pit 143	0.25-0.7	50

Notes to Table 4:

(1) Approximate percentage only, based on visual assessment

6.12 Contaminant Observations

Based on the results of the site walkover survey and subsurface assessment, potential sources of contamination from the former site uses include the following:

- Fill materials (source unknown), may contain a range of contaminants including asbestos, hydrocarbons, heavy metals etc. Filling is present in areas marked as mounded filling and disturbed ground (Drawings 1 to 4) as well as minor filling within other cleared or developed areas;
- Oil and grease from the coal mining operations including disturbed and cleared areas;
- Ash associated with boilers and coke ovens with potential contaminants including PAHs, coal tars and heavy metals;
- Asbestos lining from buildings and fences. This may be present in filling, disturbed ground or cleared areas and from opportunistic tipping on access tracks;
- A sewage pump station was observed at the northern end of the site. There is some potential for offsite migration of contamination onto the adjacent lower lying parts of the site. Potential contamination would include nutrients, metals and biological hazards. No contaminant migration would be expected if the pump station has been kept in good order;
- Parts of the site are used for agricultural purposes, in particular for grazing. Potential contamination associated with such site uses includes herbicides, pesticides and high nutrient run-off.

Observations of potential contamination within the test bores and pits are summarised in Table 5 below.

Table 5 – Contaminant Observations within Test Pits and Bores

Potential Contaminant Observation	Location/Depth (m)
Fibro fragments	Pit 67 / 0.3-0.7
	Pit 149 / 0-0.2
	Pit 152 / surface
Deleterious Material (concrete, timber, metal, bricks, glass, plastic, PVC, bone, porcelain, asphalt, sleepers, rails)	Pit 1 / 0-0.35
	Pit 4A / 0.2-1.3
	Pit 7 / 0-0.3
	Pit 9 / 0-0.7
	Pit 13 / 0-0.5
	Pit 15 / 0-0.95
	Pit 19 / 0-0.7
	Pit 22 / 0-0.7
	Pit 23 / 0-0.4
	Pit 23A / 0 - >2
	Pit 33 / 0-0.35
	Pit 39 / 0.6 – 1.0
	Pit 42 / 0.9-1.5
	Pit 48 / 0 - 0.1
	Pit 67 / 0.3-0.5
	Pit 72 / 0.4-1.7
	Pit 77A, 77B / 0-0.35
	Pit 82 / 0-0.15
	Pit 95 / 2.6-2.7
	Pit 103 / 0-0.3
	Pit 105 / 0.4 - >2.0
	Pit 106 / 0-0.25
	Pit 107 / 0 - >1.8
	Pit 109 / 0-0.45
	Pit 112 / 0-0.15
	Pit 141 / 0 – 0.3
	Pit 143 / 0.7-0.9
	Pit 149 / 0-0.2
	Pit 152 / surface
	Pit 154 / surface
	Pit 157 / surface
Asphalt and possible coal tar on timber pile	Pit 42 / 0.9-1.5
Slight hydrocarbon / PAH odour / colouration	Pit 23A / 1.0 - >2.0
	Pit 42 / 0.9-1.5
	Pit 47 / 0.35-0.65

The results of PID screening on soil samples are shown on the test pit logs in Appendix A, and generally suggest the absence of gross volatile hydrocarbon impact.

There was no visual or olfactory evidence (i.e. staining or odours) to suggest the presence of gross contamination within the soils investigated.

Seepage water was observed in some of the pits. There was no visual or olfactory evidence (i.e. staining or odours) to suggest the presence of gross contamination within seepage water.

It is noted, however, that groundwater was not sampled or analysed to confirm groundwater constituents.

7. LABORATORY TESTING

7.1 Contamination

7.1.1 General

Laboratory testing was undertaken by SGS Environmental, a National Association of Testing Authorities, Australia (NATA) registered laboratory. Analytical Methods used are shown on the laboratory sheets in Appendix C.

A total of 135 soil samples from the pits and boreholes were selected to provide an assessment of soil/fill conditions. The samples were selected to target the identified potential sources of contamination (Ref 1) and to assess general site conditions.

The selected samples were analysed for the following potential contaminants:

- Total Recoverable Hydrocarbons (TRH);
- Polycyclic Aromatic Hydrocarbons (PAH);
- Organochlorine Pesticides (OCP);
- Organophosphorus Pesticides (OPP);
- Polychlorinated Biphenyls (PCB);
- Benzene, Toluene, Ethyl Benzene, Xylene (BTEX);

- Metals: Arsenic (As); Cadmium (Cd); Chromium (Cr); Copper (Cu); Lead (Pb); Mercury (Hg); Nickel (Ni); Zinc (Zn).

Quality Control/Quality Assurance (QA/QC) testing comprised 15 soil replicate samples.

In addition, seven fibro samples and 15 soil samples from test pits were analysed for asbestos.

TCLP leachability testing for selected metals was conducted on sixteen samples that exceeded sensitive land use criteria for TRH (where offsite disposal is likely) to further assess the waste classification.

Four soil samples were analysed for full chromium suite as part of the acid sulphate soil assessment. The results of acid sulphate soil investigation are presented in Section 9.

A total of 21 soil samples were analysed for aggressiveness (sulphate, chloride and pH), and combustibility testing was undertaken on 17 samples. The results of this testing is presented in Section 10.

7.1.2 Analytical Results

The results of chemical analysis of soil samples are presented in the laboratory report sheets (Appendix C), and are summarised in Tables 6 to 10, below.

Table 6 – Laboratory Results for Metals in Soil

Test Location	Depth(m)	Metal							
		As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Pit 1	0.1	<PQL	<PQL	<PQL	0.8	5	0.18	<PQL	6.9
R4		14	0.7	7.7	27	**160**	0.18	8.5	210
Pit 2	1.6	<PQL	<PQL	0.96	3.4	9.8	<PQL	5.1	15
Pit 3	0.2	9	0.3	6.7	18	21	0.05	6.8	64
Pit 4	0.5	10	0.8	15	38	**210**	0.35	13	250
Pit 4A	1.1	6	0.8	5.9	16	26	0.05	4.7	400
Pit 5	0.8	6	0.3	6.2	6.3	7	<PQL	1.4	15
Pit 6	0.25	13	0.5	14	29	**290**	0.09	15	120
R5		10	0.4	13	26	**460**	0.07	15	120
Pit 6	0.8	6	0.2	5.1	6.4	78	0.05	2.5	18
Pit 7	0.1	21	1.9	12	880	**410**	0.14	20	860
R1		20	1.8	14	4400	**540**	0.11	22	880
Pit 7	0.6	<PQL	0.1	2.8	1.8	13	<PQL	<PQL	7.1
Pit 8	0.1	12	0.96	6.7	520	**150**	0.1	6	280
Pit 9	0.1	19	2.4	14	460	**510**	0.1	24	520
Pit 11	0.1	4	0.3	3.3	130	53	<PQL	7.5	110
R2		5	0.4	4.8	260	81	0.05	8.3	130
Pit 13	0.1	9	2.3	4.6	110	**120**	0.21	12	1500
Pit 15	0.2	6	0.8	3.1	110	**100**	0.11	7.6	570
Pit 17	0.1	15	0.8	7.9	52	**230**	0.21	8.2	150
Pit 19	0.3	15	0.8	9.9	31	**140**	0.22	10	170
R8		16	0.9	9.1	33	**160**	0.25	9.4	200
Pit 19	0.3	9	0.3	10	47	**470**	0.26	6.4	170
Pit 21	0.3	7	0.2	4.1	2.6	12	0.41	1	12
Pit 22	0.15	5	1.3	8.9	27	**160**	0.21	7.8	290
Pit 22	0.5	<PQL	<PQL	4.7	3.9	20	<PQL	1.1	27
Pit 23	0.1	6	0.6	5.7	19	91	0.15	4.8	140
Pit 23A	1.5	5	0.7	3.1	8.7	55	0.06	5.7	750
Pit 24	0.1	7	0.4	5.5	9.8	18	<PQL	2.7	45
Pit 25	0.3	<PQL	0.2	8.7	16	9	<PQL	4.6	38
Pit 27	0.5	<PQL	0.1	1.7	3.6	19	<PQL	1.2	22
Pit 28	1.6	3	<PQL	3.2	6.9	9	<PQL	1.1	12

Table 6 – Laboratory Results for Metals in Soil (continued)

Test Location	Depth(m)	Metal							
		As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Pit 29	0.1	6	0.4	4.1	7	18	<PQL	4.1	39
Pit 30	0.9	4	0.2	3.5	6.8	11	<PQL	1.4	16
Pit 31	0.2	8	1	8.5	18	59	0.12	9.4	260
Pit 32	0.6	9	0.3	8.1	7.9	9.7	<PQL	1.2	13
Pit 33	0.2	6	0.4	3.5	22	**100**	<PQL	1.8	250
Pit 35	0.1	17	1.9	8.4	18	**100**	0.08	11	620
Pit 35	0.7	10	0.4	10	5.7	11	<PQL	2	28
R3		15	0.7	16	6.4	17	<PQL	1.5	24
Pit 37	0.1	6	0.3	5.1	5.1	21	<PQL	2.1	23
Pit 38	1.9	4	0.2	1.1	3.4	7	0.05	5.9	20
Pit 39	1.6	6	0.3	6.1	11	4	<PQL	6.2	39
Pit 40	0.2	6	0.3	5.9	9.8	19	<PQL	4.9	63
Pit 41	2.0	6	0.3	3.5	4.9	14	<PQL	4.2	22
Pit 42	1.2	<PQL	0.1	1	5.9	19	<PQL	2.5	30
Pit 43	1.1	<PQL	<PQL	0.8	1	3	<PQL	<PQL	4
Pit 44	0.5	6	0.2	1.9	9.7	9	0.11	6.9	67
Pit 45	0.2	4	0.2	1.8	6.3	28	0.06	3.2	38
Pit 46	1.6	7	0.2	1.8	6.7	11	0.17	5.1	32
Pit 47	0.4	6	0.3	6.8	13	5	<PQL	8.5	47
Pit 47	2.3	6	0.9	5.2	61	20	0.08	11	760
Pit 48	0-0.5	<PQL	<PQL	6.4	1.3	1	<PQL	<PQL	35
Pit 49	0.1	9	0.6	7.1	8.9	11	<PQL	3	19
Pit 50	0.2-0.3	9	2.5	41	34	**120**	<PQL	9	200
Pit 51	0.8-1.0	5	0.2	16	12	22	0.13	7.1	22
Pit 53	0.8-1.0	<PQL	<PQL	3.1	7.5	3	<PQL	16	27
Pit 54	0.8-1.0	7	0.2	8.4	19	21	0.06	11	58
Pit 55	0-0.2	5	0.2	5.7	7.3	20	<PQL	4.9	33
Pit 56	0-0.15	15	0.6	8.7	26	70	0.06	11	120
Pit 58	0.1-0.3	4	0.3	12	4.7	18	<PQL	7.1	30
D111		4	0.3	12	5.9	15	<PQL	6.2	33
Pit 59	0-0.15	10	3.9	9.4	27	**410**	0.08	9.4	1900
D109		8	0.3	6.6	14	56	0.11	4	210

Table 6 – Laboratory Results for Metals in Soil (continued)

Test Location	Depth(m)	Metal							
		As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Pit 60	0.3-0.5	18	0.4	2.9	18	25	0.27	9.6	88
D106		85	0.3	2.7	14	20	0.57	7	36
Pit 61	0.8-1.0	5	0.3	8.6	18	11	0.05	24	85
Pit 61A	1.9-2.1	6	0.1	7	13	7	<PQL	21	78
Pit 62	0.3-0.5	4	0.1	5.4	7	7	<PQL	2.7	19
Pit 63	0.3-0.5	11	0.1	6.4	19	11	0.07	7.1	23
D112		8	0.1	9.4	26	13	0.05	9	31
Pit 64	1.3-1.5	7	0.2	8.3	8.7	25	<PQL	4.8	30
Pit 65	0-0.15	8	0.4	3.3	40	22	0.05	6.5	46
Pit 66	0.3-0.5	11	0.5	10	27	**110**	0.21	10	190
Pit 67	0.3-0.5	6	0.4	19	9.4	31	<PQL	9.8	79
Pit 69	0.0-0.15	5	0.4	9.7	17	24	0.06	8.8	100
Pit 70	1.7-1.8	10	0.3	4.3	19	24	0.09	7.4	45
Pit 71	0-0.15	8	0.5	5.1	27	25	0.06	9.4	160
Pit 72	1.3-1.5	6	1	7.2	180	**180**	0.17	19	450
Pit 73	0.2-0.3	13	0.1	2.4	6.1	5	<PQL	5.4	11
Pit 74	0.8-1.0	11	0.6	3.5	35	29	0.09	11	67
Pit 75	1.1-1.3	**130**	0.3	4.9	20	21	0.48	10	72
Pit 76	0.3-0.5	3	<PQL	6.2	17	8	<PQL	12	34
Pit 77	0.3-0.5	**120**	<PQL	3.9	6.5	38	<PQL	4.8	42
Pit 77B	0.2-0.3	12	<PQL	2.6	5.8	14	<PQL	3.7	13
Pit 79	0-0.15	4	0.4	3.5	14	8	<PQL	18	120
Pit 80	0-0.15	<PQL	<PQL	5.9	7.6	6	<PQL	2.4	25
Pit 82	0-0.15	6	0.7	16	27	63	0.07	10	190
Pit 85	0.3-0.5	26	0.4	5.7	22	16	0.13	6.3	25
Pit 87	0.8-1.0	5	0.3	11	27	15	0.06	23	92
Pit 88	0.0-0.05	20	0.4	8	15	26	<PQL	5.2	60
D129		7	0.3	4.5	8.2	17	<PQL	4.4	41
Pit 89	2.1-2.3	5	<PQL	5.1	7.9	9	<PQL	2.8	22
Pit 90	0.8-1.0	4	0.1	5.1	12	7	<PQL	6	34
Pit 90	2.8-3.0	4	0.2	6.7	25	13	0.06	15	65

Table 6 – Laboratory Results for Metals in Soil (continued)

Test Location	Depth(m)	Metal							
		As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Pit 92	0.3-0.5	<PQL	0.2	8.9	27	15	0.06	16	75
D123		4	0.2	8	26	18	0.05	20	77
Pit 93	1.3-1.5	6	0.3	6.3	26	16	0.06	27	100
Pit 95	2.5-2.7	4	<PQL	7.3	22	12	<PQL	8.1	52
Pit 96	0.8-1.0	21	<PQL	11	63	11	<PQL	2	18
Pit 99	0.2	4	<PQL	7.8	4.9	12	<PQL	3.9	33
Pit 100	0.1	8	0.6	10	51	**520**	0.05	19	160
Pit 100	0.4	9	0.3	11	23	43	0.16	13	84
Pit 101	0.1	6	0.4	5.5	9.3	91	0.09	3.6	58
Pit 103	0.1	5	1.1	7.8	13	42	<PQL	4.7	100
Pit 104	0.3	6	0.4	5.5	9.3	91	0.09	3.6	58
R7		5	<PQL	10	14	15	<PQL	14	21
Pit 105	0.6	4	<PQL	8	11	37	0.19	2.3	75
Pit 106	0.1	14	0.8	19	130	**160**	0.26	12	320
Pit 107	0.2	4	1.3	7.4	7.5	43	0.05	4.6	630
Pit 108	0.7	<PQL	<PQL	4.6	2.4	4	<PQL	2.7	12
Pit 109	0.1	10	0.5	6.5	13	71	0.16	9.5	89
Pit 110	0.3	5	<PQL	3.6	5.8	15	<PQL	4.2	21
Pit 110	1.0	6	<PQL	4.3	4.9	9.8	<PQL	4.5	16
Pit 112	0.1	13	1.5	8	43	**270**	0.11	3.7	<PQL
Pit 113	0.7	9	0.5	8.3	9	29	<PQL	4.4	59
Pit 115	0.2	5	<PQL	6.2	3.3	4	<PQL	2.4	17
R6		3	<PQL	6	2.7	4	<PQL	2.3	16
Pit 124	0.6	4	<PQL	4.4	4.9	6	<PQL	2.5	18
Pit 125	0.1	4	<PQL	2.7	2.1	12	<PQL	1.4	14
Pit 127	0.1	5	0.3	9.4	7.4	11	<PQL	3.8	31
Pit 128	0.1	5	0.6	11	12	24	0.05	15	84
Pit 130	0.1	13	<PQL	3.7	9	14	0.06	2.9	41
Pit 131	0.0-0.05	6	0.8	12	67	**130**	<PQL	5.3	270
Pit 133	0.2-0.3	10	0.3	12	3.4	17	<PQL	2.9	47
Pit 134	0.2	4	<PQL	3.9	2.9	14	<PQL	1.1	23
Pit 135	0.0-0.05	3	0.5	4.4	5.5	29	<PQL	1.9	41

Table 6 – Laboratory Results for Metals in Soil (continued)

Test Location	Depth(m)	Metal							
		As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
Pit 137	0.2-0.3	7	0.5	9.8	7	19	0.07	19	61
Pit 138	0.1	<PQL	0.4	5.5	8.2	17	<PQL	8.2	60
Pit 140	0.1	12	0.9	9.4	27	**110**	0.15	8.7	150
Pit 141	0.1	11	0.7	7.3	28	**110**	0.14	4.3	160
Pit 142	0.1	8	0.4	2	8.3	20	0.06	2.4	41
Pit 143	0.1	7	<PQL	2.9	12	19	<PQL	2.6	60
Pit 143	0.8	**150**	0.8	5.5	42	**530**	0.07	13	260
Pit 144	0.05	6	0.6	5.1	14	98	<PQL	2.7	220
Pit 146	0.1	11	0.8	5.8	9	37	<PQL	6.4	87
Pit 147A	0-0.05	11	<PQL	5.5	7.1	17	<PQL	1.9	21
Pit 149	0.05	5	4.4	6	13	**130**	0.06	3	770
Pit 152	0.1	9	0.9	3.7	15	71	0.05	1.8	78
Pit 153	0.1	<PQL	<PQL	1	0.6	6	<PQL	<PQL	2.8
Pit 157	0.1	4	<PQL	3.5	2.5	7	<PQL	3	30
Bore 23B	2.5	6	0.4	6.3	14	**120**	0.07	3.7	370
Bore 57	0.5	32	0.3	12	33	15	0.06	34	130
Bore 57	5.5	3	0.1	10	26	11	<PQL	18	120
Bore 91	3.5	5	0.1	7.4	12	30	0.05	10	75
Bore 94	2.0	5	0.3	12	35	16	0.07	28	130
Bore 97	2.0	4	0.3	10	29	12	0.05	31	150
BD4		4	0.4	10	31	13	0.06	**40**	180
Bore 97	5.5	5	0.1	7.4	16	7	<PQL	14	84
Bore 98	1.0	6	0.2	7.3	12	8	0.05	15	49
Laboratory PQL		3	0.1	0.3	0.5	1	0.05	0.5	0.3
NEHF A[1] (Ref 6)		100	20	100	1000	300	15	600	7000
General Solid Waste (Ref 8)		100	20	100	NC	100	4	40	NC
Restricted Solid Waste (Ref 8)		400	80	400	NC	400	16	160	NC

Notes to Table 6:
All results in mg/kg on a dry weight basis
PQL – Practical Quantitation Limits
NC – No Criteria
1 – Health Based Criteria for NEHF A - Residential Land Use,
3 – Chromium (VI) (Conservative)
Shaded results exceed NEHF A Health Based Criteria
Bold results exceed 'General Solid Waste' criteria (Ref 8)

Table 7 – Laboratory Results for TRH and BTEX in Soil

Test Location	Depth (m)	PID (ppm)	Analyte							
			TRH				BTEX			
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	Benzene	Toluene	Ethyl Benzene	Xylene
Pit 1	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R4		<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 2	1.6	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 3	0.2	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 4	0.5	<1	<PQL	<PQL	90	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 4A	1.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 5	0.8	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 6	0.25	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R5		<1	<PQL	34	330	420	<PQL	<PQL	<PQL	<PQL
Pit 6	0.8	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 7	0.1	<1	<PQL	<PQL	77	330	<PQL	<PQL	<PQL	<PQL
R1		<1	<PQL	<PQL	92	250	<PQL	<PQL	<PQL	<PQL
Pit 7	0.6	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 8	0.1	<1	<PQL	<PQL	56	190	<PQL	<PQL	<PQL	<PQL
Pit 9	0.1	2.0	<PQL	<PQL	54	130	<PQL	<PQL	<PQL	<PQL
Pit 11	0.1	<1	<PQL	<PQL	53	240	<PQL	<PQL	<PQL	<PQL
R2		<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 13	0.1	<1	<PQL	<PQL	100	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 15	0.2	1.8	<PQL	<PQL	420	430	<PQL	<PQL	<PQL	<PQL
Pit 17	0.1	<1	<PQL	49	270	56	<PQL	<PQL	<PQL	<PQL
Pit 19	0.1	<1	<PQL	35	300	99	<PQL	<PQL	<PQL	<PQL
R8		<1	<PQL	41	310	93	<PQL	<PQL	<PQL	<PQL
Pit 19	0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 21	0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 22	0.15	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 22	0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 23	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 23A	1.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 24	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 25	0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 27	0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 28	1.6	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 29	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 30	0.9	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Table 7 – Laboratory Results for TRH and BTEX in Soil (continued)

Test Location	Depth (m)	PID (ppm)	Analyte							
			TRH				BTEX			
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	Benzene	Toluene	Ethyl Benzene	Xylene
Pit 31	0.2	<1	<PQL	<PQL	190	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 32	0.6	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 33	0.2	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 35	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 35	0.7	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R3		<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 37	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 38	1.9	3.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 39	1.6	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 40	0.2	<1	<PQL	<PQL	73	260	<PQL	<PQL	<PQL	<PQL
Pit 41	2.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 42	1.2	4.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 43	1.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 44	0.5	5.4	<PQL	<PQL	58	140	<PQL	<PQL	<PQL	<PQL
Pit 45	0.2	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 46	1.6	6.1	<PQL	<PQL	120	220	<PQL	<PQL	<PQL	<PQL
Pit 47	0.4	6.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 47	2.3	4.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 48	0-0.05	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 49	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 50	0.2-0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 51	0.8-1.0	<1	<PQL	<PQL	110	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 53	0.8-1.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 54	0.8-1.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 55	0-0.2	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 56	0-0.15	<1	<PQL	<PQL	65	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 58	0.1-0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D111		<1	<PQL	<PQL	<PQL	77	<PQL	<PQL	<PQL	<PQL

Table 7 – Laboratory Results for TRH and BTEX in Soil (continued)

Test Location	Depth (m)	PID (ppm)	Analyte							
			TRH				BTEX			
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	Benzene	Toluene	Ethyl Benzene	Xylene
Pit 59	0-0.15	<1	<PQL	<PQL	170	57	<PQL	<PQL	<PQL	<PQL
D109		<1	<PQL	<PQL	180	97	<PQL	<PQL	<PQL	<PQL
Pit 60	0.3-0.5	<1	<PQL	42	320	120	<PQL	<PQL	<PQL	<PQL
D106		<1	<PQL	54	380	150	<PQL	<PQL	<PQL	<PQL
Pit 61	0.8-1.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 61A	1.9-2.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 62	0.3-0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 63	0.3-0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D112		<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 64	1.3-1.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 65	0-0.15	<1	<PQL	<PQL	280	170	<PQL	<PQL	<PQL	<PQL
Pit 66	0.3-0.5	<1	<PQL	<PQL	120	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 67	0.3-0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 69	0.0-0.15	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 70	1.7-1.8	<1	<PQL	91	530	100	<PQL	<PQL	<PQL	<PQL
Pit 71	0-0.15	<1	<PQL	40	290	58	<PQL	<PQL	<PQL	<PQL
Pit 72	1.3-1.5	<1	<PQL	<PQL	190	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 73	0.2-0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 74	0.8-1.0	<1	<PQL	35	270	100	<PQL	<PQL	<PQL	<PQL
Pit 75	1.1-1.3	<1	<PQL	110	640	270	<PQL	<PQL	<PQL	<PQL
Pit 76	0.3-0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 77	0.3-0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 77B	0.2-0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 79	0-0.15	<1	<PQL	<PQL	110	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 80	0-0.15	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 82	0-0.15	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 85	0.3-0.5	<1	<PQL	<PQL	130	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 87	0.8-1.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 88	0.0-0.05	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D129		<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Table 7 – Laboratory Results for TRH and BTEX in Soil (continued)

Test Location	Depth (m)	PID (ppm)	Analyte							
			TRH				BTEX			
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	Benzene	Toluene	Ethyl Benzene	Xylene
Pit 89	2.1-2.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 90	0.8-1.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 90	2.8-3.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 92	0.3-0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D123		<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 93	1.3-1.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 95	2.5-2.7	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 96	0.8-1.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 99	0.2	<1	<PQL	<PQL	<PQL	66	<PQL	<PQL	<PQL	<PQL
Pit 100	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 100	0.4	<1	<PQL	<PQL	88	98	<PQL	<PQL	<PQL	<PQL
Pit 101	0.1	<1	<PQL	<PQL	54	150	<PQL	<PQL	<PQL	<PQL
Pit 103	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 104	0.3	<1	<PQL	<PQL	89	120	<PQL	<PQL	<PQL	<PQL
R7		1.8	<PQL	<PQL	130	160	<PQL	<PQL	<PQL	<PQL
Pit 105	0.6	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 106	0.1	<1	<PQL	<PQL	<PQL	60	<PQL	<PQL	<PQL	<PQL
Pit 107	0.2	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 108	0.7	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 109	0.1	<1	<PQL	<PQL	110	81	<PQL	<PQL	<PQL	<PQL
Pit 110	0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 110	1.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 112	0.1	<1	<PQL	<PQL	110	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 113	0.7	<1	<PQL	<PQL	80	96	<PQL	<PQL	<PQL	<PQL
Pit 115	0.2	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R6		<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 124	0.6	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 125	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 127	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 128	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Table 7 – Laboratory Results for TRH and BTEX in Soil (continued)

Test Location	Depth (m)	PID (ppm)	Analyte							
			TRH				BTEX			
			C_6 - C_9	C_{10} - C_{14}	C_{15} - C_{28}	C_{29} - C_{36}	Benzene	Toluene	Ethyl Benzene	Xylene
Pit 130	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 131	0.0-0.05	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 133	0.2-0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 134	0.2	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 135	0.0-0.05	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 137	0.2-0.3	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 138	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 140	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 141	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 142	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 143	0.1	<1	<PQL	<PQL	77	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 143	0.8	<1	<PQL	<PQL	130	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 144	0.05	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 146	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 147A	0-0.05	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 149	0.05	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 152	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 153	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 157	0.1	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 23B	2.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 57	0.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 57	5.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 91	3.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 94	2.0	1.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 97	2.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
BD4		<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 97	5.5	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 98	1.0	<1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Laboratory PQL			20	20	50	50	0.5	0.5	0.5	1.5
NEHF A[1] (Ref 6)			NC	NC			NC	NC	NC	NC
Service Station Sites [2] (Ref 7)			65	1000 total			1	1.4/130[1]	3.1/50[1]	14/25[1]
General Solid Waste (Ref 8)			650	10000 total			10	288	600	1000
Restricted Solid Waste (Ref 8)			2600	40000 total			40	1152	2400	4000

Notes to Table 7:
All results in mg/kg on a dry weight basis
PQL – Practical Quantitation Limits
NC – No Criteria
PID – Photoionisation Detector
1 – Health Based Criteria for NEHF A - Residential Land Use
2 – Threshold Concentration for Sensitive Land Use
Shaded results exceed Service Station Criteria

Table 8 – Laboratory Results for OCP, OPP, PCB and PAH in Soil

Test Location	Depth (m)	Total PAH[3]	Benzo(a) Pyrene	PCB	Total OPP	Total OCP	Aldrin + Dieldrin	Chlordane	DDT	Heptachlor
Pit 1	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R4		<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 2	1.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 3	0.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 4	0.5	5.59	0.59	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 4A	1.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 5	0.8	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 6	0.25	1.81	0.21	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R5		0.78	0.08	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 6	0.8	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 7	0.1	1.98	0.18	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R1		1.31	0.11	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 7	0.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 8	0.1	2.2	0.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 9	0.1	1.92	0.22	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 11	0.1	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R2		0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 13	0.1	1.94	0.14	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 15	0.2	63.5	**5.7**	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 17	0.1	4.45	0.25	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 19	0.3	9.17	0.77	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R8		15.5	**1.2**	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 19	0.3	0.4	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 21	0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 22	0.15	0.06	0.06	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 22	0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 23	0.1	0.78	0.08	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 23A	1.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 24	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 25	0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 27	0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 28	1.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 29	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Table 8 – Laboratory Results for OCP, OPP, PCB and PAH in Soil (continued)

Test Location	Depth (m)	Total PAH[3]	Benzo(a) Pyrene	PCB	Total OPP	Total OCP	Aldrin + Dieldrin	Chlordane	DDT	Heptachlor
Pit 30	0.9	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 31	0.2	2.43	0.13	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 32	0.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 33	0.2	1.71	0.21	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 35	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 35	0.7	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R3		<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 37	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 38	1.9	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 39	1.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 40	0.2	0.77	0.07	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 41	2.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 42	1.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 43	1.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 44	0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 45	0.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 46	1.6	0.7	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 47	0.4	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 47	2.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 48	0-0.5	0.06	0.06	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 49	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 50	0.2-0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 51	0.8-1.0	3.5	0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 53	0.8-1.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 54	0.8-1.0	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 55	0-0.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 56	0-0.15	4.1	0.4	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 58	0.1-0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D111		<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 59	0-0.15	3.05	0.15	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D109		17.7	**1.7**	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 60	0.3-0.5	3.93	0.13	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D106		2.66	0.06	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Table 8 – Laboratory Results for OCP, OPP, PCB and PAH in Soil (continued)

Test Location	Depth (m)	Total PAH[3]	Benzo(a) Pyrene	PCB	Total OPP	Total OCP	Aldrin + Dieldrin	Chlordane	DDT	Heptachlor
Pit 61	0.8-1.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 61A	1.9-2.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 62	0.3-0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 63	0.3-0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D112		<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 64	1.3-1.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 65	0-0.15	1.87	0.07	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 66	0.3-0.5	3.43	0.33	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 67	0.3-0.5	0.47	0.07	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 69	0.0-0.15	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 70	1.7-1.8	3.7	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 71	0-0.15	2.41	0.11	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 72	1.3-1.5	3.55	0.25	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 73	0.2-0.3	0.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 74	0.8-1.0	3.32	0.12	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 75	1.1-1.3	7.48	0.08	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 76	0.3-0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 77	0.3-0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 77B	0.2-0.3	0.56	0.06	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 79	0-0.15	0.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 80	0-0.15	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 82	0-0.15	0.59	0.09	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 85	0.3-0.5	1.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 87	0.8-1.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 88	0.0-0.05	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D129		<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 89	2.1-2.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 90	0.8-1.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 90	2.8-3.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 92	0.3-0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
D123		<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 93	1.3-1.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 95	2.5-2.7	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Table 8 – Laboratory Results for OCP, OPP, PCB and PAH in Soil (continued)

Test Location	Depth (m)	Total PAH[3]	Benzo(a) Pyrene	PCB	Total OPP	Total OCP	Aldrin + Dieldrin	Chlordane	DDT	Heptachlor
Pit 96	0.8-1.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 99	0.2	0.4	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 100	0.1	0.59	0.09	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 100	0.4	1.63	0.13	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 101	0.1	17.1	**1.4**	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 103	0.1	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 104	0.3	0.68	0.08	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R7		2.49	0.19	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 105	0.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 106	0.1	1.89	0.19	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 107	0.2	2.19	0.19	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 108	0.7	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 109	0.1	3.88	0.38	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 110	0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 110	1.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 112	0.1	1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 113	0.7	3.15	0.15	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 115	0.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
R6		<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 124	0.6	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 125	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 127	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 128	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 130	0.1	0.4	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 131	0.0-0.05	0.36	0.06	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 133	0.2-0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 134	0.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 135	0.0-0.05	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 137	0.2-0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 138	0.1	0.58	0.08	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 140	0.1	0.27	0.07	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 141	0.1	0.89	0.09	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 142	0.1	0.2	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL

Table 8 – Laboratory Results for OCP, OPP, PCB and PAH in Soil (continued)

Test Location	Depth (m)	Total PAH	Benzo(a) Pyrene	PCB	Total OPP	Total OCP	Aldrin + Dieldrin	Chlordane	DDT	Heptachlor
Pit 143	0.1	0.89	0.09	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 143	0.8	7.75	0.75	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 144	0.05	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 146	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 147A	0-0.05	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 149	0.05	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 152	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 153	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Pit 157	0.1	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 23B	2.5	3.29	0.19	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 57	0.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 57	5.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 91	3.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 94	2.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 97	2.0	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
BD4		<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 97	5.5	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Bore 98	1.0	0.3	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL	<PQL
Laboratory PQL		1.55	0.05	0.9	0.4	2.5	0.2	0.2	0.2	0.1
NEHF A[1] (Ref 6)		20	1	10	NC	NC	10	50	200	10
Service Station Sites[2] (Ref 7)		20	1	NC	NC	NC	NC	NC	NC	NC
General Solid Waste (Ref 8)		200	0.8	50	NC	NC	NC	NC	NC	NC
Restricted Solid Waste (Ref 8)		800	3.2	50	NC	NC	NC	NC	NC	NC

Notes to Table 8:

All results in mg/kg on a dry weight basis
PQL – Practical Quantitation Limits
NC – No Criteria
1 – Health Based Criteria for NEHF A - Residential Land Use
2 – Threshold Concentration for Sensitive Land Use
3 – Sum of total positive PAH results
Shaded results exceed NEHF A Health based Criteria
Bold results exceed NSW DECC 'General Solid Waste' Guidelines

Table 9 – Laboratory Results for Asbestos in Soil and Fibro Fragments

Sample Identification	Sample Type	Asbestos Detected
Pit 1/0.1 m	Soil	No Asbestos Detected
Pit 13/0.1 m	Soil	No Asbestos Detected
Pit 21/0.3 m	Soil	No Asbestos Detected
Pit 23/0.1 m	Soil	No Asbestos Detected
Pit 33/0.2 m	Soil	No Asbestos Detected
Pit 42/1.2 m	Soil	No Asbestos Detected
Pit 52/0-0.15 m	Soil	No asbestos detected
Pit 67/0.3-0.5 m	Cement sheet fragment	Chrysotile asbestos detected
Pit 67/0.5-0.6 m	Soil	Chrysotile asbestos detected
Pit 77/0-0.01 m	Cement sheet fragment	Crocidolite, amosite and chrysotile asbestos detected
Pit 80/0-0.01 m	Cement sheet fragment	Crocidolite and chrysotile asbestos detected
Pit 80/0-0.15 m	Soil	No asbestos detected
Pit 82/0-0.15 m	Soil	No asbestos detected
Pit 95/2.5-2.7 m	Soil	No asbestos detected
Pit 144/0 m	Fibreboard fragment	Chrysotile asbestos detected
Pit 144/0.05 m	Soil	No asbestos detected
Pit 149/Fibro	Cement sheet fragment	Chrysotile asbestos detected
Pit 149/0.05	Soil	Chrysotile asbestos detected
Pit 152/Fibro	Cement sheet fragment	Chrysotile asbestos detected
Pit 152/0.1	Soil	Chrysotile asbestos detected
Pit 153/Fibro	Fibre board fragment	No asbestos detected
Pit 153/0.1	Soil	No asbestos detected, however Synthetic Mineral Fibres detected

Table 10 – TCLP Leachability Testing

Sample	Depth (m)	Benzo(a)pyrene		Arsenic (As)		Cadmium (Cd)		Chromium (Cr)[2]		Nickel (Ni)		Lead (Pb)		Mercury (Hg)	
		Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)	Total (mg/kg)	TCLP (mg/L)
R5		NT	NT	10	<PQL	NT	NT	13	<PQL	15	<PQL	460	<PQL	NT	NT
R1		0.11	<PQL	20	<PQL	NT	NT	14	<PQL	22	<PQL	540	<PQL	NT	NT
Pit 9	0.1	0.22	<PQL	19	<PQL	2.4	<PQL	14	<PQL	24	0.01	510	<PQL	NT	NT
Pit 15	0.2	5.7	<PQL	NT	NT	NT	NT	NT	NT	7.6	<PQL	100	<PQL	NT	NT
Pit 19	0.3	NT	NT	NT	NT	NT	NT	10	<PQL	6.4	<PQL	470	0.04	NT	NT
Pit 23A	1.5	NT	NT	NT	NT	NT	NT	NT	NT	5.7	0.012	55	<PQL	NT	NT
Bore 23B	2.5	0.19	<PQL	NT	NT	NT	NT	NT	NT	NT	NT	120	<PQL	NT	NT
Pit 59	0-0.15	NT	NT	NT	NT	3.9	<PQL	NT	NT	9.4	<PQL	410	<PQL	NT	NT
D109		1.7	<PQL	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
Pit 67	0.3-0.5	NT	NT	NT	NT	NT	NT	19	<PQL	9.8	<PQL	31	<PQL	NT	NT
Pit 75	1.1-1.3	NT	NT	130	<PQL	NT	NT	NT	NT	10	<PQL	21	<PQL	0.48	<PQL
Pit 77	0.3-0.5	NT	NT	120	<PQL	NT	NT	NT	NT	4.8	<PQL	38	<PQL	NT	NT
Pit 100	0.1	0.09	<PQL	NT	NT	NT	NT	NT	NT	NT	NT	520	<PQL	NT	NT
Pit 101	0.1	1.4	<PQL	NT	NT	NT	NT	NT	NT	NT	NT	91	0.02	NT	NT
R8		1.2	<PQL	16	<PQL	NT	NT	NT	NT	9.4	<PQL	160	<PQL	NT	NT
Pit 143	0.8	0.75	<PQL	150	0.31	NT	NT	NT	NT	13	<PQL	530	3.6	NT	NT
Laboratory PQL		0.05	0.0005	3	0.05	0.1	0.005	0.3	0.005	0.5	0.01	1	0.02	0.05	0.0005
General Solid Waste with TCLP (Ref 8)		10[1]	0.04	500[1]	5	100[1]	1	1900[1]	5	1050[1]	2	1500[1]	5	50[1]	0.2

Notes to Table 10:

(1) – General Waste Classification guidelines for Total Concentrations when used with TCLP Results (Ref 8)
(2) – Chromium (VI) criteria used to assess Chromium concentrations
R1 – Duplicate of Pit 7/0.1 m
R8 – Duplicate of Pit 19/0.1 m
PQL – Practical Quantitation Limit
TCLP – standard NSW EPA TCLP test
R5 – Duplicate of Pit 6/0.8 m
D109 – Duplicate of Pit 59/0-0.15 m
NT – Not Tested

7.2 Acid Sulphate Soil

Laboratory testing comprised 50 acid sulphate screening tests. The results of the screening tests are presented in Table 11, below.

Table 11 – Results of Acid Sulphate Soil Screening Tests

Sample ID	Sample Depth [a] (m)	Sample Description	Screening Test Results			
			pH			Strength of Reaction [b]
			pH_F	pH_{FOX}	pH_F - pH_{FOX}	
Pit 59	0.5-0.6	Clayey silt, some sand	6.14	4.1	2.0	1
	0.8-1.0	Sandy clay	5.7	4.6	1.1	1
	1.3-1.5	Sandy clay	5.1	4.7	0.4	1
	1.7-1.8	Conglomerate, sandy clay	5.8	5.0	0.8	1
Pit 63	0-0.15	Gravelly sandy clay, some coal	5.6	2.7	1.9	1
	0.3-0.5	Gravelly sandy clay, some coal	6.1	4.4	1.7	2
	0.8-1.0	Gravelly clayey sand	5.7	3.8	1.9	2
	1.3-1.5	Gravelly sandy silt, some clay	5.6	3.5	2.1	1
Pit 69	1.8-1.9	Clayey silt, some sand	6.1	4.3	1.8	2
	2.3-2.5	Clayey sand, some gravel	6.5	3.7	2.8	2
Pit 109	0.6	Clayey silt, some sand	6.8	5.6	1.2	2
	1.2	Silty clay, some sand	6.7	5.2	1.5	2
Pit 114	0.2	Clay, some silt	6.6	5.2	1.4	3
	0.4	Silty clay	6.9	5.0	1.9	3
	1.0	Silty clay, some gravel	5.4	3.4	2.0	2
Pit 117	0.4	Clayey silt, abundant organics	6.0	6.7	-0.7	4
	1.0	Clay, trace organics	6.3	6.5	-0.2	2
	1.5	Clay	6.3	6.8	-0.5	2
	2.5	Silty Clay	6.3	5.8	0.5	2
Pit 119	0.1	Silty clay/clayey silt, abundant organics	6.75	4.0	2.75	4
	0.6	Sandy clayey silt, some organics	6.45	3.9	2.55	1-2
	1.0	Sandy clayey silt, some organics	5.5	3.0	2.5	1-2
	1.5	Silty clay, some organics	6.0	3.1	2.9	2
	2.0	Clay, trace organics	5.4	3.6	1.8	2
	2.5	Clay, some silt, trace organics	6.6	3.9	2.7	4
Pit 123	0.2	Clay, some silt and organics	5.9	4.0	1.9	2
	0.4	Clayey silt	7.1	5.6	1.5	3
	0.9	Silty Clay	7.0	5.6	1.4	3
	1.5	Silty Clay	6.9	6.3	0.8	2
	2.0	Silty Clay	7.4	6.6	0.8	2

Table 11 – Results of Acid Sulphate Soil Screening Tests (continued)

Sample ID	Sample Depth [a] (m)	Sample Description	Screening Test Results			
			pH			Strength of Reaction [b]
			pH_F	pH_{FOX}	pH_F - pH_{FOX}	
Pit 123	2.5	Silty Clay, trace gravel	7.5	5.0	2.5	2
Pit 124	1.7	Clay, some silt, trace organics	4.9	3.2	1.7	2
	2.3	Clay, trace silt, trace organics	6.5	5.95	0.55	2
Pit 126	0.5	Clay, trace silt, some organics	6.3	3.5	2.8	2
	1.2	Clay, trace silt, trace organics	5.9	3.4	2.5	2
	1.7	Clay	5.2	3.3	1.9	1
	2.4	Clay, trace shells	5.3	3.5	1.8	1
Pit 128	0.6	Clay, some silt and organics	7.05	6.8	0.25	1-2
	1.0	Clay, trace organics	7.2	7.3	-0.1	2
	2.1	Silty sand	7.3	7.3	0	4
Pit 129	0.1	Silty clay, some organics	5.7	3.4	2.3	3
	0.5	Silty clay, some organics	5.9	3.6	2.3	2
	1.0	Silty clay, trace organics	6.6	5.1	1.5	2
	1.5	Clay, some silt	7.0	6.4	0.6	2
	1.8	Clayey silt, some gravel	7.4	5.6	2.8	2
Pit 130	1.0	Sandy clay, trace organics	7.5	4.3	3.2	1
	2.0	Sandy clay, trace organics	6.5	3.9	2.6	1
Pit 138	1.5	Clay, trace organics	5.9	3.5	2.4	2
Pit 150	0.1	Sandy silt, some clay and organics	7.0	3.2	3.8	2
	0.4	Sandy silty clay, trace gravel	7.2	4.8	2.4	1
Guideline		Sands to loamy sands, sandy loams to light clays medium to heavy clays and silty clays	<4[d]	<3.5[e]	≥1e	

Notes to Table 11:

a Depth below ground surface
b Strength of Reaction
1 denotes no or slight reaction
2 denotes moderate reaction
3 denotes high reaction
4 denotes very vigorous reaction
F denotes bubbling/frothy reaction indicative of organics
H denotes heat generated
d For actual acid sulphate soils (ASS)
e Indicative value only for Potential Acid Sulphate Soils (PASS)
Shaded results indicate an exceedence of QASSMAC criteria (Ref 10)

The QASSIT guidelines suggest that a soil pH<4 in water is an indicator of actual acid sulphate soils. The results of screening tests therefore suggest the absence of actual acid sulphate soils at the locations and depths tested.

The QASSIT guidelines also suggest that indicators of potential acid sulphate soils (PASS) include the following:

- Soil pH <3.5 in H_2O_2 (i.e. pH_{FOX});
- Drop of 1 pH unit or more between pH_F and pH_{FOX}.

Thirty seven samples exhibited a pH drop of greater than one unit, and four also indicated a soil pH of less than 3.5 in hydrogen peroxide, suggesting that potential acid sulphate soils may be present within sandy silt and clay soils at a range of depths across the site.

It is noted that the above test method is a qualitative method only and gives an indication of the intensity of total acidification (pH). The ASSMAC guidelines indicate that peroxide may also oxidise organic matter (in addition to pyrite) to produce acids which are unlikely to form under natural conditions, thus giving falsely high indication of acid sulphate potential.

Based on the results of the screening tests and the identified ASS areas on the risk maps, four soil samples were selected for detailed laboratory testing, comprising the Full Chromium Suite in accordance with QASSIT guidelines (Ref 9 and 10).

Detailed test results are contained in the attached laboratory report sheets, and are summarised in Table 12, below.

Table 12 – Results of Detailed Acid Sulphate Soil Laboratory Testing

Sample ID	Sample Depth [a] (m)	Sample Description	Laboratory Results			
			pH_{KCL}	Scr %S	s-TAA %S	Net Acidity[c] %S
Pit 119	1.0	Sandy clayey silt, some organics	4.5	<0.02	0.06	0.06
Pit 119	1.5	Silty clay, some organics	4.7	<0.02	0.09	0.09
Pit 124	1.7	Clay, some silt, trace organics	4.2	<0.02	0.17	0.19
Pit 150	0.1	Sandy silt, some clay and organics	5.7	<0.02	<0.02	<0.02
Guideline		Sands to loamy sands	-	-	-	0.03
		Sandy loams to light clays				0.06[f]/0.03[g]
		Medium to heavy clays and silty clays				0.1[f]/0.03[g]

Notes to Table 12:

a Depth below ground surface
c Calculated from ABA equation in ASS Laboratory Methods Guidelines (Ref 9)
f QASSMAC Action Criteria for disturbance of 1-1000 tonnes of material
g QASSMAC Action Criteria for disturbance of more than 1000 tonnes of material
Shaded results indicate an exceedence of QASSMAC criteria (Ref 10)
Scr – Chromium reducible sulphur
TAA – Titratable actual acidity

7.3 Combustibility Testing

Combustibility testing was undertaken on 17 fill samples containing coal materials to determine the percentage of combustible material. The results of testing are shown in Table 13, below.

Table 13 – Results of Combustibility Testing

Test Location/Depth (m)	Total Combustibles (%)
Pit 9 / 0.8	16.0
Pit 17 / 0.5	11.3
Pit 32 / 0.1	8.5
Pit 39 / 1.3	10.2
Pit 48 / 2.0	27.3
Pit 58 / 2.5-2.7	7.9
Pit 60 / 1.3-1.5	48.3
Pit 65 / 0.3-0.5	58.8
Pit 72 / 0.5-0.6	14.0
Pit 73 / 0.8-1.0	23.9
Pit 71 / 0.3-0.5	59.9
Pit 87 / 1.3-1.5	16.6
Pit 104 / 0.1	23.1
Pit 108 / 0.2	51.8
Pit 113 / 0.4	22.0
Pit 142 / 0.3	22.6
Pit 143 / 0.4	24.0

Notes to Table 13:

Combustibility estimated from % ash created on a dry weight basis

Reference should be made to the attached laboratory report sheets for details.

7.4 Aggressivity Testing

Aggressivity testing was undertaken on 21 selected soil samples across the site, and comprised pH, Chloride and Sulphate testing, summarised in Table 14, below.

Table 14 – Results of Aggressivity Testing

Test Location/Depth (m)	pH (pH Units)	Chloride*, Cl (mg/kg)	Sulphate*, SO4 (mg/kg)
Pit 2/1.6	5.3	150	190
Pit 4A/1.1	5.4	62	35
Pit 11/0.7	5.1	11	50
Pit 28/1.6	5	140	81
Pit 29/0.1	5.8	1.5	4
Pit 32/0.6	4.5	89	150
Pit 35/0.7	5.3	9.4	63
Pit 38/1.9	6.1	32	140
Pit 41/2.0	5.1	180	420
Pit 47/2.3	6	86	66
Pit 61A/1.9-2.1	6.1	75	84
Pit 64/1.3-1.5	5.3	220	190
Pit 67/0.3-0.5	5.7	7.9	10
Pit 72/1.3-1.5	5.9	<PQL	44
Pit 74/0.8-1.0	5.9	4.3	9
Pit 87/0.8-1.0	5.9	94	55
Pit 93/1.3-1.5	4.9	480	630
Pit 93/1.3-1.5	5	470	630
Pit 97/2.0	5.4	150	360
Pit 133/0.2-0.3	5.7	5.1	<PQL
Pit 137/0.2-0.3	5.5	12	56
PQL	NA	0.5	2

Notes to Table 14:

* 1:5 soil:water
NA Not Applicable

Reference should be made to the attached laboratory report sheets for details.

8. ASSESSMENT OF CONTAMINATION

8.1 Assessment Criteria

Results of the chemical analyses were compared to the following NSW EPA recommended guidelines.

- NSW EPA (1998). Contaminated Sites – Guidelines for the Site Auditor Scheme 2nd Edition, April 2006 (Ref 6);
- NSW EPA (1994). Contaminated Sites – Guidelines for Assessing Service Station Sites, December 1994, (Ref 7);
- NSW DECC (2008), "Waste Classification Guidelines: Part 1 – Classifying Waste", April 2008 (Ref 8).

The NSW EPA Guidelines for the NSW Site Auditor Scheme (Ref 6) contain National Environmental Health Forum (NEHF) levels for various beneficial use scenarios including: low density residential (A), high density residential (D), recreational (E) and commercial/industrial (F). These criteria are applicable where aesthetic and ecological concerns are not an issue. Health based criteria for standard residential uses with access to soil (NEHF A), are considered to be appropriate for the proposed residential development.

The NSW EPA Guidelines for Assessing Service Station Sites (Ref 7) were used to assess total TRH and BTEX contamination across the site. The criteria used are threshold concentrations for sensitive land use.

The NSW DECC Waste Classification Guidelines (Ref 8) was used to assess soil conditions for possible off-site disposal to a licensed landfill.

8.2 Assessment of Contamination

Soil chemical analysis results were generally within the health based criteria for low density residential land use (i.e. NEHF A), and NSW EPA sensitive land use criteria for TRH and BTEX, with the following exceptions:

- Metals: R5 at Pit 6/0.25m (Pb), Pit 7/0.1m and R1 (Pb, Cu), Pit 9/0.1m (Pb),Pit 19/0.3m (Pb), Pit 59/0-0.15m (Pb), Pit 75/1.1-1.3m (As), Pit 77/0.3-0.5m (As), Pit 100/0.1m (Pb), Pit 143/0.8m (As, Pb);
- TRH: Pit 75/1.1-1.3m; and
- Benzo(a)pyrene and Total PAH: Pit 15/0.2m; Benzo(a)pyrene only: Pit 19/0.1m, R8 D109 at Pit 59/0-0.15m and Pit 101/0.1m.

The results of laboratory analysis indicated the presence of bonded asbestos in fibro sheet fragments found at or near the surface of Pit 77, Pit 80, Pit 144, and Pit 149. Bonded asbestos was present in fragments and in soil filling at Pit 67 / 0.3-0.5m, Pit 149 / 0-0.05m, and Pit 152 / 0-0.1m.

Test locations exceeding the acceptance criteria are marked in red on Drawings 1 to 4.

Laboratory results for total concentrations indicated the waste classifications ranged between 'General Solid Waste' to 'Hazardous Waste'. Additional TCLP testing indicates the samples can be reclassified as 'General Solid Waste'. This classification is relevant for off-site disposal if proposed.

8.3 Conclusions

Minmi North

The results of the assessment in the Minmi North area indicate the land is primarily used for grazing. A former rail alignment was located along the western boundary with a triangular area at the north west boundary bounded by the former rail lines to Back Creek and Pit C.

The results of preliminary sampling and analyses indicates the presence of the following contaminants which exceed residential land use criteria:

- Lead was detected at Pit 100 / 0.1m at the southern extent of Minmi North;
- Benzo(a)pyrene was identified at Pit 101/0.1m, also at the southern extent of Minmi North.

Material identified as exceeding the land use criteria will require remediation, which may include immobilisation prior to off site disposal at a licenced landfill. Preliminary leachability testing on samples indicate the material could be disposed of at a licenced landfill as 'General Solid Waste'. It is recommended that additional investigation is undertaken to delineate the extent of the contamination.

Minmi East

Minmi East contains two former open cut mines, Browns Minmi Open Cut on the western part, and Wallsend Borehole Colliery Open Cut on the eastern part. The final backfilled landforms from both mines contain significant depths of filling. A water body is located within the backfill of the former Browns Colliery Open Cut.

Significant opportunistic tipping including car wrecks, batteries, fibro sheeting was observed along the central track orientated north-south and bisecting Minmi East. A mound of overburden with some smaller mounds of building rubble, including fibro sheeting was noted north of the former Browns Minmi Open Cut. Deleterious surface materials and possible associated surface impacts will require removal/remediation.

The results of preliminary sampling and analysis of the filling on the western portion of Minmi East indicates the absence of gross contamination. No subsurface investigation or laboratory testing was undertaken on the eastern portion of Minmi East, as no development was proposed for this area at the time of fieldwork. Detailed assessment of Minmi East is recommended if development is considered on this part of the site.

Minmi West

The assessment of Minmi West identified the following features:

- Former Purple Hill Open Cut, partially filled;
- The former B and C pits and associated infrastructure including rail siding, boilers, workshops, coke ovens and locomotive sheds. Little direct evidence of the former structures was observed;

- Mounded filling and fill embankments across the Minmi West site, associated with the former rail lines, access tracks, and former mine development. Filling included building rubble and fibro sheeting.

The results of preliminary sampling and analyses indicates the presence of the following contaminants which exceed residential land use criteria:

- Metals: R5 at Pit 6/0.25m (Pb), Pit 7/0.1m and R1 (Pb, Cu), Pit 9/0.1m (Pb),Pit 19/0.3m (Pb), Pit 59/0-0.15m (Pb), Pit 75/1.1-1.3m (As), Pit 77/0.3-0.5m (As);
- TRH: Pit 75/1.1-1.3m; and
- Benzo(a)pyrene and Total PAH: Pit 15/0.2m; Benzo(a)pyrene only: Pit 19/0.1m and R8 D109 at Pit 59/0-0.15m, Pit 101/0.1m.

These exceedances were mostly in the areas of the former Pit C workshops (Pits 9, 11 and 15, Photo 1) the former rail line and rail sidings and screens (Pits 19 and 75 and 77, Photo 5). An exceedance also occurred at Pit 6, which appears to have been an area of former residential development.

The results of laboratory analysis indicated the presence of bonded asbestos in fibro sheet fragments found at or near the surface of Pit 77 near the former screening building and Pit 80 near in an area of mounded filling. Bonded asbestos was present in fragments and in soil filling at Pit 67 / 0.3-0.5m on the former rail line to Duckenfield Colliery. It should be noted that the composition of filling across the site may be variable. The possible presence of further fibro fragments (possibly asbestos based) within fill across the site cannot therefore be discounted.

Limited investigation was undertaken on parts of the site between Railway Street and the former Purple Hill open cut pit, with the exception of Pits 50 to 53 near the former coke ovens, as this site was identified as having a high risk of pothole subsidence and was less likely to be subject to development. This area is expected to be heavily disturbed by former mining activities and similar conditions to those encountered near the workshops can be expected. Additional investigation in this area would be required to confirm conditions.

Material identified as exceeding the land use criteria will require remediation, which may include immobilisation prior to off site disposal at a licenced landfill. Preliminary leachability testing on samples indicate the material could be disposed of at a licenced landfill as 'General Solid Waste'. Detailed assessment of this part of the site is recommended prior to construction.

Minmi South

Specific site features for Minmi South include:

- Former Browns Underground Colliery and Back Creek Open Cut as well as two smaller open cuts into the Young Wallsend Seam, one which contained an entry to the Wallsend Borehole Colliery, containing extensive areas of filling;
- The northern portion of the site has been heavily disturbed, containing filling probably associated with the former Browns Colliery and Back Creek Open Cut;
- Filled ground to south of Reservoir Road;
- Several concrete capped shafts, one at the northern end of the bushland and one at the southern end, near the Link Road;
- Masonry walled dam, concrete footings and shallow rock with scattered surface chitter and fibro near the southern capped shaft;
- An asphalt / coal tar coated timber pile was observed at Pit 42 / 0.9-1.5m . Hydrocarbon odour / staining was also observed at Pit 23A / 1 to >2m, and Pit 47 / 0.35-0.65m. Laboratory testing of samples from the above locations did not indicate any elevated TRH or PAH contamination (all results were below practical quantification limits).

The results of preliminary sampling and analyses indicates the presence of the following contaminants which exceed residential land use criteria:

- Arsenic and lead exceedances were noted at Pit 143 / 0.8m the site of the capped former shaft;
- Asbestos fragments were identified on the surface at Pit 144.

It should be noted that the composition of filling across the site may be variable. The possible presence of further fibro fragments (possibly asbestos based) within fill across the site cannot therefore be discounted.

Material identified as exceeding the land use criteria will require remediation, which may include immobilisation prior to off site disposal at a licenced landfill. Preliminary leachability testing on samples indicate the material could be disposed of at a licenced landfill as "General Solid Waste'.

Link Road North and South

The Link Road sites are primarily bushland with scattered access tracks and transmission line easements running diagonally through each allotment. The Browns Colliery Record Trace indicated two shafts on the Link Road North site. Sampling and testing was not undertaken at the shaft locations due to their inaccessible nature.

The results of preliminary sampling and analyses indicates the presence of asbestos fragments and fibres in the soil at Pit 149 and Pit 152, probably from opportunistic dumping of filling on the site.

It should be noted that the composition of filling across the site may be variable. The possible presence of further fibro fragments (possibly asbestos based) within fill across the site cannot therefore be discounted.

The results of preliminary sampling and analysis of the filling in the Link Road North and South areas indicates the absence of gross contamination. Detailed assessment of this part of the site is recommended prior to construction. This should include the two shaft locations and the overgrown access track leading to Shaft No 14.

Summary of Contamination Constraints

The results of the preliminary assessment indicated that site remediation will be required in Minmi West, concentrated on the workshops, rail lines and sidings/screens, with more localised remedial works expected in Minmi North, East and South, including in localised cisterns or cesspits which can be expected in areas previously containing miners cottages. Additional investigation is recommended across the site prior to development to provide additional delineation of affected areas.

Remediation, where required, would include the preparation of a remediation action plan (RAP), appropriate excavation and removal/disposal/capping of contaminated soil, followed by validation sampling and analysis in accordance with SEPP 55 and NSW DECC guidelines (Ref 2).

The site is considered to be suitable for the proposed residential development in accordance with SEPP 55 and NSW DECC guidelines, providing the following conditions are met as part of the development:

- Detailed contamination assessment is undertaken across the site to better identify the presence of localised contamination 'hot spots';
- appropriate remediation is conducted to remove identified contaminants, including bonded asbestos fragments and asbestos impacted fill materials, and areas of soil contamination by TRH, Benzo(a)pyrene and heavy metals;
- deleterious materials and possible associated surface impact are removed;
- validation testing and verification is undertaken, where required.

Additional waste classification testing should be undertaken to classify materials prior to disposal to a licensed facility.

It is noted that validation of asbestos contamination should be conducted by a qualified asbestos consultant.

9. GEOTECHNICAL CONSTRAINTS

9.1 Disturbed Ground and Mounded Filling

Potential constraints associated with disturbed ground and mounded filling include the following:

- Presence of contamination, as described in Section 8.1 above, in particular possible buried asbestos;

- Uncontrolled filling, which has implications for building footings, requiring that the filling either be reworked or footings be founded in suitable bearing strata below the filling using piles; Due to the relatively large volumes of mine spoil expected in many places, significant earthworks (including segregation of unsuitable materials) would be required to rework the existing filling as controlled filling;
- Uncontrolled filling also has implications for services such as roads, pavements, water and sewer;
- Potential for combustion of the coal, possibly requiring removal or capping of the coal.

9.2 Founding Conditions

Uncontrolled Filling

As discussed above, uncontrolled filling is unsuitable for founding of footings. Uncontrolled filling can be expected across areas of disturbed ground, where it will probably be intermittent and of limited thickness. This includes much of Minmi West, the northern parts of Minmi South as well as parts of Minmi East. Limited filling is expected on the Link Road Sites.

Many of these are appear to contain old cisterns or cesspits which have been backfilled with uncontrolled filling. Some of these pits have been located, however it is likely that there are additional backfilled pits which have not been identified and additional more detailed investigation would be require to locate all of these. Notwithstanding any heritage requirements, if construction is proposed over these cisterns/pits, the uncontrolled filling would require removal and replacement with controlled filling. This may require over-excavation of the pits to allow access for compaction equipment.

The greatest depths of filling are expected at and surrounding the former open cut pits. Expected depths of filling at the various former pits are as follows:

- Purple Hill (Minmi West, Pits 54, 58, 61, 63 and Bores 57 and 97): The depth of filling encountered in this area ranged from about 2 m to 8 m. The base level of this former pit is estimated to be in the order of 10 m to 15 m AHD;

- Browns Colliery (Minmi East, Pits/Bores 87 to 96): The depth of filling encountered at test locations in this area ranged from about 2 m to 8 m. The base level of this former pit is estimated to be in the range 24 m to 30 m AHD;
- Open Cuts to former Young Wallsend Seam in Minmi South (Pits 38 to 47 and Bore 98). Fill was encountered in the test locations from 1.0 m to greater than 3.0m. The floor level of the coal seam is this areas is expected to be in the order of 13 m AHD to 16 m AHD, suggesting fill depths in the order of 8 m to 12 m. Overburden filling underlain by soft soil was encountered to depths of up to 5.2 m depth in the area to the north of the former pit (Bore 98);
- Wallsend Borehole Colliery Open Cut: No investigation was undertaken in this area, however mine plans indicate the base of the pit was at a level of between 58 m AHD and 64 m AHD, suggesting between 4 m and 12 m depth of filling.

As indicated above, the mine spoil is likely to have been placed without compaction and therefore there is potential for large settlements. This could be managed by removal of the filling, re-compaction of the filling, piling of building footings to below the base of the filling, or a combination of the above.

Piling is not recommended for former open cut pits in the Young Wallsend Seam as there is 20 m cover to the Borehole Seam from the base of the open cut workings, and although the risk of pothole subsidence is low for such a cover depth, repair of piled footings affected by pothole subsidence would be very difficult. These pits include two pits in Minmi South as well as the Pit at the eastern end of Minmi East.

The filling in the base of the open cuts is likely to be saturated, probably requiring dewatering of the excavations for any reworking to be undertaken. Differential settlements occur in the backfill close to the alignment of the mine high wall; significant structures should not be located over such areas. It is known that the open cut pits broke into the underground workings in places, in particular the former Wallsend Borehole Colliery No 2 Entry and the former Purple Hill Open Cut, and therefore there will also be a need to plug any such workings to prevent the filling washing / flowing into the workings leading to surface subsidence / potholing. If the filling is fully reworked then plugging can be undertaken directly, possibly using reinforced concrete, however, if the filling is left in place and a piled option adopted, it would be necessary to plug by drilling and grouting the entries.

Bushland Areas

Bushland areas which are typically relatively undisturbed and generally are underlain by Tomago and Newcastle Coal Measures where conglomerate, sandstone and siltstone are expected at shallow depth. These formations in general are expected to provide good founding conditions, probably allowing conventional shallow footings. Reactive soils may be present in these areas, which means that they shrink and swell with changing moisture conditions, leading to ground surface movements. Soil reactivity can be readily accommodated in design, and should be confirmed during future detailed investigations prior to development by classifying building sites in accordance with AS 2870-1996 (Ref 11).

Lower Lying Alluvial Soils

Alluvial soils are expected on the northern parts of Minmi North and the central parts of Minmi West marked yellow on Drawings 1 to 4. There is potential for soft and compressive soil conditions in these areas, although no significant soft soils were encountered. This should be confirmed by detailed investigation if development is proposed on these low lying areas. Such soils can be managed by using of piled footings or ground improvement.

Reactive soils may also be present in these areas. Reactive soils shrink and swell with changing moisture conditions, leading to ground surface movements. Soil reactivity can be readily accommodated in design, and should be confirmed during future detailed investigations prior to development by classifying building sites in accordance with AS 2870-1996 (Ref 11).

9.3 Acid Sulphate Soils

A preliminary acid sulphate soil assessment was undertaken with reference to the ASSMAC "Acid Sulphate Soils Manual" (Ref 9) and QASSIT "Soil Management Guidelines" (Ref 10), and comprised the following:

- Review of available acid sulphate risk maps (Refer section 3.1);

- 50 screening tests on selected soil samples for pH in water (pH_F) and pH in hydrogen peroxide (pH_{FOX});
- Four samples tested for the full chromium suite to assess acid sulphate potential.

The results of detailed laboratory testing indicate the presence of potential acid sulphate soils in the low lying areas across the northern portion of Minmi North, within sandy clayey silt and clay alluvial soils (shown as yellow on Drawings 1 and 2).

A general acid sulphate soil management procedure is presented below, however preparation of a detailed Acid Sulphate Soil Management Plan (ASSMP) should be prepared prior to construction, if disturbance of the alluvial areas is proposed.

Soil

- Any natural alluvial soils excavated should be stockpiled separately prior to lime treatment in a bunded area to collect any leachate that may form;
- Lime treatment would involve mixing Agricultural Grade Lime into the stockpiled soil to neutralise any acid generated by the acid sulphate soils. Based on the laboratory test results the rate of lime application is estimated to be approximately 10 kg/m^3 soil;
- Further on-site screening tests by DP would then be required to verify that adequate neutralisation has occurred, and if necessary adjust the liming rate;
- The base of any excavation in the affected soils should be limed at a rate of approximately 1 kg/m^2.

Groundwater

- Groundwater extracted during dewatering (if required during construction) should be tested for pH prior to discharge;
- Dewatering monitoring would involve regular visits by DP personnel to measure dewatering pH. The frequency would depend on the construction programme and monitoring results, however is likely to initially be daily, possibly reducing to weekly once excavations are complete and consistent results are being achieved;

- If the pH of discharge water is below natural levels, a lime slurry should be added to raise the pH to within natural groundwater levels.

In summary, the treatment of acid sulphate soils and groundwater should be undertaken in a controlled manner to minimise the potential for generation and migration of acidic leachate. Monitoring of soil neutralisation and discharge water, should be undertaken during any disturbance of acid sulphate soils.

9.4 Combustion

Coal and chitter (low quality coal) was encountered within the filling, primarily in the following locations:

- Former rail lines in Minmi West and Minmi North;
- Purple Cut Open Cut Pit and surrounding filling (Minmi West);
- Browns Minmi Open Cut (Minmi East);
- Open cut near entry to Wallsend Borehole Colliery (Minmi South);
- Other localised mounds of filling.

Locations where combustible material was encountered are shown on Drawings 1 to 4 in Appendix D.

The results of laboratory testing on selected samples indicated percentages of combustible materials within the range 8.5% to 60% with six of the twenty samples having a percentage greater than 30%. The thickness of layers including combustible material ranged from 0.05 m to 7.6 m, but generally less than 1 m, with an average of 1 m and a median of 0.5 m. When the laboratory results were correlated with the visual estimates of percentage combustibles in Table 3, the laboratory results generally indicated slightly lower results.

In situ combustion of such material can occur if the material is ignited by an external source such as a surface fire, or lightening. Combustion is encouraged if there is a ready supply of oxygen as typically occurs in loose filling, especially on steep slopes.

DP is unaware of any local or state or national guidelines with respect to combustible material, however Wollongong Council has developed guidelines. According to Wollongong Council Guidelines for the use of chitter material in residential development (copy attached), chitter material must have an average combustibility not exceeding 30%, and a maximum combustibility (of an individual sample) not exceeding 40%.

It is considered that there would be some risk of combustion of coal and chitter filling occurring, however the risk of this can be reduced by applying appropriate engineering solutions. Various engineering solutions to manage the potential for combustion may include one or more of the following:

- Removal of combustible material;
- Blending of inert material with combustible material;
- Compaction of the material;
- Limiting batter slopes, generally to less than about 4H:1V;
- Capping with a layer of compacted inert material.

Removal of all combustible material would be difficult to achieve in practice, as the majority of the filling contains some intermixed combustible material and full segregation would be impractical. Identification of 'hot-spots' and removal or blending with less combustible material would be more achievable and could be undertaken as part of site regrading activities, and together with either partial or full depth compaction of the filling and limiting batter slopes, would be expected to reduce the risk of combustion significantly. It may be possible to reduce the requirements for removal/blending of combustible material if the site is capped with a compacted inert material.

It is recommended that additional investigation be undertaken in the areas identified above, prior to development to further characterise the distribution of combustible material to allow refinement of suitable options for management of the combustible material.

9.5 Slope Stability

No signs of gross deep seated slope instability were observed on the site, however a number of localised slumping slopes were observed, often associated with erosion from concentrated surface water flows. These areas are shown in red on Drawings 1 to 4, and included the following:

- Steep gully sides and slopes, especially southerly trending slopes;
- Mine fill batters;
- Deforested slopes.

It is expected that such localised instabilities can be managed by appropriate hillside development and management of surface water. Additional investigation is recommended in these areas to confirm requirements. A number of steep slopes in the southern parts of the site were difficult to assess in detail due to the presence of very dense vegetation, however similar management strategies would be expected to be suitable.

Deep seated instability can often occur near the outcrop of coal seams, especially where the seam is subject to groundwater flows and pressures. Accurate delineation of the outcrops will be important in this regard and will require subsurface investigation. Subsurface investigation will need to identify the outcrop of the other coal seams that have not been mined because inappropriate development (especially deep cuts and fills) could cause slope instability on the coal and tuff layers. The highest risk of unfavourable dipping seams is on the northern parts of Link Road South, which slope to the south and where a localised groundwater seep was observed.

A number of steep cuts were observed, associated with former railway lines. These cuts generally revealed a weathered soil zone up to about 2 m deep overlying sandstone and siltstone bedrock. Some fretting of the face and parting of blocks was observed. It is expected that this can be managed by trimming of the batters and localised rock bolting and / or shot-creting. Detailed assessment of the cuts should be undertaken as part of further investigations.

The following general guidelines for construction on slopes are provided to assist with urban planning.

It is expected that individual cuts or fills of up to 2 m vertical height would generally be appropriate, however specific assessment is recommended in areas shown red on Drawing 1 to 4. Such cuts or fills should be either supported by a conventional engineered retaining wall or battered. Preliminary design or assessments should be based on stage long term batter slopes being limited to 2H:1V, however steeper batters may be possible in rock, subject to geotechnical assessment.

Deeper and/or steeper cuts and fills are likely to be possible subject to appropriate investigation and engineering design; however specialised support systems may be required. Such support systems could include the following:

- Rock cuts - rock bolting with shotcrete;
- Soil cuts – soil nailing (similar to above);
- Potentially unstable seams of coal/clay may require installation of drainage;
- Deep filling – reinforced earth walls with concrete block or gabion fascia.

Areas of deep seated instability, if identified, will require remedial engineering works. This may include one or a combination of installation of surface and subsurface drainage, remedial earthworks, and/or anchoring.

9.6 Erosion / Dispersion

Areas of erosion were noted on site and based on the Soil Landscape Sheet for Newcastle the soils on the slopes typically have high erosion potential.

Water quality may be impacted due to sediment laden run-off from the topsoil material occurring during construction. Such potential erosion and sedimentation are readily amenable to mitigation measures such as silt fences, revegetation/reshaping batters, drainage structures (catch drains), sediment traps and sedimentation basins.

9.7 Excavatability

Shallow rock is expected over much of the site, especially the southern elevated parts of the site Such shallow rock may require large earthmoving equipment for excavation, such as excavators with rock teeth or bulldozers with rippers. There is some risk that heavy ripping or pneumatic/hydraulic hammering may be required if medium or high strength rock occurs within the depth of excavation, however subsurface investigation would be required to assess the presence of such material.

9.8 Soil Salinity/Aggressivity

The generic soil landscapes encountered on site can include the presence of naturally acidic or saline soils, however reference to the NSW Government Natural Resources Atlas indicates no known occurrences or indicators of salinity on the site. No notable signs of salinity were identified during the site walk over assessment.

Saline or acidic soils may be aggressive to buried structures or services. The results of testing listed in Table 14 above indicated generally non-aggressive and mild exposure classifications when compared to the requirements for steel/concrete piles presented in AS 2159-1995 (Ref 12).

It is recommended, however, to provide sufficient concrete cover and appropriate strength to accommodate for the environment and any changes in conditions. Specific detailed assessment should be undertaken for construction in areas of potential acid sulphate soils.

9.9 Hazardous Coal Seam Gas

Monitoring of borehole gas concentrations was undertaken to assess the potential for future extraction of coal seam methane as well as the presence of hazardous gases carbon monoxide (CO), hydrogen sulphide (H_2S) and methane (CH_4).

The results are presented in the Mine Subsidence Risk Assessment (Ref 3) and indicated low concentrations of methane in some of the bores immediately following drilling, however subsequent monitoring indicated no measurable concentrations suggesting any methane which was present was limited and quickly dissipated. Trace concentrations of H_2S were measured at one location near the former entry to the Wallsend Borehole Colliery and no concentrations of CO were measured.

Therefore it is considered that there is a low risk of hazardous gases being present at the site. It is possible that trace concentrations of such gas may escape to the surface immediately following formation of mine subsidence potholes, if they occur, however such gas would be expected to quickly dissipate and as discussed in the Mine Subsidence Risk Assessment (Ref 3) development on parts of the site with a high risk of pothole subsidence will be restricted.

9.10 Summary of Geotechnical Constraints

A number of potential geotechnical constraints have been identified as outlined in the sections above, however the site is considered to be suitable for the proposed residential development, subject to application of appropriate engineering solutions including the following:

- Compaction of uncontrolled filling, where present below development or founding of footings below the filling using piles in some locations where appropriate;
- Assessment of the presence of soft soils on the northern part of the site and the use of piled footings or ground improvement, if necessary;
- Assessment of site classifications with respect to reactive soils and design of footings in accordance with AS 2870-1996;
- Develop and work in accordance with acid sulphate soil management plans for any potential disturbance of acid sulphate soils which have been identified on the northern parts of the site;
- Additional assessment of potentially combustible material and development of a management plan which may include the following options:
  - Removal of combustible material;
  - Blending of inert material with combustible material;
  - Compaction of the material;

  - Limiting batter slopes, generally to less than about 4H:1V;
  - Capping with a layer of compacted inert material.
- Detailed investigation of slope stability in particular in identified higher risk areas, to allow confirmation of limits of cuts, fills and batter slopes as well as any specialised excavation support or slope stabilisation works. Such potentially unstable slopes, if present, can typically be managed by one or a combination of the installation of surface and subsurface drainage, remedial earthworks, retaining walls and/or anchoring;
- Provision of appropriate sedimentation and erosion controls during construction;
- Possible use of heavy ripping for excavations;
- Design of footings and buried services for appropriate exposure classifications with respect to aggressive soils. Specific additional investigation should be undertaken for in areas of potential acid sulphate soils.

10. GROUNDWATER

10.1 Concept Model

Based on the results of the desktop assessment, the subsurface investigation and the site topography a conceptual groundwater model has been developed for the site as follows:

- Groundwater recharge on the majority of the site is very limited due to the low permeability clay soil and weathered rock and the well drained slopes. The vast majority of rainfall is expected either run off or be lost by evapo-transpiration;
- Some recharge may occur in these areas due to infiltration through mine subsidence induced cracks in the rock. This would be expected to infiltrate near vertically to the mine workings;
- The mine workings fall to the south and any infiltration to the mine workings would be expected to drain to the workings to the south of the site; Subsurface investigation of the mine workings (Ref 3) indicated that the mine workings on the northern parts of the site were dry, and on the central and southern parts of the site the piezometric head was at significant depth;

- A groundwater spring was noted in a southerly trending gully in the northern part of Link Road South following a period of sustained rainfall in October 2008. It is likely that this is due to infiltration of groundwater through mining induced cracks and lateral flow through an unworked coal seam. The seem was in a gully about 150 m downslope of a ridge line and therefore the catchment for infiltration of such groundwater would be limited;
- The alluvial soils on the northern parts of the site (shown in Yellow on Drawing 1) are expected to comprise unconfined aquifers perched above the less permeable underling residual soils and rock;
- These alluvial soils are in creek lines and low lying areas on the southern fringe of extensive areas of swamp to the north. The source of the recharge water is primarily from surface runoff from the upstream catchments, most of which are within the proposed development area. Some direct recharge will occur in these area and some recharge may be due to rising water levels in the swamp to the north. Groundwater recharge from the adjacent areas of residual soils will be very minor;
- Groundwater will flow within the alluvial areas, generally following the fall of the creek/gully as well as interact with the surface water flows in the creek. In times high rainfall and high creek levels the aquifer will be recharged and in times of low rainfall and low creek levels the groundwater may provide base-flow back to the creek and help maintain the water levels in lower lying ponded areas;
- The backfilled open cut pits are also expected to represent localised perched aquifers, comprising permeable backfill underlain by less permeable rock. Recharge would generally occur from direct infiltration as well as run-off from surrounding areas. These areas are generally heavily disturbed.

10.2 Effect Of Development On Groundwater Levels

It is understood that vegetation communities which can be dependant of groundwater have been identified within gully lines on the southern parts of the site as well as within the areas of alluviual soils identified on the northern parts of the site. Changes to groundwater levels in these areas may have an adverse effect on such vegetation communities.

It is considered that the alluvial soils on the northern part of the site are the only location where permanent shallow groundwater aquifers are expected (with the exception of former open cut pits) and the water table levels in these areas may be sensitive to the development.

Groundwater recharge to these aquifers is considered to be due to direct rainfall in the alluvial areas as well as runoff from the surrounding residual areas, however not due to groundwater recharge from the residual areas.

Provided that the existing surface water flow rates / levels and fluctuations thereof within the creek are maintained there will be minimal impact on the groundwater levels and therefore GDEs. This can be achieved by appropriate water-sensitive urban design, which would include the provision of surface water storage devices such as ponds or swales to limit peak flows.

The soil in the base of gullies / intermittent creeks on the central and southern parts of the site, underlain by residual soils, can be expected to become saturated in times of rainfall, however these are unlikely to represent groundwater aquifers. The seep that was observed on the northern slopes of Link Road South, which is likely to be from infiltration in a localised upslope area. The seep is likely to extend the period for which the downslope creek would otherwise flow, rather than provide a permanent source of flow. Development may reduce the amount of infiltration to the catchment area, reducing the flow from the seep and possibly reducing the amount of time that the seep is active.

Similarly to the alluvial areas, the intermittent saturation of these soils can be maintained using appropriate water sensitive urban design.

11. MINE SUBSIDENCE CONSTRAINTS

Potential constraints due to mine subsidence is the subject of a detailed mine subsidence risk assessment (Ref 3) which should be read in conjunction with this report.

12. ADDITIONAL INVESTIGATIONS

Contamination

Based on the results of assessment to date it is considered that detailed contamination assessment is required.

Areas of additional investigation should include, but not necessarily limited to, the following:

- Further assessment of the presence of, and delineation of contaminated filling, and/or contamination from mining operations. A range of potential contaminants should be assessed, including heavy metals, PAH, TRH, BTEX, OCP/CPP pesticides, PCBs and asbestos;
- Assessment of surface fibro to confirm the presence of asbestos in fibro fragments and possibly in near surface soils. Assessment of asbestos materials should be undertaken by a qualified asbestos consultant.

Remediation, if required, would include the preparation of a remediation action plan (RAP), appropriate excavation and removal/disposal/capping of contaminated soil, followed by validation sampling and analysis in accordance with NSW EPA (Ref 1) and SEPP 55 (Ref 2) guidelines.

Geotechnical

Additional geotechnical investigation is expected to be required prior to development which may include the following:

- Additional assessment of combustible material and improvement measures;
- Specific slope stability investigation of steep slopes and proposed areas of cut or filling exceeding the guidelines presented in Section 10;
- Specific foundation investigation for proposed buildings, in particular areas containing filling such as former open cut mines;
- Site classifications to AS 2870;

- Earthworks procedures and specifications;
- Pavement thickness design for roads;
- Acid sulphate soil management plan (ASSMP).

13. LIMITATIONS OF THIS REPORT

DP have performed investigation and consulting services for this project in general accordance with current professional and industry standards for land contamination investigation.

Whilst every effort has been made to ensure a representative programme of field and laboratory sampling and testing, conditions different to those identified during these tasks may exist. Therefore DP cannot provide unqualified warranties nor does DP assume any liability for site conditions not observed, or accessible during the time of the investigations.

Despite all reasonable care and diligence, the ground conditions encountered and concentrations of contaminants measured may not be representative of conditions between the locations sampled and investigated. In addition, site characteristics may change over time in response to variations in natural conditions, chemical reactions and other events, eg. groundwater movement and/or spillages of contaminating substances. These changes may occur subsequent to DP's investigations and assessment.

This report and associated documentation and the information herein have been prepared solely for the use of Coal and Allied Operations Pty Limited, in consultation with Catylis 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

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