NAMOI MINING PTY LTD
ABN: 24 071 158 373

Sunnyside Coal Project

via Gunnedah

Groundwater Assessment

Prepared by

GeoTerra Pty Ltd

March, 2008

Specialist Consultant Studies Compendium
Part 1

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Groundwater Assessment

of the

Sunnyside Coal Project
via Gunnedah

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EXECUTIVE SUMMARY

The proposed Sunnyside Open Cut coal mine is planned to be excavated to maximum depth of 65m below surface (295m AHD) over a period of approximately five years to extract the 6m to 9m thick Hoskissons Seam in elevated country approximately 15km west of Gunnedah.

The Hoskissons Seam has been previously mined by bord and pillar methods in the Gunnedah Colliery underground No.1 to 5 workings, which are located down dip and to the south of the proposed open cut pit.

Drilling and monitoring of 8 piezometers and 15 coal exploration bores in the mine vicinity along with assessment and field confirmation of 20 privately operated bores within 3km of the proposed mine indicate very low groundwater yields (<0.63L/sec).

Six exploratory bores drilled in, or adjacent to, the abandoned underground workings, piezometer monitoring and coal exploration records indicate the workings are mostly dry, apart from a down-thrown block faulted area located approximately 40m south of the proposed pit, which contains approximately 31.2ML of stored water.

Assessment of water levels and remnant void space indicates there is at least 1523ML of unfilled workings in the abandoned mine, and that water levels in the underground are primarily beneath the excavated workings and lower than the basal level of the proposed pit, outside of the isolated down-thrown block faulted section.

Field and laboratory tests indicate the:

- out-of-pit overburden batch test leachate results range from pH 6.97 to 8.43, with electrical conductivity values ranging from 724µS/cm to 2 590µS/cm;
- No. 5 Underground water pH ranges from 6.90 to 8.10, with electrical conductivity values between 3 590µS/cm to 7 360µS/cm; and
- Hoskissons Seam pH ranges from 6.62 to 7.90, with electrical conductivity values between 2 260µS/cm and 12 650µS/cm.

The proposed open cut pit is located on the outcropping flanks of Coocooboonah Creek and would be excavated through Early Triassic overburden into the Late Permian Hoskissons Seam, with no excavation through Quaternary alluvium or any associated alluvial aquifers.

The Quaternary alluvium of Coocooboonah Creek to the east and Native Cat Creek to the north can extend to at least 50m thick, whilst Rock Well Creek to the west of the Project Site is recorded to have up 10m of alluvium. No registered bores extract groundwater from the Quaternary alluvium within at least 3km of the proposed mine.

The Hoskissons Seam and its associated overburden and underlying formations are significantly intruded and / or contact metamorphosed by doleritic sills and dykes, which can be regionally extensive, particularly to the west, north and south of the proposed open cut. In addition, the stratigraphy is also significantly faulted in the same regions.

The Project Site is located within an essentially dry, ephemeral first order stream catchment which drains to the essentially dry, ephemeral Coocooboonah Creek. Coocooboonah Creek then drains into Native Cat Creek, Collygra Creek, then to the Namoi River approximately 13km northeast of the Project Site. It is located within a low rainfall, high evaporation climatic regime.

Streams in the area were dry during the study period apart from a small short lived ponding episode following a short duration storm in Coocooboonah Creek, which indicated a circum-neutral stream water pH of 7.3 and an electrical conductivity of 272µS/cm.

Of the 20 registered operating private bores within 3km of the mine site, 5 extract water from formations above the Hoskissons Seam, 2 extract from within the seam and 13 extract from lithologies beneath the Hoskissons Seam, particularly the Upper and Lower Melville Seams. All private bores have yields below 0.63L/sec, salinities between 510 - 10080µS/cm and circum neutral pH.

Two piezometers were installed to 41m below surface in the Coocooboonah Creek alluvium, 3 were installed to 81m below surface in the Hoskissons Seam and 3 were installed in the underlying Late Permian Shallow Marine Facies and Lower Delta Plain Facies to a maximum depth of 90m.

Short duration pump out tests and falling head tests assessed the Quaternary alluvium to have hydraulic conductivities below 5.3m/day. The Hoskissons Seam hydraulic conductivity ranged up to 4.0m/day whilst the underlying formations, excluding the Melville Seam, ranged up to 2.1m/day.

Groundwater within the Hoskissons Seam is unconfined where it subcrops beneath the Coocooboonah Creek alluvium, and progressively becomes more confined toward and west (down dip) of the proposed pit.

Groundwater quality of the tested overburden, Hoskissons Seam and underlying formations generally exceeded the ANZECC 2000 upland stream freshwater and 95% trigger level for freshwater species for electrolytical conductivity, total nitrogen, total phosphorus, copper, zinc, and to a lesser degree, nickel and manganese.

Acid Rock Drainage laboratory analyses and batch leach tests indicated that the waste rock is not potentially acid producing.

A FEFLOW groundwater model was sequentially assessed in six stages (Case 1 to Case 6) as the understanding of the regional hydrogeological system developed. The model represented the Project Site with four layers, which incorporated the proposed coal extraction in the Sunnyside pit as well as the effect of adjoining highly weathered doleritic intrusions in the Hoskissons Seam and the adjacent, mostly dry, Gunnedah No. 5 underground workings.

The Case 6 model assessment indicates a regionally limited area of groundwater depressurisation, with the majority of groundwater level decline occurring in the overburden above the confined Hoskissons Seam.

It is not predicted that drawdown will exceed more than up to 1m in bedrock formations outside of the immediate Sunnyside open pit area.

No observable drawdown is predicted in the overlying Quaternary alluvium of Coocooboonah Creek, Rock Well Creek, Native Cat Creek, Collygra Creek or the Namoi River.

Due to their anticipated low hydraulic conductivity, the highly weathered igneous intrusions in the vicinity of the pit significantly reduce the predicted pit inflows and extent of the cone of depression.

The mostly dry No.5 underground workings to the south and down dip of the pit have a standing water level mostly beneath the base of the proposed pit, which significantly limits the regional groundwater drawdown and rate of inflow to the proposed pit.

Pit inflows of between 64ML/year and 106ML/year are postulated by the Case 6 model scenario, however, the high evaporation rate would significantly reduce the volume of any water required to be pumped out of the pit. The mine requires around 75-100ML/year of non potable water, which may not be able to be supplied solely by pit seepage. The mine water supply requirements would be supplied, as needed, by a combination of pit seepage collection, dirty surface water circuit catchments and pumping from the No. 5 underground workings, where and if water is available.

The model indicates that the DWE registered bores on the “Sunnyside” property closest to the proposed pit would be affected by less than 5m of groundwater depressurisation following mining, however. these bores are owned by the Proponent.

The two private bores on the “Lilydale” property may experience dewatering of less than 1m, however, no other bores within the Project study area are anticipated to be adversely affected by groundwater depressurisation.

No adverse effects are anticipated on the Namoi River or its associated alluvial groundwater systems, and no adverse effects are anticipated on Groundwater Dependent Ecosystems in the study area.

No adverse effect on groundwater quality is anticipated in the study area from operation of the Sunnyside Mine.

Calculations indicate the Sunnyside Open Cut Pit void water could have electrical conductivity values that range from approximately 5 800µS/cm to 11 000µS/cm, depending on the relative proportions of groundwater inflow and surface water runoff, with a pH between 6.90 and 8.43.

Post-mining groundwater levels are modelled to recover to approximately 293m AHD after mine closure, depending on the actual as-mined hydrogeological conditions, whereas it is planned to backfill and rehabilitate the pit to a base level of 305m AHD.

Based on the projected in-pit rainfall catchment during mine operation and the reduced post rehabilitation catchment area, it is assessed that the combined groundwater seepage and post rehabilitation in pit rainfall catchment would not raise the backfilled pit water level above the 305m AHD backfill level, and as a result, a pit void lake is not anticipated to occur.

ACRONYMS COMMONLY USED THROUGHOUT THIS REPORT

CCL	Consolidated Coal Lease
CHPP	Coal Handling and Preparation Plant
DWE	Department of Water and Energy
EL	Exploration Licence
GWMA	Groundwater Management Area
LDPF	Lower Delta Plain Facies
NMPL	Namoi Mining Pty Ltd
ROM	Run-of-mine
SMF	Shallow Marine Facies

1 INTRODUCTION

This document provides an assessment of the local and regional hydrogeology of the proposed Sunnyside Project.

The objective of the study was to provide Namoi Mining Pty Ltd (NMPL) with an understanding of the local and regional groundwater system and to assess the potential combined effects from mining the Sunnyside Open Cut Pit in terms of the following components.

- Pit groundwater inflows.
- Effect on local groundwater resources.
- Final pit void salinity.
- Water volume, available void space and water quality in the old Gunnedah Mine No. 5 Entry Underground workings
- Acid rock drainage potential.

The study describes potential groundwater management and mine water supply issues that may arise, as well as outlining the potential effects on the local environment and regional bores that may occur due to operation of the mine.

The field, office and laboratory analyses enabled a conceptual hydrogeological model to be derived, with subsequent development of a "FEFLOW" computer based model which, over six stages that sequentially developed as the understanding of the regional hydrogeology progressed, assessed the potential local and regional effects from operation and decommissioning of the proposed open cut. The modelling enabled:

- simulation of hydrogeological systems in the vicinity of the mine;
- assessment of potential water supply and pit dewatering requirements; and
- assessment of the regional groundwater and environmental impact.

The 231ha Project Site is located within the 2502ha "Sunnyside" Exploration Licence 5183 (EL 5183) and Consolidated Coal Lease 701 (CCL701) approximately 15km west of Gunnedah within the Gunnedah Coalfield.

The Project Site is wholly situated within the "Sunnyside" property. The Oxley Highway is approximately 1.2km south of the Project Site, whilst the unsealed Coocooboonah Lane is approximately 1km east of the proposed open cut as shown in **Drawing 1** and **Photograph 1**.

Mining and associated activities would be undertaken within Lot 1 DP 393755 and Lot 12 DP755503.

The Project Site is located on a north facing slope that has been extensively cleared and has been used for cropping, grazing and rotational agricultural practices.

Source: Terrametrics 2006

Photograph 1
Site Location

1.1 Proposed Mine Plan

The Sunnyside open cut is proposed to produce up to 1MT/year of high ash thermal coal for approximately 5 years. It would produce a "bypass" unwashed coal with 15%-19% ash by selective mining in 3 passes.

There is approximately 5.9Mt of mineable coal within the potential open cut area in the AB and DE plies, with a maximum vertical coal to waste rock ratio of 1:7, and a maximum pit depth of 65m. Due to poor coal quality, Ply C would not be incorporated into the product and would be selectively disposed with the overburden.

The Project would involve extraction by conventional open cut mining over an area of approximately 43ha. A small auger mining operation may mine an additional 132,000t of coal from the open cut high wall during the first three years of mining activity.

Blended and crushed ROM coal would be trucked to the Whitehaven Coal Handling and preparation Plant (CHPP) and Rail Loading Facility near Gunnedah where the coal would be transferred to Port Newcastle by rail.

As no coal washing is proposed prior to offsite transport, a washery and tailings dams would not be required for the Project.

The layout of the Project Site components is shown on **Drawing 2**.

An amenity bund would be constructed along the northern, eastern and western boundaries of the ROM Coal Pad and truck loading bin.

An out-of-pit overburden emplacement would be located downslope and immediately north of the open cut and is designed to enable the pit to be established, then when adequate capacity is available to partially backfill the pit. This would create a permanent out-of-pit overburden emplacement, a re-contoured area and a shaped final void that would remain at the completion of mining.

The maximum slope planned for the out-of-pit overburden emplacement and the final void is 10^o.

A small area located immediately downslope of the out-of-pit overburden emplacement comprised of temporarily stockpiled soil which would be pre-stripped prior to forming the emplacement. It would be segregated into topsoil and subsoil which would be sequentially placed over the emplacement to promote rehabilitation and revegetation.

1.1.1 Hoskissons Seam

The Hoskissons Seam ranges from 6m to 9m thick in the Project Site, and consists of five plies (A to E).

Zone AB comprises the lower ash base of the seam up to the first stone band and is generally 2.5m to 4.0m thick. It thins to the north of the Sunnyside Open Cut area and is less than 1.6m thick in the north of EL 5183.

Zone C is the heavily banded central part of the seam between 0.7m to 1.2m thick. It has a high ash content (40% to 50%) comprising grey to carbonaceous mudstones. As a result, it is proposed to selectively mine Zone C and send it to waste.

Zone DE is located above the highest significant stone band. Although there are no bands in the zone it does have high inherent ash and is usually between 1.1m and 2.2m thick.

The roof above the Hoskissons Seam is a carbonaceous mudstone with occasional sandstone bands, and the floor is a siltstone or silty mudstone.

1.1.2 Mining Sequence

Mining would proceed from west to east as shown in **Appendix 1**.

Initial pit entry would be via a ramp on the northern side to enable access to the initial box cut at the western end of the mining area.

Overburden from the ramp and box cut would be removed to the out-of-pit overburden emplacement.

Topsoil and subsoil from disturbed areas would be stockpiled to the west of the disturbed area and would be available for sequential emplacement back over the in-pit overburden, whilst the in-pit overburden would be shaped prior to soil replacement and contouring.

During Year 5, mining would progress to partial reshaping of the final void, with the last of the open cut coal being extracted.

The final void would be reshaped by returning some of the out-of-pit overburden emplacement material to the pit and re-contouring.

The out-of-pit overburden emplacement would reach up to 30m high and would be shaped and revegetated, with slopes of up to 10^{o}.

Following pit closure, constructed rock lined flumes would divert clean surface runoff around the eastern pit periphery to enable surface runoff to flow into the Coocooboonah Creek catchment.

The surface facilities would be removed following completion of mining. The amenity bund around the ROM Coal Pad and Bin would be reshaped to enable normal farming activities to recommence.

1.2 Mine Water Supply

An anticipated net water requirement of 75ML/yr to 100ML/yr (an average of 2.4-3.2L/sec) would be required, depending on seasonal conditions.

A major portion of the total would be required for dust suppression on roads (63ML/yr to 88ML/yr). Coal crushing would require approximately 2ML/yr for conveyor dust suppression, stockpile dust suppression water sprays would require approximately 5ML/yr and approximately 5ML/yr would be required for general dust suppression around the mine.

Dust suppression water would be stored in dirty water dams, with the water sourced from site run-off harvesting, pit groundwater seepage and in-pit runoff.

If onsite sources are insufficient, additional process water may be obtained from an isolated section of the old Gunnedah Mine No 5 Entry underground workings to the south of the Sunnyside Open Cut. The water is contained in a down-thrown faulted block in the underground workings closest to and down dip from the proposed open pit, and could contain up to 31.2ML of stored water. The water stored in the abandoned workings would only be used if sufficient water is available and if the supply from pit dewatering and dam water is insufficient to meet requirements. Any water extraction from the underground workings would be appropriately licensed with the DWE prior to extraction commencing.

Bath-house and potable water would be delivered by tanker as required from the Gunnedah Town Supply.

During and after mining, surface runoff from above the mining area would be directed around the open cut by diversion drains. The water would flow through onsite waterways and sedimentation dams, with some runoff used to augment the site water supply.

2 Previous Coal Exploration and Mining

A geological database was developed to incorporate all known relevant drilling since the 1970's that formed the basis of geological modelling, mineable reserve assessment and subsequent detailed mine planning and pit design (Namoi Mining, 2006).

Four cored drillholes were drilled near the Hoskissons Seam subcrop in 1979-80. Between 1982 and 1983, 17 part-cored holes and 17 open holes were drilled, whilst ground magnetic and resistivity surveys were also carried out to delineate an average seam thickness of 7.22m.

During late 1996 to early 1997, 50 rotary open hole and touch core drillholes were drilled to cover the north-south sub-crop extent of the Hoskissons Seam in EL 5183. Drilling indicated EL 5183 was significantly affected by near surface or subcropping igneous rock.

A 1.5km^2 area in the north and a similar size area in the south (now "Sunnyside") appeared to be free of igneous activity and had relatively shallow oxidation depths of around 30m to 35m. During 1997 a total of 2,681m was drilled, including 56m of HMLC core.

In September 2005, 48 rotary open holes were drilled within the Sunnyside prospect. Five of these were touch cored for coal quality analysis. It was assessed that the Project Site had an open-cut potential of approximately 7 million tonnes (in-situ).

Drilling also identified extensive intrusive silling into the roof and floor of the Hoskissons Seam in the west and north-west portion of the open-cut target area, with lesser intrusive subcrops to the north and east of the proposed pit area.

Old bord and pillar workings associated with the Gunnedah Colliery are present to the south east of the proposed pit.

In August and September 2006, rotary open holes were drilled to identify the sub-crop trend of the underlying Melville Seam to the north and east of the proposed pit, as well as to better define the west and south-west open cut limits. During this program, 8 piezometers were installed to selected depths including the Coocooboonah Creek Alluvium through to the Lower Melville Seam.

During August and September 2007, 20 open holes were drilled to further delineate the Hoskissons Seam Subcrop line and the presence of igneous intrusive dykes and sills, as well as to confirm the presence or absence of pit water in No. 5 Underground Workings of the decommissioned Gunnedah Colliery to the south of and adjacent to the proposed Sunnyside Open Pit.

2.1 Gunnedah Coal Company Ltd

EL 5183 was previously held as an Authorisation (A139) under the Coal Mining Act, 1973, by the former owners (Gunnedah Colliery), as was CCL 701.

The decommissioned Gunnedah No. 5 Entry underground bord and pillar workings are located directly to the south and southwest of the proposed open cut.

The old No.2, No.4 workings and pit top facilities, as well as the decommissioned “Brickworks Paddock”, No.s 1, 3 and 5 bord and pillar entries and the related surface facilities lie to the southeast of the proposed Sunnyside open cut as shown in **Drawing 1**.

Mining records showing details of all seals and potential egress points for water to escape from the underground workings (C Stewart, pers comm) indicate there are no adits or other known discharge points that could directly connect, and enable the discharge of waters, from the underground workings to surface water bodies in the study area.

No known registered bores other than the decommissioned GW16789 directly intersects the old Gunnedah No. 5 workings, whilst two bores on the “Lilydale” property (GW6249 and GW 44884) extract water from stratigraphically beneath the old No.5 workings.

3 Study Area Features

3.1 Geomorphology

The Sunnyside Project Site is predominantly within cleared agricultural land used for rotation fodder, cropping and cattle grazing.

Access to the Project Site is currently via the unsealed Coocooboonah Lane.

The Project Site and adjacent areas is comprised of:

- elevated, isolated, north-west trending hills that are mostly vegetated with scrub woodland and dry sclerophyll forest, with slopes ranging from 0.5^0 to 8.0^0;
- the undulating, north-west trending "lowland" valley of Coocooboonah Creek and its tributaries to the east of the pit, which has been cleared for sheep and cattle grazing, with scattered trees and minor forest remnants;
- an elevated “upland” northerly trending valley associated with Rock Well Creek, which is not cleared in its headwaters, and becomes more cleared to the north; and
- a west-north-west trending valley along Native Cat Creek to the north of the proposed pit into which both Coocooboonah Creek and Rock Well Creek drain, which has been cleared for sheep and cattle grazing, and has scattered trees and minor forest remnants.

Tertiary igneous capped hills are present to the west, east and south of “Sunnyside”, with “Sugarloaf Mountain”, “Pyramid Hill, “Coocooboonah Hill” and “Black Jack Mountain” being named features in the area.

The proposed pit area is elevated above Native Cat Plains and lies on the north-eastern slopes of a pronounced knoll.

A lesser elevated ridge line of hills extends northward and to the west of the “Sunnyside”, through to the corner of EL 5183 as shown in **Drawing 1.**

3.2 Soil

Soil within the disturbed portion of the Project Site is anticipated to range from 0.5m to 5m deep, with deeper soil present to the north and down slope of the active mining area within the valleys of Coocooboonah Creek and in Native Cat Plain.

3.3 Climate

The study area lies within a dry sub-humid climate with an annual mean rainfall of 636mm. The driest period is from April to September and the wettest is between December and January.

Sunnyside’s inland location produces extremes in temperatures, such that summers can be hot (to 43°C) and winters falling below freezing. Temperatures are generally warm to hot in summer, mild in autumn and spring and cool with occasional frosts in winter.

The monthly maximum temperature is highest between November and March with a peak in January and lowest during July and August.

Annual average evaporation of 1752mm occurs at Gunnedah, with a maximum of 245mm in December and a minimum of 57mm in June, with potential evaporation exceeding rainfall over the year.

3.4 Surface Hydrology

The Sunnyside Project is located on the periphery of the Liverpool Plains within the Upper Namoi River Catchment Management Area, approximately 15km west of Gunnedah.

The Namoi River channel is also located approximately 12km east of the Project Site.

The nearest significant local surface watercourses are the ephemeral channels of Coocooboonah Creek and Rock Well Creek, which, respectively are approximately 1.2km east and 2km west of the proposed pit.

The Project Site is entirely located on the easterly draining slopes and alluvial flanks of Coocooboonah Creek catchment, with the pit and mine facilities located on colluvial cover over Permian sedimentary basement, upslope of the Coocooboonah Creek alluvium.

One ephemeral, unnamed stream and a smaller stream, both draining to the northeast with moderate catchment areas intersect the proposed pit and out-of-pit overburden emplacement area respectively.

Drainage on the hill-slopes has been significantly modified through installation of contour banks to limit soil erosion and gullying.

The catchment of Rock Well Creek is located to the west of, and outside the Project Site, although within EL 5183 and CCL701.

Both Rock Well Creek and Coocooboonah Creek drain into Native Cat Creek approximately 4km north of the Project Site. Native Cat Creek flows into Collygra Creek and subsequently dissipates into undefined swales within the Quaternary Namoi River alluvium, approximately 13km north of the Project Site.

Flow characteristics of watercourses traversing the proposed mine site are variable and dependent on precipitation duration and intensity, as well as soil moisture, degree and type of vegetative cover, as well as the effects of evapo-transpiration, catchment aquifer baseflow and catchment modifications.

Runoff and streamflow are closely related to rainfall events, with the main creeks and tributaries being moderately steep in the headwaters to relatively flat in the main valley, with flows prone to rapid peaking and depletion and a tendency to no or low flow over extended periods.

Flooding would be restricted mainly to Coocooboonah Creek, which is approximately 1.2km east of the pit, with floods anticipated to be typically brief in extent in the valley floor.

3.5 Geology

The following description of the site geology, stratigraphy, structure and igneous lithologies are sourced from published DMR maps as well as Gunnedah Coal Company Pty Ltd and Whitehaven Coal Mining Pty Ltd reports, with the regional geology shown in **Drawing 3**.

The Sunnyside Project Site lies in the Mullaley sub-basin of the central Gunnedah Coalfield, with the proposed extraction of the Hoskissons Seam from the Late Permian Hoskissons Coal Member of the Black Jack Formation.

Two major coal seams are identified in the Project Site, namely the 7.5m to 9.5m thick Hoskissons Seam, which is divided into 5 plies, and the underlying 0.7m to 1.9m thick (Upper) and the 0.7m to 2.4m thick (Lower) Melville Seam, which subcrops in the east of the Project Site.

The Lower Melville Seam subcrops beneath Quaternary alluvium in the Coocooboonah Creek valley floor, whilst the Hoskissons Seam subcrops under primarily transported colluvial cover on the eastern flanks of Coocooboonah Creek as shown in **Drawing 6**.

Extraction of the Melville Seam has been assessed to be uneconomic in the Project Site (Namoi Mining, 2006).

The strata has an average dip of 2^o to 3^o to the southwest.

The depth of weathering extends approximately 30m below surface, with the depth to the top of the Hoskissons Seam extending to at least 65m below surface in the pit area.

The upper members of the Late Permian Black Jack Formation and the Late Permian / Early Triassic Digby Formation overly the coal measures, which are also underlain by the Lower Delta Plain Facies as illustrated in **Drawing 6**.

3.6 Sunnyside Stratigraphy

The following stratigraphy, from youngest to oldest, is present in the Sunnyside area.

Quaternary Alluvium – up to 50m thick (based on current data) sand, gravel and clay within the stream bed and alluvial flanks of Coocooboonah Creek and shallower, approximately 10m deep alluvium within the upper reaches of Rock Well Creek.

Alluvium in the lower reaches of Coocooboonah Creek and Native Cat Creek are analogous to the silty clay Narrabri Formation and the underlying gravely clay Gunnedah Formation which are identified across the Namoi River valley.

Black Jack Sill - Upper Jurassic sills located above the Black Jack Coal Measures.

Sylvandale A Sill – Lower Jurassic sills located above the Hoskissons Seam, which are highly weathered and altered to predominantly clay in the vicinity of the proposed pit.

Sylvandale Sill – Lower Jurassic sills located within and below the Hoskissons Seam, which are highly weathered and altered to predominantly clay in the vicinity of the proposed pit.

Digby Formation – the Lower Triassic Digby Formation conformably overlies the Black Jack Formation and consists of poorly sorted conglomerate ranging from 15m to 200m thick.

Tuffaceous Stony Coal Facies – is the upper unit of the Black Jack Formation and is characterised by stony coal irregularly inter-bedded with tuff and tuffaceous claystone, with stony coal seams containing tuffaceous bands.

Goran Conglomerate – variable thickness and similar lithology to the Digby Formation.

Upper Delta Plain Facies – this facies contains coal seams, including the ***Wandobah Seam***, which is between 20m and 30m above the Hoskissons Seam and comprises inter-bedded siltstones and sandstones, minor tuffaceous sediments. White quartz channel sandstone units are present, one of which is the ***Clare Sandstone***. A heavily bioturbated siltstone / mudstone is also present.

Hoskissons Coal Member – the member ranges from 2m to 18m thick and consists of coal, carbonaceous siltstones and mudstones. It contains the ***Hoskissons Seam***, which ranges from 7.5m to 9.5m thick in the Sunnyside area and is composed of up to 5 coal plies (A to E).

Shallow Marine Facies – Shallow marine siltstone / sandstone laminates up to 15m thick, which in the upper section is a strongly bioturbated silty sandstone called the ***Arkarula Sandstone Member,*** which ranges from 1m to 15m thick.

Lower Delta Plain Facies – comprises siltstone, carbonaceous claystones, inter-bedded siltstone / sandstone and coal seams. Quartz lithic sandstone is common. It contains the **Upper and Lower Melville Seam**, which is from 35m to 50m underneath the Hoskissons Seam.

3.6.1 Geological Structures

The strata is affected primarily to the south and west of the proposed pit by at least 2 generations of faulting, with the faults essentially divided into an east west striking set that has been dislocated by a north-east south-west series. The faults dip to both the north and south, with throws measured within the Gunnedah No.5 Entry underground workings of up to 11m.

Aeromagnetic surveys indicate a number of northeast trending lineaments in the northern half of EL 5183, with drilling delineating up to 4 north east trending faults across the northern half of the EL with fault displacements between 3m and 15m.

An east northeast trending dyke is present to the south of the Sunnyside mining area, within the northern limit of the No.5 underground workings, which stopped the northerly expansion of the workings, whilst a series of east-northeast trending faults are present in the northern section of the No.5 underground workings.

A series of east-west faults with both northerly and southerly dips have been mapped in the west of EL 5183, to the west of the proposed pit.

3.7 Igneous Lithologies

At least two episodes of dolerite / teschenite intrusions are present at Sunnyside.

Major sills are present between 60m to 100m thick which occur over large areas and are located within, above and below the Hoskissons Seam as shown in **Drawing 5**. Where they transgress the seam, they completely replace or effectively destroy the seam. Where they occur under and in proximity to the seam in the vicinity of the proposed pit, the intrusions are mostly de-volatilised and altered to clay.

Minor sills and dykes also occur within or close to the Hoskissons Seam, which are generally less than 5m thick and of limited and largely undefined extent. Minor dykes and sills are common, and depending on their hardness, thickness and orientation, can present problems to mining.

Minor dykes within the No. 5 workings, to the south of the proposed pit, have either an east-northeast or a north-northeast trend, and have been mapped up to 3m wide.

The dykes are generally highly altered and weathered at shallow depths to soft white clay.

The minor sills are irregular in thickness and distribution and can be present as connecting channels between adjacent dykes.

The Sylvandale Sill is intruded between the Hoskissons and Melville Seams and outcrops in the north east of EL 5183, whilst the Sylvandale A Sill overlies the Hoskissons Seam and can be up to 35m thick.

The Black Jack Sill forms a ridge of high ground in the western portion of EL 5183.

Drilling has identified intrusions in the Hoskissons Seam to the west, south, east and north of the proposed pit.

3.8 Sunnyside Hydrogeology

Sunnyside is located within the exposed Triassic and Permian basement on the periphery of the Quaternary alluvial Zone 4 - Groundwater Management Area 4 (GWMA4) of the Upper and Lower Namoi Groundwater Source (DNR, 2003).

A Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources (DNR, 2003) was gazetted under the Water Management Act 2000, with the Water Sharing Plan intended to be introduced on November 1, 2006. Some delays in introducing the plan were encountered to enable consistency with results of the “Achieving Sustainable Groundwater Entitlements Program” and to reflect the previous consultation that had occurred. The amendments are designed to allow for a formula for entitlement reductions that take into account water users’ past consumption as well as history of extraction and to ensure that groundwater extraction is sustainable in the GWMA.

The proposed pit is located within the Permian “Black Jack Formation” Fractured Sedimentary Rock aquifer, which stratigraphically underlies the Triassic Digby and Napperby Formations that form the major scarps in the area. The outcropping basement is a recharge source for the mid catchment sedimentary rock and lower catchment consolidated rock aquifers. Recharge is generally relatively high for the fractured rock aquifers to accommodate, resulting in an upward head pressure which is established further down the groundwater flow gradient (Broughton, A.K, 1994).

The proposed Sunnyside pit is anticipated to be excavated through up to 5m of colluvial soil which overlies and the Upper Permian Tuffaceous Stony Coal, Goran Conglomerate, Upper Delta Plain Facies and into the Hoskissons Seam.

No excavation would be conducted in Coocooboonah Creek or Rock Well Creek, which represent the distal extent of the Upper Namoi River Quaternary Alluvium.

No substantial aquifers are known to be present within the proposed pit area other than groundwater of very limited yield and moderate salinity within the Hoskissons Coal Member.

3.9 DWE Registered Bores and Wells

Twenty four stock and domestic bores, one irrigation bore and two piezometers are registered within a 3km radius of the proposed Sunnyside open cut as shown in **Table 1** and **Drawing 9,** with yields ranging up to 0.63L/sec as determined from air lift or short duration pump out tests.

Based on limited available data, the stock and domestic bores range from 12.2m to 85.3m deep. Three bores (GW27356, 45097 and 45098) are on the “Sunnyside” property and are owned by NMPL.

Table 1
Department of Water and Energy Registered Bore Data

Bore	Registered Use	Drilled	Depth	Water Intersect	Drilled Standing Water Level	Yield	Aquifer Intake
INTAKE ABOVE HOSKISSONS COAL SEAM							
3706	Stock	1940	15.2	9.1 / 13.4-15.2	6.4	0.4	Sandstone
3709	Stock	1940	37.5	36.6	19.2	0.46	Shale
3715	Stock	1940	45.1	30.5 / 42.1	? / 28.7	0.04 / 0.2	Shale / sandstone
8810	Stock?	N.A.	53.3	N.A.	N.A.	N.A.	N.A.
15665	Stock	1957	24.4	15.8-16.1	12.2	0.03	Basalt
16789	Stock	1961	23.2	16.8-17.1 / 18.9-21.3	12.2/12.2	0.06 / 0.51	Conglomerate
901803	Stk Dom Irr	N.A.	58	N.A.	N.A.	N.A.	N.A.
966680	Piezo	1990	5.4	N.A.	N.A.	N.A.	N.A.
966681	Piezo	1990	2.1	N.A.	N.A.	N.A.	N.A.
967523	Stock Domestic	1997	42.36	N.A.	N.A.	N.A.	N.A.
INTAKE WITHIN HOSKISSONS COAL SEAM							
22497	Stock	1965	45.7	28.7-32.1	24.4	0.25	? / coal
44677	Stock Domestic	1926	75.9	N.A.	15.2	N.A.	? / coal
45098	Stock Domestic	1965	44.2	26.5 / 39.6-40.8	N.A.	N.A.	? / coal
INTAKE BENEATH HOSKISSONS COAL SEAM AND / OR WITHIN MELVILLE COAL SEAM							
6249	Stock	N.A.	70.7	68.9	20.7	0.25	Sandstone / coal
17082	Stock	1947	24.4	N.A.	N.A.	N.A.	? / coal
27356	Stock	1966	35.4	27.1 / 31.4-33.5	27.1 / 24.7	0.01 / 0.63	Shale / coal
44580	Stock Domestic	1977	34.0	N.A.	18.0	N.A.	? / coal
44581	Stock Domestic	1977	35	N.A.	18.0	N.A.	? / coal
44884	Stock Domestic	?	73.2	N.A.	N.A.	N.A.	? / coal
44885	Domestic	1976	36.6	N.A.	15.3	N.A.	? / coal
45013	Stock	?	76.2	N.A.	N.A.	N.A.	? / coal
45061	Stock	N.A.	84.1	N.A.	N.A.	N.A.	? / coal
45044	Stock Domestic	1942	34.1	14.6 / 34.1	N.A.	N.A.	? / coal
45045	Stock	1965	62.5	61	N.A.	N.A.	? / coal
45097	Stock Domestic	1934	85.3	54.9 / 85.3	N.A.	N.A.	? / coal
48701	Stock Domestic	1978	61.0	N.A.	45.7	0.51	? / coal
901460	Stock Domestic	1920	34	N.A.	16.0	N.A.	? / coal

Note: N.A. DWE data not supplied Shading indicates bore in current use

The registered bores directly west and southwest of the proposed pit have their water supply intakes located stratigraphically above the Hoskissons Seam in the Upper Permian / Triassic lithologies, those to the west of and down dip of the north-northwest trending subcropping Hoskissons Seam generally obtain supplies from either or both the Hoskissons and Melville Seams, whilst those to the east of the Hoskissons Seam Subcrop generally obtain water from the Upper and or Lower Melville Seam(s).

The available DWE data indicates the 27 bores and piezometers were all installed between 1920 and 1997 with groundwater generally extracted by low flow windmills, and to a lesser degree, submersible pumps.

No registered bores obtain their water supply from Quaternary Alluvium within the study area.

The majority of groundwater in the Rock Well Creek catchment is obtained from basement fractured rocks rather than valley fill alluvium, with supplies obtained from the igneous intrusives, the Goran Conglomerate or the overlying Tuffaceous Stony Coal Facies and Digby Formation.

DWE data indicates standing water levels ranged from 4.9m to 28.7m below surface at the time of measurement.

3.10 Alluvium

Based on coal exploration and DWE data, alluvium within the eastern and northern portion of EL 5183 and eastern portion of CCL701 is associated with Quaternary valley fill along the channels of Coocooboonah Creek and Native Cat Creek, within Native Cat Plain.

Alluvium within the Rock Well Creek valley is present to the west of and at higher topographic and stratigraphic elevation than the proposed pit. The width and depth of alluvium increases down the Rock Well Creek catchment to the north of EL 5183, outside the proposed pit and out-of-pit overburden emplacement areas. Rock Well Creek is a significantly smaller system than Coocooboonah Creek in the Sunnyside vicinity, with shallow localised sediments, possibly up to 10m deep.

The depth and distribution of alluvium in the creeks is not well known at this stage as there has been limited investigation to date, although it is possible the alluvium may be deeper and more variable than current records indicate. Based on available records, Coocooboonah Creek and Native Cat Creek contain a recent soil cover overlying the clay dominated sands and gravels which have been measured up to 50m deep in coal exploration bore DDH 1165.

The generally shallow, clay dominated valley fill alluvium does not provide groundwater supplies due to its very low yield, high salinity, limited depth and extent and seasonally fluctuating water levels.

No monitoring by the DWE or its predecessors of alluvial groundwater levels in Coocooboonah Creek, Native Cat Creek or Rock Well Creek catchments has been conducted to date as the systems are not significant compared to the Namoi River Valley alluvial system within the Liverpool Plains, which can be up to or over 140m deep (Broughton, AK, 1984).

Coocooboonah Creek is a “Losing Stream”, with the creek channel being perched above the alluvial groundwater system. The stream recharges the underlying groundwater system via seepage through the creek bed, rather than the groundwater system recharging the creek.

It is also postulated that the stream is “disconnected” to the underlying groundwater system due to the presence of a continuous low permeability clay based zone. This means that extraction from bores installed in the fractured basement aquifer under or near the creek is not anticipated to affect stream flow in the creek.

Alluvium within Coocooboonah Creek is interpreted to be similar to the regional Quaternary Liverpool Plains stratigraphy, however, it should be noted that the Sunnyside Project Site is located on the edge of, or, in the case of the pit, outside the Quaternary Namoi Valley alluvium.

Groundwater is located in two main formations within the Namoi Valley floodplain, which are regionally called the underlying Gunnedah Formation and the overlying Narrabri Formation.

The sandy / gravely clay alluvium of the Gunnedah Formation is the most significant aquifer in the Namoi River Valley and contains a network of connecting shoestring lenses.

3.10.1 Gunnedah Formation

The Gunnedah Formation within Coocooboonah Creek is predominantly more clay dominated compared to the Formation within the overall Namoi River Valley / Liverpool Plains region.

Within the Sunnyside area, the Gunnedah Formation unconformably overlies fractured Late Permian fractured coal measures and Triassic sandstones & conglomerates.

The Late Tertiary Pliocene alluvial sediments consist of inter-bedded clays with sand and gravel layers, and has the largest groundwater supply potential within the regional Namoi River valley sediments, with most irrigation bores obtaining water from this source.

It underlies the Narrabri Formation and is not present in all zones. Regionally, it is thickest in Zone 8 of Groundwater Management Area 4 (Broughton, A.K., 1984), to the south of Gunnedah, with basement between 60m and 140m below surface, yields up to 200 L/sec and generally low salinity (<1000 mg/L).

Although not directly observed with drilling to date, it is anticipated that subsurface springs may be seeping from the underlying fractured basement aquifers and may be discharging into the deeper alluvium underneath Coocooboonah Creek, however no evidence of springs discharging into the creek itself have been recorded.

3.10.2 Narrabri Formation

The Narrabri Formation conformably overlies the Gunnedah Formation and may be Pleistocene in age, consisting predominantly of brown clays becoming darker near the surface as well as containing lesser sand and gravel.

The channel deposits are not laterally continuous and are similar to sediments deposited by the Namoi River today i.e. shoe string lenses on a wide alluvial flood plain.

It can range up to 40m thick in the regional Namoi River valley and includes the shallowest aquifers over the alluvial area, with a variable salinity from 200 mg/L to 4000 mg/L and yields between 0.5L/sec to 40 L/sec.

3.11 Digby Formation, Tuffaceous Stony Coal Facies and Goran Conglomerate, Upper Delta Plain Facies and Wondobah Seam

The Upper Delta Plain Facies, which contain the Wondobah Seam, stratigraphically overly the Hoskissons Seam and may provide a minor, ephemeral, semi confined, low yielding perched aquifer where they are sufficiently deep within the overburden stratigraphy.

No aquifers are recorded within the overburden of EL 5183, however, water supplies are obtained in deeper, down dip intersections in overburden to the west of the Sunnyside Project Site. Water supplies are generally obtained from higher permeability conglomerates and sandstone, and in one bore, the igneous intrusives within the overburden (GW15665).

Available data indicates that the Hoskissons Seam overburden contains low yielding (<0.51L/sec) aquifers with standing water levels between 6.4m and 28.7m below surface.

3.12 Hoskissons Seam

DWE data indicates the Hoskissons Seam has limited aquifer intersections with minor yields (0.38L/sec in GW45098), with the seam subcropping in the east of the Project Site, to the west and upslope of Coocooboonah Creek.

The Hoskissons Seam is anticipated to range from unconfined to semi-confined, however no specific DWE data is available for standing water levels within the Hoskissons Seam as it has not been a targeted aquifer to date due to its shallow depth in the vicinity of the proposed pit.

Where the Hoskissons Seam is intruded by dykes and sills to the south and west of the proposed pit, the seam would have significantly lower hydraulic conductivity due to the highly weathered nature of the intrusions as well as the highly metamorphosed nature of the seam.

3.13 Shallow Marine Facies, Upper / Lower Melville Seam and Lower Delta Plain Facies

The Shallow Marine Facies and Lower Delta Plain Facies, which includes the Upper and Lower Melville Seam, subcrops to the west of, and underneath Coocooboonah Creek.

The Shallow Marine Facies is anticipated to range from unconfined to semi-confined to the east of the proposed pit and under Coocooboonah Creek, and semi-confined to confined underneath the pit, with minor yields (0.38L/sec - GW45098) and shallow groundwater levels.

GW45098, to the immediate north of the proposed pit, obtains its water supply from both the Hoskissons and Melville Seams.

The Upper and Lower Melville Seam is anticipated to range from unconfined to semi-confined to the east of the proposed pit and under Coocooboonah Creek as well as Native Cat Creek, and to be semi-confined to confined underneath the pit, with minor yields (0.1L/sec to 0.63L/sec – GW27356 and GW44885) and shallow groundwater levels.

3.14 Groundwater Chemistry

Based on DWE data collected in 1976 and 1992, groundwater in the Sunnyside area has low to moderate salinity within the basement fractured rock aquifers, with EC between 510µS/cm and 10080µS/cm and pH between 3.81 and 8.7 as shown in **Table 2**.

No discernible pattern relating to the source aquifer and groundwater pH or salinity is evident from the limited data.

Table 2
Department of Water and Energy Groundwater Chemistry

Piezometer (GW)	Sample Date	Source Aquifer	pH	EC (µS/cm)
3706	23/6/76	Sandstone	**7.6**	**6800**
6249	2/6/76	Sandstone	**8**	**3700**
8810	23/6/76	N.A.	**7.7**	**7100**
16789	1961, 1976, 1992	Conglomerate / N.A.	**6.4** / 7.6 / **3.81**	**10080 / 510 / 1116**
22497	22/6/76	Melville Coal Seam	6.7	**4100**
27356	2/6/76	Shallow Marine Facies / Melville Coal Seam	6.7	**3900**
44884	2/6/76	N.A.	**8.7**	**2680**
44885	2/6/76	Gunnedah Formation Fm?	7.1	**4400**
45013	1976 / 1992	N.A.	**7.9** / 6.9	**6000 / 1470**
45044	2/7/76	Gunnedah Formation? / Melville Coal Seam?	7.4	**6100**
45045	2/7/76	Melville Coal Seam? / Lower Delta Plain Facies?	**8.7**	**1640**
45061	22/6/76	N.A.	**7.9**	**4200**
ANZECC 2000			6.5 – 7.5	30 – 350

NOTE - default trigger values for SE Australian Upland Rivers
- shading denotes water quality parameter outside ANZECC 2000 guidelines

4 Hydrogeological Investigation Program

4.1 Regional Bore Census

A search of the DWE data base within 10km of the proposed pit was completed prior to conducting a field survey and census of regional bores within a 3km radius of the proposed Sunnyside open cut between 20 October and the 7th of November, 2006 as summarised in **Appendix 2**.

The 3km survey radial distance used is based on the anticipated regional extent of groundwater drawdown resulting from operation of the proposed Sunnyside open cut.

Five (5) of the 27 bores and the two (2) piezometers are no longer used. Of the remainder, fourteen (14) are low, variable yielding windmills and six (6) obtain water by submersible pumps.

Water quality ranges from 6.61 to 9.37pH and 1,704µs/cm to 8440 µs/cm EC.

All water is extracted from the fractured basement aquifers, with no inspected bores obtaining groundwater from the alluvium of Coocooboonah Creek or Rock Well Creek.

4.2 Groundwater Investigations

Drilling, piezometer installation, low flow pump out tests, falling head tests as well as groundwater level and water chemistry monitoring was conducted between 16 October 2006 and January, 2008 to provide input data to development of a “FEFLOW” model and assessment of the hydrogeological characteristics of the:

- Coocooboonah Creek Alluvium;
- Hoskissons Seam overburden;
- semi confined to confined Hoskissons Seam;
- unconfined Hoskissons Seam, and the underlying; and
- Shallow Marine Facies and Lower Delta Plain Facies (including the Upper and Lower Melville Seam).

The investigation program installed eight bores between 30m and 90m deep used to install eight piezometers between 23m and 90m deep.

Seventeen open coal exploration bores with either 4” or 6” casing were also accessed to obtain standing water level and water quality data within the “Sunnyside” property.

Applications for test monitoring licenses were submitted to the DWE, with the licence details shown in **Table 3**.

Table 3
Piezometer Licence Details

BORE	PROPERTY	LICENCE No.
P1	"Plain View"	90BL253767
P2	"Ferndale"	90BL253768
P3 – P8	"Sunnyside"	90BL253769

Short duration (< 4 hours), low flow pump out tests were conducted on P5 and the Sunnyside House Bore (GW 45098), with extraction from the Hoskissons Seam, Shallow Marine Facies and Melville Seam at flows between 0.04L/sec (P5) and 0.33L/sec (GW45098).

Pumped water flowed to either existing surface water dams or to pasture at a suitable distance from both the pumping well and streams in order to manage discharge of saline groundwater into the test area and the local surface water system.

4.3 Hydraulic Properties

Assessment of formation hydraulic properties within two bores was completed by low flow, short duration pump out tests and by six (6) falling head tests in piezometers within the study area and measuring the water level response as shown in **Table 4** and **Appendix 3**.

Table 4
Hydraulic Parameters

Bore	Property	Bore Depth (m)	Piezo Diam (mm)	Intake / Screen (m)	Hydraulic Conductivity (m/day)	Transmissivity (m^2/day)	Specific Yield / Storativity
Gunnedah Alluvial Formation							
P1	"Ferndale"	41	50 mm	18.0 - 29.5	5.3	N.A.	N.A.
P2	"Plain View"	31	50 mm	18.5 - 30.5	3.8	N.A.	N.A.
Hoskissons Coal Seam							
P3	"Sunnyside"	41	50 mm	32.0 - 40.0	4.0	N.A.	N.A.
P4	"Sunnyside"	81	50 mm	71.0 - 79.0	1.3	N.A.	N.A.
P5	"Sunnyside"	54	50 mm	46.0 - 54.0	0.4	3.0 / 3.1	N.A.
P5 (recovery)	"Sunnyside"	54	50mm	46.0 - 54.0	0.3	2.1	N.A
Hoskissons & Melville Coal Seams							
GW45098	"Sunnyside"		152mm	26.5? – 40.8?	0.1 / 0.4 / 1.8	1.6 / 5.2 / (26.1)	N.A.
Shallow Marine Facies & Lower Delta Plain Facies							
P6	"Sunnyside"	30	50 mm	20.0 - 23.0	0.7	N.A.	N.A.
P7	"Sunnyside"	48	50 mm	45 - 48	2.1	N.A.	N.A.

Note: P5 and GW45098 assessed with short duration pump out tests (<4 hrs)
P1,2,3,4,6 and 7 tested with falling head / Hvorslev method

4.4 Standing Water levels

Standing water levels in the available open private bores and drilled piezometers were measured as shown in **Appendix 2**, with the combined piezometric surface illustrated in **Drawing 10**.

Long term monitoring of the NMPL piezometers P1 to P8 and available DWE registered bores within the "Sunnyside" property are shown in **Figure 1**.

The data between October 2006 and January, 2008 indicates that standing water levels in the coal measures have generally fallen by between 0.26m and 1.33m over the period of monitoring. An anomalous rise of 5.92m occurred in P8, with the apparent rise due to comparison to an incorrect initial reading.

Within the Quaternary alluvium of Coocooboonah Creek, P1 rose by 0.46 and P2 fell by 0.91m over the monitoring period.

Rainfall during the monitoring period was originally in a drought, with no rainfall percolation recharge evident in the coal measures (P3 to P8), along with an indistinct response to rainfall in the Coocooboonah Creek alluvium (P1 and P2). Latter monitoring has not shown a distinctive rise in standing water levels in association with the higher rainfall for both the basement and alluvial groundwater systems. The alluvial system has both risen by approximately 0.4m (P1) and fallen by 0.85m (P2), whilst the basement piezometers indicate a fall in standing water level of between 0.3m and 1.95m, except for a rise of 0.3m in P8 since October 2006.

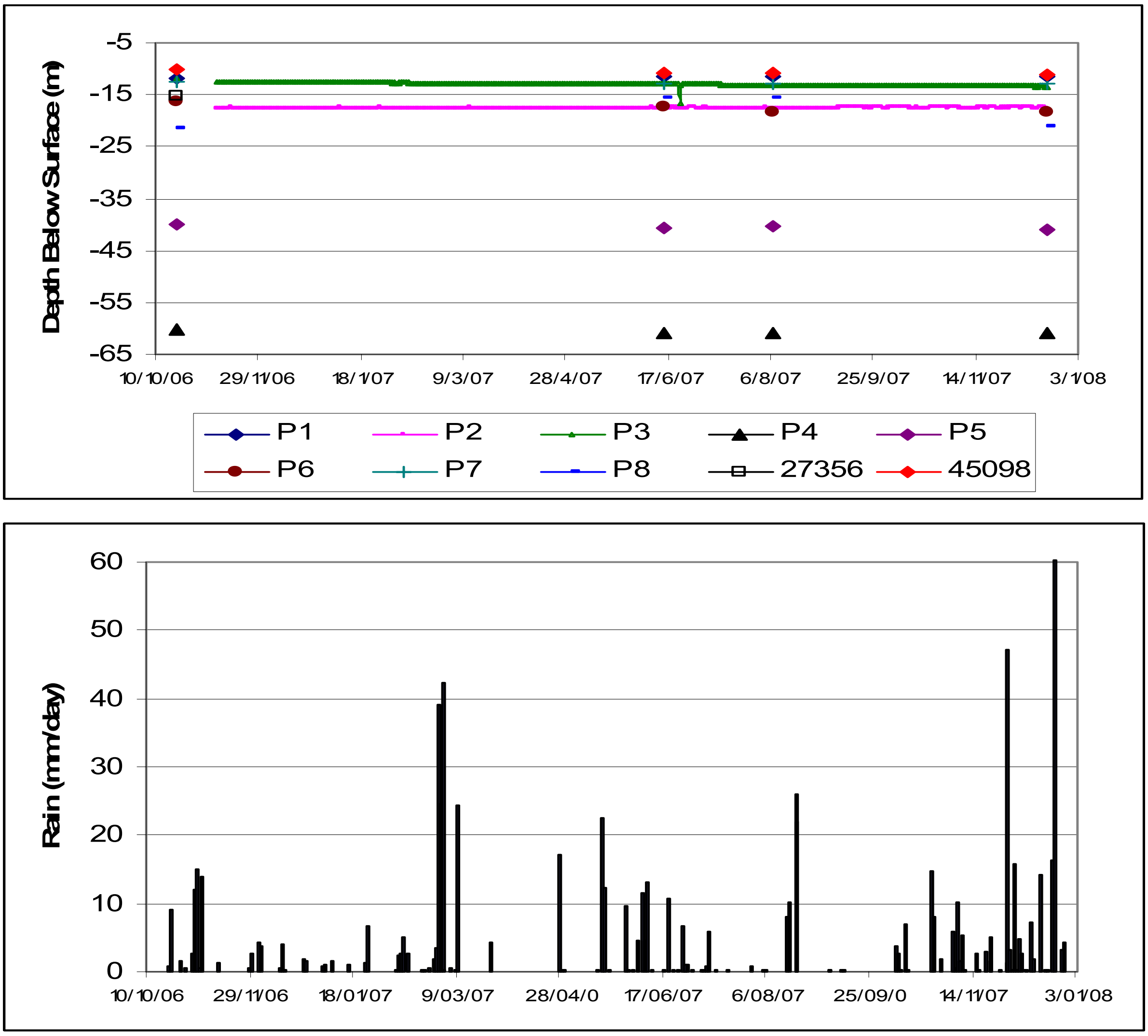

Figure 1
Sunnyside Groundwater Levels

4.5 Gunnedah No.5 Entry Underground Workings

The standing water level and degree of dry void space was investigated by drilling four bores into the workings during August / September 2007 (Beckett, J, 2007), along with field analysis of pH and EC of water samples collected from the drillholes.

It was assessed from drilling six bores that the workings were mostly dry as shown in **Figure 2**, and that there is currently approximately 1523ML of open void space in the workings downgradient of the proposed open cut.

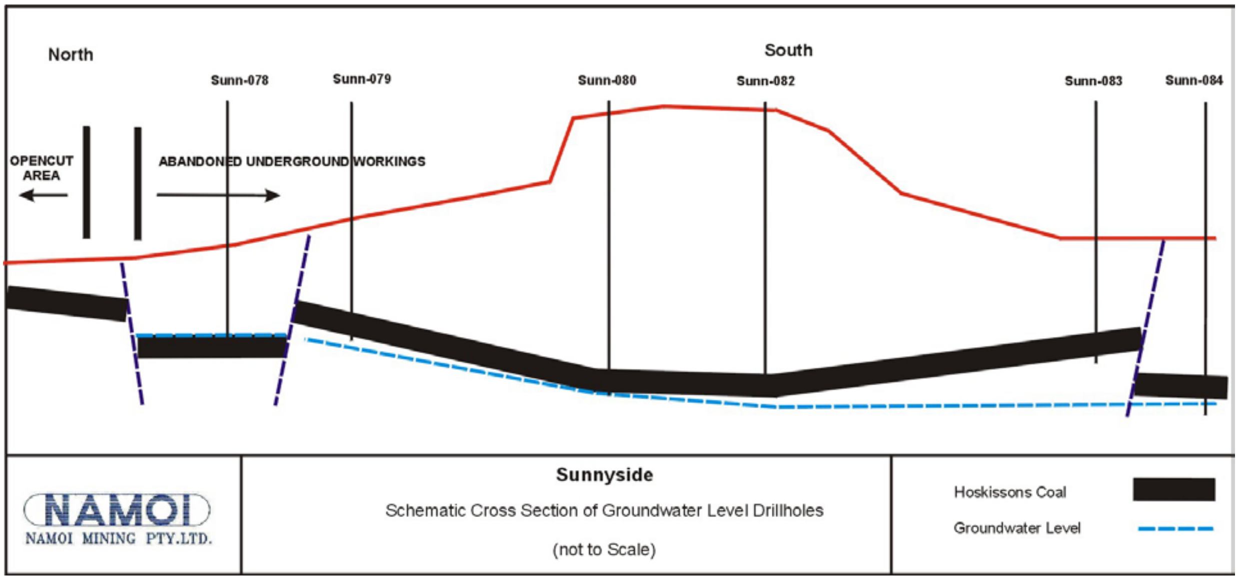

Figure 2
Sunnyside Groundwater Levels

The investigation indicated that in Borehole Sunn078, which was drilled approximately 40m south of the SE portion of the proposed pit, the seam and associated workings are flooded within a down-thrown graben fault block, with the standing water level located at 302.77m AHD, which is approximately 7m above the basal 295m AHD RL of the proposed pit.

The standing water level, below the base of Hoskissons Seam in SUNN079, at approximately 220m south of the proposed pit, is at the same approximate relative level to or just below the base of the proposed pit at 295.8m AHD, whilst the standing water level in bores Sunn80, 82, 83 and 84 are all lower than the basal pit RL.

4.6 Water Chemistry

Field stream electrical conductivity and pH were measured at selected locations as shown in **Table 5** and **Drawing 9,** whilst piezometer and coal bore water quality in and around the Project Site was assessed in the field as shown in **Table 6**.

Table 5
Field Stream Water Chemistry

Site	Date	Electrical Conductivity (µS/cm)	pH
Coocooboonah Creek (Plain View) Dam*	22/10/06	960	6.13
Coocooboonah Creek (after rain)	03/11/06	272	7.64
"Sunnyside" Dam 1	24/01/08	324	8.71
"Sunnyside" Dam 2	24/01/08	330	9.07
"Sunnyside" Dam 3	24/01/08	234	9.06
"Sunnyside" Dam 4	24/01/08	236	9.17

Note * Coocooboonah Creek dam sampled after an extended drought period

Table 6
Field Groundwater Chemistry

Bore	Date	Electrical Conductivity (µS/cm)	pH
Gunnedah	**Alluvial**	**Formation**	
P1	3/11/06	12580	7.72
P2	3/11/06	18680	9.05
Digby Formation	**Goran Conglomerate**	**and Upper Delta Plain Facies**	
GW3715	3/11/06	/	/
Hoskissons Coal	**Seam**		
P3	3/11/06	7480	7.30
P4	3/11/06	6450	7.40
P5	3/11/06	4560	7.10
Sun 43C	21/10/06	4660	6.65
Sun 44C	21/10/06	2260	6.93
Sun 45C	21/10/06	3780	7.01
Sun 46C	21/10/06	3240	7.12
Sun 47C	21/10/06	4380	6.84
Sun 48C	21/10/06	12290	6.62
Sun 52	21/10/06	8500	6.84
Sun 61	21/10/06	4560	7.19
DDH185	21/10/06	12650	6.91
Shallow	**Marine Facies**	**and Melville Coal Seam**	
GW27356	3/11/06	6170	6.61
GW45045	3/11/06	5310	8.23
GW45098	3/11/06	8440	6.80
P6	3/11/06	5490	7.09
P7	3/11/06	7330	6.99
Sun 38	3/11/06	11430	6.84
Sun 39	21/10/06	2500	7.87
Shallow Marine Facies	**Melville Coal Seam**	**and Lower Delta Plain Facies**	
Sun 57	21/10/06	5380	7.17
Sun 58	21/10/06	3860	7.11
Sun 59	21/10/06	7100	7.02
Sun 60	21/10/06	8350	6.85
P8	20/10/06	8350	6.85

4.7 Abandoned Underground Workings Water Quality

Field samples collected from bores drilled into or adjacent to the underground workings indicate that the water within or near the underground void has a pH range of 6.90 to 7.03, which suggests that the remnant workings have very low to no acid rock generation, and that the salinity ranges from 3 590uS/cm to 7 360uS/cm.

It was also observed that the pH becomes more acid down dip into the deeper workings, whilst the salinity increases down dip, away from the proposed open pit.

5 Laboratory Investigations

5.1 Bore Water Chemistry

Laboratory analyses of analysed major ion results from bore water samples are shown in **Tables 7** and **8**, with the laboratory results contained in **Appendix 4** and water categories shown in **Table 9**.

Table 7
Laboratory Water Chemistry (major ions mg/L)

Bore	pH	EC µS/cm	TDS	Na	Ca	K	Mg	Cl	F	HCO_3	SO_4	Tot N	Tot P
Quaternary	**Alluvium**												
P1	**7.6**	**12580**	11900	3350	9.5	6	62	580	0.37	4870	380	**15**	**1580**
P2	**8.7**	**18680**	17000	5210	39	12	225	420	1.0	6720	335	<0.1	**3920**
Hoskissons	**Coal Seam**												
P3	7.2	**7480**	3350	710	155	34	260	1420	0.59	1303	220	**0.9**	**0.15**
P4	**7.9**	**5030**	2450	700	76	55	93	610	.64	1330	200	**1.7**	**9.5**
P5	7.2	**4870**	2150	540	90	46	115	660	0.95	1160	56	**11.0**	0.01
45098	7.0	**8440**	3850	830	160	42	300	1700	0.86	1120	220	<0.1	0.02
No.5 Ug	**8.1**	**5420**	3180	908	102	9.4	102	1150	1.47	1060	<2	**1.3**	**0.07**
Shallow Marine	**Facies**	**Lower**	**Delta**	**Plain**	**Facies**	**and**	**Melville**	**Coal**	**Seam**				
P6	7.5	**5490**	2690	690	92	32	180	1120	0.6	1070	93	**4.9**	**0.08**
P7	7.2	**3860**	3360	790	130	19	245	1480	0.37	1010	200	**4.5**	0.02
P8	7.1	**7100**	4590	800	255	21	365	1600	0.3	720	1080	**0.5**	**0.08**
27356	6.8	**6170**	2800	485	155	18	255	1110	0.59	900	240	**1.1**	0.02
45097	**7.8**	**2630**	1440	555	9.4	3.4	7.1	490	3.2	760	<2	**0.5**	0.01
Coocooboonah	**Creek**												
	7.3	272	135	3.8	12	32	12	20	<0.1	120	4	**1.3**	**2.1**
ANZECC*	**6.5-7.5**	**30 – 350**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.25**	**0.02**

ANZECC default trigger values for risk of adverse effects from physical and chemical stressors in SE Aust. Upland Rivers
(Shading indicates values outside ANZECC 2000 criteria)

Table 8
Laboratory Water Chemistry (Filt. metals mg/L)

Bore	Cu	Pb	Zn	Ni	Fe	Mn	As_{Tot}	Se_{Tot}
Quaternary	**Alluvium**							
P1	**0.018**	0.002	**0.012**	**0.03**	0.44	0.14	0.02	<0.01
P2	**0.065**	**0.054**	**1.3**	**0.15**	19	**2.5**	**0.14**	<0.01
Hoskissons	**Coal Seam**							
P3	**0.004**	0.003	0.006	<0.01	0.02	0.02	<0.01	<0.01
P4	**0.002**	<0.001	**0.009**	**0.03**	<0.01	0.04	0.02	<0.01
P5	**0.005**	0.003	**0.009**	<0.01	0.01	0.06	<0.01	<0.01
45098	**0.003**	<0.001	**0.009**	<0.01	<0.01	0.06	<0.01	<0.01
No.5 Ug	0.0008	<0.00005	**0.013**	0.001	0.03	0.001	<0.001	<0.001
Shallow	**Marine**	**Facies**	**Lower**	**Delta**	**Plain**	**Facies**	**and Melville Coal**	**Seam**
P6	**0.002**	<0.001	**0.011**	<0.01	<0.01	<0.01	<0.01	<0.01
P7	**0.002**	<0.001	**0.014**	<0.01	<0.01	0.03	<0.01	<0.01
P8	**0.004**	<0.001	**0.046**	<0.01	<0.01	**2.1**	0.01	<0.01
27356	**0.003**	<0.001	0.005	<0.01	0.03	0.09	<0.01	<0.01
45097	**0.006**	<0.001	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01
Coocooboonah	**Creek**							
	0.005	0.002	**0.025**	<0.01	2.6	0.12	<0.01	<0.01
ANZECC	**0.0014**	**0.0034**	**0.008**	**0.011**	**-**	**1.9**	**0.024(III) / 0.013(V)**	**0.011**

ANZECC 95% trigger values for toxicants **(Shading indicates values outside ANZECC 2000 criteria)**

5.2 Waste Rock Batch Leachate

Assessment of the potential waste rock leachate pH and salinity was obtained through coarse crushing of overburden core samples representing waste rock to be placed in the backfilled pit. One kilogram of the crushed samples were batch leached in distilled water, with the pH and EC measured by calibrated Hanna Instruments Pty Ltd pH (HI 9025) and electrolytical conductivity (HI 9033) meters to obtain sequential measurements of the leachate as shown in **Table 9** and **Appendix 4**.

Table 9
Waste Rock Batch Leach Results

Bore	Depth (m)	Unit	Lithology	pH	EC^2 µS/cm	Weathering
45C	14.13 – 14.60	Wallala Conglomerate	Pebble Conglomerate	8.31	832	Slightly Weathered
	17.13 – 17.53	Wallala Conglomerate	Claystone	8.28	814	Weathered
	22.84 – 23.30	Benelabri Formation	Siltstone	8.18	936	Fresh
	36.85 – 37.25	Benelabri Formation	Sandstone	8.17	685	Fresh
	49.5 – 50.00	Hoskissons Seam Ply C	Carb claystone / tuff	8.29	1199	Fresh
46C	22.72 - 23.12	Wallala Conglomerate	Conglomerate	8.13	795	Slightly Weathered
	31.62 – 32.00	Benelabri Formation	Sandstone	8.05	947	Slightly Weathered
	32.90 – 33.35	Benelabri Formation	Siltstone / sandstone	8.19	724	Slightly Weathered
	35.63 – 36.00	Benelabri Formation	Siltstone	6.97	2590	Slightly Weathered
	36.22 – 36.32	Benelabri Formation	Coal	7.66	1677	Slightly Weathered
	58.86 – 59.28	Hoskissons Seam Ply C	Carb. claystone / tuff	8.43	1330	Fresh

NOTE: EC^2 indicates months of leaching

The leaching procedure follows a modified approach with reference to the "Australian Standard Leaching Procedure (Standards Australia (1997) AS4439.3-1997 and the ARD Test Handbook (Amira International 2002). Leach results from the batch testing were incorporated into an assessment of the potential final void salinity following an adapted method developed by (Hancock G.R, et al, 2005).

5.3 Acid Rock Drainage

Preliminary assessment of the acid rock drainage (ARD) potential was conducted by undertaking a Net Acid Production Potential (NAPP) analysis on selected samples of core shown in **Table 10** that are taken to represent waste rock to be extracted from the Sunnyside Open Cut. Laboratory analyses for the testwork are shown in **Appendix 4**.

Table 10
Net Acid Production Potential Results

	%	%	%	kgH_2SO_4/t	% $CaCO_3$	kg H_2SO_4/t	
Sample	**SO4**	**Tot S**	**S-**	**MPA**	**ANC**	**NAPP**	**ANC/MPA**
45C 14.13-14.6	0.001	0.004	0.004	0.112	1.2	-1.09	10.69
45C 22.84-23.3	0.011	0.039	0.035	1.082	0.54	0.54	0.50
45C 36.85-37.25	0.008	0.012	0.009	0.286	4	-3.71	13.97
45C Ply C	0.01	0.12	0.117	3.571	3.2	0.37	0.90
46C 35.63-36	0.031	0.015	0.005	0.146	0.64	-0.49	4.38
46C 36.22-36.4	0.021	0.62	0.613	18.760	2.8	15.96	0.15
46C 58.86-59.2	0.014	0.075	0.070	2.154	2.2	-0.05	1.02

6 Data Interpretation

6.1 Hydrogeology

6.1.1 Coocooboonah Creek and Native Cat Creek Alluvium

Based on regional exploration and DWE bore data, up to 50m of alluvium is located within the Coocooboonah Creek and Native Cat Creek valleys.

The limited spread of bores does not enable detailed assessment of the deepest alluvium in the Coocooboonah / Native Cat Creek channels, although it would be expected to lie along the current creek bed.

The sediments would have evolved through overland flow from erosion of the Liverpool Ranges to the south of the Project Site.

The alluvial sediments in the underlying clay dominated, silty / gravely / clay layers, is taken to be analogous to the regional Gunnedah Formation, although with significantly lower hydraulic conductivities. Current drilling indicates the formation can be up to 37m thick (P1, P2, DDH 1165).

The silty clay of the overlying clay dominated formation, which is taken to be analogous to the regional Narrabri Formation, was intersected at up to 13m thick (P1, P2, DDH 1165).

The alluvial sediments to the east of the proposed pit are significantly thinner, with proportionally more clay and of significantly less areal extent compared to the regional Namoi River valley within the Liverpool Plains.

Coocooboonah Creek and Native Cat Creek alluvium has limited extent as it is constrained by the headwaters and foot-slopes of the northeast trending hills, as well as by the outcropping / subcropping fractured basement.

No groundwater was intersected in the Narrabri Formation, with the first intersection from P1 at 18m and in P2 at 13m below surface within the Gunnedah Formation.

Piezometers P1 and P2 were drilled with air up to the first moist returns, then with open hole mud support to the basement.

No notable airlift or return flows were observed during drilling P1 or P2 and no yield information is available for the Quaternary alluvium from DWE private bore or coal exploration records, with very low yields (<0.2L/sec) obtained during airlift purging of P1 and P2.

Standing water levels in P1 and P2 within Coocooboonah Creek range from 11.46m to 17.62m below surface.

The alluvium of Coocooboonah Creek and Native Cat Creek does not provide a suitable groundwater supply due to the low yield, high salinity and the sediment's limited depth and extent.

No observed groundwater dependent ecosystems are present within the alluvial valleys.

6.1.2 Rock Well Creek Alluvium

Rock Well Creek is located to the west of, and both topographically and stratigraphically higher than the Project Site within an upland confined gully with shallow sediments up to 10m deep.

The valley opens out and the sediments deepen to the north of EL 5183, however limited available coal exploration and DWE drilling records do not indicate the depth of alluvium.

Rock Well Creek flows into Native Cat Creek approximately 1km north of the EL 5183 northern boundary.

It is possible that springs exist in the upland creek, however none have been identified to date.

The available data indicates that Rock Well Creek alluvium is not a significant source of groundwater supply to existing domestic or potential users, with all private bores in the Sunnyside vicinity obtaining groundwater from the underlying fractured bedrock.

No observed groundwater dependent ecosystems are present within the alluvial valleys.

6.1.3 Hoskissons Seam Overburden

Overburden in the vicinity of the proposed mine is characterised by 2^o-3^o south westerly dipping, generally semi-confined to unconfined, low yielding, weathered conglomerate, sandstone, shale, coal and tuffaceous stony coal, with intrusives distributed within and above the sequence.

Overburden to the west and south of the pit is also affected by significant EW and ENE trending faulting with throws of up to at least 11m.

The Hoskissons Seam ranges from shallow subcrop under the alluvium of Coocooboonah Creek to approximately 86m below surface to the top of the seam in DDH185, west of and outside the pit boundary. The seam continues down dip to the west and south of the pit, however the planned pit depth of 65m is limited by unsuitable overburden ratios, faulting and igneous intrusions to the south, west, north and east

Groundwater in overburden within the pit boundary is limited to a very low yielding, thin (< 2m) perched aquifer in the Wondobah Seam, which was not tested for its hydraulic parameters due to the lack of water return to surface encountered during drilling.

As a result of investigations and monitoring conducted to date, the overburden above the Hoskissons Seam in the vicinity of the proposed pit is essentially dry.

The conglomeratic units associated with the Digby Formation and Goran Conglomerate did not contain observable groundwater in drilling returns within the pit boundary.

Overburden above the Hoskissons Seam, down dip and to the west of the proposed pit provides limited groundwater supplies in private bores of up to 0.51L/sec in bores up to 53.3m deep and standing water levels between 6.4m and 28.7m below surface.

6.1.4 Hoskissons Seam

The Hoskissons Seam consists of up to 5 plies in inter-layered shale, claystone and fine sandstone that ranges from 6m to 9m thick in the mine vicinity, depending on the development of the seam, presence and effect of intrusions as well as the degree of weathering and erosion.

The seam in the vicinity of the pit is interpreted to be semi-confined to confined to the south and west and semi-confined to unconfined in the east and north in the Coocooboonah Creek valley.

The Hoskissons Seam subcrops up to 150m north of the proposed pit on the colluvial / alluvial periphery of the Coocooboonah Creek alluvial system. It does not extend beneath Coocooboonah Creek, the southern channel of which lies approximately 1km north of the proposed open pit as shown in **Drawing 4.**

During drilling, the first indication of connate water returned to surface was in the lower plies, generally beneath the mudstone / claystone dominated Ply C.

The piezometric surface in the vicinity of the proposed pit, based on the piezometers alone, mimics the ground surface fall to the north and east.

The aquifer system above and within the Hoskissons Seam is potentially hydraulically separated from the (Upper and Lower) Melville Seams by the Shallow Marine and Lower Delta Plain Facies, although no pump out tests have been conducted to test this assumption.

Measured standing water levels in the Hoskissons Seam range from 12.5m to 60.5m below surface in the vicinity of the pit.

DWE, drilling airlift and pump out test data indicates the Hoskissons Seam has a limited yield of less than approximately 0.38L/sec.

It should be noted that all private bores terminated well above the Hoskissons Seam to the west of the pit, and that the Hoskissons Seam does not provide a groundwater supply except in the north-west where the Hoskissons Seam shallows up dip in bore GW44677.

6.1.5 Shallow Marine Facies and Lower Delta Plain Facies

The Shallow Marine Facies contains siltstone and sandstone laminates up to 15m thick.

The Lower Delta Plain Facies comprises siltstone, carbonaceous claystones, inter-bedded siltstone / sandstone and coal seams, with quartz lithic sandstone being common. It contains the Upper and Lower Melville Seam, which ranges from 35m to 50m beneath the Hoskissons Seam.

The SMF / LDPF both underlie the Hoskissons Seam and are interpreted to be semi-confined to unconfined in the east within the Coocooboonah Creek valley, becoming confined down dip to the south and west.

Based on standing water level observations, the SMF / LDPF may be hydraulically separated from the overlying Hoskissons Seam.

The SMF / LDPF have standing water levels from 10.3m to 21.6m below surface.

Available DWE and drilling data indicates the SMF / LDPF can provide low yields in private bores of up to 0.63L/sec.

6.2 Groundwater Flow

Five separate groundwater systems are interpreted to be present at Sunnyside, namely:

- System 1 Hoskissons Seam Overburden, including the Wondobah Seam perched aquifer, where present; overlying the,
- System 2 Hoskissons Seam; overlying the,
- System 3 Shallow Marine Facies; overlying the,
- System 4 Upper and Lower Melville Seam / Lower Delta Plain Facies; and the
- System 5 Quaternary Coocooboonah / Rock Well / Native Cat Creek alluvium.

A contour plan of standing water levels from a combination of all bores indicates that the piezometric surface in the overburden, Hoskissons Seam and SMF / LDPF / Melville Seams is from south-west in the hills to the Quaternary alluvium of Coocooboonah Creek in the north-east and then to the north-northwest along the valley floor of Coocooboonah Creek.

Due to its confined nature and 2-3^{o} dip to the south and west of the pit, groundwater flow within the Hoskissons Seam is down dip along the seam to the southwest, into the hills, with a modification due to topographical effects to the east giving an overall south-easterly flow direction within the pit area.

Groundwater levels obtained from piezometers and open coal exploration bores indicates groundwater flow in the combined, underlying Shallow Marine Formation, Melville Seam(s) and Lower Delta Plain Facies is to the northwest, which is in the opposite direction to the Hoskissons Seam and conforms to the influence of topography.

It should be noted, however, that the SMF / LDPF/ Melville Seam flow pattern is generated from mostly open hole, unsealed bores, with various intake formations and 3 sealed intake piezometers (P6, 7 and 8), whereas the assessment in the Hoskissons Seam is from bores and piezometers slotted or completed only in the Hoskissons Seam.

Localised groundwater flow may also be affected by strata discontinuity due to faulting, and possibly flow along faults, however there is insufficient drilling information available to assess the discrete flow patterns with current data.

The water table gradient in the Hoskissons Seam is 16m over 650m (0.025) to the southeast and 30m over 3km (0.01) to the northwest in the underlying SMF / LDPF system.

The flow pattern represents a combination of:

- recharge within the hills to the southwest of the proposed open cut, with gravity driven flow from the hills to the valleys
- flow down dip in confined lithologies to the southwest, with modification for topographical effects, and
- unconfined flow to the north-east then north northwest along the Coocooboonah Creek Rock Well Creek valleys.

Flow within the area would also be modified by the effect of:

- strata dislocation from faulting,
- possible flow along higher permeability(?) faults, as well as;
- the reduction in Hoskissons Seam and overburden permeability due to the presence of weathered doleritic sills and dykes

6.3 Aquifer Interconnection

6.3.1 Hoskissons and Melville Seams

Site investigations and anecdotal information from regional studies indicate that the Hoskissons Seam and the underlying (Upper and Lower) Melville Seam are hydraulically separated from each other.

This may be altered, however, if faults, strata displacement and/or dykes provide localised, planar modifications to the strata dominated flow patterns.

6.3.2 Fractured Basement Aquifers and Quaternary Alluvium

No upward groundwater seepage has been observed in the Sunnyside area from the underlying basement fractured rock aquifers to the alluvium within the palaeo-valleys of Coocooboonah / Native Cat / Rock Well Creeks, although it may be occurring at depth based on regional experience within the Liverpool Plains (Broughton AK, 1984).

Although no direct pump-out test was conducted to assess potential leakage to or from the Quaternary alluvium, there is interpreted to be an upward leakage from the underlying strata to the Coocooboonah Creek alluvium.

It should be noted that the Hoskissons Seam subcrops approximately 1km outside of, and to the south of Coocooboonah Creek in the vicinity of the proposed open cut, on the colluvial / alluvial intermixed fringe of the Coocooboonah Creek alluvial system.

6.4 Hoskissons Seam Test Pumping and Recovery Levels

6.4.1 Piezometer 5

Drawdown in P5 progressed from 40.23m to around 41.64m below surface with a pumping rate of 0.037L/sec to 0.043L/sec, which then flattened out due to the limit of the pump's capacity after 7 minutes.

The standing water level recovered to approximately 0.79m below the original groundwater level, indicating that some dewatering of the Hoskissons Seam occurred.

6.4.2 GW45098

Drawdown in the Sunnyside House bore (GW45098) gradually progressed from 10.64m to around 16.01m below surface after 4 hours with a pump rate of 0.33L/sec.

Recovery measurement in the test was affected by water surging back into the bore when the pump was stopped, and as a result it was not possible to accurately assess the aquifer's recovery hydraulic parameters or dewatering effects.

6.4.3 Pump Out Test Period Rainfall Recharge

No rain fell during the pump out test and recovery period.

6.5 Transmissivity, Hydraulic Conductivity and Storativity

Data derived from different test methods indicate a wide range of hydraulic conductivities attributed to lithological variation at a regional scale, and/or to inherent inaccuracies in test measurement or methodology.

In areas where bedding dip and flexure increase markedly or faults are present, the fracture / joint frequency and hydraulic connectivity through the overburden can often be higher than for undisturbed measures.

6.5.1 Bedrock

Short duration, low flow pump out as well as “falling head” tests were used to assess the hydraulic conductivity and transmissivity of the Hoskissons Seam and SMF / Melville Seam / LPDF.

It should be noted that as the basement overburden above the Hoskissons Seam was dry during and after drilling at the Project Site, pump out tests or falling / rising head tests were not able to be conducted to derive site specific hydraulic conductivity and storativity for the overburden.

In addition, due to the limitations of the tests, storativity of the fractured rock and specific yield of the Quaternary alluvium was not assessed. The test results indicate the overburden was dry above the proposed open cut, except for a minor perched aquifer to the south of the pit within the Wondobah Seam where it has developed down dip of the proposed pit outline in P4, however the Seam was too thin, with very low water content to be tested and was not specifically targeted with a piezometer.

Within the pit area, due to the strata dip, the hill-slope and overburden erosion, the Wondobah Seam does not exist as a perched aquifer.

The hydraulic conductivity derived from test results ranged from 0.1 – 4.0 m/day from “falling head” and pump out tests, with transmissivities ranging from 1.6m^2/day to 5.2m^2/day for the Hoskissons Seam.

Recovery data from P5 indicates the Hoskissons Seam in the test had a transmissivity of 2.05m^2/day and an average hydraulic conductivity of 0.3m/day.

It should be noted that the transmissivity and hydraulic conductivity values derived for the Sunnyside House bore (GW45098) result from pumping an open bore drilled through both the Hoskissons and Melville Seams. No casing, screen or intake level data is available from DWE records for this bore, and therefore the intake section is assumed to be between the top of the Hoskissons Seam and the base of the Lower Melville Seam.

Based on falling head test data, the SMF / Melville Seams / LPDF has a hydraulic conductivity of 0.7 to 2.1m/day.

6.5.2 Alluvium

Falling head data indicates the lower Coocooboonah Creek gravely/ silty / sandy clay unit has a hydraulic conductivity of between 3.2m/day and 5.3m/day.

The alluvium conductivities may be underestimated as it was subsequently established from water chemistry data that the drilling mud had not been completely cleaned out from the bore annulus of P1 and P2. Drilling mud may be caking the bore annulus, restricting the flow of water from the formation and thereby reducing the apparent hydraulic conductivity of the two piezometers.

6.6 Overburden Water Chemistry

The overburden in the vicinity of the proposed pit is dry, apart from a perched very low yield aquifer in Wondobah Seam which did not contain sufficient water to obtain a sample.

6.7 Hoskissons Seam, SMF / LDPF and Alluvium Water Chemistry

Interpretation of the water chemistry analyses indicates a distinctive differentiation between the Quaternary alluvium, which is relatively young water dominated by dissolution of atmospheric carbon dioxide and connate salts, along with the influence from drilling mud.

The Hoskissons Seam is an older water which has a higher proportional component from dissolution of connate salts and magnesium dominated silicates / clays as well as bicarbonate sourced from the coal.

The underlying SMF / LDPF is similar to the Hoskissons Seam, except in P8 which has a salt / magnesium silicate / clay and gypsum derived components compared to coal derived bicarbonate.

The Coocooboonah surface water indicates a connate salt / Mg, K, Ca clay and atmospheric carbon dioxide origin as shown in **Table 11**.

Table 11
Water Categories

Bore	Aquifer Lithology	Category
P1	Coocooboonah Creek Alluvium	Na HCO_3
P2	Coocooboonah Creek Alluvium	Na HCO_3
P3	Hoskissons Coal Seam	Na Mg Cl HCO_3
P4	Hoskissons Coal Seam	Na HCO_3 Cl
P5	Hoskissons Coal Seam	Na Mg HCO_3 Cl
No.5 Ug	Hoskissons Coal Seam	Na Cl HCO_3
45098	Hoskissons / Melville Coal Seams	Na Mg Cl HCO_3
P6	Shallow Marine Facies / Lower Delta Plain Facies	Na Mg Cl HCO_3
P7	Shallow Marine Facies / Lower Delta Plain Facies	Na Mg Cl HCO_3
P8	Shallow Marine Facies / Lower Delta Plain Facies	Na Mg Cl SO_4
27356	Shallow Marine Facies / Lower Delta Plain Facies	Na Mg Cl HCO_3
45097	Shallow Marine Facies / Lower Delta Plain Facies	Na Cl HCO_3
Coocooboonah Creek	Surface Water	Mg K Ca HCO_3 Cl

Note: shading used to denotes groups of bores

A piper plot of the major ion water chemistry is shown in **Figure 3**.

6.7.1 Hoskissons Seam Salinity, Metals, Nutrients and pH

Field and laboratory measurement for the Hoskissons Seam indicates its salinity ranges from 2260µS/cm to 12290µS/cm, which all exceed the ANZECC 2000 SE Australian Freshwater Upland River and drinking water guidelines.

Copper (<0.005mg/L), zinc (< 0.013mg/L) and to a lesser degree, nickel (<0.03mg/L) exceed the ANZECC 200 95% trigger values for toxicants.

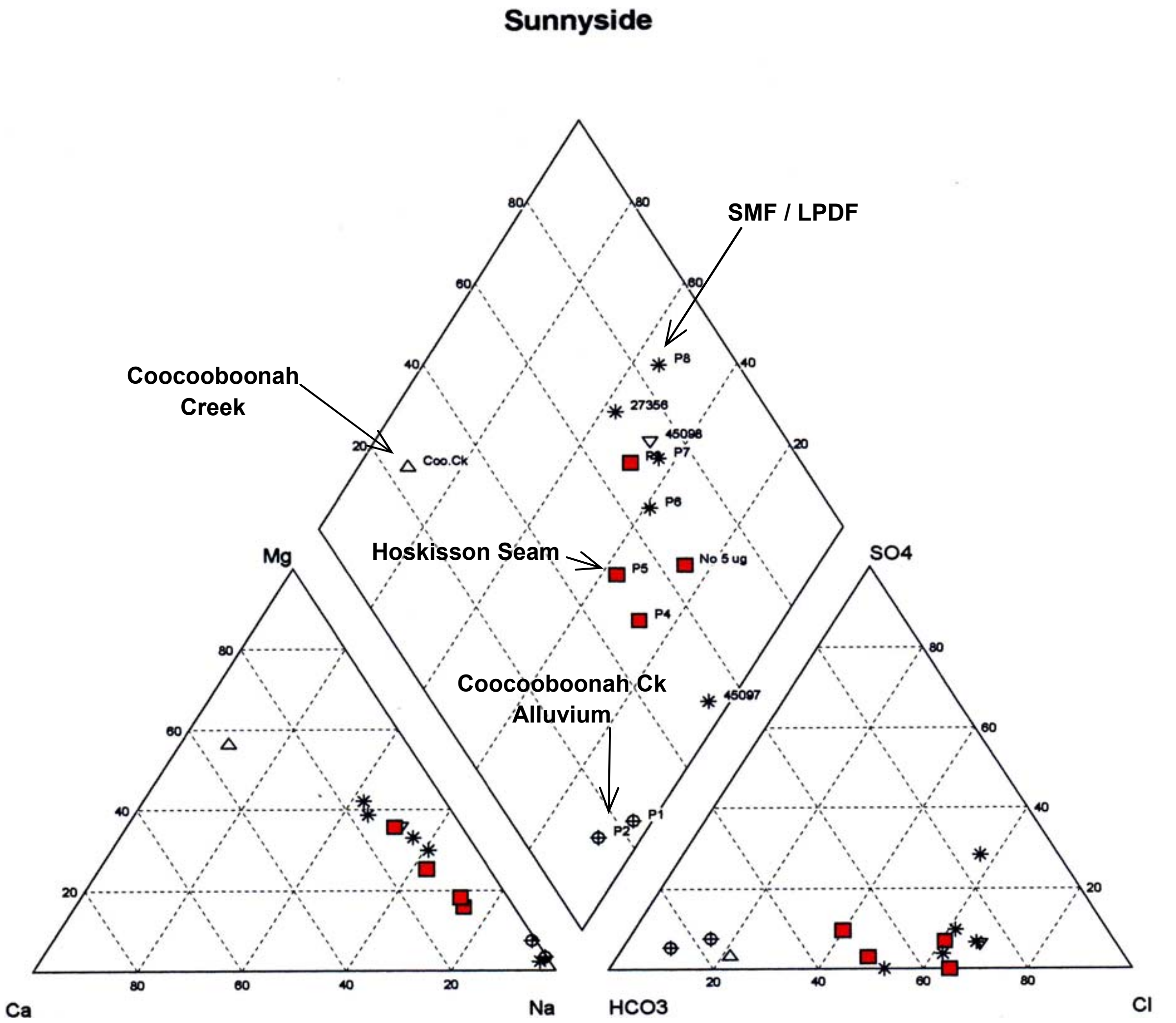

Figure 3
Sunnyside Water Chemistry

Both total nitrogen (<11.0mg/L) and total phosphorous (<9.5mg/L) also exceed the ANZECC 2000 SE Australian Freshwater Upland River guidelines.

The Hoskissons Seam pH is circum-neutral to slightly basic, with a range from 7.0 to 8.1, which is mostly within the SE Australian Freshwater Upland River guidelines, except for P4 (7.9) and in the No.5 underground (6.90 to 8.1).

6.7.2 SMF / LPDF Salinity, Metals, Nutrients and pH

The SMF / LPDF salinity ranges from 2630µS/cm to 7100µS/cm, which all exceed the ANZECC 2000 SE Australian Freshwater Upland River and drinking water guidelines.

Copper (<0.006mg/L) and zinc (< 0.046mg/L) exceed the ANZECC 200 95% trigger values for toxicants.

Both Total Nitrogen (<4.9mg/L) and, to a lesser degree, Total Phosphorous (<0.08mg/L) also exceed the ANZECC 2000 SE Australian Freshwater Upland River guidelines.

The SMF / LPDF pH is between 6.8 and 7.8, which is mostly within the SE Australian Freshwater Upland River guidelines for all bores except GW 45097.

6.7.3 Quaternary Alluvium Salinity, Metals, Nutrients and pH

Field and laboratory measurement for the Quaternary alluvium indicates the sampled water chemistry is affected by the mud used during drilling bores P1 and P2, and that further purging of the bores is required.

The drilling mud has elevated the salinity (12580µS/cm to 18680µS/cm), dissolved metals and total nitrogen, and particularly Total Phosphorous (<3920mg/L) so that most analyses exceed ANZECC criteria.

6.8 Surface Water Chemistry

Apart from one short lived rainstorm which generated some short lived puddles in Coocooboonah Creek, there was no to limited flow in Coocooboonah Creek or Rock Well Creek during the study period.

Water in one dam within Coocooboonah Creek showed elevated salinity due to extended evaporation during the ongoing drought, with 960µS/cm and a pH of 6.13.

The post rainfall puddle in Coocooboonah Creek recorded a salinity of 272µS/cm and pH of 7.3 which is within the ANZECC 2000 SE Australian Freshwater Upland River and drinking water guidelines.

Copper (0.005mg/L) and zinc (0.025g/L) exceeded the ANZECC 200 95% trigger values for toxicants.

Both Total Nitrogen (1.3mg/L) and Total Phosphorous (2.1mg/L) also exceed the ANZECC 2000 SE Australian Freshwater Upland River guidelines.

6.9 Acid Rock Drainage

The Net Acid Production Potential (NAPP) result is derived from Equation 1, and provides a potential “worst case” scenario, and would vary depending on the sulfide mineralogy / total sulfur and sulfate composition of the sample.

It is understood that not all of the sulphur in the sample would be present as sulfide, with the Total Sulfur analysis representing sulphur in both sulfide (S^-) and sulfate (SO_4) forms. As a result, the standard analysis has been modified to account for the sulfide sulphur, as opposed to the total sulphur by subtracting sulphur present in the sulfate form.

NAPP = MPA – ANC (Equation 1)

NAPP	net acid production potential	(kg H_2SO_4/t)
MPA	maximum potential acidity = (%S X 30.6)	(kg H_2SO_4/t)
%S	percent total sulfur	

The acid rock drainage (ARD) laboratory analyses data are plotted in a standard format (AMIRA International, 2002) as shown in **Figure 4**.

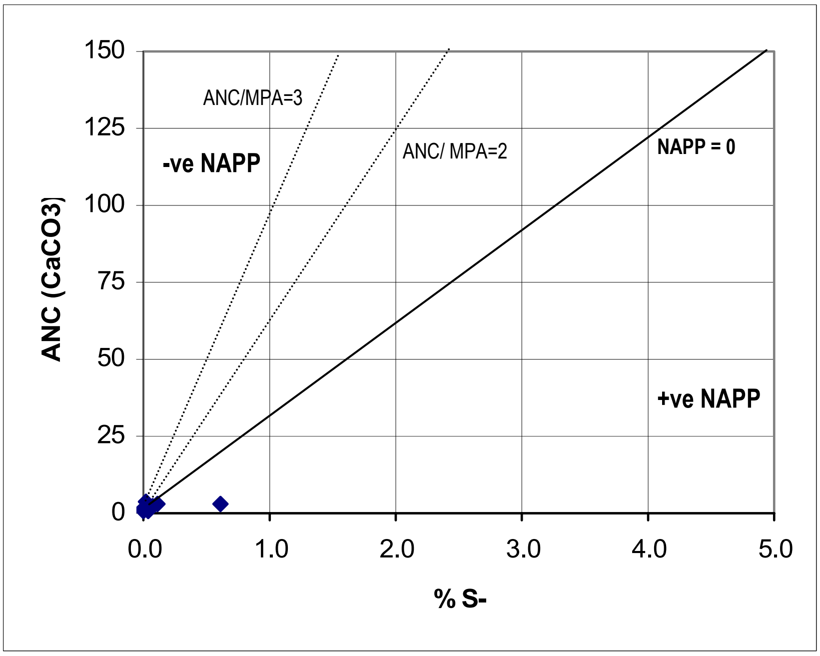

Figure 4
NAPP Plot

Assessment of the NAPP results indicate that the analysed samples are all non acid producing apart from a narrow (18cm), small volume coal seam in the overburden of SUN46C at 36.22m to 36.4mbgl as shown in **Table 10**. The small, thin coal seam represents approximately 1% of the overall waste rock volume, and therefore the acid production potential would be dominated by the non acid producing waste rock.

The out-of-pit overburden emplacement and in-pit waste rock is not anticipated to generate Acid Rock Drainage, and therefore no adverse pH or dissolved metals in leachate water quality is anticipated outside of the moderately saline, circum-neutral pH leachate generated from the coal measures waste rock.

Based on the primarily negative results from the NAPP test work, on the basis that the batch leach testing did not indicate acid rock drainage as well as the observation there is no known acid rock drainage from mines in the Gunnedah Coalfield, it was determined that no additional laboratory work was required and that the Sunnyside waste rock would not produce acid rock drainage.

Any sulfides that may have been present in the overburden above the fresh overburden / weathered overburden interface have been weathered out to depths of up to 36m below surface, and would no longer be a potential source of acid drainage.

It should also be noted that no significant observable sulfides have been logged in cores from Sunnyside, further reducing the possibility of ARD development and that stored water within the abandoned underground, down dip of the proposed pit has a pH range of 6.90 to 7.03 indicating near pH neutral conditions.

6.10 Pit Water Salinity

A modified mass balance approach was used based on (Hancock, G.R, et al, 2004 and PPK, 2002) to assess the potential pit void water salinity.

The salinity batch leach results of lithological subgroups was used to indicate their overall void water salinity contribution, with the results incorporated into **Equation 2** to estimate the pit void salinity, which can be calculated by;

$$VS_{DEC} = ((GW_a+PV_b)\ E_c) \times V_{et} \qquad \text{(Equation 2)}$$

<u>Where;</u>

VS	final void salinity (µS/cm)
DEC1	surface water runoff decile using internal catchment runoff data obtained from (SCS, 2007) with % salinity correction for runoff from out of pit overburden emplacement and ROM pad for Decile 1, 5 and 9 scenarios
GW	average influent groundwater salinity (µS/cm) - assuming 78ML/yr average inflow
a,b	proportion of each component (%)
PVL	average pit void mine spoil leachate salinity (µS/cm), which is composed of
Rc	clean runoff salinity (µS/cm), and;
L	internal pit catchment runoff salinity (µS/cm)
E_c	void lake evaporative concentration factor (av. annual evaporation / rainfall)
V_{et}	evapotranspiration correction for exposed void lake surface

The component of spoil leachate generated by each lithology is derived from the batch leach test results combined with the average leachate for each lithology and their anticipated proportional abundance within the void shown in **Table 12**.

The proportional lithological abundance in the pit void was derived from assessment of drill logs, with a bias toward waste rock extracted from the mid and eastern portions of the pit to account for development of the out-of-pit overburden emplacement in Year 1 and for the initial surficial soil / clay stripping.

Table 12
Pit Void Waste Batch Leach Results

Lithology	Average Batch Leachate Electrical Conductivity (µS/cm)	Average Lithological Proportion in Void (%)	Component of Salinity Contribution (µS/cm)
Conglomerate	814	29	236
Sandstone	816	14	114
Siltstone / Sandstone	724	39	282
Siltstone	1763	13	99
Claystone	814	2	16
Overburden Coal	1677	1	17
Ply C	1265	2	25
		Overburden Pit Void Leachate Salinity	**789**

The range of pit void salinities for the Decile 1, Decile 5 (mean) and Decile 9 surface water runoff scenarios using surface runoff data (SCS, 2007) have been estimated as shown in **Table 13**.

Table 13
Pit Void Salinity Range

Runoff Decile	Pit Void Salinity (µS/cm)
1	10,999
5	8,107
9	5,831

The calculated analytical results shown in **Table 13** provide a first pass indication of the potential pit void salinities that may occur within the Sunnyside Open Cut pit for the three scenarios used. The main observation is that the pit void salinity is highly dependent on the degree of fresh water dilution provided from surface runoff, as the groundwater salinity is relatively constant. In addition, the degree of evaporation is also a strong determining factor in the pit void salinity.

7 Groundwater Modelling

The model structure and modelling approach, model calibration, results of the six simulations and sensitivity analyses are detailed in **Appendix 5**, along with assessment of the potential impacts which are also summarised in the following sections.

The six modelled scenarios developed as knowledge of the regional hydrogeology improved. The modelling was carried out on the understanding that this investigation is preliminary in nature, with the model constructed to represent the Sunnyside Project Site based on reasonable and representative assumptions, despite limited data availability.

The assumptions and the conclusions that follow from the model analyses reflect these understandings and our assumptions. However, it is important to note that the model itself is highly flexible and can be further modified in response to new interpretations or further data that emerge as the Project develops.

Limited groundwater information prevents the transient calibration of the model, verification of groundwater levels and the confirmation of the distributions of the hydraulic conductivity.

There is some uncertainty at this stage over the level of interaction and hydraulic connection between layers and the hydraulic conductivity estimates applied to represent the formations overlying and to a certain degree underlying the Hoskissons Seam.

7.1 Conceptual Hydrogeological Model

A conceptual hydrogeological model was developed for the Sunnyside Project Site and adjoining areas to enable development of the FEFLOW model, which is described in detail in **Appendix 5**.

The open cut stratigraphy can be divided into essentially dry overburden in the pit area which migrates into low yielding overburden with depth down dip to the west of the pit. This overlies the low yielding, low permeability, unconfined Hoskissons Seam in the east to confined Hoskissons Seam in the west of the pit and down dip of the pit.

For the purpose of modelling, the proposed Sunnyside mine stratigraphy was divided into:

- LAYER 1 - low yielding semi-confined (in the east) to unconfined Hoskissons Seam (to the west) overburden overlying the;
- LAYER 2 - low yielding semi-confined to confined Hoskissons Seam in the deeper, down dip portion of the pit; over the
- LAYER 3 - low yielding semi-confined to confined SMF / LPDF (including the Upper and Lower Melville Seam) in the south and west of the pit area, transgressing to semi-confined to unconfined towards Coocooboonah Creek to the north and east of the pit; and
- LAYER 4 - low yielding, semi-confined to confined gravely clay based alluvium in the Gunnedah Formation which is overlain by the clay dominated Narrabri Formation within Coocooboonah Creek and, to a lesser degree, Rock Well Creek.

Hydraulic permeabilities and yield in the Hoskissons Seam, overburden and underlying lithologies may potentially be enhanced in regions of faulting or structural discontinuities.

The permeability of the Hoskissons Seam, where it is intruded or contact metamorphosed by the Sylvandale Sill and associated dykes would be significantly reduced as the intrusions are highly weathered and altered to a predominantly clay matrix to at least the maximum depth of the proposed pit.

Decommissioned underground workings are located down dip and topographically lower in the Hoskissons Seam to the south and southwest of the proposed pit, with the southern pit extent separated from the underground workings by a barrier of un-mined coal which has been intruded by an east northeast trending dyke, dyke swarm or sill, which stopped the northerly advance of the workings.

There is a potential for hydraulic connection between these workings and the final stage of the pit, which could result in increased inflow rates into the pit sump. It was assumed for modelling purposes that the Hoskissons Seam dips at 2 - 3^0 south west of the pit into the underground area. Under these assumed circumstances, the pit floor would be above the underground workings and there would not be a large component of inflow from the underground.

Analysis of measured standing water levels in piezometers and open private bores indicate that flow in the confined Hoskissons Seam is essentially to the south in the vicinity of the proposed pit, which incorporates both down dip south westerly flow within the seam and a north-easterly component due to topographical effects.

Groundwater flow in the unconfined and semi-confined systems to the east of the Project Site are dominated by topographical effects, with flow to the north-east off the hilly area to the south and west of the pit, then to the north-northwest along the Coocooboonah Creek / Rock Well Creek valleys toward Native Cat Creek.

7.1.1 Recharge

Recharge for the Hoskissons Seam in the vicinity of the proposed open pit is assessed to primarily occur in the southern and eastern portion of the study area, with the predominant recharge occurring along the alluvial creek channels.

It is also possible, based on regional information, that basement groundwater may be up-welling into the base of the alluvial channel of Coocooboonah Creek and the lower portion of Rock Well Creek. The actual rate and location of upwelling has not been identified to date with current data.

Considering the fractured character of the bedrock, it is likely that the hydraulic connection between the alluvial deposits and the bedrock occurs along the more intensely fractured zones, creating preferential pathways for groundwater flow. The magnitude of the potential stream bed leakage resulting in groundwater exchange rates between the alluvium and bedrock are unknown at this stage

The magnitude of creek induced recharge during wet spells and erratic flood events has not been established to date due to the lack of long term monitoring data along with the lack of sufficient high rainfall events, however the understanding of the rate of recharge in relation to wet spells and flooding can be developed with on-going monitoring.

To address the uncertainty related to the recharge mechanisms and magnitudes and relationship between Quaternary and underlying systems, field infiltration tests and regular groundwater level and stream flow monitoring is required, followed by refinement of the conceptual model when new data is available.

7.2 Modelling Code

The conceptual understanding of the hydrogeology of the Sunnyside area provided a basis for a numerical groundwater model using the FEFLOW package (Version 5.2) which was developed by the WASY Institute for Water Resources Planning and Systems Research, Berlin, Germany.

FEFLOW has become an industry standard in the context of finite element models for groundwater flow and mass and contaminant transport simulations.

7.2.1 Model Structure

The model mesh was generated using the advancing front method. Mesh refinement was carried out within and around the footprint of the proposed pit where increased detail was required in order to ensure that flow processes were adequately accommodated.

The spatial extent of the model was constrained by Collygra Creek to the west and south-west, and by a surface water divide north-west to the Coocooboonah Creek.

The model consists of 4 layers.

- Layer 1 represents alluvial deposits along the creeks. The depth and the extent of the alluvium were interpolated from the available geological information.
- Layer 2 represents geological formations above Hoskissons Seam. Little is known about the hydraulic parameters of those formations.
- Layer 3 represents Hoskissons Seam. The elevations of the top and the base of the seam were interpolated from available data. In the zones where data was not available the seam was assumed to dip 3^0 south-west with an average thickness of 7.5m.
- Layer 4 represents strata below Hoskissons Seam, including Shallow Marine Facies, Upper and Lower Melville Seams and Lower Delta Plain Facies. The minimum thickness of the latter was set to l00m.

A cross-section showing the distribution of layers is presented in Figure 3 of **Appendix 5**.

The true recharge distribution over the modeled area is unknown. Based on the conceptual model and the analysis of measured groundwater heads, it was assumed that recharge areas for the Hoskissons Seam and underlying strata would be located in southern and eastern parts of the area, along the north-east trending ridges and possibly along the alluvial channels of the creeks.

Creeks were represented as a boundary condition with a set of constraints allowing for removal only of water from the system.

Pit dewatering was represented by boundary conditions, which simulated deepening of the excavation, combined with temporal changes of hydraulic conductivity to represent the pit void. The boundary conditions were limited by appropriate constraints allowing for inflow of groundwater only into the pit sump.

Hydraulic conductivity values used in the model were based on field measurements comprising 6 falling head tests and 2 short duration pumping tests in Bore P5 and GW45098 shown in **Table 4**.

Further field anecdotal evidence suggests that the hydraulic conductivity values obtained from tests conducted in Coocooboonah Creek alluvium (Bores P1 and P2) may be underestimated due to insufficient development of the bores. If bores are not sufficiently developed the presence of residual drilling mud can have a significant impact on hydraulic conductivity measurements.

The model was calibrated for steady-state conditions to match observed groundwater heads with modeled heads. Calibration was carried out with the aid of PEST, a software package for parameter estimation.

Except for P-series bores (P1 to P8), there is some uncertainty related to the exact stratigraphic position of the private bores in the study area. The location of the private (GW-series) bores was estimated based on DWE bore depth and geological information from available bore logs.

It was assumed that all bores in the SUN-series (exploration bores) are monitoring groundwater heads within Hoskissons Seam. Two sets of calibration were carried out:

- High K (hydraulic conductivity) Case - hydraulic conductivity in Hoskissons Seam set to 3.3 m/d with the hydraulic conductivity of the remaining strata and recharge calibrated; and,
- Low K (hydraulic conductivity) Case - hydraulic conductivity in Hoskissons Seam set to 0.3 m/d with the hydraulic conductivity of the remaining strata and recharge calibrated.

The hydraulic parameters calibrated and adopted in the model for the high and low hydraulic conductivity scenario are summarised in **Table 14**.

Table 14
Hydraulic Conductivity and Storage Parameters Adopted for Modelling

Formation	Horizontal Hydraulic Conductivity (m/d)	Vertical Hydraulic Conductivity (m/d)	Specific Storage S_s (L/m)	Specific Yield S_y
Alluvium	21.8 / 26.2	3.5 / 7.2	1×10^{-4}	0.15
Overburden	$4x10^{-4}$ / 2×10^{-4}	1×10^{-4} / 5×10^{-4}	1×10^{-4}	0.1
Hoskissons Coal Seam	0.33 / 3.3	2.2×10^{-3} / 2×10^{-4}	1×10^{-4}	0.2
Shallow Marine Facies & Lower Delta Plain Facies	0.02	5×10^{-3} / 0.4	1×10^{-4}	0.1

NOTE: where shown, first value is the Low K and the second is the High K

At the time of conducting the modelling exercise and reporting, no data was available on storage parameters of modelled strata, and therefore values of specific yield and specific storage adopted in the model were based on available published values as well as from similar modelling exercises within NSW coalfields.

The results of the calibration presented in **Appendix 5** compare the measured and calibrated groundwater heads for observation bores in each of the modeled strata.

7.3 High K and Low K Cases

The model run simulated 5 years of mining and 5 years of post-closure conditions.

In the model, it was assumed that hydraulic conductivity within the pit void during excavation increases to approximately 900m/d, allowing for unrestricted groundwater movement within the void during excavation compared to conditions outside the pit.

The horizontal and vertical hydraulic conductivity of the backfill was then lowered to approximately 9m/d after it was backfilled, which is substantially higher than the initial hydraulic conductivity of the modelled strata in the pit.

7.4 Sensitivity Analysis

A sensitivity analysis was carried out to address the uncertainty of model parameters and implications for resulting model predictions as outlined in **Appendix 5**. Six cases were modelled.

Case 1 and 2 involved assessment of the model sensitivity to storage parameters. Case 1 involved lowering storage parameters for the low hydraulic conductivity scenario and Case 2 involved increasing storage parameters for the high hydraulic conductivity scenario.

Case 3 assessed the low hydraulic conductivity situation with the additional effect of doleritic intrusions and heat metamorphism within the Hoskissons Seam.

Case 4 included the Case 3 scenario, with the addition of the Gunnedah No. 5 underground workings in the Hoskissons Seam.

Case 5 was run as a modification of Case 4, and assumed that the Gunnedah No. 5 underground was fully saturated, with lower storage parameters applied that are equivalent to other related modelling exercises in NSW coalfields. Specific storage of 5 x 10^{-6} L/m was used, specific yield was decreased to 1% for interburden and 3% for the Hoskissons Coal Seam.

Case 6 was run after it was established in October 2007 that the Gunnedah No.5 underground workings were dry, apart from a fault block bounded isolated section containing 31.2ML of water. Case 6 used the same hydraulic parameters as Case 5, but incorporated an initial lower hydraulic head than Case 5 to represent the mostly dry underground workings.

The sensitivity analyses results indicate the following.

- Case 1 - The extent of the cone of depression in Hoskissons Seam is slightly increased due to the lower values of specific storage applied, whilst the inflow rates into the pit are reduced.
- Case 2 - The inflow rates into the pit are on average 10 - 20 L/s greater than for the High K Case. The extent of the cone of depression is reduced due to the higher values of specific storage applied. The recovery process is slower, as higher storage values used in this case result in a greater volume of voids to be filled.
- Case 3 – The shape and extent of the cone of depression is altered by the intrusions, with the modeled inflow rates to the pit reduced to approximately 30L/sec, decreasing to approximately 3.5l/sec at the end of mining.

- Case 4 – the extent of the cone of depression is reduced during the mine life with higher inflows to the pit compared to Case 3. After closure the cone of depression extends to the south and south east within the area of the underground workings, reaching its maximum 25 years after closure. Recovery is slow in the underground working, with the pit void requiring approximately 50 years to return to its initial level. Inflows are initially around 30L/sec decreasing to 10.5L/sec towards the end of the operation.
- Case 5 – the cone of depression extends further from the pit in comparison to other modelled cases with the recovery process being much faster due to the low storage and relatively high conductivity of the rock mass. Five years after cessation of mining, the cone of depression is very shallow and flat, indicating that the recovery process is almost complete. Average inflows to the pit vary from approximately 7L/s in the beginning to 20L/sec at the end of the pit when the open cut reaches the depth and proximity of the underground workings
- Case 6 – the regional extent and quantum of the cone of depression is significantly reduced compared to the other modelled cases due to incorporation of the mostly dry underground workings. The recovery process virtually generates no change in groundwater heads for five years after mining has ceased. Modelled open pit inflows peak at 3.5L/sec (300m^3/day or 109.5ML/year) after approximately 2.5 years of mining. As noted in **Appendix 5**, the quantum of pit inflows and regional drawdown predicted in Case 6 are anticipated to be correct, with the actual relative levels being dependent on the initial, starting piezometric head used in the model.

7.5 Summary of Model Calibration Results

Dry conditions encountered when drilling through the Hoskissons Seam overburden, and only moist conditions noted within the Hoskissons Seam together with the general lack of groundwater inflows and pit void storage observed in similar Gunnedah Coalfield open cut mines indicate the high hydraulic conductivity scenario is not likely to develop and that the low conductivity case is more likely to represent groundwater conditions in the Project Site and adjoining areas as outlined in **Appendix 5**.

Modelling outputs for the high hydraulic conductivity scenario suggest the steady state groundwater head is, in general, higher than the measured heads within the Hoskissons Seam with overall gradients in the model matching the measured data.

It is concluded that higher than observed groundwater heads in the model would result in a conservative estimate of the impact of dewatering on the surrounding groundwater regime and overestimate of groundwater inflow rates into the pit for the high hydraulic conductivity case.

In the vicinity of the pit, the match of modeled and measured groundwater heads for the low hydraulic conductivity case is better, but the overall hydraulic gradients in the model are flatter than those indicated from the field data. Attempts to improve the calibration with respect to these gradients were unsuccessful suggesting that the uniform hydraulic conductivity distributions applied within the model to represent strata may be too simplistic to allow reasonable simulation of field conditions.

Further clarification of the potential effects of the Sunnyside pit excavation are provided through the assessment of the combined effect of both intrusions / metamorphism in the Hoskissons Seam as well the effect of the mostly dry No. 5 underground workings in the Hoskissons Seam.

7.6 Potential Impact on Local Groundwater Systems and Groundwater Users

The potential drawdown effect on private bores within the Sunnyside Project study area are shown in **Table 15**, with the results based on the low hydraulic conductivity, Sensitivity Case 6, which includes the doleritic intrusions and metamorphism in the Hoskissons Seam along with the adjoining, mostly dry, Gunnedah No.5 Entry underground workings.

Bores not listed in the summary have been excluded as they are either registered, but do not exist, or alternatively, are not in use.

Table 15
Potential Private Bore Drawdown

Bore	Property	Bore Depth (m)	Measured / Drilled SWL (m)	Aquifer Intake	Potential Drawdown (+5 yrs) (m)	Potential Drawdown (+10 yrs) (m)	Potential Drawdown (+30 yrs) (m)
INTAKE ABOVE HOSKISSONS COAL SEAM							
3706	Rock Well Ck	15.2	6.4	Sandstone	0	0	0
3709	CK Douglas	37.5	19.2	Shale	0	0	0
8810	Mulwalla	53.3	N.A.	N.A.	0	0	0
901803	Ivanhoe	58	N.A.	N.A.	0	0	0
967523	Innisvale	42.36	N.A.	N.A.	0	0	0
INTAKE WITHIN HOSKISSONS COAL SEAM							
44677	“Werona”	75.9	15.2	Overburden / coal	0	0	0
45098	“Sunnyside”	44.2	N.A.	Overburden / coal	<2	<1	<0.5
22497	“Coocooboonah”			Overburden / coal	<1	<0.5	<0.5
INTAKE BENEATH HOSKISSONS COAL SEAM AND / OR WITHIN MELVILLE COAL SEAM							
6249	“Lilydale”	70.7	20.7	Sandstone / coal	<1	<0.5	<0.5
17082	“Eulalie”	24.4	N.A.	Overburden / coal	0	0	0
27356	“Sunnyside”	35.4	27.1 / 24.7	Shale / coal	<1	<0.5	<0.5
44580	“Glendower”	34.0	18.0	Overburden / coal	0	0	0
44581	“Glendower”	35	18.0	Overburden / coal	0	0	0
44884	“Lilydale”	73.2	N.A.	Overburden / coal	<1	<0.5	<0.5
44885	“Ferndale”	36.6	15.3	Overburden / coal	0	0	0
45013	“Woodlawn”	76.2	N.A.	Overburden / coal	0	0	0
45061	“Coocooboonah”	84.1	N.A.	Overburden / coal	<1	<0.5	<0.5
45045	“Plain View”	62.5	N.A.	Overburden / coal	0	0	0
45097	“Sunnyside”	85.3	N.A.	Overburden / coal	<2	<1	<0.5
48701	“Werona”	61.0	45.7	Overburden / coal	0	0	0
901460	“Illilli”	34	16.0	Overburden / coal	0	0	0

7.6.1 Strata Overlying the Hoskissons Seam

Regional groundwater drawdown in strata overlying the Hoskissons Seam is not interpreted to extend into the drawing area of private bores located outside of the mine vicinity, down dip to the west and north of the proposed pit.

As bores in this group are completed stratigraphically above the Hoskissons Seam, and do not obtain water from the Hoskissons Seam, their groundwater supply is not anticipated to be affected by mining.

A similar, albeit low, quantum of groundwater head drawdown is modelled for strata overlying the confined Hoskissons Seam compared to within the Seam as shown in **Figure 5,** as the model interprets a low connectivity between the Seam and its overlying strata.

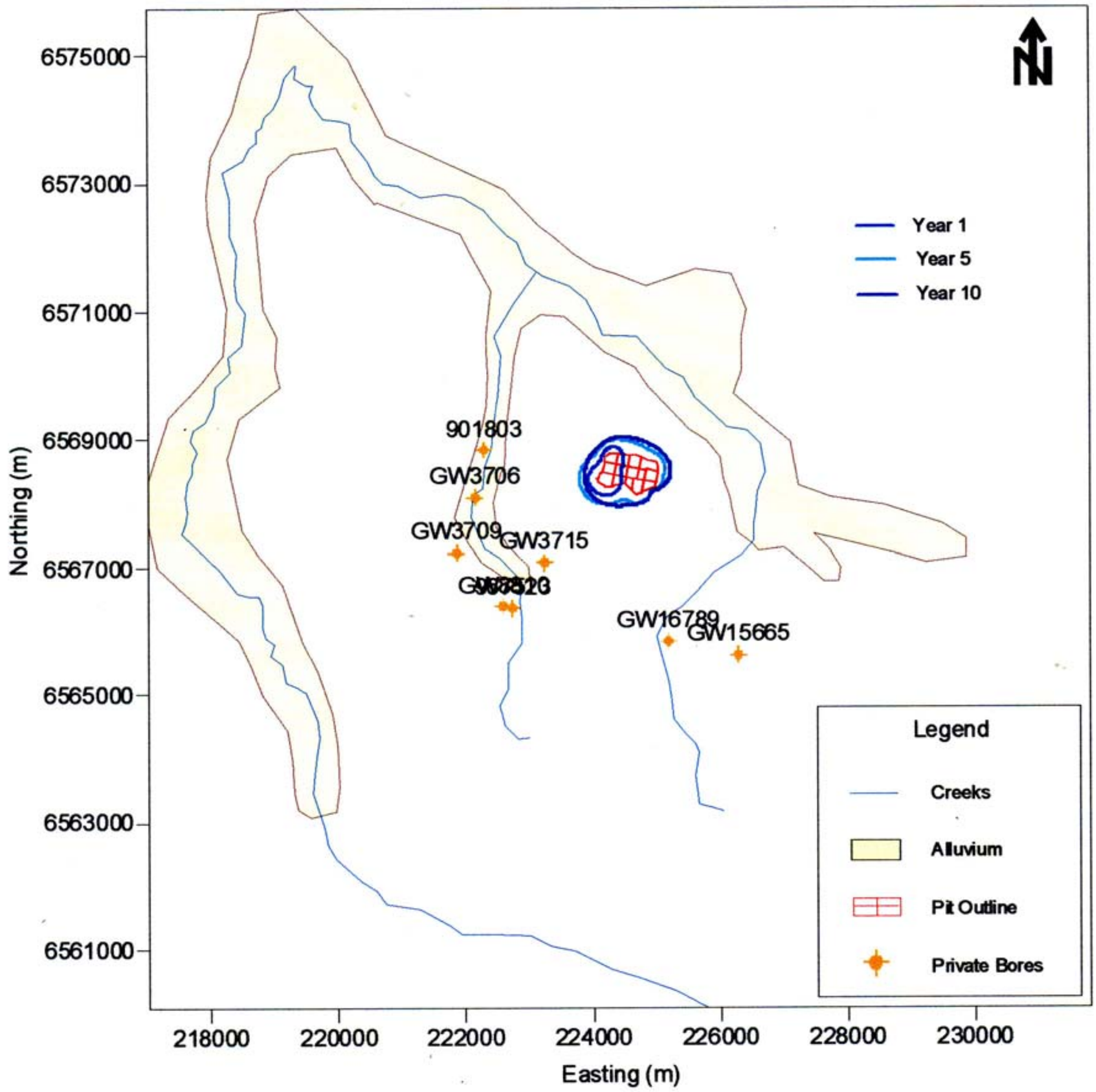

Figure 5
1m Drawdown Contour in Strata above the Hoskissons Seam, Sensitivity Case 6, Years 1 to 10

7.6.2 Hoskissons Seam

Operation of the Sunnyside open cut would draw down the piezometric surface around, and centred on, the pit within the confined Hoskissons Seam during mining, with the water table gradually returning, albeit to a lower level in the immediate vicinity of the pit due to enhanced evaporation.

Two registered bores owned by NMPL which are extracting groundwater from within the Hoskissons Seam and underlying strata on the "Sunnyside" property would be affected by groundwater drawdown of up to 2m from mining the Sunnyside pit as shown in **Figure 6** and **Appendix 5**.

The hydraulic conductivity of highly weathered intrusions located to the south, west, east and north of the proposed pit within the Hoskissons Seam and its overlying / underlying strata is lower than in the un-intruded strata, whilst the No.5 underground workings are mostly dry, which significantly reduces the predicted pit inflow rate and extent of the cone of depression within the Hoskissons Seam compared to the other modelled cases.

The hydraulic parameters of faults cutting through the area under investigation are unknown at this stage. If the hydraulic conductivity of the faults is higher than that of the surrounding strata, they may act as water conduits resulting in higher inflows into the pit. By contrast, if the hydraulic conductivities of the faults are lower than the surrounding strata, particularly where doleritic intrusions are present along the fault trace, they may act as barriers which could result in lower than estimated inflow rates into the pit. Both cases would have an impact on the distribution of the cone of depression, especially within the Hoskissons Seam.

7.6.3 Strata Underlying the Hoskissons Seam

The case 6 modelling, which was conducted after it was established the underground workings were mostly dry, indicates that two bores in the "Lilydale" property (GW6249 and GW44884), located immediately east of the Sunnyside Project Site, which extract water from strata both underneath and within the Hoskissons Seam, may be affected by less than 1m of mine dewatering related groundwater level reduction as shown in **Figure 7** and **Appendix 5**.

Since it was established the underground workings are dry, apart from a storage of 31.2ML in a down faulted section at the northern section of the underground workings, the modelled extent and quantum of regional drawdown in the aquifer stratigraphically beneath the Hoskissons Seam and the decommissioned underground was significantly reduced compared to previous modelled scenarios.

Access to monitor the "Lilydale" bores has not been possible to date, however, it is assumed that the two bores are currently providing sufficient water yield and quality to the property owner.

As the "Lilydale" bores are predicted to encounter less than 1m of drawdown, it is not anticipated that the potential longevity that each bore can be pumped at its current extraction rate, or the bore "yields" will be adversely affected.

The "yield" is determined by the current status of the bores in terms of their hydraulic parameters, as well as factors like the degree of biological and chemical encrustation of the bore annulus, casing and pump whilst the "unpumped" standing water level depth, the "pumped" drawdown depth and the depth of submersion of the pump intake determine the available drawdown in a bore.

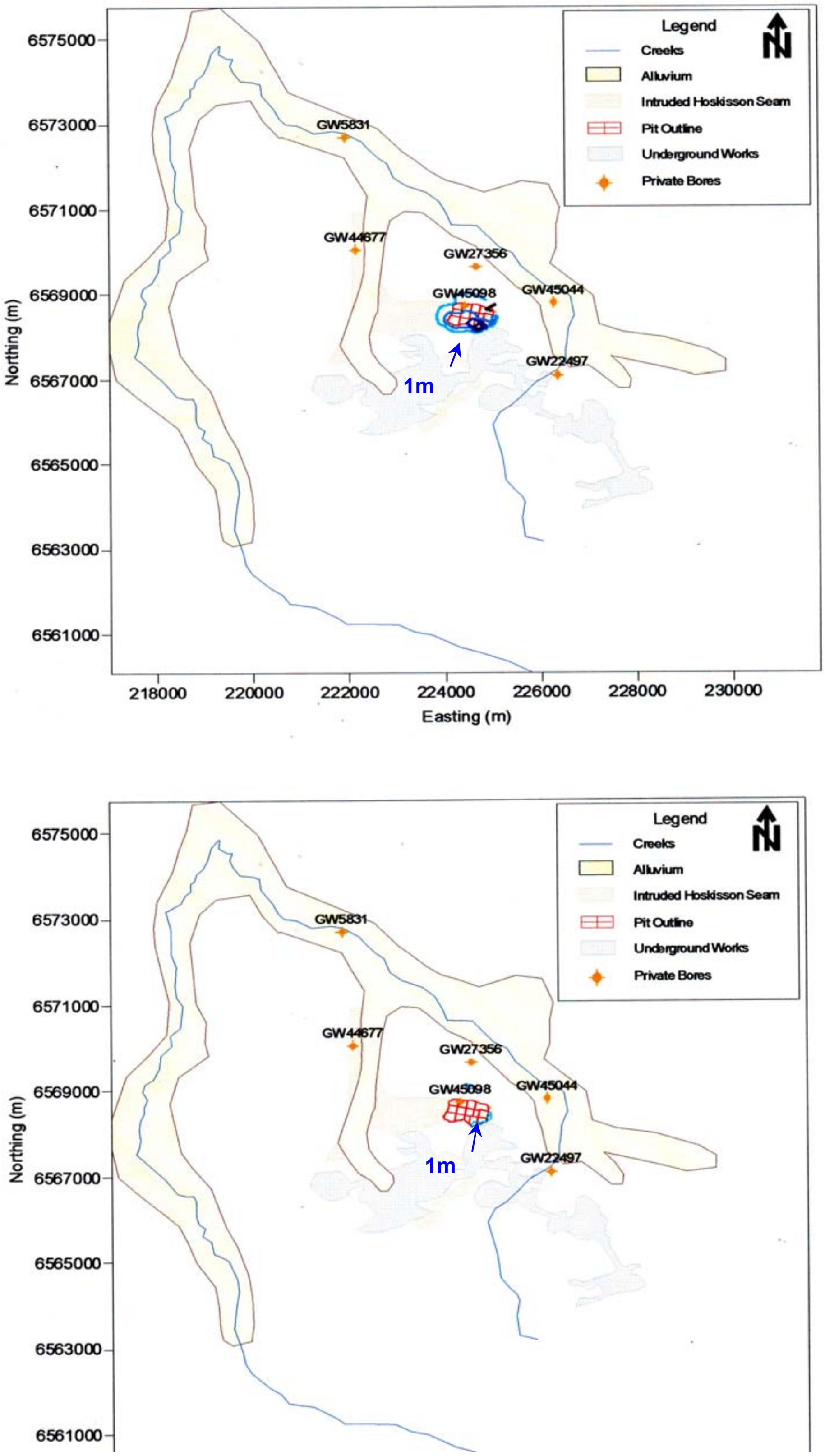

Figure 6
Hoskissons Seam Drawdown, Sensitivity Case 6, Years 5 & 10

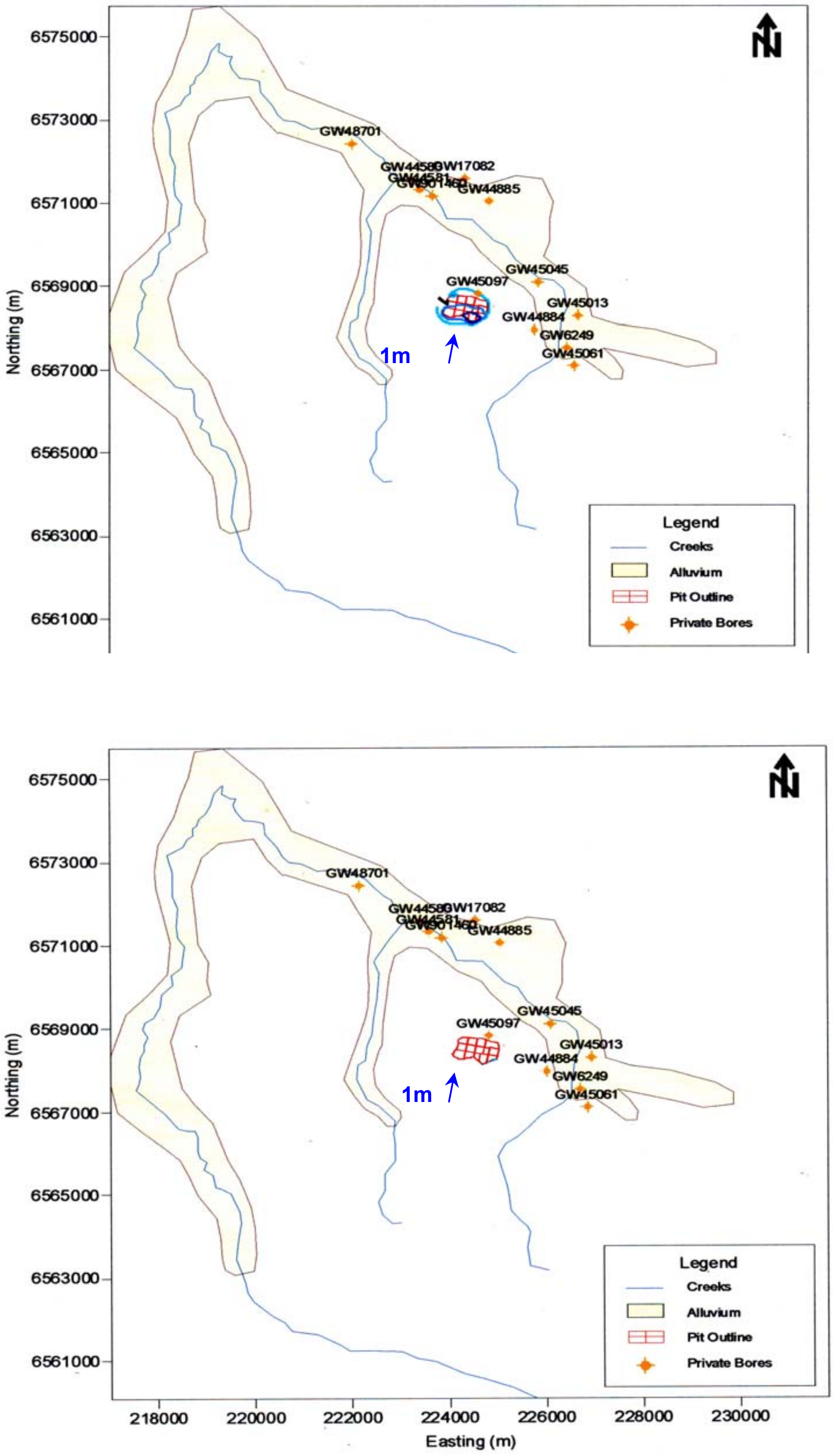

Figure 7
Drawdown in Strata under the Hoskissons Seam, Sensitivity Case 6, Years 5 & 10

The groundwater intake zone indicated from DWE records is 68.9m below ground level (mbgl) for GW6249, whilst the intake depth for GW44884 is likely to be similar to GW6249, although the records are not listed in the DWE data.

No field measured data is available on the current status of the "Lilydale" bores, however extrapolation of contoured water depth data from known sites and estimated wellhead heights indicate that the "Lilydale" bore standing water levels may both be around 18mbgl. Assuming the standing water levels are at 18mbgl, the 70.7m deep bore GW6249 could have approximately 52m of available drawdown, whilst the 73.2m deep bore GW44884 could have approximately 55m of available drawdown.

Based on the assumptions outlined above, an up to 1m reduction of available drawdown would not significantly affect the overall sustainability of the bores, depending on the depth of the pump intake. If the current pumping rates do affect the longevity that the bores can be pumped, it is likely that the pump intake can be lowered to sustain current extraction rates.

It should be noted that no private bores to the east and north of Coocooboonah Lane are anticipated to be affected by drawdown due to mining the Sunnyside Pit as the eastward progression of the drawdown cone is limited due to the Hoskissons Seam subcropping / outcropping in the vicinity of Coocooboonah Lane.

7.6.4 Potential Migration Into Underlying Aquifers of Pit Water Placed Underground

Due to the mostly dry void space within the No.5 underground mine void, which was established by dedicated drilling following development of the groundwater model, the resultant lack of additional drawdown from the workings, as well as the:

- south easterly dip of the workings,
- significantly lower permeability of the underlying, unfractured siltstone / silty sandstone Shallow Marine Facies compared to the infinite permeability of the No.5 workings void and the;
- higher permeability, secondary fractured goafed overburden above the underground workings,

It is anticipated that any pit water delivered into the decommissioned underground would fill the void space by initially draining to the lowermost section of the underground workings, which extend to approximately 5km southeast of the proposed open cut pit, then gradually fill up-dip to the north-west, toward the proposed open cut.

As the water height gradually rises above the underground void space, and due to the likely presence of subsided and cracked goafing above the workings, the introduced water would flow, in preference, into the secondary fractured overburden rather than drain under gravity into the underlying, unfractured, Shallow Marine Facies which contain a strongly bioturbated low permeability siltstone / silty sandstone up to 15m thick in the upper section of the strata.

7.6.5 Quaternary Aquifers

No Quaternary alluvial aquifers would be mined as part of the proposed mining process.

Case 6 modelling indicates that the cone of depression in the Hoskissons Seam and the overburden would not develop significantly outside of the immediate pit vicinity, and would not extend outside the outcrop / subcrop of the Hoskissons Seam, which lies approximately 1km south of the main, southern, channel of Coocooboonah Creek. Progression of the cone of depression toward the Creek would also be restricted due to the unconfined nature of the Quaternary sediments to the north of the proposed open cut pit.

It is interpreted that groundwater within alluvial aquifers associated with Coocooboonah Creek, Rock Well Creek, Native Cat Creek or the regional aquifers associated with the Namoi River would not be affected by mining the proposed Sunnyside Open Pit.

The cone of depression would not significantly extend outside of the immediate pit vicinity to the west due to the confined conditions that exist down-dip in the Hoskissons Seam to the west of the open pit.

7.7 Potential Pit Inflows

It is predicted that excavation of the Sunnyside open pit may generate low inflows due to the:

- shallow depth of cover;
- water inflows only noted during drilling from the Hoskissons Seam and underlying strata; and
- the low yields and transmissivities in the Sunnyside area.

Case 6 modelling indicates the pit may initially generate low to moderate groundwater inflows with an increasing annual inflow up to approximately Year 2.5 as the pit deepens, then will experience a reduction to Year 5 as the pit progresses toward the mostly dry underground.

Inflows for Case 6, which incorporates the effect of weathered doleritic intrusions in the Hoskissons Seam as well as the mostly dry No. 5 underground, range from approximately 64ML/year up to 106ML/year as shown in **Table 16**, **Figure 8** and **Appendix 5**.

It should be noted that the figures quoted are for modelled inflows, and do not incorporate the loss of water from the open pit that would occur due to evaporation, which would significantly reduce the actual amount of stored water as the average annual evaporation (1749mm/year) is approximately 2.5 times the annual rainfall of 636mm/yr.

Table 16
Potential Pit Groundwater Inflows (Without Evaporation)

End Of Mining Year	Modelled	Inflow	Rates
	L/sec	m^3/day	ML/year
1	3.01	260	79
2	3.13	270	102
3	3.30	285	106
4	2.55	220	67
5	2.20	190	64

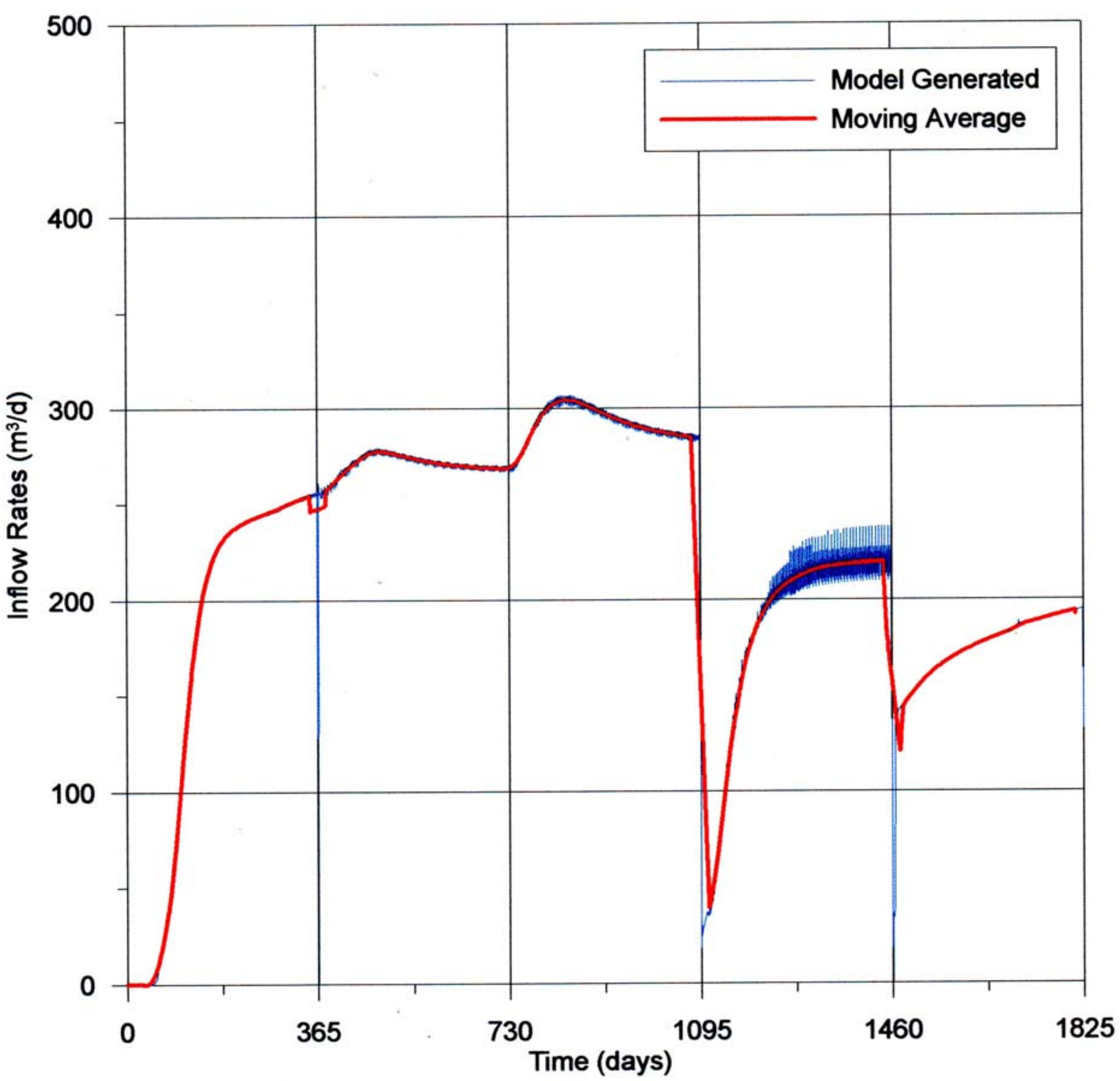

Figure 8
Case 6 Pit Groundwater Inflows

Anecdotal experience from operating the Gunnedah No 5 underground (C. Burgess, pers comm.) indicates that the mine did not generally have significant groundwater inflows, with the only notable inflows occurring for relatively short periods of time when dykes or faults were cut through.

7.8 Post Mining Pit Void Water Levels

The pit void filling process would involve groundwater inflow, surface water inflow and losses from the open water body due to evaporation of any exposed pit water. Case 6 model estimates of pit water level recovery include groundwater seepage only, and do not account for surface water inflow to the pit or evaporation are shown in **Figure 9** and **Appendix 5**.

The Case 6 groundwater recovery scenario indicates that water levels in the pit would return to approximately 293m AHD after the pit has been rehabilitated, excluding the effect of evaporation.

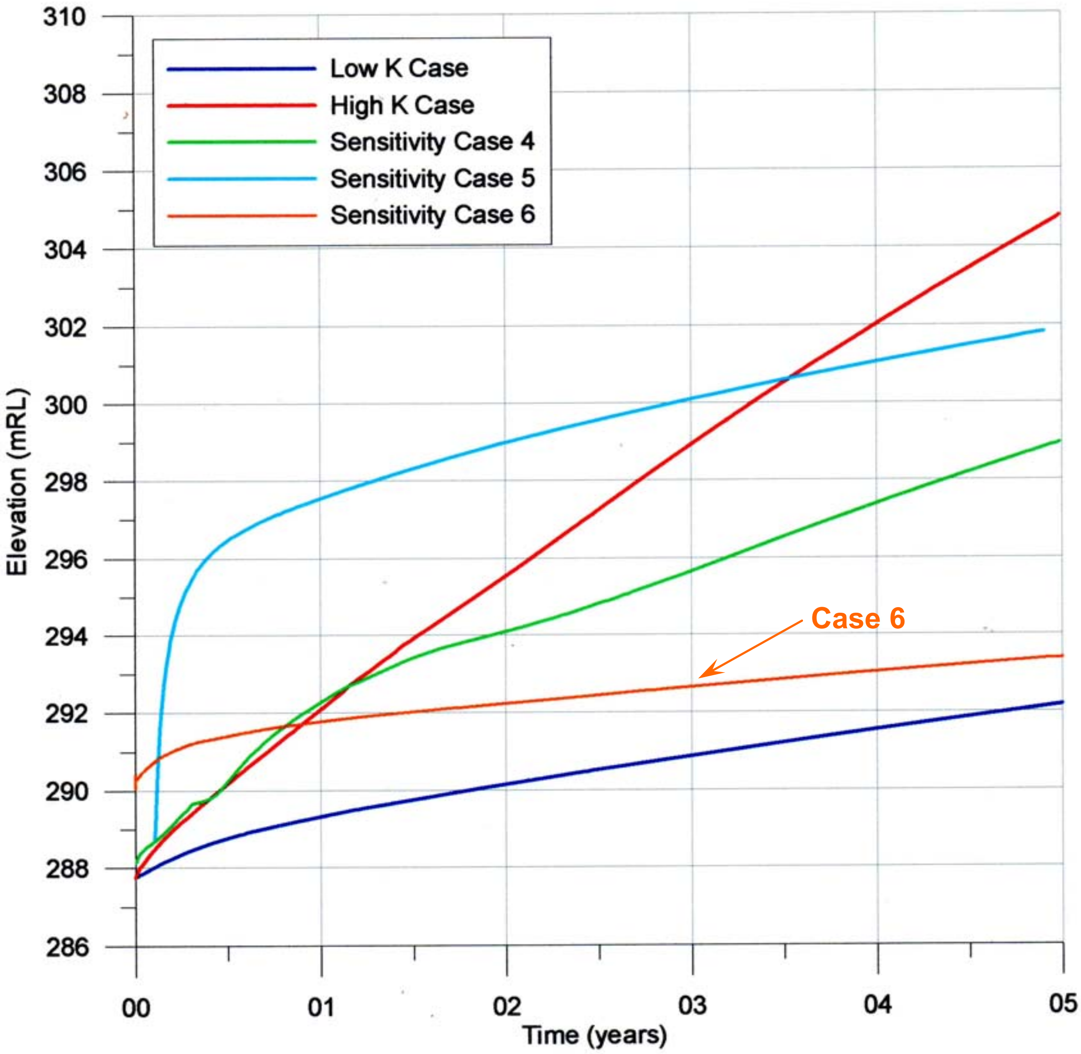

Figure 9
Case 6 Modelled Pit Water Level Recovery

Estimates of rainfall and pit void runoff water that may be captured within the pit void is estimated to range from 15.7ML/yr (10th percentile) to 35.4ML/yr (90th percentile) (SCS, 2007). This quantity of water is interpreted to be insufficient, in addition to the groundwater inflows, to raise the standing water level in the base of the rehabilitated pit above the proposed backfill RL of 305m AHD, assuming a waste rock void space of 20%.

On this basis, the combined groundwater inflow and surface water capture in the pit would not generate a pit void lake as there is insufficient inflow to raise the pit water level above the proposed waste rock backfill height.

If the ponded water becomes exposed at an isolated location in a low backfill area, the water body would be subject to the high local evaporation rate which would subsequently lower the stored water level in the void and significantly reduce the extent or presence of an in-pit lake.

7.9 Potential Connection to Underground Workings

It is planned that the current mining operation will not break through into the underground workings from the open pit footwall.

The underground workings are mostly dry, with an estimated minimum of 1523ML of open void space. One isolated section within 40m of the southeastern portion of the proposed pit, with approximately 31.2ML of water contained in a down dip, down thrown block faulted section (or graben) of the underground workings, has a standing water level approximately 7m above the proposed base of the pit. It should be noted however that the Hoskissons Seam thickness in this area of the open pit is approximately 8.5m and that the underground workings are down-dip, and primarily at a lower elevation than the proposed pit base.

On the basis the workings are mostly dry, apart from the isolated 31.2ML of water, it is not envisaged that an in-rush of water from the underground workings to the open cut will occur, and that a short duration and low volume of seepage may occur through the pit highwall until the head in the fault bounded underground workings and the exposed pit base equalise.

It is not anticipated that a connection would occur between the proposed pit and the saturated underground due to the 40m separation distance from the workings, however if an inflow does occur, the underground workings water can be managed within the open pit's water management system.

7.10 Sunnyside Project Water Supply

Case 6 modelling predictions indicate that the mine water requirement of 75ML/yr to 100ML/yr may not be met by seepage from the underground workings and strata surrounding the open pit. The Case 6 model does not account for evaporative losses in the exposed pit after groundwater inflow occurs, which would additionally reduce the water requiring storage and re-use.

The majority of open cut coal mines in the Gunnedah Coalfield with a similar scale and geological setting to Sunnyside do not have significant groundwater pit seepage, and are operated as “dry” mines (B Corbett, pers comm). In addition, the collected groundwater inflows are significantly lost through evaporation.

If inflows are insufficient for the Project Site supply, pumping from the adjacent “block faulted” section of the underground workings may provide a limited potential source of water supply.

Any pumping from the underground workings would be appropriately licensed with the DWE prior to extraction.

8 Potential Water Quality Impacts

8.1 Open Pit Void Water Quality

The pit water quality will alter depending on the variable proportion of groundwater seepage / waste rock leachate / influent “clean” stormwater / “dirty” surface water runoff and evaporation effects that apply during excavation, backfill and rehabilitation of the proposed pit.

To date, the water quality in the overburden above the Hoskissons Seam has been assessed through crushed core laboratory and long term leach batch leach tests, as the overburden has been dry above the Hoskissons Seam in the vicinity of the proposed pit during the period of investigation, and therefore connate water in the overburden could not be monitored in the field.

Individual batch leach results indicate that the overburden ranges from pH 6.97 to 8.43, with EC ranging from 724µS/cm to 2590µS/cm.

Coocooboonah Creek and Project Site dam water analyses indicates a surface water pH of 7.64 to 9.17 and an EC ranging from 236 to 330 µS/cm.

Laboratory assessment of overburden and coal seam samples from the proposed 60m deep pit did not indicate a potential for acid mine drainage, primarily as the majority of the overburden is weathered and oxidised, and there are very low sulfide levels in the coal seam.

For the in-pit void water pH range, which isn’t a parameter that can be developed from simple mathematical mixing, it would be representative to indicate that pH would range between the upper and lower bounds of the analyses of surface water (pH 7.64 - 9.17), groundwater / leachate inflow (pH 6.97 to 8.43), overburden and Hoskissons Seam groundwater (pH 7.0 to 7.9) and No. 5 underground results (6.90 to 8.10).

Based on the Case 6 groundwater inflows and “desk top” assessments conducted to date, the in-pit water electrical conductivity is anticipated to potentially range from approximately 5,800µS/cm during wet periods to approximately 11,000µS/cm during extended dry periods, whilst the in-pit water pH is anticipated to range from 6.90 to 8.43.

Analyses of water samples from the abandoned underground indicate a pH range of 6.90 to 8.10, with electrical conductivity values range from 3 590µS/cm to 7 360µS/cm, whilst bore and piezometer groundwater data from the Hoskissons Seam indicates a pH range of 6.62 to 7.9 and electrical conductivity values between 2,260µS/cm to 12,650µS/cm.

8.2 Placing Open Pit Void Water into the Gunnedah No. 5 Workings

At this stage, it is planned that a purpose drilled bore will be installed to access the underground workings close to the south eastern extremity of the open cut pit in order to deliver excess pit void water into the workings.

Although this bore will be located in a "down thrown" fault area of the underground workings, once the water level reaches the "spill point" of the block, any additional water will drain downdip, along the worked out seam.

If additional water placement is required up dip of this point, or elsewhere, additional bore(s) could be installed following consultation and licensing from DWE.

Based on the analyses conducted to date, the:

- No. 5 underground water ranges from pH 6.90 to 8.10 and electrical conductivity values from 3,590µS/cm to 7,360µS/cm;
- Hoskissons Seam and its overburden ranges from pH 6.62 to 7.9 and electrical conductivity values from 2,260µS/cm to 12,650µS/cm, whilst;
- strata underlying the Hoskissons Seam ranges from pH 6.61 to 8.23 and electrical conductivity values from 2500µS/cm to 11430µS/cm; and
- the open pit water may range from a pH of 6.90 to 8.43 and electrical conductivity values of approximately 5,800µS/cm to 11,000µS/cm.

Placement of diluted pit void water underground into the Gunnedah No. 5 underground workings does not constitute pollution in terms of pH, however the upper potential salinity of 11,000µS/cm could exceed the No.5 underground analyses to date, but not the upper bound of the monitored Hoskissons Seam water salinity.

The calculated salinities exceed the No. 5 underground water quality for the dry (Decile 1) surface water runoff scenario, whilst the mean and Decile 9 surface water runoff scenarios are similar to, or lower than, the monitored salinity in the Hoskissons Seam and No. 5 underground.

To avoid the potential degradation of the Hoskissons Seam and No. 5 underground water quality, a water quality management system for underground water placement will be required as outlined in Section 10 of this report.

NMPL will utilise the dilution effect of collected surface water to manage salinity levels in the two turkey's nest dams. The dams will only discharge underground when excess water exists, which is most likely to be at a time when salinities would be low due to surface water dilution.

Monitoring will confirm salinity levels prior to discharge underground from the two turkey's nest dams.

8.3 Potential Salt / Contaminant Migration Pathways

It is not anticipated that an increase in salinity levels in Coocooboonah Creek would occur due to leakage of groundwater out of the proposed pit or abandoned underground workings, as the pit would form an inward flowing cone of depression, and the underground workings to the south are mostly dry.

The abandoned workings also have an estimated minimum capacity of 1523ML for storage of excess pit water, if required, which if the storage capacity was totally used, would only raise the water level in the workings to the top of the seam. Saline water would not rise sufficiently to affect the surface water system.

Based on the lack of anticipated groundwater flow effects on stream salinity, solute transport modelling is not considered necessary. Some salt generation through rainfall recharge / discharge from the waste rock dumps may occur, although this is planned to be captured in the mine's dirty water system and either used on site or stored in deeper sections of the underground workings if necessary.

It is not anticipated that contaminants would be transported off site via the groundwater system due to the inward flowing cone of depression and void space issues discussed above. Off site migration of contaminants via the surface water system would also be contained within the mine's dirty water management system, and the reader is referred to the surface water study (as part of the EA assessment) for further detail.

8.4 Potential Impacts on Regional Groundwater Quality

Dewatering associated with the Sunnyside pit is not anticipated to have an adverse impact on groundwater quality within the Hoskissons Seam, or the strata over or underlying the Seam.

Modelling indicates that the deepest groundwater level declines are limited in close proximity to the pit within the "Sunnyside" property, with the cone of depression rapidly shallowing away from the pit.

On this basis, the exposure of fresh to less weathered overburden which could be oxidised, along with any enhanced leaching of salts, would be located in close proximity to the pit within the "Sunnyside" property.

No observable change in water quality due to groundwater drawdown is anticipated in private bores outside of the "Sunnyside" property as the modelled drawdowns would not lower current standing water levels beneath the depth of weathering.

8.5 Potential Impacts on Regional Surface Water Quality

No adverse effect is anticipated on the regional surface water quality in Coocooboonah Creek and other streams due to groundwater movement as the Sunnyside cone of depression does not extend as far as the creek channel. Depressurisation in the basement strata under or near the creek is not anticipated due to the isolated dewatering the Hoskissons Seam.

To date, no groundwater seeps have been observed within the Coocooboonah Creek channel.

No adverse effect is anticipated on water quality within Rock Well Creek as depressurisation of the Hoskissons Seam is not anticipated to sufficiently propagate up through strata above the Hoskissons Seam to the creek bed.

The cone of depressurisation is not modelled to extend as far north as Native Cat Creek, and therefore no adverse effects on stream water quality are anticipated.

9 Potential Impact on Stream Flows and Groundwater Dependent Ecosystems

9.1 Local Creeks

It is not anticipated that stream flow in Coocooboonah Creek or Rock Well Creek would be affected by mining the proposed pit as the cone of depression does not extend as far as the creek channels.

The potential effects are further reduced as the creeks are “Losing / Disconnected” streams where water flows from the creek into the underlying shallow groundwater system.

It is possible that deeper up-welling groundwater may be discharging into sediments at the base of Quaternary alluvium from the basement, however there is no apparent upward connection through the clay dominated sediments to the stream bed, and there are no observed springs or seeps in the creek beds.

Due to the elevated groundwater salinity and potential final void salinity, it is not proposed to discharge site water into the local surface water system as the water does not conform to ANZECC 2000 criteria for SE Australian Upland Rivers.

It is not anticipated that pit dewatering or on site surface water storage volumes would be exceeded so that off site discharge of saline water is required due to the low pit inflow rates, low rainfall and high evaporation in the area.

9.2 Potential Impact on the Namoi River and Local Alluvial Groundwater Resources

Modelling indicates that groundwater drawdown from mining the proposed Sunnyside Pit would not extend significantly into or within the alluvium of Coocooboonah Creek, and would not extend into the alluvium of Native Cat Creek, Rock Well Creek or tributaries of the Namoi River.

Mining the Sunnyside open cut would not affect river flow or groundwater supplies associated with the Namoi River alluvium.

9.3 Potential Impacts on Groundwater Dependent Ecosystems

No groundwater dependent ecosystems (GDEs) have been identified within the Sunnyside Project Site, and therefore there are no anticipated adverse effects on GDEs.

10 Monitoring, Rehabilitation, Contingency Measures and Reporting

10.1 Monitoring

A groundwater monitoring programme as outlined below would be initially conducted for 1 year and then extended with modification, following annual reviews and assessment of additional data.

The groundwater monitoring program is anticipated to be extended beyond the active mine life in order to assess the potential long term change in groundwater re-pressurisation and water quality, with the program continuing for a period agreed with the DWE / DPI-MR after closure of the relevant mining operations.

10.1.1 Sunnyside Piezometer Groundwater Levels and Groundwater Quality

A monitoring program that utilises at least 2 water level loggers, with one in the coal measures and one in the Coocooboonah Creek alluvium reading at 12 hourly intervals, along with monthly manual water level readings in piezometers P1 to P8 is recommended.

The monitoring program would be consistent across the Project Site and would have an emphasis on capturing real time data from bores located in the vicinity of surface water systems and in close proximity to the proposed open pit and abandoned underground workings.

Quarterly measurement of groundwater field pH and EC in P1 to P8 would be conducted, with annual laboratory analysis at a NATA registered laboratory for major cations and anions, total dissolved solids and selected metals.

Sampling and testing procedures would be conducted according to the Australian Guidelines for Water Quality Monitoring and reporting (ANZECC, 2000).

10.1.2 Private Bore and Well Groundwater Levels, Yield and Groundwater Quality

There are two known operational private bores within the Sunnyside drawdown area that may be affected by mine dewatering. Both bores are on the “Lilydale” property, with less than 1m of potential drawdown predicted in GW44884 and GW6249.

Quarterly measurement of the standing water level within the “Lilydale” bores as well as field assessment of pH and EC and annual laboratory analysis of groundwater samples would be conducted, with periodic reports documenting and interpreting the collected data.

If requested by the landowner due to concerns they may have, the pre-mining yield of the private bores may be tested in the field via a pump out test to determine their current status, with a follow up test, if required, if the bores are thought to be adversely affected due to mine dewatering.

The private bore monitoring program would be initiated prior to extraction of the pit, with ongoing review and possible modification of the program as further data is interpreted.

Where access is available, groundwater samples would be collected annually from the private bores and analysed at a NATA registered laboratory for major ions and selected metals.

Available private bores outside of the “Lilydale” and “Sunnyside” properties, as shown in **Drawing 9**, would be monitored in the field for standing water levels as well as field pH and EC every 6 months, with ongoing review of the data as the mine proceeds, to assess whether modification to the scheduled monitoring is required.

10.1.3 Mine Water Pumping

The volume of water pumped out of the open pit and / or into the abandoned underground workings would be monitored to compare the actual volume of pumped water to the predicted water management volumes.

10.1.4 Water Placement in Gunnedah No. 5 Workings

Following consultation and agreement with the DWE, it is proposed to install dedicated piezometers, with sealed screen intakes beneath the Hoskissons Seam at agreed locations in the vicinity of the proposed open cut pit and No.5 underground workings to enable monitoring of groundwater level and groundwater quality changes that may occur due to aquifer depressurisation and / or placement of pit water into the decommissioned, mostly “dry” underground workings.

These piezometers will augment the existing piezometers within the Hoskissons Seam and into the underground workings as required.

A management plan will be developed to avoid degrading the water quality in the No.5 underground, Hoskissons Seam and underlying strata through introduction of open pit void water. The plan will include, but will not be limited to the following strategies.

- Water will not be put into the workings if it exceeds the upper bound water quality of the Hoskissons Seam or No. 5 underground workings.
- Monitoring of the open cut void water, No.5 underground, Hoskissons Seam, underlying strata and pit dewatering storage dams.
- “Shandying” the in-pit void water with excess stored surface water before delivering it into the void, if required,

There would be a number of management strategies implemented to minimise the likelihood of hydrocarbon contamination. These are fully discussed in Section 2.9.1.2 of the Environmental Assessment.

If an unexpected spill occurs, measures would be implemented to manage the likely impacts. These measures would include the following.

1. Should any hydrocarbons be detected within the pit sump they would be removed by tanker and taken to the oil storage tanks within the bunded section at the maintenance workshop. They would be collected by a licensed waste recycling contractor along with other site waste hydrocarbons. Should the spill be large, the tanker would take the material offsite for appropriate treatment and disposal.
2. NMPL will have access to a floating containment boom as part of the Whitehaven Groups oil spill response equipment located in the Gunnedah vicinity. This response equipment would be available for use at Sunnyside, if required. Employees would be trained in its use.
3. Not all water would be removed when water is pumped from the pit sump. This would ensure that any floating hydrocarbons remain within the sump and be available for removal and recycling as described above. There will be no soluble oils used on site and should there be an accidental spill, all hydrocarbons would float on the surface of the pit water.
4. When pit water passes from the first turkey's nest dam into the second, it will pass through a combined solid and flexible barrier oil skimmer arrangement. This will minimise the likelihood of any surface floating hydrocarbons being delivered to the second turkey's nest dam.
5. When water is discharged from the second turkey's nest dam and directed into the No.5 workings, not all water in the dam will be removed. This will retain any floating hydrocarbons within the second turkey's nest dam from where they will be removed as required.
6. Monitoring will be undertaken to ensure the quality of pit water pumped into the first turkey's nest dam, the quality of the water in the second turkey's nest dam immediately prior to discharge, and the quality of the water within the underground workings. Records will also be kept of the volumes of water delivered into the dams and directed underground. The parameters tested by monitoring will include, pH, salinity, oil and greases and Total Suspended Solids (TSS).
7. Monitoring of the water being delivered into the first turkey's nest dam will identify any potential contamination and enable management measures to be implemented to control the quality of water eventually placed underground. Monitoring immediately prior to discharge from the second turkey's nest dam will confirm the quality of water to be placed underground. Monitoring of water within the underground workings will confirm water quality within that aquifer. Measuring the volumes of water will enable water balances to be maintained and ensure that storage volumes are adequate for ongoing water placement.

10.1.5 Rainfall

Rainfall would be monitored daily at the on-site weather station for the duration of mining.

10.1.6 Ongoing Monitoring

All results would be reviewed and an updated monitoring and remediation program would be developed annually, if required, in association with DWE and DPI-MR.

10.1.7 Quality Assurance and Control

QA/QC would be attained by calibrating all measuring equipment, ensuring that sampling equipment is suitable for the intended purpose, using NATA registered laboratories for chemical analyses and ensuring that site inspections and reporting follow procedures outlined in the ANZECC 2000 Guidelines for Water Quality Monitoring and Reporting.

10.2 Contingency Measures

Contingency procedures would be developed, as required, to manage any impacts identified by monitoring that may indicate un-anticipated effects in the groundwater system's response to mining.

Activation of contingency procedures would be linked to assessment of monitoring results, including both water quality and aquifer pressure levels, as well as the rate of water level changes as outlined above.

Performance indicators would be identified and agreed to by DWE/ DPI-MR prior to mining, and in order to detect when a significant change has occurred in the groundwater environment, a statistical assessment would be undertaken prior to mining.

The assessment would benchmark the pre-mining natural variation in groundwater quality and standing water levels, and from this trigger levels would be set for accepting accountability.

10.3 Impact Assessment Criteria

10.3.1 NMPL and Private Bore Groundwater Levels and Yield

There are no specific groundwater level or aquifer depressurisation criteria developed at this stage for either the coal measures or Quaternary alluvium due to in-sufficient monitoring data.

Impact assessment criteria investigation trigger levels would be initially set at an overall 3m sustained reduction in monitored groundwater levels in a private bore over a 3 month period.

In addition, the actual rate of change of water levels would be investigated to determine whether a change is solely mining induced or due to a range of other potential factors, such as variation in climate or altered groundwater extraction by a landowner.

The monitoring, management and rehabilitation strategy used would comply with the relevant aquifer interference policies of the DWE.

It is proposed that the water level monitoring data would be plotted and interpreted every twelve months, and if there is a significant increase in the rate of rise or fall in aquifer water levels, based on interpretation by a qualified hydrogeologist, then an assessment would be conducted to determine the cause of the change and to consider potential contingency measures that may be adopted.

If requested, the yield of a private bore may be tested in the field prior to extracting the pit. If a bore is thought by a landowner to be adversely affected due to mining effects, an initial "desk top" assessment would be made as to whether the potential adverse effects may be due to mine dewatering. If the effects may be due to mining, the bore would be re-tested in the field and the cause of the adverse effect would be assessed.

10.3.2 Sunnyside Piezometer and Private Bore Groundwater Quality

Groundwater quality impact assessment criteria are sourced from the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 2000) for Primary Industries (Irrigation Water) as shown in **Table 17**.

Table 17
Groundwater Quality Impact Assessment Criteria

Indicator	Irrigation Criteria
pH	<6.5 or >8.5 or >10% variation over 3 months compared to previous 12 months data
Conductivity	>10% variation over 3 months compared to previous 12 months data
TDS	>13,000mg/L or >10% variation compared to previous 12 months data
Na	>460mg/L or >10% variation compared to previous 12 months data
K	>10% variation compared to previous 12 months data
Ca	>1000mg/L or >10% variation compared to previous 12 months data
Mg	>10% variation compared to previous 12 months data
Cl	>700mg/L or >10% variation compared to previous 12 months data
HC03	>10% variation compared to previous 12 months data
N03	>400mg/L or >10% variation compared to previous 12 months data
S04	>1000mg/ or >10% variation compared to previous 12 months data
Hardness	>350mg/L as CaCO3 or >10% variation compared to previous 12 months data

A trigger to assess the cause and effects on groundwater quality would be implemented when there is a prolonged and extended non-conformance of the outlined criteria at a particular piezometer or bore.

If a parameter is outside the designated criteria for at least six months, or alternatively, if it exceeds its previous range of results by greater than a 10% variation for at least 6 months, then the cause would be investigated, and a remediation strategy proposed, if warranted.

The criteria and triggers would be reviewed after the initial 12 month of data is interpreted and may be modified as appropriate, depending on the results.

If the impacts on the groundwater system resulting from mining is demonstrated to be greater than anticipated, the company would:

- assess the significance of these impacts;
- investigate measures to minimise these impacts; and,
- describe what measures would be implemented to reduce, minimise, mitigate or remediate these impacts in the future to the satisfaction of the Director-General.

10.4 Piezometer Licensing, Maintenance and Installation

The current piezometer network would be maintained by protecting the wellhead from damage by cattle and from scrub fires by installing steel wellheads.

If required, the piezometers may be cleaned out by air sparging if they become clogged.

All new bores or piezometers would be installed by suitably licensed drillers after obtaining the relevant licence from DWE.

10.5 Rehabilitation

Remedial action may be required if monitoring results indicate the agreed standards or performance indicators are not being achieved due to failure or ineffectiveness of the company's management strategies.

Due to the localised dewatering effect from the proposed pit, it is not anticipated that groundwater system rehabilitation would be required.

10.6 Reporting

The annual report would contain an interpretation of the data along with:

- a basic statistical analysis (mean, range, variable, standard deviation) of the results for the parameters measured;
- interpretation of water quality and standing water level changes supported with graphs or contour plots; and
- interpretation and review of the results in relation to the impact assessment criteria.

At the completion of the mine, a report would be prepared that summarises all relevant monitoring to date. The report would outline any changes in the groundwater or surface systems within the study area.

Relevant monitoring and management activities for each year would be reported in the mine's Annual Environmental Management Report (AEMR).

11 Conclusions

The proposed Sunnyside Open Cut coal mine is planned to be excavated to maximum depth of 65m below surface (295m AHD) over a period of approximately five years to extract the 6m to 9m thick Hoskissons Seam in elevated country approximately 15km west of Gunnedah.

The Hoskissons Seam has been previously mined by bord and pillar methods in the Gunnedah Colliery underground No.1 to 5 workings, which are located down dip and to the south of the proposed open cut pit.

Drilling and monitoring of 8 piezometers and 15 coal exploration bores in the mine vicinity along with assessment and field confirmation of 20 privately operated bores within 3km of the proposed mine indicate very low groundwater yields (<0.63L/sec).

Six exploratory bores drilled in, or adjacent to, the abandoned underground workings, piezometer monitoring and coal exploration records indicate the workings are mostly dry, apart from a down-thrown block faulted area located approximately 40m south of the proposed pit, which contains approximately 31.2ML of stored water.

Assessment of water levels and remnant void space indicates there is at least 1523ML of unfilled workings in the abandoned mine, and that water levels in the underground are primarily beneath the excavated workings and lower than the basal level of the proposed pit, outside of the isolated down-thrown block faulted section.

Field and laboratory tests indicate the:

- out-of-pit overburden batch test leachate results range from pH 6.97 to 8.43, with electrical conductivity values ranging from 724µS/cm to 2 590µS/cm;
- No. 5 Underground water pH ranges from 6.90 to 8.10, with electrical conductivity values between 3 590µS/cm to 7 360µS/cm; and
- Hoskissons Seam pH ranges from 6.62 to 7.9, with electrical conductivity values between 2 260µS/cm and 12 650µS/cm.

The proposed open cut pit is located on the outcropping flanks of Coocooboonah Creek and would be excavated through Early Triassic overburden into the Late Permian Hoskissons Seam, with no excavation through Quaternary alluvium or any associated alluvial aquifers.

The Quaternary alluvium of Coocooboonah Creek to the east and Native Cat Creek to the north can extend to at least 50m thick, whilst Rock Well Creek to the west of the Project Site is recorded to have up 10m of alluvium. No registered bores extract groundwater from the Quaternary alluvium within at least 3km of the proposed mine.

The Hoskissons Seam and its associated overburden and underlying formations are significantly intruded and / or contact metamorphosed by doleritic sills and dykes, which can be regionally extensive, particularly to the west, north and south of the proposed open cut. In addition, the stratigraphy is also significantly faulted in the same regions.

The Project Site is located within an essentially dry, ephemeral first order stream catchment which drains to the essentially dry, ephemeral Coocooboonah Creek. Coocooboonah Creek then drains into Native Cat Creek, Collygra Creek, then to the Namoi River approximately 13km northeast of the Project Site. It is located within a low rainfall, high evaporation climatic regime.

Streams in the area were dry during the study period apart from a small short lived ponding episode following a short duration storm in Coocooboonah Creek, which indicated a circum-neutral stream water pH of 7.3 and electrical conductivity of 272µS/cm.

Of the 20 registered operating private bores within 3km of the mine site, 5 extract water from formations above the Hoskissons Seam, 2 extract from within the seam and 13 extract from lithologies beneath the Hoskissons Seam, particularly the Upper and Lower Melville Seams. All private bores have yields below 0.63L/sec, electrical conductivity values of between 510 – 10 080µS/cm and circum neutral pH.

Two piezometers were installed to 41m below surface in the Coocooboonah Creek alluvium, 3 were installed to 81m below surface in the Hoskissons Seam and 3 were installed in the underlying Late Permian Shallow Marine Facies and Lower Delta Plain Facies to a maximum depth of 90m.

Short duration pump-out tests and falling head tests assessed the Quaternary alluvium to have hydraulic conductivities below 5.3m/day. The Hoskissons Seam hydraulic conductivity ranged up to 4.0m/day whilst the underlying formations, excluding the Melville Seam, ranged up to 2.1m/day.

Groundwater within the Hoskissons Seam is unconfined where it subcrops beneath the Coocooboonah Creek alluvium, and progressively becomes more confined toward and west (down dip) of the proposed pit.

Groundwater quality of the tested overburden, Hoskissons Seam and underlying formations generally exceeded the ANZECC 2000 upland stream freshwater and 95% trigger level for freshwater species for electrolytical conductivity, total nitrogen, total phosphorus, copper, zinc, and to a lesser degree, nickel and manganese.

Acid Rock Drainage laboratory analyses and batch leach tests indicated that the waste rock is not potentially acid producing.

A FEFLOW groundwater model was sequentially assessed in six stages (Case 1 to Case 6) as the understanding of the regional hydrogeological system developed. The model represented the Project Site with four layers, which incorporated the proposed coal extraction in the Sunnyside pit as well as the effect of adjoining highly weathered doleritic intrusions in the Hoskissons Seam and the adjacent, mostly dry, Gunnedah No. 5 underground workings.

The Case 6 model assessment indicates a regionally limited area of groundwater depressurisation, with the majority of groundwater level decline occurring in the overburden above the confined Hoskissons Seam.

It is not predicted that drawdown will exceed more than up to 1m in bedrock formations outside of the immediate Sunnyside open cut pit area.

No observable drawdown is predicted in the overlying Quaternary alluvium of Coocooboonah Creek, Rock Well Creek, Native Cat Creek, Collygra Creek or the Namoi River.

Due to their anticipated low hydraulic conductivity, the highly weathered igneous intrusions in the vicinity of the pit significantly reduce the predicted pit inflows and extent of the cone of depression

The mostly dry No.5 underground workings to the south and down dip of the pit have a standing water level mostly beneath the base of the proposed pit, which significantly limits the regional groundwater drawdown and rate of inflow to the proposed pit.

Pit inflows of between 64ML/year and 106ML/year are postulated by the Case 6 model scenario, however the high evaporation rate would significantly reduce the volume of any water required to be pumped out of the pit. The mine requires around 75-100ML/year of non potable water, which may not be able to be supplied solely by pit seepage. The mine water supply requirements would be supplied, as needed, by a combination of pit seepage collection, dirty surface water circuit catchments and pumping from the No. 5 underground workings, where and if water is available.

The model indicates that the DWE registered bores on the “Sunnyside” property closest to the proposed pit would be affected by less than 5m of groundwater depressurisation following mining, however these bores are owned by the Proponent.

The two private bores on the “Lilydale” property may observe dewatering of less than 1m, however, no other bores within the Project study area are anticipated to be adversely affected by groundwater depressurisation.

No adverse effects are anticipated on the Namoi River or its associated alluvial groundwater systems, and no adverse effects are anticipated on Groundwater Dependent Ecosystems in the study area.

No adverse effect on groundwater quality is anticipated in the study area from operation of the Sunnyside Mine.

Calculations indicate the Sunnyside Open Cut Pit void water could range from electrical conductivity values of approximately 5,800µS/cm to 11,000µS/cm, depending on the relative proportions of groundwater inflow and surface water runoff, with a pH between 6.90 and 8.43.

Post mining groundwater levels are modelled to recover to approximately 293m AHD after mine closure, depending on the actual as-mined hydrogeological conditions, whereas it is planned to backfill and rehabilitate the pit to a base level of 305m AHD.

Based on the projected in-pit rainfall catchment during mine operation and the reduced post rehabilitation catchment area, it is assessed that the combined groundwater seepage and post rehabilitation in pit rainfall catchment would not raise the backfilled pit water level above the 305m AHD backfill level, and as a result, a pit void lake is not anticipated to occur.

12 Coverage of Director-General's Requirements

This section outlines where the relevant groundwater related Director-General's Requirements as outlined by Government agencies are discussed in this report.

AGENCY	REQUIREMENT	RELEVANT SECTIONS	COMMENT
Department of Environment and Conservation (now Department of Environment and Climate Change)	Impact on water quality	6.6, 6.7, 6.8	
	Assessment of final void water quality impacts	6.9, 6.10	
	Impact on water quantity and groundwater seepage into the mining void	7.8, 7.9	
	Assessment of potential water quality impacts on groundwater resources	6.6, 6.7, 6.8	
	Water quality data for the old Gunnedah mine and demonstrate that the proposed use is appropriate	6.7, 6.7.1	
	Assessment of likely frequency of discharges from the final mining void following rehabilitation	_	No discharge anticipated
	Discharges from the mining void would meet ambient water quality targets.	_	No discharge anticipated
	Stored mine void water quality would meet requirements for proposed future land-use on the premises	_	Mine void water not anticipated to be used or discharged from the rehabilitated pit
Department of Natural Resources (now Department of Water and Energy)	Information on the water table in the area	4.1, 4.2, 4.4, 6.1, 6.2, 6.3	
	Potential impacts on the quantity of groundwater in the area	7.7	
	Potential impacts on the quality of groundwater in the area	7.11 7.12	
	Potential impacts on other groundwater users	7.7	
	Information on the potential for the mine to intercept the water table	7.7	
	Potential contamination issues	7.11 7.12	
	Information from piezometers on site	4.1, 4.2, 4.4, 6.1	
	Monitoring and mitigation plan for groundwater	8.0	
Gunnedah Shire Council	Detailed analysis of the impact of the mining operation on water quality within the catchment in which the mining operation is located.	7.7	
	An ongoing water monitoring program is required to ensure that water quality and quantity is not affected by the mining operations.	8.0	
Department of Primary Industries – Mineral Resources	Predict the quality of stored water post mining	7.11	
	Provide rigour in the monitoring, prediction and assessment of groundwater impacts in the light of community sensitivity in the region.	8.0	
	The potential for groundwater drawdown effects during open cut operations and longer term recovery would be modelled	7.0	
	Assess the potential for supply and reuse of stored underground mine water within the existing Gunnedah Colliery No 5 workings	7.17	

13 References

Amira International, 2002, Free Draining Leach Column Test Procedure - ARD Test Handbook, Project P387A Prediction and Kinetic Control of Acid Mine Drainage.

ANZECC 2000, Australian and New Zealand Guidelines for Fresh and marine Water Quality, Vol 1 & 2

Beckett, J, 2007 Sunnyside Water Bore Drilling 2007 Basic Data

Broughton, A, 1994, Upper Eastern Mooki River Catchment Hydrogeological Investigation and Dryland Salinity Studies, Liverpool Plains, NSW, Vol 1, 2, Department of Water Resources Tech Serv Div TS94.013

Coffey Geotechnics Pty Ltd, 2007A Sunnyside Coal Project Groundwater Modelling Review (21 Sept, 2007)

Coffey Geotechnics Pty Ltd, 2007B Sunnyside Coal Project Groundwater Modelling Review – Commentary on Golder and Geoterra Response (21 Dec., 2007)

Cox, A.OJ. 1991, Report to Accompany Renewal Application for Authorisation 387,Gunnedah Coal Company Ltd, unpub

Cox A.OJ, Kelly R.W. 1983, A Geological Evaluation of Gollin Wallsend Coal Company Limited Gunnedah Authorisations, report GR23, Vol. 1, Consolidated Coal of Australia, unpub.

Coxhead. C 1989, Proposed New Coal Lease at Gunnedah Colliery, statement of Environmental Effects, report GR 60, Gunnedah Coal Company Ltd, unpub.

DEC, 2004, Contaminated Sites: Draft Guidelines for the Assessment and Management of Groundwater Contamination

DIPNR, 2002, Draft Guidelines For management of Stream Systems in Coal Mining – Hunter Valley

DIPNR, 2003, Groundwater Monitoring Guidelines for Mines Within the Hunter region

DIPNR, 2005, Coal Mining Potential in the Upper Hunter Valley – Strategic Assessment Environmental Planning & Assessment Act 1979

DLWC, 1997, The NSW State Groundwater Policy Framework Document

DLWC, 1998, The NSW State Groundwater Quality Protection Policy

DLWC, 1998, Aquifer Risk Assessment Report

DLWC, 2002, The NSW Groundwater Dependent Ecosystems Policy

DWE, 2003, Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources

DUAP, 2000, Coal Mines and Associated Infrastructure - EIS Guideline

Hem, J.D. 1989, Study and Interpretation of the Chemical Characteristics of Natural Water, 3rd ed., USGS Water Supply Paper 2254

Hancock G.R, Wright A.& De Silva H, 2005, Long Term Final Void Salinity Prediction For a Post Mining Landscape in the Hunter Valley, New South Wales, Australia, Hydrol. Process. 19, pp387-401, John Wiley & Sons Ltd

Ivkovic K.M, et al, 2004. Groundwater – River Interactions in the Namoi Catchment, NSW and Their Implications For Water Allocation, 9th Murray – Darling Basin Groundwater Workshop, 2004

Kuehne G., Bjornland H, 2006, Frustration, Confusion and Uncertainty – Qualitative Responses From Namoi Valley Irrigators, pp78-82, Water, Journal of the Australian Water Assoc, May 2006

Namoi Mining Pty Ltd, 2006, Exploration Licence 5183 Gunnedah NSW Sunnyside Deposit, 2005-6 Exploration Basic data geology report, unpub

NCMA, 2005, Catchment Action Plan

NCMB, 2002, Integrated Catchment Management Plan for the Namoi Catchment

NSW EPA, Interim water quality and Water flow objectives for the Namoi River

PPK Environment & Infrastructure, 2002, ACARP Project NoC7007 Water Quality and Discharge Predictions to Final Void and Spoil Catchments

Pratt, W. 1998, Gunnedah Coalfield, Notes to Accompany the 1:100,000 Scale Gunnedah Coalfield Regional Geology (North and South) Maps, Geological Survey Report GS1998/505, NSW DMR

Soil Conservation Service, 2007, Sunnyside Coal Project Surface Water Assessment

Standards Australia (1997), AS4439.3-1997, Australian Standard Leaching Procedure – Wastes, Sediments and Contaminated Soils, Part 3: Preparation of Leachates, Bottle Leaching Procedure. Standards Australia, Homebush

NSW Govt, Water Management Act 2000

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The findings contained in this report are the result of discrete / specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site / sites in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site / sites at all points. Should information become available regarding conditions at the site, GeoTerra reserve the right to review the report in the context of the additional information.

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DRAWINGS

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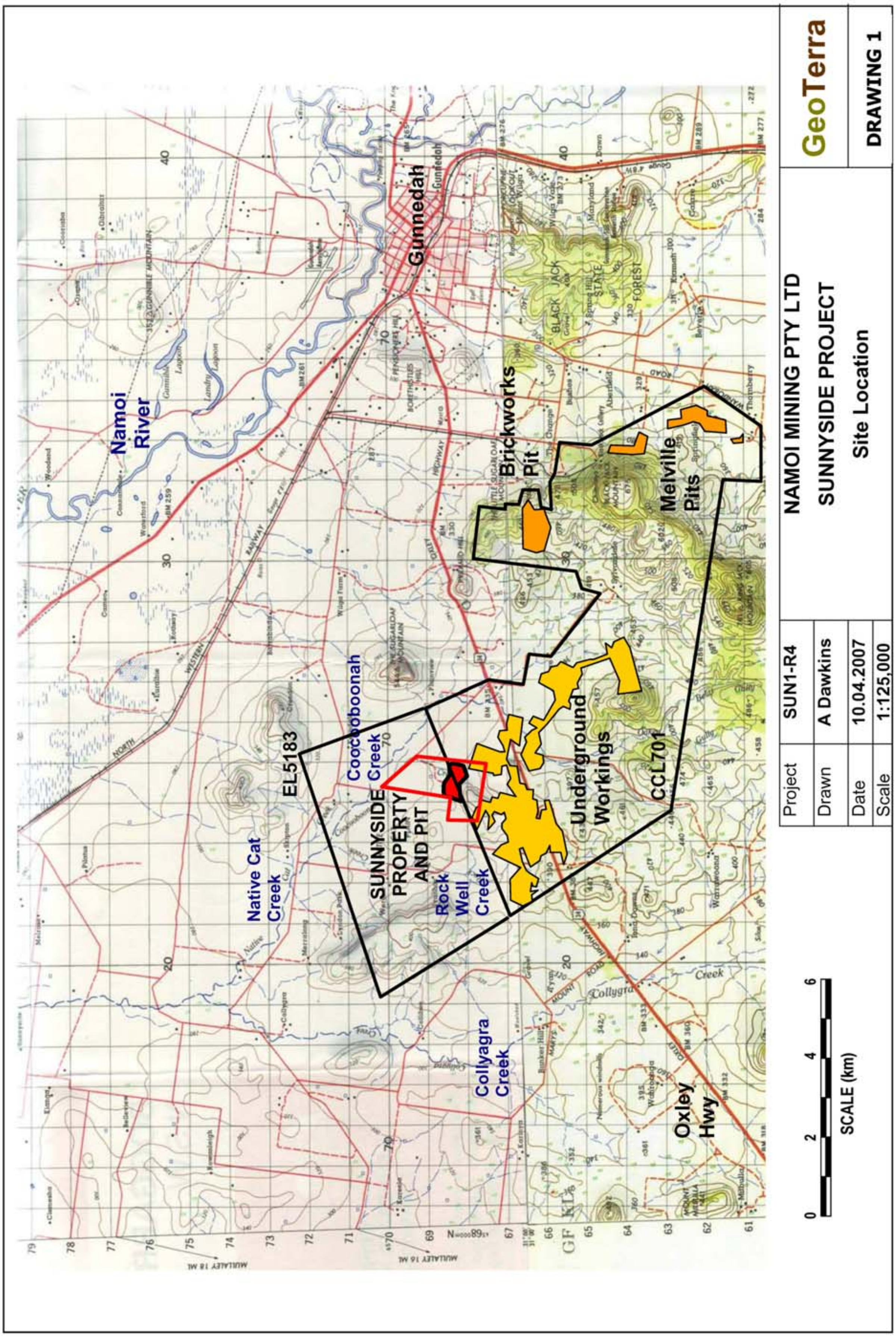


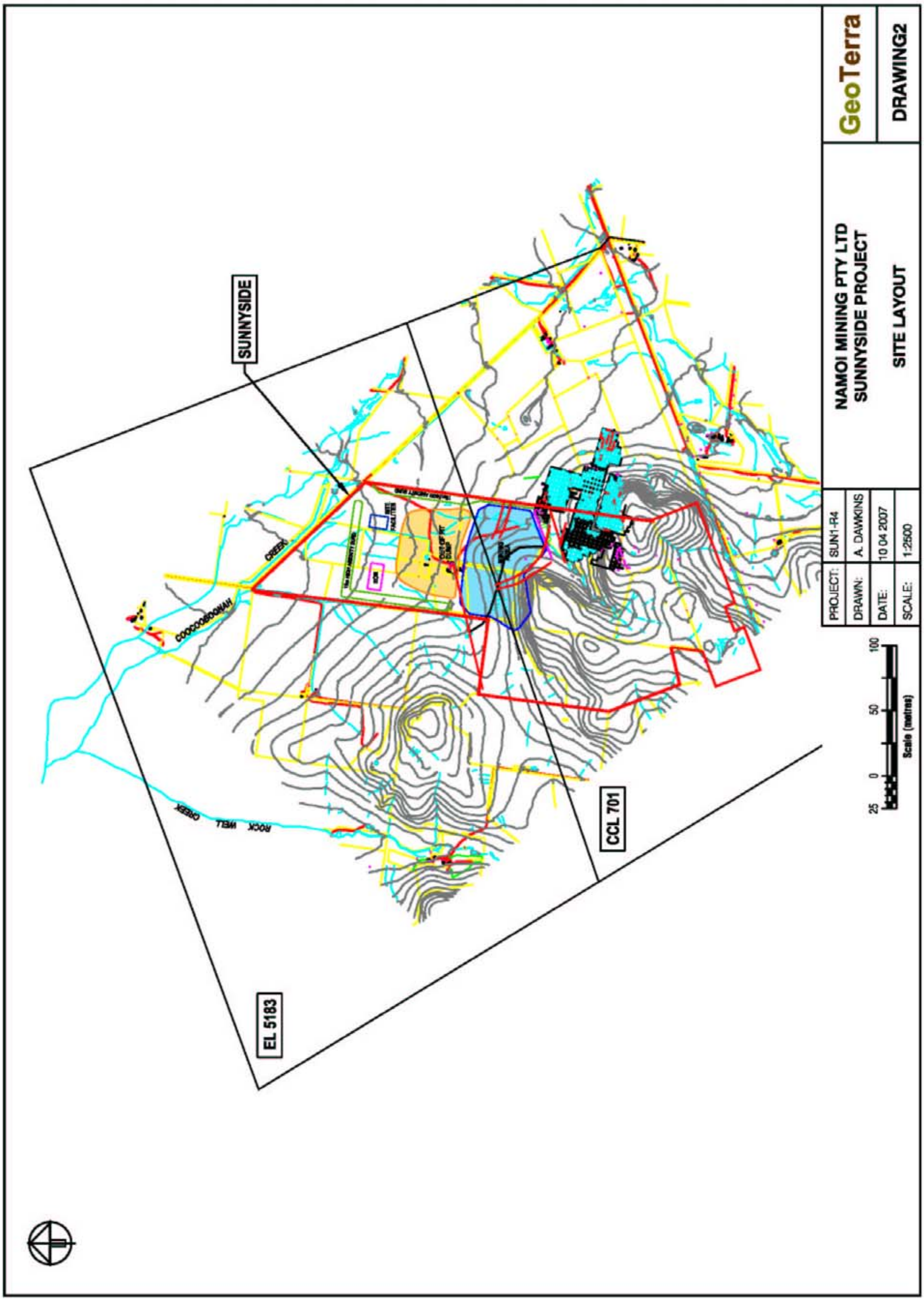
GeoTerra

DRAWING 1

NAMOI MINING PTY LTD
SUNNYSIDE PROJECT
Site Location

Project	SUN1-R4
Drawn	A Dawkins
Date	10.04.2007
Scale	1:125,000

Note: A colour version of this figure is available on the Sunnyside Coal Project CD



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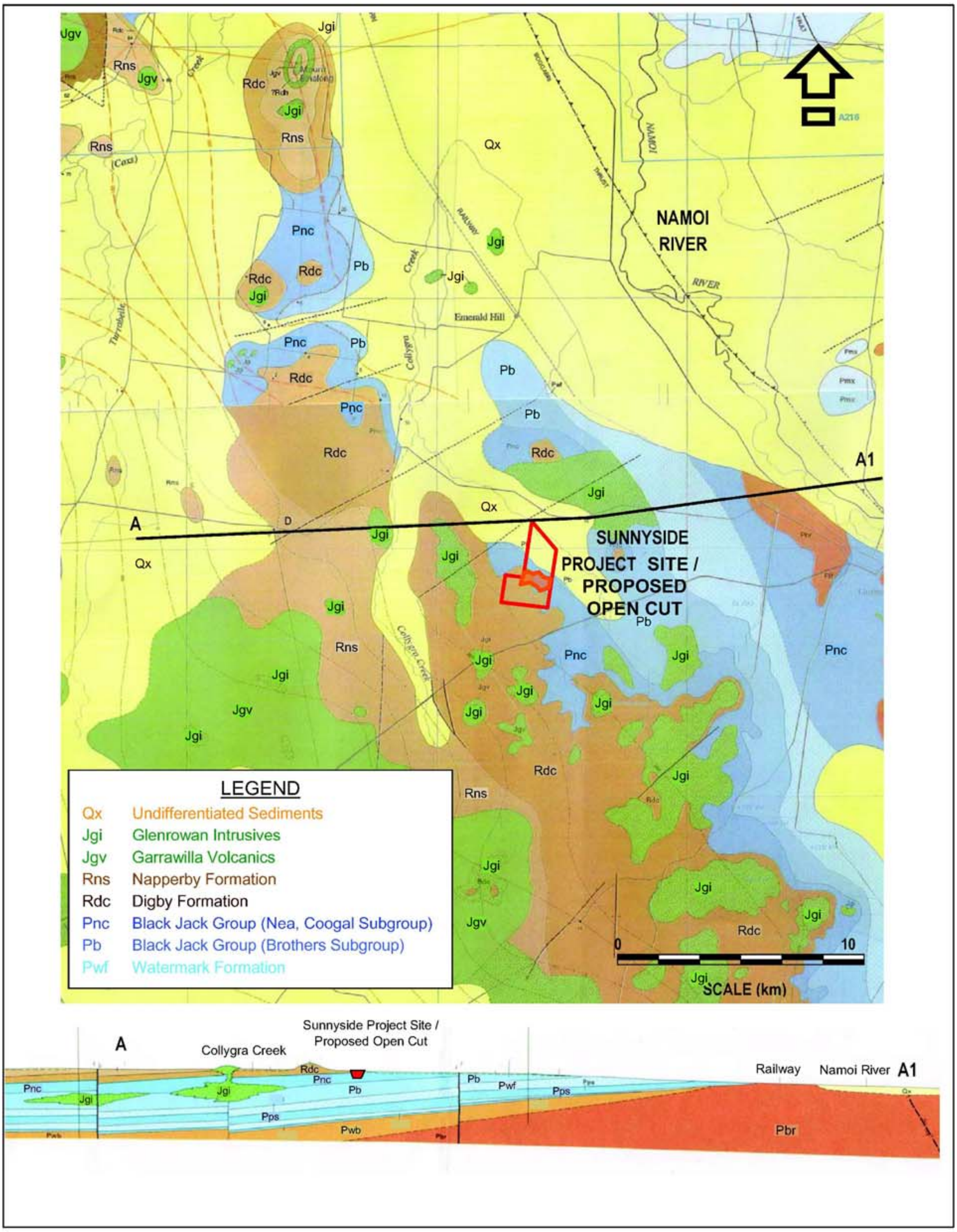

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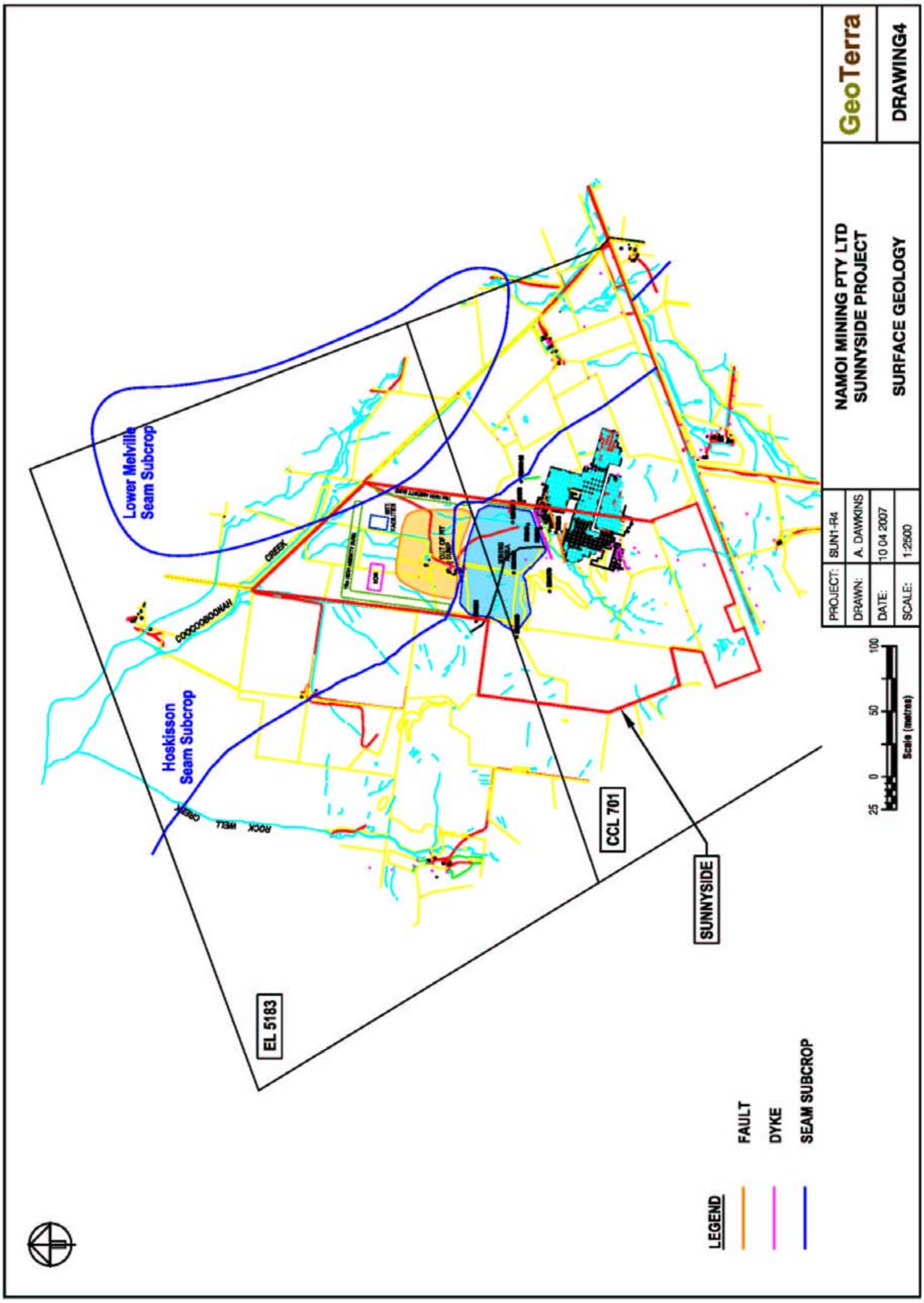
Drawn	A Dawkins	SUNNYSIDE PROJECT	
Date	10.04.2007		DRAWING 3
Scale (approx)	As Shown	Regional Geology	



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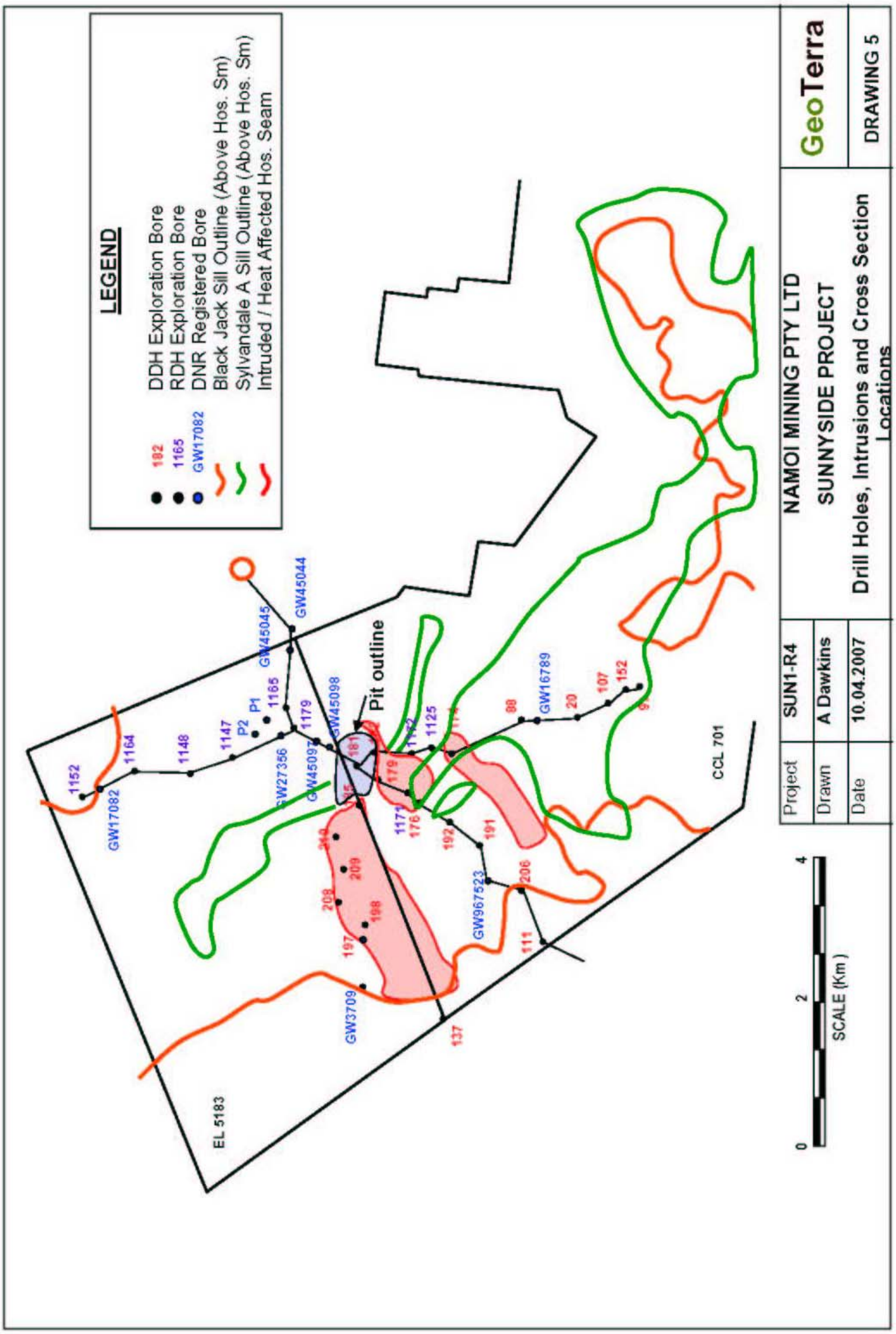

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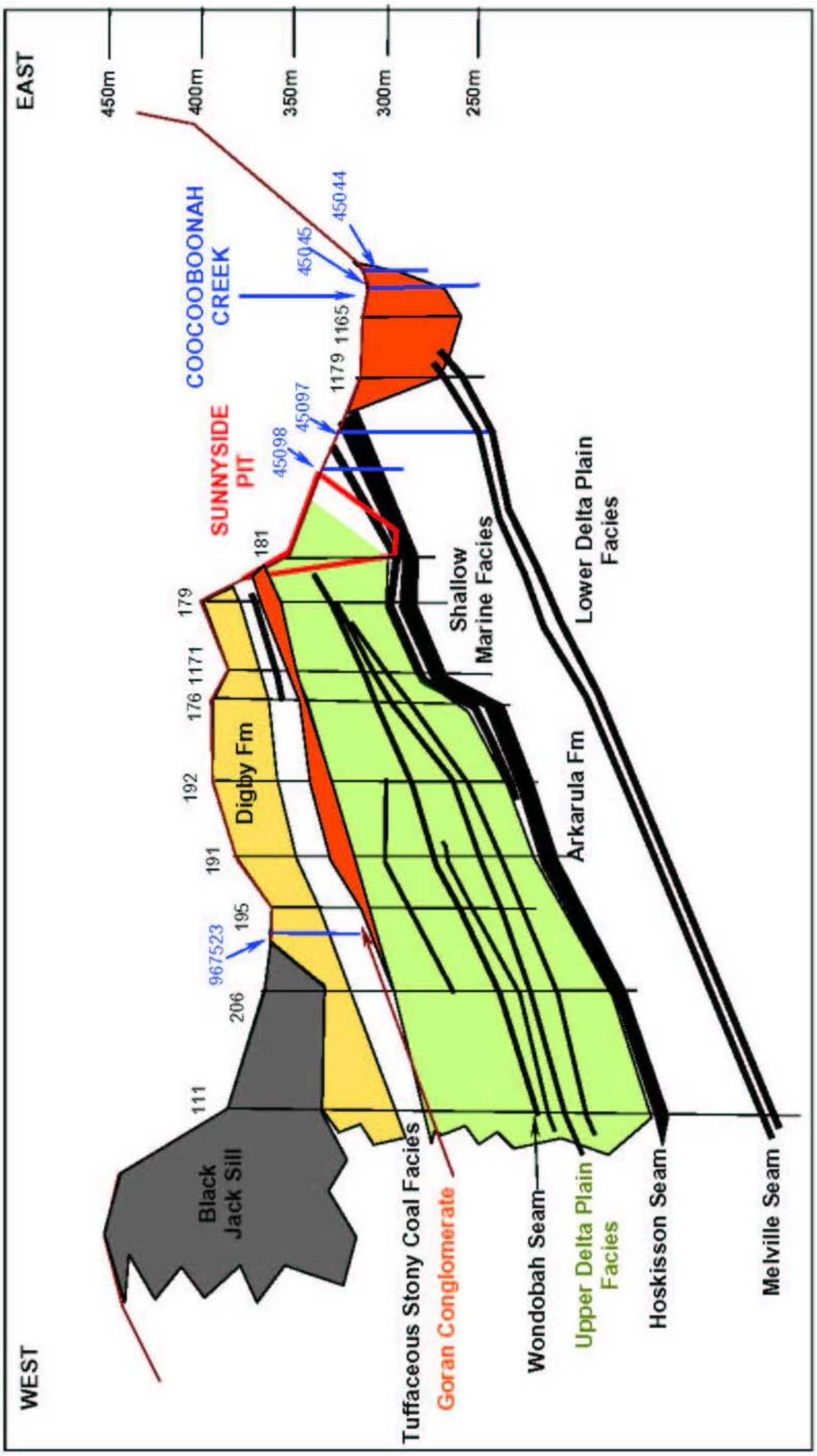


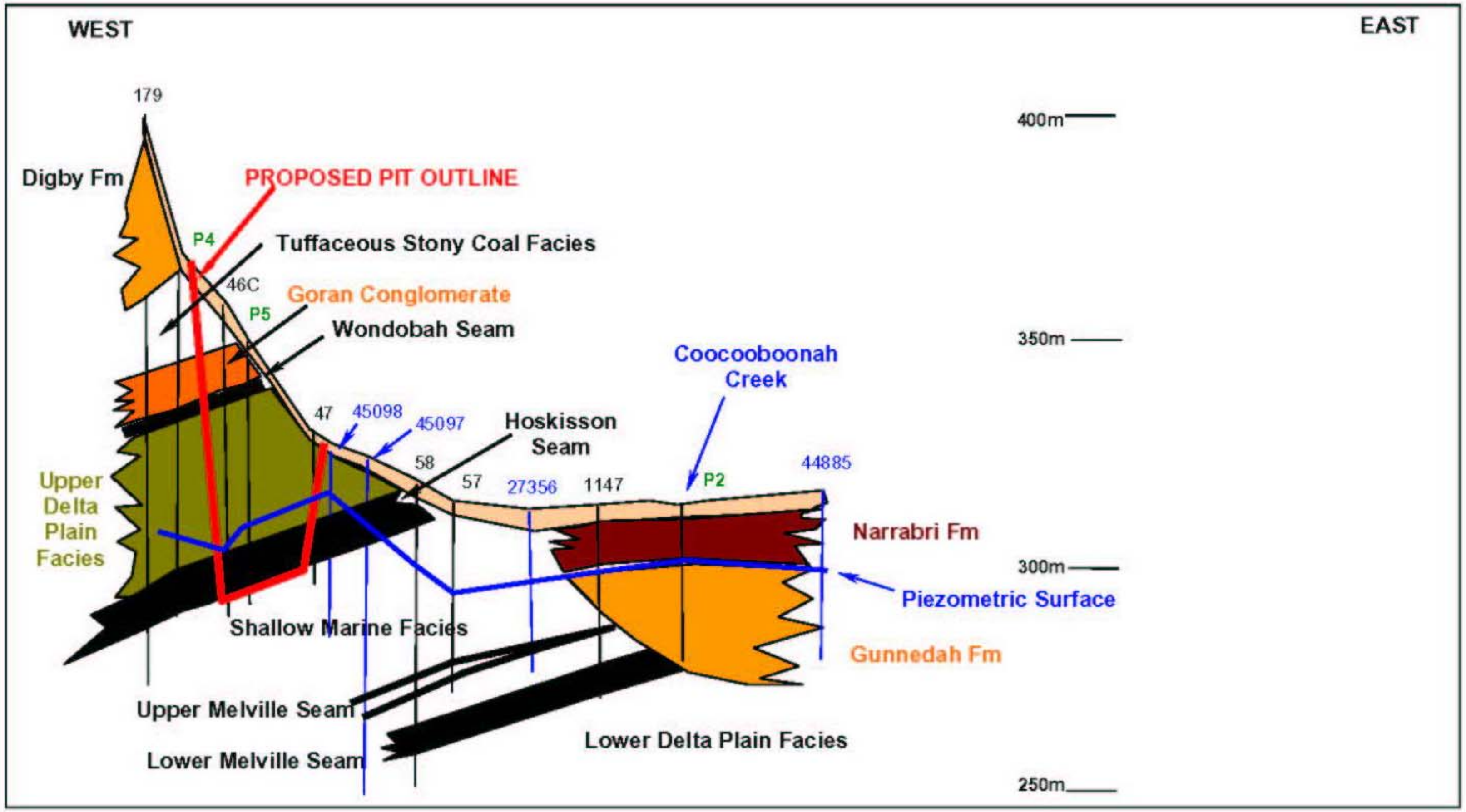
NAMOI MINING PTY LTD
SUNNYSIDE PROJECT
East West Cross Section

Project	SUN1-R4
Drawn	A Dawkins
Date	10.04.2007
Scale	As Shown

GeoTerra

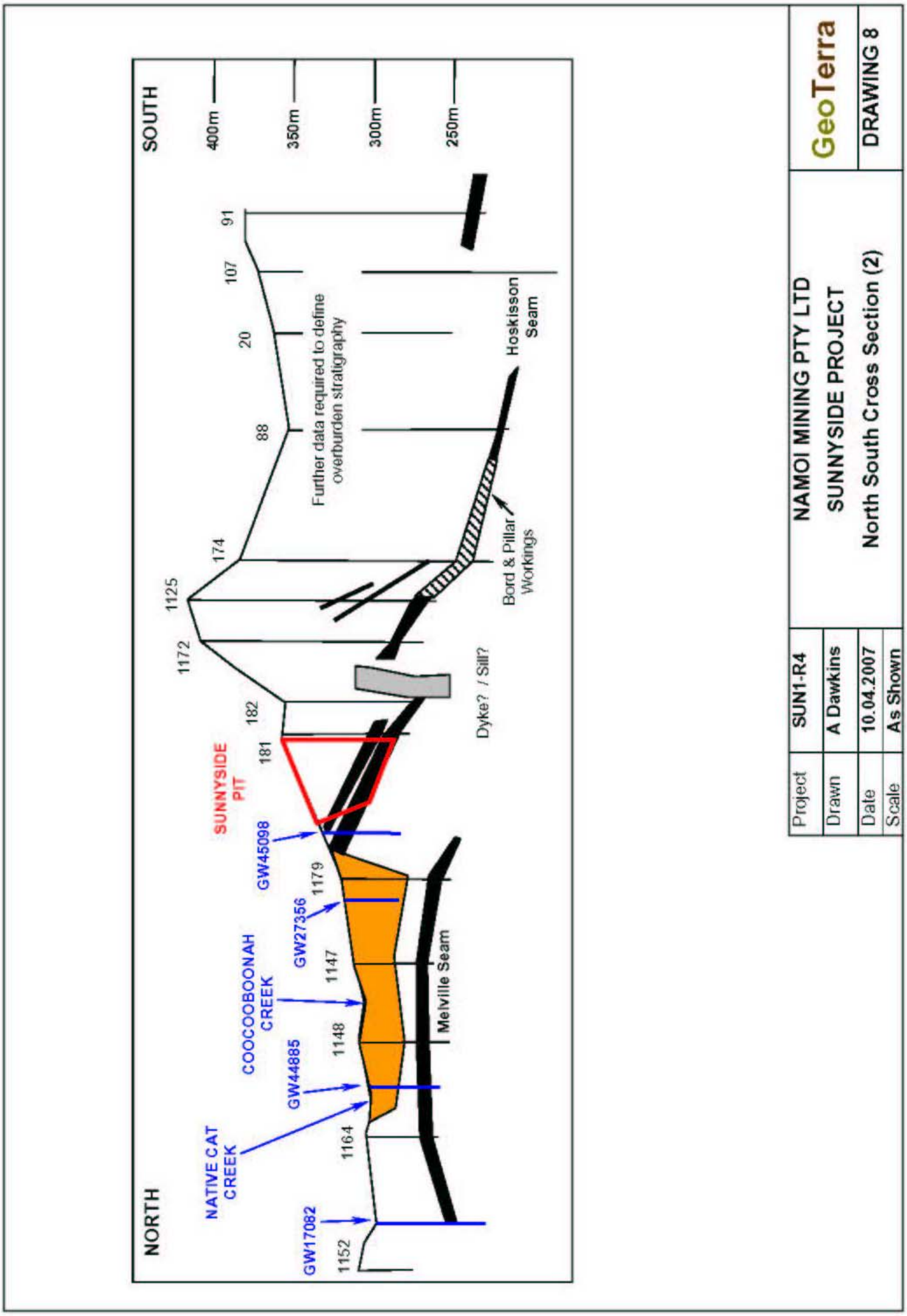
DRAWING 6

Note: A colour version of this figure is available on the Sunnyside Coal Project CD



Project	SUN1-R4	NAMOI MINING PTY LTD SUNNYSIDE PROJECT North South Cross Section (1)	GeoTerra
Drawn	A Dawkins		
Date	10.04.2007		DRAWING 7
Scale	AS Shown		

Note: A colour version of this figure is available on the Sunnyside Coal Project CD



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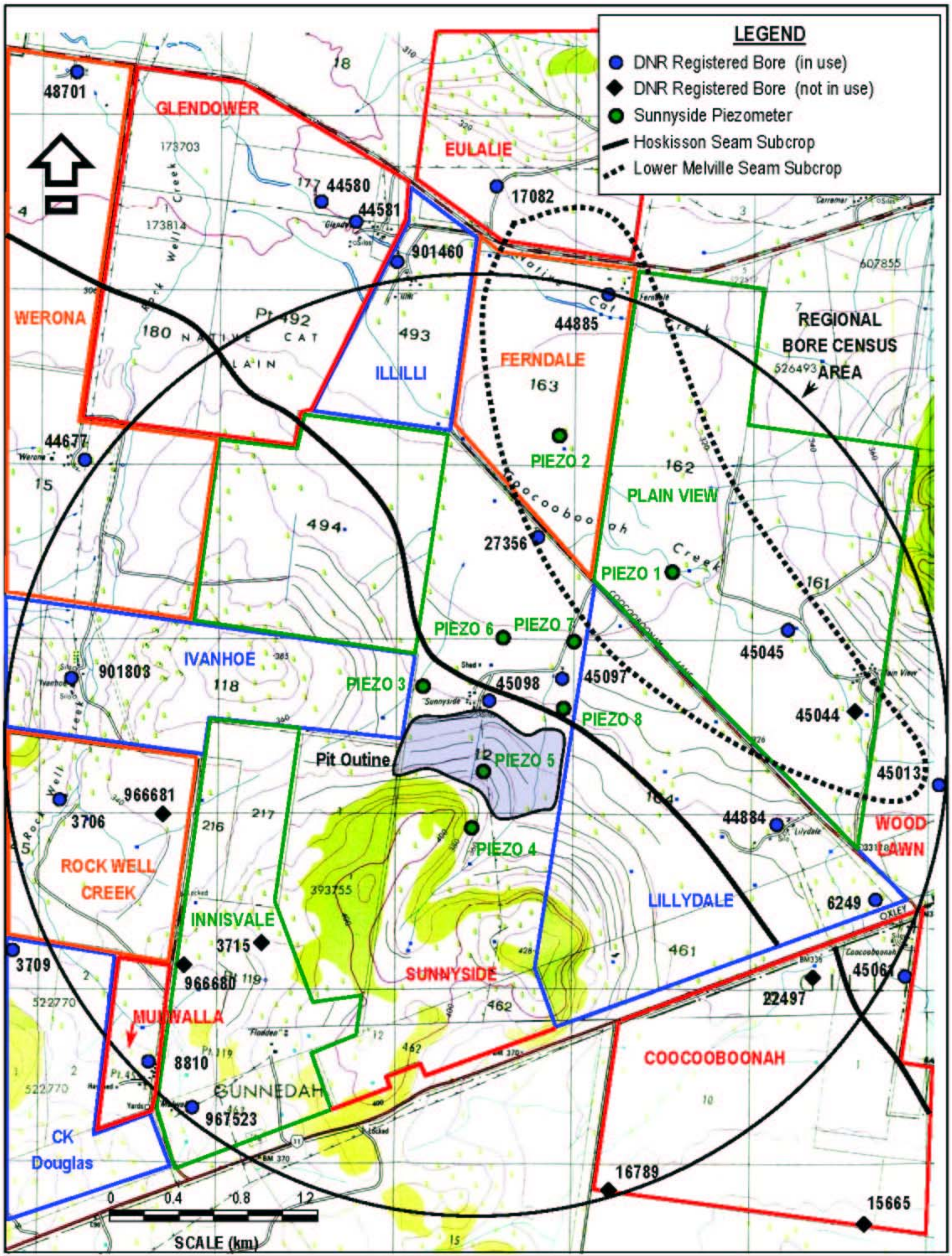

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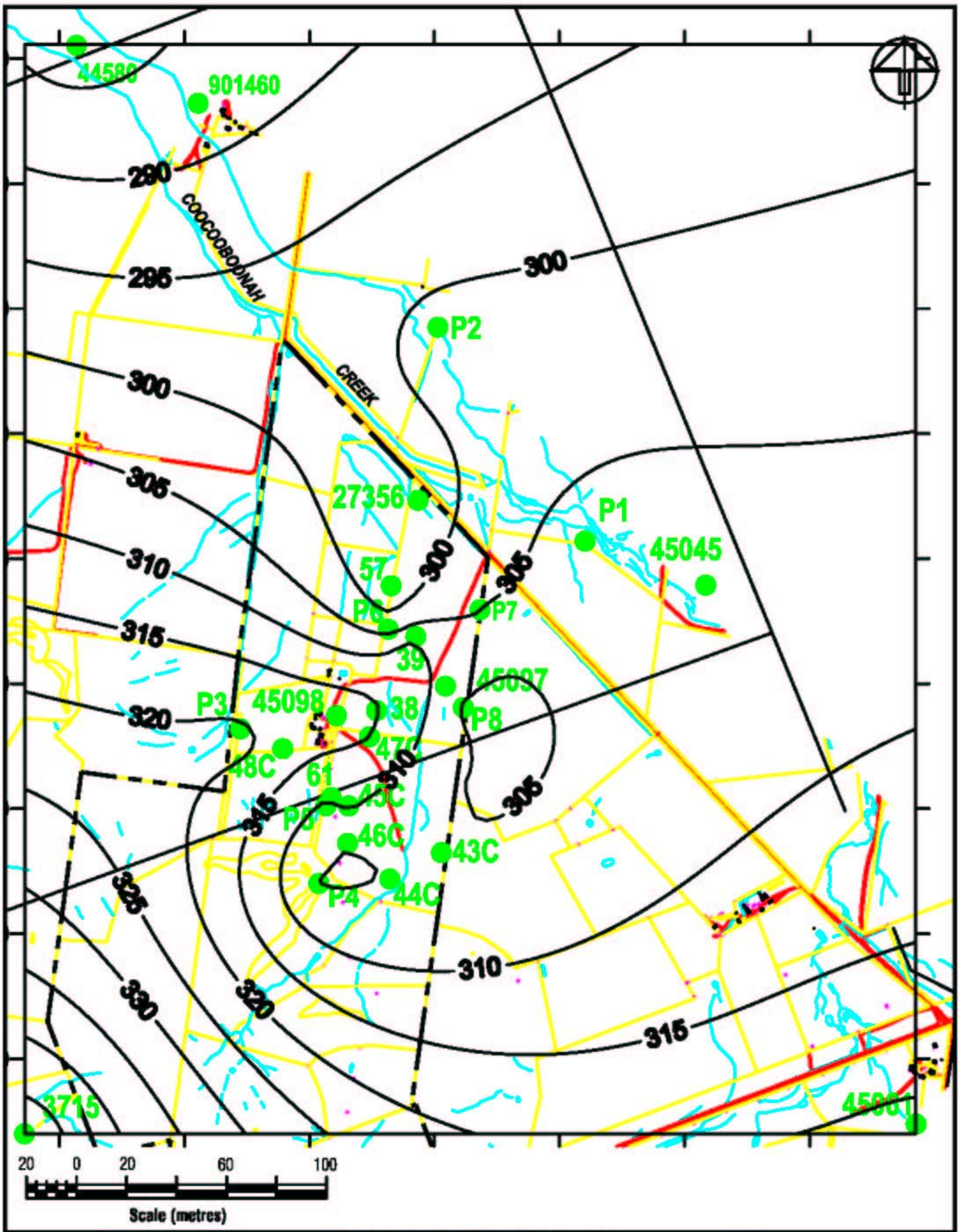
Drawn	A Dawkins	SUNNYSIDE PROJECT	
Date	10.04.2007		
Scale (approx)	As Shown	DNR Registered Bores and Property Boundaries	DRAWING 9

Note: A colour version of this figure is available on the Sunnyside Coal Project CD



PROJECT:	SUN1 - R4	NAMOI MINING PTY LTD SUUNYSIDE PROJECT	GeoTerra
DRAWN:	A. DAWKINS		
DATE:	10 04 2007	MONITORING BORES, PIEZOMETERS & PIEZOMETRIC SURFACE	DRAWING10
SCALE:	1:2000		

Note: A colour version of this figure is available on the Sunnyside Coal Project CD

APPENDICES

(No. of pages excluding this page = 105)

Appendix 1	**Mine Sequence Plans**
Appendix 2*	**DNR Registered, Piezometer & Coal Exploration Bore Data & Piezometer Drill Logs**
Appendix 3*	**Hydraulic Test Results**
Appendix 4*	**Laboratory Analyses (Bore Water, Salinity Batch Leaching, Acid Rock Drainage)**
Appendix 5	**FEFLOW Groundwater Modelling**
Appendix 6*	**Old Gunnedah No 5 Underground Mine Void Assessment**

* Note: These Appendices are presented in full on the CD for the Sunnyside Coal Project

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Appendix 1

Mine Sequence Plans

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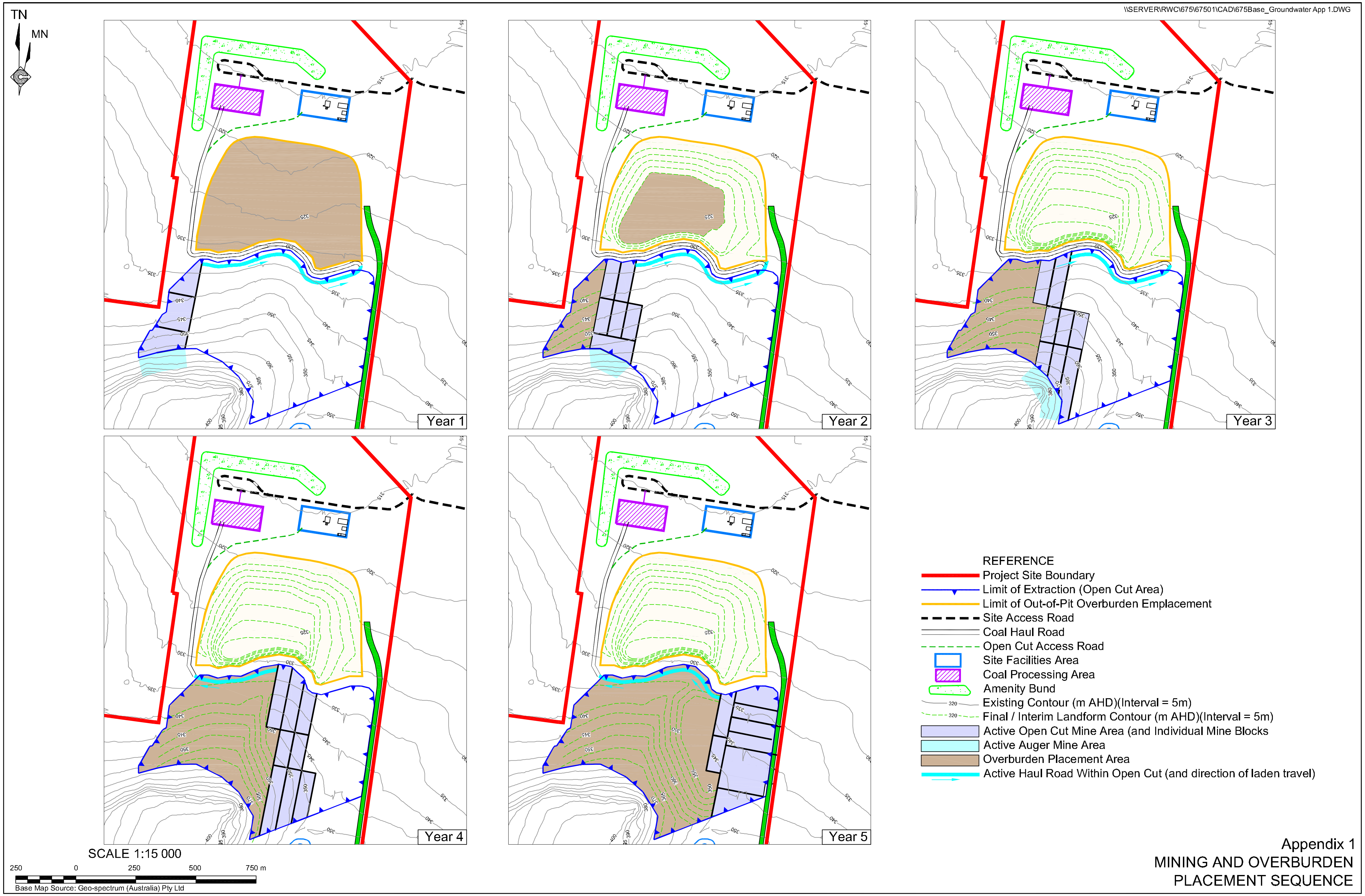

Appendix 1
MINING AND OVERBURDEN PLACEMENT SEQUENCE

Figure Prepared by R.W. Corkery & Co. Pty Ltd

Appendix 2

DNR Registered, Piezometer & Coal Exploration Bore Data & Piezometer Drill Logs

(No. of pages excluding this page = 21)

Note: This Appendix is presented in full on the CD for the Sunnyside Coal Project

Table A2-1 Regional Bore Census

Bore	Status	Type	Property	Owner	Current Use	Depth	Drilled Water Intersect	SWL mbgl	pH	EC (uS/cm)	Aquifer Intake
45097	In use	Mill	Sunnyside	WCM PL	Stock	85.3	54.9 / 85.3	bore sealed	8.25	2630	Melv Sm / LDPF
45098	In use	Sub	Sunnyside	WCM PL	Stock	44.2	26.5 / 39.6-40.8	10.54	6.80	8440	Hosk Sm / SMF
27356	In use	Mill	Sunnyside	WCM PL	Stock	35.4	27.1 / 31.4-33.5	15.20	6.61	6170	Upper Mel. Sm
3706	In use?	Mill?	Rock Well Creek	LB Staughton	Stock	15.2	9.1 / 13.4-15.2	not contacted	N.A.	N.A.	N.A.
96681	Not used	Piezo	Rock Well Creek	LB Staughton	None	2.1	N.A.	N.A.	N.A.	N.A.	N.A.
3709	In use	Mill?	?	C K Douglas	Stock	37.5	36.6	access refused	N.A.	N.A.	Shale
901803	In use?	Mill?	Ivanhoe	CK Douglas	Stk Dom Irrig	58	N.A.	access refused	N.A.	N.A.	N.A.
8810	In use	Mill	Mulwalla	GE Doubleday	Dom / poultry	53.3	N.A.	bore sealed	7.83	4190	N.A.
3715	Not used	Mill	Innisvale	GM Fogarty	None	45.1	30.5 / 42.1	24.57	7.07	4140	Shale / sandstone
966680	Not used	Piezo	Innisvale	GM Fogarty	None	5.4	N.A.	N.A.	N.A.	N.A.	N.A.
967523	In use	Sub	Innisvale	GM Fogarty	Stock dom	42.36	N.A.	bore sealed	N.A.	N.A.	N.A.
6249	In use	Mill	Lillydale	WG Coddington	Stock	70.7	68.9	access refused	N.A.	N.A.	Sandstone
44884	In use	Mill	Lillydale	WG Coddington	Stock dom	73.2	N.A.	access refused	N.A.	N.A.	N.A.
45013	In use	Sub	Woodlawn	? W Reid	Stock	76.2	N.A.	access refused	N.A.	N.A.	N.A.
45044	Not used	Mill	Plain View	R C Howarth	None	34.1	14.6 / 34.1	bore sealed	N.A.	N.A.	Gunn Fm / ?
45045	In use	Mill	Plain View	R C Howarth	Stock	62.5	61	13.18	8.23	5310	N.A.
44885	In use	Mill	Ferndale	L C Coddington	Stock Dom	36.6	N.A.	bore sealed	8.06	4820	N.A.
901460	In use	Sub	Illilli	R A Norman	Stock Dom	34	N.A.	15.48	7.32	2900	N.A.
44580	In use	Mill	Glendower	V U Bridges	Stock	34.0	N.A.	17.41	7.70	1824	N.A.
44581	In use	Mill	Glendower	V U Bridges	Stock Dom	35	N.A.	bore sealed	7.94	2130	N.A.
44677	In use	Sub	Werona	Howarth	Stock Dom	75.9	N.A.	bore sealed	6.93	6180	N.A.
48701	In use	Mill	Werona	Howarth	Stock Dom	61.0	N.A.	not inspected	N.A.	N.A.	N.A.
15665	Not used	N.A.	Coocooboonah	Howard Haulage	None	24.4	15.8-16.1	not found	N.A.	N.A.	Basalt
16789	Not used	Sub	Coocooboonah	Howard Haulage	None	23.2	16.8-17.1 / 18.9-21.3	bore sealed	N.A.	N.A.	Conglom / ?
22497	Not used	N.A.	Coocooboonah	Howard Haulage	None	45.7	28.7-32.1	not found	N.A.	N.A.	Melv Sm
45061	In use	Mill	Coocooboonah	Howard Haulage	Stock	84.1	N.A.	bore sealed	9.37	5610	N.A.
17082	In use	Sub	Eulalie	I S Braby	Stock Dom	24.4	N.A.	bore sealed	7.30	1704	N.A.

Note: **Survey dates:** 16 Oct to 7 Nov. 2006 **Mill** Windmill **Sub.** Submersible Pump **N.A.** data not available
Gunn Fm Gunnedah Formation **Hosk Sm** Hoskisson Seam **Melv Sm** Melville Seam
SMF Shallow Marine Facies **LDPF** Lower Delta Plain Facies

Table A2-2 Groundwater Monitoring Bores

Bore	Property	Drilled Depth (m)	Bore Diam (mm)	Casing (mm)	Test Date	Water Intersect (m)	SWL mbtoc/ mbgl	pH	EC (uS/cm)	Annular Seal (mbgl)	Screen (m)
Gunnedah	**Fm**										
P1	Ferndale	41	100	50	20/10/06	18.0	12.77 / 11.92	7.72	12580	10 - 11	26.5 - 29.5
P2	Plain View	31	100	50	20/10/06	13.0	17.50 / 16.70	9.05	18680	11 - 12	27.5 - 30.5
Hoskisson	**Seam**										
P3	Sunnyside	41	100	50	3/11/06	36.0	12.16 / 11.81	7.30	7480	28 - 29	37.5 - 40.5
P4	Sunnyside	81	170	50	3/11/06	36.0 / 64.0	60.70 / 60.20	7.40	6450	69 - 70	77.0 - 80.0
P5	Sunnyside	54	100	50	3/11/06	50.0	40.23 / 39.93	7.10	4560	44 - 45	51.5 - 54.5
Sun 43C	Sunnyside	44	170 / 99	4” to 30m	21/10/06	N.A.	36.08 / 36.03	6.65	4660	Open	Hole
Sun 44C	Sunnyside	52	170 / 99	4” to 42m	21/10/06	N.A.	42.14 / 42.09	6.93	2260	Open	Hole
Sun 45C	Sunnyside	56	170 / 99	4” to 45m	21/10/06	N.A.	39.34 / 39.34	7.01	3780	Open	Hole
Sun 46C	Sunnyside	67	170 / 99	4” to ? m	21/10/06	N.A.	53.78 / 53.73	7.12	3240	Open	Hole
Sun 47C	Sunnyside	33	170 / 99	4” to ? m	21/10/06	N.A.	15.79 / 15.74	6.84	4380	Open	Hole
Sun 48C	Sunnyside	42	170 / 99	4” to 26m	21/10/06	N.A.	16.25 / 16.15	6.62	12290	Open	Hole
Sun 51	Sunnyside	78	170	6” to ?	/	N.A.	/	/	/	Collapsed	Hole
Sun 52	Sunnyside	89	170	6” to ?	21/10/06	N.A.	58.18 / 58.18	6.84	8500	Open	Hole
Sun 53	Sunnyside	129	170	6” to ?	21/10/06	N.A.	>100m	/	/	Open	Hole
Sun 61	Sunnyside	60	170 / 96?	4” to 42m	21/10/06	N.A.	39.53 / 39.53	7.19	4560	Open	Hole
DDH185	Sunnyside	101	170?	4” to ?m	21/10/06	N.A.	29.66 / 29.31	6.91	12650	Open	Hole
Shallow	**Marine**	**Facies**	**& Melville**	**Seam**							
27356	Sunnyside	35.4	N.A.	152	3/11/06	27.1 / 31.4-33.5	15.42 / 15.20	6.61	6170	Open	Hole
45045	Plain View	62.5	N.A.	152	3/11/06	61	13.18 / 12.85	8.23	5310	Open	Hole
45098	Sunnyside	44.2	N.A.	152	3/1/06	26.5 / 39.6-40.8	10.54 / 10.24	6.80	8440	Open	Hole
P6	Sunnyside	30	170	50	3/11/06	23.0	16.80 / 16.35	7.09	5490	19 - 20	20.0 - 23.0
Sun 38	Sunnyside	115	170	6” to ?	3/11/06	N.A.	11.16 / 11.01	6.84	11430	Open	Hole
Sun 39	Sunnyside	55	170	6” to ?	21/10/06	N.A.	10.67 / 10.27	7.87	2500	Open	Hole
P7	Sunnyside	48	170	50	3/11/06	N.A.	13.20 / 12.70	6.99	7330		45 - 48
Shallow	**Marine**	**Facies**	**& Melville**	**Seam**	**& Lower**	**Delta Plain**	**Facies**				
Sun 57	Sunnyside	42	170	6” to ?	21/10/06	N.A.	19.40 / 19.10	7.17	5380	Open	Hole
Sun 58	Sunnyside	66	170	6” to ?	21/10/06	N.A.	17.20 / 17.20	7.11	3860	Open	Hole
Sun 59	Sunnyside	90	170	6” to ?	21/10/06	N.A.	12.91 / 12.71	7.02	7100	Open	Hole
Sun 60	Sunnyside	90	170	6” to ?	21/10/06	N.A.	22.20 / 21.55	6.85	8350	Open	Hole
P8	Sunnyside	90	170	50	20/10/06	N.A.	22.20 / 21.55	6.85	8350	unsealed	87 - 90

Client: Namoi Mining Pty Ltd

Project: Sunnyside

Location: Ferndale (Gunnedah) NSW

Job No: SUN1

Borehole: P1

North/East: 6569560 / 225592

Logged by: A Dawkins

GeoTerra
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Dulwich Hill NSW 2203
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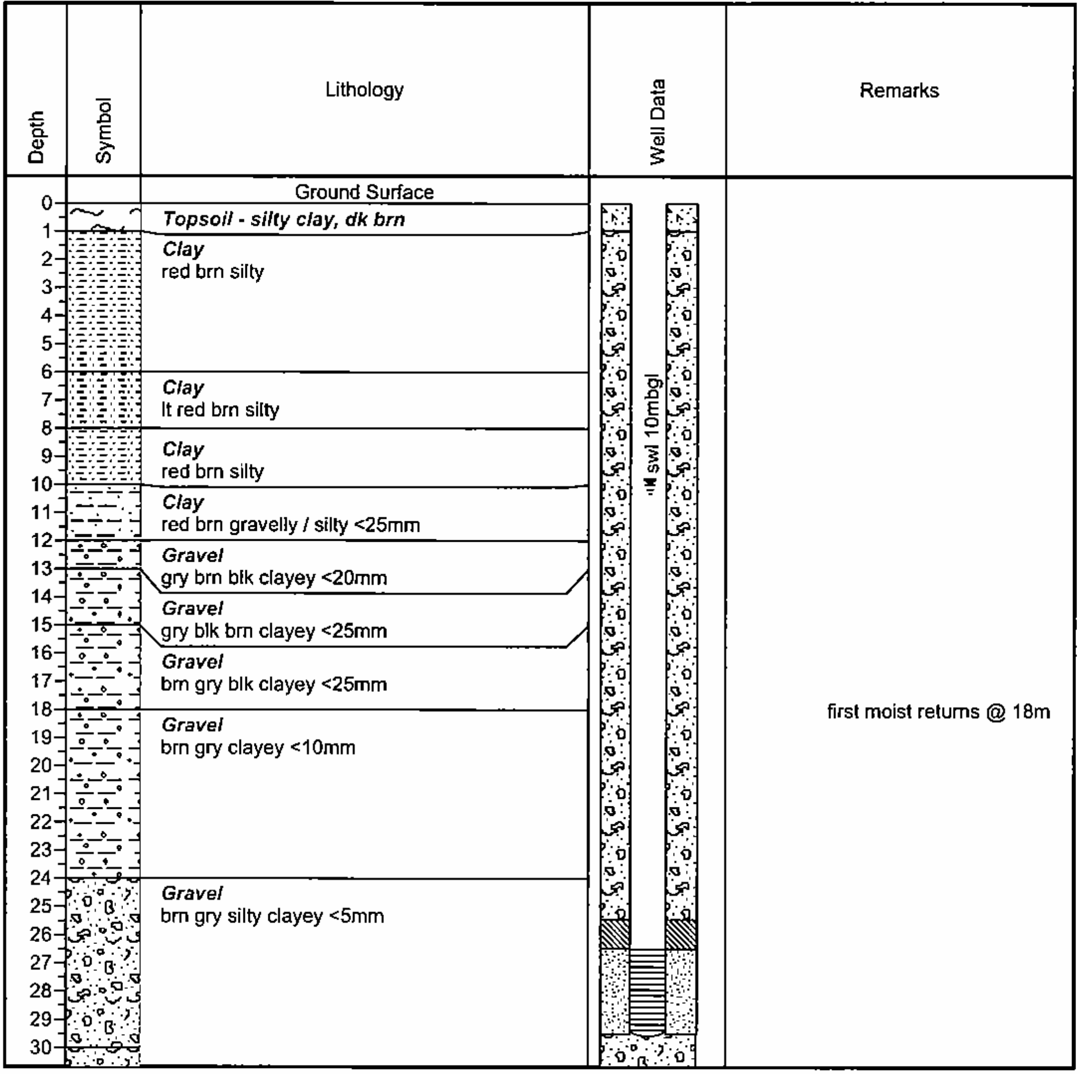
email geoterra@linet.net.au



Ground Surface

Topsoil - silty clay, dk brn

Clay
red brn silty

Clay
lt red brn silty

Clay
red brn silty

Clay
red brn gravelly / silty <25mm

Gravel
gry brn blk clayey <20mm

Gravel
gry blk brn clayey <25mm

Gravel
brn gry blk clayey <25mm

Gravel
brn gry clayey <10mm

Gravel
brn gry silty clayey <5mm

first moist returns @ 18m

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 4 3/4"
Ground RL: 317.43
Sheet: 1 of 2

Client: Namoi Mining Pty Ltd

Project: Sunnyside

Location: Femdale (Gunnedah) NSW

Job No: SUN1

Borehole: P1

North/East: 6569560 / 225592

Logged by: A Dawkins

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Depth	Symbol	Lithology	Well Data	Remarks
31 32		***Gravel*** brn gry silty clayey <10mm		hole collapsed below 29.5m
33 34 35 36 37 38		***Gravel*** brn gry silty clayey <5mm		
39 40		***Siltstone*** V weath brn gry yell		
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60		End of Borehole		

Drilled By: Nitro Drilling

Drill Method: Open Hole Hammer

Drill Date: October 2006

Hole Size: 4 3/4"

Ground RL: 317.43

Sheet: 2 of 2

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Gunnedah NSW
Job No: SUN1

Borehole: P2

North/East: 6570423 / 225012
Logged by: A Dawkins

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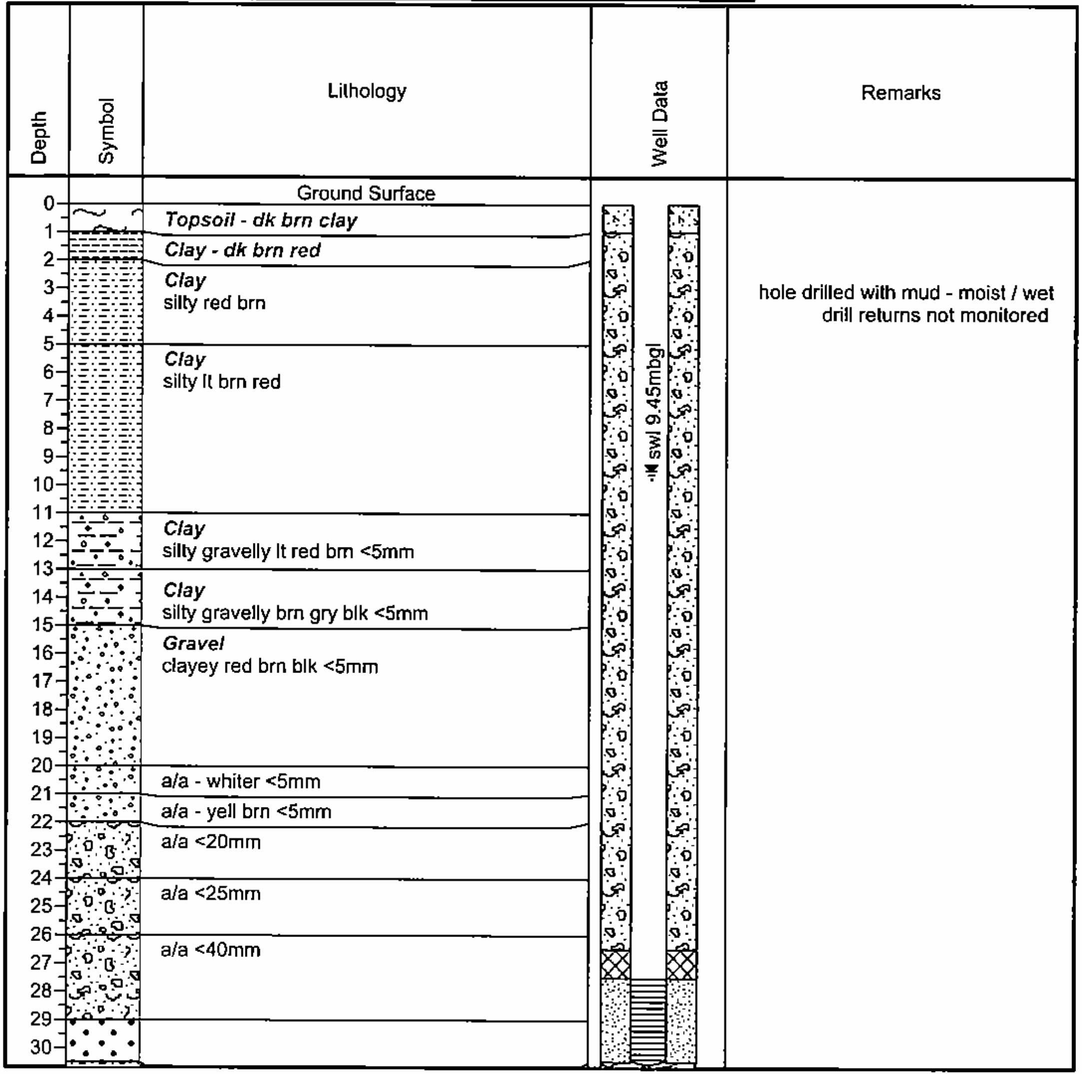
email geoterra@ilnet.net.au



Ground Surface

***Topsoil** - dk brn clay*

***Clay** - dk brn red*

Clay
silty red brn

Clay
silty lt brn red

Clay
silty gravelly lt red brn <5mm

Clay
silty gravelly brn gry blk <5mm

Gravel
clayey red brn blk <5mm

a/a - whiter <5mm

a/a - yell brn <5mm

a/a <20mm

a/a <25mm

a/a <40mm

hole drilled with mud - moist / wet drill returns not monitored

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 4 3/4"
Ground RL: 317.43
Sheet: 1 of 2

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Gunnedah NSW
Job No: SUN1

Borehole: P2
North/East: 6570423 / 225012
Logged by: A Dawkins

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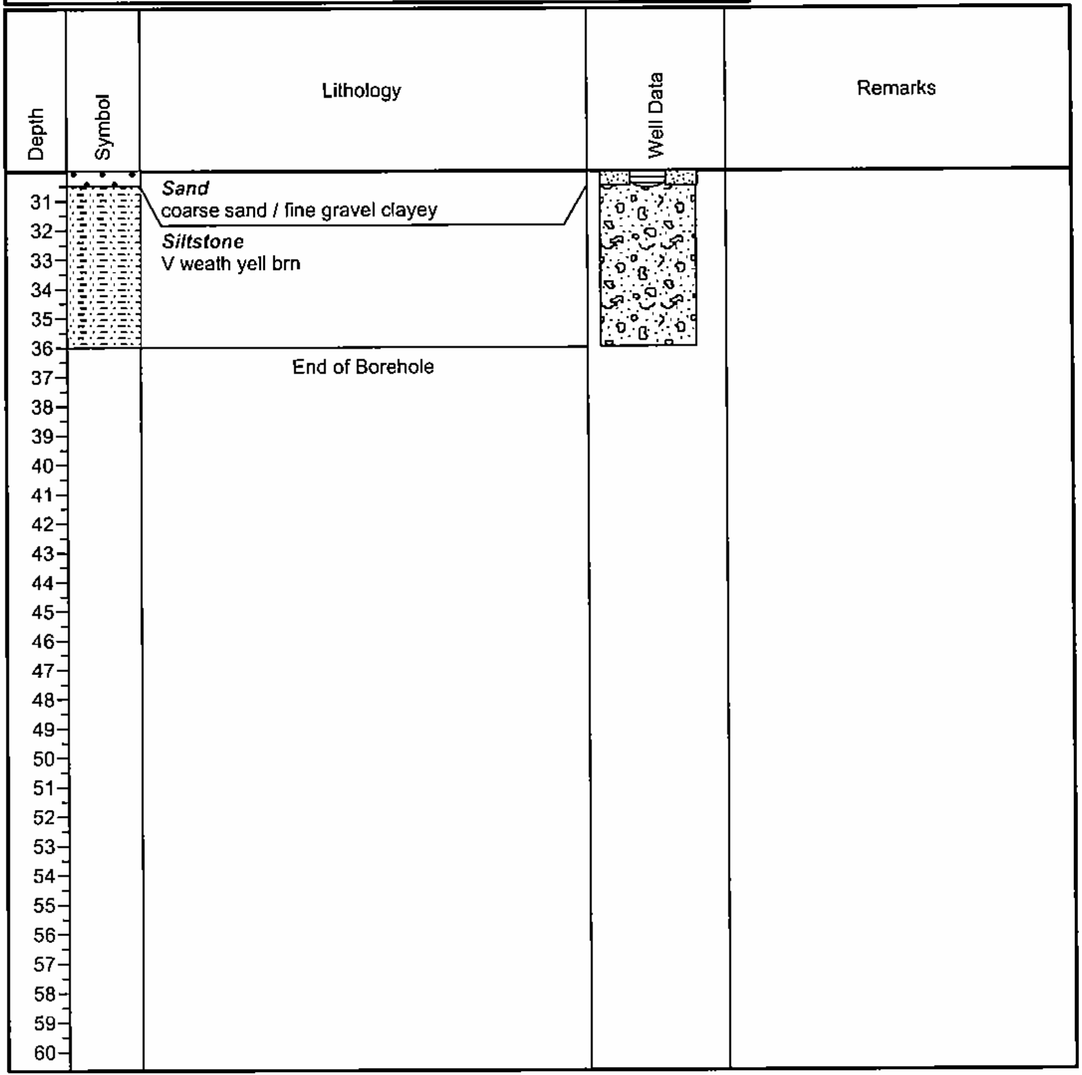

Sand
coarse sand / fine gravel clayey

Siltstone
V weath yell brn

End of Borehole

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 4 3/4"
Ground RL: 317.43
Sheet: 2 of 2

Client: Namoi Mining Pty Ltd

Project: Sunnyside

Location: Sunnyside (Gunnedah) NSW

Job No: SUN1

Borehole: P3

North/East: 6568768 / 224210

Logged by: A Dawkins

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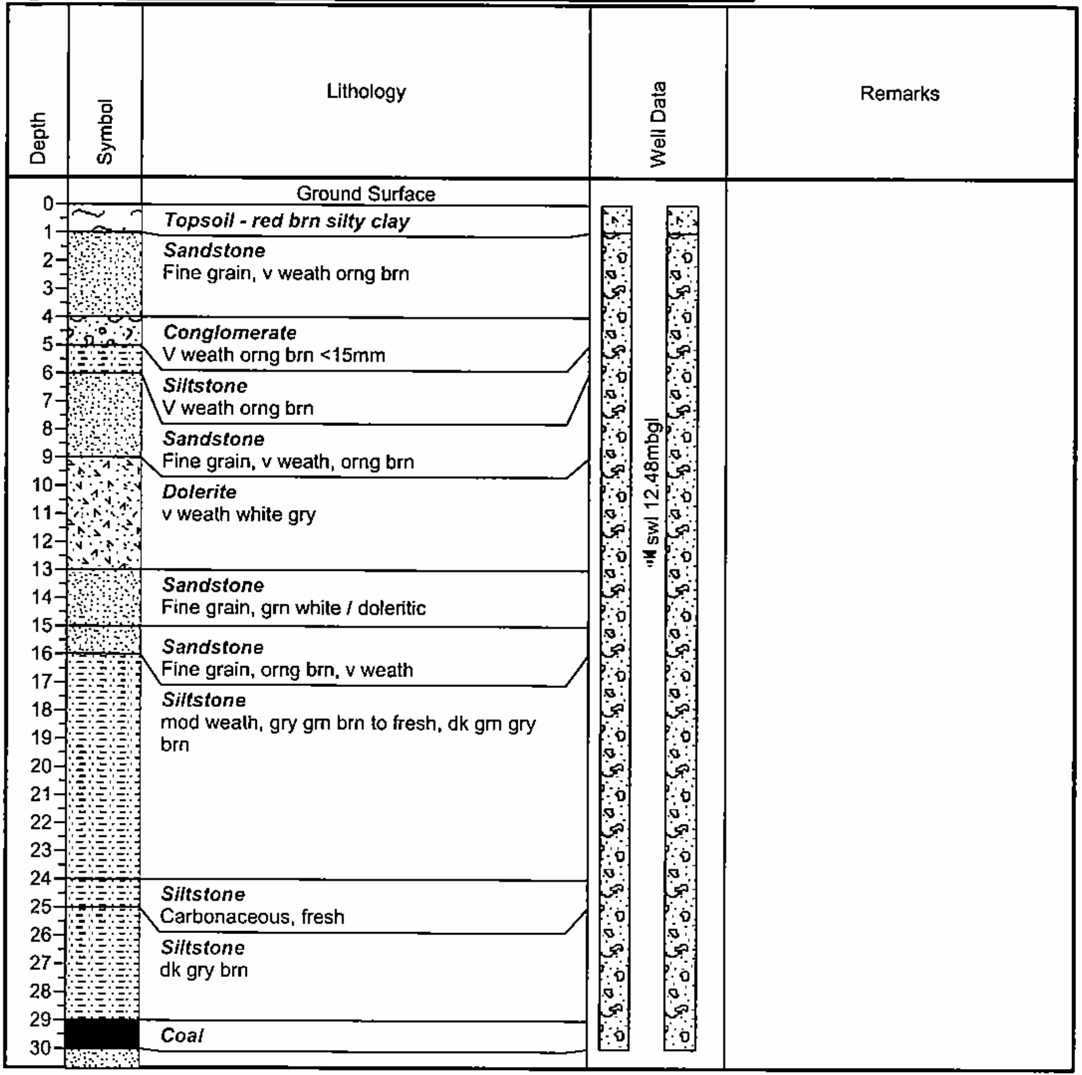
email geoterra@iinet.net.au



Topsoil - red brn silty clay

Sandstone
Fine grain, v weath orng brn

Conglomerate
V weath orng brn <15mm

Siltstone
V weath orng brn

Sandstone
Fine grain, v weath, orng brn

Dolerite
v weath white gry

Sandstone
Fine grain, grn white / doleritic

Sandstone
Fine grain, orng brn, v weath

Siltstone
mod weath, gry grn brn to fresh, dk grn gry brn

Siltstone
Carbonaceous, fresh

Siltstone
dk gry brn

Coal

Drilled By: Nitro Drilling

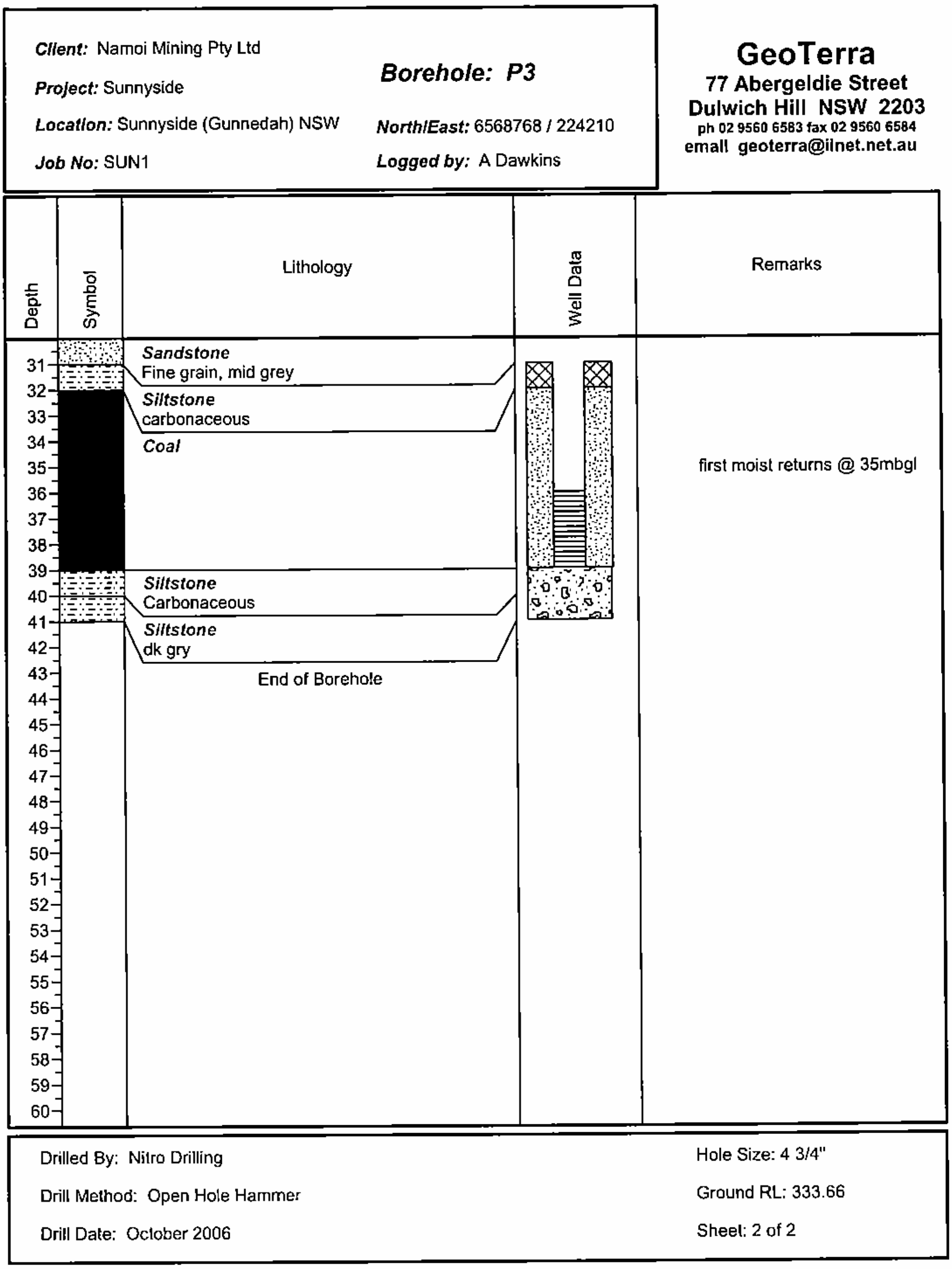
Drill Method: Open Hole Hammer

Drill Date: October 2006

Hole Size: 4 3/4"

Ground RL: 333.66

Sheet: 1 of 2



Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P3
North/East: 6568768 / 224210
Logged by: A Dawkins

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Depth	Lithology	Remarks
30–31	***Sandstone*** Fine grain, mid grey	
31–32	***Siltstone*** carbonaceous	
32–39	***Coal***	first moist returns @ 35mbgl
39–41	***Siltstone*** Carbonaceous	
41	***Siltstone*** dk gry	
	End of Borehole	

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 4 3/4"
Ground RL: 333.66
Sheet: 2 of 2

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P4

North/East: 6568198 / 224535
Logged by: A Dawkins

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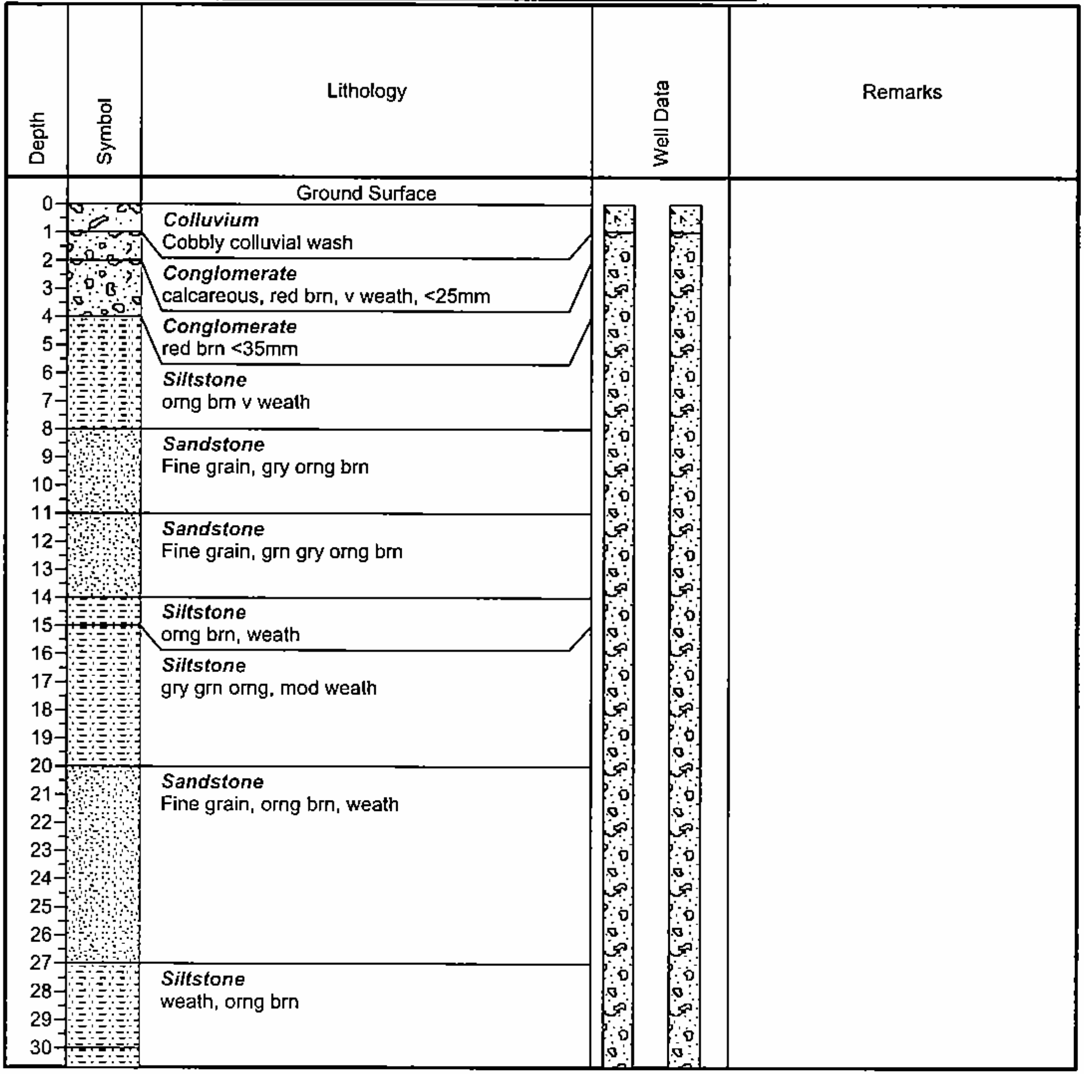

Colluvium
Cobbly colluvial wash

Conglomerate
calcareous, red brn, v weath, <25mm

Conglomerate
red brn <35mm

Siltstone
orng brn v weath

Sandstone
Fine grain, gry orng brn

Sandstone
Fine grain, grn gry orng brn

Siltstone
orng brn, weath

Siltstone
gry grn orng, mod weath

Sandstone
Fine grain, orng brn, weath

Siltstone
weath, orng brn

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 6 7/8"
Ground RL: 365.36
Sheet: 1 of 3

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P4

North/East: 6568198 / 224535
Logged by: A Dawkins

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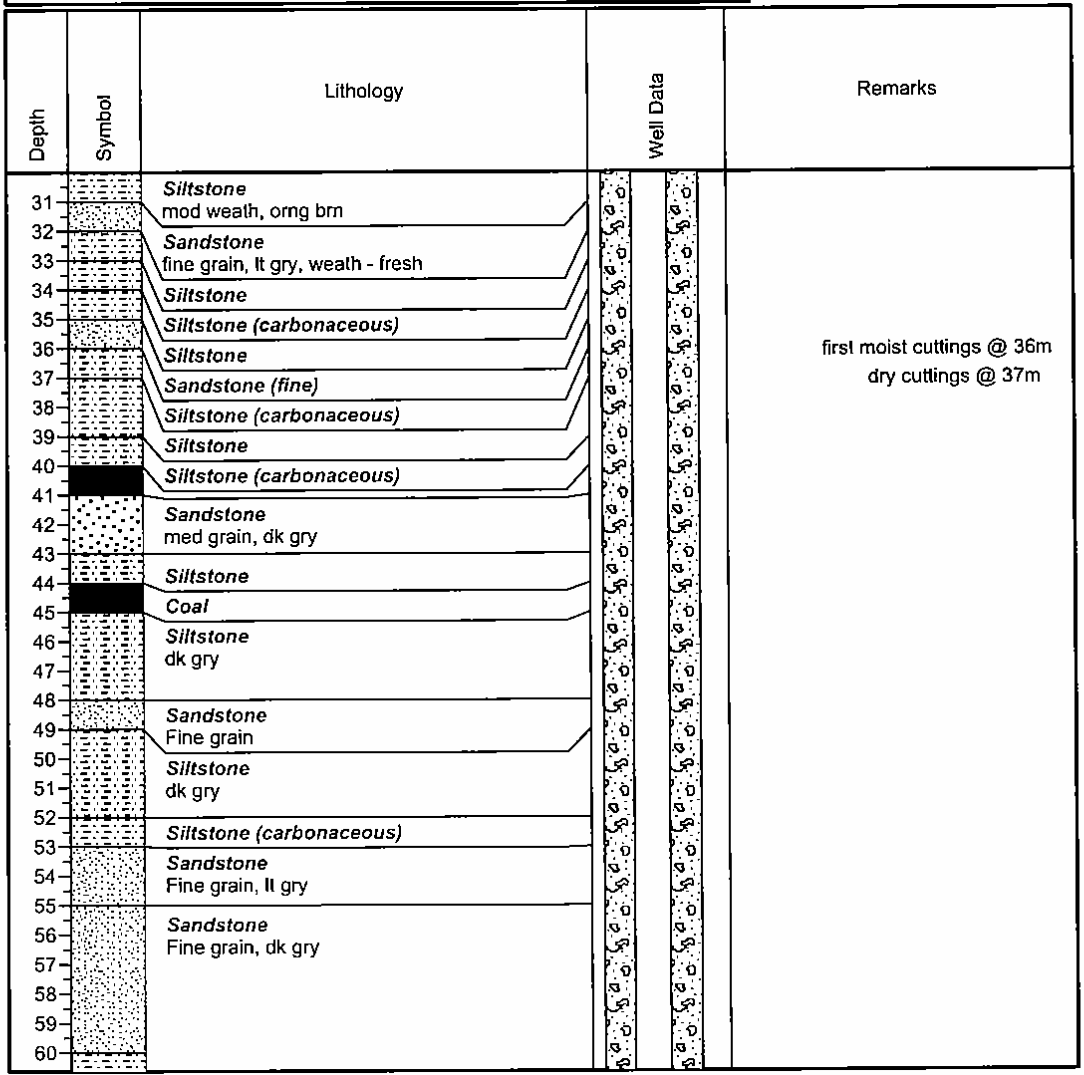

Siltstone mod weath, orng brn
Sandstone fine grain, lt gry, weath - fresh
Siltstone
Siltstone (carbonaceous)
Siltstone
Sandstone (fine)
Siltstone (carbonaceous)
Siltstone
Siltstone (carbonaceous)
Sandstone med grain, dk gry
Siltstone
Coal
Siltstone dk gry
Sandstone Fine grain
Siltstone dk gry
Siltstone (carbonaceous)
Sandstone Fine grain, lt gry
Sandstone Fine grain, dk gry

first moist cuttings @ 36m
dry cuttings @ 37m

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 6 7/8"
Ground RL: 365.36
Sheet: 2 of 3

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P4
North/East: 6568198 / 224535
Logged by: A Dawkins

GeoTerra
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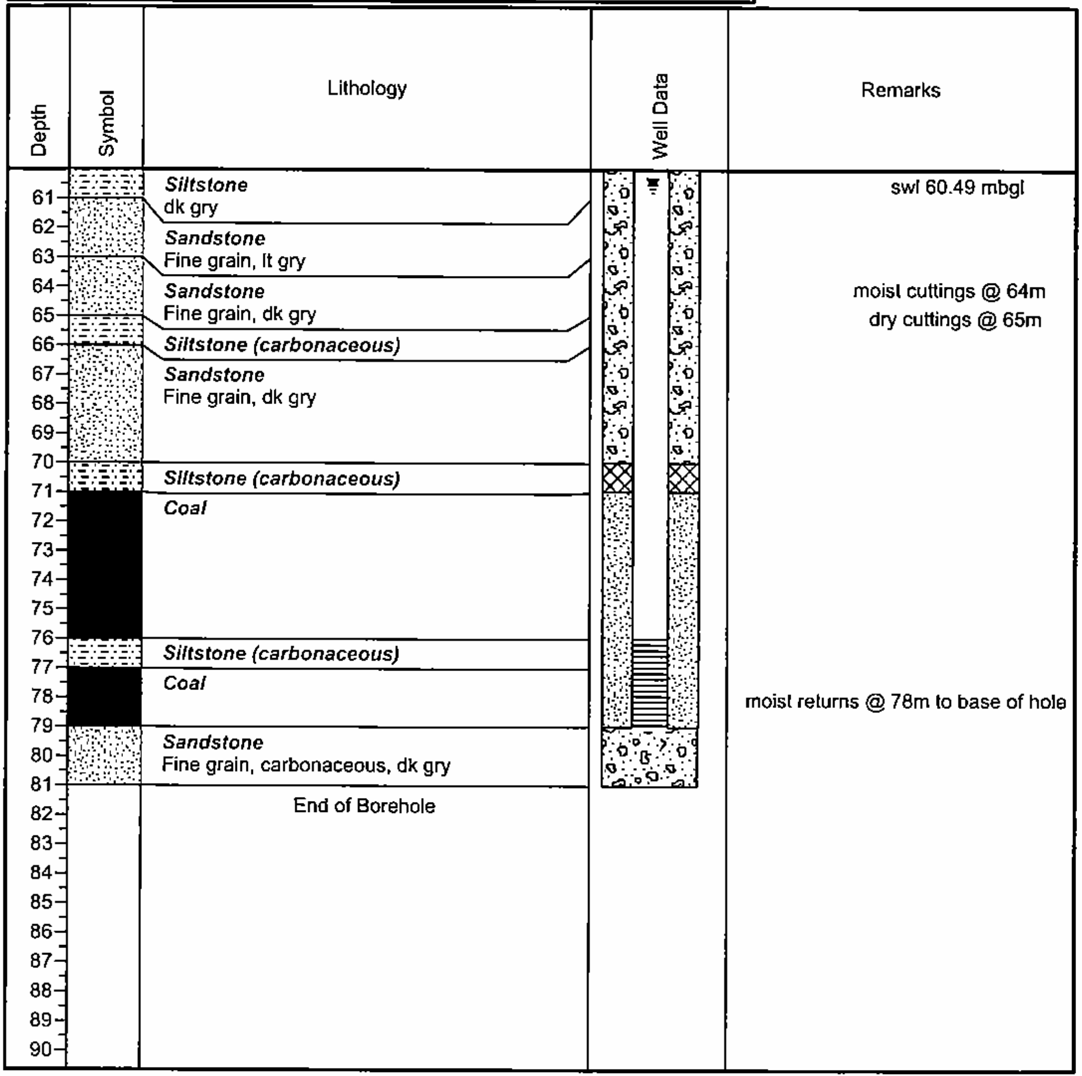

Lithology

Siltstone
dk gry

Sandstone
Fine grain, lt gry

Sandstone
Fine grain, dk gry

Siltstone (carbonaceous)

Sandstone
Fine grain, dk gry

Siltstone (carbonaceous)

Coal

Siltstone (carbonaceous)

Coal

Sandstone
Fine grain, carbonaceous, dk gry

End of Borehole

Remarks

swl 60.49 mbgl

moist cuttings @ 64m
dry cuttings @ 65m

moist returns @ 78m to base of hole

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 6 7/8"
Ground RL: 365.36
Sheet: 3 of 3

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P5

North/East: 6568586 / 224530
Logged by: A Dawkins

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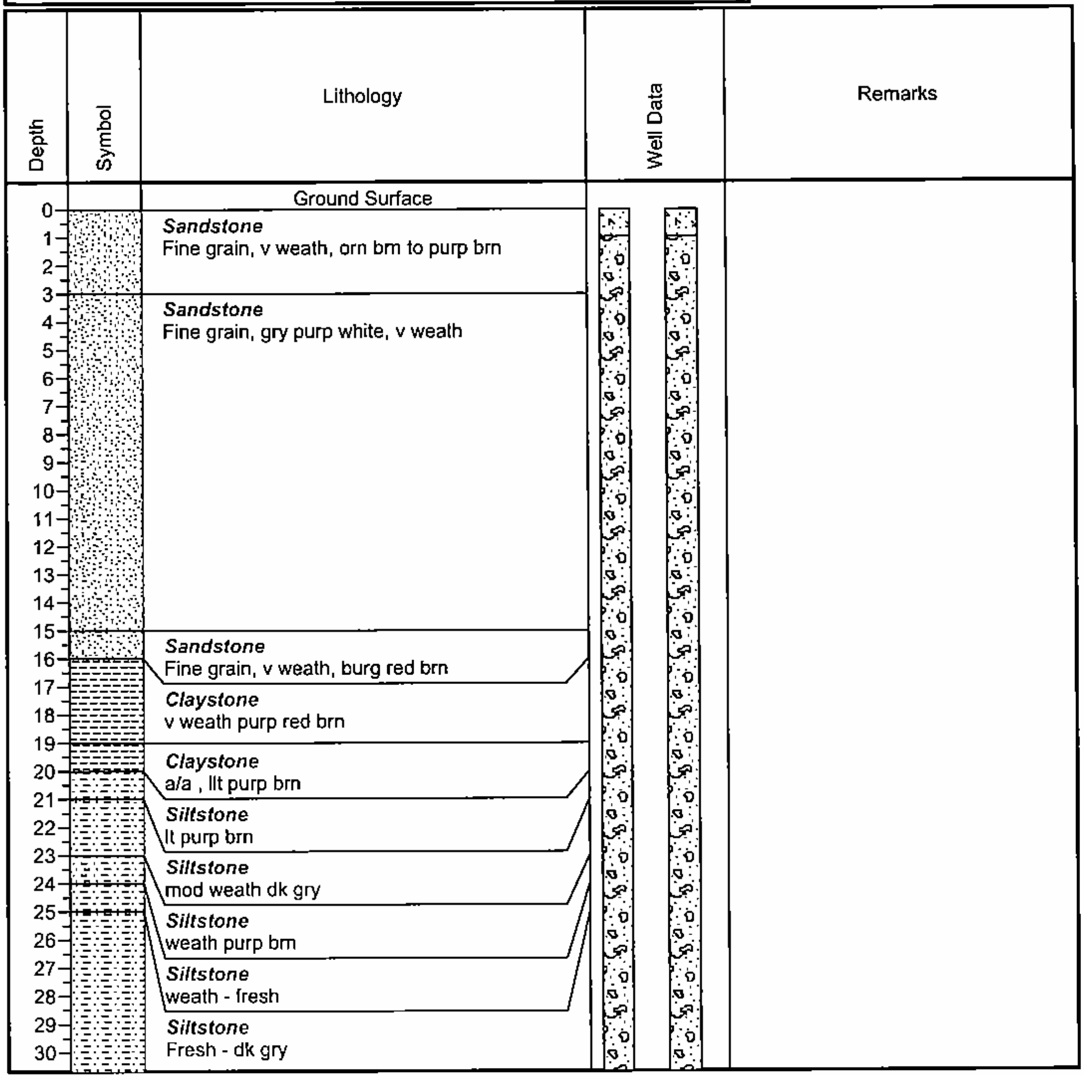

Ground Surface

Sandstone
Fine grain, v weath, orn brn to purp brn

Sandstone
Fine grain, gry purp white, v weath

Sandstone
Fine grain, v weath, burg red brn

Claystone
v weath purp red brn

Claystone
a/a , llt purp brn

Siltstone
lt purp brn

Siltstone
mod weath dk gry

Siltstone
weath purp brn

Siltstone
weath - fresh

Siltstone
Fresh - dk gry

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 4 3/4"
Ground RL: 350.66
Sheet: 1 of 2

Client: Namoi Mining Pty Ltd

Project: Sunnyside

Location: Sunnyside (Gunnedah) NSW

Job No: SUN1

Borehole: P5

North/East: 6568586 / 224530

Logged by: A Dawkins

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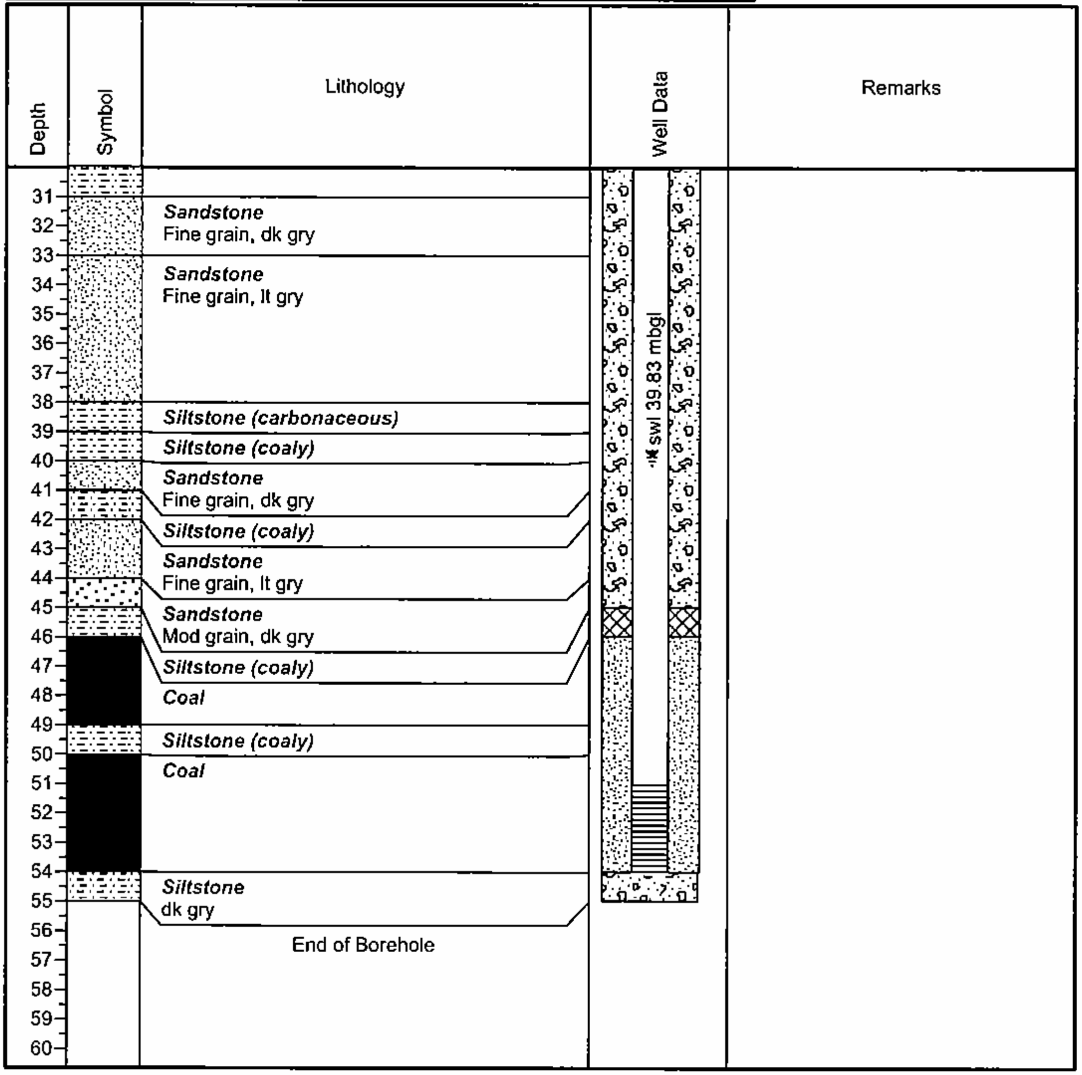

Drilled By: Nitro Drilling

Drill Method: Open Hole Hammer

Drill Date: October 2006

Hole Size: 4 3/4"

Ground RL: 350.66

Sheet: 2 of 2

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P6

North/East: 6269221 / 224808
Logged by: A Dawkins

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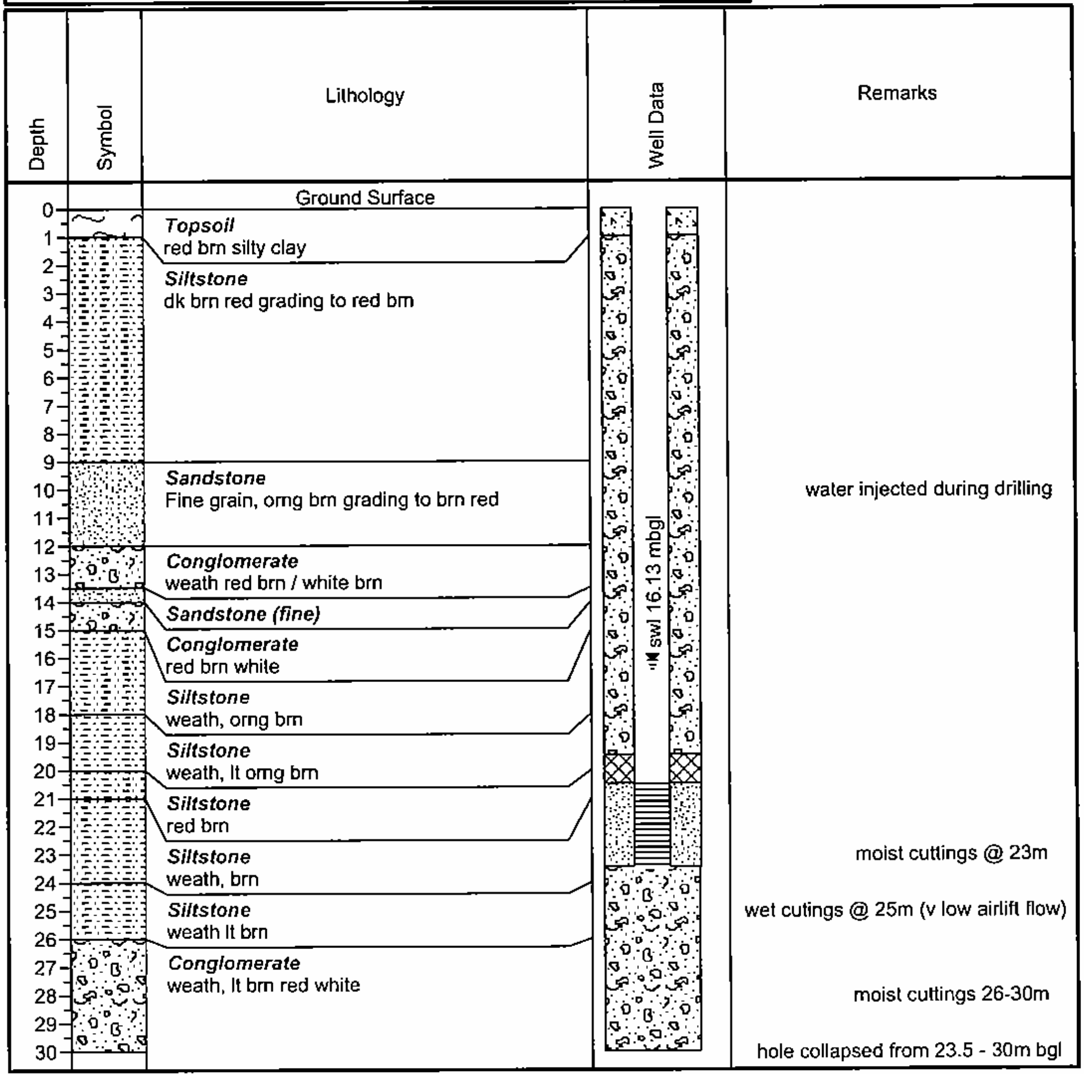


Ground Surface

Topsoil
red brn silty clay

Siltstone
dk brn red grading to red brn

Sandstone
Fine grain, orng brn grading to brn red

Conglomerate
weath red brn / white brn

Sandstone (fine)

Conglomerate
red brn white

Siltstone
weath, orng brn

Siltstone
weath, lt orng brn

Siltstone
red brn

Siltstone
weath, brn

Siltstone
weath lt brn

Conglomerate
weath, lt brn red white

water injected during drilling

moist cuttings @ 23m

wet cutings @ 25m (v low airlift flow)

moist cuttings 26-30m

hole collapsed from 23.5 - 30m bgl

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 4 3/4"
Ground RL: 319.35
Sheet: 1 of 3

Client: Namoi Mining Pty Ltd

Project: Sunnyside

Location: Sunnyside (Gunnedah) NSW

Job No: SUN1

Borehole: P6

North/East: 6269221 / 224808

Logged by: A Dawkins

GeoTerra
77 Abergeldie Street
Dulwich Hill NSW 2203
ph 02 9560 6583 fax 02 9560 6584
email geoterra@iinet.net.au

Depth	Symbol	Lithology	Well Data	Remarks
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

Drilled By: Nitro Drilling

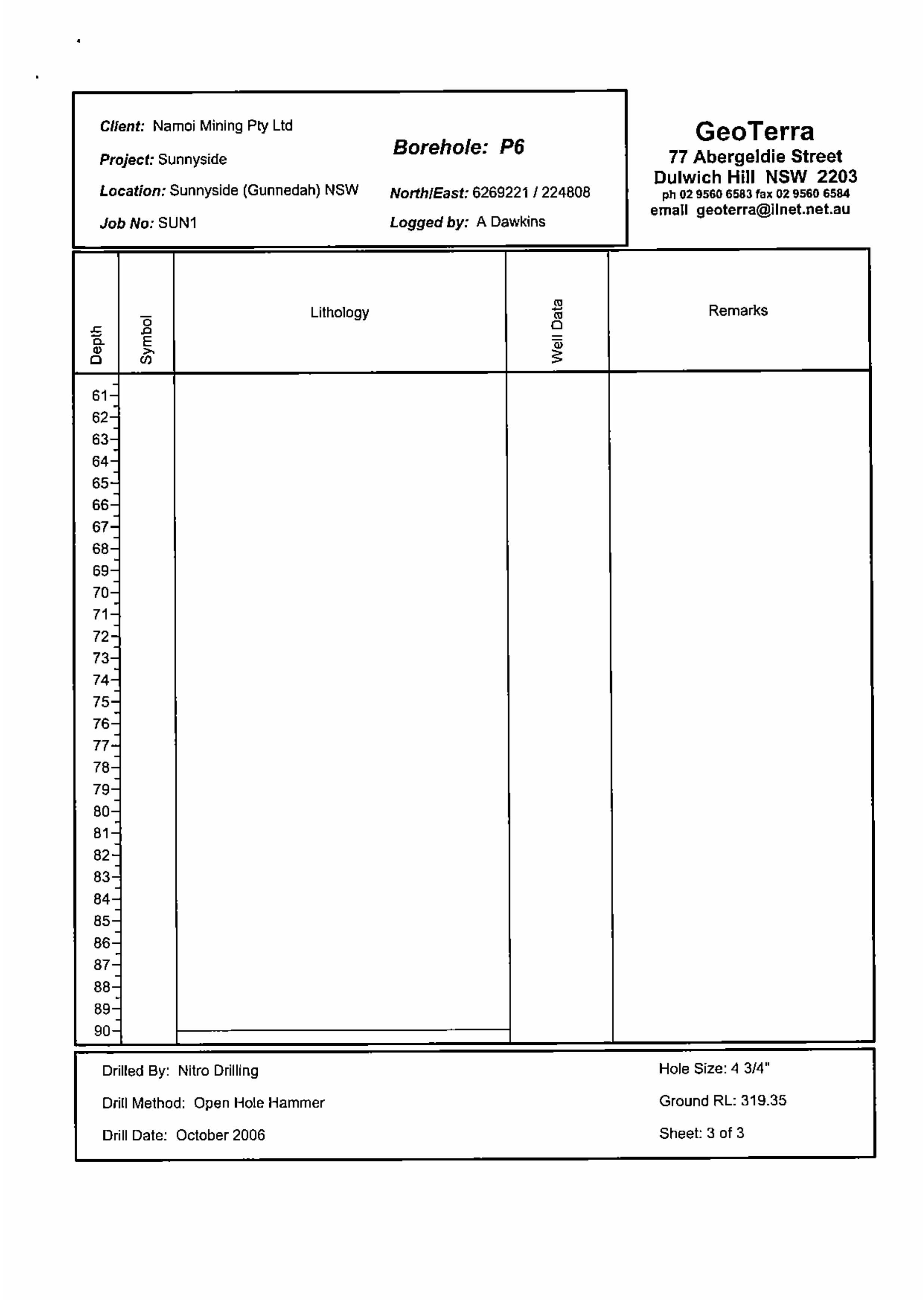
Drill Method: Open Hole Hammer

Drill Date: October 2006

Hole Size: 4 3/4"

Ground RL: 319.35

Sheet: 2 of 3



Client: Namoi Mining Pty Ltd

Project: Sunnyside

Location: Sunnyside (Gunnedah) NSW

Job No: SUN1

Borehole: P6

North/East: 6269221 / 224808

Logged by: A Dawkins

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Depth	Symbol	Lithology	Well Data	Remarks
61				
62				
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				
84				
85				
86				
87				
88				
89				
90				

Drilled By: Nitro Drilling

Drill Method: Open Hole Hammer

Drill Date: October 2006

Hole Size: 4 3/4"

Ground RL: 319.35

Sheet: 3 of 3

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P7

North/East: 6569325 / 225187
Logged by: A Dawkins

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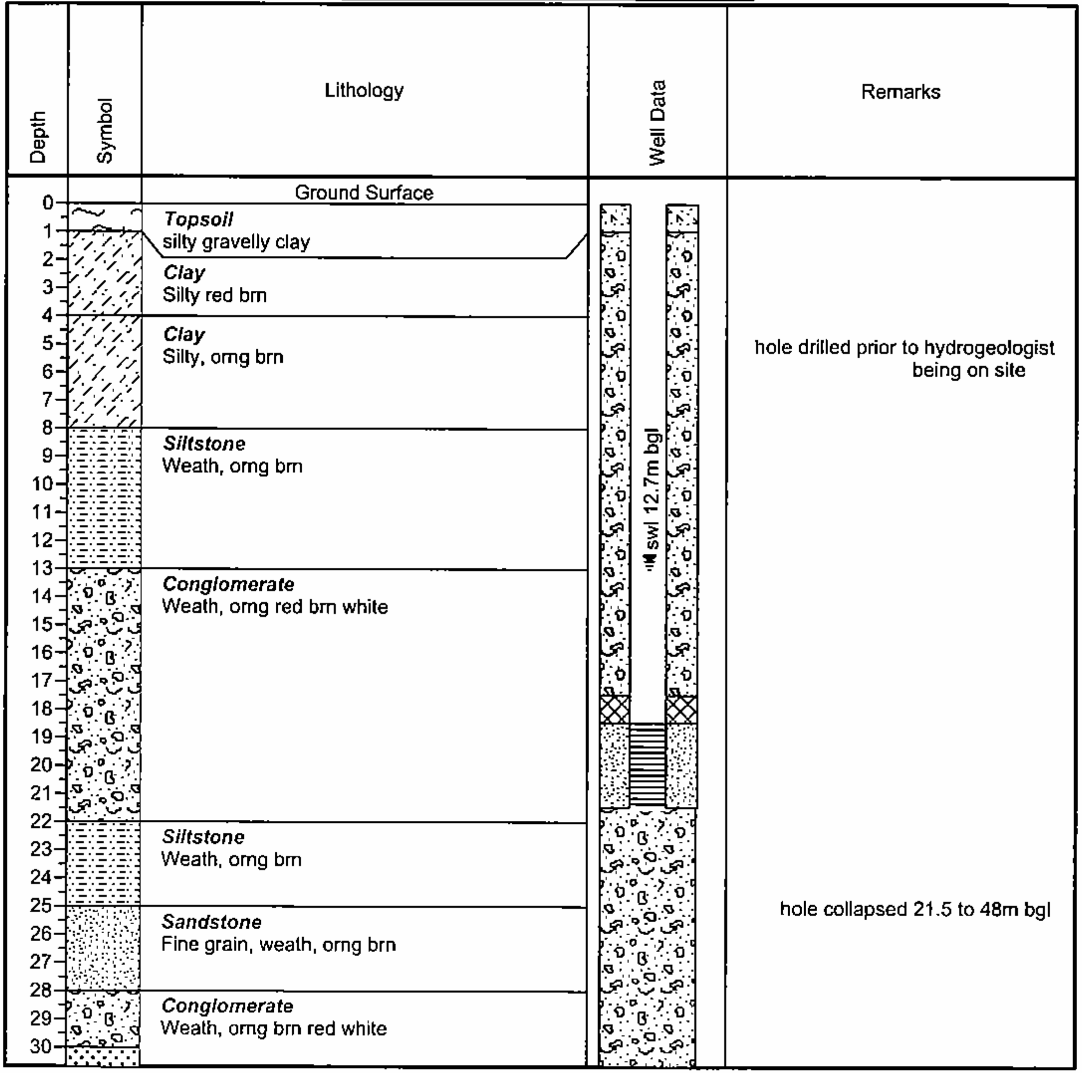

Topsoil
silty gravelly clay

Clay
Silty red brn

Clay
Silty, orng brn

Siltstone
Weath, orng brn

Conglomerate
Weath, orng red brn white

Siltstone
Weath, orng brn

Sandstone
Fine grain, weath, orng brn

Conglomerate
Weath, orng brn red white

hole drilled prior to hydrogeologist being on site

hole collapsed 21.5 to 48m bgl

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 6 7/8"
Ground RL: 317.81
Sheet: 1 of 2

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P7

North/East: 6569325 / 225187
Logged by: A Dawkins

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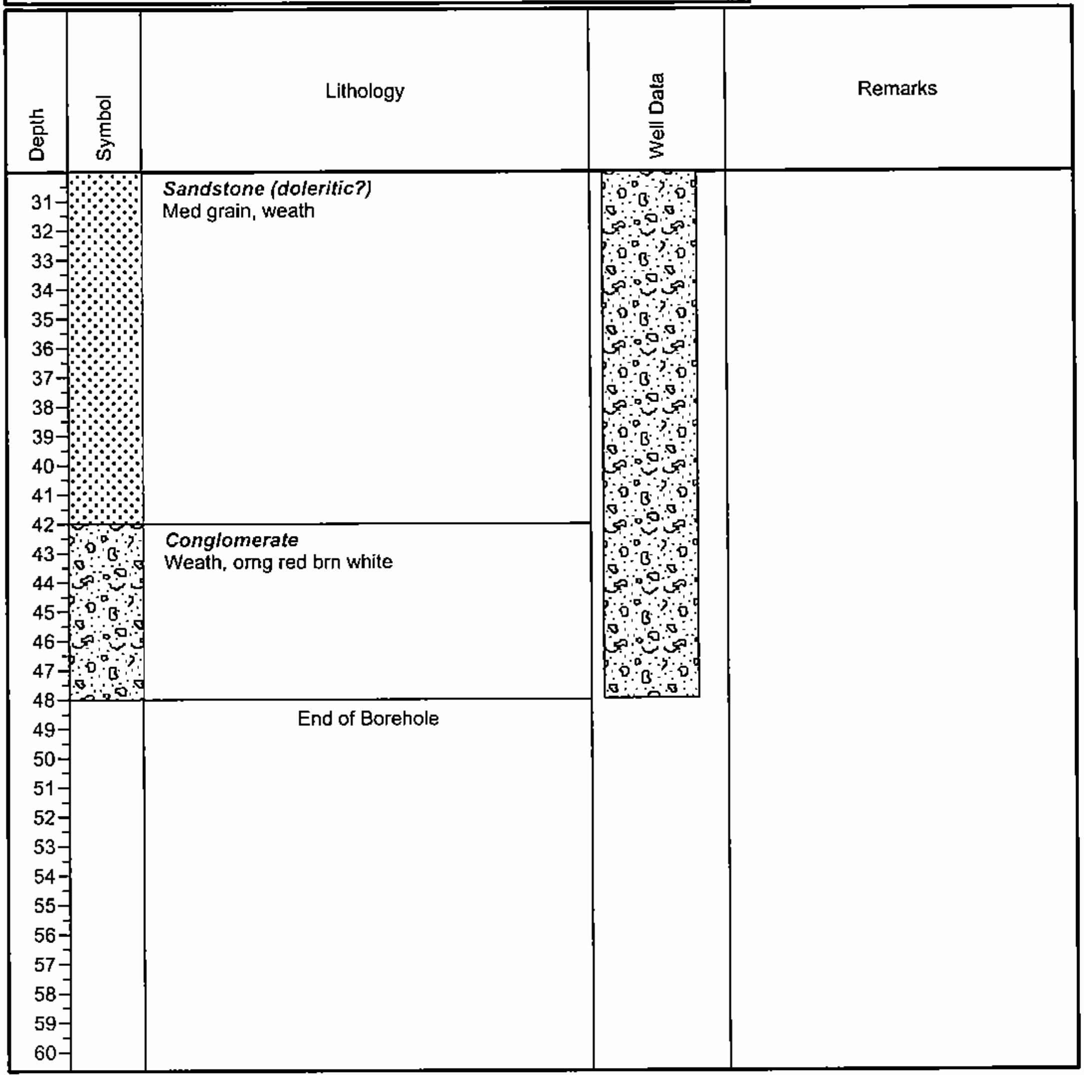

Sandstone (doleritic?)
Med grain, weath

Conglomerate
Weath, orng red brn white

End of Borehole

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 6 7/8"
Ground RL: 317.81
Sheet: 2 of 2

Client: Namoi Mining Pty Ltd

Project: Sunnyside

Location: Sunnyside (Gunnedah) NSW

Job No: SUN1

Borehole: P8

North/East: 6568597 / 225125

Logged by: A Dawkins

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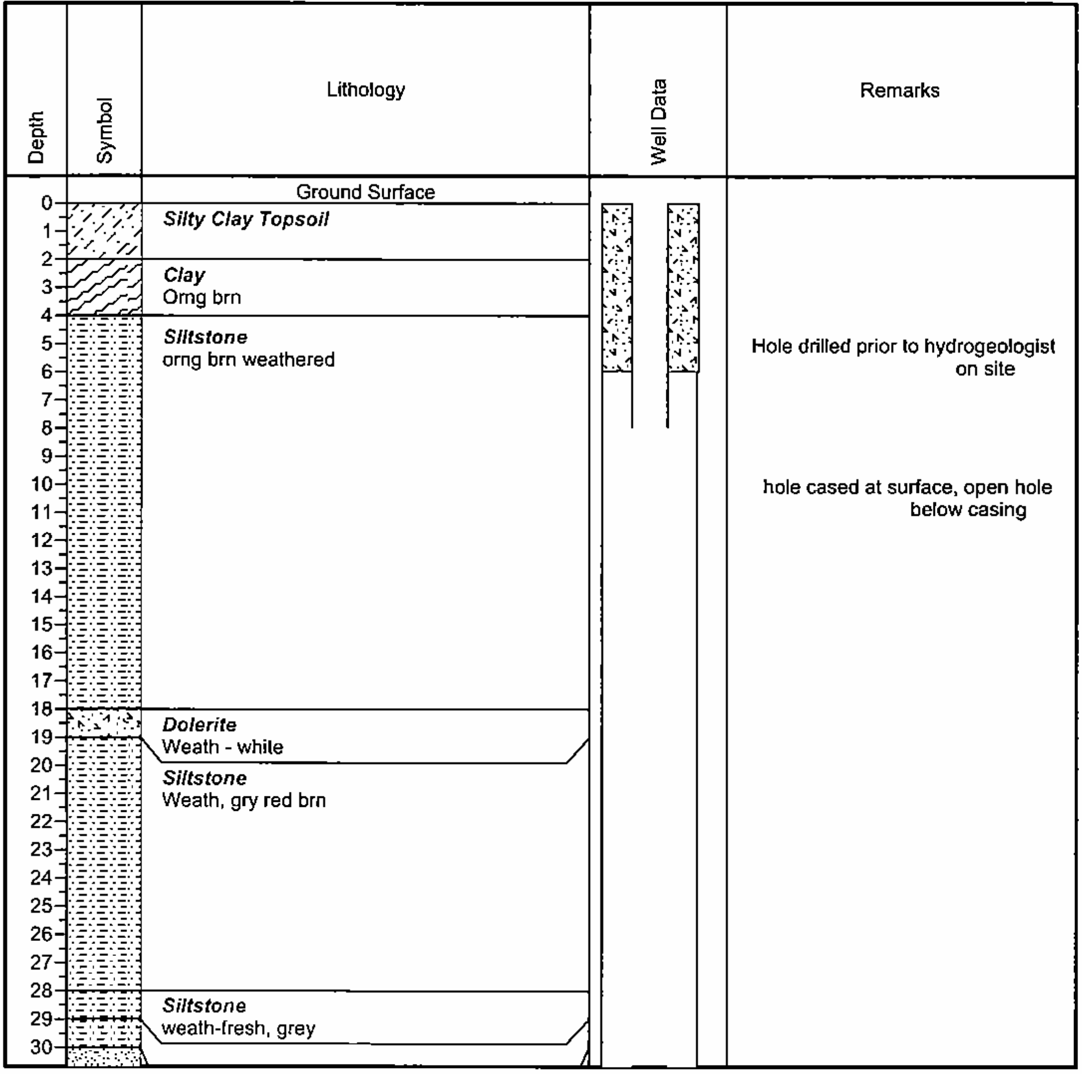

Silty Clay Topsoil

Clay
Orng brn

Siltstone
orng brn weathered

Dolerite
Weath - white

Siltstone
Weath, gry red brn

Siltstone
weath-fresh, grey

Hole drilled prior to hydrogeologist on site

hole cased at surface, open hole below casing

Drilled By: Nitro Drilling

Drill Method: Open Hole Hammer

Drill Date: October 2006

Hole Size: 6 7/8"

Ground RL: 326.48

Sheet: 1 of 3

Client: Namoi Mining Pty Ltd
Project: Sunnyside
Location: Sunnyside (Gunnedah) NSW
Job No: SUN1

Borehole: P8
North/East: 6568597 / 225125
Logged by: A Dawkins

GeoTerra
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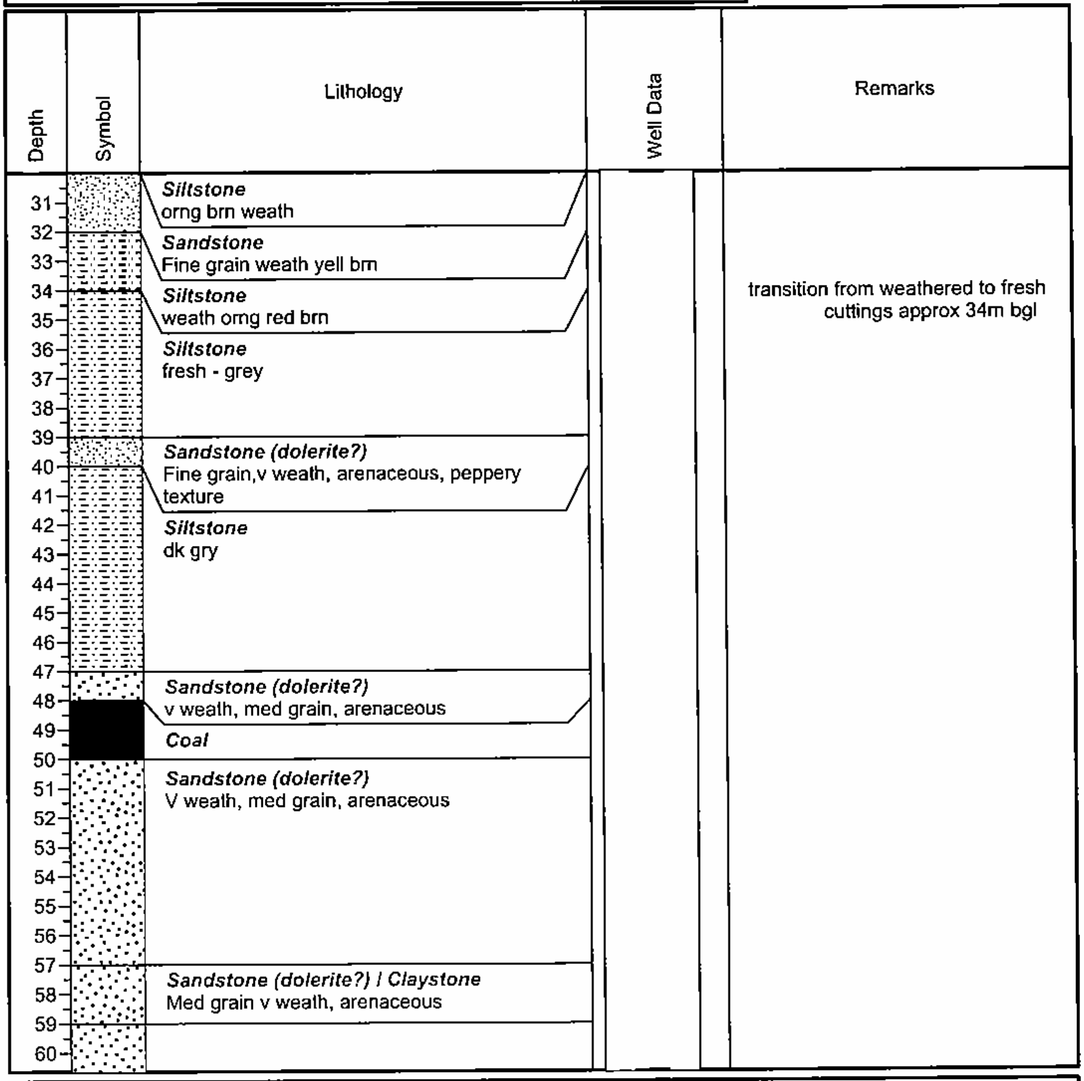
email geoterra@linet.net.au



Siltstone
orng brn weath

Sandstone
Fine grain weath yell brn

Siltstone
weath orng red brn

Siltstone
fresh - grey

Sandstone (dolerite?)
Fine grain,v weath, arenaceous, peppery texture

Siltstone
dk gry

Sandstone (dolerite?)
v weath, med grain, arenaceous

Coal

Sandstone (dolerite?)
V weath, med grain, arenaceous

Sandstone (dolerite?) / Claystone
Med grain v weath, arenaceous

transition from weathered to fresh cuttings approx 34m bgl

Drilled By: Nitro Drilling
Drill Method: Open Hole Hammer
Drill Date: October 2006

Hole Size: 6 7/8"
Ground RL: 326.48
Sheet: 2 of 3

Client: Namoi Mining Pty Ltd

Project: Sunnyside

Location: Sunnyside (Gunnedah) NSW

Job No: SUN1

Borehole: P8

North/East: 6568597 / 225125

Logged by: A Dawkins

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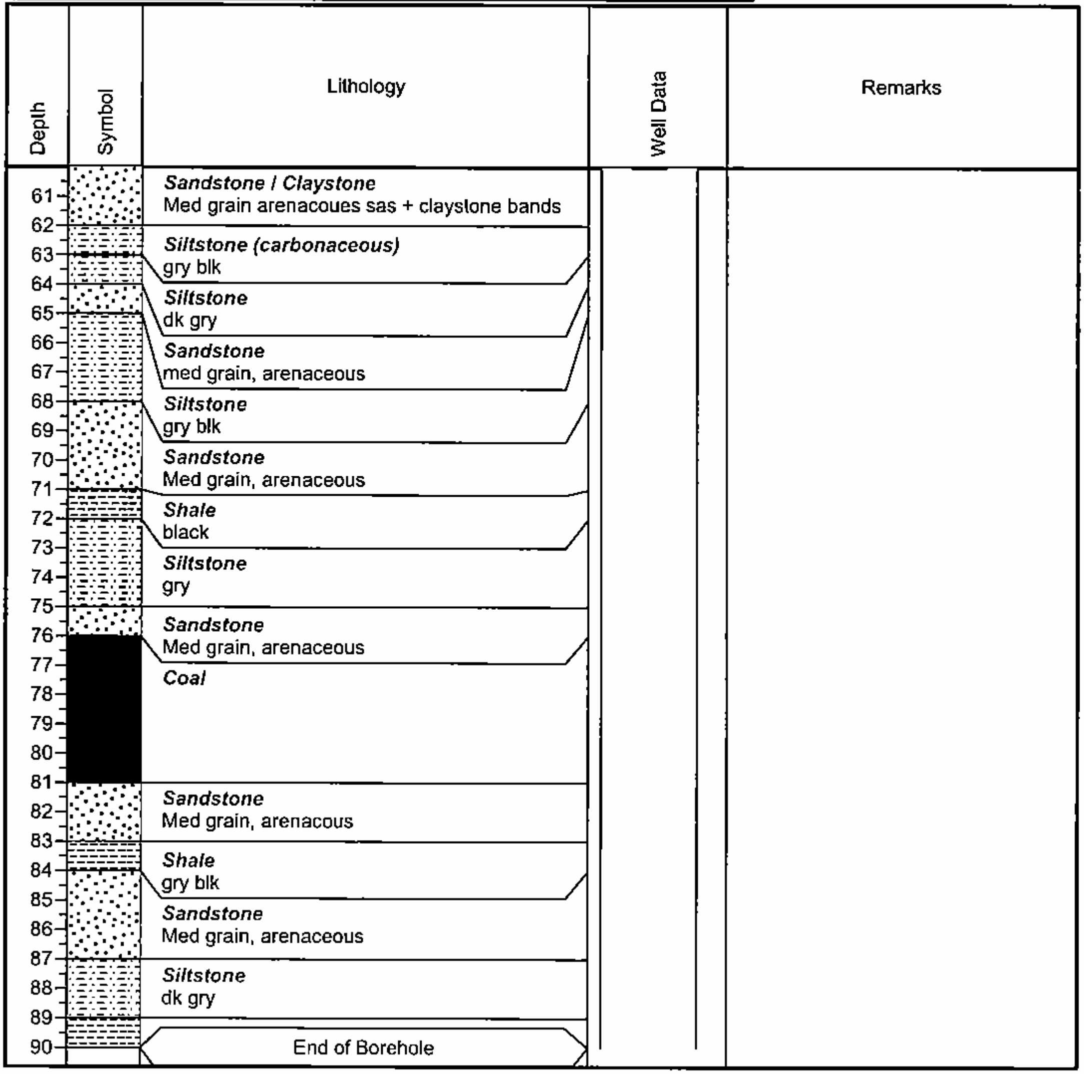


Sandstone / Claystone
Med grain arenacoues sas + claystone bands

Siltstone (carbonaceous)
gry blk

Siltstone
dk gry

Sandstone
med grain, arenaceous

Siltstone
gry blk

Sandstone
Med grain, arenaceous

Shale
black

Siltstone
gry

Sandstone
Med grain, arenaceous

Coal

Sandstone
Med grain, arenacous

Shale
gry blk

Sandstone
Med grain, arenaceous

Siltstone
dk gry

End of Borehole

Drilled By: Nitro Drilling

Drill Method: Open Hole Hammer

Drill Date: October 2006

Hole Size: 6 7/8"

Ground RL: 326.48

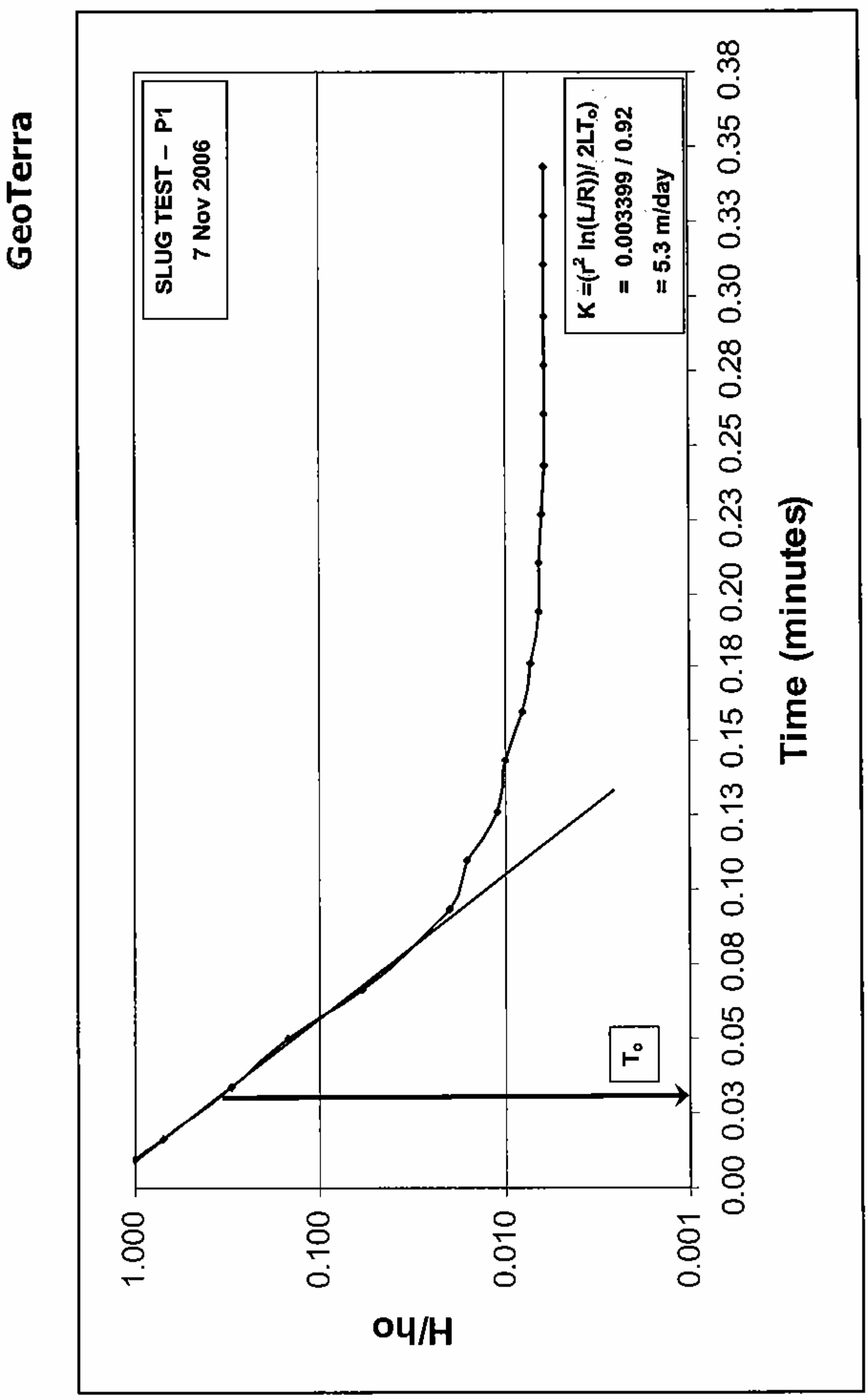
Sheet: 3 of 3

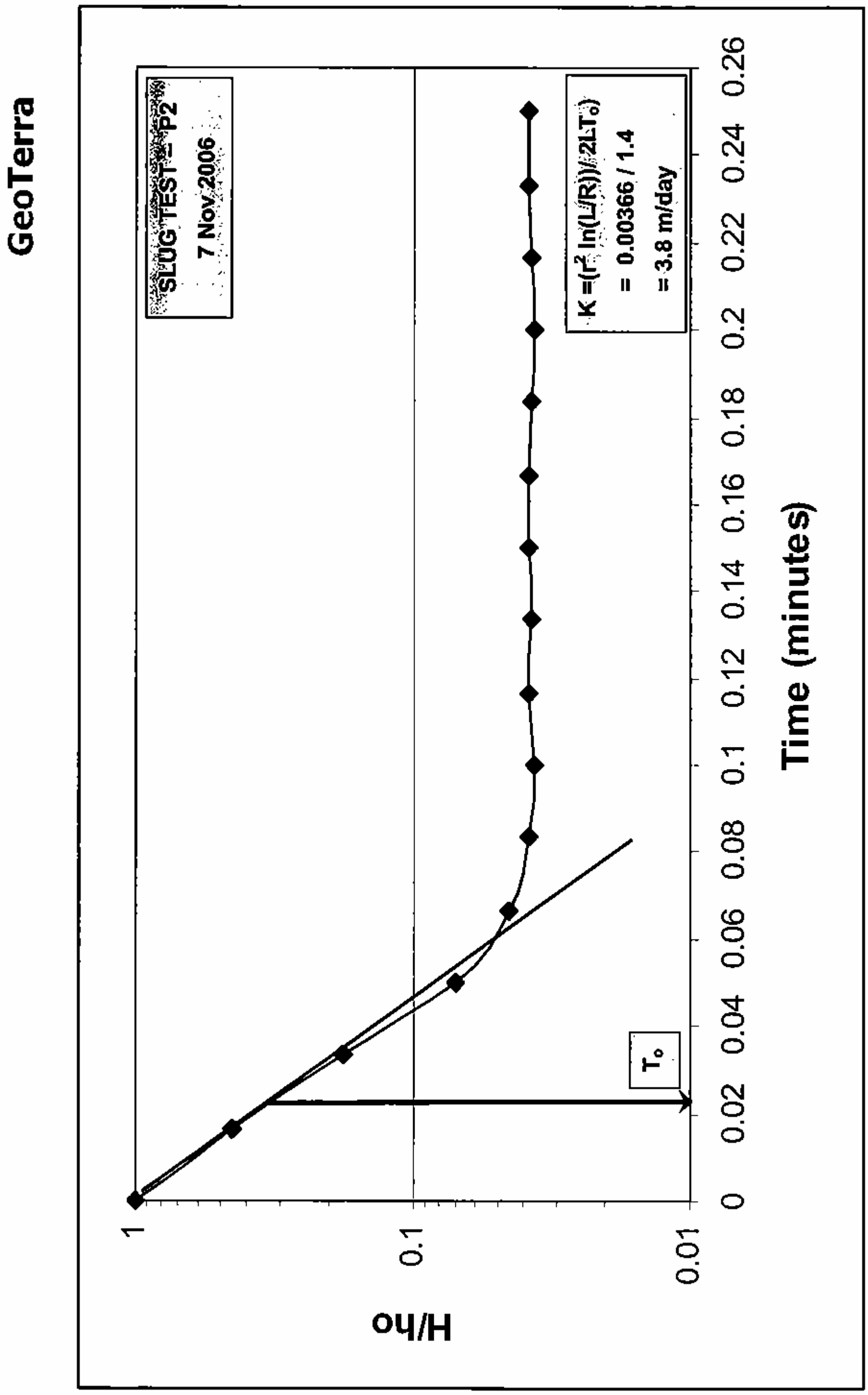
Appendix 3

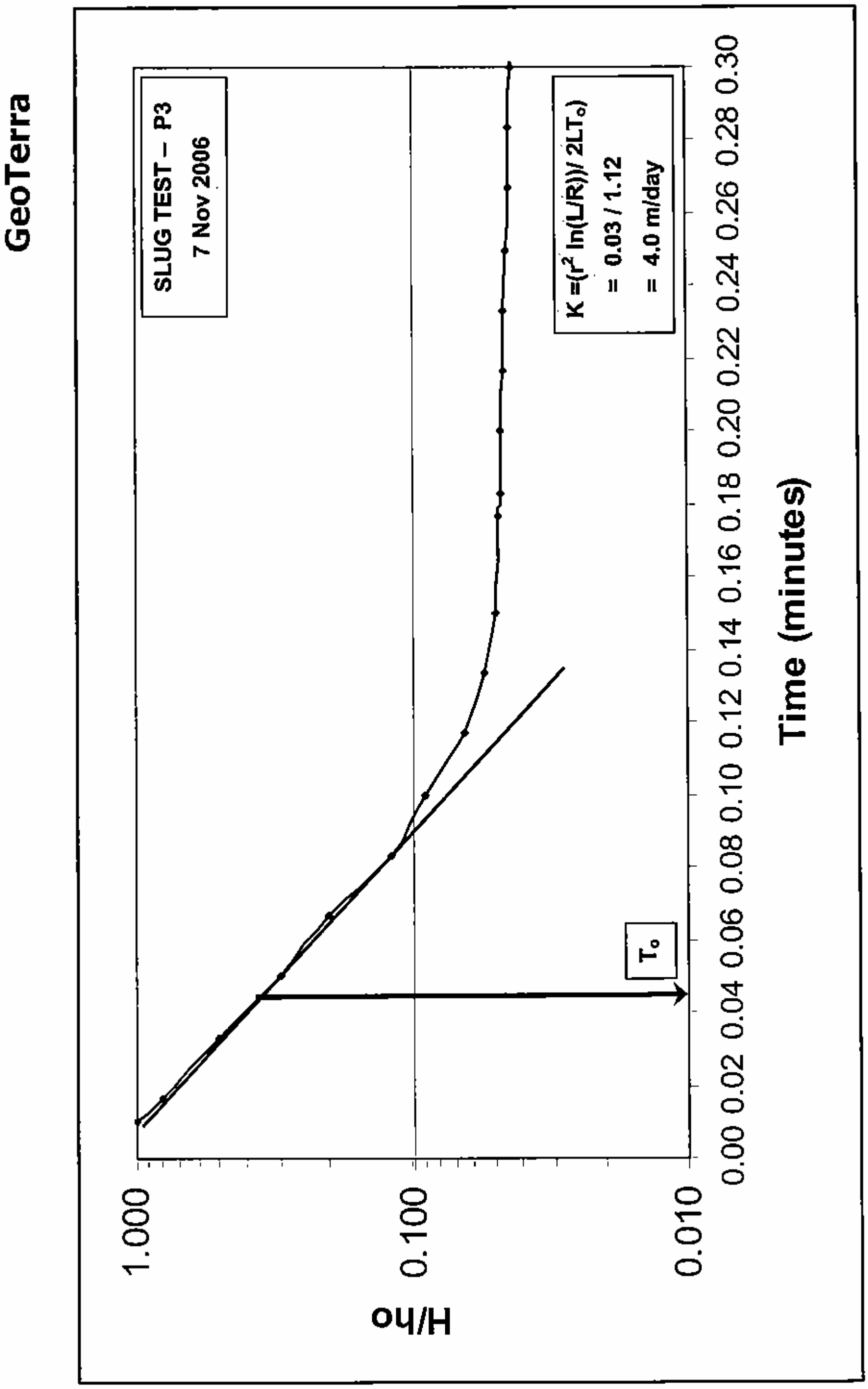
Hydraulic Test Results

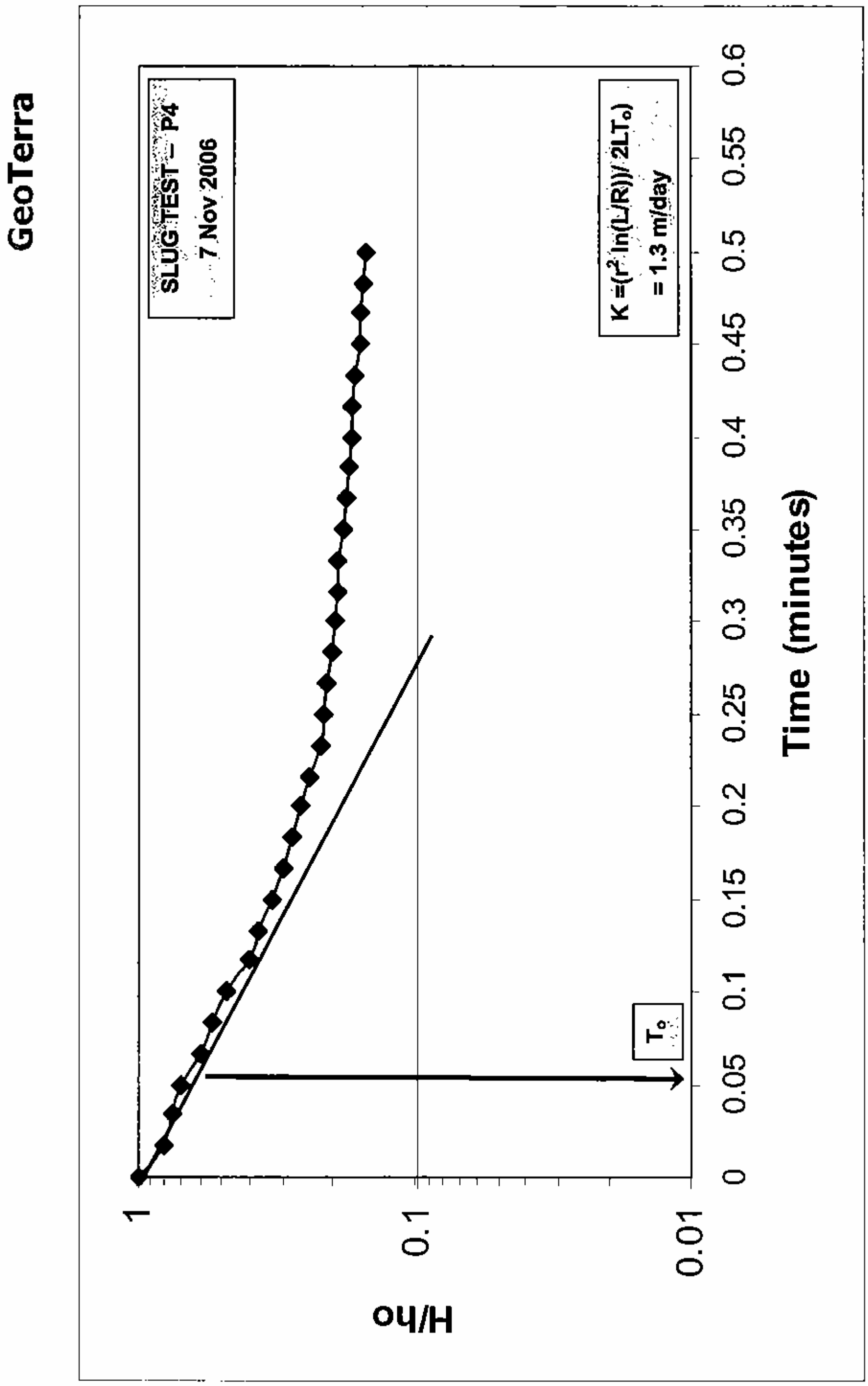
(No. of pages excluding this page = 8)

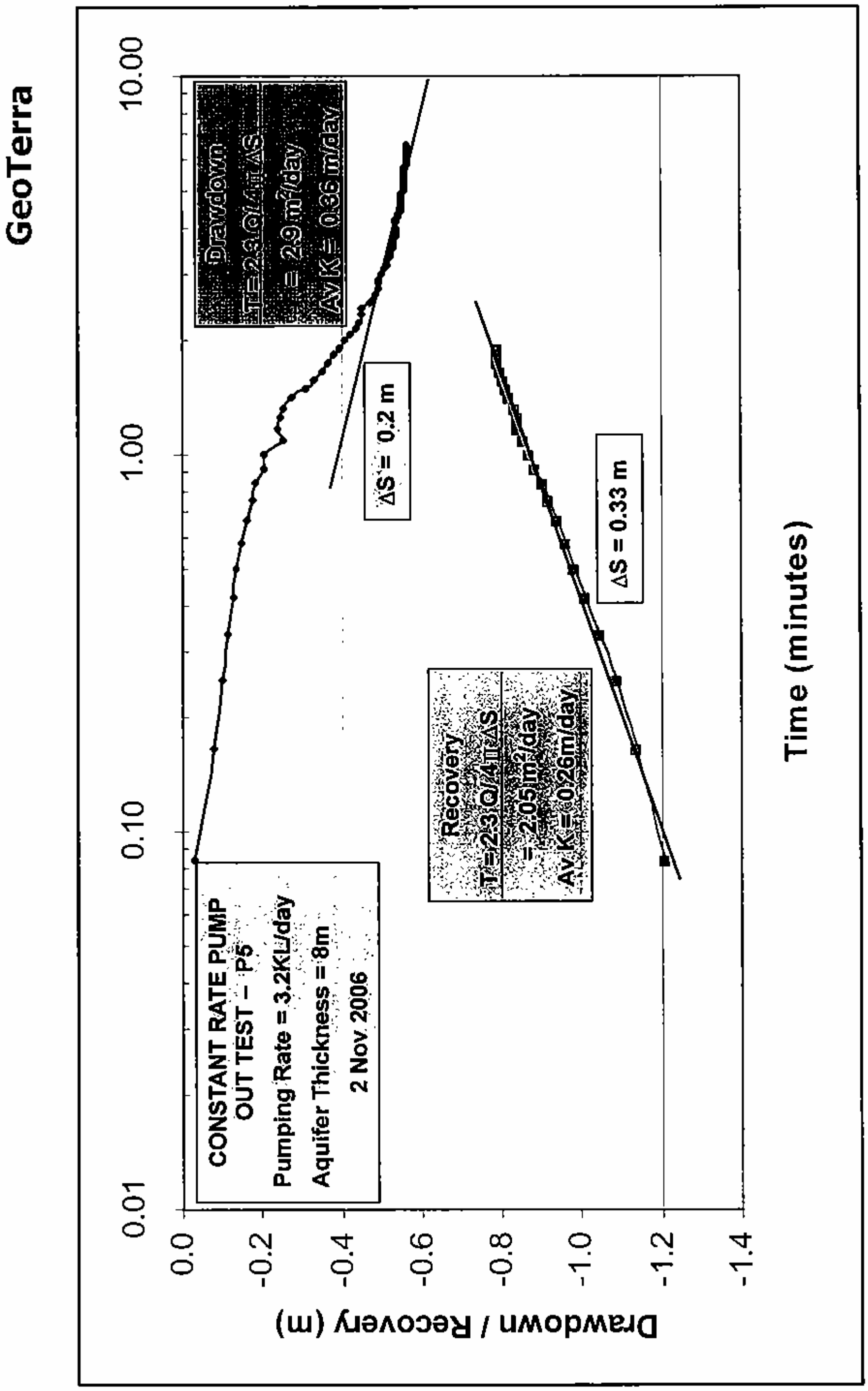
Note: This Appendix is presented in full on the CD for the Sunnyside Coal Project

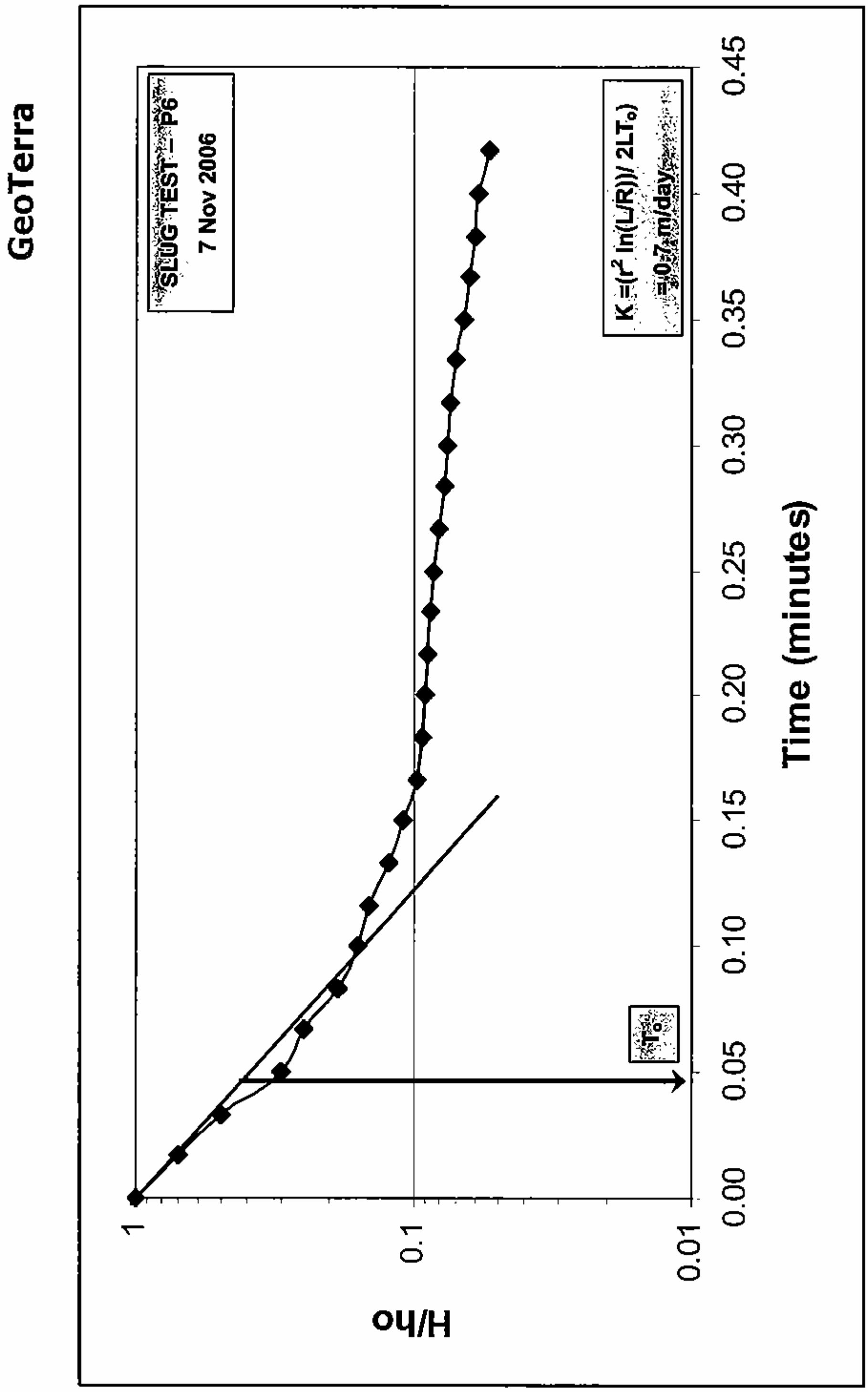

GeoTerra
SLUG TEST – P1
7 Nov 2006
K =(r² ln(L/R))/ 2LT₀)
= 0.003399 / 0.92
= 5.3 m/day
T₀
H/ho
1.000
0.100
0.010
0.001
Time (minutes)
0.00 0.03 0.05 0.08 0.10 0.13 0.15 0.18 0.20 0.23 0.25 0.28 0.30 0.33 0.35 0.38

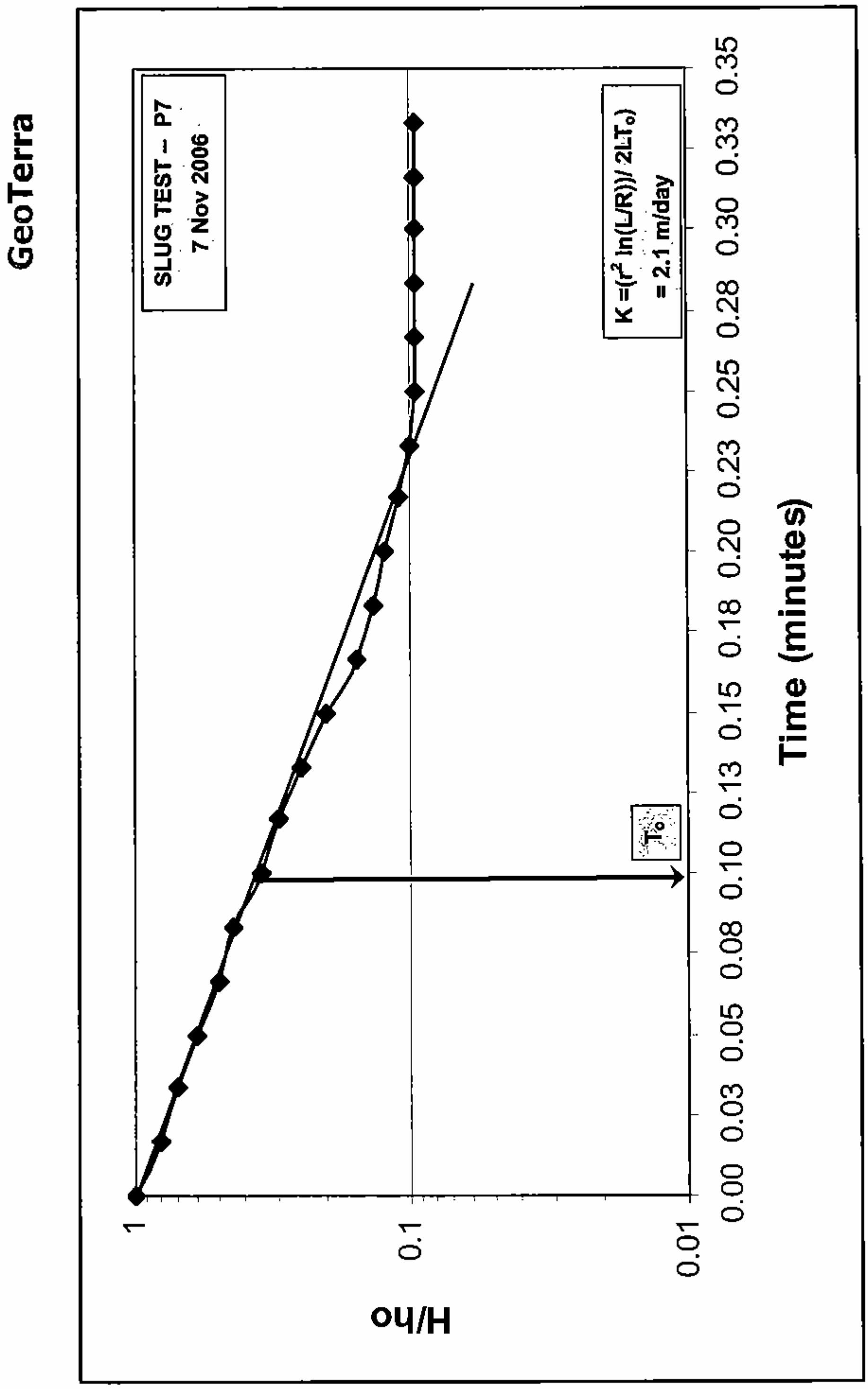

GeoTerra
SLUG TEST – P2
7 Nov 2006
K =(r² ln(L/R))/ 2LT₀)
= 0.00366 / 1.4
= 3.8 m/day
T₀
H/ho
1
0.1
0.01
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
Time (minutes)

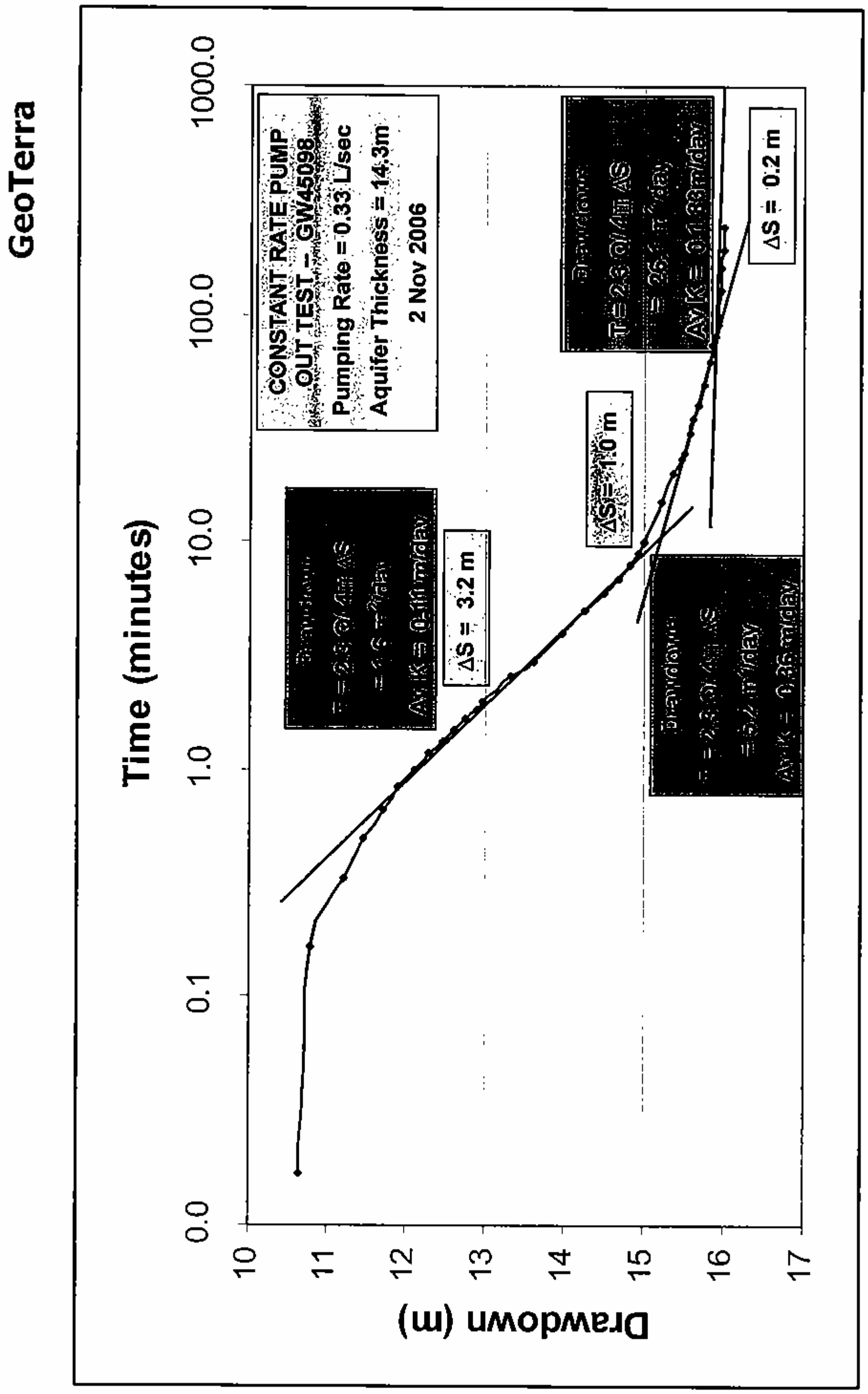

GeoTerra
SLUG TEST – P3
7 Nov 2006
$K = (r^2 \ln(L/R))/ 2LT_o)$
$= 0.03 / 1.12$
$= 4.0$ m/day
T_o
1.000
0.100
0.010
H/ho
0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30
Time (minutes)


GeoTerra
SLUG TEST – P4
7 Nov 2006
K =(r² ln(L/R))/ 2LTo)
= 1.3 m/day
To
H/ho
1
0.1
0.01
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
Time (minutes)


GeoTerra
CONSTANT RATE PUMP OUT TEST – P5
Pumping Rate = 3.2KL/day
Aquifer Thickness = 8m
2 Nov 2006
Drawdown
T=2.3Q/4πΔS
= 2.9 m²/day
Av K = 0.36 m/day
ΔS = 0.2 m
Recovery
T=2.3Q/4πΔS
= 2.05m²/day
Av K = 0.26m/day
ΔS = 0.33 m
0.01
0.10
1.00
10.00
Time (minutes)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
Drawdown / Recovery (m)


GeoTerra
SLUG TEST – P6
7 Nov 2006
K =(r² ln(L/R))/ 2LTo)
= 0.7 m/day
To
H/ho
1
0.1
0.01
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
Time (minutes)


GeoTerra
SLUG TEST – P7
7 Nov 2006
K =(r² ln(L/R))/ 2LT₀)
= 2.1 m/day
T₀
H/ho
1
0.1
0.01
0.00 0.03 0.05 0.08 0.10 0.13 0.15 0.18 0.20 0.23 0.25 0.28 0.30 0.33 0.35
Time (minutes)


GeoTerra
Time (minutes)
0.0
0.1
1.0
10.0
100.0
1000.0
Drawdown (m)
10
11
12
13
14
15
16
17
CONSTANT RATE PUMP OUT TEST – GW45098
Pumping Rate = 0.33 L/sec
Aquifer Thickness = 14.3m
2 Nov 2006
Drawdown
T = 2.3 Q/4π ΔS
= 1.6 m²/day
Av K = 0.11 m/day
ΔS = 3.2 m
ΔS = 1.0 m
Drawdown
T = 2.3 Q/4π ΔS
= 5.2 m²/day
Av K = 0.36 m/day
Drawdown
T = 2.3 Q/4π ΔS
= 26.1 m²/day
Av K = 01.83 m/day
ΔS = 0.2 m

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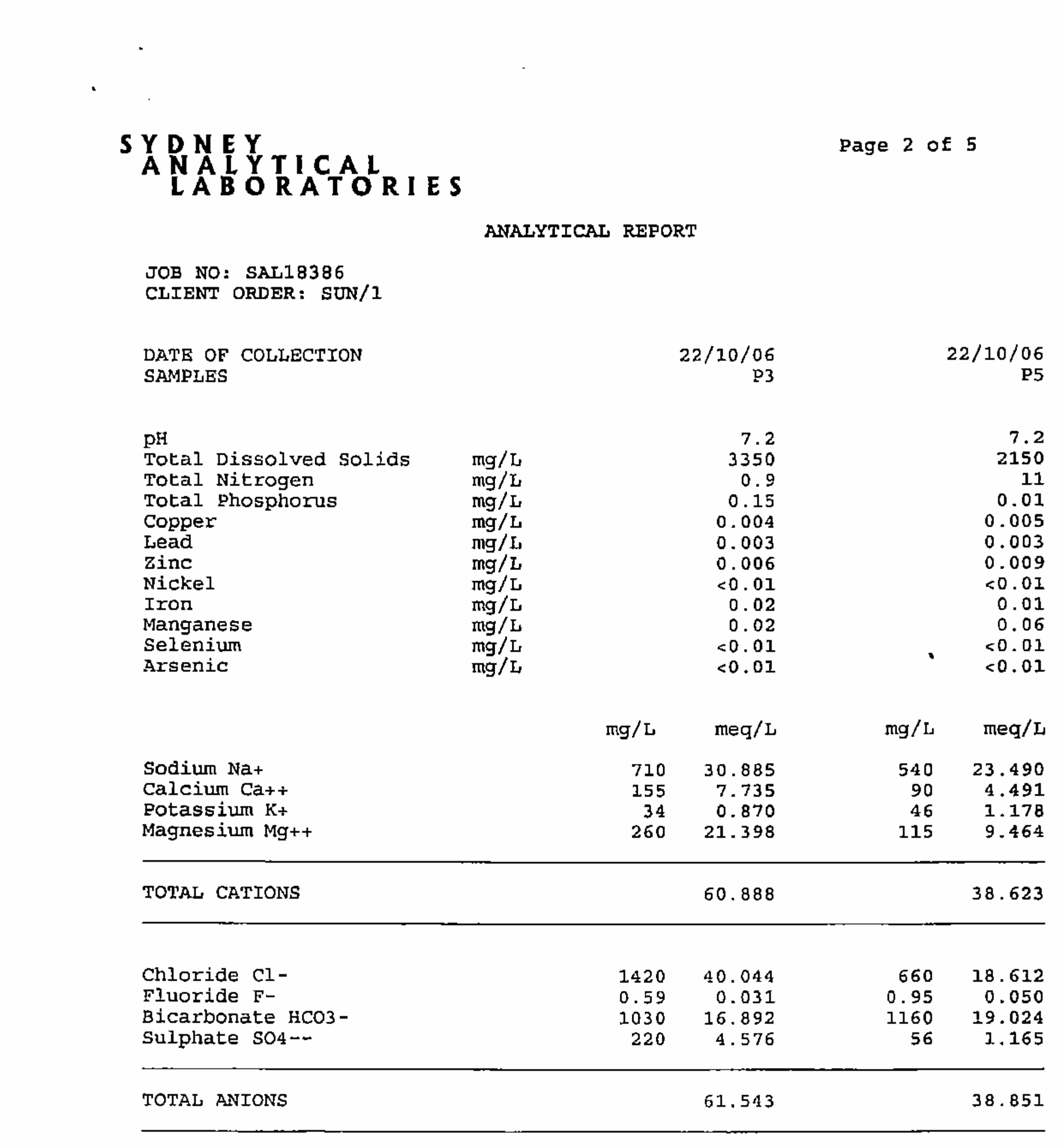
Appendix 4

Laboratory Results (Bore Water, Batch Salinity Leachate, Acid Rock Drainage)

(No. of pages excluding this page = 15)

Note: This Appendix is presented in full on the CD for the Sunnyside Coal Project



SYDNEY ANALYTICAL LABORATORIES

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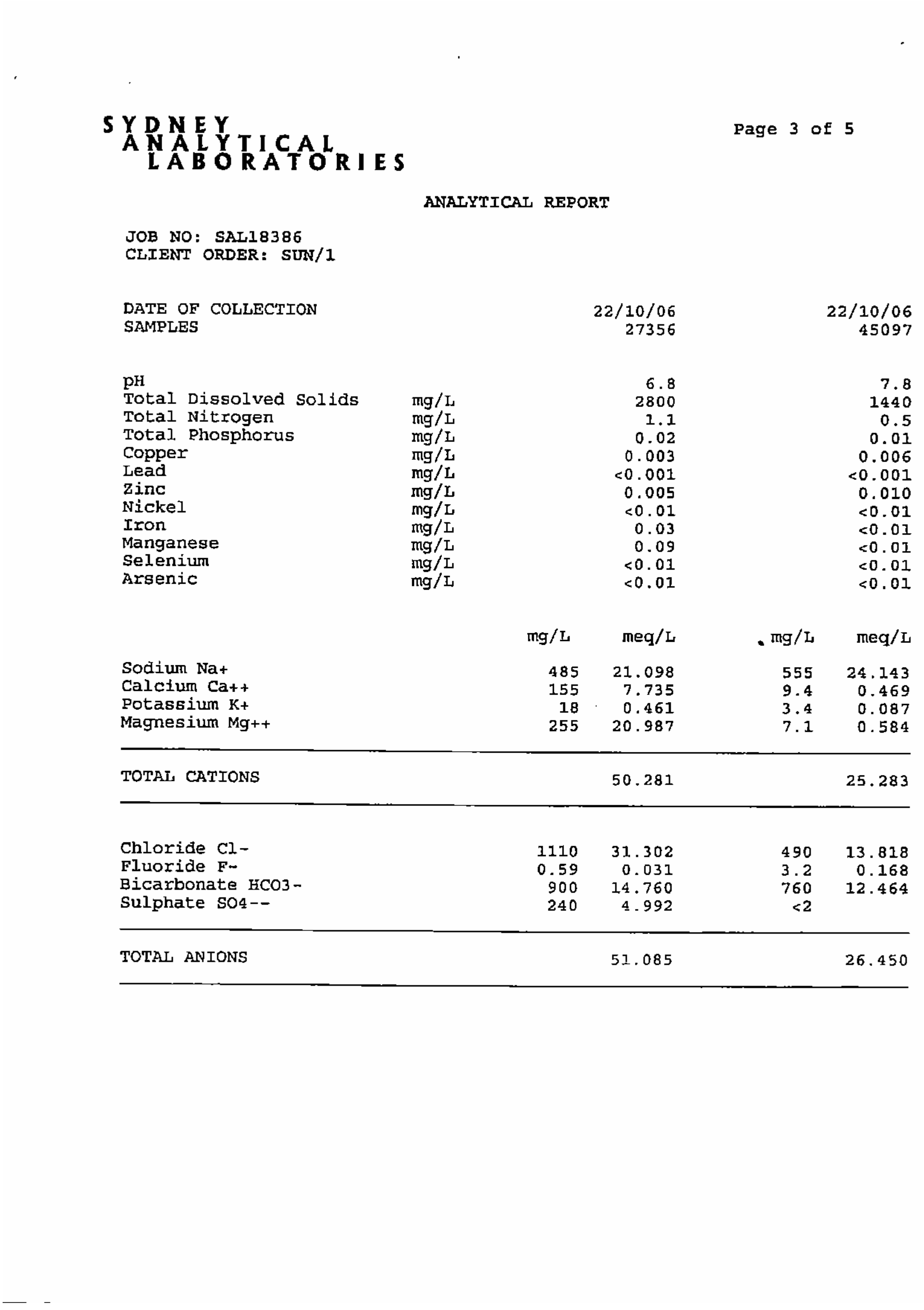
ANALYTICAL REPORT

JOB NO: SAL18386
CLIENT ORDER: SUN/1

DATE OF COLLECTION		22/10/06	22/10/06
SAMPLES		P3	P5
pH		7.2	7.2
Total Dissolved Solids	mg/L	3350	2150
Total Nitrogen	mg/L	0.9	11
Total Phosphorus	mg/L	0.15	0.01
Copper	mg/L	0.004	0.005
Lead	mg/L	0.003	0.003
Zinc	mg/L	0.006	0.009
Nickel	mg/L	<0.01	<0.01
Iron	mg/L	0.02	0.01
Manganese	mg/L	0.02	0.06
Selenium	mg/L	<0.01	<0.01
Arsenic	mg/L	<0.01	<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	710	30.885	540	23.490
Calcium Ca++	155	7.735	90	4.491
Potassium K+	34	0.870	46	1.178
Magnesium Mg++	260	21.398	115	9.464
TOTAL CATIONS		60.888		38.623
Chloride Cl-	1420	40.044	660	18.612
Fluoride F-	0.59	0.031	0.95	0.050
Bicarbonate HCO3-	1030	16.892	1160	19.024
Sulphate SO4--	220	4.576	56	1.165
TOTAL ANIONS		61.543		38.851



SYDNEY ANALYTICAL LABORATORIES

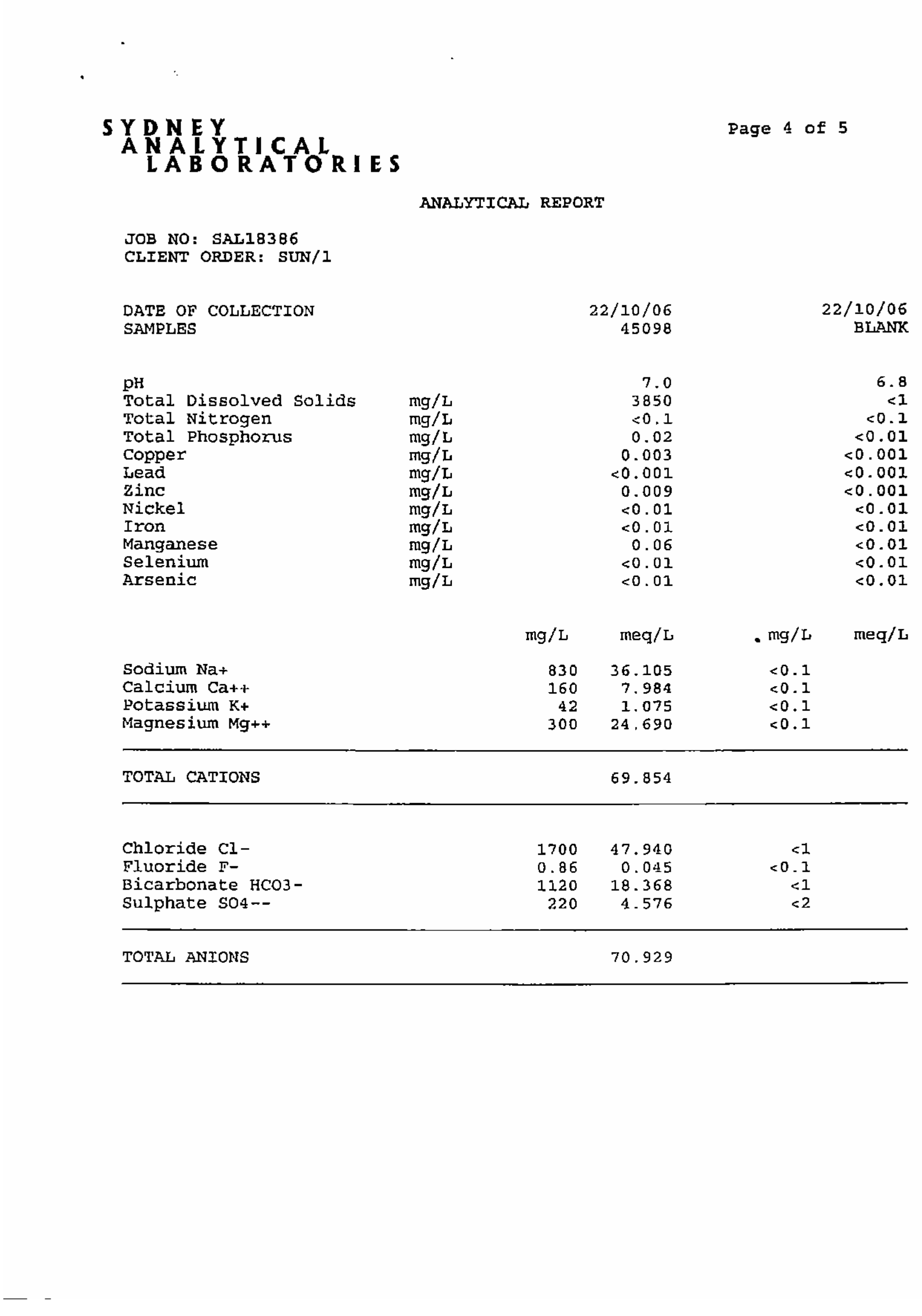
Page 3 of 5

ANALYTICAL REPORT

JOB NO: SAL18386
CLIENT ORDER: SUN/1

DATE OF COLLECTION		22/10/06	22/10/06
SAMPLES		27356	45097
pH		6.8	7.8
Total Dissolved Solids	mg/L	2800	1440
Total Nitrogen	mg/L	1.1	0.5
Total Phosphorus	mg/L	0.02	0.01
Copper	mg/L	0.003	0.006
Lead	mg/L	<0.001	<0.001
Zinc	mg/L	0.005	0.010
Nickel	mg/L	<0.01	<0.01
Iron	mg/L	0.03	<0.01
Manganese	mg/L	0.09	<0.01
Selenium	mg/L	<0.01	<0.01
Arsenic	mg/L	<0.01	<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	485	21.098	555	24.143
Calcium Ca++	155	7.735	9.4	0.469
Potassium K+	18	0.461	3.4	0.087
Magnesium Mg++	255	20.987	7.1	0.584
TOTAL CATIONS		50.281		25.283
Chloride Cl-	1110	31.302	490	13.818
Fluoride F-	0.59	0.031	3.2	0.168
Bicarbonate HCO3-	900	14.760	760	12.464
Sulphate SO4--	240	4.992	<2	
TOTAL ANIONS		51.085		26.450



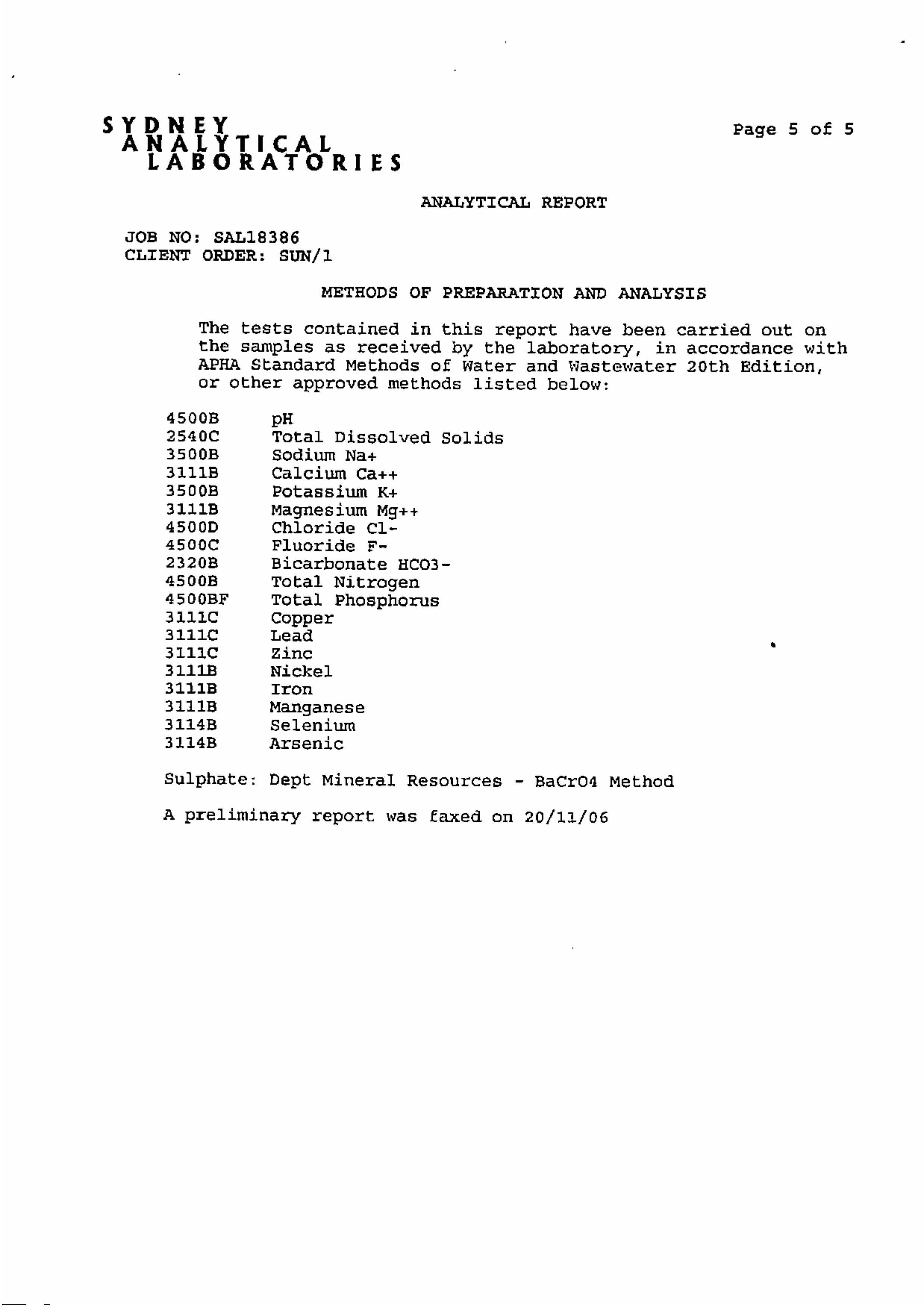
SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL18386
CLIENT ORDER: SUN/1

DATE OF COLLECTION		22/10/06	22/10/06
SAMPLES		45098	BLANK
pH		7.0	6.8
Total Dissolved Solids	mg/L	3850	<1
Total Nitrogen	mg/L	<0.1	<0.1
Total Phosphorus	mg/L	0.02	<0.01
Copper	mg/L	0.003	<0.001
Lead	mg/L	<0.001	<0.001
Zinc	mg/L	0.009	<0.001
Nickel	mg/L	<0.01	<0.01
Iron	mg/L	<0.01	<0.01
Manganese	mg/L	0.06	<0.01
Selenium	mg/L	<0.01	<0.01
Arsenic	mg/L	<0.01	<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	830	36.105	<0.1	
Calcium Ca++	160	7.984	<0.1	
Potassium K+	42	1.075	<0.1	
Magnesium Mg++	300	24.690	<0.1	
TOTAL CATIONS		69.854		
Chloride Cl-	1700	47.940	<1	
Fluoride F-	0.86	0.045	<0.1	
Bicarbonate HCO3-	1120	18.368	<1	
Sulphate SO4--	220	4.576	<2	
TOTAL ANIONS		70.929		



SYDNEY ANALYTICAL LABORATORIES

Page 5 of 5

ANALYTICAL REPORT

JOB NO: SAL18386
CLIENT ORDER: SUN/1

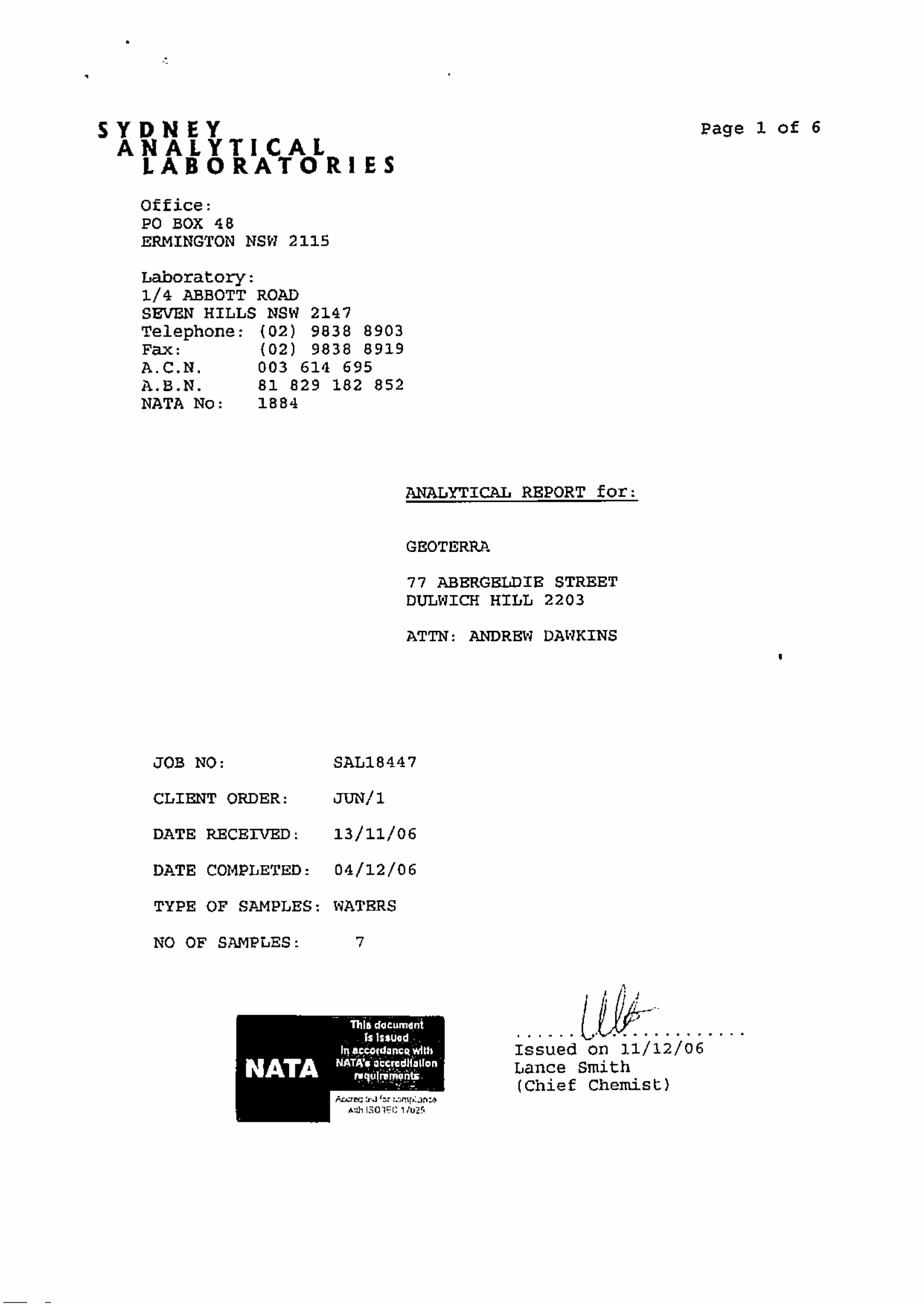
METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 20th Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
2320B	Bicarbonate HCO3-
4500B	Total Nitrogen
4500BF	Total Phosphorus
3111C	Copper
3111C	Lead
3111C	Zinc
3111B	Nickel
3111B	Iron
3111B	Manganese
3114B	Selenium
3114B	Arsenic

Sulphate: Dept Mineral Resources - BaCrO4 Method

A preliminary report was faxed on 20/11/06



SYDNEY ANALYTICAL LABORATORIES

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

Page 1 of 6

ANALYTICAL REPORT for:

GEOTERRA

77 ABERGELDIE STREET
DULWICH HILL 2203

ATTN: ANDREW DAWKINS

JOB NO: SAL18447

CLIENT ORDER: JUN/1

DATE RECEIVED: 13/11/06

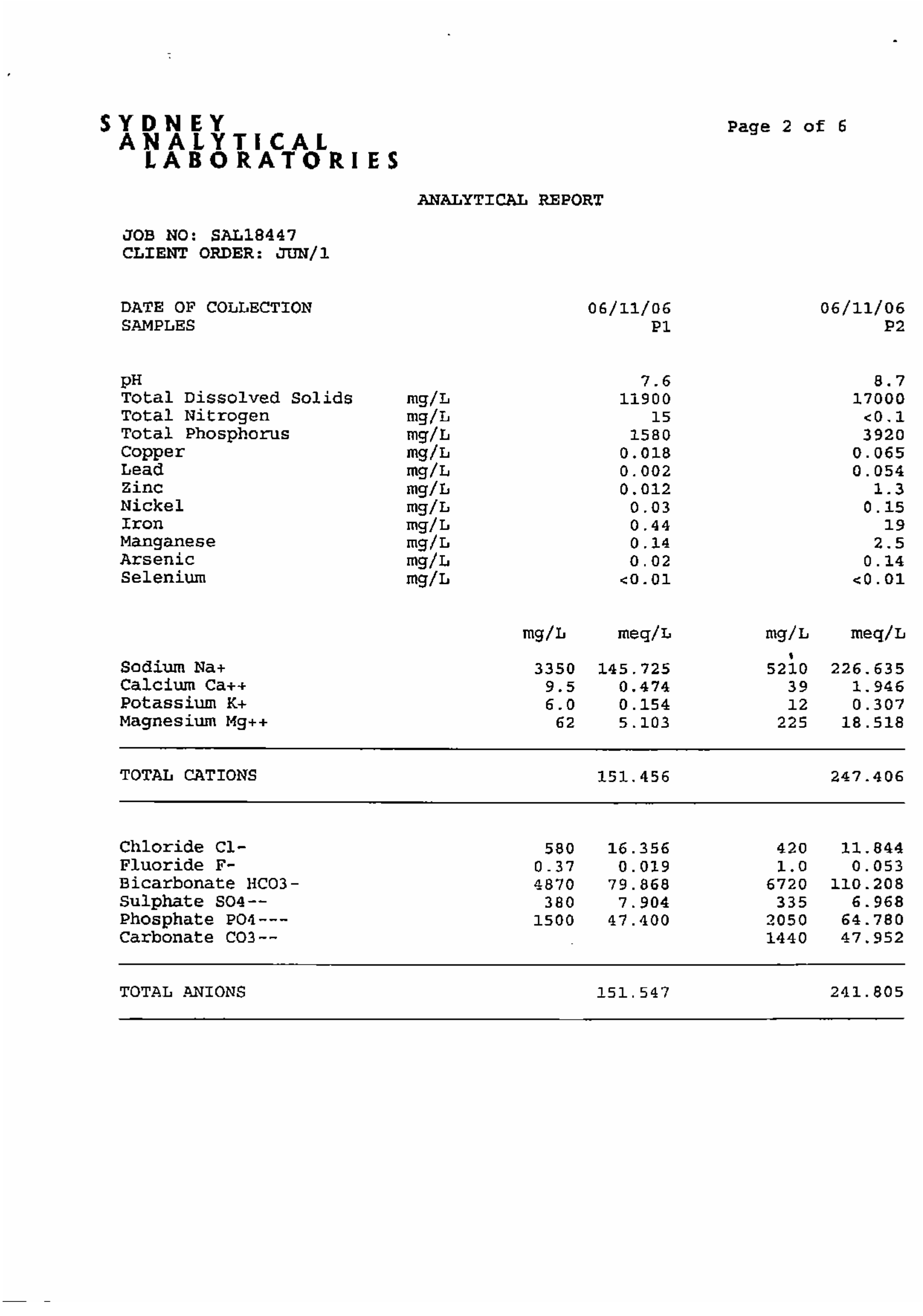
DATE COMPLETED: 04/12/06

TYPE OF SAMPLES: WATERS

NO OF SAMPLES: 7

NATA This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025

Issued on 11/12/06
Lance Smith
(Chief Chemist)



SYDNEY ANALYTICAL LABORATORIES

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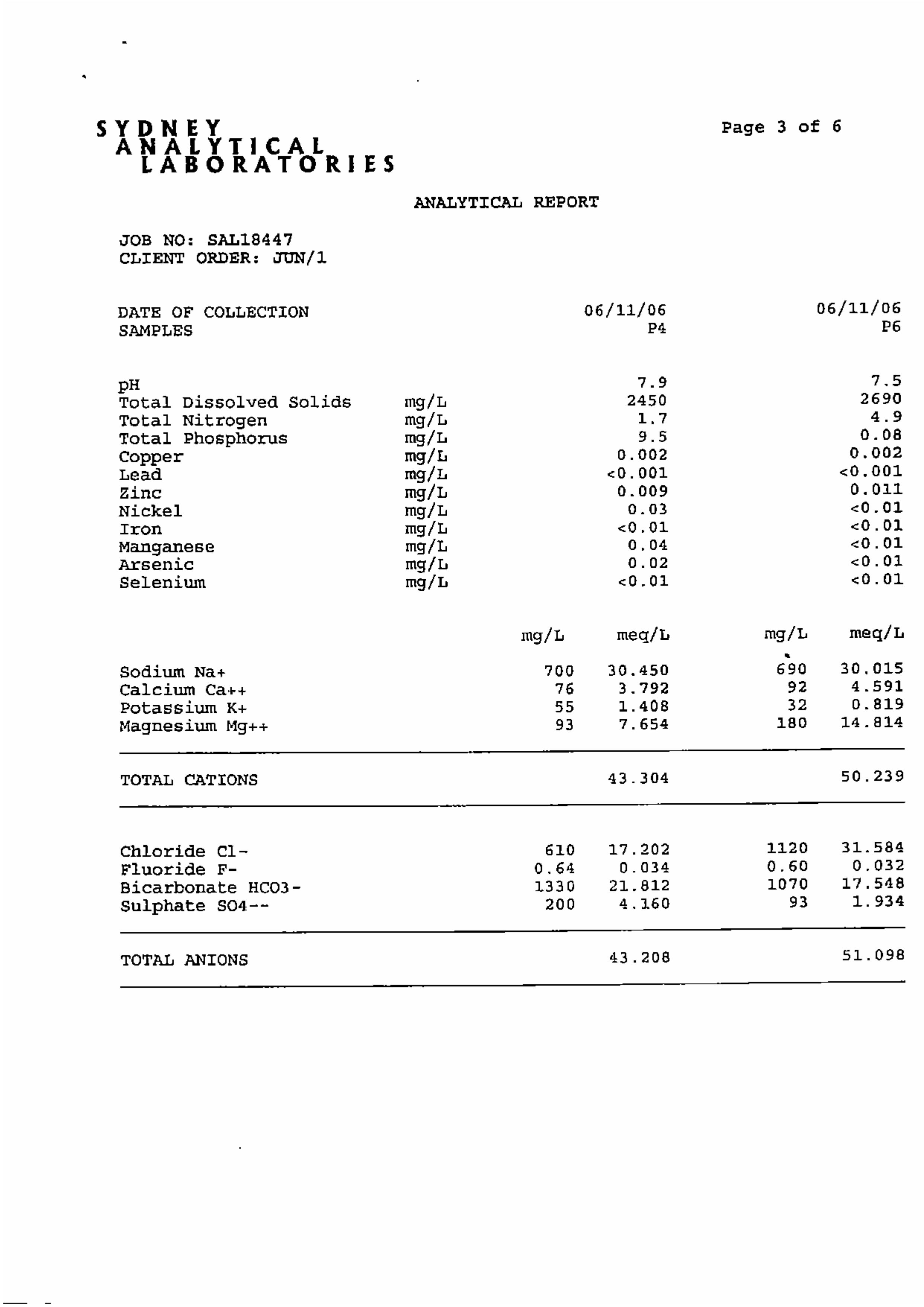
ANALYTICAL REPORT

JOB NO: SAL18447
CLIENT ORDER: JUN/1

DATE OF COLLECTION		06/11/06	06/11/06
SAMPLES		P1	P2
pH		7.6	8.7
Total Dissolved Solids	mg/L	11900	17000
Total Nitrogen	mg/L	15	<0.1
Total Phosphorus	mg/L	1580	3920
Copper	mg/L	0.018	0.065
Lead	mg/L	0.002	0.054
Zinc	mg/L	0.012	1.3
Nickel	mg/L	0.03	0.15
Iron	mg/L	0.44	19
Manganese	mg/L	0.14	2.5
Arsenic	mg/L	0.02	0.14
Selenium	mg/L	<0.01	<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	3350	145.725	5210	226.635
Calcium Ca++	9.5	0.474	39	1.946
Potassium K+	6.0	0.154	12	0.307
Magnesium Mg++	62	5.103	225	18.518
TOTAL CATIONS		151.456		247.406
Chloride Cl-	580	16.356	420	11.844
Fluoride F-	0.37	0.019	1.0	0.053
Bicarbonate HCO3-	4870	79.868	6720	110.208
Sulphate SO4--	380	7.904	335	6.968
Phosphate PO4---	1500	47.400	2050	64.780
Carbonate CO3--			1440	47.952
TOTAL ANIONS		151.547		241.805



SYDNEY ANALYTICAL LABORATORIES

Page 3 of 6

ANALYTICAL REPORT

JOB NO: SAL18447
CLIENT ORDER: JUN/1

DATE OF COLLECTION		06/11/06	06/11/06
SAMPLES		P4	P6
pH		7.9	7.5
Total Dissolved Solids	mg/L	2450	2690
Total Nitrogen	mg/L	1.7	4.9
Total Phosphorus	mg/L	9.5	0.08
Copper	mg/L	0.002	0.002
Lead	mg/L	<0.001	<0.001
Zinc	mg/L	0.009	0.011
Nickel	mg/L	0.03	<0.01
Iron	mg/L	<0.01	<0.01
Manganese	mg/L	0.04	<0.01
Arsenic	mg/L	0.02	<0.01
Selenium	mg/L	<0.01	<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	700	30.450	690	30.015
Calcium Ca++	76	3.792	92	4.591
Potassium K+	55	1.408	32	0.819
Magnesium Mg++	93	7.654	180	14.814
TOTAL CATIONS		43.304		50.239
Chloride Cl-	610	17.202	1120	31.584
Fluoride F-	0.64	0.034	0.60	0.032
Bicarbonate HCO3-	1330	21.812	1070	17.548
Sulphate SO4--	200	4.160	93	1.934
TOTAL ANIONS		43.208		51.098

SYDNEY ANALYTICAL LABORATORIES

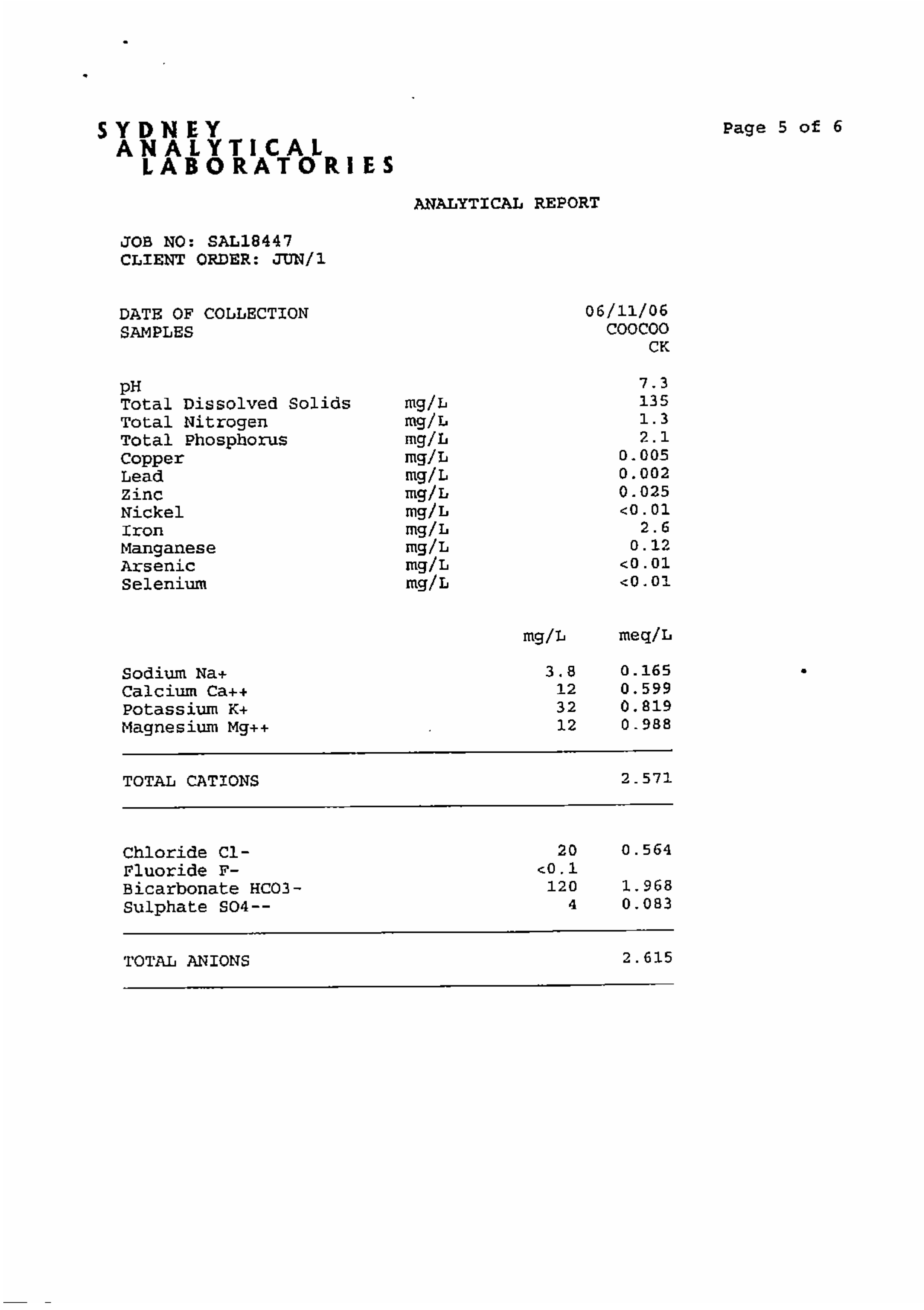
Page 4 of 6

ANALYTICAL REPORT

JOB NO: SAL18447
CLIENT ORDER: JUN/1

DATE OF COLLECTION		06/11/06	06/11/06
SAMPLES		P7	P8
pH		7.2	7.1
Total Dissolved Solids	mg/L	3360	4590
Total Nitrogen	mg/L	4.5	0.5
Total Phosphorus	mg/L	0.02	0.08
Copper	mg/L	0.002	0.004
Lead	mg/L	<0.001	<0.001
Zinc	mg/L	0.014	0.046
Nickel	mg/L	<0.01	<0.01
Iron	mg/L	<0.01	<0.01
Manganese	mg/L	0.03	2.1
Arsenic	mg/L	<0.01	0.01
Selenium	mg/L	<0.01	<0.01

	mg/L	meq/L	mg/L	meq/L
Sodium Na+	790	34.365	800	34.800
Calcium Ca++	130	6.487	255	12.725
Potassium K+	19	0.486	21	0.538
Magnesium Mg++	245	20.164	365	30.040
TOTAL CATIONS		61.502		78.103
Chloride Cl-	1480	41.736	1600	45.120
Fluoride F-	0.37	0.019	0.30	0.016
Bicarbonate HCO3-	1010	16.564	720	11.808
Sulphate SO4--	200	4.160	1080	22.464
TOTAL ANIONS		62.479		79.408



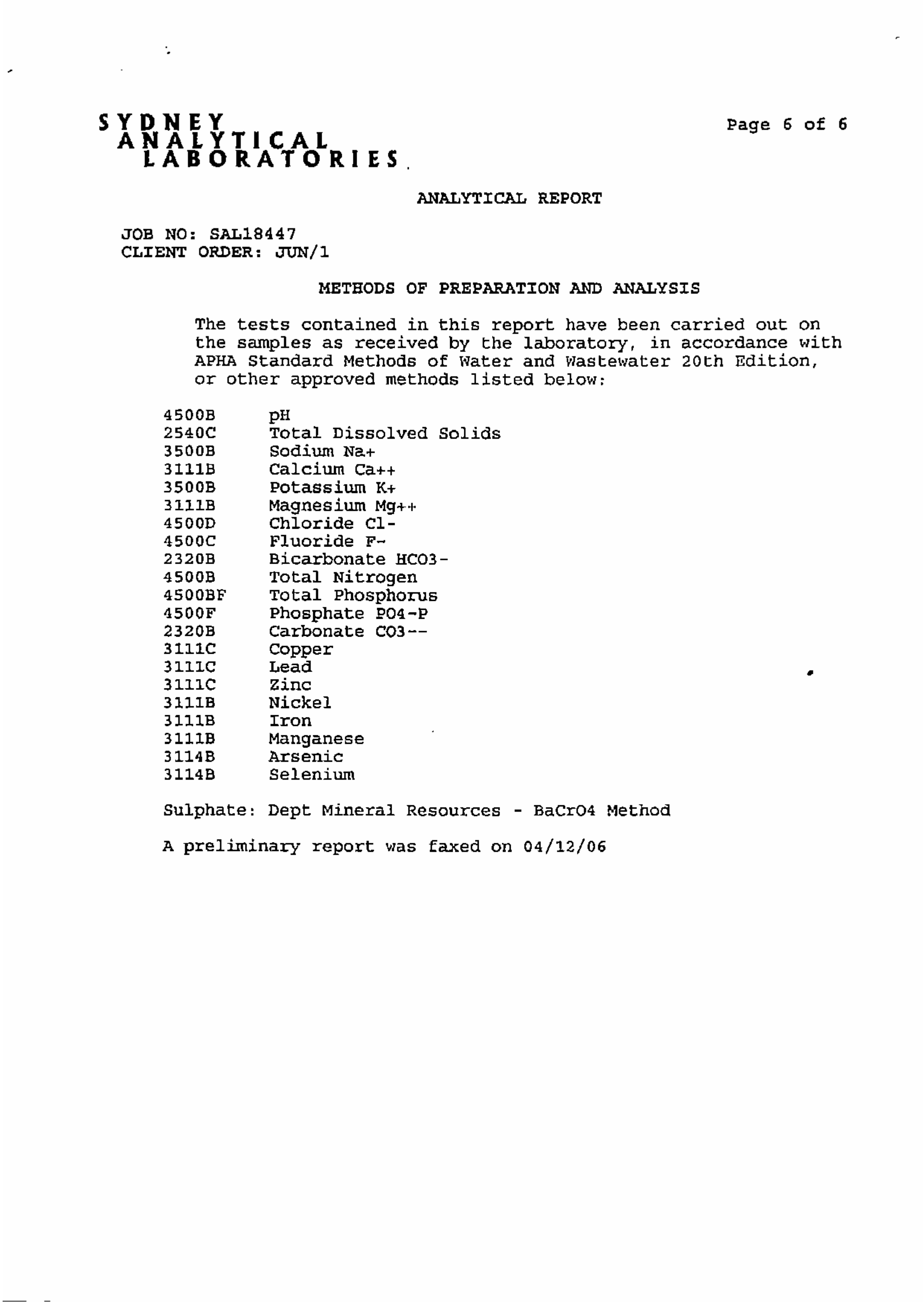
SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL18447
CLIENT ORDER: JUN/1

DATE OF COLLECTION		06/11/06
SAMPLES		COOCOO CK
pH		7.3
Total Dissolved Solids	mg/L	135
Total Nitrogen	mg/L	1.3
Total Phosphorus	mg/L	2.1
Copper	mg/L	0.005
Lead	mg/L	0.002
Zinc	mg/L	0.025
Nickel	mg/L	<0.01
Iron	mg/L	2.6
Manganese	mg/L	0.12
Arsenic	mg/L	<0.01
Selenium	mg/L	<0.01

	mg/L	meq/L
Sodium Na+	3.8	0.165
Calcium Ca++	12	0.599
Potassium K+	32	0.819
Magnesium Mg++	12	0.988
TOTAL CATIONS		2.571
Chloride Cl-	20	0.564
Fluoride F-	<0.1	
Bicarbonate HCO3-	120	1.968
Sulphate SO4--	4	0.083
TOTAL ANIONS		2.615



SYDNEY ANALYTICAL LABORATORIES

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ANALYTICAL REPORT

JOB NO: SAL18447
CLIENT ORDER: JUN/1

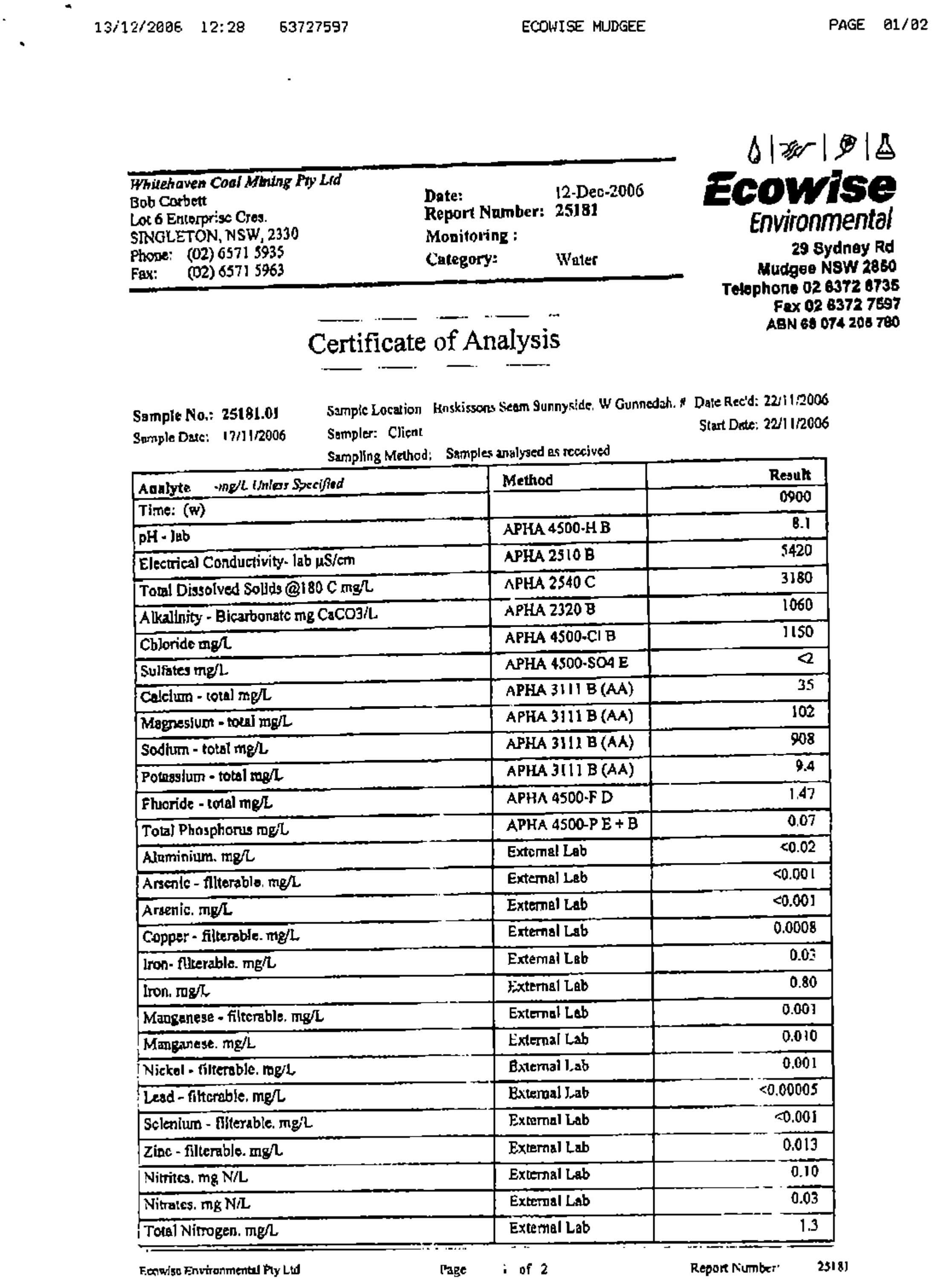
METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory, in accordance with APHA Standard Methods of Water and Wastewater 20th Edition, or other approved methods listed below:

4500B	pH
2540C	Total Dissolved Solids
3500B	Sodium Na+
3111B	Calcium Ca++
3500B	Potassium K+
3111B	Magnesium Mg++
4500D	Chloride Cl-
4500C	Fluoride F-
2320B	Bicarbonate HCO3-
4500B	Total Nitrogen
4500BF	Total Phosphorus
4500F	Phosphate PO4-P
2320B	Carbonate CO3--
3111C	Copper
3111C	Lead
3111C	Zinc
3111B	Nickel
3111B	Iron
3111B	Manganese
3114B	Arsenic
3114B	Selenium

Sulphate: Dept Mineral Resources - BaCrO4 Method

A preliminary report was faxed on 04/12/06



13/12/2006 12:28 63727597 ECOWISE MUDGEE PAGE 01/02

Whitehaven Coal Mining Pty Ltd
Bob Corbett
Lot 6 Enterprise Cres.
SINGLETON, NSW, 2330
Phone: (02) 6571 5935
Fax: (02) 6571 5963

Date: 12-Dec-2006
Report Number: 25181
Monitoring :
Category: Water

Ecowise
Environmental
29 Sydney Rd
Mudgee NSW 2850
Telephone 02 6372 6735
Fax 02 6372 7597
ABN 68 074 208 780

Certificate of Analysis

Sample No.: 25181.01
Sample Date: 17/11/2006
Sample Location Hoskissons Seam Sunnyside, W Gunnedah. # Date Rec'd: 22/11/2006
Start Date: 22/11/2006
Sampler: Client
Sampling Method: Samples analysed as received

Analyte *-mg/L Unless Specified*	**Method**	**Result**
Time: (w)		0900
pH - lab	APHA 4500-H B	8.1
Electrical Conductivity- lab µS/cm	APHA 2510 B	5420
Total Dissolved Solids @180 C mg/L	APHA 2540 C	3180
Alkalinity - Bicarbonate mg CaCO3/L	APHA 2320 B	1060
Chloride mg/L	APHA 4500-Cl B	1150
Sulfates mg/L	APHA 4500-SO4 E	<2
Calcium - total mg/L	APHA 3111 B (AA)	35
Magnesium - total mg/L	APHA 3111 B (AA)	102
Sodium - total mg/L	APHA 3111 B (AA)	908
Potassium - total mg/L	APHA 3111 B (AA)	9.4
Fluoride - total mg/L	APHA 4500-F D	1.47
Total Phosphorus mg/L	APHA 4500-P E + B	0.07
Aluminium. mg/L	External Lab	<0.02
Arsenic - filterable. mg/L	External Lab	<0.001
Arsenic. mg/L	External Lab	<0.001
Copper - filterable. mg/L	External Lab	0.0008
Iron- filterable. mg/L	External Lab	0.03
Iron. mg/L	External Lab	0.80
Manganese - filterable. mg/L	External Lab	0.001
Manganese. mg/L	External Lab	0.010
Nickel - filterable. mg/L	External Lab	0.001
Lead - filterable. mg/L	External Lab	<0.00005
Selenium - filterable. mg/L	External Lab	<0.001
Zinc - filterable. mg/L	External Lab	0.013
Nitrites. mg N/L	External Lab	0.10
Nitrates. mg N/L	External Lab	0.03
Total Nitrogen. mg/L	External Lab	1.3

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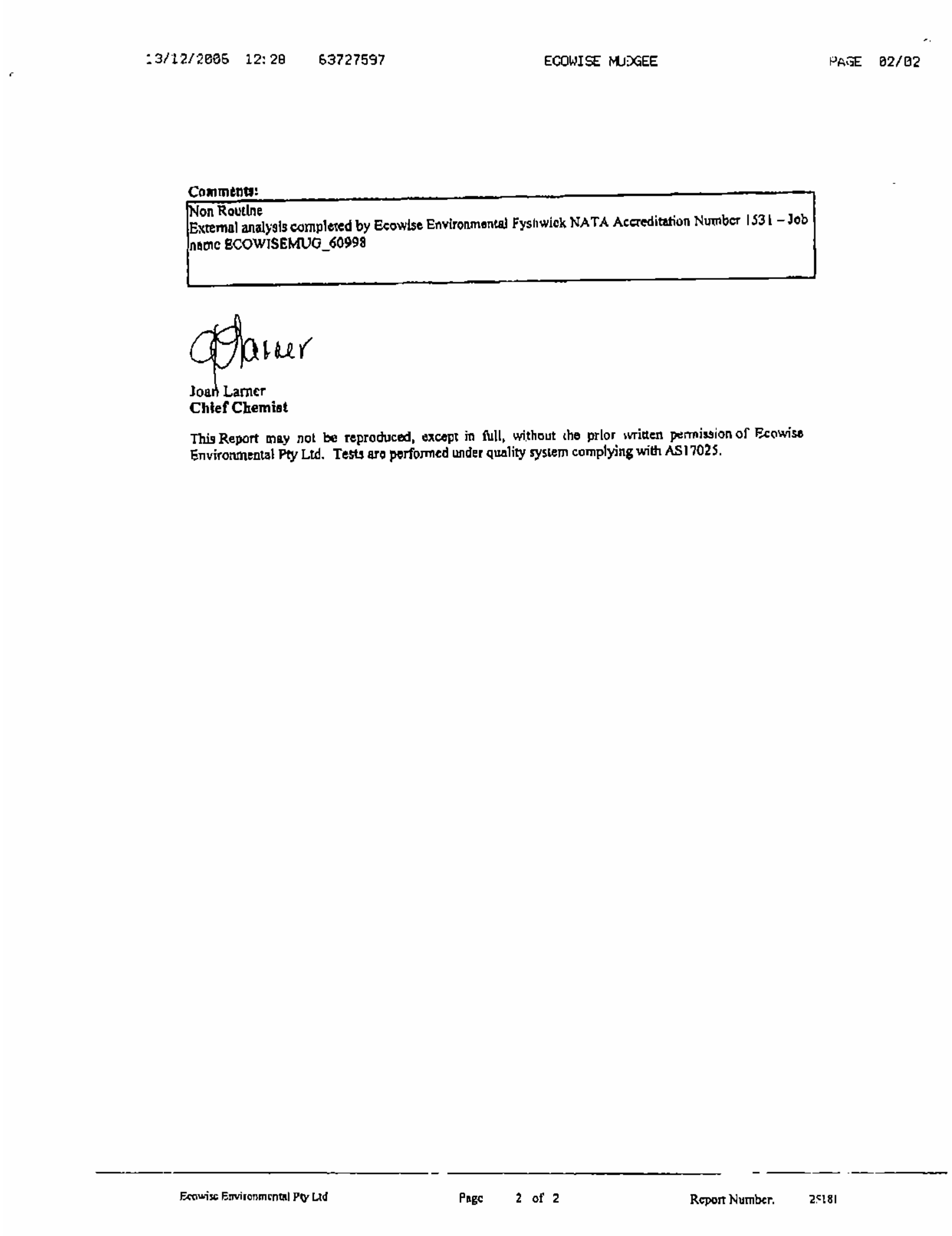

13/12/2005 12:28 63727597 ECOWISE MUDGEE PAGE 02/02

Comments:

Non Routine
External analysis completed by Ecowise Environmental Fyshwick NATA Accreditation Number 1531 – Job name ECOWISEMUG_60998

Joan Larner
Chief Chemist

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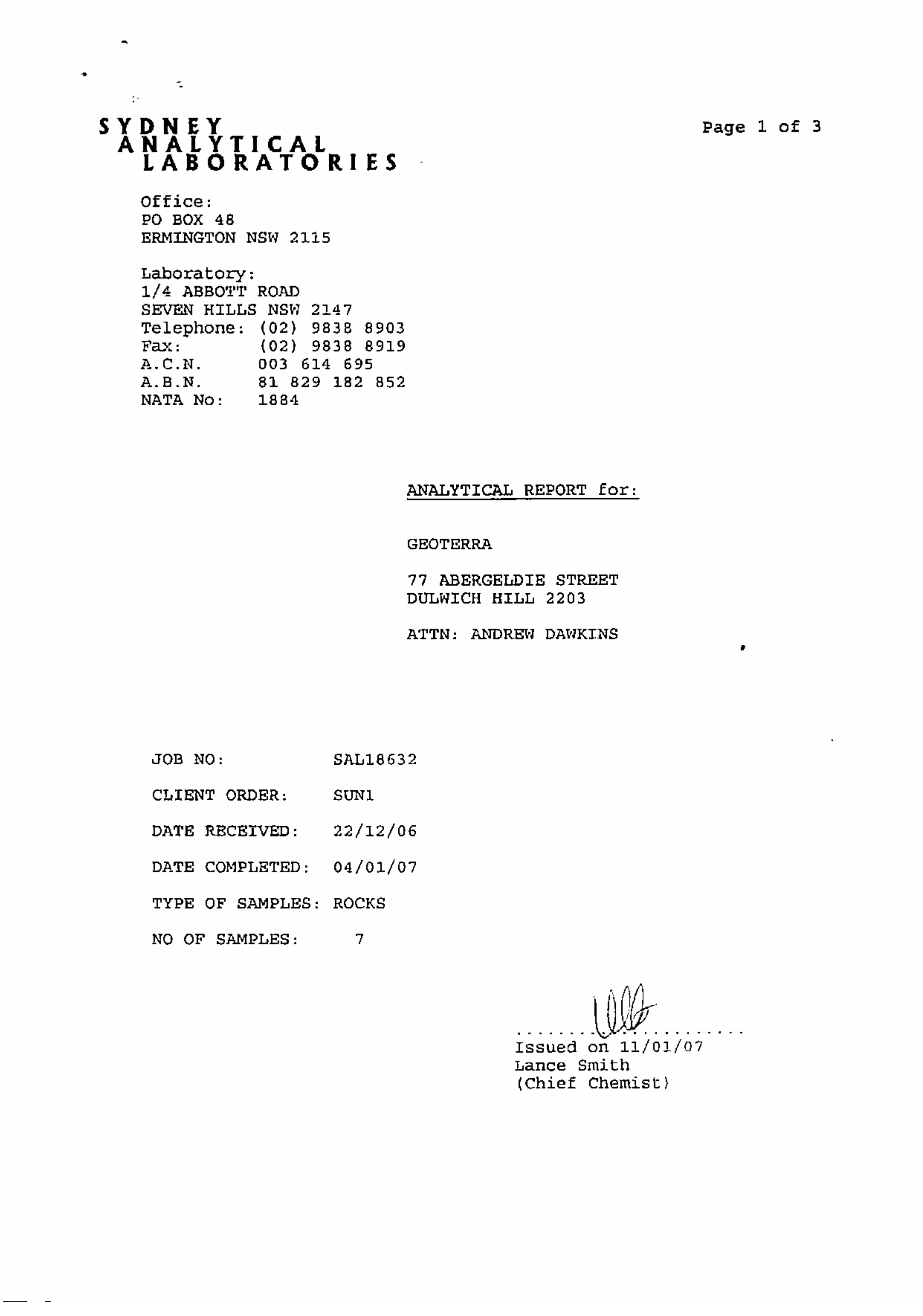

**SYDNEY
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NATA No: 1884

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ANALYTICAL REPORT for:

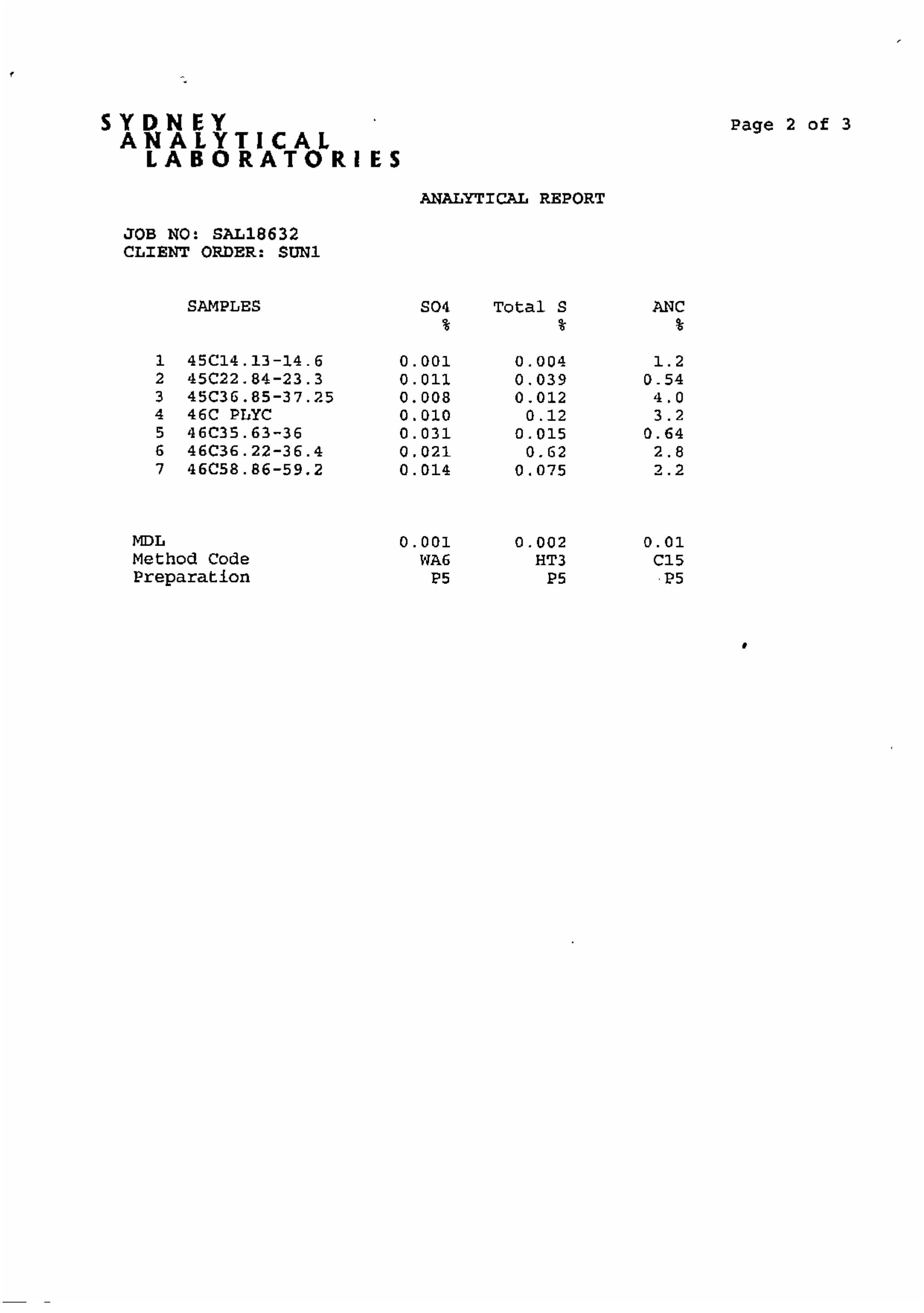
GEOTERRA

77 ABERGELDIE STREET
DULWICH HILL 2203

ATTN: ANDREW DAWKINS

JOB NO:	SAL18632
CLIENT ORDER:	SUN1
DATE RECEIVED:	22/12/06
DATE COMPLETED:	04/01/07
TYPE OF SAMPLES:	ROCKS
NO OF SAMPLES:	7

Issued on 11/01/07
Lance Smith
(Chief Chemist)



SYDNEY ANALYTICAL LABORATORIES

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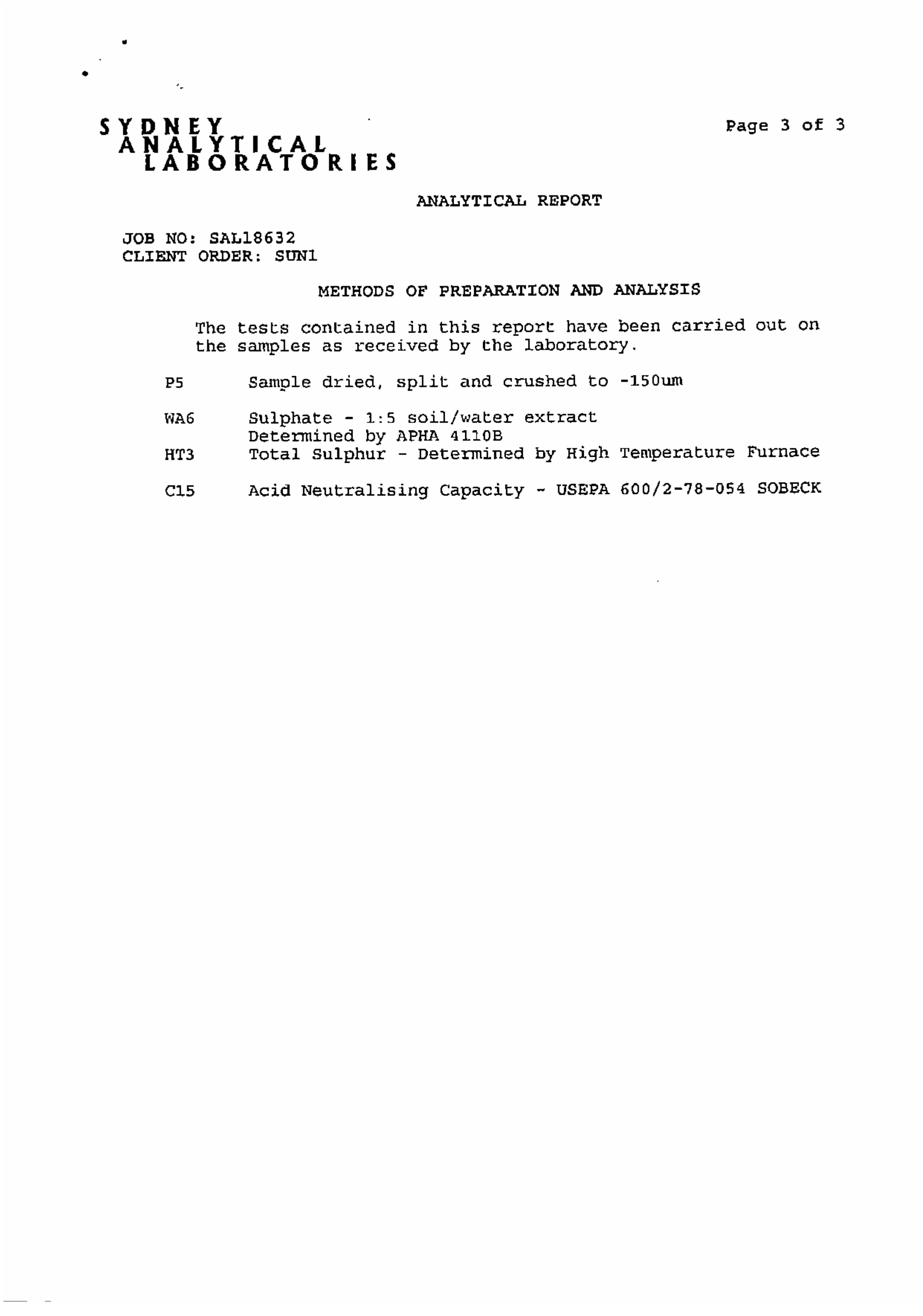
ANALYTICAL REPORT

JOB NO: SAL18632
CLIENT ORDER: SUN1

	SAMPLES	SO4 %	Total S %	ANC %
1	45C14.13-14.6	0.001	0.004	1.2
2	45C22.84-23.3	0.011	0.039	0.54
3	45C36.85-37.25	0.008	0.012	4.0
4	46C PLYC	0.010	0.12	3.2
5	46C35.63-36	0.031	0.015	0.64
6	46C36.22-36.4	0.021	0.62	2.8
7	46C58.86-59.2	0.014	0.075	2.2
MDL		0.001	0.002	0.01
Method Code		WA6	HT3	C15
Preparation		P5	P5	P5



SYDNEY ANALYTICAL LABORATORIES

Page 3 of 3

ANALYTICAL REPORT

JOB NO: SAL18632
CLIENT ORDER: SUN1

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P5	Sample dried, split and crushed to -150um
WA6	Sulphate - 1:5 soil/water extract Determined by APHA 4110B
HT3	Total Sulphur - Determined by High Temperature Furnace
C15	Acid Neutralising Capacity - USEPA 600/2-78-054 SOBECK

Appendix 5

FEFLOW Modelling

(No. of pages excluding this page = 64)

* Note – All Figures pertaining to this Appendix are presented in full on the CD for the Sunnyside Coal Project

REPORT ON
GROUNDWATER MODELLING
FOR SUNNYSIDE OPEN PIT COAL MINE
GUNNEDAH
NSW

Submitted to :

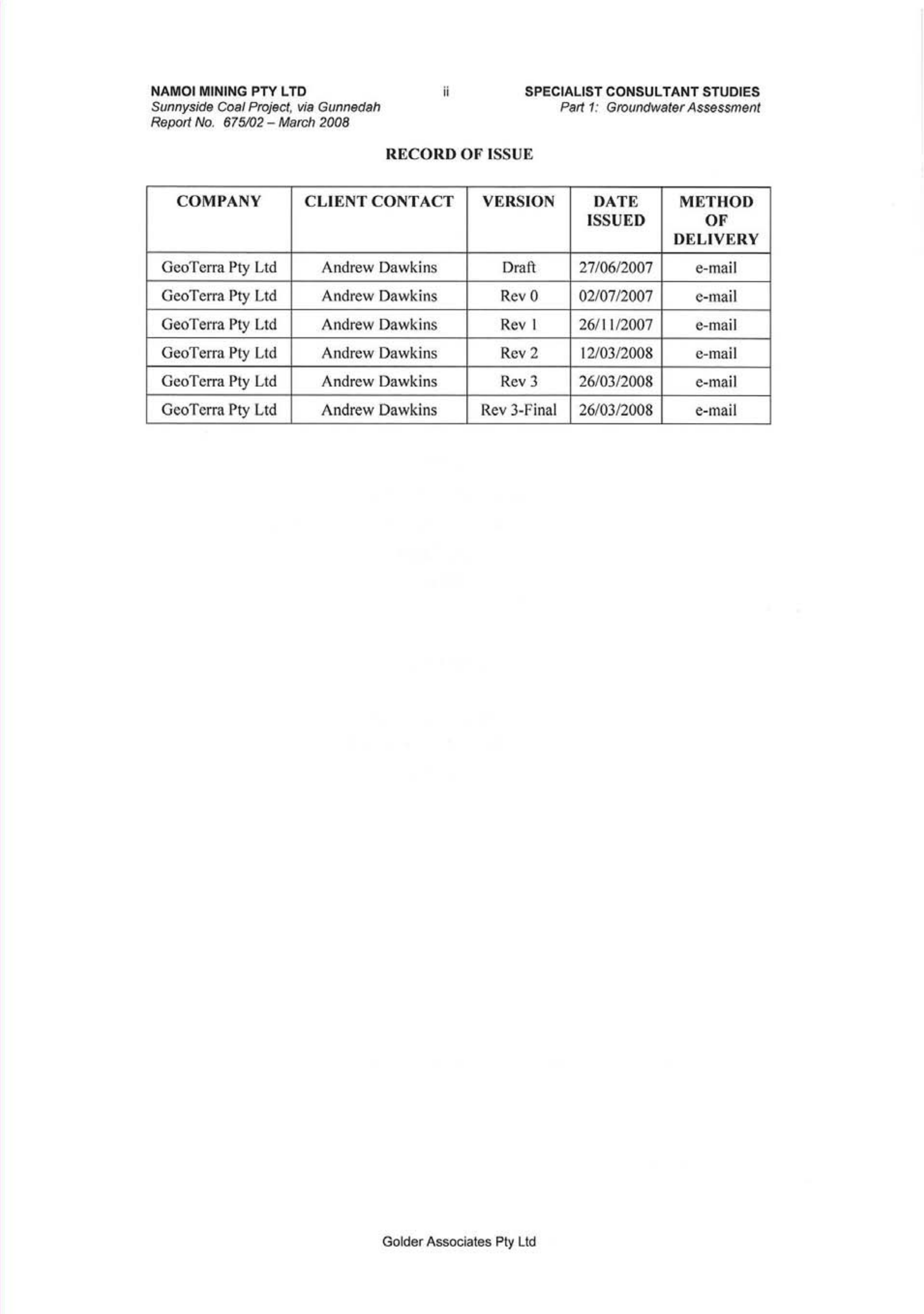
GEOTERRA PTY LTD
77 ABERGELDIE STREET
DULWICH HILL
NSW 2203

DISTRIBUTION:

1 Bound and 1 Electronic Copy - GEOTERRA PTY LTD

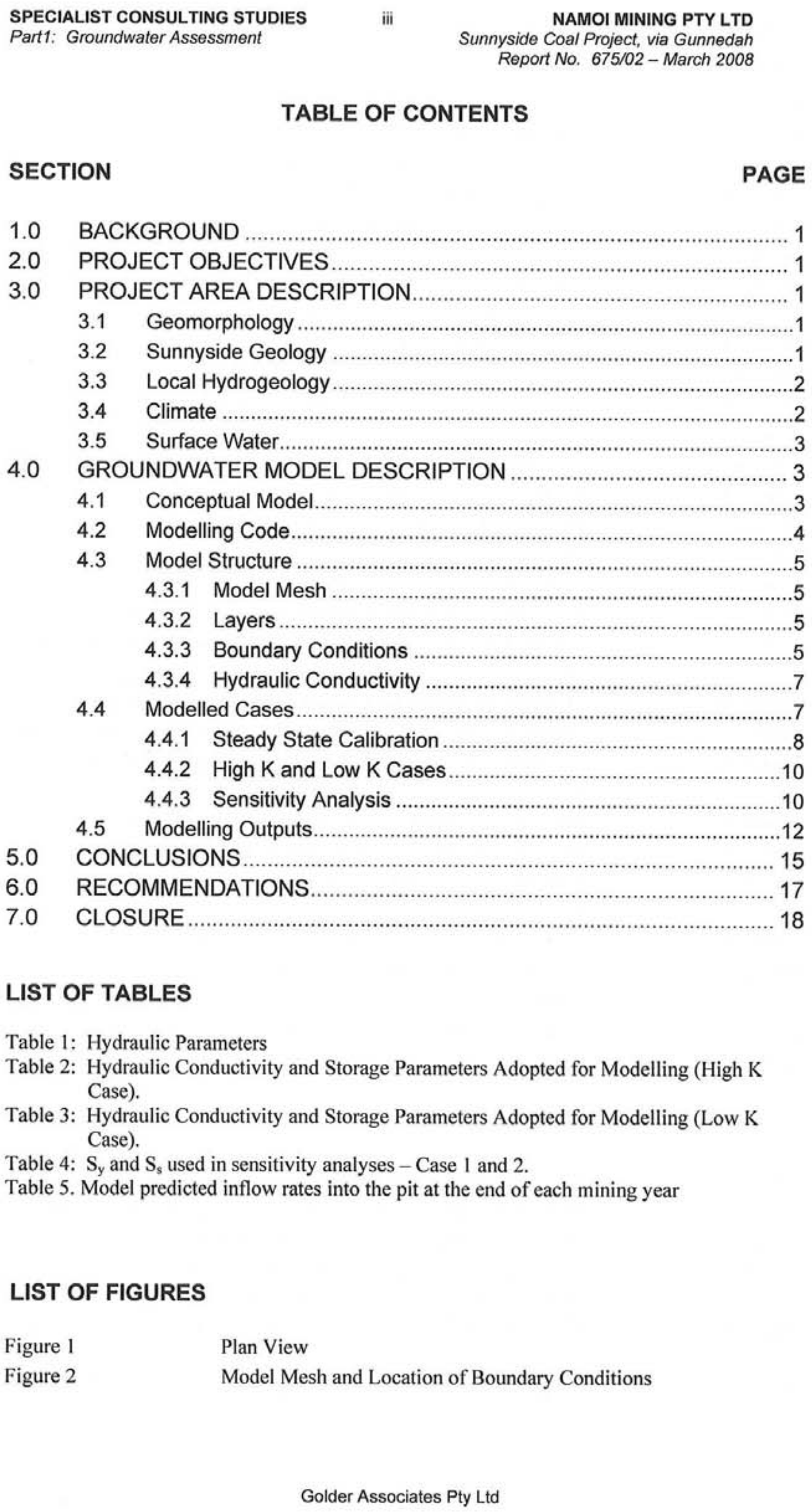
26 March 2008 008-06636017-Rev3

Golder Associates Pty Ltd



RECORD OF ISSUE

COMPANY	CLIENT CONTACT	VERSION	DATE ISSUED	METHOD OF DELIVERY
GeoTerra Pty Ltd	Andrew Dawkins	Draft	27/06/2007	e-mail
GeoTerra Pty Ltd	Andrew Dawkins	Rev 0	02/07/2007	e-mail
GeoTerra Pty Ltd	Andrew Dawkins	Rev 1	26/11/2007	e-mail
GeoTerra Pty Ltd	Andrew Dawkins	Rev 2	12/03/2008	e-mail
GeoTerra Pty Ltd	Andrew Dawkins	Rev 3	26/03/2008	e-mail
GeoTerra Pty Ltd	Andrew Dawkins	Rev 3-Final	26/03/2008	e-mail



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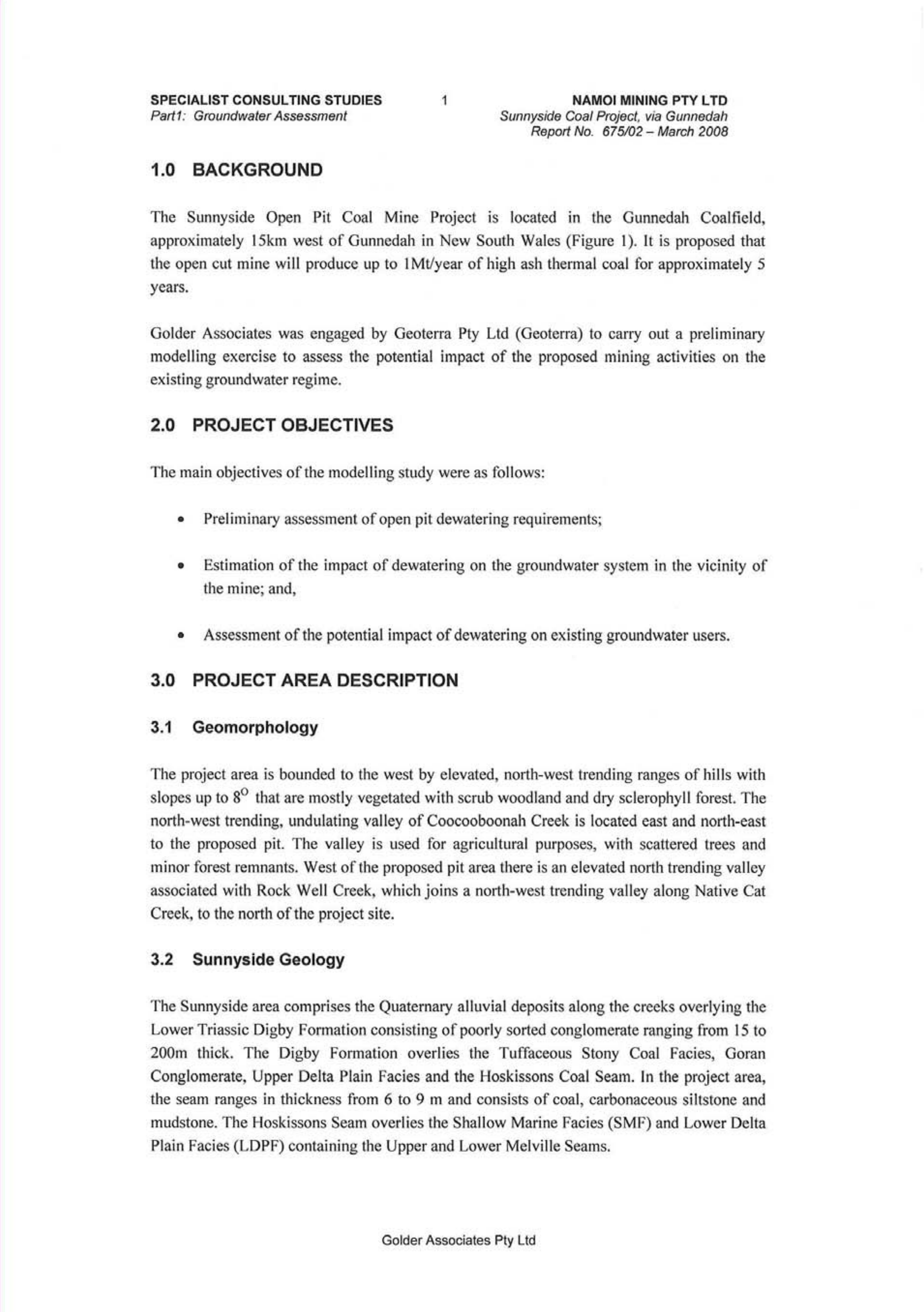


1.0 BACKGROUND

The Sunnyside Open Pit Coal Mine Project is located in the Gunnedah Coalfield, approximately 15km west of Gunnedah in New South Wales (Figure 1). It is proposed that the open cut mine will produce up to 1Mt/year of high ash thermal coal for approximately 5 years.

Golder Associates was engaged by Geoterra Pty Ltd (Geoterra) to carry out a preliminary modelling exercise to assess the potential impact of the proposed mining activities on the existing groundwater regime.

2.0 PROJECT OBJECTIVES

The main objectives of the modelling study were as follows:

- Preliminary assessment of open pit dewatering requirements;
- Estimation of the impact of dewatering on the groundwater system in the vicinity of the mine; and,
- Assessment of the potential impact of dewatering on existing groundwater users.

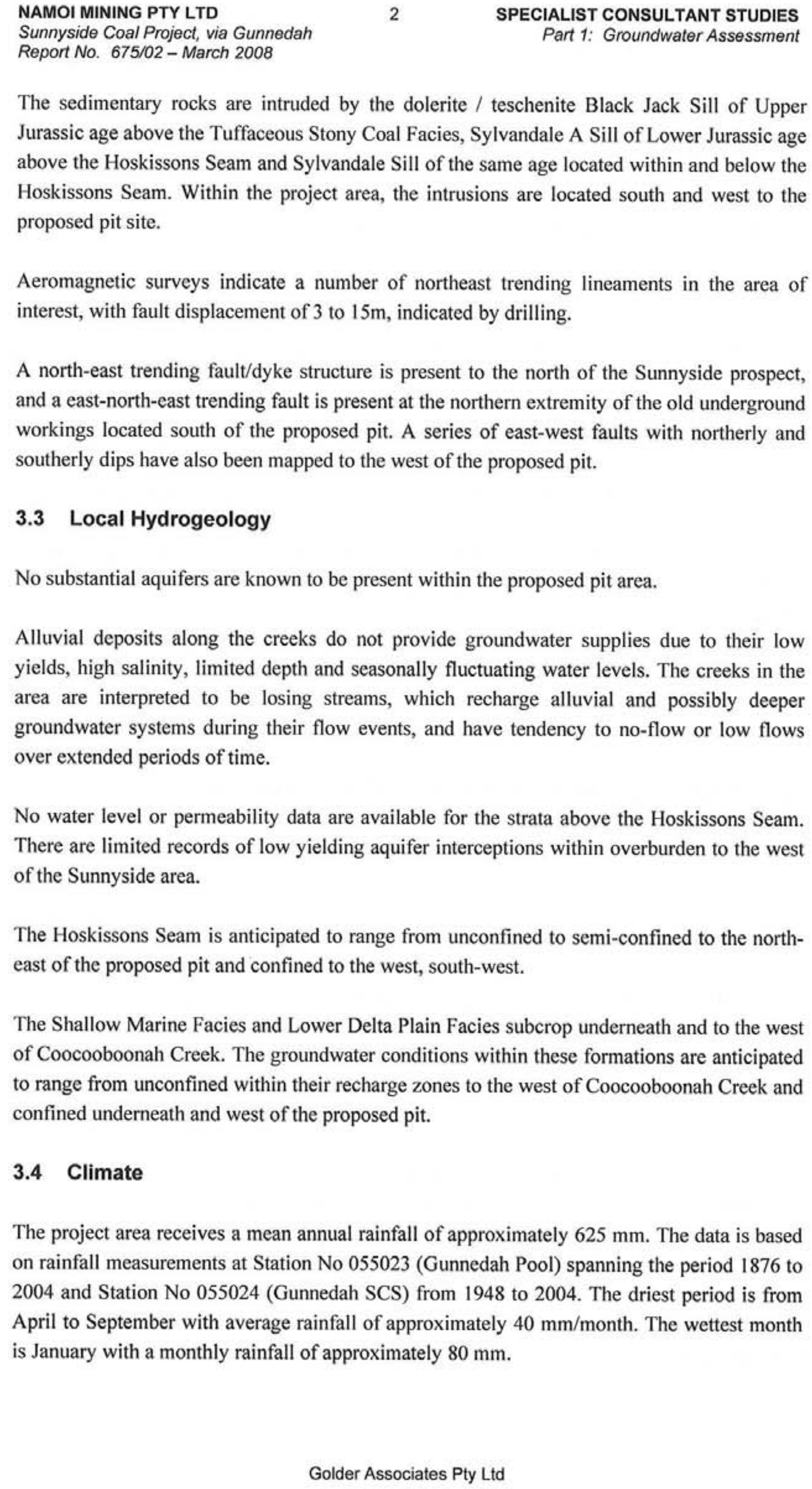
3.0 PROJECT AREA DESCRIPTION

3.1 Geomorphology

The project area is bounded to the west by elevated, north-west trending ranges of hills with slopes up to 8^{O} that are mostly vegetated with scrub woodland and dry sclerophyll forest. The north-west trending, undulating valley of Coocooboonah Creek is located east and north-east to the proposed pit. The valley is used for agricultural purposes, with scattered trees and minor forest remnants. West of the proposed pit area there is an elevated north trending valley associated with Rock Well Creek, which joins a north-west trending valley along Native Cat Creek, to the north of the project site.

3.2 Sunnyside Geology

The Sunnyside area comprises the Quaternary alluvial deposits along the creeks overlying the Lower Triassic Digby Formation consisting of poorly sorted conglomerate ranging from 15 to 200m thick. The Digby Formation overlies the Tuffaceous Stony Coal Facies, Goran Conglomerate, Upper Delta Plain Facies and the Hoskissons Coal Seam. In the project area, the seam ranges in thickness from 6 to 9 m and consists of coal, carbonaceous siltstone and mudstone. The Hoskissons Seam overlies the Shallow Marine Facies (SMF) and Lower Delta Plain Facies (LDPF) containing the Upper and Lower Melville Seams.



The sedimentary rocks are intruded by the dolerite / teschenite Black Jack Sill of Upper Jurassic age above the Tuffaceous Stony Coal Facies, Sylvandale A Sill of Lower Jurassic age above the Hoskissons Seam and Sylvandale Sill of the same age located within and below the Hoskissons Seam. Within the project area, the intrusions are located south and west to the proposed pit site.

Aeromagnetic surveys indicate a number of northeast trending lineaments in the area of interest, with fault displacement of 3 to 15m, indicated by drilling.

A north-east trending fault/dyke structure is present to the north of the Sunnyside prospect, and a east-north-east trending fault is present at the northern extremity of the old underground workings located south of the proposed pit. A series of east-west faults with northerly and southerly dips have also been mapped to the west of the proposed pit.

3.3 Local Hydrogeology

No substantial aquifers are known to be present within the proposed pit area.

Alluvial deposits along the creeks do not provide groundwater supplies due to their low yields, high salinity, limited depth and seasonally fluctuating water levels. The creeks in the area are interpreted to be losing streams, which recharge alluvial and possibly deeper groundwater systems during their flow events, and have tendency to no-flow or low flows over extended periods of time.

No water level or permeability data are available for the strata above the Hoskissons Seam. There are limited records of low yielding aquifer interceptions within overburden to the west of the Sunnyside area.

The Hoskissons Seam is anticipated to range from unconfined to semi-confined to the north-east of the proposed pit and confined to the west, south-west.

The Shallow Marine Facies and Lower Delta Plain Facies subcrop underneath and to the west of Coocooboonah Creek. The groundwater conditions within these formations are anticipated to range from unconfined within their recharge zones to the west of Coocooboonah Creek and confined underneath and west of the proposed pit.

3.4 Climate

The project area receives a mean annual rainfall of approximately 625 mm. The data is based on rainfall measurements at Station No 055023 (Gunnedah Pool) spanning the period 1876 to 2004 and Station No 055024 (Gunnedah SCS) from 1948 to 2004. The driest period is from April to September with average rainfall of approximately 40 mm/month. The wettest month is January with a monthly rainfall of approximately 80 mm.

The area is characterised by warm to hot summers and cold to mild winters with temperatures varying between 4°C and 25°C during winter and between 9°C and 43°C during summer.

Average annual evaporation totals 1962 mm with a maximum of 275mm occurring usually in December, and a minimum of 65 mm occurring in June.

3.5 Surface Water

The Sunnyside Project is located on the edge of the Liverpool Plains region in the Upper Namoi River Catchment Area, approximately 12 km south-west from Namoi River channel. Significant surface water courses located in the vicinity of the project area are Coocooboonah Creek and Rock Well Creek which are located approximately 2 km east and 2 km west of the proposed pit. Both flow into Native Cat Creek, which reports to Callygra Creek located further to the west, and to the Namoi River approximately 13 km north of the project area.

Both creeks adjacent to the proposed pit are ephemeral, with runoff related to rainfall events. The flow is prone to rapid peaking and depletion with a tendency for low or no flow occurring over extended periods.

4.0 GROUNDWATER MODEL DESCRIPTION

4.1 Conceptual Model

The conceptual hydrogeological model of the area of interest comprises:

- Alluvial deposits along the Coocooboonah Creek, Rock Well Creek and Collygra Creek;
- Low permeability formations above the Hoskissons Seam;
- The Hoskissons Seam, confined in the western and south-western part of the area, and semi-confined to unconfined in the eastern side of the proposed pit; and,
- Shallow Marine Facies and Lower Delta Plain Facies of moderate permeability underlying the Hoskissons Seam.

Recharge areas for the Hoskissons Seam are expected to be located in southern and eastern parts of the area of the interest, possibly south of the proposed open pit and also along the alluvial channels of the creeks.

The analysis of the existing groundwater level data suggests that groundwater flows towards the north-west from higher elevated north-east trending ridges towards the Upper Namoi River sediments.

South and south-east of the proposed open pit are the old underground workings of the Gunnedah No. 5 Colliery. There is a potential for hydraulic connection between these workings and the final stage of the pit, which could result in increased inflow rates into the pit sump, if the workings were saturated. As information regarding the elevation of the underground workings in relation to the proposed pit floor is not accurate, it was assumed that the Hoskissons Seam dips at 2 – 3^{O} south west of the pit into the underground area. Under these assumed circumstances, the pit floor would most likely be above or at a similar level as the underground workings and there would not be a large component of inflow from them.

Recent groundwater investigations carried out after the initial modelling exercise was completed and reported in July 2007, indicate that the underground workings are mostly dry (see "Sunnyside Coal Project via Gunnedah, Groundwater Assessment", Geoterra Pty Ltd, October 2007). Therefore, in contrary to the initial expectations, no inflow of groundwater from the underground workings to the pit is expected. To verify this hypothesis, an additional sensitivity case (Case 6) was modelled.

4.2 Modelling Code

The conceptual understanding of the hydrogeology of the Sunnyside area provided a basis for a numerical groundwater model using the FEFLOW package. FEFLOW (version 5.2) is a finite element groundwater modelling package developed by WASY Institute for Water Resources Planning and Systems Research in Berlin, Germany.

FEFLOW has become an industry standard in the context of finite element models for groundwater flow and mass and contaminant transport simulations. The finite element code allows areas that involve complex structural geometry to be represented reasonably accurately, without a loss of computational efficiency.

FEFLOW is particularly important in the assessment of open pit mine dewatering processes by offering the following advantages:

- The capability to simulate groundwater flow in conditions dominated by irregular geological structure;
- The ability to represent complex boundary conditions (particularly important during simulation of dewatering of the pit and filling the empty void during recovery);
- The ability to incorporate transient physical changes to the aquifers, for example changes to hydraulic conductivity and storage with time; and,
- An enhanced capability to represent three-dimensional geometry.

4.3 Model Structure

4.3.1 Model Mesh

The model mesh was generated using the advancing front method. Mesh refinement was carried out subsequently within and around the footprint of the proposed pit where increased detail was required in order to ensure that flow processes were adequately accommodated (Figure 2).

The spatial extent of the model was constrained by Collygra Creek to the west and south-west, and by surface water divide north and east to the Coocooboonah Creek.

4.3.2 Layers

The model consists of 4 layers:

- **Layer 1** represents alluvial deposits along the creeks. The depth and the extent of the alluvium were interpolated from the available geological information.

- **Layer 2** represents geological formations above the Hoskissons Seam. Little is known about the hydraulic parameters of those formations.

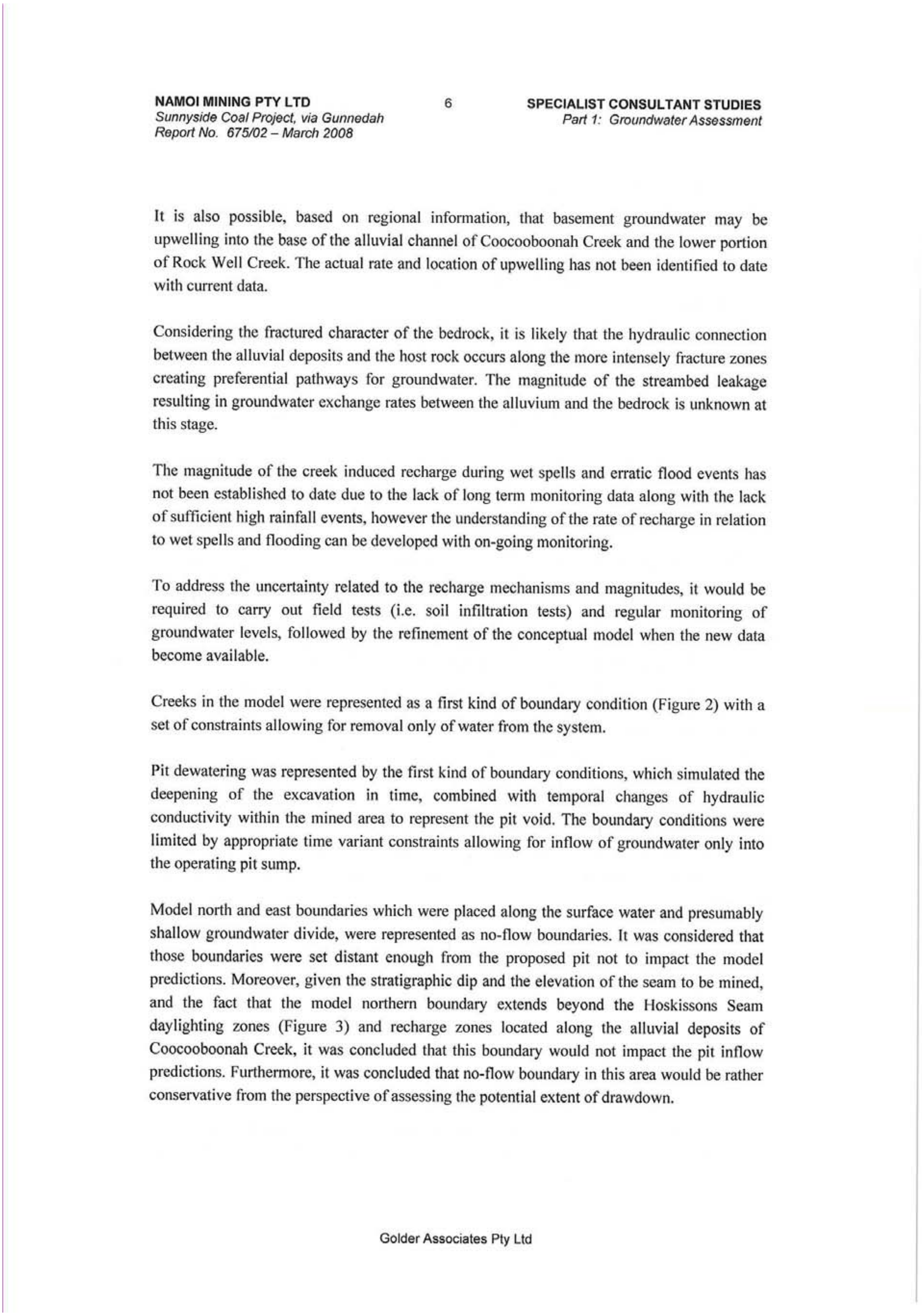
- **Layer 3** represents the Hoskissons Seam. The elevations of the top and the base of the seam were interpolated from available data. In the zones where data was not available the seam was assumed to dip 3^{O} south-west with an average thickness of 7.5m.

- **Layer 4** represents strata below the Hoskissons Seam, including Shallow Marine Facies, Upper and Lower Melville Seams and Lower Delta Plain Facies. The minimum thickness of the latter was set to 100m.

A cross-section showing spatial distribution of layers is presented in Figure 3.

4.3.3 Boundary Conditions

The true recharge distribution over the modelled area is unknown. Based on the conceptual model and the analysis of measured groundwater heads, it was assumed that recharge for the Hoskissons Seam in the vicinity of the proposed pit occurs primarily in the southern and eastern portion of the study area along the north-east trending ridges, with the predominant recharge occurring along the alluvial creek channels. The recharge distribution applied in the model following calibration (expressed as a percentage of mean annual rainfall) is shown in Figure 4.



It is also possible, based on regional information, that basement groundwater may be upwelling into the base of the alluvial channel of Coocooboonah Creek and the lower portion of Rock Well Creek. The actual rate and location of upwelling has not been identified to date with current data.

Considering the fractured character of the bedrock, it is likely that the hydraulic connection between the alluvial deposits and the host rock occurs along the more intensely fracture zones creating preferential pathways for groundwater. The magnitude of the streambed leakage resulting in groundwater exchange rates between the alluvium and the bedrock is unknown at this stage.

The magnitude of the creek induced recharge during wet spells and erratic flood events has not been established to date due to the lack of long term monitoring data along with the lack of sufficient high rainfall events, however the understanding of the rate of recharge in relation to wet spells and flooding can be developed with on-going monitoring.

To address the uncertainty related to the recharge mechanisms and magnitudes, it would be required to carry out field tests (i.e. soil infiltration tests) and regular monitoring of groundwater levels, followed by the refinement of the conceptual model when the new data become available.

Creeks in the model were represented as a first kind of boundary condition (Figure 2) with a set of constraints allowing for removal only of water from the system.

Pit dewatering was represented by the first kind of boundary conditions, which simulated the deepening of the excavation in time, combined with temporal changes of hydraulic conductivity within the mined area to represent the pit void. The boundary conditions were limited by appropriate time variant constraints allowing for inflow of groundwater only into the operating pit sump.

Model north and east boundaries which were placed along the surface water and presumably shallow groundwater divide, were represented as no-flow boundaries. It was considered that those boundaries were set distant enough from the proposed pit not to impact the model predictions. Moreover, given the stratigraphic dip and the elevation of the seam to be mined, and the fact that the model northern boundary extends beyond the Hoskissons Seam daylighting zones (Figure 3) and recharge zones located along the alluvial deposits of Coocooboonah Creek, it was concluded that this boundary would not impact the pit inflow predictions. Furthermore, it was concluded that no-flow boundary in this area would be rather conservative from the perspective of assessing the potential extent of drawdown.

4.3.4 Hydraulic Conductivity

Hydraulic conductivity values used in the model were based on field measurements comprising 6 falling head tests and 2 short duration pumping tests in Bore P5 and GW45098. The location of the tests and interpreted hydraulic conductivity values are presented in Table 1 below.

TABLE 1. HYDRAULIC PARAMETERS

Bore	Property	Bore Depth (m)	Formation	Hydraulic Conductivity* (m/d)	Test Method
P1	Ferndale	41	Alluvium	5.3	Slug
P2	Plain View	31	Alluvium	3.8	Slug
P3	Sunnyside	41	Hoskissons Seam	4.0	Slug
P4	Sunnyside	81	Hoskissons Seam	1.3	Slug
P5	Sunnyside	54	Hoskissons Seam	0.4 / 0.3	Pumping
GW45098	Sunnyside	-	Hoskissons Seam and SMF	0.1 / 0.4 / 1.8	Pumping
P6	Sunnyside	30	SMF & LDPF	0.7	Slug
P7	Sunnyside	48	SMF & LDPF	2.1	Slug

**Based on tests and their interpretation carried out by Geoterra*

SMF – Shallow Marine Facies, LDPF – Lower Delta Plain Facies

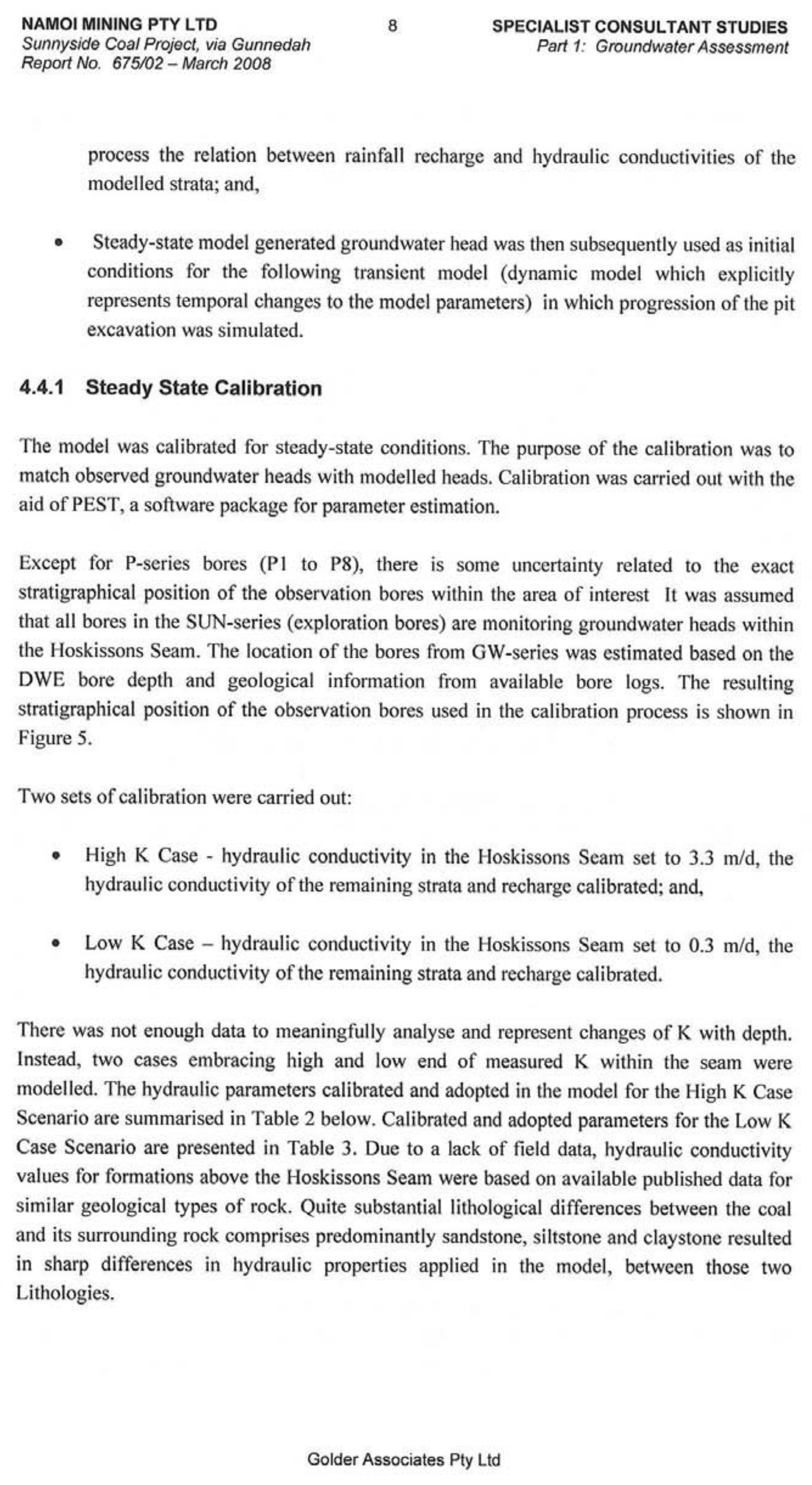
Further field anecdotal evidence suggests that the hydraulic conductivity values obtained from tests conducted in the Coocooboonah Creek alluvium (bores P1 and P2) may be underestimated due to insufficient development of the bores by the drilling contractors following construction and prior to the time of testing. If bores are not sufficiently developed the presence of residual drilling mud can have a significant impact on hydraulic conductivity measurements.

According to Geoterra, no hydraulic tests were carried out within formations above the Hoskissons Seam as those formations were dry during the field drilling and hydraulic testing programme.

4.4 Modelled Cases

The modelling exercise involved two-step approach:

- Construction of a steady-state model (static, representing average, long-term balanced groundwater conditions) which was run to define through the calibration



process the relation between rainfall recharge and hydraulic conductivities of the modelled strata; and,

- Steady-state model generated groundwater head was then subsequently used as initial conditions for the following transient model (dynamic model which explicitly represents temporal changes to the model parameters) in which progression of the pit excavation was simulated.

4.4.1 Steady State Calibration

The model was calibrated for steady-state conditions. The purpose of the calibration was to match observed groundwater heads with modelled heads. Calibration was carried out with the aid of PEST, a software package for parameter estimation.

Except for P-series bores (P1 to P8), there is some uncertainty related to the exact stratigraphical position of the observation bores within the area of interest It was assumed that all bores in the SUN-series (exploration bores) are monitoring groundwater heads within the Hoskissons Seam. The location of the bores from GW-series was estimated based on the DWE bore depth and geological information from available bore logs. The resulting stratigraphical position of the observation bores used in the calibration process is shown in Figure 5.

Two sets of calibration were carried out:

- High K Case - hydraulic conductivity in the Hoskissons Seam set to 3.3 m/d, the hydraulic conductivity of the remaining strata and recharge calibrated; and,
- Low K Case – hydraulic conductivity in the Hoskissons Seam set to 0.3 m/d, the hydraulic conductivity of the remaining strata and recharge calibrated.

There was not enough data to meaningfully analyse and represent changes of K with depth. Instead, two cases embracing high and low end of measured K within the seam were modelled. The hydraulic parameters calibrated and adopted in the model for the High K Case Scenario are summarised in Table 2 below. Calibrated and adopted parameters for the Low K Case Scenario are presented in Table 3. Due to a lack of field data, hydraulic conductivity values for formations above the Hoskissons Seam were based on available published data for similar geological types of rock. Quite substantial lithological differences between the coal and its surrounding rock comprises predominantly sandstone, siltstone and claystone resulted in sharp differences in hydraulic properties applied in the model, between those two Lithologies.

At the time of carrying out the modelling exercise and reporting there were no data available on storage parameters of modelled strata, and therefore values of specific yield and specific storage adopted in the model were based on available published figures.

TABLE 2. HYDRAULIC CONDUCTIVITY AND STORAGE PARAMETERS ADOPTED FOR MODELLING (HIGH K CASE).

Formation	Horizontal Hydraulic Conductivity (m/d)	Vertical Hydraulic Conductivity (m/d)	Specific Storage S_s (1/m)	Specific Yield S_y (-)
Alluvium	26.2	7.2	1×10^{-4}	0.15
Formations above the Hoskissons Seam	2×10^{-4}	5×10^{-4}	1×10^{-4}	0.1
Hoskissons Seam	3.3	2×10^{-4}	1×10^{-4}	0.2
SMF & LDPF	0.02	0.4	1×10^{-4}	0.1

SMF – Shallow Marine Facies, LDPF – Lower Delta Plain Facies

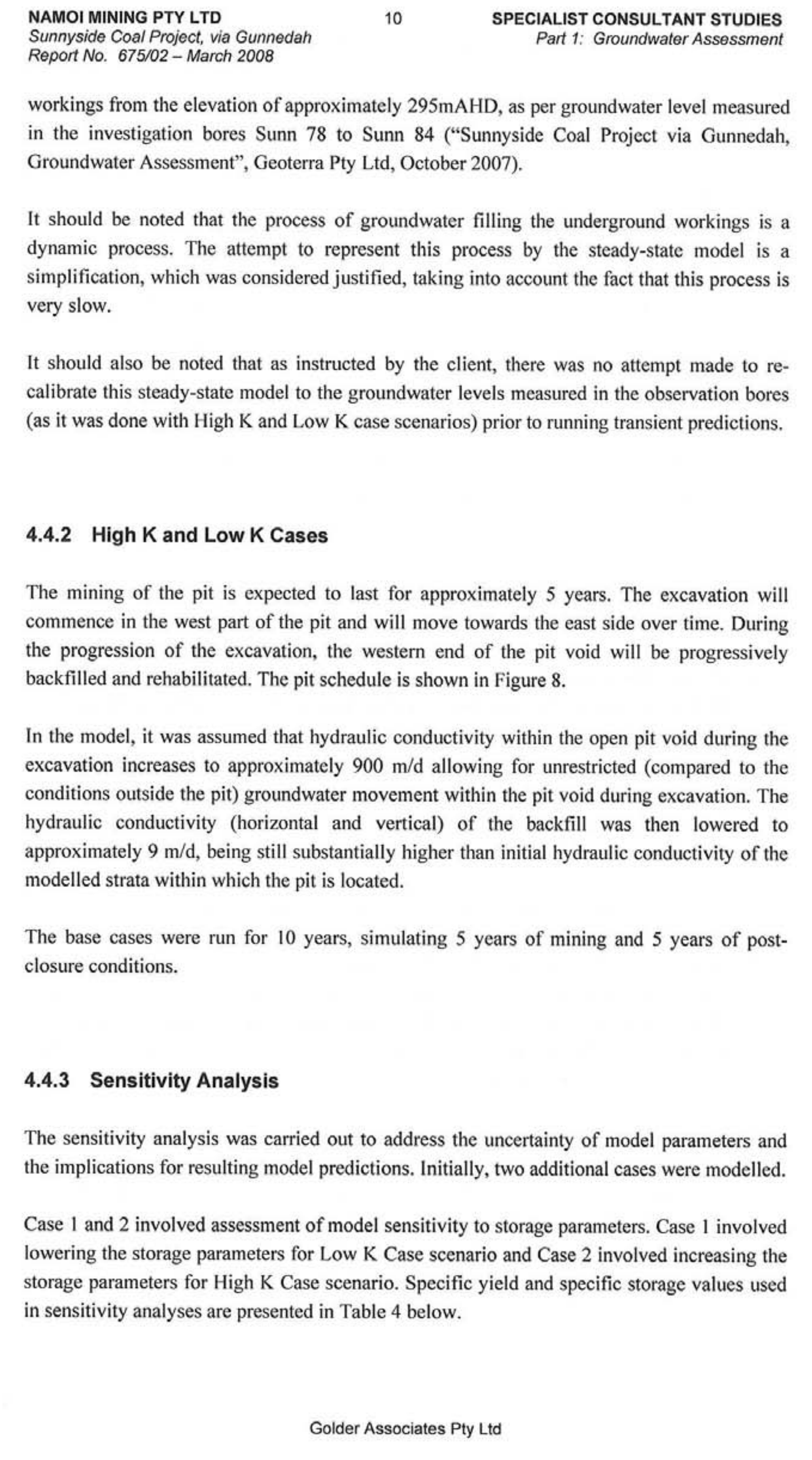
TABLE 3. HYDRAULIC CONDUCTIVITY AND STORAGE PARAMETERS ADOPTED FOR MODELLING (LOW K CASE).

Formation	Horizontal Hydraulic Conductivity (m/d)	Vertical Hydraulic Conductivity (m/d)	Specific Storage S_s(1/m)	Specific Yield S_y (-)
Alluvium	21.8	3.5	1×10^{-4}	0.15
Formations above the Hoskissons Seam	4×10^{-4}	1×10^{-4}	1×10^{-4}	0.1
Hoskissons Seam	0.33	2.2×10^{-3}	1×10^{-4}	0.2
SMF & LDPF	0.02	5×10^{-3}	1×10^{-4}	0.1

SMF – Shallow Marine Facies, LDPF – Lower Delta Plain Facies

The results of the calibration are presented in Figures 6 and 7. The graphs show a comparison between measured and calibrated groundwater heads for observation bores in each of the modelled strata.

To simulate the presence of the mostly dry underground workings in the vicinity of the proposed open cut, an additional steady-state model utilizing low hydraulic conductivity case was run. The model incorporated the inclusion of seepage face boundary conditions which were used to simulate pre-mining groundwater level at the bottom of the underground



workings from the elevation of approximately 295mAHD, as per groundwater level measured in the investigation bores Sunn 78 to Sunn 84 ("Sunnyside Coal Project via Gunnedah, Groundwater Assessment", Geoterra Pty Ltd, October 2007).

It should be noted that the process of groundwater filling the underground workings is a dynamic process. The attempt to represent this process by the steady-state model is a simplification, which was considered justified, taking into account the fact that this process is very slow.

It should also be noted that as instructed by the client, there was no attempt made to re-calibrate this steady-state model to the groundwater levels measured in the observation bores (as it was done with High K and Low K case scenarios) prior to running transient predictions.

4.4.2 High K and Low K Cases

The mining of the pit is expected to last for approximately 5 years. The excavation will commence in the west part of the pit and will move towards the east side over time. During the progression of the excavation, the western end of the pit void will be progressively backfilled and rehabilitated. The pit schedule is shown in Figure 8.

In the model, it was assumed that hydraulic conductivity within the open pit void during the excavation increases to approximately 900 m/d allowing for unrestricted (compared to the conditions outside the pit) groundwater movement within the pit void during excavation. The hydraulic conductivity (horizontal and vertical) of the backfill was then lowered to approximately 9 m/d, being still substantially higher than initial hydraulic conductivity of the modelled strata within which the pit is located.

The base cases were run for 10 years, simulating 5 years of mining and 5 years of post-closure conditions.

4.4.3 Sensitivity Analysis

The sensitivity analysis was carried out to address the uncertainty of model parameters and the implications for resulting model predictions. Initially, two additional cases were modelled.

Case 1 and 2 involved assessment of model sensitivity to storage parameters. Case 1 involved lowering the storage parameters for Low K Case scenario and Case 2 involved increasing the storage parameters for High K Case scenario. Specific yield and specific storage values used in sensitivity analyses are presented in Table 4 below.

TABLE 4. S_Y AND S_S USED IN SENSITIVITY ANALYSES – CASE 1 AND 2.

Formation	**Case 1**		**Case 2**	
	S_y (-)	**S_s (1/m)**	**S_y (-)**	**S_s (1/m)**
Alluvium	0.08	$1x10^{-5}$	0.23	$5x10^{-4}$
Formations above the Hoskissons Seam	0.05	$1x10^{-5}$	0.15	$5x10^{-4}$
Hoskissons Seam	0.10	$1x10^{-5}$	0.30	$5x10^{-4}$
SMF & LDPF	0.05	$1x10^{-5}$	0.15	$5x10^{-4}$

SMF – Shallow Marine Facies, LDPF – Lower Delta Plain Facies

Following the analysis of the modelling outputs, additional sensitivity analyses were carried out, as a further modification of Case 1, using storage parameters presented in Table 4 above:

- Case 3 – involved implementation into the model thermally affected zones within the Hoskissons Seam. The location of intruded/cindered the Hoskissons Seam was interpolated from available bore logs and, at this stage, should be considered as approximate only. Based on information provided by Geoterra, dykes to seam depth are highly thermally altered to clay. For the purpose of modelling, hydraulic conductivity of thermally affected seam was set to 1×10^{-9} m/s, being a typical value for clayey material.

- Case 4 – is a modification of Case 3 which incorporates presence of the underground workings. The outline of the workings was interpolated from available information provided by the Namoi Mining Pty Ltd. In the absence of other information, it was assumed in the model that the workings exist within the Hoskissons Seam only, and their area is represented as a void filled up with water. As a result, hydraulic conductivity of the underground workings was set to 10^{-2} m/s (approximately 900 m/d) with specific yield set to 1.

- Case 5 – was run after more area specific (Hunter Valley) data became available. Case 5 is a modification of Case 4. Case 5 involved lowering the storage parameters to the magnitudes used in similar groundwater modelling studies in Hunter Valley coal mines. Specific storage in the model was lowered to 5×10^{-6} 1/m and specific yield was decreased to 1% for inter-burden and 3% for the Hoskissons Seam. (recent request by Geoterra).

- Recent groundwater investigation (September / October 2007) carried out on site after the initial modelling exercise was completed and reported indicated, that the underground workings are mostly dry. To investigate the implications of the mostly dry underground workings on transient groundwater inflow rates into the pit, an additional modelling case was run. Case 6, which represents current understanding of the groundwater conditions on site, uses the same hydraulic parameters which were used in Case 5 but incorporates the initial groundwater head generated by the modified steady-state model, which incorporated the mostly dry underground workings in the vicinity of the pit.

4.5 Modelling Outputs

Figure 9 shows averaged model estimated inflow rates into the pit. Inflow rates for the High K Case scenario approximate 115 L/s at the end of Year 1, decreasing to approximately 35 L/s towards the end of mining in Year 5. Inflow rates for the Low K Case scenario approximate 35 L/s at the beginning of the operation, decreasing to approximately 7 L/s at the end of mining. The cumulative annual inflow volumes of groundwater seeping into the pit would vary between 3600 and 1100 ML for High K Case scenario and 1100 and 220 ML for the Low K Case scenario.

A detailed graph showing modelled inflow rates for Case 5 is presented in Figure 9a. The figure comprises three plots:

- Simulated inflow rates as per model output (model generated);
- Smoothed line representing "moving average" based on 30-day periods of time (moving average); and,
- Exponential approximation of the inflow rates over the mine life (exponential).

The simulated inflow rates show several peaks at the beginning of each of the mining phases. These peaks should be regarded as model artefacts, related to the way the pit progression has been implemented in the model. In order to provide a more representative (and realistic) inflow rate variation over the mine life, both methods (moving average and exponential approximation) for averaging the modelled inflow rates have been provided in Figure 9a.

Model generated inflow rates into the proposed pit for Case 6 are presented in Figure 9b. The rates peak at approximately 300 m^3/d during the first three years of the operation, decreasing in later years as the open pit approaches the dry underground workings. The model produced cumulative inflow into the pit vary between 64 and 106 ML per year.

TABLE 5. MODEL PREDICTED INFLOW RATES INTO THE PIT AT THE END OF EACH MINING YEAR (CASE 6)

Mining Year	Cumulative Inflow (ML/y)	Modelled Inflow Rates at the end of the Mining Year (m^3/d)
1	79	260
2	102	270
3	106	285
4	67	220
5	64	190

Modelling outputs for the High K Case scenario are presented in Figures 10 to 13. The drawdown in the Hoskissons Seam for the end of Year 1, end of mining and post-closure conditions 5 years after finalising the excavation, is shown in Figures 10 to 12. Figure 13 presents 2 m drawdown contour for the Formations above the Hoskissons Seam at the end of year 1, 5 and 5 years after finalising the excavation.

Modelling outputs for the Low K Case scenario are presented in Figures 14 to 17. The drawdown in the Hoskissons Seam for the end of Year 1, end of mining and post-closure conditions 5 years after finalising the excavation, is shown in Figures 14 to 16. Figure 17 presents 2 m drawdown contour for the Formations above the Hoskissons Seam at the end of year 1, 5 and 5 years after finalising the excavation.

Figures 18 to 46 present modelling outputs for the modelled sensitivity cases. Please note that on the figures presenting the extent of the cone of depression, only private bores extracting water from that particular layer are shown.

The sensitivity analyses results indicate:

- Case 1 – The extent of the cone of depression in the Hoskissons Seam is slightly increased due to the lower values of specific storage applied. The inflow rates into the pit are reduced (Figure 9).
- Case 2 - The inflow rates into the pit are on average 10 – 20 L/s greater than for the High K Case. The extent of the cone of depression is reduced due to the higher values

of specific storage applied. The recovery process is slower, as higher storage values used in this Case result in a greater volume of voids that has to be filled up.

- Case 3 – The shape and the extent of the cone of depression is altered by the presence of the highly weathered dykes. Modelled inflow rates into the pit are reduced to approximately 30 L/s at the beginning of the operation, decreasing to approximately 3.5 L/s towards the end of mining.

- Case 4 – The extent of the cone of depression during the mine life is reduced and inflow rates into the pit are higher due to the presence of underground workings that were assumed at the time of modelling to be filled up with water. For after closure conditions, the shallow cone of depression extends further south and south-east following the outline of the underground workings, reaching its maximum extent approximately 25 years after closure. Recovery process is slow, especially within the areas affected by underground mining, where groundwater pressure within the empty void requires up to 50 years to return to its initial stage. Modelled inflow rates approximate 30 L/s during the early years of mining, decreasing to approximately 10.5 L/s towards the end of operation.

- Case 5 – The cone of depression extends further from the pit in comparison to other modelled cases, the recovery process however is much faster due to the low storage and relatively high hydraulic conductivity of the rock mass. Five years after the closure, the cone of depression is very shallow and flat, indicating that the recovery process is almost completed. The average inflow rates into the pit vary from approximately 7 l/s at the beginning of the operations to approximately 20 l/s towards the end of the operation, when the open cut approaches the depth of underground workings, which were assumed at the time of modelling to be inundated.

- Case 6 – The extent of the cone of depression, compared to Case 5 results is reduced, mainly due to the lower initial groundwater heads prior to the commencement of the mining operations. The recovery process results in virtually no impact on the groundwater heads within the Hoskissons Seam, Shallow Marine Facies and Lower Delta Plain Facies five years after mining activities ceased. Model generated inflow rates into the open pit peak at approximately 3.5 L/s (300 m^3/d). It should be noted however, that the steady-state model used to generate the initial conditions for Case 6 model was not calibrated and therefore the results from the transient model should be treated with caution.

5.0 CONCLUSIONS

Limited groundwater information prevents the transient calibration of the model, verification of groundwater levels and the confirmation of the distributions of the hydraulic conductivity. There is some uncertainty at this stage over the level of interaction and hydraulic connections between layers and the hydraulic conductivity estimates applied to represent the formations overlying and to a certain degree underlying the Hoskissons Seam.

The analysis of the calibration graph for High K Case scenario suggest that resulting steady-state groundwater head is, in general, higher than the measured heads within the Hoskissons Seam with overall gradients in the model matching the measured data.

It is concluded that higher than observed groundwater heads in the model would result in a conservative estimate of the impact of dewatering on the surrounding groundwater regime and overestimate of groundwater inflow rates into the pit for the High K Case

In the vicinity of the pit the match of modelled and measured groundwater heads for the Low K Case is better, but the overall hydraulic gradients in the model are flatter than those indicated from the field data. Attempts to improve the calibration with respect to these gradients were unsuccessful suggesting that the uniform hydraulic conductivity distributions applied within the model to represent strata is too simplistic to allow reasonable simulation of field conditions.

Dry conditions encountered during drilling through the Hoskissons Seam overburden and moist conditions during drilling through the Hoskissons Seam (reported by Geoterra) together with anecdotal information regarding dewatering rates of mining operations in similar geological environment, suggest that the Low K Case scenario is likely to be more representative of the existing groundwater conditions in the project area.

The estimated groundwater inflows into the pit are based on the limited number of hydraulic tests (excluding estimates of the storage parameters) and on one monitoring survey of water level measurements carried out in selected observation bores. Depending on the water quality, pit seepage may be used to supplement water for operational purposes. Early modelling estimates suggested that a mine water requirement of 75 to 100 ML/annum may be met by the seepage rates into the pit. However, the latest modelling runs with dry underground workings indicate that cumulative inflow rates into the pit may be somewhat below required 75 ML/year.

Modelling outputs indicate that the progression of the cone of depression is far slower towards the alluvial deposits of Coocooboonah Creek than it is towards the west. This happens due to the presence of unconfined groundwater conditions in the vicinity of the Creek, while towards the west groundwater flows under confined conditions.

The hydraulic conductivity of the highly weathered dolerite intrusions located mainly south and west of the proposed pit is unknown at this stage but it is expected to be substantially lower than those of the Hoskissons Seam. The outputs from Case 3 sensitivity analysis suggest that the presence of intrusions is likely to reduce pit inflow rates and the extent of the cone of depression within the Hoskissons Seam.

The hydraulic parameters of faults cutting through the area under investigation are unknown. If the hydraulic conductivity of the faults is higher than that of the surrounding strata, they may act as water conduits resulting in higher inflows into the pit. By contrast, if the hydraulic conductivities of the faults are lower than the surrounding strata, they may act as barriers which may result in lower than estimated inflow rates into the pit. In both cases, it may have an impact on the distribution of the cone of depression, especially within the Hoskissons Seam.

Due to the character of the fractured rock mass in the vicinity of the pit, the inflow rates will most probably be regulated by the fracture systems surrounding the excavation. This will result in higher inflow rates when extensive fracture systems are cut through, and declining seepage rates when mining through rock with minor fracturing (tight rock).

It is planned that the current mining operation will not break through into the underground workings from the pit footwall. Hence possible leakage through the footwall would be minor. However, potentially great volumes of water stored in confined conditions within empty underground workings (which was assumed at the time of modelling) may act as a recharge boundary within the Hoskissons Seam, resulting in increased inflow rates into the mine.

Recent groundwater investigations carried out after the initial modelling exercise was completed and reported indicates that the underground workings are mostly dry. Therefore, in contrary to the initial predictions, little or no inflow of groundwater from the underground workings to the pit is expected. Consequently, Case 4 and Case 5 modelling predictions most likely overestimated pit inflow rates and the extend of the cone of depression within the Hoskissons Seam, Shallow Marine Facies and Lower Delta Plain Facies.

To verify the above hypothesis, an additional sensitivity case – Case 6 was modelled, which represents the current understanding of the hydrogeological conditions in the vicinity of the proposed pit. The Case 6 modelling results indicate that the inflow rates into the pit and potential impact of pit dewatering on the surrounding groundwater regime are greatly reduced compared to the Cases modelled before. It should be noted however, that, the model generated groundwater impact (i.e. the difference between initial and final groundwater heads generated by the model), should be treated with caution since the initial groundwater conditions used in this case were not verified against the groundwater level measured in the observation bores.

Model predictions suggest that private water supply bores which are extracting water from the strata overlying the Hoskissons Seam are likely to be unaffected by the mining operations. The bores extracting water from the Hoskissons Seam and the strata directly below the Hoskissons Seam which are located in the close proximity to the modelled cone of depression may be affected by mine operations.

The pit void filling process will involve groundwater inflow, surface water inflow and losses from the open water body due to evaporation. Model estimates of pit water level recovery for High K Case, Low K Case and Sensitivity Cases (including groundwater seepage only, and excluding surface water inflow and evaporation) are shown in Figure 46.

Recent modelling review carried out by Coffey Geotechnics Pty Ltd (Coffey) indicated their concerns regarding low hydraulic conductivity values used for FAH and the consequences it could have on model predicted inflow rates and drawdown extent in formations above the Hoskissons. Coffey also suggested simplified 2D modelling to be done to address their concerns. We do not believe that 2-D modelling would provide realistic estimates of drawdown within Mesozoic formations. Dewatering effects of open cuts are three dimensional processes, which are very difficult to model in 2-D sections at regional scale. This would result in overly simple answers. We do believe however, that 2-D cross-sectional modelling would help in addressing the uncertainty of the relationship between applied hydraulic conductivities and the indicative magnitude of drawdown in the area surrounding the pit, which may then be used as part of a qualitative appraisal of the potential impacts.

6.0 RECOMMENDATIONS

The following recommendations are made:

- Continue the groundwater level monitoring (that according to our knowledge) has been in place since the initial field assessment;
- The monitoring should be carried out on a regular basis in available observation bores to allow for a more reliable appraisal of the degree of hydraulic connection between the respective layers;
- Conduct long term pumping tests within the pit area, to allow for improved estimates of potential pit dewatering requirements;
- Carry out transient model re-calibration and verification of the predictions based on pumping tests interpretations and transient groundwater level monitoring data;

7.0 CLOSURE

This modelling study has been carried out on the understanding that this investigation is preliminary in nature. We have attempted to carry out the trials described based on reasonable and representative assumptions, despite the limited data availability. The assumptions and the conclusions that follow from the model analyses reflect these understandings and our assumptions. However, it is important to note that the model itself is highly flexible and can be modified in response to new hydrogeological interpretations or further data that emerge as the project develops.

If should you have any queries in relation to this report, please contact the undersigned at our Brisbane Ofiice.

GOLDER ASSOCIATES PTY LTD

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Dr Przemek Nalecki
Senior Hydrogeologist/Groundwater Modeller

Dr Ewan Wilson
Associate

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Figures

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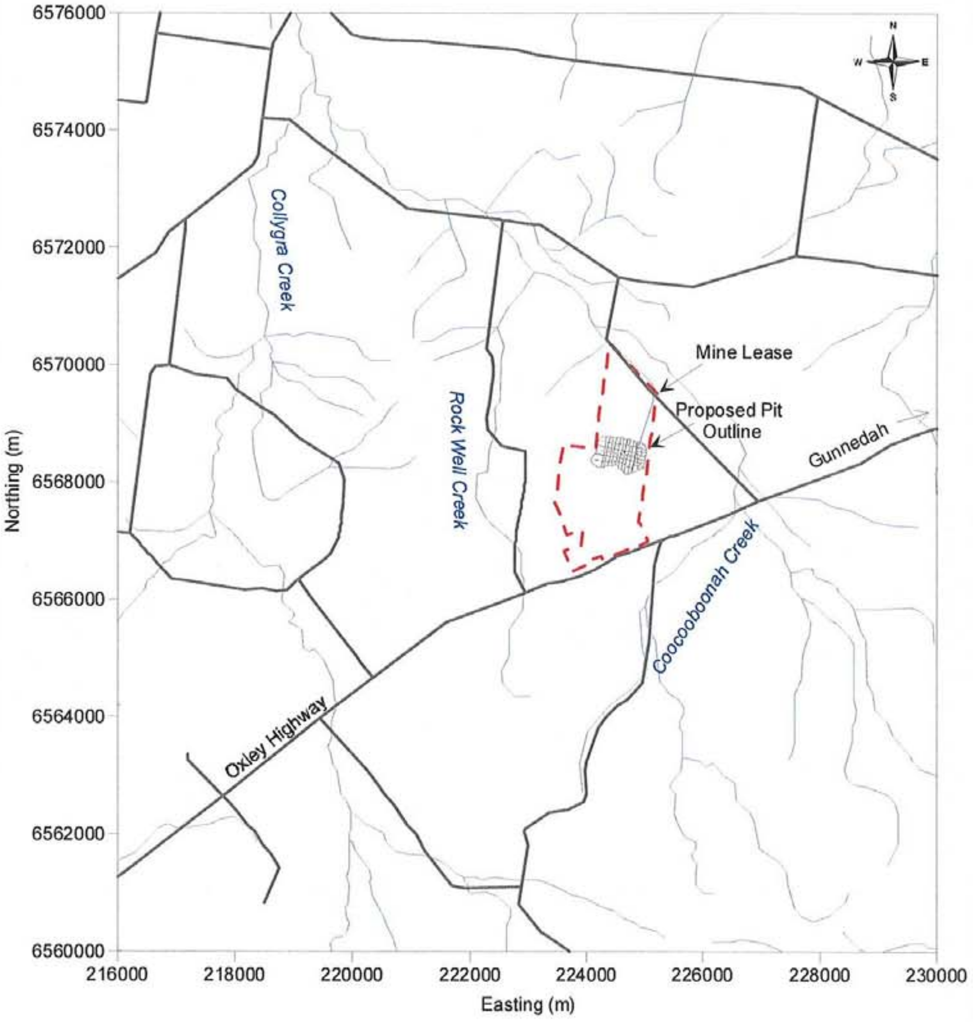

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CHECKED EW	DATE Jan 2007		
SCALE	As Shown	PROJECT No 008-06636017	FIGURE No 1 · REV No 0 · A4

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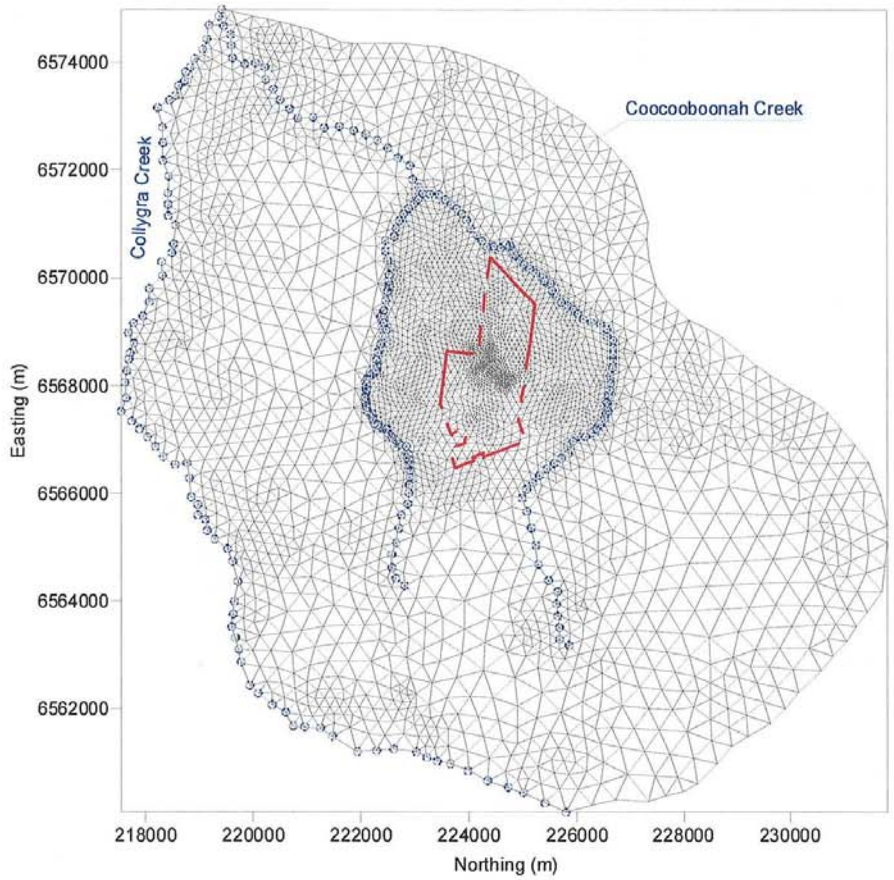

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CHECKED EW	DATE Jan 2007				
SCALE As Shown			PROJECT No 008-06636017	FIGURE No 2	REV No 0 A4

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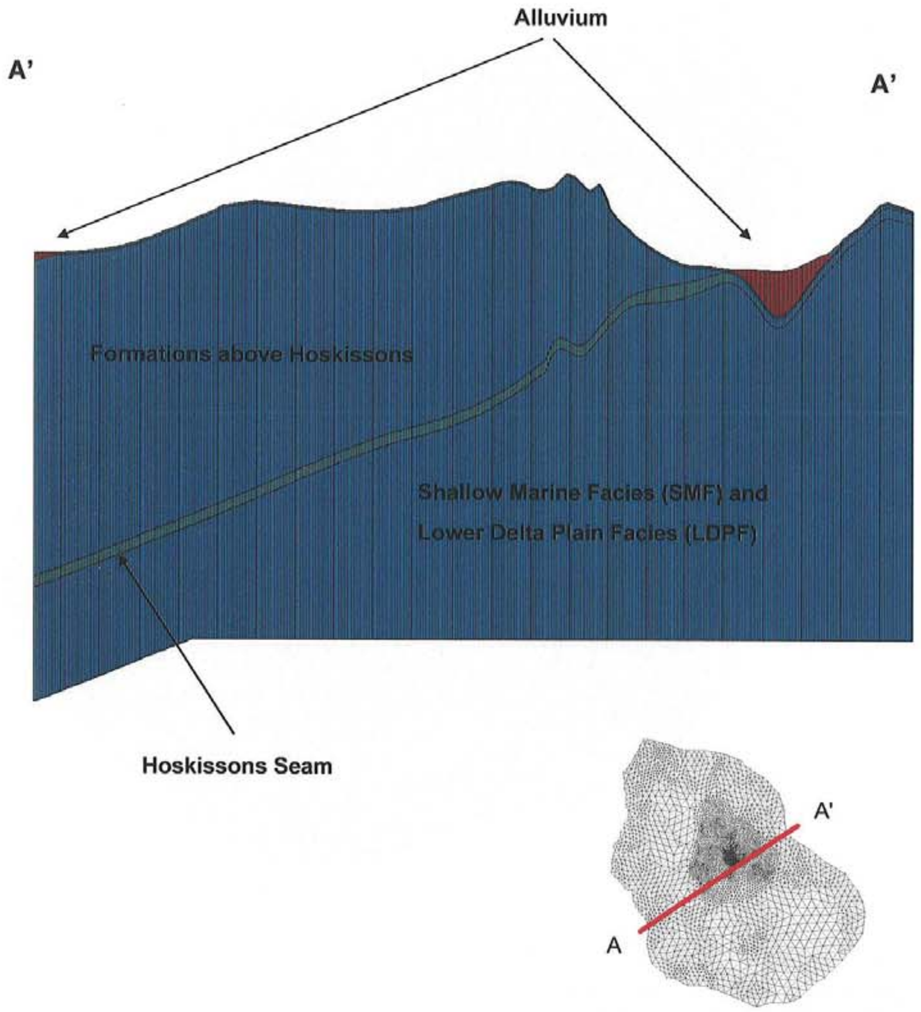

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PROJECT Sunnyside Coal Project
DRAWN PN DATE Jan 2007
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TITLE **MODEL CROSS-SECTION**
SCALE As Shown
PROJECT No 008-06636017
FIGURE No 3
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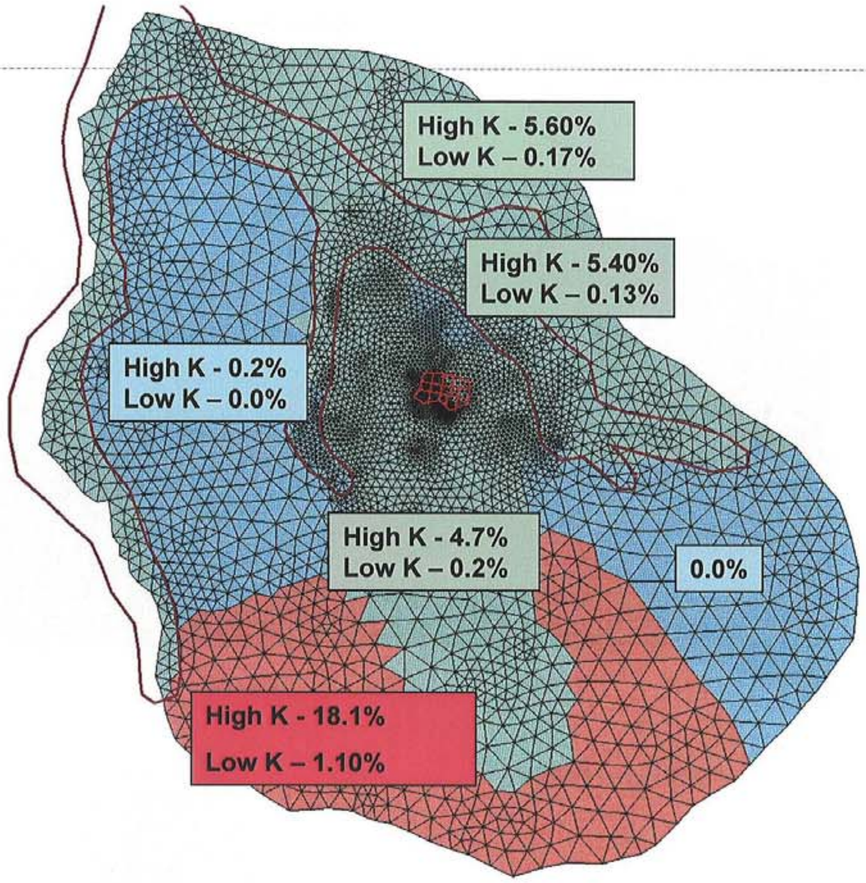

Note:

Recharge expressed as a percentage of mean annual rainfall of 626mm/annum

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	CHECKED	EW	DATE Jan 2007					
	SCALE	As Shown		PROJECT No	008-06636017	FIGURE No 4	REV No 0	A4

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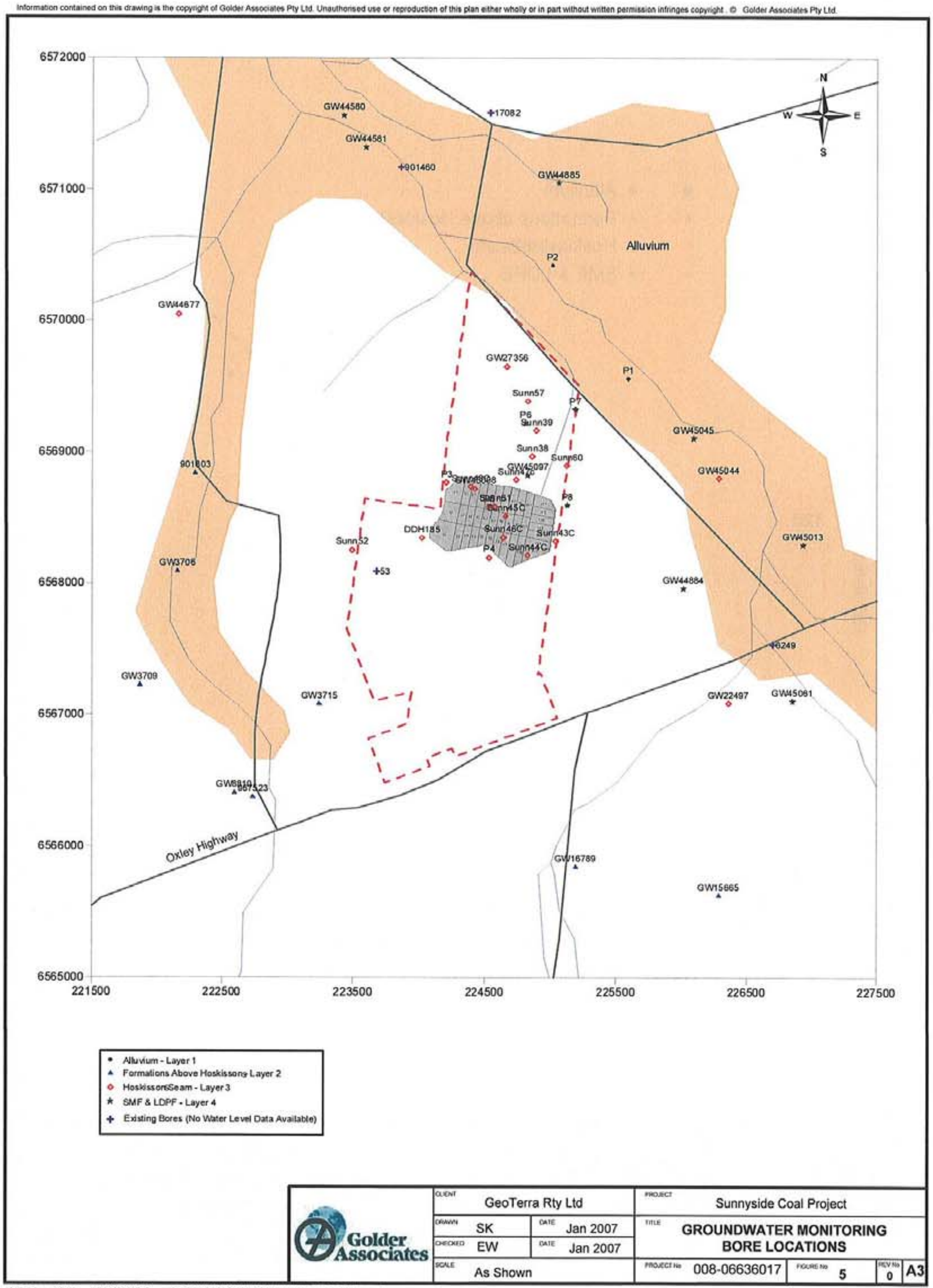

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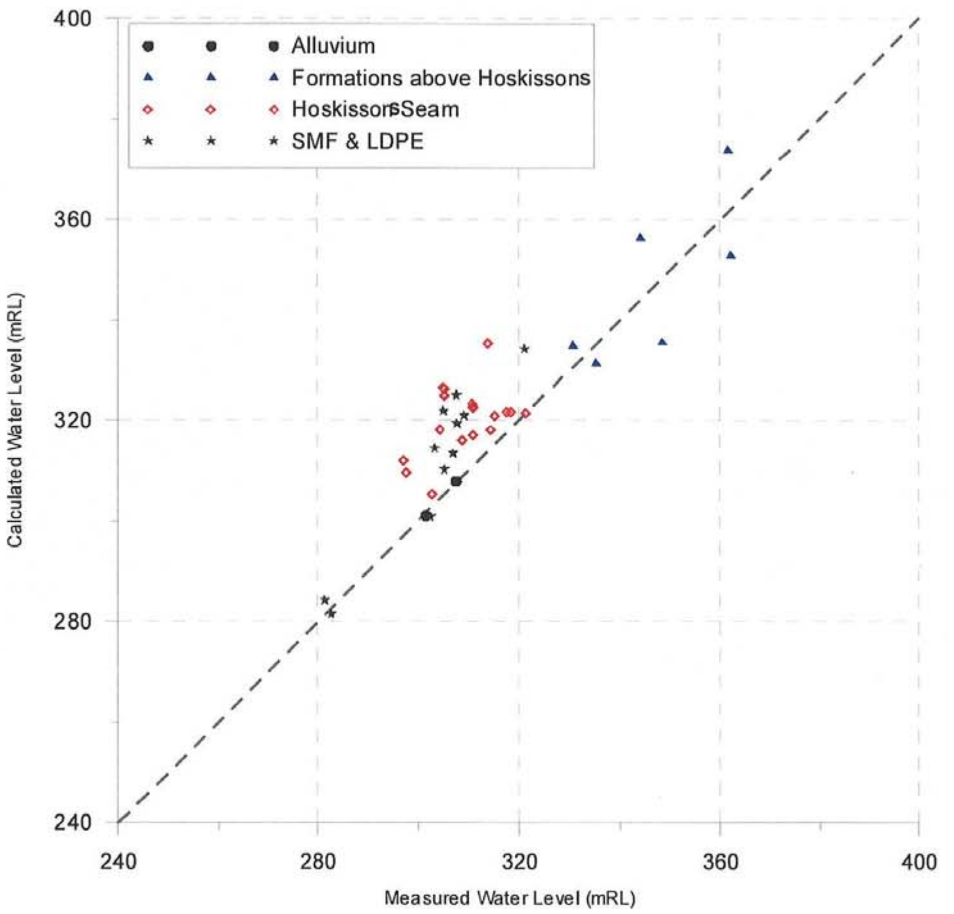

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	CHECKED EW	DATE Jan 2007	
	SCALE As Shown		PROJECT No 008-06636017 · FIGURE No 6 · REV No 0 · A4

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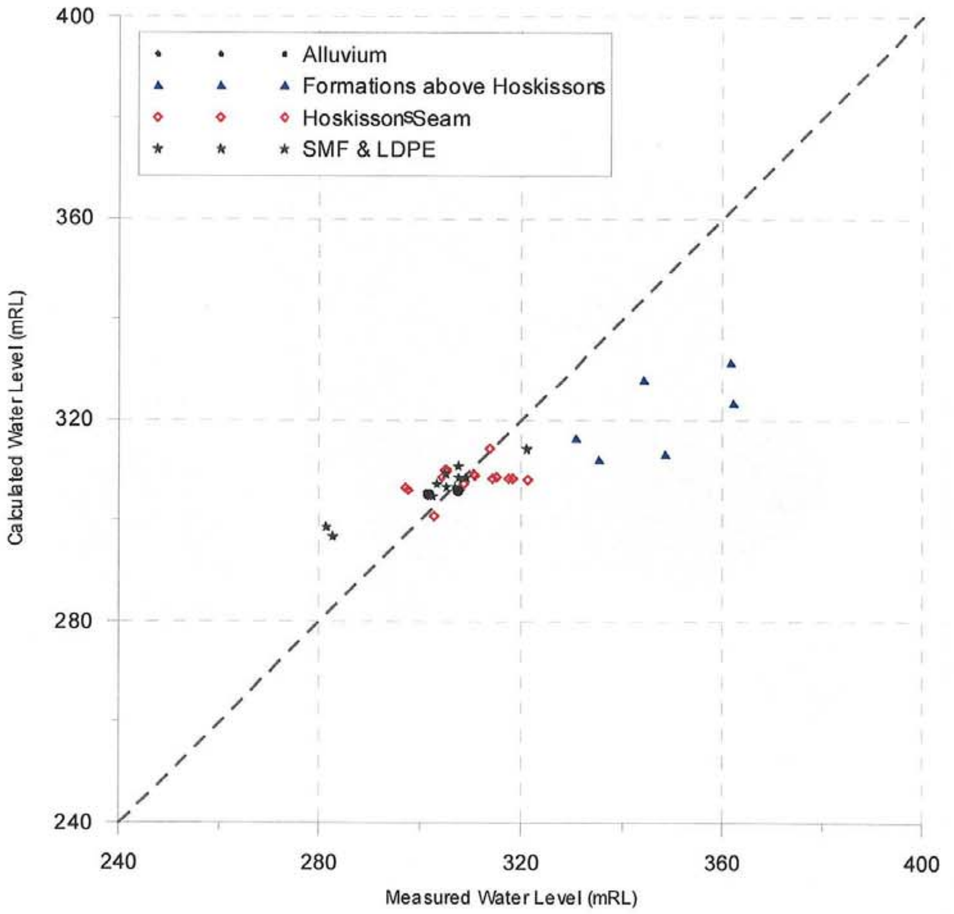

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CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project	
DRAWN PN	DATE Jan 2007	TITLE **STEADY – STATE CALIBRATION (LOW K CASE)**	
CHECKED EW	DATE Jan 2007		
SCALE As Shown		PROJECT No 008-06636017	FIGURE No 7 / REV No 0 / A4

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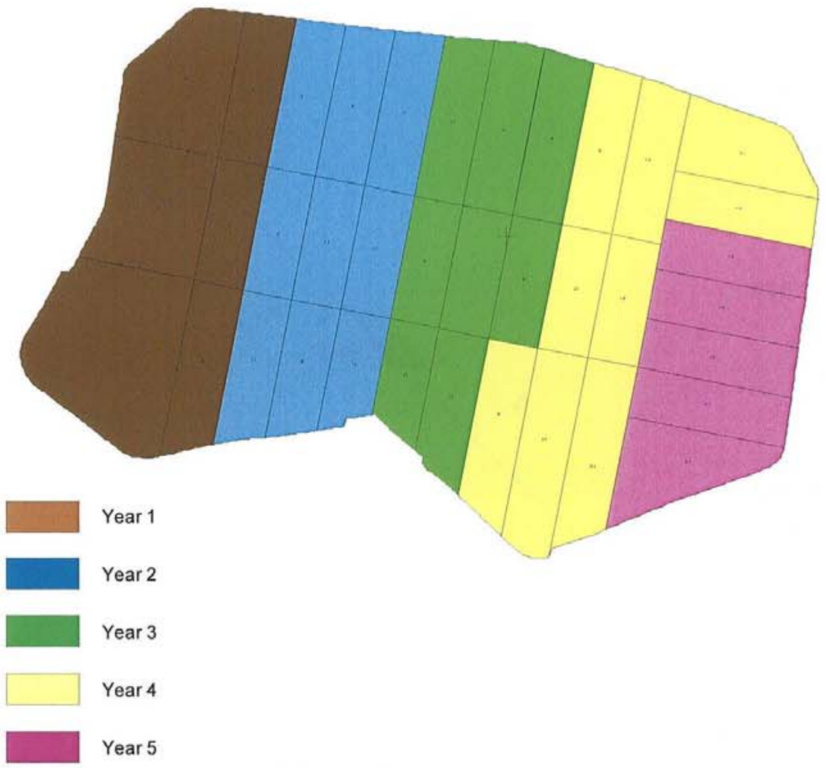

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CHECKED	EW	DATE	Jan 2007
TITLE	PIT SCHEDULE		
SCALE	As Shown		
PROJECT No	008-06636017	FIGURE No	8
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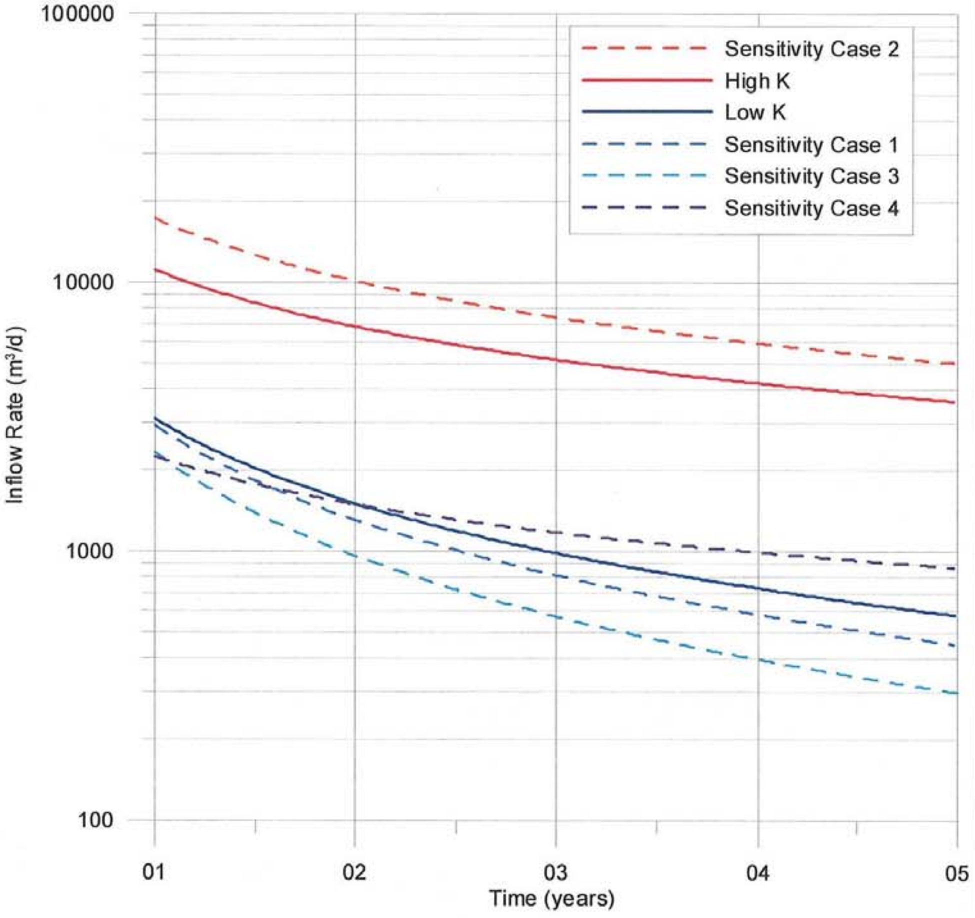

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CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project	
DRAWN PN	DATE Jan 2007	TITLE MODELLED PIT INFLOW RATES	
CHECKED EW	DATE Jan 2007		
SCALE As Shown		PROJECT No 008-06636017	FIGURE No 9 REV No 0 A4

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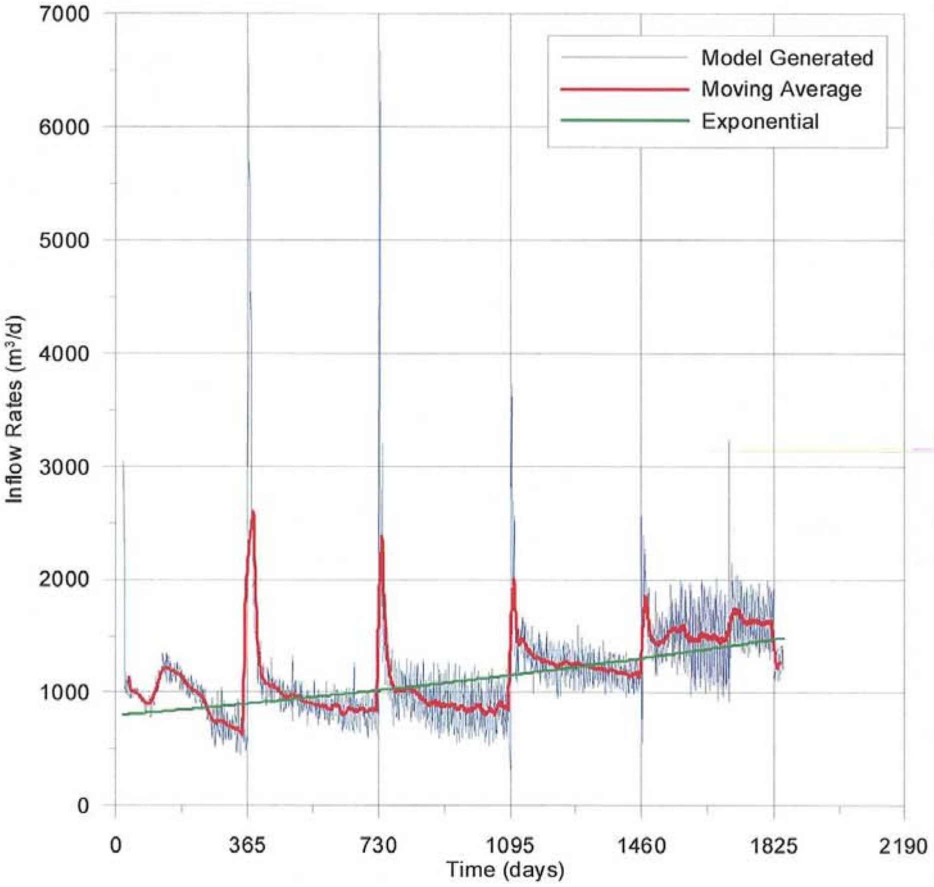

CLIENT	GeoTerra Pty Ltd
DRAWN	PN
DATE	Jun 2007
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PROJECT	Sunnyside Coal Project
TITLE	**MODELLED PIT INFLOW RATES (Case 5)**
PROJECT No	008-06636017
FIGURE No	9A
REV No	0
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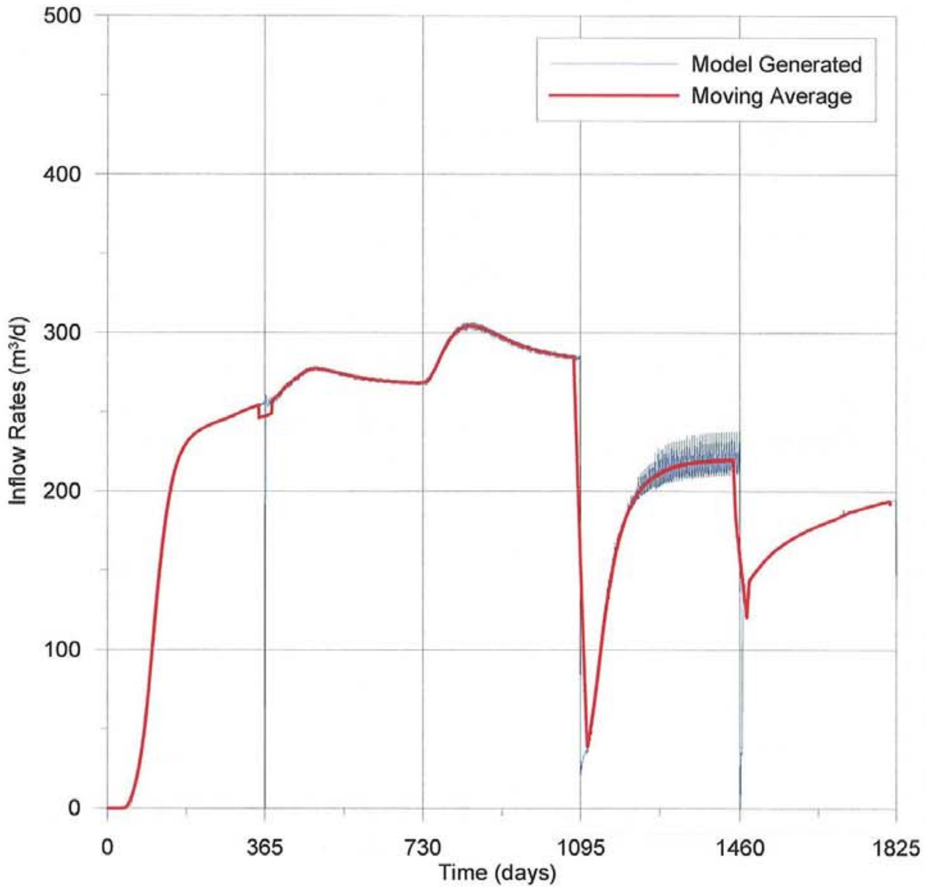

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CLIENT GeoTerra Pty Ltd
PROJECT Sunnyside Coal Project
DRAWN PN
DATE Mar 2008
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DATE
TITLE **MODELLED PIT INFLOW RATES (Case 6)**
SCALE As Shown
PROJECT No 008-06636017
FIGURE No **9B**
REV No **0**
A4

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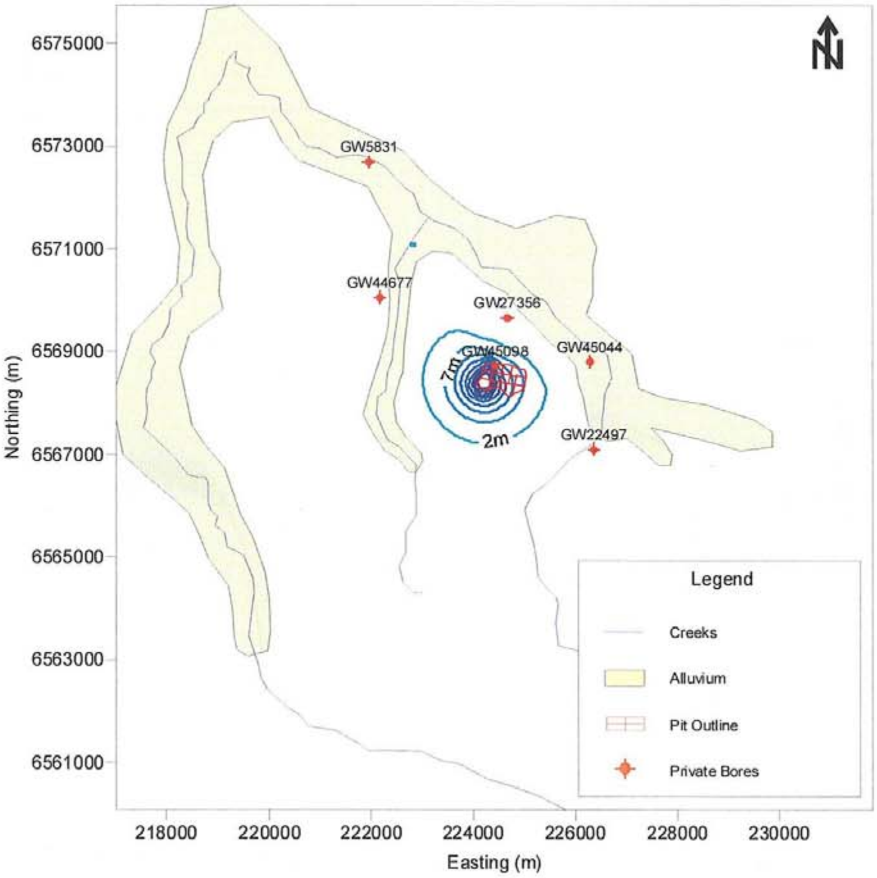

Golder Associates	CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project
	DRAWN PN	DATE Jan 2007	TITLE MODELLED DRAWDOWN IN HOSKISSONS SEAM- HIGH K CASE, YEAR 1
	CHECKED EW	DATE Jan 2007	
	SCALE As Shown		PROJECT No 008-06636017 FIGURE No 10 REV No 0 A4

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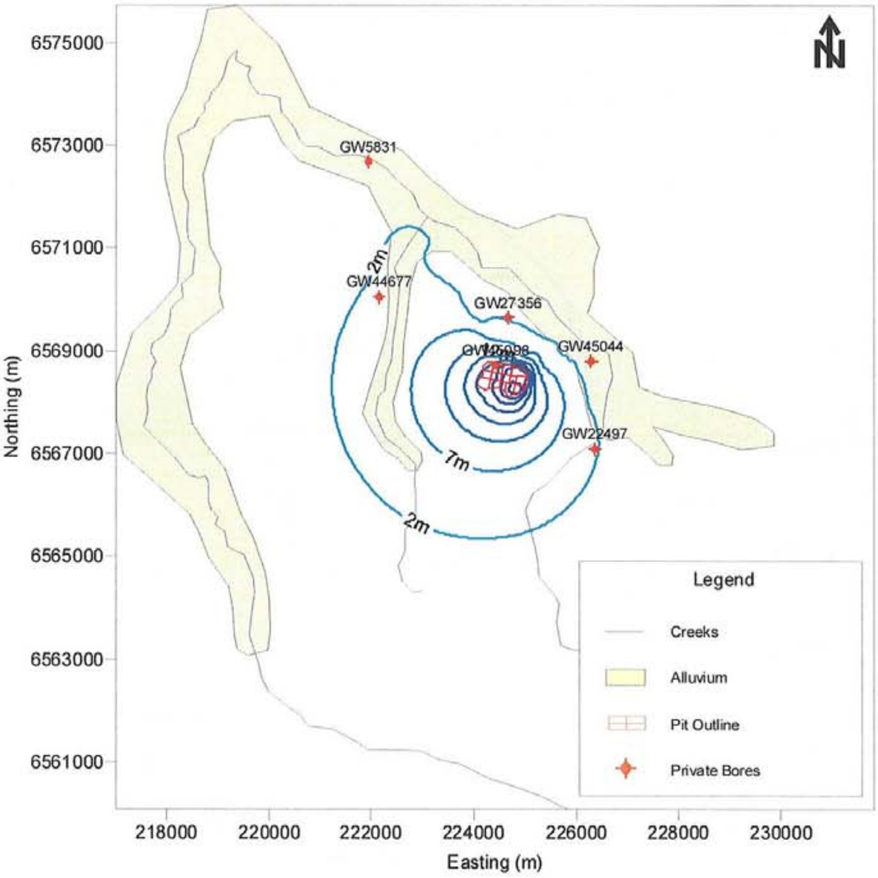

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	DRAWN PN / DATE Jan 2007	TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM-HIGH K CASE, YEAR 5**	
	CHECKED EW / DATE Jan 2007		
	SCALE As Shown	PROJECT No 008-06636017	FIGURE No 11 / REV No 0 / A4

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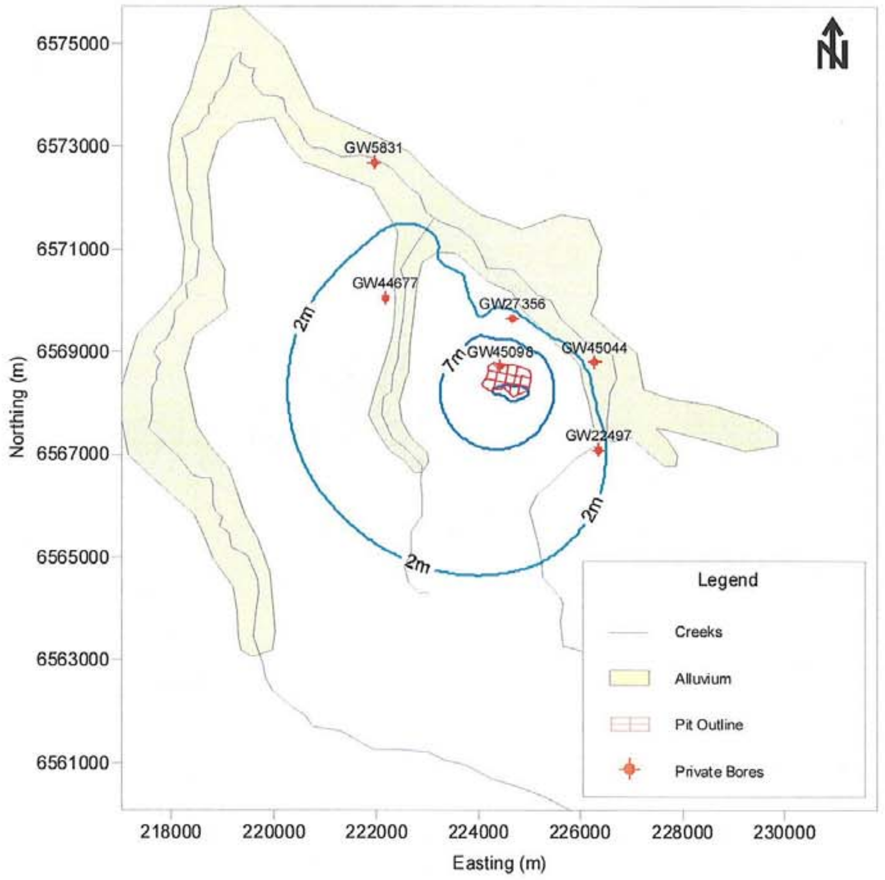

CLIENT GeoTerra Pty Ltd

PROJECT Sunnyside Coal Project

DRAWN PN DATE Jan 2007

CHECKED EW DATE Jan 2007

TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM-HIGH K CASE, YEAR 10**

SCALE As Shown

PROJECT No 008-06636017 FIGURE No 12 REV No 0 A4

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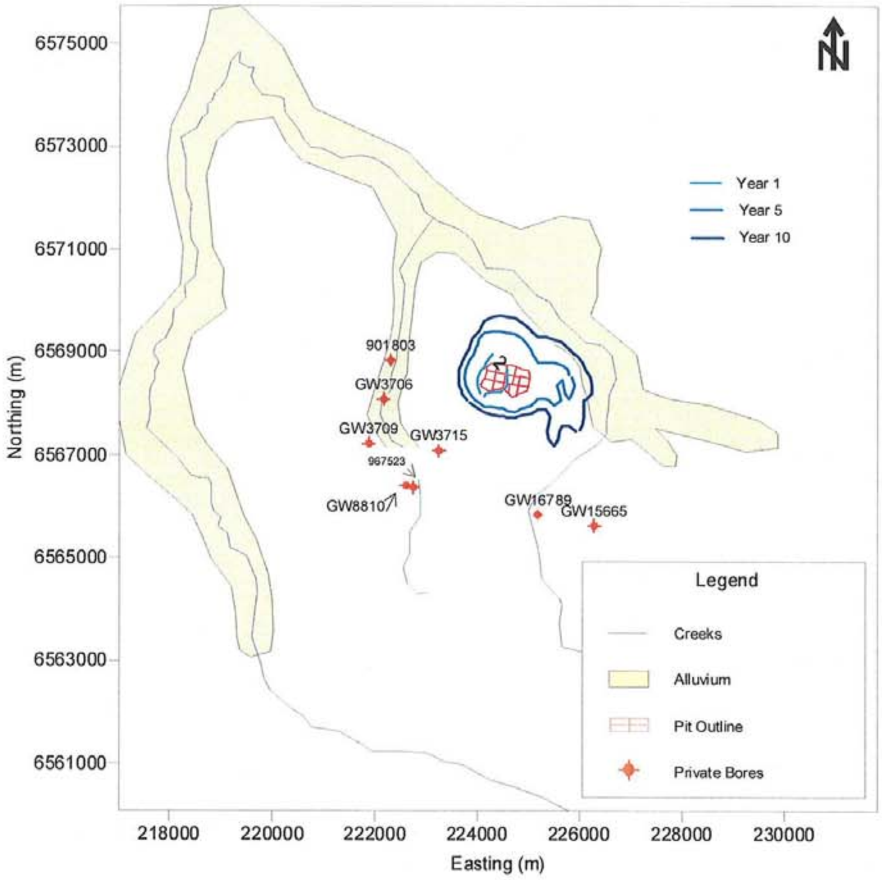

Note:
FAH – Formations Above Hoskisson

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DRAWN	PN	DATE	Jan 2007
CHECKED	EW	DATE	Jan 2007
TITLE	MODELLED 2m DRAWDOWN CONTOUR IN FAH-HIGH K CASE		
SCALE	As Shown	PROJECT No	008-06636017
FIGURE No	13	REV No	0
A4			

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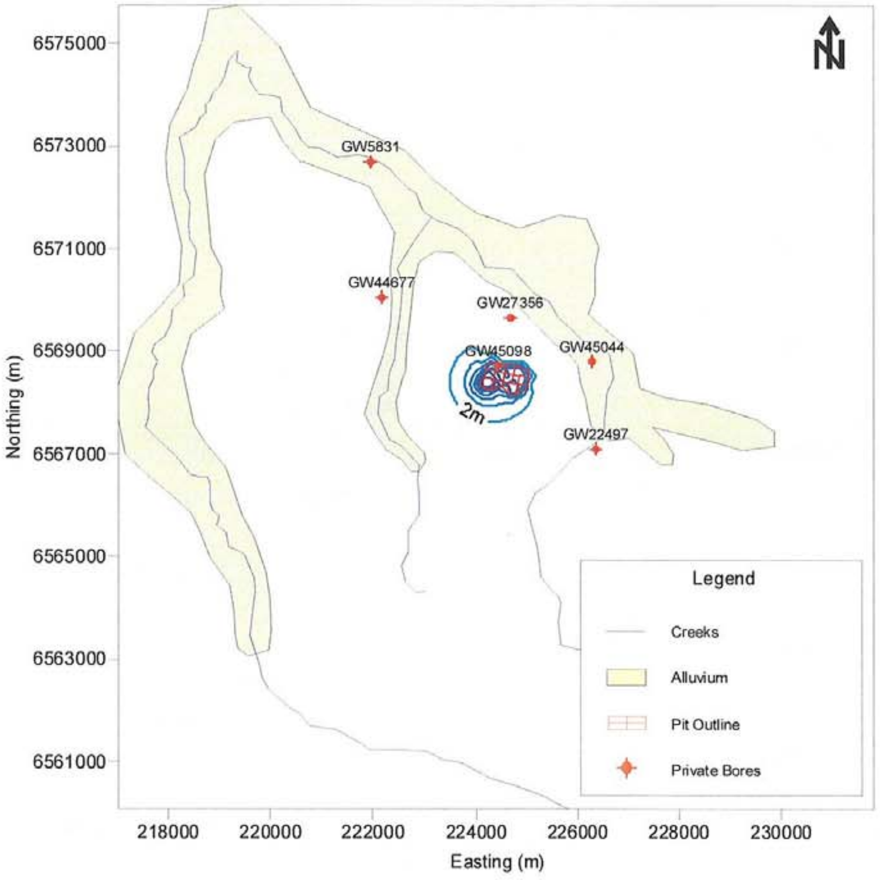

Golder Associates	CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project
	DRAWN PN	DATE Jan 2007	TITLE MODELLED DRAWDOWN IN HOSKISSONS SEAM-LOW K CASE, YEAR 1
	CHECKED EW	DATE Jan 2007	
	SCALE As Shown		PROJECT No 008-06636017 FIGURE No 14 REV No 0 A4

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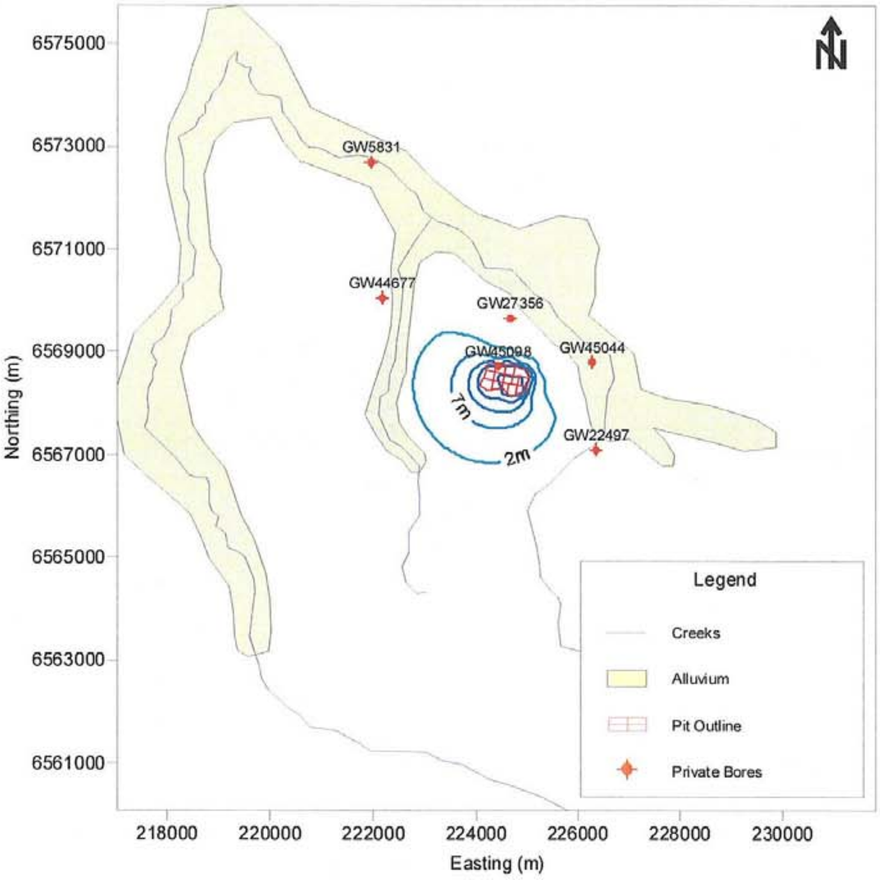

CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project				
DRAWN PN	DATE Jan 2007	TITLE MODELLED DRAWDOWN IN HOSKISSONS SEAM- LOW K CASE, YEAR 5				
CHECKED EW	DATE Jan 2007					
SCALE As Shown		PROJECT No 008-06636017		FIGURE No 15	REV No 0	A4

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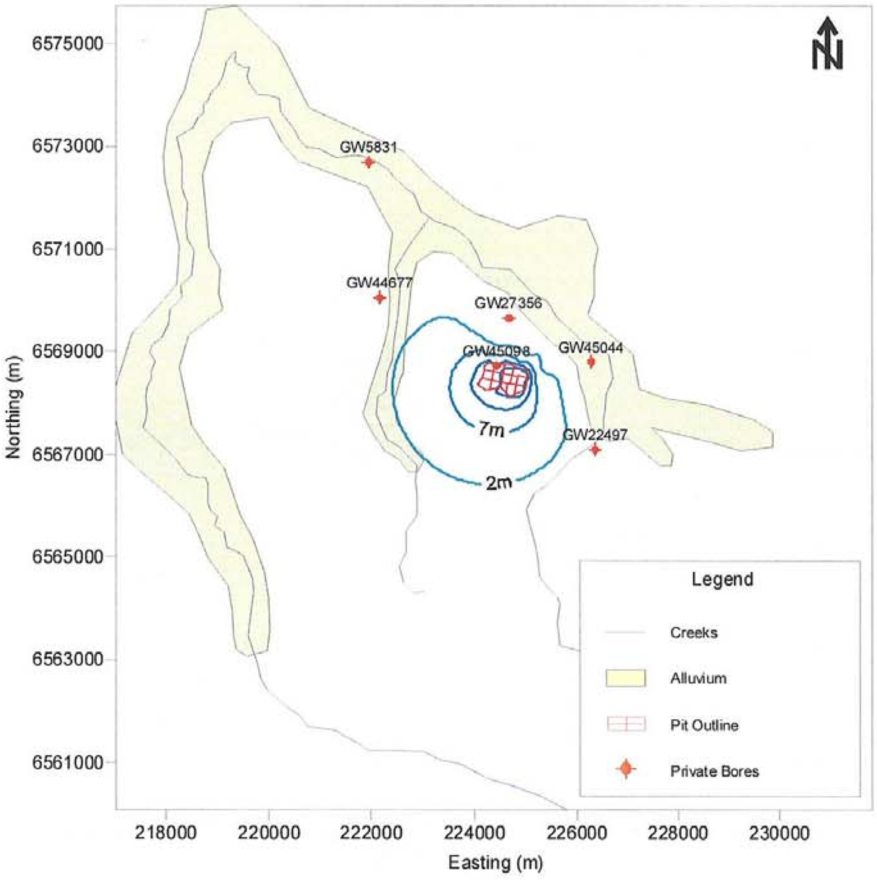

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CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project	
DRAWN PN	DATE Jan 2007	TITLE MODELLED DRAWDOWN IN HOSKISSONS SEAM- LOW K CASE, YEAR 10	
CHECKED EW	DATE Jan 2007		
SCALE As Shown		PROJECT No 008-06636017	FIGURE No 16 REV No 0 A4

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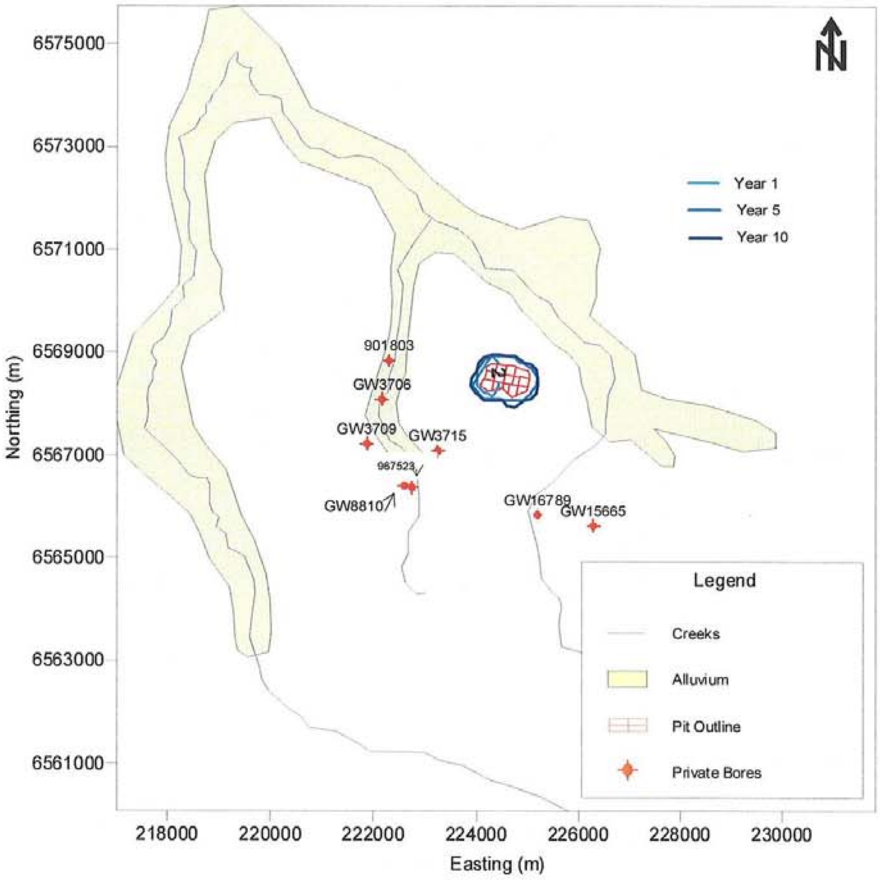

Note:
FAH – Formations Above Hoskisson

Golder Associates

CLIENT GeoTerra Pty Ltd
PROJECT Sunnyside Coal Project
DRAWN PN DATE Jan 2007
CHECKED EW DATE Jan 2007
TITLE **MODELLED 2m DRAWDOWN CONTOUR IN FAH-LOW K CASE**
SCALE As Shown
PROJECT No 008-06636017
FIGURE No 17
REV No 0
A4

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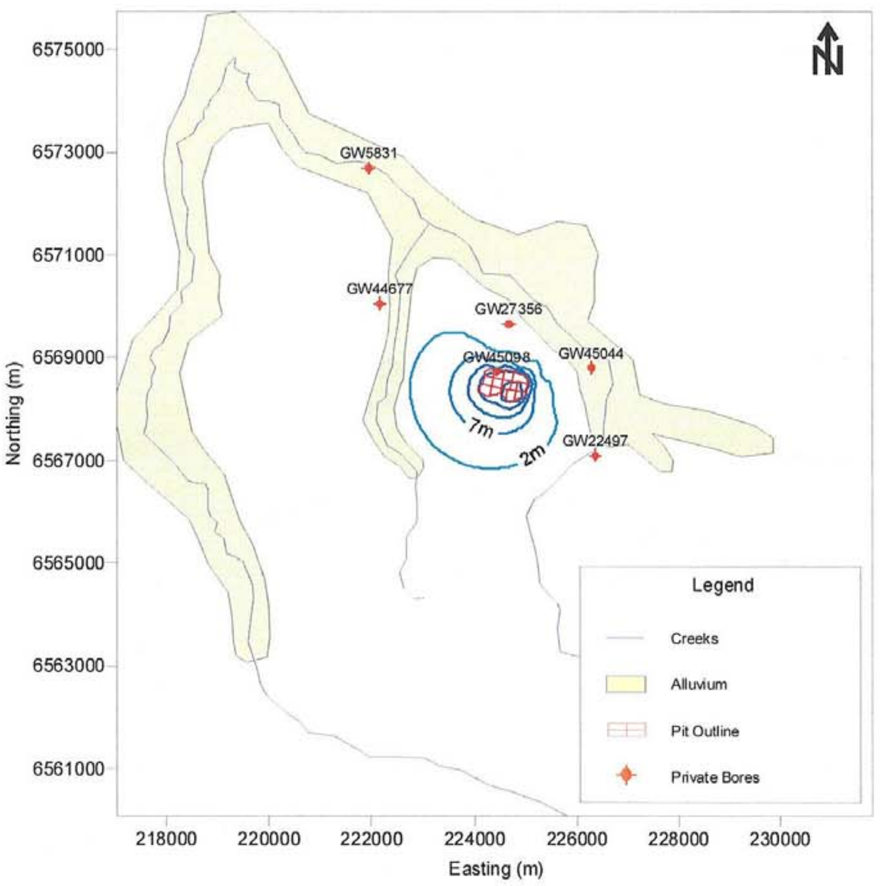

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PROJECT Sunnyside Coal Project
DRAWN PN DATE Jan 2007
CHECKED EW DATE Jan 2007
SCALE As Shown
TITLE MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 1, YEAR 5
PROJECT No 008-06636017 FIGURE No 18 REV No 0 A4

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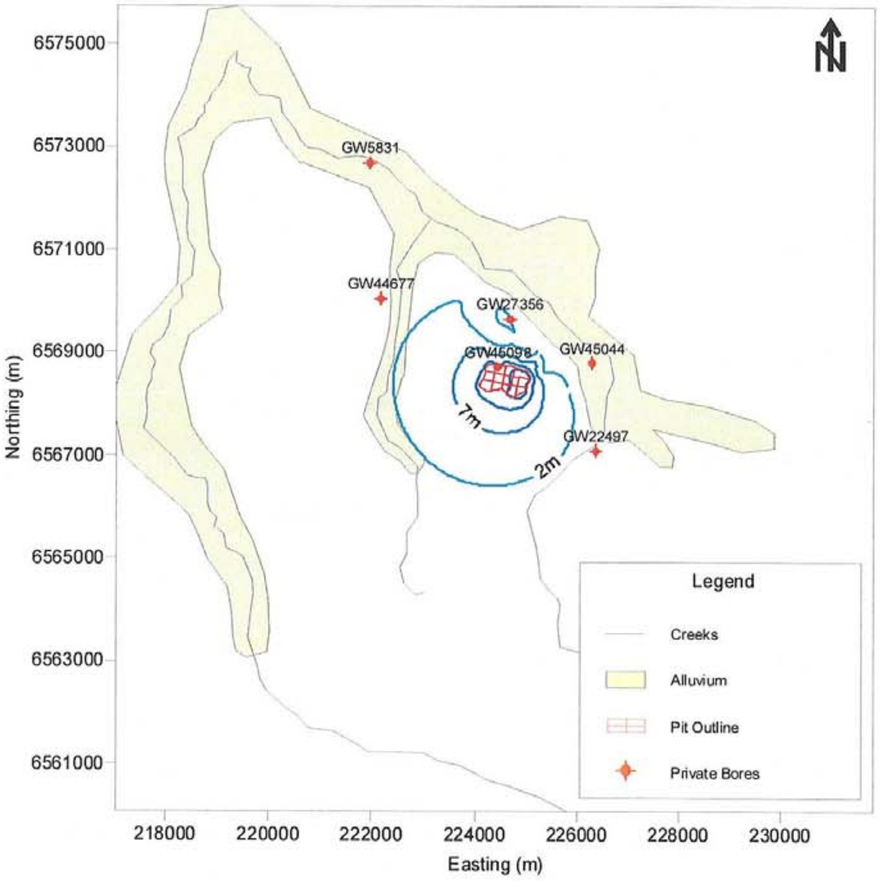

CLIENT GeoTerra Pty Ltd

PROJECT Sunnyside Coal Project

DRAWN PN DATE Jan 2007

CHECKED EW DATE Jan 2007

TITLE MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 1, YEAR 10

SCALE As Shown

PROJECT No 008-06636017 FIGURE No 19 REV No 0 A4

Golder Associates

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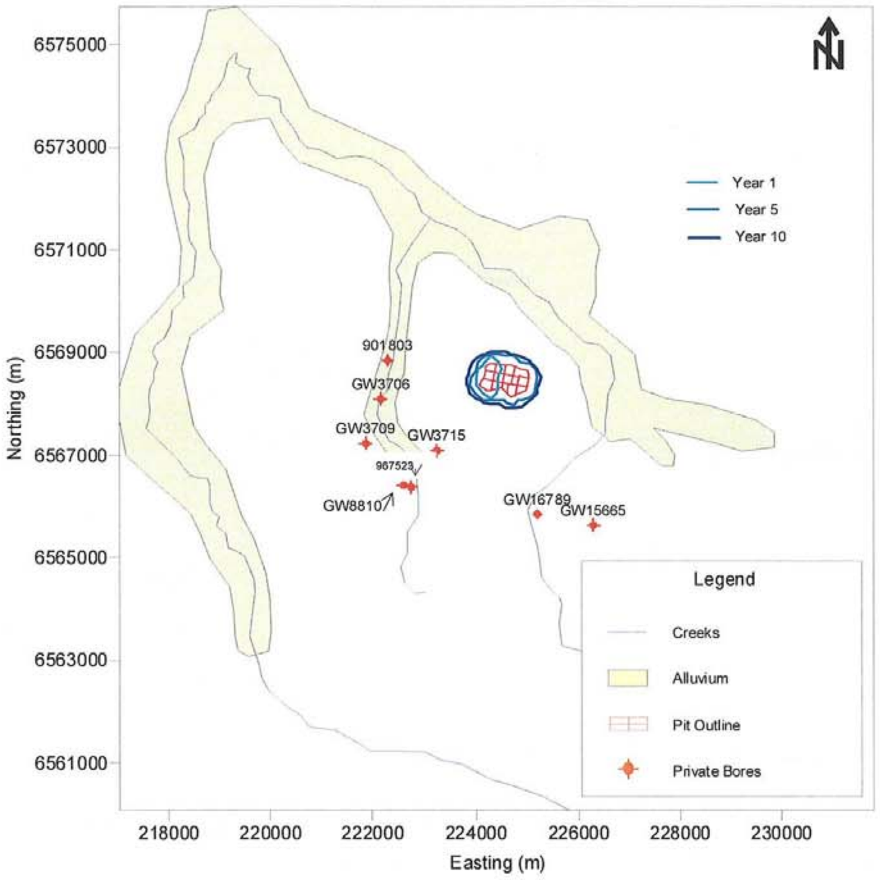

Note:
FAH – Formations Above Hoskisson

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	DRAWN PN	DATE Jan 2007	TITLE MODELLED 2m DRAWDOWN CONTOUR IN FAH-SENSITIVITY CASE 1	
	CHECKED EW	DATE Jan 2007		
	SCALE As Shown		PROJECT No 008-06636017	FIGURE No 20 REV No 0 A4

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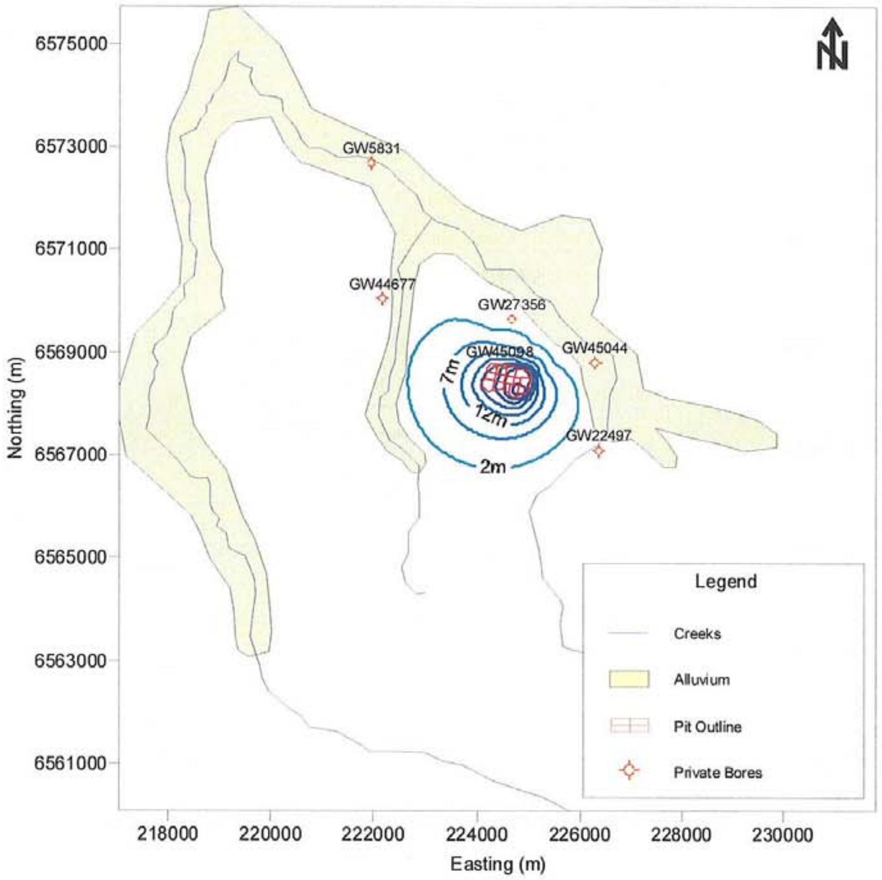

Golder Associates

CLIENT GeoTerra Pty Ltd
PROJECT Sunnyside Coal Project
DRAWN PN
DATE Jan 2007
CHECKED EW
DATE Jan 2007
TITLE MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 2, YEAR 5
SCALE As Shown
PROJECT No 008-06636017
FIGURE No 21
REV No 0
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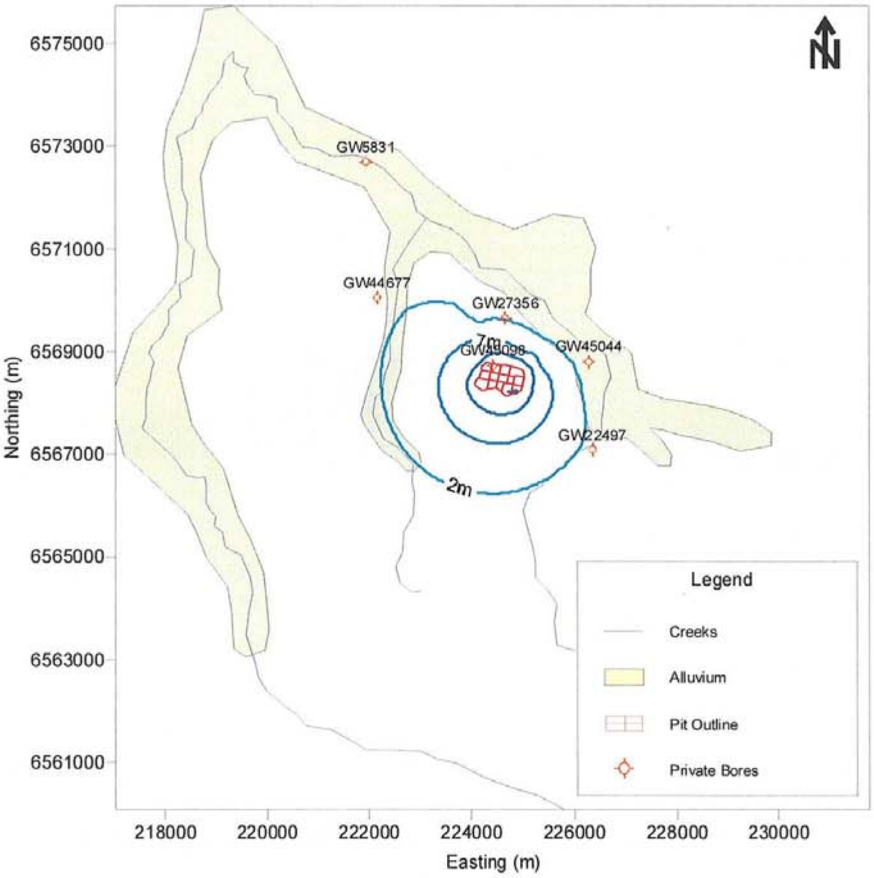

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CLIENT GeoTerra Pty Ltd
PROJECT Sunnyside Coal Project
DRAWN PN
DATE Jan 2007
CHECKED EW
DATE Jan 2007
TITLE MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 2, YEAR 10
SCALE As Shown
PROJECT No 008-06636017
FIGURE No 22
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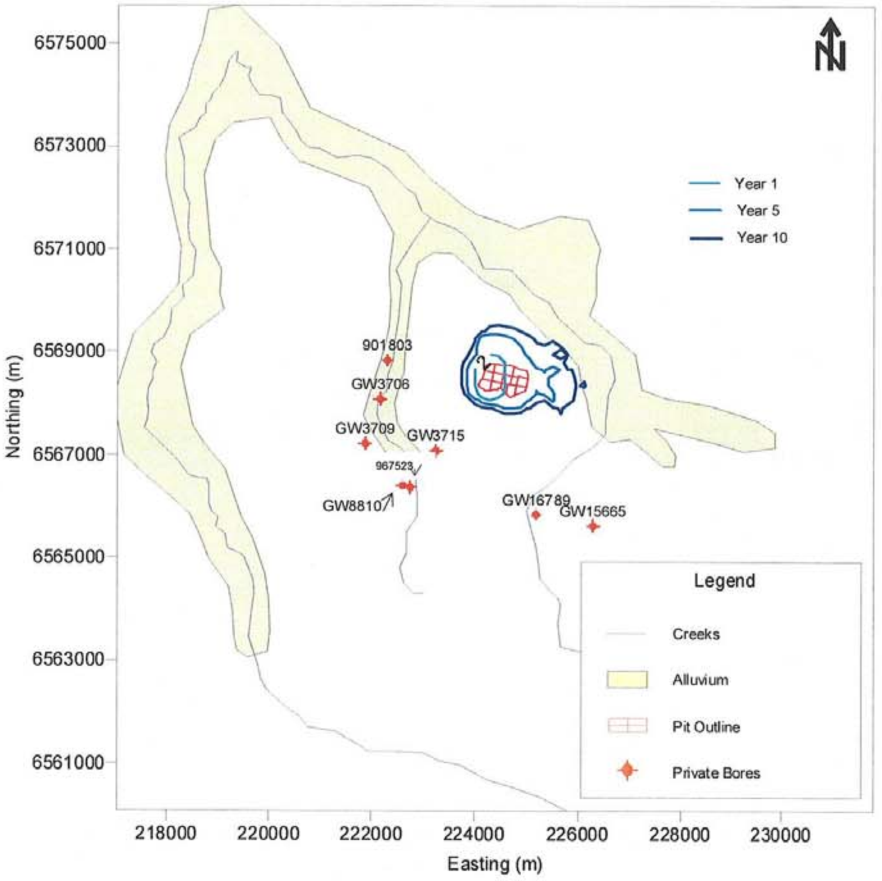

Note:
FAH – Formations Above Hoskisson

Golder Associates

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PROJECT Sunnyside Coal Project
DRAWN PN DATE Jan 2007
CHECKED EW DATE Jan 2007
TITLE **MODELLED 2m DRAWDOWN CONTOUR IN FAH-SENSITIVITY CASE 2**
SCALE As Shown
PROJECT No 008-06636017 FIGURE No 23 REV No 0 A4

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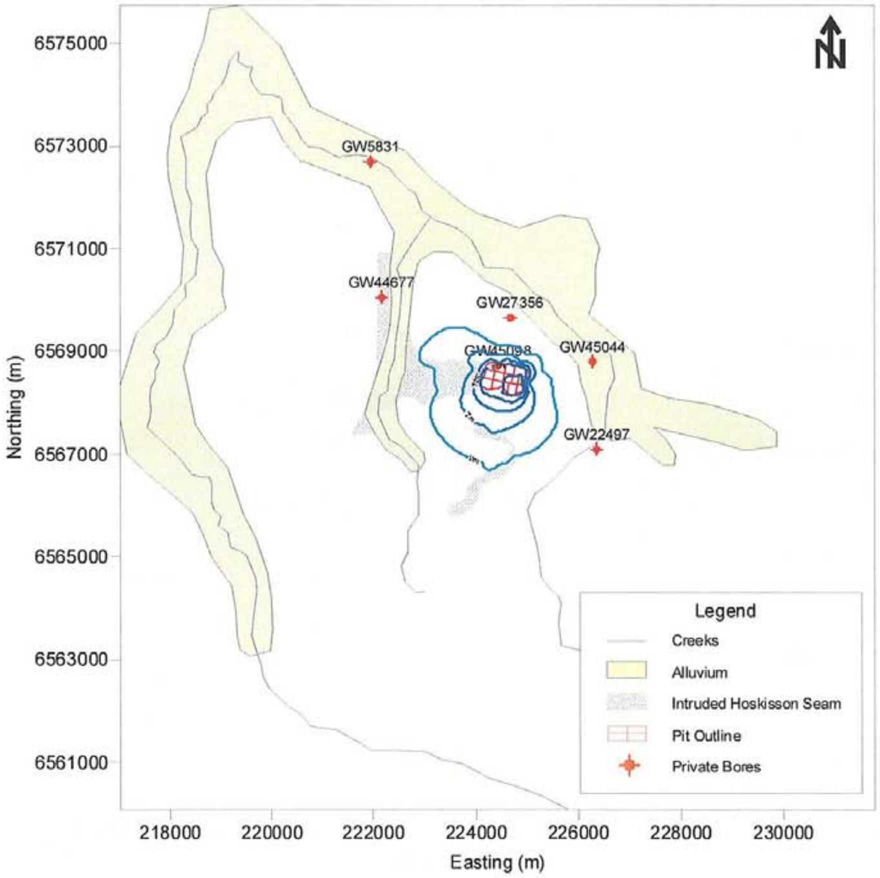

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CLIENT GeoTerra Pty Ltd
PROJECT Sunnyside Coal Project
DRAWN PN
DATE Jan 2007
CHECKED EW
DATE Jan 2007
TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 3, YEAR 5**
SCALE As Shown
PROJECT No 008-06636017
FIGURE No 24
REV No 0
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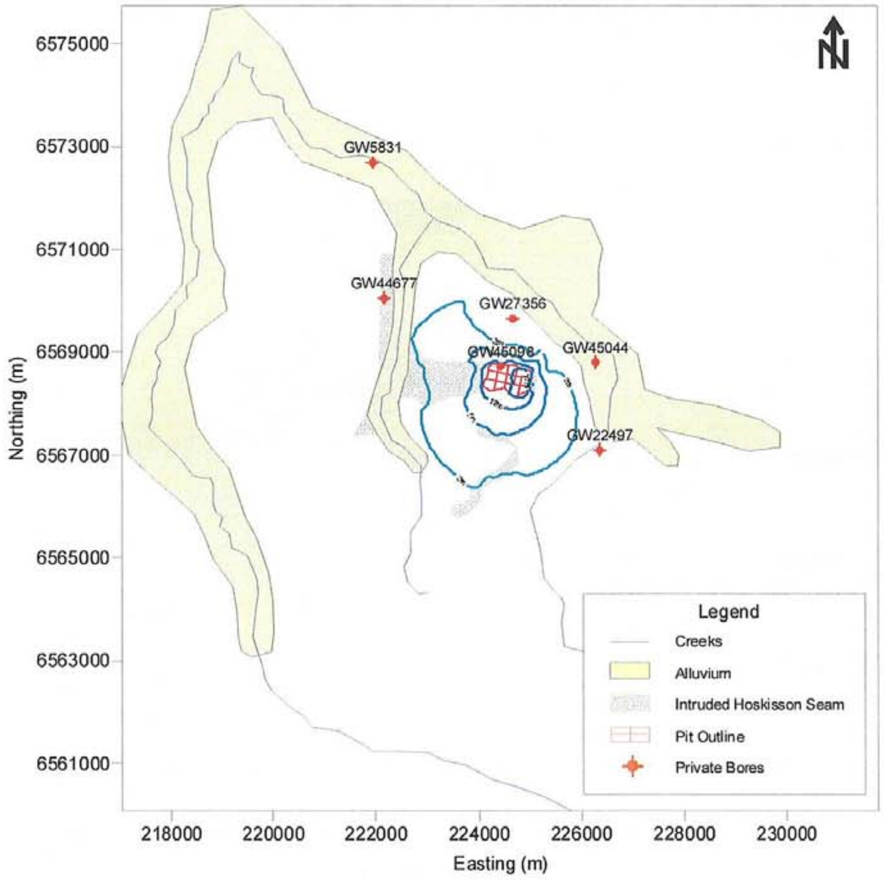

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	CHECKED EW	DATE Jan 2007	
	SCALE As Shown		PROJECT No 008-06636017 FIGURE No 25 REV No 0 A4

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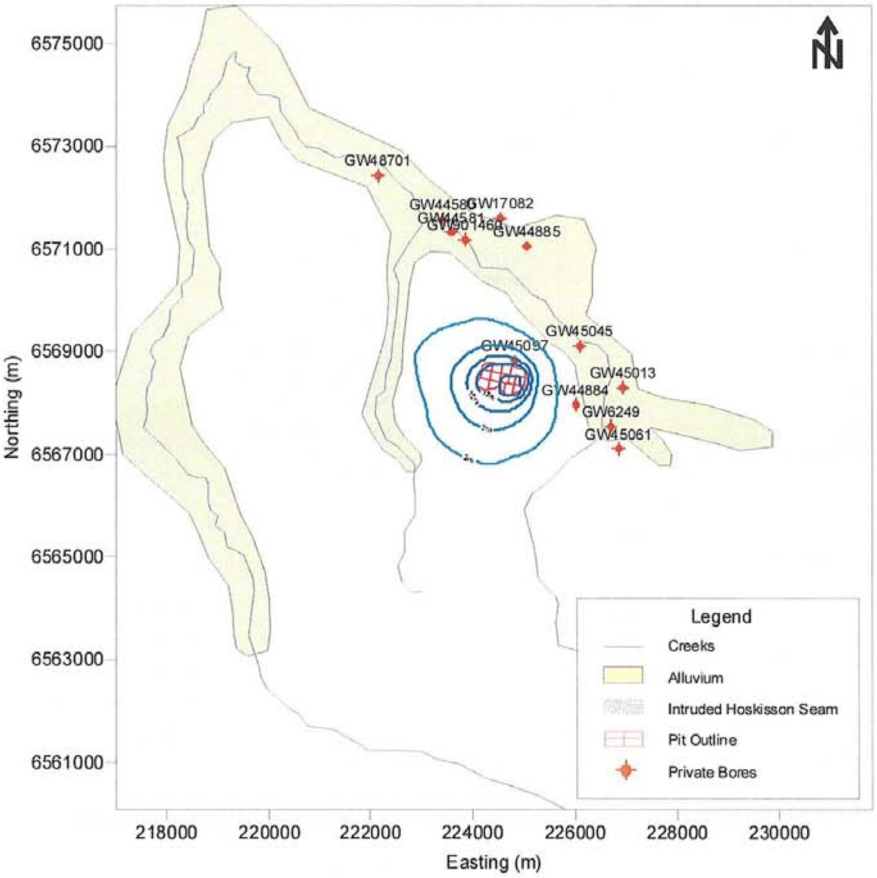

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DRAWN PN	DATE Jan 2007	TITLE **MODELLED DRAWDOWN IN SMF & LDPF SENSITIVITY CASE 3, YEAR 5**	
CHECKED EW	DATE Jan 2007		
SCALE As Shown		PROJECT No 008-06636017	FIGURE No 26
		REV No 0	A4

Golder Associates

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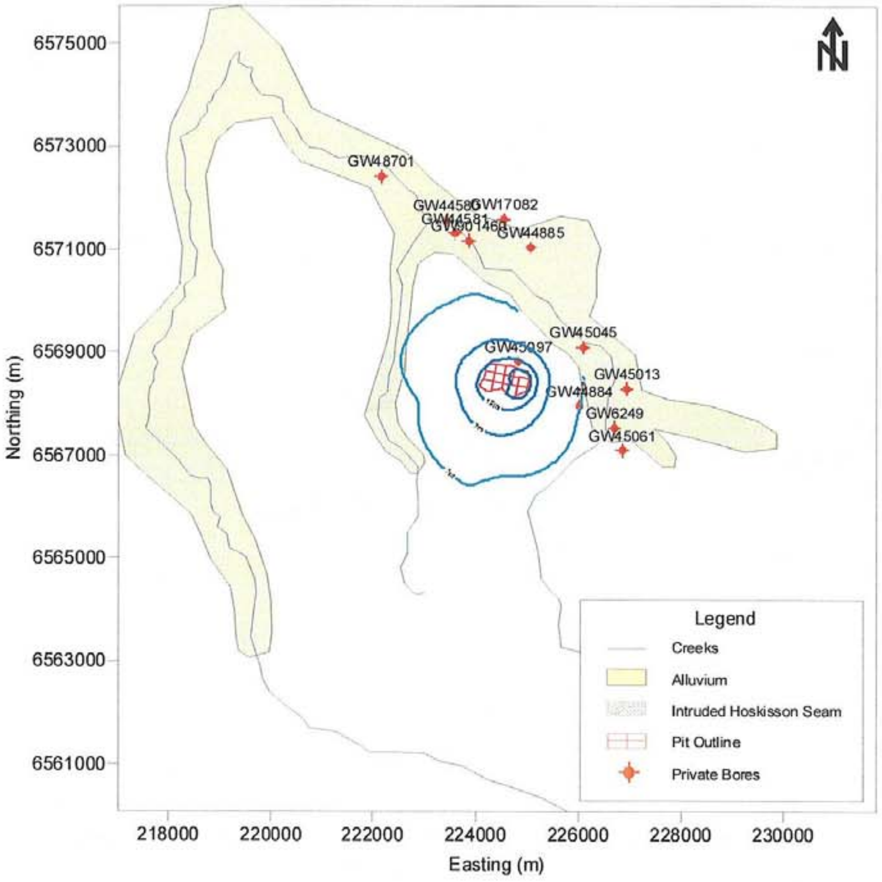

Golder Associates

CLIENT	GeoTerra Pty Ltd	PROJECT	Sunnyside Coal Project
DRAWN PN	DATE Jan 2007	TITLE	**MODELLED DRAWDOWN IN SMF & LDPF SENSITIVITY CASE 3, YEAR 10**
CHECKED EW	DATE Jan 2007		
SCALE	As Shown	PROJECT No 008-06636017	FIGURE No 27 / REV No 0 / A4

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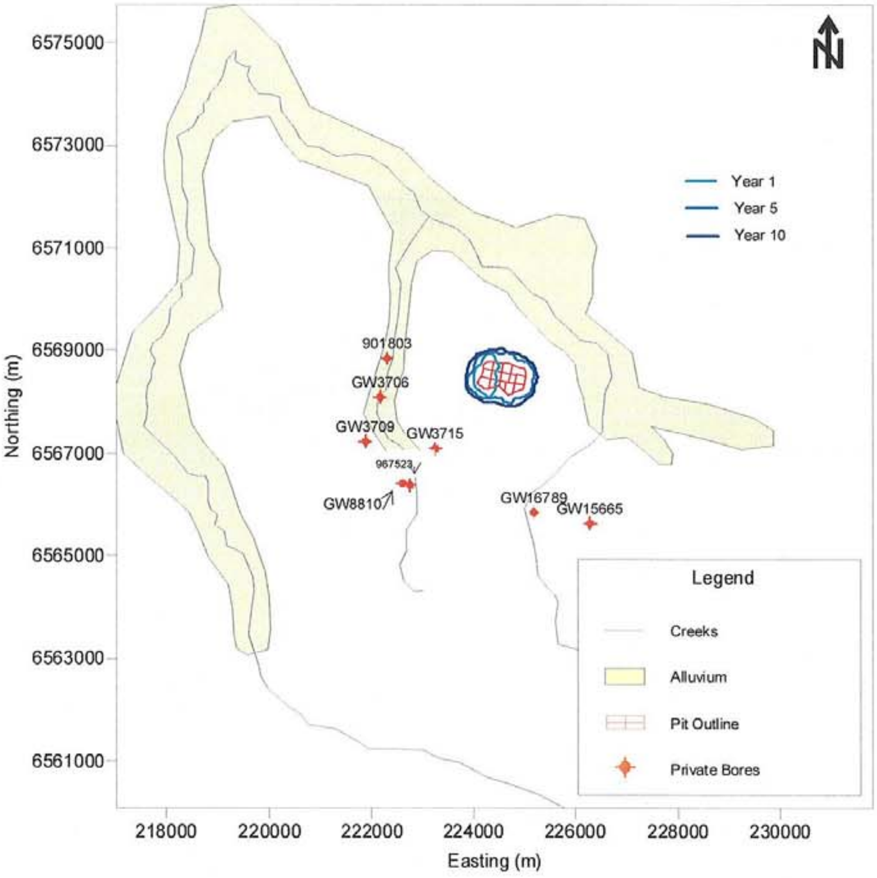

Note:
FAH – Formations Above Hoskisson

CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project	
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CHECKED EW	DATE Jan 2007		
SCALE As Shown		PROJECT No 008-06636017	FIGURE No 28 · REV No 0 · A4

Golder Associates

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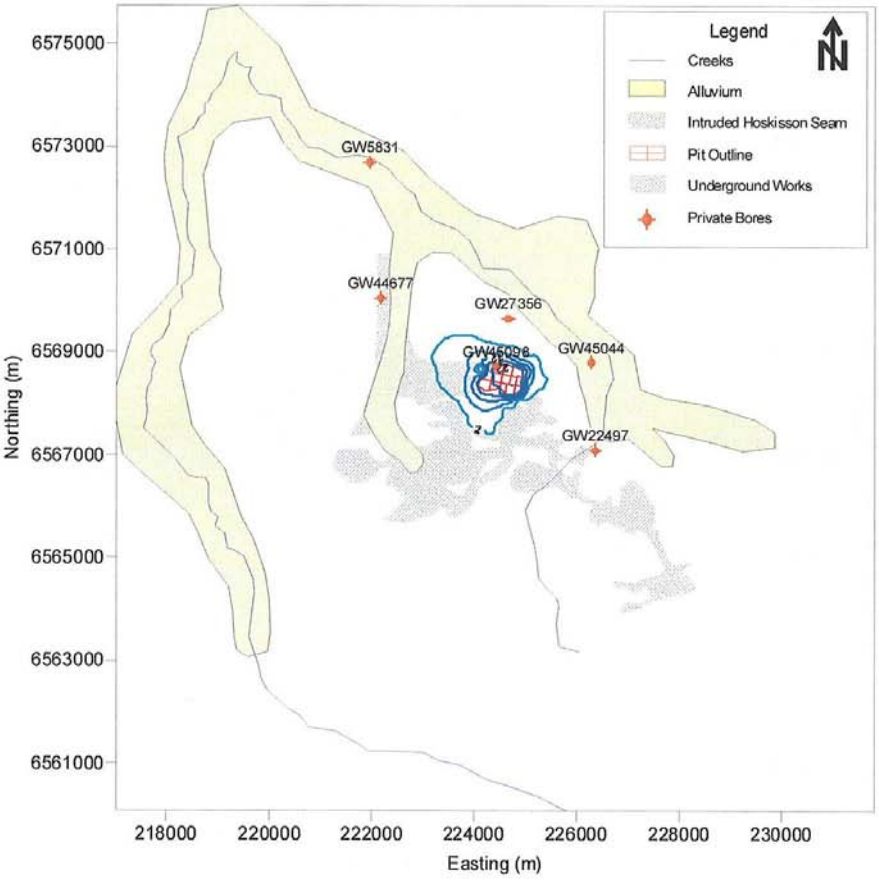

Golder Associates

CLIENT GeoTerra Pty Ltd

PROJECT Sunnyside Coal Project

DRAWN PN DATE Jan 2007

CHECKED EW DATE Jan 2007

TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM- SENSITIVITY CASE 4, YEAR 5**

SCALE As Shown

PROJECT No 008-06636017 FIGURE No 29 REV No 0 A4

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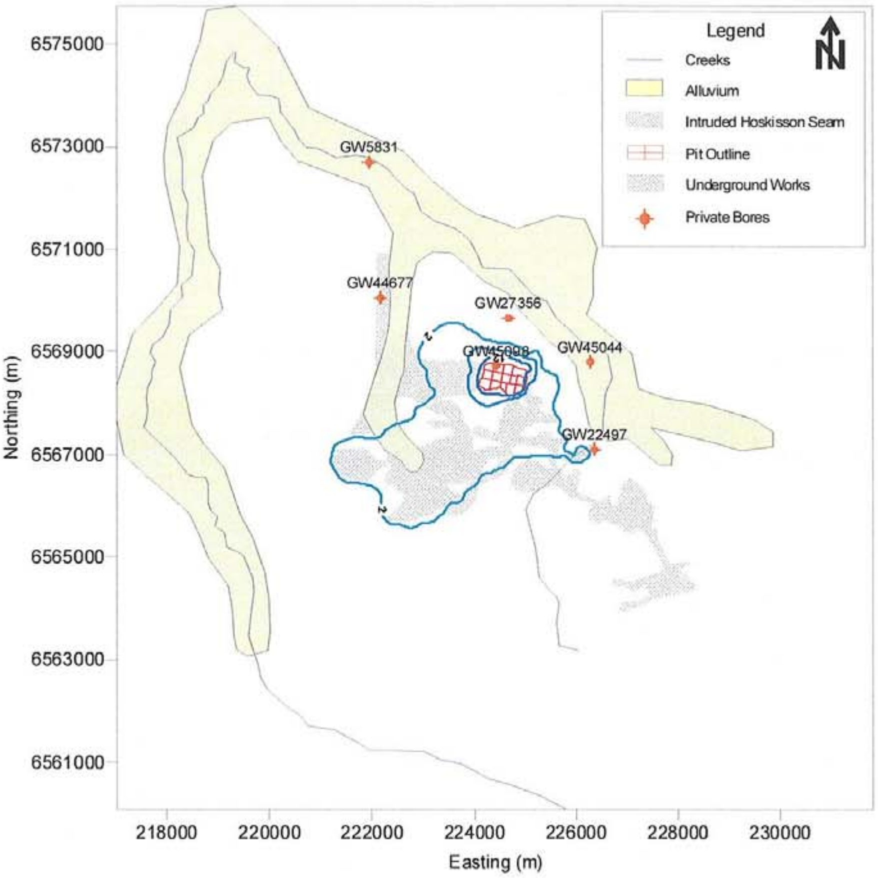

CLIENT GeoTerra Pty Ltd

PROJECT Sunnyside Coal Project

DRAWN PN DATE Jan 2007

CHECKED EW DATE Jan 2007

TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 4, YEAR 10**

SCALE As Shown

PROJECT No 008-06636017 FIGURE No 30 REV No 0 A4

Golder Associates

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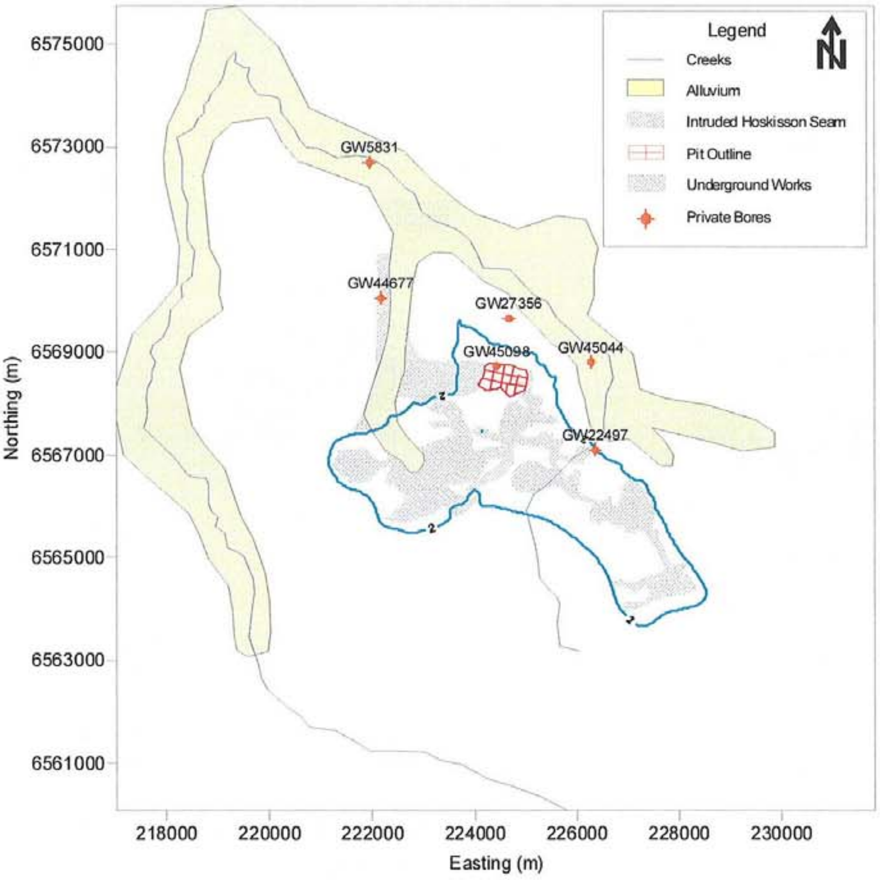

CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project	
DRAWN PN	DATE Jan 2007	TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 4, YEAR 30**	
CHECKED EW	DATE Jan 2007		
SCALE As Shown		PROJECT No 008-06636017	FIGURE No 31 REV No 0 A4

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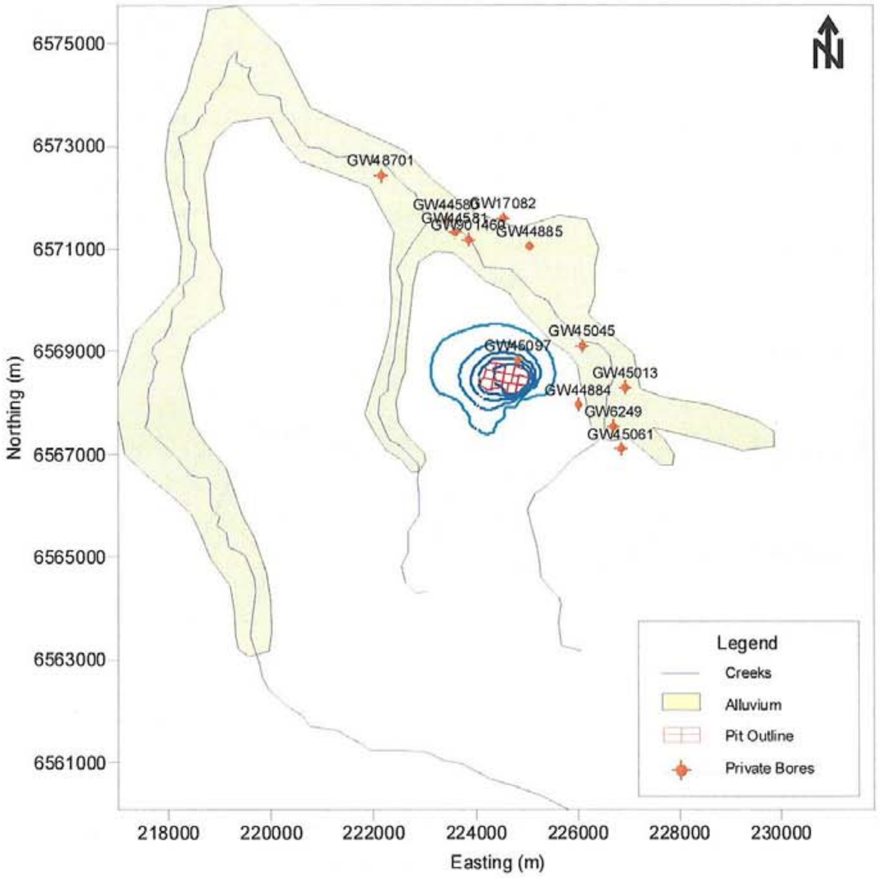

Golder Associates

CLIENT	GeoTerra Pty Ltd	PROJECT	Sunnyside Coal Project
DRAWN PN	DATE Jan 2007	TITLE	MODELLED DRAWDOWN IN SMF & LDPF SENSITIVITY CASE 4, YEAR 5
CHECKED EW	DATE Jan 2007		
SCALE	As Shown	PROJECT No 008-06636017	FIGURE No 32 REV No 0 A4

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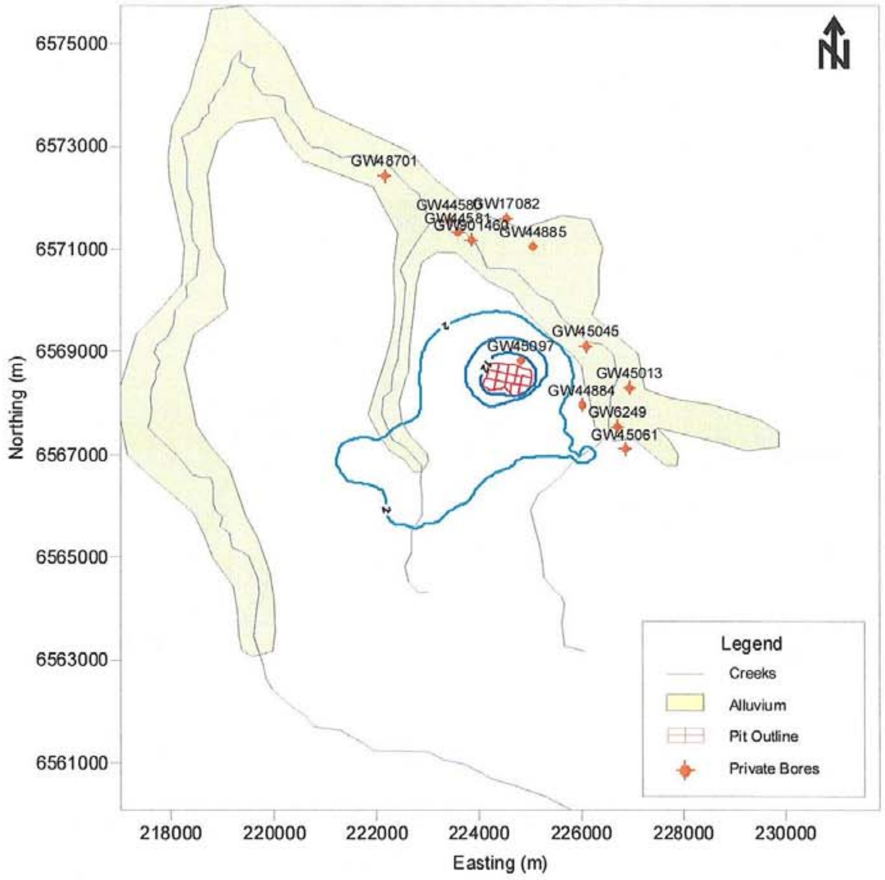

Golder Associates

CLIENT GeoTerra Pty Ltd
PROJECT Sunnyside Coal Project
DRAWN PN DATE Jan 2007
CHECKED EW DATE Jan 2007
TITLE **MODELLED DRAWDOWN IN SMF & LDPF SENSITIVITY CASE 4, YEAR 10**
SCALE As Shown
PROJECT No 008-06636017
FIGURE No 33
REV No 0
A4

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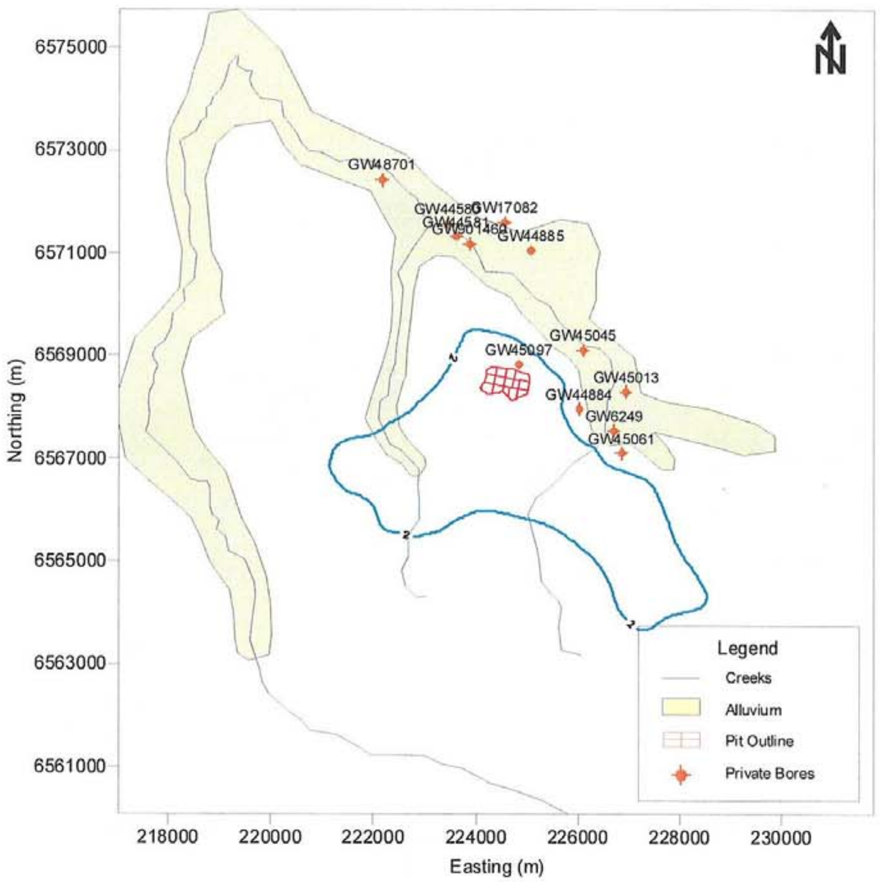

Golder Associates

CLIENT	GeoTerra Pty Ltd	PROJECT	Sunnyside Coal Project
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CHECKED EW	DATE Jan 2007		
SCALE	As Shown	PROJECT No 008-06636017	FIGURE No 34 · REV No 0 · A4

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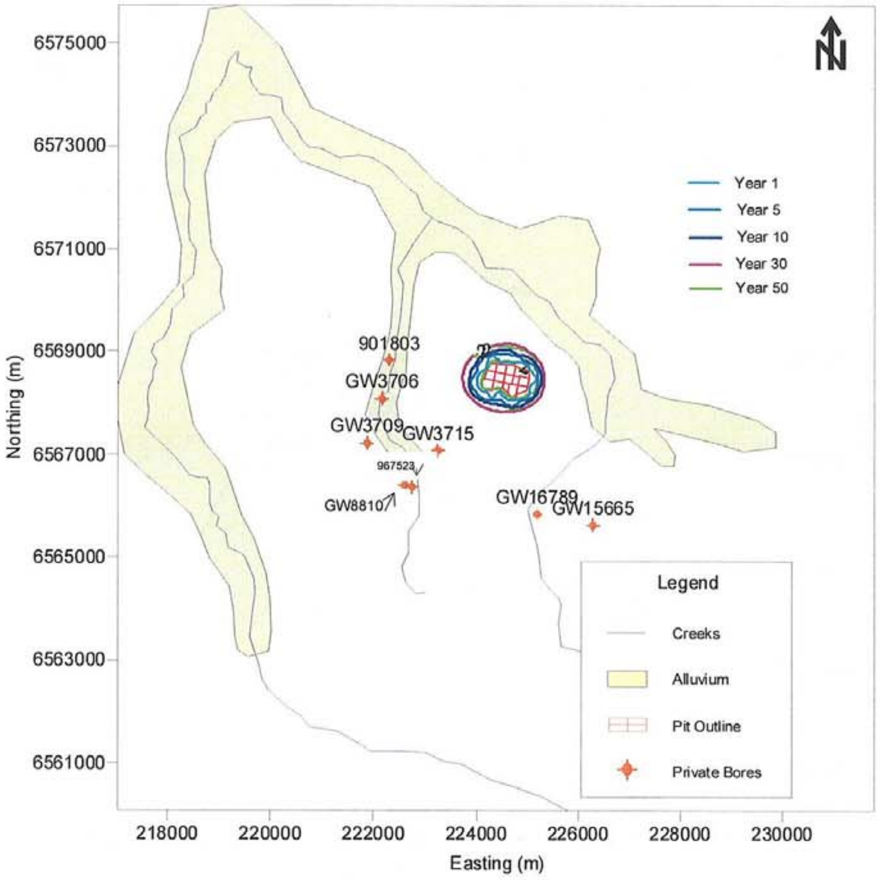

Note:
FAH – Formations Above Hoskisson

CLIENT	GeoTerra Pty Ltd	PROJECT	Sunnyside Coal Project
DRAWN	PN	DATE	Jan 2007
CHECKED	EW	DATE	Jan 2007
TITLE	MODELLED 2m DRAWDOWN CONTOUR IN FAH - SENSITIVITY CASE 4		
SCALE	As Shown		
PROJECT No	008-06636017	FIGURE No	35
REV No	0	A4	

Golder Associates

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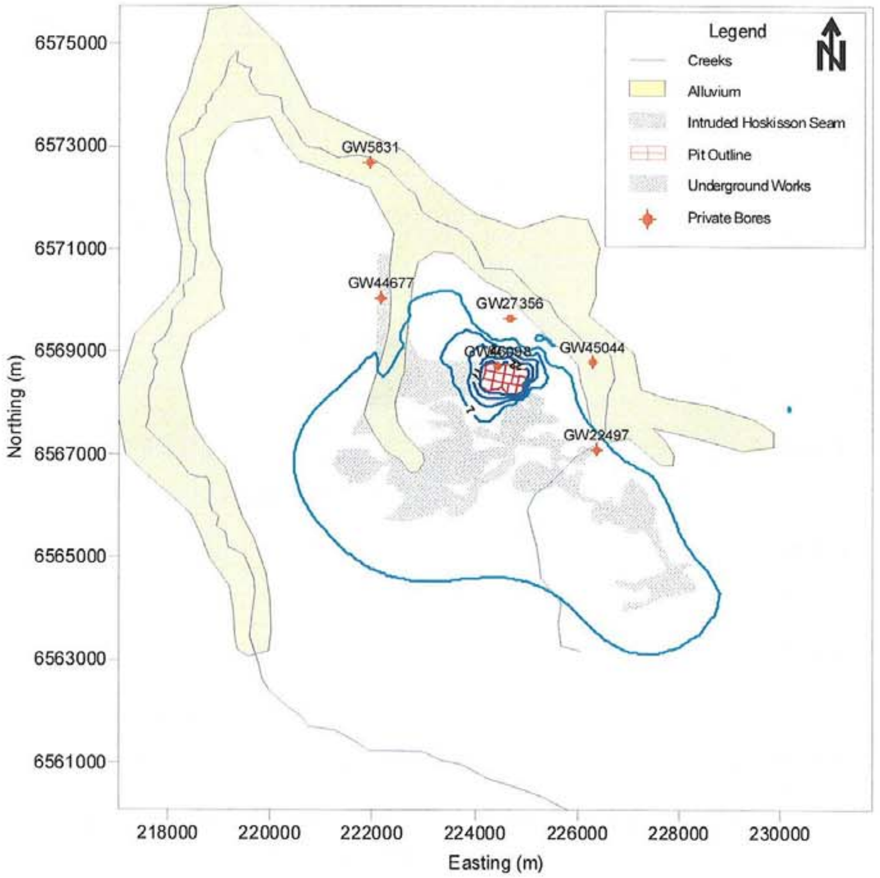

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DRAWN PN	DATE Jun 2007	TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 5, YEAR 5**	
CHECKED RS	DATE Jun 2007		
SCALE As Shown		PROJECT No 008-06636017	FIGURE No 36 REV No 0 A4

Golder Associates

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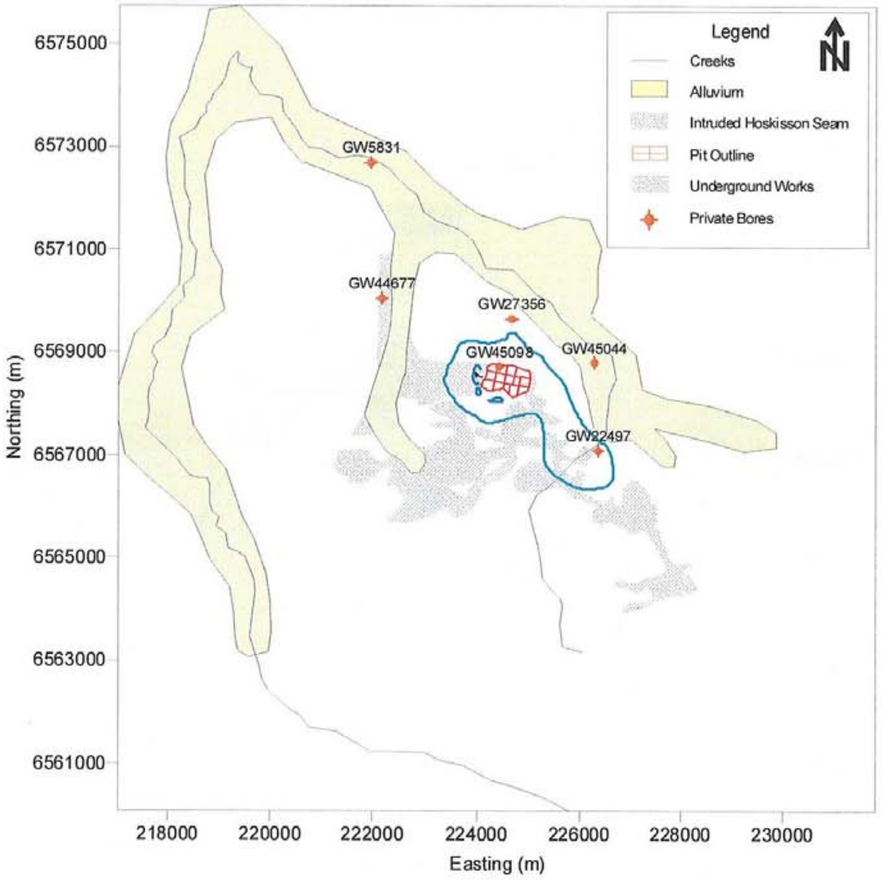

CLIENT GeoTerra Pty Ltd		PROJECT Sunnyside Coal Project	
DRAWN PN	DATE Jun 2007	TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM- SENSITIVITY CASE 5, YEAR 10**	
CHECKED RS	DATE Jun 2007		
SCALE As Shown		PROJECT No 008-06636017	FIGURE No 37 REV No 0 A4

Golder Associates

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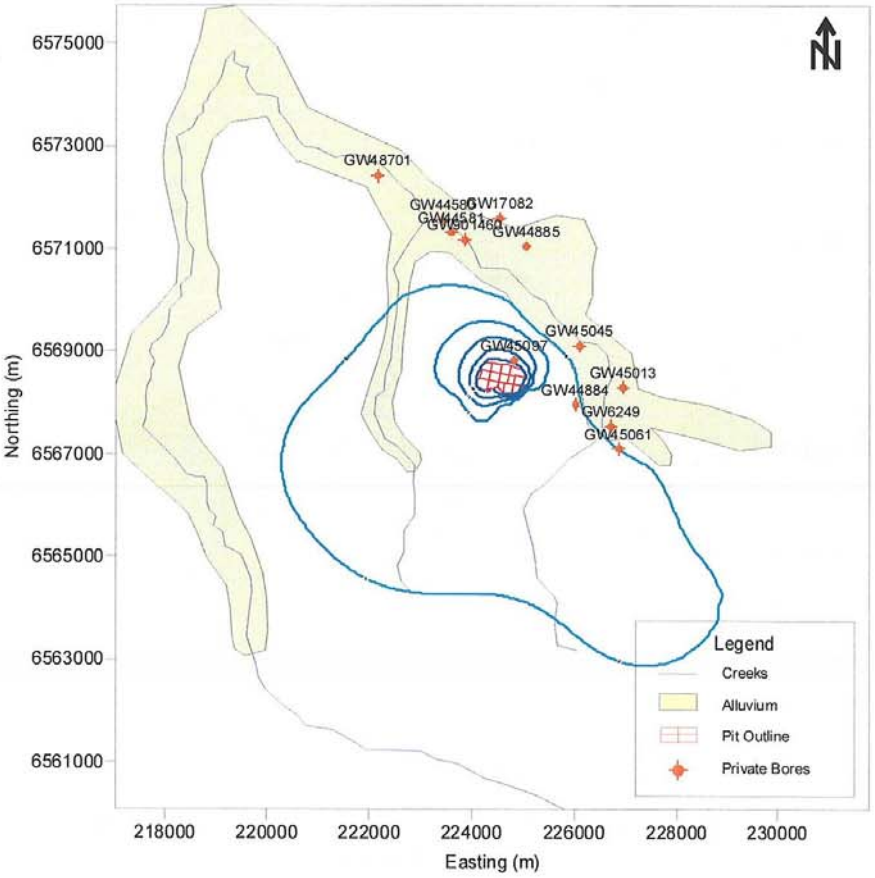

Golder Associates

CLIENT	GeoTerra Pty Ltd	PROJECT	Sunnyside Coal Project
DRAWN PN	DATE Jun 2007	TITLE	**MODELLED DRAWDOWN IN SMF & LDPF SENSITIVITY CASE 5, YEAR 5**
CHECKED RS	DATE Jun 2007		
SCALE	As Shown	PROJECT No 008-06636017	FIGURE No 38 REV No 0 A4

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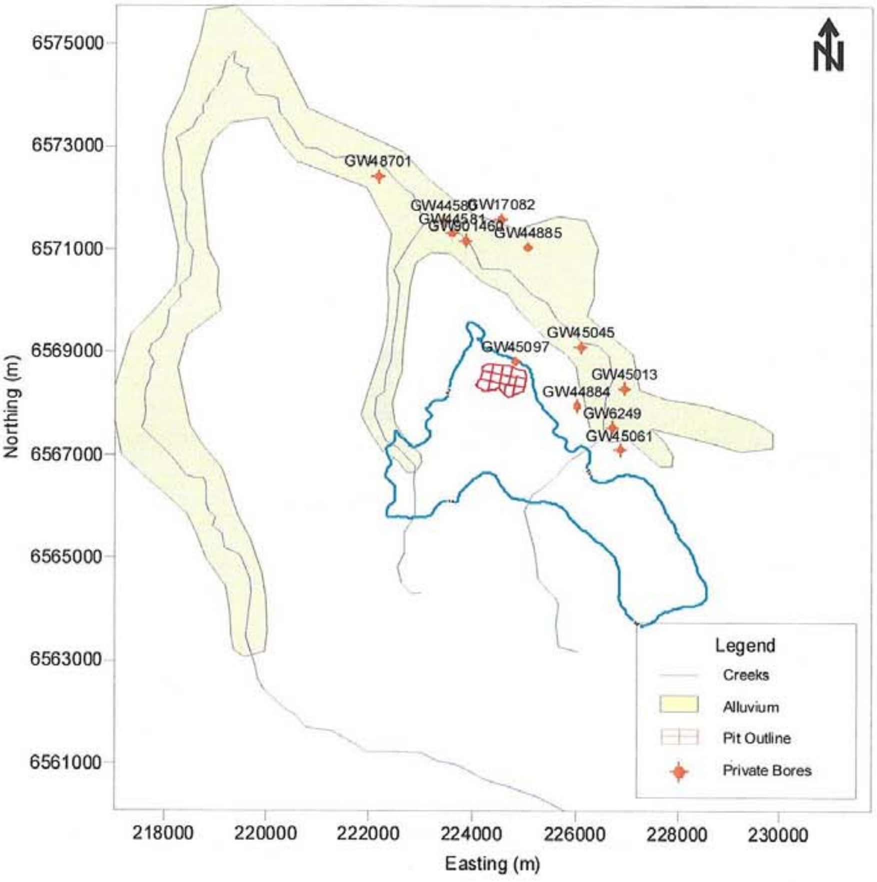

Golder Associates

CLIENT GeoTerra Pty Ltd

PROJECT Sunnyside Coal Project

DRAWN PN DATE Jun 2007

CHECKED RS DATE Jun 2007

TITLE **MODELLED DRAWDOWN IN SMF & LDPF SENSITIVITY CASE 5, YEAR 10**

SCALE As Shown

PROJECT No 008-06636017 FIGURE No 39 REV No 0 A4

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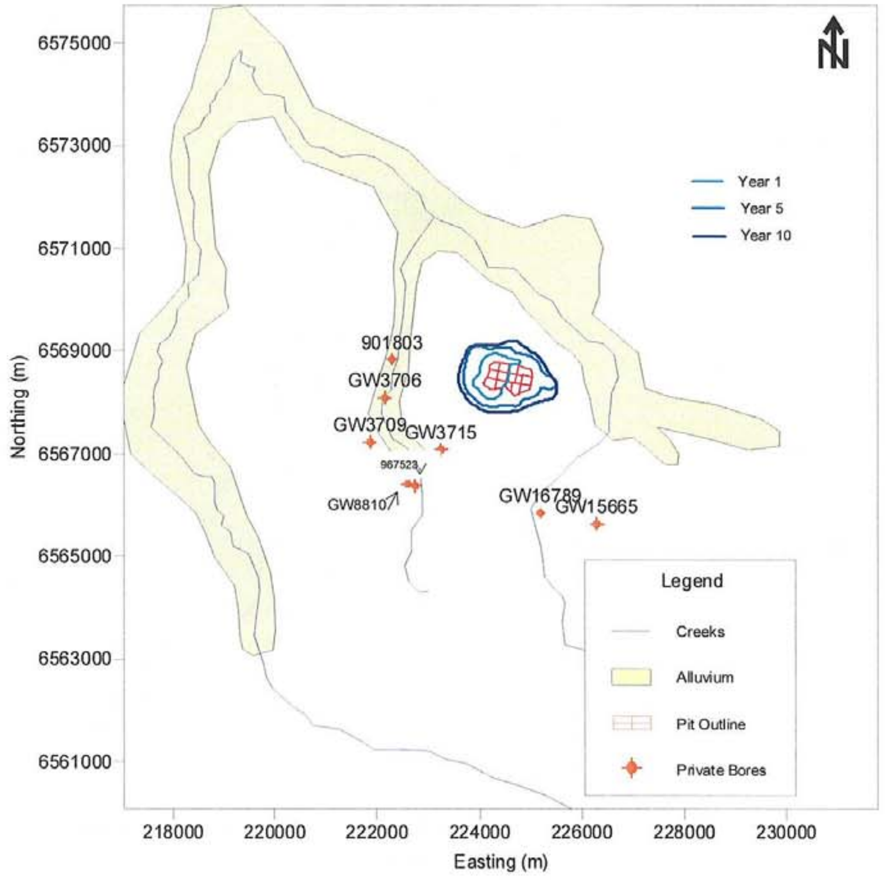

Note:
FAH – Formations Above Hoskisson

CLIENT	GeoTerra Pty Ltd	PROJECT	Sunnyside Coal Project
DRAWN PN	DATE Jun 2007	TITLE	**MODELLED 2m DRAWDOWN CONTOUR IN FAH - SENSITIVITY CASE 5**
CHECKED RS	DATE Jun 2007		
SCALE	As Shown	PROJECT No 008-06636017	FIGURE No 40 · REV No 0 · A4

Golder Associates

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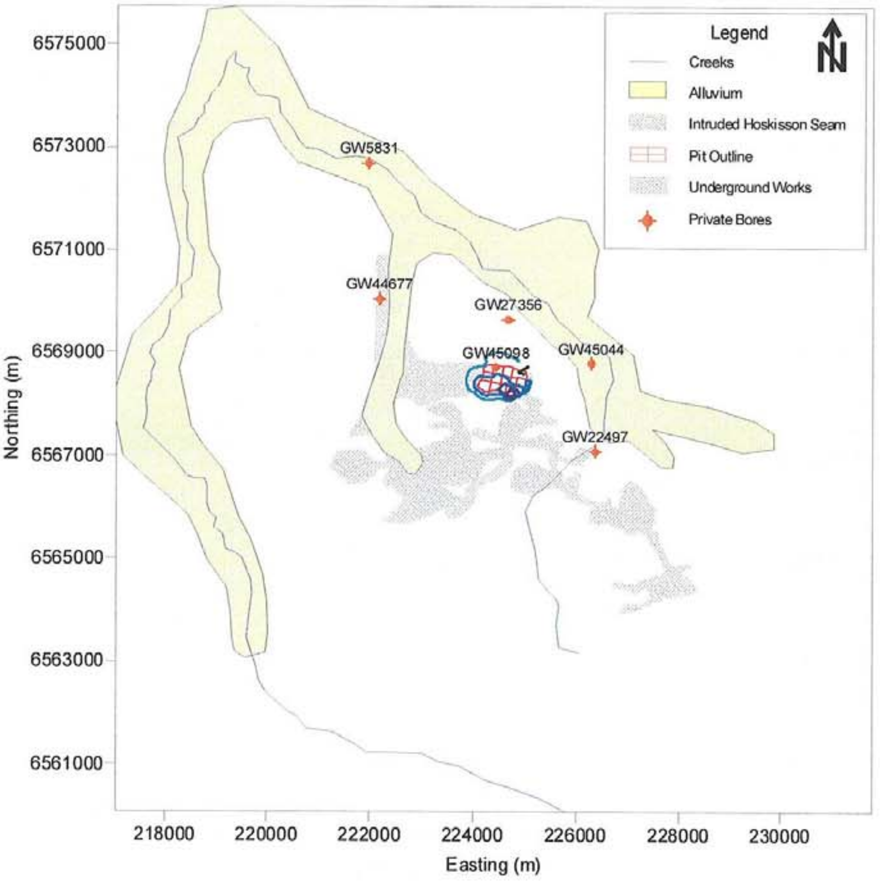

Golder Associates

CLIENT GeoTerra Pty Ltd

PROJECT Sunnyside Coal Project

DRAWN PN DATE Mar 2008

CHECKED EW DATE Mar 2008

TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM- SENSITIVITY CASE 6, YEAR 5**

SCALE As Shown

PROJECT No 008-06636017 FIGURE No 41 REV No 0 A4

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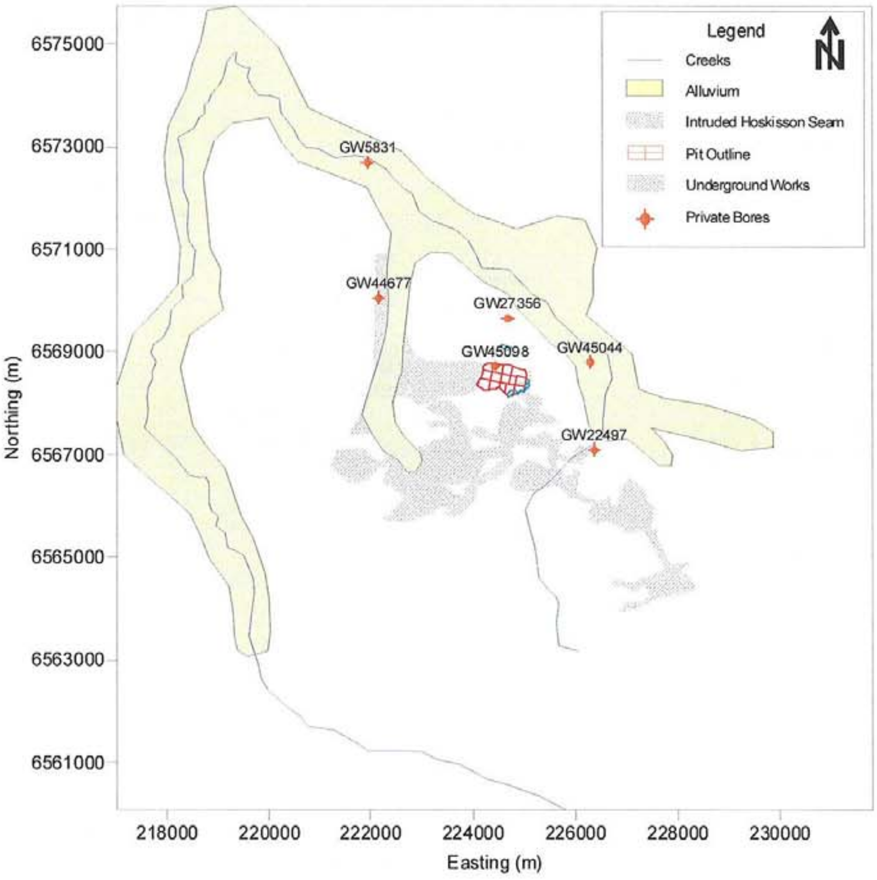

Golder Associates

CLIENT GeoTerra Pty Ltd

PROJECT Sunnyside Coal Project

DRAWN PN DATE Mar 2008

CHECKED EW DATE Mar 2008

TITLE **MODELLED DRAWDOWN IN HOSKISSONS SEAM-SENSITIVITY CASE 6, YEAR 10**

SCALE As Shown

PROJECT No 008-06636017 FIGURE No 42 REV No 0 A4

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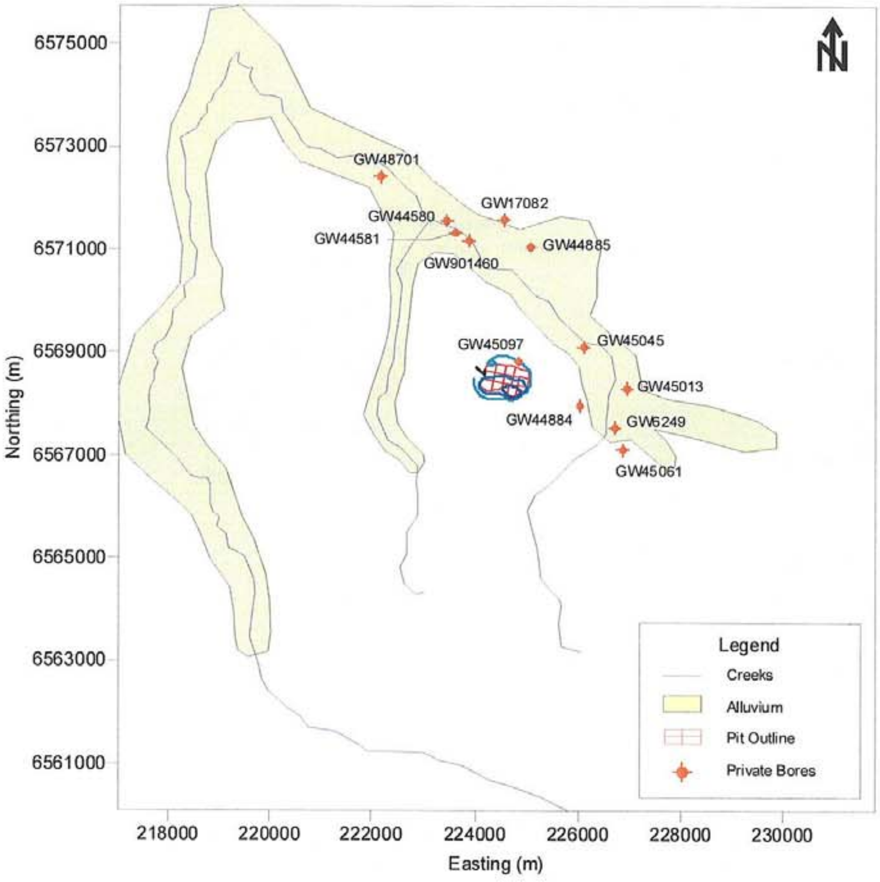

Golder Associates

CLIENT	GeoTerra Pty Ltd	PROJECT	Sunnyside Coal Project
DRAWN PN	DATE Mar 2008	TITLE	MODELLED DRAWDOWN IN SMF & LDPF SENSITIVITY CASE 6, YEAR 5
CHECKED EW	DATE Mar 2008		
SCALE	As Shown	PROJECT No 008-06636017	FIGURE No 43 REV No 0 A4

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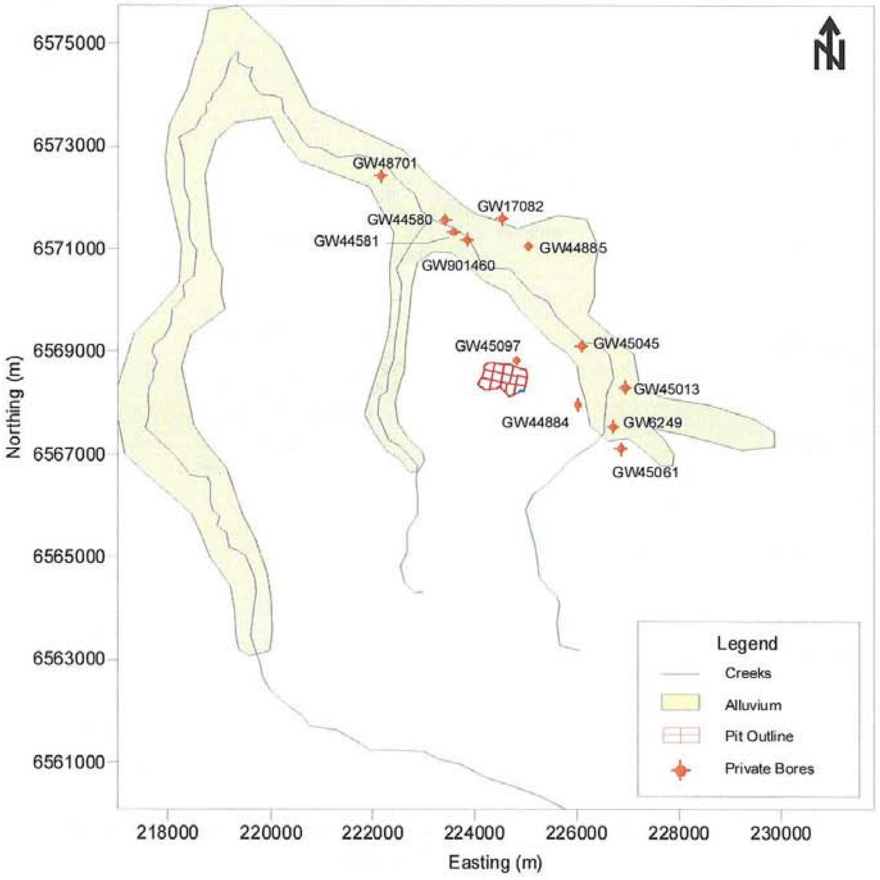

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DRAWN	PN	DATE	Mar 2008
CHECKED	EW	DATE	Mar 2008
SCALE	As Shown	PROJECT No	008-06636017

Golder Associates

TITLE **MODELLED DRAWDOWN IN SMF & LDPF SENSITIVITY CASE 6, YEAR 10**

FIGURE No 44 REV No 0 A4

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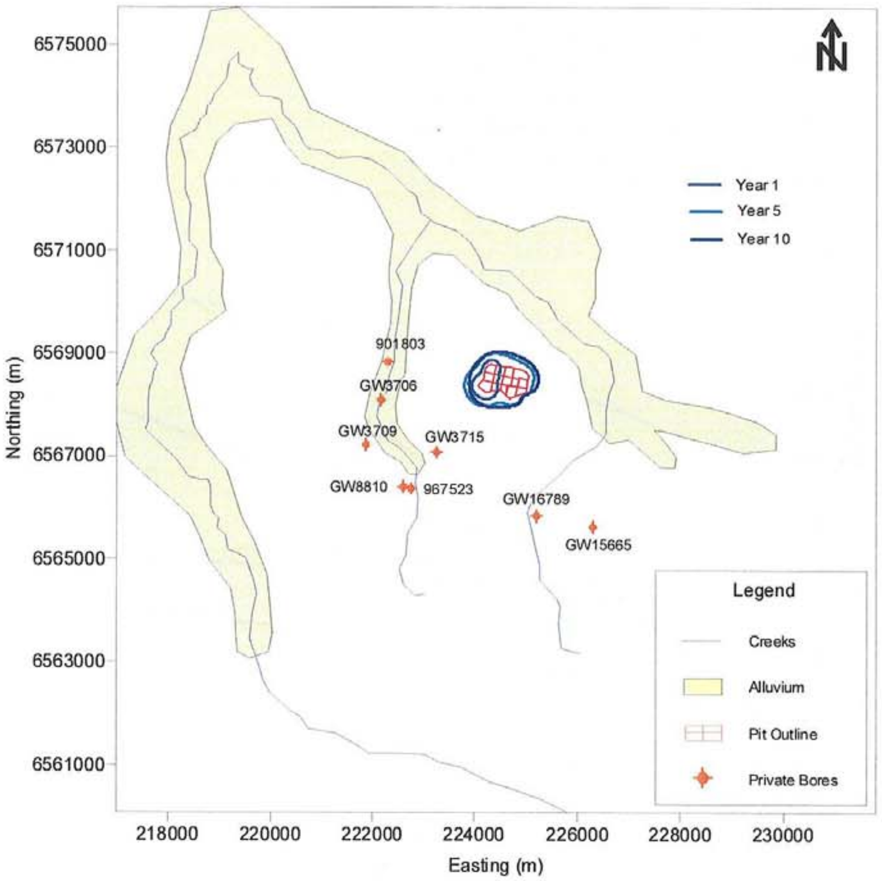

Note:
FAH – Formations Above Hoskisson

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	CHECKED EW	DATE Mar 2008			
	SCALE As Shown		PROJECT No 008-06636017	FIGURE No 45	REV No 0 A4

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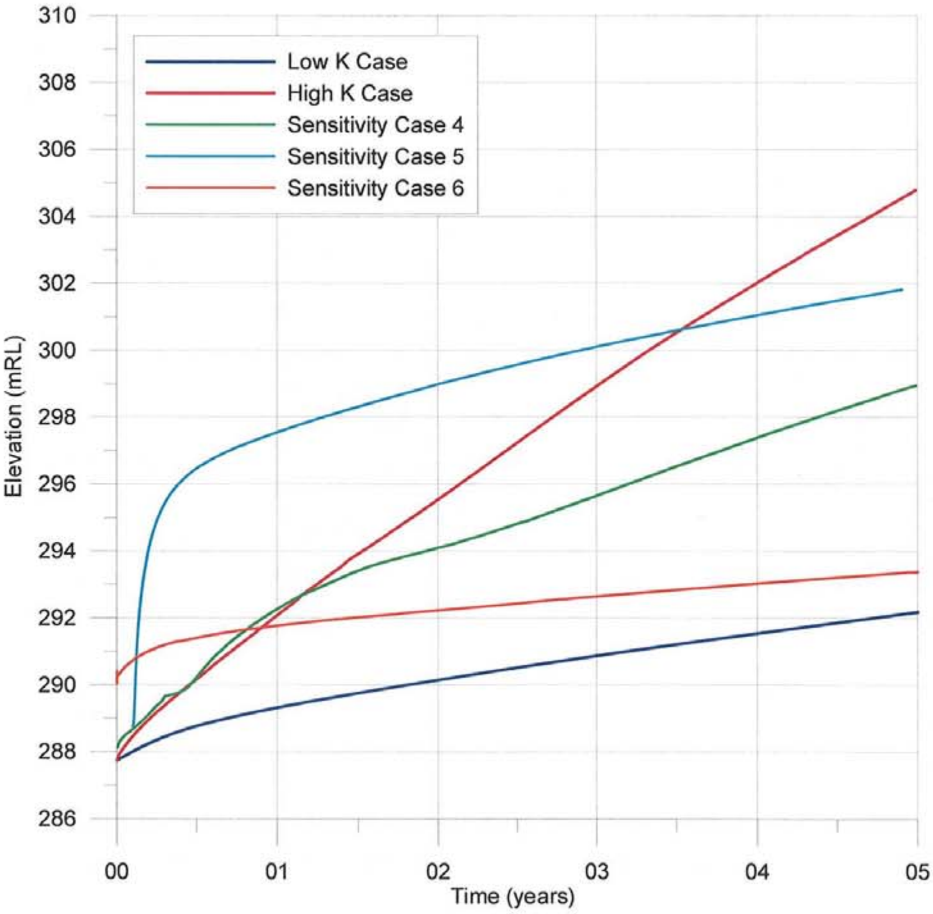

Golder Associates

CLIENT GeoTerra Pty Ltd

PROJECT Sunnyside Coal Project

DRAWN PN DATE Mar 2008

CHECKED EW DATE Mar 2008

TITLE **MODELLED WATER LEVEL RECOVERY WITHIN PIT VOID**

SCALE As Shown

PROJECT No 008-06636017 FIGURE No **46** REV No **0** **A4**

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Appendix 6

Old Gunnedah No 5 Underground Mine Void Assessment

(No. of pages excluding this page = 20)

Note: This Appendix is presented in full on the CD for the Sunnyside Coal Project

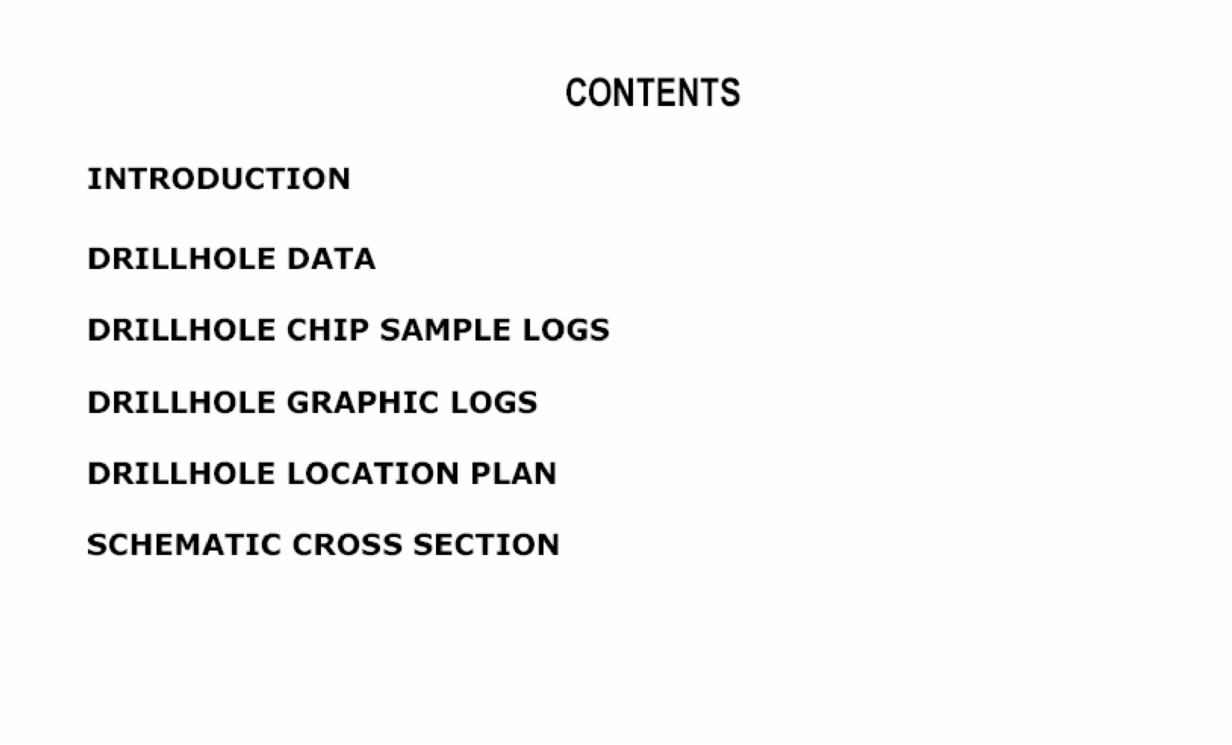
Sunnyside EL 5183
Groundwater Level Drilling 2007
Revised Data Report

Prepared by:

Jeff Beckett
Belford Dome Resource Assessment

October 2007

GeoTerra Pty Ltd



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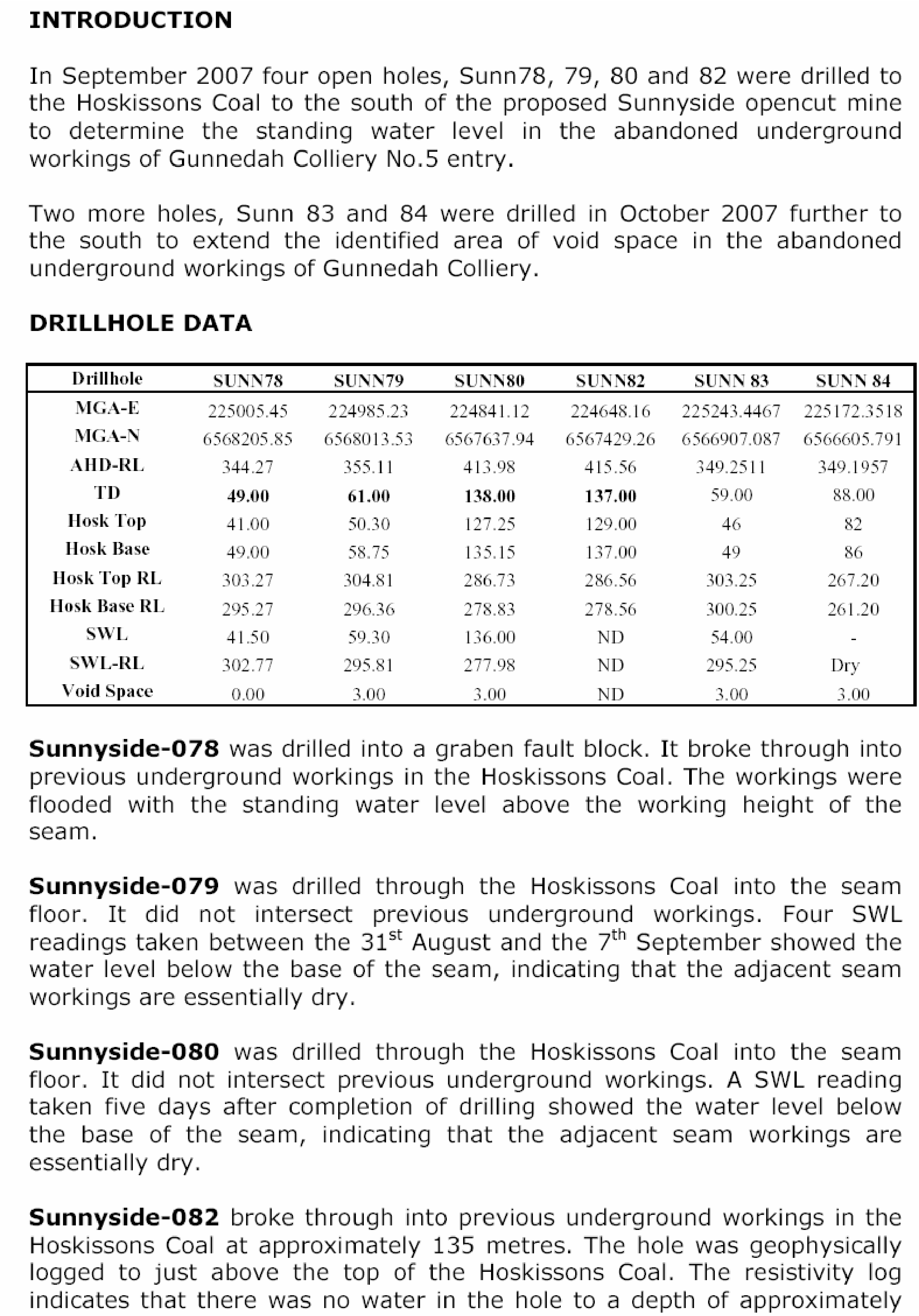


INTRODUCTION

In September 2007 four open holes, Sunn78, 79, 80 and 82 were drilled to the Hoskissons Coal to the south of the proposed Sunnyside opencut mine to determine the standing water level in the abandoned underground workings of Gunnedah Colliery No.5 entry.

Two more holes, Sunn 83 and 84 were drilled in October 2007 further to the south to extend the identified area of void space in the abandoned underground workings of Gunnedah Colliery.

DRILLHOLE DATA

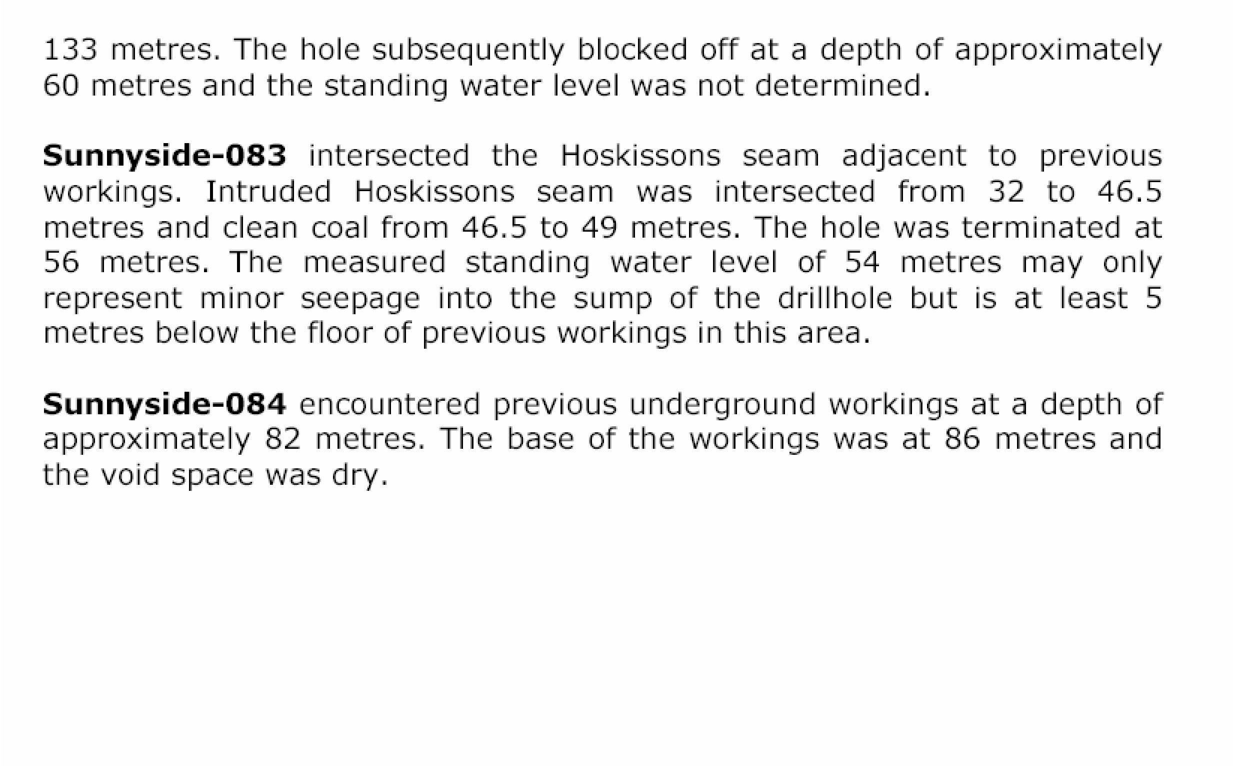
Drillhole	SUNN78	SUNN79	SUNN80	SUNN82	SUNN 83	SUNN 84
MGA-E	225005.45	224985.23	224841.12	224648.16	225243.4467	225172.3518
MGA-N	6568205.85	6568013.53	6567637.94	6567429.26	6566907.087	6566605.791
AHD-RL	344.27	355.11	413.98	415.56	349.2511	349.1957
TD	**49.00**	**61.00**	**138.00**	**137.00**	59.00	88.00
Hosk Top	41.00	50.30	127.25	129.00	46	82
Hosk Base	49.00	58.75	135.15	137.00	49	86
Hosk Top RL	303.27	304.81	286.73	286.56	303.25	267.20
Hosk Base RL	295.27	296.36	278.83	278.56	300.25	261.20
SWL	41.50	59.30	136.00	ND	54.00	-
SWL-RL	302.77	295.81	277.98	ND	295.25	Dry
Void Space	0.00	3.00	3.00	ND	3.00	3.00

Sunnyside-078 was drilled into a graben fault block. It broke through into previous underground workings in the Hoskissons Coal. The workings were flooded with the standing water level above the working height of the seam.

Sunnyside-079 was drilled through the Hoskissons Coal into the seam floor. It did not intersect previous underground workings. Four SWL readings taken between the 31st August and the 7th September showed the water level below the base of the seam, indicating that the adjacent seam workings are essentially dry.

Sunnyside-080 was drilled through the Hoskissons Coal into the seam floor. It did not intersect previous underground workings. A SWL reading taken five days after completion of drilling showed the water level below the base of the seam, indicating that the adjacent seam workings are essentially dry.

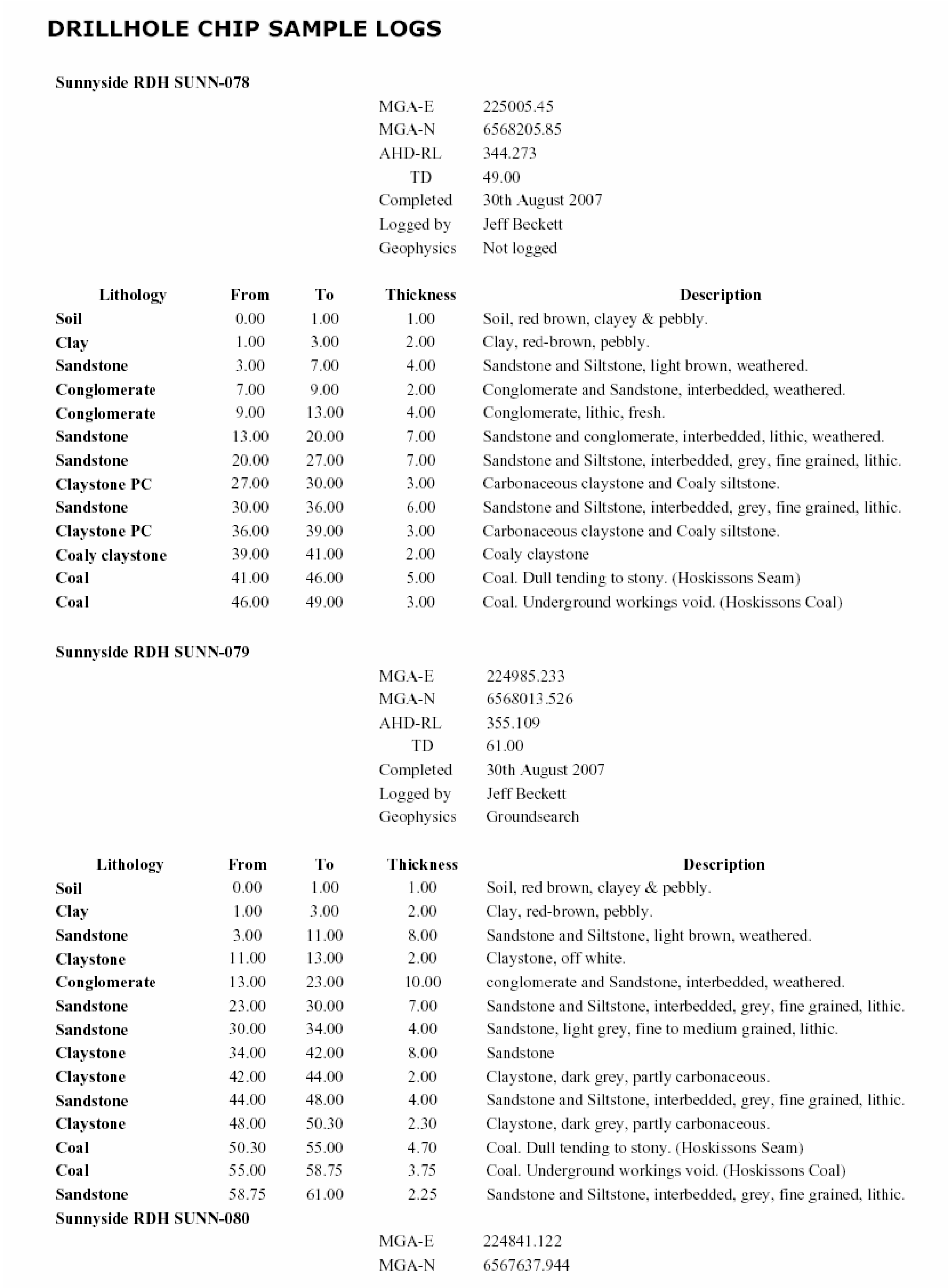
Sunnyside-082 broke through into previous underground workings in the Hoskissons Coal at approximately 135 metres. The hole was geophysically logged to just above the top of the Hoskissons Coal. The resistivity log indicates that there was no water in the hole to a depth of approximately



133 metres. The hole subsequently blocked off at a depth of approximately 60 metres and the standing water level was not determined.

Sunnyside-083 intersected the Hoskissons seam adjacent to previous workings. Intruded Hoskissons seam was intersected from 32 to 46.5 metres and clean coal from 46.5 to 49 metres. The hole was terminated at 56 metres. The measured standing water level of 54 metres may only represent minor seepage into the sump of the drillhole but is at least 5 metres below the floor of previous workings in this area.

Sunnyside-084 encountered previous underground workings at a depth of approximately 82 metres. The base of the workings was at 86 metres and the void space was dry.



DRILLHOLE CHIP SAMPLE LOGS

Sunnyside RDH SUNN-078

MGA-E	225005.45
MGA-N	6568205.85
AHD-RL	344.273
TD	49.00
Completed	30th August 2007
Logged by	Jeff Beckett
Geophysics	Not logged

Lithology	From	To	Thickness	Description
Soil	0.00	1.00	1.00	Soil, red brown, clayey & pebbly.
Clay	1.00	3.00	2.00	Clay, red-brown, pebbly.
Sandstone	3.00	7.00	4.00	Sandstone and Siltstone, light brown, weathered.
Conglomerate	7.00	9.00	2.00	Conglomerate and Sandstone, interbedded, weathered.
Conglomerate	9.00	13.00	4.00	Conglomerate, lithic, fresh.
Sandstone	13.00	20.00	7.00	Sandstone and conglomerate, interbedded, lithic, weathered.
Sandstone	20.00	27.00	7.00	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.
Claystone PC	27.00	30.00	3.00	Carbonaceous claystone and Coaly siltstone.
Sandstone	30.00	36.00	6.00	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.
Claystone PC	36.00	39.00	3.00	Carbonaceous claystone and Coaly siltstone.
Coaly claystone	39.00	41.00	2.00	Coaly claystone
Coal	41.00	46.00	5.00	Coal. Dull tending to stony. (Hoskissons Seam)
Coal	46.00	49.00	3.00	Coal. Underground workings void. (Hoskissons Coal)

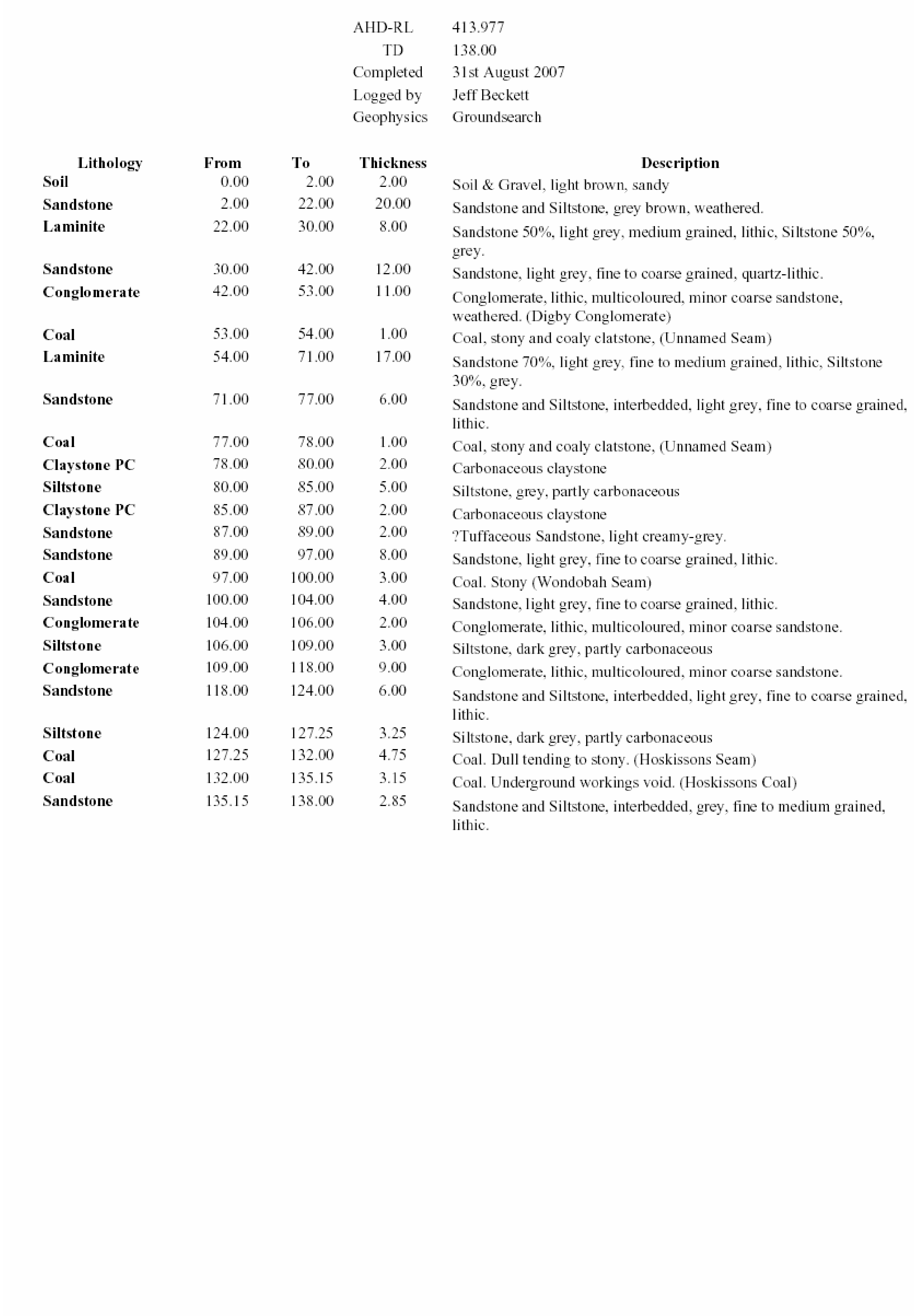
Sunnyside RDH SUNN-079

MGA-E	224985.233
MGA-N	6568013.526
AHD-RL	355.109
TD	61.00
Completed	30th August 2007
Logged by	Jeff Beckett
Geophysics	Groundsearch

Lithology	From	To	Thickness	Description
Soil	0.00	1.00	1.00	Soil, red brown, clayey & pebbly.
Clay	1.00	3.00	2.00	Clay, red-brown, pebbly.
Sandstone	3.00	11.00	8.00	Sandstone and Siltstone, light brown, weathered.
Claystone	11.00	13.00	2.00	Claystone, off white.
Conglomerate	13.00	23.00	10.00	conglomerate and Sandstone, interbedded, weathered.
Sandstone	23.00	30.00	7.00	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.
Sandstone	30.00	34.00	4.00	Sandstone, light grey, fine to medium grained, lithic.
Claystone	34.00	42.00	8.00	Sandstone
Claystone	42.00	44.00	2.00	Claystone, dark grey, partly carbonaceous.
Sandstone	44.00	48.00	4.00	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.
Claystone	48.00	50.30	2.30	Claystone, dark grey, partly carbonaceous.
Coal	50.30	55.00	4.70	Coal. Dull tending to stony. (Hoskissons Seam)
Coal	55.00	58.75	3.75	Coal. Underground workings void. (Hoskissons Coal)
Sandstone	58.75	61.00	2.25	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.

Sunnyside RDH SUNN-080

MGA-E	224841.122
MGA-N	6567637.944



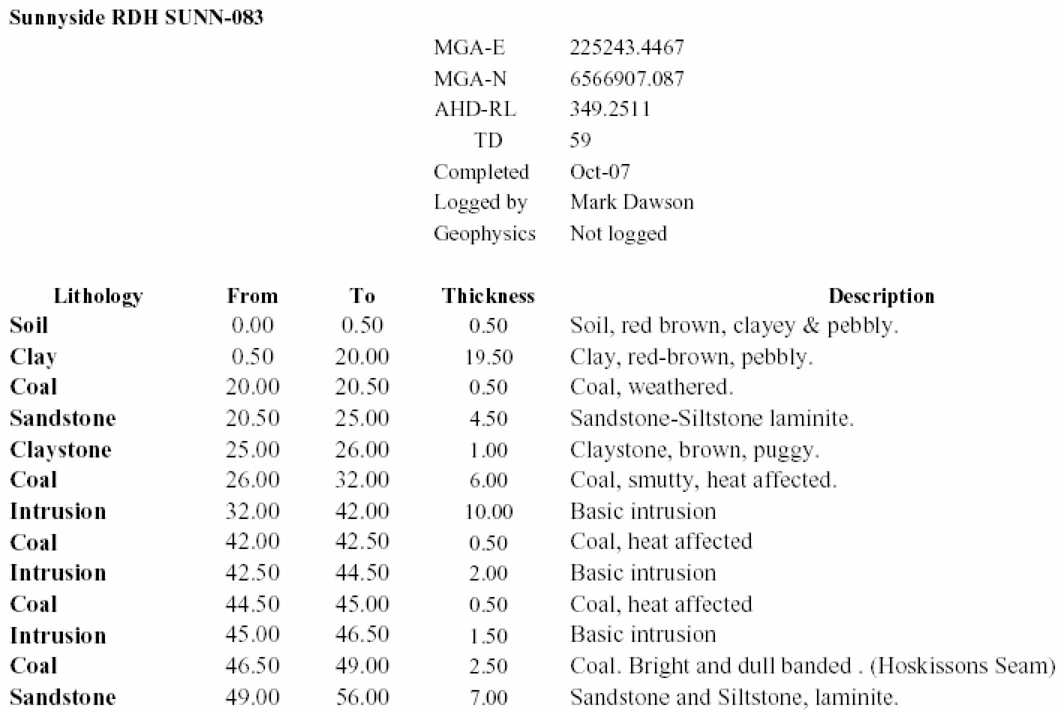
AHD-RL	413.977
TD	138.00
Completed	31st August 2007
Logged by	Jeff Beckett
Geophysics	Groundsearch

Lithology	From	To	Thickness	Description
Soil	0.00	2.00	2.00	Soil & Gravel, light brown, sandy
Sandstone	2.00	22.00	20.00	Sandstone and Siltstone, grey brown, weathered.
Laminite	22.00	30.00	8.00	Sandstone 50%, light grey, medium grained, lithic, Siltstone 50%, grey.
Sandstone	30.00	42.00	12.00	Sandstone, light grey, fine to coarse grained, quartz-lithic.
Conglomerate	42.00	53.00	11.00	Conglomerate, lithic, multicoloured, minor coarse sandstone, weathered. (Digby Conglomerate)
Coal	53.00	54.00	1.00	Coal, stony and coaly clatstone, (Unnamed Seam)
Laminite	54.00	71.00	17.00	Sandstone 70%, light grey, fine to medium grained, lithic, Siltstone 30%, grey.
Sandstone	71.00	77.00	6.00	Sandstone and Siltstone, interbedded, light grey, fine to coarse grained, lithic.
Coal	77.00	78.00	1.00	Coal, stony and coaly clatstone, (Unnamed Seam)
Claystone PC	78.00	80.00	2.00	Carbonaceous claystone
Siltstone	80.00	85.00	5.00	Siltstone, grey, partly carbonaceous
Claystone PC	85.00	87.00	2.00	Carbonaceous claystone
Sandstone	87.00	89.00	2.00	?Tuffaceous Sandstone, light creamy-grey.
Sandstone	89.00	97.00	8.00	Sandstone, light grey, fine to coarse grained, lithic.
Coal	97.00	100.00	3.00	Coal. Stony (Wondobah Seam)
Sandstone	100.00	104.00	4.00	Sandstone, light grey, fine to coarse grained, lithic.
Conglomerate	104.00	106.00	2.00	Conglomerate, lithic, multicoloured, minor coarse sandstone.
Siltstone	106.00	109.00	3.00	Siltstone, dark grey, partly carbonaceous
Conglomerate	109.00	118.00	9.00	Conglomerate, lithic, multicoloured, minor coarse sandstone.
Sandstone	118.00	124.00	6.00	Sandstone and Siltstone, interbedded, light grey, fine to coarse grained, lithic.
Siltstone	124.00	127.25	3.25	Siltstone, dark grey, partly carbonaceous
Coal	127.25	132.00	4.75	Coal. Dull tending to stony. (Hoskissons Seam)
Coal	132.00	135.15	3.15	Coal. Underground workings void. (Hoskissons Coal)
Sandstone	135.15	138.00	2.85	Sandstone and Siltstone, interbedded, grey, fine to medium grained, lithic.

Sunnyside RDH SUNN-082

MGA-E	224648.156
MGA-N	6567429.258
AHD-RL	415.564
TD	135.00
Completed	3rd September 2007
Logged by	Mark Dawson
Geophysics	Groundsearch

Lithology	From	To	Thickness	Description
Soil	0.00	1.00	1.00	Soil, light brown, sandy
Siltstone	1.00	5.00	4.00	Siltstone, grey brown, partly weathered.
Siltstone	5.00	8.00	3.00	Siltstone, grey.
Sandstone	8.00	20.00	12.00	Sandstone, light grey to light brown, fine to coarse grained, quartz-lithic.
Conglomerate	20.00	38.00	18.00	Conglomerate, lithic, multicoloured, minor coarse sandstone, weathered. (Digby Conglomerate)
Siltstone	38.00	39.00	1.00	Siltstone, orange, weathered
Siltstone	39.00	40.00	1.00	Siltstone, grey.
Coal	40.00	41.00	1.00	Coal tending to carbonaceous claystone
Laminite	41.00	50.00	9.00	Sandstone 50%, light grey, fine to medium grained, lithic-tuffaceous, siltstone 50%, grey.
Sandstone	50.00	56.00	6.00	Sandstone, light grey, fine to coarse grained, lithic.
Tuff	56.00	58.02	2.02	Tuff, light green-grey
Coal	58.02	59.18	1.16	Coal. Stony (Unnamed Seam)
Claystone PC	59.18	60.00	0.82	Carbonaceous claystone
Conglomerate	60.00	75.00	15.00	Conglomerate, lithic, multicoloured, minor coarse sandstone.
Tuff	75.00	76.32	1.32	Tuff, light green-grey, may be tuffaceous sandstone.
Coal	76.32	77.68	1.36	Coal. Stony (Unnamed Seam)
Siltstone	77.68	79.00	1.32	Siltstone, grey, partly carbonaceous
Laminite	79.00	80.50	1.50	Sandstone 50%, light grey, fine to medium grained, lithic, siltstone 50%, grey.
Tuff	80.50	83.00	2.50	Tuff, light green-grey, may be tuffaceous sandstone.
Siltstone	83.00	84.00	1.00	Siltstone, grey, partly carbonaceous
Laminite	84.00	87.00	3.00	Sandstone 50%, light grey, fine to medium grained, lithic, siltstone 50%, grey.
Conglomerate	87.00	96.00	9.00	Conglomerate, lithic, multicoloured, minor coarse sandstone.
Tuff	96.00	98.20	2.20	Tuff, light green-grey
Coal	98.20	101.12	2.92	Coal. Stony (Wondoba Seam)
Siltstone	101.12	103.00	1.88	Siltstone, grey, partly carbonaceous
Sandstone	103.00	110.48	7.48	Sandstone, light grey, fine to coarse grained, lithic.
Coal	110.48	111.91	1.43	Coal. Stony (Unnamed Seam)
Laminite	111.91	129.00	17.09	Sandstone 50%, light grey, fine to medium grained, lithic, siltstone 50%, grey.
Coal	129.00	135.00	6.00	Coal. Dull tending to stony. (Hoskissons Seam)
Coal	135.00	137.00	2.00	Coal. Underground workings void. (Hoskissons Coal)



Sunnyside RDH SUNN-083

MGA-E	225243.4467
MGA-N	6566907.087
AHD-RL	349.2511
TD	59
Completed	Oct-07
Logged by	Mark Dawson
Geophysics	Not logged

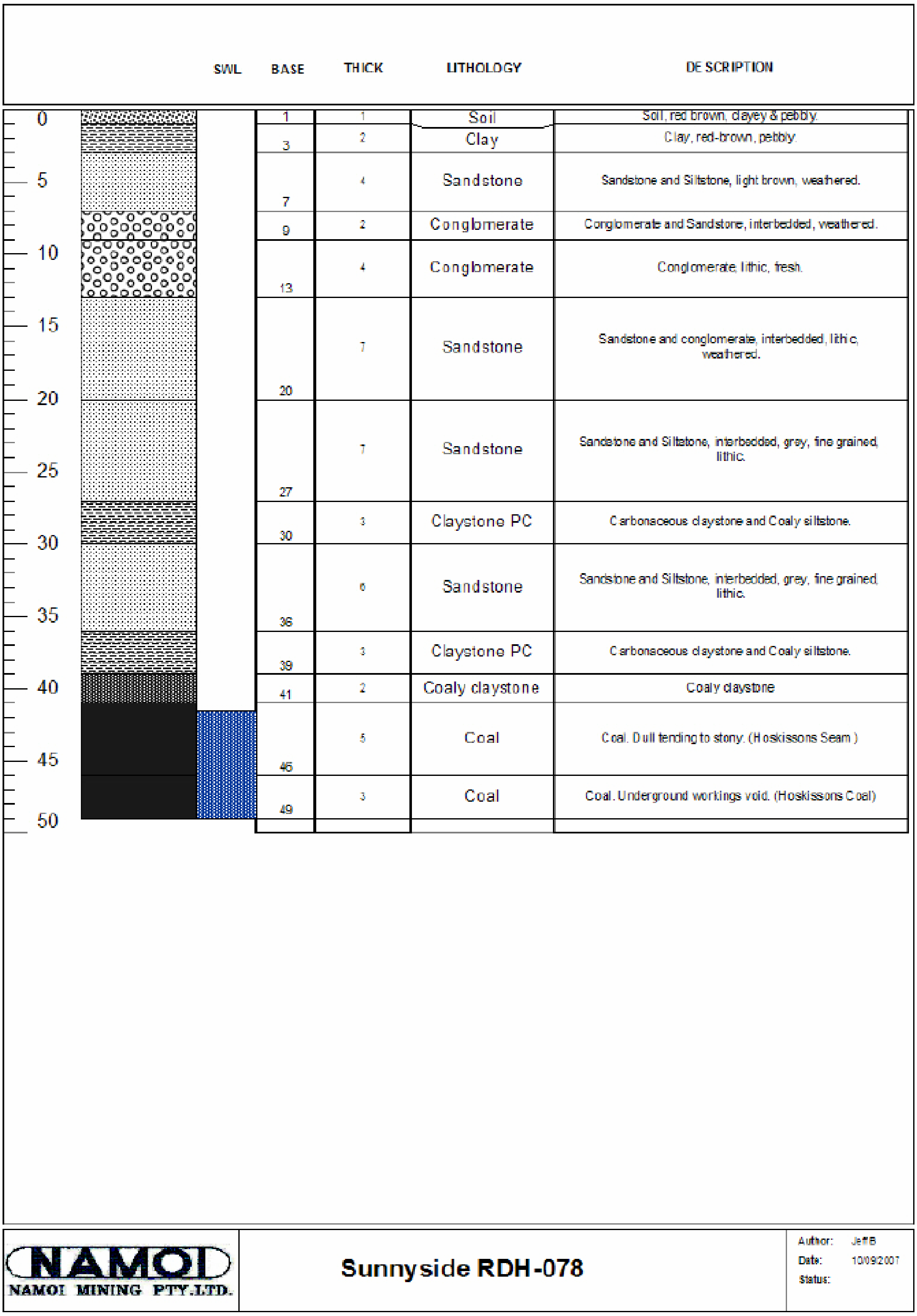
Lithology	From	To	Thickness	Description
Soil	0.00	0.50	0.50	Soil, red brown, clayey & pebbly.
Clay	0.50	20.00	19.50	Clay, red-brown, pebbly.
Coal	20.00	20.50	0.50	Coal, weathered.
Sandstone	20.50	25.00	4.50	Sandstone-Siltstone laminite.
Claystone	25.00	26.00	1.00	Claystone, brown, puggy.
Coal	26.00	32.00	6.00	Coal, smutty, heat affected.
Intrusion	32.00	42.00	10.00	Basic intrusion
Coal	42.00	42.50	0.50	Coal, heat affected
Intrusion	42.50	44.50	2.00	Basic intrusion
Coal	44.50	45.00	0.50	Coal, heat affected
Intrusion	45.00	46.50	1.50	Basic intrusion
Coal	46.50	49.00	2.50	Coal. Bright and dull banded . (Hoskissons Seam)
Sandstone	49.00	56.00	7.00	Sandstone and Siltstone, laminite.

Sunnyside RDH SUNN-084

MGA-E	225172.35
MGA-N	6566605.79
AHD-RL	349.20
TD	88.00
Completed	Óctober 2007
Logged by	Mark Dawson
Geophysics	Not logged

Lithology	From	To	Thickness	Description
Soil	0.00	1.00	1.00	Soil, red brown, clayey & pebbly.
Clay	1.00	14.00	13.00	Clay, red-brown, sandy.
Conglomerate	14.00	20.00	6.00	Pebble Conglomerate. weathered.
Sandstone	20.00	29.00	9.00	Sandstone-Siltstone laminite
Coal	29.00	31.00	2.00	Coal.
Claystone	31.00	32.00	1.00	Claystone, tuffaceous.
Coal	32.00	33.00	1.00	Coal.
Sandstone	33.00	38.00	5.00	Sandstone-Siltstone laminite
Conglomerate	38.00	42.50	4.50	Pebble Conglomerate.
Coal	42.50	43.00	0.50	Coal.
Claystone	43.00	44.00	1.00	Carbonaceous Claystone.
Sandstone	44.00	46.00	2.00	Sandstone-Siltstone laminite
Sandstone	46.00	50.00	4.00	Sandstone.
Coal	50.00	52.00	2.00	Coal
Claystone	52.00	53.00	1.00	Carbonaceous Claystone.
Siltstone	53.00	55.00	2.00	Siltstone
Sandstone	55.00	63.00	8.00	Sandstone-Siltstone laminite
Coal	63.00	65.00	2.00	Coal
Claystone	65.00	66.00	1.00	Carbonaceous Claystone.
Sandstone	66.00	74.00	8.00	Sandstone-Siltstone laminite
Conglomerate	74.00	76.00	2.00	Pebble Conglomerate.
Sandstone	76.00	77.00	1.00	Sandstone-Siltstone laminite
Coal	77.00	86.00	9.00	No sample, workings from approx. 82 metres

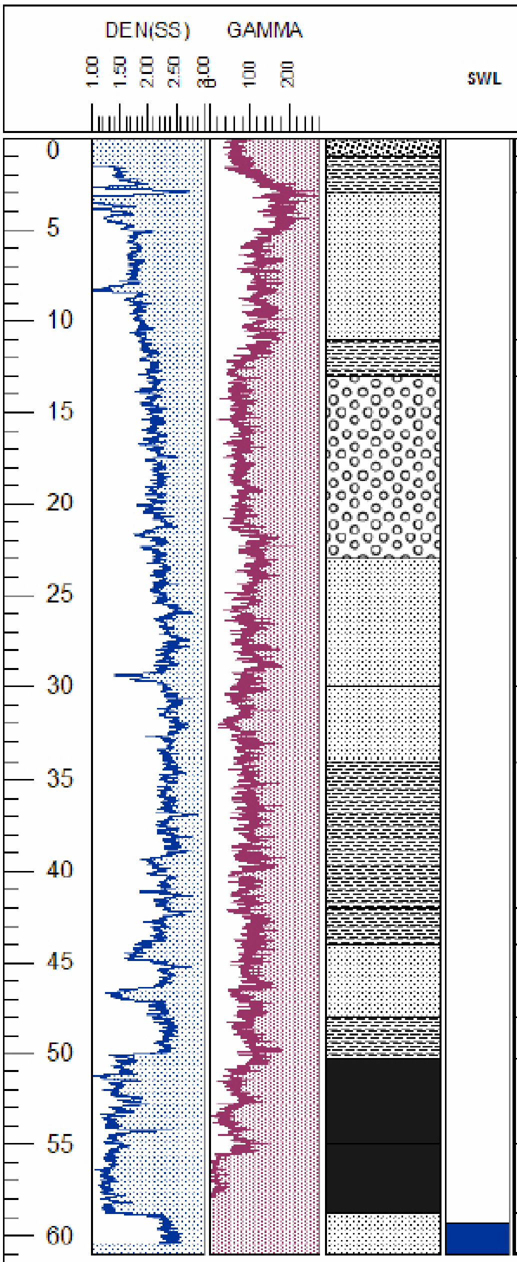
DRILLHOLE GRAPHIC LOGS



BASE	THICK	LITHOLOGY	DESCRIPTION
1	1	Soil	Soil, red brown, clayey & pebbly.
3	2	Clay	Clay, red-brown, pebbly.
7	4	Sandstone	Sandstone and Siltstone, light brown, weathered.
9	2	Conglomerate	Conglomerate and Sandstone, interbedded, weathered.
13	4	Conglomerate	Conglomerate, lithic, fresh.
20	7	Sandstone	Sandstone and conglomerate, interbedded, lithic, weathered.
27	7	Sandstone	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.
30	3	Claystone PC	Carbonaceous claystone and Coaly siltstone.
36	6	Sandstone	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.
39	3	Claystone PC	Carbonaceous claystone and Coaly siltstone.
41	2	Coaly claystone	Coaly claystone
46	5	Coal	Coal. Dull tending to stony. (Hoskissons Seam)
49	3	Coal	Coal. Underground workings void. (Hoskissons Coal)

Sunnyside RDH-078

Author: JeffB
Date: 10/09/2007
Status:



BASE	THICK	LITHOLOGY	DESCRIPTION
1	1	Soil	Soil, red brown, clayey & pebbly.
3	2	Clay	Clay, red-brown, pebbly
11	8	Sandstone	Sandstone and Siltstone, light brown, weathered.
13	2	Claystone	Claystone, off white.
23	10	Conglomerate	conglomerate and Sandstone, interbedded, weathered.
30	7	Sandstone	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.
34	4	Sandstone	Sandstone, light grey, fine to mediumgrained, lithic.
42	8	Claystone	Sandstone
44	2	Claystone	Claystone, dark grey partlycarbonaceous.
48	4	Sandstone	Sandstone and Siltstone, interbedded, grey, fine grained, lithic.
50.3	2.3	Claystone	Claystone. dark grey partlycarbonaceous.
55	4.7	Coal	Coal. Dull tending to stony. (Hoskissons Seam)
58.75	3.75	Coal	Coal. Underground workings void. (Hoskissons Coal)
61	2.25	Sandstone	Sandstone and Siltstone, interbedded. grey fine to medium grained, lithic.

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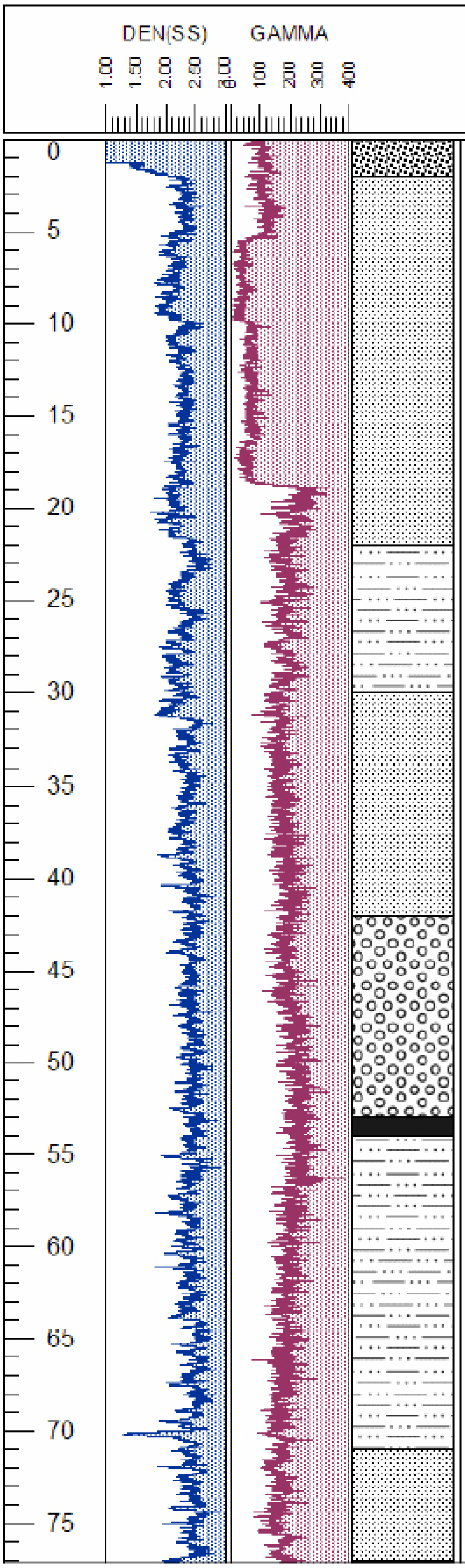
Sunnyside RDH-079

Author: JeffB
Date: 10/09/2007
Status:



SWL	BASE	THICK	LITHOLOGY	DESCRIPTION
	2	2	Soil	Soil & Gravel, light brown, sandy
	22	20	Sandstone	Sandstone and Siltstone, greybrown, weathered.
	30	8	Laminite	Sandstone 50%, light grey, fine to medium grained. lithic-tuffaceous, siltstone 50%, grey.
	42	12	Sandstone	Sandstone, light grey to light brown, fine to coarse grained, quartz-lithic.
	53	11	Conglomerate	Conglomerate, lithic, multicoloured, minor coarse sandstone, weathered. (Digby Conglomerate)
	54	1	Coal	Coal, stony and coaly siltstone, (Unnamed Seam)
	71	17	Laminite	Sandstone 70%, light grey, fine to medium grained, lithic, Siltstone 30%, grey.
	77	6	Sandstone	Sandstone and Siltstone, interbedded, light grey, fine to coarse grained, lithic.

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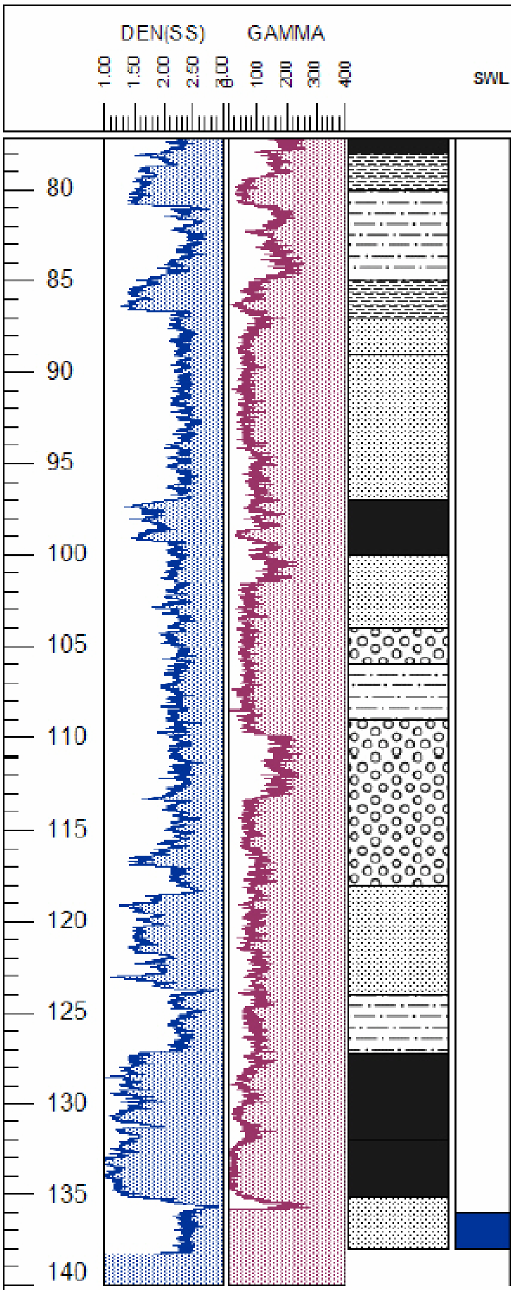
Sunnyside RDH-080

Author: Jeff B
Date: 10/09/2007
Status:



BASE	THICK	LITHOLOGY	DESCRIPTION
78	1	Coal	Coal, stony and coaly claystone, (Unnamed Seam)
80	2	Claystone PC	Carbonaceous claystone
85	5	Siltstone	Siltstone, grey, partly carbonaceous
87	2	Claystone PC	Carbonaceous claystone
89	2	Sandstone	? Tuffaceous Sandstone, light creamy grey.
97	8	Sandstone	Sandstone, light grey, fine to coarse grained, lithic.
100	3	Coal	Coal. Stony (Wondobah Seam)
104	4	Sandstone	Sandstone, light grey, fine to coarse grained, lithic.
106	2	Conglomerate	Conglomerate, lithic, multicoloured, minor coarse sandstone.
109	3	Siltstone	Siltstone, dark grey, partly carbonaceous
118	9	Conglomerate	Conglomerate, lithic, multicoloured, minor coarse sandstone.
124	6	Sandstone	Sandstone and Siltstone, interbedded, light grey, fine to coarse grained, lithic.
127.25	3.25	Siltstone	Siltstone, grey, partly carbonaceous
132	4.75	Coal	Coal. Dull tending to stony. (Hoskissons Coal)
135.15	3.15	Coal	Coal (Hoskissons Coal)
138	2.85	Sandstone	Sandstone and Siltstone, interbedded, grey, fine to medium grained, lithic.

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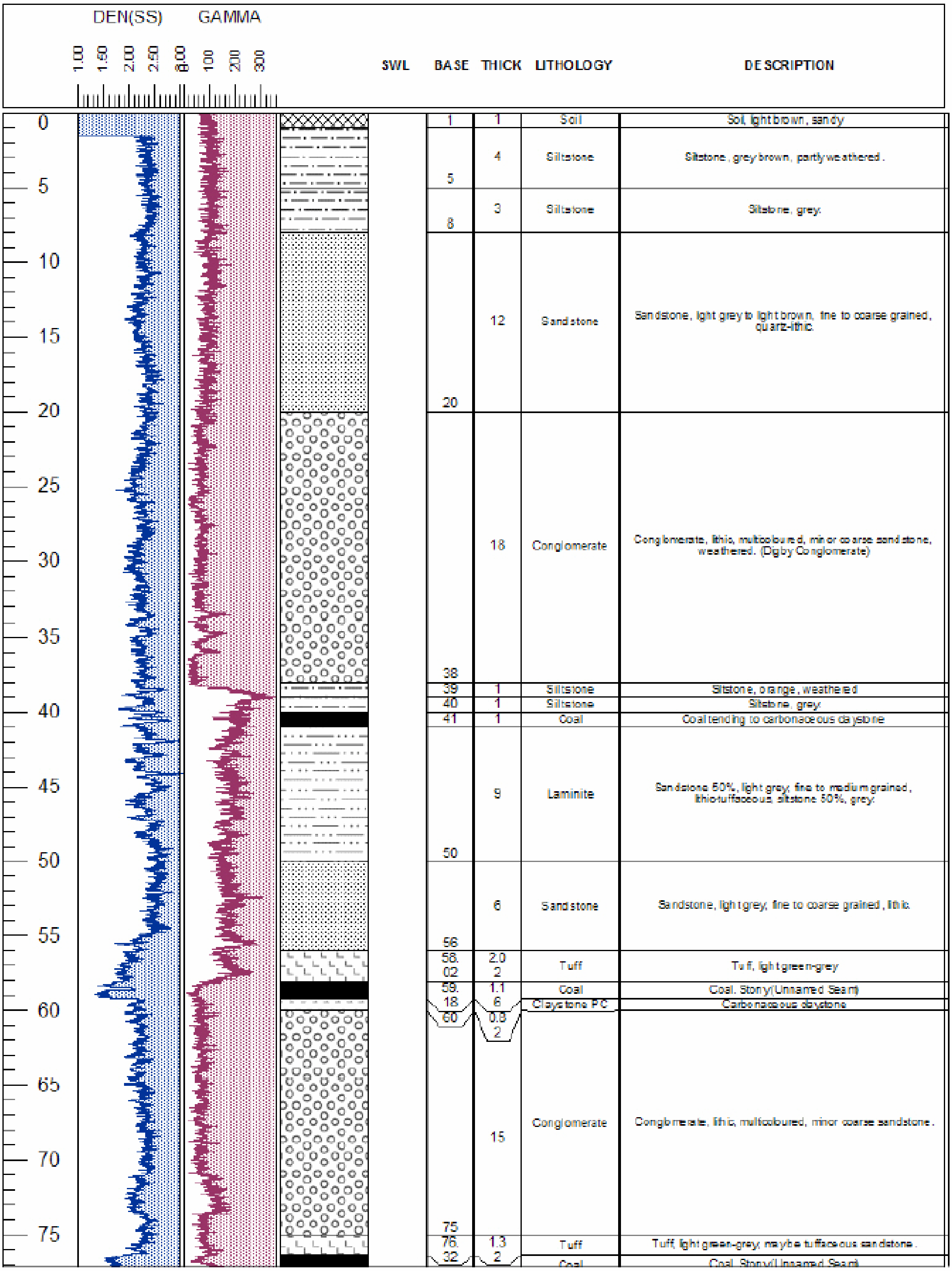
Sunnyside RDH-080

Author: Jeff B
Date: 10/09/2007
Status:



SWL	BASE	THICK	LITHOLOGY	DESCRIPTION
	1	1	Soil	Soil, light brown, sandy
	5	4	Siltstone	Siltstone, grey brown, partly weathered.
	8	3	Siltstone	Siltstone, grey.
	20	12	Sandstone	Sandstone, light grey to light brown, fine to coarse grained, quartz-lithic.
	38	18	Conglomerate	Conglomerate, lithic, multicoloured, minor coarse sandstone, weathered. (Digby Conglomerate)
	39	1	Siltstone	Siltstone, orange, weathered
	40	1	Siltstone	Siltstone, grey.
	41	1	Coal	Coal tending to carbonaceous claystone
	50	9	Laminite	Sandstone 50%, light grey, fine to medium grained, lithic-tuffaceous, siltstone 50%, grey.
	56	6	Sandstone	Sandstone, light grey, fine to coarse grained, lithic.
	58.02	2.02	Tuff	Tuff, light green-grey
	59.18	1.16	Coal	Coal. Stony(Unnamed Seam)
	60	0.82	Claystone PC	Carbonaceous claystone
	75	15	Conglomerate	Conglomerate, lithic, multicoloured, minor coarse sandstone.
	76.32	1.32	Tuff	Tuff, light green-grey, maybe tuffaceous sandstone.
			Coal	Coal. Stony(Unnamed Seam)

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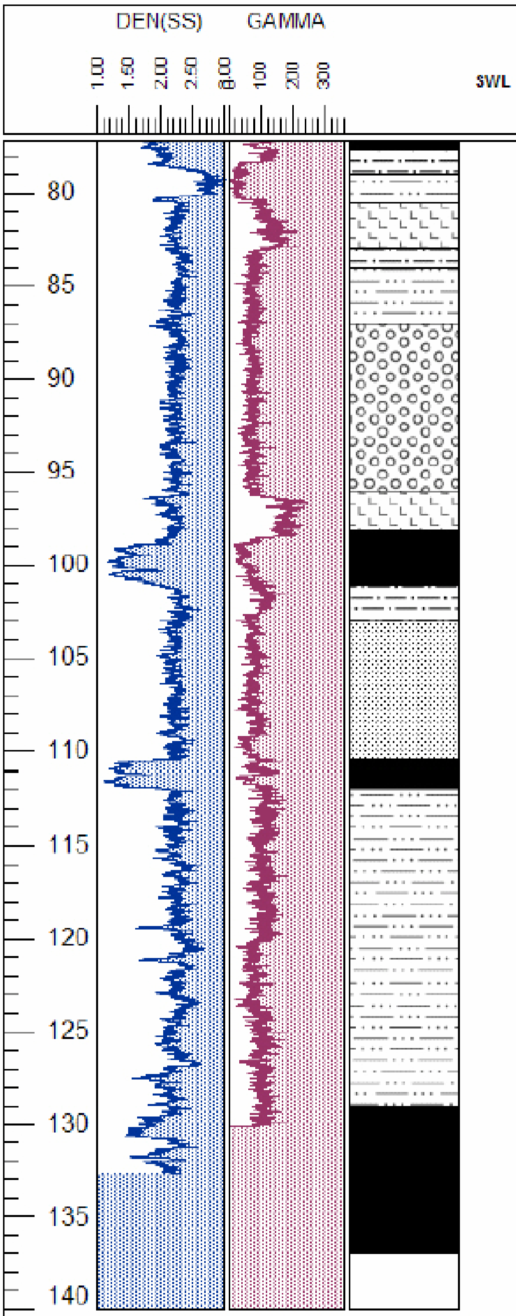
Sunnyside RDH-082

Author: JeffB
Date: 10/09/2007
Status:



BASE	THICK	LITHOLOGY	DESCRIPTION
77. 68	1.3 6	Siltstone	Siltstone, grey, partly carbonaceous
79 80. 5	1.3 2 1.5	Laminite	Sandstone 50%, light grey, fine to medium grained, lithic, siltstone 50%, grey.
83	2.5	Tuff	Tuff, light green-grey, maybe tuffaceous sandstone.
84	1	Siltstone	Siltstone, grey, partly carbonaceous
87	3	Laminite	Sandstone 50%, light grey, fine to medium grained, lithic, siltstone 50%, grey.
96	9	Conglomerate	Conglomerate, lithic, multicoloured, minor coarse sandstone.
98. 2	2.2	Tuff	Tuff, light green-grey
101 .12	2.9 2	Coal	Coal. Stony(Wondoba Seam)
103	1.8 8	Siltstone	Siltstone. grey. partly carbonaceous
110 .48	7.4 8	Sandstone	Sandstone, light grey, fine to coarse grained, lithic.
111 .91	1.4 3	Coal	Coal. Stony(Unnamed Seam)
129	17. 09	Laminite	Sandstone 50%, light grey, fine to medium grained. lithic. siltstone 50%, grey.
135	6	Coal	Coal. Dull tending to stony. (Hoskissons Seam)
137	2	Coal	Coal. Underground workings void. (Hoskissons Coal)

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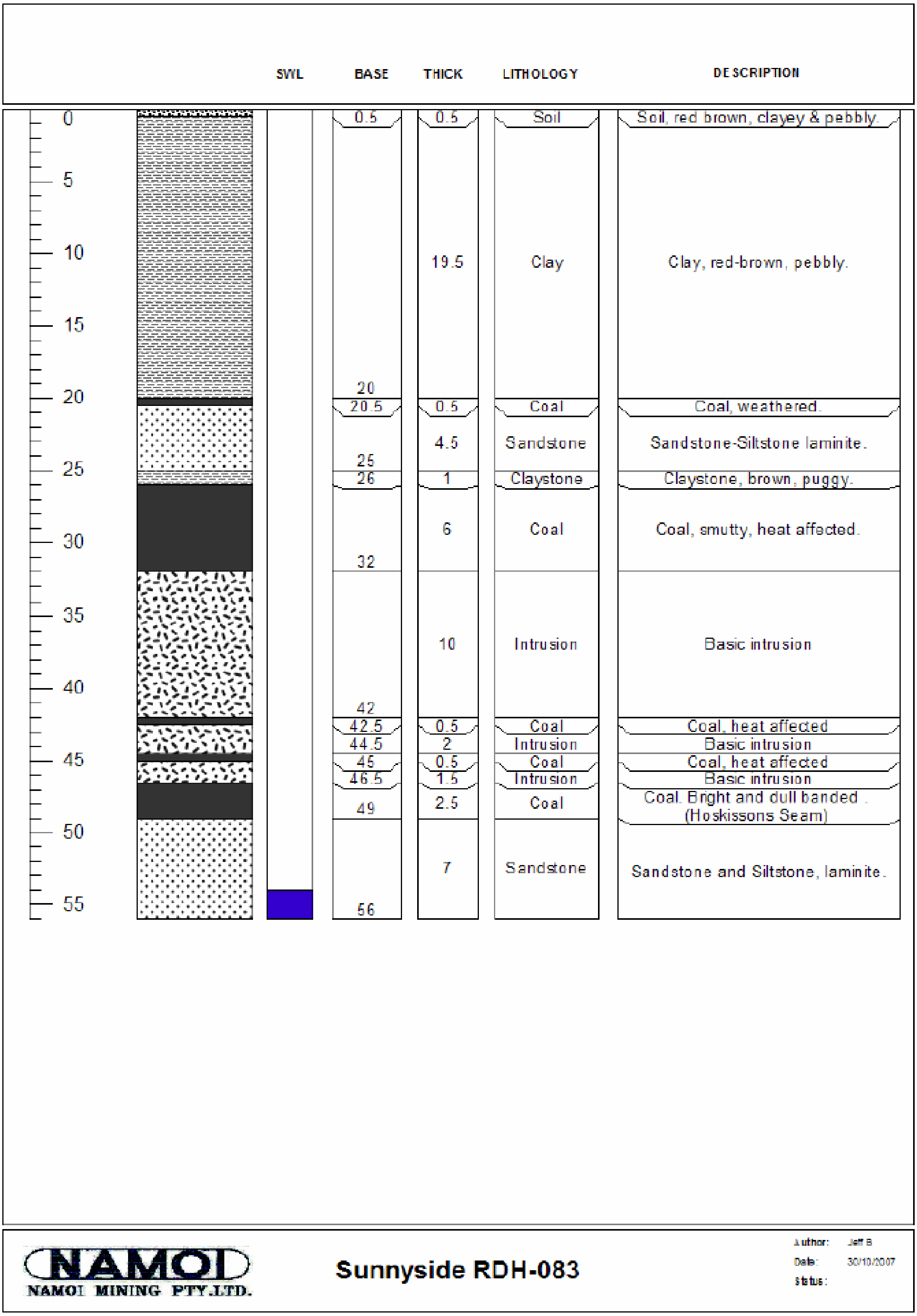
Sunnyside RDH-082

Author: JeffB
Date: 10/09/2007
Status:



BASE	THICK	LITHOLOGY	DESCRIPTION
0.5	0.5	Soil	Soil, red brown, clayey & pebbly.
20	19.5	Clay	Clay, red-brown, pebbly.
20.5	0.5	Coal	Coal, weathered.
25	4.5	Sandstone	Sandstone-Siltstone laminite.
26	1	Claystone	Claystone, brown, puggy.
32	6	Coal	Coal, smutty, heat affected.
42	10	Intrusion	Basic intrusion
42.5	0.5	Coal	Coal, heat affected
44.5	2	Intrusion	Basic intrusion
45	0.5	Coal	Coal, heat affected
46.5	1.5	Intrusion	Basic intrusion
49	2.5	Coal	Coal. Bright and dull banded . (Hoskissons Seam)
56	7	Sandstone	Sandstone and Siltstone, laminite.

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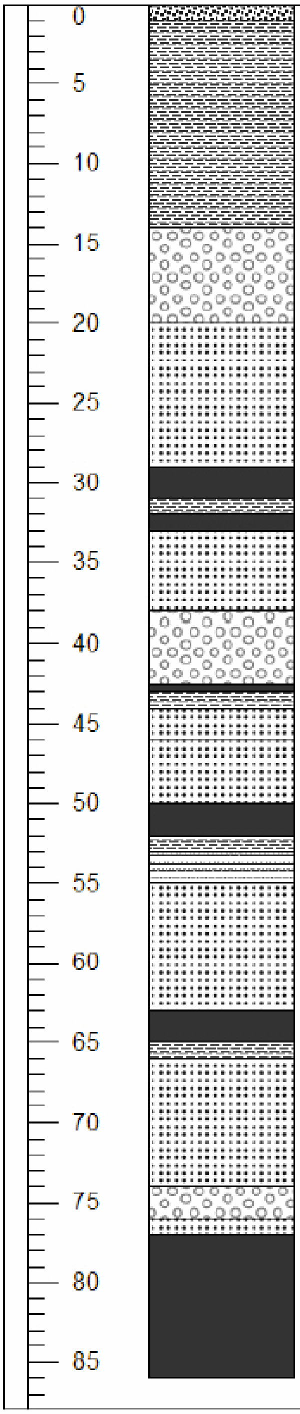
Sunnyside RDH-083

Author: Jeff B
Date: 30/10/2007
Status:



BASE	THICK	LITHOLOGY	DESCRIPTION
1	1	Soil	Soil, red brown, clayey & pebbly.
14	13	Clay	Clay, red-brown, sandy.
20	6	Conglomerate	Pebble Conglomerate. weathered.
29	9	Sandstone	Sandstone-Siltstone laminite
31	2	Coal	Coal.
32	1	Claystone	Claystone, tuffaceous.
33	1	Coal	Coal.
38	5	Sandstone	Sandstone-Siltstone laminite
42.5	4.5	Conglomerate	Pebble Conglomerate.
43	0.5	Coal	Coal
44	1	Claystone	Carbonaceous Claystone.
46	2	Sandstone	Sandstone-Siltstone laminite
50	4	Sandstone	Sandstone.
52	2	Coal	Coal
53	1	Claystone	Carbonaceous Claystone.
55	2	Siltstone	Siltstone
63	8	Sandstone	Sandstone-Siltstone laminite
65	2	Coal	Coal
66	1	Claystone	Carbonaceous Claystone.
74	8	Sandstone	Sandstone-Siltstone laminite
76	2	Conglomerate	Pebble Conglomerate.
77	1	Sandstone	Sandstone-Siltstone laminite
86	9	Coal	No sample, workings from approx. 82 metres

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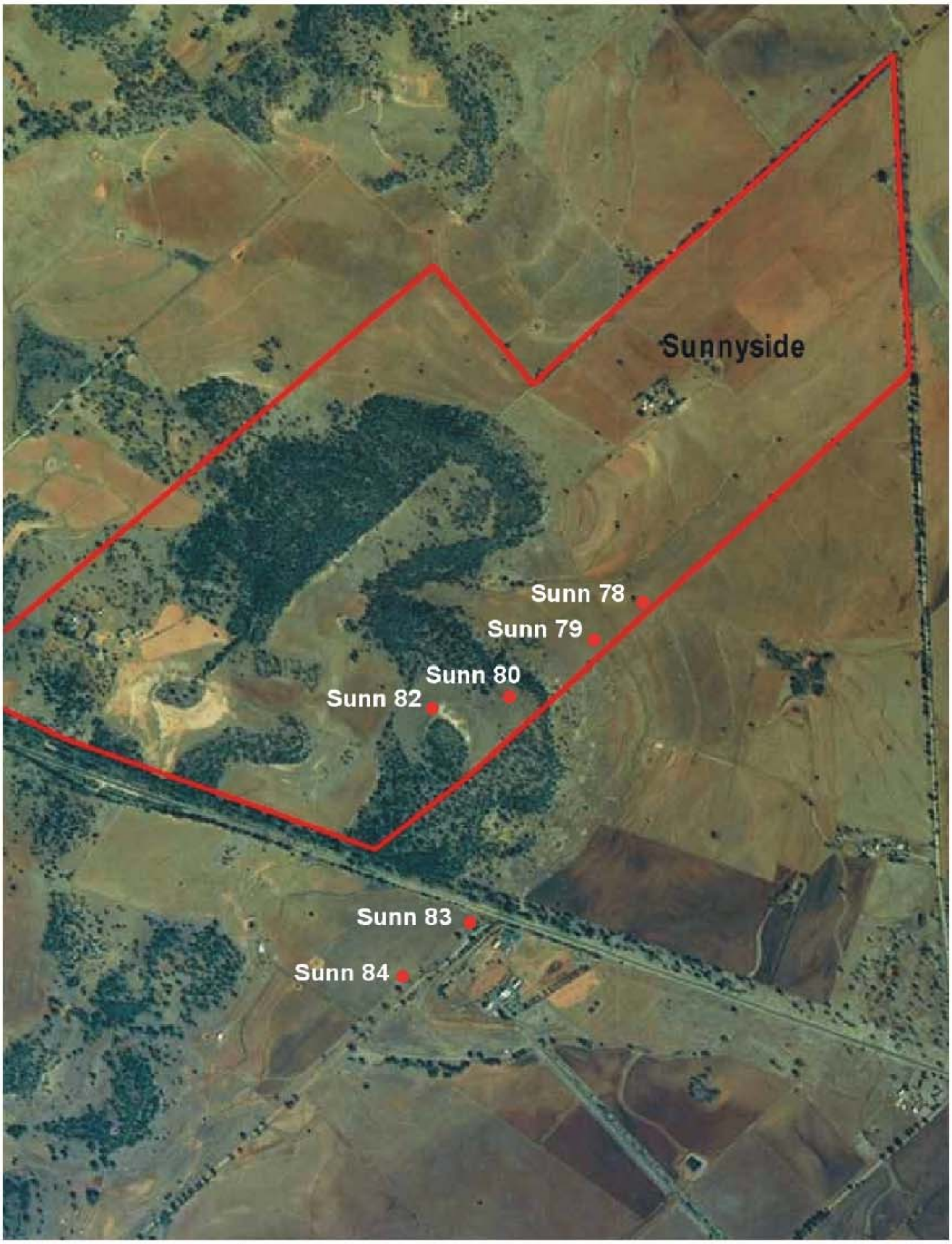
Sunnyside RDH-084

Author: JeffB
Date: 30/10/2007
Status:

DRILLHOLE LOCATION PLAN



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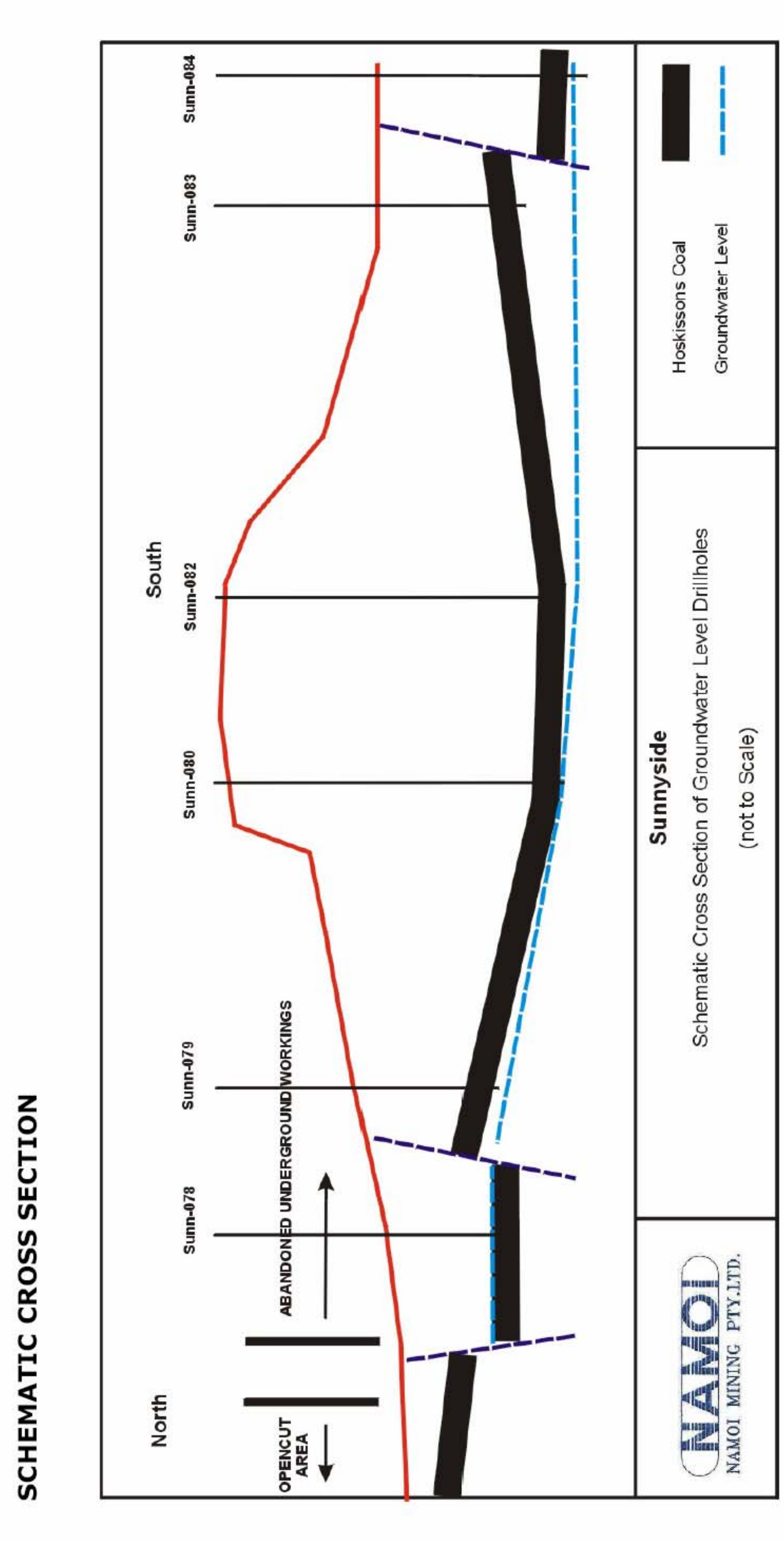
Sunnyside

Location of Groundwater Level Drillholes


SCHEMATIC CROSS SECTION
North
South
OPENCUT AREA
ABANDONED UNDERGROUND WORKINGS
Sunn-078
Sunn-079
Sunn-080
Sunn-082
Sunn-083
Sunn-084
Hoskissons Coal
Groundwater Level
Sunnyside
Schematic Cross Section of Groundwater Level Drillholes
(not to Scale)
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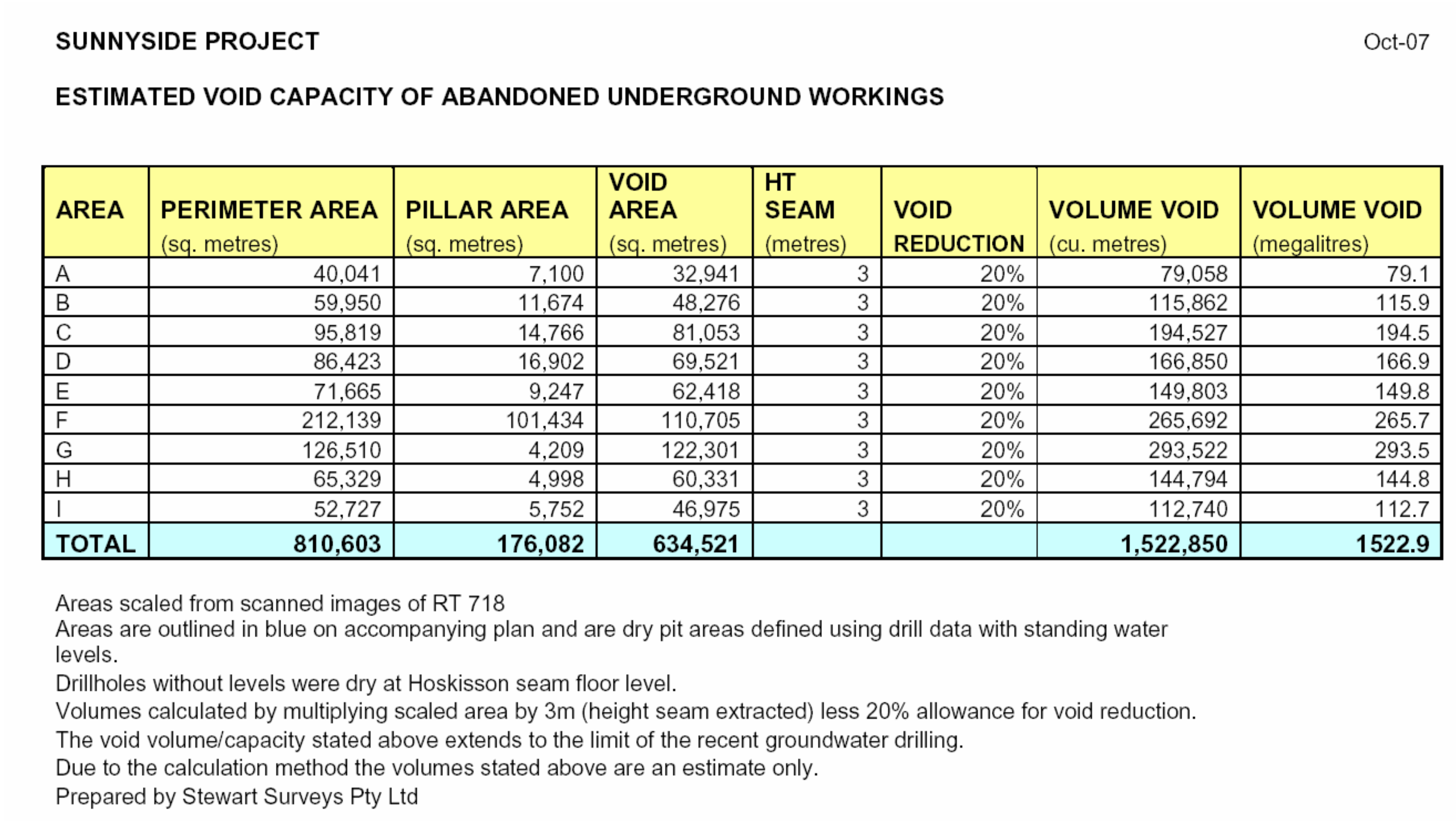

SUNNYSIDE PROJECT Oct-07

ESTIMATED VOID CAPACITY OF ABANDONED UNDERGROUND WORKINGS

AREA	**PERIMETER AREA** (sq. metres)	**PILLAR AREA** (sq. metres)	**VOID AREA** (sq. metres)	**HT SEAM** (metres)	**VOID REDUCTION**	**VOLUME VOID** (cu. metres)	**VOLUME VOID** (megalitres)
A	40,041	7,100	32,941	3	20%	79,058	79.1
B	59,950	11,674	48,276	3	20%	115,862	115.9
C	95,819	14,766	81,053	3	20%	194,527	194.5
D	86,423	16,902	69,521	3	20%	166,850	166.9
E	71,665	9,247	62,418	3	20%	149,803	149.8
F	212,139	101,434	110,705	3	20%	265,692	265.7
G	126,510	4,209	122,301	3	20%	293,522	293.5
H	65,329	4,998	60,331	3	20%	144,794	144.8
I	52,727	5,752	46,975	3	20%	112,740	112.7
TOTAL	**810,603**	**176,082**	**634,521**			**1,522,850**	**1522.9**

Areas scaled from scanned images of RT 718
Areas are outlined in blue on accompanying plan and are dry pit areas defined using drill data with standing water levels.
Drillholes without levels were dry at Hoskisson seam floor level.
Volumes calculated by multiplying scaled area by 3m (height seam extracted) less 20% allowance for void reduction.
The void volume/capacity stated above extends to the limit of the recent groundwater drilling.
Due to the calculation method the volumes stated above are an estimate only.
Prepared by Stewart Surveys Pty Ltd

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