FINAL

SASOL MINING
MIDDELBULT - BLOCK 8 - SHONDONI

EIAR (NEMA, MPRDA & NEMWA)

APPENDICES

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COMPILED FOR

SASOL MINING (Pty) Ltd
Middelbult – Block 8 – Shondoni

COMPILED BY

JMA Consulting (Pty) Ltd
Sustainable Environmental Solutions through Integrated Science and Engineering

APPENDIX 5.6(A)

SPECIALIST REPORT
GROUND WATER

FINAL FOR I&AP REVIEW

SASOL MINING
MIDDELBULT-SHONDONI
GROUND WATER
SPECIALIST REPORT

Date: 13 August 2010
JMA Project No: 10391
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COMPILED FOR

SASOL MINING (Pty) Ltd
Middelbult Colliery
Shondoni Shaft

COMPILED BY

JMA Consulting (Pty) Ltd
Sustainable Environmental Solutions
through
Integrated Science and Engineering

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1. INTRODUCTION

Sasol Mining operates a number of underground coal mines in the Secunda Area. Middelbult Colliery represents one of the underground mines and has been in operation since 1981. During its existence Middelbult Colliery has gone through several expansions. Whilst some of the original shafts have already been closed and rehabilitated, new shafts have been developed to access coal within the Middelbult Reserves.

As part of this ongoing development to ensure access to exploitable reserves, Sasol Mining is now investigating options to replace the existing West Shaft with a new shaft (Shondoni) in the Block 8 reserves in order to increase its reserve utilisation of the existing Middelbult operations (original Middelbult Reserves and Block 8 Reserves). At the same time the current mine lease area is also extended to now include the Block 8 Northern Reserves, the Springbokdraai Reserves and the Leeuwpan Reserves.

The proposed expansions require Environmental Authorisations. As part of this, potential environmental impacts must be assessed and the Environmental Management Plan (EMP) must be amended in terms of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA). In order to achieve this, the current Environmental Impact Assessment (EIA) and Environmental Management Programme Report (EMPR) approved under the Minerals Act (Act 50 of 1991) must be amended.

Additionally, an Environmental Authorisation is required in terms of the National Environmental Management Act (NEMA) (Act 107 of 1998) for all listed activities related to the proposed expansion whilst an Integrated Water Use License Application (IWULA) is also required in terms of the National Water Act (NWA) (Act 36 of 1998) to authorize water uses related to the expansion.

The proposed infrastructure expansion of the Middelbult operations, comprise one additional shaft complex (Shondoni Shaft) with associated infrastructure in the Block 8 Reserves and a new overland conveyor to convey the coal to an existing conveyor in the south which will transport the coal to the Sasol Mining central coal stockpile area (Sasol Coal Supply or SCS), and of course the underground workings for the additional reserve blocks (Block 8 Northern Reserves, the Springbokdraai Reserves and the Leeuwpan Reserves).

The proposed future mining activities will be conducted by means of underground mining operations, utilising the bord-and-pillar and high extraction methods to extract coal from the No.4 and No.2 Coal Seams. It is anticipated that approximately 8.5 to 9.5 million tons of coal per year will be mined.

The increased utilisation of coal reserves will mean that Middelbult (Block 8) will continue mining (current schedule) for an additional 3 to 4 years. The long-term plan for Middelbult-Shondoni is to maximise its life thereby ensuring optimal coal reserve utilisation.

Since its inception in 1981, Middelbult Colliery has applied for, and has obtained approval for an EMPR (applied in 2001) as well as an EMPR Addendum (applied in 2003 for Block 8) in terms of the provisions of the old Minerals Act.

The intention of this current EMPR Addendum and EIA/EMP is to combine all the previous work done at Middelbult Colliery into one single integrated document which will represent the overall comprehensive Environmental Impact Assessment and Environmental Management Plan for Middelbult Colliery, including all new, as well as historic Shafts, Conveyors and Mining Operations, but now in compliance with the requirements of both the MPRDA as well as NEMA.

However, a clear distinction will be made in the report to separate all activities already authorized and new activities for which authorization are currently sought.

Figure 1(a) shown below, puts the project into an authorization time line perspective. The current Middelbult-Block 8 mine lease boundary is indicated with the **red** line.

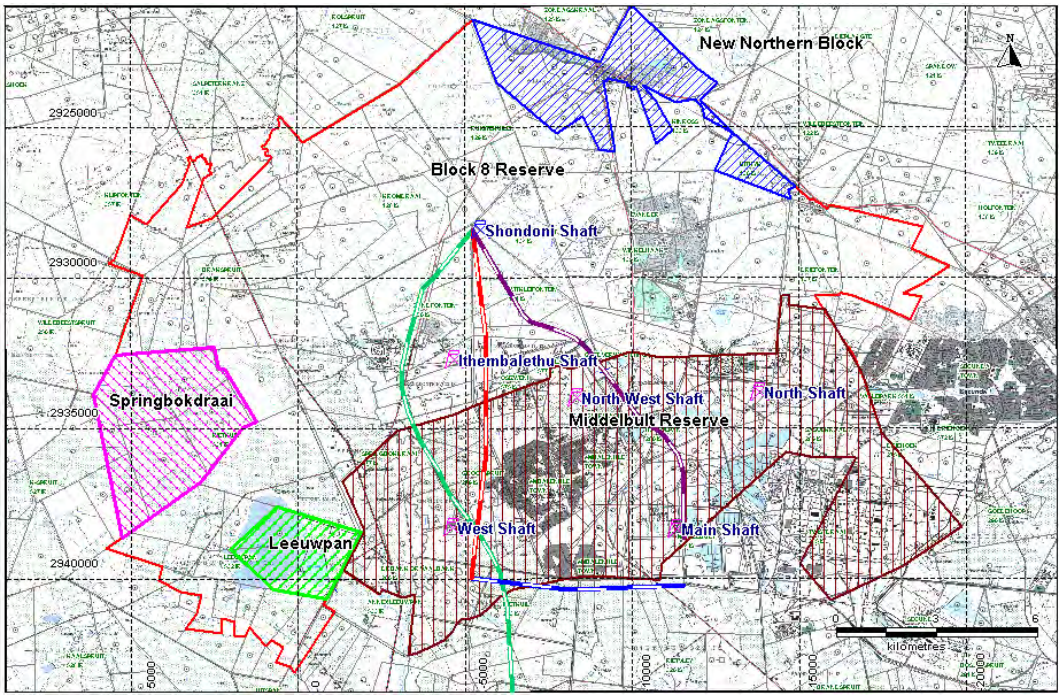


Figure 1(a): Middelbult-Block 8-Shondoni Project Area

The area highlighted with **brown vertical lines**, represents the original Middelbult Colliery area for which an EMPR was submitted to the DME **in 2001 and which was approved in 2002**. The approval included the highlighted Underground Mining Area (both the No.2 Seam and the No.4 Seam), the four shafts, Main Shaft, North Shaft, West Shaft and North-West Shaft, as well as the Coal Conveyor from the Main Shaft to the Sasol Central Coal Stockpile Area. Both North Shaft as well as North West Shaft have been decommissioned and closed and are not active any longer.

The area within the **red line** and which is not highlighted, represents the Block 8 EMPR Addendum which was submitted **in 2003 and approved in 2004**. This approval includes the Underground Mining on the No.2 Seam and the No.4 Seam within this area, as well as the Ithembalethu Shaft.

The **current application** therefore relates to the additional shaft indicated as Shondoni Shaft, the **green** coal conveyor belt from the Shondoni Shaft towards the south where it joins up with an existing conveyor belt, as well as the Underground Mining on the No.2 Seam and No.4 Seam for the areas highlighted in **green** (Leeuwpan Reserves), **magenta** (Springbokdraai Reserves) and **blue** (New Northern Block Reserves).

2. THE NEMA AND MPRDA EIA PROCESSES

With effect from 3 July 2006, the listed activities and authorisation process promulgated in terms of the National Environmental Management Act 107 of 1998 (NEMA), commenced (**save for those listed activities in respect of mining which will commence at a date to be published**) and the relevant notices promulgated in terms of the Environment Conservation Act (ECA) (Act 73 of 1989) pertaining to identified activities and the Environmental Impact Assessment (EIA) Regulations have been repealed.

Section 24 of the NEMA, headed "Environmental Authorisations" sets out the provisions which are to give effect to the general objectives of Integrated Environmental Management (IEM). In terms of section 24(1), the potential consequences for or impacts on the environment of *inter alia* listed activities must be considered, investigated, assessed, and reported on to the competent authority and/or the Minister of Mineral Resources, except in respect of those activities that may commence without having to obtain an environmental authorisation in terms of the NEMA.

Accordingly, the listed activities have been promulgated in two different government notices, namely Government Notice R. 386 in Government Gazette No. 28753 of April 2006 (GNR 386), which identifies those activities for which a Basic Assessment must be undertaken in accordance with the procedure set out in regulation 22 to 26 of GNR 385, and Government Notice R. 387 in Government Gazette No. 28753 of 21 April 2006 (GNR 387), which identifies those activities for which a Scoping and Environmental Impact Assessment must be undertaken in accordance with the procedure set out in regulations 27 to 36 of GN R. 385.

The Schedules to both GNR 386 and GNR 387 set out those activities that have been identified in terms of section 24(2)(a) and (d) of the NEMA which may not commence without environmental authorisation from the competent authority and for which the investigation, assessment and communication of potential impacts of the activities must follow the procedure described in regulation 22 to 26 of the regulations in respect of those activities that require a "Basic Assessment" or in terms of Regulation 27 to 36 of the regulations in respect of those activities that require "Scoping and Environmental Impact Assessment".

This application for Middelbult Shondoni is an application *inter alia* in terms of section 24 of the NEMA referred to above, read with GNR 385 and in particular

the application for **Scoping and Environmental Impact Assessment** described in regulations 27 to 36. Various listed activities in both GNR 386 and GNR 387 will be undertaken in order to give effect to the project and these have been identified and listed in the application that will be submitted to the Department of Economic Development, Environment, and Tourism (DEDET).

However, in view of the fact that listed activities related to mining have not yet become part of the application to DEDET, these activities must be authorized by DMR in terms of the provisions of the MPRDA and the MPRDA Regulations GNR 527, which similarly also requires both the Scoping and EIA processes.

The diagram below, Figure 2.1(a), illustrates the processes for both a Basic Assessment, and a Scoping and Environmental Impact Assessment. As described in Section 2.1, various listed activities in both GNR 386 and GNR 387 have been identified for the Middelbult Shondoni Project and will be incorporated into one Scoping and Environmental Impact Assessment Process for this project.

However, the same EIA process will also be followed to give compliance with the requirements of the MPRDA Regulations, save that a formal application does not have to be lodged with DMR.

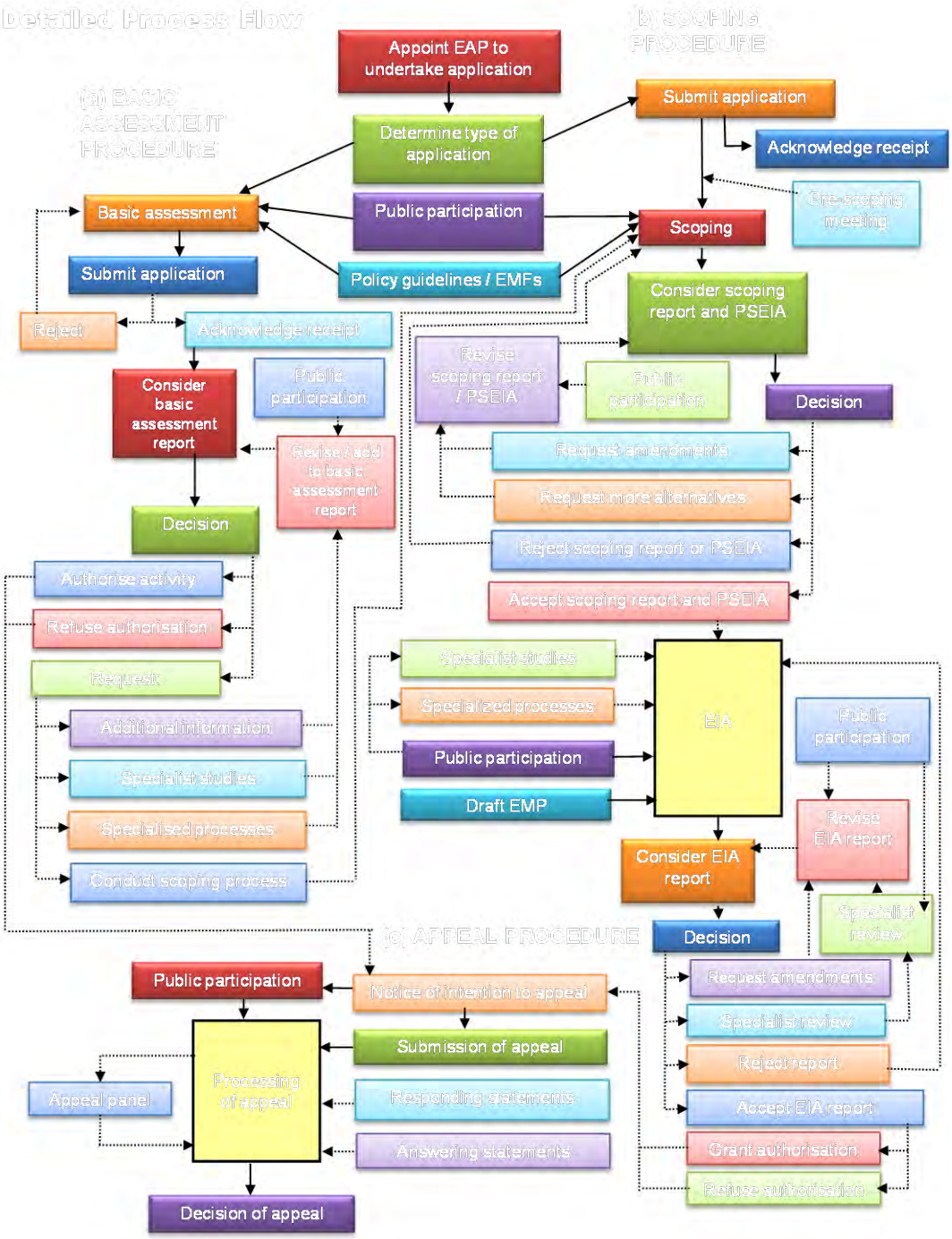


Figure 2.1(a): Combined NEMA and MPRDA EIA Process Flow Diagram

3. CURRENT ENVIRONMENTAL STATUS

3.1 REGIONAL GEOHYDROLOGICAL SETTING

The regional geohydrological setting is described with reference to available published regional information for the study area. The study area includes by the Middelbult Reserve, Block 8 Reserve, Springbokdraai Reserve, Leeuwpan Reserve and New Northern Block Reserve Extents. The regional geohydrological chapter will deal with the regional topography, meteorology, surface drainage, geology, geohydrology and historical mining, all of which will have an influence on the geohydrological setting of the study area.

3.1.1 Regional Topography

The study area is located within the Mpumalanga Province of South Africa. The topography of the Mpumalanga Province varies and has a distinctive mountainous north-eastern region and a flatter, expansive south-western region. The north-eastern region varies substantially in elevation (between 150 mamsl and 2200 mamsl) and covers the transition between the "Lowveld" and the "Highveld". The study area (located by the white dot on Figure 3.1.1(A)) falls within the elevated flatter south-eastern to eastern region of the province.

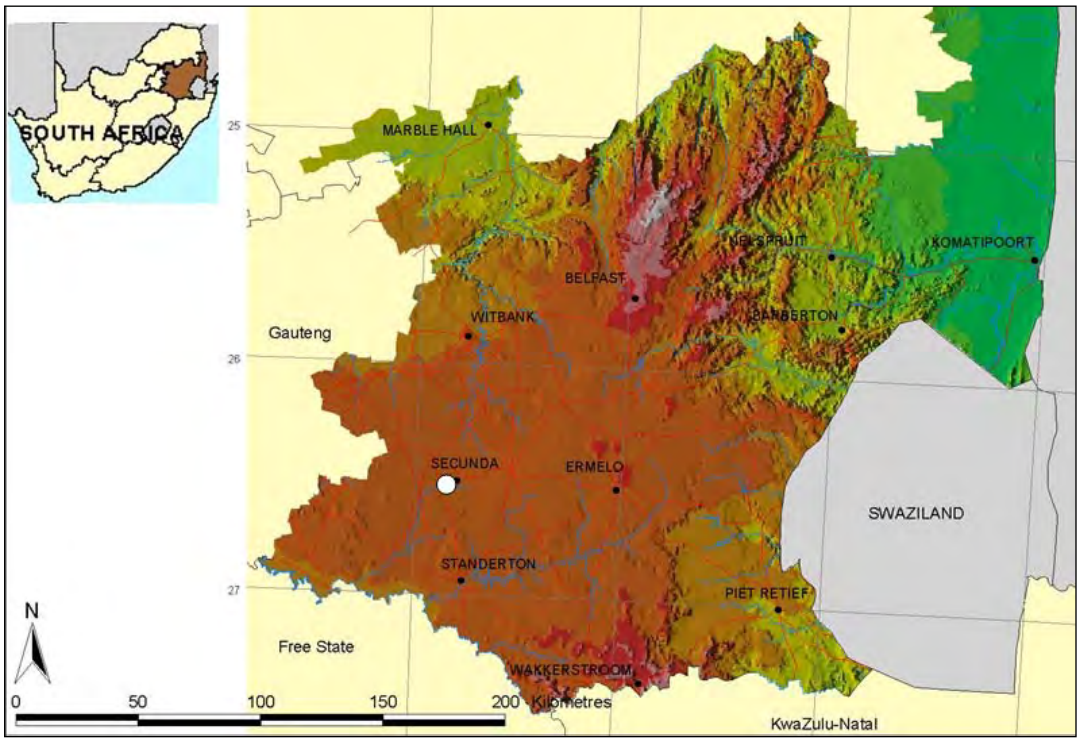


Figure 3.1.1(A): 3D Surface ENPAT map of Mpumalanga

Figure 3.1.1(A) is the 3D Image of Environmental Potential Atlas for the Mpumalanga Province Series, supplied by the Department of Environmental Affairs and Toursim, 2000 and illustrates the regional surface topography of Mpumalanga.

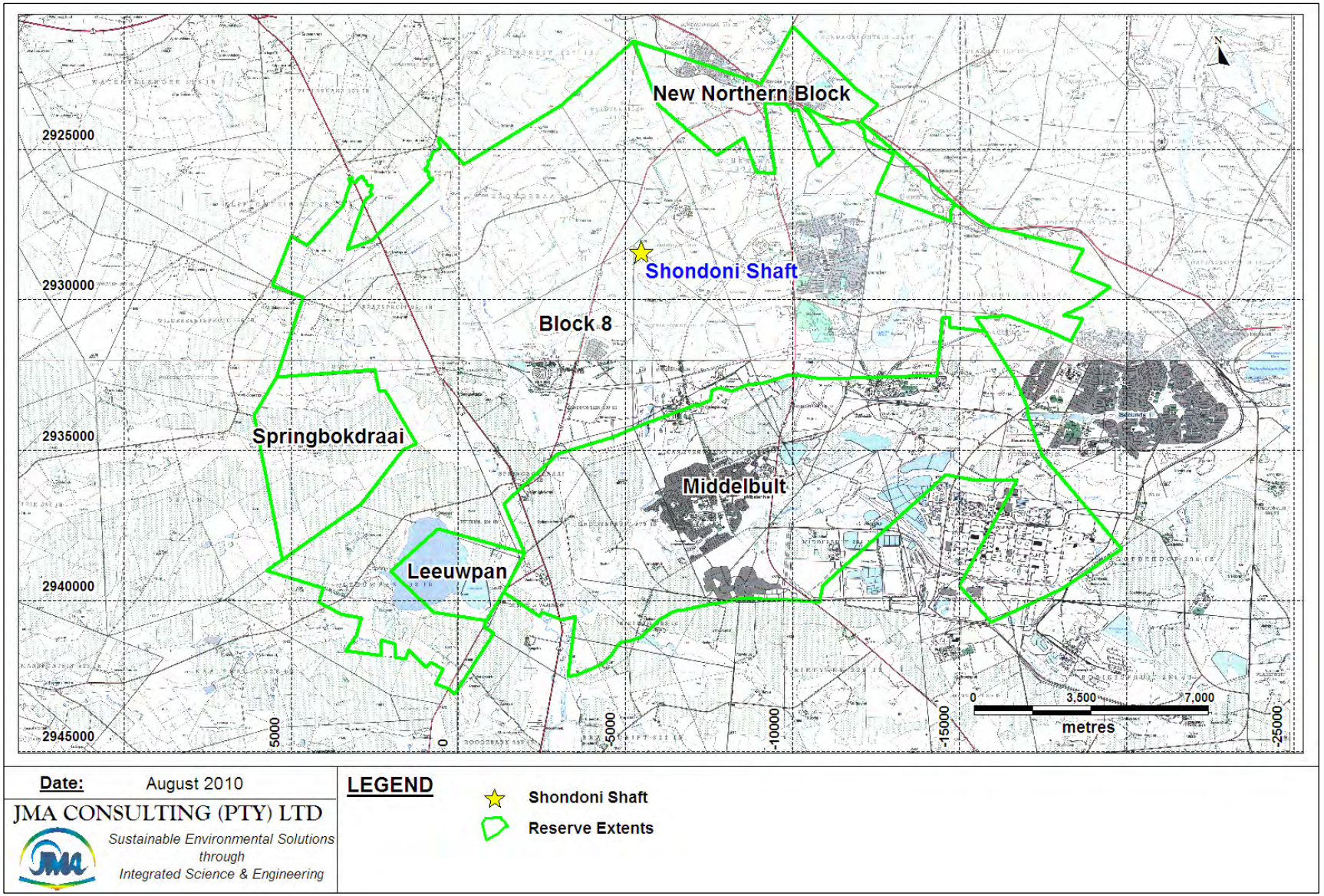


Figure 3.1.1(B): Regional Topography

The localized topography of the study area will be discussed with reference to the clipped region of the four (2628BD Leandra (3), 2628DB Willemsdal (3), 2629AC Evander (3) and 2629CA Secunda (3)) 1:50 000 Topographical Maps Sheets of South Africa, displayed as Figure 6.1.1(B). The natural topography of the study area is flat, slightly undulating and ranges in elevation between 1600 and 1650 mamsl (meters above mean sea level). The natural surface topography has however been altered as a result of the various anthropogenic and mining activities in the area. Several mine dumps, ash dumps, stockpiles and stream diversions etc are evident at across the surface of the study area.

3.1.2 Regional Meteorology

The climate of Mpumalanga contrasts vastly between the far eastern and north-eastern "Lowveld" and the "Highveld", which covers most of the central and western extent of the province. The climate of the Lowveld is typically subtropical with hot, humid summer days in which temperatures often reach 40°C. The average temperatures may reach up to 30°C in the summer and up to 23°C during the winter months. The average minimum temperatures range between 19°C and 6°C during the summer and winter months respectively. Rainfall predominantly occurs during the summer and autumn months (September to May), whilst the winters are mild and dry. The climate of the Highveld is typically characterized by hot summer months, between October and March and cold winters from May through to August. The rainfall of the Highveld is highly seasonal and falls predominantly in the form of late afternoon thunder storms during the summer months. The winters are cold and dry and are often associated with vast early morning mist belts and frost.

Figure 3.1.2(B) is the Mean Annual Precipitation Map (per quaternary catchment) of the Environmental Potential Atlas for the Mpumalanga Province series, supplied by the Department of Environmental Affairs and Toursim, 2000 and indicates the rainfall distribution across the Mpumalanga Province. Figure 3.1.2(B) indicates that lowveld and low lying areas adjacent to Marble Hall have the lowest Mean Annual Precipitation (MAP) across the province (460 – 620 mm/annum). Figure 6.1.2(A) further indicates that the western and central regions of the Highveld have the lowest MAP (620 - 750 mm/annum). The MAP progressively increases towards the east across the Highveld with the MAP reaching 1040 to 1335 mm/annum across the most eastern regions of the Highveld and is closely related to the elevation of the region as well.

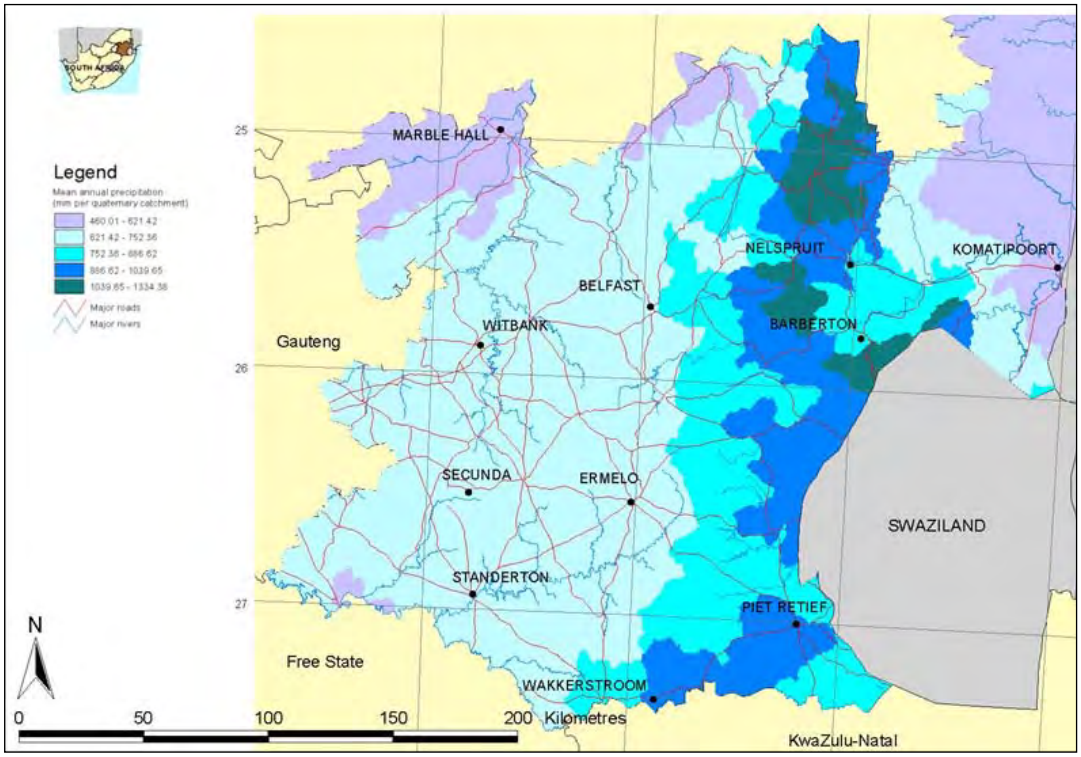


Figure 3.1.2(A): Regional MAP of Mpumalanga

The regional meteorology of the study area will be discussed with reference to the data obtained from the Bethal Monitoring Station. The climate across the study area is temperate and fairly uniform with warm summers and cold winters with sharp frost. The summer temperatures are mild with a maximum average of 25°C and a minimum average of 12°C. Winters are cold with a maximum average of 18°C and a minimum average of 1°C.

The MAP of the study area is 711 mm which occurs as showers and thunderstorms, and falls mainly from September to April. The winter months of June, July and August are dry and their combined rainfall comprises only 3.9% of the total annual precipitation. The Mean Annual Evaporation (MAE) of the study area, as determined using the A-Pan technique, is 1729 mm/annum.

The prevailing winds within the study area, are seasonal and blow from the southwest and northwest during winter months and from the east and northwest during the summer months.

3.1.3 Regional Surface Drainage

Figure 3.1.3(A) is map indicating the major surface water drainage systems of the Mpumalanga Province, and indicates the Mean Annual Runoff for each the quaternary catchments. It is evident from Figure 3.1.3(A) that there are three distinct surface water flow regimes in Mpumalanga. The northern (Komati/Crocodile River and Olifants River Primary Catchments) of the three drainage systems has a mean annual runoff of between 10 million m^3 and 140 million m^3, per quaternary catchment per annum. The eastern regime (Mfolozi/Pongola River Primary Catchment) has a mean annual runoff of between 810 million m^3 and 1.6 billion m^3, per quaternary catchment per annum. The study area is located within the western (Vaal River Primary Catchment) of the three

drainage systems, which has a mean annual runoff of between 140 million m^3 and 280 million m^3, per quaternary catchment per annum.

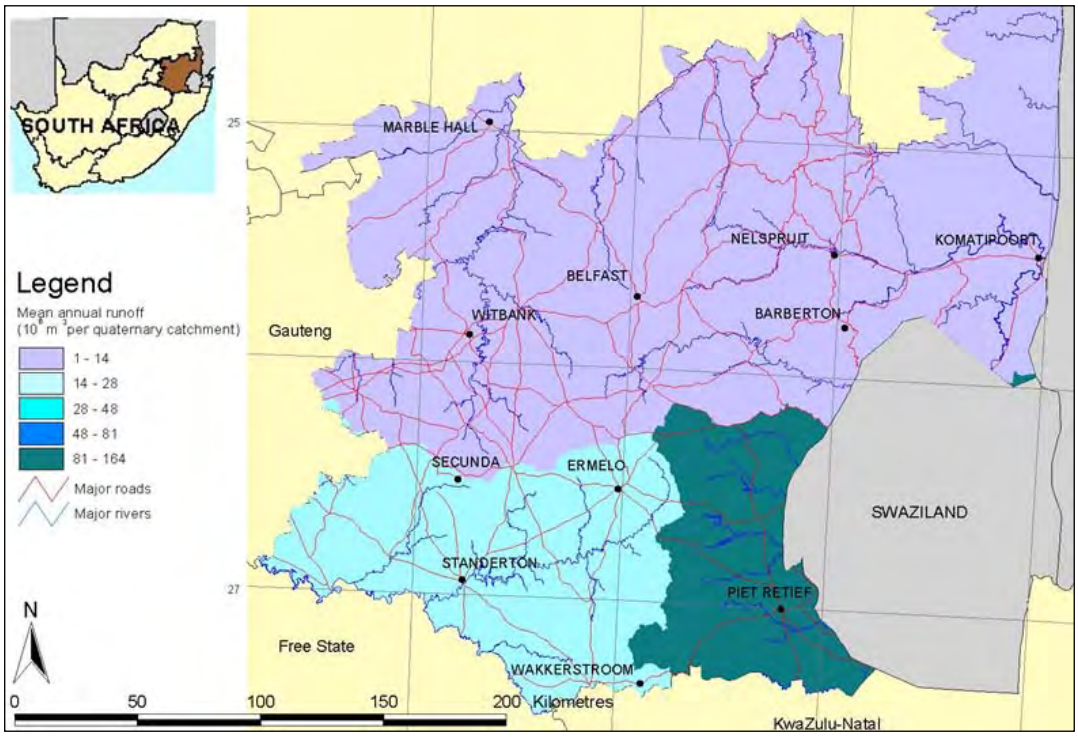


Figure 3.1.3(A): Regional Drainage Systems of Mpumalanga

The extent of the New Northern Block Reserves lies on the watershed that separates the C12D quaternary catchment from the B11D quaternary catchment, and is in fact the boundary between the Vaal River and the Olifants River Primary Catchments.

The study area falls within the northern extent of C12D quaternary catchment, which drains in a southerly direction within the study area (Figure 6.1.3(B)). The major surface water drainage bodies in the study area include the Grootspruit, Trichardtspruit, Kleinspruit, Wildebeestspruit, Watervalspruit, Kaalspruit and the Waterval River.

The Grootspruit drains in a southerly to south-westerly direction across the north-eastern regins of the study area, whilst the Trichardtspruit and Kleinspruit drain in a westerly to south-westerly direction across the eastern extent of the study area. The Watervalspruit and Wildebeestspruit both drain in a south-easterly to easterly direction across the western and north-western regions of the study area. The Kaalspruit drains in an easterly to south-easterly direction across the south-western regions of the study area. Each of the tributaries drain into the Waterval River which drains in a Southerly direction across the entire extent of the study area and ultimately drains in to the Vaal River.

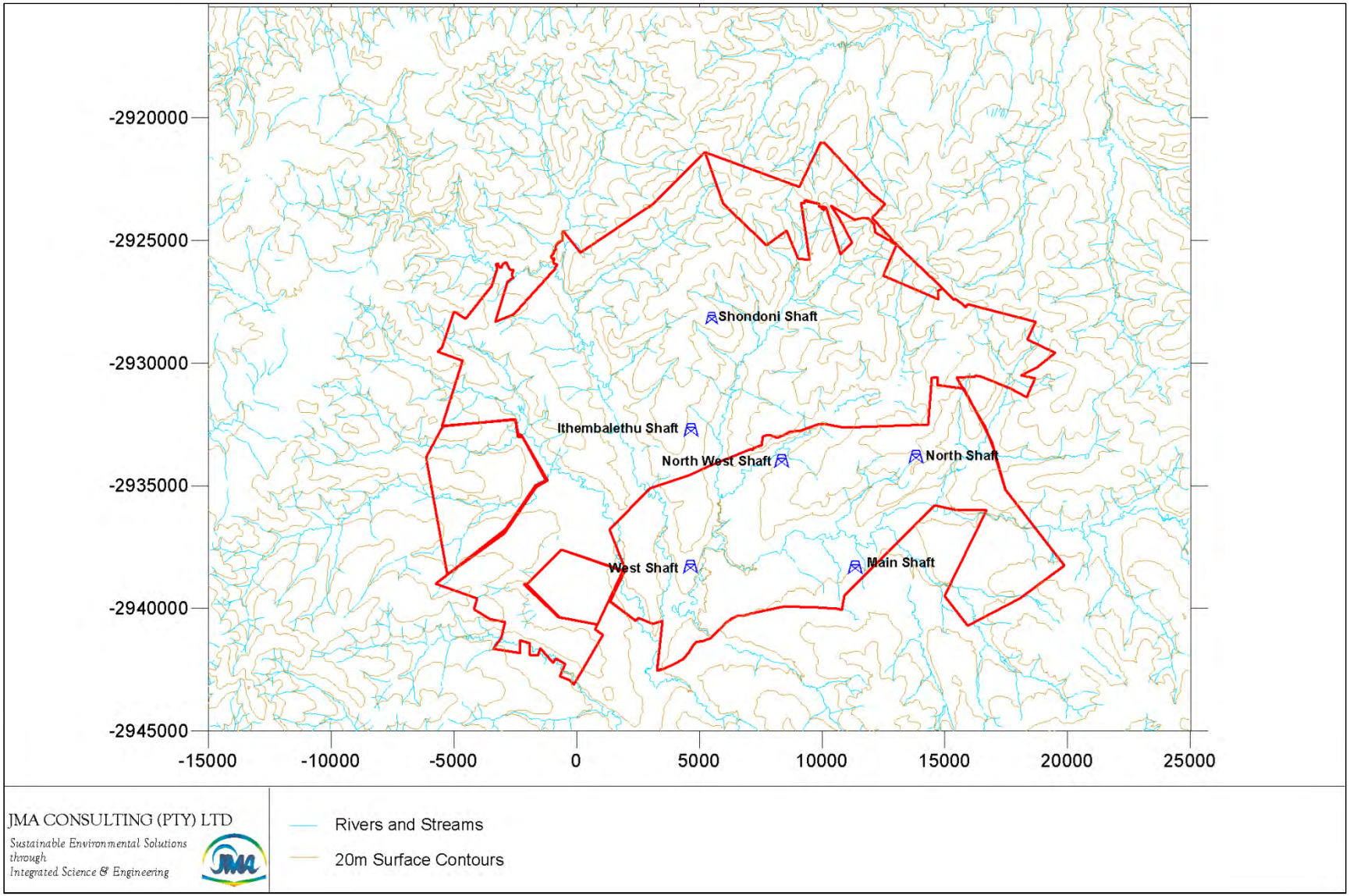


Figure 3.1.3(B): Major Surface Drainage Features of the Study Area

3.1.4 Regional Geology

The geology across the Mpumalanga Province is highly variable as indicated by the Environmental Potential Atlas for the Mpumalanga Province Series' Dominant Geology Map, supplied by the Department of Environmental Affairs and Toursim, 2000 (Figure 3.1.4(A)). Figure 3.1.4(A) indicates that the surface geology of the south-western extent of the province Karroo Sediments (shales, arenites, mudstones, tillite) as well as dolerite intrusions.

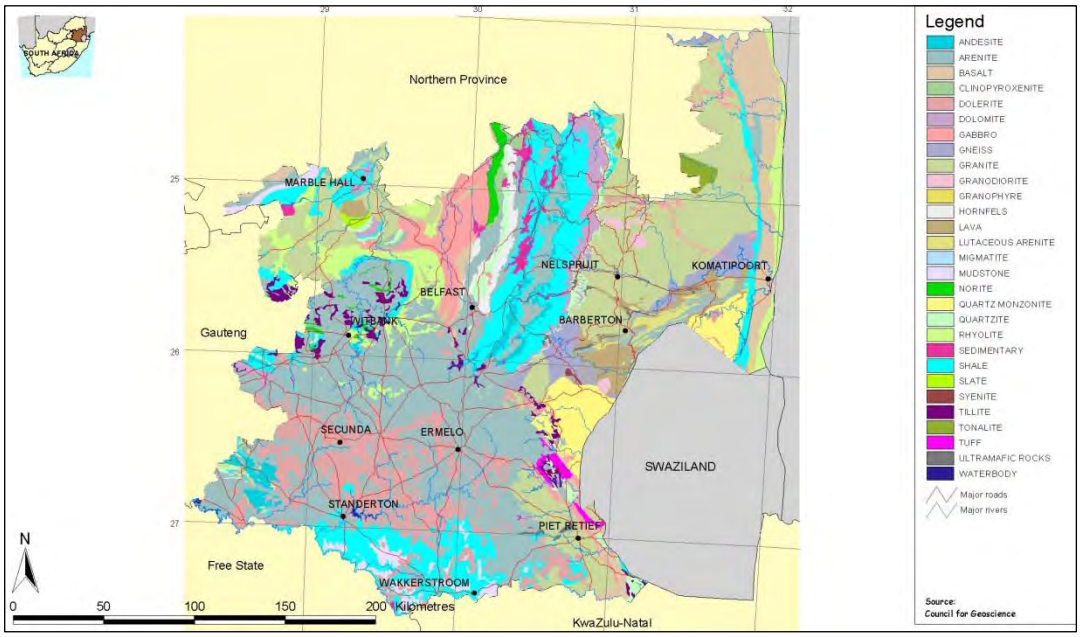


Figure 3.1.4(A): Mpumalanga Province Surface Geology

The occurrence and movement of ground water, as well as the ground water quality, are functions of the geological host rock in which the ground water occurs, including the alteration thereof as a result of human activities, such as mining. The regional geology of the across the extent of the study area will be discussed with reference to the clipped region of the 1:250 000 Geological Map Series of South Africa – Sheet 2628 EAST RAND, (1986), displayed as Figure 3.1.4(A). The Regional Geology Map (Figure 6.1.4(A)) depicts that the surface geology within and adjacent to the Study Area is dominated by the sedimentary rocks of the Vryheid Formation (Pv) as well as Jurassic Age Dolerite Intrusives (Jd).

The Vryheid Formation forms part of the Ecca Group of the Karroo Supergroup, and outcrops extensively across the study area. The Vryheid Formation generically consists of interbedded sandstones and shale layers. Carbonaceous shale and coal layers are generally associated with the Vryheid Formation as well. The dolerite present within the study area (Jd) is younger than the Vryheid Formation and intruded into and through the sedimentary rocks of the Vryheid Formation. The dolerite intrusions typically occur as dykes and sills and are often responsible for the devolatization of the coal adjacent to the dolerite intrusions. The river beds across the study are typically associated with the deposition of tertiary and quaternary sands and sediments.

Figure 3.1.4(A) indicates that gold (Au), silver (Ag) and coal (C) has been or is currently being mined within the study area as well.

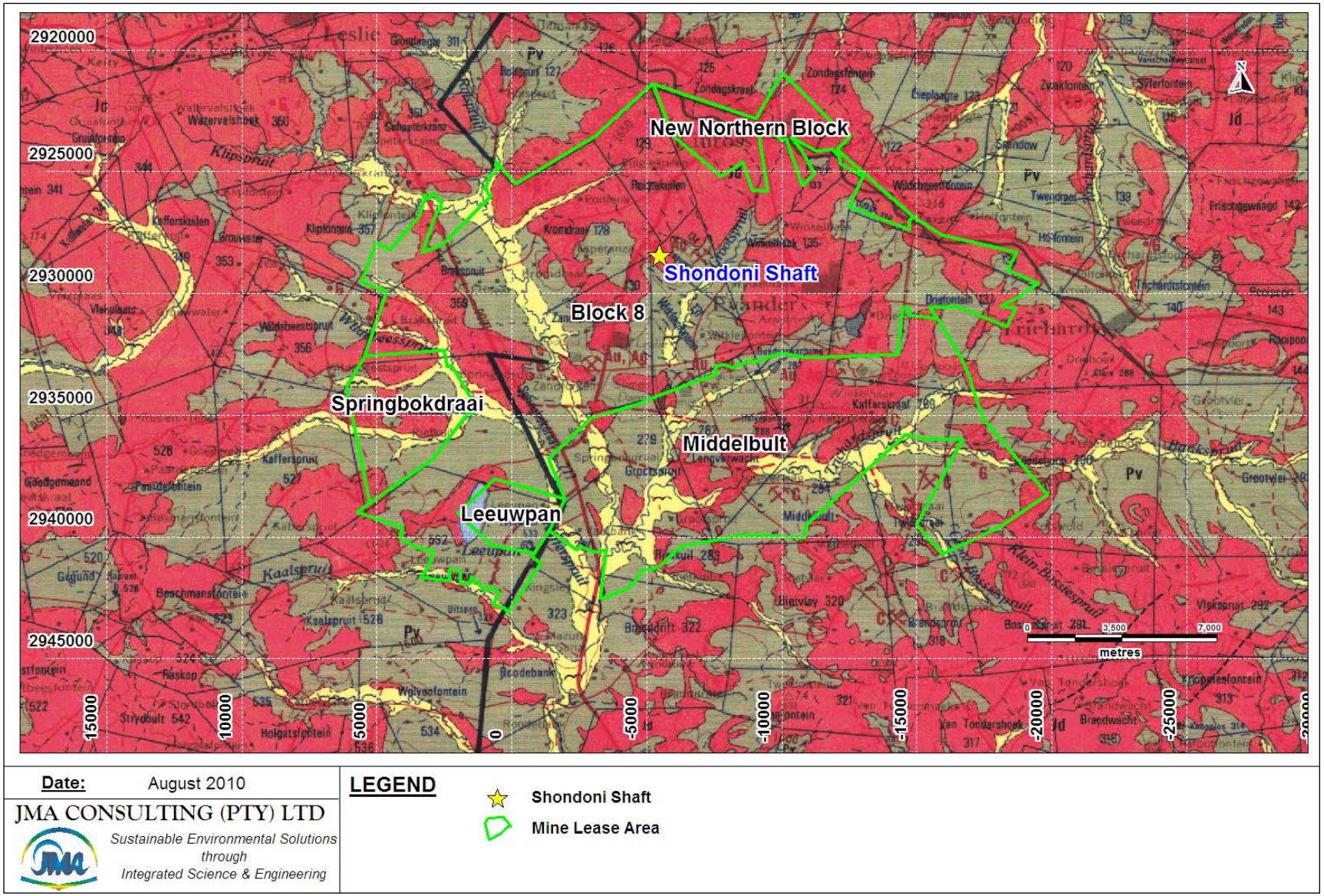


Figure 3.1.4(A): Regional Geology of the Study Area

3.1.5 Regional Geohydrology

The regional geohydrology of the study area will be discussed with reference to the available information relevant to the map extract displayed as Figure 3.1.5(A). This map extract was clipped from the published 1:500 000 Hydrological Map Series of the Republic of South Africa, Sheet 2526 Johannesburg, 1999.

The regional geohydrological attributes of the study area are clearly a function of the geological formation distribution. Two distinctly separate surface stratigraphic sequences (Pe and Jd) occur within the study area, each with their own geohydrological manifestations. Both sequences outcrop extensively and interchangeably across the extent of the study area.

Geohydrological Zone 1: Permian Age Ecca Group Sediments

The surface geology within the southern extent of the study area is predominantly underlain by the argillaceous rocks (shale, mudstone and siltstone) and arenaceous (sandstone) of the Ecca Group – denoted by Pe on Figure 3.1.5(A).

The primary ground water occurrences within this zone are in joints and fractures associated with the contact zones, related to the heating and cooling of the country rock, caused by the intrusions of the dolerite dykes and sills. Ground water is also extensively present within the weathered zones of the Ecca Group litholgies.

The borehole yielding potential within this geohydrological zone is classified as d2, which indicates an average yield which varies between 0.1 l/s to 0.5 l/s, although much larger yields are often associated with more localized contact zones. The aquifer type is classified as intergranular and fractured, and no large scale ground water abstraction is indicated to occur from these aquifers within the bounds of the study area. The ground water potential for the western area is given as between 40 and 60%, which indicates the probability of drilling a successful borehole (yield > 0.1 l/s) whilst the probability of obtaining a yield in excess of 2 l/s is given as between 0% and 20%.

Geohydrological Zone 2: Jurassic Age Dolerite

The surface geology across the northern extent of the Block 8 Reserve as well as the New Northern Block Reserve consists almost entirely of ultramafic to mafic Jurassic Age Dolerite Intrusives – denoted by Jd on Figure 3.1.5(A).

The primary ground water occurrences within this zone are in joints and fractures associated with the contact zones, related to the heating and cooling of the intrusive bodies as well as in the contact zones with the host rock. The borehole yielding potential within this geohydrological zone is predominantly classified as d2, which indicates an average yield which varies between 0.1 l/s to 0.5 l/s, although much larger yields are often associated with more localized contact zones. The aquifer type is classified as intergranular and fractured, and no large scale ground water abstraction is indicated to occur from these aquifers within the bounds of the study area. There is however a localized area within the dolerite to the south-east of the study area that is classified as d3, indicating that the average

yield varies between 0.5 and 2.0 l/s. The aquifer type is still classified as intergranular and fractured.

aquifer type is classified as intergranular and fractured, and no large scale ground water abstraction is indicated to occur from these aquifers within the bounds of the study area. The ground water potential for the western area is given as between 40 and 60%, which indicates the probability of drilling a successful borehole (yield > 0.1 l/s) whilst the probability of obtaining a yield in excess of 2 l/s is given as between 0% and 20%.

The mean annual recharge (MAR) to the ground water system within the study area is estimated to be between 25 mm and 50 mm per annum, which relates to about 5% of the mean annual precipitation (MAP). The ground water contribution to surface stream base flow is relatively low, estimated to be less than 25 mm per annum. The aquifer storativity (S) for the fractured aquifers in this part of the study area is estimated to be between 0.001 and 0.01. The saturated interstice types (storage medium) are fractures which are restricted principally to the zone directly below the ground water level. The pristine ground water quality is good with a Total Dissolved Solids (TDS) range of between 300 mg/l to 500 mg/l. The ground water is classified to be of the hydrochemical type B, with dominant cations Ca^{2+} and Mg^{2+} and dominant anion being HCO_3^-.

3.1.6 Regional Historical Mining

Figure 3.1.4(A) indicates that gold (Au), silver (Ag) and coal (C) has been or is currently being mined within the study area. The regional historical mining will however only be discussed with reference to Figure 3.1.6(A) and will not extend beyond the extent bound by the study area.

Figure 3.1.6(A) delineates the extents of the historically underground mined areas (pink) as well as the proposed underground mining extents of the No. 4 coal seam (light blue) and No. 2 coal seam (dark blue) respectively. The detailed mine layout and underground mining methods are discussed in the technical report and will not be addressed in this Groundwater Baseline report. Figure 3.1.6(A) indicates that the entire Middelbult Reserve has been mined out as well as the southern extent of the Block 8 Reserve. The No. 4 coal seam has been historically mined by standard board and pillar underground mining methods from these reserves.

The proposed underground mine layout however depicts that both the No. 4 and No. 2 coal seams will be mined out by underground mining methods in the future. The No. 4L seam ranges in elevation between 1436.20 mamsl and 1527.14 mamsl with an average elevation of 1483.43 mamsl. The No. 2 seam occurs some 20 to 30 meters below the No. 4L seam and ranges in elevation between 1408.98 mamsl and 1493.50 mamsl with an average elevation of 1449.734 mamsl.

It is evident from the Figure 3.1.6(A) that the current proposed underground mining extent of the No 4 Coal Seam is far larger than for the No 2 coal seam. The No. 4 coal seam will be mined out by standard Board and Pillar as well as High Extraction underground mining methods, whilst the No 2 seam will be entirely mined by standard Board and Pillar underground mining methods.

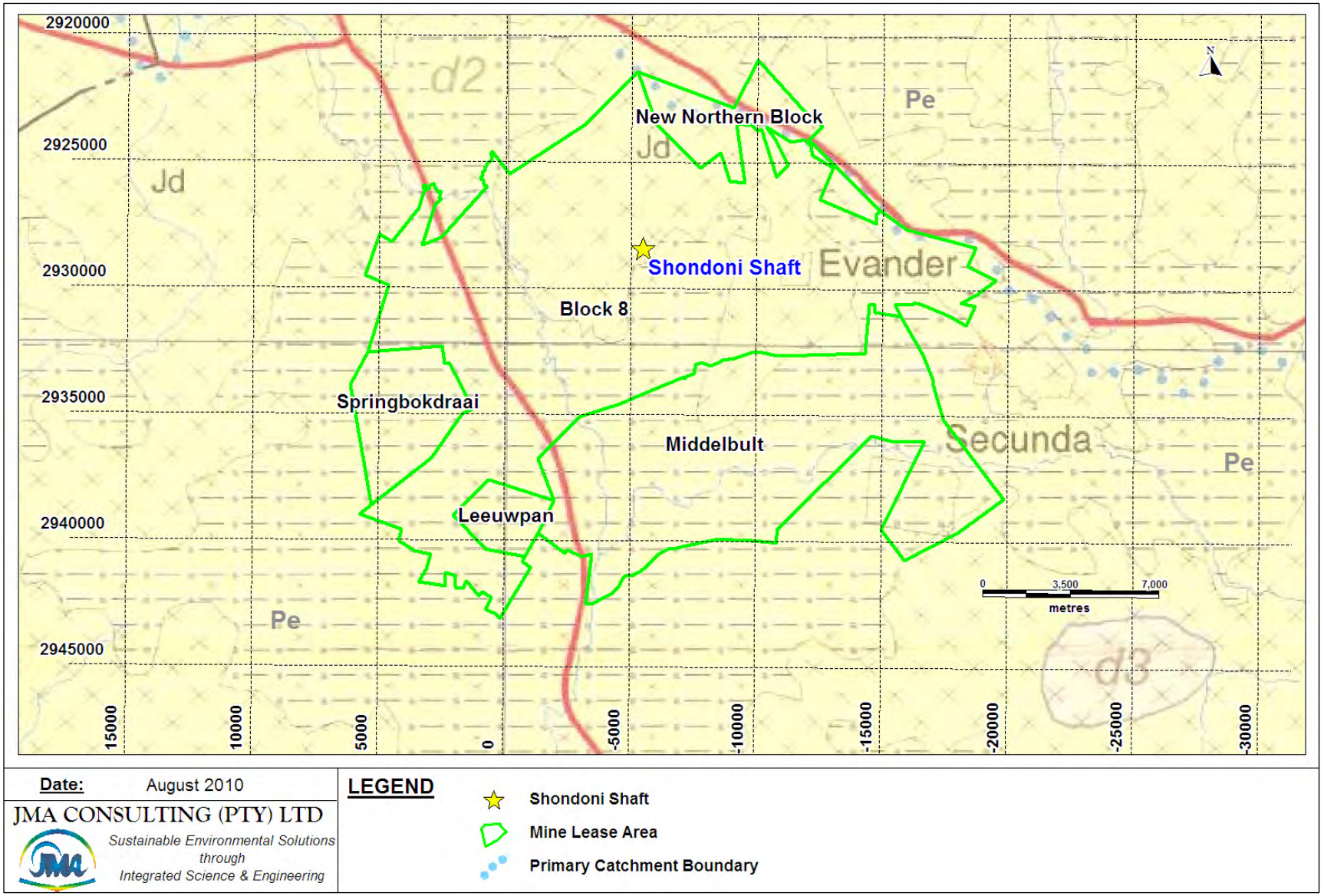


Figure 3.1.5(A): Regional Geohydrology of the Study Area

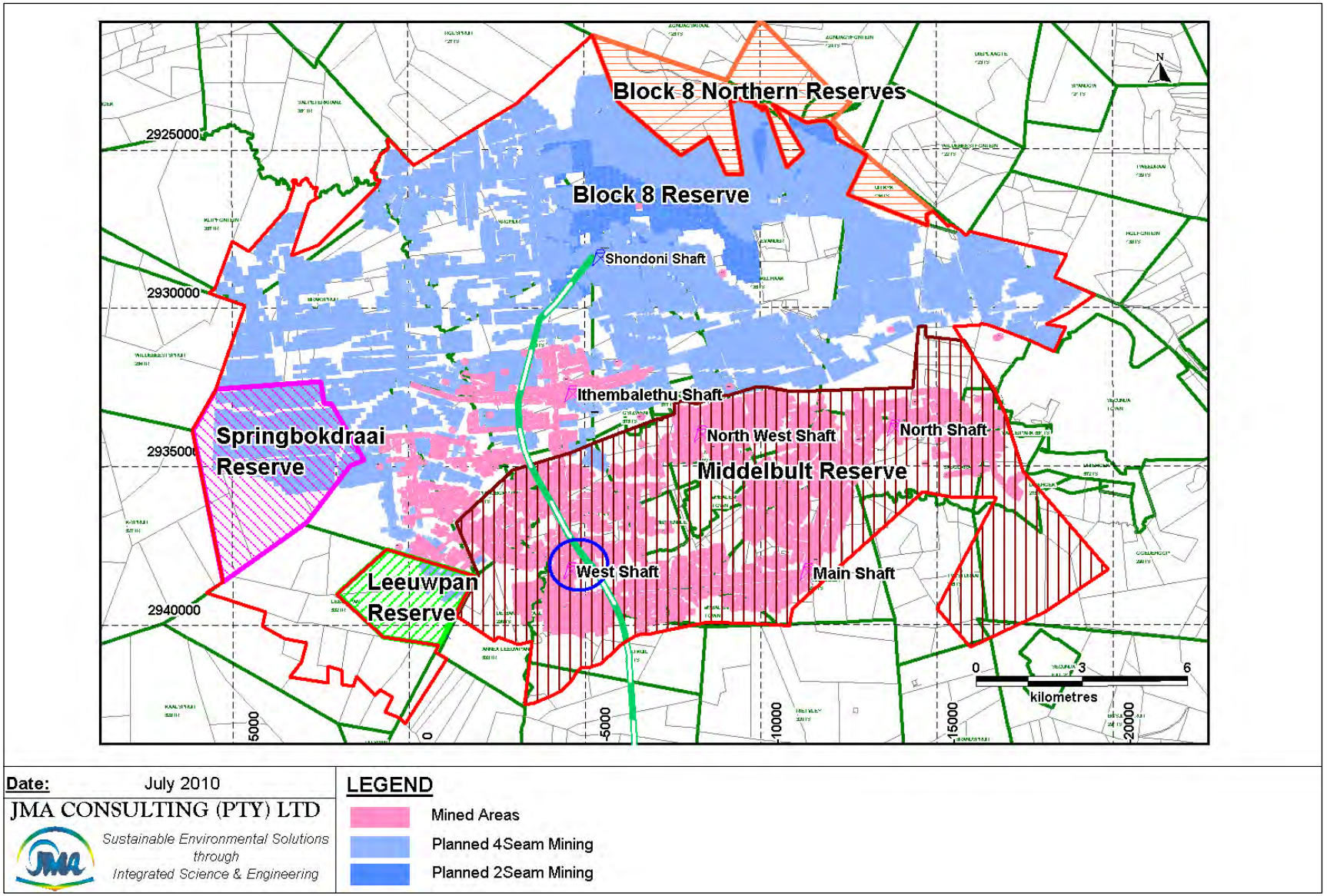


Figure 3.1.6(A): Regional Historical Mining

3.2 PHYSICAL AQUIFER DESCRIPTION

During a recent geohydrological investigation, a total of 30 monitoring boreholes were drilled specifically for geohydrological purposes. The boreholes were drilled in pairs, one shallow borehole (SSW-) of 30 m deep to investigate the shallow weathered zone aquifer(s), and one deep borehole (SDF-) ranging in depth between 80 - 150 m, to investigate the deep fractured aquifer. The shallow weathered zone aquifer(s) were sealed off in the deep boreholes (SDF-) with 30 m solid steel casing and sealed with cement and bentonite at the surface. The solid casing installed in the shallow boreholes (SSW-) ranged in depth between 2 m and 12 m, averaging at 6 m. The borehole logs and site reports, as well as multi-parameter profiles for these boreholes were recorded and are attached as Appendix 3(A) and 3(B) respectively.

The boreholes were sited using geophysical (magnetic) methods with the aim of intersecting the following geological structures:

- Four boreholes pairs (SSW- & SDF- 4, -7, -10 & -13) were sited to intersect the large east-west orientated normal fault that stretches over a distance of roughly 16 km between Brandspruit 359 IR in the west and the town of Evander in the east. This large feature also intersects the Kinross Mines Ltd Slimes Dams to the west of Evander.

- One pair of boreholes (SSW- & SDF-2) were sited to intersect the smaller normal fault that stretches over a distance of roughly 4 km between Witkleifontein 131 IS in the west and Evander's Sewage Works and the Winkelhaak Mines Slimes Dams in the east.

- Two pairs of boreholes (SSW- & SDF-6 & -9) were sited to penetrate the two dykes intersecting both the Kinross Mines Ltd Slimes Dams and the Leslie Gold Mines Ltd Slimes Dams.

- One pair of boreholes (SSW- & SDF-3) was sited to intersect the 7 m thick sub-vertical rising B8 dolerite sill that compartmentalizes or separate most of the Block 8 reserve from the Middelbult underground workings.

In addition to information obtained from these boreholes, geohydrological and hydrochemical information from over 170 external user's boreholes (inclusive of 28 monitoring boreholes used for observation purposes by Kinross, Winkelhaak and Leslie Gold Mines Ltd), 1 dug well and 16 fountains were obtained during the various hydro-census'. The locations of the monitoring boreholes, external user boreholes, as well as the exploration boreholes are indicated in Figure 6.2(A). The locations of these boreholes and fountains, as well as their respective numbers are indicated on the Map attached as Appendix 3.2(A).

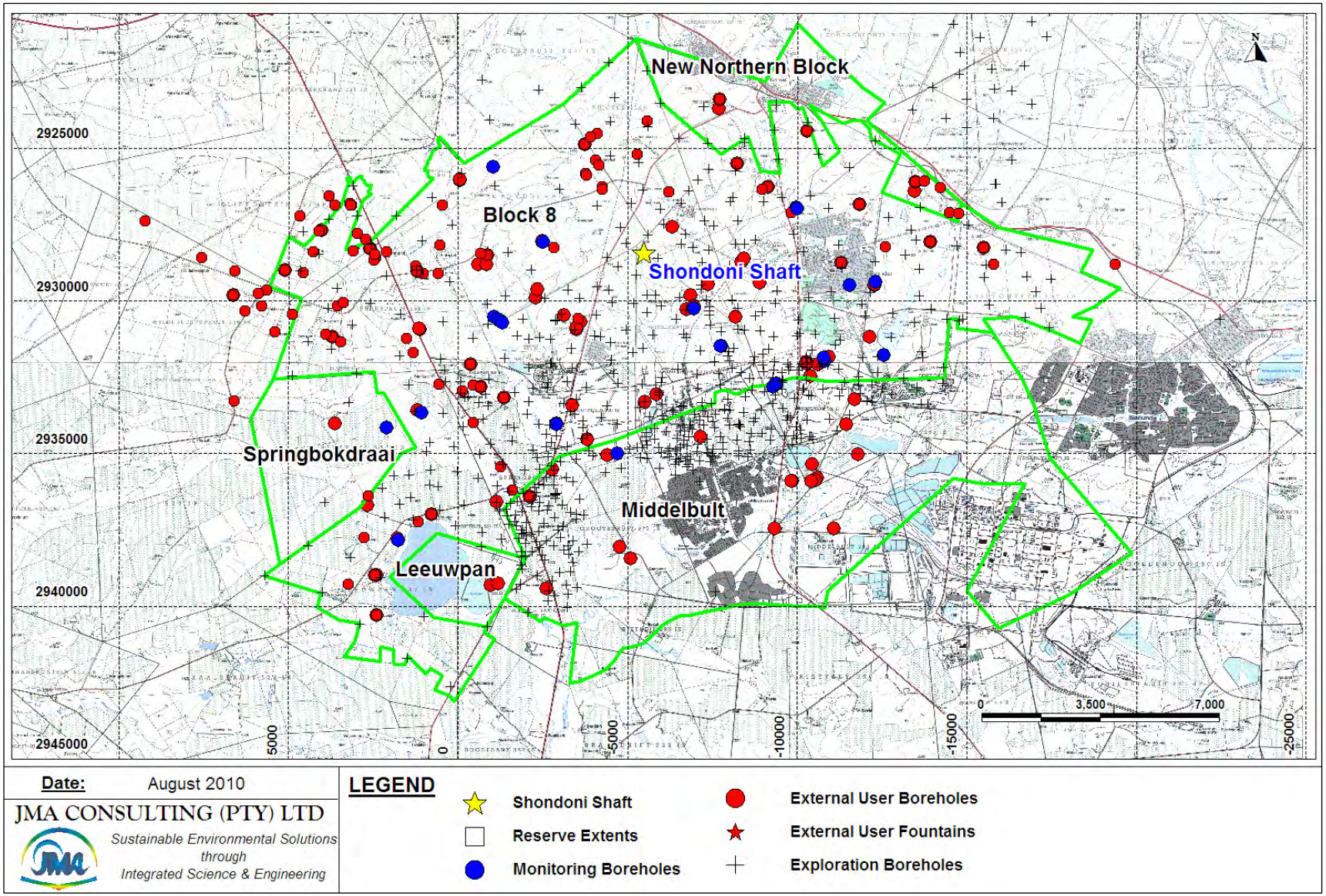


Figure 3.2(A): Borehole and Fountain Locations

3.2.1 Aquifer Matrix (Soil and Geological Matrix)

The surface of the study area consists predominantly of overburden and a dark brown to black, sandy clay layer, with an average thickness of between 1 and 2 meters thick. The clay layer is quite extensive across the extent of the study area and formed due to the weathering of the underlying lithologies. The nature of the clay layer is therefore dependant on the underlying host rock lithologies.

The host rock within the study area consists of sedimentary lithologies of the Vryheid Formation as well as Jurrassic Age dolerite intrusions. The Vryheid Formation forms part of the Ecca Group of the Karroo Supergroup, and consists of interbedded sandstone, mudstone and shale layers. Carbonaceous shale and coal layers are generally associated with the Vryheid Formation as well. The dolerite present within the study area is younger than the Vryheid Formation and intruded into and through the sedimentary rocks of the Vryheid Formation. The dolerite intrusions typically occur as dykes and sills and are often responsible for the devolatization of the coal adjacent to the dolerite intrusions.

The general lithological profile of the study area, up to, and including the No. 2 coal seam, comprises of:

- Soft overburden consisting of soils and weathered sandstone and some occasional highly weathered dolerite.
- Hard overburden consisting of fresh to slightly weathered dolerite, sandstone and shale units.
- No.5 coal seam (only present in some areas)
- Inter burden units of sandstone
- No.4H and/or 4L coal seam with a thin layer of sandstone in between if both are present
- Karoo Sediments
- No. 2 coal seam

3.2.2 Aquifer Types (Primary, Weathered, Fractured, Karst)

There are three major aquifer types present within the extent of the study area, namely:

- shallow weathered zone perched aquifers
- shallow weathered zone Karoo aquifers
- deep fractured Karoo aquifers (zone below the weathered zone)

The shallow perched aquifers are essentially restricted to the soil (soft overburden) horizon and have a very limited vertical depth. These aquifers are however laterally very extensive and are exposed to unconfined atmospheric conditions.

The host rocks of the other two aquifer types are the Karoo sediments as well as the dolerite intrusions. The nature and physical parameters of these aquifers are dependent on the occurrence, geometry, size, spatial extent as well as the fracturing status (of both the dolerite and Karoo lithologies) associated with the intrusions. For example, dolerite dykes and sills may form aquifer boundaries or act as ground water conduits, depending on their size as well as their weathering

and fracturing conditions. In essence, the characteristics of all three aquifer systems may vary depending on the localized conditions.

It is important to note, that due to the complex nature of these dolerite intrusion, many different aquifer units or compartments exist. All these units are different, not only in terms of physical properties, but also in terms of geometry and size. This also implies that it is not always possible to unilaterally classify an aquifer zone, into any of the three categories listed above.

It is a known fact that different piezometric pressures exist both at depth, and for different aquifer units. The perched aquifer usually displays unconfined conditions, whilst the shallow weathered zone aquifer displays unconfined to semi-unconfined conditions, and the deep aquifer predominantly confined conditions. It is typical for Karoo type aquifers (both shallow weathered zone and deep) that the shallow part of an aquifer exists with a higher potential for exploitation, than the deeper aquifers.

Ground water flow in all three aquifer types is essentially horizontal, however, interconnection between the aquifer types, can introduce non-horizontal flow components. The ground water flow within the aquifers occurs primarily as a result of advection caused by gravity. Ground water flow in underground sections, which are not fully flooded, is also gravitational and therefore controlled by the mine floor contours, and only become pressure controlled when fully flooded.

3.2.3 Aquifer Zones (Unsaturated, Saturated)

The thickness of the unsaturated zone is taken as the distance from the surface down to the ground water level, whilst the thickness of the saturated zone is taken as the distance from the ground water level down the interface between the weathered/fractured zone and the fresh lithologies. The weathering and fracture status of the geology penetrated, was recorded during the drilling programme and is included in the borehole logs and site reports, attached as Appendix 3(A).

With reference to the available geological information from exploration boreholes, supplemented with data obtained during drilling of the geohydrological monitoring boreholes, the physical thicknesses for the three different aquifer types, are summarized in Table 3.2.3(A).

Table 3.2.3(A): Aquifer Zone Thickness'

Aquifer Type	Aquifer Depths (mbgl)	Saturated Thickness (m)
Shallow Perched Aquifer	0 m to 6.4 m	-
Shallow Weathered Zone Aquifer	6.4 m to 15.2 m	3.9 m to 15 m
Deep Karoo Aquifer	15.2 m to 165 m	74 m to 108 m

Table 3.2.3(A) indicates that depths below the surface at which each of the aquifers occur. It is evident from the table that shallow perched aquifer is underlain by the shallow weathered zone aquifer which is further underlain by the deeper Karoo aquifer. The thickness of these aquifers is dependent on the water levels as well as the depth of the interface between the weathered/fractured zones and the fresh host rock lithologies.

In each instance where an impact on an aquifer is assessed, the potential and/or sensitivity of the aquifer(s) impacted on, will contribute towards the impact assessment made. It is therefore important to arrive at an overall aquifer classification, based on the base line information generated. The overall classifications of the aquifers present within the study area are therefore classified as medium potential aquifers, as these aquifers have a viable exploitation potential for small scale domestic and stock-watering purposes. The aquifers will, however, not support formal irrigation or water provision for extensive areas or communities.

3.2.4 Lateral Aquifer Boundaries (Physical, Hydraulic, Arbitrary)

The lateral extent of the ground water zones within the study area is severely complex. The lateral extent of the perched aquifers is usually finite and varies as a function of the lateral extent of soil and clay lenses at the surface.

Due to the scale of the investigation as well as the interconnectivity of the underground mining activities, the physical extent of the Karoo aquifers can be taken as infinite. Their lateral extent within the study area would naturally be highly dependent on the distribution and interconnectivity of the dolerite dykes and sills. In certain areas across the extent of the study area, these intrusives intersect one another and would have compartmentalized the adjacent aquifers. The degree and extent of compartmentalization prior to mining would have been very localized and is currently undetermined, as these compartments have since been be affected to various degrees as a result of the underground mining activities.

In addition to the geological features, the maximum natural lateral extent of the ground water zone (prior to mining) within the study area is limited by hydraulic boundaries. These include those boundaries formed by the major rivers and streams which act as ground water discharge boundaries, topographical water sheds which act as no-flow boundaries and surface infiltration sources (tailings dams) which usually represent constant head influx boundaries. Several of the natural hydraulic boundaries identified are delineated in Figure 3.2.4(A).

However, when mining activities impact on the ground water level distribution, these hydraulic boundaries become dynamic, resulting in an induced hydraulic boundary, usually manifesting as a cone of de-watering. It is important to realize from the discussion above, that aquifer boundaries are both physical and hydraulic in nature, both of which become dynamic in the mining environment.

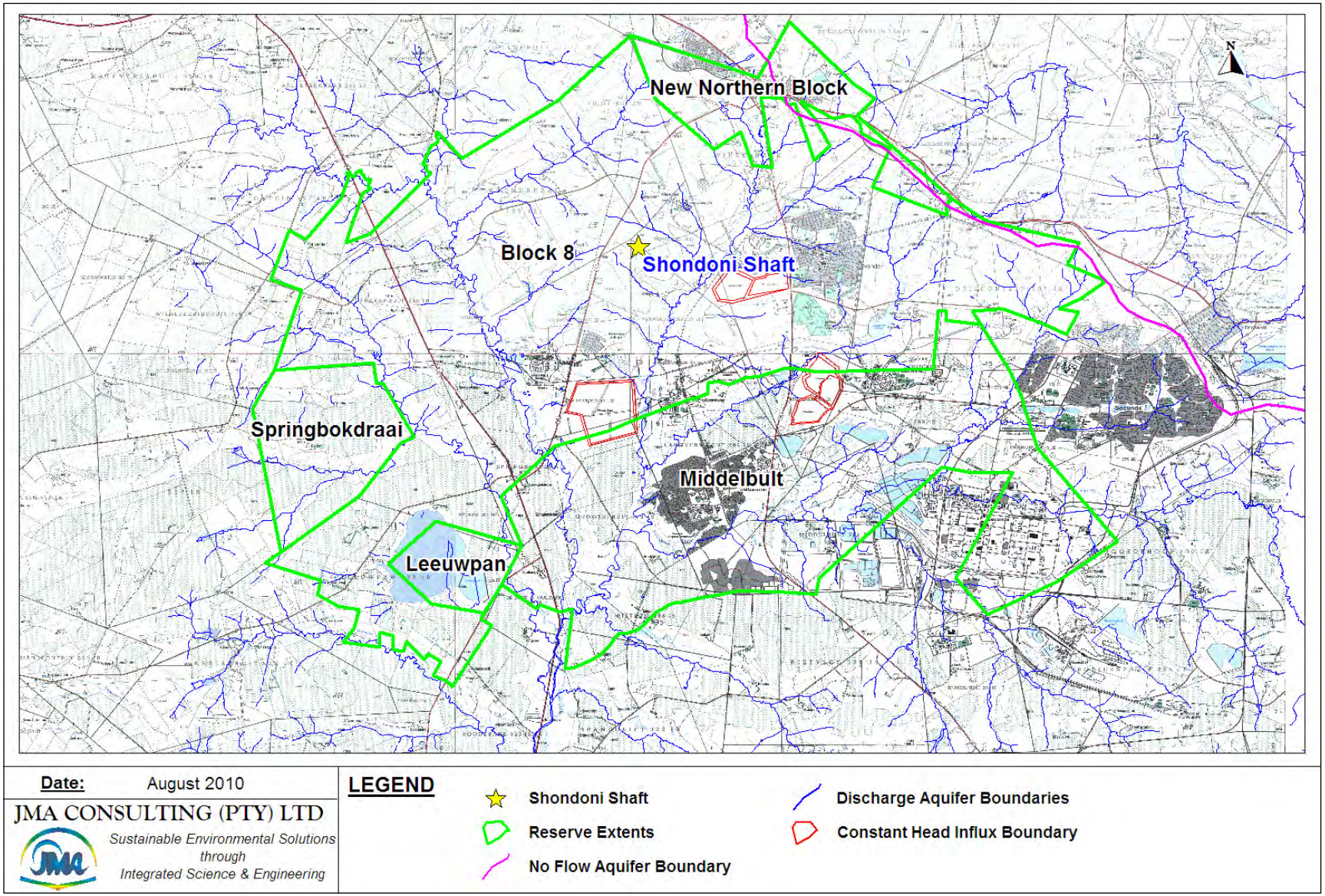


Figure 3.2.4(A): Natural Hydraulic Aquifer Boundaries (Including Slimes Dams)

3.2.5 Preferential Ground Water Flow Zones

In order to make an assessment of the ground water flow directions within the study area, the ground water level elevations in boreholes were used. Due to the nature of shallow weathered zone aquifers, the ground water contours essentially mimic those of the surface topography. It can therefore be stated that the natural regional ground water flow directions (in areas not impacted by mining), will be perpendicular to the surface topography contour lines and down towards the spruits and rivers.

The presence of the dolerite intrusions as well as the underground mining activities, do however effect the ground water flow of the area. During underground mining operations, ground water is removed from the aquifers and ultimately lowers the ground water level of the aquifer. This is known as "dewatering" and may have a significant impact on the ground water flow directions as well as the ground water flow velocities. The degree of impact is related to the volume of ground water extracted, the extent to which as well as the depth at which the dewatering takes place. Due to the scale of the study area as well as the impacts of the underground mining activities and dewatering, detailed ground water flow directions and flow velocities will not be defined for the purpose of the ground water baseline report.

The effect that the natural geological features may have on the ground water flow zone will however be discussed. The dolerite intrusions present within the study area may act as ground water flow barriers and may in fact cause preferential ground water flow zone, or both. Fresh dolerite is impermeable and if the extent thereof is sufficiently continuous, ground water will not be able to pass through the dolerite intrusives may from ground water barriers. The interconnectivity of these impermeable dolerite intrusions may result in the compartmentalization of the adjacent aquifers. It is important to note here that due to the impact of the underground mining activities, the extents and degree of the compartmentalization cannot be determined. The highly zone adjacent to the dolerite intrusions and country rock (Karoo Sediments), known as the contact zone, may be highly fractured. This contact zone generally has a high secondary porosity and may form a preferential ground water flow zone. The degree of fracturing as well as the interconnectivity of the fractures in this zone determines the effect that it may have as a preferential ground water flow zone.

3.3 HYDRAULIC AQUIFER DESCRIPTION

The hydraulic aquifer description relates to the parameters which determine the hydraulic ground water properties, such as the occurrence, availability, storage and movement of the ground water within the shallow weathered zone aquifer systems present within the study area. The hydraulic aquifer description will be based on the borehole yield information and geological logs obtained during drilling of the geohydrological boreholes, as well as from information generated during the profiling, sampling and aquifer testing conducted at the 30 monitoring boreholes. The borehole logs and site information reports as well as the EC profiles measured at the 30 monitoring boreholes are attached as Appendix 3(A) and 3(B) respectively.

3.3.1 Borehole Yields

Four pairs of boreholes (SSW- & SDF-4, -7, -10 and -13) were sited to intersect the large east-west striking normal fault. This fault was possibly intersected in boreholes SSW-7, SDF-7 and SDF-10. Major water strikes were encountered in boreholes SSW-7 and SDF-7, both located some 800 m west of the Kinross Mines Ltd Slimes Dams. Large calcified fracture planes with pyrite mineralisation, yielding ± 22 l/s were intersected, in the overlying B4 dolerite at a depth of 17-18 m, in borehole SSW-7. Borehole SDF-7, situated some 10 m south of borehole SSW-7, recorded a water strike of ± 19 l/s, also at a depth of 17-18 m, in highly fractured B4 dolerite (no calcification observed). A further 10 l/s were measured at a depth of 41-43 m, along a fracture in a fresh sandstone/shale succession. Boreholes SSW- & SDF-2 were sited to intersect the smaller normal fault to the south of the larger one discussed above. There was however no evidence recorded that this structure was intersected by either of the two boreholes. In conclusion it can be stated that out of the 10 boreholes geophysically sited to intersect these two faults, only three intersections (of which only two were water bearing), were recorded with some degree of confidence.

Two borehole pairs (SSW- & SDF-6 and -9) were sited to penetrate the two dykes individually intersecting both the Kinross Mines Ltd Slimes Dams and the Leslie Mines Slimes Dams. No dolerite was intersected in borehole SSW-6, whilst borehole SDF-6, sited on the dyke intersecting the Kinross Mines Ltd Slimes Dam, penetrated the dyke at a depth of 5-15 m below the surface. Although this intersection was recorded as highly weathered between 5-8 m and weathered, fractured between 8-12 m, no water strike was encountered. No dolerite was intersected in borehole SSW-9, whilst borehole SDF-9, sited to intersect the dyke indicated to cut across the Leslie Mines Slimes Dam, some 420 m east of the dam, penetrated a B12 dolerite sill at a depth of 41-42 m below the surface. No water strike was encountered along this intersection.

One borehole pair (SSW- & SDF-3) was sited to intersect the 7 m thick sub-vertical rising B8 dolerite sill that compartmentalizes or separate most of the Block 8 reserve from the Middelbult reserve. Borehole SSW-3 intersected the B8 dolerite at depths of 1-7 m and 8-17 m below the surface. A water strike of ± 0,10 l/s was recorded between 15-16 m. Borehole SDF-3 intersected B8 dolerite at a depth of 1-13 m below the surface. A water strike of ± 0,30 l/s was recorded between 8-9 m. Another water strike of ± 2,40 l/s was recorded between 17-20 m,

along a slightly weathered, fractured shale intersection, probably attributable to this dolerite intrusion.

Twenty-three dolerite intersections were recorded in twenty of the thirty newly drilled geohydrological boreholes. Thirteen water strikes, associated with host rock contacts as well as the contact between weathered and fresh dolerite, were recorded along these intersections. Three of these water strikes were recorded below the limit of weathering.

Six water strikes, ranging in depth between 6 m and 18 m were recorded in five of the fifteen newly drilled shallow weathered zone (SSW-Group) boreholes. Their estimated yields ranged between 0,1 l/s and 23 l/s, averaging at 4,25 l/s. Discarding the outlier associated with borehole SSW-7, the average estimated yield calculates to 0,70 l/s.

Only one water strike with an estimated yield of 0,40 l/s was recorded at a depth of 27-28 m, some 13 m below the limit of weathering in borehole SSW-8. Eight water strikes were recorded at depth below the limit of weathering in seven of the fifteen newly drilled deep Karoo aquifer (SDF-Group) boreholes. The water strikes ranged in depth between 27 m and 80 m and their estimated yields ranged between 0,10 l/s and 10 l/s, averaging at 1,51 l/s. Discarding the outlier associated with borehole SDF-7 and including the water strike recorded below the limit of weathering in borehole SSW-8, the average estimated yield calculates to 0,31 l/s.

Eight water strikes were recorded within the limit of weathering in five of the deep boreholes. They ranged in depth between 5 m and 33 m and their yields ranged between 0,1 l/s and 19 l/s, averaging at 4,1 l/s. Discarding the outlier associated with borehole SSW-7, the average estimated yield calculates to 1,99 l/s.

Analyses of the water strike information indicates that 81 % of the water strikes occurred at depths between 11 m and 33 m, while their reported yields ranged between 0,16 l/s and 6,11 l/s, averaging at 1,33 l/s. 19% of the strikes ranged in depth between 40 m and 80 m, while their reported yields ranged roughly between 0,25 l/s and 1,66 l/s, averaging at 0,93 l/s.

The 96 reported yields for the external user's boreholes ranged between 0,01 l/s and 8,3 l/s, averaging at 1,27 l/s. Statistical analyses of all water yielding borehole data - considered to represent the shallow weathered zone aquifer - calculates to an average yield of roughly 1,36 l/s. Analyses of all the water yielding borehole data considered representing the deep Karoo aquifer calculates to an average yield of roughly 0,62 l/s.

3.3.2 Aquifer Permeability/Transmissivity

The hydraulic conductivity or permeability (k) of an aquifer is a measure of the ease with which ground water can pass through the aquifer system. The permeability is defined as the volume of water discharged from a unit area of an aquifer under a unit hydraulic gradient per unit time (expressed as m/day). The permeability of the aquifer was determined by analyzing the rate of change in the water level of the shallow weathered zone aquifer during a permeability (slug) test.

Slug tests were performed in 13 of the shallow boreholes (SSW-Group) and 14 of the deep boreholes (SDF-Group), ranging in depth between 80 - 150 m, to determine the hydraulic conductivity distribution within the saturated Karoo aquifers.

The aquifer permeability distribution across the study area is depicted in Figure 3.3.2(A). A statistical summary of the permeability's for the Shallow Weathered Zone Aquifers and Deep Karoo Aquifers are listed in Tables 3.3.2(A) and 3.3.2(B) respectively.

Table 3.3.2(A): Shallow Weathered Zone Aquifers Permeability

Description of statistical analyses	Hydraulic conductivity (m/day)
Minimum value	0.0003 m/day
Maximum value	6.250 m/day (fault zone)
Arithmetic Mean	0.060 m/day
Geometric Mean	0.018 m/day
Harmonic Mean	0.003 m/day
Chosen for Shallow weathered zone aquifer	**0.015 m/day**

Table 3.3.2(B): Deep Karoo Aquifers Permeability

Description of statistical analyses	Hydraulic conductivity (m/day)
Minimum value	0.001 m/day
Maximum value	5.819 m/day (fault zone)
Arithmetic Mean	0.023 m/day
Geometric Mean	0.007 m/day
Harmonic Mean	0.002 m/day
Chosen for deep Karoo aquifer	**0.004 m/day**

Table 3.3.2(A) indicates that the calculated permeability values for the Shallow Weathered Zone Aquifers varied substantially between 0.0003 m/day and 6.250 m/day. Table 3.3.2(B) indicates that the calculated permeability values for the Deep Karoo Aquifers were higher and varied between 0.001 m/day and 5.819 m/day. The permeabilities assigned to the two aquifer systems were 0.015 m/day and 0.004 m/day for the Shallow Weathered Zone Aquifers and the Deep Karoo Aquifers respectively.

Additionally, statistical analyses of packer tests, conducted at different depths in 3 of the deep boreholes indicated the following:

- A mean hydraulic conductivity of 0.0043 m/day was calculated for fresh sandstone/siltstone intervals.
- A hydraulic conductivity of 0.0156 m/day was calculated for the 4 m fresh to slightly jointed B4 dolerite test section (30-34 m) in borehole SDF-11.
- A hydraulic conductivity of 0.573 m/day was calculated for the 4 m (fine grained sandstone) test section (60-64 m) across a water intersection roughly yielding 0,90 l/s in borehole SDF-14.

Hydraulic conductivities calculated for falling head tests, conducted in 2 of the deep boreholes (SDF-Group) compared well with the values obtained from the

slug tests performed in the same holes. Statistical assessment of hydraulic conductivities in South African hard rock aquifers, indicate the actual k-values to lie somewhere between the geometric and harmonic mean. A k-value of 0.02 m/day is therefore proposed as realistic value for the shallow weathered zone aquifers within the study area, while a value of 0.006 m/day, is proposed for the deep Karoo aquifers.

3.3.3 Aquifer Storativity

The storativity (S) of an aquifer is defined as the volume of water that an aquifer releases from, or takes into, storage per unit surface area of the aquifer per unit hydraulic gradient.

The storativity of the Karoo Aquifers within the study area was obtained from literature and is taken to be approximately 0.0001. The saturated interstice types or storage medium of the aquifer are the interstices and fractures present below the ground water level, as a result of weathering and the weathering related fractures of the host rock and dolerite intrusives.

3.3.4 Aquifer Porosity

The porosity of an aquifer is the ratio of the void space to the total volume of the aquifer. The porosity gives is an indication of the amount of water in the subsurface, but does not represent the volume that can be released from or taken into storage. The ratio between the volume of water that can be drained from the aquifer and the total volume of the aquifer is referred to as the effective porosity.

A total of 20 samples of the main sandstone units of the study area, were submitted to MATROLAB Civil Engineering Services for porosity testing. The saturation and buoyancy method - according to the SABS 0259 protocol (1990). The results obtained from the laboratory are summarized in Table 3.3.4(A).

Table 3.3.4(A): Summary of the Aquifer Porosity within the Study Area

Lithological Unit	Minimum	Maximum	Average
Fine grained Sandstone	0.3%	9.9%	**4.1%**
Medium to Coarse grained Sandstone	7.7%	14.4%	**10.1%**
Total Aquifer Average	0.3%	14.4%	**5.8%**

The large range in calculated porosity between the fine and medium grained sandstone is a function of the degree of pore-cementation and on the extent (depth) of weathering as well. The difference in porosity between the different grain-size sandstones is evident in Table 3.3.4(A). Based on the data obtained from MATROLAB and an average effective porosity for the shallow weathered zone is taken as 3.6 %, whilst the average effective porosity for the deep Karoo aquifer zone is taken as 0.58 %.

3.4 AQUIFER DYNAMICS

3.4.1 Rainfall Recharge

The mean annual precipitation (MAP) across the study area as recorded from the Bethal Monitoring Station is 711 mm per annum. The recharge to the shallow weathered zone aquifers within the study area will occur primarily through infiltration of the rain water and surface water bodies. The natural recharge to the Karoo aquifers within the study area has been influenced to varying degrees as a result of the underground mining activities. The recharge values obtained from the "SASOL MINE WATER MANAGEMENT TOOL" will be used and are summarized in Table 3.4.1(A) below.

Table 3.4.1(A): Recharge values obtained from the "Sasol Mine Water Management Tool".

Type of mining	Thick soils		Alluvium		Rocky Outcrops & Shallow Soils	
	Range	Ave	Range	Ave	Range	Ave
Board & Pillar Mining (Mining > 80 m deep)	1-2 %	1.5 %	1.5-3 %	2.0 %	2.5-3.5 %	3.0 %
Board & Pillar Mining (Mining < 80 m deep)	1-3 %	2.0 %	2-4 %	3.0 %	4-6 %	5.0 %
Board & Pillar Mining (Along major faults & dykes)	1-3 %	2.5 %	2-4 %	3.5 %	4-6 %	5.0 %
High Extraction Mining (free draining)	2-3.5 %	3.0 %	5-12 %	9.0 %	7-15 %	12 %
High Extraction Mining (non-free draining)	7-12 %	10 %	10-20 %	15 %	15-25 %	20 %

The thick soils represent areas with low recharge values, the alluvium represents areas with medium recharge values and the rocky outcrops and shallow soils represent surface areas with high recharge potentials. Table 3.4.1(A) indicates that the different underground mining methods influence the recharge of surface water to the ground water to varying degrees as well. It is evident from Table 3.4.1(A) that areas where High Extraction Mining will take place will ultimately result in higher recharge areas than in areas that will be mined by Board and Pillar methods.

3.4.2 Ground Water Level Depths and Fluctuations

Ground water levels were recorded at 151 boreholes within the study area. A map, depicting the depth to water table distribution for the study area, is included at As Figure 3.4.2(A). The ground water level depths have not altered significantly over the past ten years, except for the areas that have been directly affected by aquifer dewatering associated with the underground mining activities.

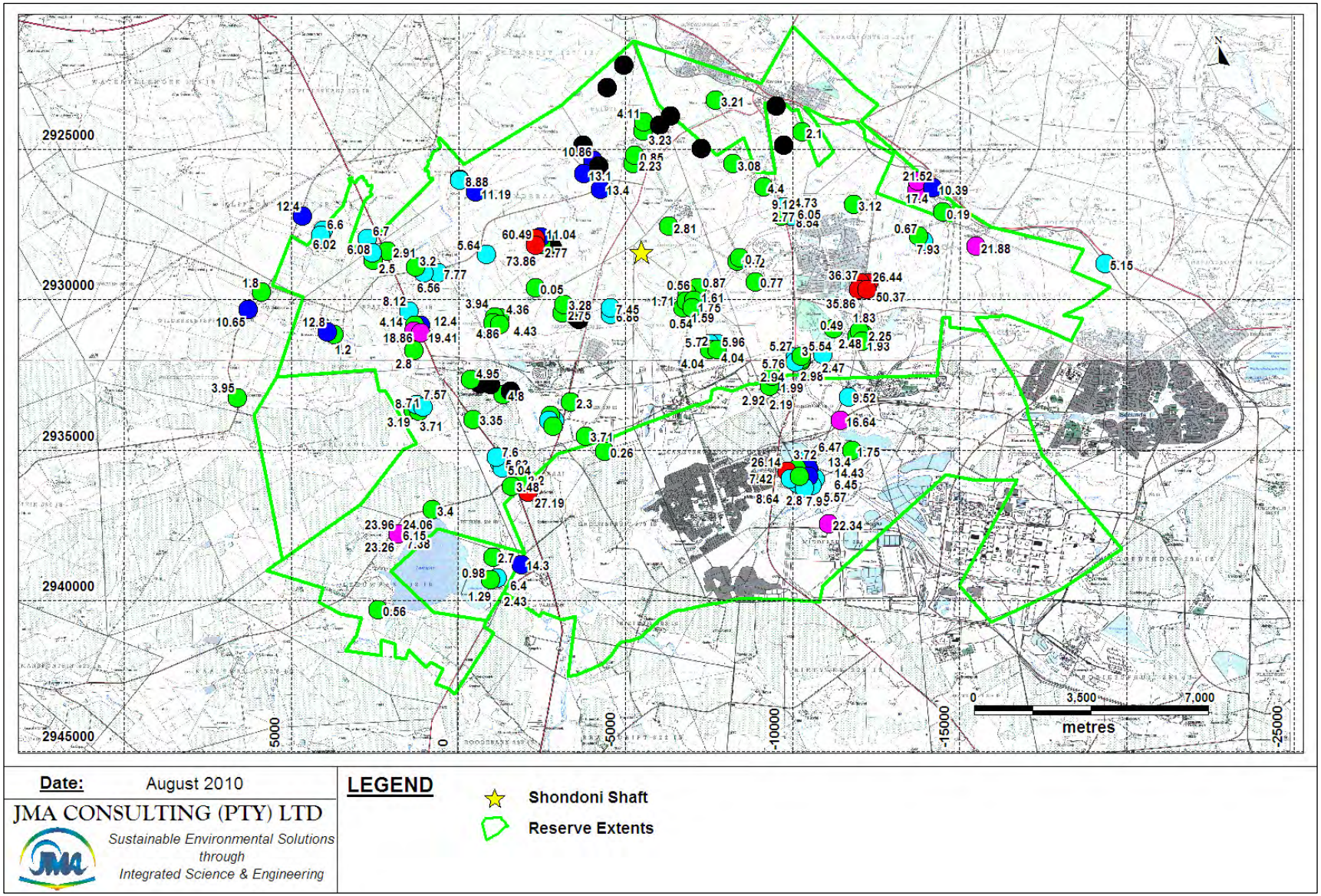


Figure 3.4.2(A): Ground Water Level Depth Distribution

The following observations are important regarding the depth to ground water tables:

- The depth to water level observed, varied between 0.05 m and 73.86 m, with a mean of 8.04 m.
- The depth to water level observed in the shallow weathered zone (SSW-) boreholes, varied between 0.27 m and 26.44 m, with a mean of 6.49 m.
- The depth to water level observed in the deep Karoo aquifer (SDF-) boreholes, varied between 0.24 m and 73.86 m, with a mean of 14.56 m
- The depth to water level observed in 74 external user's boreholes ranged between 0.05 m and 27.19 m, with an average depth of 6.23 m.
- The areas in which the water levels have been affected by dewatering are related to the panels of high extraction of underground mining activities.
- Figure 6.4.2(A) indicates that the water levels are in fact erratic across the study area and distinct linear trend is observed. There is also no definite step in the observed depth to water table on either side of the major fault zones.
- Due to the nature of shallow weathered zone aquifers, the ground water contours essentially mimic those of the surface topography. It can therefore be stated that the natural regional ground water flow directions (in areas not impacted by mining), will be perpendicular to the surface topography contour lines and down towards the spruits and rivers.

3.5 AQUIFER HYDROCHEMISTRY

A total of 114 water samples were collected throughout the extent of the study area, which included 109 ground water samples, 3 dam samples and 2 fountain samples. The aquifer hydrochemistry will be discussed with reference to the 104 ground water samples that were sampled from the various boreholes and wells. The locations of the ground water sampling points are indicated on Figure 3.5.1(A).

3.5.1 Background Ground Water Quality

The assessment of the background ground water quality was based on data obtained from the water samples collected from the newly drilled geohydrological monitoring boreholes, as well as from the external users' boreholes. The ground water samples were submitted to a laboratory and were analyzed for the following parameters: pH, EC, TDS, Ca, Mg, Na, K, Si, F, Total Alkalinity, Cl, SO4, NO3, Al, Fe and Mn. The concentrations of each of the elements in the ground water were then classified according to the SANS 241:2006 Drinking Water Standard and are listed in Table 3.5.1(A).

Table 3.5.1(A): Ground Water Quality Compliance

BH No.	pH	EC	TDS	Ca	Mg	Na	K	Cl	SO_4	NO_3	F	Al	Fe	Mn
GSS-1	7.44	61	367	47	27	51.5	7.5	40	86	6.26	0.41	0.04	0.10	0.01
GSS-2	7.50	60	338	40	23	65.6	5.1	70	42	0.26	0.43	0.06	0.12	0.01
GST-1	7.30	61	342	48	16	53.3	34.7	21	31	7.71	0.26	0.03	0.10	0.02
GWE-1	7.70	24	138	21	11	14.0	3.2	13	15	0.50	0.20	0.10	0.03	0.03
GWE-101	7.30	118	724	108	29	95.0	8.8	177	25	0.20	0.60	1.38	2.67	0.18
GWE-105	7.60	63	388	44	24	60.0	13.7	13	16	2.60	0.20	0.10	1.42	0.03
GWE-112	7.40	54	338	24	11	87.0	1.7	30	7	0.50	0.20	0.10	0.14	0.03
GWE-115	7.50	76	472	62	26	68.0	4.0	40	14	2.60	0.20	0.10	0.03	0.03
GWE-124	7.50	58	368	74	13	28.0	8.8	9	21	6.50	0.20	0.10	0.17	0.03
GWE-130	7.70	97	598	69	28	102.0	2.8	91	76	0.80	0.20	0.10	0.03	0.03
GWE-14	8.40	93	598	26	19	169.0	1.0	55	30	0.30	0.80	0.10	0.06	0.07
GWE-143	7.60	94	642	83	44	53.0	6.5	46	9	12.00	0.50	0.10	0.03	0.03
GWE-145	8.00	74	504	98	22	13.0	10.6	68	14	13.00	0.20	0.10	0.11	0.03
GWE-15	7.60	80	532	70	42	33.0	14.4	27	52	5.70	0.30	0.10	0.05	0.03
GWE-150	7.00	187	1300	204	108	65.0	8.7	265	147	31.00	0.40	0.10	0.03	0.03
GWE-159	7.70	49	306	28	10	73.0	1.9	22	5	0.80	0.50	0.10	0.22	0.14
GWE-168	7.80	65	400	60	25	47.0	4.9	39	46	1.10	0.20	0.10	0.03	0.05
GWE-17	8.50	73	512	30	30	51.0	44.0	40	75	5.60	0.40	0.10	0.03	0.03
GWE-19	7.60	76	496	47	22	97.0	2.3	24	27	0.40	0.60	0.10	0.03	0.03
GWE-22	8.00	93	584	19	6	173.0	2.0	99	26	0.50	3.20	0.10	0.03	0.03
GWE-25	7.60	84	580	82	49	30.0	1.1	12	114	8.00	0.30	0.10	0.25	0.03
GWE-31	7.70	78	514	28	14	141.0	2.2	15	13	0.70	0.30	0.16	0.57	0.04
GWE-48	8.00	77	500	58	36	44.0	27.0	16	5	0.40	0.50	0.44	6.79	0.06
GWE-54	8.20	56	334	21	38	37.0	4.9	36	5	0.20	0.20	0.10	1.96	0.03
GWE-56	7.60	89	504	69	44	55.0	2.7	55	5	2.40	0.30	0.10	0.03	0.03
GWE-6	7.70	89	604	80	43	53.0	5.1	37	81	1.80	0.40	0.10	0.30	0.03
GWE-7	7.50	113	734	96	67	69.0	1.0	30	107	2.80	0.50	0.10	0.19	0.03
GWE-70	7.80	133	868	62	62	122.0	3.4	233	43	1.80	0.40	0.21	0.61	0.03
GWE-73	7.40	176	1344	132	86	93.0	3.4	328	68	1.40	0.80	0.16	0.45	0.17
GWE-77	7.50	251	1760	95	108	290.0	2.7	576	110	0.60	1.30	7.71	15.00	0.52
GWE-78	7.40	98	608	48	30	129.0	2.0	64	5	0.20	0.60	0.61	1.48	0.12
GWE-79	7.30	77	486	72	36	52.0	1.0	18	6	3.30	0.40	0.23	0.40	0.03
GWE-85	7.20	304	2688	263	161	136.0	11.2	705	229	0.20	0.90	29.00	83.00	1.36
GWE-88	7.50	352	1982	16	5	702.0	3.4	913	242	0.20	0.40	0.30	0.49	0.08
GWE-9	7.30	125	884	124	77	50.0	1.1	57	139	10.00	0.30	0.75	3.01	0.07
GWE-90	7.10	1517	10650	543	979	935.0	9.8	2991	2717	0.20	0.20	0.14	14.00	5.63
GWE-92	7.30	127	1026	132	47	53.0	11.5	238	54	1.30	0.60	0.42	0.76	0.03
GWE-93	6.90	306	2528	273	165	65.0	10.3	870	77	0.80	0.20	0.10	0.50	0.03
GWE-95	6.90	334	2930	252	147	184.0	5.3	903	129	0.20	0.80	0.42	4.88	0.28
GWE-98	8.10	61	372	56	22	45.0	4.8	27	46	0.20	0.40	0.10	0.03	0.03

BH No.	pH	EC	TDS	Ca	Mg	Na	K	Cl	SO_4	NO_3	F	Al	Fe	Mn
GWE-99	7.80	52	344	60	18	29.0	7.8	14	18	2.30	0.30	0.10	0.03	0.03
HP-7-1 D	7.78	394	2720	140	89	708.0	8.3	1000	590	2.70	0.50	0.03	0.10	0.01
HP-7-2 D	7.76	227	1329	153	139	109.0	1.9	466	266	4.93	0.41	0.03	0.10	0.01
HP-7-2 S	7.60	81	502	85	59	24.3	0.7	21	109	5.12	0.51	0.03	0.10	0.01
KB-12	7.38	633	3241	248	271	607.0	0.7	1483	251	2.26	0.48	0.02	0.12	0.02
KB-13	7.75	133	747	61	33	176.0	4.3	207	38	0.31	0.65	0.03	0.16	0.02
KB-15	6.90	68	361	48	27	50.9	4.7	72	46	0.88	0.33	0.03	0.17	0.01
KB-16	7.70	76	425	33	29	97.6	2.2	25	18	0.63	0.64	0.02	0.12	0.01
KB-5	7.43	395	2105	259	227	195.0	5.2	1013	263	0.79	0.23	0.02	0.11	0.01
KB-7	7.32	404	2176	226	138	375.0	2.7	1053	170	0.96	0.44	0.02	0.12	0.20
KD-1	7.57	93	604	102	64	38.2	1.7	41	94	14.00	0.22	0.03	0.10	0.01
KD-2	7.17	120	697	61	25	156.0	7.0	35	134	4.26	0.51	0.03	0.15	0.08
KD-F1	7.54	72	406	52	40	61.8	0.9	19	24	0.36	0.30	0.06	0.11	0.01
KSS-1	7.38	68	425	53	31	58.8	7.0	38	114	6.15	0.52	0.04	0.11	0.01
LB-2	7.34	169	904	184	57	81.4	18.3	376	72	1.27	0.08	0.03	0.10	0.01
LB-3	7.24	407	2135	365	205	90.6	14.0	1210	139	0.93	0.07	0.01	0.11	0.02
LM-9	7.20	25	141	18	13	17.5	4.6	9	21	0.29	0.21	0.38	0.42	0.05
LPB-4	7.64	50	276	55	18	30.9	9.2	13	21	1.29	0.16	0.03	0.10	0.01
LPB-5	7.18	683	4536	853	212	411.0	15.1	2664	198	0.29	0.35	0.02	0.10	0.17
LPB-6	7.54	141	784	154	42	89.2	12.1	279	24	4.31	0.49	0.03	0.10	0.04
LSS-1	7.35	53	314	40	23	45.8	7.3	41	53	5.24	0.33	0.07	0.13	0.01
LSS-2	7.05	64	393	49	26	58.7	9.8	49	58	13.00	0.33	0.04	0.10	0.01
REGM-120	7.65	84	474	62	60	28.3	1.4	38	82	2.41	0.55	0.02	0.12	0.01
REGM-122	7.64	841	5167	668	496	504.0	7.1	2037	1368	4.65	0.56	0.01	0.14	0.02
REGM-133	8.00	64	380	4	1	150.0	1.9	47	18	2.05	0.60	0.03	0.12	0.01
REGM-190	7.80	189	1108	74	143	146.0	0.6	177	162	0.32	5.50	0.02	0.46	0.22
REGM-194	7.58	89	513	36	54	87.9	1.8	9	32	1.38	0.73	0.02	0.12	0.37
REGM-197	5.73	1576	10797	1770	1100	767.0	2.9	5474	1654	0.01	0.11	0.03	0.26	1.34
RKL-7	8.35	87	530	86	44	64.5	0.9	72	62	3.47	0.26	0.03	0.10	0.02
RKL-8	7.40	48	268	40	13	52.9	5.1	17	1	0.21	0.08	0.03	0.74	0.03
SDF-1	7.50	77	468	44	22	84.0	2.4	40	17	0.20	0.30	1.68	18.00	0.12
SDF-10	7.80	64	404	43	24	58.0	2.7	11	33	0.20	0.20	2.68	27.00	0.27
SDF-11	8.20	234	1348	3	2	563.0	1.9	347	12	0.20	4.60	2.14	6.17	0.06
SDF-12	7.70	68	432	44	29	71.0	5.4	18	17	0.20	0.40	0.58	17.00	0.15
SDF-13	8.00	110	662	32	20	209.0	5.8	18	78	0.20	0.60	0.90	9.49	0.12
SDF-14	8.20	69	422	6	2	159.0	3.3	16	5	0.20	0.50	0.54	0.97	0.03
SDF-15	9.80	76	418	2	2	168.0	4.1	27	20	1.00	0.60	0.83	5.31	0.05
SDF-2	7.60	73	448	50	48	34.0	1.0	8	15	0.20	0.50	1.06	11.00	0.05
SDF-3	7.80	158	916	32	20	262.0	3.9	228	74	0.20	1.20	1.62	9.58	0.27
SDF-4	9.90	167	1156	2	2	380.0	5.2	120	33	1.10	12.00	7.96	7.38	0.06
SDF-5	8.10	68	406	20	10	113.0	2.4	56	5	0.20	1.40	1.23	2.85	0.05
SDF-6	8.00	85	516	22	10	147.0	2.8	53	17	0.20	0.30	3.93	11.00	0.09
SDF-7	7.70	73	460	37	27	81.0	1.9	16	5	0.20	1.00	0.56	4.94	0.07
SDF-8	7.80	277	1568	47	16	469.0	5.1	665	136	0.20	0.30	0.19	4.96	0.06
SDF-9	7.60	61	394	22	10	95.0	3.2	45	14	0.20	0.30	0.99	14.00	0.13
SSW 4	8.60	300	2162	13	7	659.0	0.0	104	1035	0.00	0.00	0.00	0.00	0.00
SSW-1	8.50	55	364	21	10	85.0	3.4	30	5	0.20	0.90	3.74	5.67	0.32
SSW-10	7.80	68	466	36	22	87.0	3.2	11	10	0.20	0.40	3.32	8.05	0.14
SSW-11	7.90	117	716	38	20	187.0	11.7	152	86	0.20	0.20	0.63	0.75	0.10
SSW-12	7.50	74	592	47	29	78.0	5.6	18	18	0.20	0.30	0.58	1.18	0.03
SSW-13	7.70	115	868	88	65	83.0	14.1	9	72	2.80	0.70	0.24	2.17	0.23
SSW-14	7.60	77	548	51	42	64.0	3.3	13	74	0.20	0.40	0.24	6.35	0.03
SSW-15	7.90	88	596	16	10	187.0	7.3	20	14	1.00	0.60	0.36	4.40	0.03
SSW-2	7.88	92	542	53	58	94.3	1.3	14	34	0.24	0.50	0.05	0.32	0.14
SSW-3	7.80	257	1776	141	112	207.0	6.1	444	200	0.20	0.50	2.28	5.53	0.27
SSW-5	8.00	85	508	16	8	170.0	2.6	80	5	0.20	1.30	2.55	10.00	0.10
SSW-6	8.10	79	492	30	16	121.0	3.9	45	19	0.20	0.40	0.64	4.18	0.06
SSW-7	8.00	73	462	35	28	83.0	2.4	16	5	0.20	1.10	0.25	2.03	0.03
SSW-8	7.70	313	1934	79	42	491.0	7.3	723	150	0.20	0.20	0.36	0.67	0.03
SSW-9	8.00	63	396	24	12	96.0	4.2	41	9	0.20	0.40	0.33	2.87	0.04
UTK-1	7.83	117	676	98	67	68.5	5.4	136	84	2.58	0.25	0.04	0.10	0.01
WB-4	7.68	352	2199	36	2	864.0	3.3	1015	208	0.50	0.17	0.05	0.10	0.01
WB-5	7.68	187	1289	68	57	313.0	8.8	305	393	0.20	0.20	0.04	0.10	0.01
WB-6	7.28	237	1648	154	126	233.0	7.7	503	560	0.26	0.48	0.03	0.11	0.01
WKH-10	7.63	79	456	73	47	38.4	19.0	23	58	4.05	0.20	0.04	0.10	0.01
WVR-1	7.22	26	156	19	13	19.2	4.4	10	34	0.32	0.22	0.69	0.80	0.02
ZFT-1	7.49	45	243	36	21	14.9	11.1	28	47	8.18	0.02	0.02	0.12	0.02

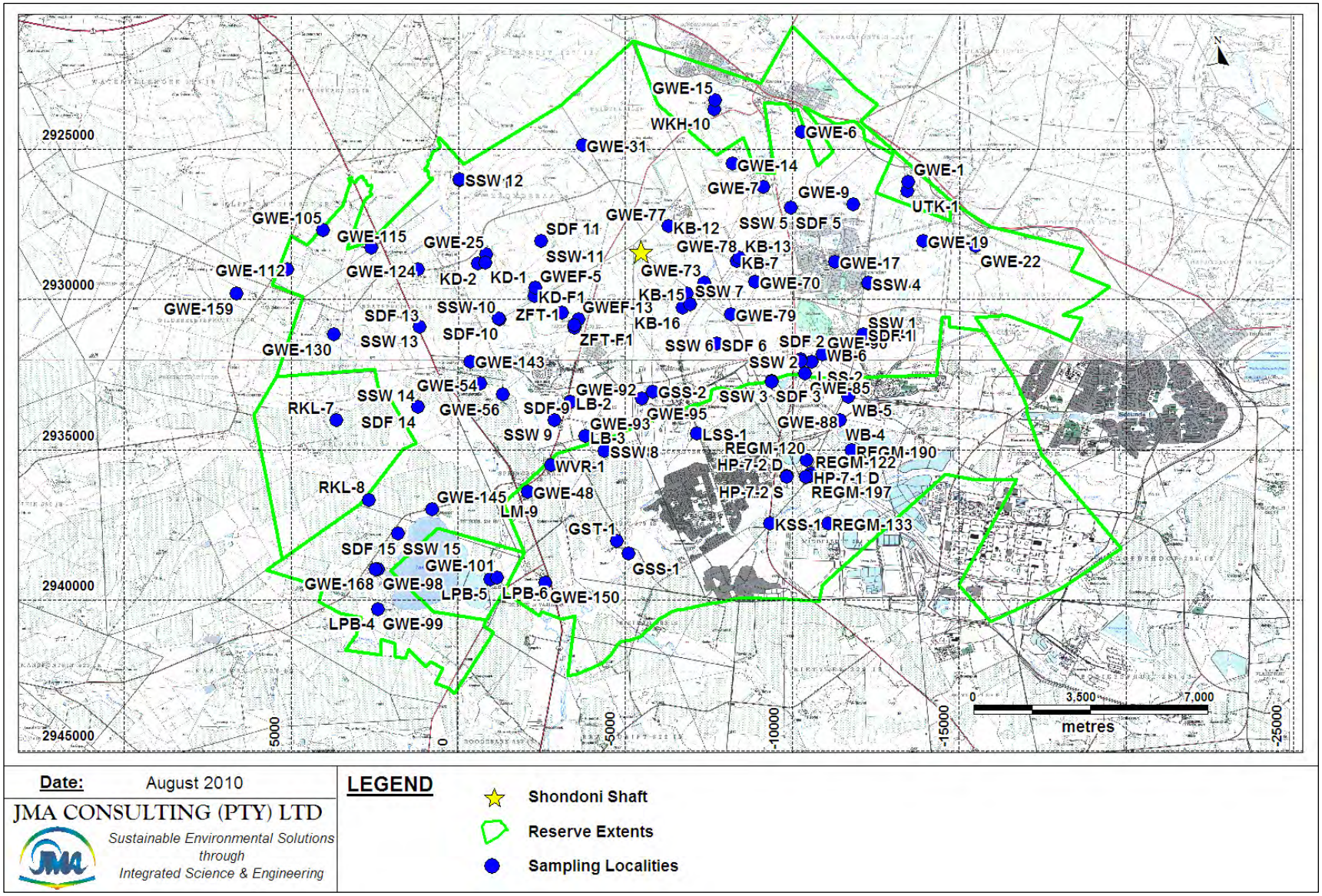


Figure 3.5.1(A): Ground Water Sampling Localities

The SANS Standard specifies two compliance classes namely Class I (Recommended) and Class II (Maximum Allowable). The colour coding for ground water quality used throughout this report interprets compliance with Class I as Full Compliance (green) and compliance with Class II as Marginal Compliance (orange). Exceedance of the Class II standard is interpreted as Non-Compliance (red).

The ground water geochemistry listed in Table 3.5.1(A) was determined from the ground water samples collected across the entire extent of the study area (Figure 3.5.1(A)). Due to the nature of the environment adjacent to several of the boreholes, the geochemistry of several boreholes was not used as the ground water quality at these boreholes had been affected by anthropogenic activities and do therefore not represent the background ground water quality.

Hydro-chemical imaging was used as a first screening tool, to eliminate boreholes, possibly influenced by any pollution source. This also meant that boreholes close to pollution sources (surface and sub-surface) were carefully scrutinised and discarded from this study group, if deemed necessary. After a statistical evaluation of Electrical Conductivity (EC) values, all boreholes with EC values in excess of 100 mS/m were discarded. Ground water samples are affected by mining-related pollution have lower pH values, and ground water samples that were classified as having non-compliant or marginally compliant pH values were therefore discarded as well. Elevated SO_4 and Fe concentrations are also indicators of possible mining-related contamination of the ground water. It should however be noted that the due to the nature of aquifer and associated host geology (naturally occurring Fe in the Karoo aquifers, as well as the weathering of dolerite dykes and sills), Fe is in fact naturally elevated in the ground water systems within the study area as well. Because of this, only SO_4 was used as a further screening tool, discarding all boreholes with SO_4 values exceeding 20 mg/l. Indicators, including NO_3 and Cl, were used to assess possible agricultural related influences, on external users' boreholes and springs. Some influences from agricultural activities were found, in the form of elevated NO_3 levels.

The remainder of the samples (33) where then screened to determine whether any individual outliers occurred for each of the individual parameters. Where the natural background value of any constituent was present at a natural elevated value (like F, Mn, Al and Fe), it was included in the background chemistry group. Through this screening process of elimination, a distinctive background image emerged, both in terms of hydro-chemical image, as well as water quality ranges, for the different water quality variables. A summary of the background ground water quality is listed in Table 3.5.1(B).

Table 3.5.1(B): Background Ground Water Quality Summary

Element / Parameter	Min Value	Mean Value	Max Value	Range
pH	**7.30**	**7.78**	**8.50**	1.20
EC (mS/m)	**24**	**69**	**98**	74
TDS (mg/l)	**138**	**433**	**608**	470
Ca (mg/l)	**4.3**	**34.9**	**72.0**	67.7
Mg (mg/l)	**1.3**	**20.5**	**48.0**	46.7
Na (mg/l)	**14**	**90**	**187**	173
K (mg/l)	**1**	**4**	**27**	26
Cl (mg/l)	**8**	**3**	**80**	72
SO_4 (mg/l)	**1.47**	**10.69**	**19.00**	17.53
NO_3 (mg/l)	**0.20**	**0.75**	**3.30**	3.10
F (mg/l)	**0.08**	**0.49**	**1.40**	1.32
Al (mg/l)	**0.02**	**0.80**	**3.93**	3.91
Fe (mg/l)	**0.03**	**4.26**	**18.00**	17.98
Mn (mg/l)	**0.01**	**0.06**	**0.32**	0.31

Table 3.5.1(B) indicates that the average background ground water quality has fully compliant concentrations for the elements pH, E, TDS, Ca, Mg, Na, K, Cl, SO_4, NO_3, F and Mn, whilst the average Al and Fe concentrations have non compliant qualities. The majority of the samples had fully compliant concentrations for each element analyzed for. Al and Fe had the most elevated concentrations in the background ground water samples, followed by NO_3 and Mn.

Hydrochemical imaging was performed for the samples that were used to determine the background ground water quality and composition within the study area. Piper and Durov diagrams were compiled using the macro chemistry variables pH, EC, Ca, Mg, Na, K, Total Alkalinity, Cl, SO_4 and NO_3. The resulting Piper and Durov Diagrams depicting the background ground water hydrochemical image are shown in Figure 3.5.1(B) and Figure 3.5.1(C) respectively.

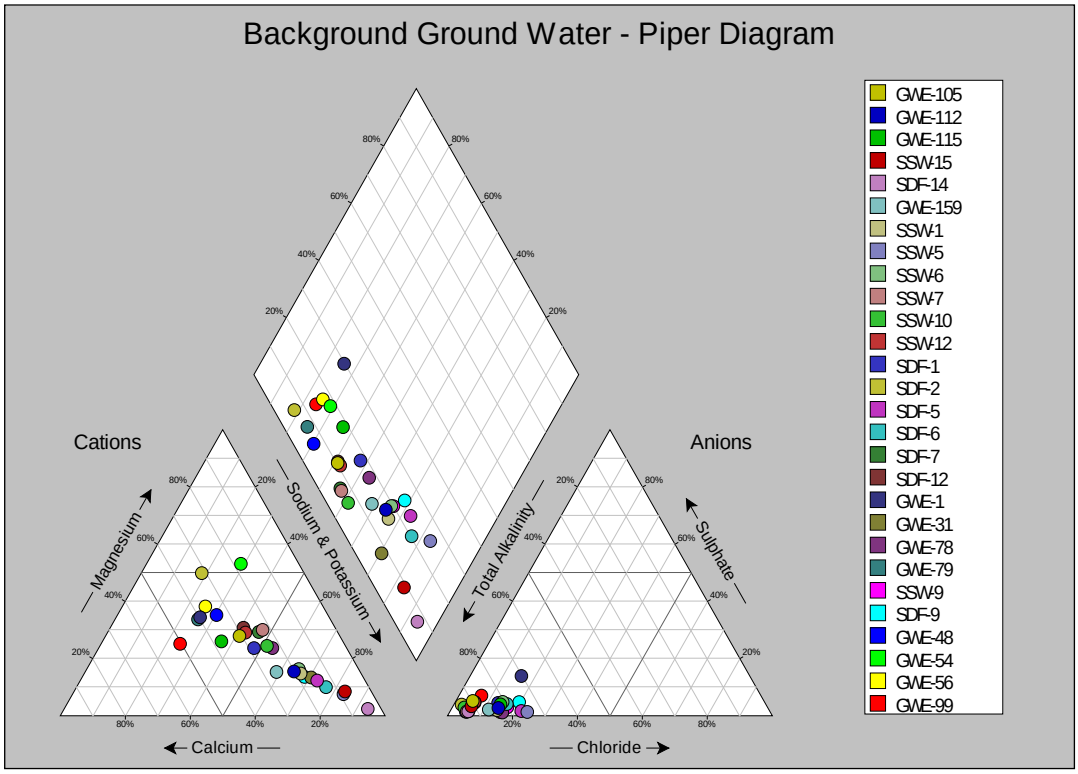


Figure 3.5.1(B): Background Ground Water Piper Diagram

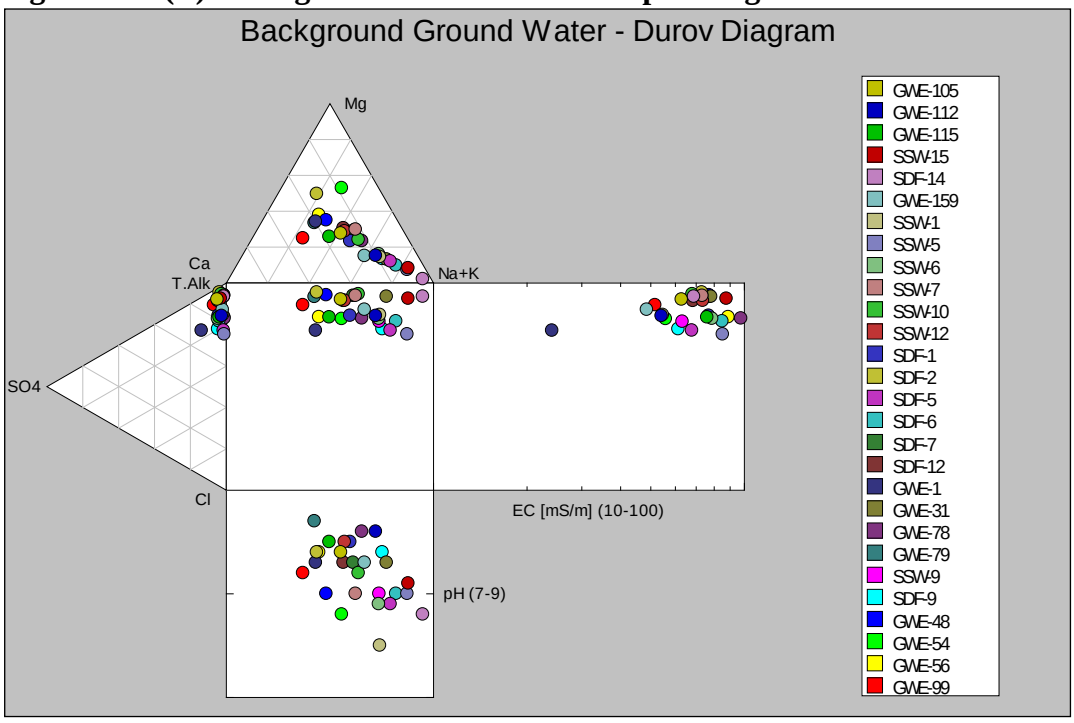


Figure 3.5.1(C): Background ground water Durov Diagram

The Pier and Durov Diagrams indicate that the ground water is classified as having a Type B and Type C hydrochemical facies. The dominant cation is variable, with most samples being dominant in Na + K. Interesting to note is that the ratio between the equivalent Ca and Mg concentrations remains constant for most of the background ground water samples collected. The dominant anion is clearly bicarbonate (T.Alk). Several of the background ground water samples had elevated NO3 concentrations (not seen on the Piper or Durov Diagrams), indicating sporadic influences as a result of agricultural activities within the study area. Fe and Al values have elevated concentrations as well, which predominantly result from the influence of the adjacent host rocks.

The pH of the background ground water is slightly alkaline and ranges between 7.3 and 8.5 with an average pH of 7.78. The EC of the Background ground water samples ranges between 24 mS/m and 98 mS/m, with an average EC value of 69 mS/m. The majority of the background ground water samples have EC values greater than 70 mS/m.

The background ground water quality, including the possible influences from the agricultural activities, remains of a very good quality and plots as “recent and unpolluted” ground water. This further supports the statement that water in the area emanating from springs and external user’s boreholes are probably not from deep circulation, but rather from the saturation of the shallow weathered zone and/or perched aquifers. Any mining related impacts on the ground water are expected to result in a decrease in the pH, as well as an increase in the TDS and SO_4 concentrations.

3.5.2 Current Site Specific Ground Water Quality

The assessment of the status of the ground water quality within the study area is based on the water quality data generated from samples taken at the 30 monitoring boreholes. The quality of the ground water sampled at the monitoring boreholes was assessed according to the SANS 241:2006 Drinking Water Standard and is depicted in Table 3.5.2(A).

Table 3.5.2(A): Monitoring Borehole Compliance – SANS 241:2006

BH No.	pH	EC	TDS	Ca	Mg	Na	K	Cl	SO4	NO3	F	Al	Fe	Mn
SSW-1	8.50	55	364	21	10	85.0	3.4	30	5	0.20	0.90	3.74	5.67	0.32
SSW-2	7.88	92	542	53	58	94.3	1.3	14	34	0.24	0.50	0.05	0.32	0.14
SSW-3	7.80	257	1776	141	112	207.0	6.1	444	200	0.20	0.50	2.28	5.53	0.27
SSW 4	8.60	300	2162	13	7	659.0	0.0	104	1035	0.00	0.00	0.00	0.00	0.00
SSW-5	8.00	85	508	16	8	170.0	2.6	80	5	0.20	1.30	2.55	10.00	0.10
SSW-6	8.10	79	492	30	16	121.0	3.9	45	19	0.20	0.40	0.64	4.18	0.06
SSW-7	8.00	73	462	35	28	83.0	2.4	16	5	0.20	1.10	0.25	2.03	0.03
SSW-8	7.70	313	1934	79	42	491.0	7.3	723	150	0.20	0.20	0.36	0.67	0.03
SSW-9	8.00	63	396	24	12	96.0	4.2	41	9	0.20	0.40	0.33	2.87	0.04
SSW-10	7.80	68	466	36	22	87.0	3.2	11	10	0.20	0.40	3.32	8.05	0.14
SSW-11	7.90	117	716	38	20	187.0	11.7	152	86	0.20	0.20	0.63	0.75	0.10
SSW-12	7.50	74	592	47	29	78.0	5.6	18	18	0.20	0.30	0.58	1.18	0.03
SSW-13	7.70	115	868	88	65	83.0	14.1	9	72	2.80	0.70	0.24	2.17	0.23
SSW-14	7.60	77	548	51	42	64.0	3.3	13	74	0.20	0.40	0.24	6.35	0.03
SSW-15	7.90	88	596	16	10	187.0	7.3	20	14	1.00	0.60	0.36	4.40	0.03
SDF-1	7.50	77	468	44	22	84.0	2.4	40	17	0.20	0.30	1.68	18.00	0.12
SDF-2	7.60	73	448	50	48	34.0	1.0	8	15	0.20	0.50	1.06	11.00	0.05
SDF-3	7.80	158	916	32	20	262.0	3.9	228	74	0.20	1.20	1.62	9.58	0.27
SDF-4	9.90	167	1156	2	2	380.0	5.2	120	33	1.10	12.00	7.96	7.38	0.06
SDF-5	8.10	68	406	20	10	113.0	2.4	56	5	0.20	1.40	1.23	2.85	0.05
SDF-6	8.00	85	516	22	10	147.0	2.8	53	17	0.20	0.30	3.93	11.00	0.09
SDF-7	7.70	73	460	37	27	81.0	1.9	16	5	0.20	1.00	0.56	4.94	0.07
SDF-8	7.80	277	1568	47	16	469.0	5.1	665	136	0.20	0.30	0.19	4.96	0.06
SDF-9	7.60	61	394	22	10	95.0	3.2	45	14	0.20	0.30	0.99	14.00	0.13
SDF-10	7.80	64	404	43	24	58.0	2.7	11	33	0.20	0.20	2.68	27.00	0.27
SDF-11	8.20	234	1348	3	2	563.0	1.9	347	12	0.20	4.60	2.14	6.17	0.06
SDF-12	7.70	68	432	44	29	71.0	5.4	18	17	0.20	0.40	0.58	17.00	0.15
SDF-13	8.00	110	662	32	20	209.0	5.8	18	78	0.20	0.60	0.90	9.49	0.12
SDF-14	8.20	69	422	6	2	159.0	3.3	16	5	0.20	0.50	0.54	0.97	0.03
SDF-15	9.80	76	418	2	2	168.0	4.1	27	20	1.00	0.60	0.83	5.31	0.05

Table 3.5.2(A) indicates that in addition to Al and Fe (which were naturally elevated in the ground water), Mg, Na, Cl, SO_4 and F had elevated concentrations with several samples having “non-compliant” concentrations. Several of the pH values were more alkaline and were classified as “marginally compliant” with regards to the SANS 241:2006 Drinking Water Standard. The EC, TDS and Mn also had slightly more elevated concentrations and several of the samples were classified as having “marginally compliant” concentrations.

A summary of the ground water geochemistry within the study area is listed in Table 3.5.2(B). The table summarises the geochemistry of the ground water sampled from SSW- and SDF monitoring boreholes. The data given in Table 3.5.2(B) has have been classified according to the SANS 241:2006 Drinking Water Standard.

Table 3.5.2(B): SSW- and SDF- Ground Water Quality Summary

Element / Parameter	SSW-Samples			SDF-Samples		
	Min Value	Mean Value	Max Value	Min Value	Mean Value	Max Value
pH	7.50	7.93	8.6	7.5	8.11	9.9
EC (mS/m)	55	124	313	61	111	277
TDS (mg/l)	364	828	2162	394	668	1568
Ca (mg/l)	13	46	141	2	27	50
Mg (mg/l)	7	32	112	2	16	48
Na (mg/l)	64	179	659	34	193	563
K (mg/l)	ND	5.09	14.1	1	3.41	5.8
Cl (mg/l)	9	115	723	8	111	665
SO_4 (mg/l)	5	116	1035	5	32	136
NO_3 (mg/l)	ND	0.42	2.8	0.2	0.31	1.1
F (mg/l)	ND	0.53	1.3	0.2	1.61	12
Al (mg/l)	ND	1.04	3.74	0.19	1.79	7.96
Fe (mg/l)	ND	3.61	10	0.97	9.98	27
Mn (mg/l)	ND	0.10	0.32	0.03	0.11	0.27

Table 3.5.2(B) indicates that the average quality of the ground water within the study area sampled from the SSW-boreholes has the same compliance as the background ground water quality, with the exception of Mn. The average Mn concentration was classified as “fully compliant” in the background ground water quality but has an average “marginal compliance” quality in the SSW boreholes. The SDF samples displayed a similar situation, except that the average F concentration was elevated to a “non-compliant” quality.

Table 3.5.2(B) indicates that several samples sampled from both the SSW- and SDF- boreholes had non-compliant Na and Cl concentrations. Mg and SO_4 were also elevated to non compliant concentrations in the SSW- samples and may indicate a possible mining related impact on the ground water quality. Table 3.5.2(B) also indicates that the SSW- ground water samples had a poorer quality than the SDF- ground water samples, which further indicates that possible anthropogenic surface or mining related activities may have had an effect on the ground water quality within the study area.

The geochemistry of the ground water sampled from the 30 monitoring boreholes within the study area was then assessed and compared to the geochemistry of the background ground water, in order to determine whether impacts could be determined. Piper and Durov diagrams were again compiled using the macro chemistry variables pH, EC, Ca, Mg, Na, K, Total Alkalinity, Cl, SO_4 and NO_3. The resulting Piper and Durov Diagrams depicting the hydrochemical image of the ground water in the study area are shown in Figure 3.5.2(A) and Figure 3.5.2(B) respectively.

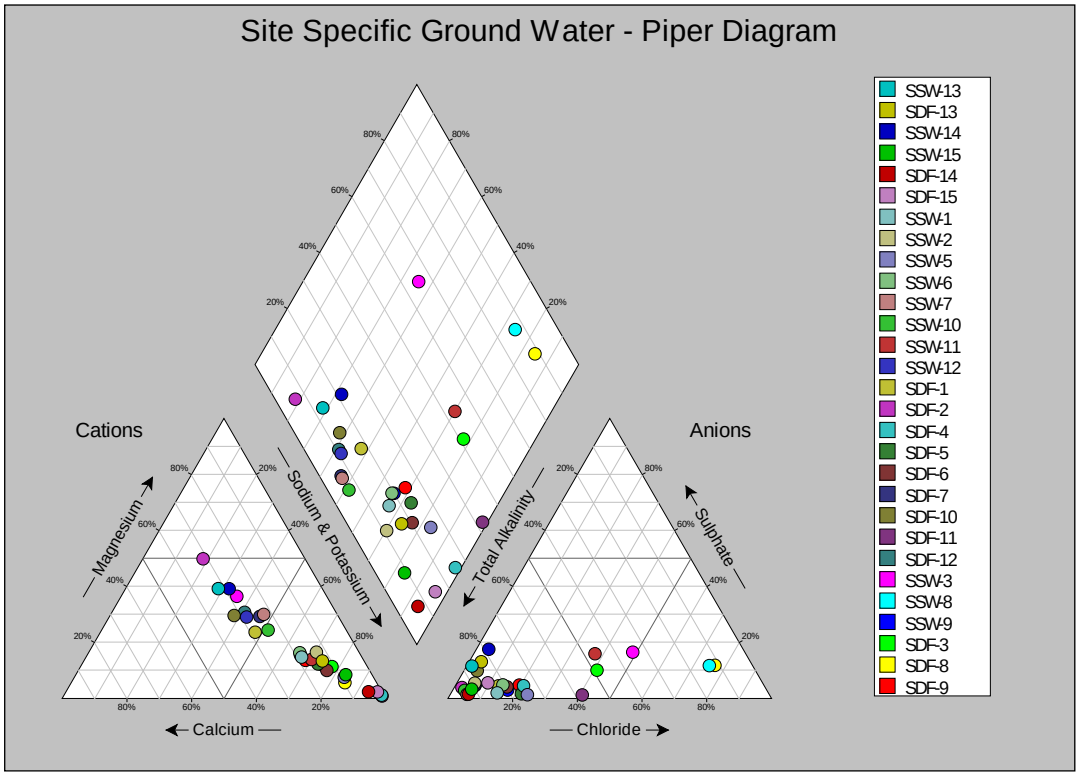


Figure 3.5.2(A): Study Area Ground Water Piper Diagram

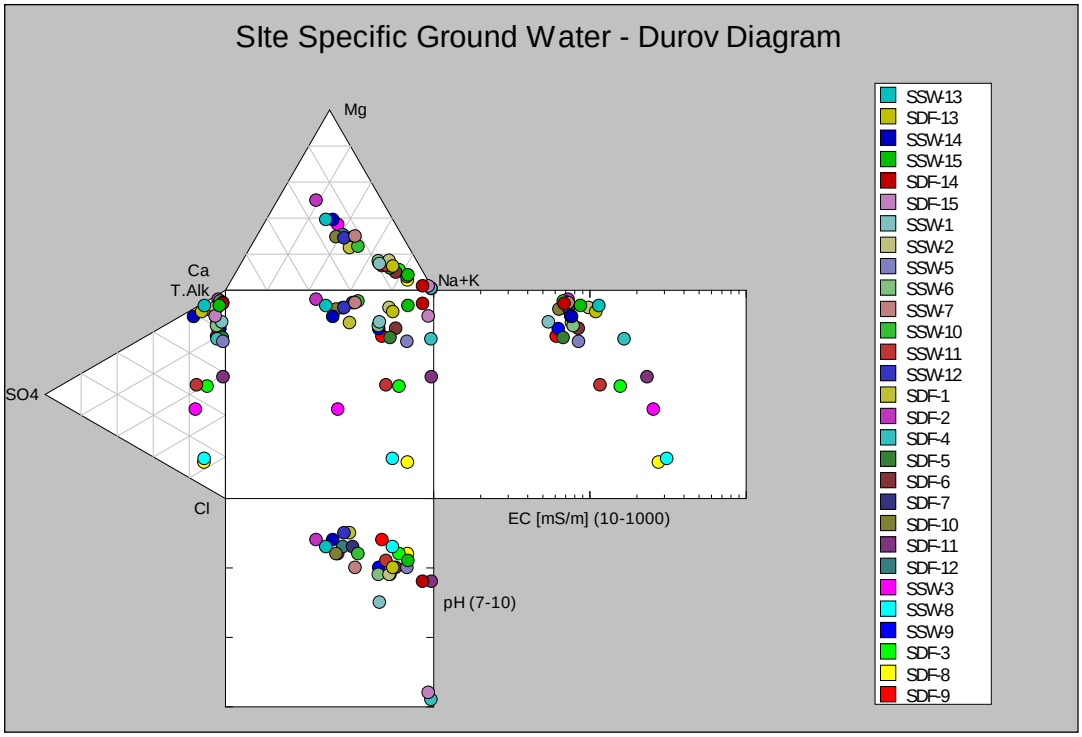


Figure 3.5.2(B): Study Area Ground Water Durov Diagram

It is evident from Figures 3.5.2(A) and 3.5.2(B) that there has been a distinct shift in the hydrochemical image in several of the ground water samples taken from the monitoring boreholes. The most notable of these include the ground water samples taken from SSW-3, SSW-8, SSW-11, SDF-3 and SDF-8.

The equivalent major cation concentration distribution remained relatively similar to the background ground water quality, and the relative Ca:Mg ratio remained constant as well. The equivalent major cation concentration distribution had altered significantly with several of the samples having significantly higher equivalent Cl concentrations. Several samples had higher equivalent SO_4 concentrations as well.

The shift in the geochemistry signature of several ground water samples, predominantly SSW- samples, it is determined that several localized anthropogenic surface and mining related activities have had an impact on and altered the ground water geochemistry to varying degrees within the study area.

3.5.3 Multi Parameter Profiling

Multi-parameter profiles at each of the 30 monitoring boreholes were performed. These profiles are attached as Appendix 3(B) and include the following:

- Temperature (ºC)
- Conductivity (mS/m)
- Dissolved Oxygen Concentration (mg/l)
- pH
- ORP (Oxidation-Reduction Potential) (mV)

The following observations are made regarding the profiles, and specific reference is made to ground water where pyrite is present:

- The temperature of mine ground water in a geohydrological borehole is generally in the range between 16 and 19ºC. Locally elevated temperatures observed in the profiles occur as a result of the exothermic oxidation of pyrite, and are the product of bacteriological workings. The bacteria are optimal at a temperature of about 30ºC.
- For the oxidation process of pyrite by oxygen, bacteria needs oxygen, thus the higher the dissolved oxygen, the more the oxidation of pyrite and the lower the pH becomes. In reducing environments, no oxidation of pyrite will occur and some microbes will even produce pyrite in anoxic-sulfidic conditions. Pyrite oxidation may still occur just above the water table in the unsaturated zone (where more oxygen is present) if pyrite is present. The dissolved oxygen in rainwater is 8 mg/l. Most boreholes show elevated dissolved oxygen at top because of the contact with the atmosphere.
- The temperature at the top of the boreholes is often elevated because of the naturally warmer water of the unsaturated zone that travels down the borehole as well as the result of naturally warmer air in contact with the surface of the boreholes.
- The results of the profiles for the each of the parameters profile din the boreholes complement each other directly or indirectly. These profiles are used to ain in the interpretation of the geohydrology of the sub-surface as well.

SDF-9 and SDF-6

- Boreholes SDF-9 and SDF-6 were drilled into the deeper Karoo aquifer and the multi-parameter profiles were done from about 5 m to a depth of about 75 m in the deeper boreholes.
- The boreholes have a constant temperature around 18ºC for the first 40 m. SDF-6 does show a slight elevation in temperature at the top. After 40 m the temperature start rising slowly to about 19ºC.
- The dissolved oxygen is at about 8 mg/l at the top of the boreholes and decrease to about 2 mg/l at 19 m and to nearly 0 mg/l deeper down.
- The Electrical Conductivity is constant in the boreholes for the first 60 m, in borehole SDF-9 at about 105 mS/m, in borehole SDF-6 around 150 mS/m. At the interval of the profile from about 60 to 75 m, the conductivity rises in SDF-9 to 165 mS/m and in SDF-6 to 175 mS/m.
- The pH also stays around 7.4 in both boreholes but at the same interval mentioned above, 60 to 75 m, the pH starts rising to 8.4 in SDF-9 and to 9.3 in SDF-6.
- Both profiles show a slight increase in reducing conditions in the profiles but after the interval from 60 to 75 m, much more stronger reducing conditions are present.
- The increase of pH and Conductivity, with the strong decrease in reducing conditions at the interval from about 60 to 75 m are very evident and show definite stratification deep in the borehole. The ground water samples of both boreholes were taken in this interval and are very similar in the sense that the same parameters are elevated or reduced.
- Boreholes indicating similar profiles are boreholes SDF-13, SDF-12, SDF-14 that are also drilled into the deeper Karoo aquifer. Shallower boreholes with similar profiles are SSW-2 and SSW-11.

SDF-8 and SDF-13

- Borehole SDF-8 was drilled into the deep Karoo aquifer and SSW-7, SSW-9 and SSW-13 were drilled into the shallow weathered zone aquifer. The multi-parameter profiles were performed from the top of the water level to about 30 m in the shallow boreholes; and to about 80 m in SDF-8.
- All the boreholes show significantly elevated temperatures at the top and the maximum temperatures are much higher than that of other profiles done within the study area. SDF-8 and SSW-13 show maximum temperatures elevated just above 28ºC and SSW-7 and SSW-9 just above 23ºC. Because of this significant elevation one could expect bacteriological working and, because it is in an oxygen-rich environment, the oxidation of pyrite.
- In borehole SDF-8 the conductivity is slightly elevated at the top and then decline constantly deeper down the borehole. Boreholes SSW-7 and SSW-9 show a rise in conductivity in the first few meters until 4 m and 7 m respectively, after which it stays about constant deeper down.
- In boreholes SDF-8 and SSW-13 the dissolved oxygen starts to decline after a few meters to just above 0 mg/l. Boreholes SSW-7 and SSW-9 show very similar profiles. What is evident in all four boreholes is the slight depletion in dissolved oxygen at the top. This may be because the bacteria that show their presence with the elevated temperature at the top, are using oxygen and thus give rise to a slight depletion in oxygen at the top.

- Contrasting to the above, the pH stays relatively high in all four boreholes. This indicates no bacterial working but rather that enough alkalinity is present in the surrounding rocks to neutralize any acid produced.
- The important indicator of pyrite oxidation is elevated SO4. In the ground water samples of SDF-8 and SSW-13, SO4 values are elevated at 136 and 72 mg/l, higher than the maximum background SO4 value of 20 mg/l.
- Microbiological activity is clear in boreholes SDF-8 and SSW-13. Although elevated temperature occurs in SSW-7 and SSW-9, not enough evidence is present to justify significant oxidation of pyrite. The deeper borehole SDF-7 near SSW-7 also shows slightly elevated temperature (nearly 22ºC) at the top, but no indication of contamination of the water is present.
- Borehole SDF-8 is drilled close to an old gold mine dump and confirms the presence of ground water contamination. The geology of the borehole consists mostly of sandstone and shale layers throughout the borehole. Dolerite is present from 18 to 45 m and carbonaceous shale and a thin coal layer at 72 to 74 m.

SDF-1, SDF-2, SDF-3, SDF-10, SSW-1, SSW-3, SSW-6, SSW-14 and SSW-15

- All boreholes show slightly elevated temperatures at the top, but the temperature is seldom higher than 20ºC. This indicates no or insignificant pyrite oxidation.
- There is a lower electrical conductivity at the top, which may be due to water that falls constantly from above and dilute the water at the top of the borehole.
- All boreholes show high dissolved oxygen at the top of about 8.26 mg/l. The oxygen decreases further down the borehole to nearly 0 mg/l.
- The pH profile also starts a bit higher and decline further down the borehole and in most boreholes starts rising slightly again deeper down.
- In all boreholes, except SSW-15, the conditions become more reducing deeper down which may also indicate that the deeper water are not circulated very often and are older. No drastic variation in any parameter indicates any sharp stratification.

SDF-4, SDF-5, SDF-11, SSW-5 and SSW-12

- SDF-4, SDF-5 and SSW-12 show slight elevation in temperature at the top, which may be because of natural reasons as discussed above but boreholes SDF-11 and SSW-5 show constant temperatures from top to bottom.
- SDF-4, SDF-5 and SSW-12 show elevated pH that decline further down the boreholes. Boreholes SDF-4 and 11 show slight declined pH at the top but the pH's stay about constant deeper down the boreholes.
- SDF-4 and SSW-12 show more oxidizing conditions downwards and SDF-5, SDF-11 and SSW-5 becomes more reducing downwards. No drastic variation in any parameter indicates any sharp stratification.

3.6 AQUIFER CLASSIFICATION

The aquifer classification is done in accordance with the formal DWAF protocol "South African Aquifer System Management Classification, December 1995." Special attributes of aquifers related to structural features (such as fracturing along dyke/fault contact zones, or karst development) have been incorporated into the classification through the "Second Variable Classification".

Classification is done in accordance with the following definitions for Aquifer System Management Classes:

Sole Aquifer System:

An aquifer which is used to supply 50 per cent or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial.

Major Aquifer System:

Highly permeable formations, usually with a known, or probable, presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (less than 150 mS/m Electrical Conductivity).

Minor Aquifer System:

These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important for local supplies and in supplying base flow for rivers.

Non-Aquifer System:

These are formations with negligible permeability that are regarded as not containing ground water in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, ground water flow through such rocks, although imperceptible, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.

Aquifer System Management and Second Variable Classifications

Aquifer System Management Classification		
Class	**Points**	**Karoo Aquifers**
Sole Source Aquifer System:	6	-
Major Aquifer System:	4	-
Minor Aquifer System:	2	2
Non-Aquifer System:	0	-
Special Aquifer System:	0 – 6	-
Second Variable Classification – Mining Related Dewatering		
Class	**Points**	**Karoo Aquifers**
High:	3	-
Medium:	2	-
Low:	1	1

The Karoo Aquifers present within the study area appear to have been locally impacted by underground mining operations as a result of dewatering. This is observed by the localized drop in the water levels across the study area.

*Aquifer System Management Classification Points = **3***

Ground Water Quality Management Classification

Aquifer System Management Classification		
Class	**Points**	**Karoo Aquifers**
Sole Source Aquifer System:	6	-
Major Aquifer System:	4	-
Minor Aquifer System:	2	2
Non-Aquifer System:	0	-
Special Aquifer System:	0 – 6	-
Aquifer Vulnerability Classification		
Class	**Points**	**Karoo Aquifers**
High:	3	-
Medium:	2	-
Low:	1	1

*Aquifer System Management Classification Points = **3***

The indicated level of ground water protection is derived from the Ground Water Quality Management Index (GQM Index).

GQM Index = Aquifer System Management Classification x Aquifer Vulnerability Classification
= *3 x 3*
= ***9***

Indicated Level of Ground Water Protection

GQM Index	*Level of Protection*	*Karoo Aquifers*
<1	*Limited*	-
1 - 3	*Low Level*	-
3 - 6	*Medium Level*	-
6 - 10	*High Level*	*9*
>10	*Strictly Non-Degradation*	-

Aquifer Protection Classification

The ratings for the Aquifer System Management Classification and Aquifer Vulnerability Classification yield a Ground Water Quality Management Index of 12 for the Karoo Aquifers within the study area, indicating that High Level of ground water protection is required.

3.7 GROUND WATER USE

A borehole and spring hydrocensus, was performed within a one km radius of the study area. A total of 170 boreholes, 1 dug well and 16 fountains were identified. The localities of these boreholes, well and fountains are located in Figure 3.7(A). These localities as well as their borehole/well/fountain numbers are indicated on the map attached as Appendix 3.2(A).

98 of the boreholes surveyed, including one dug well, were found to be in use, while 17 were found to have been destroyed. As far as the application status and use of the boreholes are concerned, the following information was gathered:

- 17 boreholes are used solely for domestic purposes.
- 33 boreholes are used for agricultural and domestic purposes.
- 18 boreholes are used solely for stock watering.
- 2 boreholes are used solely for domestic garden purposes.
- 28 monitoring boreholes are used for observation purposes by Kinross, Winkelhaak and Leslie Gold Mines Ltd.

The above boreholes supply roughly 721 people, 38 gardens, one nursery, 5862 large stock units, 6 dairies, 965 small stock units, 27050 poultry units and water to irrigate roughly 7 hectares.

Four (4) of the 16 fountains surveyed are in use. As far as the application status of the fountains is concerned, 2 fountains are used solely for stock watering and the other two are used for agricultural and domestic purposes. The fountains supply water to 10 people, 325 large stock units and 150 small stock units.

The following observations, related to geohydrological aspects, have relevance to the information obtained:

- The reported depths for the external user's boreholes ranged between 13 m and 150 m, averaging at 55 m.
- The depths of water strikes for the external user's boreholes ranged between 11 m and 100 m, averaging at 32 m.
- The reported yields for the external user's boreholes ranged between 0.01 l/s and 8.30 l/s, averaging at 1.27 l/s.
- The estimated yields for the external user's fountains ranged between 0.05 l/s and 2.00 l/s, averaging at 0.47 l/s.
- The depth to water level observed for the external user's boreholes and fountains ranged between 0 m and 27.19 m, averaging at 4.75 m.

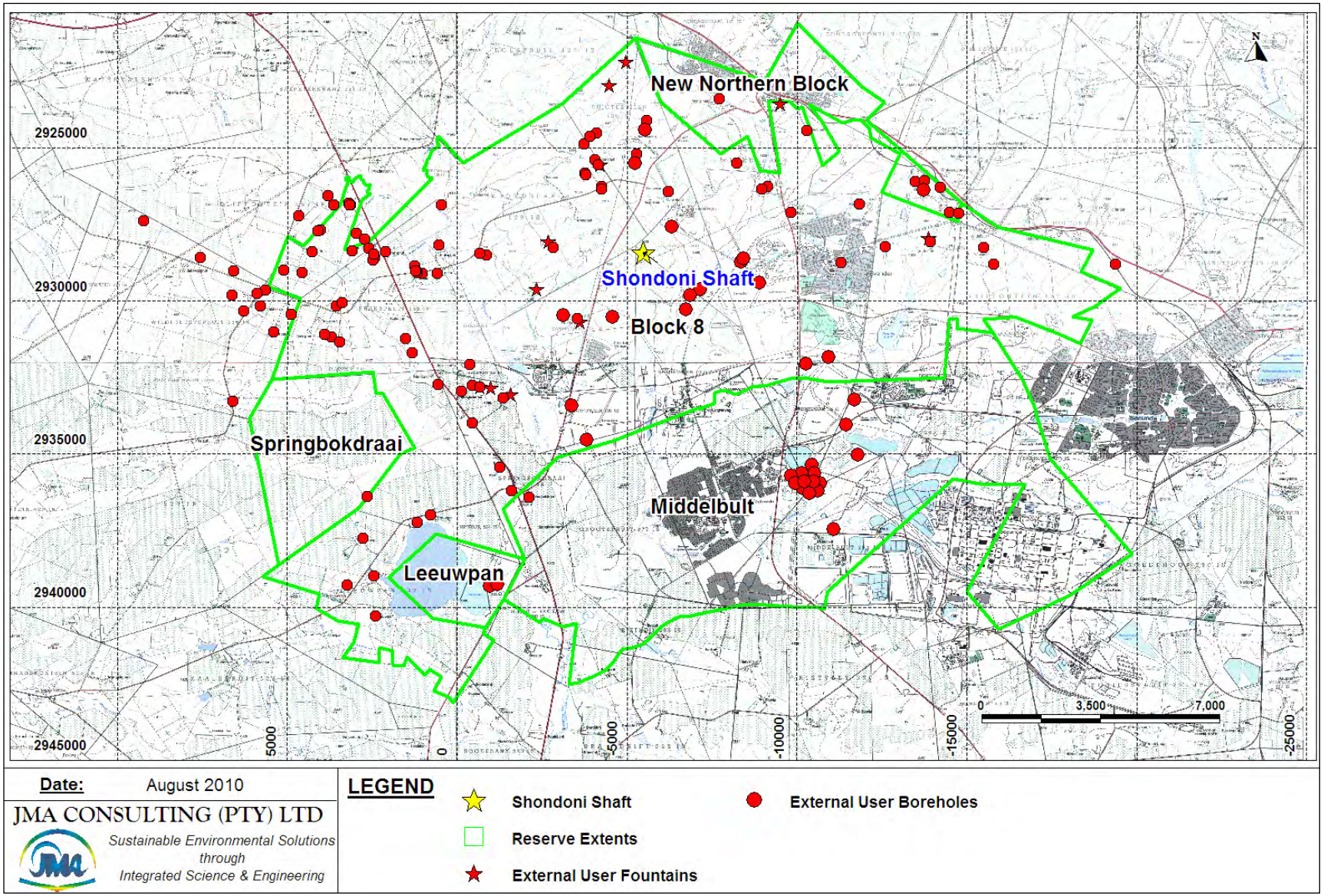


Figure 3.7(A): Hydrocensus Sampling Localities

4. PROJECT/ACTIVITY DESCRIPTION

4.1. OPERATIONAL PHASE WATER BALANCE

4.1.1 Mining schedule

The proposed Sasol Shondoni No. 2 and 4 coal seam workings are scheduled from FY21 to FY48 and from FY10 to FY48 respectively. A total of 2 702 ha and 10 406 ha of No. 2 and 4 coal seam mining are planned respectively. Almost 22% of the No. 4 coal seam workings will undergo further high extraction. The mining schedules for the proposed No. 2 and 4 coal seam workings are depicted in **Figure 4.1.1(A)** and **Figure 4.1.1(B)** below:

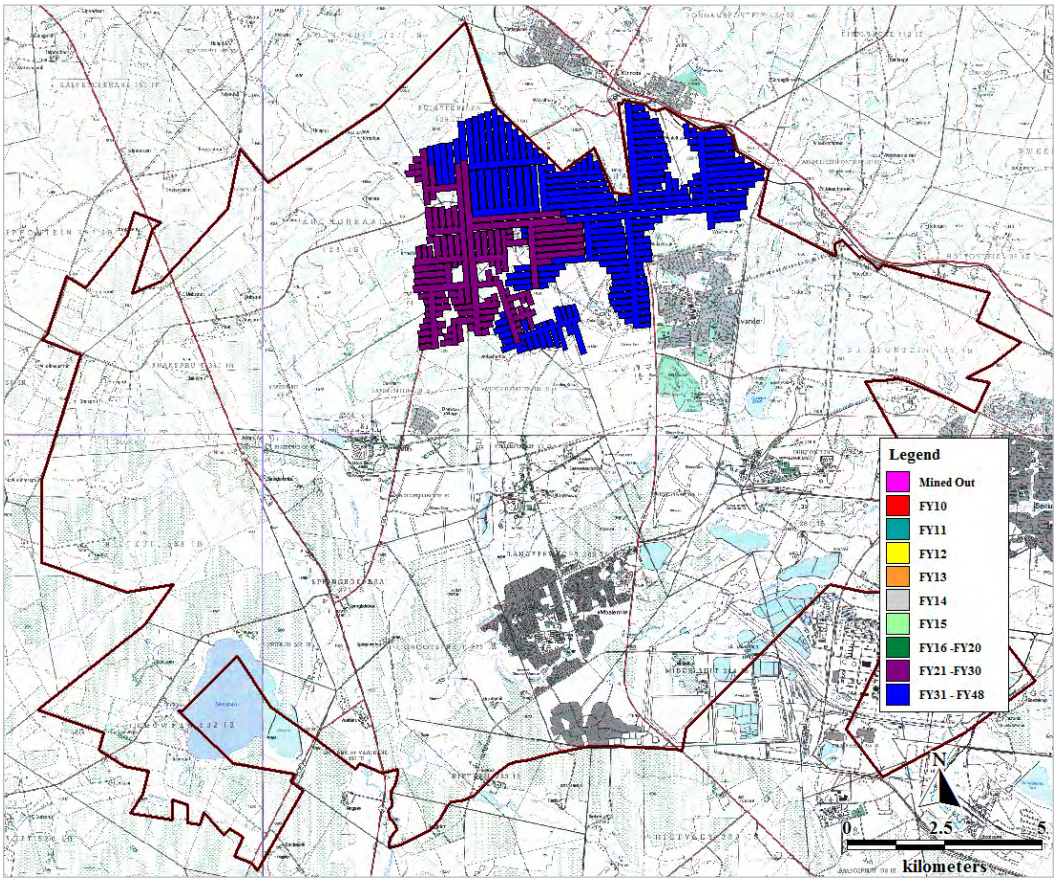


Figure 4.1.1(A). No. 2 coal seam underground mining schedule.

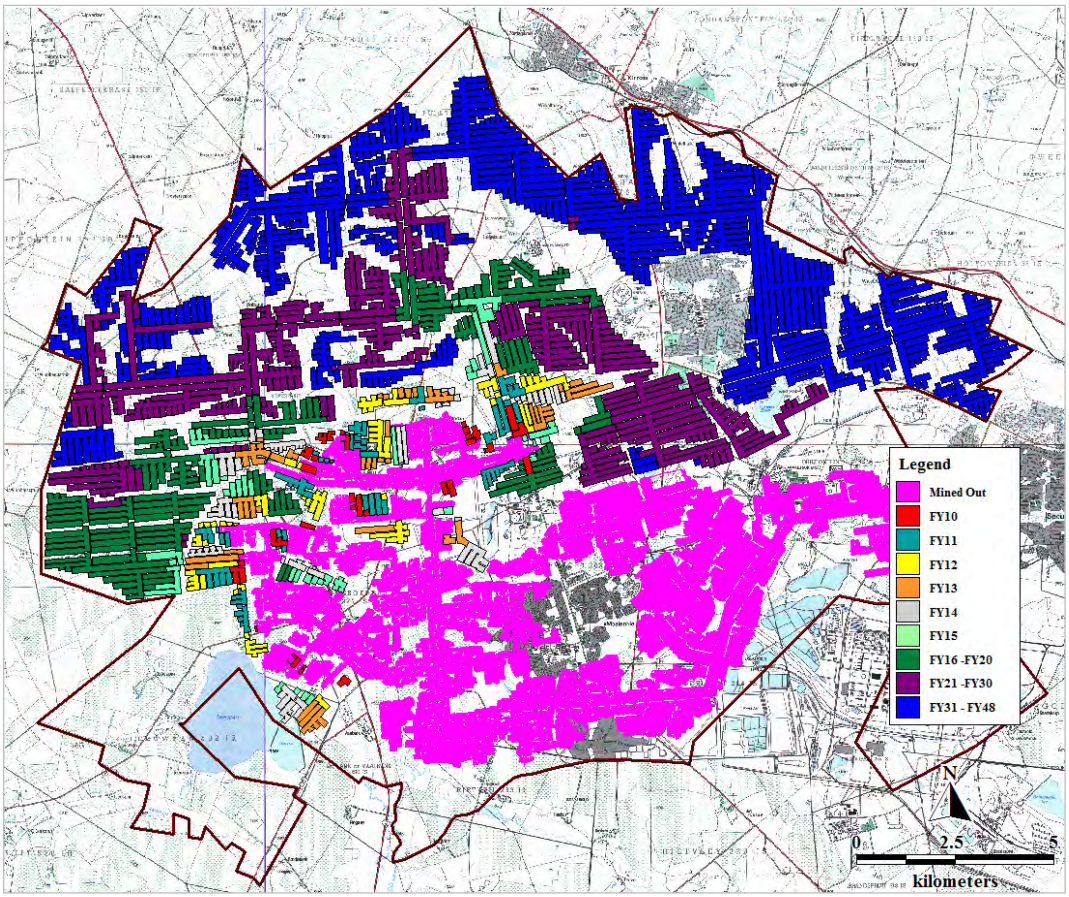


Figure 4.1.1(B). No. 4 coal seam underground mining schedule.

4.1.2 Ground water make

The groundwater make calculations for the Sasol Shondoni No 2 and 4 coal seam workings are given in **Table 4.1.2(A)** and **(B)** below.

From **Table 4.1.2(A)** and **(B)** the following conclusions could be made:

- For the No. 2 coal seam workings a total of 2 702 ha of bord and pillar mining (at an extraction rate of 47%) is planned.
- For the No. 4 coal seam workings a total of 10 406 ha of bord and pillar mining (at an extraction rate of 55%) is planned and almost 22% thereof will be undergo further high extraction (at an extraction rate of 60%).
- The total post-closure groundwater make for the Sasol Shondoni No. 2 and No. 4 coal seam workings will be 189 133 m^3/d and 2 561 811 m^3/d.

Table 4.1.2(A). Groundwater balance for the proposed No. 2 coal seam workings.

Year of Mining	Area Bord & Pillar(m^2)	Cumulative Area Board & Pillar (m^2)	Recharge (m^3/a)	Recharge (m^3/d)
FY 21	918 900	918 900	3 216	9
FY 22	918 900	1 837 800	9 648	27
FY 23	918 900	2 756 700	16 081	45
FY 24	918 900	3 675 600	22 513	63
FY 25	918 900	4 594 500	28 945	81
FY 26	918 900	5 513 400	35 378	99
FY 27	918 900	6 432 300	41 810	117
FY 28	918 900	7 351 200	48 242	136
FY 29	918 900	8 270 100	54 675	154
FY 30	918 900	9 189 000	61 107	172
FY 31	990 556	10 179 556	67 790	190
FY 32	990 556	11 170 111	74 724	210
FY 33	990 556	12 160 667	81 658	229
FY 34	990 556	13 151 222	88 592	249
FY 35	990 556	14 141 778	95 526	268
FY 36	990 556	15 132 333	102 459	288
FY 37	990 556	16 122 889	109 393	307
FY 38	990 556	17 113 444	116 327	327
FY 39	990 556	18 104 000	123 261	346
FY 40	990 556	19 094 556	130 195	366
FY 41	990 556	20 085 111	137 129	385
FY 42	990 556	21 075 667	144 063	405
FY 43	990 556	22 066 222	150 997	424
FY 44	990 556	23 056 778	157 931	444
FY 45	990 556	24 047 333	164 864	463
FY 46	990 556	25 037 889	171 798	483
FY 47	990 556	26 028 444	178 732	502
FY 48	990 556	27 019 000	185 666	522
Post-closure New UG	**0**	**27 019 000**	**189 133**	**531**

Table 4.1.2(B). Groundwater balance for the proposed No. 4 coal seam mine workings.

Year of Mining	Area High Extraction (m^2)	Cumulative Area High Extraction (m^2)	Area Bord & Pillar (m^2)	Cumulative Area Board & Pillar (m^2)	Total Mining Area (m^2)	Liberation from Overlying Units (m^3/a)	Recharge (m^3/a)	Total Water Make (m^3/a)	Total Water Make (m^3/d)
FY 10	122 300	122 300	1 289 700	1 289 700	1 412 000	64 208	12 880	77 088	36
FY 11	94 680	216 980	2 686 320	3 976 020	4 193 000	49 707	47 547	97 254	134
FY 12	183 706	400 686	2 656 294	6 632 314	7 033 000	96 446	93 715	190 160	263
FY 13	144 900	545 586	2 828 100	9 460 414	10 006 000	76 073	142 457	218 529	400
FY 14	227 000	772 586	2 677 000	12 137 414	12 910 000	119 175	192 707	311 882	541
FY 15	315 700	1 088 286	2 618 300	14 755 714	15 844 000	165 743	246 869	412 612	693
FY 16	298 800	1 387 086	2 791 200	17 546 914	18 934 000	156 870	304 093	460 963	854
FY 17	298 800	1 685 886	2 791 200	20 338 114	22 024 000	156 870	361 994	518 864	1 017
FY 18	298 800	1 984 686	2 791 200	23 129 314	25 114 000	156 870	419 895	576 765	1 179
FY 19	298 800	2 283 486	2 791 200	25 920 514	28 204 000	156 870	477 796	634 666	1 342
FY 20	298 800	2 582 286	2 791 200	28 711 714	31 294 000	156 870	535 697	692 567	1 505
FY 21	601 700	3 183 986	2 155 300	30 867 014	34 051 000	315 893	598 689	914 581	1 682
FY 22	601 700	3 785 686	2 155 300	33 022 314	36 808 000	315 893	666 770	982 662	1 873
FY 23	601 700	4 387 386	2 155 300	35 177 614	39 565 000	315 893	734 851	1 050 744	2 064
FY 24	601 700	4 989 086	2 155 300	37 332 914	42 322 000	315 893	802 933	1 118 825	2 255
FY 25	601 700	5 590 786	2 155 300	39 488 214	45 079 000	315 893	871 014	1 186 906	2 447
FY 26	601 700	6 192 486	2 155 300	41 643 514	47 836 000	315 893	939 095	1 254 988	2 638
FY 27	601 700	6 794 186	2 155 300	43 798 814	50 593 000	315 893	1 007 176	1 323 069	2 829
FY 28	601 700	7 395 886	2 155 300	45 954 114	53 350 000	315 893	1 075 258	1 391 150	3 020
FY 29	601 700	7 997 586	2 155 300	48 109 414	56 107 000	315 893	1 143 339	1 459 232	3 212

Year of Mining	Area High Extraction (m^2)	Cumulative Area High Extraction (m^2)	Area Bord & Pillar (m^2)	Cumulative Area Board & Pillar (m^2)	Total Mining Area (m^2)	Liberation from Overlying Units (m^3/a)	Recharge (m^3/a)	Total Water Make (m^3/a)	Total Water Make (m^3/d)
FY 30	601 700	8 599 286	2 155 300	50 264 714	58 864 000	315 893	1 211 420	1 527 313	3 403
FY 31	775 000	9 374 286	1 736 111	52 000 825	61 375 111	406 875	1 282 026	1 688 901	3 601
FY 32	775 000	10 149 286	1 736 111	53 736 936	63 886 222	406 875	1 355 157	1 762 032	3 807
FY 33	775 000	10 924 286	1 736 111	55 473 047	66 397 333	406 875	1 428 287	1 835 162	4 012
FY 34	775 000	11 699 286	1 736 111	57 209 158	68 908 444	406 875	1 501 418	1 908 293	4 217
FY 35	775 000	12 474 286	1 736 111	58 945 270	71 419 556	406 875	1 574 549	1 981 424	4 423
FY 36	775 000	13 249 286	1 736 111	60 681 381	73 930 667	406 875	1 647 679	2 054 554	4 628
FY 37	775 000	14 024 286	1 736 111	62 417 492	76 441 778	406 875	1 720 810	2 127 685	4 834
FY 38	775 000	14 799 286	1 736 111	64 153 603	78 952 889	406 875	1 793 940	2 200 815	5 039
FY 39	775 000	15 574 286	1 736 111	65 889 714	81 464 000	406 875	1 867 071	2 273 946	5 245
FY 40	775 000	16 349 286	1 736 111	67 625 825	83 975 111	406 875	1 940 201	2 347 076	5 450
FY 41	775 000	17 124 286	1 736 111	69 361 936	86 486 222	406 875	2 013 332	2 420 207	5 655
FY 42	775 000	17 899 286	1 736 111	71 098 047	88 997 333	406 875	2 086 462	2 493 337	5 861
FY 43	775 000	18 674 286	1 736 111	72 834 158	91 508 444	406 875	2 159 593	2 566 468	6 066
FY 44	775 000	19 449 286	1 736 111	74 570 270	94 019 556	406 875	2 232 724	2 639 599	6 272
FY 45	775 000	20 224 286	1 736 111	76 306 381	96 530 667	406 875	2 305 854	2 712 729	6 477
FY 46	775 000	20 999 286	1 736 111	78 042 492	99 041 778	406 875	2 378 985	2 785 860	6 683
FY 47	775 000	21 774 286	1 736 111	79 778 603	101 552 889	406 875	2 452 115	2 858 990	6 888
FY 48	775 000	22 549 286	1 736 111	81 514 714	104 064 000	406 875	2 525 246	2 932 121	7 093
Post-closure New UG	**0**	**22 549 286**	**0**	**81 514 714**	**104 064 000**	**0**	**2 561 811**	**2 561 811**	**7 196**

4.1.3 Mine floor contours and implications for mine water flow

The mine floor contours and the general directions of mine water flow for the No. 2 and 4 coal seam workings are depicted in **Figures 4.1.3(A)** and **(B)** below:

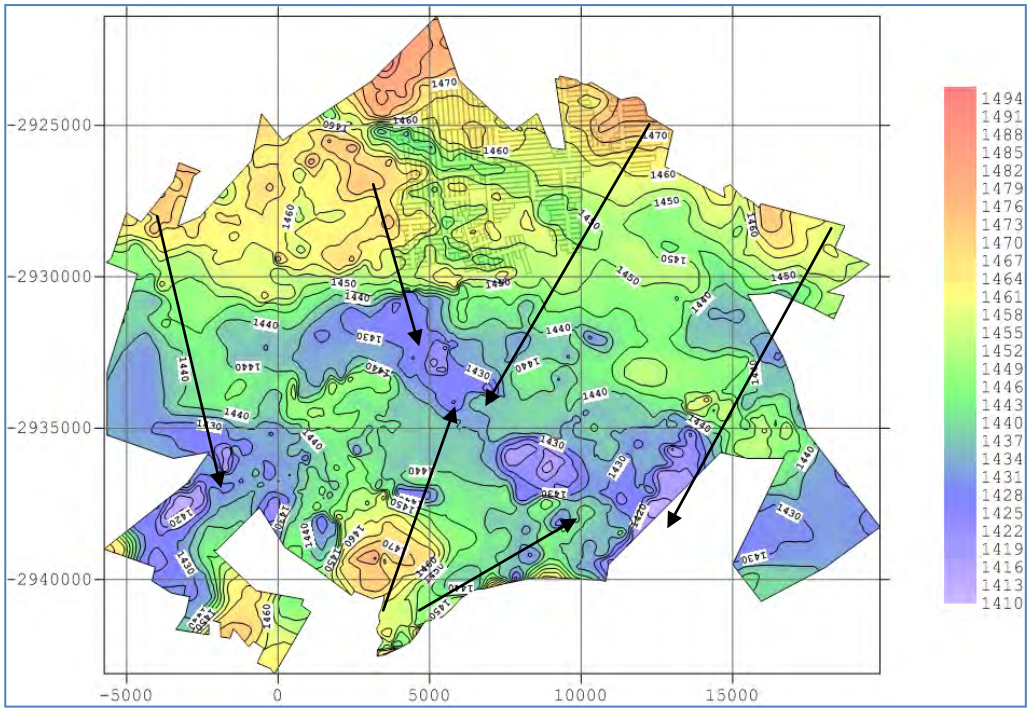


Figure 4.1.3(A). No 2 coal seam floor contour and mine water flow directions.

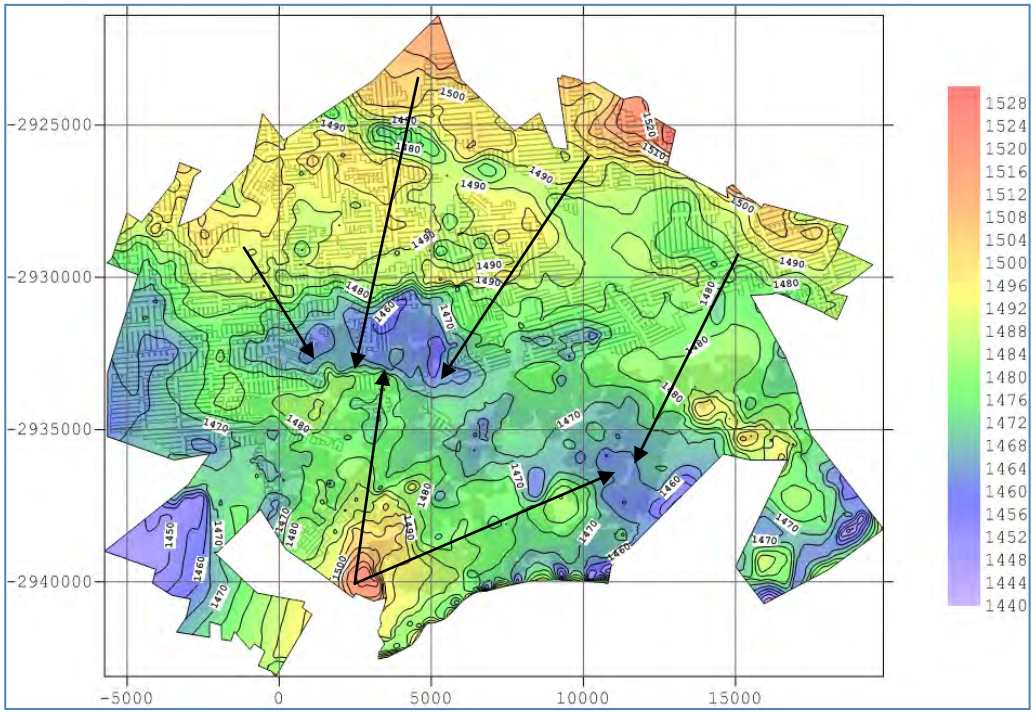


Figure 4.1.3(B). No 4 coal seam floor contour and mine water flow directions.

From the above figures the following observations could be made:

- In the extent of the mine boundary the No. 2 coal seam floor at Sasol Shondoni is elevated above 1 450 mamsl in the north-eastern, northern, north-western and southern parts. The mining floor dips from these regions towards the central (1 410 - 1 450 mamsl) part.

  The floor of the proposed No. 2 coal seam workings ranges between 1 439 - 1 479 mamsl.

- In the extent of the mine boundary the No. 4 coal seam floor at Sasol Shondoni is elevated above 1 490 mamsl in the north-eastern, northern and southern parts. The mining floor dips from these regions towards the central (1 442 - 1 490 mamsl) parts.

  The floor of the proposed No. 4 coal seam workings ranges between 1 455 - 1 527 mamsl.

- Mine water will flow perpendicular to the mine floor contours as indicated in the figures above.

4.1.4 Mine water storage capacity

The mine water storage capacity for the No. 2 and 4 coal seam workings was calculated and are depicted in **Figure 4.1.4(A)** and **(B)** respectively below. **Table 4.1.4(A)** below summarizes the post-closure water storage capacity at Sasol Shondoni.

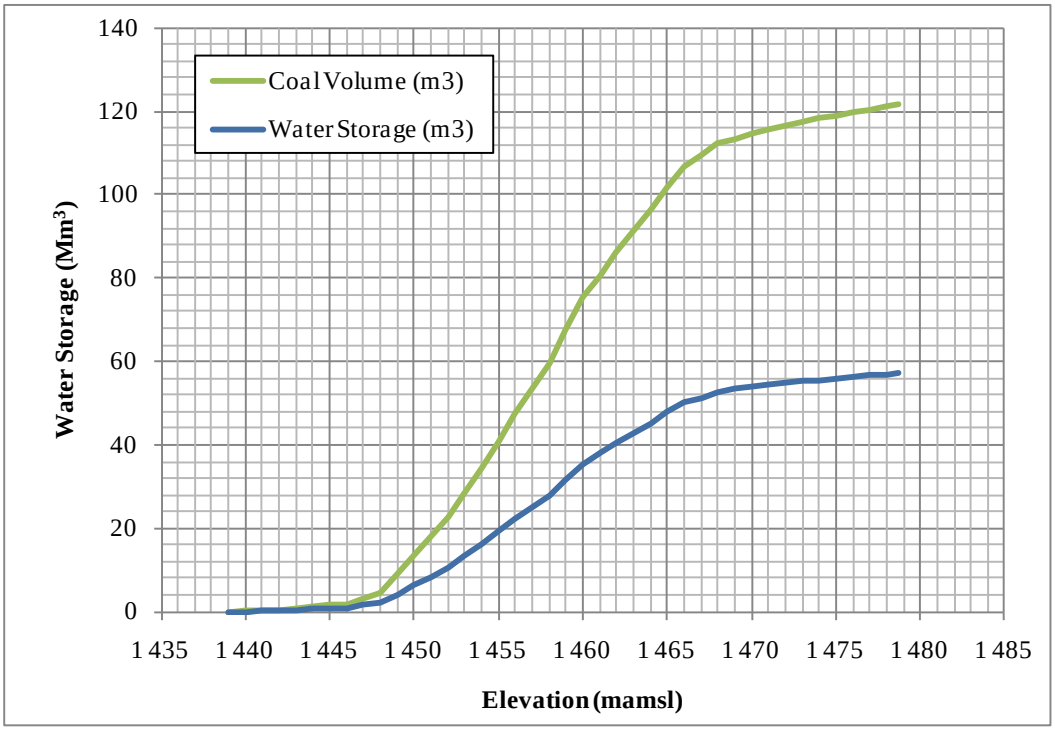


Figure 4.1.4(A). Stage curve for the proposed No. 2 coal seam workings.

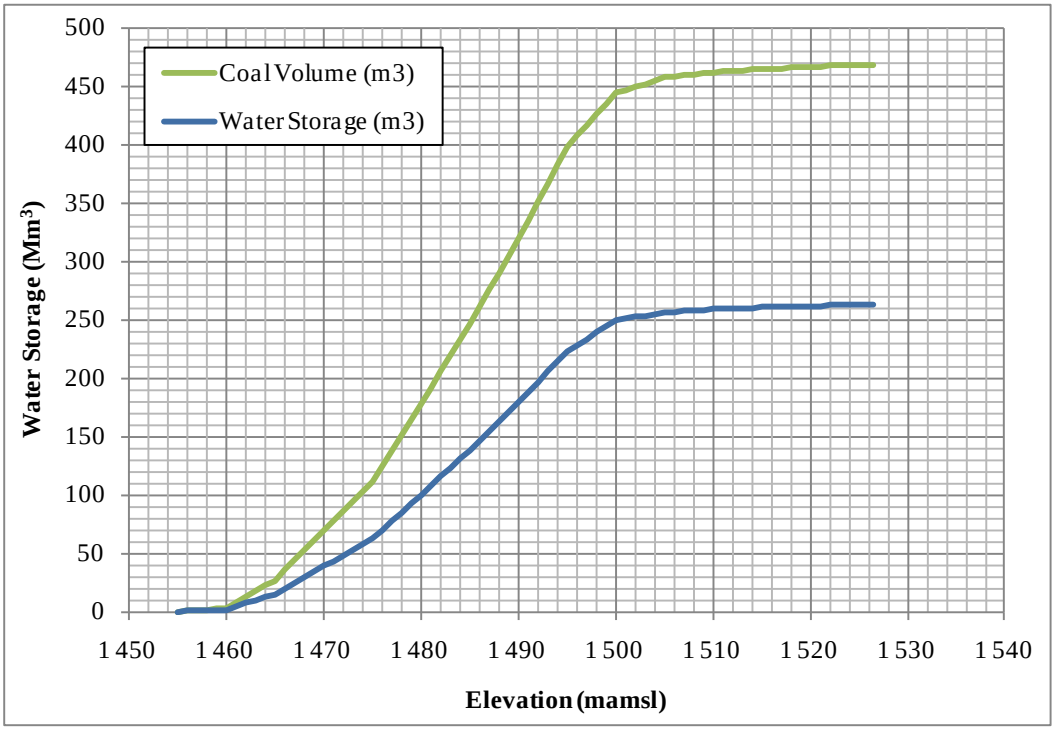


Figure 4.1.4(B). Stage curve for the proposed No. 4 coal seam workings.

Table 4.1.4(A). Storage capacity for proposed mining at Sasol Shondoni.

Mining Area	No. 2 Coal Seam Mine Workings	No. 4 Coal Seam Mine Workings
Total Area (Mm^2)	27	104
Bord and Pillar Area (Mm^2)	27	82
High Extraction (Mm^2)	0	23
Minimum Floor Elevation (mamsl)	1 439	1 455
Maximum Floor Elevation (mamsl)	1 479	1 527
Coal Volume (m^3) (at thickness 4.5 m)	122	468
Extraction Yield - Bord and Pillar	0.47	0.55
Extraction Yield - High Extraction	-	0.60
Water Storage (Mm^3)	57	263

From the above the following observations could be made:

- For the No. 2 coal seam workings a total of 2 702 ha of bord-and-pillar mining (at an extraction rate of 47%) is planned.

  With a bord and pillar extraction rate of 47%, the post-closure water storage for the No. 2 coal seam workings will be 57 Mm^3.

- For the No. 4 coal seam workings an initial total of 10 406 ha bord and pillar mining is planned and almost 22% thereof will be undergo further high extraction.

  With a bord and pillar extraction rate of 55% and selective high extraction of 60%, the post-closure water storage for the No. 4 coal seam workings will be 263 Mm^3.

4.2 Post closure water balance

The following discussion on the life of mine water balance is an extract from the Jones and Wagener specialist report. JMA reported the water make for average rainfall over the life of mine, while J&W took into consideration seasonality (wet and dry extreme cycles). Note that the water balance diagrams show the cumulative water make to be expected, while the flat water make curve after FY2050 shows the expected flooding rate post closure:

Water make refers to the water generated through the mining activities. This includes rainfall related inflows as well as groundwater inflows.

The total water make from the underground mining areas is given in Figure 4.2(A) for the period through to closure showing seasonality. Note that these water makes include the bord and pillar areas already mined, since the storage calculations are also for both the historical and future mining at Block 8.

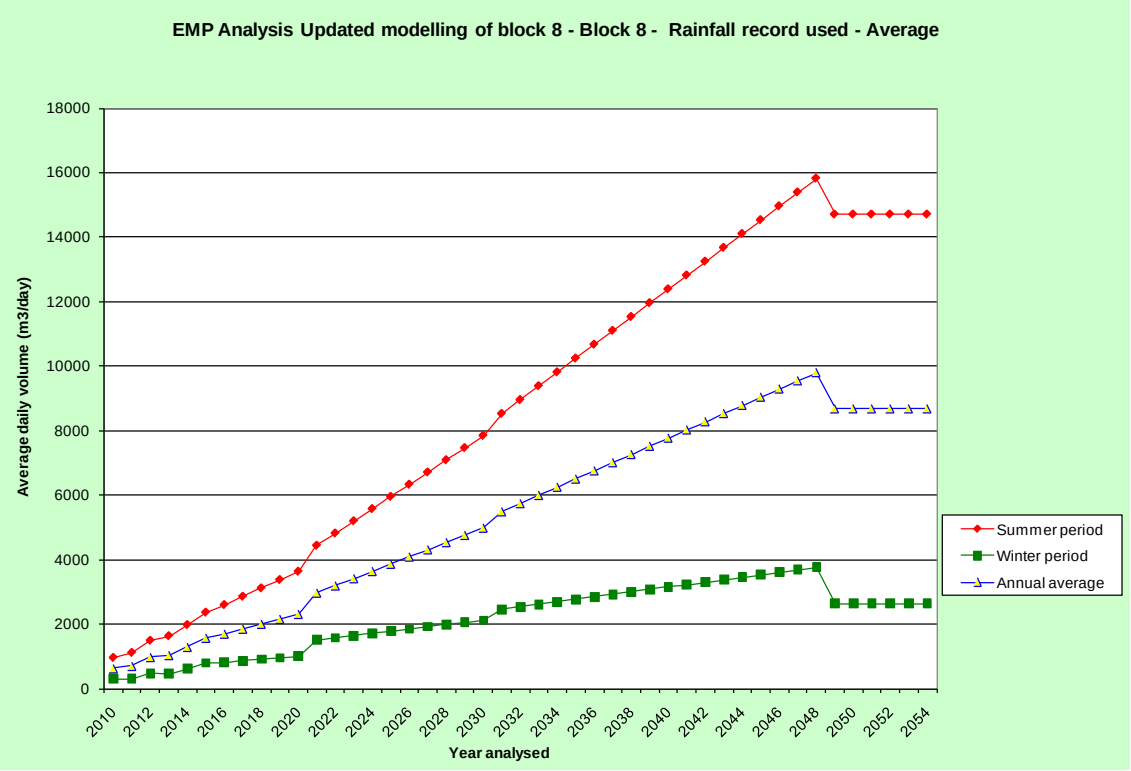


Figure 4.2(A) Current predicted water make at Middelbult Shondoni Block 8 for average rainfall.

Key points to note include:

- The mining of 2 seam workings only commences around 2020, indicated as a small increase in the water make trend.
- Post closure, the dewatering of the aquifer associated with high extraction mining reduces, with an associated reduction in the overall water make.
- The assessment is based on a macro level review of mine water make, and there is a need for detailed review of the high extraction areas as the project progresses to ensure that inflows from non-free draining areas are minimised.

The contribution of the various mining areas to the net water make is given in Figure 4.2(B).

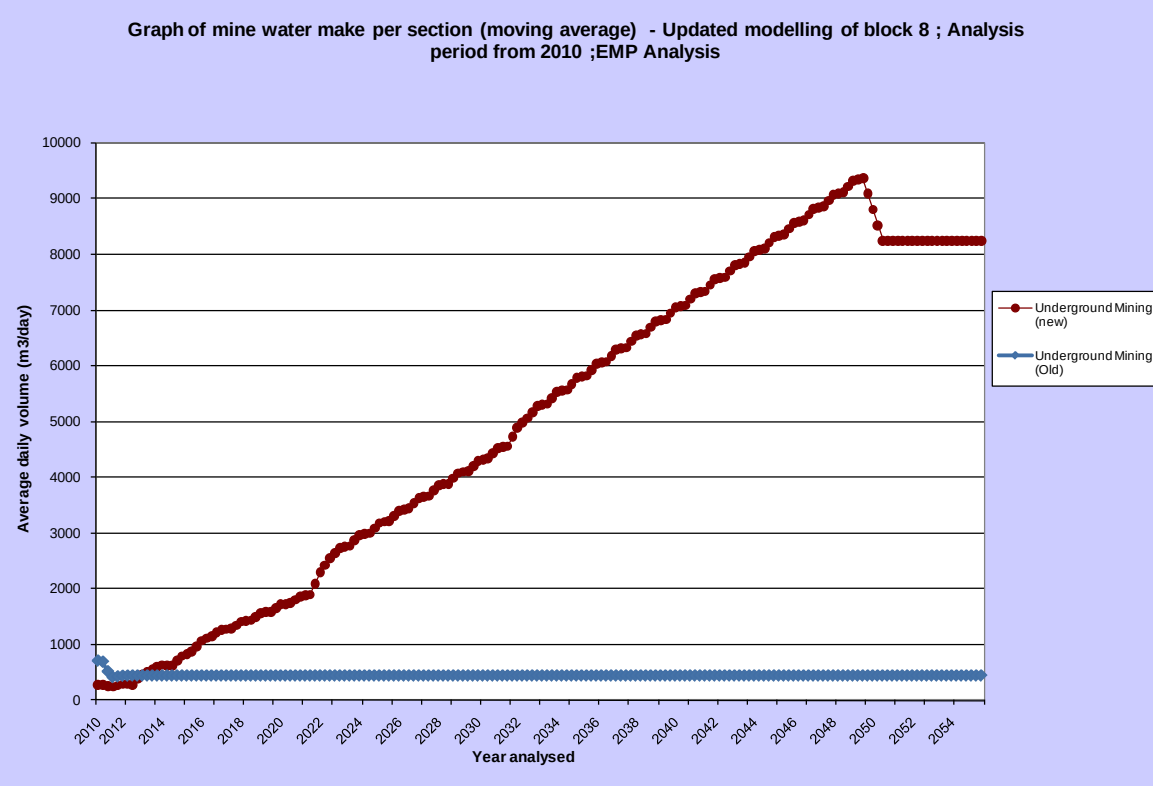


Figure 4.2(B) Contribution of the various areas to the net water make.

It is apparent that the bord and pillar mining in the current workings contributes very little to the overall water make compared to the new high extraction developments to the north.

A schematic of the overall water balance for the life of the mine is given in Figure 4.2(C).

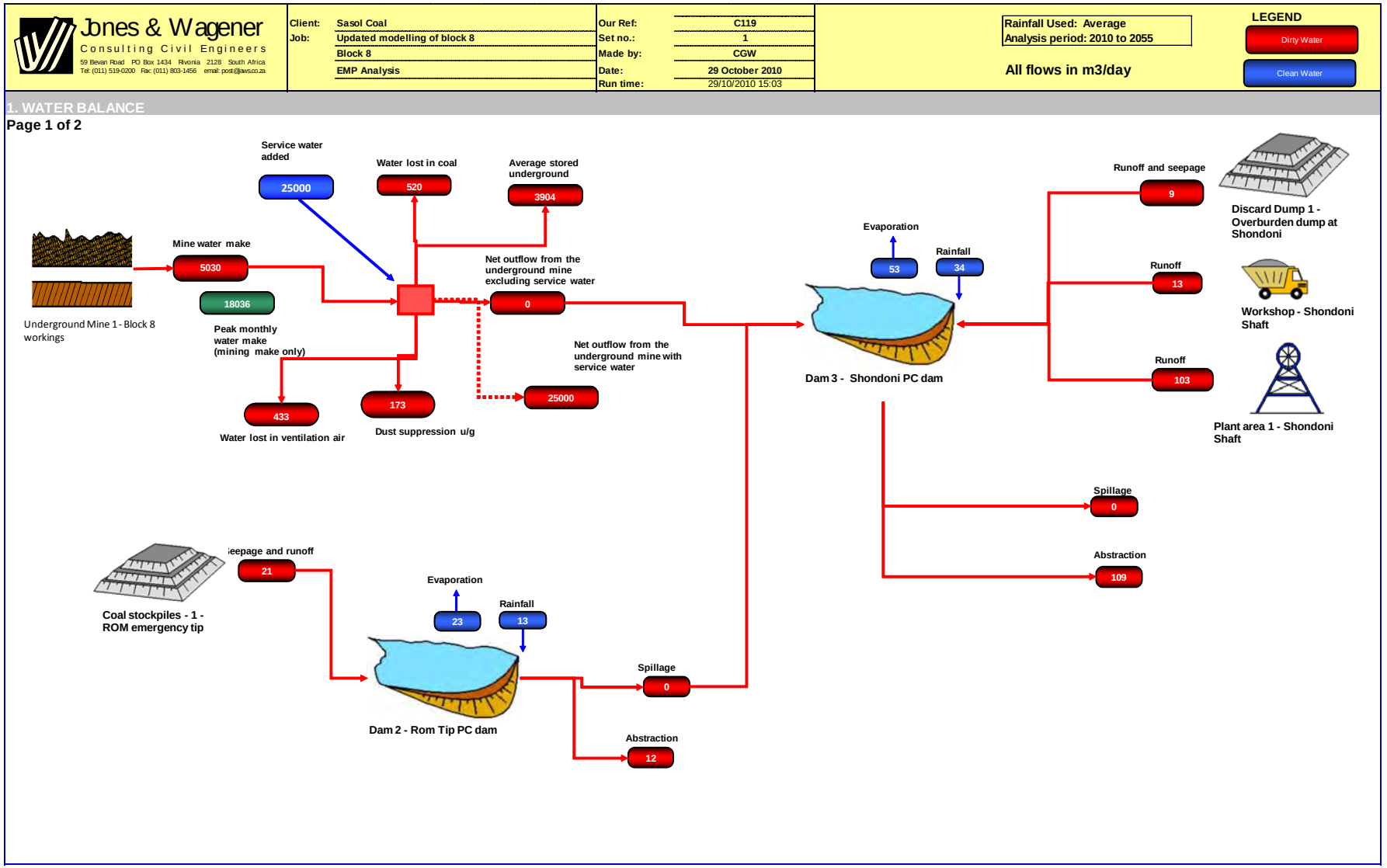


Figure 4.2(C) Schematic water balance over the life of mine.

5. ENVIRONMENTAL IMPACT ASSESSMENT

5.1 IMPACT ASSESSMENT METHODOLOGY

The impact assessment methodology at Sasol Shondoni is based on a Sasol Coal Standard impact assessment rating. A series of steps are taken to go through a process of

1. Identifying and quantifying an impact (determining the severity). **Step 1**.
2. Calculating the likelihood of an impact happening. **Step 2.**
3. Quantification of the level of magnitude attached to the impact. **Step 3.**

During the identification process the following aspects are considered:

- The physical quantity of the potential impact (be it a volume, concentration or quantitative measurement).
- The toxicity of impact, measured against a pre-defined hazard rating.
- The measurement of the extent of an impact.
- The duration of the impact, measured in years.
- The Environmental status of the impact.
- The regulatory impact in terms of legislation that has relevance.
- The impact on any Interested and Affected parties.

A quantitative rating system is used to assign a value to each of the above aspects:

Criteria	Definition	Points
Quantity	**The quantity (Volume) that will impact on the environment**	
	Less than 1m^3 / incident or > 10 mg/ m^3 or < 61dBa	0
	More than 1 m^3 but less than 10 m^3 per incident or > 25 mg/ m^3	1
	More than 10 m^3 but less than 100 m^3 per incident > 50 mg/ m^3 or > 61dBa	2
	More than 100 m^3 but less than 1000 m^3 per incident or > 100mg/ m^3	3
	More than 1000 m^3 per incident \ continuous or > 120 mg/ m^3 or > 85dBa	4

Toxicity	Hazard rating (Dangerous properties of hazardous material)	
	Non-hazardous – (substances which will not result in any risk)	0
	Hazard rating 1 – (Substances which could result in relatively low risk)	1
	Hazard rating 2 – (Substances which could result in serious risk)	2
	Hazard rating 3 – (Substance which could result in severe risk)	3
Extent	**How far does the impact extend?**	
	Limited to Business unit	0
	Limited to mine lease area	1
	Regional (Refer to TEKSA area)	2
	National (Refer to Mpumalanga area)	3
	International (refer to beyond South Africa's boundaries)	4
Duration	**How long will the impact last?**	
	Less than 5 years	0
	Between 5 – 15 years	1
	Exceeding mine lifetime	2
	Impact permanently present	3
Status	**Status of impact**	
	Beneficial (Improve the environment) – no risk reduction needed	-1
	Neutral (No change to the environment) – No risk reduction needed	0
	Adverse (Degradation of the environment) – Risk reduction needed	1
Legislation	**Are there any regulatory requirements applicable to aspects – impacts?**	
	None	0
	Yes, No fines, not cause loss of operating permit, but still reportable incident	1
	Yes, and will result in / prosecution or loss in production	2
	Yes, and will cause loss of operating permit or mine stoppage.	3
	Yes, and may lead to closing down of mine	4
I & AP's	**Interested and affected parties (I&AP)**	
	No impact	0
	Impact to employees in unit	1
	Impact to local community / stakeholders	2
	Impact to general public – beyond TEKSA area (Bad publicity)	3

Table 5.1(A). Impact Assessment Criteria used at Sasol Shondoni.

Once a sum value has been determined for a specific impact, an Impact Severity Score is calculated (C-number) as **Step 1**, based on the Table below:

Severity score	Risk matrix Consequence category
21 - 22	C7
19 - 20	C6
17 - 18	C5
14 - 16	C4
10 - 13	C3
5 - 9	C2
Less than 5	C1

Table 5.1(B). Impact Assessment Criteria used at Sasol Shondoni.

During **Step 2** the likelihood of an impact occurring/re-occurring is assessed at the hand of the Table provided below:

Likelihood Descriptors	Probability Intervals	Likelihood Definitions	P-value
Unforeseen	0 – 0.1%	The event is not foreseen to occur	P1
Highly unlikely	0.1 – 1%	The event may occur in exceptional circumstances (very remote)	P2
Very unlikely	1 – 5%	The event may occur in certain circumstances (remote chance)	P3
Low	5 – 15%	The event could occur (moderate chance)	P4
Possible	15 – 40%	The event may occur (realistic chance)	P5
Likely	40 – 75%	The event will probably occur (significant chance)	P6
Almost Certain	75 – 100%	The event is expected to occur or occurs regularly	P7

Table 5.1(C). Likelihood of an impact occurring (P-value).

Finally, the overall impact is quantified in a “Level of Risk” matrix, by combining the C-value (calculated in **Step 1**) with the P-value (calculated in **Step 2**) in the matrix provided below (**Step 3**). The overall impacts will be ranked based on the Level of Risk, as identified below:

	P1	P2	P3	P4	P5	P6	P7
C7	Level 3 Risk	Level 3 Risk	Level 3 Risk	Level 1 Risk	Level 1 Risk	Level 1 Risk	Level 1 Risk
C6	Level 3 Risk	Level 3 Risk	Level 3 Risk	Level 2 Risk	Level 2 Risk	Level 2 Risk	Level 1 Risk
C5	Level 4 Risk	Level 4 Risk	Level 4 Risk	Level 3 Risk	Level 2 Risk	Level 2 Risk	Level 2 Risk
C4	Level 5 Risk	Level 5 Risk	Level 5 Risk	Level 3 Risk	Level 3 Risk	Level 3 Risk	Level 3 Risk
C3	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 5 Risk	Level 5 Risk	Level 5 Risk	Level 4Risk
C2	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 5 Risk
C1	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk	Level 6 Risk

Table 5.1(D). Level of Risk Matrix for impacts at Sasol Shondoni.

5.2 CONSTRAINTS AND LIMITATIONS OF IMPACT ASSESSMENTS

The following constraints and limitations can be present at the ground water impact assessment study:

Quantity: The quantification of ground water related impacts are sometimes based on the results of ground water models and/or analytical calculations. These quantities are calibrated with known similar geohydrological conditions. However, the exact impact can only be determined during the operational phase activities when monitoring/measurement devices are used. In the event where a loss in borehole yield takes place, this loss in volume is based on information sourced from 3rd parties.

Toxicity: The toxicity of ground water quality deterioration is measured against SABS Drinking Water Standards. No detailed Toxicological studies were performed. The Standard use is deemed sufficient for the study.

Extent: A high degree of certainty can be attached to this parameter. The most ground water related impacts take place within the Business Unit.

Duration: The duration of ground water related impacts can be assessed at the hand of the time of impact, i.e. Operational Phase, Close Phase , etc. The duration of long term impacts is a function of the calibration of flooding models. No single mining operation is the same, and flooding rates will differ. Continuous monitoring will increase the confidence levels of models.

Status: No limitations or constraints exist for these criteria.

Legislation: The legislation pertaining to EIA applications, MPRDA regulations and DWAF regulations is very clear.

I & AP: No limitations or constraints exist for these criteria.

5.3 IDENTIFICATION OF ACTIVITIES

5.3.1 Construction Phase

5.3.1.1 NEMA EIA Listed Activities (GNR 386 & GNR 387)

Activity Description	Impact Identification/Description
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GNR 386 ACTIVITIES	
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	The construction of a 15 000t ROM coal stockpile area at Shondoni Shaft. The construction activities consist of the preparation of a suitable footprint area and will in itself not lead to any potential ground water pollution.
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	The Conveyor Pedestal will not intersect ground water, therefore no impact will take place.
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	The construction of a Storm Water Pollution Control Dam that can lead to a deterioration of ground water quality directly beneath the facility.
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	Conveyor Pedestal will not intersect ground water, so no ground water related impact will take place.
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	The storage of diesel fuel in storage tanks can lead to ground water pollution due to spillages/leaks.
Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	Clearance of vegetation will not intersect ground water, so no impact will take place.
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Any water removed from the No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas, or pumped to surface to the Storm Water Pollution Control Dam (SWPCD).
Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	Installation of Radio System will not intersect ground water, so no ground water related impact will take place.
Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	The construction of an access road will not intersect ground water, so no ground water related impact will take place.
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GNR 387 ACTIVITIES	
Construction of a Double Circuit 132 kV Overhead Power line from Eskom Supply Point (SOL B) to Shondoni Mine Transmission Feeder Bays - Activity 1 (l).	The construction of the Overhead Power line will not intersect ground water, so no ground water related impact will take place.
Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area) at a rate of more than 50 cubic meters per day -	The construction of a coal conveyor belt will not intersect ground water, so no ground water related impact will take place.

Activity 1 (j).	
Development of an area including shaft surface infrastructure and conveyor route where more than 20 hectares is disturbed - Activity 2.	This activity only refers to surface disturbance. Since no ground water is intersected, no ground water related impact will take place.

5.3.1.2 NWA Water Uses

Activity Description	Impact Identification/Description
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40	
Taking water from a water resource - Section 21 (a).	Ground water seepage into the shaft complex during construction activities, through weathered and fresh aquifer units (to a depth of 120 meters).
Impeding or diverting the flow of water in a watercourse - Section 21 (c).	Not Applicable.
Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	Not Applicable.
Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	Ground water seepage captured in the shaft complex during construction activities will be pumped to pollution control dams on surface. Since the water originated in a construction area, it is considered polluted.
Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	Not Applicable.
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Any water removed from the No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas. A detailed mine optimisation plan has been designed to create the necessary storage of water in mined out areas for the total Life of Mine.

5.3.1.3 GNR 704 Activity Exemptions

Activity Description	Impact Identification/Description
Exemptions from GNR 704	
No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	Not Applicable.
No person in control of a mine or activity may, except in relation to a matter contemplated in Regulation 10 (winning sand and alluvial minerals), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 metres from any water course or estuary, whichever is the greatest - Regulation 4(b).	Not Applicable.
No person in control of a mine or activity may use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any water course or estuary - Regulation 4(d).	Not Applicable.
No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource - Regulation 5.	Not Applicable.
No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	Not Applicable.

5.3.1.4 NEMWA Listed Waste Management Activities

Activity Description	Impact Identification/Description
NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008	
NEMWA Section 19(3) and GN 718.	Not Applicable.

5.3.1.5 Shondoni Surface Shaft Activities

Activity Description	Impact Identification/Description
SHONDONI SHAFT AREA	
Construction and commissioning of the shaft complex at Shondoni.	Depletion in ground water availability as a result of ground water seepage during the construction of the shaft complex.
Construction and commissioning of the shaft complex at Shondoni	Deterioration in ground water quality as a result of ground water seepage into the shaft complex during construction activities.

5.3.1.6 Shondoni Underground Mining Activities

Activity Description	Impact Identification/Description
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM	
Construction and commissioning of the shaft complex at Shondoni.	No mining activities will commence at Shondoni before the shaft complex is completed, so no ground water related impact will take place.

5.3.1.7 Shondoni Coal Conveyor Activities

Activity Description	Impact Identification/Description
CONVEYOR BELT ROUTE	
Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area).	The construction of a coal conveyor belt will not intersect ground water, so no ground water related impact will take place.

5.3.2 Operational Phase

5.3.2.1 NEMA EIA Listed Activities (GNR 386 & GNR 387)

Activity Description	Impact Identification/Description
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GNR 386 ACTIVITIES	
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	The operation of a 15 000t ROM coal stockpile area at Shondoni Shaft. Seepage from the stockpile area can lead to ground water pollution, if not managed correctly.
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	The Conveyor Pedestal will not intersect ground water, so no impact will take place.
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	The operation of a Storm Water Pollution Control Dam (SWPCD) that can lead to a deterioration of ground water quality directly beneath the facility.
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	Conveyor Pedestal will not intersect ground water, so no ground water related impact will take place.
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	The storage of diesel fuel in storage tanks can lead to ground water pollution due to spillages/leaks.
Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	Not Applicable.
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Any water removed from the No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas, or pumped to surface to the Storm Water Pollution Control Dam (SWPCD).
Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	Not Applicable.
Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	Not Applicable.
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GNR 387 ACTIVITIES	
Construction of a Double Circuit 132 kV Overhead Power line from Eskom Supply Point (SOL B) to Shondoni Mine Transmission Feeder Bays - Activity 1 (l).	The operation of the Overhead Power line will not intersect ground water, so no impact will take place.
Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area) at a rate of more than 50 cubic meters per day - Activity 1 (j).	The operation of a coal conveyor belt will not intersect ground water, so no ground water related impact will take place.

Development of an area including shaft surface infrastructure and conveyor route where more than 20 hectares is disturbed - Activity 2.	This activity only refers to surface disturbance. Since no ground water is intersected, no impact will take place.

5.3.2.2 NWA Water Uses

Activity Description	Impact Identification/Description
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40	
Taking water from a water resource - Section 21 (a).	All underground water accruing in mining sections during the operational phase will be stored in mined-out underground mine workings (storage reservoirs). This component will only be triggered if any water is pumped to surface. No 21(a) application is required at this stage. If and when this happens, an amendment to the WULA will be done.
Impeding or diverting the flow of water in a watercourse - Section 21 (c).	Not Applicable.
Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	Not Applicable.
Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	Ground water seepage captured from the ROM stockpile (maximum 2000m^3/a) at Shondoni Shaft Complex will be pumped to the Storm Water Pollution Control Dam (SWPCD).
Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	Not Applicable.
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Any water removed from the No.2 and No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas. A detailed mine optimisation plan has been designed to create the necessary storage of water in mined out areas for the total Life of Mine.

5.3.2.3 GNR 704 Activity Exemptions

Activity Description	Impact Identification/Description
Exemptions from GNR 704	
No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	Not Applicable.
No person in control of a mine or activity may, except in relation to a matter contemplated in Regulation 10 (winning sand and alluvial minerals), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 metres from any water course or estuary, whichever is the greatest - Regulation 4(b).	Not Applicable.
No person in control of a mine or activity may use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any water course or estuary - Regulation 4(d).	Not Applicable.
No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource - Regulation 5.	Not Applicable.
No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	Not Applicable.

5.3.2.4 NEMWA Listed Waste Management Activities

Activity Description	Impact Identification/Description
NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008	
NEMWA Section 19(3) and GN 718.	Not Applicable.

5.3.2.5 Shondoni Surface Shaft Activities

Activity Description	Impact Identification/Description
SHONDONI SHAFT AREA	
Operating the shaft complex at Shondoni for the Life of Mine.	Depletion in ground water availability and deterioration of ground water quality in the Shaft as a result of ground water seepage during the operational phase of the shaft complex. The shaft complex will be sealed/grouted, so little to no impact will take place.

5.3.2.6 Shondoni Underground Mining Activities

Activity Description	Impact Identification/Description
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM	
The influx of groundwater recharge into mine workings due to bord and pillar mining of the No's 2 and 4 coal seam.	Ground water recharge from surface will enter areas of bord and pillar mining due to the fact that mining will create an increasing void.
The increased influx of groundwater into mine workings due to pillar extraction activities of the No.4 coal seam.	An increased ground water recharge from surface will take place due to sub-surface subsidence on the No.4 coal seam.
Inter-mine and inter-section flow of ground water during the operational phase.	Ground water resources stored in underground mining units can migrate from one mine/section to an adjacent mine/section, due to a difference in hydraulic pressure. Flow can also be induced where flooding compartments decant into surrounding compartments due to a roll in the coal seam floor.
Depletion of external users' groundwater resources and fountains due to bord and pillar mining activities of the No's 2 and 4 coal seams.	Bord and pillar mining activities can intersect external user's boreholes directly and can lead to a reduction/complete depletion of external user's borehole yields.
Depletion of external users' groundwater resources and fountains due to pillar extraction mining activities of the No. 4	Pillar extraction mining activities can lead to sub-surface subsidence that in turn will lead to a reduction /complete depletion of external user's

coal seam.	borehole yields.
Depletion of stream base flow due to sub-surface subsidence of the No.4 coal seam.	Pillar extraction mining activities can lead to sub-surface subsidence that in turn will lead to a reduction /complete depletion of ground water base flow to rivers and non-perennial streams.
Deterioration in groundwater quality in all underground sections, and migration into the receiving environment.	Ground water recharge to underground mining units that remains in reservoirs will come in contact with coal pillars, mine floors and roofs. A gradual deterioration in ground water quality will take place over time, depending amongst other things, residence times, natural buffer capacity and mixing ratios of ground water from different sources.
Groundwater pollution originating from the ROM coal stock pile at the Shondoni Shaft Complex.	The operation of a 15 000t ROM coal stockpile area at Shondoni Shaft. Seepage from the stockpile area can lead to ground water pollution, if not managed correctly.
Groundwater pollution originating from the Storm Water Pollution Control Dam (SWPCD).	The operation of a Storm Water Pollution Control Dam (SWPCD) that can lead to a deterioration in ground water quality directly beneath the facility.

5.3.2.7 Shondoni Coal Conveyor Activities

Activity Description	Impact Identification/Description
CONVEYOR BELT ROUTE	
Operation of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area).	The Life of Mine operation of a coal conveyor belt will not intersect/impact ground water resources, so no ground water related impact will take place.

5.3.3 Decommissioning Phase

5.3.3.1 NEMA EIA Listed Activities (GNR 386 & GNR 387)

Activity Description	Impact Identification/Description
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GNR 386 ACTIVITIES	
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	The decommissioning of a 15 000t ROM coal stockpile area at Shondoni Shaft. Residual seepage from the stockpile footprint area can lead to further ground water pollution.
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	The Conveyor Pedestal will not intersect ground water, so no impact will take place during decommissioning of the infrastructure.
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	The decommissioning of the Storm Water Pollution Control Dam (SWPCD) footprint can lead to residual ground water pollution.
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	The Conveyor Pedestal will not intersect ground water, so no ground water related impact will take place during decommissioning of the infrastructure.
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	The decommissioning of diesel fuel storage tanks can lead to residual ground water pollution.
Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	Not Applicable.
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Not Applicable.
Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	Not Applicable.
Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	Not Applicable.
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GNR 387 ACTIVITIES	
Construction of a Double Circuit 132 kV Overhead Power line from Eskom Supply Point (SOL B) to Shondoni Mine Transmission Feeder Bays - Activity 1 (l).	The decommissioning of the Overhead Power line will not intersect ground water, so no ground water related impact will take place.
Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area) at a rate of more than 50 cubic meters per day - Activity 1 (j).	The decommissioning of a coal conveyor belt will not intersect ground water, so no ground water related impact will take place.

Development of an area including shaft surface infrastructure and conveyor route where more than 20 hectares is disturbed - Activity 2.	This activity only refers to surface disturbance. Since no ground water is intersected, no ground water related impact will take place.

5.3.3.2 NWA Water Uses

Activity Description	Impact Identification/Description
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40	
Taking water from a water resource - Section 21 (a).	Not Applicable, since no water will be pumped to surface during the decommissioning phase.
Impeding or diverting the flow of water in a watercourse - Section 21 (c).	Not Applicable.
Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	Not Applicable.
Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	Not Applicable, since no water will be captured from any ROM stock piles (decommissioned).
Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	Not Applicable.
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Not Applicable, since no water will be moved around for decommissioning purposes.

5.3.3.3 GNR 704 Activity Exemptions

Activity Description	Impact Identification/Description
Exemptions from GNR 704	
No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	Not Applicable.
No person in control of a mine or activity may, except in relation to a matter contemplated in Regulation 10 (winning sand and alluvial minerals), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 metres from any water course or estuary, whichever is the greatest - Regulation 4(b).	Not Applicable.
No person in control of a mine or activity may use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any water course or estuary - Regulation 4(d).	Not Applicable.
No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource - Regulation 5.	Not Applicable.
No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	Not Applicable.

5.3.3.4 NEMWA Listed Waste Management Activities

Activity Description	Impact Identification/Description
NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008	
NEMWA Section 19(3) and GN 718.	Not Applicable.

5.3.3.5 Shondoni Surface Shaft Activities

Activity Description	Impact Identification/Description
SHONDONI SHAFT AREA	
Closing the shaft complex at Shondoni.	Localized depletion of ground water (if it occurred during the operational phase) will be reversed, and ground water levels will start to return to pre-mining ground water levels.

5.3.3.6 Shondoni Underground Mining Activities

Activity Description	Impact Identification/Description
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM	
The continuous influx of groundwater recharge into mine workings due to bord and pillar mining of the No's 2 and 4 coal seam, during the decommissioning phase.	Ground water recharge due to operational phase mining activities will continue during the decommissioning phase. The impact will persist well beyond the post-closure phase and will be addressed in that section.
The increased influx of groundwater into mine workings due to pillar extraction activities of the No.4 coal seam, during the decommissioning phase.	Ground water recharge due to operational phase mining activities will continue during the decommissioning phase. The impact will persist well beyond the post-closure phase and will be addressed in that section.

5.3.3.7 Shondoni Coal Conveyor Activities

Activity Description	Impact Identification/Description
CONVEYOR BELT ROUTE	
Decommissioning of the Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area).	The decommissioning of the coal conveyor belt will not intersect/impact ground water resources, so no ground water related impact will take place.

5.3.4 Post-closure Phase

5.3.4.1 NEMA EIA Listed Activities (GNR 386 & GNR 387)

Activity Description	Impact Identification/Description
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GNR 386 ACTIVITIES	
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	The final closure of a 15 000t ROM coal stockpile area at Shondoni Shaft. Residual seepage from the stockpile footprint area can lead to further ground water pollution.
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	The Conveyor Pedestal will not intersect ground water, so no ground water related impact will take place during final closure.
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	The closure and final rehabilitation of the Storm Water Pollution Control Dam (SWPCD) footprint can lead to ground water pollution.
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	The Conveyor Pedestal will not intersect ground water, so no impact will take place during final closure of the infrastructure.
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	The removal of diesel fuel storage tanks. No free product will be left, so no ground water related impact is possible.
Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	Not Applicable.
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Not Applicable.
Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	Not Applicable.
Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	Not Applicable.
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GNR 387 ACTIVITIES	
Construction of a Double Circuit 132 kV Overhead Power line from Eskom Supply Point (SOL B) to Shondoni Mine Transmission Feeder Bays - Activity 1 (l).	The removal of the Overhead Power line will not intersect ground water, so no ground water related impact will take place.
Construction of a Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area) at a rate of more than 50 cubic meters per day - Activity 1 (j).	The final removal of the coal conveyor belt will not intersect ground water, so no ground water related impact will take place.

Development of an area including shaft surface infrastructure and conveyor route where more than 20 hectares is disturbed - Activity 2.	This activity only refers to surface disturbance. Since no ground water is intersected, no impact will take place.

5.3.4.2 NWA Water Uses

Activity Description	Impact Identification/Description
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40	
Taking water from a water resource - Section 21 (a).	After final flooding of mining sections, water will be stored in underground mining sections. IF surface treatment of ground water is required, the appropriate amendment to the WULA will be made to register this water use
Impeding or diverting the flow of water in a watercourse - Section 21 (c).	Not Applicable.
Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	Not Applicable.
Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	Not Applicable, since no water will be captured from any ROM stock piles removed during closure phase).
Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	Not Applicable.
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Not Applicable, since no water will be moved around for closure purposes.

5.3.4.3 GNR 704 Activity Exemptions

Activity Description	Impact Identification/Description
Exemptions from GNR 704	
No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	Not Applicable.
No person in control of a mine or activity may, except in relation to a matter contemplated in Regulation 10 (winning sand and alluvial minerals), carry on any underground or opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood line or within a horizontal distance of 100 metres from any water course or estuary, whichever is the greatest - Regulation 4(b).	Not Applicable.
No person in control of a mine or activity may use any area or locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution of a water resource within the 1:50 year flood line of any water course or estuary - Regulation 4(d).	Not Applicable.
No person in control of a mine or activity may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource - Regulation 5.	Not Applicable.
No person in control of a mine or activity may locate or place any residue deposit, dam, reservoir together with any associated structure or any other facility within the 1:100 year flood line or within a horizontal distance of 100 metres from any water course or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked - Regulation 4(a).	Not Applicable.

5.3.4.4 NEMWA Listed Waste Management Activities

Activity Description	Impact Identification/Description
NATIONAL ENVIRONMENTAL MANAGEMENT ACT: WASTE ACT, ACT NO. 59 OF 2008	
NEMWA Section 19(3) and GN 718.	Not Applicable.

5.3.2.5 Shondoni Surface Shaft Activities

Activity Description	Impact Identification/Description
SHONDONI SHAFT AREA	
Final closure of the shaft complex at Shondoni.	Localized depletion of ground water (if it occurred during the operational phase) will be reversed, and ground water levels will finally return to pre-mining ground water levels.

5.3.4.6 Shondoni Underground Mining Activities

Activity Description	Impact Identification/Description
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM	
The continuous influx of groundwater recharge into mine workings until all mining units is flooded.	Ground water recharge from surface will enter areas of bord and pillar and high extraction mining until all mining units are flooded.
The decant of underground mine water to surface, after total flooding of mining units.	After final flooding of mining sections, ground water can seep to surface due to conduit flow from high extraction subsidence areas.
Inter-mine and inter-section flow of ground water during the post closure phase.	Ground water resources stored in Shondoni underground mining units can migrate from one mine/section to an adjacent mine/section, due to a difference in hydraulic pressure. Flow can also be induced where flooding compartments decant into surrounding compartments due to a roll in the coal seam floor.
Continuous depletion of external users' groundwater resources and fountains due to pillar extraction mining activities of the No. 4 coal seam.	Pillar extraction mining activities can lead to sub-surface subsicence that in turn will lead to a reduction /complete depletion of external user's borehole yields, for indefinite time frames.
Depletion of stream base flow due to sub-surface subsidence of the No.4 coal seam, post-closure.	Pillar extraction mining activities can lead to sub-surface subsidence, that in turn will lead to a reduction/complete depletion of ground water base flow to rivers and non-perennial streams., for indefinite periods of time.

Deterioration in groundwater quality in all underground sections, and migration into the receiving environment, after mining activities have stopped.	Ground water recharge to underground mining units that remains in reservoirs will come in contact with coal pillars, mine floors and roofs. A gradual deterioration in ground water quality will take place over time, eventually leading to total acidification of underground mine water.
Groundwater pollution originating from the ROM coal stock pile footprint at the Shondoni Shaft Complex after closure.	Seepage from the stockpile area footprint can lead to ground water pollution, if not rehabilitated correctly.
Groundwater pollution originating from the Storm Water Pollution Control Dam (SWPCD) footprint after closure.	Seepage from the SWPCD footprint can lead to ground water pollution, if not rehabilitated correctly.

5.3.4.7 Shondoni Coal Conveyor Activities

Activity Description	Impact Identification/Description
CONVEYOR BELT ROUTE	
Final removal of the Coal Conveyor from Shondoni Shaft to Middelbult Main Shaft (to the central Sasol Coal Supply area).	The removal of the coal conveyor belt will not intersect/impact ground water resources, so no ground water related impact will take place.

5.4 ASSESSMENT OF GEOHYDROLOGICAL IMPACTS

The geohydrological impact description is based on individual ground water impacts for the different stages of operation at Sasol Shondoni, namely for the:

- Construction Phase
- Operational Phase
- Decommissioning Phase
- Post-closure Phase

The overall description and quantification of any given geohydrological impact will be the same for all of the given Regulatory processes:

- **NEMA EIA Listed Activities (GNR 386 & GNR 387.**
- **NWA Water Uses**
- **GNR 704 Activity Exemptions**
- **NEMWA Listed Waste Management Activities**
- **Shondoni Surface Shaft Activities**
- **Shondoni Underground Mining Activities**
- **Shondoni Coal Conveyor Activities**

All impacts will therefore be discussed and quantified for the stage of mining operation.

5.4.1 Construction phase

5.4.1.1 Impact on the availability of ground water

Bord and pillar mining and Pillar Extraction mining

The impact on the availability of ground water will be insignificant. This is due to the fact that no structural instabilities are expected in the shaft complexes, and related impacts on the physical and hydraulic aquifer characteristics are insignificant. Although ground water will flow through the walls of the vertical shafts during construction, influxes will be grouted immediately, preventing the establishment of a significant cone of de-watering around the vertical shafts.

5.4.1.2 Impact on the quality of ground water

Influxes of ground water into the vertical shafts during the construction phase are expected to be insignificant. The water that does enter the excavations will however, have increased solids in suspension, due to the construction activities.

Deterioration in ground water quality due to the oxidation of pyritic material in the vertical shafts is very unlikely during the construction phase. This is mainly due to the short contact time of ground water with material in the excavations, as well as the fact that the ground water entering the vertical shafts has a natural

buffering capacity in short-residence geohydrological environments (refer to Part 3). All unwanted water resulting from excavations will be discharged.

5.4.2 Operational phase

5.4.2.1 The influx of ground water into mine workings due to bord and pillar mining and pillar extraction activities

During bord and pillar mining significant influxes of ground water to the underground mines will only occur with the intersection of preferential ground water flow zones, during mining of the No.2 and 4L coal seams, including dolerite dyke contact zones, dolerite sill contact zones, faults or fissures.

Insufficient information currently exists to accurately delineate all the localities of these flow zones on the No.2 and 4L coal seam horizons. As such, calculation of influx rates from these features is not possible. The magnitude of influxes related to these features seldom cause extensive cones of depression in the ground water regime. However, the ground water resources of external users located the mine-intersected feature could be affected.

The detailed water make in this section can be seen in TABLE 4.1.2(A). The TABLE below gives a summary of the water balance on an annual basis:

TABLE 5.4.2.1(A)
Recharge in the No.2 seam bord and pillar areas mined from FY2021- 2048

Schedule	Cumulative rainfall recharge:2 Seam (m^3/a)	Total ground water recharge (m^3/day)
FY21	3 216	9
FY25	28 945	81
FY30	61 107	172
FY35	95 526	268
FY40	130 195	366
FY45	164 864	463
TOTAL (FY48)	**189 133**	**531**

The cumulative ground water recharge for this section comes to 189 133 m^3/a, or **531** m^3/day for year 2048. This flooding rate will remain stable until all mining units are flooded.

Bord and pillar mining and pillar extraction of the No.4L coal seam

As can be seen in FIGURE 4.1.1(B), an area roughly 22% of the total FY2010 – FY2048 schedule is recommended for pillar extraction. The bord and pillar mining sections of the No.2 coal seam and the above mentioned sections were split in terms of water make, since these areas can be managed individually.

The volumes of water make to be expected in the bord and pillar sections to the north of the fault will be in the same order as for the southern reserves (1.1 – 1.6% of MAP). Pillar extraction will, however, yield greater water make volumes due to potential surface subsidence.

Pillar extraction with subsequent roof collapse will increase the hydraulic conductivity of the geological strata above the mine. This activity will result in the release of ground water stored in the formations above the pillar extraction panels and cause an influx of ground water into the workings over the immediate, short and medium term. Ground water contained in formations immediately above the pillar extraction panels will drain into the mine within a matter of days/weeks. Lateral inflows from undisturbed formations (possibly above and from surrounding rock) will occur for a more extended time period (months).

De-watering and the coincidental influx of ground water into the mine workings, as a result of total extraction mining, is therefore much more severe than for bord & pillar underground mining activities.

The main contributors to the influx volumes are:

- annual rainfall recharge.
- lateral inflows from the surrounding rock mass - deep aquifer.
- water released from storage in the overlying rock mass - shallow and deep aquifers.
- inflows related to geological features.
- inflows from surrounding mined out areas.

Some of the above contributors cannot be quantified at this stage, or is insignificant in terms of the total water make. The ground water components for the overall water balance were calculated and can be seen in TABLE 4.1.2(B).

TABLE 5.4.2.1 summarises the results:

TABLE 5.4.2.1(B)
Recharge in all mining sections of the No4 Coal seam (FY2010-2048)

Schedule	Cumulative rainfall recharge (m^3/a)	Total ground water recharge (m^3/day)
FY10	77 088	36
FY15	412 612	693
FY20	692 567	1 505
FY25	1 186 906	2 447
FY30	1 527 313	3 403
FY35	1 981 424	4 423
FY40	2 347 946	5 245
FY45	2 712 729	6 477
TOTAL (FY48)	**2 932 121**	**7 196**

The maximum recharge for this section comes to 2 931 121 m^3/a, or **7 196** m^3/day for year 2048.

The actual increase in ground water recharge will be a function of:

- The actual extent of the surface depressions forming ponds on surface;
- The occurrence of areas which have a higher recharge potential because of the type of soil and vegetative cover; and
- The dimensions of apertures (cracks), and the infilling of these cracks with sediment.

From TABLE 4.1.2(B) it is evident that the release in storage of water in overlying stratigraphical units is the main contributor to the ground water make during the operational phase. The management of this water will be a priority during the operational phase of the Sasol Middelbult Shondoni mine. Please refer to the Jones & Wagener specialist report for more detail on this water management.

5.4.2.2 Intermine flow during the operational phase

Inter-mine flow can occur between two neighbouring mines/sections if hydraulic continuity exits between them, and if a hydraulic gradient between water in the two mines/sections exists.

Quantification of the actual inter mine flow is a complex process. Not only is high integrity information on hydraulic inter-connectivity and water level gradients a fundamental pre-requisite, but the hydraulic gradient response is of a transient nature. However, inter-mine flow usually only occurs during the post closure mining phase, as underground mines are not flooded to a significant degree during the operational phase, due to water balance use, selective storage and de-watering.

The likelihood of inter-mine flow during the operational phase at Block 8 mining sections is remote for the following reasons:

- As stated earlier, mining units are usually dewatered and thus unsaturated during the operational phase.
- The water balance of the bord and pillar sections adjacent to the Middelbult Mine (2010 – 2015) will be managed as part of the Middelbult Mine water balance.
- A major reservoir for storage will become available at the Springbokdraai reserve areas after this section is mined out (2020). Storage capacity of at least 30 Mm^3 will be available for mine water management during the operational phase.

5.4.2.3 Depletion of external user's ground water resources and fountains

Bord and pillar mining does not lead to a drop in ground water levels in the shallow weathered zone aquifer, providing that pillars remain structurally stable. Where deeper boreholes penetrate into/close to mine workings, a drop in water level can be expected.

In pillar extraction panels, declining ground water levels within and around the goafs, will manifest as a cone of depression, stretching in all directions around areas of pillar extraction. The extent of this cone of depression is a function of the magnitude in the water level decline and subject to the hydraulic conductivity of the surrounding aquifer host rock. Physical and hydraulic aquifer boundaries will also influence the final delineation of such a cone of depression.

Potential pillar extraction mining at Sasol Middelbult Shondoni will take place between 85 m and 160 m below surface. Modelling performed for the pillar extraction areas yielded a radius of between 250 m and 500 m from the pillar extraction panels for the cone of depression.

Since the exact areas of pillar extraction have not been finalised yet, it is not possible at this stage to distinguish between external users falling above bord and pillar areas, from the external users falling above high extraction areas. All boreholes currently in use (as confirmed by the owner/foreman/manager), and all fountains falling above the Block 8 underground reserves, are listed in APPENDIX 3.

5.4.2.4 Depletion of stream base flow

Impact on surface water resources will be restricted to areas where mining intersects a preferential ground water flow zone, in hydraulic continuity with a surface water feature. With safety measures associated with bord and pillar mining, no structural problems, which can lead to surface subsidence, are expected.

The areas allocated for potential pillar extraction mining, as indicated on FIGURE 4.1.1(B) avoided all wetlands, flood plains, drainage lines, river systems and dams. **These areas will be further refined, as to comply with the prescribed distances that pillar extraction mining must be from any surface water resource**.

5.4.2.5 Deterioration of ground water quality in the underground sections and migration into the receiving environment, during the operational phase.

Bord and pillar mining

Ground water draining into the mine workings will initially be of a good quality. The pH will be alkaline due to the presence of bicarbonate species. However, once the ground water reaches the mine, the material that it comes into contact with will influence its quality.

The following sequence of chemical reactions will occur:

- The water seeping into the mine will generally be of good quality, except for suspended solids present. Most, if not all of the water resulting from operations, will be used during the operational phase. Isolated areas of water make can however be present, and will drain to the lowest point of the mine.

- The water present will be alkaline, but the Total Dissolved Solids content will increase due to the contact with the coal floor/pillars.

- Ground water will continue to percolate through the roof downward to the saturated areas. This will lead to the mixing of initially alkaline to neutral ground water, with relative stagnant, alkaline ground water on the mined horizon.

- With the current proposed water management measures, regional acidification is not expected during the operational phase.

Pillar extraction mining

The following sequence of chemical reactions will occur:

- The water liberated in the stratigraphical units above pillar extraction panels, as well as the water seeping into the mine, will generally be of good quality, but contain suspended solids, in the form of sediment and carbonaceous material e.g. shale and coal.

- The majority of ground water saturation on the mined horizon (average thickness of 4.6 m) will take place in a matter of days to weeks, due to the reduction in storativity of the mine void, during goaf formation. Very little, if any, pyrite oxidation will take place in this saturated zone. The quality of this ground water will initially remain constant, providing that water is not continuously pumped out of this zone.

- Pyrite oxidation will commence in the unsaturated areas of the mined void (if any), as well as in the unsaturated zones of the goaf. The rate of oxidation will vary considerably, depending on the rate of ingress of ground water (the residence time), the rate of ingress of oxygen and the contact areas available for oxidation.

- This initial acidification will be neutralised by the natural buffering capacity in the overlying rock. This will take place for many years, until all the neutralising potential is depleted. Isolated areas of buffering depletion might take place quickly, but regional acidification in the total goaf area will not occur for many years.

- Ground water will percolate through the unsaturated goaf areas downward to the saturated mined void. This will lead to the mixing of initially alkaline to neutral ground water, with relative stagnant, alkaline ground water on the mined horizon.

- Isolated areas of buffering depletion will take place. This will lead to the formation of acidic conditions in the goaf area, with low pH ground water that will percolate downwards to the saturated zones.

- It is believed that, with the current proposed water management measures, regional acidification is not expected during the operational phase. During the operational phase the quality of the ground water will remain alkaline to neutral, with elevated levels of Total Dissolved Solids.

TABLE 5.4.2.5 (A) below gives an indication of ground water quality that can be expected, if large volumes of water are stored underground during the total operational phase:

TABLE 5.4.2.5(A)
Ground water qualities expected at Sasol Middelbult Shondoni during operational phase storage

Parameter	Operational storage quality
pH	6.6
EC (mS/m)	160 – 250
Ca (mg/l)	200 – 350
Mg (mg/l)	120 - 200
Na (mg/l)	25
K (mg/l)	20
T.Alk. (mg/l)	80
Cl (mg/l)	15
SO_4 (mg/l)	500 – 650
F (mg/l)	0.9
Al (mg/l)	0
Mn (mg/l)	1 – 2
Fe (mg/l)	1

5.4.2.6 Ground water pollution originating from potential pollution sources on surface

Infrastructure that could lead to ground water pollution in the Sasol Middelbult Shondoni reserve area is the Run of Mine Coal Stockpile (Capacity 15 000tons) and the Surface Water Pollution Control Dam (SWPCD). The quantification and extent of potential pollution from these sites are quantified in Part 6 of this report.

Additional potential pollution sources present at surface is a number of gold mine slimes dams. Contaminants from these features can percolate through the unsaturated zone to the saturated zone, situated above/within the Sasol Middelbult Shondoni coal reserves. Once contaminants reach the ground water table, lateral migration along the ground water gradients will occur and ground water contaminant plumes will establish. Depending on local conditions, these ground water contaminant plumes may result in primary aquifer contamination.

Secondary contamination of surface water resources may also result where the contaminant plumes establish hydraulic continuity with surface water resources (streams, rivers, pans, dams).

Of greater importance to this study is the potential for tertiary contamination of the Sasol Middelbult Shondoni coal horizon, in the event of direct geohydrological continuity between primary pollution and the coal seam horizon. This will happen in the event of coal mining taking place to close to and/or under the gold mine slimes dams.

Geohydrological sampling indicated elevated values for EC, TDS, Cl and especially SO_4 in some monitoring boreholes (GWE-30, GWE-85, GWE-88, GWE-95, SDF-8, SSW-8) drilled around the old gold mine dumps. Of note are the three boreholes around the Winkelhaak slimes dams that show marginal to non-compliance with the S.A Drinking Water Standard.

The potential impact on infiltration is directly related to the extent and magnitude of the ground water mounds around infiltration sources, as well as the quality of the infiltrated water. Increased ground water monitoring around these facilities is crucial in determining the quantity and quality of infiltration from the proposed facilities.

5.4.3 Decommissioning phase

5.4.3.1 All ground water impacts

During the decommissioning phase, final rehabilitation of underground mining sections will take place. The decommissioning activities themselves are not expected to result in additional impacts to the geological or ground water regimes. In the underground sections, water levels will continue to accumulate, as water will no longer be used as part of the operational phase water management.

Estimates for the post closure mine water balance included mine flooding rates as well as post closure decant rates, for both the underground sections. Sources of ground water in rehabilitated mining sections during post closure include surface decant, ground water seepage and inter-mine flow.

Measures will be put in place during decommissioning to manage all seepage as part of the post-closure water balance. More detail will be given in the post-closure water balance of the Jones and Wagener report. Measures to manage all ground water related impacts are proposed for the operational phase, and these measures must be completed during the decommissioning phase to ensure minimisation of post closure and long-term ground water impacts.

5.4.4 Post-closure phase

5.4.4.1 Potential surface decant from the underground sections

No.2 Seam Bord and pillar mining (2021 – 2048)

These mine workings at Sasol Middelbult Shondoni underground section after closure, will consist of decommissioned and closed-off No.2 seam coal seam compartments.

The following post-closure information is relevant to the given mine scheduling plan:

TABLE 5.4.4.1(A)
Post closure recharge/decant assessment for the No.2 seam bord and pillar sections mined from 2021 - 2048

Flooding status	Total area mined (m^3)	Time of average flooding (years)	Recharge/Decant rate (m^3/day)
Before 2021	27 019 000	~	531
Post closure	**27 019 000**	**290 - 354**	**502**

The time of "average" flooding includes increased influx of the known preferential flow zones, as well as the potential inter-section flow. Not all preferential influx zones are known at this point, so the volumes might increase, as more operational phase information becomes available. Since active storage of water from potential pillar extraction compartments, in these bord and pillar compartments is seen as a management option, the time of flooding can be reduced. Refer to Section 4.1 for the volumes of water-make and various water management options, during the operational and post-closure phases.

The likelihood of underground bord and pillar mine workings decanting directly onto the surface is dependent on the proximity of such workings to the surface and the hydraulic pressure exerted on the underground water mass towards the point(s) of possible decant.

The mining of the No.2 coal seam will take place at depths generally deeper than 120m, and the potential volume of decant is very small. With the exception of vertical shafts, no other known hydraulic pressure points exist that will force water under gradient towards the surface.

The time before underground flooding for these compartments is also considerable. For this reason, the underground bord and pillar sections can be used as storage for water from the pillar extraction panels, to reduce the overall flooding time.

No.4L Coal seam Bord and pillar mining and pillar extraction (2010 – 2048)

These mine workings at Sasol Middelbult Shondoni underground section after closure, will consist of decommissioned and closed-off No.4L coal seam bord and pillar compartments, as well as closed-off pillar extraction compartments, provided that only the recommended areas for pillar extraction are mined.

The following post-closure information is relevant to the given mine scheduling plan:

TABLE 5.4.4.1(B)
Post closure recharge/decant assessment for the bord and pillar and pillar extraction sections (2010 – 2048)

Mining status	Total area mined (m^3)	Time of average flooding (years)	Recharge/Decant rate (m^3/day)
Bord and pillar	81 514 700	290	1 594
Pillar extraction	~22 550 000	40 – 70	5 600
TOTAL	**104 064 000**	**90 - 110**	**7 194**

The time of "average" flooding does include increased influx of the known preferential flow zones, as well as the potential inter-section flow. Not all preferential influx zones are known at this point, so the volumes might increase, as more operational phase information becomes available.

The difference in water make between the bord and pillar sections and the pillar extraction sections is evident. The active storage of water from pillar extraction areas in any bord and pillar section of the Sasol Middelbult Shondoni reserve is part of the mining water management plan. Refer to Section 4 for the volumes of water-make and various water management options, during the operational and post-closure phases.

The likelihood of pillar extraction compartments decanting directly onto the surface is also dependent on the proximity of such workings to the surface and the hydraulic pressure exerted on the underground water mass towards the point(s) of possible decant.

Although mining of the No.4L coal seam will take place at depths generally deeper than 100m, the formation of sub-vertical hydraulic pressure zones could result, forcing water under gradient towards the surface. The volumes of potential decant are also much higher than that of bord and pillar compartments, contributing to the hydraulic pressure in these compartments.

5.4.4.2 Mine water seepage

Bord and pillar and pillar extraction mining

Mine water seepage occurs as a result of hydraulic gradients, and relates to the mining status of neighbouring mines, in terms of aquifer saturation and flooding status.

The following hydraulic/mining scenarios are relevant for the Sasol Middelbult Shondoni underground sections:

- The ground water regimes to the north, west and south-west of Sasol Middelbult Shondoni underground mine are undisturbed. The ground water seepage rates to the mine workings will resemble those of undisturbed geohydrological environments.

- The Syferfontein underground/strip mine will be situated some 2000 m to the north-east of the Sasol Middelbult Shondoni underground mine. The ground water seepage rates between these two sections will resemble those of undisturbed geohydrological environments, Regional inter-mine flow will only occur if no management measures are put in place at these mining sections.

- The southern and south-eastern boundary of the Sasol Middelbult Shondoni underground workings is dominated by the direct link with the Middelbult Colliery (2010-2015. However, in a post-closure environment, these closed-off sections could have ground water flow-interaction, which will influence the influx rates of both sections.

- A major reservoir for storage will be available at the Springbokdraai reserve areas after this section is mined out (2020). Storage capacity of at least 30 Mm^3 will be available for mine water management during the operational phase. The remainder of the water balance will be successfully managed after closure. After planned mining stop after 2048, the mine will flood along contour lines, as indicated in Figures 4.1.3(A and B).

- A series of perennial and non-perennial river systems are present above the Sasol Middelbult Shondoni reserve. Depending on the mining technique used, increased influx of these features can take place towards the mining horizon.

- A number of gold mine slimes dams are present above the Sasol Middelbult Shondoni reserve. Depending on the mining technique, and the distance of mining from these features, increased influx polluted water can take place downwards to the mining horizon.

All anticipated influx volumes were investigated with a 2-layered finite difference flow model. The results generated are for 2 different underground mining horizons. The model includes the possible interaction between the Sasol

Middelbult Shondoni mining sections, all surrounding mines, as well as faults and dykes identified to date.

In order to make the results obtained applicable to other mining areas, modelling results indicates the influx as converted to volume/unit length/month (*m^3/km/month*).

- The ground water influx from undisturbed surrounding aquifers to the mining sections was calculated using the hydraulic data generated during the baseline studies. The volume of ground water influx is 450 – 550m^3/km/month. This value is the same as for the pre-mining (undisturbed) ground water fluxes.

- The increase in ground water flux due to pillar extraction activities close to the non-perennial and perennial streams in the study area, is an additional 600 m^3/km/month. This value is applicable for a minimum mining distance of **100 m from river systems**.

- The potential increase in ground water flux due to inter-mine flow between the sealed-off sections Sasol Middelbult Shondoni and Middelbult Colliery is an additional 2000 m^3/km/month. This value is applicable for a **50 m wide barrier** pillar left between the underground sections. The influx is reduced to 1000 m^3/km/month with a **barrier pillar of 100 m**.

- The increase in ground water flux due to pillar extraction (pe) activities close to the gold mine slimes dams, can be summarised as follows:

Pillar Extraction Proximity to Slimes Dams	Increase in Ground water Influx
300 m	250 m^3/km/month
200 m	460 m^3/km/month
150 m	770 m^3/km/month
100 m	1100 m^3/km/month
50 m	2100 m^3/km/month
0 m	3800 m^3/km/month

The potential volume of polluted ground water that can drain into the mine from the gold mine slimes dams is evident. For this reason, a minimum distance of 300 m of pillar extraction mining from the gold mine slimes dams perimeters are recommended.

5.4.4.3 Long-term quality of all decant/mine water/seepage

Bord and pillar mining

Detailed acid-base accounting was performed on coal samples and stratigraphic units directly above the No.4L coal seam of the Sasol Middelbult Shondoni underground sections. Additional leaching tests were also performed to determine the leaching characteristics of these stratigraphical units, as well as the long-term water quality trends.

The following reaction sequence in terms of long-term ground water quality can be expected from the bord and pillar underground sections, post-closure:

- Pyrite oxidation on the mined horizons will be extensive due to the slow flooding during the post-closure phase.
- Initial acidification will be neutralised by the natural buffering capacity in the coal seam, as well as from ground water flooding the sections. This will take place over many years, until all the neutralising potential is depleted.
- Poor quality ground water will be present on the mine horizon when total flooding is completed.
- As stated earlier the likelihood of the water on the mine horizon decanting on surface is very small. Stratification of ground water will take place above the bord and pillar mining horizons, with only shallow weathered zone aquifer discharge “decanting” on surface.

Pillar extraction mining

The following reaction sequence in terms of long-term ground water quality can be expected from the pillar extraction section post-closure:

- Pyrite oxidation on the mined horizon will be limited due to the relative fast saturation of this zone during the operational phase. Provided that no water is pumped from these voids, these waters will remain alkaline to neutral for many years, past post-closure.
- Pyrite oxidation will continue in the unsaturated areas of the goafs, until a hydraulic equilibrium is reached. The rate of acidification will be reduced in the saturated areas of the goaf.
- All initial acidification will be neutralised by the natural buffering capacity in the overlying rock. This will take place for many years, until all the neutralising potential is depleted.
- Isolated areas of buffering depletion will take place in both the saturated and unsaturated zones. This will lead to the formation of acidic conditions in the goaf area, with low pH “hot spots” that will percolate downwards to the saturated zones.

- Depending on the size and distribution of these “hot spots”, the overall buffering capacity will continue to be reduced/depleted many years after closure. Eventual acidification of the total complex will take place.

- The total water make at Sasol Middelbult Shondoni pillar extraction section will consist of a mixture/stratification of:

  - Initial alkaline ground water on the mined horizon.

  - Initial alkaline ground water percolating through the goafs and stratigraphical units to the saturated zone.

  - Neutral ground water recharging in the goaf after mining has ceased (returns to geohydrological equilibrium). The neutral state of this water can be attributed to the sporadic depletion of buffering capacity.

  - Low pH ground water on the mined horizon, once buffering depletion and bacteriological action has commenced. The rate of acidification will again be lower because of saturated conditions.

  - Low pH ground water formed in the unsaturated areas of the goaf.

  - Recharge of rainwater into the total system

The different qualities of ground water to be expected at Sasol Middelbult Shondoni , in different mining sections, are shown in TABLE 5.4.1.3 (A)

TABLE 5.4.1.3(A)
Ground water qualities expected at Sasol Middelbult Shondoni during storage and post closure

Parameter	Operational storage quality	Surface seepage quality after total flooding – bord and pillar sections	Surface seepage quality after total flooding – pillar extraction sections
pH	6.6	7.5	2.5
EC (mS/m)	160 – 250	70 – 110	600 – 800
Ca (mg/l)	200 – 350	60	100 – 200
Mg (mg/l)	120 - 200	25	100 – 140
Na (mg/l)	25	20	60
K (mg/l)	20	10	30
T.Alk. (mg/l)	80	300	0
Cl (mg/l)	15	25	40

SO_4 (mg/l)	500 – 650	< 50	2500 – 3200
F (mg/l)	0.9	0.9	1.7
Al (mg/l)	0	0	50 – 70
Mn (mg/l)	1 – 2	0.5	10 – 20
Fe (mg/l)	1	1	20 - 50

Stratification of waters with differing salinity is a well understood phenomenon, and has been studied and researched in great depth, inter alia in studies related to sea-water intrusion in coastal aquifers.

It has been shown in these studies that in the absence of induced hydraulic stresses (e.g. pumping) the actual salinity interface is quite sharp with the diffuse interface zone restricted to a scale of a few meters, even for concentration gradients of 30 000 mg/l: 1000 mg/l.

This suggests that unless induced hydraulic stresses occur within the flooded mining environment, stratification is most likely to occur, thus effectively containing high salinity waters on the horizons at which they occurred/accumulated.

Therefore, unless hydraulic mechanisms occur, which can transport high salinity waters from the mined horizon, through the overlying saturated formations, onto surface, the high salinity water will most probably stay on the mined horizon.

It should be remembered that in the saturated overlying weathered zone aquifers, ground water flow will essentially be horizontal, thus preferentially causing surface discharge of recently recharged water from surface.

The probability for the presence/occurrence of non-equilibrium hydraulic stresses in a total extraction mining area could be higher than in conventional bord & pillar mining areas, due to the structural modifications present in such areas.

In the end, each mine will have to be assessed on a site specific basis, as aspects such as depth of mining, presence of dykes and faults, extent of structural disturbance, rate of flooding and inter-connectivity with other mines, may influence the post-closure decant scenario for that mine.

6. ENVIRONMENTAL MANAGEMENT MEASURES

6.1 IMPACT SIGNIFICANCE ASSESSMENT SUMMARY TABLES

6.1.1 Construction phase

Activity description	Criteria for determining severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk level before mitigation
	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL			
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES											
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	2	1	0	0	0	3	1	7	C2	Almost Certain	Level 5 Risk
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	~	~	~	~	~	~	~	0	~	~	~
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	4	1	0	0	0	3	1	9	C2	Almost Certain	Level 5 Risk
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	~	~	~	~	~	~	~	0	~	~	~
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	2	3	0	2	1	3	2	13	C3	Highly Unlikely	Level 6 Risk

Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	~	~	~	~	~	~	~	**0**	~	~	~
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	**4**	**1**	**1**	**0**	**0**	**3**	**1**	**10**	**C3**	**Very unlikely**	**Level 6 Risk**
Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	~	~	~	~	~	~	~	**0**	~	~	~
Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	~	~	~	~	~	~	~	**0**	~	~	~

Activity description	**Criteria for determining severity**								**SEVERITY C-NUMBER**	**Degree Of Likelihood**	**Risk level before mitigation**
	Quantity	**Toxicity**	**Extent**	**Duration**	**Status**	**Legislation**	**I & AP's**	**SEVERITY TOTAL**			
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40											
Taking water from a water resource - Section 21 (a). Ground water seepage into the shaft complex.	**2**	**0**	**0**	**0**	**1**	**2**	**1**	**6**	**C2**	**Likely**	**Level 6 Risk**
Impeding or diverting the flow of water in a watercourse - Section 21 (c).	~	~	~	~	~	~	~	**0**	~	~	~
Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	~	~	~	~	~	~	~	**0**	~	~	~

Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g). Deterioration of ground water seepage in the shaft complex.	**2**	**0**	**0**	**0**	**1**	**2**	**1**	**6**	**C2**	**Likely**	**Level 6 Risk**
Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	~	~	~	~	~	~	~	**0**	~	~	~
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j). Any water removed from the No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas.	**4**	**1**	**1**	**0**	**0**	**3**	**1**	**10**	**C3**	**Very unlikely**	**Level 6 Risk**

Activity description	**Criteria for determining severity**								**SEVERITY C-NUMBER**	**Degree Of Likelihood**	**Risk level before mitigation**
	Quantity	**Toxicity**	**Extent**	**Duration**	**Status**	**Legislation**	**I & AP's**	**SEVERITY TOTAL**			
SHONDONI SHAFT AREA											
Construction and commissioning of the shaft complex at Shondoni can lead to a reduction in ground water yield around the shaft complex.	**2**	**0**	**1**	**0**	**1**	**2**	**1**	**7**	**C2**	**Likely**	**Level 6 Risk**
Construction and commissioning of the shaft complex at Shondoni can lead to a reduction in ground water quality around the shaft complex.	**2**	**1**	**1**	**0**	**1**	**2**	**1**	**8**	**C2**	**Likely**	**Level 6 Risk**

Activity description	Criteria for determining severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk level before mitigation
	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL			
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM											
Construction and commissioning of the shaft complex at Shondoni. No mining will commence in the Shondoni part of the mine. Restricted mining activities will take place at Middelbult.	≈	≈	≈	≈	≈	≈	≈	**0**	≈	≈	≈

6.1.2 Operational phase

Activity description	Criteria for determining severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk level before mitigation
	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL			
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES											
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	4	1	0	2	1	3	1	12	C3	Very Unlikely	Level 6 Risk
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	~	~	~	~	~	~	~	0	~	~	~
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	4	2	1	2	1	3	2	15	C4	Almost Certain	Level 3 Risk
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	~	~	~	~	~	~	~	0	~	~	~
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	2	3	1	2	1	3	2	14	C4	Highly Unlikely	Level 5 Risk
Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	~	~	~	~	~	~	~	0	~	~	~
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to	4	2	1	2	1	3	2	15	C4	Almost Certain	Level 3 Risk

facilitate the efficient continuation of mining and for the safety of people - Activity 13.											
Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	~	~	~	~	~	~	~	**0**	~	~	~
Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	~	~	~	~	~	~	~	**0**	~	~	~

Activity description	**Criteria for determining severity**								**SEVERITY C-NUMBER**	**Degree Of Likelihood**	**Risk level before mitigation**
	Quantity	**Toxicity**	**Extent**	**Duration**	**Status**	**Legislation**	**I & AP's**	**SEVERITY TOTAL**			
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40											
Taking water from a water resource - Section 21 (a). All underground water accruing in mining sections during the operational phase will be stored in mined-out underground mine workings (storage reservoirs). This component will only be triggered if any water is pumped to surface. No 21(a) application is required at this stage. If and when this happens, an amendment to the WULA will be done.	~	~	~	~	~	~	~	**0**	~	~	~
Impeding or diverting the flow of water in a watercourse - Section 21 (c).	~	~	~	~	~	~	~	**0**	~	~	~
Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	~	~	~	~	~	~	~	**0**	~	~	~

Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g). Ground water seepage captured from the ROM stockpile (maximum 2000m^3/a) at Shondoni Shaft Complex will be pumped to the Storm Water Pollution Control Dam (SWPCD).	**4**	**1**	**0**	**2**	**1**	**2**	**1**	**11**	**C3**	**Almost Certain**	**Level 4 Risk**
Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	~	~	~	~	~	~	~	**0**	~	~	~
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j). Any water removed from the No.2 and No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas. A detailed mine optimisation plan has been designed to create the necessary storage of water in mined out areas for the total Life of Mine.	**4**	**1**	**1**	**2**	**1**	**4**	**2**	**15**	**C4**	**Almost Certain**	**Level 3 Risk**

Activity description	**Criteria for determining severity**								**SEVERITY C-NUMBER**	**Degree Of Likelihood**	**Risk level before mitigation**
	Quantity	**Toxicity**	**Extent**	**Duration**	**Status**	**Legislation**	**I & AP's**	**SEVERITY TOTAL**			
SHONDONI SHAFT AREA											
Depletion in ground water availability and deterioration of ground water quality in the Shaft as a result of ground water seepage during the operational phase of the shaft complex. The shaft complex will be sealed/grouted, so little to no impact will take place.	**1**	**0**	**0**	**2**	**1**	**1**	**1**	**6**	**C2**	**Highly Unlikely**	**Level 6 Risk**

Activity description	Criteria for determining severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk level before mitigation
	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL			
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM											
The influx of groundwater recharge into mine workings due to bord and pillar mining of the No's 2 and 4 coal seam.	**4**	**0**	**1**	**2**	**1**	**3**	**1**	**12**	**C3**	**Almost Certain**	**Level 4 Risk**
The increased influx of groundwater into mine workings due to pillar extraction activities of the No.4 coal seam.	**4**	**0**	**1**	**2**	**1**	**3**	**1**	**12**	**C3**	**Almost Certain**	**Level 4 Risk**
Inter-mine and inter-section flow of ground water during the operational phase.	**4**	**1**	**1**	**2**	**0**	**2**	**1**	**11**	**C3**	**Possible**	**Level 5 Risk**
Depletion of external users' groundwater resources and fountains due to bord and pillar mining activities of the No's 2 and 4 coal seams.	**1**	**0**	**0**	**2**	**1**	**3**	**2**	**9**	**C2**	**Unforeseen**	**Level 6 Risk**
Depletion of external users' groundwater resources and fountains due to pillar extraction mining activities of the No. 4 coal seam.	**2**	**0**	**1**	**2**	**1**	**3**	**2**	**11**	**C3**	**Low**	**Level 5 Risk**
Depletion of stream base flow due to sub-surface subsidence of the No.4 coal seam.	**4**	**0**	**2**	**2**	**1**	**3**	**2**	**14**	**C4**	**Low**	**Level 3 Risk**
Deterioration in groundwater quality in all underground sections, and migration into the receiving environment.	**4**	**2**	**1**	**3**	**1**	**3**	**1**	**15**	**C4**	**Almost Certain**	**Level 3 Risk**
Groundwater pollution originating from the ROM coal stock pile at the Shondoni Shaft Complex.	**2**	**2**	**0**	**2**	**1**	**3**	**1**	**11**	**C3**	**Almost Certain**	**Level 4 Risk**

Groundwater pollution originating from the Storm Water Pollution Control Dam (SWPCD).	**4**	**2**	**1**	**2**	**1**	**3**	**2**	**15**	**C4**	**Almost Certain**	**Level 4 Risk**

6.1.3 Decommissioning phase

Activity description	Criteria for determining severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk level before mitigation
	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL			
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES											
The decommissioning of a coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	1	1	0	0	1	1	0	4	C1	Possible	Level 6 Risk
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	~	~	~	~	~	~	~	0	~	~	~
The decommissioning of Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	2	2	1	0	1	1	0	7	C2	Almost Certain	Level 5 Risk
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	~	~	~	~	~	~	~	0	~	~	~
The decommissioning of Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	1	3	0	0	1	1	0	6	C2	Very Unlikely	Level 6 Risk
Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	~	~	~	~	~	~	~	0	~	~	~
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to	~	~	~	~	~	~	~	0	~	~	~

facilitate the efficient continuation of mining and for the safety of people - Activity 13.											
Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	~	~	~	~	~	~	~	**0**	~	~	~
Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	~	~	~	~	~	~	~	**0**	~	~	~

Activity description	**Criteria for determining severity**								**SEVERITY C-NUMBER**	**Degree Of Likelihood**	**Risk level before mitigation**
	Quantity	**Toxicity**	**Extent**	**Duration**	**Status**	**Legislation**	**I & AP's**	**SEVERITY TOTAL**			
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40											
Taking water from a water resource - Section 21 (a). All underground water accruing in mining sections during the decommissioning phase will be stored in mined-out underground mine workings (storage reservoirs). This component will only be triggered if any water is pumped to surface. No 21(a) application is required at this stage. If and when this happens, an amendment to the WULA will be done.	~	~	~	~	~	~	~	0	~	~	~
Impeding or diverting the flow of water in a watercourse - Section 21 (c).	~	~	~	~	~	~	~	0	~	~	~
Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).	~	~	~	~	~	~	~	0	~	~	~

Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g). Ground water seepage captured from the ROM stockpile (maximum 2000m^3/a) at Shondoni Shaft Complex will be pumped to the Storm Water Pollution Control Dam (SWPCD).	≈	≈	≈	≈	≈	≈	≈	0	≈	≈	≈
Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).	≈	≈	≈	≈	≈	≈	≈	0	≈	≈	≈
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j). Any water removed from the No.2 and No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas.	≈	≈	≈	≈	≈	≈	≈	0	≈	≈	≈

Activity description	**Criteria for determining severity**								**SEVERITY C-NUMBER**	**Degree Of Likelihood**	**Risk level before mitigation**
	Quantity	**Toxicity**	**Extent**	**Duration**	**Status**	**Legislation**	**I & AP's**	**SEVERITY TOTAL**			
SHONDONI SHAFT AREA											
Localized depletion of ground water (if it occurred during the operational phase) will be reversed, and ground water levels will start to return to pre-mining ground water levels.	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**3**	**C1**	**Almost Certain**	**Level 6 Risk**

Activity description	Criteria for determining severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk level before mitigation
	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL			
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM											
The continuous influx of groundwater recharge into mine workings due to bord and pillar mining of the No's 2 and 4 coal seam, during the decommissioning phase.	**4**	**1**	**1**	**0**	**1**	**0**	**1**	**8**	**C2**	**Almost Certain**	**Level 5 Risk**
The increased influx of groundwater into mine workings due to pillar extraction activities of the No.4 coal seam, during the decommissioning phase.	**4**	**1**	**1**	**0**	**1**	**0**	**1**	**8**	**C2**	**Almost Certain**	**Level 5 Risk**

6.1.4 Post-closure phase

Activity description	Criteria for determining severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk level before mitigation
	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL			
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES											
The final closure of a coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	1	1	0	0	1	1	0	4	C1	Possible	Level 6 Risk
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	~	~	~	~	~	~	~	0	~	~	~
The final closure of Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	0	1	1	0	1	1	0	4	C2	Almost Certain	Level 6 Risk
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	~	~	~	~	~	~	~	0	~	~	~
The final closure of Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	1	0	0	0	1	1	0	3	C2	Very Unlikely	Level 6 Risk
Removal of Indigenous Vegetation of 3 hectares or more during Site Clearance for Construction of Shondoni Shaft Complex and related Infrastructure - Activity 12.	~	~	~	~	~	~	~	0	~	~	~
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to	~	~	~	~	~	~	~	0	~	~	~

facilitate the efficient continuation of mining and for the safety of people - Activity 13.											
Installation of a Tetra Radio System above ground at the Shaft Complex Area - Activity 14.	~	~	~	~	~	~	~	**0**	~	~	~
Construction of an Access Road (wider than 4m) to Shondoni Shaft Complex from Tar road R547 - Activity 15.	~	~	~	~	~	~	~	**0**	~	~	~

Activity description	**Criteria for determining severity**								**SEVERITY C-NUMBER**	**Degree Of Likelihood**	**Risk level before mitigation**
	Quantity	**Toxicity**	**Extent**	**Duration**	**Status**	**Legislation**	**I & AP's**	**SEVERITY TOTAL**			
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40											
Taking water from a water resource - Section 21 (a). After final flooding of mining sections, water will be stored in underground mining sections. If surface treatment of ground water is required, the appropriate amendment to the WULA will be made to register this water use.	**4**	**2**	**1**	**3**	**1**	**2**	**2**	**15**	**C4**	**Almost Certain**	**Level 3 Risk**
Impeding or diverting the flow of water in a watercourse - Section 21 (c).											
Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit - Section 21 (f).											
Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).											

Altering the bed, banks, course or characteristics of a watercourse - Section 21 (i).											
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).											

Activity description	**Criteria for determining severity**								**SEVERITY C-NUMBER**	**Degree Of Likelihood**	**Risk level before mitigation**
	Quantity	**Toxicity**	**Extent**	**Duration**	**Status**	**Legislation**	**I & AP's**	**SEVERITY TOTAL**			
SHONDONI SHAFT AREA											
Final closure of the shaft complex. Localized depletion of ground water (if it occurred during the operational phase) will be reversed, and ground water levels will finally return to pre-mining ground water levels.	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**C1**	**Almost Certain**	**Level 6 Risk**

Activity description	Criteria for determining severity								SEVERITY C-NUMBER	Degree Of Likelihood	Risk level before mitigation
	Quantity	Toxicity	Extent	Duration	Status	Legislation	I & AP's	SEVERITY TOTAL			
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM											
The continuous influx of groundwater recharge into mine workings until all mining units is flooded.	4	1	1	2	1	3	2	14	C4	Almost Certain	Level 3 Risk
The decant of underground mine water to surface, after total flooding of mining units.	4	1	0	2	1	2	2	12	C3	Low	Level 5 Risk
Inter-mine and inter-section flow of ground water during the post closure phase.	4	1	2	3	1	4	3	18	C5	Possible	Level 2 Risk
Continuous depletion of external users' groundwater resources and fountains due to pillar extraction mining activities of the No. 4 coal seam.	2	0	1	3	1	2	2	11	C3	Low	Level 5 Risk
Depletion of stream base flow due to sub-surface subsidence of the No.4 coal seam, post-closure.	4	0	1	2	1	3	2	13	C3	Very Unlikely	Level 6 Risk
Deterioration in groundwater quality in all underground sections, and migration into the receiving environment, after mining activities have stopped.	4	2	1	3	1	3	2	16	C4	Almost Certain	Level 3 Risk
Groundwater pollution originating from the ROM coal stock pile footprint at the Shondoni Shaft Complex after closure.	2	1	0	1	1	1	1	7	C2	Very Unlikely	Level 6 Risk
Groundwater pollution originating from the Storm Water Pollution Control Dam (SWPCD) footprint after closure.	2	1	0	1	1	1	1	7	C2	Very Unlikely	Level 6 Risk

6.2 ENVIRONMENTAL MANAGEMENT OBJECTIVES AND MEASURES

6.2.1 Construction phase

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES						
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	The construction of a 15 000t ROM coal stockpile area at Shondoni Shaft. The construction activities consist of the preparation of a suitable footprint area and will in itself not lead to any potential ground water pollution.	Level 5 Risk	LOW	Ensure that construction activities do not introduce any substance into the sub-surface that can lead to ground water pollution.	Prevent spillages of any hazardous liquid or solid substance used during the construction of the ROM stockpile footprint.	Level 5 Risk
Conveyor Pedestal for crossing of Trichardt Spruit (in the 1:10 year flood line) - Activity 1 (m).	Conveyor Pedestal will not intersect ground water, so no impact will take place.	Level 5 Risk	LOW	Ensure that construction activities do not introduce any substance into the sub-surface that can lead to ground water pollution.	Prevent spillages of any hazardous liquid or solid substance used during the construction of the Pollution Control Dam.	Level 5 Risk
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	The construction of a Storm Water Pollution Control Dam that can lead to a deterioration of ground water quality directly beneath the facility.	Level 6 Risk	LOW	Ensure that diesel tanks are placed in industry-standard bunkers with the appropriate lining systems to prevent the leakage of any diesel spill away from the bunker.	All spillages must be captured inside the bunded areas before any spillage to the surrounding environment takes place.	Level 6 Risk
Excavation for Coal Conveyor Pedestal for crossing of Trichardt Spruit, removing more than 5 cubic meters of material - Activity 4.	Conveyor Pedestal will not intersect ground water, so no impact will take place.	Level 6 Risk	LOW	Minimise the volumes of water to be pumped to surface to surface pollution control dams.	Optimise storage space in old underground units to prevent the need to pump water from underground mine workings to surface water pollution control dams.	Level 6 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40						
Taking water from a water resource - Section 21 (a).	Ground water seepage into the shaft complex during construction activities, through weathered and fresh aquifer units (to a depth of 120 meters).	Level 6 Risk	LOW	If significant influxes of ground water occur, remove the water from the shaft construction area.	Grout/seal influx zones and pump seepage water to the appropriate surface water control dam.	Level 6 Risk
Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	Ground water seepage captured in the shaft complex during construction activities will be pumped to pollution control dams on surface. Since the water originated in a construction area, it is considered polluted.	Level 6 Risk	LOW	If significant influxes of ground water occur, remove the water from the shaft construction area.	Pump excess ground water to pollution control dams on surface.	Level 6 Risk
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Any water removed from the No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas. A detailed mine optimisation plan has been designed to create the necessary storage of water in mined out areas for the total Life of Mine.	Level 6 Risk	LOW	Minimise the volumes of water to be pumped to surface to surface pollution control dams.	Optimise storage space in old underground units to prevent the need to pump water from underground mine workings to surface water pollution control dams.	Level 6 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
SHONDONI SHAFT AREA						
Construction and commissioning of the shaft complex at Shondoni.	Depletion in ground water availability as a result of ground water seepage during the construction of the shaft complex.	Level 6 Risk	LOW	Prevent influx of ground water into the shaft complex.	Grout/seal influx zones and pump seepage water to the appropriate surface water control dam.	Level 6 Risk
Construction and commissioning of the shaft complex at Shondoni	Deterioration in ground water quality as a result of ground water seepage into the shaft complex during construction activities.	Level 6 Risk	LOW	Prevent long residence time of ground water accumulation in the shaft complex.	Grout/seal influx zones and pump seepage water to the appropriate surface water control dam.	Level 6 Risk

6.2.2 Operational phase

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES						
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	The operation of a 15 000t ROM coal stockpile area at Shondoni Shaft. Seepage from the stockpile area can lead to ground water pollution, if not managed correctly.	Level 6 Risk	LOW	To prevent the seepage of contaminated water from the ROM stockpile entering the underlying aquifer units.	The ROM stockpile must be operated on a lined surface. Any surface water run-off will be captured and handled as dirty water in the Surface Water Dam.	Level 6 Risk
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	The operation of a Storm Water Pollution Control Dam (SWPCD) that can lead to a deterioration of ground water quality directly beneath the facility.	Level 3 Risk	MEDIUM	To prevent the seepage of contaminated water from the Storm Water Pollution Control Dam (SWPCD) entering the underlying aquifer units.	Prevent seepages and spillages of polluted water from the SWPCD by implementing the appropriate lining system. Excess run-off from the facility must be captured and managed as part of the operational phase water balance.	Level 4 Risk
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	The storage of diesel fuel in storage tanks can lead to ground water pollution due to spillages/leaks.	Level 5 Risk	HIGH	Ensure that diesel tanks are placed in industry-standard bunkers with the appropriate lining systems to prevent the leakage of any diesel spill away from the bunker.	All spillages must be captured inside the bunded areas before any spillage to the surrounding environment takes place. Suitably qualified personnel will be responsible for the clean-up of any diesel spills of any size and nature (Hazmat).	Level 6 Risk
Removal of water found in the underground workings on the No.4 Seam and the No.2 Seam workings to facilitate the efficient continuation of mining and for the safety of people - Activity 13.	Any water removed from the No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas, or pumped to surface to the Storm Water Pollution Control Dam (SWPCD).	Level 3 Risk	LOW	Minimise the volumes of water to be pumped to surface to the Storm Water Pollution Control Dam (SWPCD).	Optimise storage space in old underground units to prevent the need to pump water from underground mine workings to the Storm Water Pollution Control Dam (SWPCD).	Level 4 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40						
Disposing of waste in a manner which may detrimentally impact on a water resource - Section 21 (g).	Ground water seepage captured from the ROM stockpile (maximum 2000m^3/a) at Shondoni Shaft Complex will be pumped to the Storm Water Pollution Control Dam (SWPCD).	Level 4 Risk	LOW	To prevent the seepage of contaminated water from the ROM Stockpiles entering the underlying aquifer units.	Pump excess ground water seepage to the Storm Water Pollution Control Dam (SWPCD).	Level 5 Risk
Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people - Section 21 (j).	Any water removed from the No.2 and No.4 Coal seam will be deemed polluted and stored in other sections of mined out areas. A detailed mine optimisation plan has been designed to create the necessary storage of water in mined out areas for the total Life of Mine.	Level 3 Risk	MEDIUM	1. Minimise the volumes of water to be pumped to the Storm Water Pollution Control Dam (SWPCD). 2. Optimise underground storage reservoirs to ensure safe and responsible mining during the LOM.	Manage the operational phase water balance responsibly to reduce water make and optimise underground storage space available.	Level 4 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
SHONDONI SHAFT AREA						
Operating the shaft complex at Shondoni for the Life of Mine.	Depletion in ground water availability and deterioration of ground water quality in the Shaft as a result of ground water seepage during the operational phase of the shaft complex. The shaft complex will be sealed/grouted, so little to no impact will take place.	Level 6 Risk	LOW	Prevent influx of ground water into the shaft complex.	Grout/seal influx zones and pump seepage water to the Storm Water Pollution Control Dam (SWPCD).	Level 6 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM						
The influx of groundwater recharge into mine workings due to bord and pillar mining of the No's 2 and 4 coal seam.	Ground water recharge from surface will enter areas of bord and pillar mining due to the fact that mining will create an increasing void.	Level 4 Risk	LOW	Manage the influx of normal ground water recharge as part of the operational phase water balance.	Manage the operational phase water balance responsibly to reduce water make and optimise underground storage space available.	Level 4 Risk
The increased influx of groundwater into mine workings due to pillar extraction activities of the No.4 coal seam.	An increased ground water recharge from surface will take place due to sub-surface subsidence on the No.4 coal seam.	Level 4 Risk	HIGH	Manage the influx of additional ground water make due to pillar extraction activities.	Manage the operational phase water balance responsibly to reduce water make and optimise underground storage space available.	Level 4 Risk
Inter-mine and inter-section flow of ground water during the operational phase.	Ground water resources stored in underground mining units can migrate from one mine/section to an adjacent mine/section, due to a difference in hydraulic pressure. Flow can also be induced where flooding compartments decant into surrounding compartments due to a roll in the coal seam floor.	Level 5 Risk	LOW	Calculate and allocate low-lying reservoirs for underground water storage.	Measure water levels in reservoirs to ensure that no unit is over-utilized. Move between storage compartments (reservoirs) before inter-mine or inter-section flow takes place.	Level 5 Risk
Depletion of external users' groundwater resources and fountains due to bord and pillar mining activities of the No's 2 and 4 coal seams.	Bord and pillar mining activities can intersect external user's boreholes directly and can lead to a reduction/complete depletion of external user's borehole yields.	Level 6 Risk	LOW	Monitor all external users' boreholes for 1) yield and 2) quality deterioration, based on a structured monitoring protocol.	Supply external users with supplementary water in the cases where a mining-related impact can be proven.	Level 6 Risk
Depletion of external users' groundwater resources and fountains due to pillar extraction mining activities of the No. 4 coal seam.	Pillar extraction mining activities can lead to sub-surface subsidence, that in turn will lead to a reduction/complete depletion of external user's borehole yields.	Level 5 Risk	HIGH	Monitor all external users' boreholes for 1) yield and 2) quality deterioration, based on a structured monitoring protocol.	Supply external users with supplementary water in the cases where a mining-related impact can be proven.	Level 5 Risk
Depletion of stream base flow due to sub-surface subsidence of the No.4 coal seam.	Pillar extraction mining activities can lead to sub-surface subsidence, that in turn will lead to a reduction/complete depletion of ground water base flow to rivers and non-perennial streams.	Level 3 Risk	HIGH	Avoid pillar extraction activities below surface streams or obtain rock-mechanical evidence that no surface subsidence will take place.	In the event that surface water streams or non-perennial streams is intersected by surface subsidence, rehabilitate the stream as soon as possible, to prevent further ingress of surface water to underground mining units.	Level 3 Risk

Deterioration in groundwater quality in all underground sections, and migration into the receiving environment.	Ground water recharge to underground mining units that remains in reservoirs will come in contact with coal pillars, mine floors and roofs. A gradual deterioration in ground water quality will take place over time, depending amongst other things, residence times, natural buffer capacity and mixing ratios of ground water from different sources.	Level 3 Risk	HIGH	The deterioration of ground water in underground units is a given. The migration of polluted ground water will be avoided by managing the water in underground storage compartments.	Monitor underground ground water qualities on a quarterly basis. Prevent the mixing of poor and good quality water in the same reservoir - rather keep in separate reservoirs.	Level 3 Risk
Groundwater pollution originating from the ROM coal stock pile at the Shondoni Shaft Complex.	The operation of a 15 000t ROM coal stockpile area at Shondoni Shaft. Seepage from the stockpile area can lead to ground water pollution, if not managed correctly.	Level 4 Risk	LOW	To prevent the seepage of contaminated water from the ROM stockpile entering the underlying aquifer units.	The ROM stockpile must be operated on a lined surface. Any surface water run-off will be captured and handled as dirty water in the Surface Water Dam.	Level 4 Risk
Groundwater pollution originating from the Storm Water Pollution Control Dam (SWPCD).	The operation of a Storm Water Pollution Control Dam (SWPCD) that can lead to a deterioration in ground water quality directly beneath the facility.	Level 4 Risk	LOW	To prevent the seepage of contaminated water from the Storm Water Pollution Control Dam (SWPCD) entering the underlying aquifer units.	Prevent seepages and spillages of polluted water from the SWPCD by implementing the appropriate lining system. Excess run-off from the facility must be captured and managed as part of the operational phase water balance.	Level 4 Risk

6.2.3 Decommissioning phase

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES						
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	The decommissioning of a 15 000t ROM coal stockpile area at Shondoni Shaft. Residual seepage from the stockpile footprint area can lead to further ground water pollution.	Level 6 Risk	LOW	To prevent the residual seepage of contaminated water from the ROM stockpile entering the underlying aquifer units.	The ROM stockpile footprint must be rehabilitated to pre-mining surface- and topographical conditions.	Level 6 Risk
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	The decommissioning of the Storm Water Pollution Control Dam (SWPCD) footprint.	Level 5 Risk	LOW	To prevent the residual seepage of contaminated water from the Storm Water Pollution Control Dam (SWPCD) footprint entering the underlying aquifer units.	Prevent residual seepages and spillages of polluted water from the SWPCD footprint by rehabilitating the surface area to pre-mining surface- and topographical conditions.	Level 5 Risk
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	The decommissioning of diesel fuel storage tanks can lead to residual ground water pollution.	Level 6 Risk	LOW	Ensure that the diesel tanks and associated infrastructure is empty when decommissioning, to prevent the leakage of any diesel spill away from the bunker footprint.	All residual spillages must be captured inside the footprint areas before any spillage to the surrounding environment takes place.	Level 6 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
SHONDONI SHAFT AREA						
Closing the shaft complex at Shondoni.	Localized depletion of ground water (if it occurred during the operational phase) will be reversed, and ground water levels will start to return to pre-mining ground water levels.	Level 6 Risk	LOW	The return of ground water levels to pre-mining levels is a positive impact.	None	Level 6 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM						
The continuous influx of groundwater recharge into mine workings due to bord and pillar mining of the No's 2 and 4 coal seam, during the decommissioning phase.	Ground water recharge due to operational phase mining activities will continue during the decommissioning phase. The impact will persist well beyond the post-closure phase and will be addressed in that section.	Level 5 Risk	LOW	Manage the influx of normal ground water recharge as part of the closure phase water balance.	Refer to mitigation measures proposed for the closure phase.	Level 5 Risk
The increased influx of groundwater into mine workings due to pillar extraction activities of the No.4 coal seam, during the decommissioning phase.	Ground water recharge due to operational phase mining activities will continue during the decommissioning phase. The impact will persist well beyond the post-closure phase and will be addressed in that section.	Level 5 Risk	LOW	Manage the influx of additional ground water make due to pillar extraction activities as part of the closure phase water balance.	Refer to mitigation measures proposed for the closure phase.	Level 5 Risk

6.2.4 Post-closure phase

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
LISTED ACTIVITIES AT SHONDONI IN TERMS OF NEMA (ACT 107 OF 1998): GN 386 ACTIVITIES						
Coal throw out stockpile area at Shondoni Shaft with a storage of more than 250 tons but less than 100 000 tons - Activity 1 (c).	The final closure of a 15 000t ROM coal stockpile area at Shondoni Shaft. Residual seepage from the stockpile footprint area can lead to further ground water pollution.	Level 6 Risk	LOW	To prevent the residual seepage of contaminated soils from the ROM stockpile entering the underlying aquifer units.	The ROM stockpile footprint must be rehabilitated to pre-mining surface- and topographical conditions.	Level 6 Risk
Service Water Dams and Storm Water Pollution Control Dam at Shondoni Shaft Complex with a capacity of 50 000 cubic metres or more - Activity 1 (n).	The closure and final rehabilitation of the Storm Water Pollution Control Dam (SWPCD) footprint.	Level 6 Risk	LOW	To prevent the residual seepage of contaminated soils from the Storm Water Pollution Control Dam (SWPCD) footprint entering the underlying aquifer units.	Prevent residual seepages and spillages of polluted water from the SWPCD footprint by rehabilitating the surface area to pre-mining surface- and topographical conditions.	Level 6 Risk
Diesel Fuel Storage Tanks at Shondoni Shaft Complex with a combined capacity of more than 30 cubic metres but less than 1 000 cubic metres - Activity 7.	The removal of diesel fuel storage tanks.	Level 6 Risk	LOW	All risks are removed at this stage	No spillages can happen at this stage.	Level 6 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
NATIONAL WATER ACT (ACT 36 OF 1998): SECTION 40						
Taking water from a water resource - Section 21 (a).	After final flooding of mining sections, water will be stored in underground mining sections. If surface treatment of ground water is required, the appropriate amendment to the WULA will be made to register this water use.	Level 3 Risk	LOW	To treat polluted water from underground facilities, to prevent the decant of polluted water.	Desalinate polluted underground water on surface.	Level 3 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
SHONDONI SHAFT AREA						
Final closure of the shaft complex at Shondoni.	Localized depletion of ground water (if it occurred during the operational phase) will be reversed, and ground water levels will finally return to pre-mining ground water levels.	Level 6 Risk	LOW	The return of ground water levels to pre-mining levels is a positive impact.	None	Level 6 Risk

Activity Description	Impact Description	Risk level before mitigation	Mitigatory difficulty	Mitigation/Management objective	Proposed Mitigation Measure	Risk level after mitigation
UNDERGROUND MINING ACTIVITIES OF THE NO.S 2 AND 4 COAL SEAM						
The continuous influx of groundwater recharge into mine workings until all mining units are flooded.	Ground water recharge from surface will enter areas of bord and pillar and high extraction mining until all mining units are flooded.	Level 3 Risk	LOW	Manage the influx of normal ground water recharge as part of the post closure phase water balance.	Manage the post-closure phase water balance responsibly to reduce water make and optimise underground storage space available, until all mining units are flooded.	Level 3 Risk
The decant of underground mine water to surface, after total flooding of mining units.	After final flooding of mining sections, ground water can seep to surface due to conduit flow from high extraction subsidence areas.	Level 5 Risk	HIGH	Prevent uncontrollable decant of underground mine water on surface.	If surface decant takes place, manipulate ground water elevations in the total mining complex by pumping and treating polluted water on surface.	Level 5 Risk
Inter-mine and inter-section flow of ground water during the post closure phase.	Ground water resources stored in Shondoni underground mining units can migrate from one mine/section to an adjacent mine/section, due to a difference in hydraulic pressure. Flow can also be induced where flooding compartments decant into surrounding compartments due to a roll in the coal seam floor.	Level 2 Risk	HIGH	Manage the overall water balance of the total Sasol Coal mining complex to prefent uncontrollable inter-mine flow to surrounding mines.	Measure water levels in the overal Sasol Coal reservoirs to ensure that no unit is over-utilized, and allowed to migrate or decant. Move between storage compartments (reservoirs) before inter-mine or inter-section flow takes place or pump excess water to surface where water can be desalinated.	Level 3 Risk
Continuous depletion of external users' groundwater resources and fountains due to pillar extraction mining activities of the No. 4 coal seam.	Pillar extraction mining activities can lead to sub-surface subsidence, that in turn will lead to a reduction/complete depletion of external user's borehole yields, for indefinite time frames.	Level 5 Risk	HIGH	Monitor all external user's boreholes for 1) yield and 2) quality deterioration, based on a structured monitoring protocol.	Supply external users with supplementary water in the cases where a mining-related impact can be proven.	Level 5 Risk
Depletion of stream base flow due to sub-surface subsidence of the No.4 coal seam, post-closure.	Pillar extraction mining activities can lead to sub-surface subsidence, that in turn will lead to a reduction/complete depletion of ground water base flow to rivers and non-perennial streams, for indefinite periods of time.	Level 6 Risk	HIGH	Surface rehabilitation of subsidence areas must reduce the reduction of stream base flow.	In the event that surface water streams or non-perennial streams is intersected by surface subsidence, rehabilitate the stream as soon as possible, to prevent further ingress of surface water to underground mining units.	Level 6 Risk

Deterioration in groundwater quality in all underground sections, and migration into the receiving environment, after mining activities have stopped.	Ground water recharge to underground mining units that remains in reservoirs will come in contact with coal pillars, mine floors and roofs. A gradual deterioration in ground water quality will take place over time, eventually leading to total acidification of underground mine water.	Level 3 Risk	HIGH	The deterioration of ground water in underground units is a given. The migration of polluted ground water will be avoided by managing the water in underground storage compartments.	Monitor underground ground water qualities on a quarterly basis. Excess water in the total Sasol Mine area must be pumped to surface and desalinated.	Level 3 Risk
Groundwater pollution originating from the ROM coal stock pile footprint at the Shondoni Shaft Complex after closure.	Seepage from the stockpile area footprint can lead to ground water pollution, if not rehabilitated correctly.	Level 6 Risk	LOW	Prevent residual seepage of contaminated water from the ROM stockpile footprint by rehabilitating the footprint correctly.	Rehabilitate footprints to SABS 0268 Standards to remove any residual contaminants.	Level 6 Risk
Groundwater pollution originating from the Storm Water Pollution Control Dam (SWPCD) footprint after closure.	Seepage from the SWPCD footprint can lead to ground water pollution, if not rehabilitated correctly.	Level 6 Risk	LOW	Prevent residual seepage of contaminated water from the SWPCD footprint by rehabilitating the footprint correctly.	Rehabilitate footprints to SABS 0268 Standards to remove any residual contaminants.	Level 6 Risk

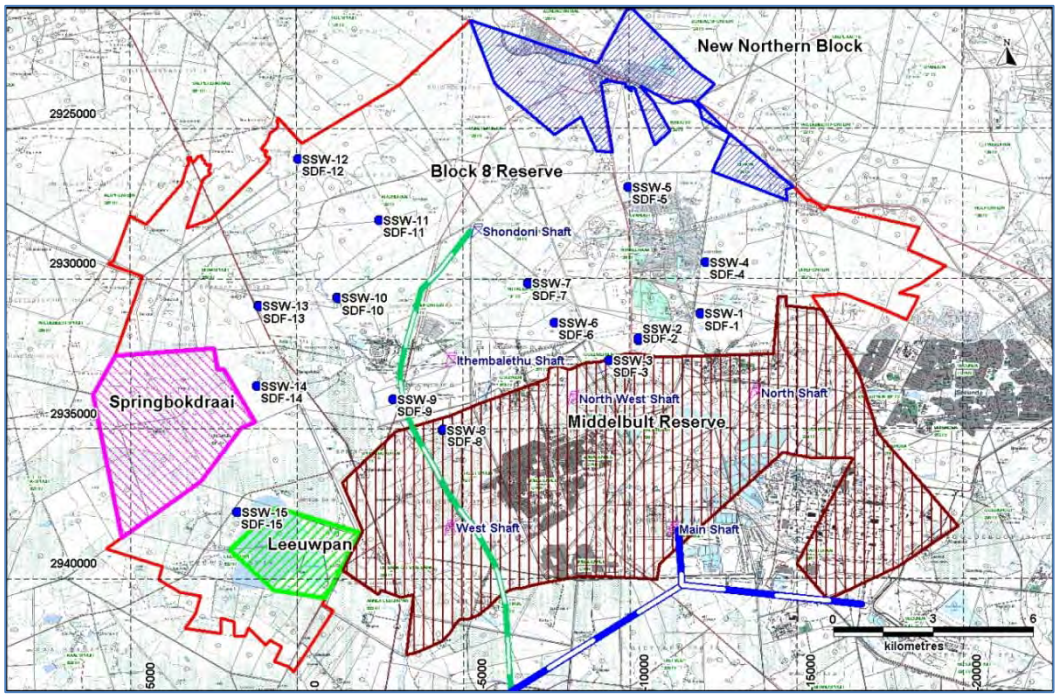
7. ENVIRONMENTAL MONITORING PLAN

The ground water monitoring plan at Sasol Middelbult Shondoni will concentrate on two ground water related impacts, namely:

- The potential impact of bord and pillar mining activities on ground water yield and ground water quality of external users in the shallow weathered aquifers.

- The potential impact of increased extraction mining activities on ground water yield and ground water quality of external users in the shallow weathered aquifers

A ground water monitoring system is in place for the greater Sasol Mining Division – the so-called REGM monitoring system. In addition to that, the following monitoring boreholes were drilled during the 2002 Block 8 investigation. JMA suggests that these localities are added to the REGM monitoring system. This system recommends a 6-monthly monitoring for borehole yield and qualities, and is reported on a bi-annual basis to the Department of Water Affairs:



Number:	*Latitude [°]*	*Longitude [°]*
SDF-1	*26.49249*	*29.12165*
SDF-2	*26.49995*	*29.10294*
SDF-3	*26.50655*	*29.09408*
SDF-4	*26.4771*	*29.12309*
SDF-5	*26.45441*	*29.09984*
SDF-6	*26.49529*	*29.07769*

Number:	Latitude [°]	Longitude [°]
SDF-7	26.48346	29.06966
SDF-8	26.5275	29.04399
SDF-9	26.51831	29.02895
SDF-10	26.48788	29.01239
SDF-11	26.46438	29.02486
SDF-12	26.44611	29.00048
SDF-13	26.4903	28.98851
SDF-14	26.5143	28.98789
SDF-15	26.55214	28.98191

Number:	Latitude [°]	Longitude [°]
SSW-1	26.49244	29.12163
SSW-2	26.50047	29.10296
SSW-3	26.50667	29.09406
SSW-4	26.477	29.12309
SSW-5	26.45445	29.09981
SSW-6	26.49527	29.07764
SSW-7	26.48336	29.06965
SSW-8	26.52751	29.04393
SSW-9	26.51825	29.02896
SSW-10	26.48775	29.01225
SSW-11	26.46433	29.02488
SSW-12	26.44606	29.00049
SSW-13	26.49019	28.98846
SSW-14	26.5143	28.98783
SSW-15	26.55214	28.98196

When high-extraction activities commence over the total mine lease area, the monitoring system must be upgraded on an annual basis:

- All external user's boreholes (yielding more than 0.2 l/s), within a radius of 500m of proposed increased extraction activities must be monitored for ground water level response, on a quarterly basis.
- Additional monitoring boreholes will be drilled after consultation with an independent Geohydrologist.

Respectfully submitted

Original signed by

Jaco van der Berg (Pr.Sci.Nat.)

Original signed by

Shane Turner (Cand.Sci.Nat.)

Prj5449

APPENDIX 2(A)

PERSONNEL CV’s

Jasper L Müller (Pr.Sci.Nat.)

Date of Birth: 16 November 1957

Nationality: S A Citizen

Position in firm: Managing Director

Qualification:

B. Sc.: Geology and Geohydrology, UOFS, 1979
B. Sc. (Hons): Geohydrology, UOFS, 1980
M. Sc. (Cum Laude): Geohydrology, UOFS, 1984

Memberships:

Geological Society of SA : Ground Water Division
South African Council for Natural Scientific Professions
National Groundwater Association.

Period employed:

1981 Hydrologist with Dept. of Water Affairs.
1983 Researcher with Institute for Ground Water Studies, UOFS.
1987 Divisional Head, Geohydrology, Environmental Science Services
1988 Founded Jasper Müller Associates.

Jasper Müller received his training as geohydrologist at the Institute for Ground Water Studies (University of the Freestate). He worked at IGS as Researcher / Lecturer, specialising in numerical aquifer analyses.

He left IGS in 1986 and joined the consulting firm Terradata, where he was involved in projects related to ground water pollution and water supply.

In 1987 he was appointed at the consulting firm Environmental Science Services. His responsibility was to structure and build a division for water sciences (ground water and surface water). During his tenure at ESS he also floated a division on ground water monitoring.

During 1988, Jasper founded JMA, which has since evolved into a consulting firm employing 17 people. JMA is a multi-disciplinary team specialising in geohydrology.

Since 1988 Jasper Müller was involved on a consulting level on more than 200 JMA projects related to water supply, aquifer management, ground water quality investigations, ground water monitoring, ground water impact and risk modelling, ground water pollution remediation and litigative consultative work.

E-mail: **jasper@jmaconsult.co.za**

Jaco van der Berg (Pr.Sci.Nat.)

Date of Birth: 19 May 1972

Nationality: S A Citizen

Position in firm: Director : Mining Division

(Shareholder)

Qualification:

B. Sc.: Geology/Geochemistry, UOFS, 1993
B. Sc. (Hons): Geochemistry, UOFS, 1994
M. Sc.: Geohydrology, UOFS, 1998

Memberships:

South African Council for Natural Scientific Professions

Period employed:

1995 Geologist with Anglo American Corporation of SA
1999 Project Geohydrologist with Jasper Müller Associates

Jaco van der Berg received his training as geologist at the Geology Department of the University of the Freestate. He was an Anglo American Corporation of South Africa Bursary holder from 1991 - 1994.

He worked as a geologist-in-training at Freddies No.5 shaft during 1995. From there, he was transferred to Western Holdings No.9 shaft until the end of 1996. His main responsibilities during these two years, were:

- Underground geological mapping of development ends, raises and stopes
- Updating geological data sheets
- Structural geology planning
- Core drilling and logging
- Attending scrutiny and planning meetings
- Reserve planning

He left Anglo American in 1997 to do his M Sc at the Institute of Ground Water Studies (University of the Freestate). His thesis was on the application of power station fly ash in rehabilitation of mining environments.

He was appointed as project geohydrologist at JMA in 1998. His main line of responsibilities was the compilation of ground water inputs for mine EMPR's and geochemical modeling and risk assessment of mine residue deposits.

E-mail: **jaco@jmaconsult.co.za**

Shane Turner (Cand.Sci.Nat.)

Date of Birth: 7 October 1986

Nationality: S A Citizen

Position in firm: Junior Scientist (Geohydrology)

Qualification:

B. Sc. Geology: Earth Science, US, 2007
B. Sc. (Hons) Geology, US, 2008

Memberships:

South African Council for Natural Scientific Professions
Golden Key International Honour Society

Period employed:

2009 Junior Scientist at JMA

E-mail: **shane@jmaconsult.co.za**

APPENDIX 3(A)

BOREHOLE LOGS AND SITE INFORMATION REPORTS

SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00001 ***Number:*** SSW-1 ***Site type:*** Borehole

Distr./Farm No.: 137 IS ***Site Name/Des.:*** BOREHOLE SSW-1 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-12126.259	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2931161.003	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.39
Altitude [m]:	1595.40			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	10.00	215	20011106	CASED TO 165
JMA	10.00	30.00	165	20011106	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011106	0.00	8.00	165	Steel	2					
20011106	8.00	10.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	SAND AND CLAY	Brown			Sandy	Damp
1.00	6.00	SAND	Brown	Yellowish	Fine	Gritty	Damp
6.00	23.00	SANDSTONE AND SHALE	Grey	Light		Weathered	
23.00	30.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1430	0.00	1.83	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1800	0							0.02		

Jasper Müller Associates cc.
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Delmas
2210
Tel: (013)665 1788
E-mail: webmaster@jma-cc.co.za

Borehole Construction and Geological Log

Date compiled: 2/22/02

BASIC SITE INFORMATION:

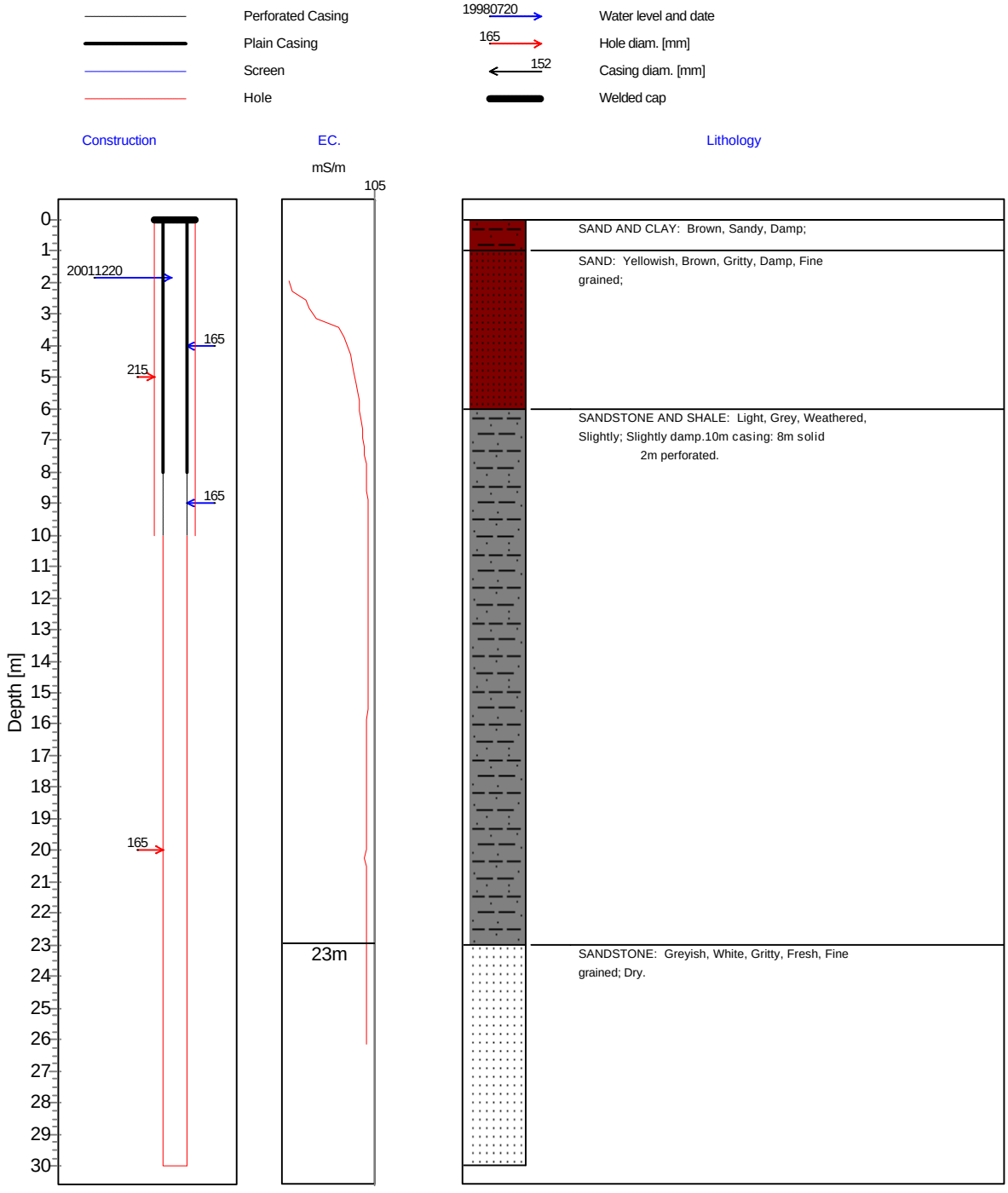
Site Identifier: 2629AC00001 ***Number:*** SSW-1 ***Site type:*** Borehole

Distr./Farm No.: 137 IS ***Site Name/Descr.:*** BOREHOLE SSW-1 : BLOCK 8C

Y Coord. [m]:	-12126.259	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)
X Coord. [m]:	2931161.00	***Alt. No. 2:***		***Site status:***	In use
Altitude [m]:	1595.40			***Site purp.:***	Observation
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment

Depth [m]:	30.00
Collar h. [m]:	0.39
Drain. reg.:	C12D
Diam. [mm]:	165
Rep. inst.:	JMA

Construction and Geohydrological Legend



COMMENT:

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Tel: (013)665 1788
E-mail: webmaster@jma-cc.co.za

SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00002 ***Number:*** SSW-2 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SSW-2 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-10264.052	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2932049.268	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.46
Altitude [m]:	1584.90			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	6.00	215	20011114	CASED TO 165
JMA	6.00	30.00	165	20011114	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011114	0.00	3.00	165	Steel	2					
20011114	3.00	6.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	SAND AND CLAY	Black			Damp	
1.00	3.00	DOLERITE	Brown	Dark		Clayey	Weathered
3.00	5.00	DOLERITE	Brown	Yellowish	Fine to medium	Weathered	Clayey
5.00	7.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
7.00	16.00	SANDSTONE	White	Greyish	Fine	Gritty	Weathered
16.00	24.00	SHALE	Grey	Dark		Weathered	Carbonaceous
24.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1215	0.00	5.76	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1800	0							0.033		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

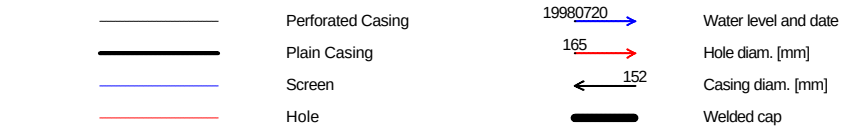
BASIC SITE INFORMATION:

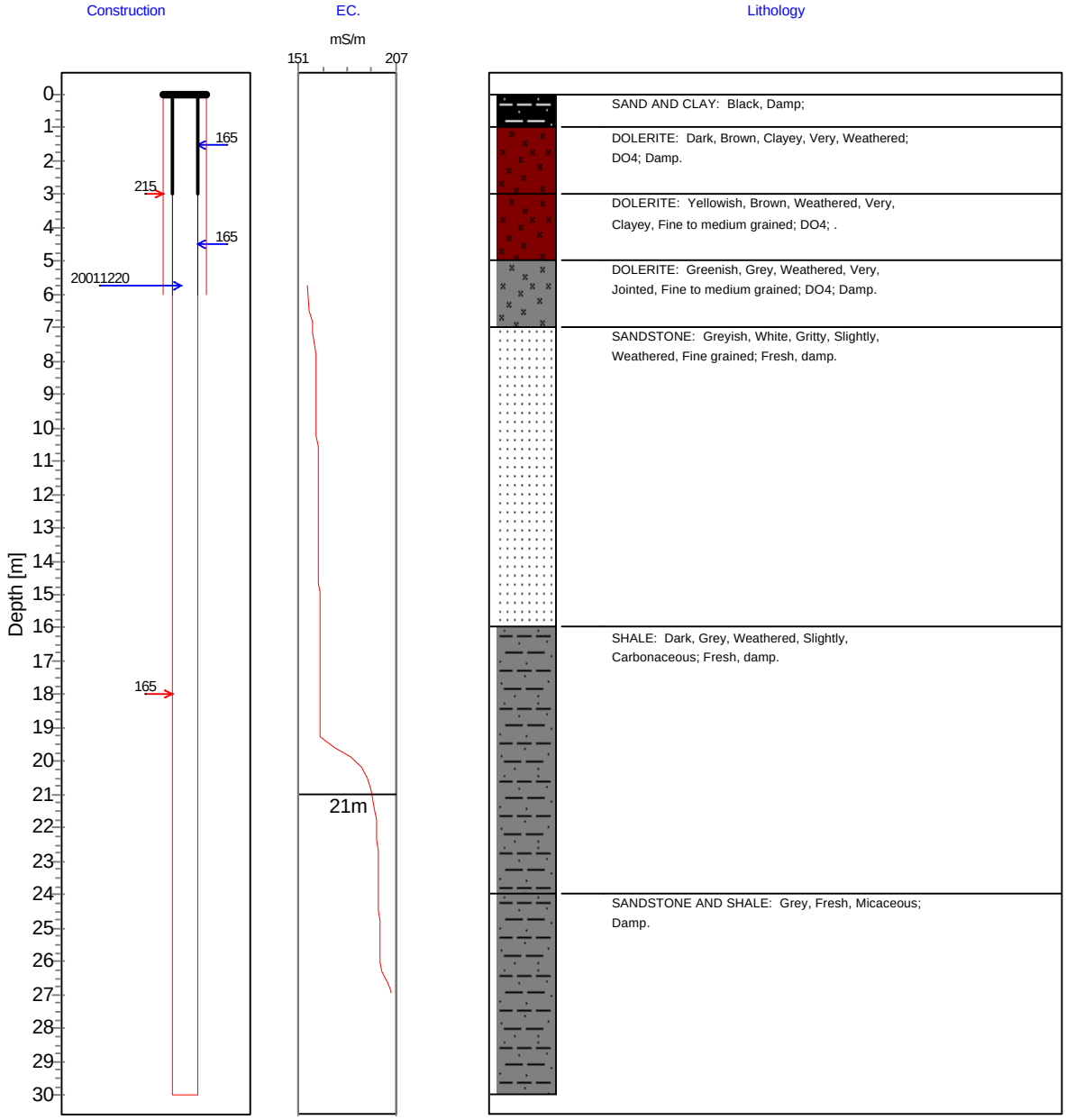
Site Identifier: 2629AC00002 ***Number:*** SSW-2 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SSW-2 : BLOCK 8C

Y Coord. [m]:	-10264.052	***Alt. No. 1:***		***Depth [m]:***	30.00
X Coord. [m]:	2932049.27	***Alt. No. 2:***		***Collar h. [m]:***	0.46
Altitude [m]:	1584.90	***Topo-set.:***	Hillside (slope)	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit	***Site status:***	In use	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System	***Site purp.:***	Observation	***Rep. inst.:***	JMA
		Use applic.:	Industrial - mining		
		Equipment:	No equipment		

Construction and Geohydrological Legend





COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA00003 **Number:** SSW-3 **Site type:** Borehole

Distr./Farm No.: 135 IS **Site Name/Des.:** BOREHOLE SSW-3 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-9376.629	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2932735.112	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.33
Altitude [m]:	1580.49			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	8.00	215	20011106	CASED TO 165
JMA	8.00	30.00	165	20011106	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011106	0.00	8.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	15.00	16.00	0.10	Estimated			SEEPAGE WATER

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown	Dark		Clayey	Damp
1.00	5.00	DOLERITE	Brown	Light		Weathered	Clayey
5.00	7.00	DOLERITE	Grey	Brownish	Medium to coarse	Jointed	Weathered
7.00	8.00	SHALE	Grey	Dark		Carbonaceous	Baked
8.00	17.00	DOLERITE	Grey	Greenish	Medium	Weathered	Fresh
17.00	25.00	SANDSTONE AND SHALE	Grey			Fresh	
25.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011220	1820	0.00	1.99	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011220	1200	0							0.225		

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Borehole Construction and Geological Log

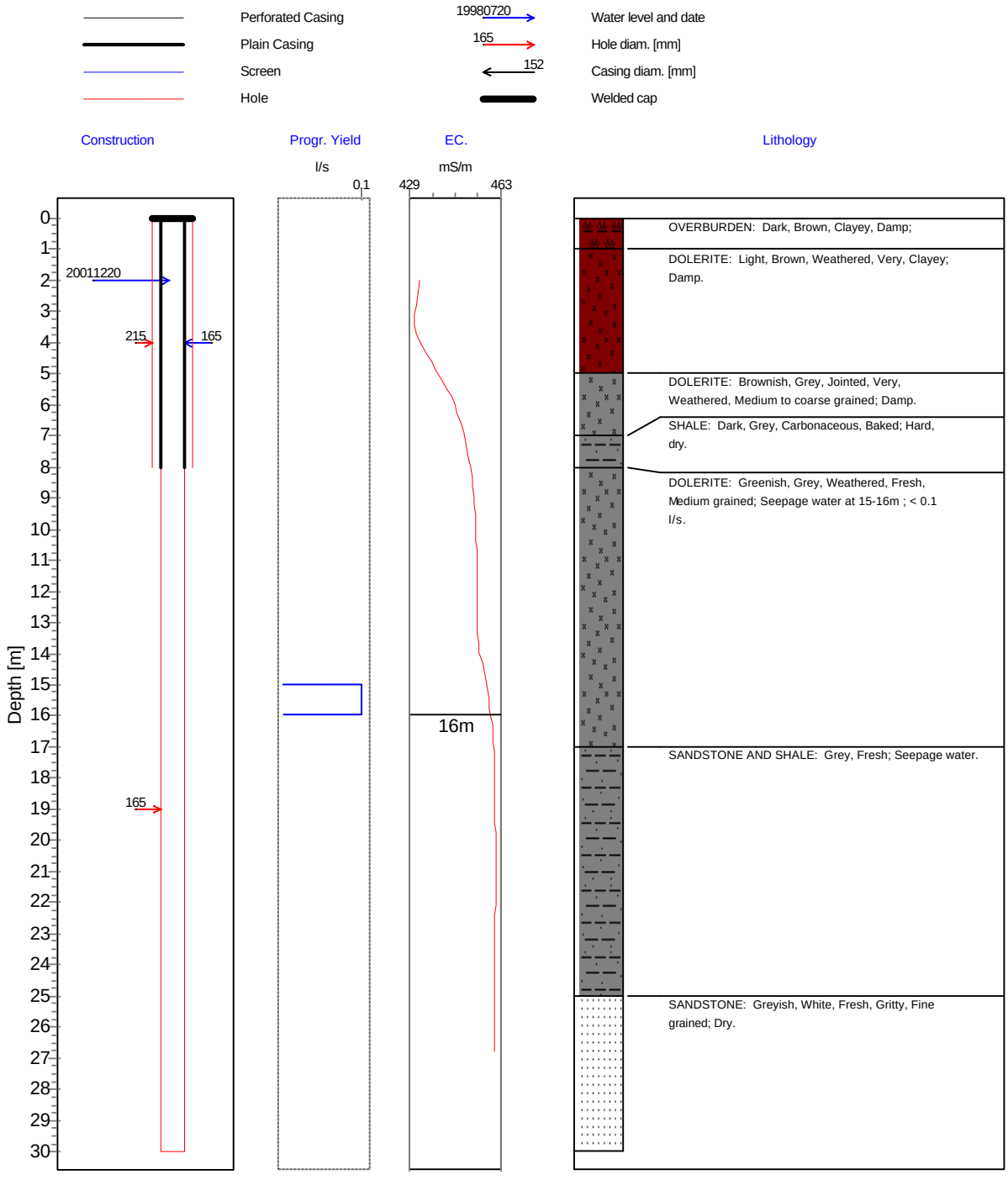
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629CA00003 ***Number:*** SSW-3 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SSW-3 : BLOCK 8C

Y Coord. [m]:	-9376.62900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2932735.11	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.33
Altitude [m]:	1580.49			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00004 ***Number:*** SSW-4 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SSW-4 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-12273.566	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2929450.186	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.40
Altitude [m]:	1643.42			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	6.00	215	20011121	CASED TO 165
JMA	6.00	30.00	165	20011121	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011121	0.00	3.00	165	Steel	2					
20011121	3.00	6.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown	Dark		Clayey	Sandy
1.00	2.00	SANDSTONE	White	Brownish	Fine	Weathered	Gritty
2.00	3.00	DOLERITE	Brown			Weathered	Clayey
3.00	4.00	DOLERITE	Grey	Brownish	Fine to medium	Weathered	Jointed
4.00	6.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
6.00	30.00	DOLERITE	Grey	Greenish		Fresh	Dry

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Borehole Construction and Geological Log

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00004 ***Number:*** SSW-4 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SSW-4 : BLOCK 8C

Y Coord. [m]:	-12273.566	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2929450.19	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.40
Altitude [m]:	1643.42			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

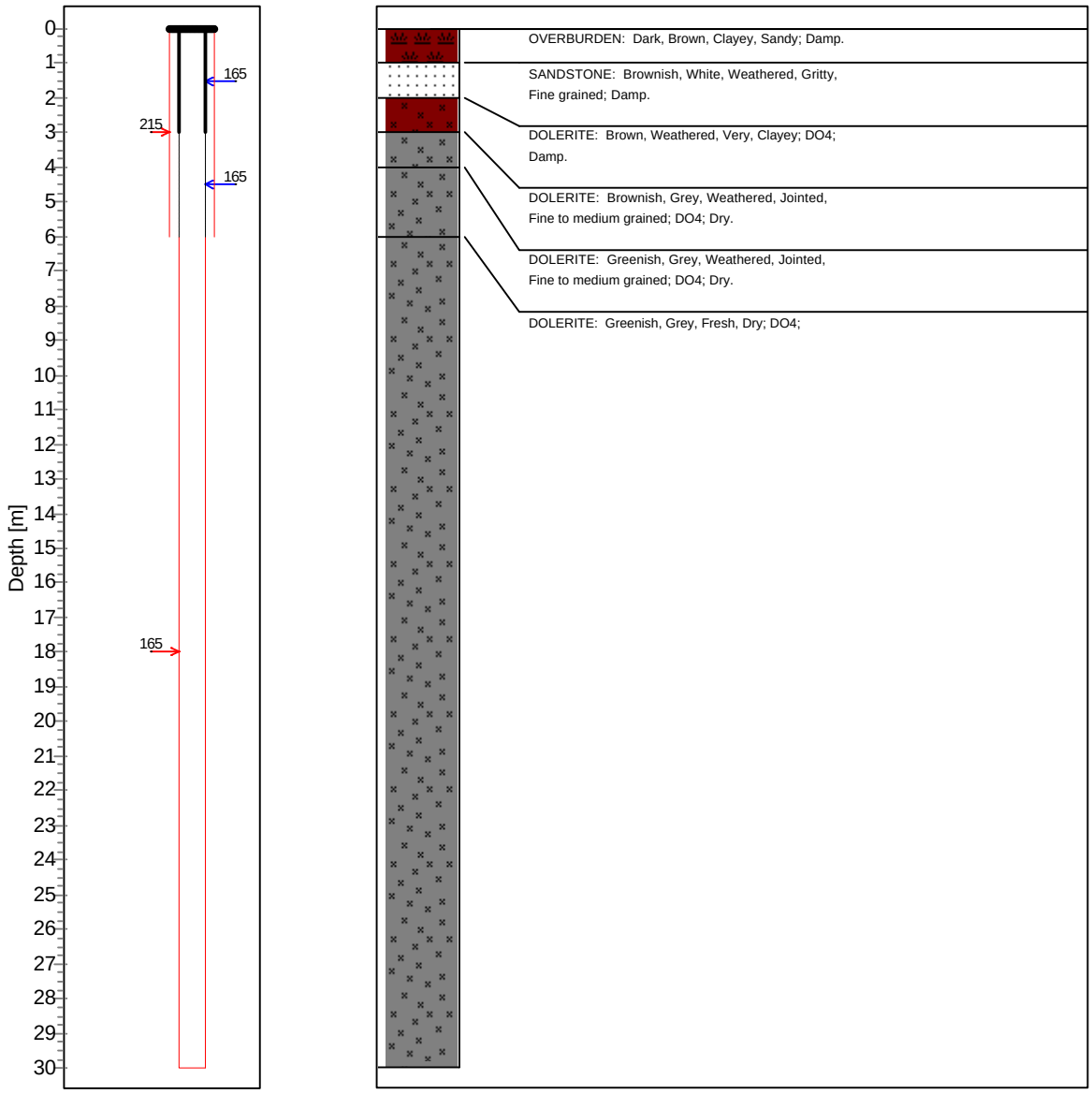
Construction and Geohydrological Legend

Perforated Casing
Plain Casing
Screen
Hole

19980720 — Water level and date
165 — Hole diam. [mm]
152 — Casing diam. [mm]
Welded cap

Construction

Lithology



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00005 ***Number:*** SSW-5 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SSW-5 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-9954.009	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2926950.148	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.30
Altitude [m]:	1602.66			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	18.00	215	20011127	CASED TO 165
JMA	18.00	30.00	165	20011127	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011127	0.00	12.00	165	Steel	2					
20011127	12.00	18.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	2.00	OVERBURDEN	Brown			Clayey	Damp
2.00	5.00	CLAY	Brown	Dark		Damp	
5.00	8.00	MUDSTONE	Brown	Yellowish		Weathered	Clayey
8.00	14.00	MUDSTONE	Brown	Greyish		Weathered	Damp
14.00	18.00	SANDSTONE AND SHALE	Grey			Weathered	Micaceous
18.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020107	1055	0.00	6.05	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020107	1800	0							0.028		

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Borehole Construction and Geological Log

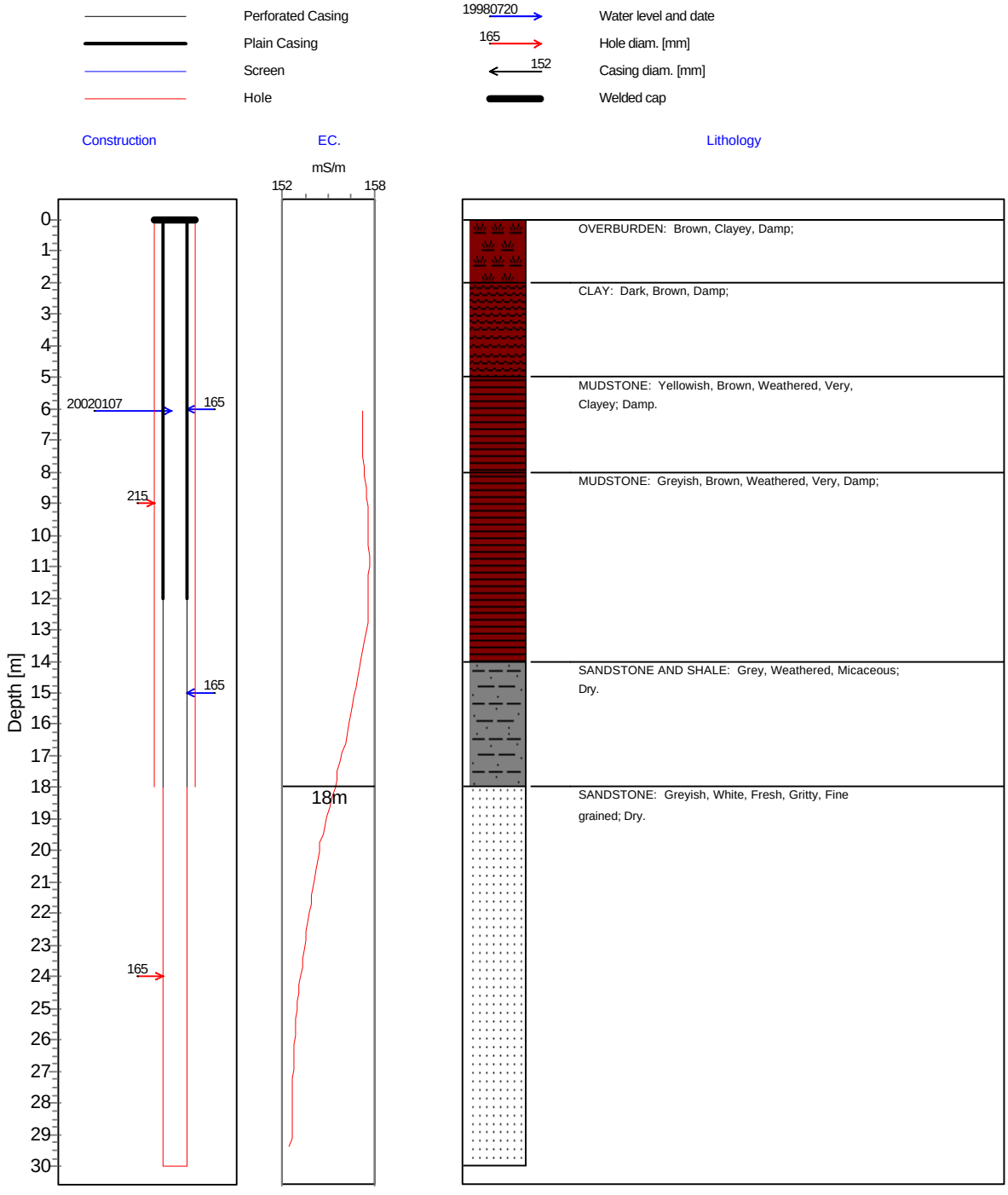
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00005 ***Number:*** SSW-5 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SSW-5 : BLOCK 8C

Y Coord. [m]:	-9954.00900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2926950.15	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.30
Altitude [m]:	1602.66			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00006 ***Number:*** SSW-6 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Des.:*** BOREHOLE SSW-6 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-7740.139	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2931471.237	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.43
Altitude [m]:	1598.56			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	12.00	215	20011106	CASED TO 165
JMA	12.00	30.00	165	20011106	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011106	0.00	8.00	165	Steel	2					
20011106	8.00	12.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Clayey	Damp
1.00	8.00	SANDSTONE AND SHALE	Grey			Weathered	Micaceous
8.00	12.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
12.00	14.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
14.00	28.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
28.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1655	0.00	5.72	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1800	0							0.007		

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Borehole Construction and Geological Log

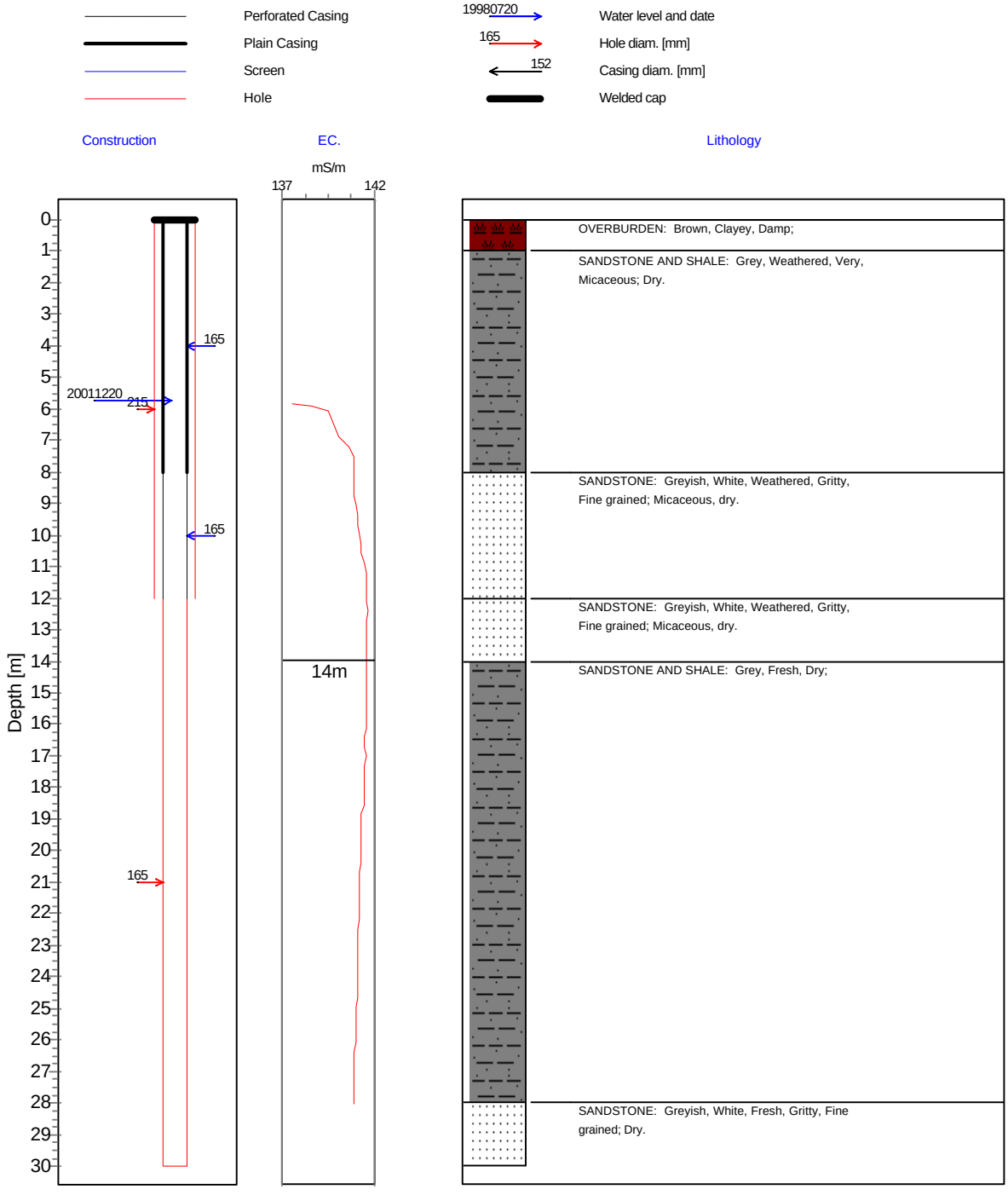
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00006 ***Number:*** SSW-6 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Descr.:*** BOREHOLE SSW-6 : BLOCK 8C

Y Coord. [m]:	-7740.13900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2931471.24	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.43
Altitude [m]:	1598.56			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00007 **Number:** SSW-7 **Site type:** Borehole

Distr./Farm No.: 131 IS **Site Name/Des.:** BOREHOLE SSW-7 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-6944.293	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2930151.57	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.45
Altitude [m]:	1580.61			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	20.00	215	20011107	CASED TO 165
JMA	20.00	30.00	165	20011107	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011107	0.00	2.00	165	Steel	2					
20011107	2.00	20.00	165	Steel	2	Perforated or slotted	250	2	43	250

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	11.00	12.00	3.00	Estimated			
JMA	17.00	18.00	22.00	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Black	Brownish		Clayey	Damp
1.00	4.00	CLAY	Brown			Sandy	Damp
4.00	8.00	SANDSTONE	Brown	Light	Fine	Weathered	Gritty
8.00	10.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
10.00	12.00	SHALE	Grey	Greenish		Baked	Hard
12.00	15.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
15.00	17.00	DOLERITE	Grey	Dark	Fine to medium	Weathered	Jointed
17.00	18.00	DOLERITE				Mineralised	
18.00	20.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
20.00	25.00	DOLERITE	Grey	Greenish	Fine to medium	Fresh	Jointed
25.00	26.00	SANDSTONE AND SHALE	Grey			Fresh	Baked
26.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011221	1300	0.00	1.71	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011221	30	0							6.25		

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Borehole Construction and Geological Log

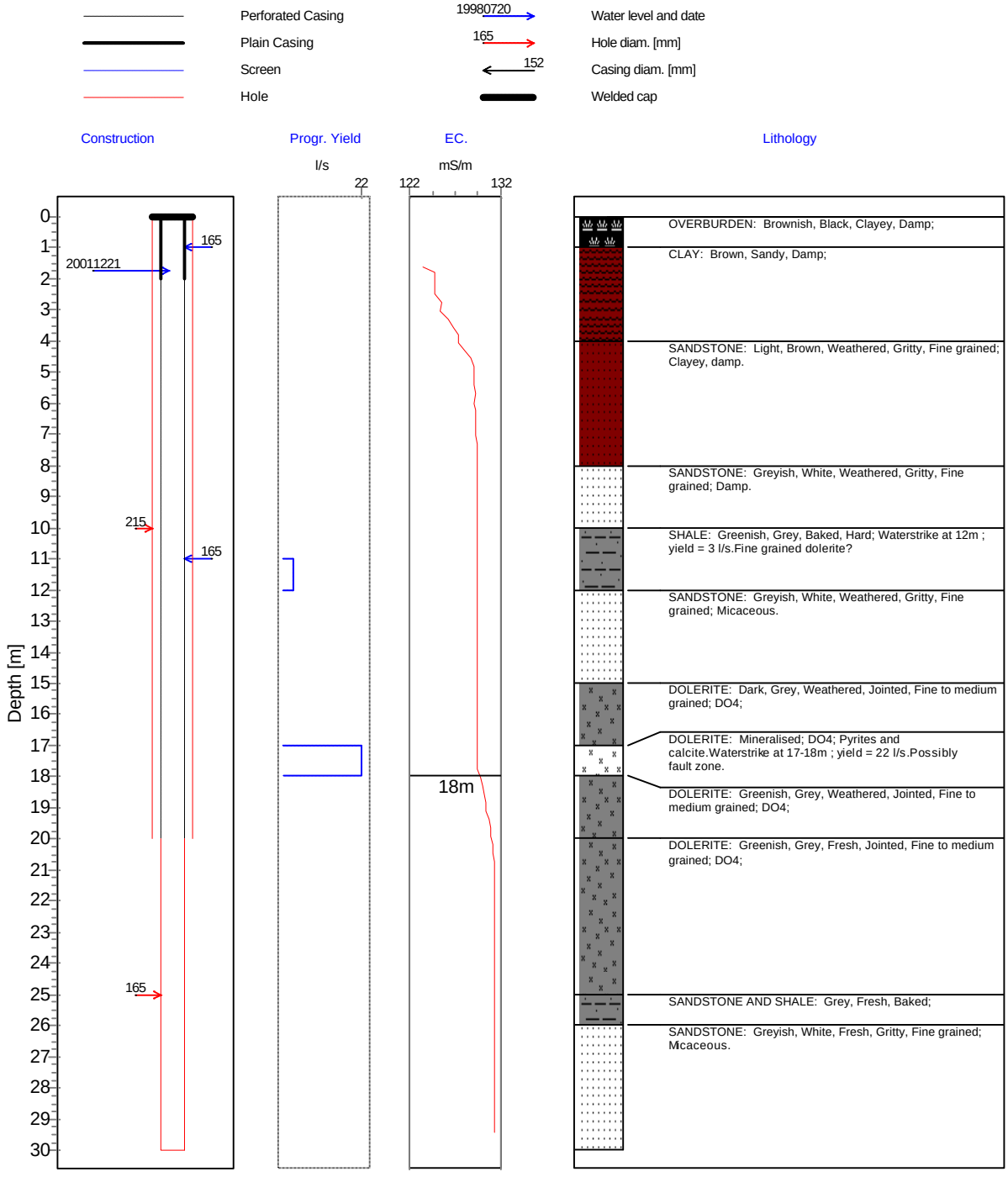
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00007 ***Number:*** SSW-7 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Descr.:*** BOREHOLE SSW-7 : BLOCK 8C

Y Coord. [m]:	-6944.29300	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2930151.57	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.45
Altitude [m]:	1580.61			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA00008 ***Number:*** SSW-8 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Des.:*** BOREHOLE SSW-8 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-4378.945	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2935041.205	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.37
Altitude [m]:	1580.88			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	9.00	215	20011109	CASED TO 165
JMA	9.00	30.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011109	0.00	5.00	165	Steel	2					
20011109	5.00	9.00	165	Steel	2	Perforated or slotted	250	2	43	250

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	16.00	18.00	0.10	Estimated			
JMA	27.00	28.00	0.40	Estimated			ARTESIAN

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Gravel-bearing	Damp
1.00	4.00	SANDSTONE AND SHALE	Brown	Yellowish		Weathered	Clayey
4.00	5.00	SANDSTONE	Brown	Yellowish	Fine	Weathered	Gritty
5.00	15.00	SANDSTONE AND SHALE	Brown	Light		Weathered	Dry
15.00	16.00	SANDSTONE AND SHALE	Grey			Fresh	
16.00	18.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
18.00	30.00	DOLERITE				Fresh	Jointed

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011221	1105	0.00	0.27	ARTESIAN

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Borehole Construction and Geological Log

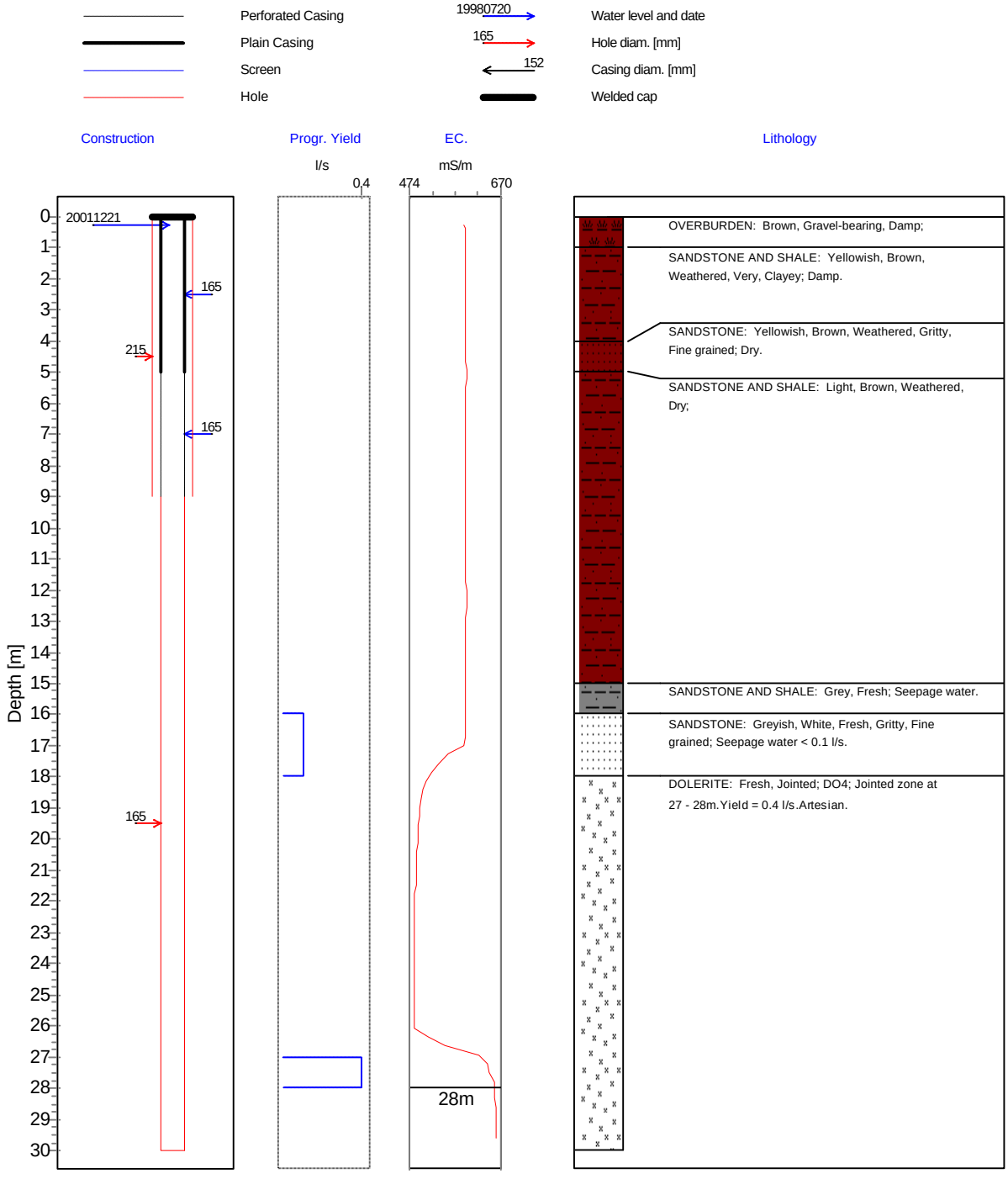
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629CA00008 ***Number:*** SSW-8 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Descr.:*** BOREHOLE SSW-8 : BLOCK 8C

Y Coord. [m]:	-4378.94500	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2935041.21	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.37
Altitude [m]:	1580.88			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA00009 **Number:** SSW-9 **Site type:** Borehole

Distr./Farm No.: 130 IS **Site Name/Des.:** BOREHOLE SSW-9 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-2886.305	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2934014.816	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.38
Altitude [m]:	1569.18			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	10.00	215	20011108	CASED TO 165
JMA	10.00	30.00	165	20011108	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011108	0.00	6.00	165	Steel	2					
20011108	6.00	10.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown			Clayey	Damp
1.00	7.00	CLAY	Brown			Sandy	Damp
7.00	9.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
9.00	18.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
18.00	21.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
21.00	24.00	SHALE	Grey	Dark		Fresh	Carbonaceous
24.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011221	1405	0.00	4.62	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011221	1800	0							0.012		

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Borehole Construction and Geological Log

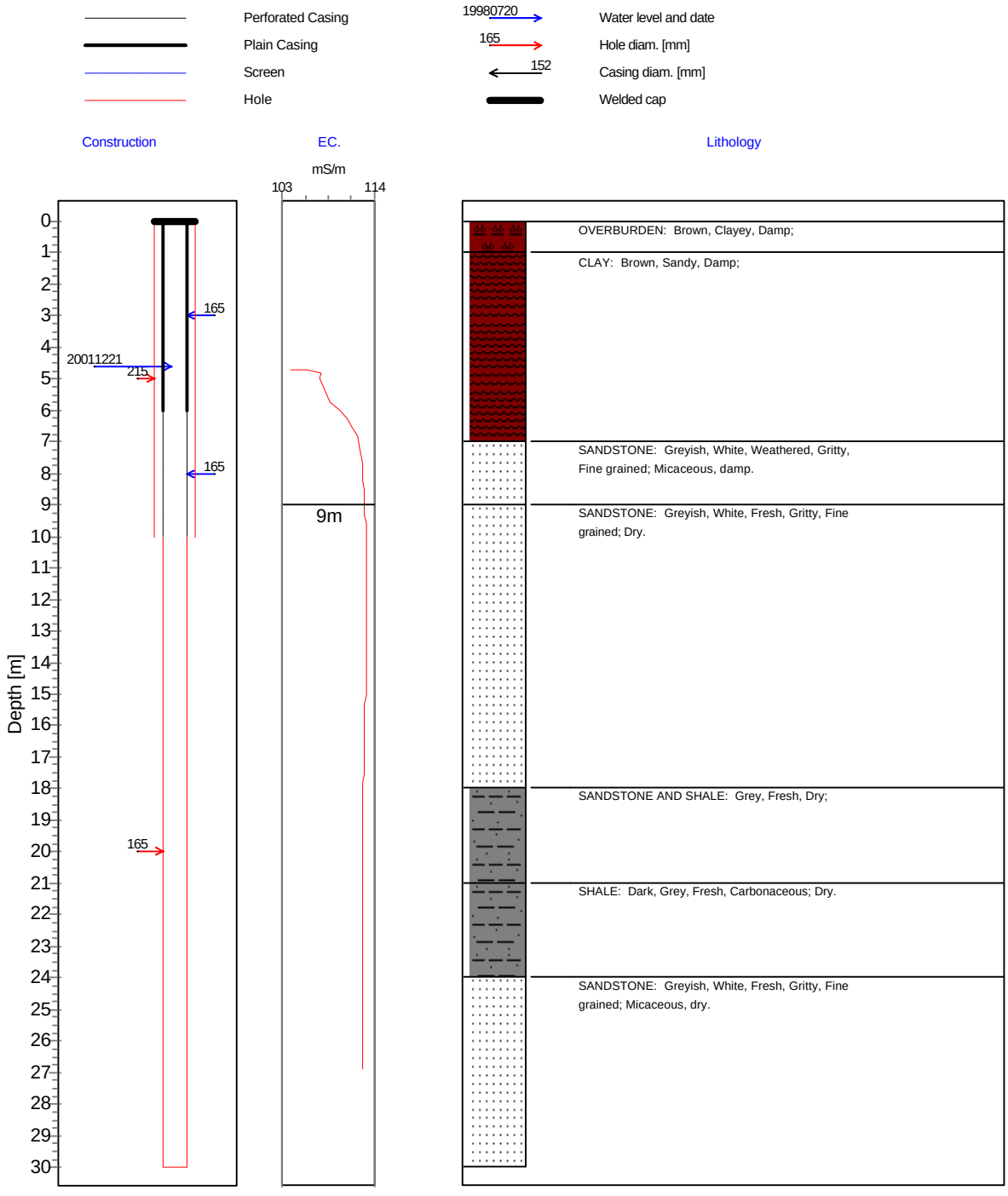
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629CA00009 ***Number:*** SSW-9 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Descr.:*** BOREHOLE SSW-9 : BLOCK 8C

Y Coord. [m]:	-2886.30500	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2934014.82	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.38
Altitude [m]:	1569.18			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00010 **Number:** SSW-10 **Site type:** Borehole

Distr./Farm No.: 128 IS **Site Name/Des.:** BOREHOLE SSW-10 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-1221.131	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2930635.716	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.39
Altitude [m]:	1571.97			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	9.00	215	20011113	CASED TO 165
JMA	9.00	30.00	165	20011113	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011113	0.00	6.00	165	Steel	2					
20011113	6.00	9.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown	Yellowish		Damp	
1.00	4.00	DOLERITE	Grey	Brownish	Fine to medium	Weathered	Jointed
4.00	6.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
6.00	8.00	MUDSTONE	Grey			Weathered	Dry
8.00	13.00	MUDSTONE	Grey			Weathered	Dry
13.00	19.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
19.00	24.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
24.00	28.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
28.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1325	0.00	3.94	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	1800	0							0.052		

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Borehole Construction and Geological Log

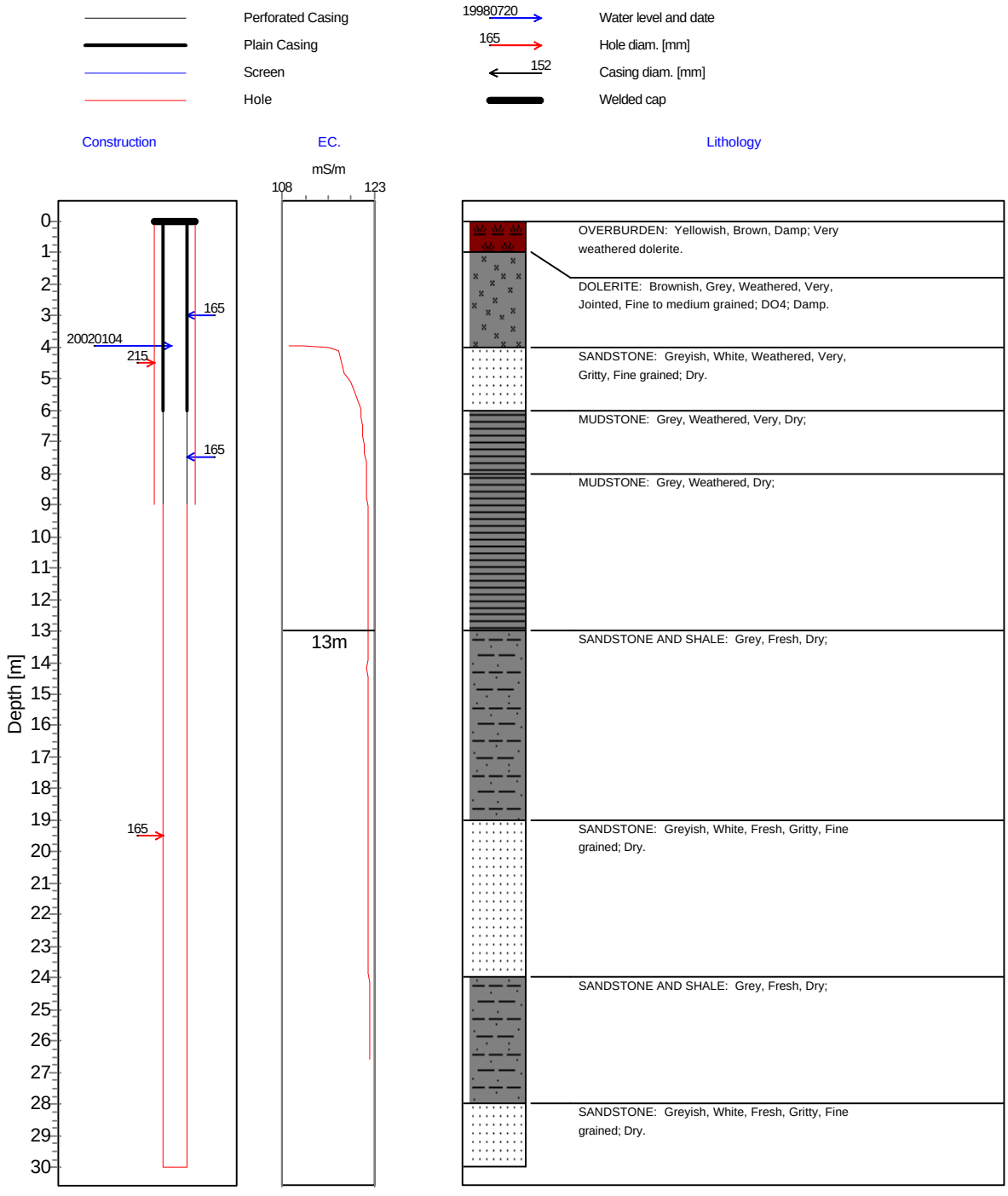
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00010 ***Number:*** SSW-10 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SSW-10 : BLOCK 8C

Y Coord. [m]:	-1221.13100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2930635.72	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.39
Altitude [m]:	1571.97			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00011 ***Number:*** SSW-11 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Des.:*** BOREHOLE SSW-11 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-2481.011	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2928041.734	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.38
Altitude [m]:	1634.82			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	6.00	215	20011110	CASED TO 165
JMA	6.00	30.00	165	20011110	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011110	0.00	6.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Damp	
1.00	4.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
4.00	8.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
8.00	30.00	DOLERITE	Grey	Greenish	Fine to medium	Fresh	Dry

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	0950	0.00	11.04	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.0003		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

BASIC SITE INFORMATION:

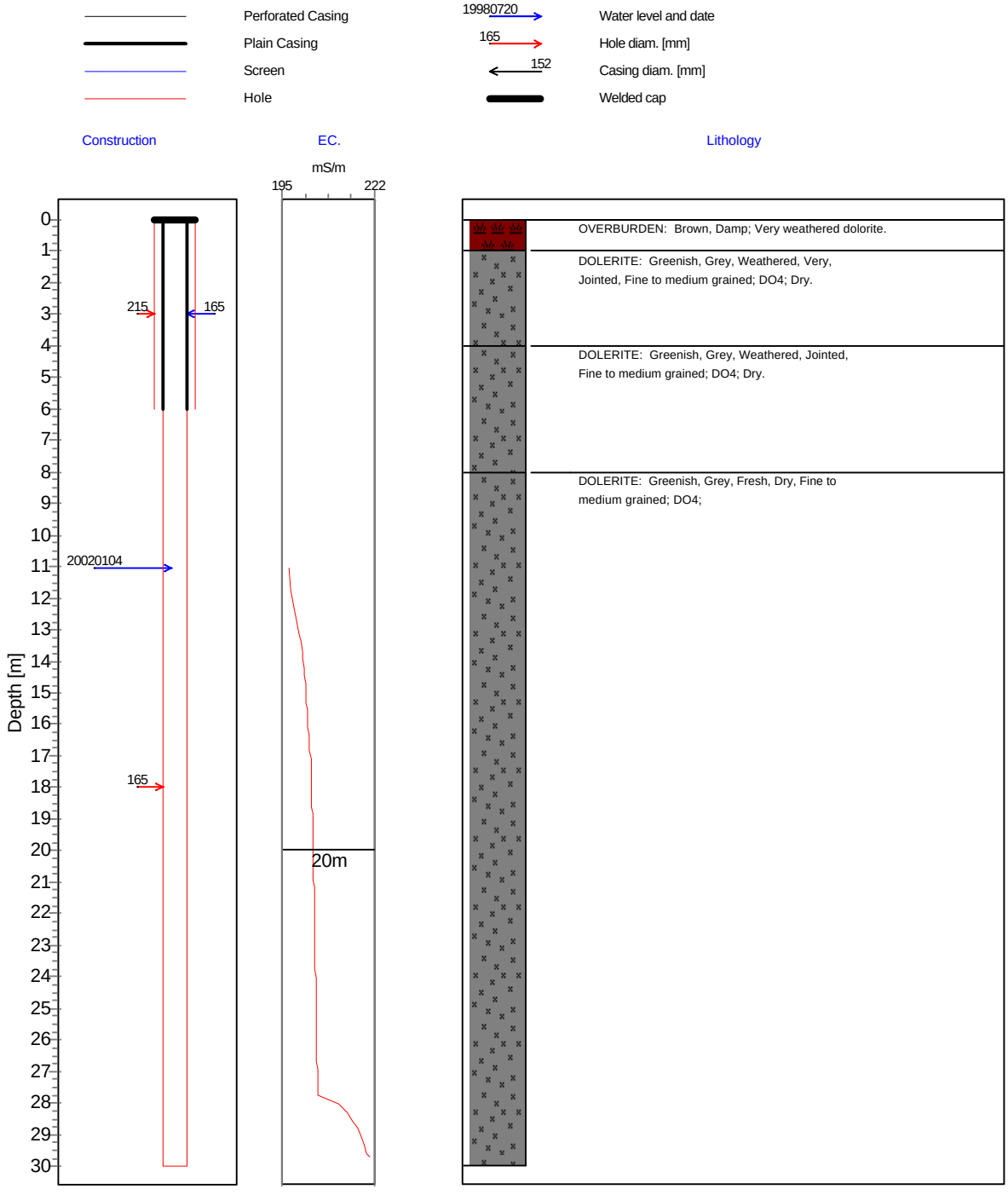
Site Identifier: 2629AC00011 ***Number:*** SSW-11 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SSW-11 : BLOCK 8C

Y Coord. [m]:	-2481.01100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)
X Coord. [m]:	2928041.73	***Alt. No. 2:***		***Site status:***	In use
Altitude [m]:	1634.82			***Site purp.:***	Observation
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment

Depth [m]:	30.00
Collar h. [m]:	0.38
Drain. reg.:	C12D
Diam. [mm]:	165
Rep. inst.:	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC00012 **Number:** SSW-12 **Site type:** Borehole

Distr./Farm No.: 128 IS **Site Name/Des.:** BOREHOLE SSW-12 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	-49.03	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2926016.517	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.44
Altitude [m]:	1607.43			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	8.00	215	20011109	CASED TO 165
JMA	8.00	30.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011109	0.00	4.00	165	Steel	2					
20011109	4.00	8.00	165	Steel	2	Perforated or slotted	250	2	43	250

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	7.00	12.00	0.10	Estimated			SEEPAGE WATER

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Grey	Dark		Damp	
1.00	5.00	DOLERITE	Brown	Yellowish		Weathered	Damp
5.00	7.00	DOLERITE	Grey	Greenish		Weathered	Jointed
7.00	12.00	DOLERITE	Grey	Greenish		Fresh	
12.00	15.00	SANDSTONE AND SHALE	Grey			Fresh	
15.00	26.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
26.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1148	0.00	8.90	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	900	0							0.21		

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Borehole Construction and Geological Log

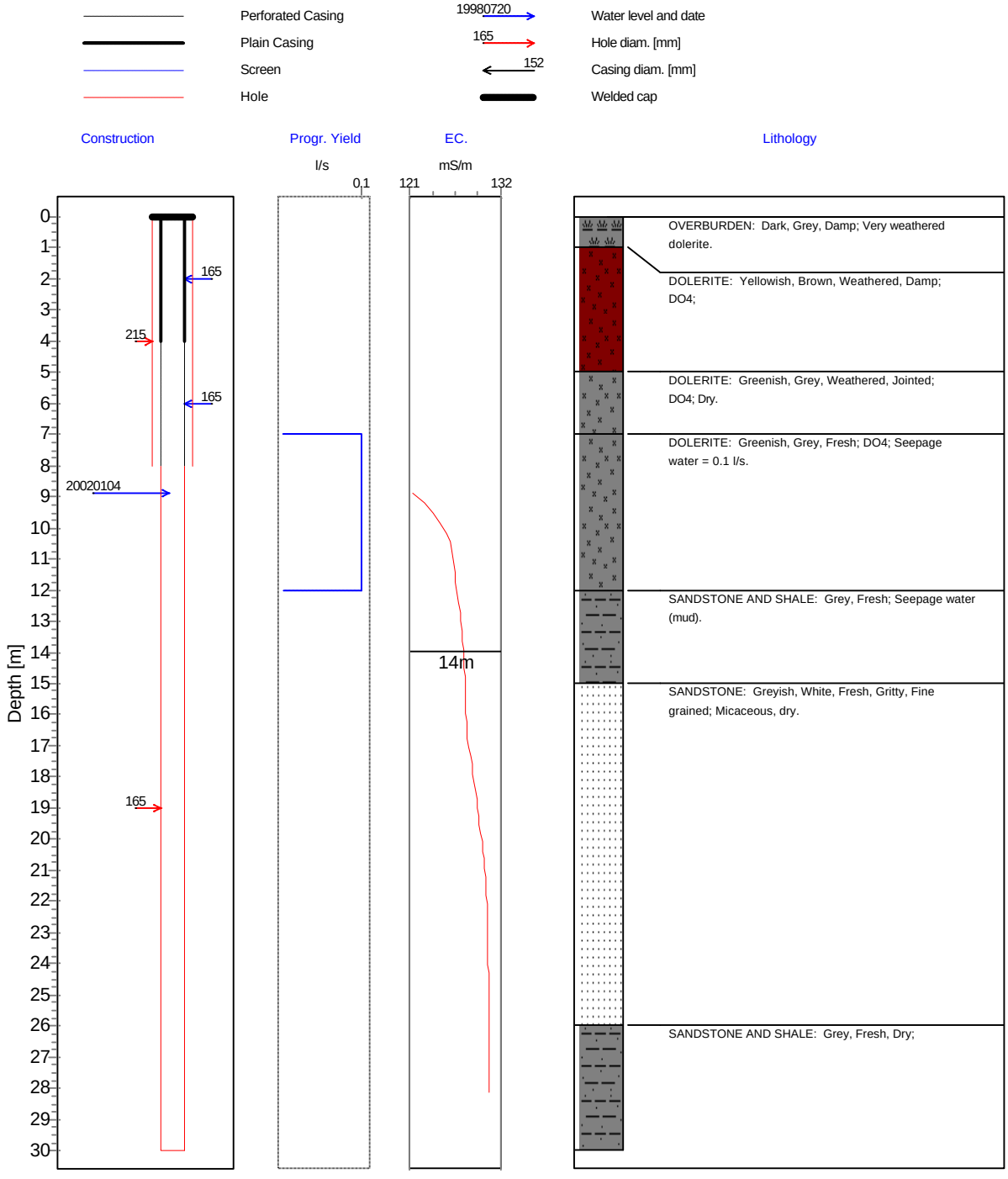
Date compiled: 2/25/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC00012 ***Number:*** SSW-12 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SSW-12 : BLOCK 8C

Y Coord. [m]:	-49.03000	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2926016.52	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.44
Altitude [m]:	1607.43			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628BD00013 ***Number:*** SSW-13 ***Site type:*** Borehole

Distr./Farm No.: 359 IR ***Site Name/Des.:*** BOREHOLE SSW-13 : BLOCK 8

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	1150.64	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2930905.615	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.46
Altitude [m]:	1606.77			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	7.00	215	20011123	CASED TO 165
JMA	7.00	30.00	165	20011123	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011123	0.00	4.00	165	Steel	2					
20011123	4.00	7.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Grey	Dark		Clayey	Damp
1.00	6.00	DOLERITE	Brown	Yellowish		Weathered	Damp
6.00	7.00	DOLERITE	Grey	Greenish		Weathered	Jointed
7.00	8.00	DOLERITE	Grey	Greenish		Weathered	Jointed
8.00	29.00	DOLERITE	Grey	Greenish		Fresh	
29.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	1435	0.00	4.14	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.002		

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Borehole Construction and Geological Log

Date compiled: 2/25/02

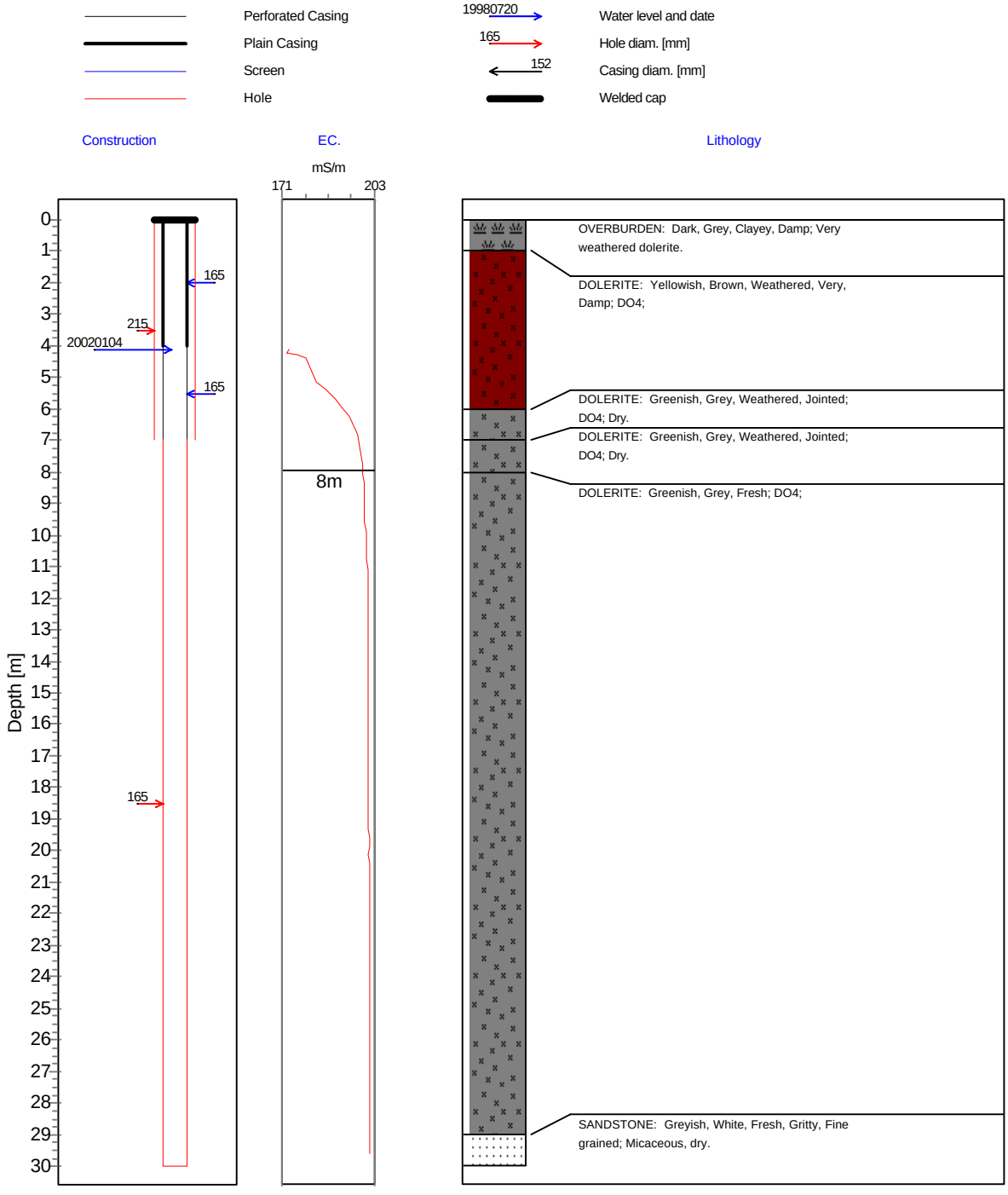
BASIC SITE INFORMATION:

Site Identifier: 2628BD00013 ***Number:*** SSW-13 ***Site type:*** Borehole

Distr./Farm No.: 359 IR ***Site Name/Descr.:*** BOREHOLE SSW-13 : BLOCK 8

Y Coord. [m]:	1150.64000	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2930905.62	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.46
Altitude [m]:	1606.77			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628DB00014 ***Number:*** SSW-14 ***Site type:*** Borehole

Distr./Farm No.: 531 IR ***Site Name/Des.:*** BOREHOLE SSW-14 : BLOCK 8C

Region Type: ***Region Descr.:*** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	1213.472	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2933576.742	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.40
Altitude [m]:	1571.15			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	12.00	215	20011124	CASED TO 165
JMA	12.00	30.00	165	20011124	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011124	0.00	6.00	165	Steel	2					
20011124	6.00	12.00	165	Steel	2	Perforated or slotted	250	2	43	250

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	12.00	14.00	0.10	Estimated			

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Clayey	
1.00	11.00	MUDSTONE	Brown	Yellowish		Weathered	Dry
11.00	12.00	SHALE	Grey			Baked	Jointed
12.00	14.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
14.00	24.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
24.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	1655	0.00	3.71	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.137		

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Borehole Construction and Geological Log

Date compiled: 2/25/02

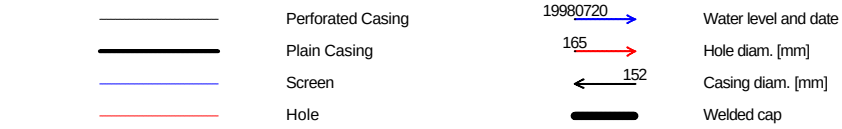
BASIC SITE INFORMATION:

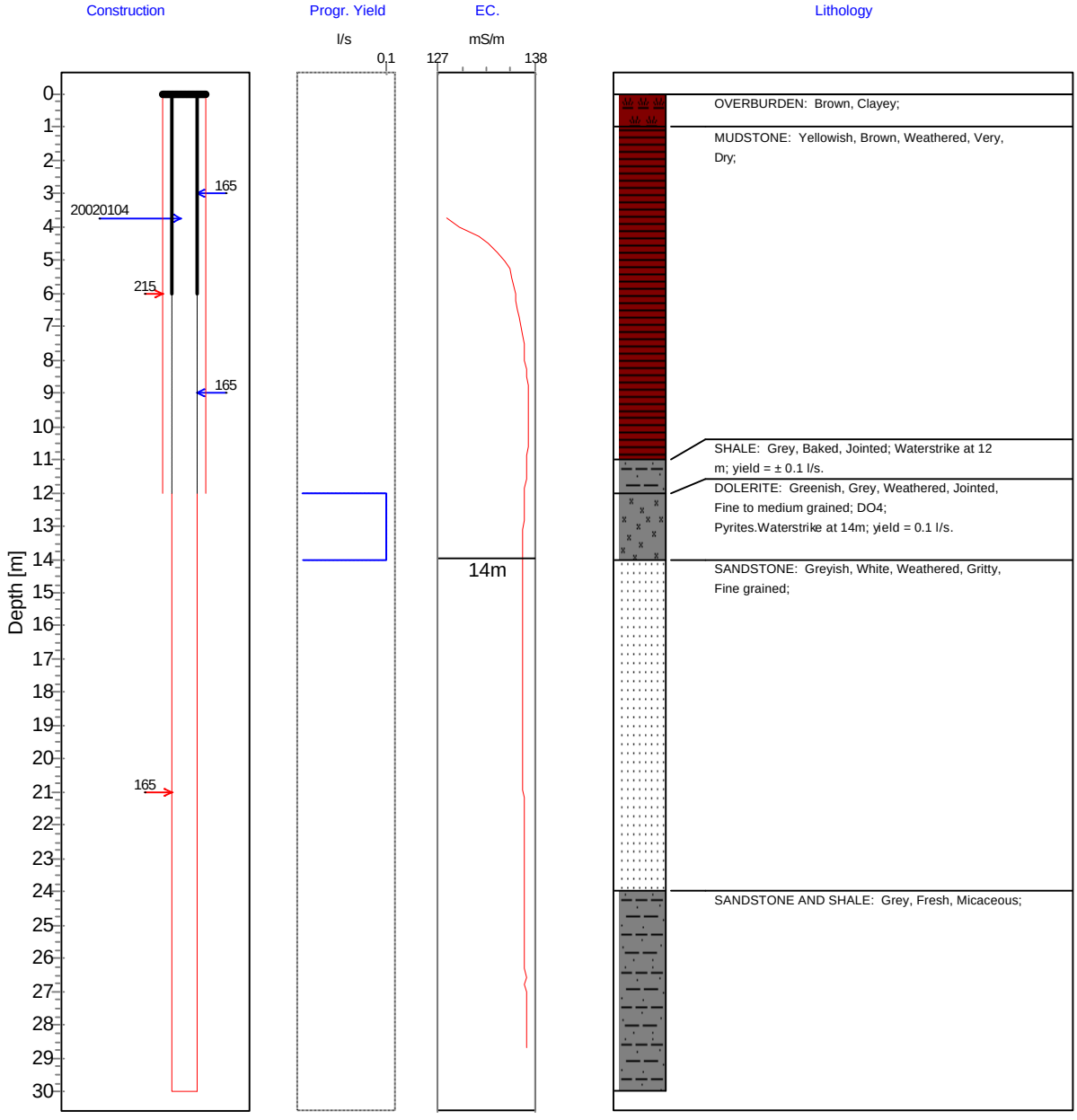
Site Identifier: 2628DB00014 ***Number:*** SSW-14 ***Site type:*** Borehole

Distr./Farm No.: 531 IR ***Site Name/Descr.:*** BOREHOLE SSW-14 : BLOCK 8C

Y Coord. [m]:	1213.47200	***Alt. No. 1:***		***Depth [m]:***	30.00
X Coord. [m]:	2933576.74	***Alt. No. 2:***		***Collar h. [m]:***	0.40
Altitude [m]:	1571.15	***Topo-set.:***	Hillside (slope)	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit	***Site status:***	In use	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System	***Site purp.:***	Observation	***Rep. inst.:***	JMA
		Use applic.:	Industrial - mining		
		Equipment:	No equipment		

Construction and Geohydrological Legend





COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628DB00015 **Number:** SSW-15 **Site type:** Borehole

Distr./Farm No.: 532 IR **Site Name/Des.:** BOREHOLE SSW-15 : BLOCK 8C

Region Type: **Region Descr.:** SHALLOW WEATHERED ZONE AQUIFER

Y Coord. [m]:	1797.385	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	30.00
X Coord. [m]:	2937769.592	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.42
Altitude [m]:	1594.28			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	12.00	215	20011109	CASED TO 165
JMA	12.00	30.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011109	0.00	8.00	165	Steel	2					
20011109	8.00	12.00	165	Steel	2	Perforated or slotted	250	2	43	250

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown	Reddish		Clayey	Damp
1.00	5.00	SANDSTONE AND SHALE	Brown	Greyish		Weathered	Sandy
5.00	11.00	SANDSTONE AND SHALE	Grey			Weathered	Dry
11.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020107	1755	0.00	7.05	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020107	1800	0							0.003		

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Borehole Construction and Geological Log

Date compiled: 2/25/02

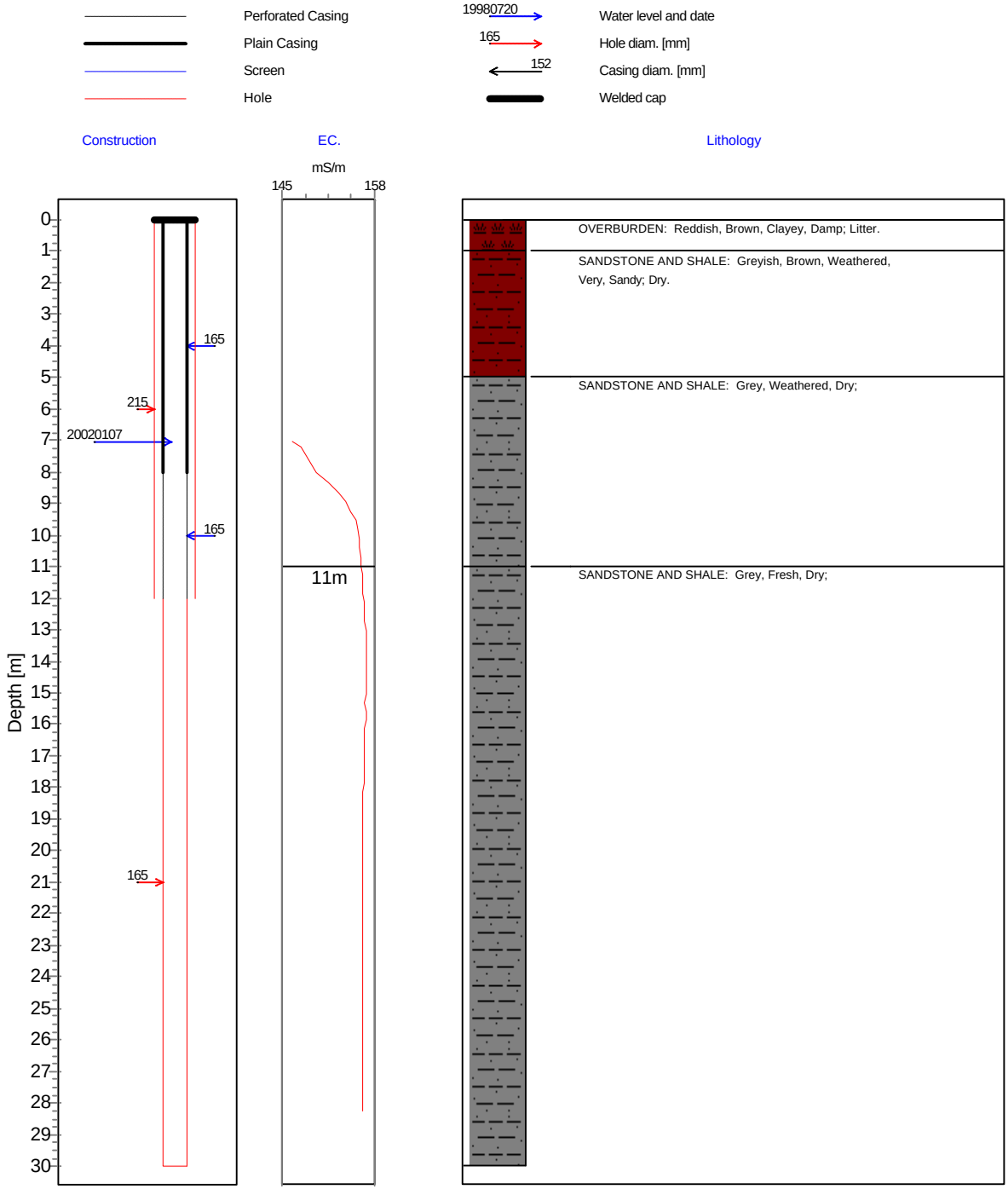
BASIC SITE INFORMATION:

Site Identifier: 2628DB00015 ***Number:*** SSW-15 ***Site type:*** Borehole

Distr./Farm No.: 532 IR ***Site Name/Descr.:*** BOREHOLE SSW-15 : BLOCK 8C

Y Coord. [m]:	1797.38500	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	30.00
X Coord. [m]:	2937769.59	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.42
Altitude [m]:	1594.28			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10001 **Number:** SDF-1 **Site type:** Borehole

Distr./Farm No.: 137 IS **Site Name/Des.:** BOREHOLE SDF-1 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-12128.87	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2931166.389	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.37
Altitude [m]:	1595.55			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011106	CASED TO 165
JMA	30.00	80.00	165	20011106	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011106	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	31.00	48.00	0.20	Estimated		Geologist, technician,	WATER STRIKE

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	3.00	SAND AND CLAY	Brown	Dark		Sandy	
3.00	6.00	SOIL	Brown	Yellowish	Fine	Gritty	
6.00	23.00	SANDSTONE AND SHALE	Grey	Light		Weathered	
23.00	28.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
28.00	31.00	SANDSTONE AND SHALE	Grey			Fresh	
31.00	48.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
48.00	59.00	SANDSTONE AND SHALE	Grey			Fresh	
59.00	65.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
65.00	67.00	SANDSTONE AND SHALE	Grey			Fresh	
67.00	72.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
72.00	74.00	SHALE	Black	Greyish		Carbonaceous	Fresh
74.00	77.00	SANDSTONE AND SHALE	Grey			Fresh	
77.00	80.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011220	1505	0.00	1.93	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011220	1800	0							0.046		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

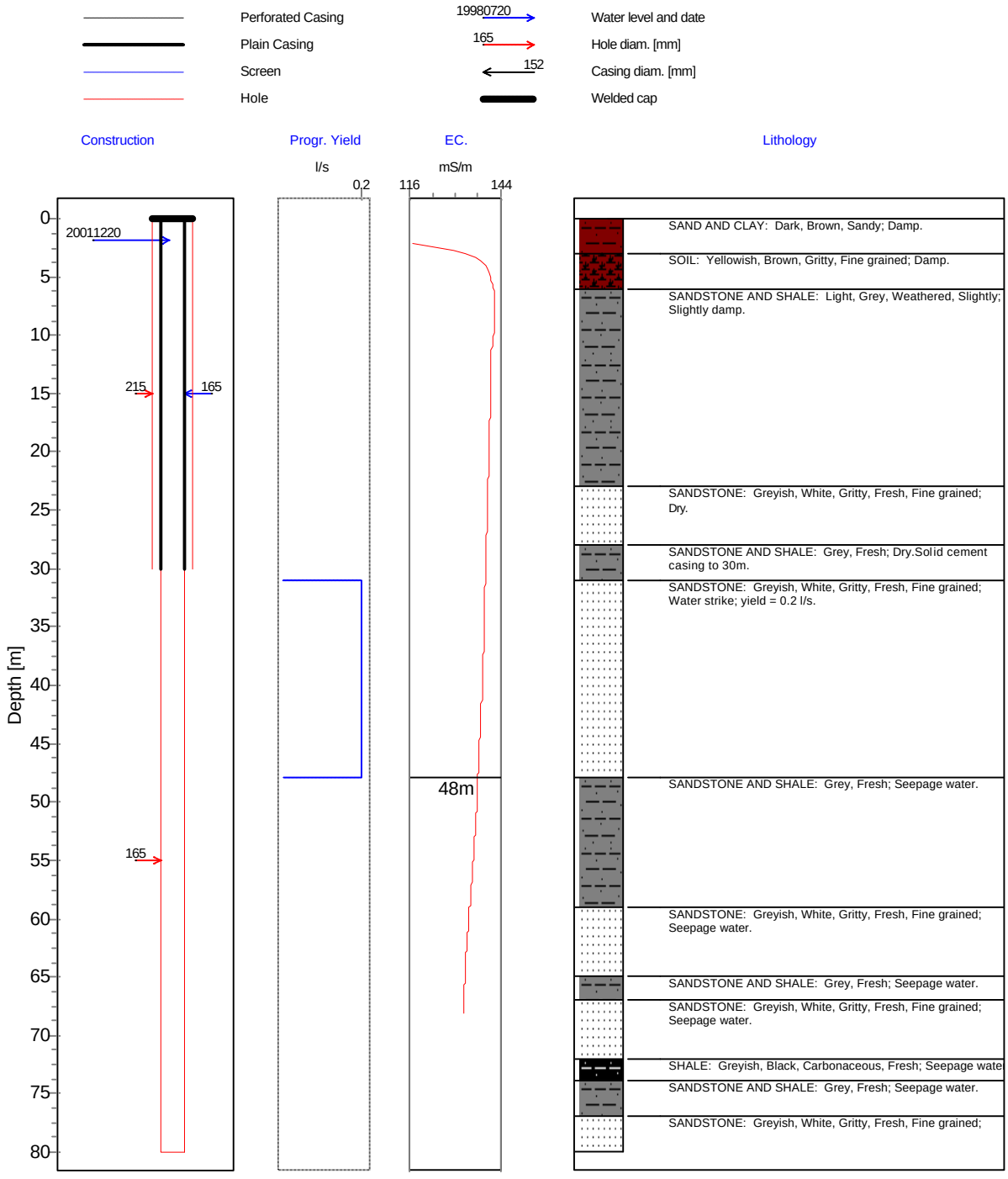
BASIC SITE INFORMATION:

Site Identifier: 2629AC10001 ***Number:*** SDF-1 ***Site type:*** Borehole

Distr./Farm No.: 137 IS ***Site Name/Descr.:*** BOREHOLE SDF-1 : BLOCK 8

Y Coord. [m]:	-12128.870	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2931166.39	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.37
Altitude [m]:	1595.55			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10002 **Number:** SDF-2 **Site type:** Borehole

Distr./Farm No.: 135 IS **Site Name/Des.:** BOREHOLE SDF-2 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-10262.341	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2931990.899	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.47
Altitude [m]:	1585.91			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011114	CASED TO 165
JMA	30.00	80.00	165	20011114	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011114	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	6.00	6.00	0.10	Estimated			SEEPAGE WATER

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	SAND AND CLAY	Brown			Damp	
1.00	2.00	DOLERITE	Brown	Yellowish		Weathered	Sandy
2.00	6.00	DOLERITE	Brown	Yellowish	Medium	Weathered	
6.00	11.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
11.00	17.00	SANDSTONE	White	Greyish	Fine	Gritty	Weathered
17.00	36.00	SANDSTONE AND SHALE	Grey			Fresh	Damp
36.00	42.00	SANDSTONE	White	Greyish	Fine	Gritty	Micaceous
42.00	48.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
48.00	56.00	SANDSTONE	White	Greyish	Fine	Gritty	Micaceous
56.00	58.00	SANDSTONE	White	Greyish	Medium to coarse	Gritty	Fresh
58.00	61.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
61.00	66.00	SANDSTONE AND SHALE	White	Greyish		Fresh	Micaceous
66.00	80.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011220	1325	0.00	3.00	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011220	1800	0							0.003		

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Borehole Construction and Geological Log

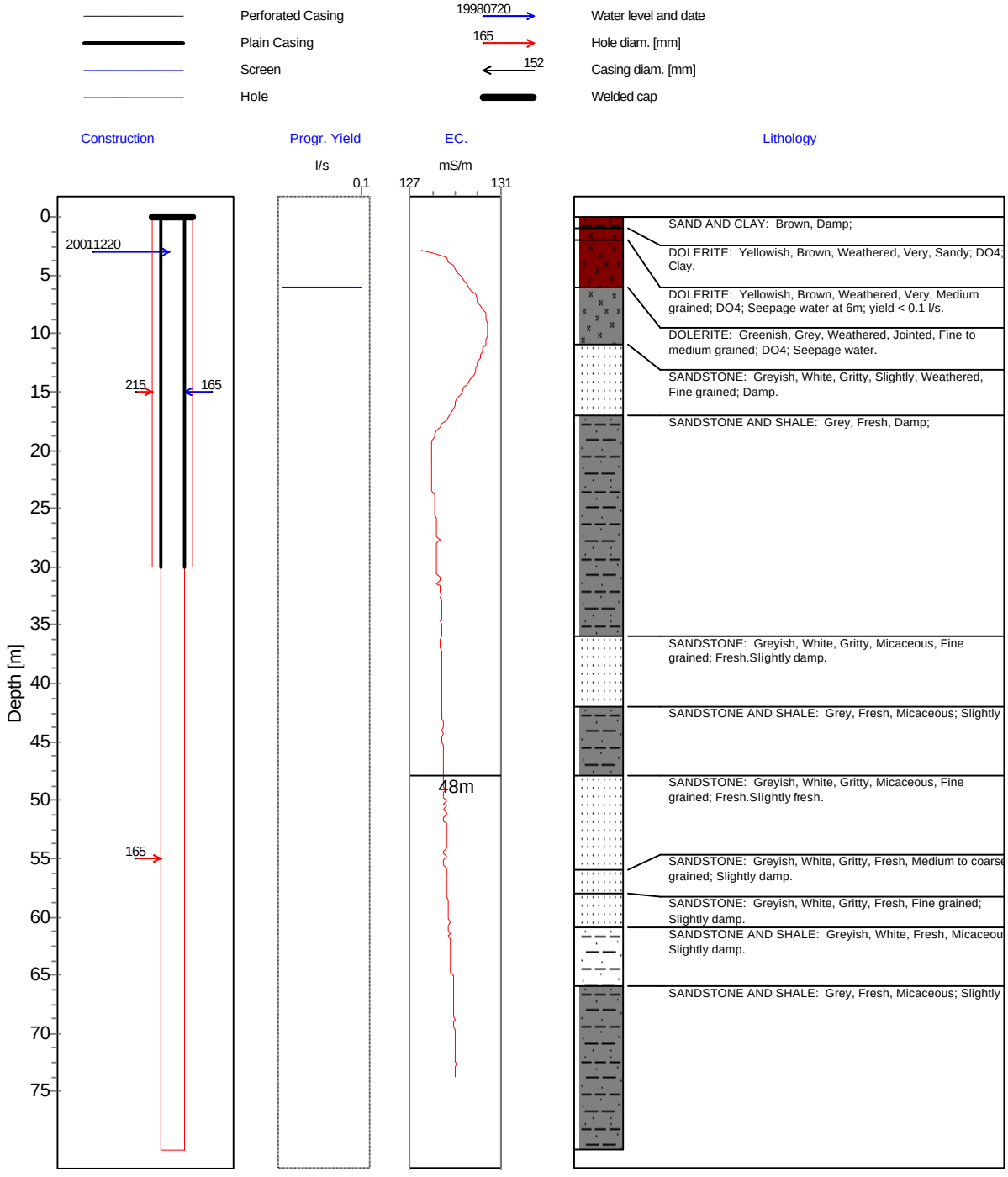
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10002 ***Number:*** SDF-2 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SDF-2 : BLOCK 8

Y Coord. [m]:	-10262.341	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2931990.90	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.47
Altitude [m]:	1585.91			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA10003 **Number:** SDF-3 **Site type:** Borehole

Distr./Farm No.: 135 IS **Site Name/Des.:** BOREHOLE SDF-3 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-9378.1	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2932721.884	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.33
Altitude [m]:	1581.11			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011105	CASED TO 165
JMA	30.00	80.00	165	20011105	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011105	0.00	30.00	165	Other material	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	8.00	9.00	0.30	Estimated			SEEPAGE WATER
JMA	17.00	18.00	1.70	Estimated			
JMA	19.00	20.00	0.70	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown	Dark		Clayey	Damp
1.00	2.00	DOLERITE	Grey	Dark		Weathered	Gravel-bearing
2.00	5.00	DOLERITE			Medium to coarse	Weathered	Feldspathic
5.00	8.00	DOLERITE	Grey	Greenish	Medium to coarse	Weathered	Jointed
8.00	13.00	DOLERITE	Grey		Medium to coarse	Weathered	Jointed
13.00	14.00	SHALE	Grey	Dark		Carbonaceous	Baked
14.00	25.00	SHALE	Grey			Weathered	Jointed
25.00	27.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
27.00	46.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
46.00	54.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
54.00	72.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	
72.00	73.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
75.00	80.00	SANDSTONE AND SHALE	White	Greyish		Fresh	Micaceous

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011220	1740	0.00	2.92	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011220	1800	0							0.001		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

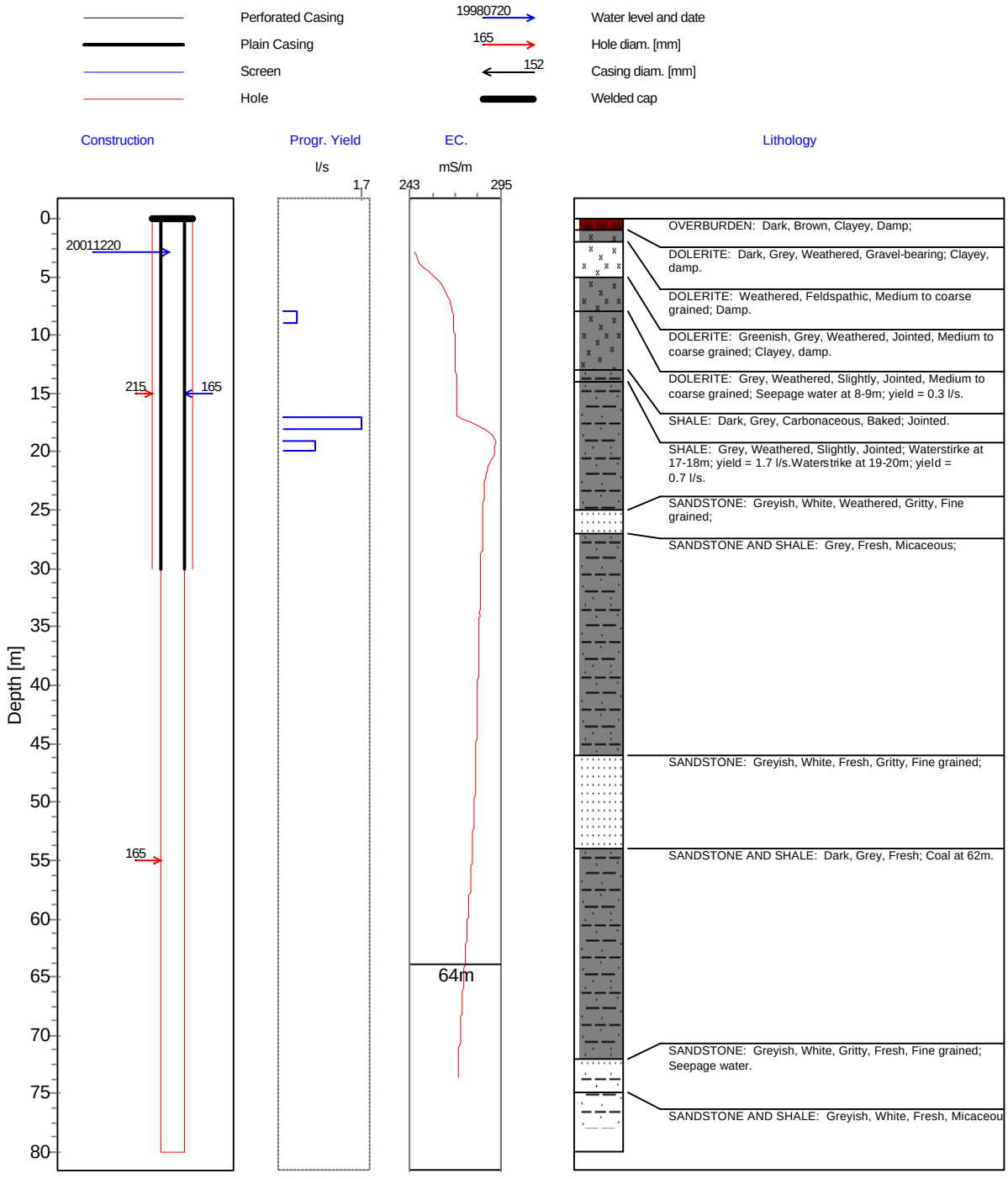
BASIC SITE INFORMATION:

Site Identifier: 2629CA10003 ***Number:*** SDF-3 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SDF-3 : BLOCK 8

Y Coord. [m]:	-9378.10000	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2932721.88	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.33
Altitude [m]:	1581.11			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10004 ***Number:*** SDF-4 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Des.:*** BOREHOLE SDF-4 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-12273.32	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2929461.409	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.30
Altitude [m]:	1643.25			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011121	CASED TO 165
JMA	30.00	80.00	165	20011121	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011121	0.00	25.00	165	Steel	2					
20011121	25.00	30.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Sandy	Damp
1.00	5.00	SANDSTONE	White	Brownish	Fine	Weathered	Gritty
5.00	6.00	DOLERITE	Grey	Brownish		Weathered	Jointed
6.00	49.00	DOLERITE	Grey	Greenish		Fresh	
49.00	50.00	SANDSTONE	Grey		Fine	Gritty	Micaceous
50.00	53.00	SANDSTONE	White	Greyish	Fine	Gritty	Fresh
53.00	58.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
58.00	60.00	SHALE	Grey	Dark		Fresh	Carbonaceous
60.00	70.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
70.00	80.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020107	0840	0.00	50.37	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020107	1800	0							0.002		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

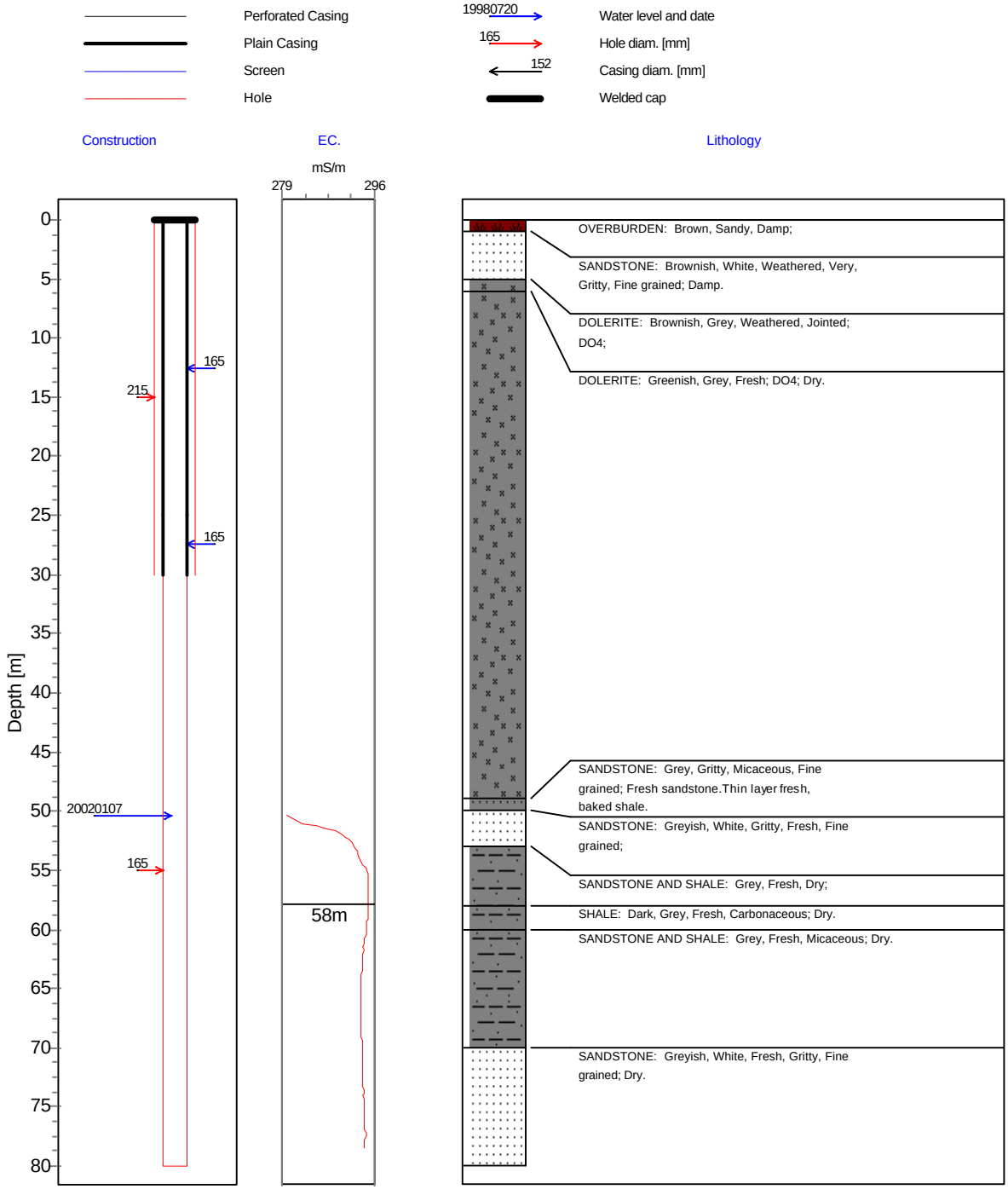
BASIC SITE INFORMATION:

Site Identifier: 2629AC10004 ***Number:*** SDF-4 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SDF-4 : BLOCK 8

Y Coord. [m]:	-12273.320	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2929461.41	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.30
Altitude [m]:	1643.25			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10005 **Number:** SDF-5 **Site type:** Borehole

Distr./Farm No.: 135 IS **Site Name/Des.:** BOREHOLE SDF-5 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-9957.746	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	150.00
X Coord. [m]:	2926945.507	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.27
Altitude [m]:	1602.75			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011127	CASED TO 165
JMA	30.00	150.00	165	20011127	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011127	0.00	30.00	165	PVC	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	30.00	67.00	0.10	Estimated			SEEPAGE WATER
JMA	76.00	80.00	0.10	Estimated			SEEPAGE WATER

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown			Clayey	Damp
1.00	4.00	CLAY	Brown	Dark		Damp	
4.00	9.00	MUDSTONE	Brown	Yellowish		Weathered	Clayey
9.00	12.00	MUDSTONE	Brown	Greyish		Weathered	Damp
12.00	17.00	SANDSTONE AND SHALE	Grey			Weathered	Micaceous
17.00	48.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
48.00	57.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
57.00	67.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
67.00	86.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
86.00	98.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
98.00	100.00	SANDSTONE AND SHALE	Grey			Fresh	
100.00	110.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
110.00	111.00	COAL					
111.00	144.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
144.00	145.00	COAL					
145.00	149.00	SANDSTONE			Fine	Fresh	Gritty
149.00	150.00	COAL					

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020107	1005	0.00	9.12	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020107	1800	0							0.001		

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Borehole Construction and Geological Log

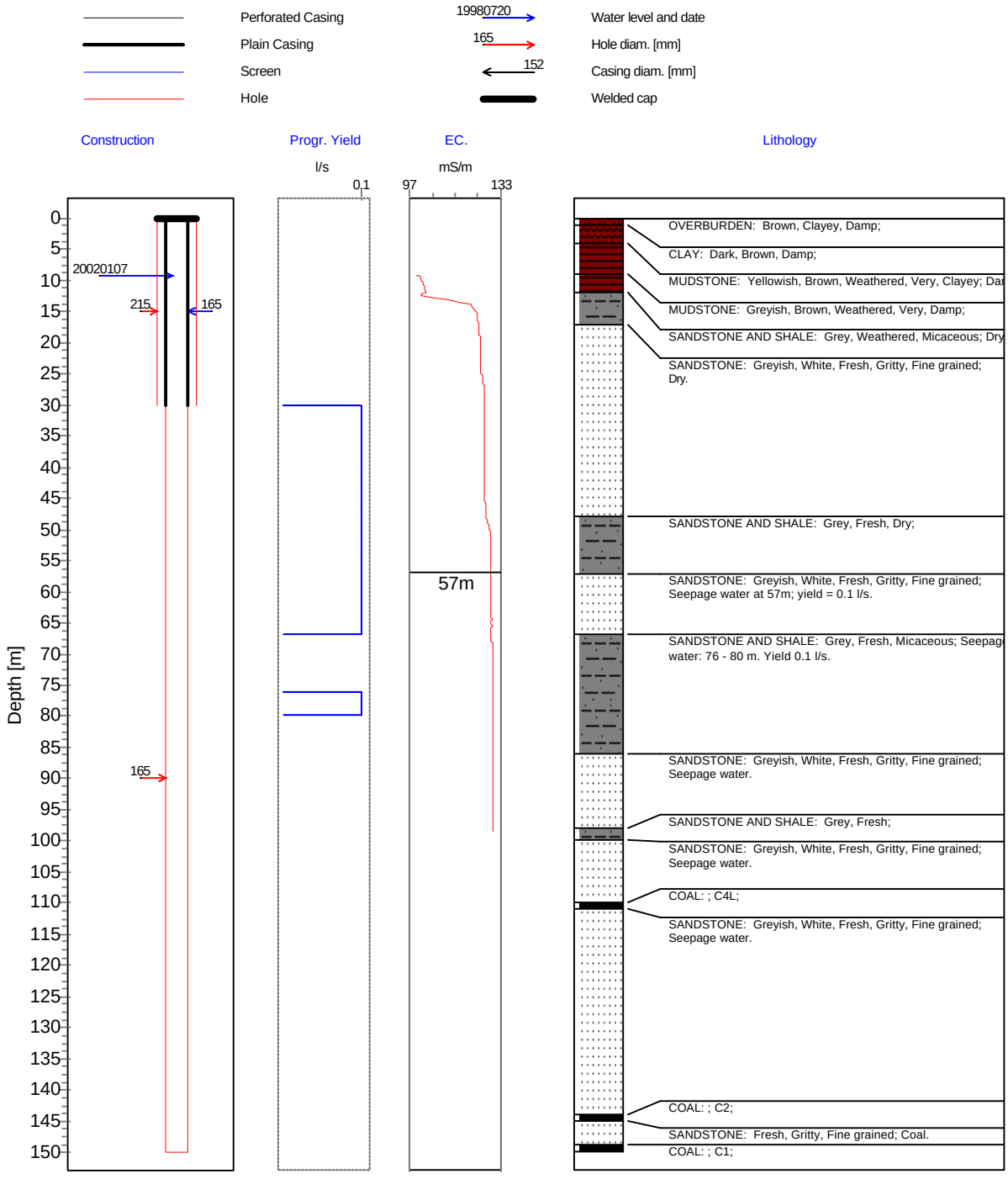
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10005 ***Number:*** SDF-5 ***Site type:*** Borehole

Distr./Farm No.: 135 IS ***Site Name/Descr.:*** BOREHOLE SDF-5 : BLOCK 8

Y Coord. [m]:	-9957.74600	***Alt. No. 1:***		***Depth [m]:***	150.00
X Coord. [m]:	2926945.51	***Alt. No. 2:***		***Collar h. [m]:***	0.27
Altitude [m]:	1602.75	***Topo-set.:***	Hillside (slope)	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit	***Site status:***	In use	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System	***Site purp.:***	Observation	***Rep. inst.:***	JMA
		Use applic.:	Industrial - mining		
		Equipment:	No equipment		

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10006 ***Number:*** SDF-6 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Des.:*** BOREHOLE SDF-6 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-7745.621	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2931473.15	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.43
Altitude [m]:	1598.84			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011107	CASED TO 165
JMA	30.00	80.00	165	20011107	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011107	0.00	30.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Damp	
1.00	5.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
5.00	8.00	DOLERITE	Brown			Weathered	Damp
8.00	12.00	DOLERITE	Grey	Brownish	Fine to medium	Weathered	Jointed
12.00	15.00	DOLERITE	Grey	Greenish	Fine to medium	Fresh	Dry
15.00	16.00	SHALE	Grey			Fresh	Baked
16.00	30.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
30.00	44.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
44.00	53.00	DOLERITE	Grey	Greenish	Medium	Fresh	Dry
53.00	60.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
60.00	80.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011220	1620	0.00	4.04	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011220	1800	0							0.017		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

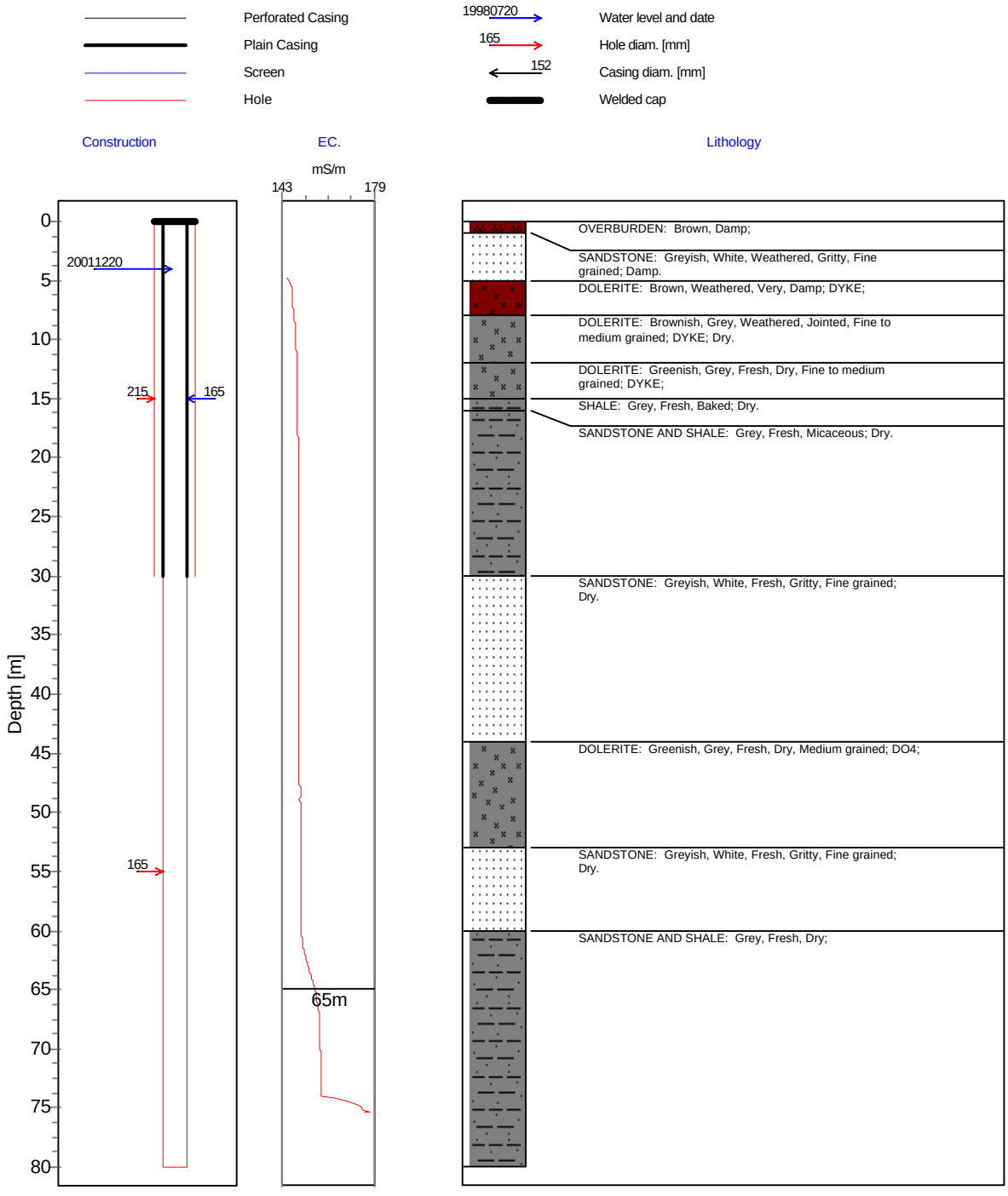
BASIC SITE INFORMATION:

Site Identifier: 2629AC10006 ***Number:*** SDF-6 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Descr.:*** BOREHOLE SDF-6 : BLOCK 8

Y Coord. [m]:	-7745.62100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2931473.15	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.43
Altitude [m]:	1598.84			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10007 **Number:** SDF-7 **Site type:** Borehole

Distr./Farm No.: 131 IS **Site Name/Des.:** BOREHOLE SDF-7 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-6945.279	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2930161.941	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.37
Altitude [m]:	1580.56			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011114	CASED TO 165
JMA	30.00	80.00	165	20011114	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011114	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	8.00	10.00	1.00	Estimated			
JMA	17.00	18.00	19.00	Estimated			
JMA	41.00	43.00	10.00	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Black			Clayey	Damp
1.00	4.00	CLAY	Brown	Yellowish		Sandy	Damp
4.00	5.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
5.00	8.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
8.00	18.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Fresh
18.00	24.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
24.00	28.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
28.00	29.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous
29.00	35.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
35.00	36.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
36.00	37.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
37.00	38.00	SHALE	Grey	Dark		Fresh	Carbonaceous
38.00	41.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
41.00	43.00	SANDSTONE AND SHALE				Weathered	Jointed
43.00	44.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
44.00	67.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
67.00	69.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
69.00	77.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
77.00	79.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
79.00	80.00	COAL					

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011221	1310	0.00	1.59	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20011221	25	0							5.82		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

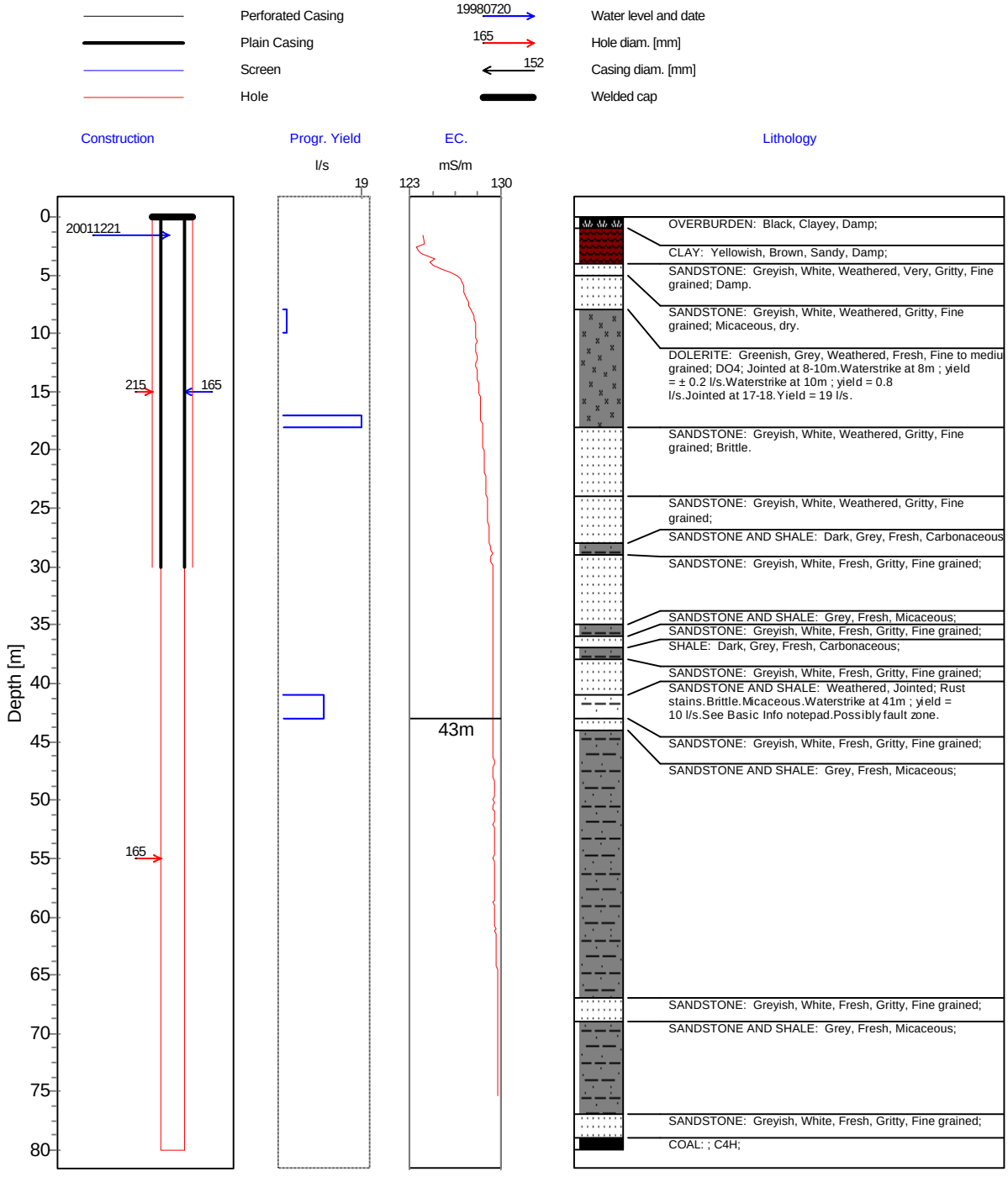
BASIC SITE INFORMATION:

Site Identifier: 2629AC10007 ***Number:*** SDF-7 ***Site type:*** Borehole

Distr./Farm No.: 131 IS ***Site Name/Descr.:*** BOREHOLE SDF-7 : BLOCK 8

Y Coord. [m]:	-6945.27900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2930161.94	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.37
Altitude [m]:	1580.56			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA10008 **Number:** SDF-8 **Site type:** Borehole

Distr./Farm No.: 130 IS **Site Name/Des.:** BOREHOLE SDF-8 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-4384.176	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	84.00
X Coord. [m]:	2935039.747	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.51
Altitude [m]:	1580.77			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011108	CASED TO 165
JMA	30.00	84.00	165	20011108	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011108	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	12.00	13.00	0.10	Estimated			SEEPAGE WATER
JMA	27.00	28.00	0.50	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Brown			Gravel-bearing	Damp
1.00	5.00	SANDSTONE AND SHALE	Brown	Yellowish		Weathered	Clayey
5.00	15.00	SANDSTONE AND SHALE	Brown	Greyish		Weathered	
15.00	16.00	SANDSTONE AND SHALE	Grey			Fresh	
16.00	18.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
18.00	27.00	DOLERITE	White	Greyish		Fresh	
27.00	28.00	DOLERITE	White	Greyish		Jointed	
28.00	45.00	DOLERITE	White	Greyish		Fresh	
45.00	51.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
51.00	70.00	SANDSTONE AND SHALE	Grey			Fresh	
70.00	72.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
72.00	74.00	SHALE	Grey	Dark		Fresh	Carbonaceous
74.00	84.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20011221	1115	0.00	0.26	SLUGTEST

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Borehole Construction and Geological Log

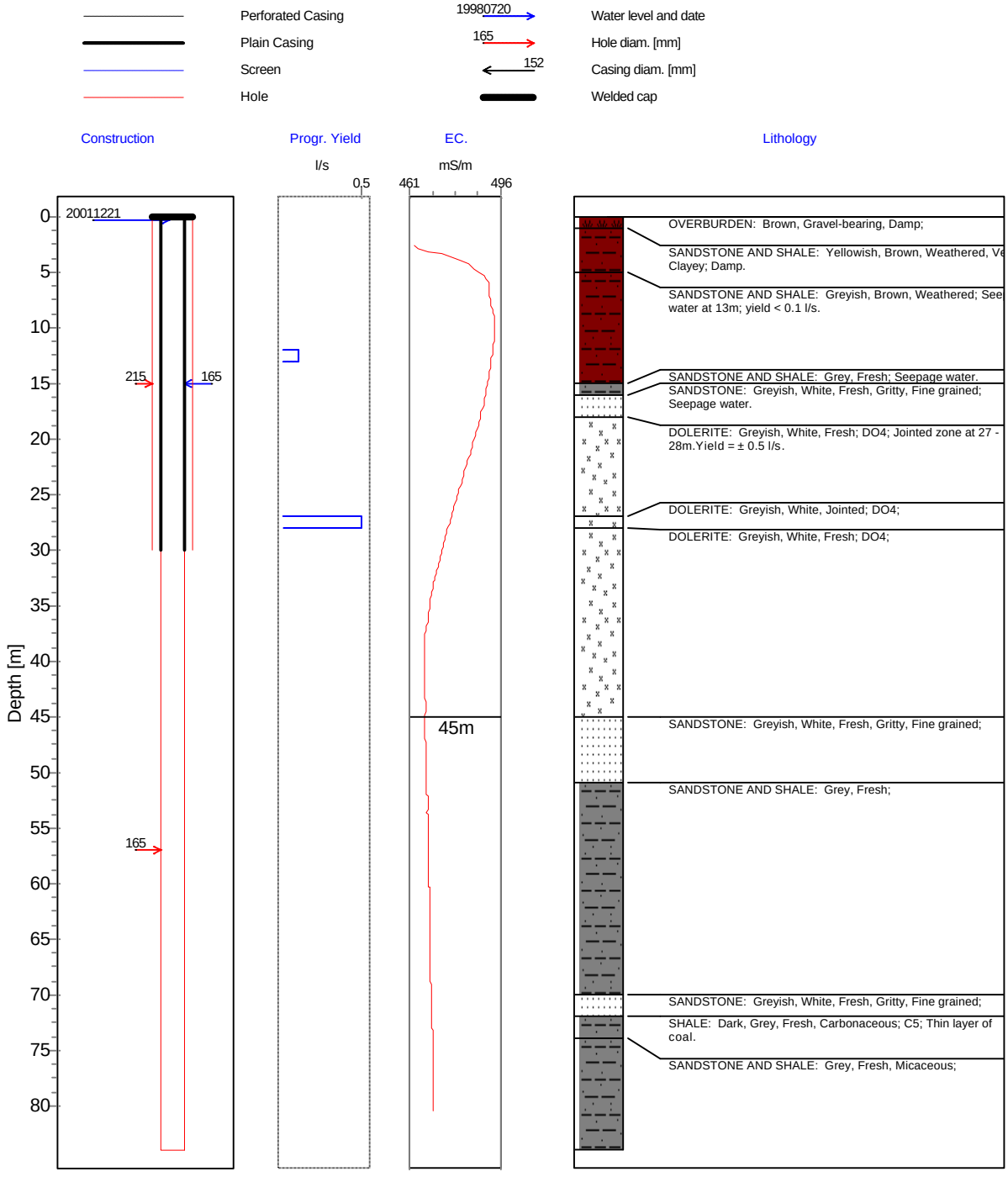
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629CA10008 ***Number:*** SDF-8 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Descr.:*** BOREHOLE SDF-8 : BLOCK 8

Y Coord. [m]:	-4384.17600	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	84.00
X Coord. [m]:	2935039.75	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.51
Altitude [m]:	1580.77			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629CA10009 ***Number:*** SDF-9 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Des.:*** BOREHOLE SDF-9 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-2885.659	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2934021.126	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.47
Altitude [m]:	1568.90			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011108	CASED TO 165
JMA	30.00	80.00	165	20011108	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011108	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bot. [m]*	*Yield [l/s]*	*Method meas.*	*Aquifer type*	*Info source*	*Comment*
JMA	72.00	72.00	0.20	Estimated			

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Clayey	Damp
1.00	7.00	CLAY	Brown			Sandy	Damp
7.00	9.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
9.00	18.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
18.00	22.00	SHALE	Grey	Dark		Fresh	Carbonaceous
22.00	41.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
41.00	42.00	DOLERITE	Green	Greyish	Medium to coarse	Fresh	Dry
42.00	45.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
45.00	48.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
48.00	54.00	SANDSTONE	Grey	Greenish	Fine	Fresh	Gritty
54.00	55.00	SHALE	Grey	Dark		Fresh	Carbonaceous
55.00	57.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
57.00	70.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
70.00	73.00	SANDSTONE AND SHALE	Grey			Fresh	
73.00	80.00	SANDSTONE	White	Greenish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20011221	1440	0.00	4.79	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20011221	1800	0							0.006		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

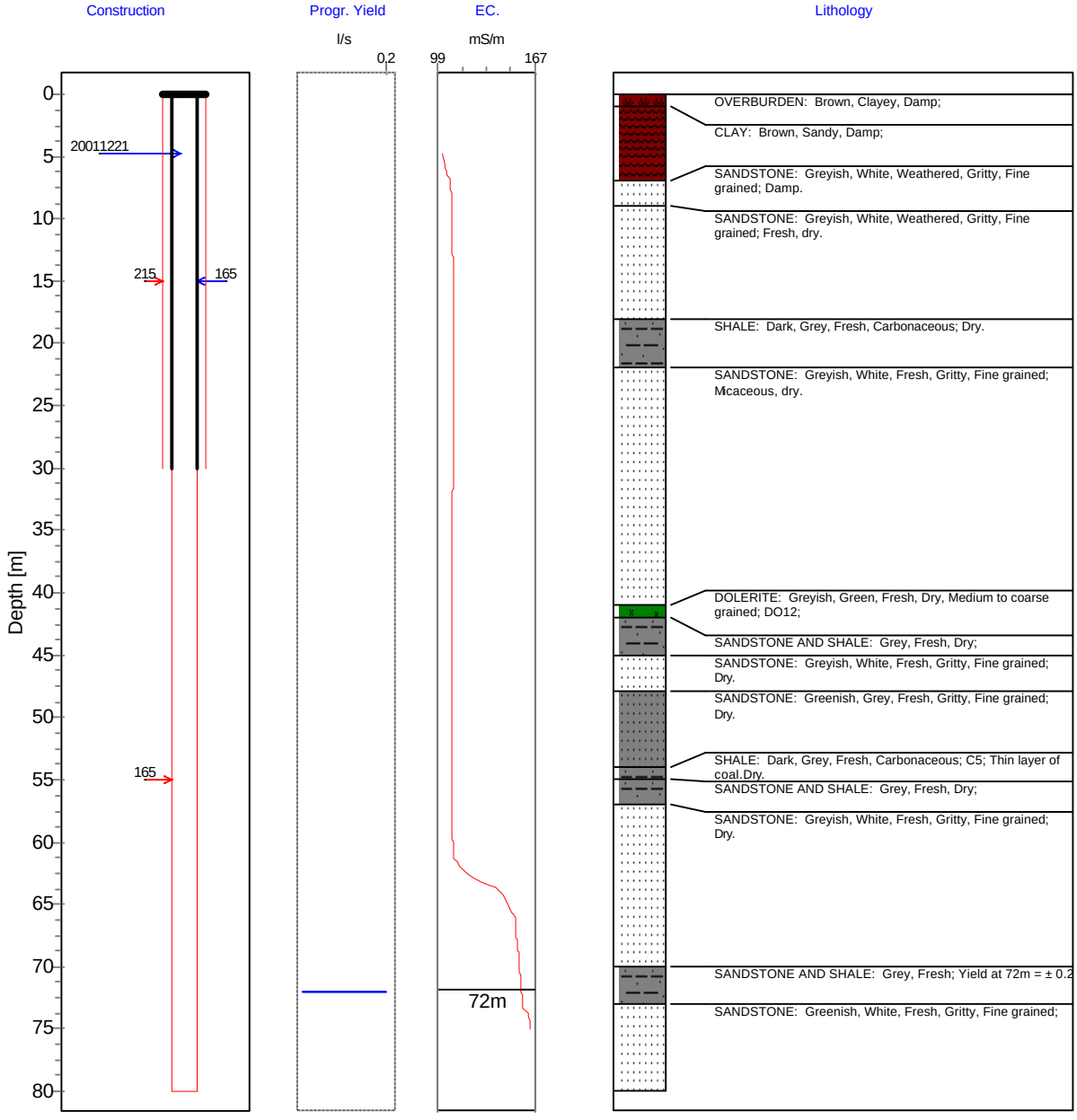
BASIC SITE INFORMATION:

Site Identifier: 2629CA10009 ***Number:*** SDF-9 ***Site type:*** Borehole

Distr./Farm No.: 130 IS ***Site Name/Descr.:*** BOREHOLE SDF-9 : BLOCK 8

Y Coord. [m]:	-2885.65900	***Alt. No. 1:***	***Topo-set.:***	Hillside (slope)	***Depth [m]:*** 80.00
X Coord. [m]:	2934021.13	***Alt. No. 2:***	***Site status:***	In use	***Collar h. [m]:*** 0.47
Altitude [m]:	1568.90		***Site purp.:***	Observation	***Drain. reg.:*** C12D
Coord. acc.:	Accurate to within 1 unit		***Use applic.:***	Industrial - mining	***Diam. [mm]:*** 165
Coord. meth.:	Global Positioning System		***Equipment:***	No equipment	***Rep. inst.:*** JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10010 ***Number:*** SDF-10 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Des.:*** BOREHOLE SDF-10 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-1235.451	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2930650.269	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.36
Altitude [m]:	1572.22			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011112	CASED TO 165
JMA	30.00	80.00	165	20011112	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011112	0.00	30.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown			Damp	
1.00	7.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
7.00	8.00	MUDSTONE	Grey			Weathered	Dry
8.00	12.00	MUDSTONE	Grey			Weathered	Dry
12.00	13.00	SHALE	Grey			Baked	Jointed
13.00	15.00	SANDSTONE AND SHALE				Fresh	
15.00	16.00	DOLERITE			Fine	Fresh	Jointed
16.00	19.00	MUDSTONE	Grey			Fresh	Dry
19.00	24.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
24.00	28.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous
28.00	50.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
50.00	63.00	SANDSTONE	White	Greenish	Fine	Fresh	Gritty
63.00	65.00	SHALE	Grey	Dark		Fresh	Carbonaceous
65.00	69.00	SANDSTONE AND SHALE				Fresh	Micaceous
69.00	78.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
78.00	80.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	1250	0.00	4.43	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.004		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

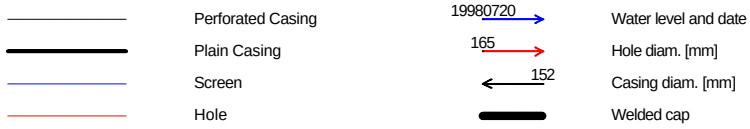
BASIC SITE INFORMATION:

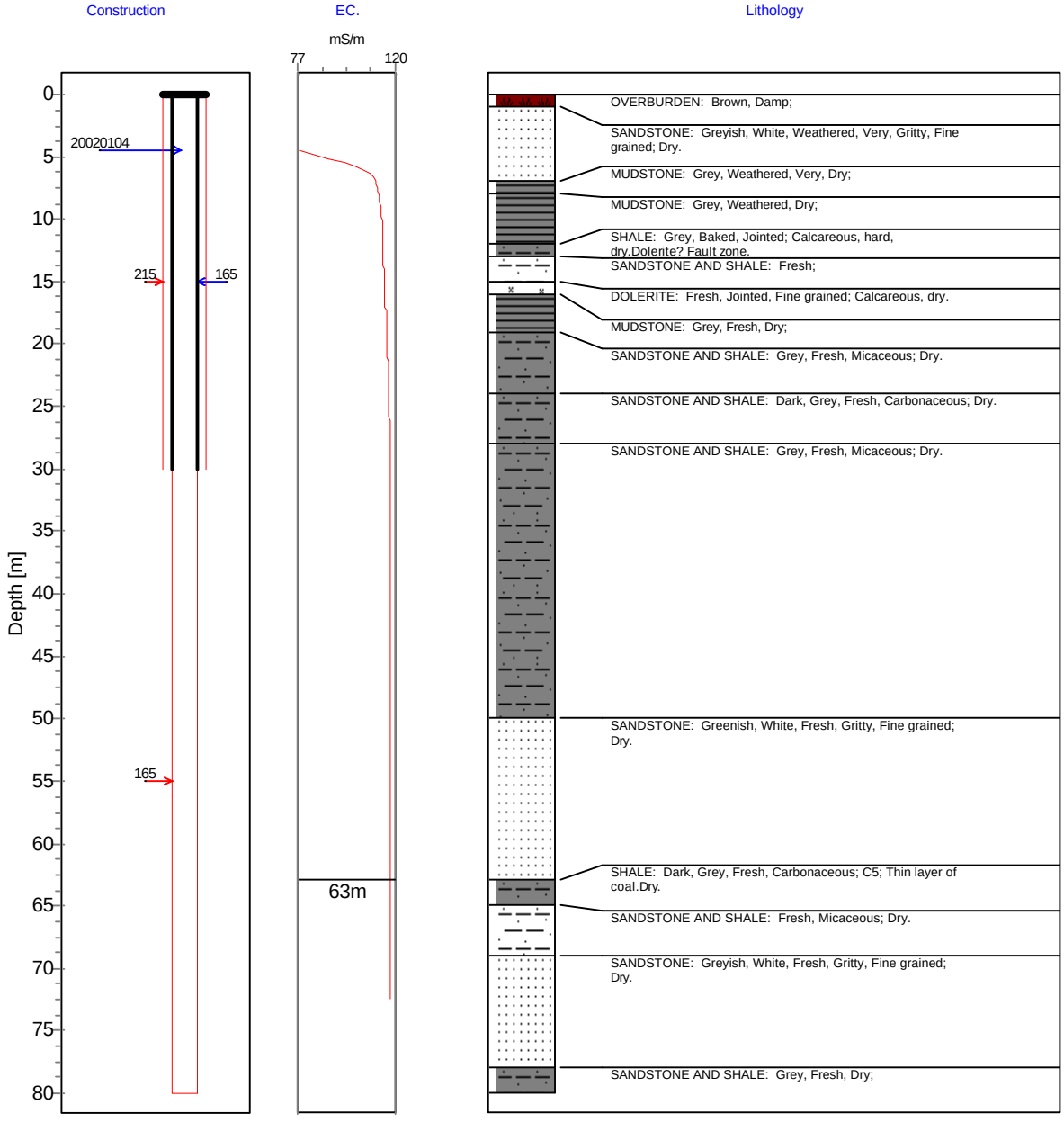
Site Identifier: 2629AC10010 ***Number:*** SDF-10 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SDF-10 : BLOCK 8

Y Coord. [m]:	-1235.45100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2930650.27	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.36
Altitude [m]:	1572.22			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend





COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10011 ***Number:*** SDF-11 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Des.:*** BOREHOLE SDF-11 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-2479.305	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	144.00
X Coord. [m]:	2928046.206	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.25
Altitude [m]:	1634.64			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	6.00	215	20011126	CASED TO 165
JMA	6.00	144.00	165	20011126	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011126	0.00	6.00	165	PVC	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	2.00	OVERBURDEN	Brown			Dry	
2.00	4.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
4.00	8.00	DOLERITE	Grey	Greenish	Fine to medium	Weathered	Jointed
8.00	40.00	DOLERITE	Grey	Greenish	Fine to medium	Fresh	Dry
40.00	46.00	DOLERITE	Grey	Greenish		Fresh	Jointed
46.00	48.00	MUDSTONE	Grey	Greenish		Fresh	Dry
48.00	57.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
57.00	66.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
66.00	73.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous
73.00	93.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
93.00	105.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
105.00	107.00	SHALE	Grey	Dark		Fresh	Carbonaceous
107.00	108.00	COAL	Black			Dry	
108.00	109.00	SHALE	Grey	Dark		Fresh	Carbonaceous
109.00	126.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
126.00	134.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
134.00	135.00	COAL					
135.00	138.00	SANDSTONE	White	Greyish	Fine to medium	Fresh	Gritty
138.00	141.00	COAL					
141.00	144.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020104	0910	0.00	73.86	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020104	1800	0							0.053		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

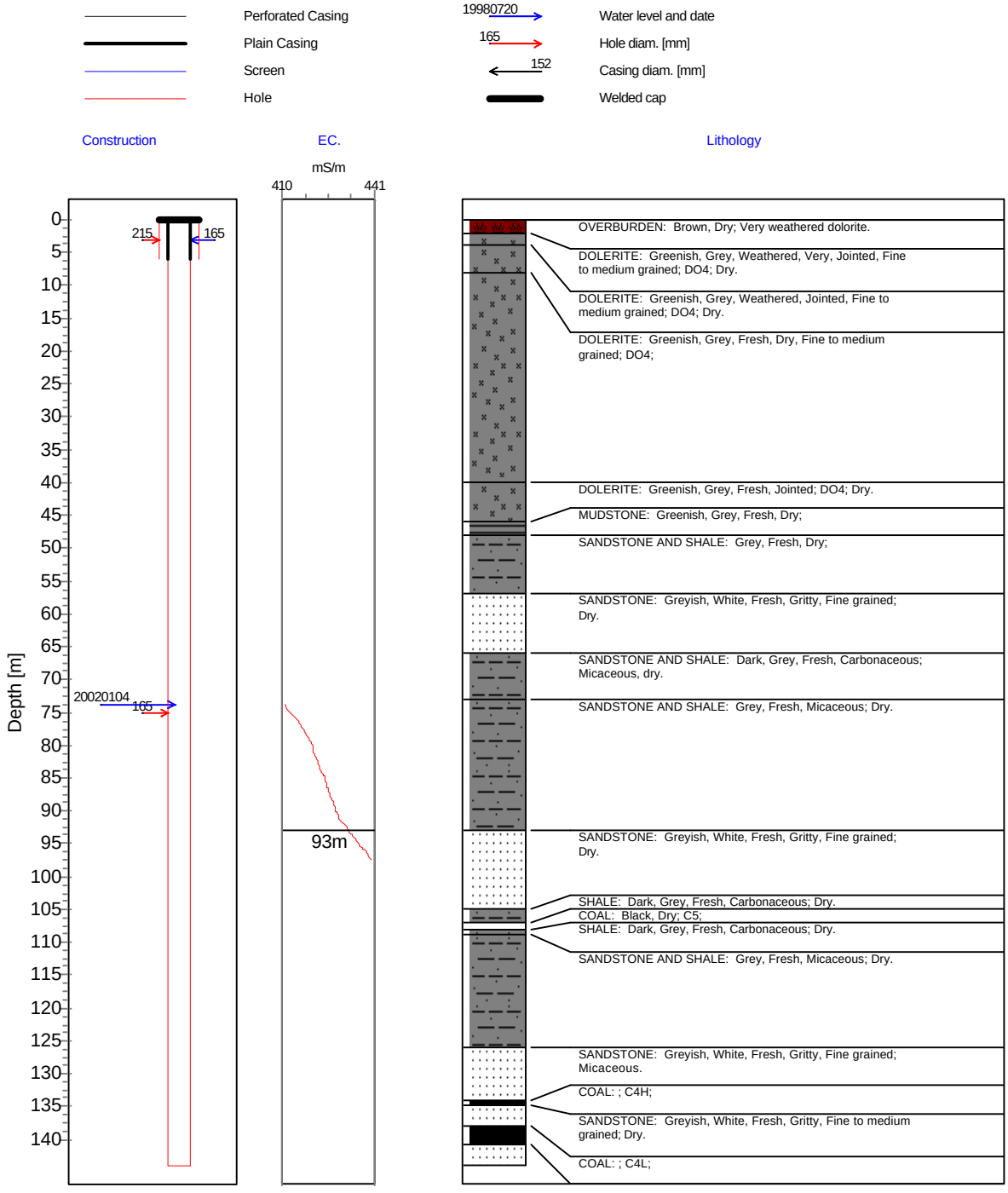
BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10011 ***Number:*** SDF-11 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SDF-11 : BLOCK 8

Y Coord. [m]:	-2479.30500	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)
X Coord. [m]:	2928046.21	***Alt. No. 2:***		***Site status:***	In use
Altitude [m]:	1634.64			***Site purp.:***	Observation
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment

Depth [m]:	144.00
Collar h. [m]:	0.25
Drain. reg.:	C12D
Diam. [mm]:	165
Rep. inst.:	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2629AC10012 **Number:** SDF-12 **Site type:** Borehole

Distr./Farm No.: 128 IS **Site Name/Des.:** BOREHOLE SDF-12 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	-48.109	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2926022.541	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.43
Altitude [m]:	1607.45			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011109	CASED TO 165
JMA	30.00	80.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011109	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	11.00	12.00	0.10	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Grey	Dark		Damp	
1.00	4.00	DOLERITE	Brown	Yellowish		Weathered	Damp
4.00	7.00	DOLERITE	Grey	Greenish		Weathered	Jointed
7.00	12.00	DOLERITE	Grey	Greenish		Fresh	
12.00	14.00	SANDSTONE AND SHALE	Grey			Fresh	
14.00	27.00	SANDSTONE			Fine	Fresh	Gritty
27.00	44.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous
44.00	53.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
53.00	80.00	SANDSTONE AND SHALE	Grey			Fresh	Dry

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1135	0.00	8.88	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	600	0							0.126		

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Borehole Construction and Geological Log

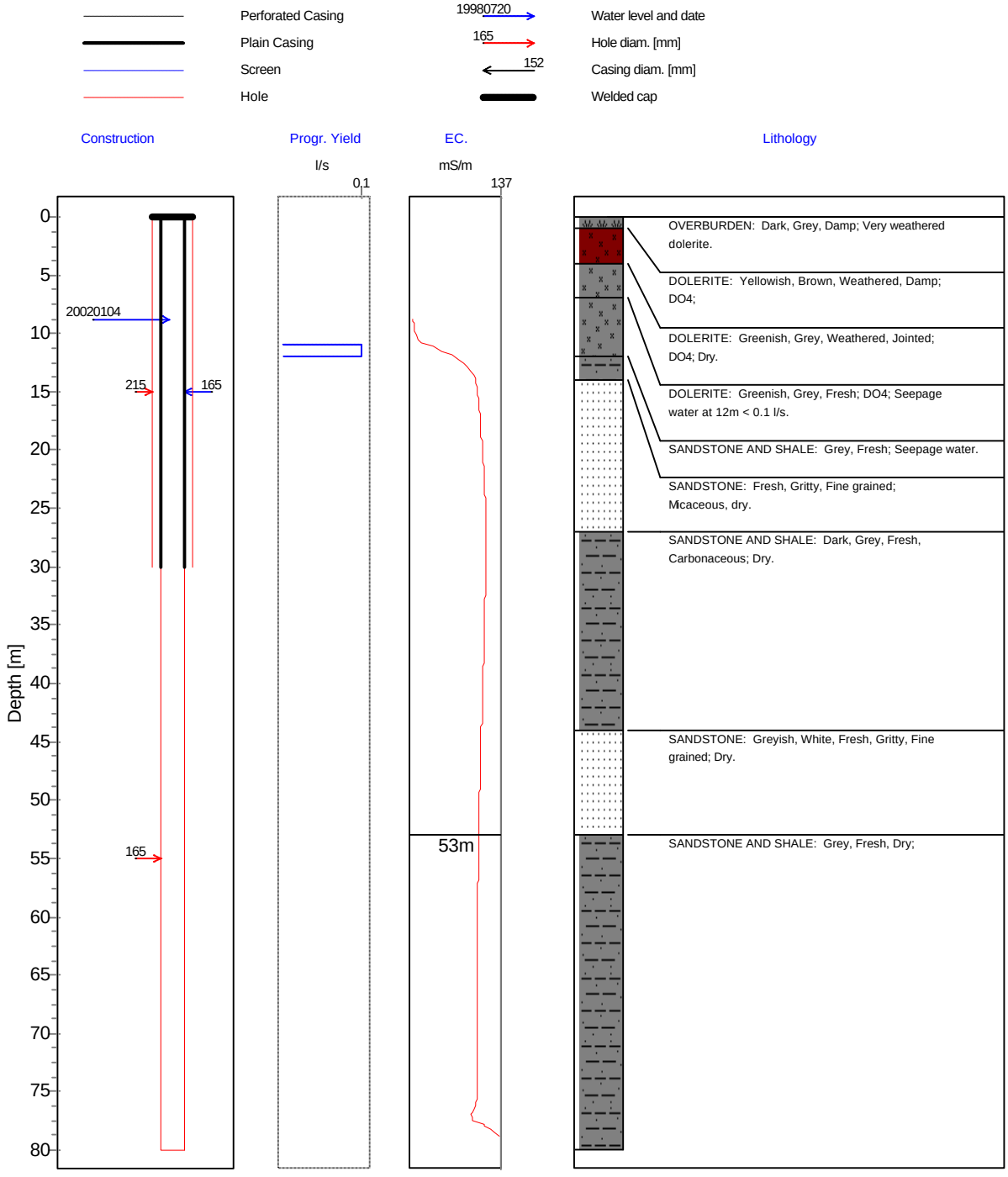
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2629AC10012 ***Number:*** SDF-12 ***Site type:*** Borehole

Distr./Farm No.: 128 IS ***Site Name/Descr.:*** BOREHOLE SDF-12 : BLOCK 8

Y Coord. [m]:	-48.10900	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2926022.54	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.43
Altitude [m]:	1607.45			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628BD10013 **Number:** SDF-13 **Site type:** Borehole

Distr./Farm No.: 359 IR **Site Name/Des.:** BOREHOLE SDF-13 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	1145.281	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	80.00
X Coord. [m]:	2930918.419	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.28
Altitude [m]:	1606.65			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	30.00	215	20011124	CASED TO 165
JMA	30.00	80.00	165	20011124	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011124	0.00	30.00	165	Steel	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	28.00	29.00	0.10	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Grey	Dark		Clayey	Damp
1.00	4.00	DOLERITE	Brown	Yellowish		Weathered	Damp
4.00	6.00	DOLERITE	Grey	Brownish		Weathered	Jointed
6.00	27.00	DOLERITE	Grey	Greenish		Fresh	Jointed
27.00	29.00	DOLERITE	Grey	Greenish		Weathered	Jointed
29.00	30.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
30.00	36.00	SANDSTONE AND SHALE	Grey			Fresh	Wet
36.00	38.00	SHALE	Grey	Dark		Fresh	Carbonaceous
38.00	39.00	SANDSTONE AND SHALE	Grey			Fresh	Wet
39.00	54.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
54.00	57.00	SANDSTONE AND SHALE	Grey			Fresh	Wet
57.00	66.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
66.00	69.00	SANDSTONE AND SHALE	Grey			Fresh	Wet
69.00	80.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1550	0.00	19.41	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	1800	0							0.024		

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Borehole Construction and Geological Log

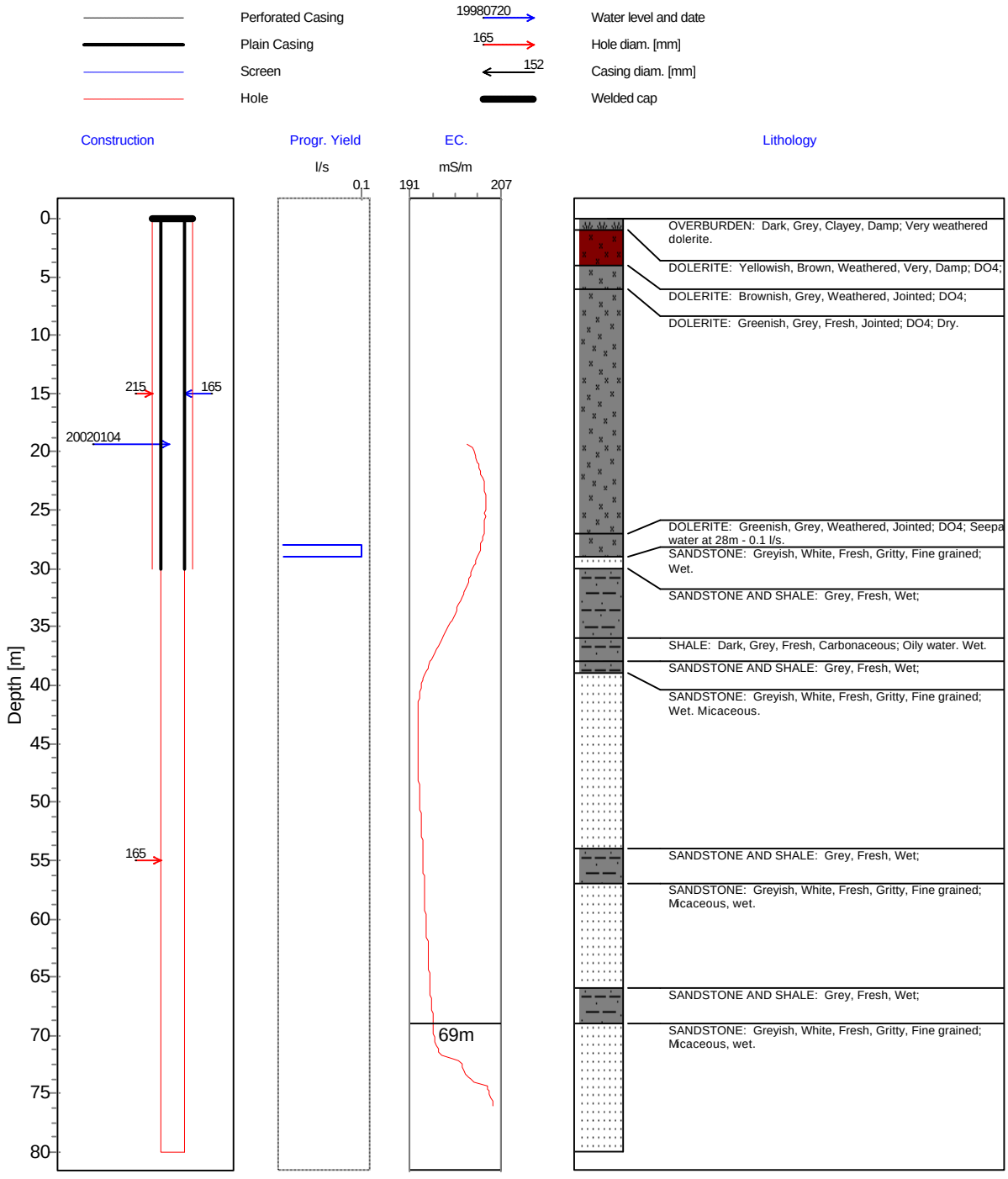
Date compiled: 2/22/02

BASIC SITE INFORMATION: ***Site Identifier:*** 2628BD10013 ***Number:*** SDF-13 ***Site type:*** Borehole

Distr./Farm No.: 359 IR ***Site Name/Descr.:*** BOREHOLE SDF-13 : BLOCK 8

Y Coord. [m]:	1145.28100	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2930918.42	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.28
Altitude [m]:	1606.65			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628DB10014 **Number:** SDF-14 **Site type:** Borehole

Distr./Farm No.: 531 IR **Site Name/Des.:** BOREHOLE SDF-14 : BLOCK 8

Region Type: **Region Descr.:** DEEP FRACTURED AQUIFER

Y Coord. [m]:	1207.168	**Reg./BB.:**		**Topo-set.:**	Hillside (slope)	**Depth [m]:**	102.00
X Coord. [m]:	2933576.875	**G-Nr.:**		**Site status:**	In use	**Col. ht. [m]:**	0.49
Altitude [m]:	1571.32			**Site purp.:**	Observation	**Drain. reg.:**	C12D
Coord. acc.:	Accurate to within 1 unit			**Use applic.:**	Industrial - mining	**Diam. [mm]:**	165
Coord. meth.:	Global Positioning System			**Equipment:**	No equipment	**Rep. inst.:**	JMA

HOLE DIAMETER:

Rep. Inst.	Depth to Top [m]	Depth to Bottom [m]	Diameter [mm]	Date const.	Comment
JMA	0.00	36.00	215	20011124	CASED TO 165
JMA	36.00	102.00	165	20011124	NO CASING

CASING DETAILS:

Date inst.	Dep. to top [m]	Bot. [m]	Diam. [mm]	Material	Thickn. [mm]	Opening Type	Length	Width	Hori. dist.	Vert. dist.
20011124	0.00	36.00	165	PVC	2					

AQUIFER:

Rep. Inst.	Depth to Top [m]	Depth to Bot. [m]	Yield [l/s]	Method meas.	Aquifer type	Info source	Comment
JMA	26.00	28.00	2.00	Estimated			
JMA	32.00	33.00	8.00	Estimated			
JMA	60.00	64.00	0.90	Estimated			

GEOLOGY:

Dep. Top [m]	Bot. [m]	Lithology code	Colour Primary	Secondary	Texture	Feature Primary	Secondary
0.00	1.00	OVERBURDEN	Grey	Dark		Clayey	Damp
1.00	11.00	MUDSTONE	Grey			Weathered	Dry
11.00	12.00	DOLERITE	Grey	Brownish	Fine to medium	Weathered	Dry
12.00	13.00	SHALE	Grey			Weathered	Baked
13.00	26.00	SANDSTONE	White	Greyish	Fine	Weathered	Gritty
26.00	44.00	SANDSTONE AND SHALE	Grey			Fresh	Jointed
44.00	47.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
47.00	52.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
52.00	54.00	SANDSTONE	White	Greyish		Fresh	Gritty
54.00	62.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
62.00	65.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
65.00	87.00	SANDSTONE AND SHALE	Grey			Fresh	Micaceous
87.00	89.00	COAL					
89.00	90.00	SANDSTONE	White	Greyish	Fine to medium	Fresh	Gritty
90.00	92.00	COAL					
92.00	96.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
96.00	97.00	SANDSTONE	Grey		Fine	Fresh	Gritty
97.00	102.00	SANDSTONE AND SHALE	Grey			Fresh	

WATER LEVEL:

Meth. meas.	Level status	Piez.	Info source	Date meas.	Time meas.	Sec.	Water lev. [m]	Comment
Electrical contact	Static	0	Field checked	20020104	1735	0.00	7.57	SLUGTEST

TESTING DETAILS:

Description	Date started	Durat. [s]	Depth to intk. [m]	Disch. rate[l/s]	Drawd. [m]	Recovery: [m]	%	[min]	Trans. [m²/d]	Perm. [m/d]	Storat.	Comment
SLUGTEST	20020104	300	0							0.253		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

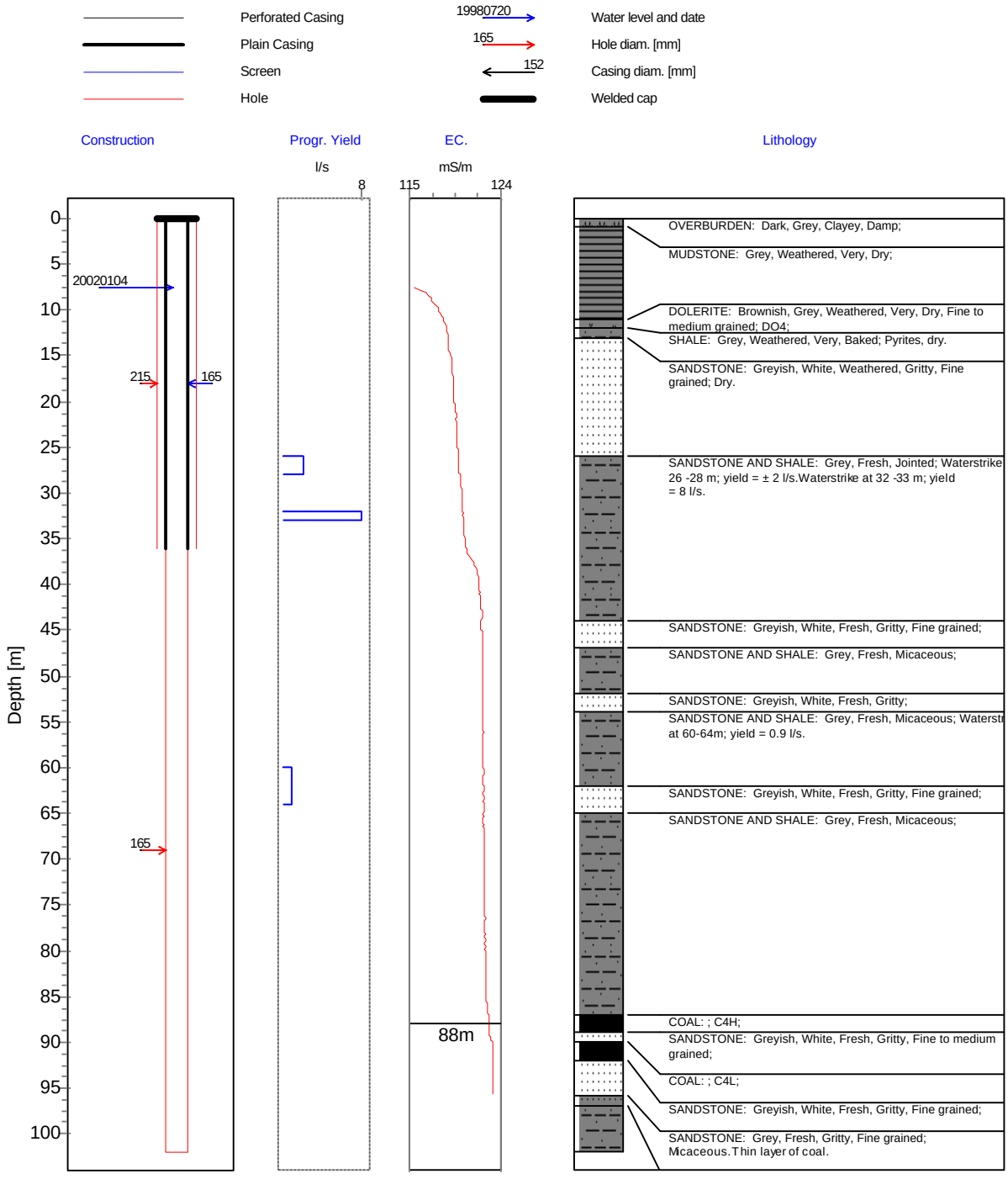
BASIC SITE INFORMATION: ***Site Identifier:*** 2628DB10014 ***Number:*** SDF-14 ***Site type:*** Borehole

Distr./Farm No.: 531 IR ***Site Name/Descr.:*** BOREHOLE SDF-14 : BLOCK 8

Y Coord. [m]:	1207.16800	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)
X Coord. [m]:	2933576.88	***Alt. No. 2:***		***Site status:***	In use
Altitude [m]:	1571.32			***Site purp.:***	Observation
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment

Depth [m]:	102.00
Collar h. [m]:	0.49
Drain. reg.:	C12D
Diam. [mm]:	165
Rep. inst.:	JMA

Construction and Geohydrological Legend



COMMENT:

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SITE INFORMATION REPORT

Date compiled: 2/22/02

BASIC SITE INFORMATION:

Site Identifier: 2628DB10015 ***Number:*** SDF-15 ***Site type:*** Borehole

Distr./Farm No.: 532 IR ***Site Name/Des.:*** BOREHOLE SDF-15 : BLOCK 8

Region Type: ***Region Descr.:*** DEEP FRACTURED AQUIFER

Y Coord. [m]:	1802.728	***Reg./BB.:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2937769.248	***G-Nr.:***		***Site status:***	In use	***Col. ht. [m]:***	0.45
Altitude [m]:	1594.46			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

HOLE DIAMETER:

Rep. Inst.	*Depth to Top [m]*	*Depth to Bottom [m]*	*Diameter [mm]*	*Date const.*	*Comment*
JMA	0.00	30.00	215	20011109	CASED TO 165
JMA	30.00	80.00	165	20011109	NO CASING

CASING DETAILS:

Date inst.	*Dep. to top [m]*	*Bot. [m]*	*Diam. [mm]*	*Material*	*Thickn. [mm]*	*Opening Type*	*Length*	*Width*	*Hori. dist.*	*Vert. dist.*
20011109	0.00	30.00	165	Steel	2					

GEOLOGY:

Dep. Top [m]	*Bot. [m]*	*Lithology code*	*Colour Primary*	*Secondary*	*Texture*	*Feature Primary*	*Secondary*
0.00	1.00	OVERBURDEN	Brown	Reddish		Clayey	Damp
1.00	5.00	SANDSTONE AND SHALE	Brown	Greyish		Weathered	Dry
5.00	11.00	SANDSTONE AND SHALE	Grey			Weathered	Dry
11.00	33.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
33.00	39.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
39.00	54.00	SANDSTONE AND SHALE	Grey			Fresh	Dry
54.00	62.00	SANDSTONE	White	Greyish	Fine	Fresh	Gritty
62.00	80.00	SANDSTONE AND SHALE	Grey	Dark		Fresh	Carbonaceous

WATER LEVEL:

Meth. meas.	*Level status*	*Piez.*	*Info source*	*Date meas.*	*Time meas.*	*Sec.*	*Water lev. [m]*	*Comment*
Electrical contact	Static	0	Field checked	20020107	1715	0.00	24.06	SLUGTEST

TESTING DETAILS:

Description	*Date started*	*Durat. [s]*	*Depth to intk. [m]*	*Disch. rate[l/s]*	*Drawd. [m]*	*Recovery: [m]*	*%*	*[min]*	*Trans. [m²/d]*	*Perm. [m/d]*	*Storat.*	*Comment*
SLUGTEST	20020107	1800	0							0.001		

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Borehole Construction and Geological Log

Date compiled: 2/22/02

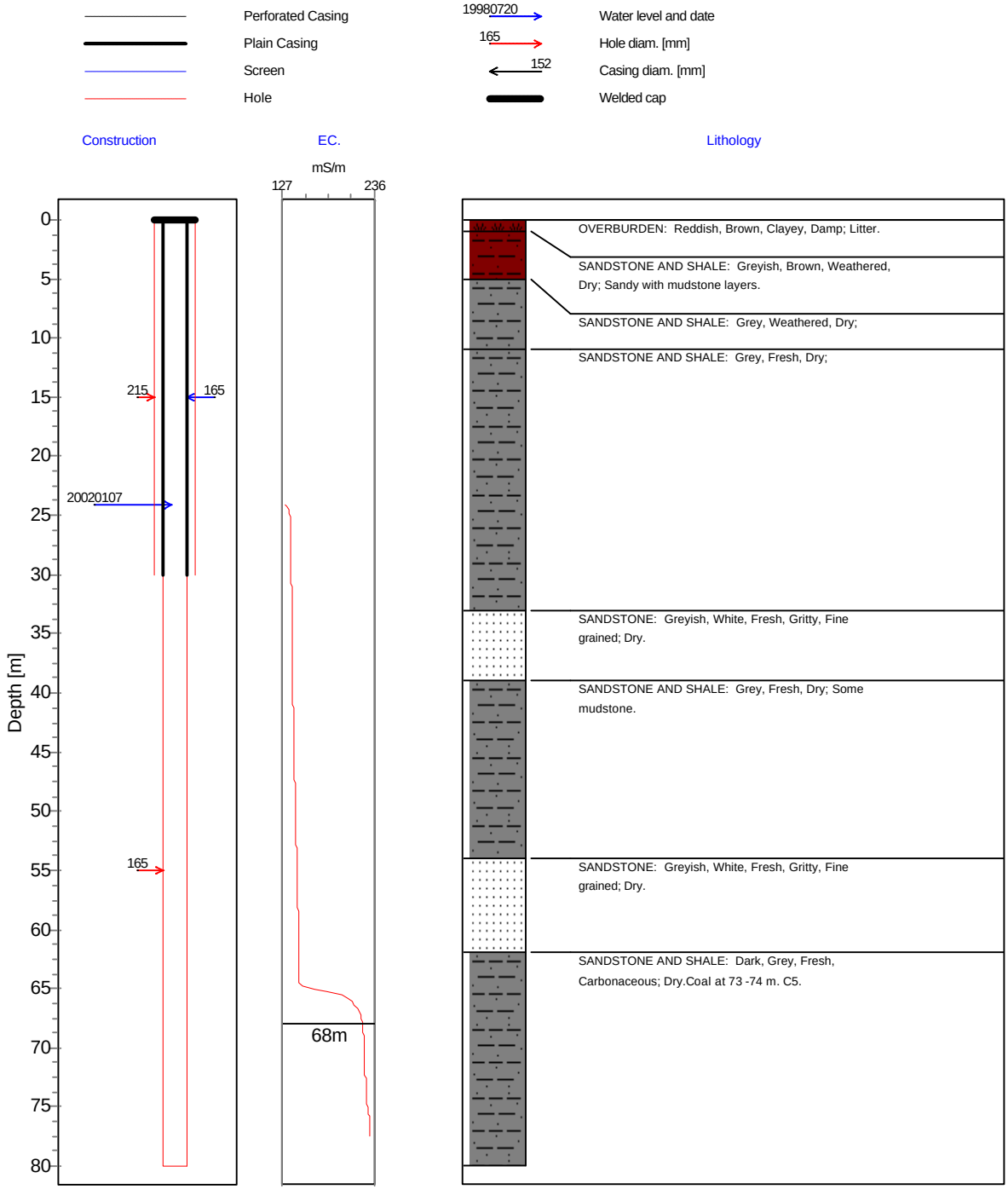
BASIC SITE INFORMATION:

Site Identifier: 2628DB10015 ***Number:*** SDF-15 ***Site type:*** Borehole

Distr./Farm No.: 532 IR ***Site Name/Descr.:*** BOREHOLE SDF-15 : BLOCK 8

Y Coord. [m]:	1802.72800	***Alt. No. 1:***		***Topo-set.:***	Hillside (slope)	***Depth [m]:***	80.00
X Coord. [m]:	2937769.25	***Alt. No. 2:***		***Site status:***	In use	***Collar h. [m]:***	0.45
Altitude [m]:	1594.46			***Site purp.:***	Observation	***Drain. reg.:***	C12D
Coord. acc.:	Accurate to within 1 unit			***Use applic.:***	Industrial - mining	***Diam. [mm]:***	165
Coord. meth.:	Global Positioning System			***Equipment:***	No equipment	***Rep. inst.:***	JMA

Construction and Geohydrological Legend



COMMENT:

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APPENDIX 3(B)

MULTI PARAMETER PROFILES

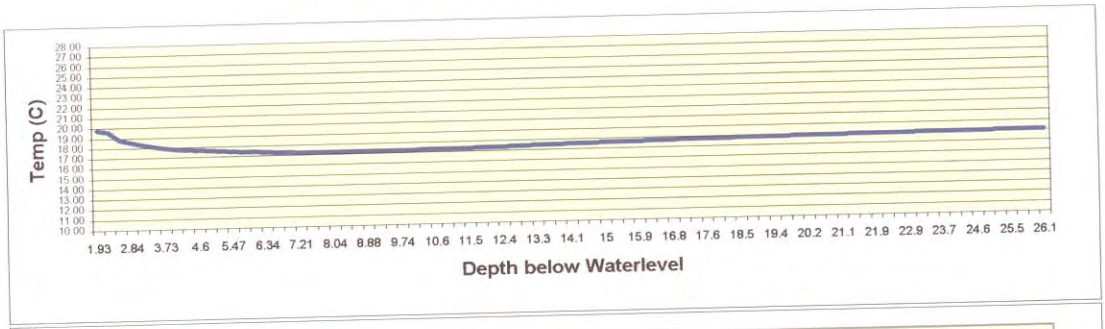
Borehole Chemical Profile Date Compiled: 7/24/02

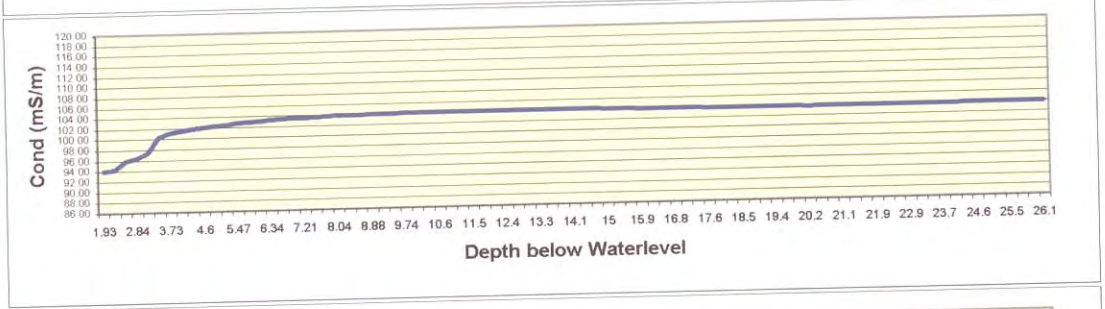
BASIC SITE INFORMATION

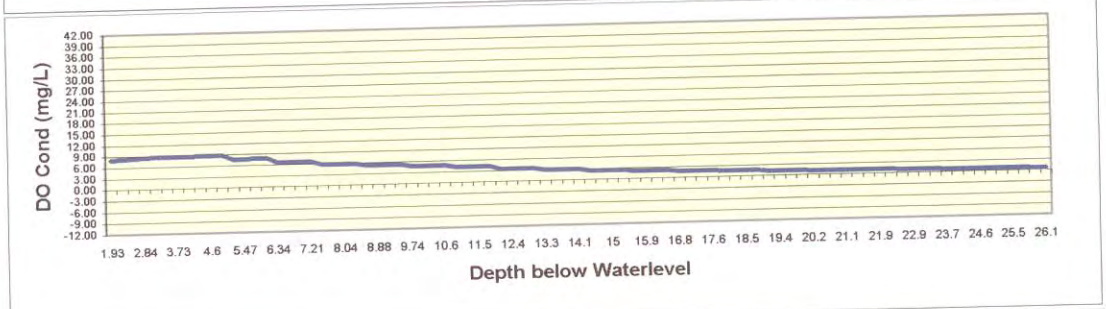
Site Identifier: 2629AC00001 Number: **SSW-1** Type: B

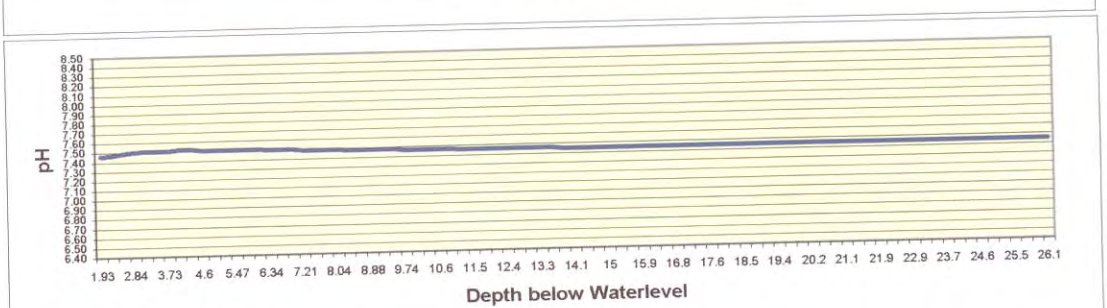
Site Name / Description: Sasol Block 8: Borehole SSW-1 Block 8

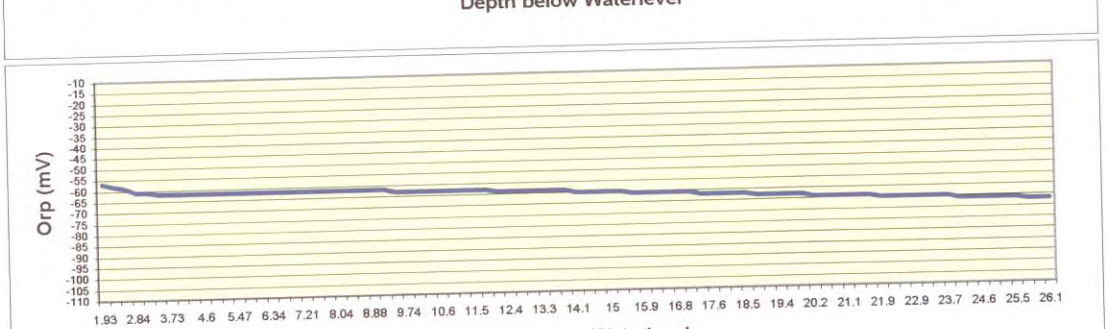
YSI 600XLM Multi-Parameter Profile











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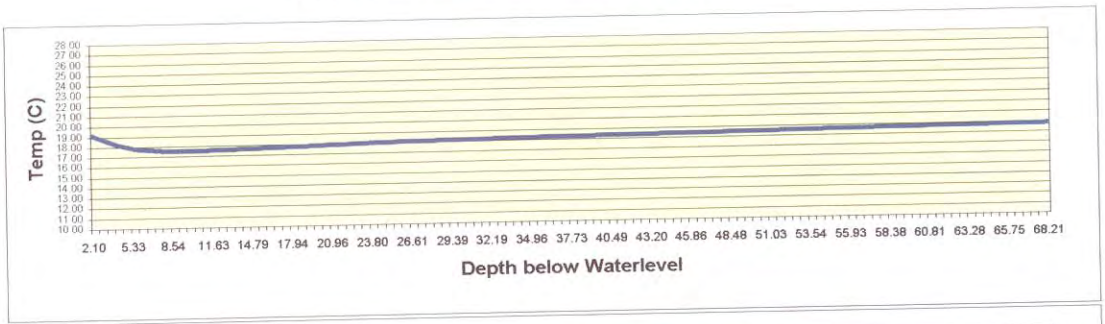
Borehole Chemical Profile Date Compiled: 7/24/02

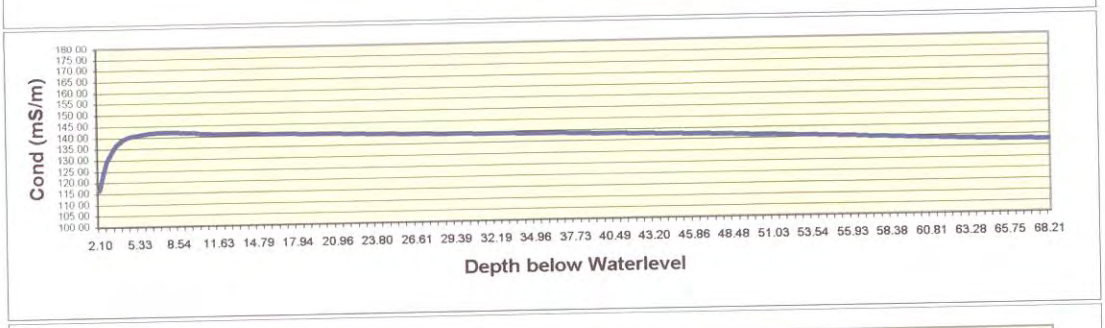
BASIC SITE INFORMATION

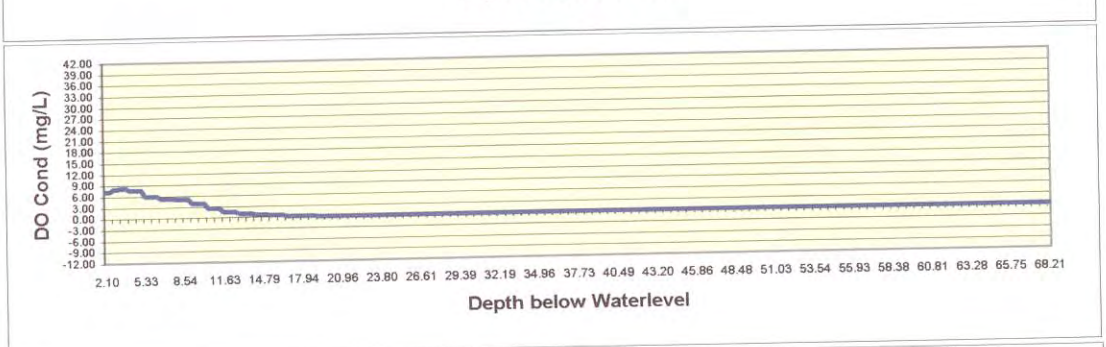
Site Identifier: 2629AC10001 Number: **SDF-1** Type: B

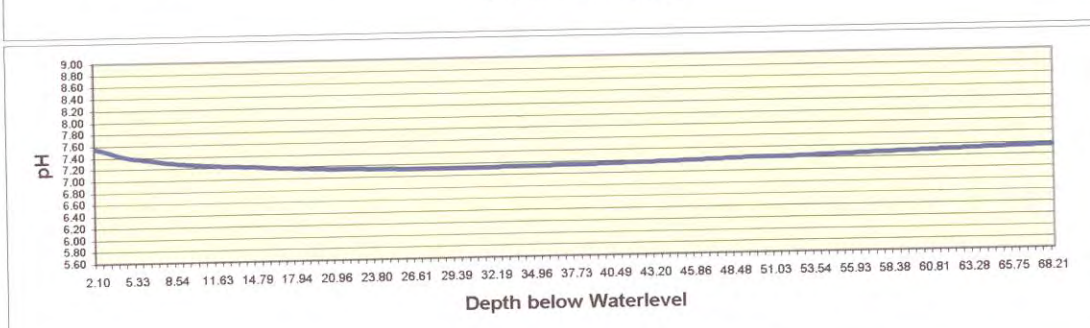
Site Name / Description: Sasol Block 8: Borehole SDF-1

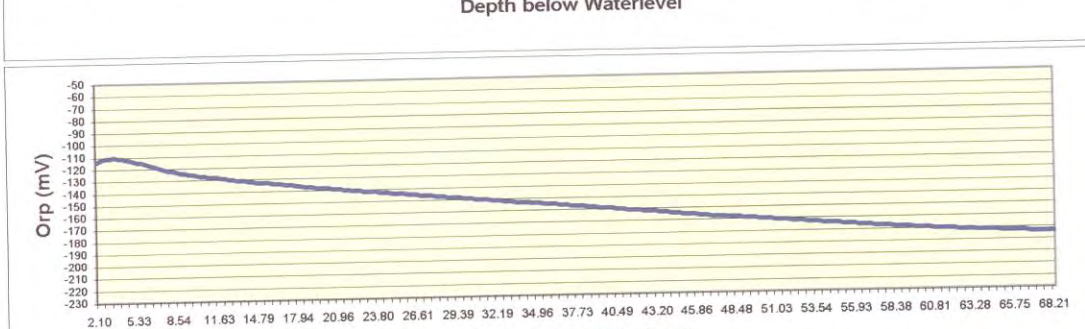
YSI 600XLM Multi-Parameter Profile











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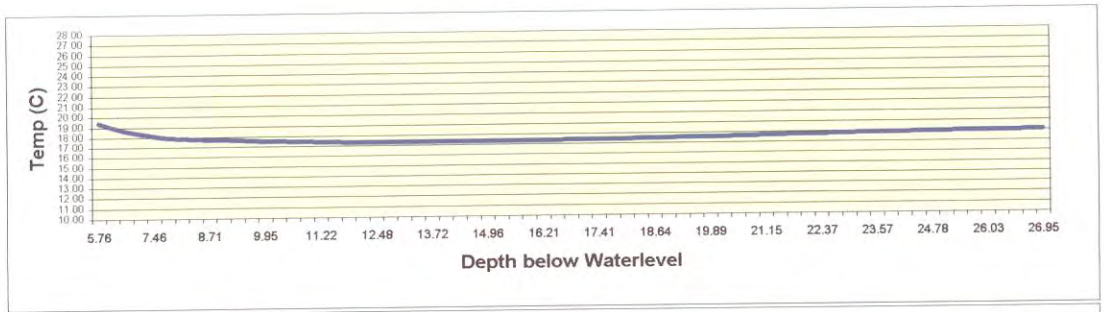
Borehole Chemical Profile Date Compiled: 7/24/02

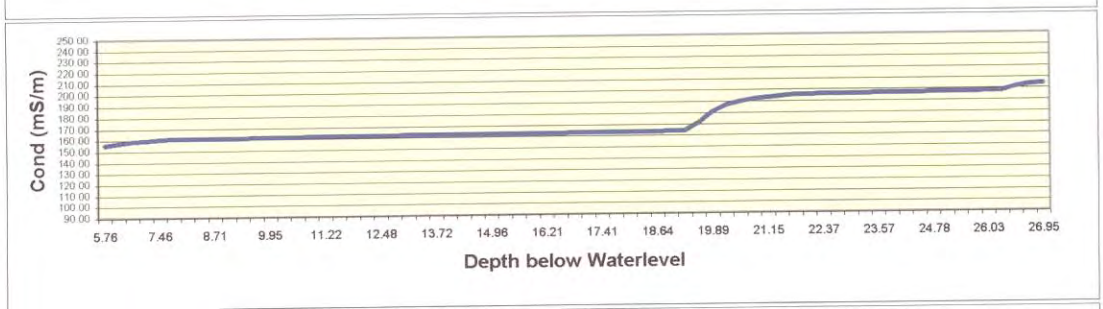
BASIC SITE INFORMATION

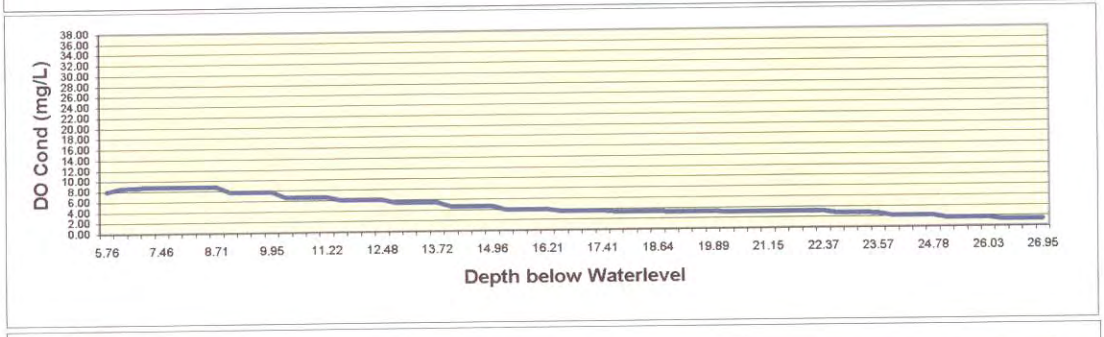
Site Identifier: 2629AC00002 Number: **SSW-2** Type: B

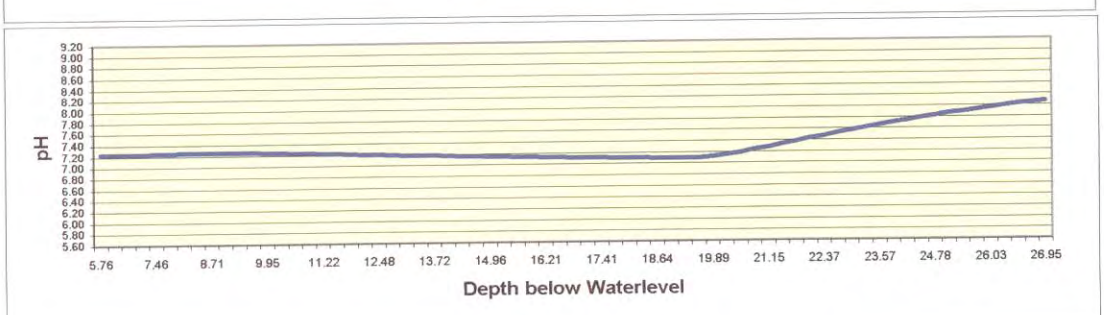
Site Name / Description: Sasol Block 8: Borehole SSW-2 Block 8

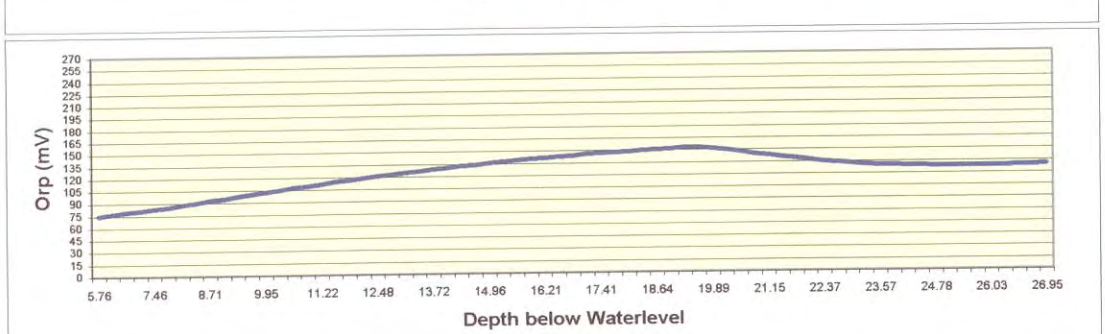
YSI 600XLM Multi-Parameter Profile











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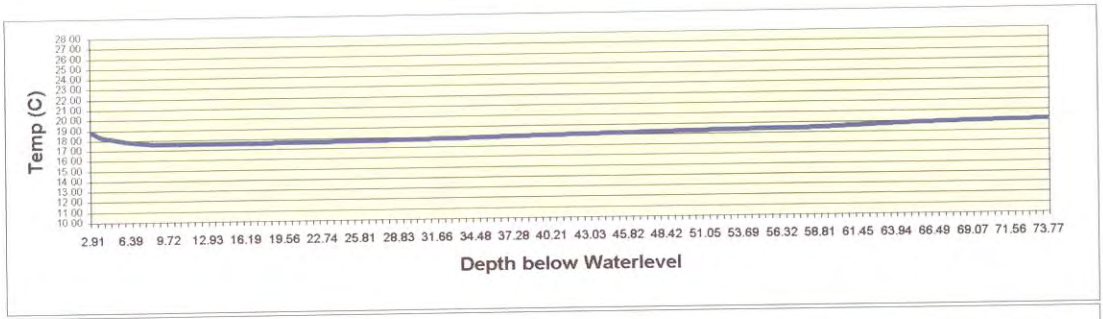
Borehole Chemical Profile Date Compiled: 7/24/02

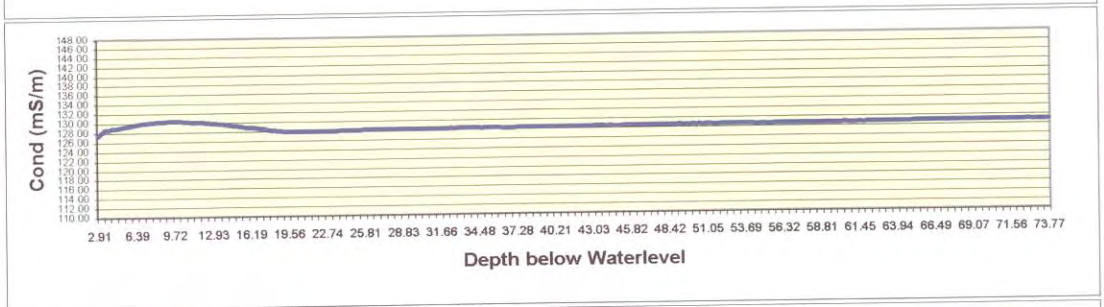
BASIC SITE INFORMATION

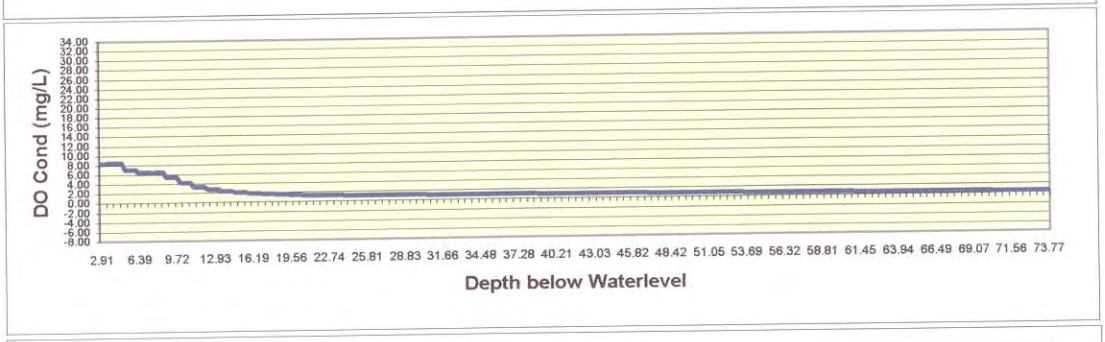
Site Identifier: 2629AC10002 Number: **SDF-2** Type: B

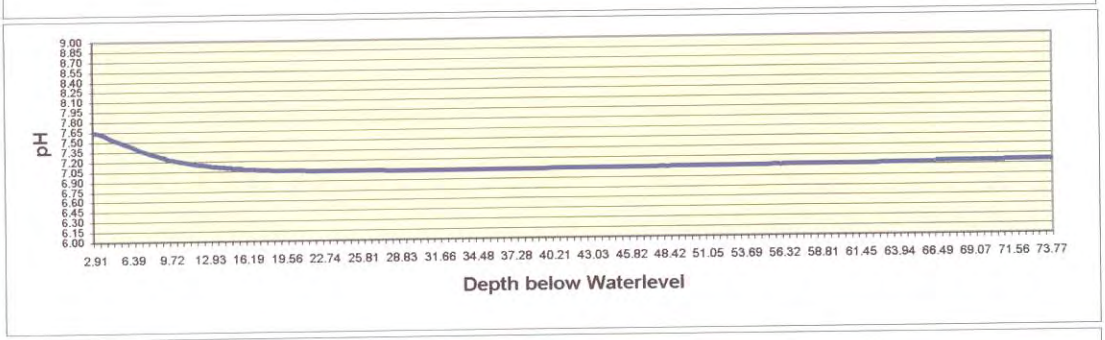
Site Name / Description: Sasol Block 8: Borehole SDF-2

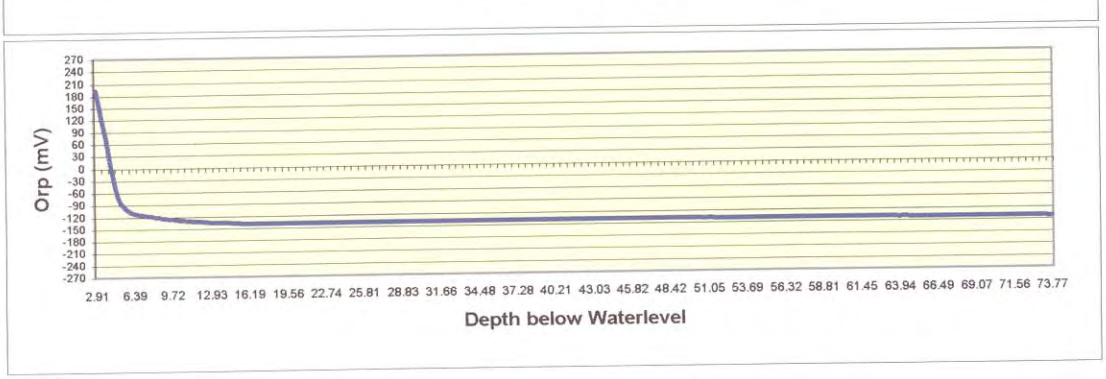
YSI 600XLM Multi-Parameter Profile











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Borehole Chemical Profile

Date Compiled: 7/24/02

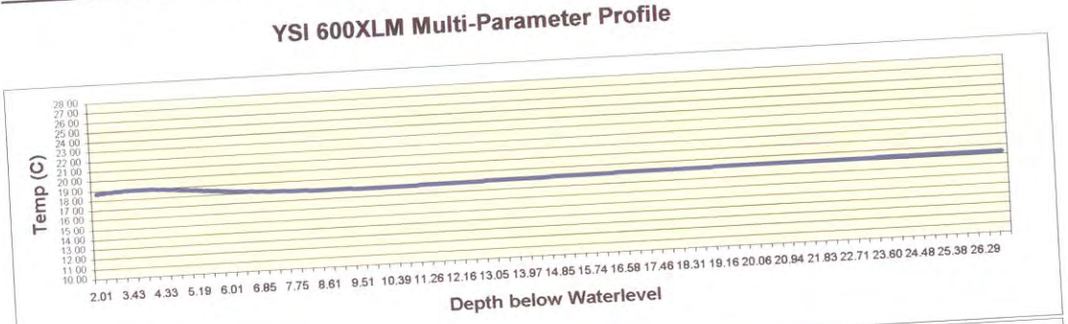
BASIC SITE INFORMATION

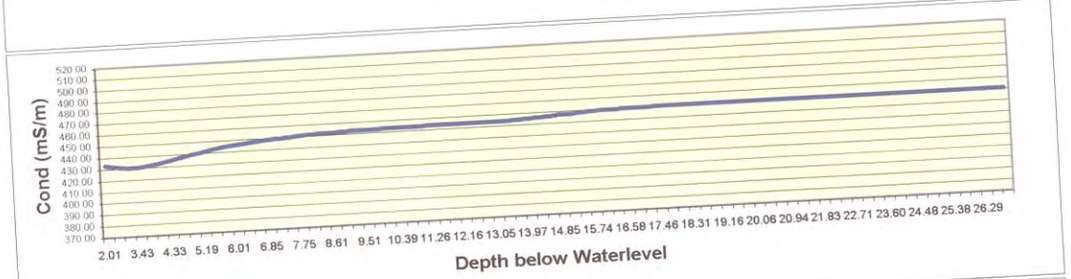
Number: **SSW-3** Type: B

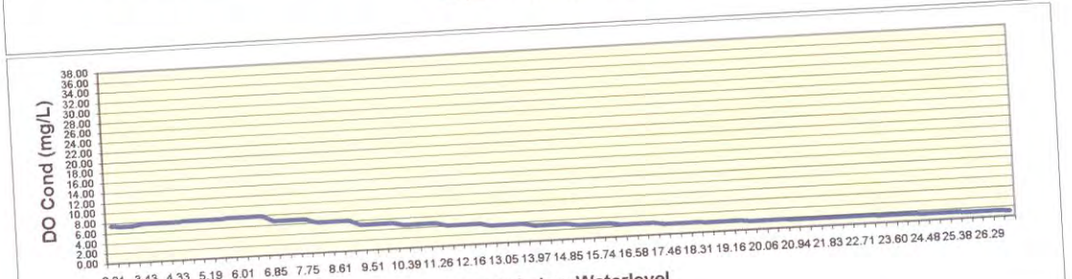
Site Identifier: 2629CA00003

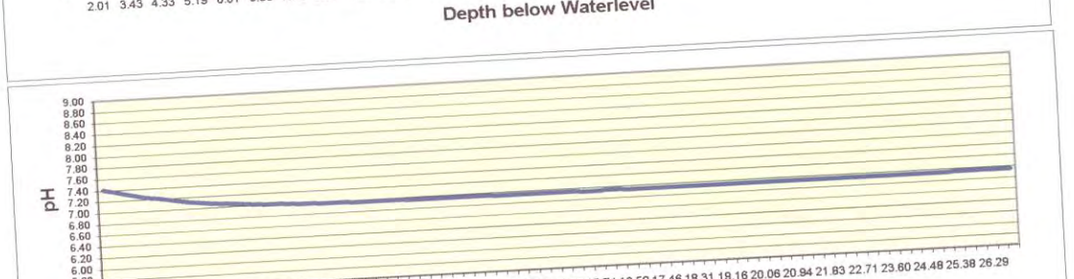
Site Name / Description: Sasol Block 8: Borehole SSW-3 Block 8

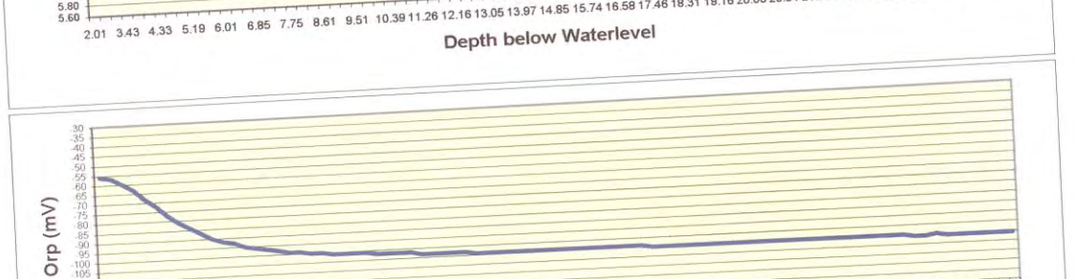
YSI 600XLM Multi-Parameter Profile











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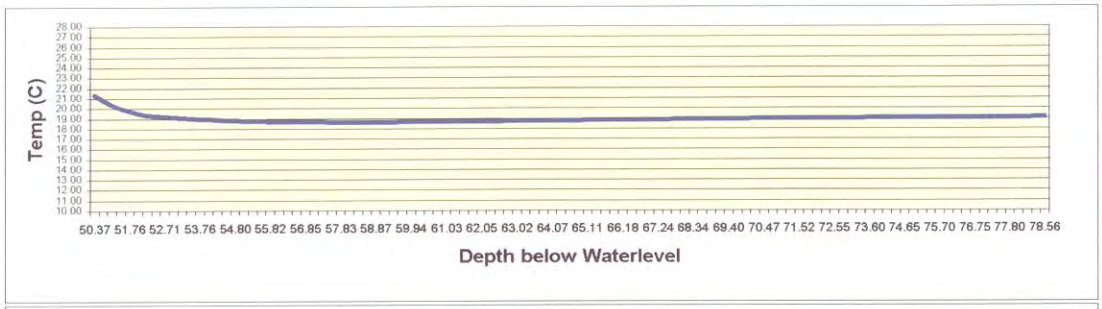
Borehole Chemical Profile Date Compiled: 7/24/02

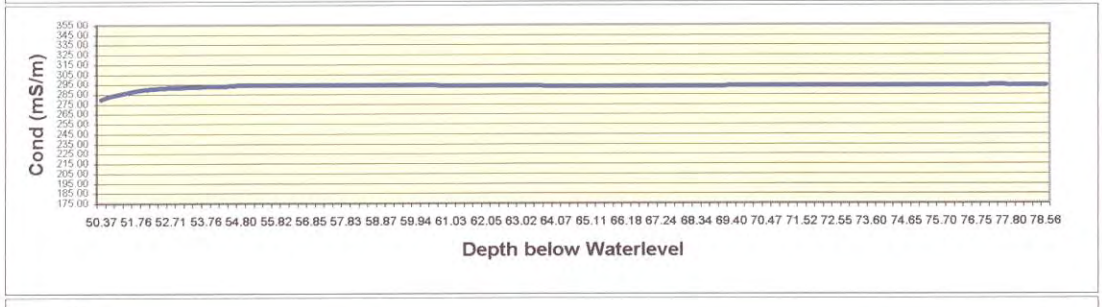
BASIC SITE INFORMATION

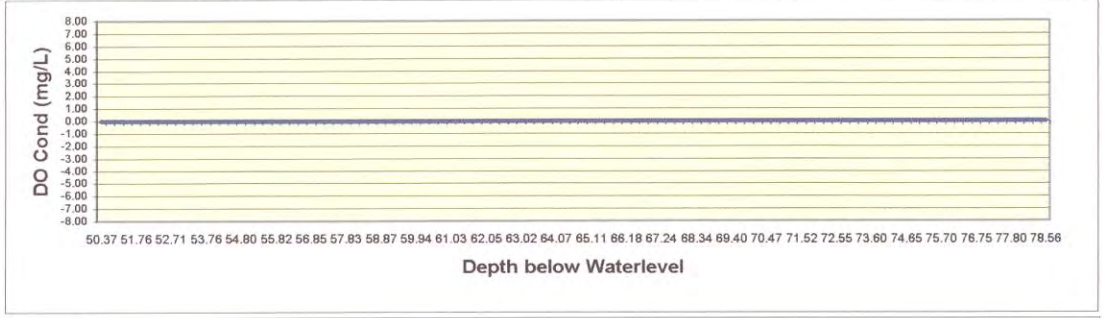
Site Identifier: 2629AC10004 Number: **SDF-4** Type: B

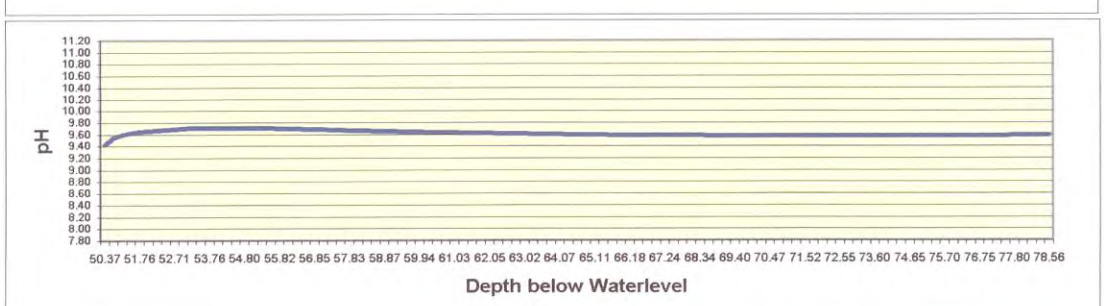
Site Name / Description: Sasol Block 8: Borehole SDF-4

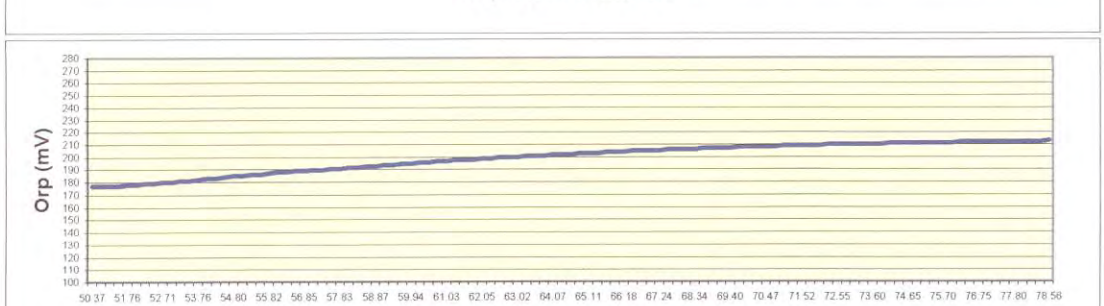
YSI 600XLM Multi-Parameter Profile











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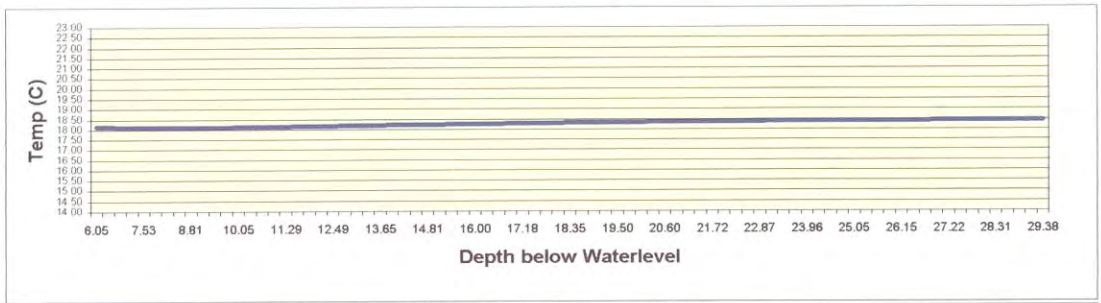
Borehole Chemical Profile Date Compiled: 7/24/02

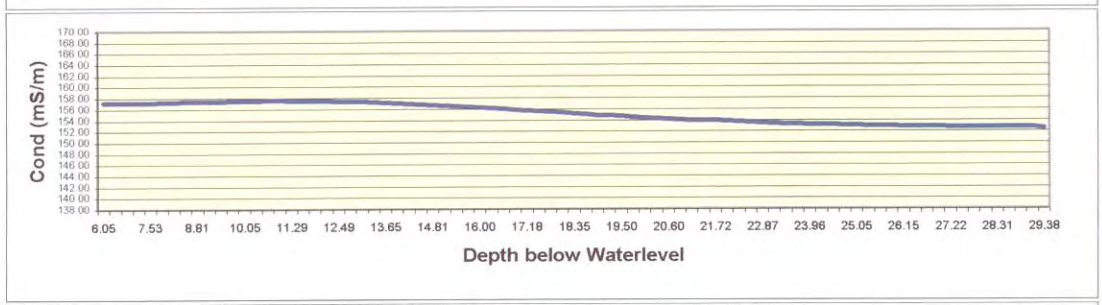
BASIC SITE INFORMATION

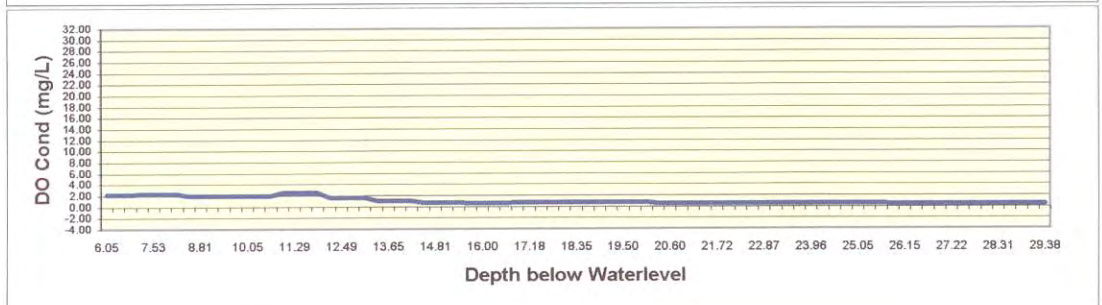
Site Identifier: 2629AC00005 Number: **SSW-5** Type: B

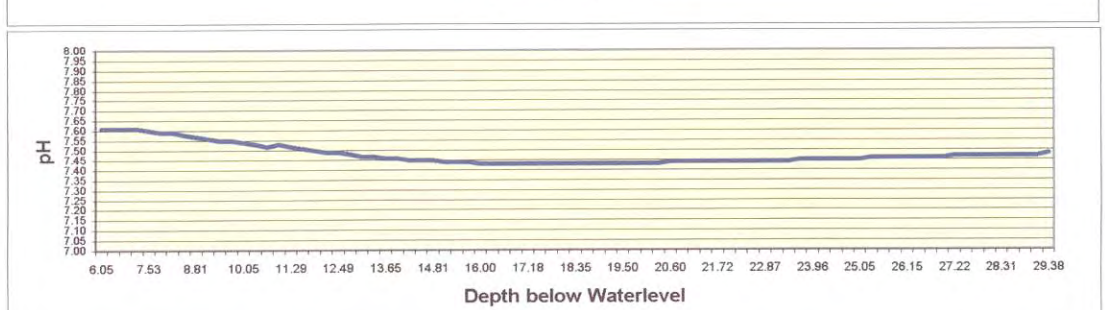
Site Name / Description: Sasol Block 8: Borehole SSW-5 Block 8

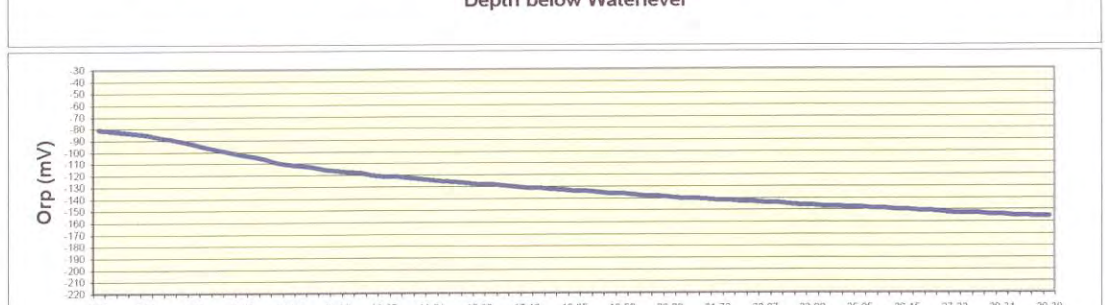
YSI 600XLM Multi-Parameter Profile











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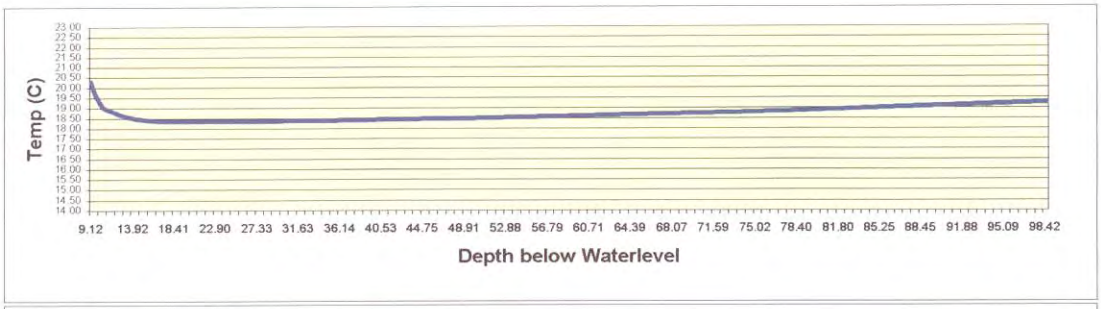
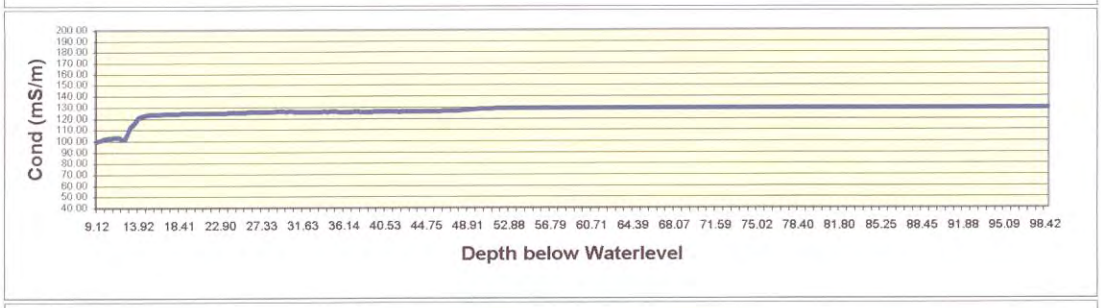
BASIC SITE INFORMATION

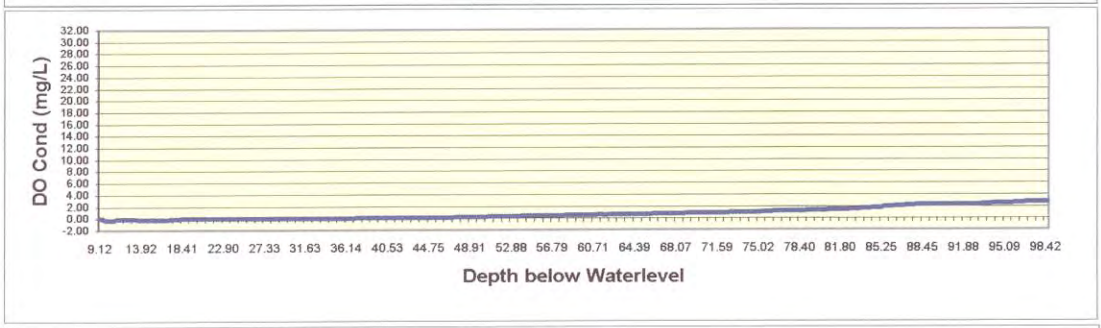
Site Identifier: 2629AC10005 Number: **SDF-5** Type: B

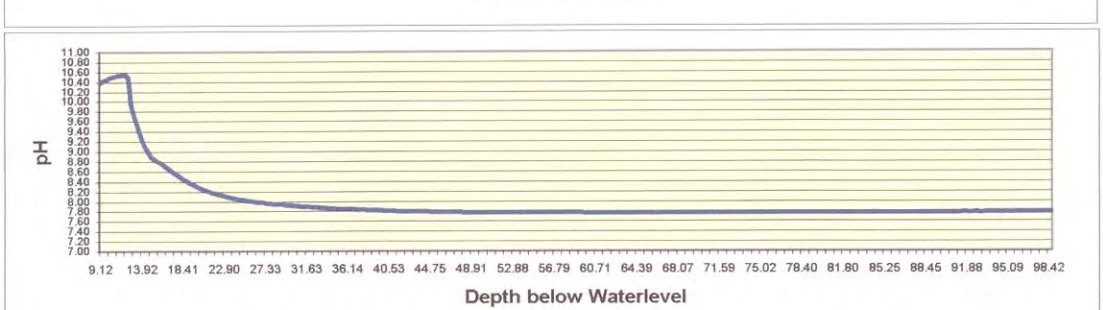
Site Name / Description: Sasol Block 8: Borehole SDF-5

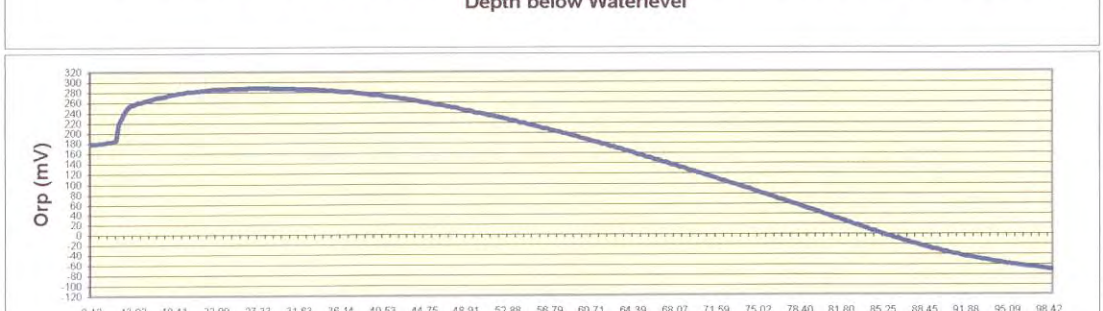
YSI 600XLM Multi-Parameter Profile











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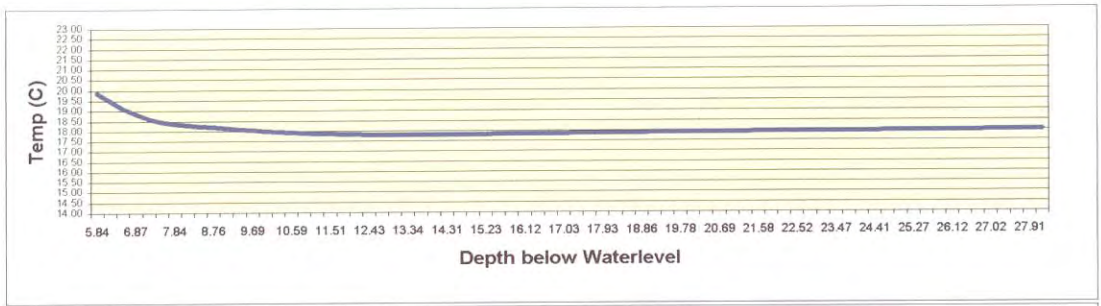
Borehole Chemical Profile Date Compiled: 7/24/02

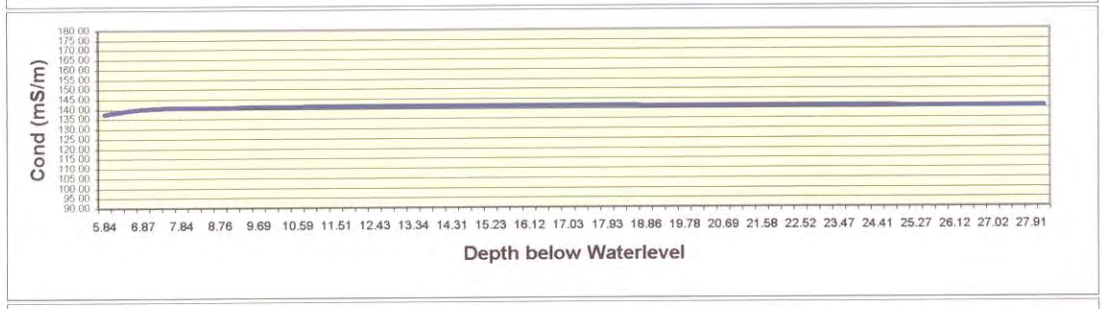
BASIC SITE INFORMATION

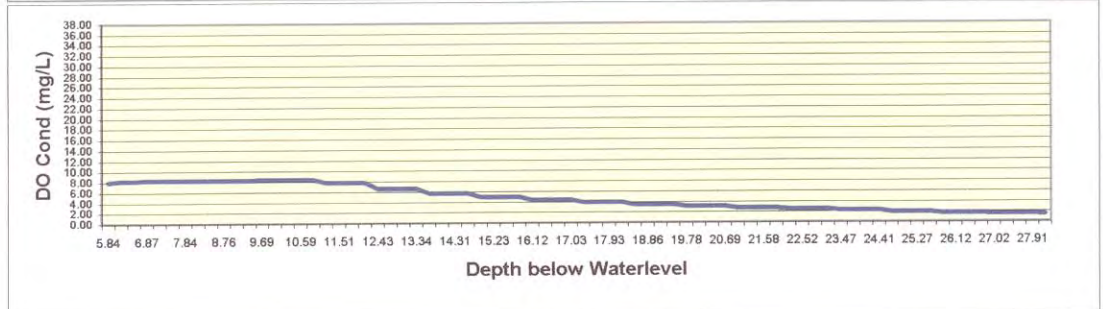
Site Identifier: 2629AC00006 Number: **SSW-6** Type: B

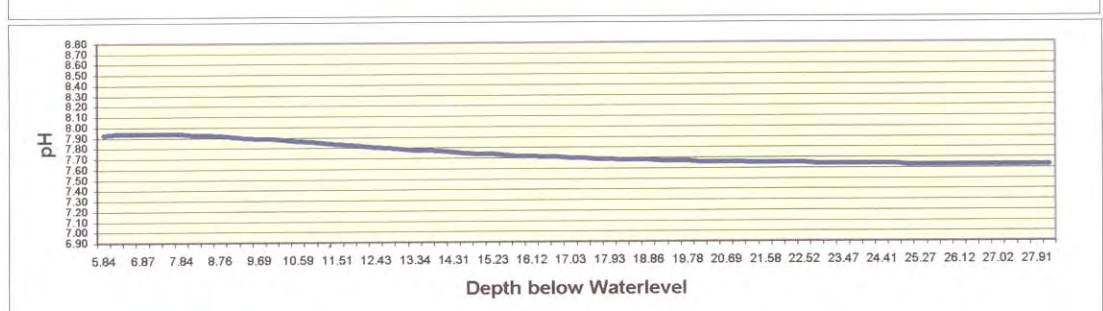
Site Name / Description: Sasol Block 8: Borehole SSW-6 Block 8

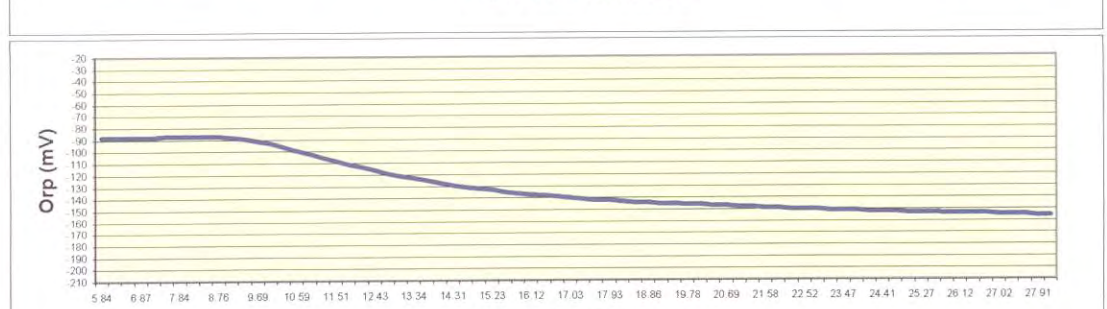
YSI 600XLM Multi-Parameter Profile











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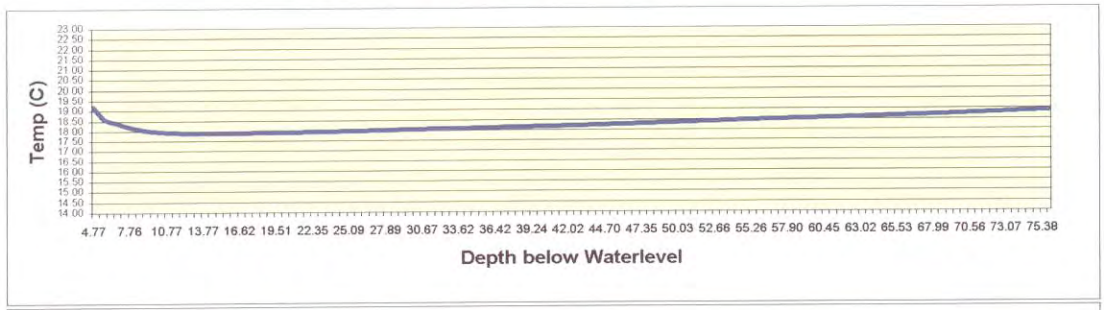
Borehole Chemical Profile Date Compiled: 7/24/02

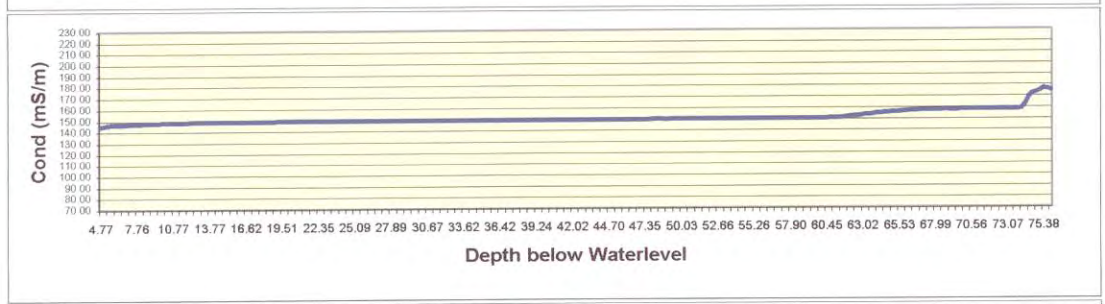
BASIC SITE INFORMATION

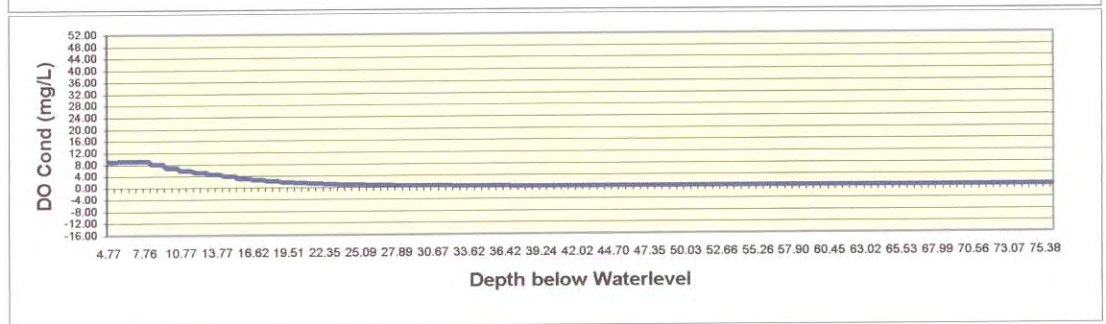
Site Identifier: 2629AC10006 Number: **SDF-6** Type: B

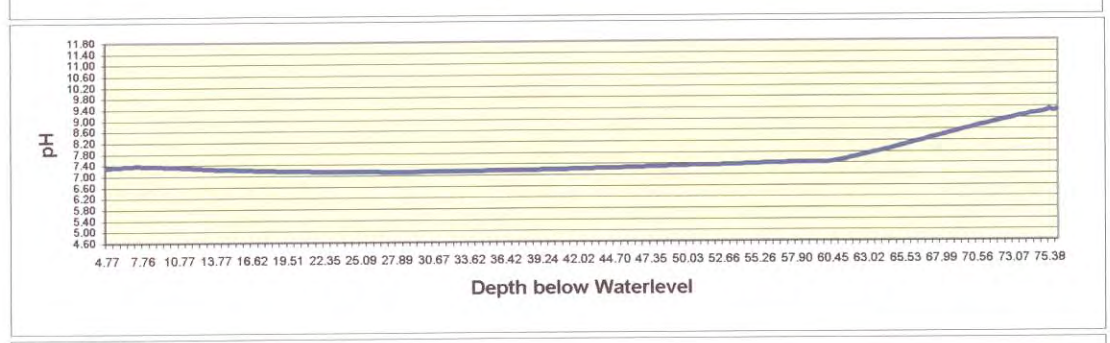
Site Name / Description: Sasol Block 8: Borehole SDF-6

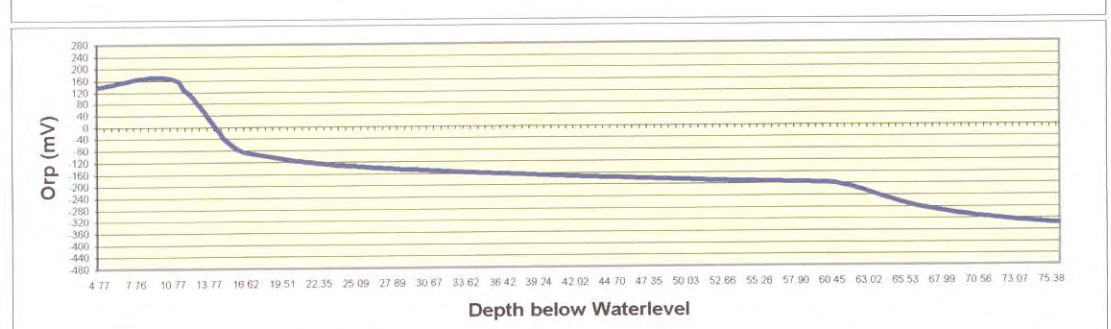
YSI 600XLM Multi-Parameter Profile











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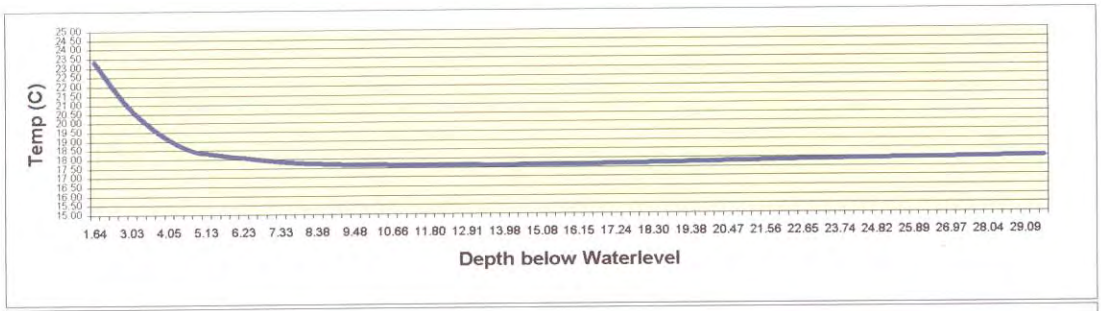
Borehole Chemical Profile Date Compiled: 7/24/02

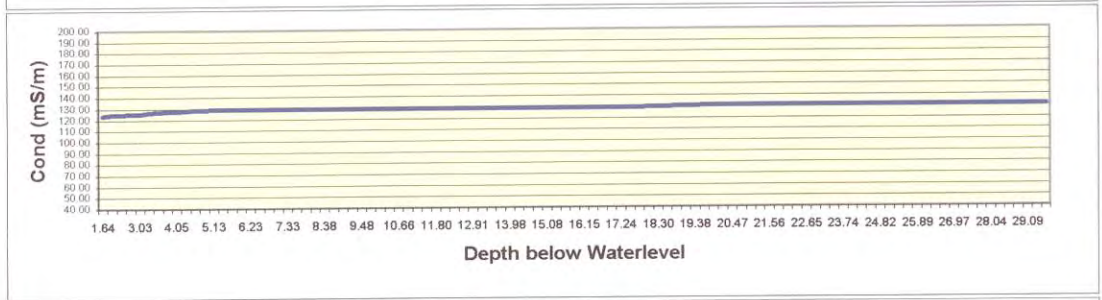
BASIC SITE INFORMATION

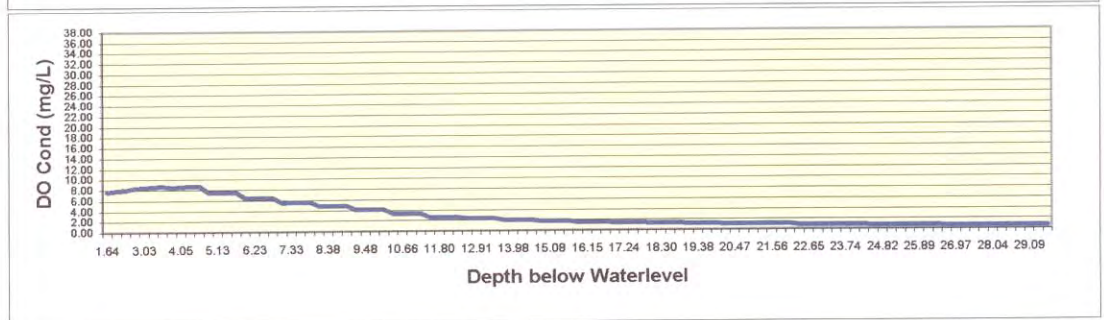
Site Identifier: 2629AC00007 Number: **SSW-7** Type: B

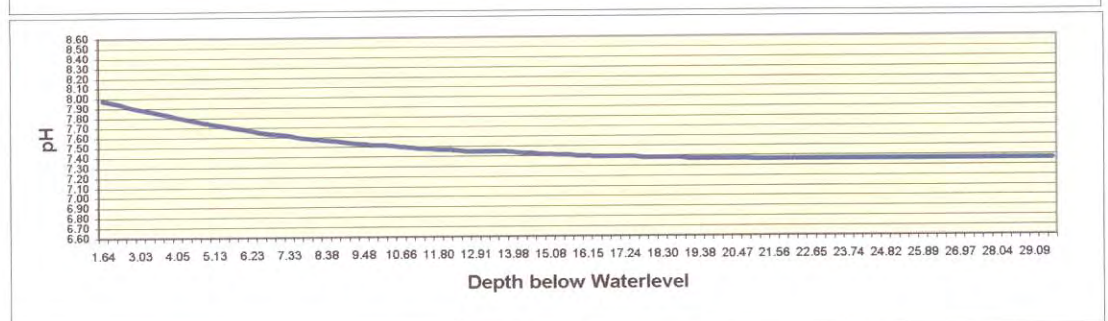
Site Name / Description: Sasol Block 8: Borehole SSW-7 Block 8

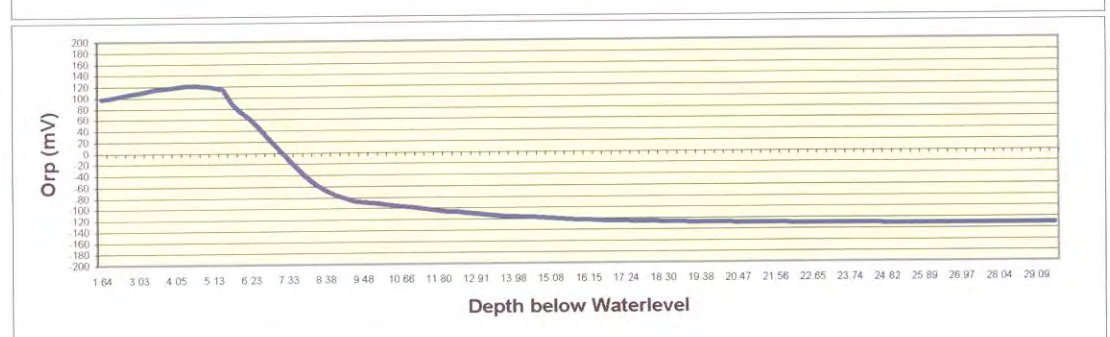
YSI 600XLM Multi-Parameter Profile











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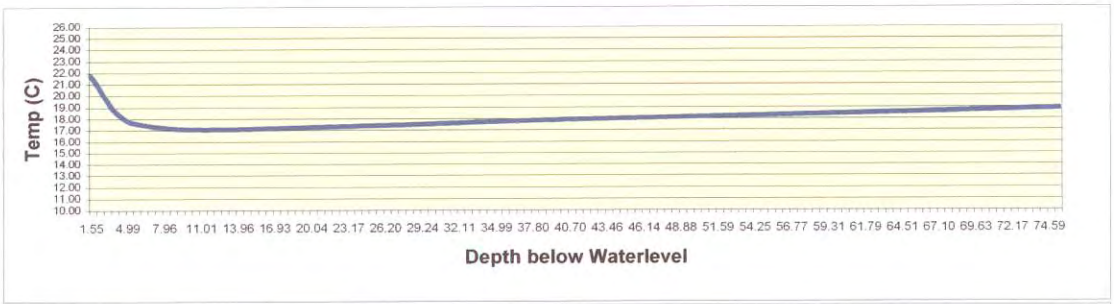
Borehole Chemical Profile Date Compiled: 7/25/2002

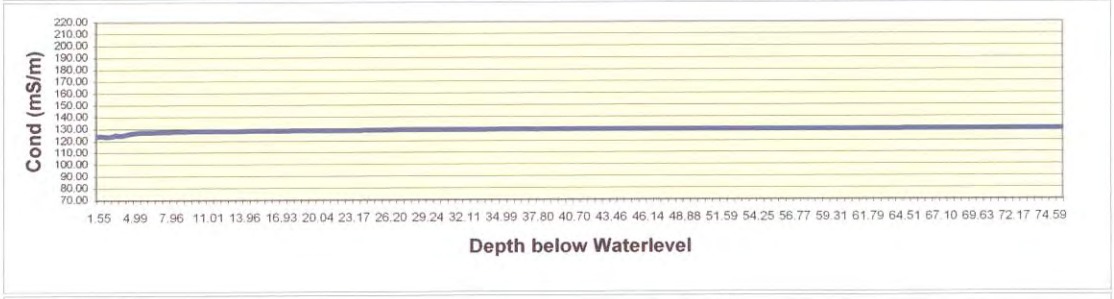
BASIC SITE INFORMATION

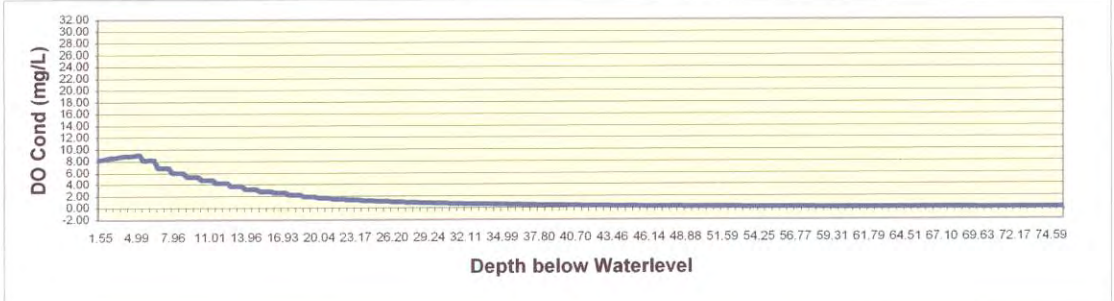
Site Identifier: 2629AC10007 Number: **SDF-7** Type: B

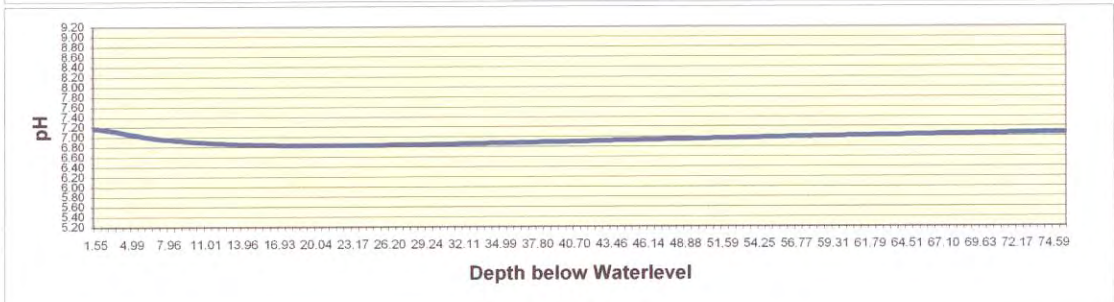
Site Name / Description: Sasol Block 8: Borehole SDF-7

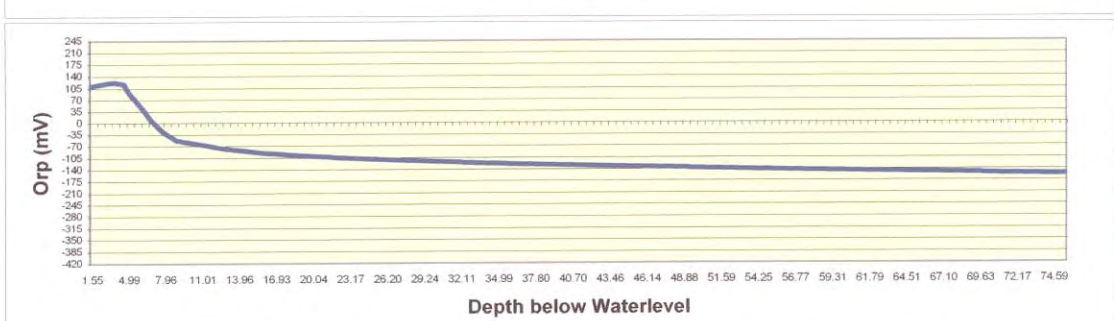
YSI 600XLM Multi-Parameter Profile











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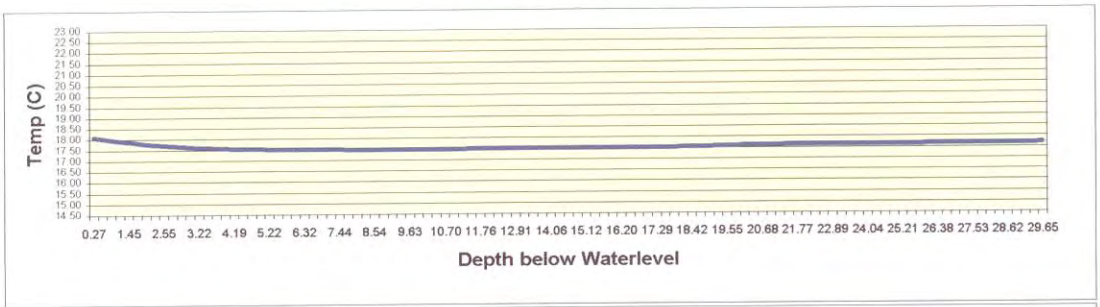
Borehole Chemical Profile Date Compiled: 7/24/02

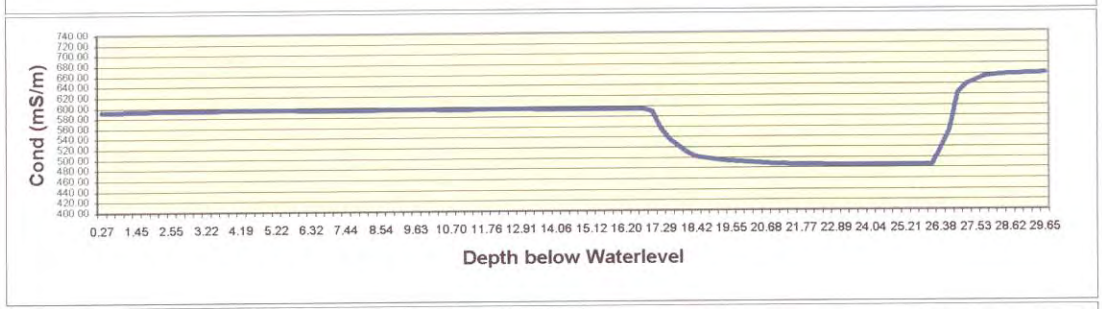
BASIC SITE INFORMATION

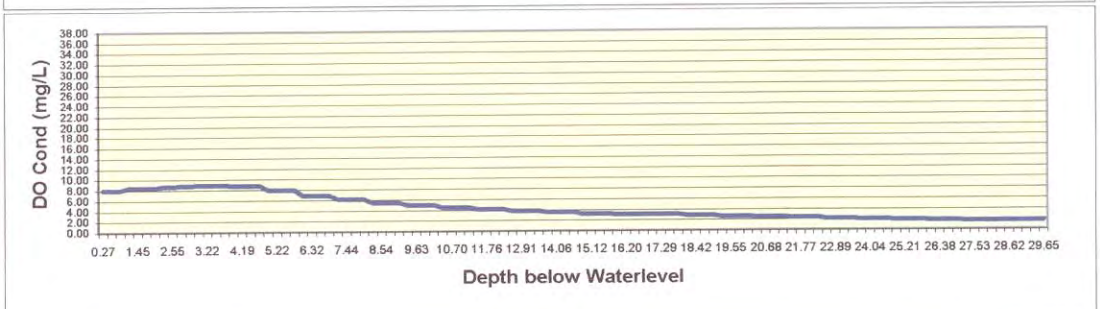
Site Identifier: 2629CA00008 Number: **SSW-8** Type: B

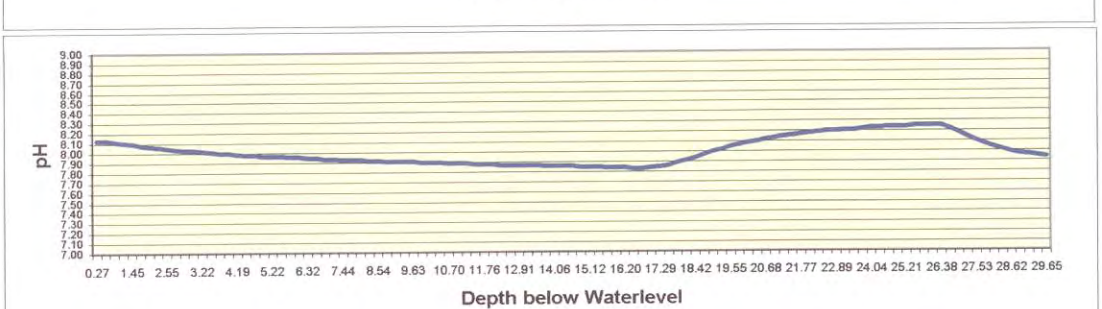
Site Name / Description: Sasol Block 8: Borehole SSW-8 Block 8

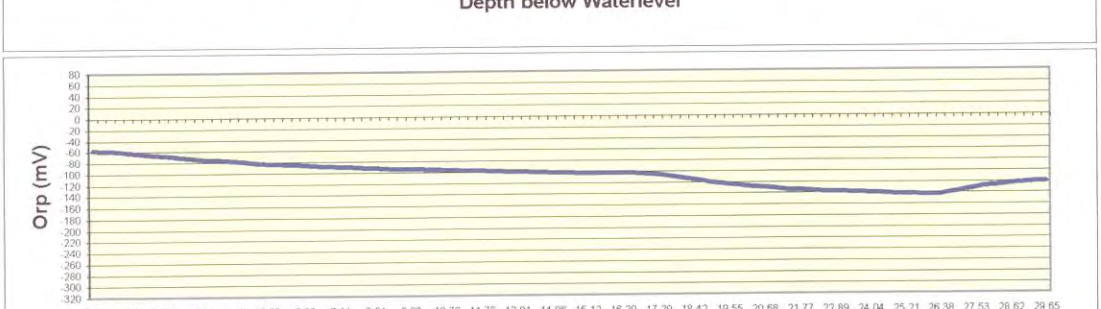
YSI 600XLM Multi-Parameter Profile











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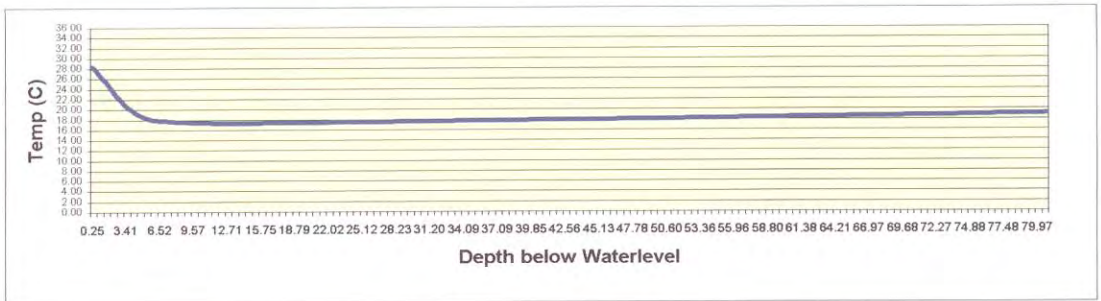
Borehole Chemical Profile Date Compiled: 7/24/02

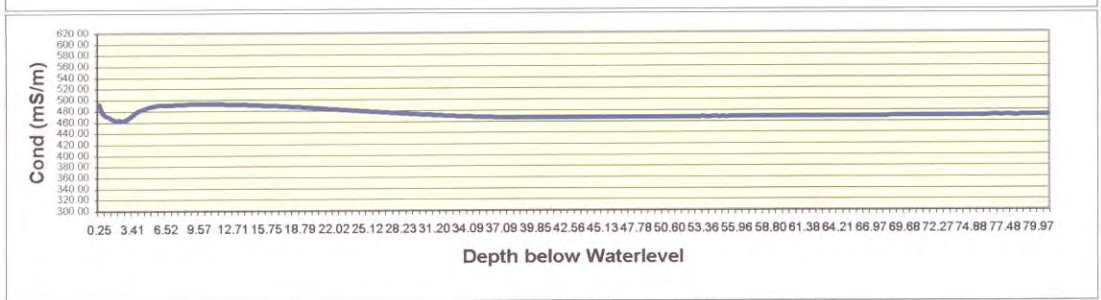
BASIC SITE INFORMATION

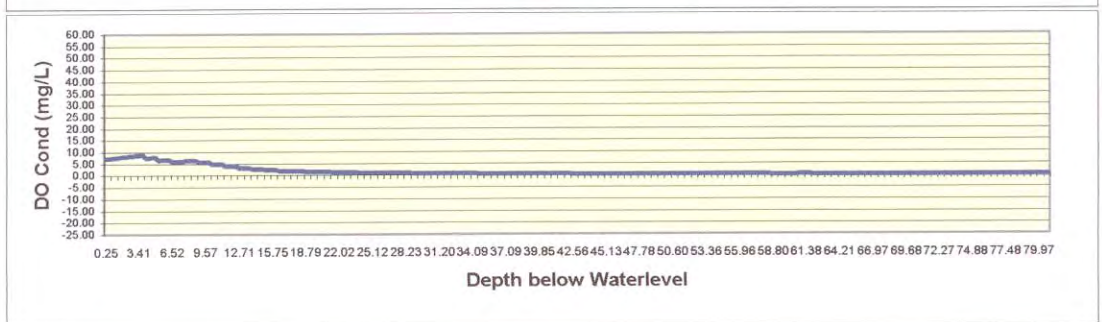
Site Identifier: 2629CA10008 Number: **SDF-8** Type: B

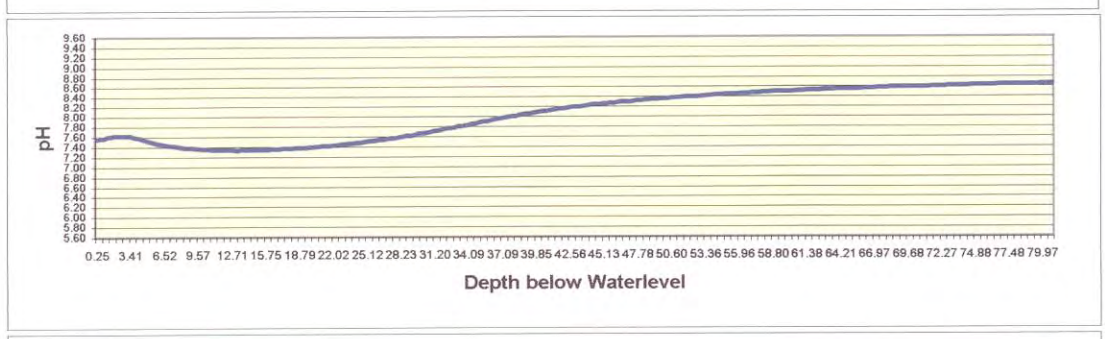
Site Name / Description: Sasol Block 8: Borehole SDF-8

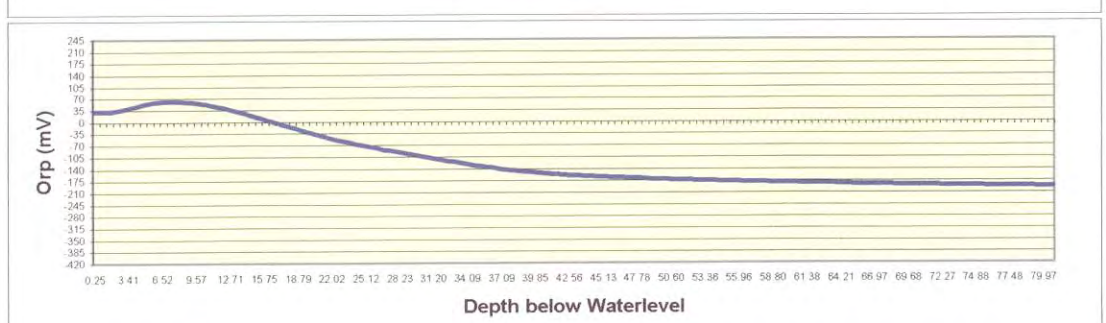
YSI 600XLM Multi-Parameter Profile











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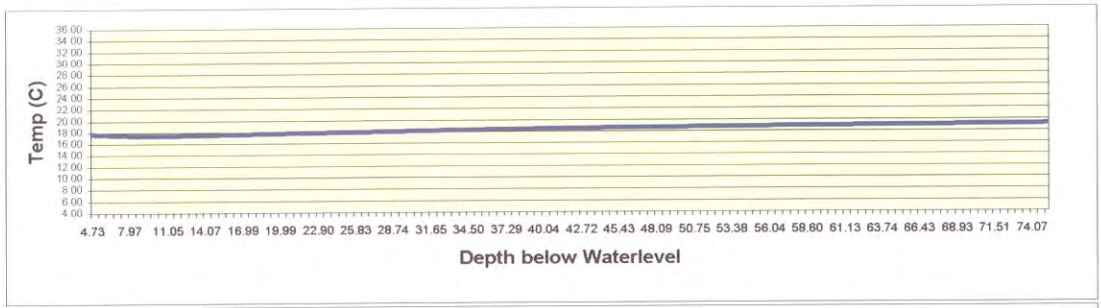
Borehole Chemical Profile Date Compiled: 7/24/02

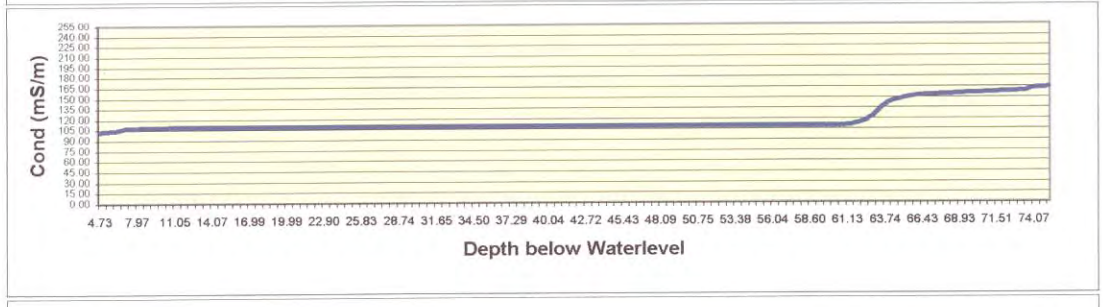
BASIC SITE INFORMATION

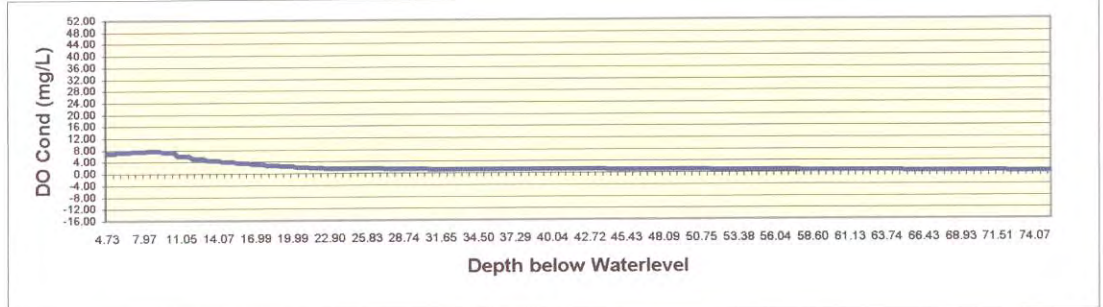
Site Identifier: 2629CA10009 Number: **SDF-9** Type: B

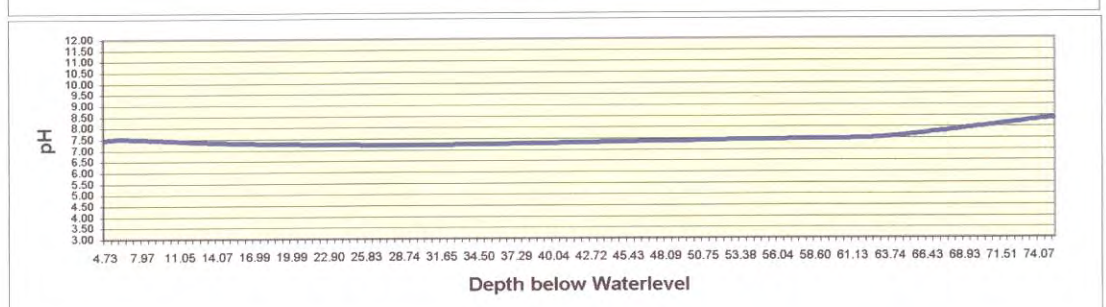
Site Name / Description: Sasol Block 8: Borehole SDF-9

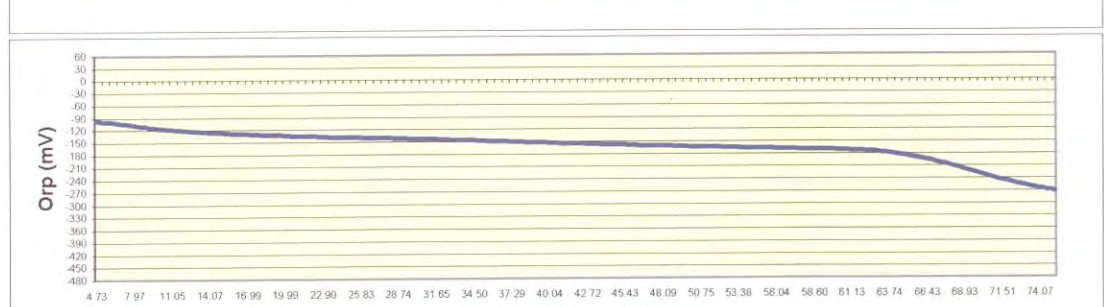
YSI 600XLM Multi-Parameter Profile











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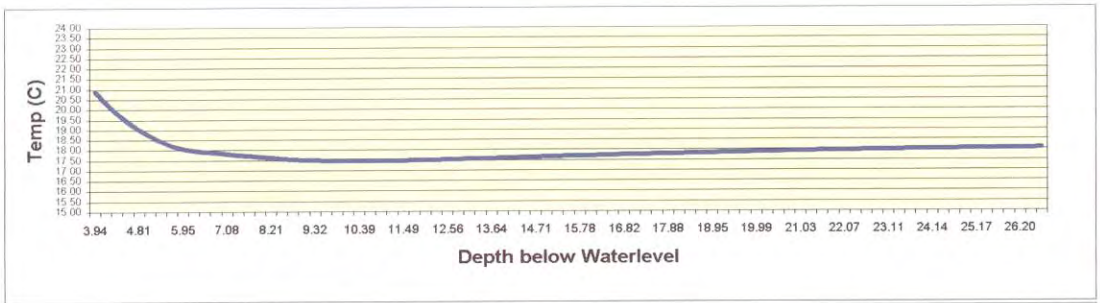
Borehole Chemical Profile Date Compiled: 7/24/02

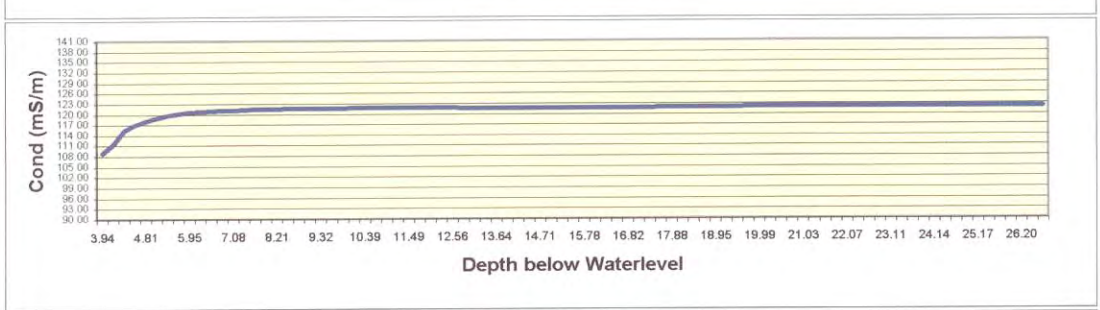
BASIC SITE INFORMATION

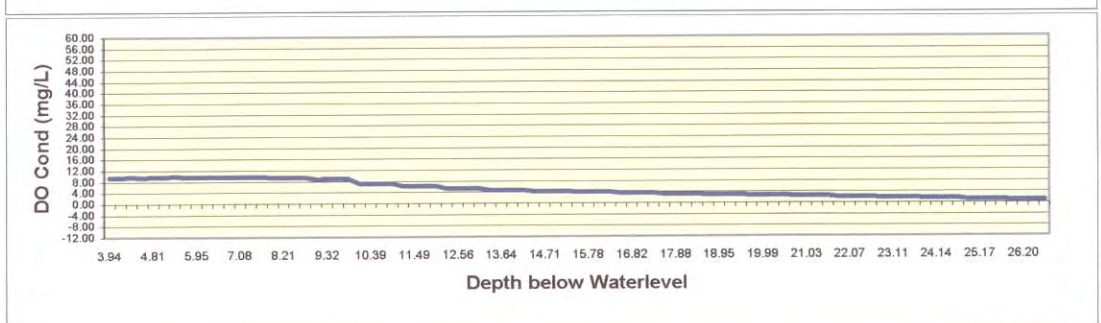
Site Identifier: 2629AC00010 Number: **SSW-10** Type: B

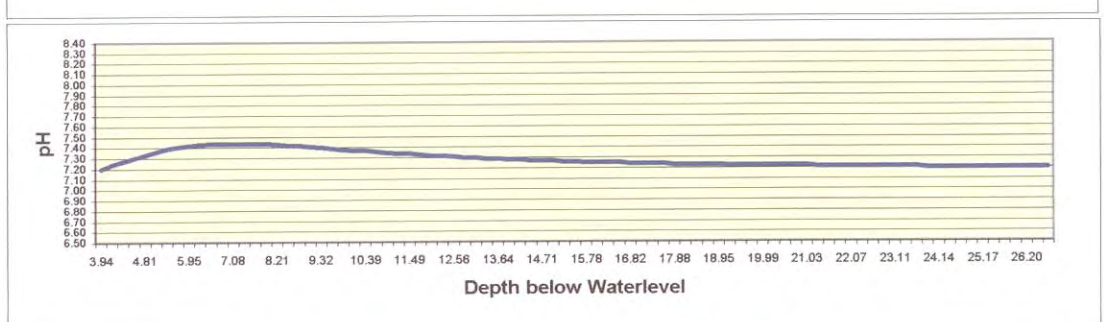
Site Name / Description: Sasol Block 8: Borehole SSW-10 Block 8

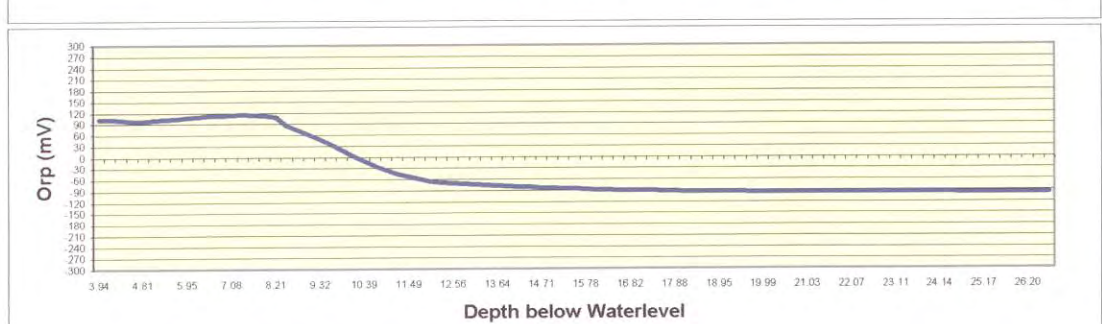
YSI 600XLM Multi-Parameter Profile











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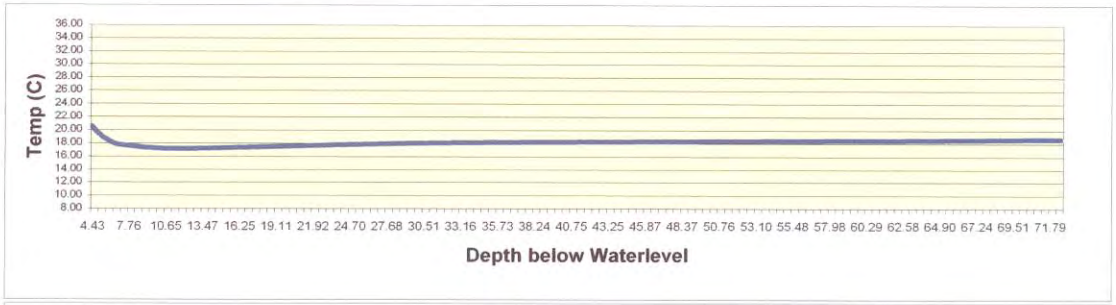
Borehole Chemical Profile Date Compiled: 7/25/2002

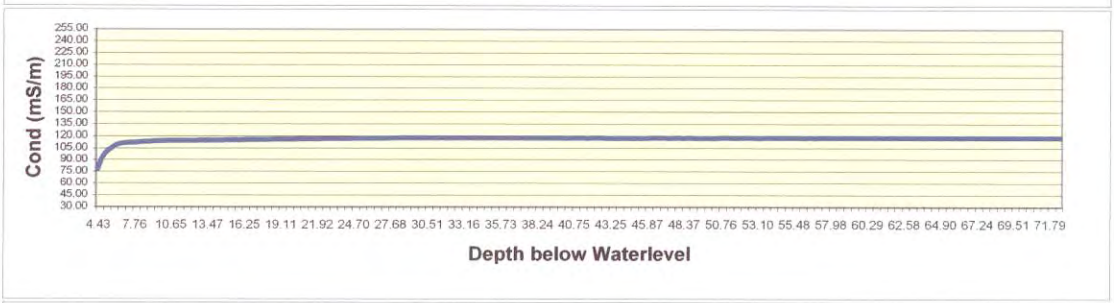
BASIC SITE INFORMATION

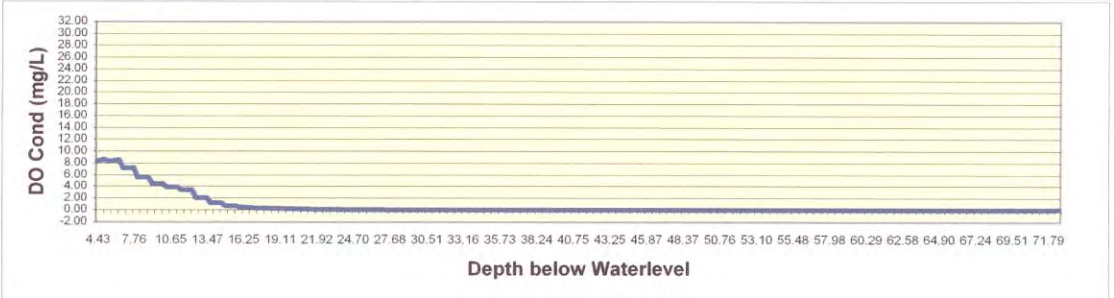
Site Identifier: 2629AC10010 Number: **SDF-10** Type: B

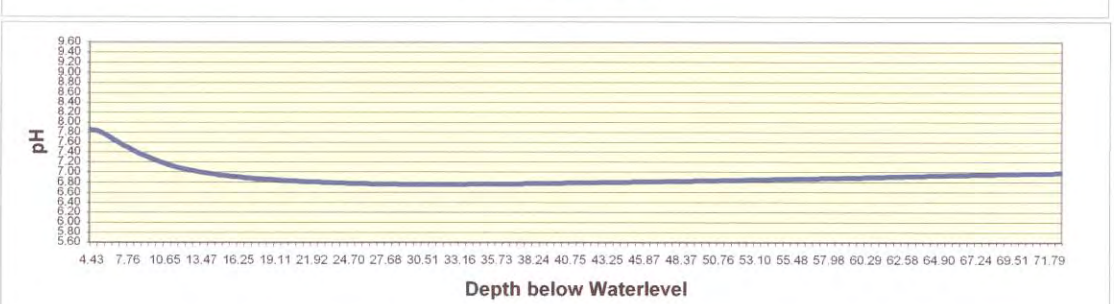
Site Name / Description: Sasol Block 8: Borehole SDF-10

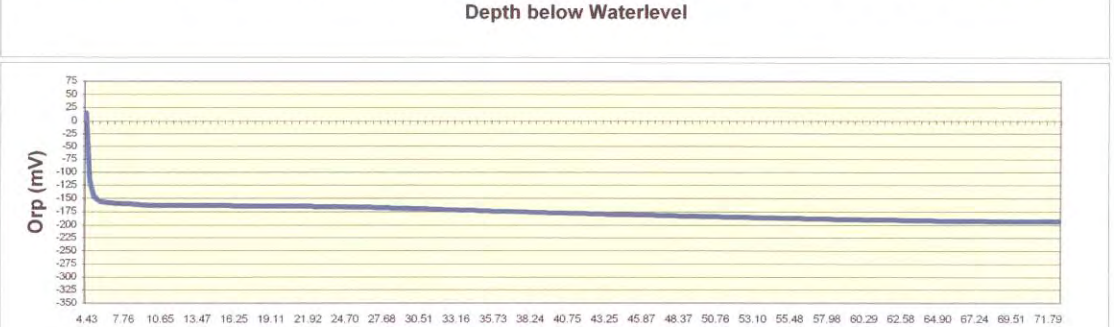
YSI 600XLM Multi-Parameter Profile











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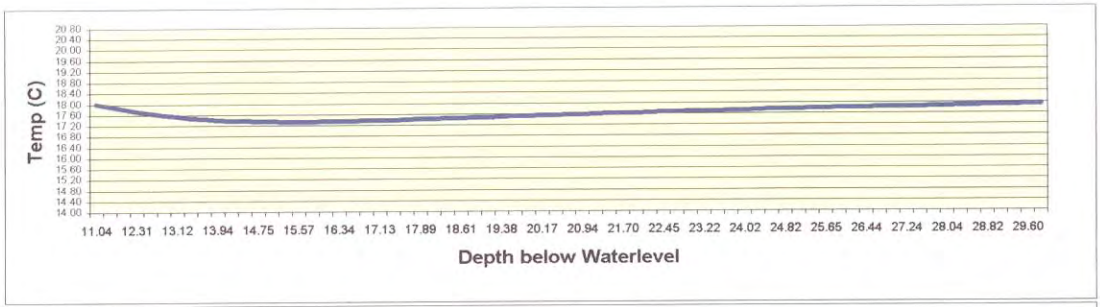
Borehole Chemical Profile Date Compiled: 7/24/02

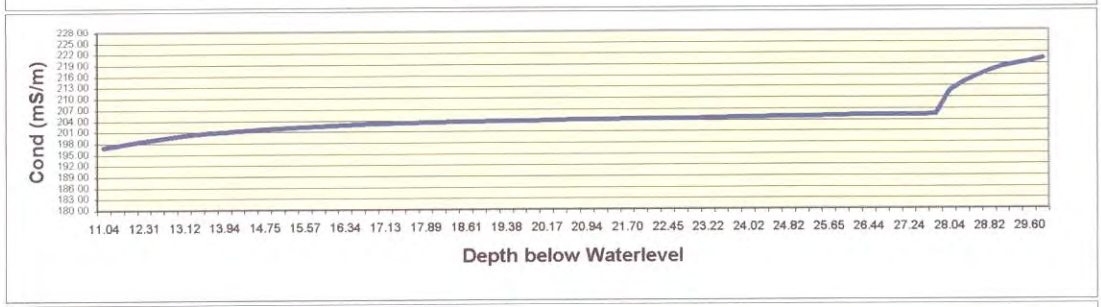
BASIC SITE INFORMATION

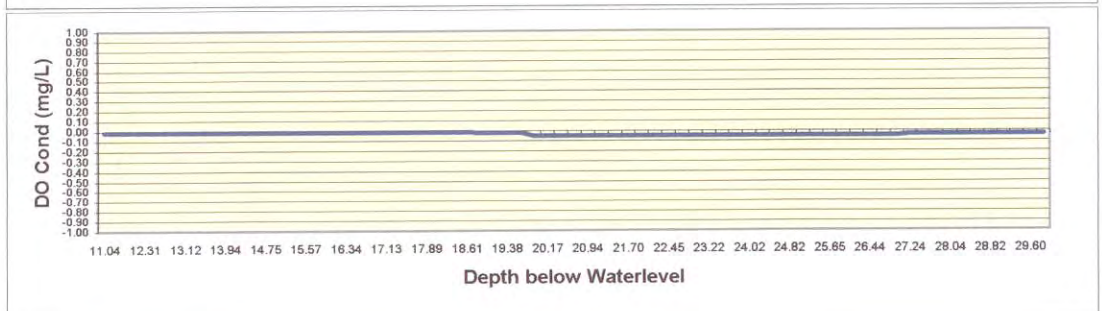
Site Identifier: 2629AC00011 Number: **SSW-11** Type: B

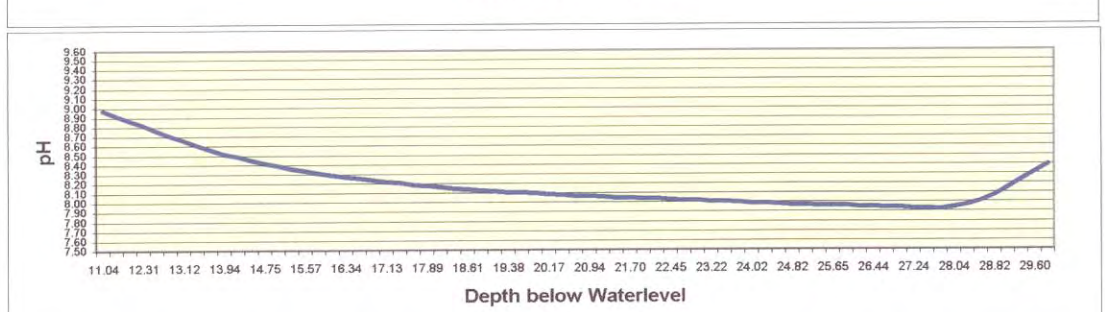
Site Name / Description: Sasol Block 8: Borehole SSW-11 Block 8

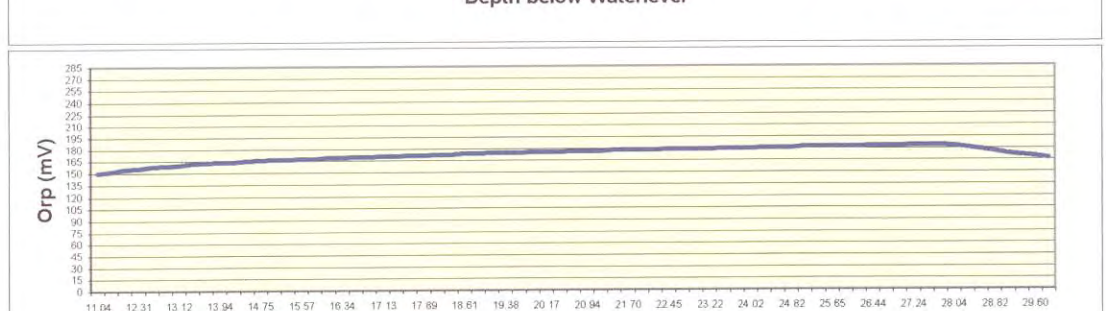
YSI 600XLM Multi-Parameter Profile











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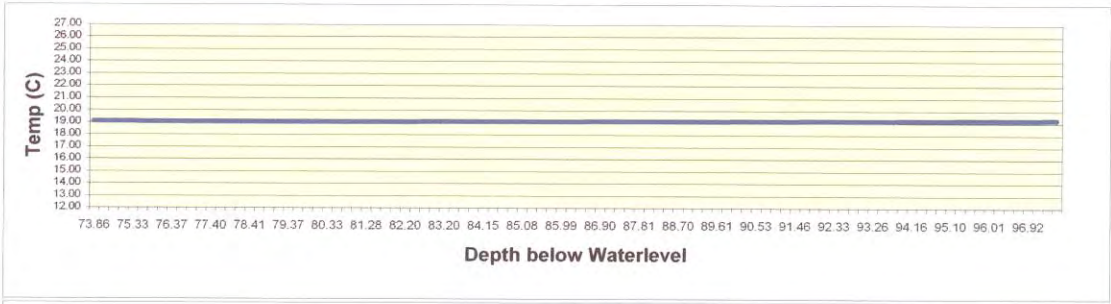
Borehole Chemical Profile Date Compiled: 7/25/2002

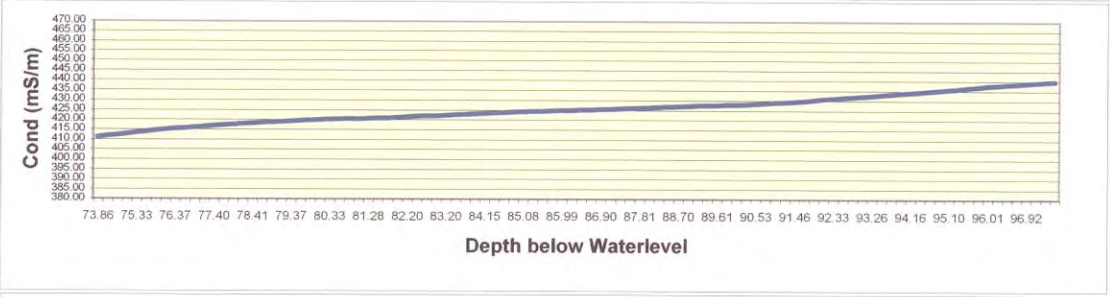
BASIC SITE INFORMATION

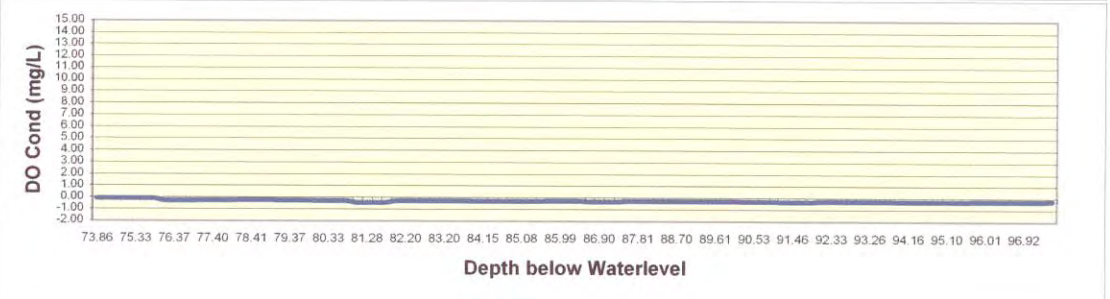
Site Identifier: 2629AC10011 Number: **SDF-11** Type: B

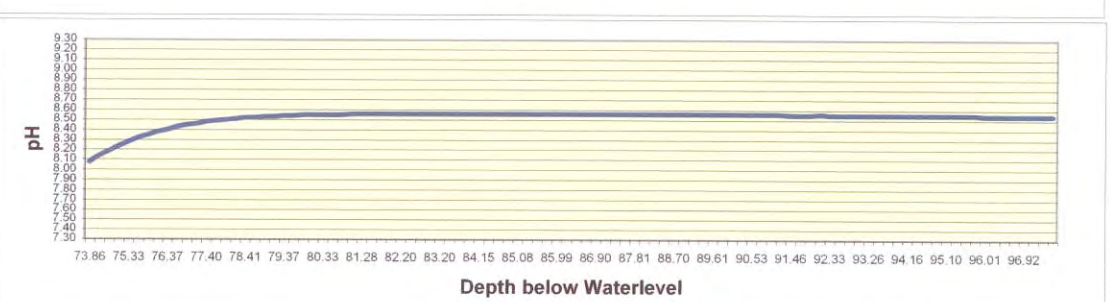
Site Name / Description: Sasol Block 8: Borehole SDF-11

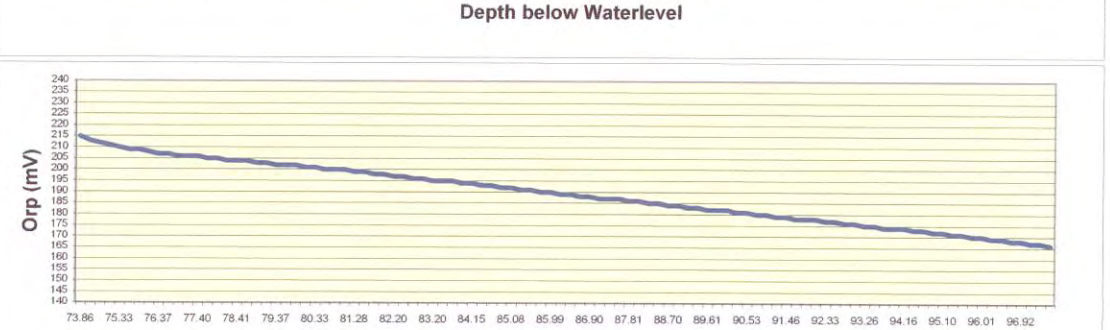
YSI 600XLM Multi-Parameter Profile











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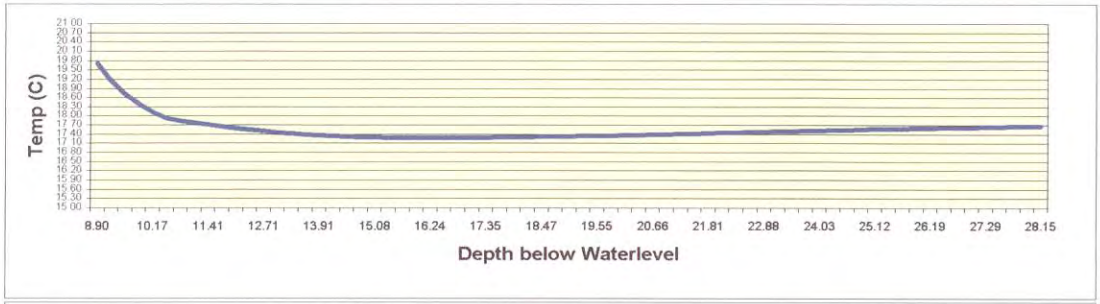
Borehole Chemical Profile Date Compiled: 7/24/02

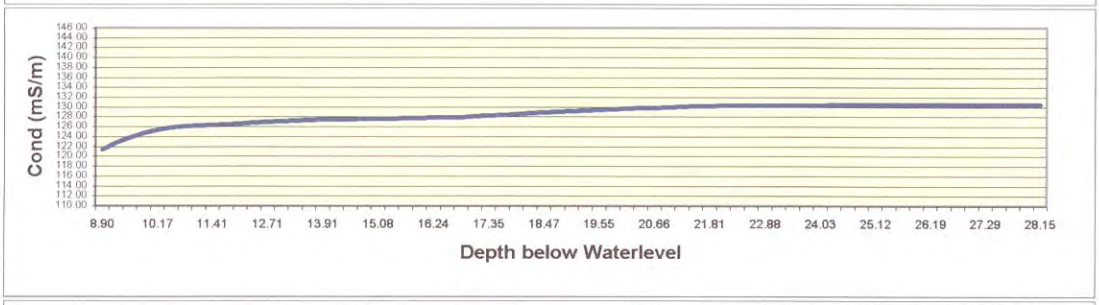
BASIC SITE INFORMATION

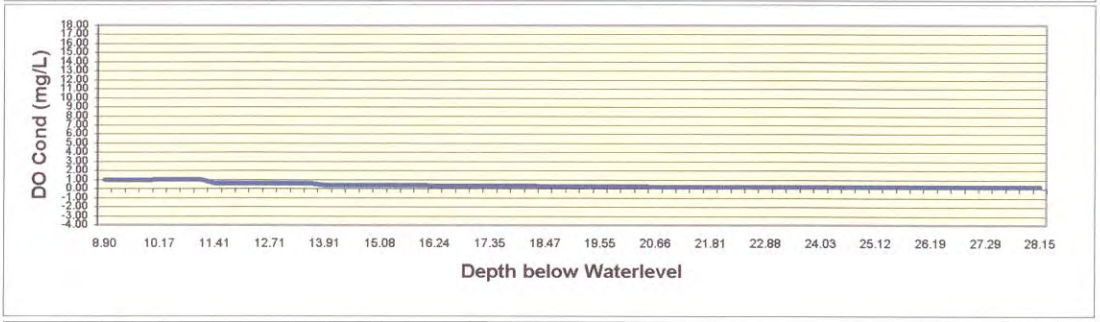
Site Identifier: 2629AC00012 Number: **SSW-12** Type: B

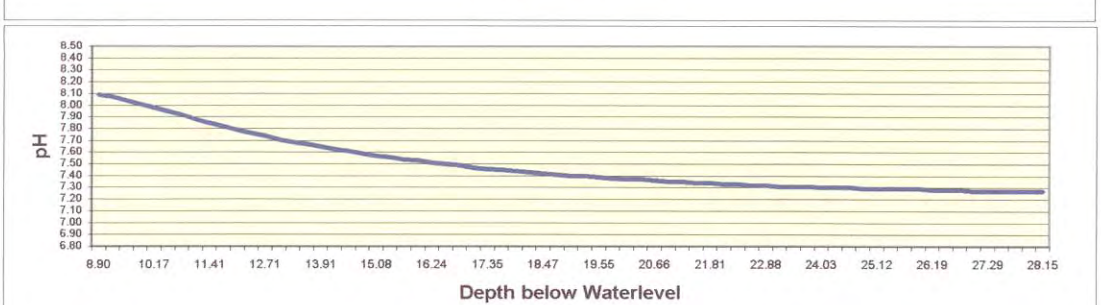
Site Name / Description: Sasol Block 8: Borehole SSW-12 Block 8

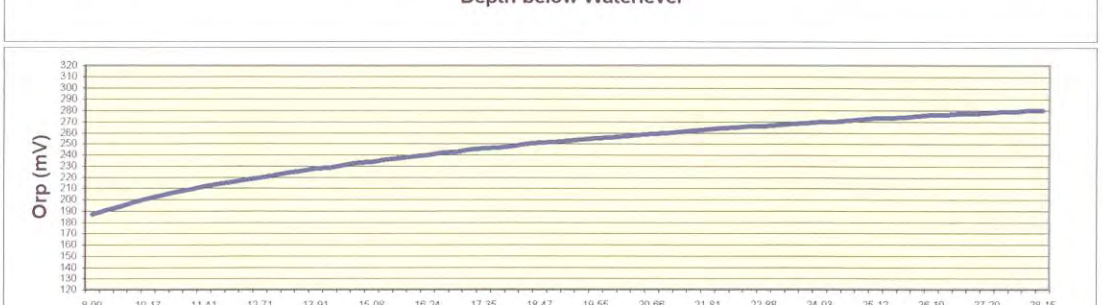
YSI 600XLM Multi-Parameter Profile











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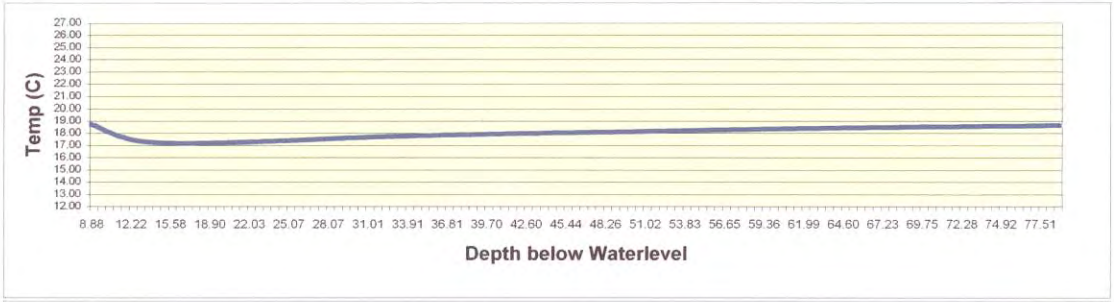
Borehole Chemical Profile Date Compiled: 7/25/2002

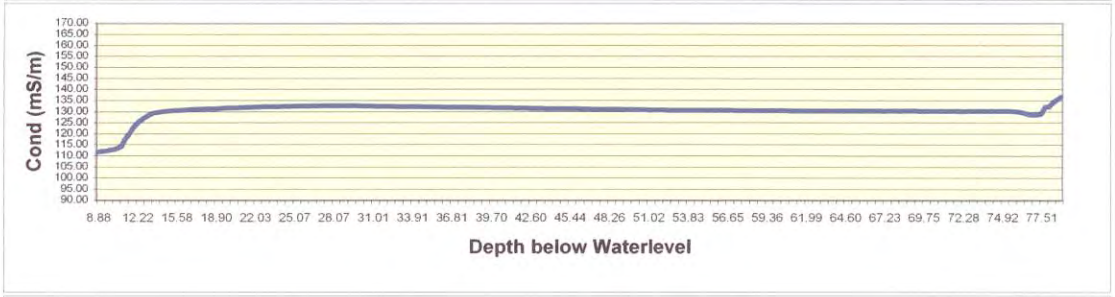
BASIC SITE INFORMATION

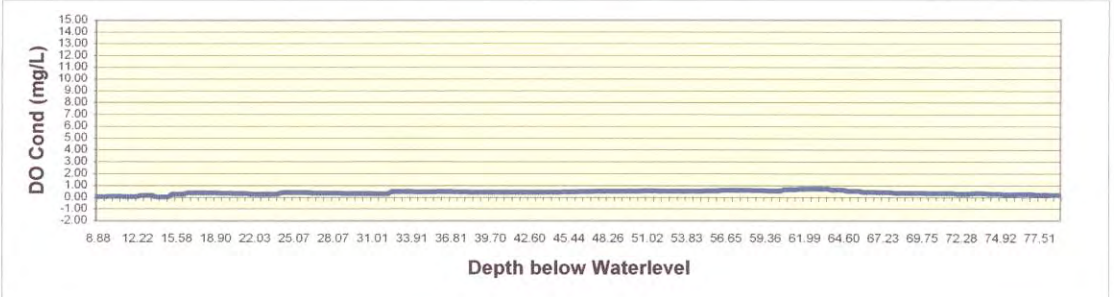
Site Identifier: 2629AC10012 Number: **SDF-12** Type: B

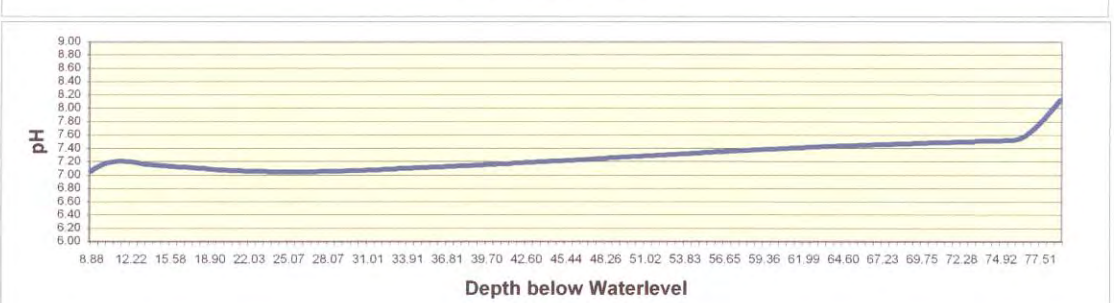
Site Name / Description: Sasol Block 8: Borehole SDF-12

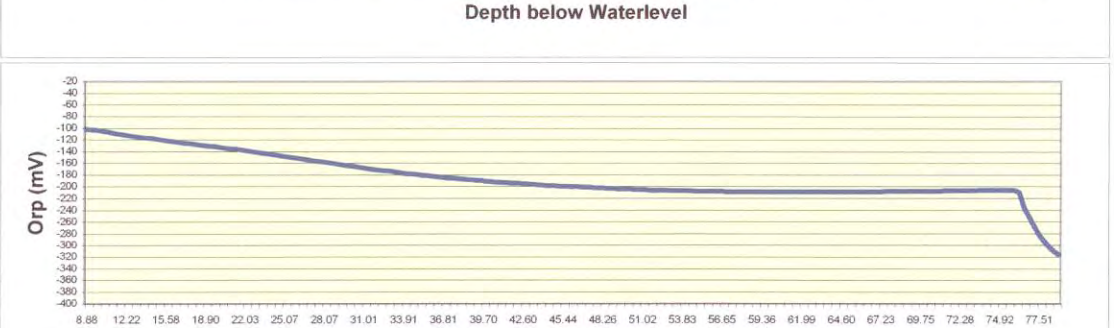
YSI 600XLM Multi-Parameter Profile











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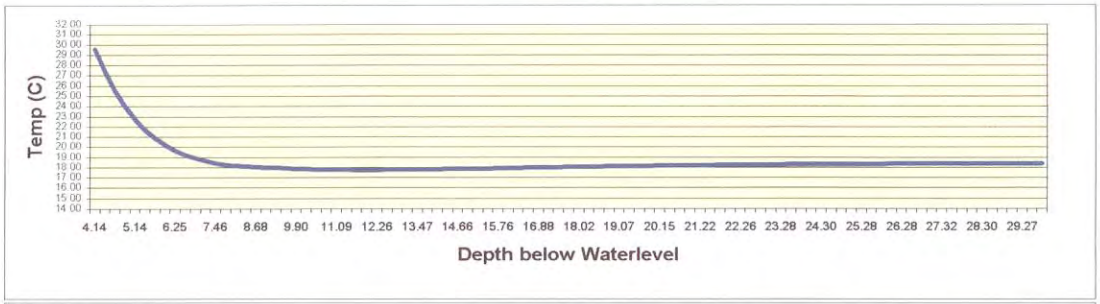
Borehole Chemical Profile Date Compiled: 7/24/02

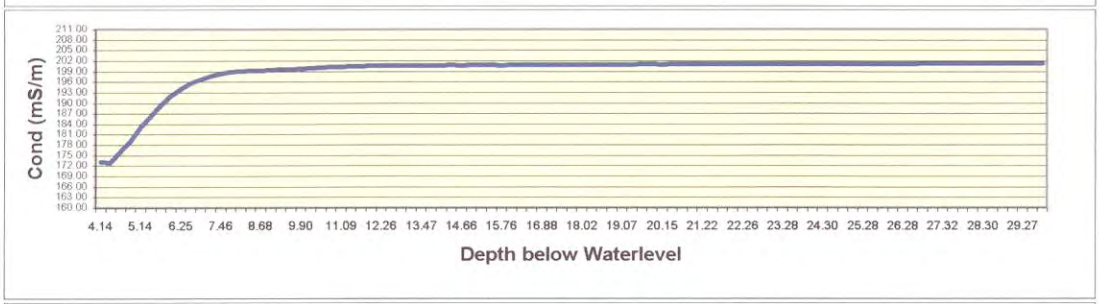
BASIC SITE INFORMATION

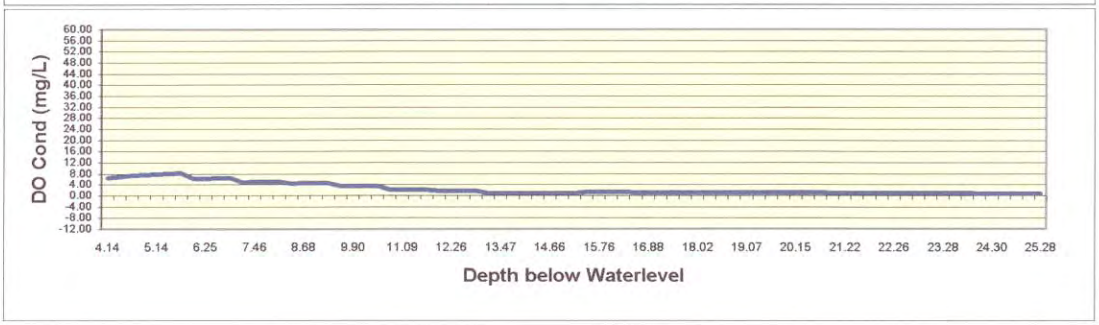
Site Identifier: 2628BD00013 Number: **SSW-13** Type: B

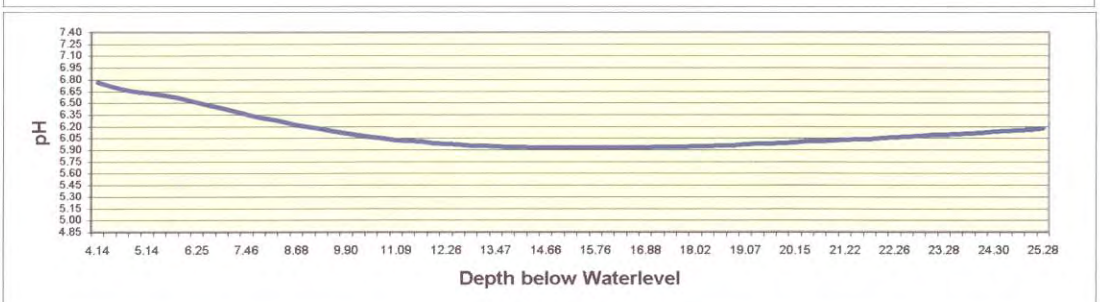
Site Name / Description: Sasol Block 8: Borehole SSW-13 Block 8

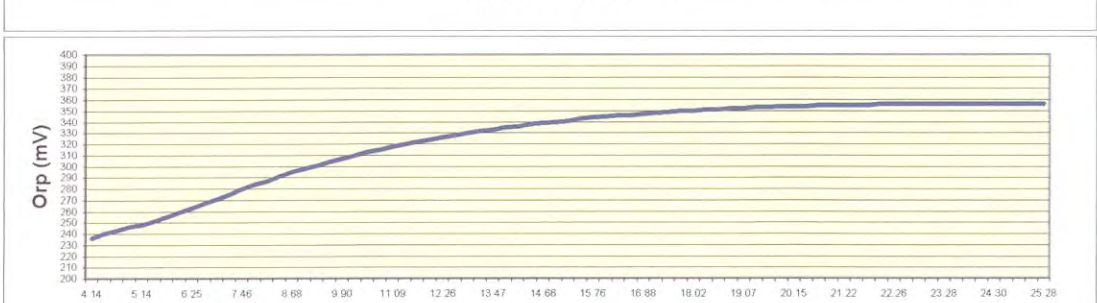
YSI 600XLM Multi-Parameter Profile











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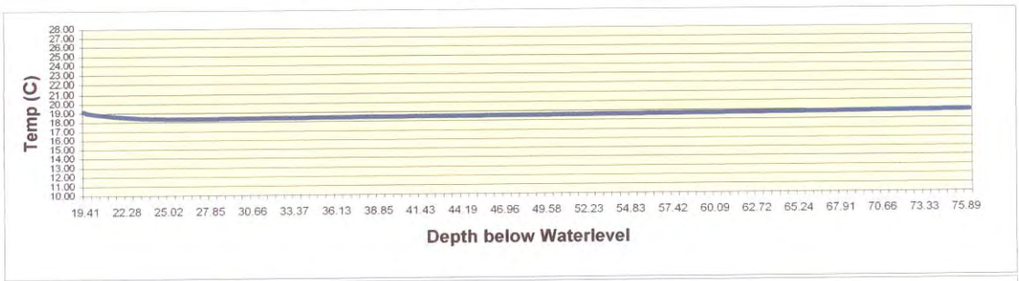
Borehole Chemical Profile Date Compiled: 7/25/2002

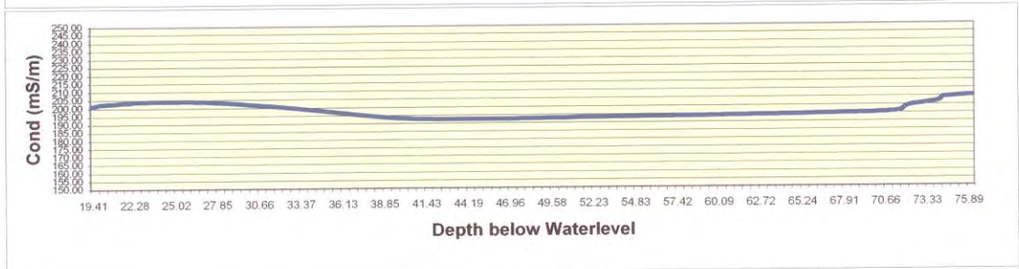
BASIC SITE INFORMATION

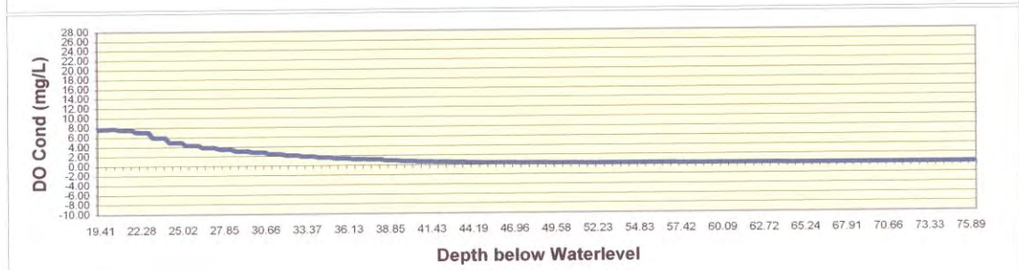
Site Identifier: 2628BD10013 Number: **SDF-13** Type: B

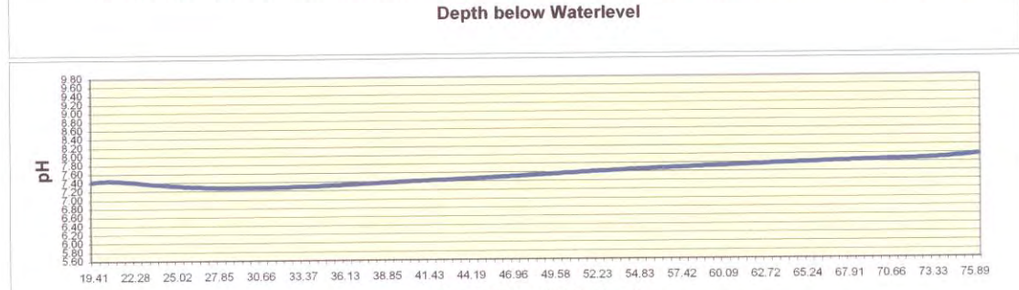
Site Name / Description: Sasol Block 8: Borehole SDF-13

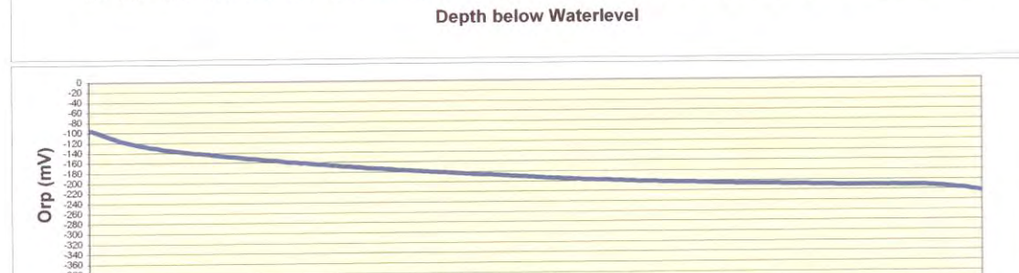
YSI 600XLM Multi-Parameter Profile











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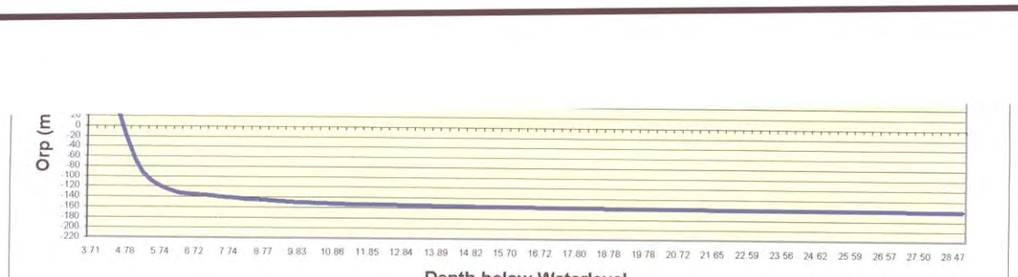

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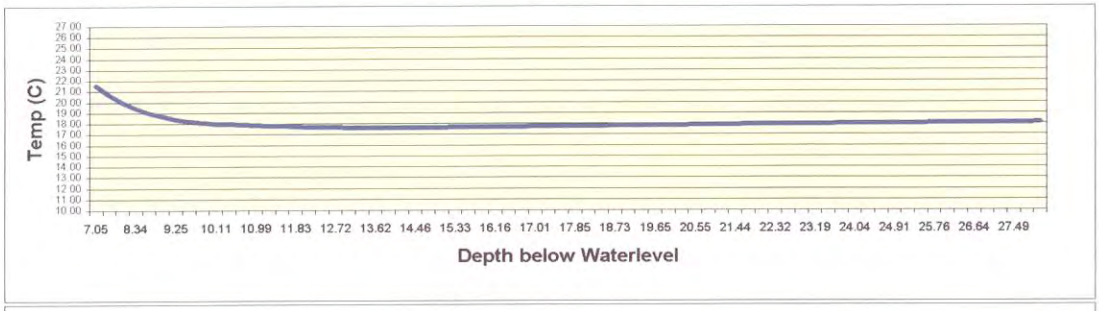
Borehole Chemical Profile Date Compiled: 7/24/02

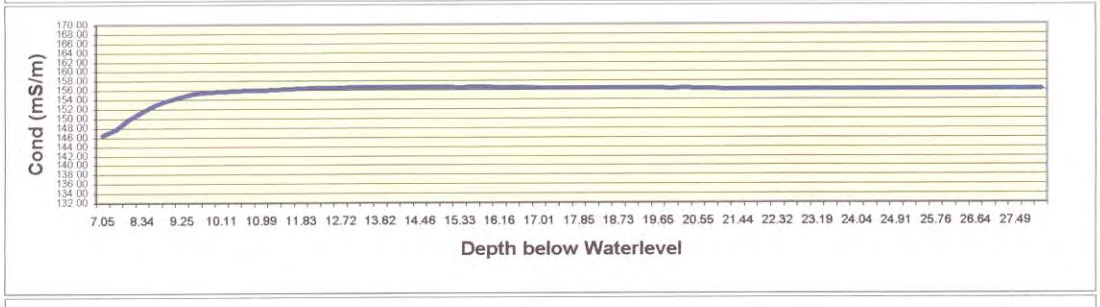
BASIC SITE INFORMATION

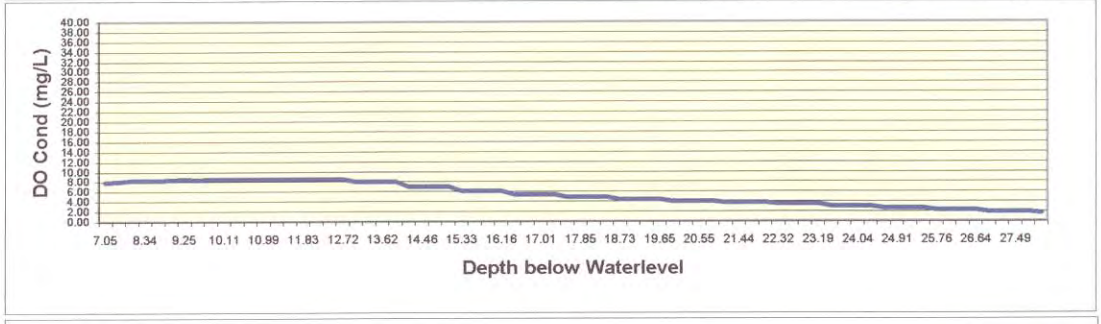
Site Identifier: 2628DB00015 Number: **SSW-15** Type: B

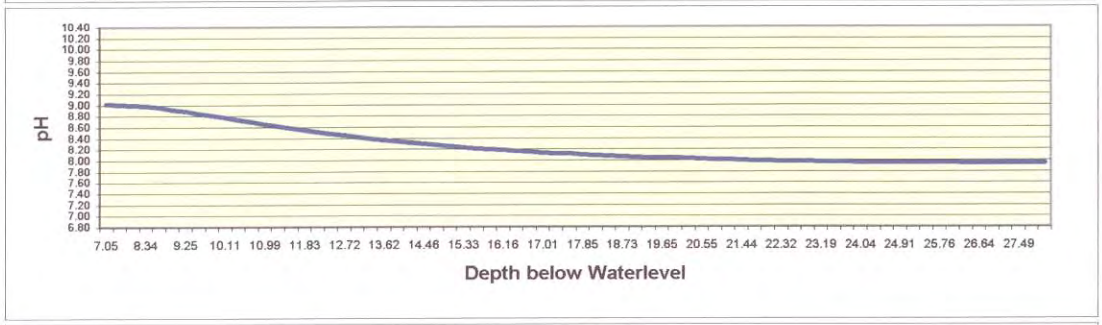
Site Name / Description: Sasol Block 8: Borehole SSW-15 Block 8

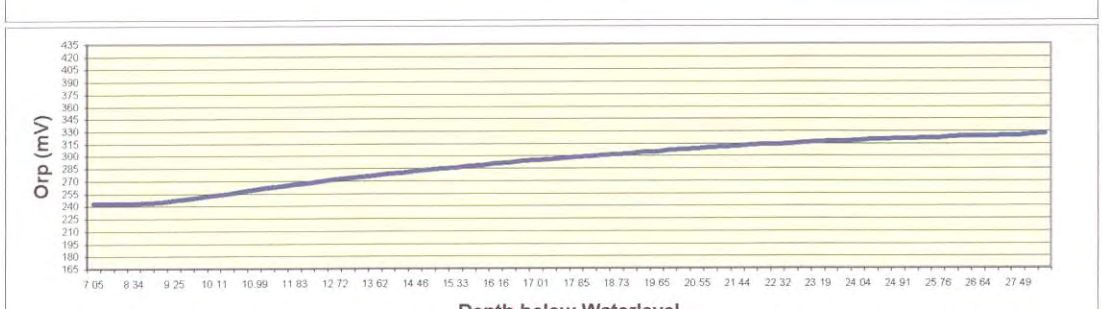
YSI 600XLM Multi-Parameter Profile











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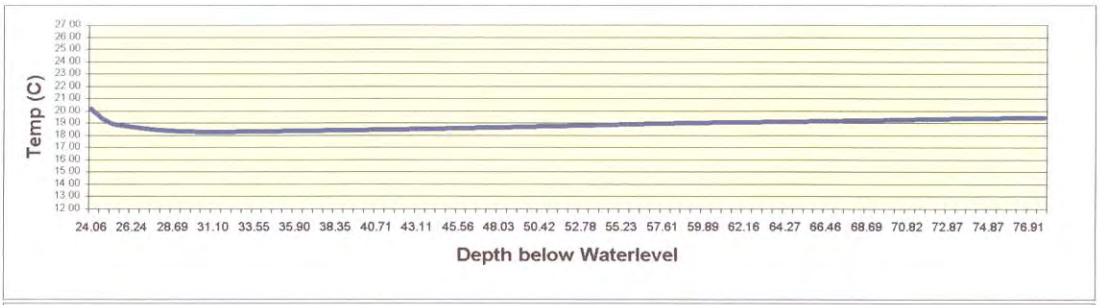
Borehole Chemical Profile Date Compiled: 7/24/02

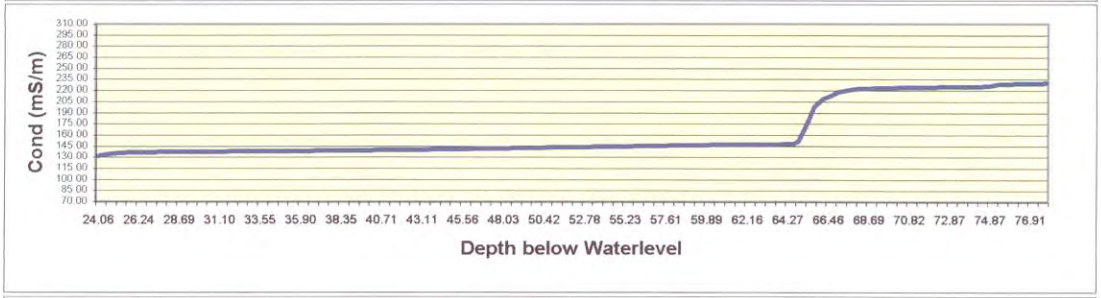
BASIC SITE INFORMATION

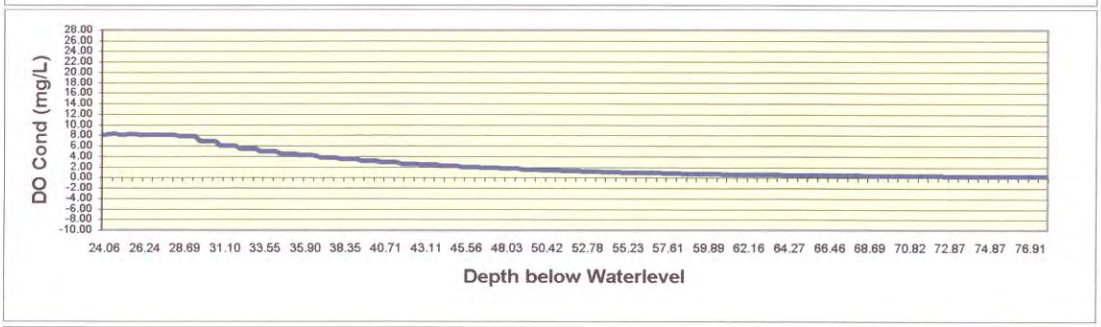
Site Identifier: 2628DB10015 Number: **SDF-15** Type: B

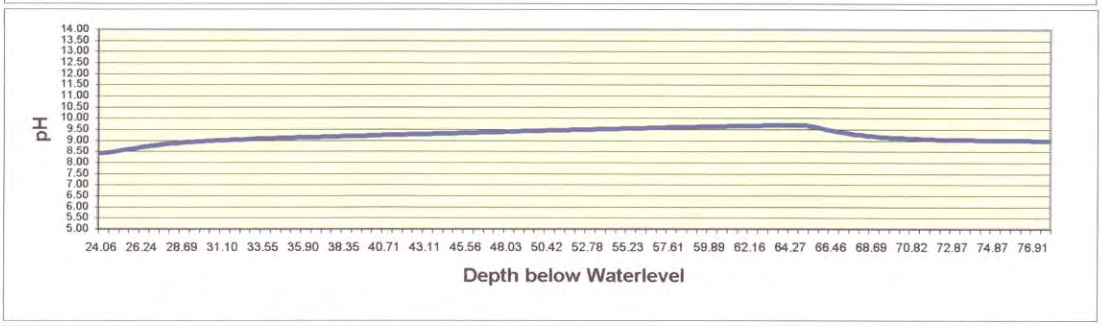
Site Name / Description: Sasol Block 8: Borehole SDF-15

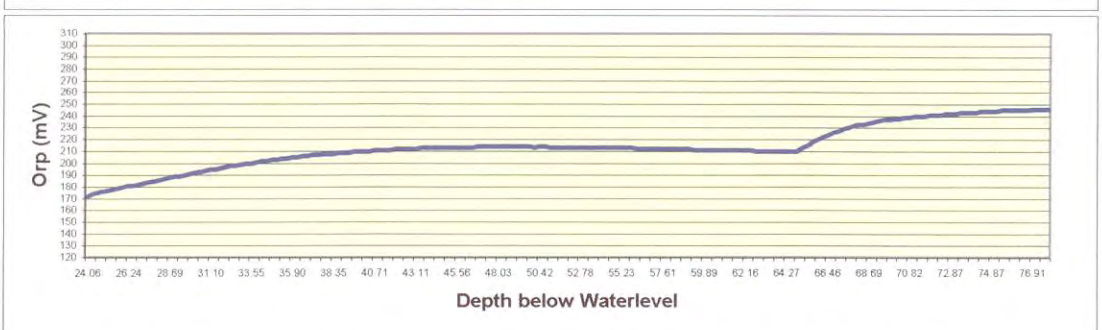
YSI 600XLM Multi-Parameter Profile











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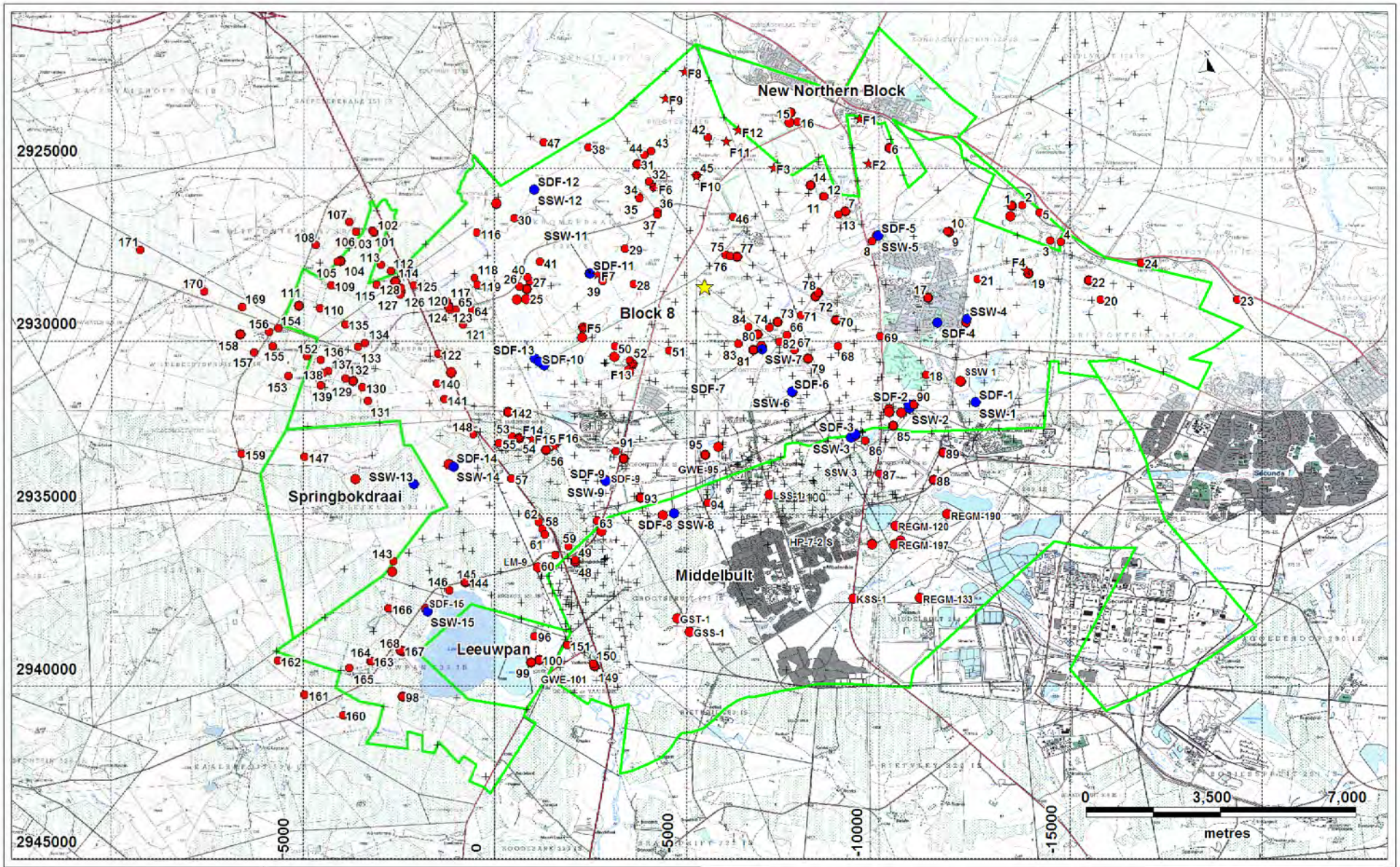
APPENDIX 3.2(A)

BOREHOLE LOCALITY MAP AND NUMBERS



Date: August 2010

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LEGEND

- Shondoni Shaft
- Reserve Extents
- Monitoring Boreholes
- External User Boreholes
- External User Fountains
- Exploration Boreholes

APPENDIX 3.4(A)

GROUND WATER LEVEL DEPTHS

Ground Water Level Depths

Site ID	BH No.	WL	Site ID	BH No.	WL	Site ID	BH No.	WL
2628BD00013	SSW-13	4.14	2629AC00012	SSW-12	8.9	2629AC20050	GWE-50	3.28
2628BD00013	SSW-13	12.4	2629AC00012	SSW-12	9.44	2629AC20051	GWE-51	7.45
2628BD10013	SDF-13	18.86	2629AC00015	KB-7	1.42	2629AC20142	GWE-142	2.8
2628BD10013	SDF-13	19.41	2629AC00017	KB-9	0.87	2629AC30004	GWEF-4	0.67
2628BD20064	GWE-64	7.77	2629AC00020	KB-12	2.81	2629AC30005	GWEF-5	0.05
2628BD20065	GWE-65	6.56	2629AC00021	KB-13	0.7	2629CA00002	KB-5	0.77
2628BD20101	GWE-101	6.4	2629AC00023	KB-15	0.56	2629CA00003	SSW-3	1.99
2628BD20105	GWE-105	6.6	2629AC00024	KB-16	0.54	2629CA00003	SSW-3	2.19
2628BD20106	GWE-106	6.02	2629AC00026	RTK-1	3.23	2629CA00006	WB-4	16.64
2628BD20109	GWE-109	12.4	2629AC00029	RTK-4	2.23	2629CA00007	WB-5	9.52
2628BD20113	GWE-113	6.7	2629AC00032	UTK-2	17.4	2629CA00008	SSW-8	0.27
2628BD20123	GWE-123	8.12	2629AC00035	SSW-2	2.98	2629CA00008	SSW-8	0.28
2628BD20125	GWE-125	3.2	2629AC10001	SDF-1	1.93	2629CA00008	WB-6	5.54
2628BD20126	GWE-126	2.91	2629AC10001	SDF-1	2.48	2629CA00009	SSW-9	4.62
2628BD20128	GWE-128	2.5	2629AC10002	SDF-2	2.47	2629CA00009	SSW-9	5.55
2628BD20129	GWE-129	6.08	2629AC10002	SDF-2	3	2629CA00010	LB-2	2.3
2628BD20130	GWE-130	1.2	2629AC10004	SDF-4	35.86	2629CA00011	LB-3	3.71
2628BD20133	GWE-133	12.8	2629AC10004	SDF-4	36.37	2629CA00016	LPB-5	0.98
2628BD20152	GWE-152	14.3	2629AC10004	SDF-4	50.37	2629CA00017	LPB-6	2.43
2628BD20157	GWE-157	1.8	2629AC10005	SDF-5	8.54	2629CA00022	REGM-120	6.47
2628BD20158	GWE-158	10.65	2629AC10005	SDF-5	9.12	2629CA00023	REGM-122	13.4
2628DB00014	SSW-14	3.19	2629AC10006	SDF-6	4.04	2629CA00024	REGM-133	22.34
2628DB00014	SSW-14	3.71	2629AC10006	SDF-6	4.04	2629CA00025	REGM-190	1.75
2628DB00015	SSW-15	6.15	2629AC10007	SDF-7	1.59	2629CA00029	REGM-196	6.45
2628DB00015	SSW-15	7.05	2629AC10007	SDF-7	1.61	2629CA00030	REGM-197	3.72
2628DB00015	SSW-15	7.38	2629AC10010	SDF-10	4.43	2629CA00031	REGM-198	8.64
2628DB10014	SDF-14	7.57	2629AC10010	SDF-10	4.86	2629CA00032	REGM-199	5.57
2628DB10014	SDF-14	8.71	2629AC10011	SDF-11	60.49	2629CA00033	HP-7-2 D	26.14
2628DB10015	SDF-15	23.26	2629AC10011	SDF-11	73.86	2629CA00034	HP-7-2 S	7.42
2628DB10015	SDF-15	23.96	2629AC10012	SDF-12	8.88	2629CA00035	HP-7-1 D	14.43
2628DB10015	SDF-15	24.06	2629AC10012	SDF-12	9.4	2629CA00036	HP-7-1 M	7.95
2628DB20145	GWE-145	3.4	2629AC20002	GWE-2	21.52	2629CA00037	HP-1-7 S	2.8
2628DB20160	GWE-160	3.95	2629AC20003	GWE-3	0.19	2629CA10003	SDF-3	2.92
2629AC00001	SSW-1	1.83	2629AC20005	GWE-5	10.39	2629CA10003	SDF-3	2.94
2629AC00001	SSW-1	2.25	2629AC20006	GWE-6	2.1	2629CA10008	SDF-8	0.24
2629AC00001	ZFT-1	2.75	2629AC20007	GWE-7	4.4	2629CA10008	SDF-8	0.26
2629AC00002	SSW-2	5.27	2629AC20008	GWE-8	2.77	2629CA10009	SDF-9	4.79
2629AC00002	SSW-2	5.76	2629AC20009	GWE-9	3.12	2629CA10009	SDF-9	5.61
2629AC00002	ZFT-2	6.86	2629AC20014	GWE-14	3.08	2629CA20048	GWE-48	27.19
2629AC00004	SSW-4	25.5	2629AC20015	GWE-15	3.21	2629CA20053	GWE-53	4.95
2629AC00004	SSW-4	26.44	2629AC20018	GWE-18	0.49	2629CA20056	GWE-56	4.8
2629AC00005	SSW-5	4.73	2629AC20019	GWE-19	7.93	2629CA20057	GWE-57	3.35
2629AC00005	SSW-5	6.05	2629AC20022	GWE-22	21.88	2629CA20058	GWE-58	5.63
2629AC00006	SSW-6	5.72	2629AC20023	GWE-23	5.15	2629CA20059	GWE-59	2.2
2629AC00006	SSW-6	5.96	2629AC20025	GWE-25	5.64	2629CA20060	GWE-60	3.48
2629AC00007	SSW-7	1.71	2629AC20030	GWE-30	11.19	2629CA20061	GWE-61	5.04
2629AC00007	SSW-7	1.75	2629AC20032	GWE-32	10.86	2629CA20062	GWE-62	7.6
2629AC00010	SSW-10	3.94	2629AC20034	GWE-34	13.1	2629CA20096	GWE-96	2.7
2629AC00010	SSW-10	4.36	2629AC20037	GWE-37	13.4	2629CA20099	GWE-99	0.56
2629AC00011	SSW-11	2.77	2629AC20042	GWE-42	4.11	2629CA20100	GWE-100	1.29
2629AC00011	SSW-11	11.04	2629AC20045	GWE-45	0.85			