B E A L

CONSULTING ENGINEERING & PROJECT MANAGEMENT

REPORT

ENVIRONMENTAL IMPACT
MANAGEMENT SERVICES

STORM WATER MANAGEMENT PLAN AND WATER BALANCE FOR ELANDSFONTEIN COLLIERY

Submitted to:

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B599_SWMP&Water Balance_Rev1

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1. INTRODUCTION

Environmental Impact Management Services (EIMS) commissioned BEAL Consulting and Project Management (BEAL) to compile a Conceptual Storm Water Management Plan (SWMP) and Water Balance for the Elandsfontein Colliery (Elandsfontein) and to size the related infrastructure to support the Water Use Licence application (WULA). This report provides the water balance and infrastructure results for the study as well as recommendations resulting from the work done.

1.1. Study objective

The **overall** project objective is to provide a SWMP which is cost effective, implementable and complies with the regulatory requirements.

The specific objectives of this report are to provide a Conceptual Engineering Design that is aligned to the Norms and Standards, codes and reference documents in support of the Water Use Licence Application (WULA).

1.2. Regulatory framework

The following engineering standards, codes and reference documents are applicable to this project:

- Best Practice Guidelines for Water Resource Protection in the South African Mining Industry: Directorate: Resource Protection and Waste: Department Water Affairs and Forestry, Republic of South Africa:
  - A4 – Pollution Control Dams;
  - A5 – Water Management for Surface Mines;
  - G1 – Storm Water Management;
  - G5 – Water Management Aspects for Mine Closure;
  - H1 – Integrated Mine Water Management; and
  - H2 – Pollution Prevention and Minimisation of Impacts.
- Government Notice GN 704 for water resource protection, clean and dirty water separation;
- National Norms and Standards for the assessment of Waste to landfill disposal, NEMWA. 2008;
- Capacity requirements for collection and conveyance systems; and
- The Dam Safety Regulations GN 1560 of 25 July 1986.

2. SCENARIO DESCRIPTION

A key requirement for the SWMP is to identify the clean and dirty water areas and to come up with a plan to intercept dirty water and to temporary store the dirty water in a pollution control dam which will meet the Norms and Standards as set out by the Department of Water affairs.

Based on the field assessment and the topography of the area the, dirty water catchments was delineated (Scenario 1). Scenario 1 requires 8 pollution control dams with concrete lined channels which intercepts the dirty storm water run-off and drains it to an associated lined PCD as indicated in the figure below.

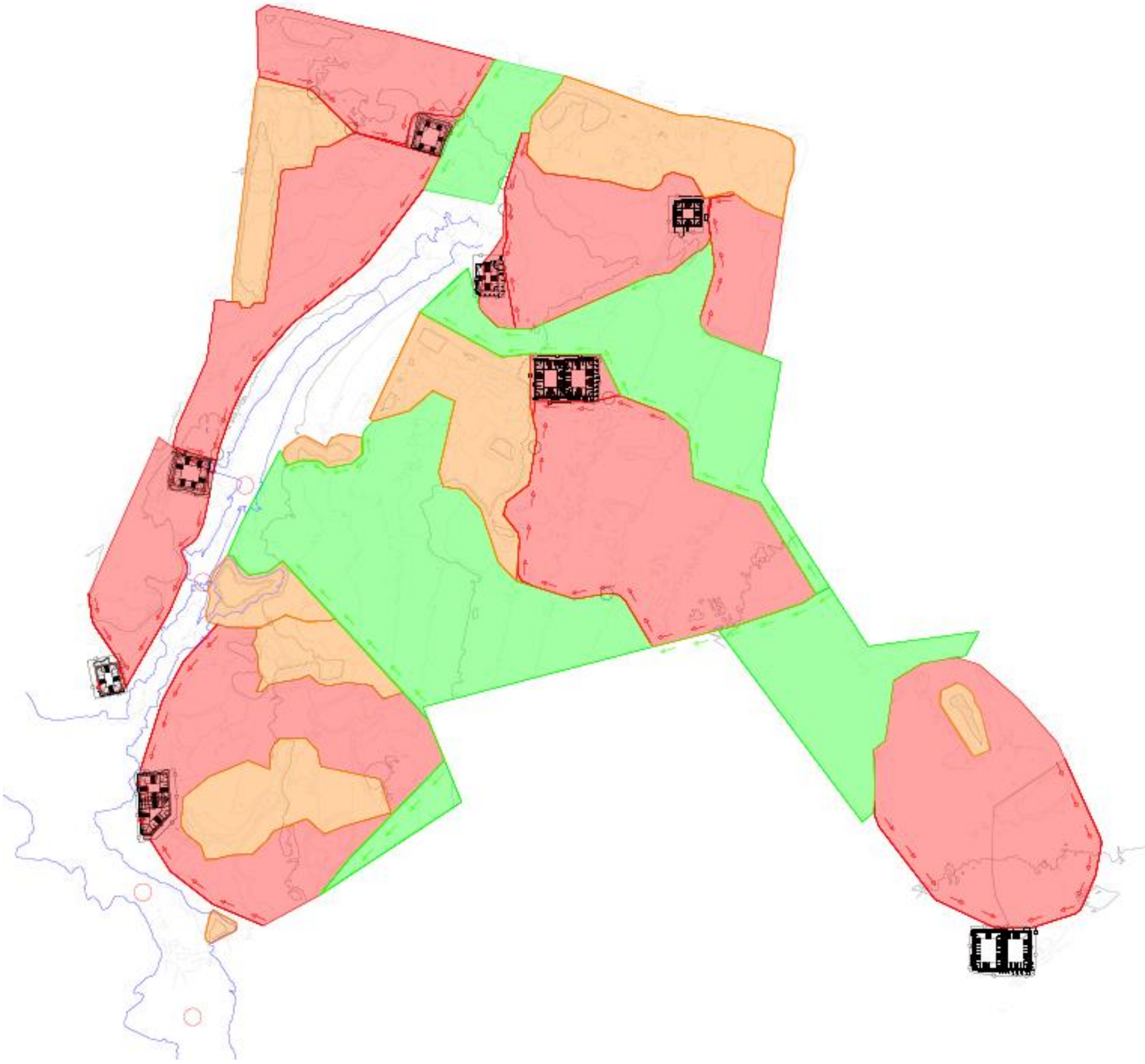


Figure 1: Scenario 1 Layout Plan

On further investigation it could be seen that some dirty areas were contaminated with single loads of contaminated/carbonations material and could therefore be decontaminated (Scenario 2). This will allow the area to be deemed as a clean area which will reduce total accumulation of dirty water and hence reducing the number of PCD's required.

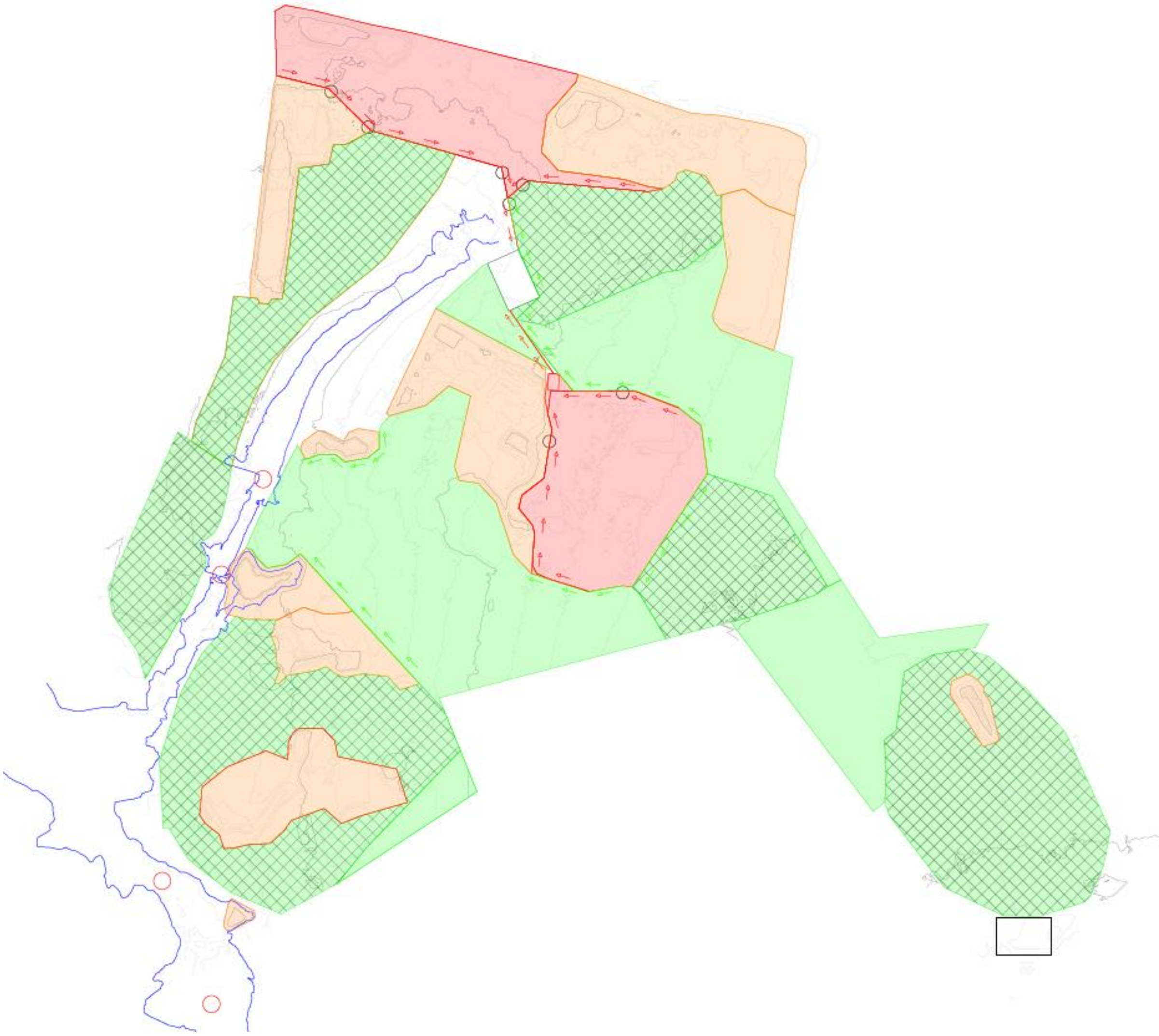


Figure 2: Scenario 2 Layout Plan

Scenario 1 will be submitted with the current water use licence application as a worst-case scenario. However, scenario 2 conceptualise a more likely case on how the mine can minimise their liability by decontaminating the dirty catchments and should be strongly considered moving forward.

3. CLIMATIC DATA

The climate data used in this study is summarised in Table 1.

Table 1: Climate data

Month	Average Rainfall (mm)	Average Rain Days	Average evaporation (mm S-Pan)
October	73.6	7.0	182.1
November	119.3	9.6	171.8
December	119.4	9.6	189.2
January	136.1	10.4	185.8
February	95.6	7.3	154.9
March	81.6	6.8	152.9
April	40.6	4.2	117.6
May	17.6	2.0	99.0
June	9.0	0.9	80.4
July	6.4	0.8	88.0
August	8.9	1.1	116.5
September	22.4	2.6	151.0
Mean Annual	**705.8***		**1689**

* *Note: The mean annual precipitation does not necessarily equal the sum of the monthly average precipitation. This is because an avarege year generally consists of months of above and below overage rainfall.*

3.1. Sources of rainfall data

Daily rainfall data was sourced from the CCWR (Computing Centre for Water Research, Natal University) rainfall database (gauge number 0515382 – Witbank (MAG)). The gauge is located approximately 4 km east of the mining rights area. The CCWR data that was used contains daily records and patched records between September 1905 and December 1967, or over 72 years. An additional 46 years of daily data for Witbank (SAWB gauge number 0515412 2) was purchased from the South African Weather Bureau. The full data set therefore runs from September 1905 to August 2013. The data is considered representative of the mining rights area and is good quality.

3.2. Sources of evaporation data

The mean annual evaporation was sourced from the average evaporation for quaternary catchment B20G, documented in the Water Resources of South Africa, 2005 Study (Middleton, B J; Bailey, A K;, 2009). Its monthly distribution was sourced from the Water Resources of South Africa Study data set, zone 4A (Midgley, et al., 1990). The data is considered representative of the mining rights area.

4. SITE LOCATION

Elandsfontein Colliery is located on the farm Elandsfontein 309JS southwest of the Emalahleni town centre, which falls within the Emalahleni local municipality of the Nkangala District municipality in the Mpumalanga province of South Africa (Figure 2 1). Highveld Steel and Vanadium complex (hereafter Highveld steel) is located north of Elandsfontein and Anglo

Thermal Coal's Umlalazi operations, (Umlalazi) is located directly east on portion 2 of the farm Elandsfontein 309JS.

5. WATER BALANCE

The water balance presented in this report is a static water balance. It represents average flows between facilities and along hydrological interfaces. Peak flows cannot be accounted for as the water balance is a static water balance, showing average flows.

The Mpumalanga Highveld has distinct wet and dry seasons. Over 94% of Elandsfontein Colliery's mean annual rainfall falls between September and April inclusively. Over 77% of the area's mean annual evaporation occurs in this period. For this reason, the water balance was divided into a wet season and a dry season water balance. The wet season water balance represents the period 1 September to 30 April. The rest of the year is included in the dry season water balance. An average water balance that represents average flows throughout the year is also presented in Appendix A.

5.1. Water Balance Description

The colliery is currently operational, with one active pit and associated stockpiles, and one operational pollution control dam (PCD 3). There are 2 pollution control dams at the South Eastern corner (PCD 1 and 2) close to the adit area. Additional pits are proposed in the S102 amendment to the MWP. Each of these pits will have associated stockpiles and pollution control dams. A washing and screening plant is included. Discards are placed in the old northern pit.

The average annual water balances for the proposed mining operations are provided in Appendix A. The inflows are presented on the left of the water balance figures. The facilities and inter-facility flows are shown in the centre of the water balance figures. The outflows are shown on the right of these figures.

The direction of water movement is illustrated with black arrows. The values adjacent to the arrows represent average flows in m^3/day or m^3/yr. Clean water flows are shown in blue, while dirty flows are shown in red. The scenario represented is indicated in the top right-hand corner.

One of the fundamental principles of a water balance is that inflows must equal outflows unless the difference is accommodated in storage changes. The pollution control dams are relatively small and will not accommodate storage changes over a season, so storage changes are assumed to be zero. Daily storage changes will occur in practice but will not be seen when viewed in the context of a static water balance over a season. Any excess water is assumed to be pumped out of the pollution control dams and managed as part of an excess dirty water management system such as a treatment plant, forced evaporation, selling to other users or some other dirty water management strategy.

5.2. Sources of Flow Information

The mine has provided flow meter data and ROM tonnages. Groundwater inflows into the active pit are estimated. These inflows are modelled inflows and should be monitored once mining commences. The water balance assumptions should be revisited once reliable data becomes available.

5.3. Water Balance Results

The average annual water balances for the Elandsfontein Colliery are provided in Appendix A. A static water balance cannot account for the dynamics of the pit development. A snapshot of the colliery's pit development is used to calculate the water balance. The snapshot comprises the full pit development of the current pit.

This represents the condition where the most water is produced by the site. As more pits are opened and rehabilitated, the dirty areas on the mine will be reduced. Up to 8 pollution control dams are required to manage storm water from the colliery's dirty areas.

During the wet season, the Elandsfontein water balance will be a positive water balance with an average wet season excess of 922 m^3/day. During the dry season, the water balance will be a deficit water balance, with an average plant make-up of 87m^3/day and a dry season average make-up of 258 m^3/day.

The excess water available in the wet season will require some form of active management. This could include selling the water to another user, forced evaporation (one to two fans likely), treatment to discharge standards and release to the environment, or some other management intervention. The volumes are too large to be practically evaporated.

6. POLLUTION CONTROL DAM DESIGN

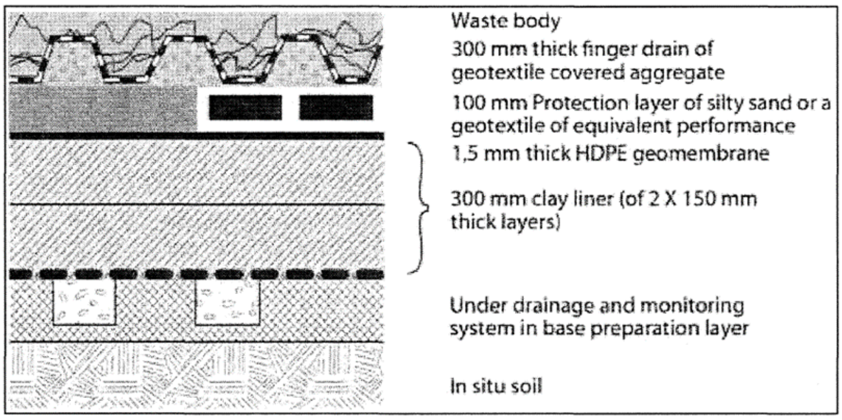
6.1. Introduction

The pollution control dams accommodate storm water from the dirty areas on the colliery (Described in drawing number B599_001_CON_002), the ROM stockpile area, the hards dump and surrounding undeveloped catchments.

6.2. Design Considerations

The design criteria was based on the following principles:

- The dam needs to accommodate the excess water resulting from a long-term monthly water balance, plus the 50-year storm runoff volume; and
- Waste Classification conducted by Gradient Groundwater Consulting indicated a Type 3 waste which requires a Class C barrier system. The composition of the Class C barrier system is illustrated in the figure below:



*It should be noted that the 50-year storm was added to the monthly time series because individual storms during the month are not modelled and are averaged out during the month.

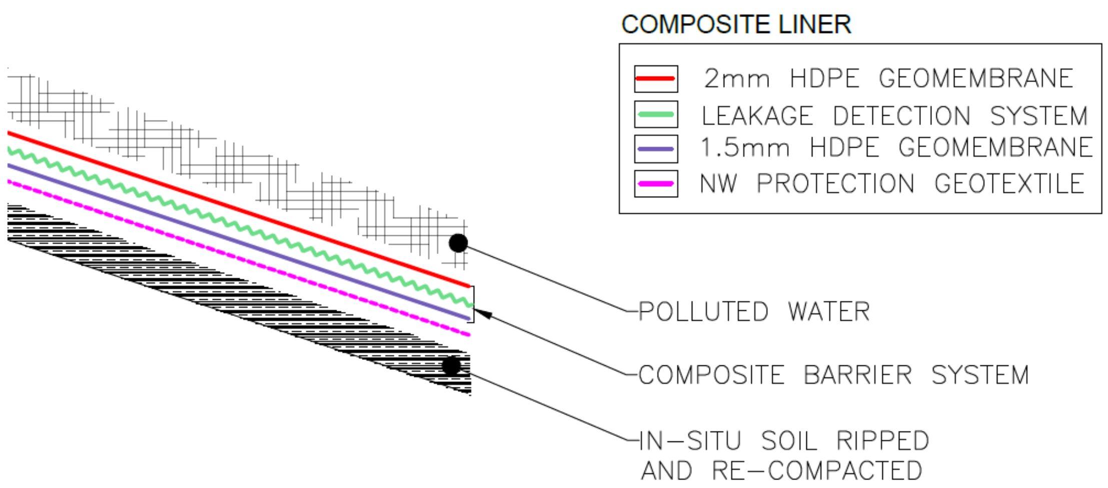
6.3. Barrier Requirement

As discribed in the design considerations section of this report the waste clasfication conducted requires a Class C barrier system.

Due to site specific contraints the following deviations to the Norm's and Standard's are proposed:

- The minimum requirement specification requires the installation of a 300mm clay layer. This layer has very specific properties and will also require clay from a specific source which is not available in the site area;
- A Geosynthetic Clay Layer was also considered for the replacement of the clay layers but due to unsatisfactory confining pressure in an empty dam scenario, which are expected due to a deficit water balance in the dry months, this will not be an option;
- The 300mm clay layer will therefore be replaced by a 1.5mm HDPE liner;
- The primary liner system will be an exposed 2mm HDPE liner. The deviation from a 1.5mm HDPE to a 2mm HDPE is due to the end of life cycle requirement of 12 years;
- Cuspated drainage sheet will collect any leakage from the primary liner to a collection manhole where frequent monitoring will be done to ensure that the leakage action rate is not exceeded;
- The HDPE liner will be monitored by means of Standard Oxidative Induction Time (OIT) tests to determine the life cycle of the barrier, should the end of life be reached before the 12 year LOM, the HDPE liner will have to be replaced; and
- An underdrain system will be installed should the detailed investigation indicate a shallow groundwater aquifer.

Based on the reasons stated above, the recommended barrier system to use is described in the figure below.



PCD BARRIER CONFIGURATION

The barrier as described below will meet the barrier criteria of a class c barrier system.

6.3.1. *50-Year and 100-Year Storm Events*

The peak rainfall data used is presented in Table 2.

Table 2: Peak 24-hr rainfall depth for the Elandsfontein Colliery

Recurrence interval	24-hr rainfall depth (mm)
50-yr	115
100-yr	130

The Utility Programs for Drainage software was used to calculate the flood peaks. The Rational Method, Alternative Rational Method, SDF Method and Unit hydrograph Method were used to calculate the flood peaks. The Rational Method was selected as the most appropriate flood peak to use for the Grootspruit tributary.

6.4. *Dam capacity requirement*

The table below provide the dam capacities required for the 1:50 year flood event:

Table 3: Required PCD capacities (Excl. Freeboard)

PCD	50-yr storm volume (m3)	Normal operating storage (m^3)	Normal operating storage plus 50-yr storm volume (m^3)
1	8 225	13 293	21 518
2	4 787	10 567	15 354
3	12 834	824	13 658
4	12 925	19 111	32 036
5	28 418	43 279	71 697
6	5 340	11 728	17 068
7	19 873	32 713	52 586
8	19 644	43 696	63 340

6.5. *Spillway sizing*

The spillway on the pollution control dams will need to cater for storm water generated from the dirty upstream catchments, plus direct rainfall on the dam. This is shown in the table below:

Table 4: Spillway sizes

PCD	100-yr flood peak (m^3/s)	Spillway width (m)	No of spillways	50-yr flow depth (m)	100-yr flow depth (m)
1	4.2	7	1	0.40	0.50
2	1.9	3	1	0.43	0.52
3	5.6	9	1	0.42	0.52
4	4.44	7	1	0.42	0.52
5	9.62	8	2	0.40	0.50
6	4.04	7	1	0.40	0.50
7	12.65	10	2	0.42	0.52
8	8.78	7	2	0.42	0.52

The mine's water balance is a positive water balance so an evaporative PCD is unfeasible. The minimum size of the PCD's is the 50-year design storm volume from the PCD's catchments are listed in table 3 above (The modelling capacity included the freeboard but is excluded in the table)

The required PCD's capacities are summarised in table 3. Note that the PCD capacities assume that the mine water balance is brought back to a neutral or deficit water balance. This can be achieved by a large continuous demand such as a water treatment plant, forced evaporation, or some other means of dirty water disposal. The washing plant demand is already included in the water balance.

The size of the water treatment plant will depend on the groundwater inflows into the pit. The groundwater inflows are not known at the time of writing and were estimated at 50m^3/day.

7. STORM WATER DESIGN

Clean and dirty storm water channels have been identified by BEAL. These channels, shown in the drawings presented in Appendix B, were sized during this study.

7.1. Catchment Delineation

The catchments were delineated using 1 m contour data supplied by Elandsfontein.

7.2. Peak Rainfall

The peak rainfall data, presented in Table 2 was used to calculate the flood peaks.

7.3. Flood Peak Calculation

The positions of the storm water channels are shown in drawing number B599_001_CON_002. The sub-catchments reporting to these channels were delineated. The sub-catchments are small and the rational method was therefore a suitable method of determining the flood peaks.

The recorded mean annual precipitation (MAP) for the closest and most representative weather station is provided in Table 1.

This data was interpolated to allow for the simulation of a 24 hour storm event with a return period up to 50 years. The peak floods for the simulated 24 hour storm event were determined by applying the Rational Method.

The old Department of Water Affairs' calculation sheet was used to determine the runoff coefficients. The time-to-concentration of the sub-catchments was calculated using the SCS method which is suitable for relatively undeveloped catchments. Adamson's TR102 (Adamson, 1981) was used to convert the 24-hour peak rainfall data to rainfall intensities appropriate to the time-to-concentration of the catchments. The 1085 method was used to calculate catchment slopes. The results of these calculations for all sub-catchments are summarised in table 2.

7.4. Design of Dirty Water Channels and Berm

The surface water infrastructure include lined dirty water channels and clean stormwater diversion berms.

7.4.1. Channel Sizing

The channels were sized to accommodate the flood peaks presented in table 2. The Mannings open channel flow equation was used to calculate flow depth in the channel. A Mannings n of 0.030 was used for vegetated channels and 0.015 for concrete lined channels. The channels are sized assuming trapezoidal channels with side slopes of 1:1.5 (V:H).

It is good practice to allow approximately 0.3m of freeboard in the channel. This is to allow for wave action and flow surges in the channel. A summary of the channel sizes is presented in table 5 of this report.

Table 5: Summary of Infrastructure Sizes

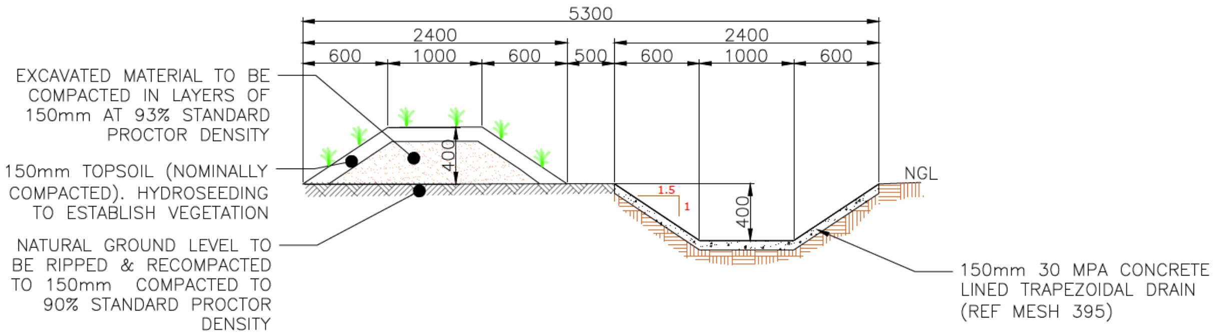
Channel	50-yr flood peak (m^3/s)	Lining	Bottom width (m)	Longitudinal slopes (V:H)*	Max flow depth (m)	Channel depth (m)	Max flow velocity (m/s)*	Flow type at max velocity
Channel 1	3.0	Concrete	1	1:200	0.6	0.9	2.5	Supercritical
Channel 2	0.2	Concrete	1	1:110	0.1	0.4	1.3	Supercritical
Channel 3	0.2	Concrete	1	1:100	0.1	0.4	1.4	Supercritical
Channel 4	1.2	Concrete	1	1:120	0.4	0.7	2.3	Supercritical
Channel 5	1.0	Concrete	1	1:64	0.3	0.6	2.7	Supercritical
Channel 6	3.2	Concrete	1	1:51	0.5	0.8	4.0	Supercritical
Channel 7	3.1	Concrete	1	1:150	0.6	0.9	2.6	Supercritical
Channel 8	0.2	Concrete	1	1:200	0.1	0.5	1.0	Supercritical
Channel 9	6.7	Concrete	1	1:160	0.9	1.0	3.3	Supercritical
Channel 10	0.4	Concrete	1	1:61	0.1	0.5	2.0	Supercritical
Channel 11	2.1	Concrete	1	1:200	0.5	0.8	2.3	Supercritical
Channel 12	0.9	Concrete	1	1:52	0.2	0.6	2.8	Supercritical
Channel 13	5.4	Concrete	1	1:200	0.8	1.0	2.9	Supercritical
Channel 14	3.9	Concrete	1	1:110	0.6	0.9	3.3	Supercritical
Channel 15	4.1	Concrete	1	1:200	0.7	1.0	2.7	Supercritical
Channel 16	2.4	Concrete	1	1:200	0.6	0.9	2.3	Supercritical

Berm	50-yr flood peak (m^3/s)	Lining	Top width (m)	Longitudinal slopes (V:H)*	Max flow depth (m)	Berm Height (m)	Max flow velocity (m/s)*	Flow type at max velocity
Berm	8.7	Geomat	1	1:34	0.4	1.0	3.4	Supercritical

General note: All channels are trapezoidal with side slopes of 1:1.5 (V:H)
** Note: Flow velocities are based on the maximum longitudinal gradient. These gradients will need to be confirmed during subsequent design phases.*

7.4.2. Typical Detail of Dirty Water channels

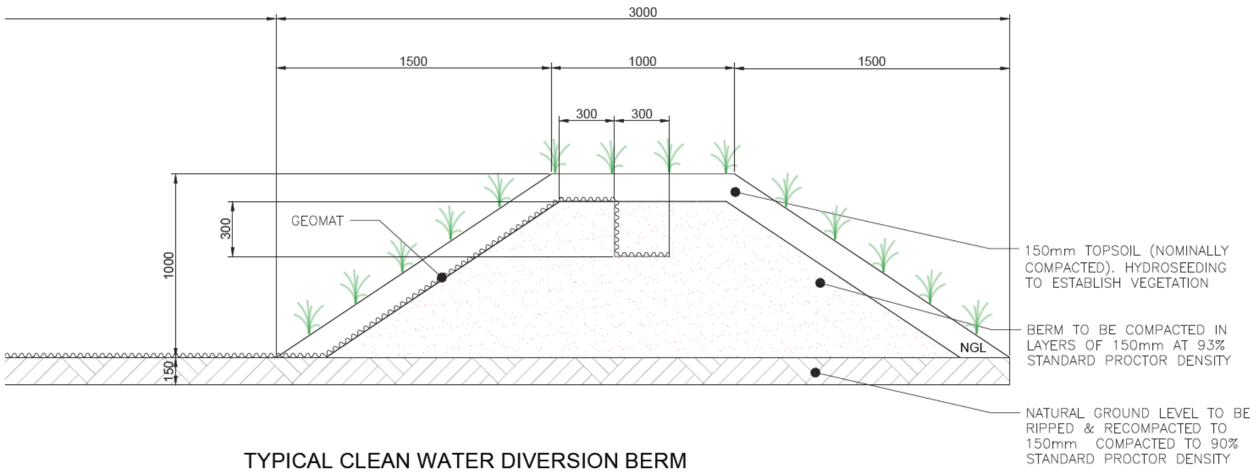
The figure below provides a typical detail of the dirty water channels.



DIRTY WATER CHANNEL

7.4.3. Clean water diversion berms

The figure below provides a typical detail of the clean water diversion berms.



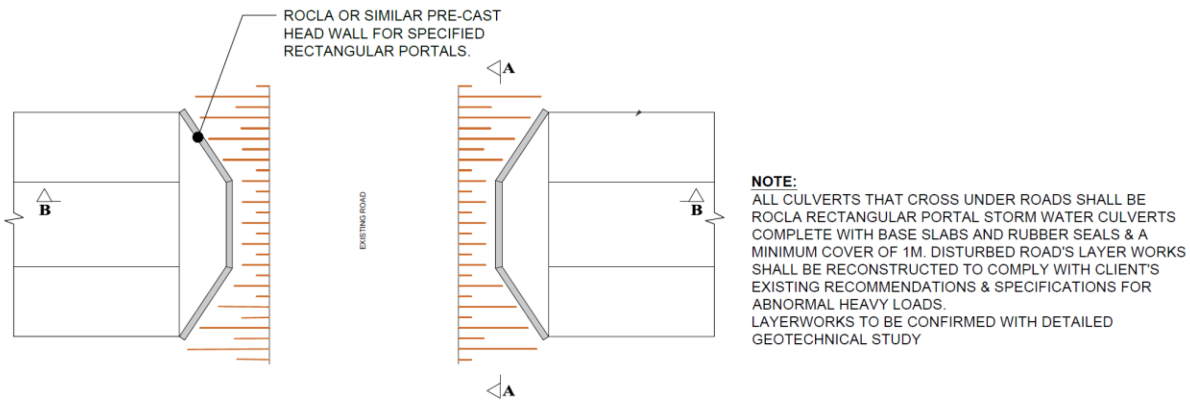
TYPICAL CLEAN WATER DIVERSION BERM

7.5. CULVERT DESIGN

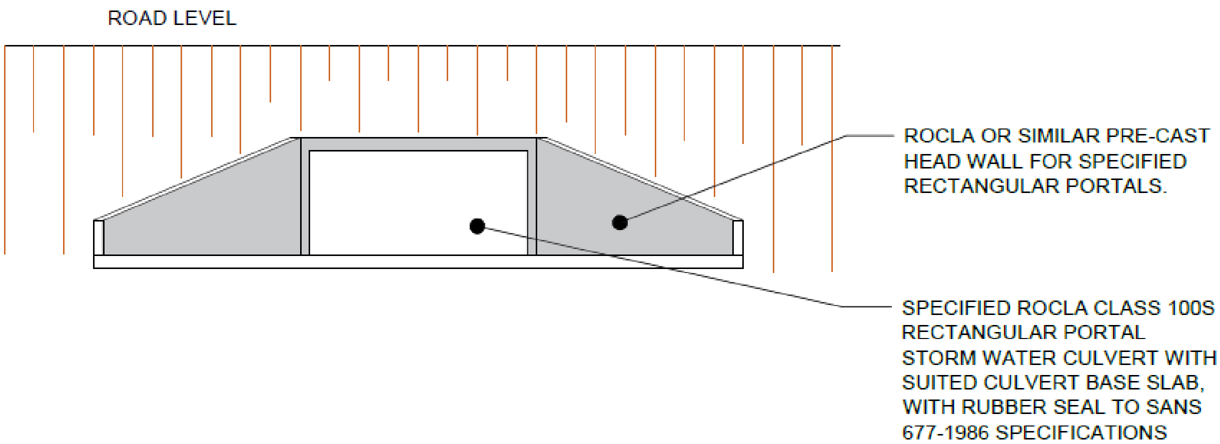
The culverts will be placed at the intersection between the channels and the internal road infrastructure. The table below provide the sizing of each channel.

Table 6: Summary of infrastructure sizes

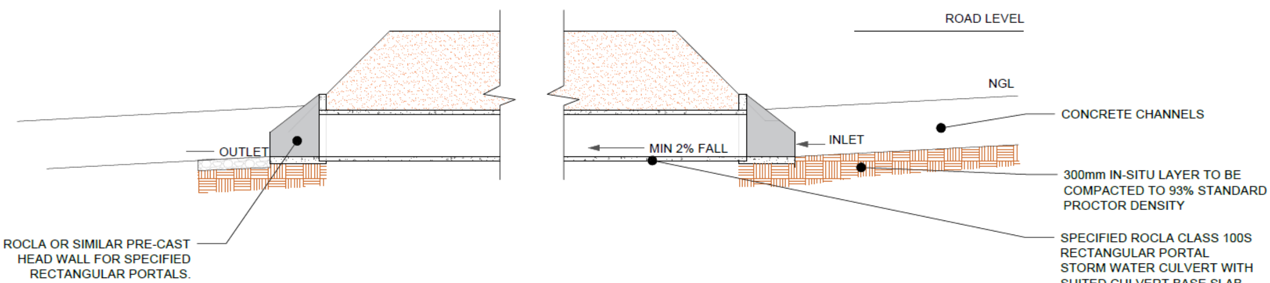
Culvert	50-yr flood peak (m^3/s)	Type	Span (mm)	Height (V:H)*	No of
Culvert 1	2,97	Portal	3000	600	1
Culvert 2	2,97	Portal	3000	600	1
Culvert 3	0,18	Portal	450	450	1
Culvert 4	0,97	Portal	1200	600	1
Culvert 5	0,97	Portal	1200	600	1
Culvert 6	3,09	Portal	2100	450	2
Culvert 7	6,7	Portal	3000	600	2
Culvert 8	6,7	Portal	3000	600	2
Culvert 9	0,36	Portal	750	450	1



TYPICAL WATER CULVERT & STRUCTURE - PLAN VIEW



TYPICAL WATER CULVERT & STRUCTURE



TYPICAL WATER CULVERT & STRUCTURE

8. STOCKPILE AREA

From the Geohydrological investigation the Stockpile areas are classified as a type 3 waste and will require a Class C barrier system. The footprint of the dirty water catchment extends across approx. 50Ha area. The Class C barrier system will have to be altered to accommodate for high traffic volumes. It should also be noted that the solution should accommodate the collection of dirty water infiltration as well as surface run-off. The surface run-off will be collected by means of surface water channels and temporary contained in a lined pollution control dams. Clean water will be diverted around the site using diversion berms. The water infiltration can managed by either installing a zero-infiltration barrier system which will prevent infiltration to the groundwater aquafer or alternatively by installing a series of groundwater interception boreholes that can collect the infiltrated water and use it at the plant.

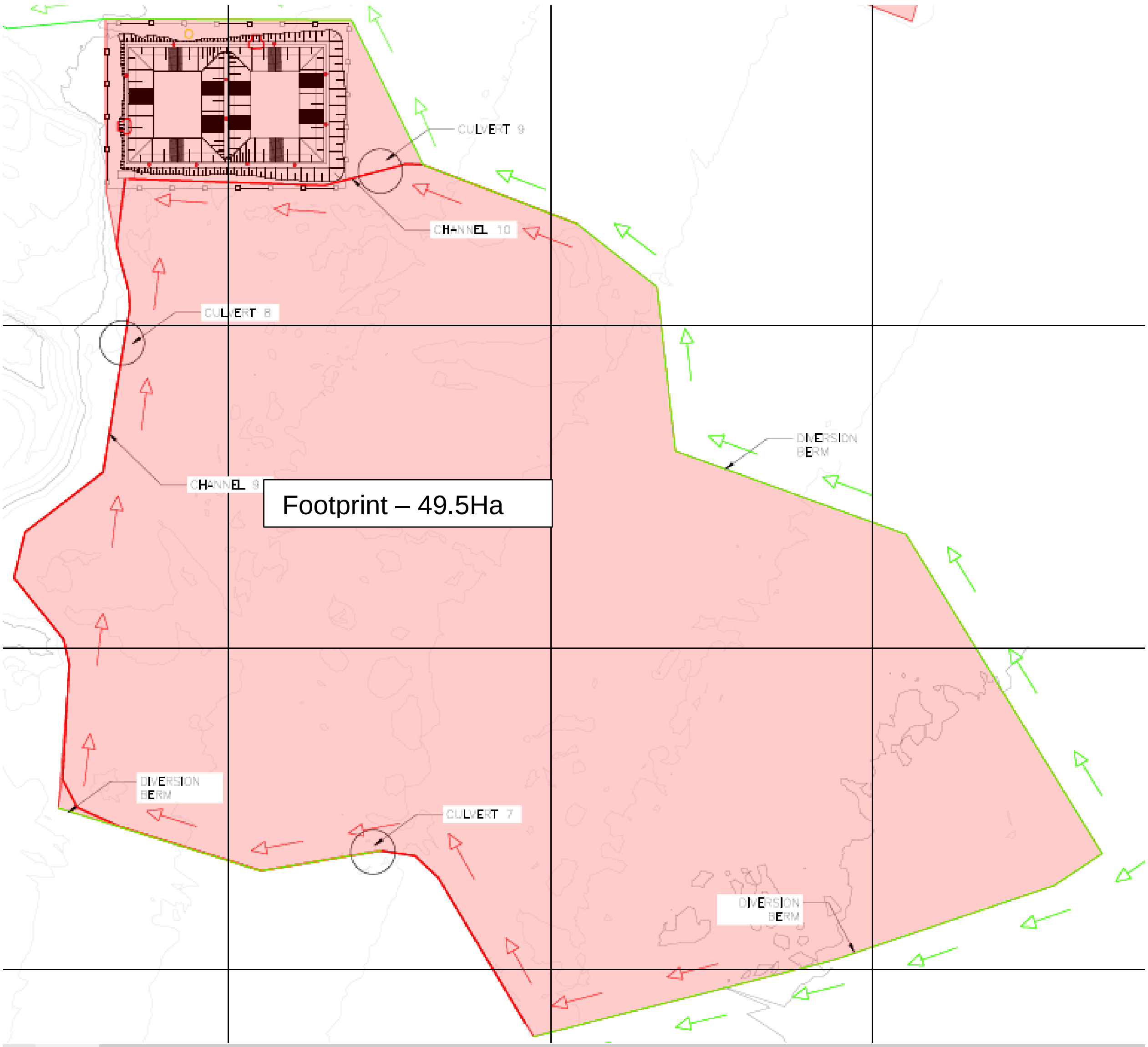


Figure 3: General Layout of Stockpile area

The images below illustrate the proposed alternative barrier systems to the Norms and Standards.

Alternative 1 is the preferred barrier for the stockpile footprint as this area will have a substatial amount of truck movement.

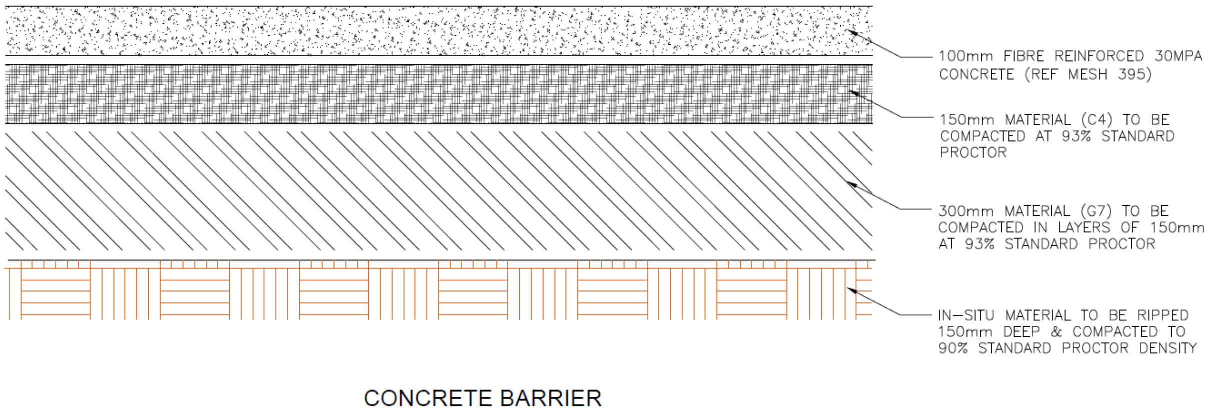


Figure 4: Concrete Barrier for Stockpile area

Alternative 2 allows for a thick soil cover over single composite barrier system as described in the Norms and Standards for a Class C barrier system. The thick soil cover will be for the protection of the geosynthetic barrier system.

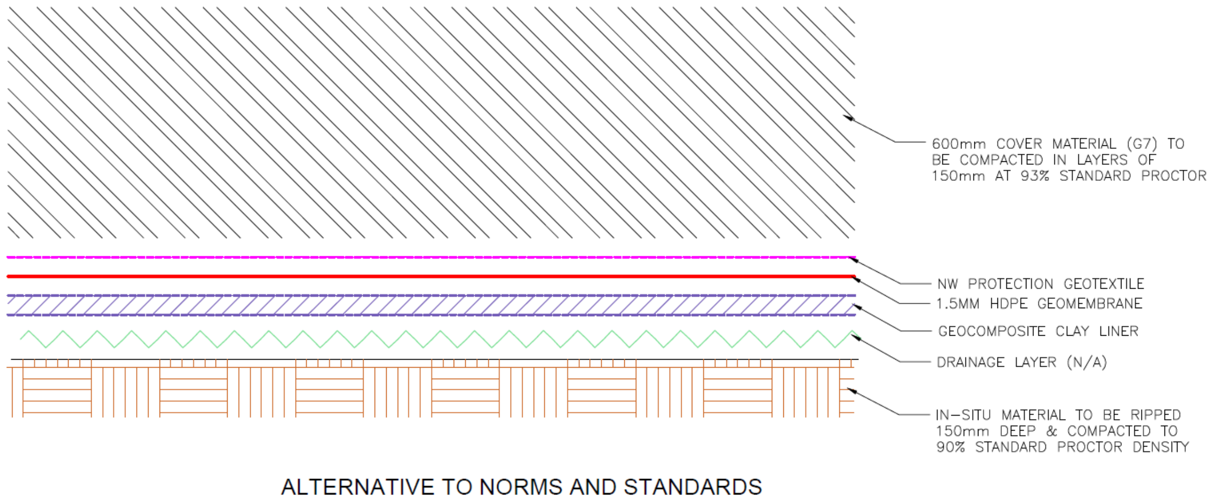


Figure 5: Alternative Barrier for Stockpile area

Alternative 3 allows for a series of groundwater interception boreholes which will collect dirty water infiltration. This specific alternative should be further explored, and a groundwater specialist should be appointed to investigate the feasibility and design of the interception system.

9. STREAM CROSSINGS

There are four stream crossing required for the mining operation. The stream crossings are deemed clean as trucks are assumed to be covered with sails to eliminate carbonations material from spilling on the clean areas.

The locations of the stream crossings are listed below:

	X - Co-ordinate	Y- Co-ordinate
Stream Crossing 1	-2866640.253	8261.683
Stream Crossing 2	-2866952.785	8120.188
Stream Crossing 3	-2867957.252	7931.327
Stream Crossing 4	-2868359.492	8103.569
**LO 29 South African Survey grid, WGS 84*		

For the purpose of this report it should be noted that all the stream crossings will be clean. The sizing of the stream crossings will be investigated during the detailed design phase of the project.

10. CONCLUSIONS

BEAL was appointed to conduct a SWMP for Elandsfontein Colliery. The following remarks are made in conclusion of this report:

- Scenario 1 requires 8 pollution control dams;
- Scenario 2 includes the decontamination of dirty water catchments to reduce the number of dams required as well as to reduce the volume of dirty water to be managed. The number of dams can be reduced to between 4 and 5 dams;
- Clean and Dirty Water will be separated by means of Dirty water channels and Clean water diversion berms which include associated culverts at road interception points;
- Four stream crossings are allowed for;
- Surface water infiltration at the stockpile areas should be mitigated by means of a Class C barrier system as per legislation. Alternatives with the same level of performance was proposed in this report;
- The water balance conducted in this study is a high-level desktop water balance, providing high-level water balance outputs; and
- The storm water management infrastructure was sized to comply with GN704 and is presented in Appendix B.

11. ASSUMPTIONS, QUALIFICATIONS AND LIMITATION

- A detailed groundwater study should be conducted to investigate the interception borehole alternative;
- A detailed engineering design should be conducted including a geotechnical assessment;
- It should be noted that the decontamination of the areas should be delineated by a soil specialist and the quality assurance should be carried out by a third party;
- Third party quality assurance will be required during the implementation phase of the project;
- Chemical compatibility testing was not considered in this report.

12. REFERENCES

- Middleton, B.J. and Bailey, A.K., Water Resources of South Africa, 2005 study (WR2005), 2009. WRC Report No TT 382/08.
- Midgley, D.C., Pitman, W.V., Middleton, B.J. Surface Water Resources of South Africa, 1990. WRC Report No 298/2.1/94, Volume 2.

Dr Bruce Randell (Pr. Eng.)
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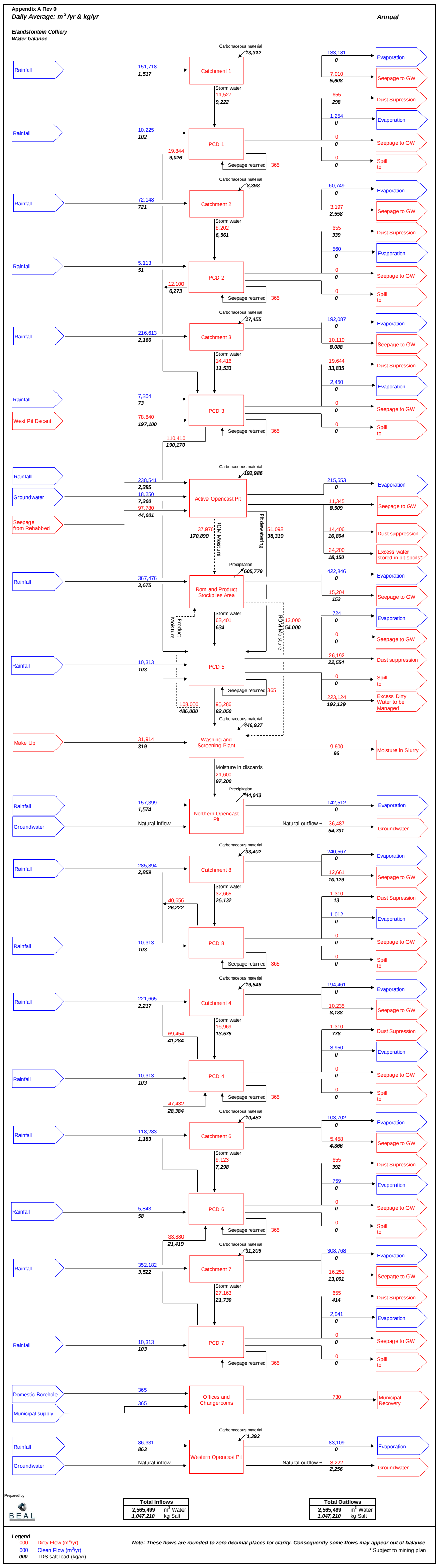
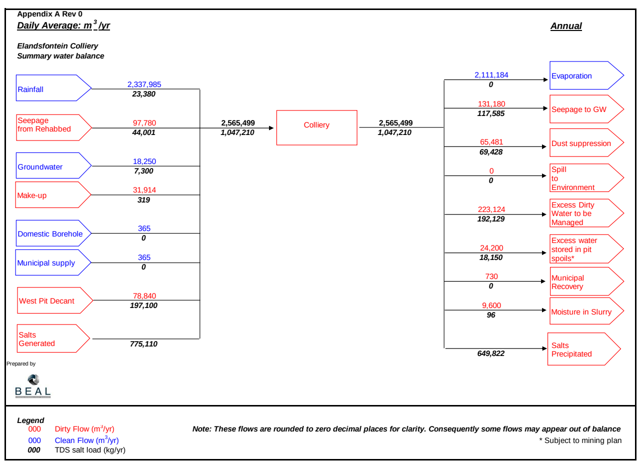
APPENDIX A

WATER AND SALT BALANCE DIAGRAMS

APPENDIX B

STORM WATER MANAGEMENT DRAWINGS





Salt balance / Water balance

Catchment 1

Salt balance:

In	Out	Diff
1,517.2	0.0	
13,312.3	5,607.6	
	9,221.8	
14,829.5	14,829.5	0.0

Water balance:

In	Out	Diff
151,718.2	133,181.4	
	7,009.5	
	11,527.3	
151,718.2	151,718.2	0.0

PCD 1

Salt balance:

In	Out	Diff
102.3	297.8	
9,221.8	0.0	
	0.0	
	0.0	
	9,026.2	
9,324.1	9,324.1	0.0

Water balance:

In	Out	Diff
10,225.2	654.8	
11,527.3	1,253.7	
	0.0	
	0.0	
	19,844.0	
21,752.5	21,752.5	0.0

Catchment 2

Salt balance:

In	Out	Diff
721.5	0.0	
8,397.8	2,557.8	
	6,561.4	
9,119.3	9,119.3	0.0

Water balance:

In	Out	Diff
72,147.7	60,748.6	
	3,197.3	
	8,201.8	
72,147.7	72,147.7	0.0

PCD 2

Salt balance:

In	Out	Diff
51.1	0.0	
6,561.4	0.0	
	0.0	
	339.5	
	6,273.1	
6,612.5	6,612.5	0.0

Water balance:

In	Out	Diff
5,112.6	559.6	
8,201.8	0.0	
	0.0	
	654.8	
	12,100.0	
13,314.4	13,314.4	0.0

Catchment 3

Salt balance:

In	Out	Diff
2,166.1	0.0	
17,454.7	8,087.9	
	11,533.0	
19,620.8	19,620.8	0.0

Water balance:

In	Out	Diff
216,612.6	192,086.6	
	10,109.8	
	14,416.2	
216,612.6	216,612.6	0.0

PCD 3

Salt balance:

In	Out	Diff
73.0	0.0	
197,100.0	0.0	
9,026.2	0.0	
11,533.0	33,835.3	
6,273.1	190,170.0	
224,005.3	224,005.3	0.0

Water balance:

In	Out	Diff
7,303.7	2,449.6	
78,840.0	0.0	
19,844.0	0.0	
14,416.2	19,644.3	
12,100.0	110,410.0	
132,503.9	132,503.9	0.0

Opencast Pit

Salt balance:

In	Out	Diff
2,385.4	170,889.9	
7,300.0	0.0	
44,001.2	8,508.7	
192,985.7	10,804.4	
	38,319.4	
	18,150.0	
246,672.3	246,672.3	0.0

Water balance:

In	Out	Diff
238,541.3	37,975.5	
18,250.0	215,553.0	
97,780.4	11,344.9	
	14,405.8	
	51,092.5	
	24,200.0	
354,571.7	354,571.7	0.0

ROM and Product Stockpiles

Salt balance:

In	Out	Diff
3,674.8	0.0	
486,000.0	152.0	
170,889.9	634.0	
	605,778.6	
	54,000.0	
660,564.7	660,564.7	0.0

Water balance:

In	Out	Diff
367,475.6	422,846.3	
108,000.0	15,203.7	
37,975.5	63,401.0	
	12,000.0	
513,451.1	513,451.1	0.0

PCD 5

Salt balance:

In	Out	Diff
103.1	0.0	
190,170.0	0.0	
26,221.8	22,553.9	
634.0	0.0	
38,319.4	192,129.1	
41,284.2	82,049.5	
296,732.5	296,732.5	0.0

Water balance:

In	Out	Diff
10,312.9	724.0	
110,410.0	0.0	
40,656.0	26,192.4	
63,401.0	0.0	
51,092.5	223,124.0	
69,454.0	95,286.0	
345,326.4	345,326.4	0.0

Washing and screening plant

Salt balance:

In	Out	Diff
319.1	96.0	
82,049.5	97,200.0	
54,000.0		
446,927.4	486,000.0	
583,296.0	583,296.0	0.0

Water balance:

In	Out	Diff
31,914.0	9,600.0	
95,286.0	21,600.0	
12,000.0	108,000.0	
139,200.0	139,200.0	0.0

Northern Opencast Pit

Salt balance:

In	Out	Diff
1,574.0	0.0	
97,200.0	54,730.8	
	44,043.2	
98,774.0	98,774.0	0.0

Water balance:

In	Out	Diff
157,399.1	142,511.9	
21,600.0	36,487.2	
178,999.1	178,999.1	0.0

Catchment 8

Salt balance:

In	Out	Diff
2,858.9	0.0	
33,402.0	10,129.2	
	26,131.8	
36,260.9	36,260.9	0.0

Water balance:

In	Out	Diff
285,893.6	240,567.4	
	12,661.4	
	32,664.7	
285,893.6	285,893.6	0.0

PCD 8

Salt balance:

In	Out	Diff
103.1	13.1	
26,131.8	0.0	
	0.0	
	0.0	
	26,221.8	
26,234.9	26,234.9	0.0

Water balance:

In	Out	Diff
10,312.9	1,309.6	
32,664.7	1,012.0	
	0.0	
	0.0	
	40,656.0	
42,977.6	42,977.6	0.0

Catchment 4

Salt balance:

In	Out	Diff
2,216.6	0.0	
19,546.4	8,187.8	
	13,575.3	
21,763.1	21,763.1	0.0

Water balance:

In	Out	Diff
221,664.6	194,460.8	
	10,234.8	
	16,969.1	
221,664.6	221,664.6	0.0

PCD 4

Salt balance:

In	Out	Diff
103.1	778.5	
28,384.3	0.0	
13,575.3	0.0	
	0.0	
	41,284.2	
42,062.7	42,062.7	0.0

Water balance:

In	Out	Diff
10,312.9	1,309.6	
47,432.0	3,950.3	
16,969.1	0.0	
	0.0	
	69,454.0	
74,713.9	74,713.9	0.0

Catchment 6

Salt balance:

In	Out	Diff
1,182.8	0.0	
10,481.9	4,366.4	
	7,298.3	
11,664.7	11,664.7	0.0

Water balance:

In	Out	Diff
118,283.2	103,702.3	
	5,458.0	
	9,122.9	
118,283.2	118,283.2	0.0

PCD 6

Salt balance:

In	Out	Diff
7,298.3	0.0	
58.4	0.0	
21,419.4	0.0	
	391.9	
	28,384.3	
28,776.2	28,776.2	0.0

Water balance:

In	Out	Diff
9,122.9	759.1	
5,843.0	0.0	
33,880.0	0.0	
	654.8	
	47,432.0	
48,845.9	48,845.9	0.0

Catchment 7

Salt balance:

In	Out	Diff
3,521.8	0.0	
31,209.2	13,000.7	
	21,730.3	
34,731.0	34,731.0	0.0

Water balance:

In	Out	Diff
352,181.5	308,767.8	
	16,250.9	
	27,162.9	
352,181.5	352,181.5	0.0

PCD 7

Salt balance:

In	Out	Diff
103.1	414.0	
21,730.3	0.0	
	0.0	
	0.0	
	21,419.4	
21,833.4	21,833.4	0.0

Water balance:

In	Out	Diff
10,312.9	654.8	
27,162.9	2,940.9	
	0.0	
	0.0	
	33,880.0	
37,475.7	37,475.7	0.0

Western Open Pit

Salt balance:

In	Out	Diff
863.3	0.0	
1,392.3		
	2,255.6	
2,255.6	2,255.6	0.0

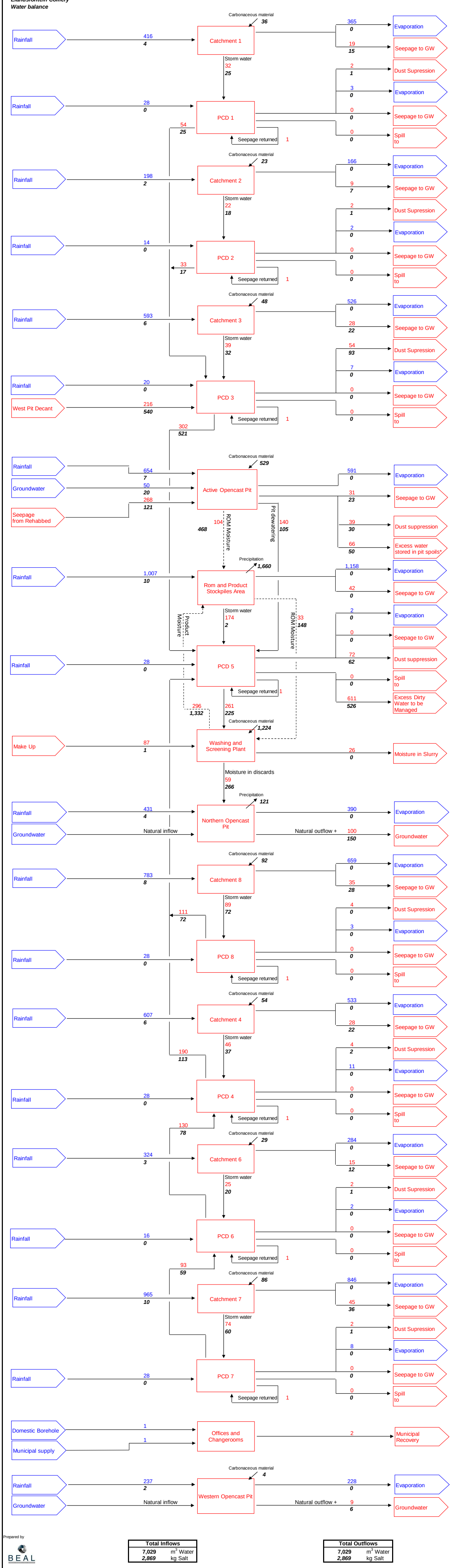
Water balance:

In	Out	Diff
86,331.4	83,109.1	
	3,222.3	
86,331.4	86,331.4	0.0

Appendix A Rev 0

Daily Average: m^3/day & kg/day — ***Full Year***

Elandsfontein Colliery
Water balance



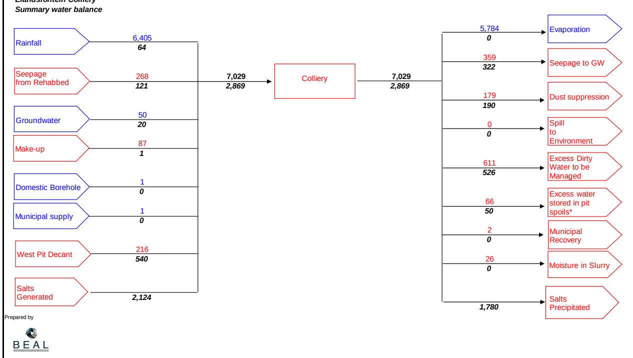
Legend
000 Dirty Flow (m^3/day)
000 Clean Flow (m^3/day)
000 TDS salt load (kg/day)

Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance
* Subject to mining plan

Appendix A Rev 0

Daily Average: m^3/day — ***Full Year***

Elandsfontein Colliery
Summary water balance



Legend
000 Dirty Flow (m^3/day)
000 Clean Flow (m^3/day)
000 TDS salt load (kg/day)

Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance
* Subject to mining plan

Salt balance

Catchment 1

In	Out	Diff
4.2	0.0	
36.5	15.4	
	25.3	
40.6	40.6	0.0

PCD 1

In	Out	Diff
0.3	0.8	
25.3	0.0	
	0.0	
	0.0	
	24.7	
25.5	25.5	0.0

Catchment 2

In	Out	Diff
2.0	0.0	
23.0	7.0	
	18.0	
25.0	25.0	0.0

PCD 2

In	Out	Diff
0.1	0.0	
18.0	0.0	
	0.0	
	0.9	
	17.2	
18.1	18.1	0.0

Catchment 3

In	Out	Diff
5.9	0.0	
47.8	22.2	
	31.6	
53.8	53.8	0.0

PCD 3

In	Out	Diff
0.2	0.0	
540.0	0.0	
24.7	0.0	
31.6	92.7	
17.2	521.0	
613.7	613.7	0.0

Opencast Pit

In	Out	Diff
6.5	468.2	
20.0	0.0	
120.6	23.3	
528.7	29.6	
	105.0	
	49.7	
675.8	675.8	0.0

ROM and Product Stockpiles

In	Out	Diff
10.1	0.0	
1,331.5	0.4	
468.2	1.7	
	1,659.7	
	147.9	
1,809.8	1,809.8	0.0

PCD 5

In	Out	Diff
0.3	0.0	
521.0	0.0	
71.8	61.8	
1.7	0.0	
105.0	526.4	
113.1	224.8	
813.0	813.0	0.0

Washing and screening plant

In	Out	Diff
0.9	0.3	
224.8	266.3	
147.9		
1,224.5	1,331.5	
1,598.1	1,598.1	0.0

Northern Opencast Pit

In	Out	Diff
4.3	0.0	
266.3	149.9	
	120.7	
270.6	270.6	0.0

Catchment 8

In	Out	Diff
7.8	0.0	
91.5	27.8	
	71.6	
99.3	99.3	0.0

PCD 8

In	Out	Diff
0.3	0.0	
71.6	0.0	
	0.0	
	0.0	
	71.8	
71.9	71.9	0.0

Catchment 4

In	Out	Diff
6.1	0.0	
53.6	22.4	
	37.2	
59.6	59.6	0.0

PCD 4

In	Out	Diff
0.3	2.1	
77.8	0.0	
37.2	0.0	
	0.0	
	113.1	
115.2	115.2	0.0

Catchment 6

In	Out	Diff
3.2	0.0	
28.7	12.0	
	20.0	
32.0	32.0	0.0

PCD 6

In	Out	Diff
20.0	0.0	
0.2	0.0	
58.7	0.0	
	1.1	
	77.8	
78.8	78.8	0.0

Catchment 7

In	Out	Diff
9.6	0.0	
85.5	35.6	
	59.5	
95.2	95.2	0.0

PCD 7

In	Out	Diff
0.3	1.1	
59.5	0.0	
	0.0	
	0.0	
	58.7	
59.8	59.8	0.0

Western Open Pit

In	Out	Diff
2.4	0.0	
3.8		
	6.2	
6.2	6.2	0.0

Water balance

Catchment 1

In	Out	Diff
415.7	364.9	
	19.2	
	31.6	
415.7	415.7	0.0

PCD 1

In	Out	Diff
28.0	1.8	
31.6	3.4	
	0.0	
	0.0	
	54.4	
59.6	59.6	0.0

Catchment 2

In	Out	Diff
197.7	166.4	
	8.8	
	22.5	
197.7	197.7	0.0

PCD 2

In	Out	Diff
14.0	1.5	
22.5	0.0	
	0.0	
	1.8	
	33.2	
36.5	36.5	0.0

Catchment 3

In	Out	Diff
593.5	526.3	
	27.7	
	39.5	
593.5	593.5	0.0

PCD 3

In	Out	Diff
20.0	6.7	
216.0	0.0	
54.4	0.0	
39.5	53.8	
33.2	302.5	
363.0	363.0	0.0

Opencast Pit

In	Out	Diff
653.5	104.0	
50.0	590.6	
267.9	31.1	
	39.5	
	140.0	
	66.3	
971.4	971.4	0.0

ROM and Product Stockpiles

In	Out	Diff
1,006.8	1,158.5	
295.9	41.7	
104.0	173.7	
	32.9	
1,406.7	1,406.7	0.0

PCD 5

In	Out	Diff
28.3	2.0	
302.5	0.0	
111.4	71.8	
173.7	0.0	
140.0	611.3	
190.3	261.1	
946.1	946.1	0.0

Washing and screening plant

In	Out	Diff
87.4	26.3	
261.1	59.2	
32.9	295.9	
381.4	381.4	0.0

Northern Opencast Pit

In	Out	Diff
431.2	390.4	
59.2	100.0	
490.4	490.4	0.0

Catchment 8

In	Out	Diff
783.3	659.1	
	34.7	
	89.5	
783.3	783.3	0.0

PCD 8

In	Out	Diff
28.3	3.6	
89.5	2.8	
	0.0	
	0.0	
	111.4	
117.7	117.7	0.0

Catchment 4

In	Out	Diff
607.3	532.8	
	28.0	
	46.5	
607.3	607.3	0.0

PCD 4

In	Out	Diff
28.3	3.6	
130.0	10.8	
46.5	0.0	
	0.0	
	190.3	
204.7	204.7	0.0

Catchment 6

In	Out	Diff
324.1	284.1	
	15.0	
	25.0	
324.1	324.1	0.0

PCD 6

In	Out	Diff
25.0	2.1	
16.0	0.0	
92.8	0.0	
	1.8	
	130.0	
133.8	133.8	0.0

Catchment 7

In	Out	Diff
964.9	845.9	
	44.5	
	74.4	
964.9	964.9	0.0

PCD 7

In	Out	Diff
28.3	1.8	
74.4	8.1	
	0.0	
	0.0	
	92.8	
102.7	102.7	0.0

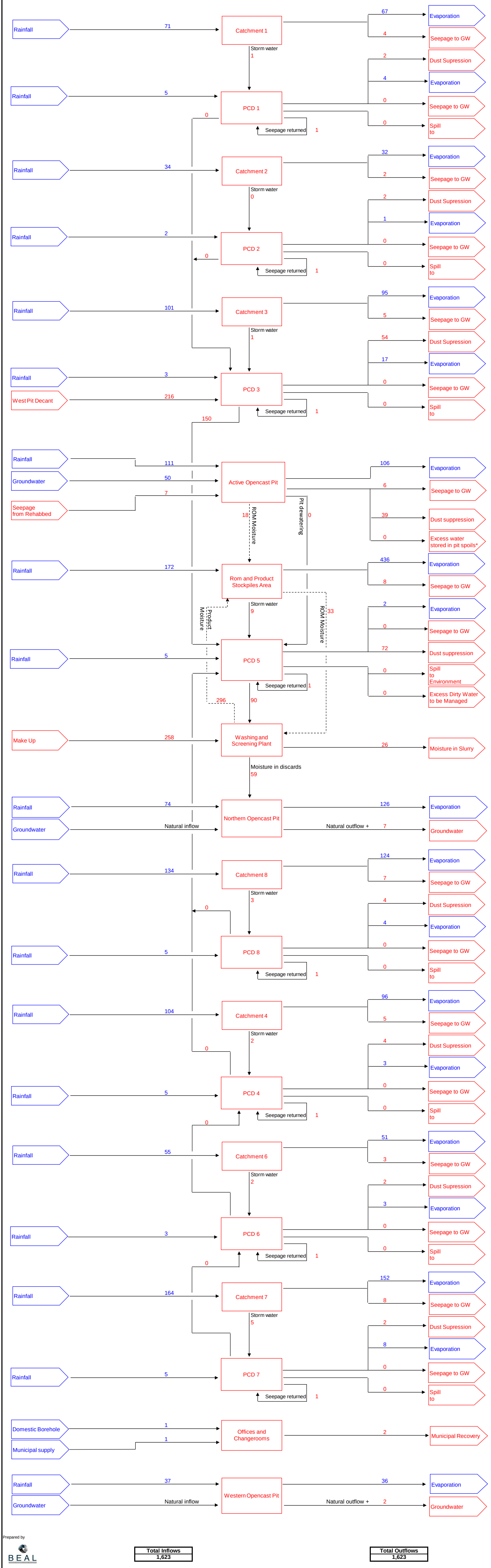
Western Open Pit

In	Out	Diff
236.5	227.7	
	8.8	
236.5	236.5	0.0

Appendix A Rev 0

Daily Average: m³/day — **Dry Season**

Elandsfontein Colliery
Water balance



Prepared by
BEAL

Legend
000 Dirty Flow (m³/day)
000 Clean Flow (m³/day)

Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance
* Subject to mining plan

Water balance

Catchment 1		
In	Out	Diff
70.9	66.6	
	3.5	
	0.7	
70.9	70.9	0.0

PCD 1		
In	Out	Diff
4.8	1.8	
0.7	3.7	
	0.0	
	0.0	
	0.0	
5.5	5.5	0.0

Catchment 2		
In	Out	Diff
33.7	31.7	
	1.7	
	0.3	
33.7	33.7	0.0

PCD 2		
In	Out	Diff
2.4	0.9	
0.3	0.0	
	0.0	
	1.8	
	0.0	
2.7	2.7	0.0

Catchment 3		
In	Out	Diff
101.2	95.2	
	5.0	
	1.0	
101.2	101.2	0.0

PCD 3		
In	Out	Diff
3.4	16.6	
216.0	0.0	
0.0	0.0	
1.0	53.8	
0.0	150.0	
220.4	220.4	0.0

Opencast Pit		
In	Out	Diff
111.4	17.7	
50.0	105.5	
7.1	5.6	
	39.5	
	0.3	
	0.0	
168.6	168.6	0.0

ROM and Product Stockpiles		
In	Out	Diff
171.6	435.6	
295.9	8.2	
17.7	8.6	
	32.9	
485.2	485.2	0.0

PCD 5		
In	Out	Diff
4.8	2.0	
150.0	0.0	
0.0	71.8	
8.6	0.0	
0.3	0.0	
0.0	90.0	
163.7	163.7	0.0

Washing and screening plant		
In	Out	Diff
258.5	26.3	
90.0	59.2	
32.9	295.9	
381.4	381.4	0.0

Northern Opencast Pit		
In	Out	Diff
73.5	125.5	
59.2	7.2	
132.7	132.7	0.0

Catchment 8		
In	Out	Diff
133.5	124.3	
	6.5	
	2.7	
133.5	133.5	0.0

PCD 8		
In	Out	Diff
4.8	3.6	
2.7	3.9	
	0.0	
	0.0	
	0.0	
7.5	7.5	0.0

Catchment 4		
In	Out	Diff
103.5	96.4	
	5.1	
	2.1	
103.5	103.5	0.0

PCD 4		
In	Out	Diff
4.8	3.6	
0.0	3.3	
2.1	0.0	
	0.0	
	0.0	
6.9	6.9	0.0

Catchment 6		
In	Out	Diff
55.2	50.9	
	2.7	
	1.7	
55.2	55.2	0.0

PCD 6		
In	Out	Diff
1.7	2.6	
2.7	0.0	
0.0	0.0	
	1.8	
	0.0	
4.4	4.4	0.0

Catchment 7		
In	Out	Diff
164.5	151.6	
	8.0	
	4.9	
164.5	164.5	0.0

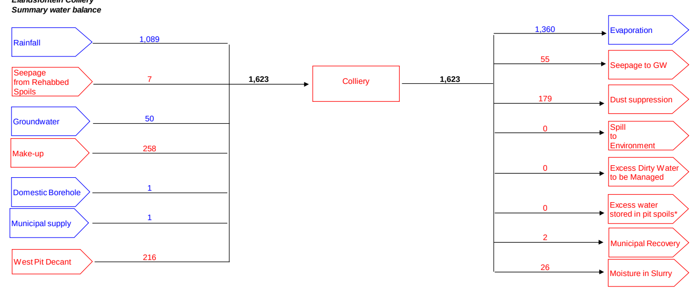
PCD 7		
In	Out	Diff
4.8	1.8	
4.9	8.0	
	0.0	
	0.0	
	0.0	
9.8	9.8	0.0

Western Open Pit		
In	Out	Diff
37.3	35.6	
	1.7	
37.3	37.3	0.0

Appendix A Rev 0

Daily Average: m³/day — **Dry Season**

Elandsfontein Colliery
Summary water balance



Prepared by
BEAL

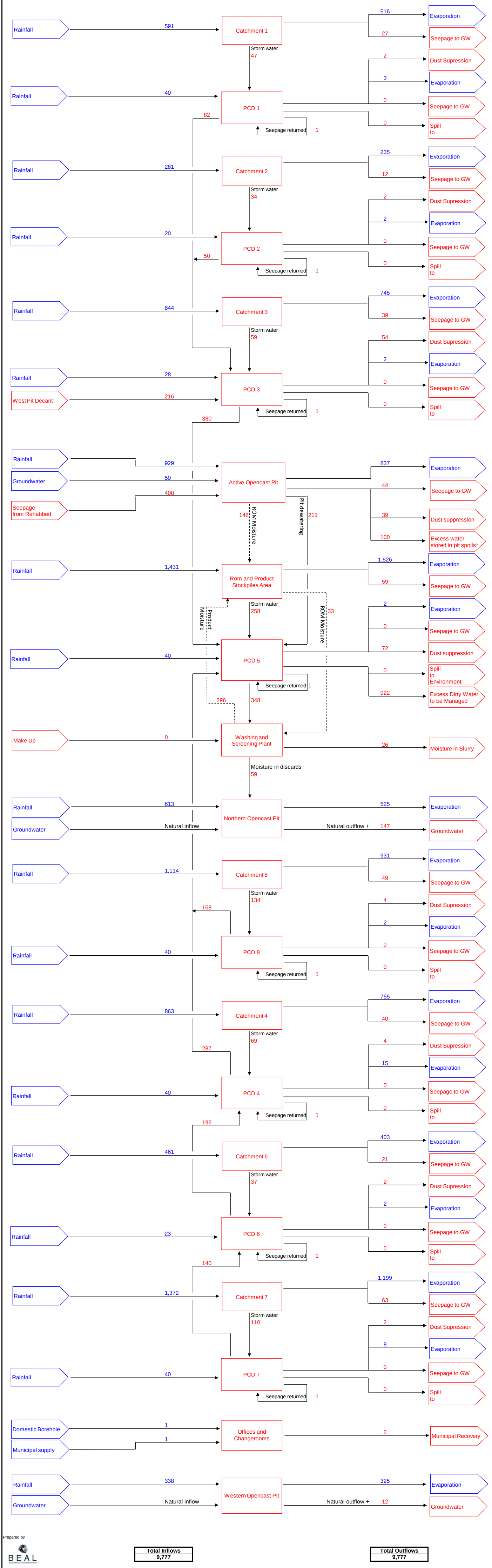
Legend
000 Dirty Flow (m³/day)
000 Clean Flow (m³/day)

Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance
* Subject to mining plan

Appendix A Rev 0

Daily Average: m³/day ***Wet Season***

Elandsfontein Colliery
Water balance



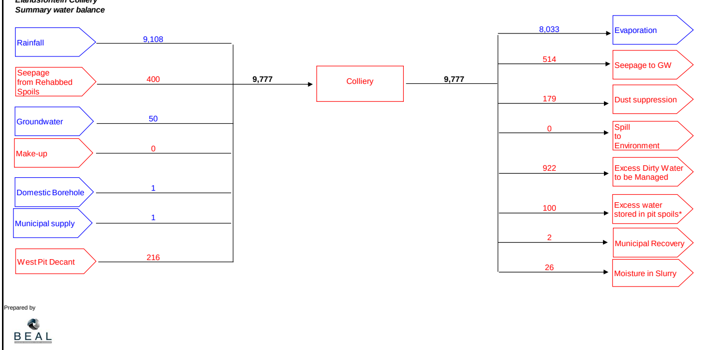
Legend
000 Dirty Flow (m³/day)
000 Clean Flow (m³/day)

Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance
* Subject to mining plan

Appendix A Rev 0

Daily Average: m³/day ***Wet Season***

Elandsfontein Colliery
Summary water balance



Legend
000 Dirty Flow (m³/day)
000 Clean Flow (m³/day)

Note: These flows are rounded to zero decimal places for clarity. Consequently some flows may appear out of balance
* Subject to mining plan

Water balance

Catchment 1		
In	Out	Diff
590.9	516.5	
	27.2	
	47.3	
590.9	590.9	0.0

PCD 1		
In	Out	Diff
39.8	1.8	
47.3	3.3	
	0.0	
	0.0	
	82.0	
87.1	87.1	0.0

Catchment 2		
In	Out	Diff
281.0	234.9	
	12.4	
	33.7	
281.0	281.0	0.0

PCD 2		
In	Out	Diff
19.9	1.8	
33.7	0.0	
	0.0	
	1.8	
	50.0	
53.6	53.6	0.0

Catchment 3		
In	Out	Diff
843.7	745.4	
	39.2	
	59.1	
843.7	843.7	0.0

PCD 3		
In	Out	Diff
28.4	1.7	
216.0	0.0	
82.0	0.0	
59.1	53.8	
50.0	380.0	
435.5	435.5	0.0

Opencast Pit		
In	Out	Diff
929.1	147.9	
50.0	837.1	
400.4	44.1	
	39.5	
	211.0	
	100.0	
1,379.5	1,379.5	0.0

ROM and Product Stockpiles		
In	Out	Diff
1,431.3	1,525.9	
295.9	58.7	
147.9	257.6	
	32.9	
1,875.1	1,875.1	0.0

PCD 5		
In	Out	Diff
40.2	2.0	
380.0	0.0	
168.0	71.8	
257.6	0.0	
211.0	922.0	
287.0	348.0	
1,343.8	1,343.8	0.0

Washing and screening plant		
In	Out	Diff
0.5	26.3	
348.0	59.2	
32.9	295.9	
381.4	381.4	0.0

Northern Opencast Pit		
In	Out	Diff
613.0	525.1	
59.2	147.1	
672.2	672.2	0.0

Catchment 8		
In	Out	Diff
1,113.5	930.9	
	49.0	
	133.6	
1,113.5	1,113.5	0.0

PCD 8		
In	Out	Diff
40.2	3.6	
133.6	2.2	
	0.0	
	0.0	
	168.0	
173.8	173.8	0.0

Catchment 4		
In	Out	Diff
863.3	754.6	
	39.7	
	69.1	
863.3	863.3	0.0

PCD 4		
In	Out	Diff
40.2	3.6	
196.0	14.6	
69.1	0.0	
	0.0	
	287.0	
305.2	305.2	0.0

Catchment 6		
In	Out	Diff
460.7	402.6	
	21.2	
	36.9	
460.7	460.7	0.0

PCD 6		
In	Out	Diff
36.9	1.8	
22.8	0.0	
140.0	0.0	
	1.8	
	196.0	
199.6	199.6	0.0

Catchment 7		
In	Out	Diff
1,371.7	1,198.9	
	63.1	
	109.7	
1,371.7	1,371.7	0.0

PCD 7		
In	Out	Diff
40.2	1.8	
109.7	8.1	
	0.0	
	0.0	
	140.0	
149.9	149.9	0.0

Western Open Pit		
In	Out	Diff
337.8	325.3	
	12.5	
337.8	337.8	0.0