LEHATING MINE

PRE-FEASIBILITY DESIGN OF THE
TAILINGS STORAGE FACILITY
PRE-FEASIBILITY DESIGN REPORT

Report No.: JW028/12/D087 - Rev 1

FEBRUARY 2012

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SYNOPSIS

Lehating Mine is a planned underground manganese mine located approximately 73km north-west of Kuruman in the Northern Cape Province, South Africa. The mining of the Wessels-type Mn ore will result in tailings with a grading of less than 1mm, which will require a Tailings Storage Facility (TSF). Jones and Wagener were appointed to perform a pre-feasibility design and cost estimate for a Tailings Storage Facility (TSF) for these tailings. This document constitutes the Pre-Feasibility Design Report for the TSF.

Four potential sites were reviewed for the TSF. The preferred site, termed Option 1, has no fatal social or environmental flaws, and represents a low to medium hazard. The environmental consultant on the project, SLR Consulting, stated that, "the tailings [are] unlikely to impact chemically on the underlying environment and [are] unlikely to generate acid mine drainage. Therefore, lining of the tailings storage facility may not be required. Further test work as detailed below would be needed to confirm this."

The TSF has been sized for a tailings volumetric deposition rate of 1268 m^3/month (dry bulk density = 2200 kg/m^3), a 20 year design life. In sizing the TSF it was ensured that the annual rate of rise did not exceed 3m, and that the total height of the facility did not exceed 20m. This height included a 2m freeboard.

SLR Consulting's suggestion that a liner may not be required for this facility has a major bearing on the cost of the facility, since these liners are very expensive. The alternative of a clay lining for the basin of the TSF is dependent on suitable clayey soil being found within relatively close proximity to the site. The construction estimate of the TSF is approximately R7,860,000 (including liner costs).

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1. INTRODUCTION

1.1 Background

Lehating Mine is a planned underground manganese mine located approximately 20km north-west of Hotazel, and 73km north-west of Kuruman in the Northern Cape Province, South Africa (please refer to **Figure 1**). The proposed mine is situated on Portion 1 of the farm Lehating 741, i.e. a greenfields site. The proposed mine is within the Kalahari Manganese Field (KMF).

This farm is situated on the northern side of the Kuruman River, in quaternary subcatchment D41M, in the upper reaches of the Kuruman River catchment. The mean annual precipitation is between 300-400mm, while the mean annual evaporation is in the region of 2200-2600mm (see Surface Water Resources of South Africa 1990: Book of Maps: Volume III, WRC Report number 298/3.2/94).

J&W were requested on 9 May 2011 to submit a proposal for the pre-feasibility design of the Tailings Storage Facility (TSF) by Mr Michiel Kemink of Lehating Mine. J&W were subsequently appointed to undertake this project.

The terms of reference for the proposal included the following:

- Confirmation of the production tonnages and LOM requirements,
- Site selection for the tailings waste facility (TSF),
- Pre-feasibility engineering design drawings (level of detail at 30% accuracy),
- Construction Cost Estimate (+/-20% accuracy),
- Pre-Feasibility Design Report.

The purpose of the project is to provide pre-feasibility designs, with recommendations for Bankable Feasibility Designs, construction cost estimates and pre-feasibility drawings. A figure indicating the integration of tasks for the development of a Tailings Storage Facility

(TSF) design report is included in **Appendix B** (including those tasks not included in this Scope of Work).

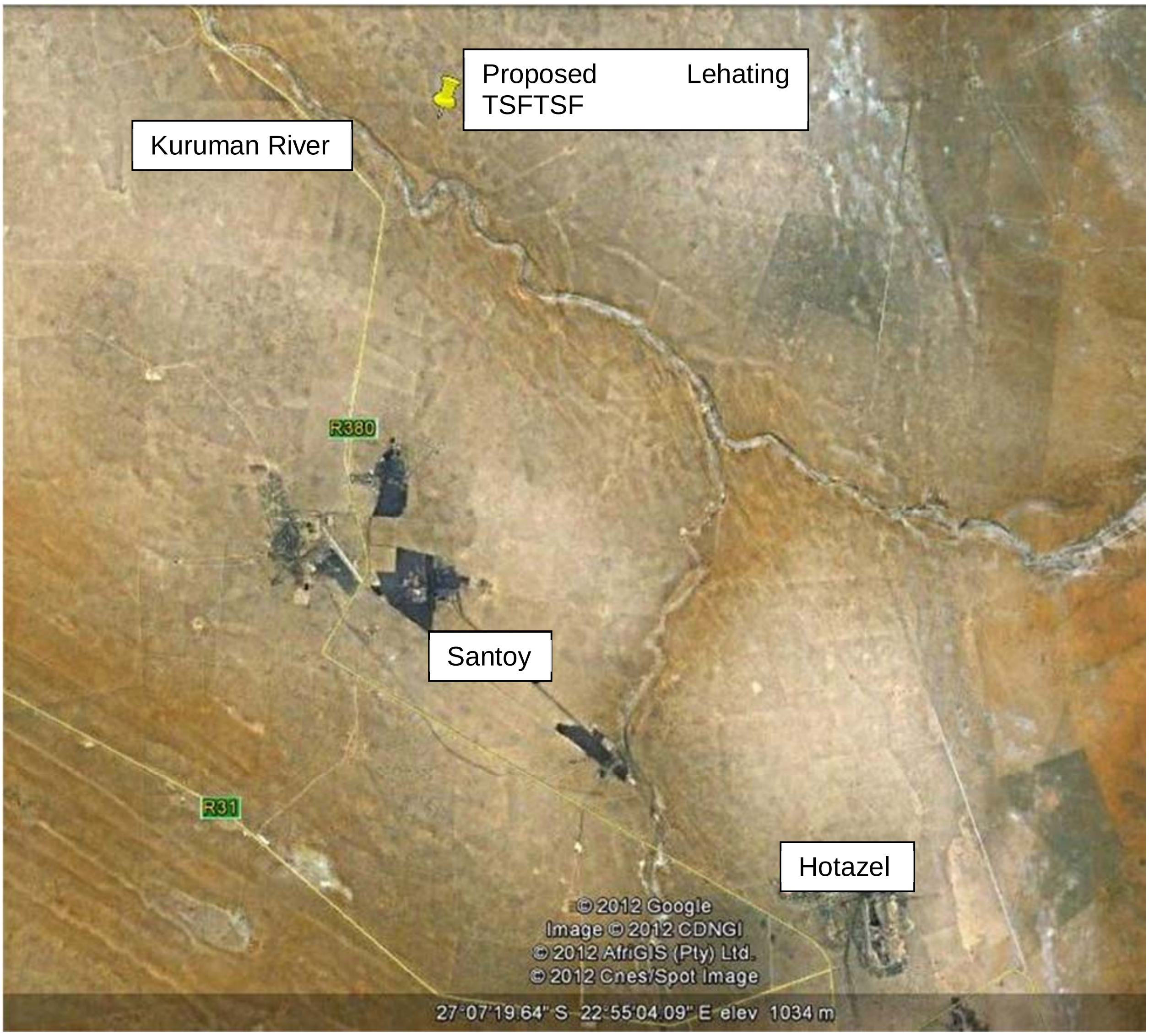


Figure 1: Locality plan of proposed Tailings Storage Facility relative to Hotazel and Santoy

1.2 Scope and Purpose

1.2.1 Confirmation of Production Tonnages and LOM requirements

J&W was required to confirm with Lehating Mine the production tonnages and LOM requirements.

1.2.2 Site Selection

The client was to indicate their preferred site for the greenfields TSF development. J&W would then identify other suitable sites based on desktop first order engineering characteristics. The various sites were to be presented and discussed with the client.

It was assumed that the client would appoint environmental specialists who would be responsible for providing environmental inputs to the site selection phase of the study.

The site selection phase involved two iterations, a desktop phase indicating all available sites, and a pre-feasibility phase that focussed on two or three viable sites.

1.2.3 Pre-Feasibility Design of the TSF

The pre-feasibility design of the TSF involved an iterative process including all components of the TSF. The components are:

- Capacity analyses,
- Geometric design (including slope determination),
- Liner recommendations,
- Penstock/barge recommendations,
- Zone of influence (Note: Hazardous waste classification and characterisation was excluded from this scope. It was assumed that the client would provide the chemical and physical properties and classifications of the waste),
- Filter drain designs,
- Return water sump/dam with pumpstation (excluding pipeline),
- Pre-feasibility design drawings (30% accuracy levels),

1.2.4 Construction Cost Estimate and report

Pre-feasibility level construction cost estimates were to be carried out, based on the various alternatives investigated. The level of accuracy was to be approximately 20% of the final construction costs. A pre-feasibility design report was to be compiled, summarizing the site selection, pre-feasibility design and cost estimates.

1.2.5 Meetings

Several meetings were allowed for in order to discuss the progress of the project, obtain inputs from other specialists, and to present the final draft deliverable.

1.2.6 Exclusions

The following items were excluded from the scope of work:

- The definition of the quality and physical and chemical characteristics of the residue to be stored were to be carried out by a specialist. It was assumed that the quality and physical and chemical characteristics of the residue to be stored would be provided to J&W. No laboratory tests or leachate tests were included in this scope of work. It was assumed that this information would be provided by the client (It is essential that each waste or residue to be stored needs to be subjected to a screening level hazard assessment as described in the Department of Water Affairs' (DWA) Best Practice Guideline (BPG) A2 for water management at TSFs.[1] In addition a conceptual level model must be prepared, as well as a screening level risk assessment and geochemical sampling and test work).

[1] Department of Water Affairs and Forestry, 2007. Best Practice Guideline A2: Water Management for Tailings Storage Facilitys, page 9

- It was assumed that hydrological and geohydrological studies appertaining to the proposed TSF site would be made available to J&W. No such studies formed part of this project (According to the DWA BPG A2 for water management at TSFs[2] the hydrological and stormwater component includes delineating catchments, undertaking hydrological calculations, preparing a conceptual water balance, river flow measurements and water quality assessment and identifying surface water impacts. The hydrogeology component includes undertaking a hydrocensus, borehole siting, drilling and testing, and identifying groundwater impacts.)
- Environmental baseline studies, environmental impact assessments, permitting and applications (e.g. water use license applications, etc.) were excluded from the scope of work. It was assumed that the client would appoint an environmental consultant who would incorporate all of the environmental inputs and application processes into their scope of work.
- No site visits were envisaged for the pre-feasibility design phase. If site visits were required during the project, they could be performed at normal J&W rates.
- Geotechnical investigations were excluded from this phase.
- Additional work required not included in this scope

1.2.7 Deliverables

The deliverable of the contract must include:

- Pre-feasibility design report,
- Pre-feasibility design drawings (30% accuracy) with cost estimates (20% accuracy)

1.3 Report Structure

This report consists of two volumes. Volume I of II is the pre-feasibility design report. Volume II of II is a book of plans. The book of plans is an A3 document. The drawings within this book of plans have however been reduced from A1 size drawings.

1.4 Definitions and Abbreviations

1.4.1 Commercial

J&W	**J**ones **&** **W**agener (Pty) Ltd
DWA	**D**epartment of **W**ater **A**ffairs

1.4.2 Technical

TSF	**T**ailings **S**torage **F**acility
LOM	**L**ife **O**f **M**ine
SG	**S**pecific **G**ravity = ρ / ρ_{H2O} (unitless)
EIA	**E**nvironmental **I**mpact **A**ssessment
BPG	**B**est **P**ractice **G**uideline
HDPE	**H**igh **D**ensity **P**olyethylene

[2] Department of Water Affairs and Forestry, 2007. Best Practice Guideline A2: Water Management for Tailings Storage Facilitys, page 13

Symbols

ρ	Density, kg/m^3
φ'	Effective stress angle of internal friction, degrees
c'	Cohesion in terms of effective stresses, kPa

1.5 Reference Documents

The following references were consulted in preparing the scope of the investigation:

(i) Department of Water Affairs and Forestry, 2007. Best Practice Guideline A2: Water Management for Tailings Storage Facilities (ISBN 978-0-9802679-3-8)

(ii) SABS 0286:1998. Code of Practice for Mine Residue[3]

2. LEGAL FRAMEWORK

The DWA BPG A2 for water management at Tailings Storage Facilitys provides the following principle legal framework for TSFs[4]:

- The National Water Act, 1998 (Act No.36 of 1998) stipulates that a water use authorisation must be obtained before construction of a TSF and/or return water dam may commence.
- Government Notice No. 704, National Water Act, 1998 (Act No. 36 of 1998) deals with regulations on the use of water for mining and related activities aimed at the protection of water resources. Specific attention is drawn to the following pertinent regulations under this notice:
    - Regulation 2: Information and notification
    - Regulation 4: Restrictions on locality
    - Regulation 5: Restrictions on use of material
    - Regulation 6: Capacity requirements of clean and dirty water systems
    - Regulation 7: Protection of water resources
    - Regulation 8: Security and additional measures
    - Regulation 9: Temporary or permanent cessation of a mine.
- The Dam Safety Regulations (published in Government Notice R.1560 of 25 July 1986) requires that every dam with a safety risk shall be classified in accordance with regulation 2.4 on the basis of its size and hazard potential. An authorisation is required from the dam safety office before construction of a dam commences.
- The National Environmental Management Act, 1998 (Act No.107 of 1998) requires that an environmental impact assessment (EIA) must be carried out before the construction of a new TSF commences.
- The Mineral and Petroleum Resources Development Act, 2002 and its regulations requires that an environmental impact assessment be undertaken for a mine, which

[3] Renamed SANS 01286 in later publications

[4] Department of Water Affairs and Forestry, 2007. Best Practice Guideline A2: Water Management for Tailings Storage Facilitys, page 10

will include TSFs. The EIA will include a scoping report and an environmental impact assessment report.

3. PRODUCTION TONNAGES AND LOM REQUIREMENTS

Lehating Mine have provided their design criteria to J&W for the storage of tailings resulting from the mining of Wessels-type manganese ore (see **Appendix A**). These include the following:

- Deposition rate: 2790 tons/month
- Dry (bulk) density: 2200 kg/m^3
- Volumetric deposition rate: 1268 m^3/month
- Design life: 20 years

The Wessels-type ore is a high grade ore, containing on average 44 to 48 wt.% manganese. The Wessels-type ore constitutes about 3% of the known reserves in the Kalahari Manganese Field (KMF), and occurs in the north-western part of the main Kalahari deposit.[5]

4. SITE SELECTION

The objective of the site selection process was to identify the most appropriate site for the development of a TSF. Site selection for TSFs should be made on the basis of:[6]

- Technical viability,
- Economics (development, operational and closure costs),
- Environmental impact,
- Hazard and risk, and
- Resource utilization.

The appropriate level of detail for the site selection process is dictated by the safety classification rating and zone of influence of the TSF as defined in SABS 0286.[7] The safety classification serves to differentiate between residue deposits of high, medium and low hazard on the basis of their potential to cause harm to life or property. It is the basis for identifying the hazards with Tailings Storage Facilities.

Sites that contain potentially fatal flaws such as dykes/faults, wetlands or major water courses within the TSF footprint area are not recommended without suitable mitigation measures. In assessing potential sites (the trade-off study and site selection) it is essential that technical, potential land use, financial and regulatory issues are considered.

[5] Details obtained from Lehating's website: www.lehating.com

[6] Department of Water Affairs and Forestry, 2007. Best Practice Guideline A2: Water Management for Tailings Storage Facilitys, page 15

[7] See SABS 0286:1998, Section 7.2.4, 7.4.1 and 7.4.2 (page 26-27) and Annexure A (page 57)

In addition, the potential environmental and social impacts associated with each location, including potential impacts on archaeological sites, any wetland areas, and/or other ecologically sensitive areas, must be considered.[8]

It is a requirement that no tailings facility be developed in an area with an inherent fatal flaw. The following situations may represent fatal flaws in that they may prohibit the development of an environmentally or publicly acceptable residue disposal facility, except at excessive cost:

- Areas below the 1:50 year flood line - this eliminates wetlands, vlei areas, pans and flood plains, where water pollution would result from residue disposal.
- Areas in close proximity to significant surface water bodies - e.g. water courses or dams.
- Unstable areas - These could include fault zones, seismic zones and dolomitic areas where sinkholes and subsidence are likely.
- Sensitive ecological and/or historical areas - these include nature reserves and areas of ecological and cultural or historical significance.
- Catchment areas for important water resources - although all sites ultimately fall within a catchment area, the size and sensitivity of the catchment may represent a fatal flaw, especially if it feeds an important water resource.
- Areas characterized by flat gradients, shallow or emergent ground water - e.g. vlei areas, pans and springs, where a sufficient unsaturated zone separating the residue and the ground water would not be possible.
- Areas characterized by steep gradients, where the stability of the slopes could be problematic.
- Areas of ground water recharges on account of topography and/or highly permeable soils.
- Areas overlying or adjacent to important or potentially important aquifers.
- Areas characterized by shallow bedrock with little soil cover - These are frequently also associated with steep slopes, which may be unsuitable for residue disposal.
- Areas with insufficient borrow material for starter wall construction and rehabilitation.
- Areas in close proximity to land-uses which are incompatible with residue disposal - land uses which are incompatible with residue disposal would attract community resistance and would include residential areas, nature reserves and cemeteries.
- Areas where adequate buffer zones are not possible – Buffer zones are separations between the residue disposal facility and any adjacent residential or sensitive development. They are established to ensure that the residue disposal operation does not have an adverse impact on quality of life and/or public health.
- Areas immediately upwind of a residential area in the prevailing wind direction(s).

[8] Department of Water Affairs and Forestry, 2007. Best Practice Guideline A2: Water Management for Tailings Storage Facilitys, page 16

- Areas over which servitudes are held that would prevent the establishment of a residue disposal facility - e.g. Rand Water, ESKOM or Roads Department servitudes.
- Any area characterized by any factor that would prohibit the development of a residue facility except at prohibitive cost.

SLR Consulting[9], who provided the pre-feasibility environmental inputs to the site selection process, concluded that, "A number of 'no-go' zones have been identified with regard to the placement of surface infrastructure. These include areas of ecological sensitivity, the 1:100 year flood zone of the Kuruman River, preferential surface water flow paths, the major aquifer zone present above the mineralised zone, and potential areas of archaeological importance associated with the river and sand dune."

Further, SLR Consulting "recommended that the TSF be located at least 100m to the east of the mineralised zone and north of the Kuruman flood zone and associated sensitive habitats, as well as outside of preferential surface water flow paths. This may also have implications for the positioning of the proposed processing and supportive infrastructure."

Four possible sites were selected as part of the site selection process. These are shown in the accompanying Book of Plans, drawings D087-00-030 and D087-00-040 (or in **Appendix C**). In this drawing these sites are identified as Option 1, Option 2, Option 3 and Option 4. Taking into account the various selection criteria, Option 1 was selected as the preferred option for the proposed TSF. Drawings D087-00-050 and D087-00-060 in the accompanying Book of Plans (or **Appendix C**) show the concept design of the TSF for Option 1.

5. PRE-FEASIBILITY DESIGN OF THE TSF

The DWA BPG A2[10] sets out that the TSF should adopt a holistic approach, including:

- Sustainability,
- Full life cycle of the TSF,
- Water quality and quantity, and
- Surface water and groundwater.

5.1 Hazard classification of tailings

The hazard classification was performed by SLR Consulting[11], and what follows under this heading is taken directly from their report.

Based on discussions with the project team, it is SLR's understanding that the tailings material will consist of a thickened slurry made up of the crushed ore that is too fine

[9] *SLR Consulting (Africa) (Pty) Ltd SLR Project L024-02, Report No.1, PRE-FEASIBILITY INPUT FOR THE PROPOSED LEHATING MINE – EIA PROCESS, TAILINGS WASTE CHARACTERISATION AND SITE SELECTION, October 2011, Page 5*

[10] Department of Water Affairs and Forestry, 2007. Best Practice Guideline A2: Water Management for Tailings Storage Facilitys, page 2

[11] *SLR Consulting (Africa) (Pty) Ltd SLR Project L024-02, Report No.1, PRE-FEASIBILITY INPUT FOR THE PROPOSED LEHATING MINE – EIA PROCESS, TAILINGS WASTE CHARACTERISATION AND SITE SELECTION, October 2011, Page 5*

(< 1mm) to be commercially viable. The chemical properties are linked to the lithology of the Hotazel Formation manganese deposits.

In this regard, the manganese deposits are associated with high percentages of Mn, Fe, CaO and SiO2 in an approximate ratio of 5:1:0.8:0.5, respectively. Acid base accounting, leachate tests and pH paste tests of Hotazel Formation manganese ore have been conducted for various mines in the wider area, the results of which show the following trends:

- Acid base accounting tests show low sulphur content; elevated calcium levels; a high neutralising capacity; and unlikely acid formation potential.
- Leachate testing of manganese ore from surrounding mines shows elevated concentrations of Mn, Fe and Ca as well as high electro conductivity and total dissolved solids. In most cases, these concentrations are above the Department of Water Affairs Guidelines for Domestic Use and Livestock Watering as well as the Departments' Minimum Requirements Acceptable Risk Limits.

It should be noted that the elevated concentrations produced by leachate tests are done so under aggressive acidic conditions, and since the ore does not have any acid generating potential, this is unlikely to occur. It is however likely that any leachate produced from this material will be of an alkaline to neutral, saline nature (typical pH of 8 to 10), with the paste pH testing of manganese ore from nearby mines indicating the longevity of the inherent alkalinity. Based on the above trends the tailings is unlikely to impact chemically on the underlying environment and is unlikely to generate acid mine drainage. Therefore, lining of the tailings storage facility may not be required. Further test work as detailed below would be needed to confirm this.

Although results similar to those presented above can be expected, characterisation of the actual Lehating Mine tailings should be carried out to satisfy Section 73(2) of Regulation R527 of the MPRDA. This section calls for the characterisation of waste materials to identify any potentially significant health or safety hazards and environmental impacts that may be associated with the residue when stockpiled or deposited at the site under consideration. Residue stockpiles and deposits must be characterised in terms of their physical and chemical characteristics. It is suggested that a manganese ore sample be taken from exploration cores for further testing. Key aspects in this regard include:

- toxicity;
- propensity to oxidize and decompose;
- propensity to undergo spontaneous combustion;
- pH and chemical composition of the water separated from the solids;
- stability and reactivity and the rate thereof; and
- neutralizing potential.

Spontaneous combustion is not a concern for manganese tailings and is therefore not considered further.

5.2 Capacity analysis of TSF

Various parameters determine the concept design of the TSF. These include the design life of the facility, the total capacity required, the rate of rise, and the freeboard. The life of the facility has been set to 20 years, while the total capacity required is 304364m^3.

(assuming a dry (bulk) density of 2200 kg/m^3 and a deposition rate of 2790 tons /month).[12] The freeboard was set at 2m.

The rate of rise is the level that the TSF may not exceed on an annual basis. The rate of rise factor is significant in that it limits the occurrence of excess pore pressure build-up in the dam, causing failure at the critical points (i.e. the side slopes) of the TSF. A maximum rate of rise of 3m/annum has been utilised for this project. This means that the slimes dam crest may not rise at a rate more than three metres per year. The rate of rise limit is influenced by the construction methodology, material particle characteristics, as well as the chemical and physical characteristics of the tailings.

The side slopes were designed to a 1:3 (one metre vertical to three metres -horizontally) slope, which ensures sustainable and stable side slopes. The dimensions of the proposed slimes dam are shown on Drawing D087-00-050 in **Appendix C**. The optimized footprint area is 181m x 181m, or 32761m^2 (3.3 ha). The maximum proposed slimes storage facility height is 20m (top elevation at 1028 m).

Drawing D087-00-080 in the Book of Plans shows a typical cross-section through a TSF (or refer to **Appendix C**).

The following table provides the rate of rise and capacity analysis of the proposed Lehating Mine TSF.

Table 1: Life of Mine volume calculation for the 181m x 181m TSF

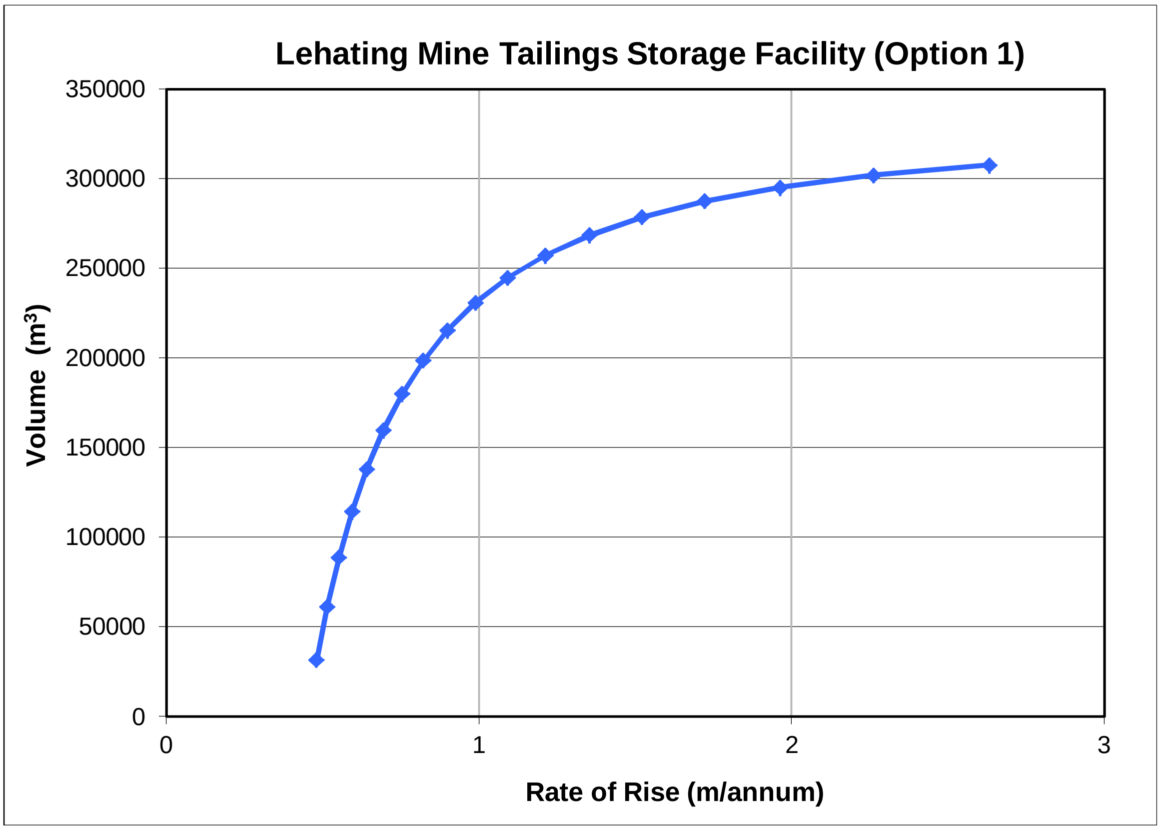
Elevation (m)	Cumulative volume (m^3)	Incremental volume (m^3)	Rate (years)	Duration (years)	ROR
1008					
1009	31687	31687	2.08	2.08	0.5
1010	61274	29587	1.94	4.03	0.5
1011	88833	27559	1.81	5.84	0.6
1012	114436	25603	1.68	7.52	0.6
1013	138155	23719	1.56	9.08	0.6
1014	160062	21907	1.44	10.52	0.7
1015	180229	20167	1.33	11.84	0.8
1016	198728	18499	1.22	13.06	0.8
1017	215631	16903	1.11	14.17	0.9
1018	231010	15379	1.01	15.18	1.0
1019	244937	13927	0.92	16.10	1.1
1020	257484	12547	0.82	16.92	1.2
1021	268723	11239	0.74	17.66	1.4
1022	278726	10003	0.66	18.32	1.5
1023	287565	8839	0.58	18.90	1.7
1024	295312	7747	0.51	19.41	2.0
1025	302039	6727	0.44	19.85	2.3
1026	307818	5779	0.38	20.23	2.6
1027	312721	4903	0.32	20.55	3.1
1028	316820	4099	0.27	20.82	3.7

[12] These design assumptions were provided by Lehating Mine. Refer to Appendix A for more details.

Note that a capacity of 307,818m^3 is available when the facility is at a height of 18m (1026m.amsl), thus ensuring a 2m freeboard. This capacity can be achieved within 20 years (19.85 years), and the rate of rise during this period does not exceed 3m/annum.

The following figure shows graphically the volume of slimes pumped into the TSF against the rate of rise.

Figure 2: Graph of the Rate of Rise versus the Volume of slimes pumped into the TSF



5.3 Design components of TSF

The tailings will be delivered to the site in a slurry consisting of particles finer than 1.0mm and having a slurry density of approximately 1.4 t/m^3.

Drawings D087-00-050 and D087-00-060 in the accompanying Book of Plans (and **Appendix C**) show the design of Option 1, the preferred option, at a pre-feasibility level of detail. Drawing D087-00-070 shows the design of Options 2, 3 and 4 at the same level of detail. The TSF consists of various components, the most important of which is described below.

5.3.1 Starter Wall

The starter wall, or embankment, makes up a large proportion of the cost and work in constructing the deposit. Due to its height, and the volume of fine material stored behind it, the starter wall must be carefully designed and constructed to ensure that it is sufficiently stable.

In South Africa's mining and industrial sectors it is common practice (except for very fine tailings) for the outer retaining structure of the tailings dam to be formed by using a portion of the waste tailings itself, with the rest of the tailings being deposited behind this outer impoundment. A small clay, earth or rock starter wall is first placed to define the toe of the dam.

The two metre high starter wall for Option 1 is shown at a pre-feasibility level of detail in Drawing D087-00-060 in the Book of Plans and in **Appendix C**. The starter wall has a 1:2.5 internal side slope, and a 1:3 external side slope.

An access road and dirty water canal are required along the toe of the main outer wall to facilitate the inspection of the wall.

5.3.2 Liner

The purpose of a lining system is to prevent the pollution of groundwater resources during the operational and post closure phases of the TSF. The principle inherent in the design of a liner is to minimise the rate of seepage into the foundation layers of the TSF by providing a layer with low permeability. A lining system is required for a TSF for the following conditions:

- When leachate or seepage from the residue has a high pollution potential, and
- When the TSF is underlain by a groundwater resource of a strategic nature.

SLR Consulting have indicated that "lining of the tailings storage facility may not be required. Further test work … would be needed to confirm this."[13] Please refer to the Hazard Classification section of this report, or the original report by SLR Consulting for more information in this regard. Despite this possibility, the client has requested that a liner be included in the pre-feasibility design and cost estimate.

5.3.3 Under-drainage system

A filter drain is to be constructed at the inner toe of the wall, and in a herringbone formation under the TSF basin. The purpose of an under-drainage system is to:[14]

- Improve the stability of a TSF by lowering the phreatic surface. Unsaturated residue is more stable and less mobile (in the event of failure) than saturated residue,
- Reduce the long term seepage and hence facilitate a reduction in ground and surface water impacts,

[13] SLR Consulting (Africa) (Pty) Ltd SLR Project L024-02, Report No.1, PRE-FEASIBILITY INPUT FOR THE PROPOSED LEHATING MINE – EIA PROCESS, TAILINGS WASTE CHARACTERISATION AND SITE SELECTION, October 2011, Page 5

[14] Department of Water Affairs and Forestry, 2007. Best Practice Guideline A2: Water Management for Tailings Storage Facilitys, page 25

- Reduce the post closure differential settlement, and
- Increase the return water to the plant.

The principle inherent in the design of an under-drainage system is to prevent the stability of the slope from being threatened by the presence of the seepage or a raised phreatic surface. This is achieved by the under drain terminating the lateral migration of the seepage before it reaches the slope face. This principal applies throughout the life of the TSF.

The under-drainage system is shown for the four site options at a pre-feasibility level of detail in Drawings D087-00-060 (Option 1) and D087-00-070 (Options 2, 3 and 4) in the Book of Plans and in **Appendix C**.

The filter drain consists of progressively finer 150mm layers of selected materials having particle sizes that will retain the particles of the finer layer above while allowing free drainage of seepage water. The layer adjacent to the tailings must be fine enough to retain the very fine tailings and is generally constructed of selected clean river sand. This is underlain by a layer of approximately +4mm to 6mm aggregate, which is in turn underlain by approximately +10mm to 20mm coarse aggregate. A perforated HDPE "geopipe" is embedded in this final layer to convey all collected seepage water away from the drain.

5.3.4 Penstock/Barge

A decant penstock tower and pipe system consists of a vertical tower located in the middle of the TSF. The penstock is connected to a horizontal outlet pipe located under the tailings deposit. Water entering the penstock tower is discharged by gravity through the tower-and-pipe system to the outer perimeter. The tower is raised in small increments as the depth of the tailings deposit increases.

Sometimes a barge is used instead of a penstock. A floating pump barge system consists of a pumpstation located on the TSF. Excess water is removed by pumping.

5.3.5 Return water sump/dam

Outside the starter wall is a dirty water drain which leads to a return water reservoir equipped with a return water pump.

5.3.6 Disposal system

To encourage steep beach formation and the settlement of the coarse fraction near the wall, deposition will be performed using the spraybar method. This method reduces the velocity of the slurry upon deposition which allows the coarser particles in the slurry to drop out of suspension quickly.

The delivery system consists of a 250mm HDPE main delivery line from the plant to the deposit, with 250mm pipes branching off from the mainline on the wall crest to the individual spraybars.

Two valves are supplied at each of the branches to provide control over deposition. One valve on each spraybar line controls that spraybar's operation, and a valve on the main delivery line at each branch is to reduce pressure losses and settlement of slurry in the pipe beyond the operational spraybars. For example, if deposition is close to the plant end of the deposit, valves beyond the current deposition area can be closed to improve pressure in the line and to prevent settlement of slurry in the remainder of the line, which can result in blockages.

Deposition can be performed by multiple spraybars simultaneously. The spraybars themselves consist of 30m lengths of 180mm HDPE pipe, drilled with 50mm diameter holes spaced at 1m centres. The hole diameter and spacing, as well as the spraybar diameter have been selected to adequately reduce the velocity of the slurry stream upon deposition.

There are 12 spraybars in total to provide sufficient control over deposition, the formation of an even beach with minimal fine material against the wall, and the location of the pool. This is important for both the stability of the deposit and the return water system.

The slurry will be deposited by the spraybar method to encourage the formation of a beach. This will keep the supernatant pool away from the outer wall and improve overall stability by creating a relatively free draining zone close to the wall. The deposition area i.e. the active spraybar or spraybars, is to be changed frequently to limit the formation of semi-circular “fans” of tailings and hence the accumulation of fine material against the outer wall at the edges of the fans.

As little water as possible is to be stored within the TSF, since this has negative effects on seepage and the deposit’s stability. The deposition method is relatively simple and the deposit can be operated by the mine itself rather than requiring a specialist contractor. As the tailings level in the deposit rises with time, the spraybars must be moved up the face of the outer wall to prevent them from being buried.

It is recommended that a flushing system is incorporated into the delivery system to eliminate settled slurry in the line in the event of plant shutdown.

5.4 Monitoring Requirements for TSF

The following requirements are required to monitor the performance of the tailings dam in order to ensure legal compliance and long-term stability.

5.4.1 Deposition rates

Deposition rates must be recorded on a monthly basis, and must be compared to the design rate.

5.4.2 Freeboard

The freeboard must be measured on a monthly basis, either by means of a survey or the installation of freeboard poles, and compared to the set minimum freeboard.

5.4.3 Under-drain flow rates

Under-drain flow rates must be measured on a monthly basis, and the trends must be analysed. A decreasing trend indicates that the drain outlets are silting up and should be jet-rodded.

5.4.4 Rainfall

Rainfall is to be measured daily as part of the overall water balance modelling. The deposit must be inspected by mine personnel on a daily, weekly and monthly basis. The deposit must also be inspected quarterly by a professional engineer, who will also conduct an annual audit of the TSF.

Other items to be monitored are the pool location and the condition of the outer wall particularly for signs of bulging, sloughing, cracking, seepage, erosion gullies and rat-holing.

Visual inspection of the downstream natural ground for seepage is also required. If the deposit shows signs of instability, and it is deemed necessary, more sophisticated monitoring can be initiated. These measures include the installation of piezometers, movement pegs, or conducting piezocone testing.

5.5 Safety classification of TSF

The zone of influence for the TSF has been calculated according to the criteria given in SABS 0286:1998. Section 7.4.2.2 of this code reads:

"The boundary of the zone of influence should be determined as follows:

a) upstream of any point on the perimeter, the lesser of a distance of 5h from the toe (where h is the height of the deposit at the point under consideration); and the distance to the point where the ground level exceeds h/2 above the elevation of the toe at the point on the perimeter;

b) on sides parallel to the ground slope – a distance of 10h from the toe; and

c) downstream of the lowest point on the perimeter, a distance of 100h."

The zone of influence is shown on Drawing D087-00-090 in the Book of Plans, and in **Appendix C**. On this plan the 0.5m contours are shown (where available). The contour 1008m.amsl is coloured blue for the 0.5m contours, since this is the same elevation as the base of the TSF, and indicates where the water will flow (either upstream or downstream). Due to the limited nature of the 0.5 contours a conservative approach has been taken in delineating the zone of influence. Item c) from Section 7.4.2.2 of SABS 0286:1998 states that the zone of influence must extend a distance of 100h downstream of the lowest point on the perimeter, where 'h' is the height of the deposit. Since the maximum height of the proposed TSF is 20m, this constitutes a distance of 2000m. The zone of influence therefore extends a distance of 2000m in all directions, except where this zone intercepts with the Kuruman River. The southern extent of the zone of influence coincides with the Kuruman River since no impact flow can proceed south of this drainage entity.

According to SABS 0286:1998 all Tailings Storage Facilitys should be classified into one, or a combination, of the following safety categories: high hazard, medium hazard, and low hazard. The safety classification should be based on the anticipated configuration of the residue deposit at the end of its design life, and should be determined by means of the questionnaire in Annexure A and Table 2 (Safety classification criteria) in SABS 0286:1998 (refer to **Appendix D** of this report for a copy of the questionnaire). In terms of Table 2:

- With reference to the number of residents in the zone of influence, the classification is a low hazard, (no residents live in the zone of influence).

- The number of workers in the zone of influence is unknown since SLR Consulting's socio economic assessment[15] does not indicated the number of jobs that this development will create. It is however assumed that there will be between 11-100 workers within the zone of influence. This results in a safety classification, in terms of the number of workers, of a medium hazard.
- In terms of the value of third party property in the zone of influence, the safety classification is a low hazard.
- With reference to the depth to underground mine workings the safety classification is low due to the fact that no underground mining will occur below the proposed TSF.

The safety classification of the TSF is therefore a low to medium hazard.

6. CONSTRUCTION COST ESTIMATE

The construction cost estimate is a first order estimate. The main components involved in the construction of the TSF are:

6.1.1 Site Clearance

The site clearance component involves clearing the footprint area of the TSF equal to the extent of the cut area beyond the toe line of the TSF. The clear and grub component involves the removal of grass, shrubs and trees. Topsoil beneath the TSF footprint area will be stripped to a depth of approximately 200mm, and stockpiled for subsequent rehabilitation. For the purposes of this pre-feasibility site selection report, this depth is assumed to be 200mm, but can be increased to obtain available capping volumes for rehabilitation (to be determined during detailed design).

6.1.2 Excavations

The starter wall will be constructed to a specified level. The purpose of the starter wall is to contain the first flush tailings while maintaining an acceptable rate of rise. The starter wall consists of a key cut into the foundation layers to bedrock level (if available). The purpose of the key is to prevent seepage water draining underneath the starter wall, as well as providing structural support for potential overturning or sliding of the starter wall.

The dam basin will be prepared to receive the tailings body. It has been assumed at this stage that a synthetic HDPE liner system will be included in the design of the TSF. This assumption will however need to be confirmed during the detailed design phase of the project. The dam preparation will involve grading the stripped dam basin surface to exact lines, levels and slopes to achieve maximum capacity and effective subsurface drainage.

6.1.3 Subsurface Drainage System

To minimize pore pressure build-up in the slimes dam, as well as seepage infiltration to the underground mining area, a sub-soil drainage system has been included in this cost-

[15] SLR Consulting (Africa) (Pty) Ltd SLR Project L024-02, Report No.1, PRE-FEASIBILITY INPUT FOR THE PROPOSED LEHATING MINE – EIA PROCESS, TAILINGS WASTE CHARACTERISATION AND SITE SELECTION, October 2011, Page 16

analysis. The drainage would typically consist of a network of perforated/slotted pipes in a herringbone formation, designed to collect and transport the seepage water emanating from the slimes dam. The outlet of these drainage pipes connects into a collection sump outside the TSF's toe line, from where the collected water will be pumped to either a pollution control dam or the plant. The cost of the pollution control dam and the associated pipelines have not been included in this assessment.

6.1.4 Starter Wall

The starter wall will be constructed from homogenous compacted clayey fill material. The starter wall will achieve minimum permeability of the wall, and will be compacted to a high degree of compaction at optimum moisture content. It has been assumed for this assessment that 100% will have to be imported from a borrow area nearby (the availability of this material will need to be verified, since the area consists largely of moderate to deep sandy and sandy loam soils). This assumption will have to be verified during the detailed design phases of this project.

Another purpose of the starter wall is to prevent clean runoff water from entering the slimes dam.

6.1.5 Pipes

For the purpose of this analysis, HDPE pipes from the plant have been measured accordingly. The purpose of these pipes will be to transport the tailings from the plant to the slimes dam. The pumps and mechanical equipment required is not included in this analysis. The assumed diameter for costing purposes is 150mm (HDPE). The design of theses pipes will have to be carried out in the detailed design phase of this project and the cost revisited.

6.1.6 Penstock Ring System

A penstock system will be required to drain surface runoff as well as production water collected on the lowest point on the surface level of the slimes dam. The penstock typically consist of concrete rings (diameter = 500mm) placed on top of each other. At the bottom, the pipe bends and drains towards a collection facility (i.e. pollution control dam or sump). The cost of the collection facility has not been included in this analysis.

As no design has been carried out at this stage, the cost for a typical penstock system has been adopted. The design and costing of the penstock system will have to be revisited during the detailed design phase.

6.1.7 Concrete Work

This item allows for the installation of concrete items such as concrete blocks for pipelines, penstock concrete work, outlet structures and benching inside manholes and sumps etc.

6.1.8 Miscellaneous

Allowance has been made for a 1.8m high cattle fence to be installed 10m parallel from the extent of the cut line of the TSF.

6.1.9 Preliminary and General

The preliminary and general cost items typically involve the contractor's establishment, disestablishment and weekly/monthly running costs on labour, plant, equipment etc. Typically, in the mining industry, this value constitutes in the region of 15% of the construction value of the project.

6.1.10 Rates

The rates have been obtained from the December 2008 cost estimate for the Lehating Mine TSF, escalated at CPI for three years.   . The estimated accuracy of this estimate is between -20% and +20%. An improved cost estimate can be presented after the detailed design phase.

Table 2: Pre-Feasibility Cost Estimate of TSF Civil Engineering Works

Item	Description	Unit	Qty	Rate	Amount
1	Stripping, clear and grub	ha	3.28	R 23 500	R 77 080
2	Rip & recompact base	ha	3.28	R 44 000	R 144 320
3	Starter Wall:				
3a	- Key construction	m^3	3600	R 76	R 274 482
3b	- Embankment forming	m^3	12585	R 94	R 1 180 976
4	HDPE Liner System	m^2	32761	R 129	R 4 227 152
5	Sub-soil drains to return water dam	m	1300	R 235	R 304 980
6	Penstock to above surface elevation	Sum	1	R 300 000	R 300 000
7	Miscellaneuos (5%)	%	R 6 508 990	5%	R 325 500
	Sub-Total				R 6 834 490
	Preliminary & General			15%	R 1 025 174
	Total				R 7 859 664

7. CONCLUSIONS

A suitable site has been selected for the TSF. According to the environmental consultant there are no fatal social or environmental fatal flaws inhibiting the development of this facility. There is sufficient capacity within the proposed TSF to contain the tailings of the mining enterprise for a period of 20 years (at the deposition rate provided by the client). It is possible that a synthetic liner will not be necessary for the facility, which will significantly reduce the cost of the TSF. This will however need to be verified, but the HDPE liner has been included at this stage.

8. RECOMMENDATIONS

It is recommended that:

- Further acid base accounting, leachate testing and pH paste tests must be performed on the manganese to be mined by Lehating. The Wessels-type ore is a high grade ore, containing on average 44 to 48 wt.% manganese. The Wessels-type ore constitutes about 3% of the known reserves in the Kalahari Manganese Field, and occurs in the north-western part of the main Kalahari deposit. The acid base accounting, leachate tests and pH paste tests of Hotazel Formation manganese ore that were conducted by SLR Consulting for various mines in the wider area may well have not been representative of the Wessels-type Mn ore. These tests are important since they will determine whether a synthetic liner or a clay layer will be sufficient for the containment of the seepage from the facility.

- Geotechnical investigations must be performed within the toe line area proposed for the TSF to ascertain the quality of the founding material for the construction of the facility.
- A search must be made for a borrow pit with a sufficient quality and quantity of clayey soil for the starter wall, key, and TSF basin clay layer. It will be useful to consult local people involved in the construction or agricultural industry.
- It is essential that Lehating fulfil all regulatory requirements before commencing with the construction of the facility, in line with the framework presented in Section 2 of this report.

Gareth Simpson (M.Eng)
Project Engineer

Adriaan Oosthuizen (Pr Eng)
Technical Director

Danie Brink (Pr Eng)
Project Director
for Jones & Wagener

14 February 2012

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Document template: ReportGeotech_tem_Rev0_20110131.dotx

APPENDIX A

LEHATING MINING DESIGN CRITERIA

APPENDIX A - Table of Contents

Lehating Mining (Pty) Ltd
Registration No. 2006/032350/07

12 Kareekraal Avenue
Eldoraigne X3
Centurion 0157
South Africa

Tel: +27 0(10) 591 3232
Fax: +27 0(10) 641 8826

15 December 2011

Jones & Wagener
PO Box 1434
Revonia, 2128

Dear Adriaan,

I refer the meeting held at our office yesterday with Nico Hager and yourself.
Herewith please find confirmation of the design criteria as acceptable to the client.

Design Assumptions **Job no: D087**

Mine	Lehating (Kuruman area)	
Tailings	Wessels type manganese ore	
Ore density	4.5	From client
Grading	<1mm	Metago environmental report
Dry (bulk) density (kg/m3)	2200	From client
ø' (degrees)	35	Assumed by J&W
c' (kPa)	0	Assumed by J&W
Outer slope (ave)	1:3	Assumed by J&W
Max height (m)	20	Assumed by J&W
Max ror (m/a)	3	Assumed by J&W
Ave ror (m/a)	2.5	Assumed by J&W
Ideal Shape	Square (L = B) to Rectangle (L ≤ 2B)	Assumed by J&W
Deposition rate (t/month)	2790	From client
Slurry pulp SG to dam	1.4	From client
Method of deposition	Spray bar	Assumed by J&W
Volumetric deposition rate (m3/month)	1268	Calculated from client design criteria
Design Life (yr)	20	From client
Total Capacity required (m3)	304364	Calculated from client design criteria

We trust this meets with your requirements for confirmations to complete your design brief

Directors: C Sambo (Chairman), C J Steenkamp, M Kemink, S Nkosi, N Hager, D Cunningham, T L Mosey (USA)

Yours faithfully

Michiel Kemink
Project Director

APPENDIX B

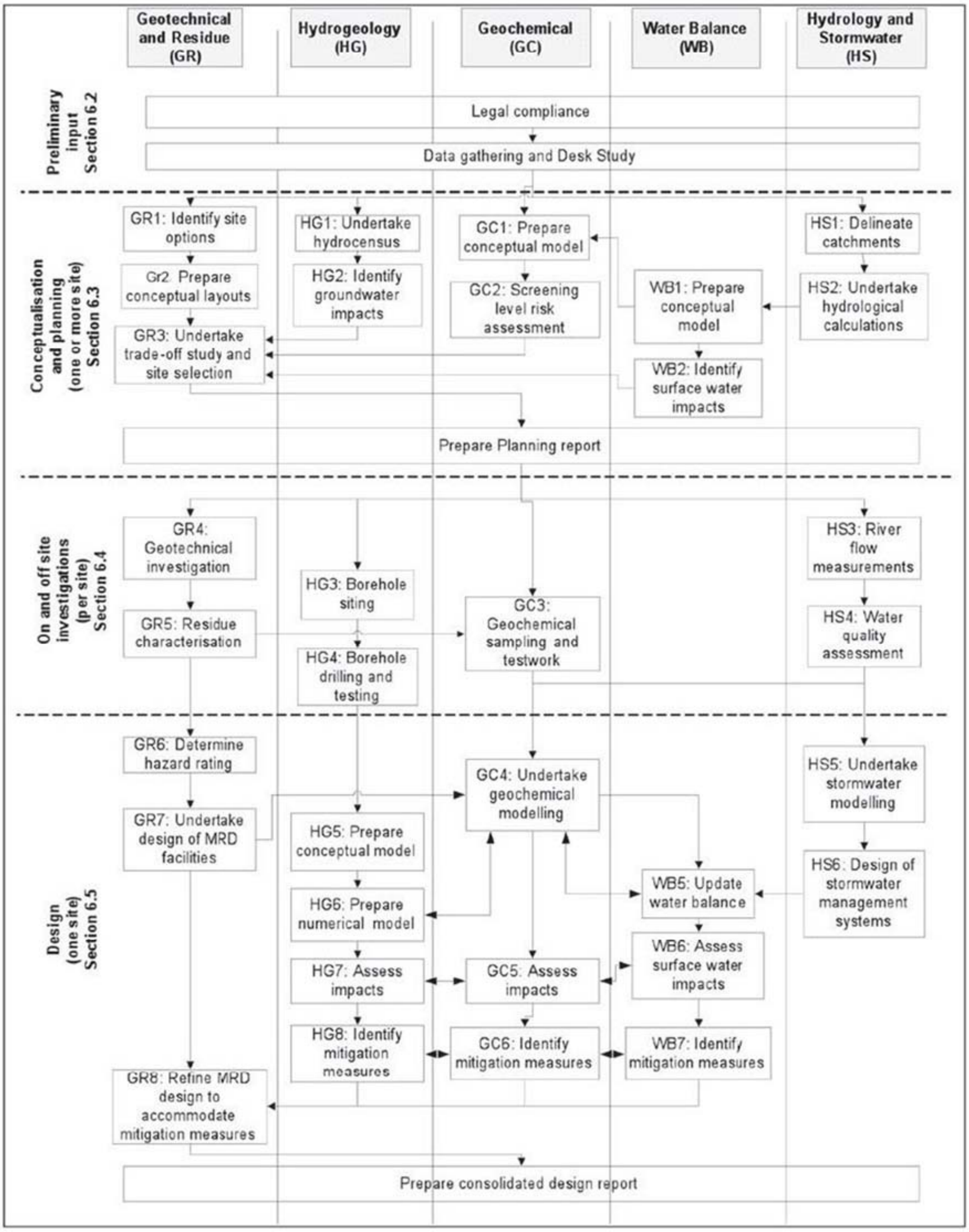
BEST PRACTICE GUIDELINES

APPENDIX B - Table of Contents

Table 5.1: Summary of authorisation requirements for MRDs

Applicable Act	Section	Legal requirements	Guiding notes
National Water Act, 1998 (Act No.36 of 1998)	21	21 (c) impeding or diverting the flow of water in a watercourse 21(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit 21(g) disposing of waste in a manner which may detrimentally impact on a water resource 21(i) altering the bed, banks, course or characteristics of a watercourse.	A section 21 (g) water use authorisation is the **primary** authorisation that is required for all MRDs and return water dams. This includes compliance with Regulation No. 704. A section 21(f) water use authorisation is required if discharge is envisaged from the return water dam. Section 21 (c) and (i) authorisations are required if local or regional Storm Water diversion schemes are envisaged. The water use authorisations, and the application therefore, are combined into an Integrated Water Use Authorisation for the mine.
The Dam Safety Regulations (published in Government Notice R. 1560 of 25 July 1986)	9C of the NWA	Classification of the dam Approval to construct a MRD	Use form DW 692E For Category I dams, use form DW 694E and submit construction drawings For Category II and III dams, the APP must apply for a authorisation to impound (this involves the submission of an operation and maintenance manual and emergency preparedness plan together with an application form DW 696E)
Environment Conservation Act (ECA), 1989 (Act 73 of 1989)	Gov Notice R. 1182 and R. 1183	Environmental impact assessment (EIA)	The EMP and EIA processes for licensing of a MRD on a mine site should be integrated
Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)	39, 48, 49, 50	Environmental management programme or plan (EMP) and environmental impact assessment (EIA)	

Figure 6 .1: Integration of tasks in the conceptualisation, investigation and design phases



APPENDIX C

DRAWINGS

APPENDIX C - Table of Contents

(REFER DRAWING BOOK VOLUME II OF II FOR A1 SIZE DRAWINGS)

LEHATING TAILINGS STORAGE FACILITY
PRE-FEASIBILITY STUDY

A1 PLANBOOK
FEBRUARY 2012
PROJECT No:D087

Prepared by:

Jones & Wagener
Consulting Civil Engineers
Tel. (011) 519-0200
Fax. (011) 519-0201
e-mail post@jaws.co.za
59 Bevan Road
P.O. Box 1434
Rivonia 2128

LIST OF DRAWINGS

Jones & Wagener
Consulting Civil Engineers

LEHATING MINE

LEHATING TSF PRE -FEASIBILITY STUDY

LIST OF DRAWINGS

D087-00-000

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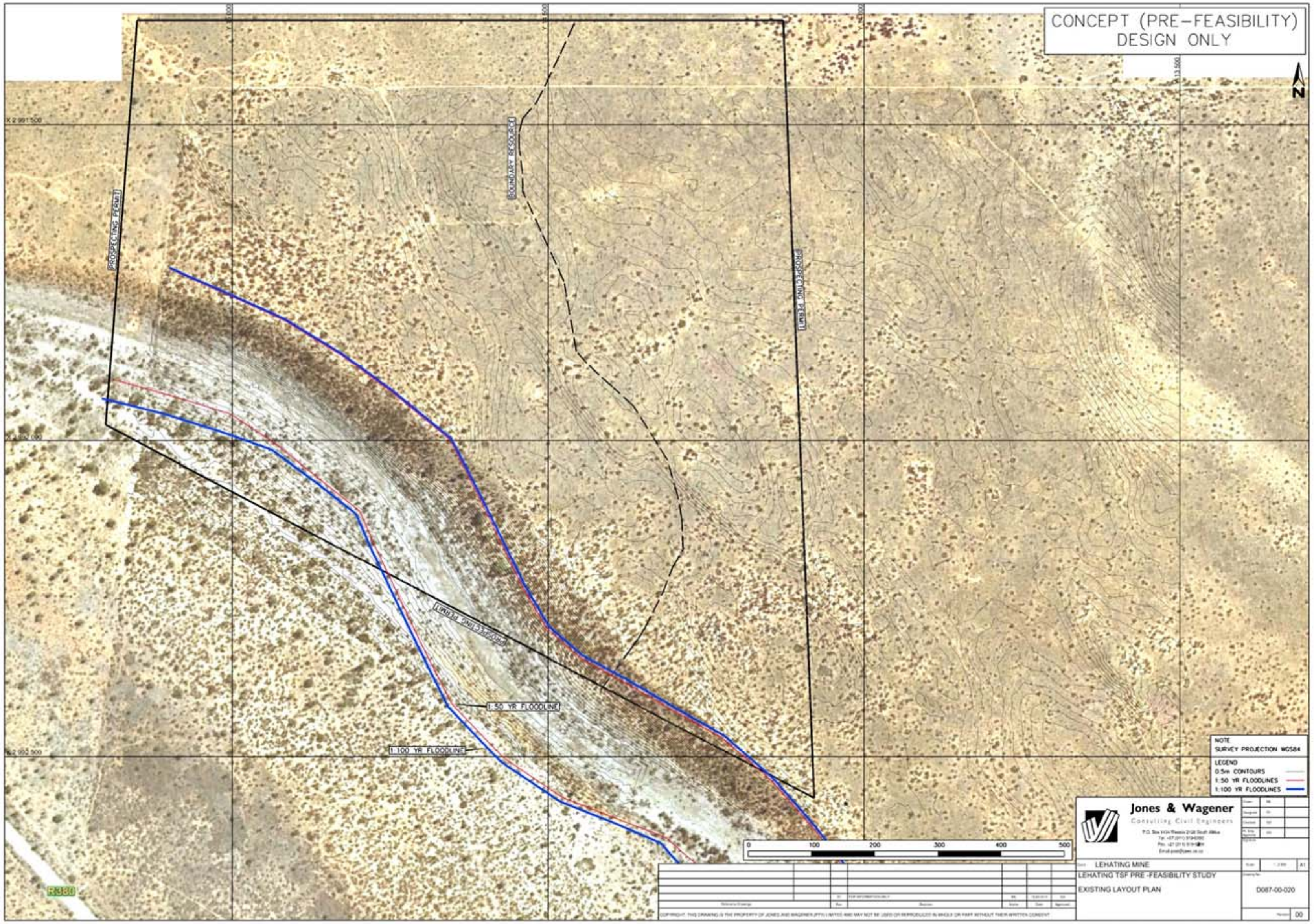
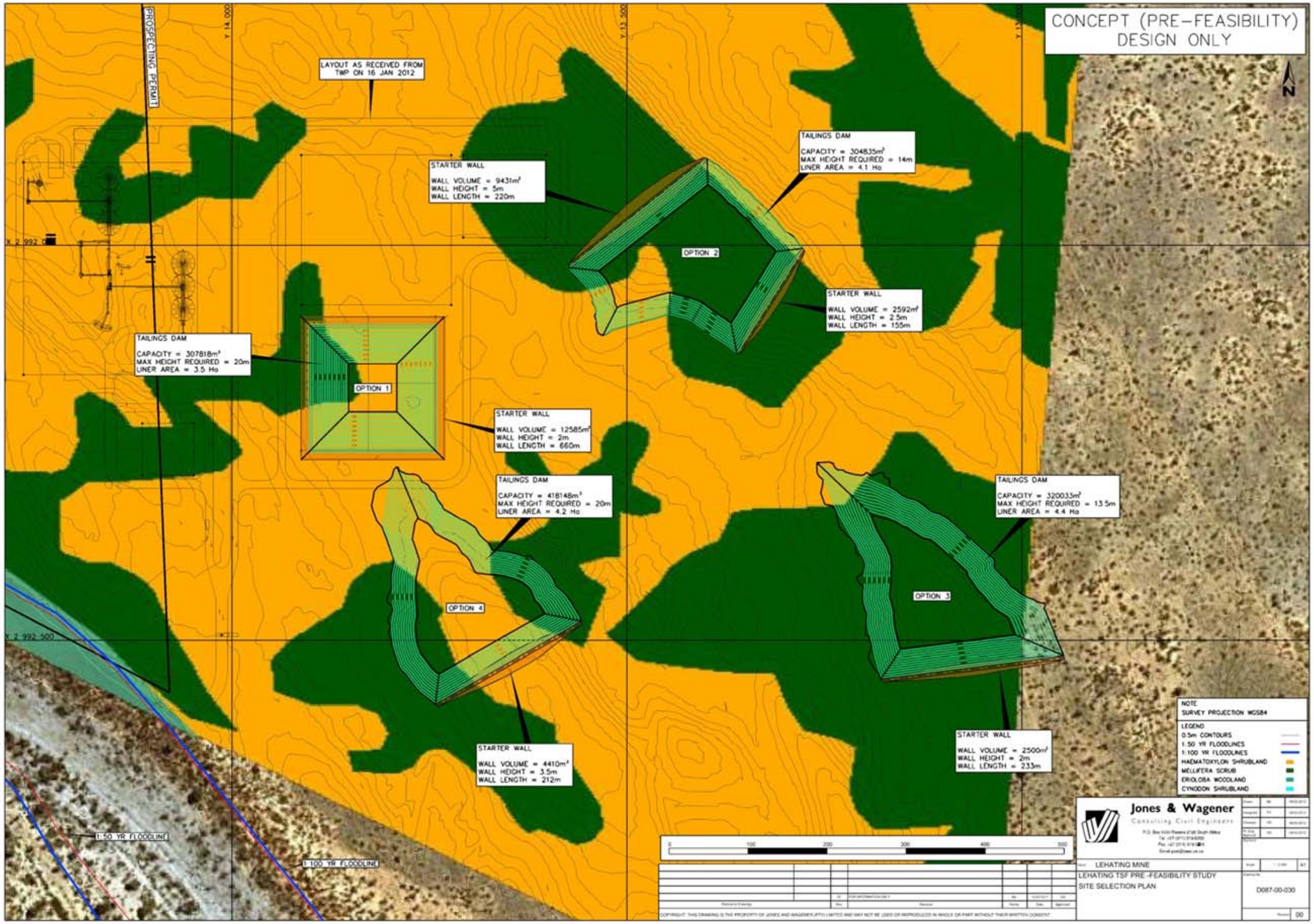
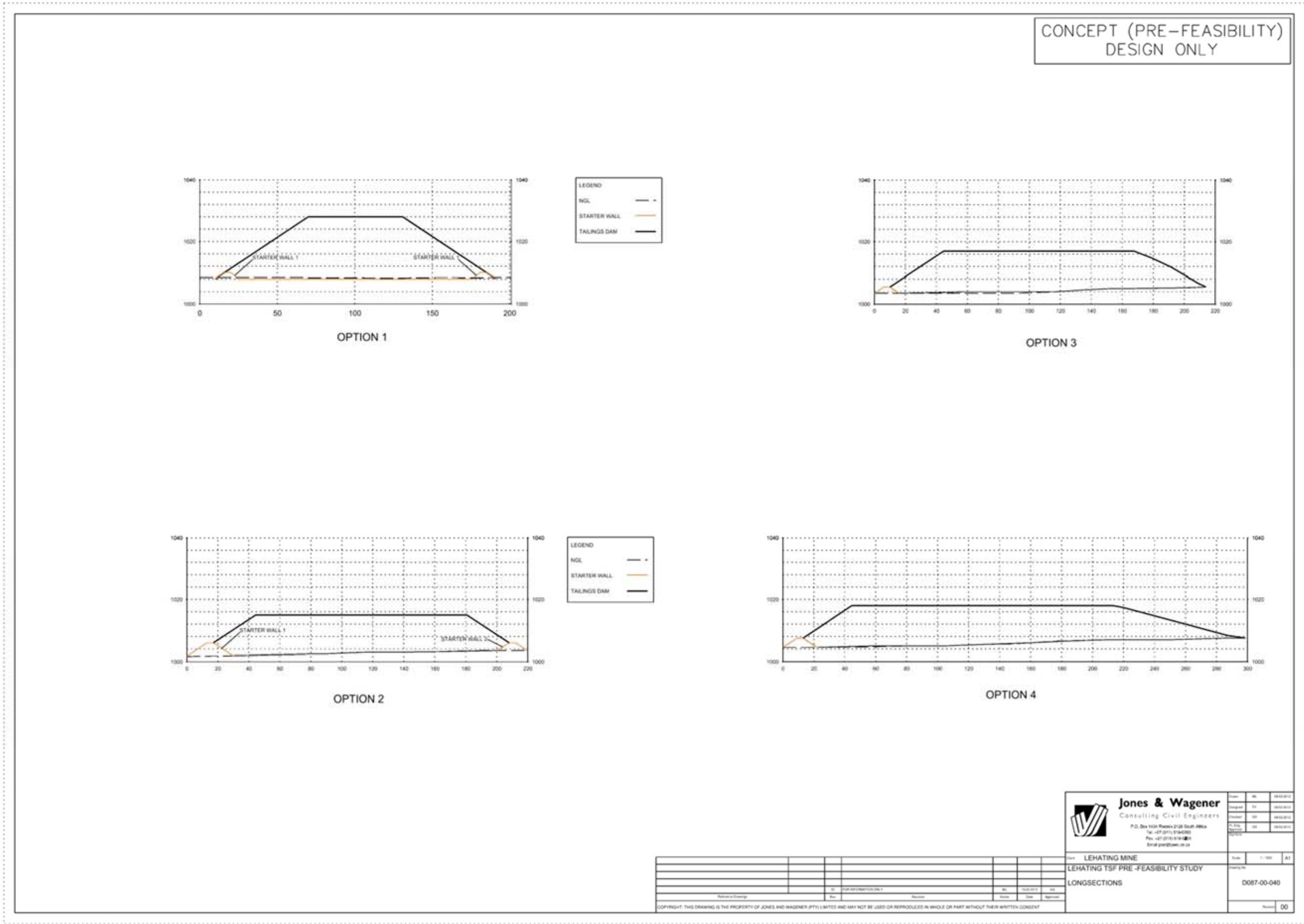

CONCEPT (PRE-FEASIBILITY)
DESIGN ONLY
N
PROSPECTING PERMIT
BOUNDARY ROAD
PROSPECTING PERMIT
PROSPECTING PERMIT
1:50 YR FLOODLINE
1:100 YR FLOODLINE
R380
0
100
200
300
400
500
NOTE
SURVEY PROJECTION WGS84
LEGEND
0.5m CONTOURS
1:50 YR FLOODLINES
1:100 YR FLOODLINES
Jones & Wagener
Consulting Civil Engineers
LEHATING MINE
LEHATING TSF PRE -FEASIBILITY STUDY
EXISTING LAYOUT PLAN
D087-00-020
A1
00



CONCEPT (PRE-FEASIBILITY) DESIGN ONLY
PROSPECTING PERMIT
LAYOUT AS RECEIVED FROM TWP ON 16 JAN 2012
TAILINGS DAM
CAPACITY = 304835m³
MAX HEIGHT REQUIRED = 14m
LINER AREA = 4.1 Ha
STARTER WALL
WALL VOLUME = 9431m³
WALL HEIGHT = 5m
WALL LENGTH = 220m
OPTION 2
STARTER WALL
WALL VOLUME = 2592m³
WALL HEIGHT = 2.5m
WALL LENGTH = 155m
TAILINGS DAM
CAPACITY = 307818m³
MAX HEIGHT REQUIRED = 20m
LINER AREA = 3.5 Ha
OPTION 1
STARTER WALL
WALL VOLUME = 12585m³
WALL HEIGHT = 2m
WALL LENGTH = 660m
TAILINGS DAM
CAPACITY = 418148m³
MAX HEIGHT REQUIRED = 20m
LINER AREA = 4.2 Ha
OPTION 4
TAILINGS DAM
CAPACITY = 320033m³
MAX HEIGHT REQUIRED = 13.5m
LINER AREA = 4.4 Ha
OPTION 3
STARTER WALL
WALL VOLUME = 4410m³
WALL HEIGHT = 3.5m
WALL LENGTH = 212m
STARTER WALL
WALL VOLUME = 2500m³
WALL HEIGHT = 2m
WALL LENGTH = 233m
1:50 YR FLOODLINE
1:100 YR FLOODLINE
NOTE
SURVEY PROJECTION WGS84
LEGEND
0.5m CONTOURS
1:50 YR FLOODLINES
1:100 YR FLOODLINES
HAEMATOXYLON SHRUBLAND
MELLIFERA SCRUB
ERIOLOBA WOODLAND
CYNODON SHRUBLAND
0
100
200
300
400
500
Jones & Wagener
Consulting Civil Engineers
LEHATING MINE
LEHATING TSF PRE-FEASIBILITY STUDY
SITE SELECTION PLAN
D087-00-030
00


CONCEPT (PRE-FEASIBILITY)
DESIGN ONLY
OPTION 1
OPTION 2
OPTION 3
OPTION 4
LEGEND
NGL
STARTER WALL
TAILINGS DAM
Jones & Wagener
Consulting Civil Engineers
LEHATING MINE
LEHATING TSF PRE -FEASIBILITY STUDY
LONGSECTIONS
D087-00-040
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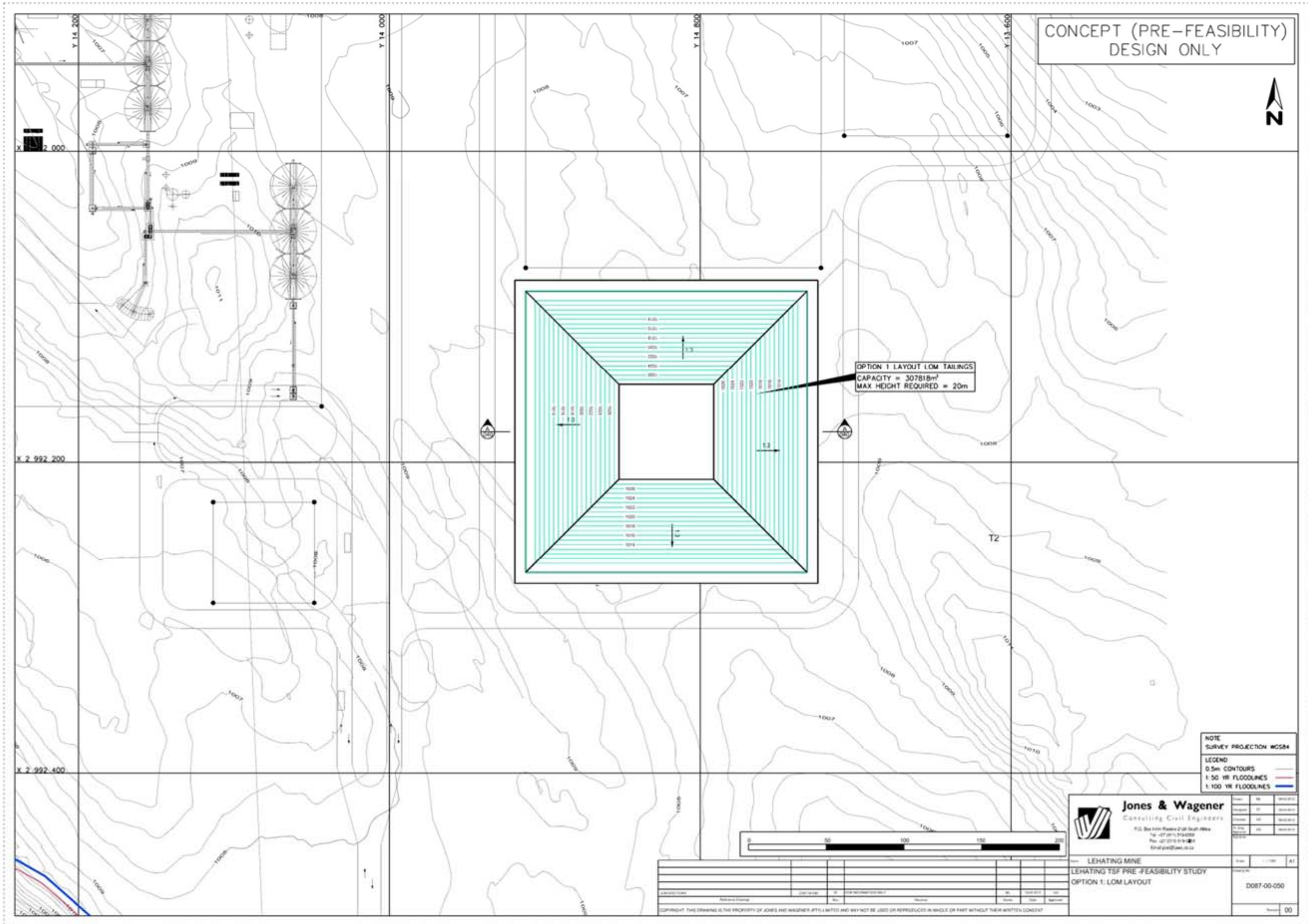
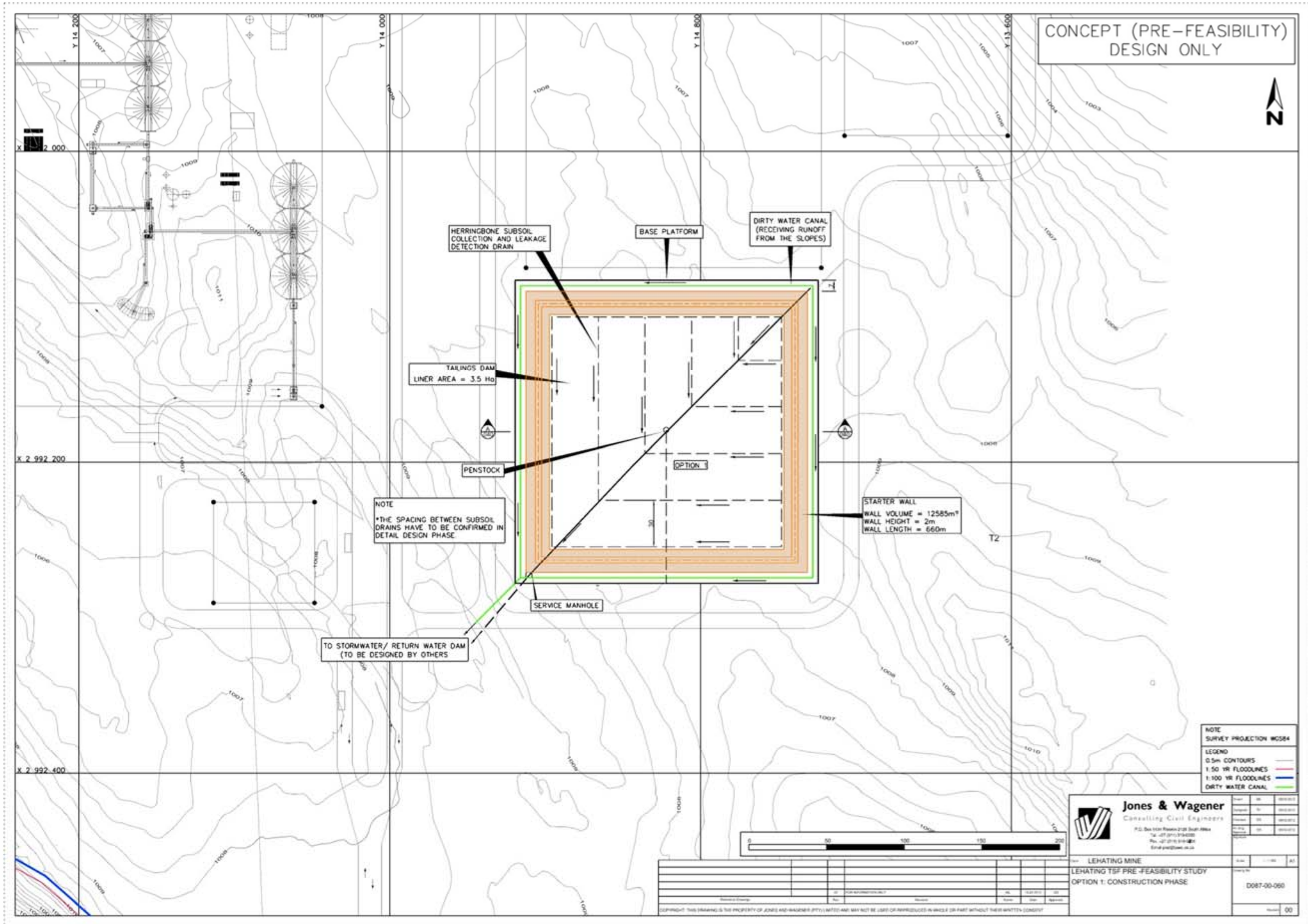
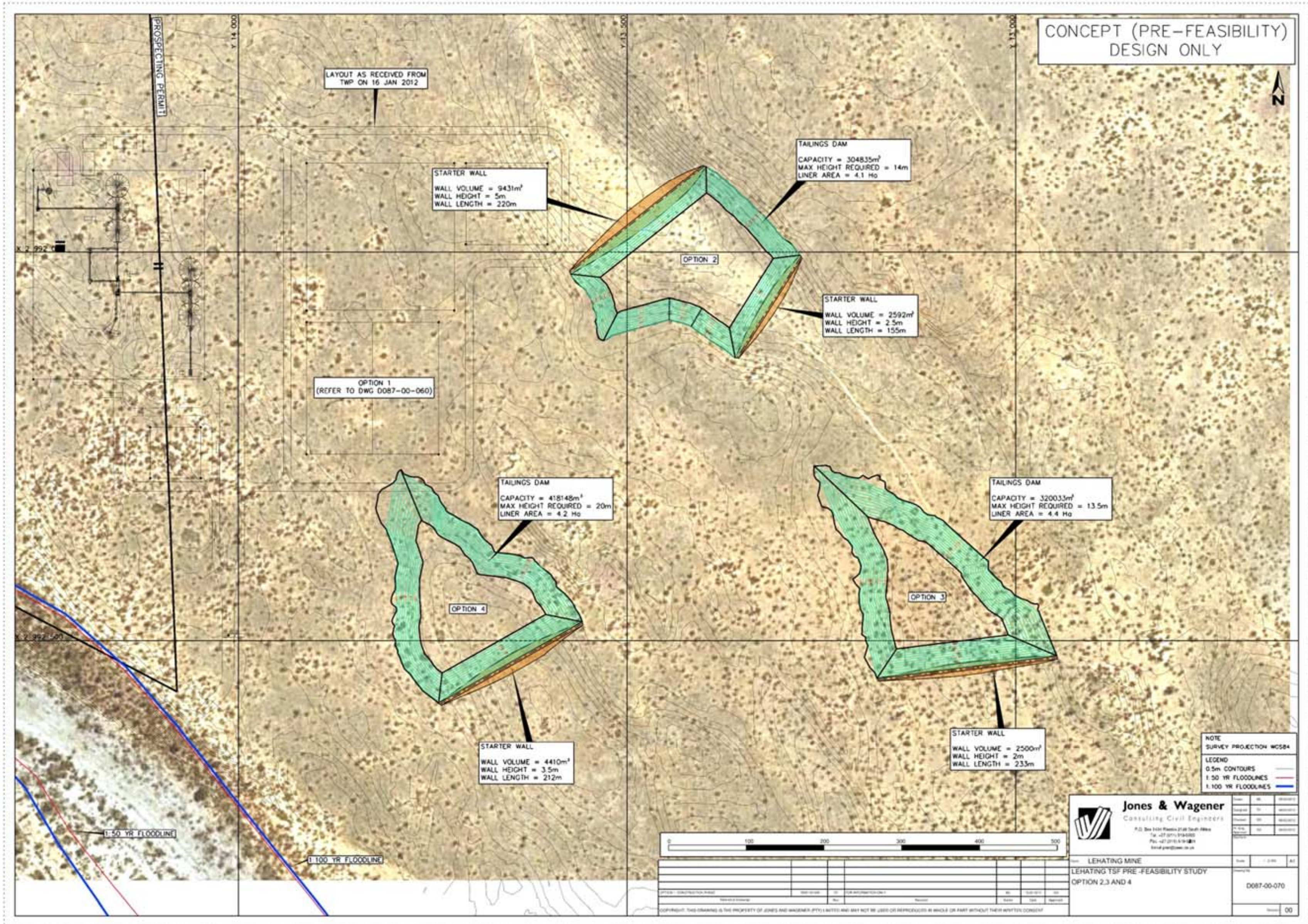
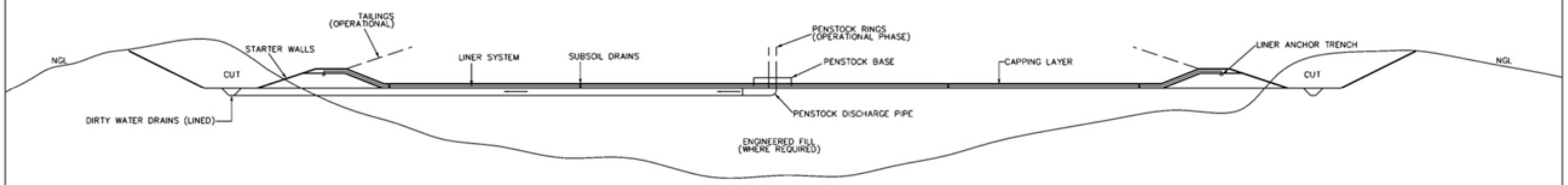


CONCEPT (PRE-FEASIBILITY)
DESIGN ONLY
N
OPTION 1 LAYOUT LOM TAILINGS
CAPACITY = 307818m³
MAX HEIGHT REQUIRED = 20m
X 2 992 200
X 2 992 400
Y 14 200
Y 14 000
Y 14 800
T2
NOTE
SURVEY PROJECTION WGS84
LEGEND
0.5m CONTOURS
1:50 YR FLOODLINES
1:100 YR FLOODLINES
0
50
100
150
200
Jones & Wagener
Consulting Civil Engineers
LEHATING MINE
LEHATING TSF PRE -FEASIBILITY STUDY
OPTION 1: LOM LAYOUT
D087-00-050
00


CONCEPT (PRE-FEASIBILITY) DESIGN ONLY
N
HERRINGBONE SUBSOIL COLLECTION AND LEAKAGE DETECTION DRAIN
BASE PLATFORM
DIRTY WATER CANAL (RECEIVING RUNOFF FROM THE SLOPES)
TAILINGS DAM LINER AREA = 3.5 Ha
PENSTOCK
OPTION 1
NOTE
*THE SPACING BETWEEN SUBSOIL DRAINS HAVE TO BE CONFIRMED IN DETAIL DESIGN PHASE
STARTER WALL
WALL VOLUME = 12585m³
WALL HEIGHT = 2m
WALL LENGTH = 660m
SERVICE MANHOLE
TO STORMWATER/ RETURN WATER DAM (TO BE DESIGNED BY OTHERS)
X 2 992 200
X 2 992 400
Y 14 200
Y 14 000
Y 13 800
Y 13 600
T2
NOTE
SURVEY PROJECTION WGS84
LEGEND
0.5m CONTOURS
1:50 YR FLOODLINES
1:100 YR FLOODLINES
DIRTY WATER CANAL
0
50
100
150
200
Jones & Wagener
Consulting Civil Engineers
LEHATING MINE
LEHATING TSF PRE -FEASIBILITY STUDY
OPTION 1: CONSTRUCTION PHASE
D087-00-060
A1
00


CONCEPT (PRE-FEASIBILITY) DESIGN ONLY
PROSPECTING PERMIT
LAYOUT AS RECEIVED FROM TWP ON 16 JAN 2012
STARTER WALL
WALL VOLUME = 9431m³
WALL HEIGHT = 5m
WALL LENGTH = 220m
TAILINGS DAM
CAPACITY = 304835m³
MAX HEIGHT REQUIRED = 14m
LINER AREA = 4.1 Ha
OPTION 2
STARTER WALL
WALL VOLUME = 2592m³
WALL HEIGHT = 2.5m
WALL LENGTH = 155m
OPTION 1 (REFER TO DWG D087-00-060)
TAILINGS DAM
CAPACITY = 418148m³
MAX HEIGHT REQUIRED = 20m
LINER AREA = 4.2 Ha
OPTION 4
TAILINGS DAM
CAPACITY = 320033m³
MAX HEIGHT REQUIRED = 13.5m
LINER AREA = 4.4 Ha
OPTION 3
STARTER WALL
WALL VOLUME = 4410m³
WALL HEIGHT = 3.5m
WALL LENGTH = 212m
STARTER WALL
WALL VOLUME = 2500m³
WALL HEIGHT = 2m
WALL LENGTH = 233m
NOTE
SURVEY PROJECTION WGS84
LEGEND
0.5m CONTOURS
1:50 YR FLOODLINES
1:100 YR FLOODLINES
1:50 YR FLOODLINE
1:100 YR FLOODLINE
Jones & Wagener
LEHATING MINE
LEHATING TSF PRE-FEASIBILITY STUDY
OPTION 2,3 AND 4
D087-00-070

CONCEPT (PRE-FEASIBILITY) DESIGN ONLY



TYPICAL SECTION: CIVIL CONSTRUCTION PHASE (CONCEPTUAL ONLY)

N.T.S

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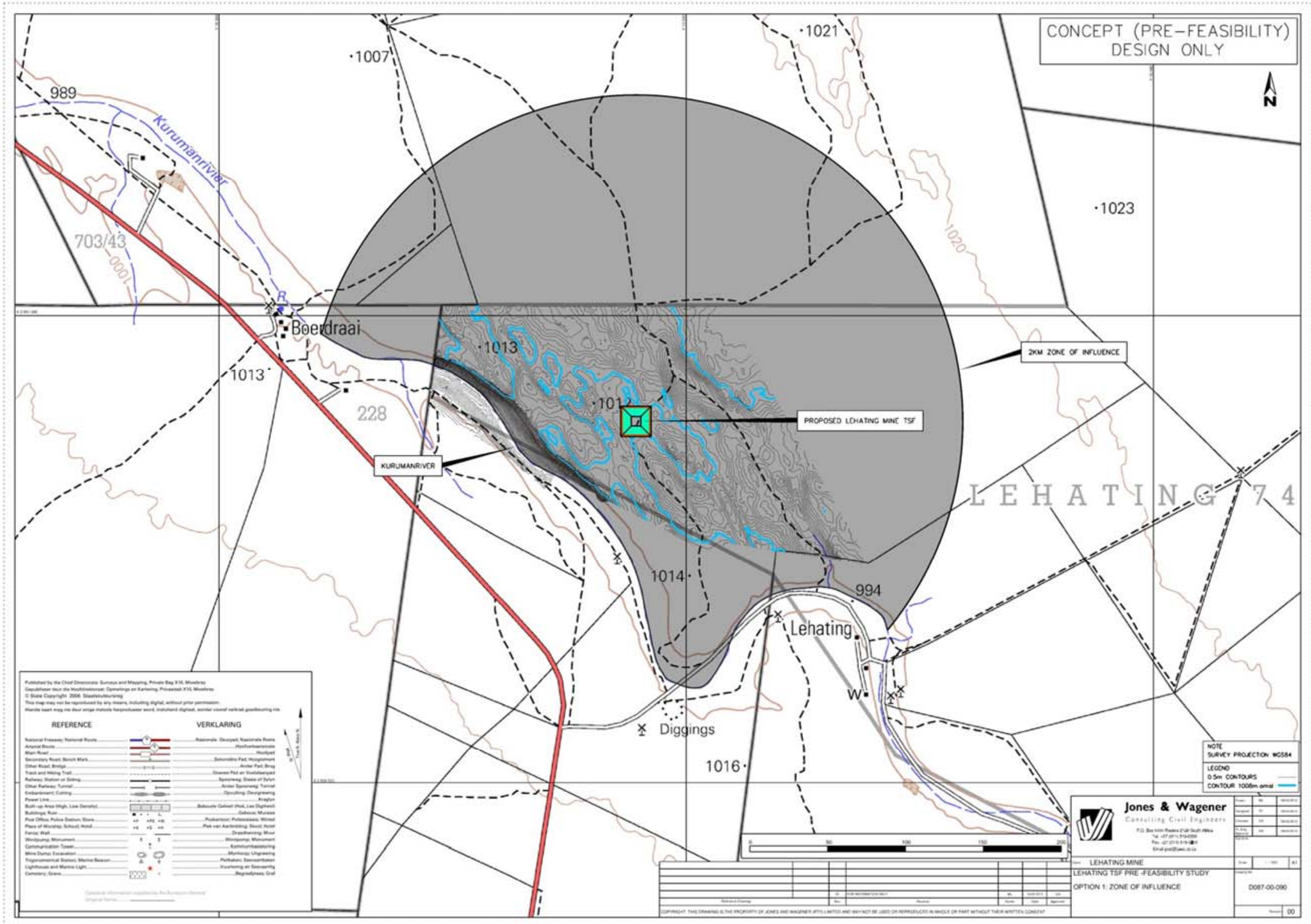
Consulting Civil Engineers

LEHATING MINE
LEHATING TSF PRE -FEASIBILITY STUDY
TYPICAL SECTION DETAIL

D087-00-080

00 FOR INFORMATION ONLY


CONCEPT (PRE–FEASIBILITY)
DESIGN ONLY
N
·1007
·1021
989
Kurumanrivier
703/43
·1023
1020
Boerdraai
1013
·1013
228
2KM ZONE OF INFLUENCE
·1012
PROPOSED LEHATING MINE TSF
KURUMANRIVER
LEHATING 74
1014·
994
Lehating
W
Diggings
1016·
REFERENCE
VERKLARING
NOTE
SURVEY PROJECTION WGS84
LEGEND
0.5m CONTOURS
CONTOUR 1008m amsl
0
50
100
150
200
Jones & Wagener
Consulting Civil Engineers
LEHATING MINE
LEHATING TSF PRE -FEASIBILITY STUDY
OPTION 1: ZONE OF INFLUENCE
D087-00-090
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APPENDIX D

SAFETY CLASSIFICATION

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Annex A
(normative)

Safety classification

A.1 General

This questionnaire should be completed by the owners of all Tailings Storage Facilitys. A separate
questionnaire should be completed for each residue deposit (or for each group of residue deposits where at least one flank of neighbouring deposits is coincident).

The objective of the questionnaire is to establish a safety classification for the residue deposit (or group of deposits) referred to in the questionnaire. The safety classification refers to the hazard potential of the deposit with respect to loss of life or economic loss to a third party (or both).

It is important to note that this is a safety classification for the residue deposit and therefore only focuses on the potential impacts arising from the existence of the deposit. The probabilities of occurrence of failure events (i.e. the risks) are not addressed as part of this classification. A high classification potential might not therefore result in a high probability of failure and a high classification does not necessarily imply that the residue deposit poses a high risk – it merely stresses the importance of the deposit and therefore the scope of the risk management plan required to maintain risks at an appropriate level.

Part 1 General information

1.1 Name of mine . . . .
1.2 Postal address of mine . . . .
1.3 Telephone number (area code in brackets) . . . .
1.4 Magisterial district . . . .
1.5 DME region . . . .
1.6 Nearest town . . . .
1.7 Direction and distance to town (km) . . . .
1.8 Name of person responsible for residue deposit . . . .
1.9 Number of deposit (DME reference) . . . .
1.10 Common name of deposit . . . .
1.11 Name of the closest river/stream to the deposit . . . .

Part 2 Safety classification

2.1 Description of residue being deposited (for example, platinum tailings) . . . .
2.2 Is residue deposited hydraulically? YES/NO . . . .
2.3 Is the deposit still active? YES/NO . . . .
2.4 If not, how long ago was the deposit decommissioned? . . . . (years)
2.5 What will the ultimate maximum height of the deposit be on closure (measured as the difference between the highest crest elevation and the lowest toe elevation)? . . . . (m)
2.6 What is the current maximum height of the deposit? . . . . (m)

2.7 When did deposition start? . . . . (year)
2.8 What is the steepest overall outer slope of the deposit? . . . . (degrees)
2.9 What is the steepest ground slope gradient, measured downstream of the deposit on the perimeter of the deposit, averaged over a distance of 200 m from the toe . . . . (%)
2.10 Is the deposit located on undermined ground? YES/NO . . . .
2.11 If yes, what is the shallowest depth to underground excavations? . . . . (m)
2.12 Prepare a line diagram of the deposit to scale (suggested 1:25 000), that shows the following:

a) outline of the deposit, showing approximate ground contours at a maximum of 5 m vertical
intervals for a distance around the deposit (determined from the guidelines in clause A.2);
b) zone of potential influence of a failure of the deposit (determined from the guidelines in clause A.2); and
c) property/infrastructure/services located within the zone of influence.

A.2 Guidelines for determination of zone of influence (based on response to questions in part 2: Safety classification)

Step 1 If the answer to 2.2 is yes, go to step 2, otherwise go to step 5. (If the deposit is encapsulated with a non-hydraulically placed material of thickness > *h* (see 7.4.2), go to step 5.)

Step 2 If the answer to 2.3 is yes, go to step 4, otherwise go to step 3.

Step 3 If the answer to 2.4 is less than 5 years, go to step 4, otherwise go to step 5.

Step 4 In these cases, the deposit could potentially flow after failure and therefore the zone of influence is mainly determined by ground topography and the height of the residue deposit. The zone of influence should be sketched as follows:

a) upstream side – a distance of 5*H* from the toe (where *H* is the height in metres from 2.5 see
part 2: safety classification), or to a point where the natural ground elevation exceeds *H*/2
above the toe elevation;
b) sides parallel to ground slope – a distance of 10*H* from the toe; and
c) downstream side – a distance determined from the maximum of the following:
1) 100*H* (from 2.5), or
2) twice the gradient (from 2.9), with a minimum of 0,5 km and a maximum of 6,0 km.

Step 5 In these cases, the deposit is unlikely to flow after failure and therefore the zone of influence is mainly determined by the height of the residue deposit. The zone of influence is a distance of twice the maximum design height at the point of consideration, measured from the toe around the full perimeter.

NOTE – If the owner can demonstrate that the material has a low potential to flow, the classification is to be based on
non-hydraulically placed material.