2.20 VISUAL ASPECTS BASELINE

The Visual Assessment Base Line Specialist Study was compiled in order to fulfil the requirements of various sets of legislation, regulations and guidelines as applicable to Environmental Authorizations for the Glencore Merafe Boshoek Mine and Smelter Operations.

It is to be expected that any mining and beneficiation activity will have some form of visual impact and therefore JMA Consulting (Pty) Ltd, whom was appointed as the Environmental Assessment Practitioner (EAP) on the project, contracted Zeli Design to conduct a Visual Impact Assessment (VIA) in support of the required amendment to the EMPR and the related EIA for the GMBS operations.

The comprehensive Visual Specialist Report is attached as **APPENDIX 2.20 (A)** to this report.

The deliverables of the VIA study must support applications which may be required in fulfilment of the requirements of the Mineral and Petroleum Resources Development Act, the National Environmental Management Act, the National Water Act, the National Environmental Management: Waste Act and the National Environmental Management: Air Quality Act.

2.20.1 Project Background

The GMBS site is located in a semi-rural setting. Due to the nature and extent of the mining and smelting activities, a degree of visual impact will occur, affecting observers in the vicinity of the site.

It will be the ultimate aim of the Visual Impact Assessment (VIA) to determine the extent and significance of the visual impact, and if negative and possible, methods to mitigate these effects.

Using the information generated during the compilation of a contextual analysis, view shed analyses and a photographic assessment, a comprehensive base line description was compiled in order to establish the current visual conditions in the area where the current and proposed GMBS activities will occur.

This is required to serve as "base line" against which to assess any changes that the operations will have on visual aspects as well as against which to evaluate any future complaints received from the public during the operational phase.

2.20.2 Contextual Analysis

A contextual analysis was performed in order to establish the visual character "base line" for the site.

2.20.2.1 Location

The Glencore Merafe Boshoek Mine and Smelter operations is located approximately 30 km to the North-West of Rustenburg in the Bojanala Eastern District of the North-West province of South Africa.

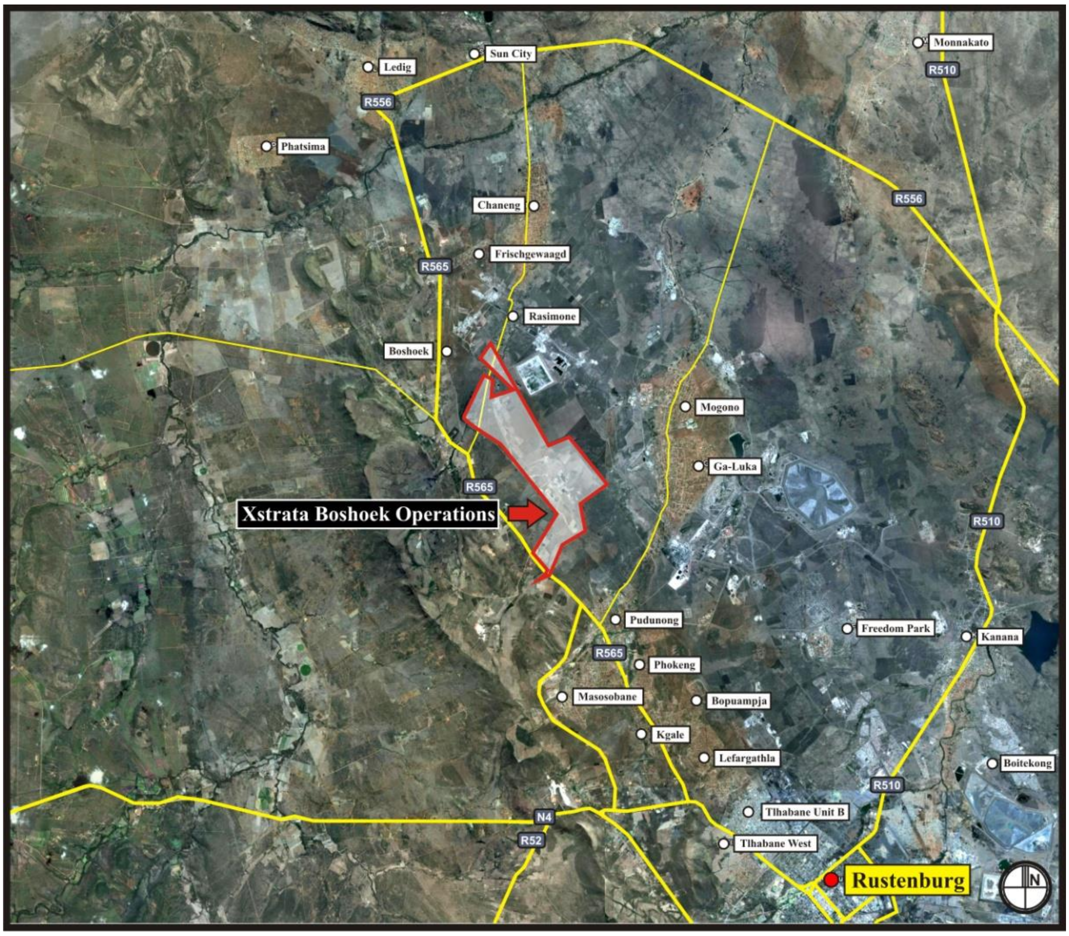

Figure 2.20.2.1(a): The GMBS Site indicated near the Town of Rustenburg located within the Bojanala Region, North-West

2.20.2.2 Economy

Although the North-West province has many tourism attractions the mainstay of the economy of the province is mining, which generates more than half of the province's gross domestic product and provides jobs for a quarter of its workforce.

2.20.2.3 Vegetation and Topography

The GMBS site and its surrounds are located within the Savannah Biome. The vegetation of the Bojanala-Rustenburg region can be described as covered in natural bushveld vegetation and the topography as mountainous, the site being flanked by the Magaliesberg Mountain Range to the West and South-West and by the Pilanesberg to the North. The site itself lies on flat land.

2.20.2.4 Near Vicinity Land Use

The land use adjacent to the GMBS is dominated by agricultural and mining related activities.

- **The agricultural activities** are dominated by local grazing veld for cattle and small livestock.

- **The mining operations** take the form of opencast and underground operations that exploit the Rustenburg Layered Suite of the Bushveld Igneous Complex for its chrome, platinum and platinum group element (PGE) content. The LG-6 chromitite layer, UG-2 chromitite layer and the Merensky Reef are the main reefs that are currently being at and to the east of GMBS.

- **Human settlement** in the area consists of the settlement of Boshoek, which is located within 1 km to the South-West of GMBS and the settlements Rasimone, Frischgewaagd and Chaneng that are situated to the North, Mogono and Ga-Luka to the East of GMBS and Pudunong, Phokeng and Masobobane to the South-East of GMBS.

The GMBS land use is compatible with the near vicinity land use of the area and will be assessed as such. As can clearly be seen, the GMBS is only one of many mining activities in the area.

2.20.3 Visibility Analysis

The Glencore Merafe Boshoek Operations sites (the Mining Management Areas and the Ferrochrome Beneficiation Plant Management Area) are situated in the veld outside Rustenburg, in the midst of many other mining activities. None of the operations are situated on local topographical highpoints and thus are locally camouflaged to a degree by topography and vegetation. As such, the sites are rarely highly visible from any direction over significant distances. During the topographical assessment of the sites, surface contours were generated over 10 meter intervals.

The 10 m surface elevation contour data was then used to create maps representing the surface topography of the study area. The 10 m surface elevation contour data was further used to create a view-shed analysis of the surface topography of the area in which the sites are located.

2.20.3.1 View Shed Analysis

A view shed analysis was performed prior to the site specific photographic analysis in order to determine the visibility of the site from priority access points/routes such as public roads and community settlements.

The analysis was performed with SURFER, creating a 3-dimensional topographical contour map (Figure 2.20.3.1 (a)), using the 1:50 000 published DTM information obtained from the Surveyor General and ARCVIEW creating the 2-dimesional View-Shed map (Figure 2.20.3.1 (b)).

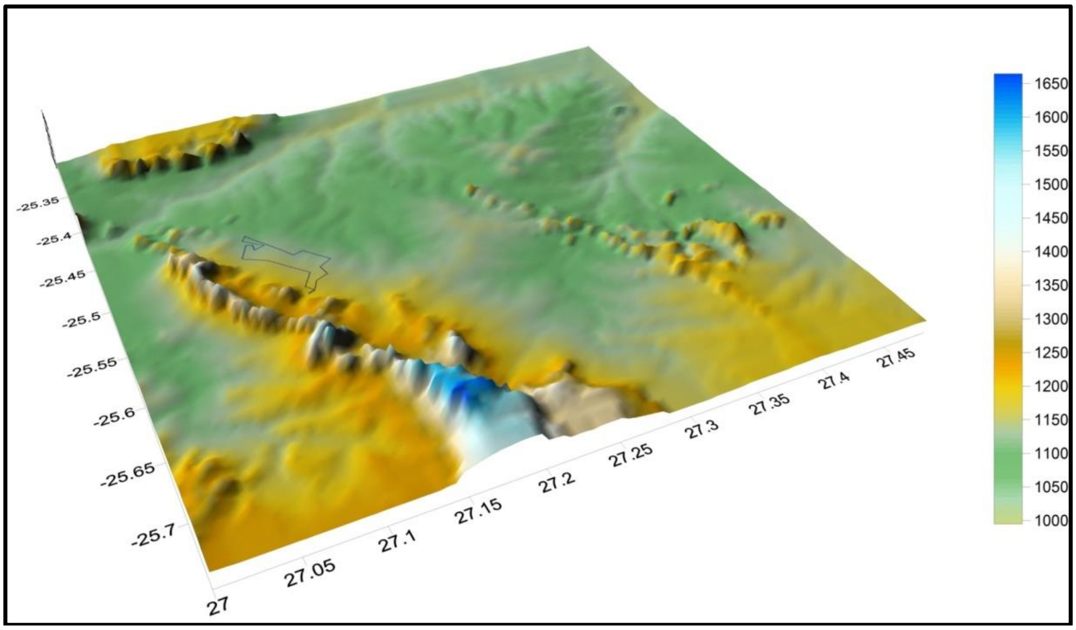

Figure 2.20.3.1 (a): Three Dimensional Regional Relief Map of the GMBS Area

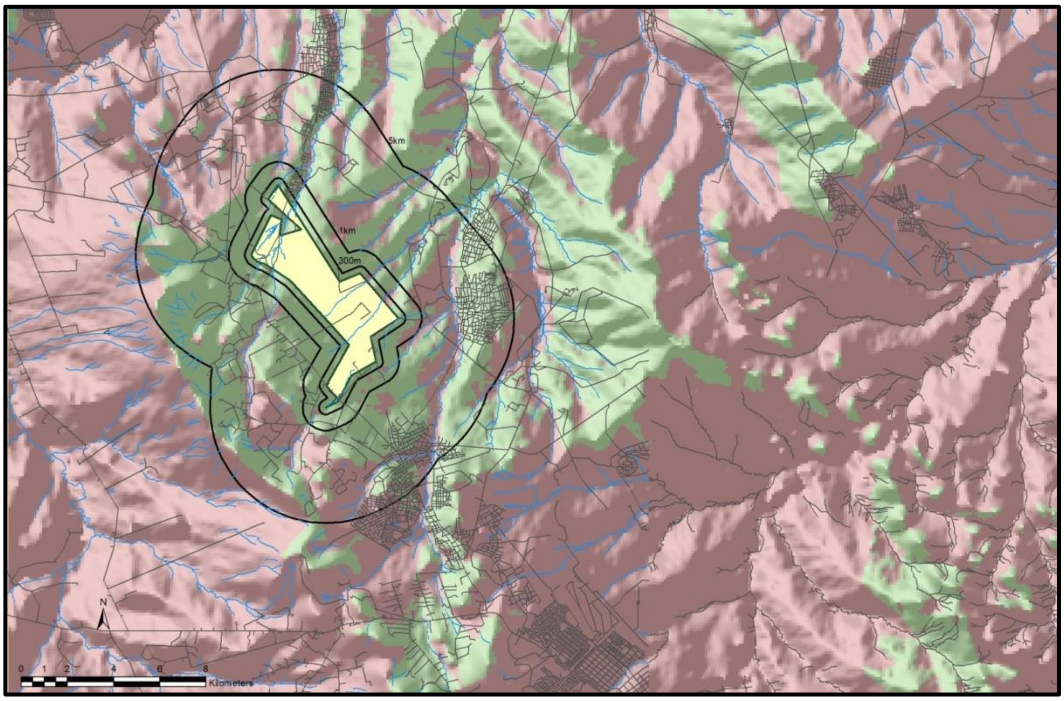

Figure 2.20.3.1 (b): View Shed Map (GMBS site visible from within the green areas)

The view-shed analysis represented in Figure 2.20.3.1 (b) indicates the visibility of the Mine and Smelter sites from all areas shown as green, and non-visibility from all areas shown in purple. It is however important to note here that the view-shed analysis is based entirely on the surface elevation data obtained from the 10 m contours and does not take the shielding effect of vegetation or surface infrastructure into consideration.

The resulting maps provided a sound basis from which to assess potential vantage points to the sites and on which to base planning for the photographic assessment.

Visibility Range of Proposed Sites

Due to the vegetation (a grassy ground layer and a distinct upper layer of woody plants ranging from 3 m to 7 m high) and the topography (mountainous) associated with the area in which the GMBS is located, a restricted visibility range is created. Short range views of physical objects are to be found, and surrounding the sites there are not many views from higher ground, as such not many long range views to the site can be found.

The GMBS activities can be seen as two visual entities:

1. **The Ferrochrome Beneficiation Plant Management Area (PMA), where the biggest visual concerns are the furnaces and the slag dumps.**

   The elements of the PMA operations, such as the furnaces that are mostly highly visible, are visible not because the element itself is highly visually intrusive in the landscape, but because of the emissions coming from it.

   The slag dumps are only visible at close to medium range due to the topography and vegetation camouflaging these elements.

2. **The Mining Management Area (MMA), is divided into the:**

a) **The Northern Opencast Mining Operations (NOMO) near the plant area, where the biggest visual concern is the stock piles and dust generated due to mining activity.**

   The stockpiles and activity of the NOMO is highly visible from the public road that runs by the PMA, past NOMO and through the townships of Rasimone and Chaneng. The stock piles can be identified as mining activity from several viewpoints. The slimes dam which is another prominent element on the site is not visible from any public view point. At the open-cast operations, the mining activities as such are not directly visible and will only be noticed as dust generated in the open pit and on the access roads.

   Since rehabilitation has taken place on the mining site, only two stockpiles of topsoil and the chrome stockpiles are visible from a distance. The spiral plant behind NOMO is also visible.

The salvage yard is also currently visible as all the activities that were taking place at NOMO are rehabilitated. After rehabilitation the stock piles will slowly begin to visually disappear in the landscape.

b) The Southern Opencast Mining Operations (SOMO) behind the Bafokeng Sports Campus, where the biggest visual concern is the stock piles and dust generated due to rehabilitation activity.

The chrome stock piles of SOMO are only visible from very few view vantage points and no mining activities as such are directly visible.

After rehabilitation the stock piles will slowly begin to visually disappear in the landscape.

In conclusion: after visiting the sites, and selecting the View Points for the photographical survey along public roads and from rural- and informal settlements surrounding the sites, it was observed that although there are some long range views to the GMBS, the true visibility of the sites are more restricted than indicated on the View Shed Analysis, because of the vegetation camouflaging elements, and the topography blocking long- and medium range views.

2.20.3.2 Photographic Assessment

A detailed photographic survey was done of the study site and adjacent areas from numerous surrounding vantage points shown in Figure 2.20.3.2 (a). The photographic compilations are produced in 2D by taking a series of photographs of a 3D environment. These are used to complete a view of the study area. This is done to give a clearer indication of the visual nature of the areas that will visually be affected by the activities, which will in turn aid in the design and installation of visual mitigation measures.

The photographic assessment proves support of the mentioned visibility range of the GMBS sites.

The assessment distinguishes between long-, medium- and short range views as well as highly-, slightly-, and not-visible views. Also indicated on the map in Figure 2.20.3.2 (a) are several buffers. Within and on the 300 meter buffer around the sites, the vantage points will be Short Range Views. Within and on the 1 km buffer around the sites, the vantage points will be Medium Range Views. Further than that, all vantage points will be Long Range Views.

To avoid clustering of data and information, the photographic assessment is presented at the hand of 11 photographic compilations in the Visual Impact Baseline Study, each representing views to the GMBS sites. See Figure 2.20.3.2 (b) for an example of these photographic compilations. The full set of photographic compilations are contained in the Visual Aspects Specialist Report attached as **APPENDIX 2.20 (A)**.

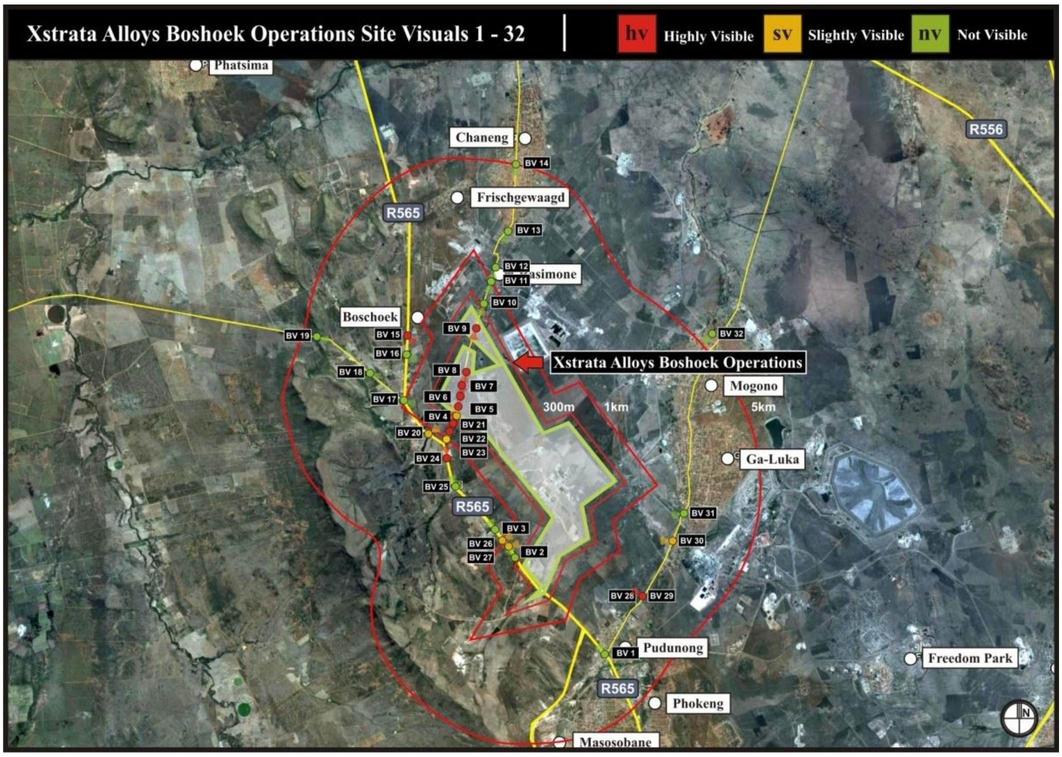

Figure 2.20.3.2 (a): Map of the GMBS Sites and Vantage Points from Which photographs were taken

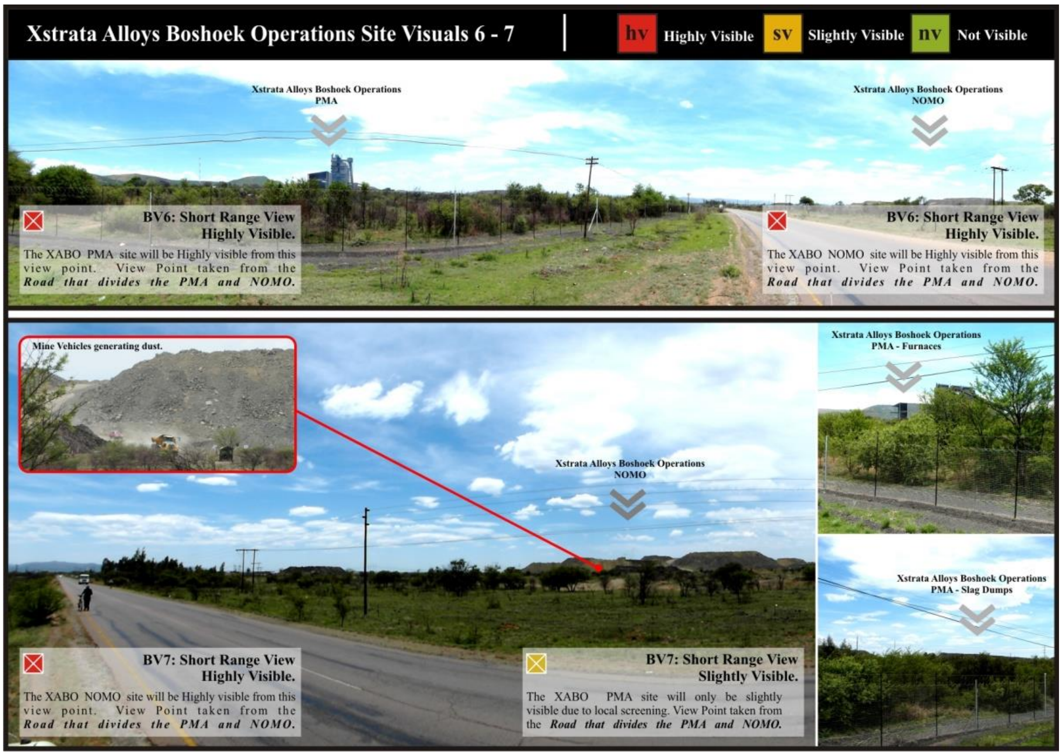

Figure 2.20.3.2 (b): Glencore Merafe Boshoek Operation Site Visuals 6 – 7. An example of a Photographic Compilation analysing the GMBS sites

2.20.3.3 Visual Base Line Conditions – Current Visual Character

Regional Visual Character – Long Range Views

Regionally the visual character is three-fold:

The first: is that of the mining belt between Brits and Rustenburg. This area along the N4 Highway is largely occupied by mining facilities. Here the perceived degree of human intrusion is very high, and the vegetation not uniquely bushveld anymore.

Therefore if the GMBS infrastructure is viewed against the visual character of the mining belt as backdrop, the visual impact will be relatively insignificant, as the nature of these elements will not contrast greatly with their surrounding visual context.

The second: is that of the bushveld vegetation and mountainous topography of the area. The perceived degree of human intrusion in the area of the site is moderate with a grassy ground layer and a distinct upper layer of woody plants. Although the GMBS site is situated on relatively flat pieces of land, this type of vegetation and topography can be found in most of the surrounding areas. The veld adjacent to the site is acceptable for natural camouflage of lower structures.

Together with the vegetation the topography also lends itself to natural camouflage. The hills create an effective background against which the infrastructure can be viewed. The hills have relatively dark colours and many shade variations, which cause a significant degree of visual "camouflage" of these structures. The visual impact of the GMBS in the larger area will be moderate.

The third: is that of human settlement. Rural- and informal settlements, and farms make out the bulk of human settlement in the near vicinity of the site. Because the GMBS Plant area is situated next to the small settlement of Boshoek, it is visible from rare views from this settlement situated South-West of the site. The Operations are also visible from rural settlements situated to the North, East and South-East and roads situated close by in all directions.

- The **farming population** density in this area is low and problematic views will only occur from roads used close to the mining activity rather than from farm steads. Most farming activities can be found to the North-West, West and South West of the GMBS operations and the mountainous topography of that specific area renders views totally insignificant.

- The **rural settlement population** density in the area is high, but views are generally restricted due to short range obstructions, and many a time, when a view is situated at a medium range from the Operations, other mining activities can be seen in the foreground closer to the viewer than that of the GMBS, rendering the visual intrusion insignificant.

- The GMBS is not visible from the town of **Rustenburg**, which is the nearest large formal human settlement.

The visual impact of the site, on the settlements in near vicinity of the site is moderate, but little or no measures can be taken to improve this. The fact that the GMBS is viewed against the backdrop of hills contributes to camouflage it, and the vegetation blocking many close, medium and long range views, helps to make it becomes visually acceptable.

In terms of visual character, the existing facility does not intrude radically with the surrounding regional visual character.

Local Visual Character – Short/Medium Range Views

In this report, short-range views are defined as those views that are closer than 300 meters to a feature, whether the view is not visible, slightly visible or highly visible.

Physical Objects Obscuring Views

When buildings, vegetation or landforms obscure a view, the range of the view is shortened, thus, eliminating the long-range view concerning objects further away. This view can no longer be influenced by the visual intrusion of an object you are no longer able to see.

In this proposed context, this phenomenon is illustrated by the presence of the existing GMBS in the landscape. Short range views across to the site and its surroundings are generally not restricted. Although many parts along the roads are planted with trees, consist of natural vegetation or contain structures closer to the road which can be observed, restricting views to the site, the GMBS sites are still visible from several sections along the roads. Furthermore the vegetation found along the road is constantly changing, and as such the visibility of the site and surroundings subtly changes as time passes. The fact that the site is visible from short-range views does not however suggest a complete negative visual impact, as there are other factors also to consider.

The Setting of the Site

Where views are not obstructed by nearby objects, the existing mining/industrial complex draws the observer's attention. Part of the Operation's infrastructure is two furnaces, which is the highest vertical objects in the Plant Management Area. These elements are the most visible elements of the GMBS. If not for the setting of the site, within an active mining area, in a mountainous area with rich natural vegetation, this element would probably have been a short/medium-range visual concern. But in this instance, considering the setting of the site, the visual intrusion becomes moderate and acceptable.

The Backdrop against Which an Element is Viewed

Another factor that may influence short-range views is the backdrop against which an element is viewed. When viewed from close up, landscape elements are usually seen against the sky and are therefore more visible. When the same elements are viewed against a backdrop of similar colour, they tend to be "hidden" more.

This phenomenon is generally reserved for medium/long-range views, as in this instance, accept in specific cases where an operation is situated close to objects higher than the components of the site.

Landscape Character

In this document, Landscape Character is a discussion of the nature and occurrence of the physical environment.

Morphology and Topography

Even though the site and surrounding areas for the most part still possess their natural landscape form, they occur in an area where the local topography and morphology have been altered in some way due to mining and other activities. The area therefore by no means represents a greenfields morphological and/or topographical environment.

Surface Vegetative Cover

At the GMBS sites significant portions of both, the sites themselves, as well as parts of the immediate surroundings, farms and rural settlement areas, have been disturbed and altered by anthropogenic activities, resulting in the original vegetation being scattered to non-active parts of the land. In the larger area though, the vegetation is still semi-pristine.

Current On-Site and Adjacent Land Use

From a land use perspective, the overall landscape character is dominated by mining, agricultural and residential (informal) activities.

The GMBS is compatible with the near vicinity land use of the area.

Existing Visual Character

The existing visual character of the site and greater region is far from undisturbed and is in fact characterised extensively by manmade elements and mining activities. The existing GMBS sites are not uniquely visible and therefore do not visually dominate the area, and do not visually contrast with the area’s character context.

Landscape Visual Quality Assessment

In this document, Landscape Quality is a measurement of the union of ecological integrity and aesthetic appeal. Ecological integrity refers to the condition or overall health of the landscape measured in terms of the quality of the physical environment – morphology, topography and vegetation.

Using these criteria to analyse the landscape quality of the GMBS sites and their immediate surroundings, the following conclusions were subjectively (but in a professional opinion) made. Where the natural/expected condition of the site and immediate surroundings is unaltered, a rating of 1 is given, and where the expected existing condition is not present or has been changed, a rating of 0 is given.

Table 2.20.3.3 (a): Local Landscape Quality

Ecological Integrity	
Morphology	0
Topography	0
Vegetation	0
Aesthetic Appeal	
Topographical ruggedness	0
Presence of water	0
Natural versus human landscape	0
Land use compatibility	1

As can be seen from the Table above, the ecological integrity of the sites and immediate surroundings has been largely altered.

It can be argued that the landscape quality is relatively low, but acceptable, considering that industry and mining in this area is a major economic booster for the region and the country. The area character is already damaged and typically mining. Substantial human intervention has already occurred locally and the visual intrusion of the GMBS is relatively low.

Visual Character (Sense of Place) Assessment

According to Lynch (Lynch, 1992) sense of place is "the extent to which a person can recognise or recall a place as being distinct from other places, as having a vivid or unique, or at least particular character of its own".

Using this definition, the GMBS sites Sense of Place were analysed and, the following subjective conclusions are made:

- The region discussed in the mining belt between Brits and Rustenburg has a very specific character, which is a mining/industrial and residential/rural combination. The area itself and the site of the GMBS both have a relatively moderate visual quality, but fits into the character of place. The natural landscape though, the mountainous topography and natural bushveld does give the region a unique feeling when viewed from other vantage points.

- The current GMBS' character is similar to those of other mining facilities in the larger area and it can therefore not be considered to have a unique genius loci or sense of place.

- The presence of the GMBS sites do detract from the aesthetic appeal of the area, but as other mining activities also occur in the larger area, the visual impact is to some extent lessened. The setting of the site also contributes to minimise the impact. The nature of the visual impact will however be undesirable and visual mitigation should be considered where applicable.

3 PROJECT DETAILS AND ANTICIPATED IMPACTS

The subject matter of this project comprises the **addition, alteration and expansion of Ferrochrome Smelting Beneficiation Plant related infrastructure** at the existing Glencore Merafe Venture Boshoek Mine and Smelter.

In order to obtain the required Environmental Authorizations for these activities, the following is required:

- An EMPR Addendum in terms of the provisions of the MPRDA.
- A Scoping and EIA Process for activities as defined in the Listing Notices of the EIA Regulations GNR 544, 545 and 546 of NEMA.
- A Scoping and EIA Process for waste management activities as listed in Regulation GNR 921 of NEMWA.

In order to support the EMPR Addendum Process, all documentation compiled for this Scoping and EIA Process will contain both:

- the existing infrastructure and process description as relevant to the current operations as approved in the current EMPR, together with the Impact Assessment and Approved EMP as per the approved EMPR (**section 3.2**), as well as
- the infrastructure and process descriptions of the proposed new activities for which the relevant applications for environmental authorizations will be made (**section 3.3**).

However, the actual Environmental Impact Assessment (EIA), the determination of Management Objectives, the conceptualization and specification Environmental Management Measures and the Monitoring Proposals (EMP) **will focus on the new proposed activities for the site**.

A distinction will therefore be made in this Chapter **between already existing** and **authorized infrastructure** and activities described in the approved EMPR, and **new proposed activities** and processes related to the proposed additions, alterations and expansions.

It should be noted that some of the actual details of the site infrastructure differ from the original planning as foresaw in the EMPR. The description in this document will reflect the actual current site conditions and not the originally foreseen.

Unless information to the contrary is provided, however, information used during compilation of the original EMPR will be used e.g. production rates, estimated rates of waste generation and deposition, conceptual designs for dams and waste disposal facilities, etc.

3.1 APPLICANT, LOCATION, RESOURCE AND MOTIVATION

3.1.1 Project Applicant

Project Applicant:	Glencore Merafe Venture Operation – Boshoek Smelter
Trading Name:	Merafe Ferrochrome and Mining (Pty) Ltd
Business Registration No:	1976/001116/07 ; VAT 4010216903
Contact Person:	Francois Coetzee
Physical Address:	Cnr of Boshoek Station & Rasimone Road
Postal Address:	Private Bag X4011, Boshoek, 0301
Telephone no:	+27 (0) 14 573-1200
Fax no:	014 573 1239
E-mail:	francois.coetzee@glencore.co.za

3.1.2 Project Location

3.1.2.1 Regional Setting

The Boshoek Smelter and Boshoek Mine, A Glencore Merafe Venture Operation is located approximately 30 km to the north-west of Rustenburg in the North West Province of South Africa.

Figure 3.1.2.1(a): Regional Locality – Glencore Boshoek Operations

The site falls within the Rustenburg Local Municipality within the Bojanala Platinum District Municipality (BPDM). The Bojanala District Municipality (BDM) is the largest of the four district municipalities within North West Province (NWP). The district is located in the north-eastern side of the NWP and also shares boundaries with municipalities in other provinces listed as follows:

- The Waterberg District Municipality to the north;
- The West Rand District Municipality to the south-east;
- The City of Tshwane Metropolitan Municipality to the east;
- The Dr Kenneth Kaunda District Municipality to the south; and
- The Ngaka Modiri Molema District Municipality to the west.

The BPDM comprises five local municipalities, namely Kgetlengrivier, Madibeng, Moretele, Moses Kotane, and Rustenburg. Major settlements with their respective orientations and distances from the site location are listed below:

Table 3.1.2.1(a): Settlements and Towns around the Site

Town	Distance from Site (km)	Direction from Site
Chaneng	9.01	North
Robega	8.6	North-West
Mafenya	11.4	North
Rasimone	5.2	North-West
Ga-Luka	7.37	East
Freedom Park	15.33	South East
Boitekong	23.95	South East
Pudunong	8.22	South
Rustenburg	21.45	South

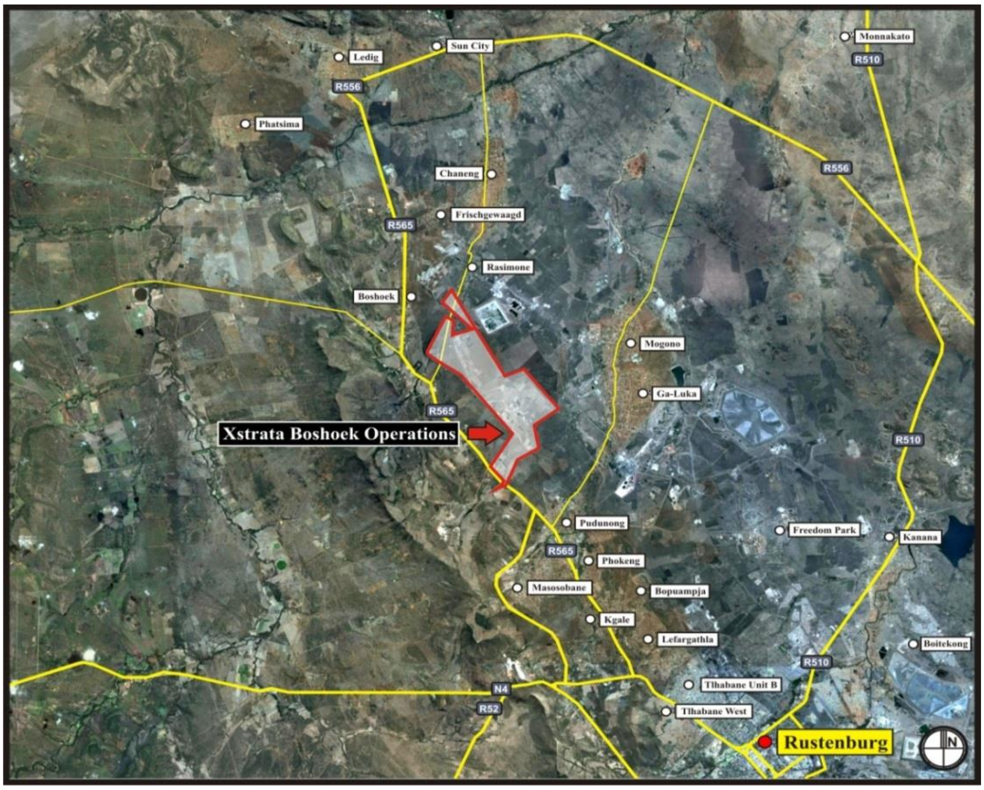

Figure 3.1.2.1 (b): Boshoek Site in relation to Surrounding Communities

3.1.2.2 Local Setting

The Glencore Merafe Venture Operation -Boshoek Smelter and Boshoek Mine (GMBS) is located in the south-western regions of the A22F quaternary catchment within the Limpopo River Primary Catchment Area and within the Crocodile (West) and Marico Water Management Area. The surface water at the site drains in a northerly and north-easterly direction and has been affected by the various surface activities (predominantly mining related) within the area.

The Matlapyane stream, a non-perennial stream which has its source within the Magaliesberg Mountain Range to the south-west of the site, drains in a northerly direction through the Ferrochrome Plant Beneficiation Management Area.

The Borethane stream has its source within the Mining Management Area and drains in a north-easterly direction into the Lerangane River to the north-east of the site. Both the Matlapyane and the Borethane streams eventually drain into the Elands River to the north and north-east of the site.

The GMBS study area is flanked by the Magaliesberg Mountain Range to the west and south-west and by the Pilanesberg to the north. The land use adjacent to the site is dominated by agricultural and mining related activities.

The regional mining operations take the form of opencast and underground operations that exploit the Rustenburg Layered Suite of the Bushveld Igneous Complex for its chrome, platinum and platinum group element (PGE) content. The LG-6 chromitite layer, UG-2 chromitite layer and the Merensky Reef are the main reefs that are currently being mined in the area.

The settlement of Boshoek is located within 1 km to the south-west of the site. The settlements Rasimone, Frischgewaagd and Chaneng are situated to the north, Mogono and Ga-Luka to the east, and Pudunong, Phokeng and Masobobane to the south-east of the site.

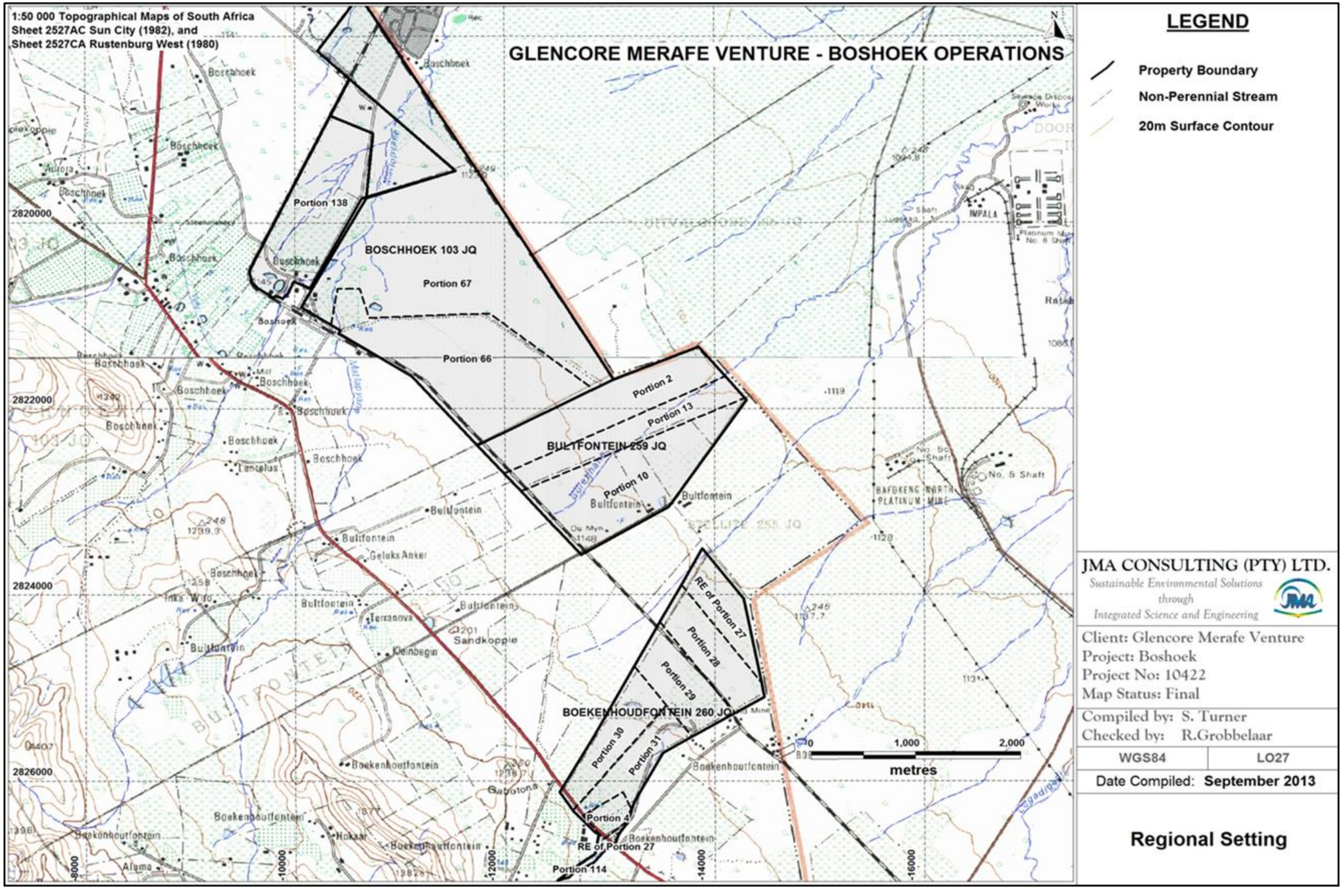

Figure 3.1.2.2(a): Local Setting - Glencore Merafe Boshoek Mine and Smelter

3.1.3 Project Resource Attributes

3.1.3.1 Mineral Deposit

The opencast mining operations at GMBS are situated within the western limb of the Bushveld Igneous Complex. The in-situ chromite is generally exploited from the Lower Group (LG), Middle Group (MG) and Upper Group (UG) chromitite layers from within the Rustenburg Layered Suite.

The lithologies of the Bushveld Igneous Complex have a north-west to south-east strike and have a true dip of around 12° to the north-east within the study area. Dykes, rolls, potholes and faults occur within the study area and are expected to influence the continuity and occurrence of the chromitite layers. The extents of the linear geological features at GMBS, as obtained from the most recent Amended Mining Work Programme (March 2012) are delineated on Figure 3.1.3.1 (a).

The GMBS opencast mining operations extracted chromitite ore from the LG-6 and MG-1 chromitite layers of the Rustenburg Layered Suite. The MG-2, MG-3 and LG-6A chromitite layers are of poor quality with regards to their chrome content and are thus often treated as part of the waste rock / overburden material. The minerals exploited at GMBS Mine (as obtained from the Amended Mining Work Programme (March 2012)) are listed in Table 3.1.3.1 (a), with chromite being the primary mineral exploited.

Table 3.1.3.1(a): Minerals Exploited at GMBS Mine

Mineral	Primary or Associated	Definition as per MPRDA			
		Code	Commodity	Type Code	Type Description
Chromite	Primary	Cr	Chrome Ore	B	Ferrous and base metals
Platinum Group Minerals	Associated	PGM	Platinum Group Metals	PGM	Platinum Group Minerals
Copper Ore Minerals	Associated	Cu	Copper Ore	B	Ferrous and base metals
Gold Ore Minerals	Associated	Au	Gold Ore	GS	Gemstones (except diamonds)
Nickel Ore Minerals	Associated	Ni	Nickel Ore	B	Ferrous and base metals
Lead Ore Minerals	Associated	Pb	Lead	B	Ferrous and base metals

The mineral content of the various chromitite layers identified at GMBS are indicated by the Cr_2O_3 grade, which is expressed as the Cr_2O_3 mass percentage (%). The average Cr_2O_3 grade (%) of the various chromitite layers are provided in Table 3.1.3.1(b).

Table 3.1.3.1 (b): Average Cr_2O_3 grade (%) of the Chromitite Layers

Chromitite Layer	MG4C	MG4B	MG4A	MG3	MG2	MG1	LG6A	LG6	LG5
Cr_2O_3 (5%)	30.66	32.91	33.30	33.87	37.82	39.15	33.33	40.08	37.53

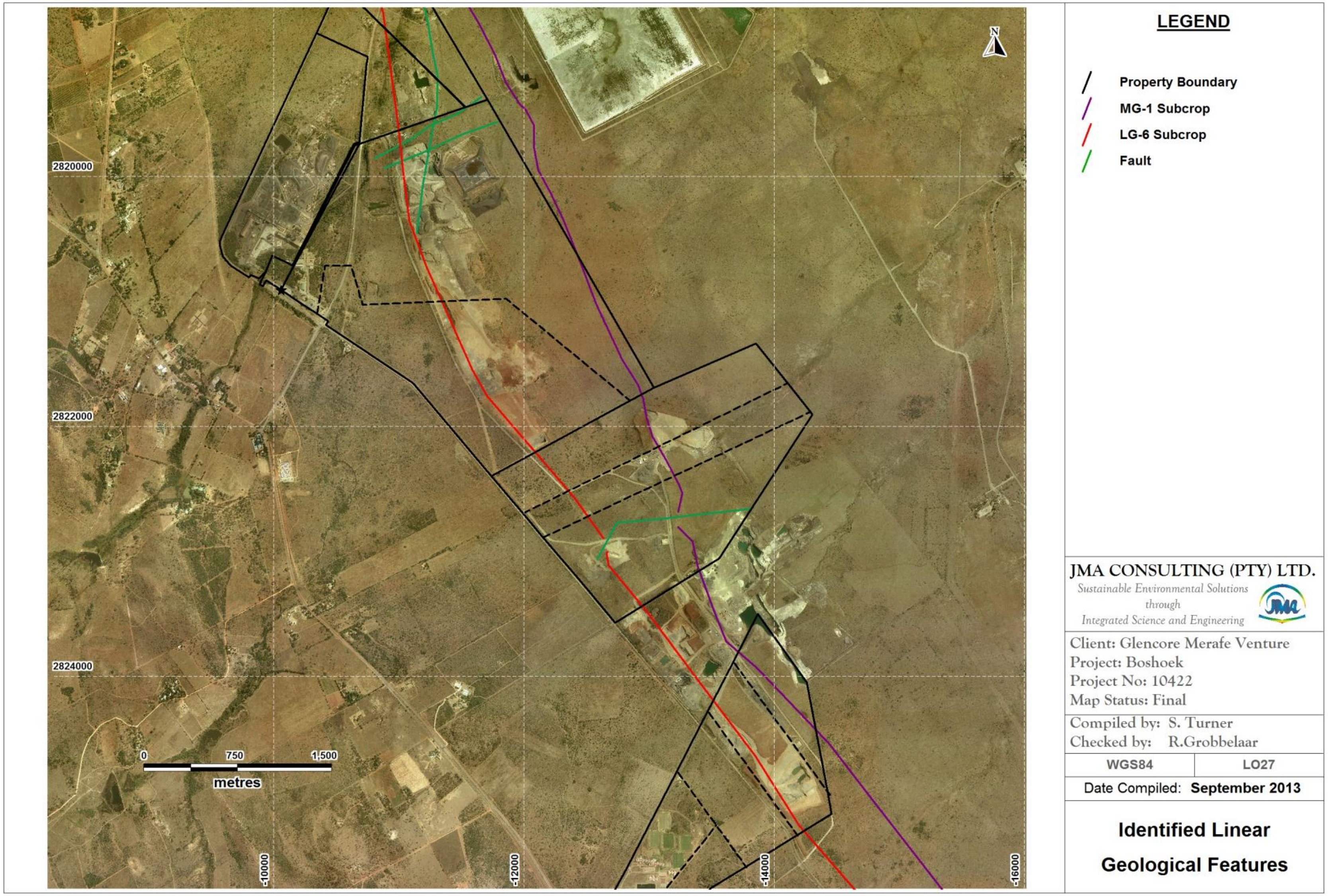

Figure 3.1.3.1(a): Linear Features and Mineral Ore Bodies at GMBS

3.1.3.2 Mineable Seams/Ore Bodies

The Mineral Resources and Mineral Reserves are obtained from the Amended Mining Work Programme (March 2012) and are reported using the Joint Ore Reserves Committee (JORC) Code as a guideline. The Mineral Resources and Mineral Reserves quantification and categories are based on the exploration drilling that has been done at GMBS.

The drilling is done on regular 200 m x 200 m grid, however, this is not permitted in certain areas due to various surface infrastructure. The drilling information indicates occasional significant lithological thickness variations in the layering of the lithological units towards the north-western parts of the GMBS sector where the Rustenburg Layered Suite approaches the Pilanesberg Complex.

The Mineral Resources at GMBS Mine are categorised and listed in Table 3.1.3.2(a).

Table 3.1.3.2(a): GMBS Mineral Resource Categories

Mineral Resource Category	Inferred	Indicated	Measured
Tonnage (Mt)	-	15.93	1.41
Grade (% Cr_2O_3)	-	40.20	40.28

3.1.3.3 Planned Life of Mine/Facility

A distinction must be made between the life of the Mine and the life of the Ferrochrome Smelter.

The final active mining is scheduled for 2013 after which the open cast mining areas will be rehabilitated. This is in line with the 5 to 8 years life of mine as specified in the current EMPR which was approved in August 2007.

The life of the Smelter is theoretically indefinite as it can continue to operate despite the mine being depleted. This is due to the fact that the Smelter obtains its ore for neighbouring and other mines in the area.

3.1.3.4 Product Specifications

The GMBS Mine produces chromitite extracted from the LG-6 and MG-1 chromitite layers of the Rustenburg Layered Suite. The average mineral content of the various chromitite layers extracted varies between 39.15% and 40.08% expressed as the Cr_2O_3 mass percentage (%).

The GMBS Smelter produces Ferrochrome. Ferrochrome is a corrosion-resistant alloy of chrome and iron. The ferrochrome metal produced at the Glencore Merafe Boshoek Smelter is a silvery grey alloy metal which contains a mixture of between 48% – 52% Cr, 7% – 8% C, 3%– 5% Si and 35% – 37% Fe, as required by the consumer.

Over 80% of the world's ferrochrome is utilized in the production of stainless steel. The average chrome content in stainless steel is approximately 18%.

Mineralogical and elemental analyses conducted on GMBS final product, revealed that the final products are comprised mostly of amorphous material (probably Cr phases) (70% and 76%), Cr_7C_3 (24% and 18%), and Fe_3Si (6% and 7%). The high amorphous content indicate that the material was subjected to heat for a short period under low pressure and that no crystallisation took place.

3.1.3.5 Product Markets

Ferrochrome (FeCr) is an alloy of chromium and iron containing between 50% and 70% chromium. The ferrochrome is produced by electric arc melting of chromite, an iron magnesium chromium oxide and the most important, chromium ore. Most of the world's ferrochrome is produced in South Africa, Kazakhstan and India, which have large domestic chromite resources. Increasing amounts are coming from Russia and China. The production of steel is the largest consumer of ferrochrome, especially the production of stainless steel with chromium content of 10% to 20% is the main application of ferrochrome.

3.1.3.6 Product Price

Prices of ferrochrome are often quoted in terms of United States cents (¢) per pound (lb) of chrome contained, although producing companies will generally report production and sales in terms of metric tonnes FeCr sold. In order to calculate the value of a metric tonne of FeCr from a price quoted in US cents, the percentage of chrome within the ferrochrome must be known. In a simple example if 1 metric tonne of FeCr with 55% chrome contained is sold for 100¢ US (per lb of Cr contained) then the value would be: 55% * (1 metric ton FeCr) = 550 kg Cr = 1212.54 lb Cr (55%). Multiply 1212.54 lb times 100¢/lb = US $ 1212.54, then round appropriately.

3.1.4 Project Motivation

Originally the Glencore Merafe Venture Operation Boshoek Smelter and Boshoek Mine was constructed by Merafe Resources Limited (Merafe) in March 2001 and was successfully commissioned in 2002. The first batch of ferrochrome was tapped from the Smelter on 13 June 2002. The smelter then aimed to produce 240 000 tonnes of ferrochrome per annum.

Since July 2004, the ferrochrome smelter complex operated as a Xstrata - Merafe Chrome Joint Venture, until its purchase by Glencore in 2013 to become the Glencore Merafe Venture Boshoek Mine and Smelter. Both the Mine and Smelter therefore represent existing operations for which motivated environmental authorizations were obtained (EIA and EMPR).

However, the **mine is nearing its final rehabilitation** stage, whilst the **smelter requires upgrades, extensions, as well as new water and waste management facilities** to continue its operations. These include:

- New Access Road to Slimes Dam and Slag Dump
- New Lapa Pond
- New Storm Water Drainage Canals/Berms
- Extension of Temporary Waste Storage Facilities
- Upgrade of Salvage Yard
- New Slag Dump
- New Slag Dump Pollution Control Dam
- New Slurry/Slimes Dam
- Upgrade of Dust Control at Raw Materials Proportioning Plant
- Upgrade of Air Pollution Control Equipment at Furnaces (tap hole fume extraction system)

These project alterations/additions require applications for environmental authorizations as required in terms of various sets of legislation:

- EMPR Addendum in terms of MPRDA
- EIA and EMP in terms of NEMA
- Waste License in terms of NEMWA
- Water Use License in terms of NWA

This project motivation therefore speaks to the motivation for these upgrades, extensions and/or additions as required to continue with the Smelting operations at Boshoek.

3.1.4.1 Legal Standing

Glencore is one of the world's largest global diversified natural resource companies and is one of the biggest companies within the FTSE 100 Index. The Group's industrial and marketing activities are supported by a global network of more than 90 offices located in over 50 countries. Their diversified operations comprise of over 150 mining and metallurgical sites, offshore oil production assets, farms and agricultural facilities. They employ approximately 190,000 people, including contractors.

The combination of a leading integrated producer and marketer of commodities with a leading portfolio of industrial assets enables them to capture value at every stage of the supply chain from sourcing raw materials deep underground to delivering products to an international customer base.

They are a major producer and marketer of over 90 commodities that are transformed into products used in everyday life, such as mobile phones, bicycles, cutlery, plastics and electricity, to customers in industries ranging from automotive to food processing and power.

The company is structured into three distinct business segments:

- Metals and Minerals: focusing on copper, nickel, zinc/lead, alloys, alumina/aluminium and iron ore. They have interests in both controlled and non-controlled industrial assets that include mining, smelting, refining and warehousing operations;
- Energy Products: focusing on oil and coal. Their Energy Products businesses include controlled and non-controlled coal mining and oil production operations and investments in strategic handling, storage and freight equipment and facilities; and
- Agricultural Products: focusing on grains, oils/oilseeds, cotton and sugar. Their Agricultural Products group is supported by both controlled and non-controlled storage, handling and processing facilities in strategic locations.

Locally the Glencore Merafe Venture, of which the Boshoek Mine and Smelter is one entity, comprises operations that are located across the mineral-rich Bushveld Complex of South Africa's North West and Mpumalanga provinces, where it employs over 12,300 people including contractors.

In line with South Africa's Mining Industry Charter, Glencore has fulfilled all Black Economic Empowerment obligations in respect of joint ventures and ownership, which is crucial for security of tenure. Merafe Resources, Kagiso Trust Investments, the Ngazana Consortium and the Bakwena Ba Mogopa Community all have ownership participation in respect of chrome, PGM and vanadium assets respectively.

3.1.4.2 Need for Product

Over 80% of the world's ferrochrome is utilised in the production of stainless steel. In 2006 28 Mt of stainless steel were produced. Stainless steel depends on chromium for its appearance and its resistance to corrosion. The average chrome content in stainless steel is approximately 18%. It is also used when it is desired to add chromium to carbon steel. FeCr from Southern Africa, known as 'charge chrome' and produced from a Cr containing ore with a low Cr content, is most commonly used in stainless steel production.

Alternatively, high carbon FeCr produced from high grade ore found in Kazakhstan (among other places) is more commonly used in specialist applications such as engineering steels where a high Cr to Fe ratio and minimum levels of other elements such as sulphur, phosphorus and titanium are important and production of finished metals takes place in small electric arc furnaces compared to large scale blast furnaces.

3.1.4.3 Strategic Importance of the Resource/Product

Ferrochrome is a corrosion-resistant alloy of chrome and iron containing between 50% and 55% chrome. Over 80% of the world's ferrochrome is utilized in the production of stainless steel. The average chrome content in stainless steel is approximately 18%.

Having acquired Xstrata Alloys, Glencore, together with its ‘Pooling and Sharing Venture’ (“PSV”) partner, Merafe Resources Limited, now have a combined capacity in excess of 1.76 million tonnes of ferrochrome per annum. Glencore is now the world's largest, and amongst the lowest cost, integrated ferrochrome producers in the world.

All of the group's chrome mines are either opencast or shallow underground mines. The gently dipping reefs of chromite are accessed by box cuts and decline shafts. Mining is of opencast or board and pillar nature and is currently conducted at depths ranging from surface (opencast), or from 50 m to 350 m below surface. All development is on reef, thereby minimizing waste dilution. In addition to ore from its own mines, ore is purchased from nearby platinum producers, where chrome-rich finds are discarded as a waste product.

3.1.4.4 Socio-Economic Benefits

The Socio-Economic base line description contained in section 2.5 of this report, clearly confirms that there is no doubt that the continued operation of the Glencore Merafe Venture Boshoek Smelter will have a positive impact on the socio-economic aspects of the Rustenburg municipality, with the major impacts focussed on the smaller areas of Boshoek, Rasimone with lesser impact on Phokeng, Ga-Luka and other smaller settlements.

The socio-economic baseline discusses the current status of the zone in terms of the broader economic outcomes/objectives of local economic systems. These economic objectives include outcomes in terms of the traditional focus area of **economic efficiency** (economic growth and employment), **economic equity** (income distribution and poverty alleviation) as well as long term **economic stability** (including long term environmental sustainability and potential macro-economic risks).

The information generated indicates that the platinum and chrome mine segment employed 37% of the total workforce of the region in 2000. In 2011, this percentage has increased to 52%. Information on economic output shows that 64.7% of the GVA generated in Rustenburg municipality comes from the metal ore mining sector, thus reflecting the resource based character of the economy. The higher output value of the platinum and chrome mining sector compared to employment, suggests this sector as a fairly capital intensive sector.

Source: IHS Global Insight database 2012

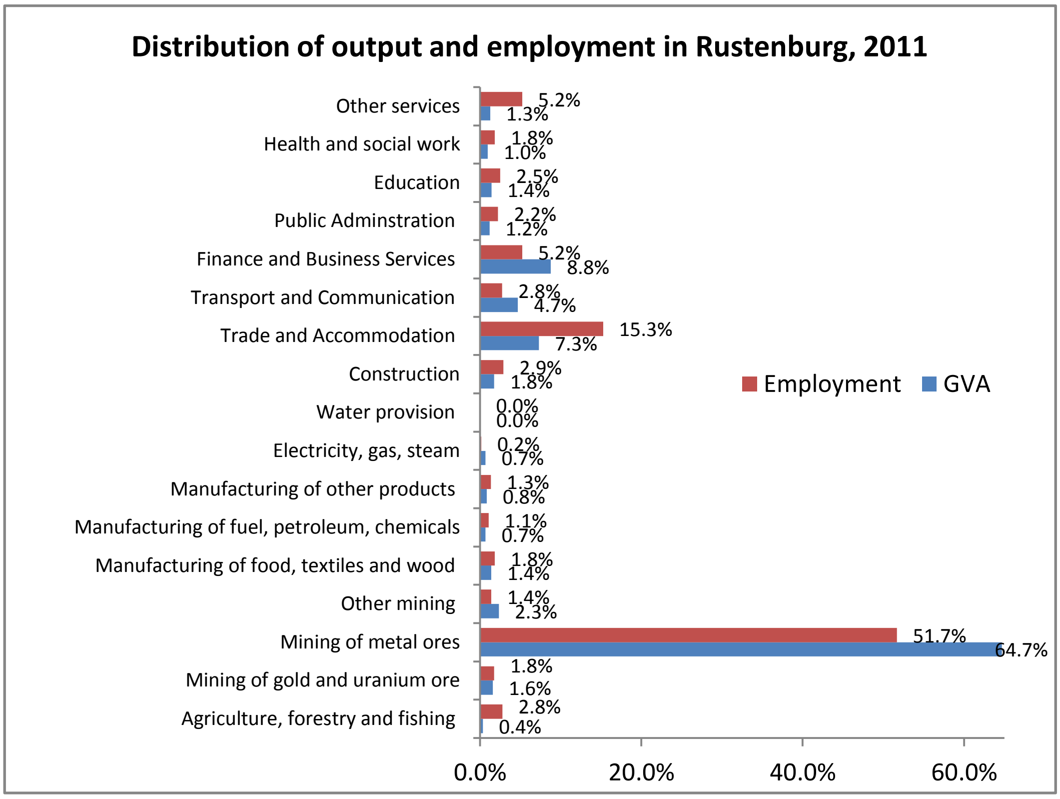

Figure 3.1.4.4 (a): Rustenburg Employment & Output – 2011

The study revealed that the real economic output growth rate of the Rustenburg municipality was on average 4.3% per year between 2000 and 2011, compared to the growth rate of 2.8% for the North West Province and the national average of 3.5% for the same period. The driving force behind this high growth was the metal ore (platinum and chrome) mining sector, which experienced a real economic output growth of 4.4% per year between 2000 and 2011.

South Africa is the world's largest producer of chrome ore and ferrochrome. In 2011, South Africa produced approximately 38% of the world's ferrochrome and 48% of the world's chrome ore (Craig Fossey, 2012).

Products from mining activities make out the majority of exports from Rustenburg municipality. These products include platinum, chromite, UG2 chrome ore and ferrochrome.

Due to the mining sector activities, the Gross Value Added/Production Income (GVA) per capita for the Rustenburg municipal area is much higher than the national and provincial averages. In GVA/capita for the Rustenburg municipality was R138 000 per current prices in 2011 compared to the national and provincial averages of R53 000 and R50 000 respectively.

The graph below shows the percentage of people living in poverty for Rustenburg municipality compared to the country and North West province as a whole.

Source: IHS Global Insight database 2012

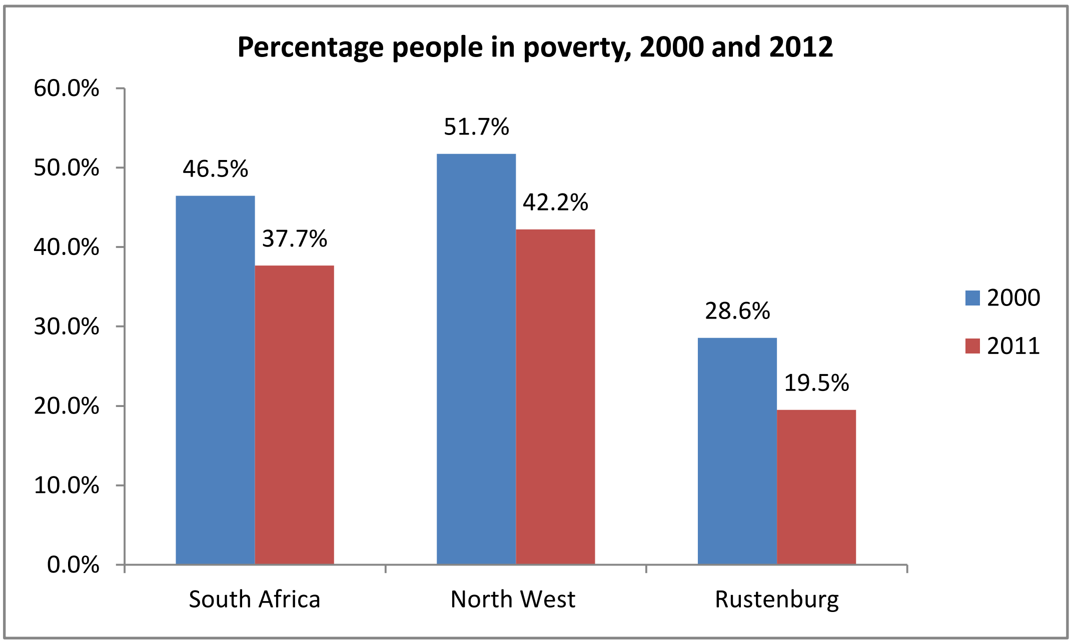

Figure 3.1.4.4 (a): Poverty Levels – 2000 and 2011

3.1.4.5 Need for the Project (timing)

The current chrome mining and ferrochrome smelting operations at Glencore Merafe Boshoek Mine and Smelter were authorized through various environmental authorization mechanisms during the early and mid 2000's. During those applications motivations were given for the original start-up of the operations as is well documented in the approved EMPR for the site.

The predicted positive socio-economic impacts actually manifested as is graphically demonstrated by the fact that the site provides employment to more than 800 people. The proven positive contribution of the operation as part of the broader mining sector to the socio-economic well being of the region, is obvious from the socio-economic base line description.

The project to be motivated here, essentially relates to the upgrade, expansion and addition to existing project components at GMBS, and is therefore required not for expansion purposes, but essentially represent activities required to ensure continued operation of the site. Should these activities not be authorized, the GMBS operations will have to close down.

The proposed activities are required in order to sustain the current land use which has been active since 2002. The activities are intended to prolong the current beneficial land use and are similar to what already exists at the site. Furthermore the current activities contribute significantly to the socio-economic well being of the surrounding communities.

The proposed activities will not require additional resources or services and will in fact continue to support ongoing service delivery from a municipal perspective.

3.1.4.6 Desirability for the Project (placing)

As stated above, the current chrome mining and ferrochrome smelting operations at Glencore Merafe Boshoek Mine and Smelter were authorized through various environmental authorization mechanisms during the early and mid 2000's. During those applications motivations were given for the original start-up of the operations as is well documented in the approved EMPR for the site.

The proposed activities which form the subject matter of the current applications, will be located within the boundary of the existing Glencore Merafe Venture Boshoek Mine and Plant, and will therefore neither compromise the current land use, as approved for the site – EIA and EMPR, nor will it compromise the broader land use context of the existing mining belt as described for the broader area.

The proposed activities relate primarily to **upgrades, extensions, as well as new water and waste management facilities** for the Smelter Plant and which are required essentially for Air Quality Management, Water Management and Waste Management, and will therefore support the existing environmental management for the site and the region as a whole.

It is not expected that any of the activities will impact on sensitive natural and cultural areas or on people's health or wellbeing, nor is it expected that it will result in unacceptable opportunity costs.

Detailed impact assessments will be conducted during the EIA phase for socio-cultural, heritage, socio-economic and a host of biophysical environmental components to ensure that the proposed activities can be constructed, operated, decommissioned and closed within acceptable environmental objectives.

3.2 CURRENT BOSHOEK ACTIVITY INFRASTRUCTURE AND PROCESS

The currently existing infrastructure and processes at GMBS, as approved in the EMPR of 23 August 2007, will be described separately from the new infrastructure and processes applied for in this environmental authorization process. It is, however, necessary to include the existing infrastructure and process description, as it will be required in the EMPR Addendum, which also forms part of this current process.

A distinction will therefore be made in this chapter **between already existing** and authorized infrastructure (section 3.2) and activities described in the approved EMPR, and **new proposed activities** and processes related to the proposed additions, alterations and expansions (section 3.3).

It should be noted that some of the actual details of the site infrastructure differ from the original planning as foresaw in the EMPR. The description in this document will reflect the actual current site conditions and not the originally foreseen.

Unless information to the contrary is provided, however, information used during compilation of the original EMPR will be used e.g. production rates, estimated rates of waste generation and deposition, conceptual designs for dams and waste disposal facilities, etc.

The information of the current infrastructure and processes at GMBS contained in this chapter was primarily extracted from 2 existing reports, supplemented with information generated as a Specialist Study by JMA Consulting, specifically for the purposes of this EMPR Addendum, the EIA Application, a Water Use License Application, as well as a Waste License Application.

APPENDIX 3.2 (A):	APPROVED (2007) GMBS EMPR – 2004 - METAGO
APPENDIX 3.2 (B):	REPORT ON WASTE AND WATER MANAGEMENT SA CHROME EXPANSION - 2004 - METAGO
APPENDIX 3.2 (C):	PROCESS AND MATERIAL CHARACTERIZATION 2013 - JMA

3.2.1 The Overall Operation at Boshoek

The Glencore Merafe Venture Mine and Smelter essentially comprise an opencast Chrome Mining operation as well as a Ferrochrome Smelting Operation. The Smelter was commissioned in 2002 and the mine started operating in 2007.

Mining is conducted by mining contractors whilst the smelter employs some 450 people.

Although the site operates as a single legal mining entity, the overall operations has been divided into two separate, activity related, Management Areas for the purposes of this Environmental Authorization process.

- Mining Management Area
- Smelting Management Area

3.2.1.1 General Site Layout

The general site layout at GMBS, showing the two management areas with their respective sub-areas, is shown in Figure 3.2.1.1(a).

The Mining Management Area has three geographical sub-components:

- southern open cast mining area (mined by Andru Mining on behalf of GMBS)
- northern open cast mining area (mined by Benhaus Mining on behalf of GMBS)
- concentrator (spiral plant) area

It is important to note that the open cast mining operations have been stopped in 2013 and are currently being closed and rehabilitated. However, the concentrator plant will continue to operate but now as a sub-component of the Smelting Management Area. It will therefore be discussed under the Smelting Management Area.

The Smelting Management Area therefore now has four geographical sub-components:

- the main Ferrochrome Smelter with its ancillary infrastructure and processes
- the Smelter Slurry Disposal area
- the Spiral Plant (concentrator)
- the Spiral Plant and Jig Plant Tailings Disposal area

3.2.1.2 Access Routes and Roads

The main access to the Glencore Merafe Venture Mine and Smelter is from the D1813 via the R565 and R556 roads. The access road networks in the area are shown on Figure 3.2.1.2(a). The D1813 road, a north-south road and the D114, an east-west road carries relatively low volumes of traffic during the morning and afternoon peak hours. The R565 road is an existing two lane surfaced road and forms part of the major road network from Rustenburg to the rest of the road network in the North West Province. The R556 road is an existing two lane surfaced road and links the R565 road with the Pilanesberg area and currently the major link road between Sun City and the Gauteng area.

The traffic volumes on the R565 / R556 roads are mainly traffic from Rustenburg to the Pilanesberg area as well as to the surrounding mining and farm areas. The R565 and R556 carry approximately 1200 vph and 290 vph in both directions respectively. During the afternoon peak hour the main direction on the R565 is southbound towards Rustenburg with approximately 460 vph in a southerly direction.

The traffic volumes on the Mafenya Village road, D1813 and D114 are less than 100 vph in both directions during the peak hours. Traffic on the Mafenya Village road and D1813 is mainly traffic to and from Chaneng Village and between Rustenburg and the mining areas.

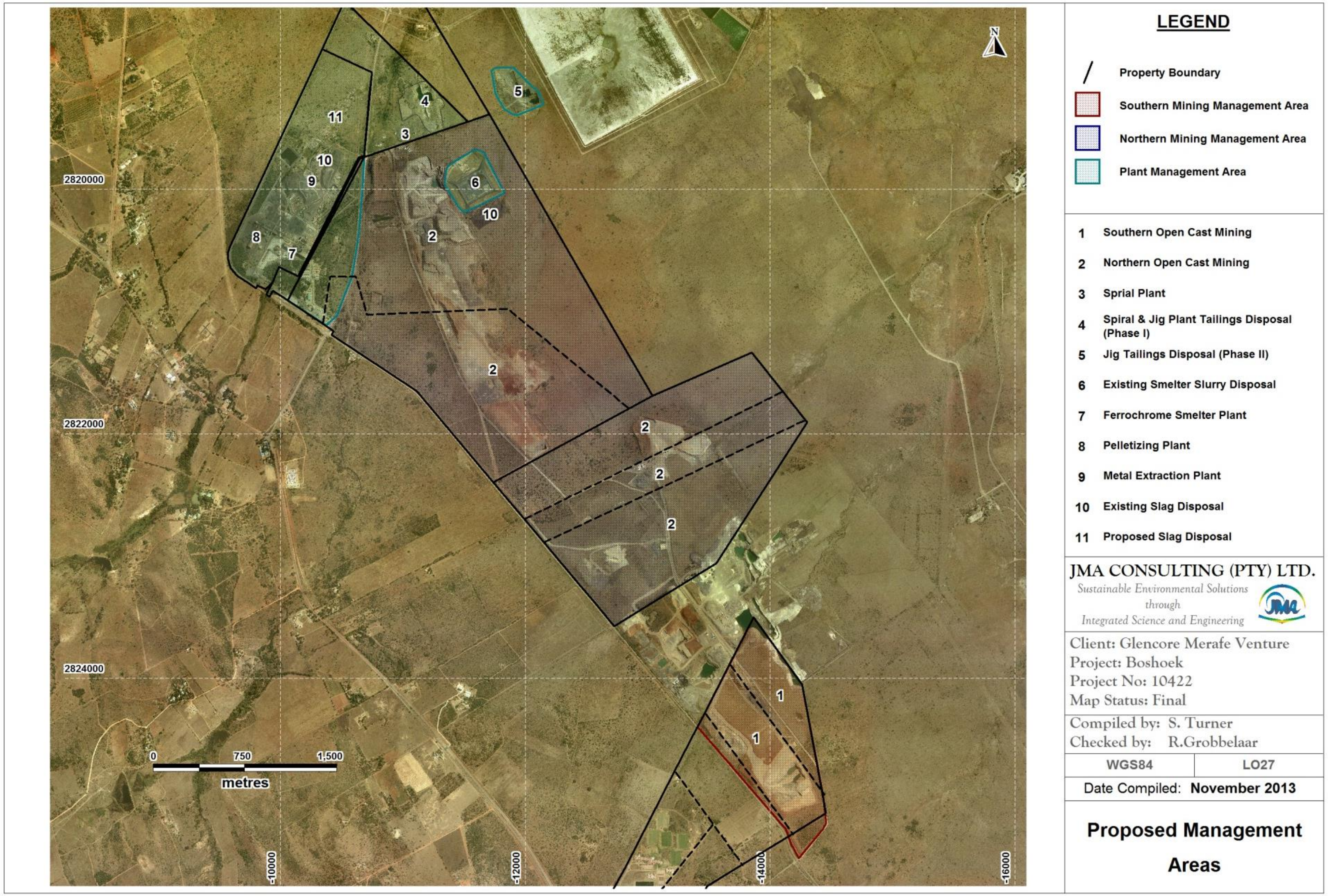

Figure 3.2.1.1(a): GMBS Management Areas and Sub-Areas

Figure 3.2.1.2(a): **Access Road Network for the GMBS Site**

3.2.1.3 Site Infrastructure and Process Inventory

A detailed site infrastructure and process inventory was compiled. Large scale maps, showing the infrastructure and the main process areas, are attached as **APPENDIX 3.2(D)** to this report. The following exist on site, most of which can be identified on these maps:

- Access Roads
- Railway Lines
- Incoming Power Lines and Eskom Yard
- Security Fencing and Access Control
- Internal Service Roads
- Weighbridges
- Internal Overhead Power Lines
- Stores
- Administration Buildings and Offices
- Conference Centre
- Canteen
- Induction Centre
- Laboratory
- Clinic
- Temporary waste storage areas (bins)
- Workshops and Wash Bays
- Contractors Yard
- Electrical Substations

- Southern Opencast Area
    - security fencing
    - access control
    - offices
    - workshops
    - topsoil stockpiles
    - overburden stockpiles
    - haul roads
    - rehabilitated areas
    - storm water diversion measures

- Northern Open Cast Area
    - security fencing
    - access control
    - offices
    - workshops
    - topsoil stockpiles
    - overburden stockpiles
    - haul roads
    - final mine voids
    - rehabilitated areas
    - storm water diversion measures

- Raw Material Stockpile and Loading Area
    - raw materials stockpiles
    - loading bins
    - offices
    - conveyors
    - surface water management measures (details discussed later)

- Motswedi Pelletizing/Sintering Plant
    - materials stockpiles
    - conveyors
    - loading bins
    - day bins
    - slurry pit
    - clarifier
    - capillary filters
    - pellets stockpile
    - offices
    - workshops
    - pelletizing plant
    - sinter plant
    - surface water management measures (details discussed later)

- Smelting Plant and Final Product Stockpiles
    - process water dams
    - loading bins
    - conveyors
    - sand and slag mixture stockpiles
    - clarifiers
    - water cooling system
    - furnaces
    - slag cooling bays
    - offices
    - workshops
    - laboratory
    - primary crusher
    - secondary crusher
    - final product storage bins
    - final product stockpiles
    - weighbridge
    - surface water management measures (details discussed later)

- Metal Extraction Plant
    - stores
    - offices
    - un-processed slag stockpiles (details discussed later)
    - crushers
    - conveyors
    - jigging process feed stockpile
    - jigging plant
    - jig tailings disposal facility (details discussed later)
    - classifiers

- classifier product bunker
- recovered chrome product stockpile
- MEP Jig Plant Process Water Dam (details discussed later)
- processed slag disposal facilities (details discussed later)

- Concentrator (Spiral) Plant Area
  - security fencing
  - access control
  - offices
  - crusher
  - conveyors
  - lumpy ore stockpile
  - fine ore stockpile
  - water storage reservoir
  - wash plant
  - spiral plant
  - drying cylcones
  - fine metallurgical concentrate
  - spiral plant tailings dumps
  - final spiral plant tailings disposal (details discussed later)

- Waste Management Facilities
  - Mine Overburden Disposal
  - Mine Waste Rock Disposal
  - Spiral Plant Tailings Disposal Facility
  - Salvage Yard (Domestic and Industrial Waste)
  - Slag Stockpiling and Slag Disposal Facilities
  - Jig Tailings Disposal Facility
  - Slimes/Slurry Disposal Facilities
  - Sewage Treatment Plant

- Water Use and Water Management Facilities
  - Potable Water Supply
  - Process Water Supply
  - Process Water Reticulation
    - North Pit Void 1 to Jig Plant and Spiral Plant Tailings Quarry Dam
    - Furnace Clarifier Slurry to Slurry/Slimes Dam
    - Slurry/Slimes Dam Return Water to Process Water Dams 101 & 102
    - Jig Plant Tailings to Jig Plant and Spiral Plant Tailings Quarry Dam
    - Jig Plant Tailings Return Water to MEP Jig Plant Process Water Dam
    - Spiral Plant Tailings to Jig Plant and Spiral Plant Tailings Quarry Dam
    - Spiral Plant Tailings Return Water to Spiral Plant Water Reservoir
    - Plant Dirty Water PCD to Process Water Dams 101 & 102
    - Plant Storm Water PCD to Process Water Dams 101 & 102
  - Process Water Storage
    - Process Water Dam 101
    - Process Water Dam 102
    - HSEC Reservoir (storage for garden irrigation)
    - Sinter Plant Slurry Pit

    - MEP Jig Plant Process Water Dam
    - Slimes Dam Return Water Sump
    - Jig and Spiral Tailings Quarry Dam – Phase 1
    - Jig and Spiral Tailings Quarry Dam – Phase 2
  - Recreational Water Use
    - Recreation Dam 1
    - Recreation Dam 2
  - Storm Water Management
    - Storm Water Diversion at South Pit
    - Storm Water Diversion at North Pit
    - Storm Water Diversion at Concentrator
    - Storm Water Diversion at Slurry Disposal Facility
    - Storm Water Diversion at Jig Tailings Quarry
    - Storm Water Diversion at Concentrator Tailings Quarry
    - Storm Water Diversion at Smelting Plant
    - Storm Water Canals at Smelting Plant
    - Plant Dirty Water PCD
    - Plant Storm Water PCD
  - Ground Water Management
    - Dewatering of South Pit
    - Dewatering of North Pit
    - Slurry/Slimes Facility Liner System
    - Process Water Dams Liner Systems
    - Pollution Control Dams Liner Systems
    - Materials and Product Stockpiles Liner Systems
    - Slag and Tailings Disposal Underdrains
  - Water Treatment Plant (polluted process and storm water)

- Air Quality Control Systems
  - Dust Suppression at South Pit – Bowsers with Mine Water
  - Dust Suppression at North Pit – Bowsers with Mine Water
  - Dust Suppression at Smelting Plant – Bowsers with Jig Tailings Quarry Water
  - Raw Materials Handling and Day Bin Area - Wet Scrubbing
  - Dosing and Batching Circuit for the Sinter Plant and S3 Furnace - Dry Cartridge Filters
  - S2 Furnace Dosing and Batching Circuit - Wet Scrubbing
  - Sintering Furnace Drying Section - Wet Scrubbing
  - Sintering Furnace Heating Section - Wet Scrubbing
  - Sintering Furnace Sintering Section – Wet Scrubbing
  - Sintering Furnace Pellet Products - Wet Scrubbing
  - Smelter Preheater - Wet Scrubbing
  - Smelter 2 - Wet Venturi Scrubbing
  - Smelter Tap Holes - Wet Scrubbing

3.2.1.4 Power Supply

The GMBS Ferrochrome Smelting Plant is supplied with ESKOM Power. Four Eskom Power Lines enter the site from the north and terminate at the Eskom Yard located due north from the two furnaces. The ESKOM Yard is shown in Figure 3.2.1.4(a).

Electricity is reticulated from the ESKOM Yard to electrical sub-stations located at the different activity centres within the greater Ferrochrome Smelting Management Area. The localities of the ESKOM Yard as well as the electrical sub-stations are shown on Figure 3.2.1.4(b).

Table 3.2.1.4(a) shows photographs of the different electrical sub-stations.

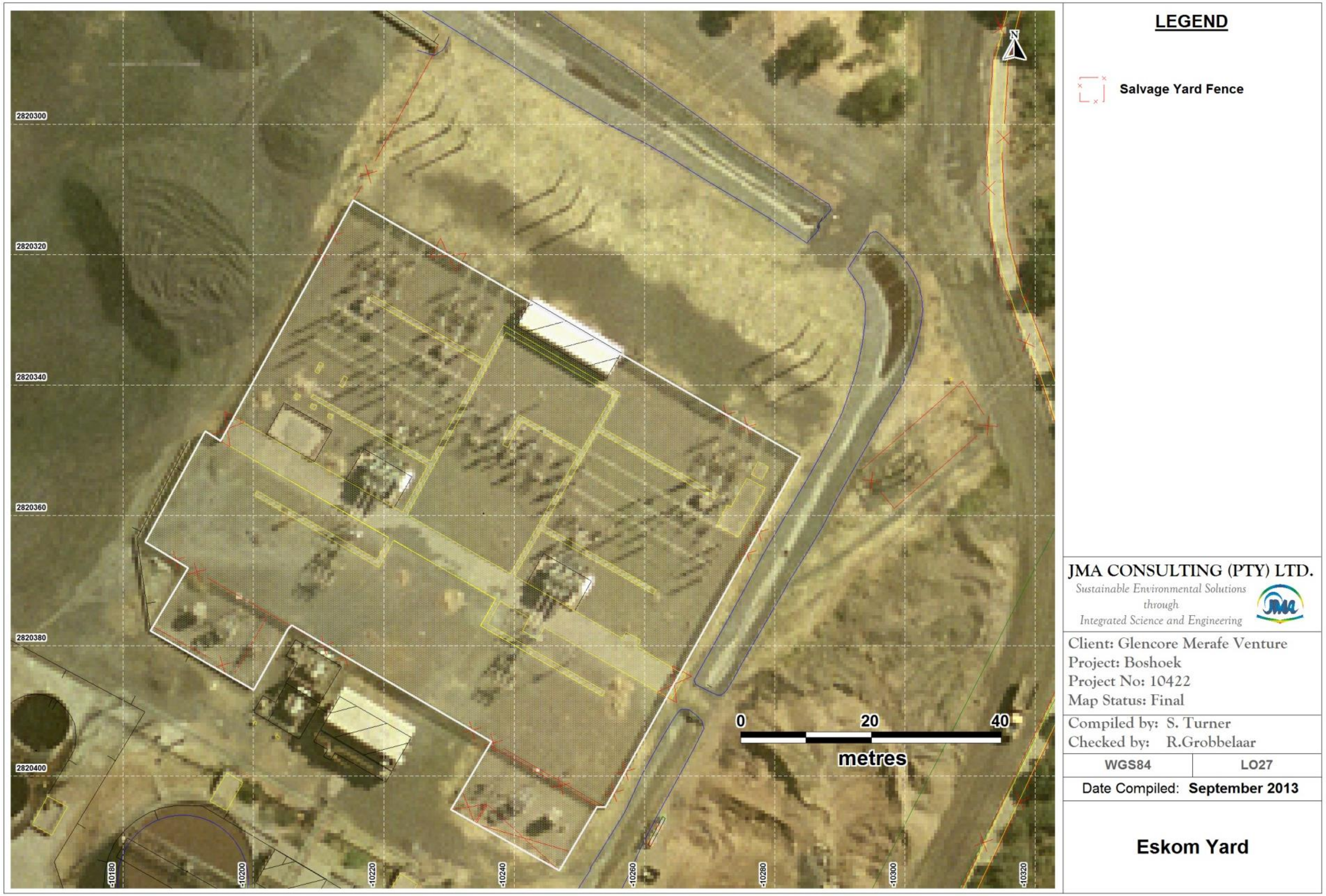

Figure 3.2.1.4(a): ESKOM Yard at GMBS

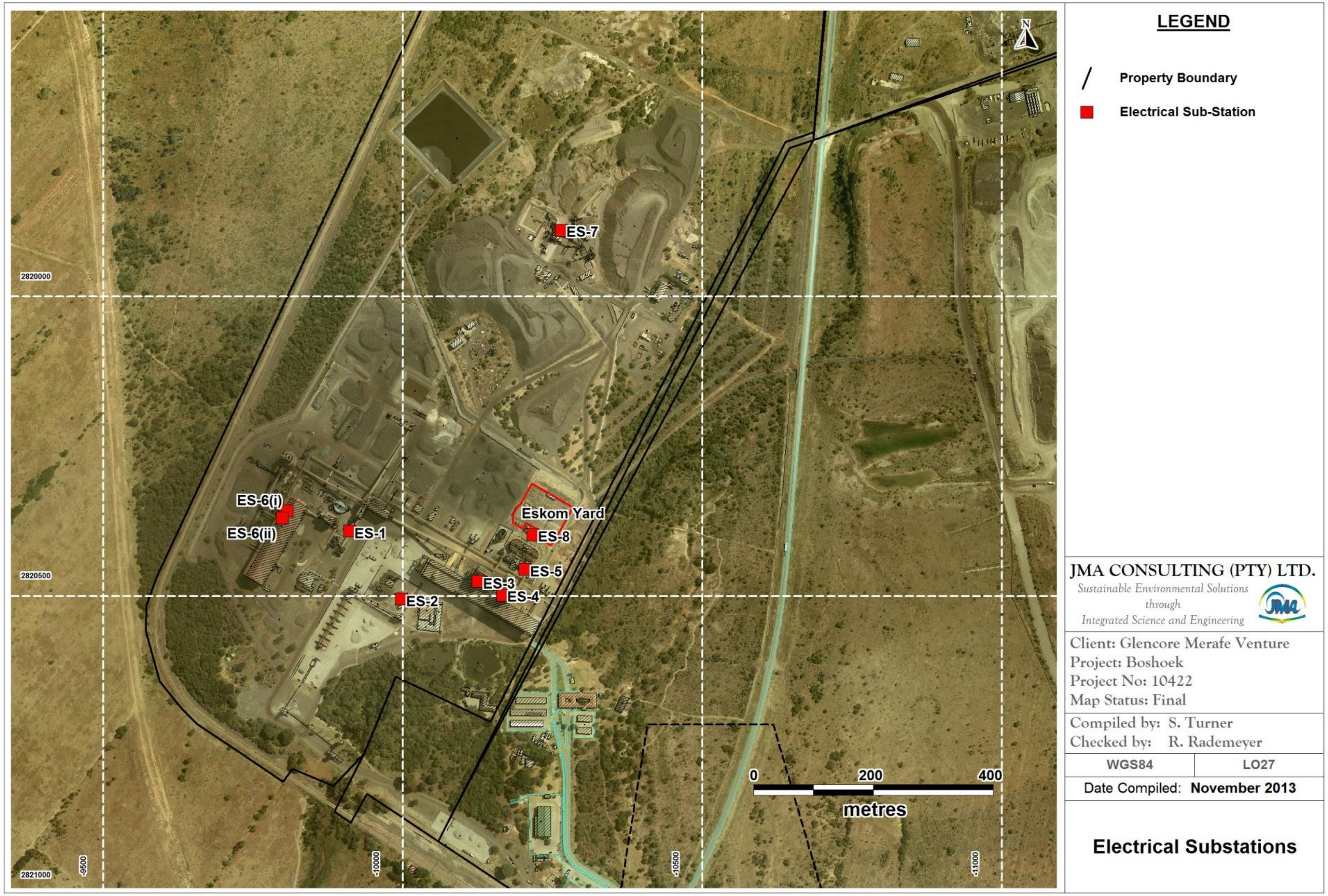

Figure 3.2.1.4(b): Localities of ESKOM Yard and Electrical Sub-Stations at GMBS

Table 3.2.1.4(a): Photographs of ESKOM Yard and GMBS Sub-Stations

	
ESKOM Yard	ESKOM Yard
	
ESKOM Yard	ES-1) 20 Substation – Raw Materials
	
ES-2) 40 Substation – Final Products	ES-3) 32 Substation – F2 Furnaces (380v and 525v)
	
ES-4) 33 Substation – F3 Furnaces (380v and 525v)	ES-5) 60 Substation – Water Plant

3.2.2 Activity and Process Description for Mining Management Area

Mining commenced in 2007. Active mining has stopped in 2013. The southern open cast mining area is currently in the final stages of rehabilitation, whilst rehabilitation in the northern open cast mining area has commenced and is progressing well.

These two open cast mining operational areas are separated by the Farm Stellite 255, Registration Division JQ that is currently owned by Ilitha Mining (Pty) Ltd.

Glencore Merafe Venture sub-contracted the operation of their opencast mining activities to Andru Mining (Pty) Ltd (southern open pit) and Benhaus Mining (Pty) Ltd (northern open pit).

3.2.2.1 Mining Method

The mining of the ore was performed only by means of opencast mining methods using a truck and shovel (excavator) method. Only the LG6 chrome seam was mined for the first two years after which both the LG6 and MG1 were mined simultaneously.

The initial boxcuts were 70 metres wide (on strike) and 180 metres long (on dip). Each pit had two open operating faces i.e. one north and one south, each approximately 180 metres long. Each strip had a width of at least 35 metres, with backfilling occurring in at least three strips behind the working face.

Two boxcuts were open during the first two years after which there were two boxcuts operating at any given time (one in each ore body).

3.2.2.2 The Mining and Concurrent Rehabilitation Process

The process of mining followed a sequence of stripping and stockpiling the topsoil, stripping and stockpiling the overburden, drilling, blasting twice a week, cleaning out the ore and hauling it on private roads to the concentrator plant.

As mining was completed in a given block it was backfilled with the overburden of the next block. The topsoil from the next block was placed on the overburden to facilitate rehabilitation. These activities continued 18 hours a day from Monday to Friday and every alternate Saturday. Breaks between shifts were used for maintenance of equipment.

The following activities were undertaken during the mining operation:

<u>Clear and Grub</u>

Special steps were taken to preserve any protected species of flora and fauna ahead of the mining operation. Subsequently the area is cleared en masse. Firstly the trees were felled after which a grader and/or dozer was used to scarify the surface, removing all plant material.

Removal of Topsoil

Top-soils were excavated separately where possible and used for rehabilitation. Topsoil removal and deposition was done by means of a bowl scraper or a dozer and excavator. The dozer was used to stockpile topsoil just beyond the final high-wall while topsoil from further away over the pit footprint was loaded into trucks by excavator, then hauled and tipped onto backfilled areas for levelling by the dozer and finally by the grader. The topsoil stockpile created beyond the final high-wall will be dozed back onto the replaced overburden once the pit has advanced.

Removal of Soft Overburden

Soft overburden (weathered material) varies in depth from less than a metre to several metres deep, with an average of one metre. The soft overburden offers an opportunity for "free-dig" i.e. excavation without prior blasting. From the box-cut footprint the soft overburden was excavated by excavator then hauled by truck and finally deposited on a stockpile for later placement on top of the backfill. The soft overburden was tipped directly onto rock backfill in the pit where backfilling had been completed to the pre-determined elevations.

Removal of Hard Overburden

The hard or un-weathered overburden was blasted before excavation. Once blasted a portion of the broken overburden was "dozed-over" and a portion was "hauled-back". It is estimated that approximately 20% of the overburden was "dozed-over" into the adjacent pit void. The remaining overburden material was loaded by excavator into off-highway haul trucks and deposited into the worked out areas, on top of material that was dozed over. Because only a relatively small volume of material was extracted for beneficiation – namely 800mm for an average depth of 12.5m, the swell factor will require backfilling of the mined out areas to an elevation above the original natural ground level. This height will be determined by the necessity to place all overburden over the area of the original footprint i.e. at steady state no overburden will report to stockpile. The original boxcut material was however placed on a stockpile, located to ensure the shortest and most direct haul route from the stockpile to the final void. This material will only be moved at the end of the pit's life for final rehabilitation.

Mining of Ore

The thin chromitite seams are quite susceptible to mining losses and dilution. Therefore the top-reefcontact had to be adequately prepared. It was therefore imperative that fragmentation was carefully controlled and coarser rather than finer fragmentation was preferred. The thin seam and the requirement for maximum lump size material predicates that due care had to be taken with the drilling pattern and blasting of the chromitite. Optimal rock-breaking was achieved with smaller holes. A de-powered emulsion i.e. one with less oxidizer was used to achieve optimal fragmentation. Due to the lower volumes and to minimize dilution and mining losses on the thin chromitite seam, a smaller mining excavator – nominal 40 tons could be used. This excavator was matched with four off-highway 35 ton articulated dump trucks (ADT). The ADT's were preferred because of the inclined haul out of the pit.

Final Rehabilitation

Due to the ore/overburden ratio, no final voids will be left after mining as the bulking factor will result in a material excess. After final backfill, the areas will be shaped to be free draining, re-soiled and re-vegetated.

In the north pit two voids (one in the north and one in the south) will be left for access for possible future mining.

3.2.2.3 Mining Infrastructure

Typical infrastructure for the open cast mining operations comprised of:

- security fences
- access control booms
- storm water diversion trenches/berms
- topsoil, overburden and waste rock stockpiles
- haul roads
- ROM ore stockpile
- offices
- stores
- workshops

3.2.2.4 Southern Open Cast Mining Area

All active mining in the southern open cast mining area has stopped and final rehabilitation is progressing well. The current extent of rehabilitation is slightly more progressed than which is visible on the aerial photograph shown in Figure 3.2.2.4(a), where sections of both the LG6 and MG1 workings are still open.

When rehabilitation is completed, all voids will be backfilled, shaped to be free draining, re-soiled and revegetated. Upgradient storm water diversion measures will be removed to allow free flow of storm water across the rehabilitated areas along the natural drainage direction which is towards the north east.

3.2.2.5 Northern Open Cast Mining Area

All active mining in the northern open cast mining area has also stopped and rehabilitation has commenced and is progressing well. The current extent of rehabilitation is slightly more progressed than which is visible on the aerial photograph shown in Figure 3.2.2.5(a), where large sections of the LG6 workings are still open.

When rehabilitation is completed, all voids (except 2) will be backfilled, shaped to be free draining, re-soiled and re-vegetated. Upgradient storm water diversion measures will be removed to allow free flow of storm water across the rehabilitated areas along the natural drainage direction which is towards the north east.

The two remaining voids are left for potential future mining access and are shown on Figure 3.2.2.5(a).

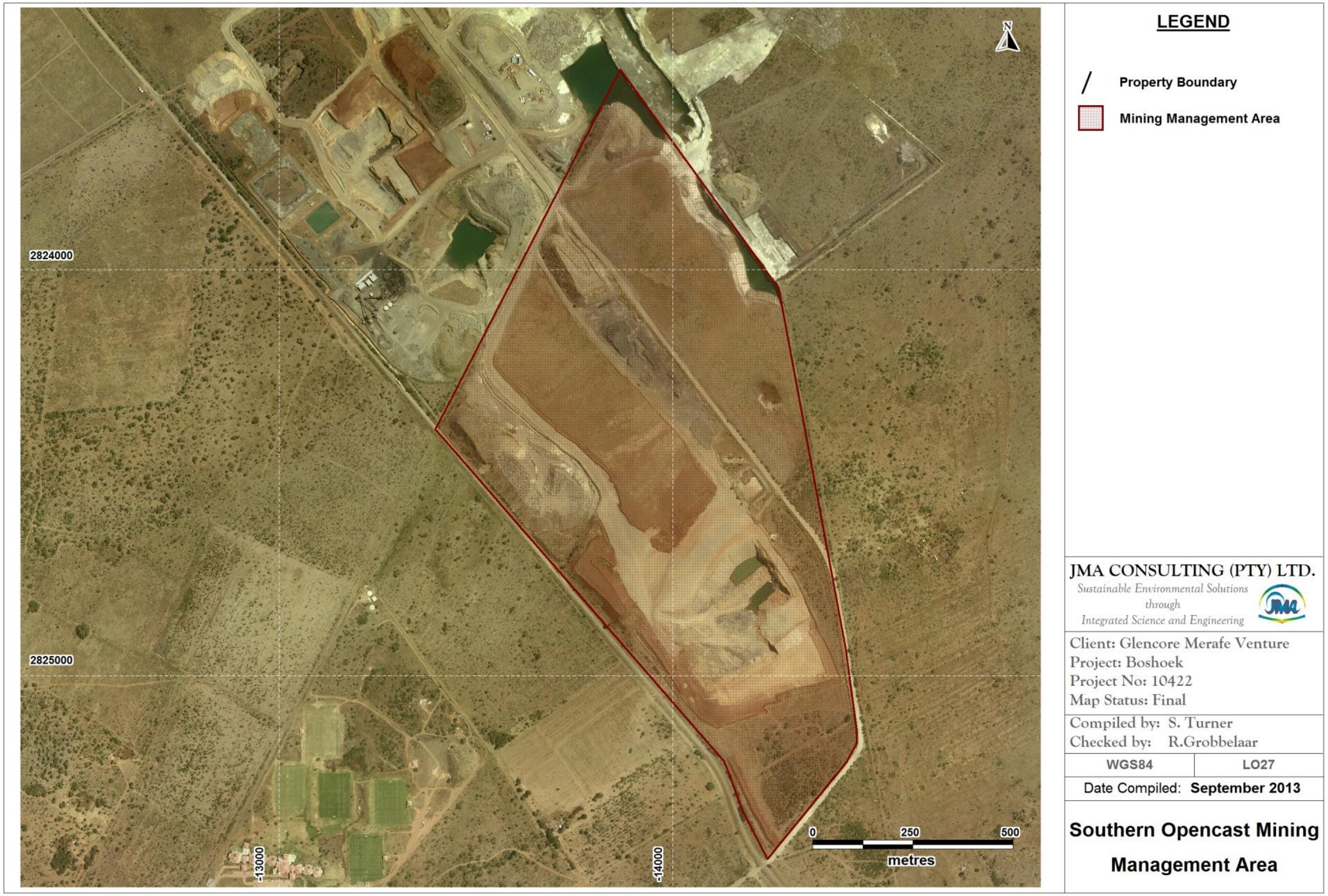

Figure 3.2.2.4(a): Southern Opencast Mine Management Area

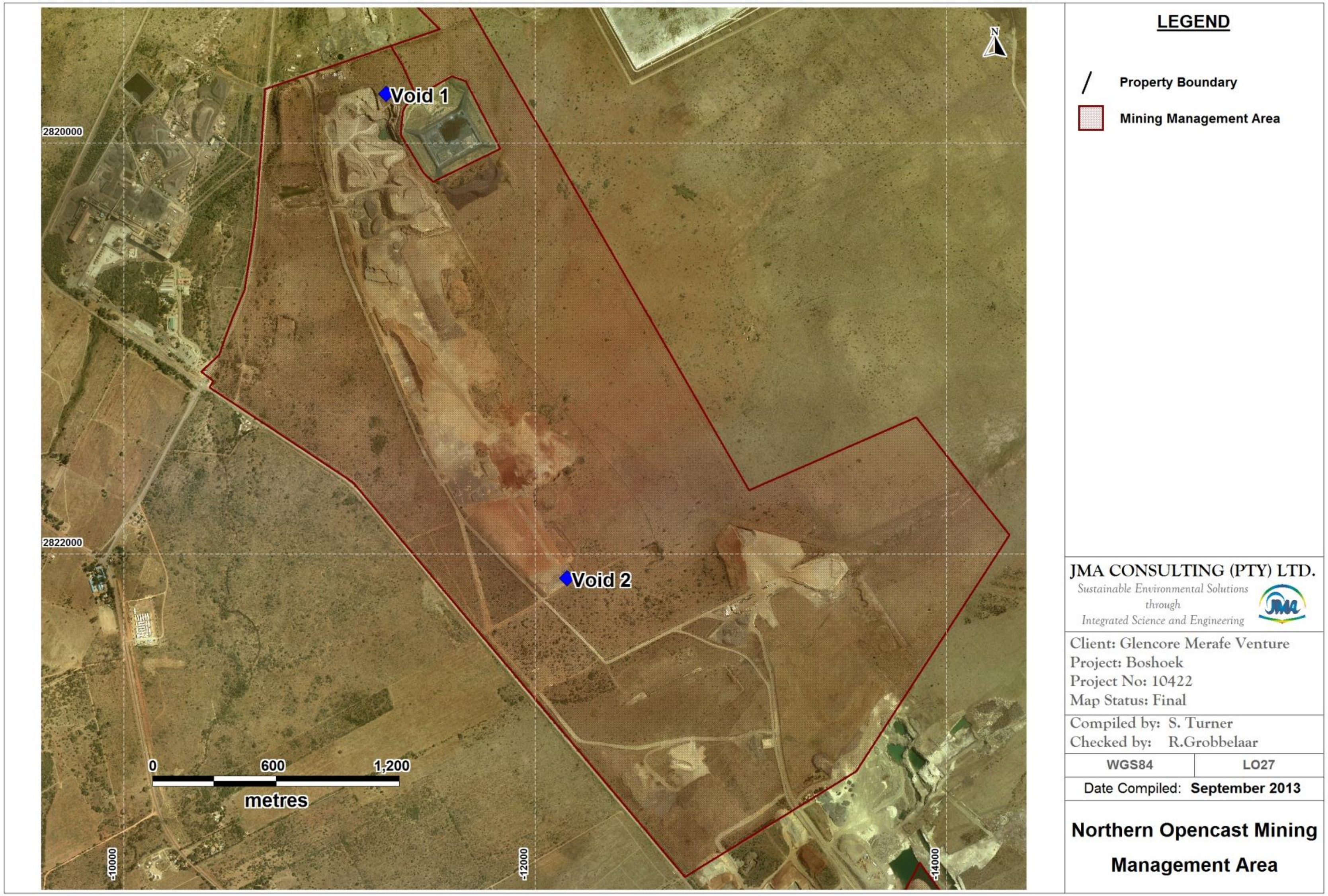

Figure 3.2.2.5(b): Northern Opencast Mine Management Area

3.2.2.6 Concentrator (Spiral Plant) Area

The discussion below will reflect the activities and processes at the concentrator which were active during the active mining phase when the spiral plant was used to concentrate the ore mined at the GMBS open cast sections. The spiral plant will continue to operate but will now be used by the Smelting Plant to concentrate ore obtained from other mining activities for use at the GMBS. A separate discussion to describe these activities will be given under the headings dealing with the Smelting Management Area.

The layout of the Concentrator (Spiral) Plant is depicted on Figure 3.2.2.6(a).

Crushing and Screening of Mined Material

Wet ROM was tipped into a feeder bin over a grizzly to scalp off the large rocks. The ROM was then fed via the grizzly feeder into a crusher and then onto a feeder conveyor and screen. The oversize material (+80mm) was returned to the crusher via the return conveyor. The correct size (+35mm to 80mm) lumpy material was fed over a picking belt where additional waste material was removed and used for backfill in the mine.

Lumpy material was deposited by a slew conveyor on to the sorted lumpy stockpile. The fines (less than 35mm) from the screen were deposited by conveyor onto the fines stockpile and transported by conveyor via a tunnel below the stockpile to the wash plant for wet screening. The +1mm material was delivered to a ball mill.

Spiral Plant

Undersized mine ore and mining waste was further separated by a gravity mechanism, where the heavier material moved to the inside of the spiral and was collected as concentrate compared to the lighter material (waste), which is pushed to the outside of the spiral and collected as the tailings of the spiral. The purpose of the cyclone was to remove the ultrafine material which was then pumped (or gravity fed) to a thickener. The cyclone underflow was treated by a bank of spirals. This involved a number of stages depending on product quality required. The recovered metal material was re-worked and processed and the waste material was disposed of as a slurry into the eastern section of the abandoned LG6 opencast workings (Bafokeng Chrome Holdings Boshoek Mine Site) which are located immediately north of the concentrator plant. This disposal option was described as Option 2 in the approved EMPR for the Glencore Merafe Venture Boshoek Mine.

Drying and Quality Control Areas

The concentrate was dewatered by a cyclone and dumped onto a concrete floor. Water from the cyclones was returned to the process. The concentrate was then allowed to partially dry before being transported to the final product stockpile. No fugitive dust was generated because the material was still wet.

Materials Stockpile and Storage Areas at the Concentrator Plant

The plant layout and location was designed to accept material direct from the mine and supply the final ore direct to the customer with minimum handling of the materials to reduce costs and the generation of fines/dust. Materials that were stockpiled during the concentrating process are listed in Table 3.2.2.6(a).

Table 3.2.2.6(a): Materials Processed at Concentrator Plant

Material	Tonnes/Annum
ROM	480 000
Lumpy Ore	78 000
Fine Metallurgical Concentrate	234 000
Waste Rock	106 000
Tailings	62 000

Figure 3.2.2.6(a): Concentrator (Spiral) Plant

3.2.3 Activity and Process Description for Smelting Management Area

The activities related to, and processes occurring in each of the following smelting management area sub-components will now be described in more detail.

- Raw Material Stockpiles and Loading Area
- Motswedi Pelletizing/Sintering Plant
- Smelting Plant
- Metal Extraction Plant
- Spiral Plant
- Waste Management Facilities
- Water Management Facilities
- Air Quality Control Systems

3.2.3.1 Raw Materials Stockpiles and Loading Area

All the raw materials used at GMBS are brought onto site and stockpiled by means of tipping trucks. No raw material is currently obtained from the GMBS mining operations. The raw materials used at GMBS include: chromitite ore material (*chromitite ore, metal fines chrome ore mixture* and *pellets*), reductant material (*anthracite, coke, duff coal,* and *char*), flux material (*limestone, dolomite* and *quartzite*) and binding material (*bentonite*). The raw material is predominantly stockpiled at the surface to the north of the pelletizing and smelting plants. Certain materials are however stockpiled in designated bins removing their exposure to atmospheric conditions. The raw material stockpiles are continually rolled-over in order to minimize the residence time of the raw material on the surface. The extent of the raw material stockpile and loading areas are depicted on Figure 3.2.3.1(a). The indicated maximum quantities of raw materials stockpiled on site are listed in Table 3.2.3.1(a) below.

Table 3.2.3.1(a): Indicated Maximum Quantity of Raw Materials Stockpiled on Site

Raw Material	Quantity (tons)
Chromitite Ore (UG2)	26,000
Metal Fines Chrome Ore Mixture	8,000
Pellets	59,000
Anthracite	10,000
Coke	10,000
Char	3,000
Limestone	2,000
Dolomite	3,000
Quartzite	3,000

The raw materials are loaded from the specific stockpiles and fed into bunkers and feed hoppers according to the corresponding proportions required. Each raw material bunker is fitted with weigh belt feeders, so that the mass of material conveyed to the pelletizing plant is recorded ensuring that the feed rate is adjusted according to the required proportions.

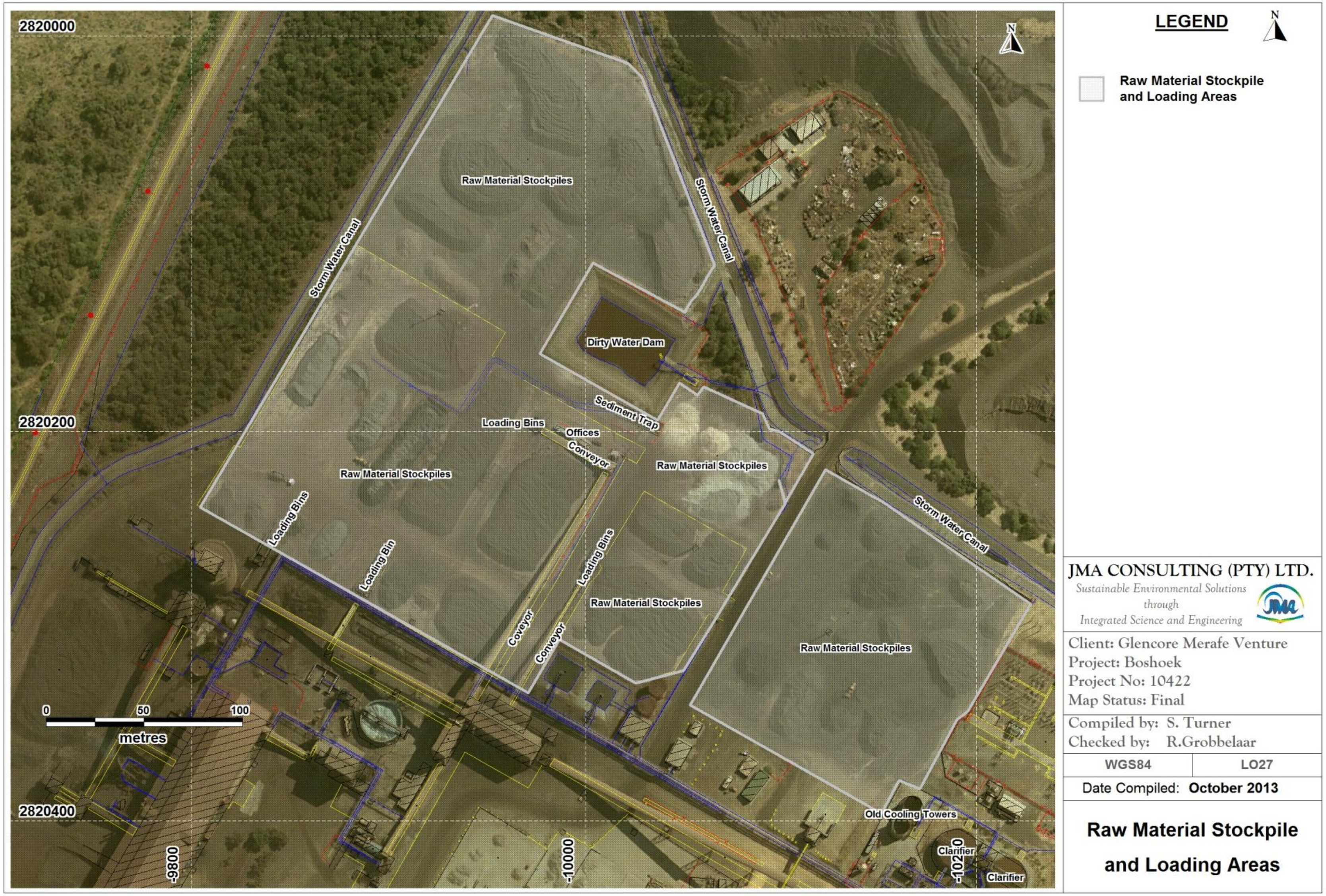

Figure 3.2.3.1 (a): Layout and Infrastructure in the Raw Material Stockpile and Loading Area

Table 3.2.3.1(b): Indicated Quantity of Raw Materials Stockpiled on Site

Material	Density (t/m^3)	Existing		New	
		Quantity (m^3)	Quantity (Tons)	Quantity (m^3)	Quantity (Tons)
Daily Feed Coke	0.7	890	623	890	623
Daily Feed Char	0.8	740	592	740	592
Daily Feed Lumpy LG6 Ore	2.8	390	1092	390	1092
Daily Feed Concentrated Ore	2.9	1260	3654	1260	3654
Daily Feed Quartz, Dolomite, Limestone	1.6	280	448	280	448
Daily Feed Anthracite	1.1	-	-	-	623
Strategic Coke	0.7	2000	1400	18571	13000
Strategic Char	0.8	2000	1600	2500	2000
Strategic LG6 Lumpy	2.8	515	1442	1429	4000
Strategic UG2	2.9			13793	40000
Strategic LG6 Concentrate	2.9	770	2233	12759	37000
Strategic Pellet	2.3	Not given		60870	140000
Strategic Anthracite	1.1	2000	2200	12727	14000
Strategic Quartz, Dolomite, Limestone	1.6	370	592	3750	6000
Bentonite	1.2	60	72	60	72
Diesel	0.832	5000	4160	-	-
Nitric Acid	1.513	5	7.565	4	6
Low Pressure Gas	-	5 x 90kg	-	-	-
Paste	-	20 x 500kg	-	-	-
Flocculent	-	100 liters	-	-	-
Grease	-	200kg	-	-	-
Oil	-	300kg	-	-	-

Table 3.2.3.1(c): Indicated Existing Raw Materials and Method of Storage

Material	Quantity	Method of Storage
Daily feed coke	890m^3	Concrete base
Daily feed char	740m^3	Concrete base
Daily feed lumpy LG6 and UG2 ore	390m^3	Concrete base and compacted clay
Daily feed concentrated ore	1260m^3	Concrete base
Daily feed quartz, dolomite, limestone	280m^3	Turf / Field
Strategic coke	2000m^3	Concrete base
Strategic char	2000m^3	Concrete base
Strategic LG6 Lumpy	515m^3	Compacted turf / field
Strategic LG6 concentrate	770m^3	Concrete base
Strategic UG2 concentrate	690m^3	Concrete base
Strategic anthracite	2000m^3	Concrete base
Strategic quartz,dolomite, limestone	370m^3	Compacted turf
Bentonite	60m^3	Raw material stores in sealed bins
Pellets	Variable	Concrete base and concrete silo
Diesel	5000 litres	Sealed tank in bunded concrete area
Nitric acid	5000 litres	Sealed vessel in chemical store
Low pressure gas	5 of 90kg vessels	Sealed vessels in chemical store
Paste	20 of 500kg cylinders	Concrete base in the furnace building
Flocculent	100 litres	Sealed containers in the stores
Grease	200kg	Sealed drums in chemical stores
Oil	300kg	Sealed drums in the chemical store

3.2.3.2 Motswedi Sinter Plant

The use of pellets holds several advantages for Ferrochrome production as a whole. It improves specific energy consumption through much improved chrome recovery, thereby increasing daily production for the same raw material throughput in the furnaces. Furthermore it causes an inherent lowering in dust generation due to more favourable furnace bed gas permeability, reducing the so-called bed turnovers. Bed turnovers are the major cause of dust generation from the furnace bed. Less slag is also generated, reducing dust generation due to slag handling to an absolute minimum. Very little dust is generated by handling of the pellets when loading or transporting due to its very high abrasion resistance. This is a direct result of the use of bentonite, a high temperature binder used in the pelletizing process.

The Motswedi Pelletizing Plant comprises of an Outokumpu designed steel belt sintering process which produces pre-reduced pellets for use in the furnaces as a replacement for concentrate and lumpy ores. The feed materials are ground in a ball mill, dewatered in capillary effect ceramic filters, pelletized in a drum and finally sintered in a furnace to form spherical, equally sized, hard and porous chromite pellets that will be used as a raw material in the smelter plant. A schematic process flow diagram for the pelletizing plant is depicted as Figure 3.2.3.2(a). The layout of the pelletizing plant and associated infrastructure is depicted on Figure 3.2.3.2(b).

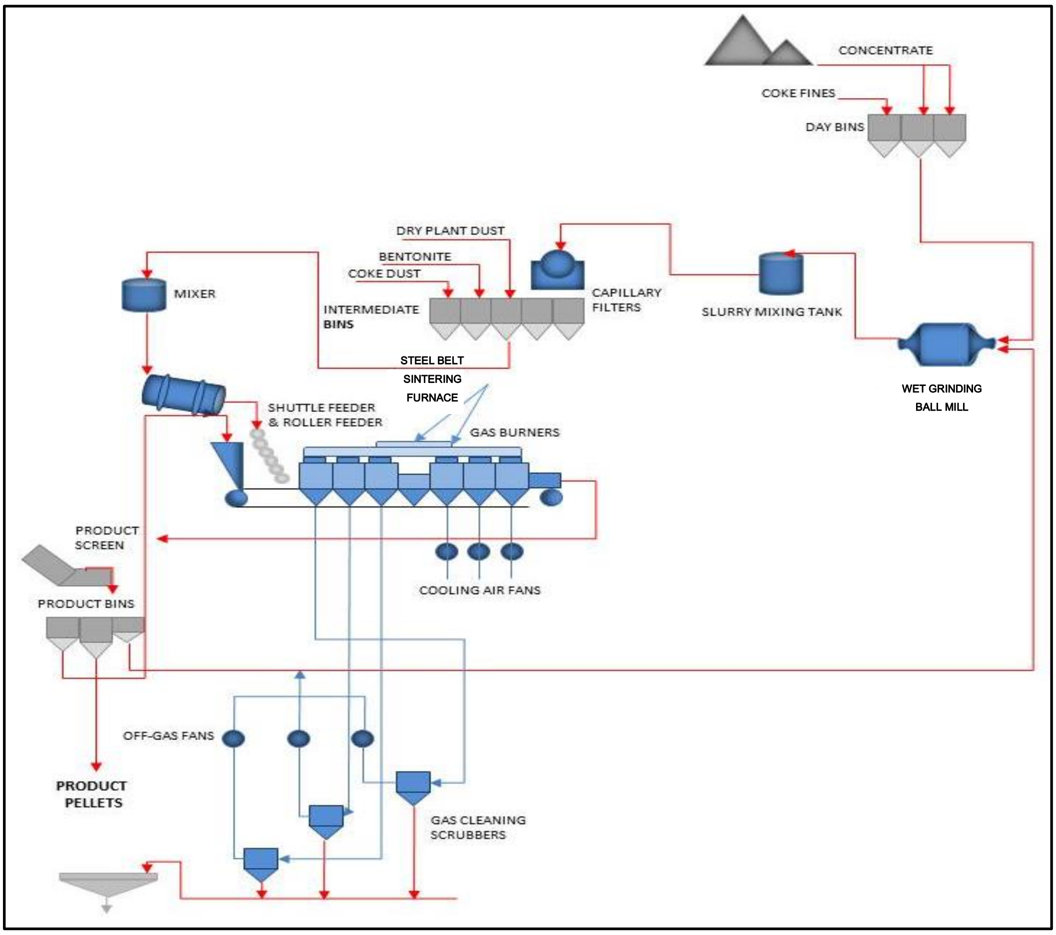

Figure 3.2.3.2(a): Schematic Process Flow Diagram of the Motswedi Pelletizing Plant

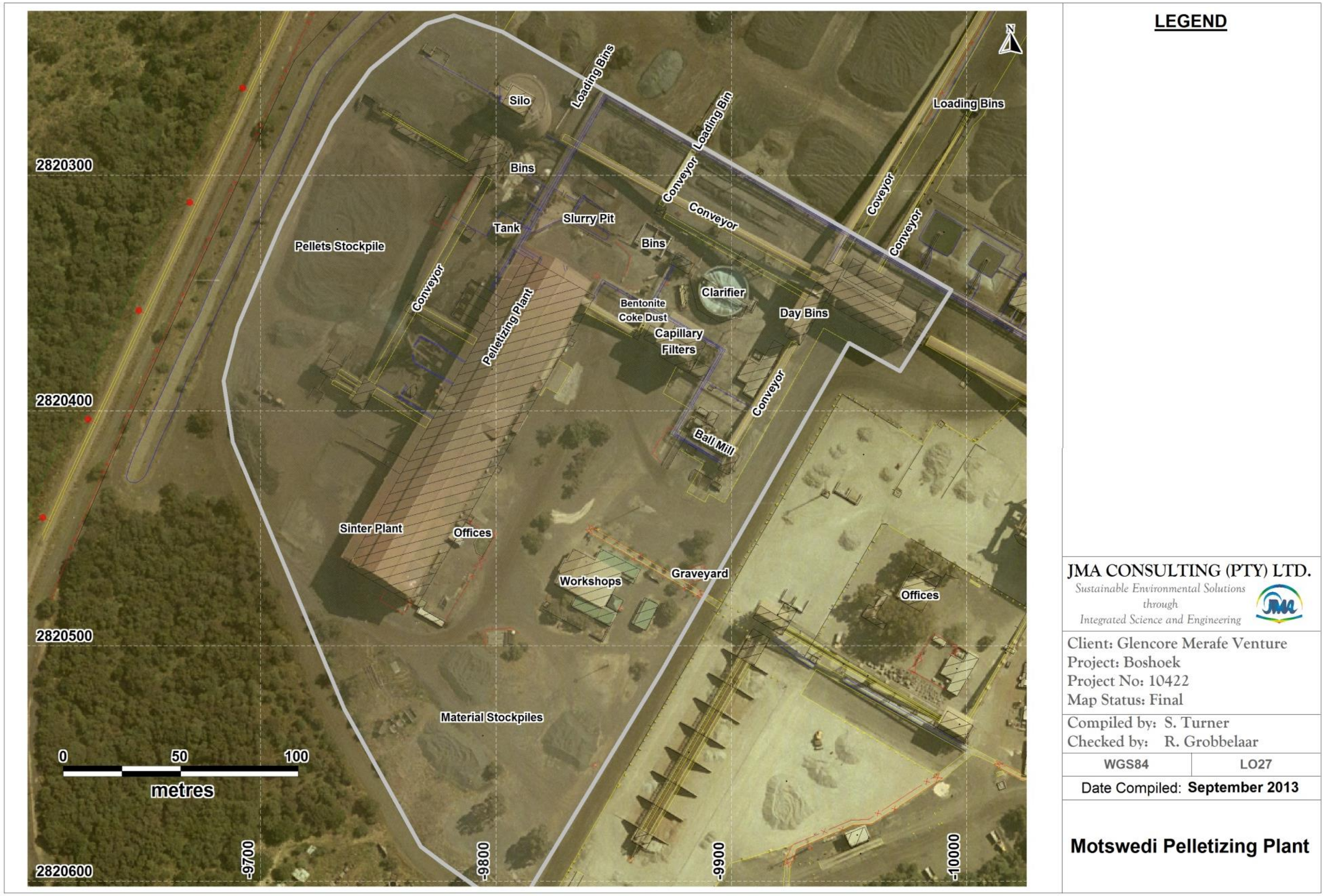

Figure 3.2.3.2(b): Motswedi Pelletizing (and sintering) Plant

Dosing

The raw materials are received according to the pre-determined proportions and concentrations and are initially stored in the specific day bins at the Motswedi Pelletizing Plant. The raw materials are then fed by means of table feeders onto a conveyor according to the specified concentrations and mixing ratios.

The mixing of the raw materials is important as because it could influence the grade of the final product (ferrochrome). The raw materials that are predominantly used during the pelletizing process include: UG-2 and LG-6 chromitite ore material, coke breeze/fines, recycle mix material, undersized pellets and ore fines.

Bentonite is used as a binding agent in the pellets and is added as a very fine powder and mixed homogeneously with the chromite. Fine coke is also added to the concentrate before grinding. Normally all coke is added before grinding. Some coke dust can occasionally be added before pelletizing as well to increase the carbon content in the pellets before sintering as the coke is used as the main energy source during sintering.

Grinding / Milling

During the grinding / milling procedure, the feed mixture is milled through a screen to a size that is suitable for pelletizing and sintering (>75 μm). Steel balls (grinding media), feed mixture and water are fed simultaneously into the wet-grinding ball mill at a rate that produces a slurry material with the correct grind and density. This slurry is further screened on a 2 mm trammel screen before it is pumped to the slurry tank via a cooler to lower the temperature to below 50°C. The temperature needs to be lowered to safeguard the ceramic filter plates.

The density of the slurry is checked on a regular basis ensuring that the slurry is at the desired density and degree of saturation. If the slurry is too fine or too coarse it will negatively influence the filter process.

Filtering

During filtering the feed pump is equipped with a frequency converter to adjust the slurry level in the filter basin. The pump also operates during the washing period and the slurry is by-passed through splitter box back to the mixing tank. There is one belt conveyor after each filter to take the filter cake to the filter cake bins.

The filtrate water generated flows down to the floor tanks located on the base floor beneath the filters. The water discharge pipe from the filter forms a barometric leg keeping up a vacuum in the filter. Backwash takes place in every circle of the discs, but the main washing is made with water containing some nitric acid. Before washing, the basin is emptied to the mixing tank and the basing is flushed with recycling water and the washing water is emptied to the floor sump.

The ceramic capillary filter consists of:

- a slurry basin,
- a drum with ceramic discs and driving mechanism of the drum,
- an agitator with driving mechanism,
- a filtrate receiver and vacuum pump,
- acid washing system,
- ultrasonic cleaning equipment, and
- a control unit for the filter.

The CERAMIC® filter discs are patented sintered alumina membranes with uniform micro porous filter media which only allows liquid to flow through and no air or solids penetrate the filter material. As the discs are immersed into the slurry basin, a pressure difference, maintained with a small vacuum pump causes formation on the surface of the discs and dewatering takes place.

The discs are submerged into the slurry and a vacuum is applied to the plates. The pressure difference causes a cake to develop. As the discs proceed to rotate the cake is then dried by the same pressure difference and finally scraped off. The filter is equipped with a backwash system, and feeds a small portion of the filtrate back into the filter to clean the plates immediately after the scrappers during every revolution.

Ultrasonic and Acid Wash

From time to time the ceramic plates are regenerated by acid wash to return the fill permeability. The filtration is interrupted and the slurry is discharged from the filter basin. The filter basin is filled and the plates are washed back with diluted acid. When the basin is filled the ultrasonic transducers are connected.

Proportioning

There are intermediate storage bins for the filter cake, bentonite and coke dust outside the pelletizing plant building. The wet filter cake is a sluggish material, which easily arches in the hoppers during stoppages, and the additional materials are already in the powder form, which is suitable for pelletizing.

These materials are fed to the bins pneumatically and are covered with cartridge filters on the bin roof for the off-gas from the pneumatic conveyors. The moist filter cake, which comprises predominantly of carbon, plant dust and bentonite, is weighed proportionately onto the collecting belt conveyor by two disc feeders and additional materials by screw feeders of loss-in-weight feeding system. All feeders are used during operation and the filter cake feed rate is weighed from the collecting belt conveyor, according to the feed set point to the sintering furnace.

Mixing

The materials are continually mixed in a horizontal rotating mixer during the operation of the pelletizing plant. The additional materials are further mixed to the concentrate to obtain the desired homogeneous mixture required for pelletizing.

The mixture consists of:

- mixing chamber with replaceable wearing liners,
- mixing devices; agitators and scrappers,
- feed, discharge rate adjustment system,
- automatic lubrication system,
- nozzles for water addition,
- drives with motors, and
- safety instruments.

The concentrate with additional materials laid on top is conveyed to the mixer on a belt conveyor. The materials are then charged to the mixer through a feeding chute. After mixing the product is discharged onto a belt conveyor and transported to the pelletizing section at a discharge rate controlled by the material load in the mixer. Additional water is sprayed into the material in the mixer to adjust the final moisture content to between 8.5-9%, which is close to, but under the pelletizing moisture. The final moisture adjustment is made in the mixer in the pelletizing area.

The material is then mixed in the rotating cylindrical mixer pan and discharged through the discharge gate and a round rotating lid. The mixer is provided with two star-type agitators and as stationary mixing tools there is one deflector and a bottom/wall scrapper. The mixer is mounted on load cells of continuous control of the filling rate.

Pelletizing

The materials are further well mixed in a horizontal rotating mixer and then pelletized in a pelletizing drum to pellets with diameters of between 5 mm and 20 mm. The green pellets are screened using a roller screen that is located under the discharge end of the pelletizing drum. Screen undersize drops onto a conveyor located under the screen and oversized lumps are fed to the same conveyor through a roller crusher.

In the pelletizing drum the mixed material is lifted up by the drum and then cut back with a cutter bar so that the material rolls down again. This action leads to the production of the pellets. The pellet size is adjusted during pelletizing by the rotation speed, drum slope and the recycling circuit. The roller screen is provided with an adjustable part for manually controlling the product pellet size. It controls the size of the pellets going to circulation and thus the size of the product. Green pellets of the desired size are dropped on a belt conveyor feeding the shuttle feeder of the sintering furnace.

The balling drum comprises of a drum shell, which rests on four roller assemblies. The rubber roller assemblies on one side drive of the drum and the thrust roller restrains the drum to move axially. The inside of the drum is about 3m in diameter and is 10m in length.

The scroll forms part of the discharged section of the drum and is cut out with a special pattern to achieve a good distribution of the green pellets on the whole width of the subsequent roller screen. The drum is lined inside with rubber cloth which is attached to the drum by longitudinal flat bars. When the rubber cloth is in the top position it will hang down and makes the lining self-cleansing.

Three water spray nozzles are located inside the drum for the final moisture adjustment of the pellets. The nominal inclination of the pelletizing drum is 7° although it can vary from 5 to 7° by changing the spacers between the drum frame and the supporting frame.

Roller Screen

The pellets are sprayed with water and fall onto a roller screen where the smaller pellets fall through the screen and are recycled back into the pelletizing drum. The roller screen is a self-supported unit located crosswise under the discharge end of the pelletizing drum, to screen the undersize pellets to recycling. The screen is operationally divided into three parts. In the first upper section, the gap between the rollers is manually adjusted to 7 mm and the fine part pellets are fall onto a belt conveyor under the screen.

In the middle part the gap is remotely sleeplessly adjustable by a pneumatic cylinder. The product rate to sintering is controlled by adjusting the gap (i.e. the pellet size between the undersize and the product pellets. This gap is adjustable between 7 mm and 15 mm. In the lower section the gap between the rollers is manually adjustable and the pellets of the desired size fall through the screen and onto the product conveyor belt.

Sintering

The sintering furnace comprises of a multi-compartment furnace through which the green pellets are carried onto a perforated steel conveyor belt. The counter-current flow of gases dry and pre-heat those entering the front-end compartments. The sintered pellets (circulating) are used as a bottom layer on the steel belt to protect it from reaching excessively high temperatures. The pellets are fed on the belt from the bottom layer feed.

The most important reactions in the sintering of the chromite concentrate are the combustion of the coke / anthracite, oxidation of iron and the changes in the chromite structure in connection with a large ion exchange between the chromite and the silicates. Sintering occurs in oxidizing conditions and iron in the chromite lattice oxidizes from Fe^{2+} to Fe^{3+}. The oxidation reaction is exothermic giving energy to sintering reactions.

Generally, the energy required in the sintering is consumed in:

- vaporization of the moisture of green pellets,
- calcinations and other minor reactions,
- heating of the feed material to the temperatures required for the reactions, and
- heat losses into surrounds.

Energy is supplied to the sintering by:

- oxidation of iron,
- burning of carbon, added to the pellets,
- burning of fuel added to burners, and
- gas circulating from the cooling zones.

The green pellets are fed to the sintering furnace by a feeding system consisting of a shuttle feeder and a roller feeder provided with a wide belt feeder. The roller feeder spreads the pellets on top of the bottom layer pellets and forms the pellet bed of about 290 mm to the sintering furnace. The total bed thickness is 450 mm.

A laser measures the level of the bed and controls the speeds of the steel belt to keep the bed height constant. If the green pellet feed varies a lot, the feed to the furnace has to be stopped and started again, when the pelletizing circuit is in balance.

Initially, in the drying compartment, the pellets are dried by circulating gases of about 350-450°C from the third cooling compartment. Drying gas is sucked through the bed from two wind boxes located under the belt. The temperature of the drying gas is controlled by letting part of the gas to by-pass the compartment.

Secondly, in the heating compartment, the temperature of the pellets is increased so that the pellets are calcined and the carbon in the bed is ignited. Heating gas of about 1100-1150°C is taken from the second cooling compartment. Heating gas is sucked through the bed from the wind box. The temperature of the heating zone is controlled by burning CO-gas (LPG-gas, if CO-gas not available) to the circulating gas through burners located around the circulating gas duct.

Thirdly, in the sintering compartment, the temperature is increased to the sintering temperature, which is about 1250°C. Again the gas is sucked through the bed from the wind box. Heating gas is taken to the first cooling compartment and the gas temperature is controlled to about 1250°C - 1350°C by ring burners, burning of carbon monoxide. The oxidation of iron in the bed gives the main energy for sintering.

Sintered pellets are cooled in three cooling compartments by blowing air through the bed. The cooling gases are circulated to the front-end compartments. The air is blown to each wind box separately according to the pressure control in the compartments over the bed. The sintered pellets including fresh sintered pellets and bottom layer pellets are then discharged onto a belt for product screening.

Gas Cleaning

The gases are taken out separately from each zone to control the sintering temperature profile. The gases are sucked from the wind boxes and cleaned in wet cascade scrubbers. The gas flows are controlled by off-gas fans provided with variable speed drives to control the temperature profile in the sintering furnace.

The slurry is intermittently taken from the scrubber basins, drying, heating and sintering, sections based on set point input. It is taken to the floor sump in the scrubber area via floor canals and pumped from the sump to the water processing area.

Pellet Handling

The pellets produced from the sintering furnace are screened by a vibrating screen and conveyed to the pellet handling bins. In upset conditions the sintered pellets which are not well sintered or are wetted by the emergency water sprays are taken out on a stockpile before screening. That typically occurs after stoppages when the furnace temperatures are not in balance. From the stockpile the pellets can be returned to the screen at a later stage after drying thoroughly.

The sintered pellets from the screen are conveyed to pellet handling bins through conveyors and supply bottom layer pellets back to the plant. Vibrating screens are fitted below the bins so that the fines or dust produced from pellet handling can be minimized forming clean, dry, bottom layer pellets.

Water Processing

Water is needed in the Sintering Plant in basically every process step for grinding, for making green pellets, for cooling, for off-gas scrubbing and generally for washing purposes. The consumption of fresh water is minimized by using recycled water. However, part of the water is evaporated in sintering, in gas scrubbing and in open cooling systems and make-up water is needed to cover that. The sintering cascade slurry is acidic and bleed off is needed for preventing salification.

The filtrate water from ceramic filters is solid free and is stored in a 50 000 L filtrate water tank and is reused in washing and back washing of the ceramic filters. All the slurry water from the plant is collected and pumped to the ultrasep.

Overflow from the ultrasep flows to the steel tank and to TK 804 where it is stored and reused in the plant as recycled or process water. The underflow from ultrasep will discharge into the sump where it settles. The clear water will be pumped back to ultrasep and the slurry will be removed by excavator or TLB to dry out and be used as recycle feed material.

The slurry water collected to the thickener goes through the wet screen. The screen overflow (mostly containing chips) collects at the bunker and is then cleared and cleaned. The screen underflow will flow onto the thickener inlet on top. The thickener overflow is stored in two cement tanks and pumped to the plant to be used as process water. The thinker underflow then goes to either: 1) the ball mill, 2) the slurry mixing tank or 3) recycled back to the thickener, depending on the density of the slurry.

3.2.3.3 Ferrochrome Smelter Plant

The smelter plant consists of two 54 MVA closed arc furnaces (Furnace 2 and 3). The furnaces are energy intensive and high electrode currents are supplied via carbon electrodes to produce heat and metallurgical reaction which produce ferrochrome. As soon as enough melt is produced in the furnace, tapping is used to remove and separate both metal and slag.

The layout of the smelter plant and associated infrastructure is depicted on Figure 3.2.3.3(a) and a schematic process flow diagram for the smelter plant is depicted as Figure 3.2.3.3(b).

Raw Materials

Three types of raw materials are fed to the furnaces, namely: chrome rich ores, reductants and fluxes.

The chrome rich ores used at Boshoek (*Lumpy* and *Chips*) are mined outside of the Boshoek Operational Area and are delivered on site by trucks. The pellets produced at the Motswedi Pelletizing plant are also used a raw material within the furnaces.

The reducing agents used at Boshoek include *Coke*, *Char* and *Anthracite*. The function of the reductants is to enhance the melting of the ore by improving the electrical conductivity of the raw mix and reducing the chrome containing ore to ferrochrome metal.

The fluxes used at Boshoek include *Dolomite*, *Limestone* and *Quartzite* and are used to enhance the viscosity and melting temperature of the slag inside the furnaces. They also assist in adjusting the silica level in the furnace charge.

Pre Heater

The preheater is a holding device that reduces the amount of the moisture in raw materials before being introduced to the furnaces. This takes place after the raw materials have been discharged from the day bins into the kiln via conveyor belts.

The raw materials are fed from the day bins and into the preheater via conveyor belts. The preheater is a holding device that reduces the amount of the moisture in the raw materials before being introduced into the furnace. The raw material goes into the preheater where it comes into contact with CO gas from the furnace creating a contour current flow, where moisture in the material is reduced. Raw material in the feed bin enters the preheater through two tubular feeders. The raw material mix is distributed evenly into the preheater sectors automatically or by manually rotating the distribution device and loading from the lowest sector.

The purpose of the preheater is to eliminate moisture from the charge raw material and preheat it as well. The carbon reactions limit the preheater temperature in the mixing chamber to between 700°C and 800°C.

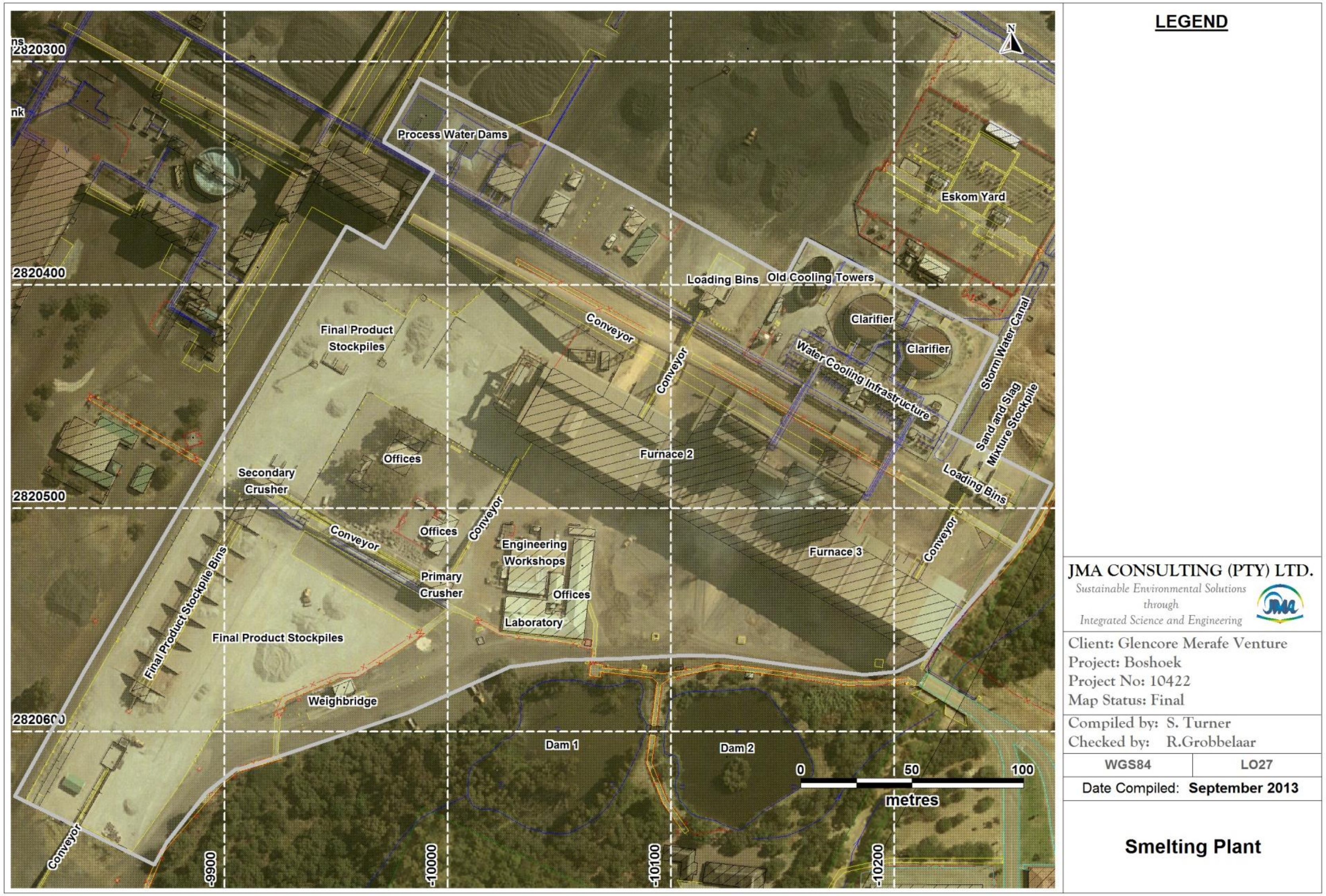

Figure 3.2.3.3(a): **Ferrochrome Smelter Plant**

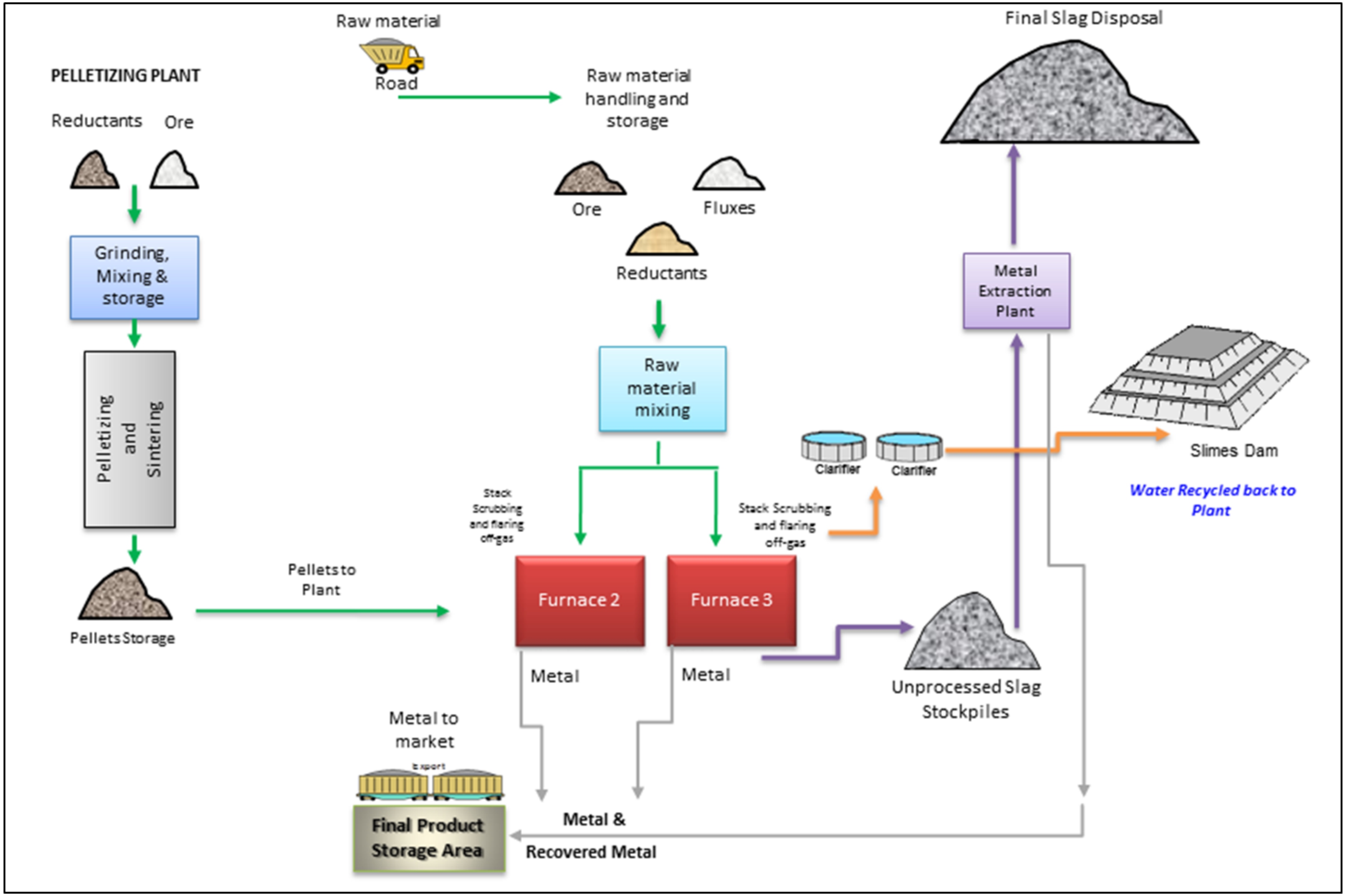

Figure 3.2.3.3(b): Schematic Process Flow Diagram for the Ferrochrome Smelter Plant

The charge material inside the preheater is heated up by hot air that is produced from burning the CO gas inside the combustion gas chamber. The off gas produced is sucked into the venture scrubber, cleaned and separated to go either to the stacks and/or the recycling blowers where it is re-used. The heated charge mix flows through the nine feed chutes into the furnace for further melting.

Furnaces

At the furnaces, the ore is fed to the smelters where it is combined with the reductants and heated via high voltage carbon electrodes. The furnaces are continually filled with raw material in order to keep the electrodes submerged. The carbon in the raw materials, in combination with the heat, allows the furnace to produce reduced ferrochrome metal. The fluxes serve as a cleaning agent in that they react with the impurities within the metallic pool to form a molten slag material that floats to the top of the relatively heavier liquid material. As soon as enough melt is produced in the furnace, both metal and slag is removed / tapped.

The metal and slag are tapped concurrently from the furnace into a separation point, utilizing a separator block and skimmer plate. The tapping process involves the drilling of a hole into the melted material, followed by an oxygen lance which results in the flow of melt down to the skimmer to form ingots.

Once the metal has solidified, the metal ingots are removed from the sand mould, taken to mechanical break floors, cooled down with water and then mechanically broken according to the consumer requirements. The slag and sand from the tapping floor is then transported to the unprocessed slag dump where it is reworked at the metal extraction plant.

The furnace clarifiers' slurry is pumped from the furnaces to the slimes dam where it is deposited.

Final Product Stockpiles

The final metal products are crushed and screened to different sizes depending on customer requirements, after which it is stockpiled either in final product bins or alternatively on final product stockpiles located in the Smelter Area. A second final product stockpile area is located next to the railway siding along the southern perimeter of the Smelting Management Area.

The final product stockpile bins and areas are located on concrete lined areas. The areas are swept on a regular basis to ensure that no product is lost during rainfall events.

3.2.3.4 Metal Extraction Plant

Slag from the Furnaces is conveyed to the Metal Extraction Plant for Jig and Magnetic separation. At this the stage metal containing slag is crushed, screened and separated by dense medium (jigs) and magnetically. The Metal Extraction Plant is divided into three sections and is operated in order to recover as much ferrochrome from the unprocessed slag as possible. The tailings from the jigs will be carried over the end of the jig by means of the jig water, a dewatering screen separate the water from the tails. The tails is discarded on the processed slag dumps.

The three sections at the Metal Extraction Plant are namely: Crusher Plant, Jigging Plant and Classifier Plant. The layout of the Metal Extraction Plant is depicted on Figure 3.2.3.4(a). The schematic process flow diagram of the Metal Extraction Plant is indicated in Figure 3.2.3.4(b) and the schematic process flow diagram of the Crushing Operation is indicated in Figure 3.2.3.4(c).

Crusher Plant

The unprocessed slag from the furnaces is reclaimed from the stockpile and hauled to the vibrating grizzly feeder which discards material with a size above 200 mm into an adjacent concrete bunker.

All the material that is smaller than 200 mm in diameter is transferred onto a double deck poly panel screen. The first deck of the screen consists of poly panels with a maximum aperture size of 50 mm. All material that is greater than 50 mm in diameter is fed into the jaw crusher to be crushed further. The reduced lumps are then fed from the jaw crusher to the conveyor and fed through the vibrating grizzly crusher and are re-screened. The second deck of the screen consists of poly panels with a maximum aperture size of 25 mm. Material that is greater than 25 mm in diameter is fed into the cone crusher for size reduction. The reduced lumps are then fed through the vibrating grizzly crusher and are re-screened. The material that is smaller than 25 mm in diameter is then conveyed to the jigging process feed stockpile.

Jigging Plant

The process flow diagram of the jigging process is indicated in Figure 3.2.3.4(d). The metal extraction plant has two jigs installed for the recovery of chrome from the unprocessed slag material. The jigging process begins with the material samples that are smaller than 25 mm in diameter. The material is passed through a vibrating feeder onto a conveyor which feeds the material through the two jigs (Apic 11 fines jig (3mm x 8mm) and the M5 course jig (8mm x 25mm)). The jigs utilize the difference in density between the metallic ferro chrome and the slag, and thus the difference in settling rate in water to separate the metal and the slag.

From these two jigs, the recovered chrome and middlings are conveyed to the designated bunkers / stockpiles and the recovered ferrochrome is sent to the final product stockpile areas. The middlings and fed through the jigs repeatedly until all the ferrochrome is recovered. The processed slag will however be transported from the screen and will be deposited onto the processed slag dump. The particles with a diameter of less than 1 mm collect in the wet screen under pan and are pumped to the collection tank for feed into the classifiers.

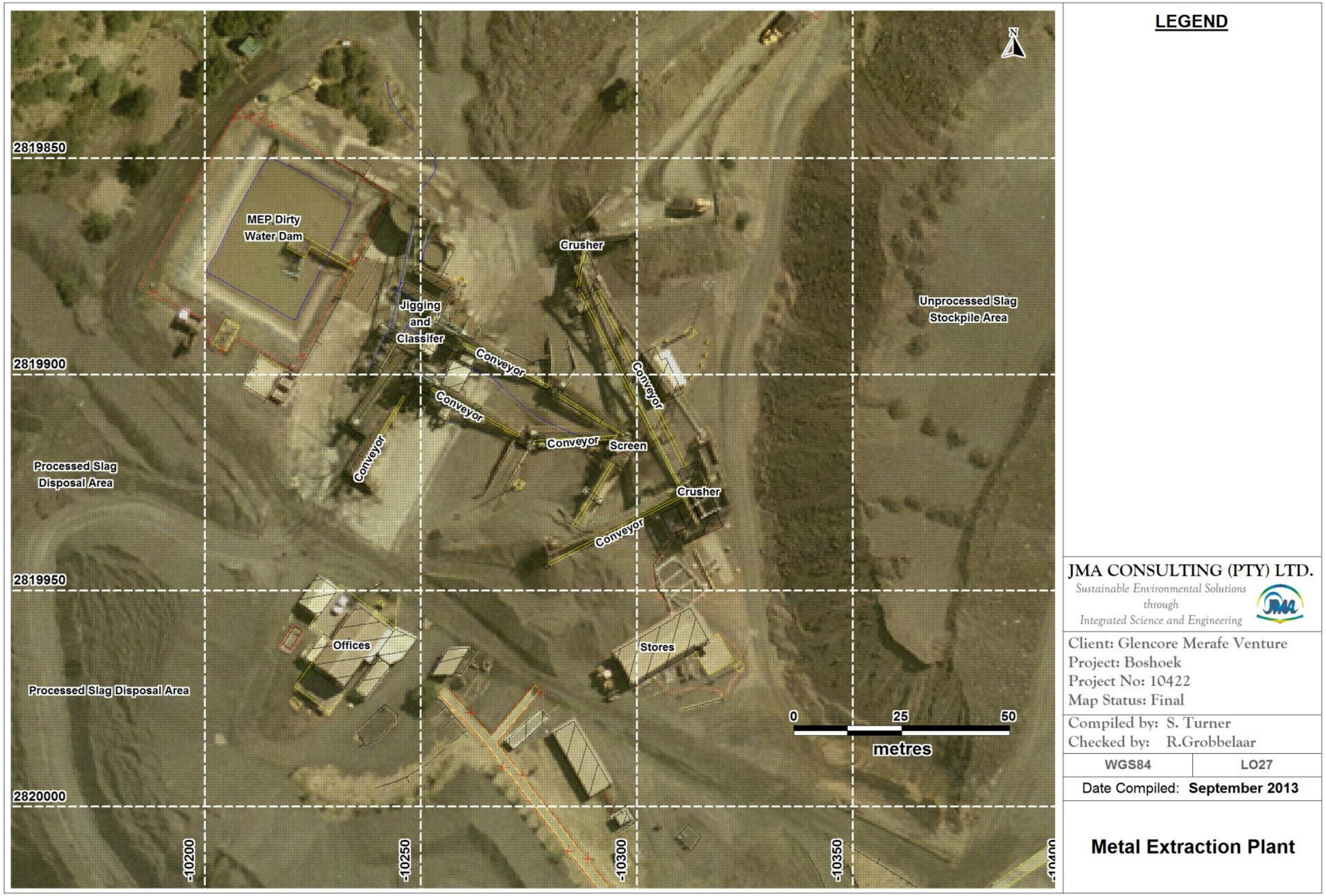

Figure 3.2.3.4(a): Metal Extraction Plant

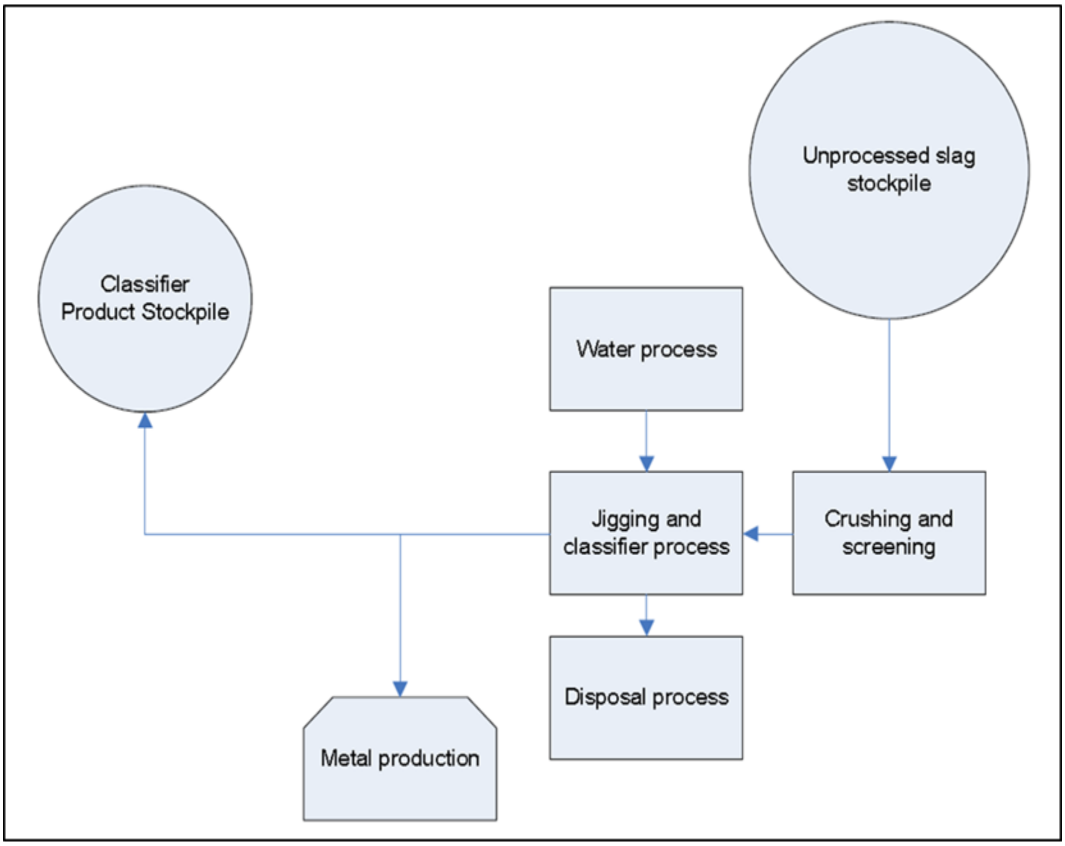

Figure 3.2.3.4(b): Schematic Process Diagram of the Metal Extraction Plant

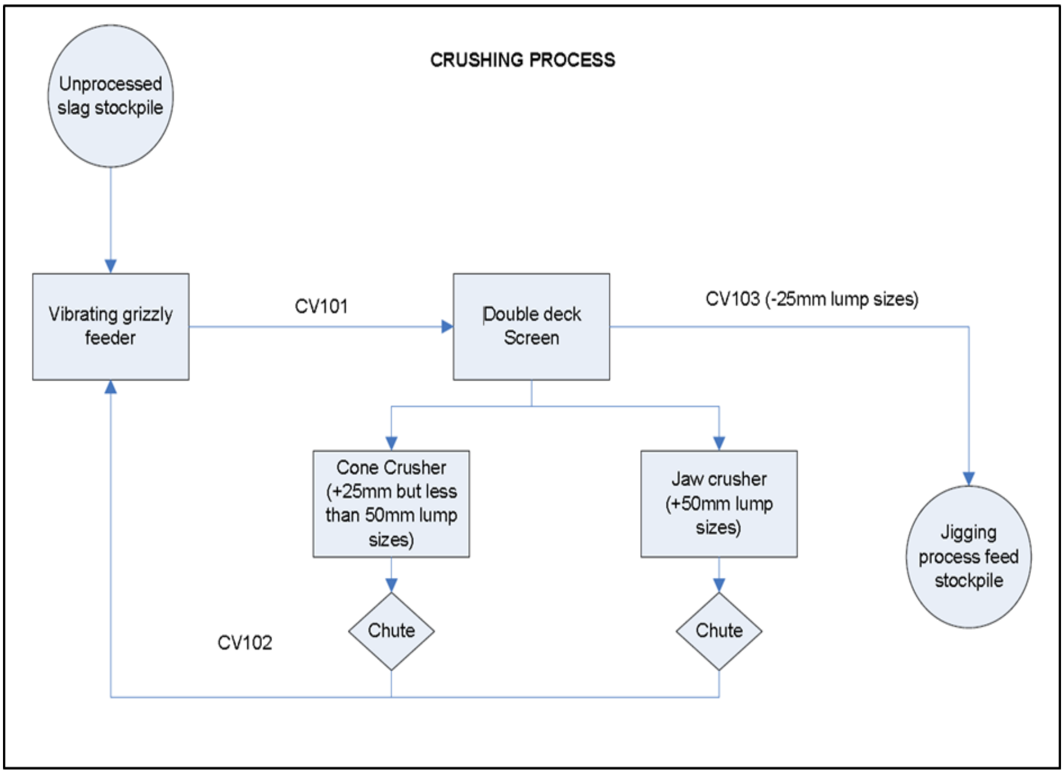

Figure 3.2.3.4(c): Schematic Process Diagram of the Crushing Process

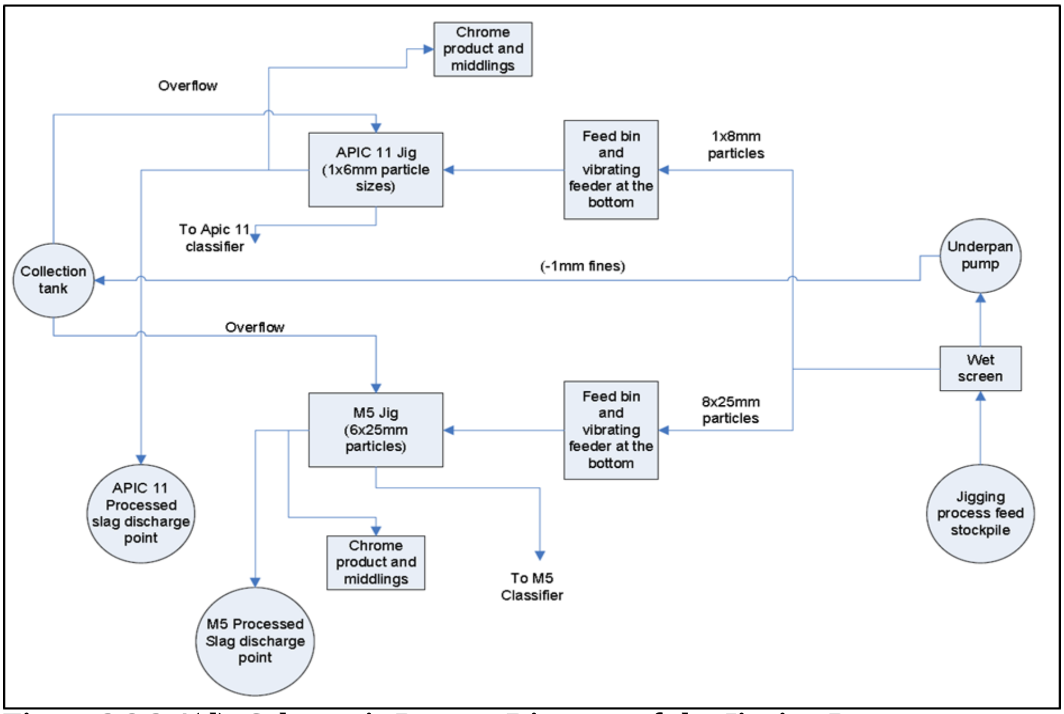

Figure 3.2.3.4(d): Schematic Process Diagram of the Jigging Process

Classifier Plant

The schematic process flow diagram of the classifier process is indicated in Figure 3.2.3.4(e). The fines pumped from the wet screen under pan pump to the collection tank, overflows the two jigs' collection tanks. From the jigs' collection tanks, the fines are pumped to the classifiers. The slimes and the majority of the majority of the water overflow to the thickener where the slimes settle and the water recycled for re-use in the process. The tailings overflow to the mixing tank from where they are pumped to the tailings vibrating screen for disposal at the JIG Tailings Disposal Quarry.

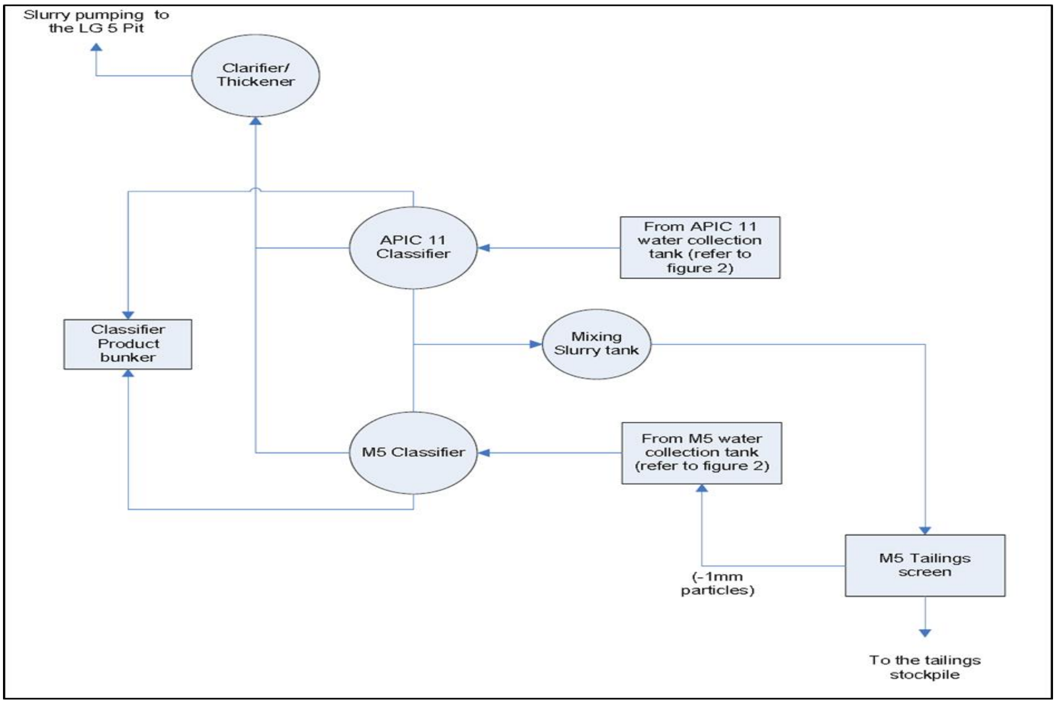

Figure 3.2.3.4(e): Schematic Process Diagram of the Classifier Process

3.2.3.5 Spiral Plant

The Smelting Operation requires two types of chromite ore namely Lumpy Ore and Fine Ore Concentrate. During the active mining phase at GMBS the spiral plant was used to separate and concentrate the ore mined at the GMBS open cast sections. However, now that the mining has stopped, the Spiral Plant section of the old Concentrator Plant will continue to operate but will now be used by the Smelting Plant to concentrate fine ore obtained from other mining activities for use at the GMBS. The layout of the Spiral Plant is depicted on Figure 3.2.3.5(a).

Crushing and Screening of Mined Material

LG6 and LG2 tailings sourced from Platinum Mines will now be concentrated at the Spiral Plant prior to being supplied to the Smelting Plant. Although it is assumed that the imported ore will be less than 35 mm in size and would therefore not require the initial crushing and screening, this section of the concentrator plant will be retained. The imported fines material (less than 35mm) will be deposited onto fines stockpiles and then transported by conveyor via a tunnel below the stockpile to the wash plant for wet screening. The +1mm material will be delivered to a ball mill.

Spiral Plant

Undersized imported mine ore and reclaimed and recycled mining waste from the old concentrator and spiral plant disposal pits, will be separated by a gravity mechanism, where the heavier material moves to the inside of the spiral and is collected as concentrate compared to the lighter material (waste), which is pushed to the outside of the spiral and collected as the tailings of the spiral. The purpose of the cyclone is to remove the ultrafine material which is then pumped (or gravity fed) to a thickener. The cyclone underflow will be treated by a bank of spirals. This involves a number of stages depending on product quality required. The recovered metal material is re-worked and processed and the waste material is disposed of as a slurry, together with the fines from the Jig Plant at the Metal Extraction Plant, into the abandoned MG1 opencast workings on the property of the neighbouring BRPM, which is located immediately east of the concentrator plant. This disposal option for fines materials was described as Option 2 in the approved EMPR for the Glencore Merafe Venture Boshoek Mine.

Drying and Quality Control Areas

The concentrate is dewatered by a cyclone and dumped onto a concrete floor. Water from the cyclones was returned to the process. The concentrate is then allowed to partially dry before being transported to the final product stockpile. No fugitive dust is expected to be generated because the material is still wet.

Materials Stockpile and Storage Areas at the Spiral Plant

The location of current raw materials and product stockpiles at the Spiral Plant is indicated on Figure 3.2.3.5(a).

The material currently being re-worked at the Spiral (Concentrator) Plant includes the following:

- Boshoek Fines
- Wonderkop Fines
- Jig (MEP) Tailings
- Spiral Plant Tailings

The concentrated material that is recovered from the spiral plant is sent to the Motswedi Sinter and Pelletizing Plant where it is incorporated with the raw material to make pellets.

Figure 3.2.3.5(a): Spiral Plant

3.2.4 Waste Management (Mining Waste)

All active mining has stopped and the open pits are currently being rehabilitated. The discussion to follow therefore refers to mining waste management during the operational phase of the mine and is described here in order to document mining waste disposal practices which were authorized in the approved EMPR.

A detailed Waste and Water Management Study was undertaken by Metago Environmental Engineers in support of the EMPR that was compiled for mining authorization purposes. This report is attached as APPENDIX 3.2(B) to this report and forms the basis from which the current site conditions with respect to waste management will be described. This document also contains conceptual designs for facilities. The detailed designs are generated for the purposes of license applications as required in terms of the authorizations of these facilities terms of the provisions of either the NWA or the NEMWA.

3.2.4.1 Overburden and Waste Rock

The roll-over open cast mining method required the temporary stockpiling of topsoil, overburden and waste rock during the initial phases of operational phase of the mining operation. As mining progressed, these materials were rolled over for backfilling and re-soiling purposes.

The originally stripped and excavated material was stockpiled to the east of the open pits but beyond the line defining the final highwall perimeter. This was done to ensure the minimum haulage distance for the placement of these materials into the final voids for rehabilitation. This was done as foreseen in the approved EMPR. Refer the detailed Waste and Water Management Study undertaken by Metago Environmental Engineers in support of the EMPR and attached as **APPENDIX 3.2(B)**, for layout drawings and conceptual design information.

The topsoil, overburden and waste rock which originated from the mine were all considered geochemically inert materials and had for instance no Acid Generating Potential.

3.2.4.2 Concentrator (Spiral Plant) Tailings

The tailings (fine waste rock) generated at the concentrator were disposed of in the old abandoned LG6 open cast mine workings located immediately north of the concentrator. The tailings were slurried into the open pit voids.

This activity was undertaken during the operational phase of the mine in accordance with what was proposed in the approved EMPR – Option 2 versus Option 1 which comprised the provision of an above ground tailings facility. Refer the detailed Waste and Water Management Study undertaken by Metago Environmental Engineers in support of the EMPR for motivation, layout drawings and conceptual design information - attached as **APPENDIX 3.2(B)**.

The locality and extent of the now terminated mining related Concentrator Tailings Disposal operation in the abandoned open cast workings is shown in Figure 3.2.4.2(a).

Figure 3.2.4.2(a): Concentrator Tailings Disposal Facility Phase 1 in abandoned Open Cast Workings

3.2.5 Waste Management (Smelting Plant Waste)

Waste Management for wastes generated by/at the Smelting Plant (non mining waste) is governed by the National Environmental Management Waste Act (NEMWA) and must be authorized in terms of its provisions.

A detailed Waste and Water Management Study was undertaken by Metago Environmental Engineers in support of the EMPR that was compiled for mining authorization purposes. This report is attached as **APPENDIX 3.2(B)** to this report and forms the basis from which the current site conditions with respect to waste management will be described.

3.2.5.1 Domestic and Industrial Waste (Salvage Yard)

The Glencore Merafe Venture Boshoek Smelter Salvage Yard forms the main facility for the storage and management of domestic and industrial waste generated at the site.

This Temporary Waste Storage Facility is operated under a Waste License (License Number 12/9/11/L239/7) in Terms of Section 20(b) of the National Environmental Management: Waste Act, 2008 (Act No.59 of 2008), issued to Merafe Ferrochrome and Mining (Pty) Ltd on 23 March 2010.

The license authorizes the temporary storage of general and hazardous waste on portion 138 of the farm Boshoek 103 JQ.

The Salvage Yard is located to the south of slag disposal area and to the north of the eastern / central storm water canal and covers a surface area of 1.02 ha. The layout of the salvage yard is depicted on Figure 3.2.5.1(a).

The salvage yard serves as a temporary waste storage and management area, from which the waste that is generated at the plant can be temporarily stored, handled, sorted and loaded for removal from the site. The following activities take place within the salvage yard:

- Temporary storage and sorting of general/domestic waste;
- Temporary storage and sorting of hazardous waste;
- Temporary storage, sorting, grading, control and re-distribution of the salvageable re-usable scrap waste;
- Temporary storage, sorting, grading and control of the non-salvageable re-usable scrap waste.
- Temporary storage and removal of ferrous and non-ferrous scrap material.

The aforementioned services relate to all type of waste generated at the plant, which include:

- General waste;
- Hazardous waste excluding used laboratory chemicals;
- Reusable waste including ferrous and non-ferrous metal scrap;
- Shredding of confidential documents;
- Rubber waste;

- Recyclable waste and non-recyclable waste including:
    - Paper cardboard;
    - Machine wood;
    - Garden/green waste
    - Food waste;
    - Used/waste oil;
    - Concrete and glass; conveyor belt
    - Batteries
    - Pallets
    - Plastic; and
    - Sludges.

At present, several contractors purchase and collect some of the waste material from the site, including the salvage yard. Waste material is brought to the salvage from throughout the plant's skips and bins via mobile machinery, where they are stockpiled in the relevant areas. Initial waste sorting occurs into bins within the recycle stations located at each waste source.

Figure 3.2.5.1(b): Typical Recycle Station

Contractors further remove the material from the Salvage Yard for re-working, recycling, selling or disposal. The expected average monthly waste materials, waste classification, final waste stream, incoming and outgoing waste volumes as obtained from the relevant sources on site, was provided by Xstrata is indicated in Table 3.2.5.1(a).

The information provided in Table 3.2.5.1(a) assumes that all the waste that is brought into the salvage yard is temporarily stored, reworked and removed from the salvage yard. No waste material is therefore expected to accumulate at the Salvage Yard over the long term or life of operations at GMBS.

3.2.5.2 Medical and Laboratory Wastes (Removed by Service Providers)

Medical waste generated at the on-site Clinic and laboratory wastes generated at the Laboratory require special management. In both instances, the waste streams are of low volume.

The wastes are therefore placed in appropriate receptacle containers, stored in designated areas at the Clinic and Laboratory, and then removed on a regular scheduled basis by fully accredited waste removal service providers (currently SharpMed (collect on arrangement) and Enviroserv respectively).

3.2.5.3 Slag Stockpiling and Disposal Facilities

The GMBS Slag Disposal areas are located to the north of the eastern / central storm water canal, as well as to the south of the Slimes Dam.

Slag is generated in the furnaces at an average rate of some 233 000 tonnes per annum, which is slightly less than the 297 000 tons per annum foreseen in the original EMPR.

The slag is initially transported from the breaking floors and is temporarily stockpiled at the unprocessed slag stockpile areas. The unprocessed coarse slag is reworked at the metal extraction plant and the final processed slag is deposited at one of the two slag disposal sites. This is not in line with the original planning in the EMPR.

Neither the unprocessed Slag Stockpiles, nor the Slag Dumps are lined with liner systems. This is in line with the original concept as approved in the EMPR. The decision not to line the slag facilities was based on a motivation contained in the detailed Waste and Water Management Study undertaken by Metago Environmental Engineers in support of the EMPR that was compiled for mining authorization purposes. This report is attached as **APPENDIX 3.2(B)** to this report.

The layouts of the slag stockpile and disposal facilities are depicted on Figures 3.2.5.3(a) and 3.2.5.3(b).

The fine grained slag material waste generated at the metal recovery jigging plant is disposed of in the MG5 derelict quarry to the north-east of the Slimes Dam – this facility will be discussed separately.

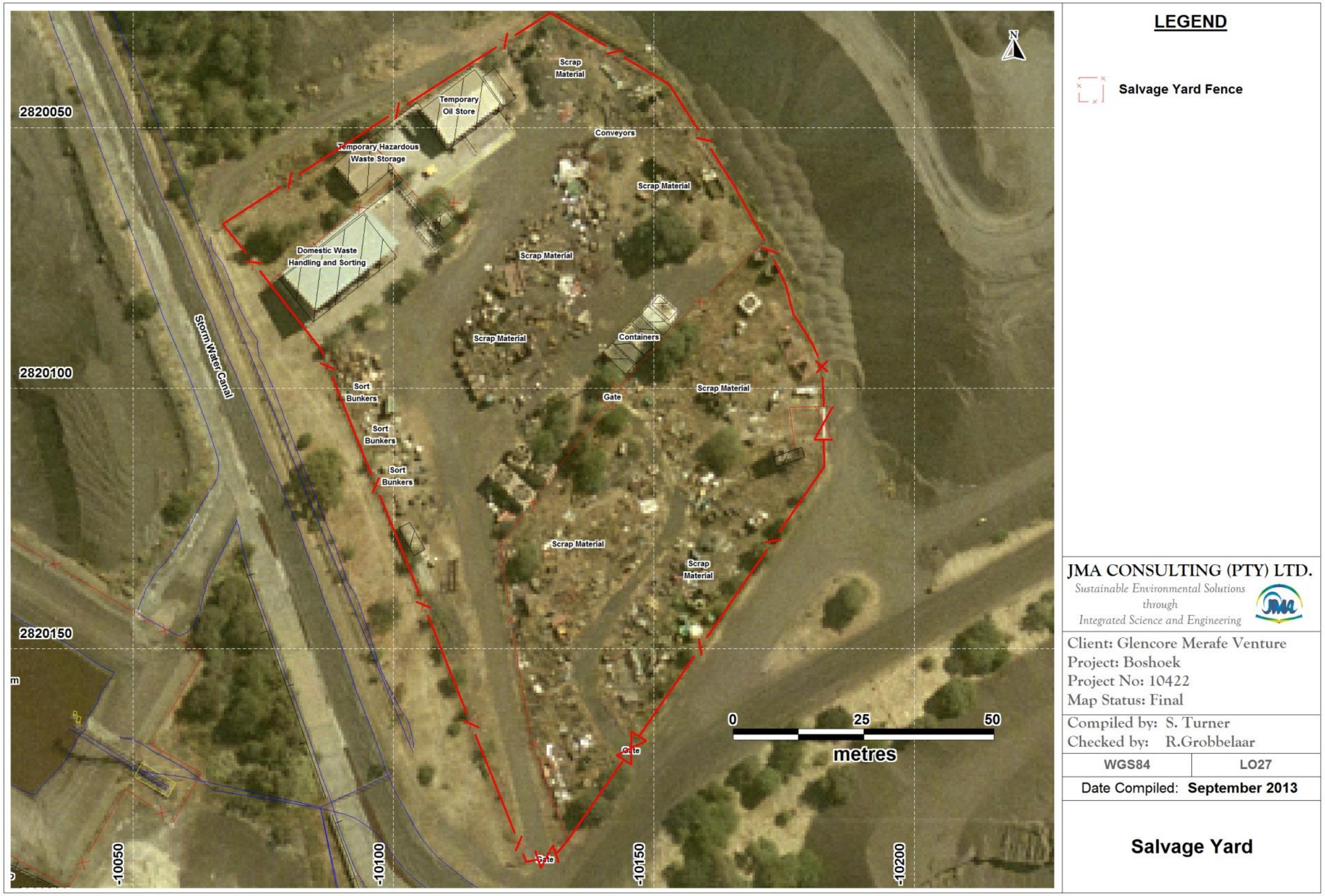

Figure 3.2.5.1(a): Salvage Yard Layout

Table 3.2.5.1 (a): Expected Maximum Monthly Volumes of Waste Reworked at and Removed from the GMBS Salvage Yard

NATURE OF WASTE	WASTE CLASSIFICATION	FINAL WASTE STREAM	XSTRATA	BADGERS	BOUVEST	CANTEEN	INCOMING VOLUME	RE-WORKED VOLUME	OUTGOING VOLUME
RECYCLABLE / RE-USEABLE			kg/month	kg/month	kg/month	kg/month	kg/month	kg/month	kg/month
Rubber lined Steel	General (Non-Hazardous) Waste – Recycled / Re-used	Sell to North West Recycling	2	0	0	0	2	2	2
Unclean Metal		Sell to North West Recycling	117	0	0	0	117	117	117
Unprocessed Scrap Metal		Sell to North West Recycling	1460	12	14	0	1486	1486	1486
Scrap Steel Auction		Auction	0	0	0	0	0	0	0
Subgrade Steel		Sell to North West Recycling	177	0	0	0	177	177	177
Rubber / Conveyor		North West Recycling	272	0	0	0	272	272	272
HDPE Pipes		Sell to North West Recycling	50	0	0	0	50	50	50
Cans		North West Recycling	3	0	0	0	3	3	3
Plastic		North West Recycling	4	0	0	0	4	4	4
Paper		North West Recycling	5	0	0	0	5	5	5
Electric Motors		Sell to North West Recycling	5	0	0	0	5	5	5
Domestic (Wet)		Farming	3	0	0	12	15	15	15
Wood (Mixed)	Other (Non-Hazardous) Recycled / Re-used	Community	173	12	0	0	185	185	185
Oil (kl)	Waste Oil (Hazardous) Recycled / Re-used	Oilkol	17	33	0	1	51	51	51
TOTAL			2409	57	14	13	2493	2493	2493
NON-RECYCLABLE				kg	kg	kg	kg	kg	kg
Garden Waste	Other (Non-Hazardous) – Disposed Off-Site	Off-Site Landfill	0	0	0	0	0	0	0
Hazardous Waste	Hazardous Waste not reported elsewhere – Disposed Off-Site	Enviro Serve	41	0	0	0	41	41	41
Domestic (Dry)	General Waste – Disposal Off Site	Off-Site Landfill	490	0	0	0	490	490	490
TOTAL			531	0	0	0	531	531	531
OTHER				kg	kg	kg	kg	kg	kg
Building Rubble	General Waste	On-Site Landfill							
TOTAL			2940	57	14	13	3024	3024	3024

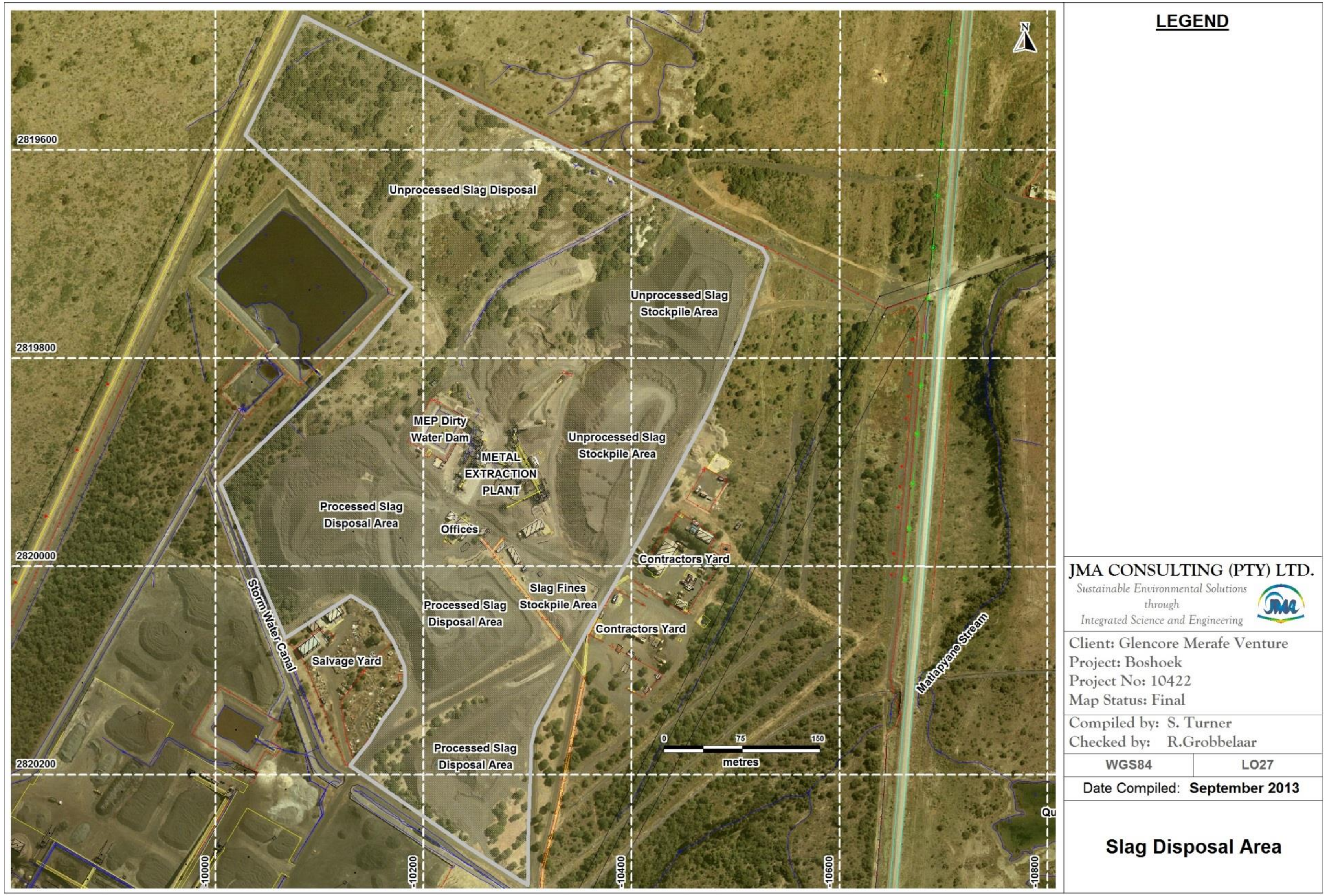

Figure 3.2.5.3(a): Unprocessed Slag Stockpile and Processed Slag Disposal Areas

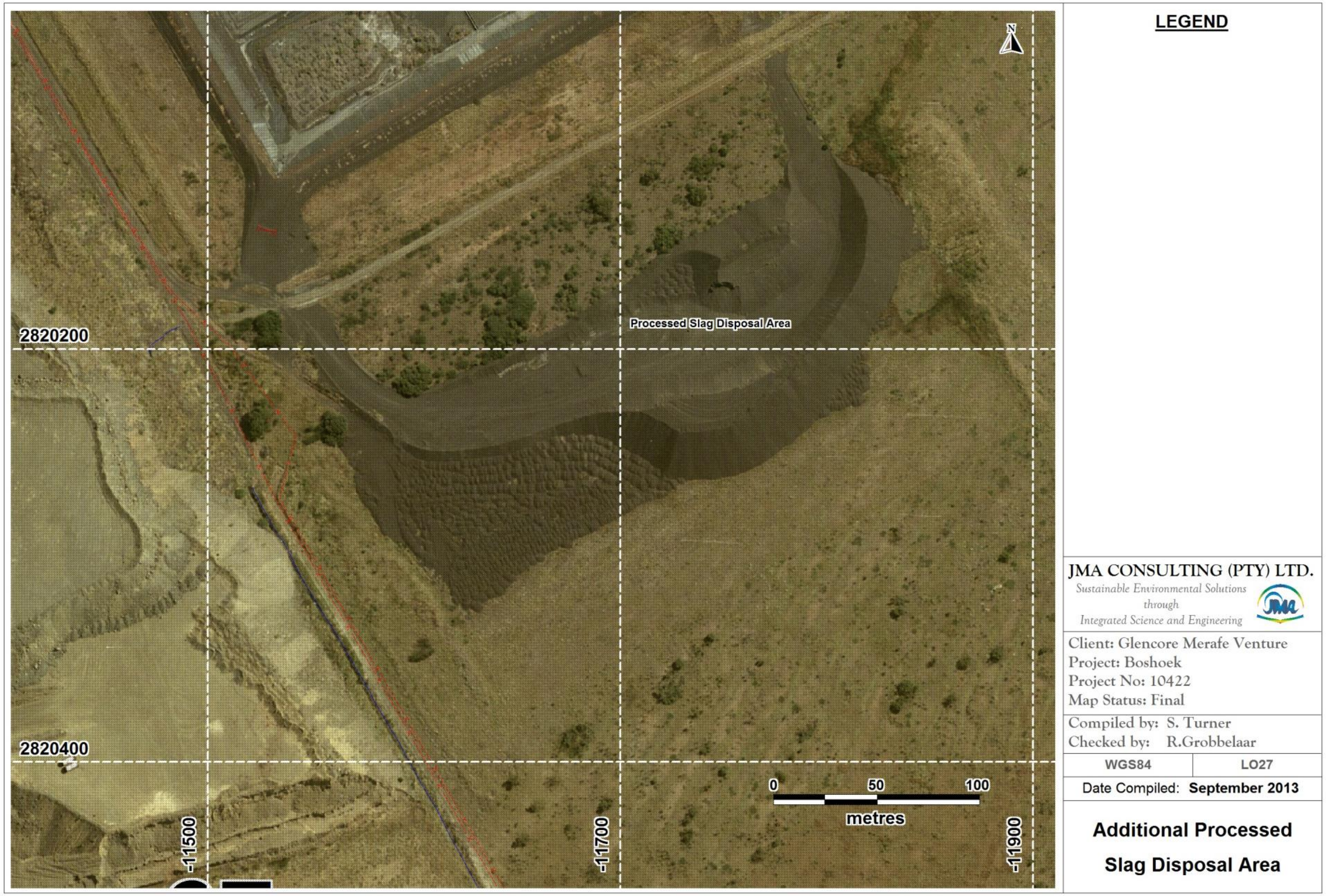

Figure 3.2.5.3(b): Additional Processed Slag Disposal Area

3.2.5.4 Jig Plant Tailings Disposal Facility

The Jig Tailings Disposal Facility at GMBS represents Option 2 (In Pit Disposal) in the approved EMPR and was selected instead of providing an above ground tailings facility (Option 1) in the EMPR).

The Jig Plant Tailings comprises fine slag material originating from the Metal Extraction Plant. The jig tailings are pumped as a slurry along a pipe line from the jig plant to the Jig Plant Tailings Disposal Facility located in an abandoned mine quarry which mined the MG5 seam on the property of BRPM. GMBS has a lease agreement with BRPM.

The facility is unlined. The decision not to line the slag facilities was based on a motivation contained in the detailed Waste and Water Management Study undertaken by Metago Environmental Engineers in support of the EMPR that was compiled for mining authorization purposes. This report, which also contains the conceptual designs for the facility, is attached as **APPENDIX 3.2(B)** to this report.

The layout of the Jig Tailings Disposal Facility is depicted on Figure 3.2.5.4(a).

3.2.5.5 Spiral Plant Tailings Disposal Facility

The Spiral Plant Tailings will be disposed of (slurried into) in the same facility as the Jig Tailings – see Figure 3.2.5.4(a) for locality and extent.

The Spiral Plant tailings will be a mixture of Jig Tailings (reworking of old jig tailings deposit) and mine tailings (reworking of old mine tailings as well as concentration of new LG6 tailings from platinum mines), and will therefore be similar in composition and chemical image to the original waste generated at the concentrator plant and the jig plant.

In view of the fact that the origin of the tailings, its physical attributes, its chemical composition, as well as the disposal method will be the same as originally foreseen, this activity will continue to be undertaken in accordance with what was proposed in the approved EMPR – Option 2 versus Option 1 which comprised the provision of an above ground tailings facility. Refer the detailed Waste and Water Management Study undertaken by Metago Environmental Engineers in support of the EMPR for motivation, layout drawings and conceptual design information - attached as **APPENDIX 3.2(B)**.

The facility is unlined. The decision not to line the facilities was based on a motivation contained in the detailed Waste and Water Management Study undertaken by Metago Environmental Engineers in support of the EMPR that was compiled for mining authorization purposes. This report, which also contains the conceptual designs for the facility, is attached as **APPENDIX 3.2(B)** to this report.

LEGEND

JMA CONSULTING (PTY) LTD.
Sustainable Environmental Solutions through Integrated Science and Engineering

Client: Glencore Merafe Venture
Project: Boshoek
Project No: 10422
Map Status: Final

Compiled by: S. Turner
Checked by: R.Grobbelaar

WGS84	LO27
Date Compiled:	**September 2013**

Jig Tailings Disposal Facility

Figure 3.2.5.4(a): Jig Plant and Spiral Plant Tailings Disposal Facility Phase 2 at abandoned Open Cast Workings

3.2.5.6 Slimes/Slurry Disposal Facility

The GMBS Slimes/Slurry disposal area lies to the east of the ferrochrome smelting plant and immediately adjacent to the northern opencast mining operations. The facility was designed, constructed and is currently being operated as proposed in the approved EMPR. The decision to line the slimes/slurry disposal facility was based on a motivation contained in the detailed Waste and Water Management Study undertaken by Metago Environmental Engineers in support of the EMPR that was compiled for mining authorization purposes.

This report, which also contains the conceptual designs for the facility, is attached as **APPENDIX 3.2(B)** to this report. The walls of the slurry dams are built with slag material, then provided with a liner system and then filled with slurry.

The slimes/slurry material is pumped from the plant furnace clarifiers and is deposited at the slimes/slurry dam as slurry where the solid constituents within the slurry settles out from the slurry solution. The slurry is deposited in the designated areas within the slimes dam in order to form a slurry mud beach in such a way to effectively form a pool in the centre of the dam. The water within the slimes dam is conveyed to a slimes dam return water sump, where it is pumped and re-used as process water.

The water that drains out the base through the penstock (through concrete rings placed on top of each other) drains into an underground drainage line into two concrete sumps. The penstock rings forms a barrier against the slurry and only clean water drains through. The clean water is then pumped back to the process dams for re-use in the furnace and sinter process water systems. The schematic process flow diagram of the slimes dam is indicated in Figure 3.2.5.6(a) whilst the layout of the slimes/slurry dam and slimes/slurry dam return water dam is depicted on Figure 3.2.5.6(b).

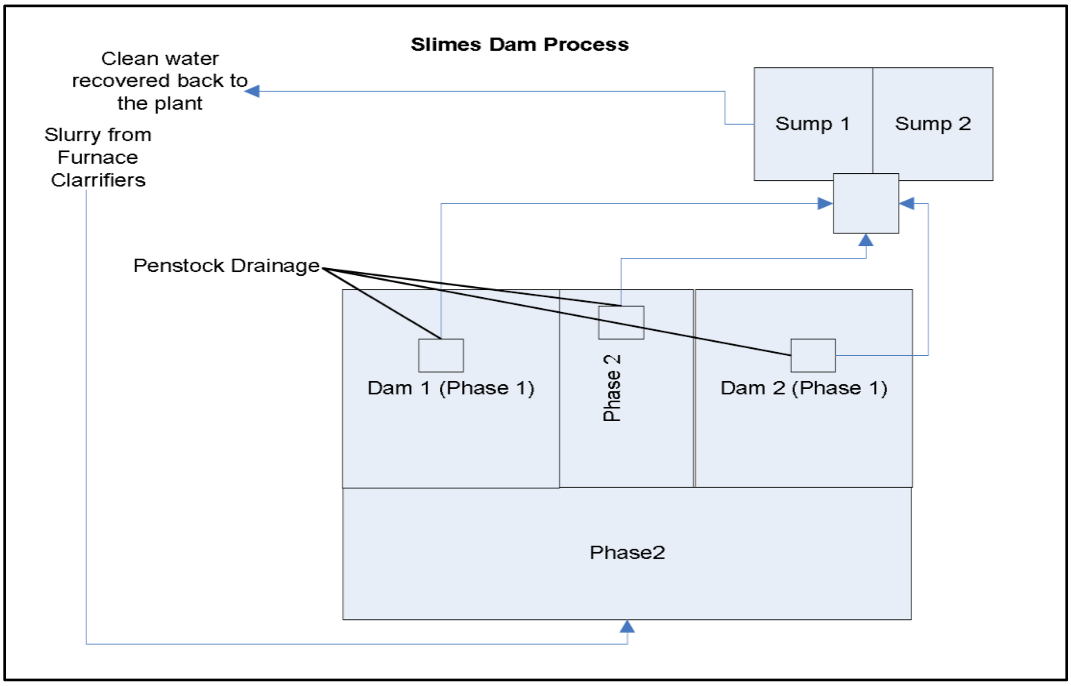

Figure 3.2.5.6(a): Schematic Process Diagram of the Slimes/Slurry Process

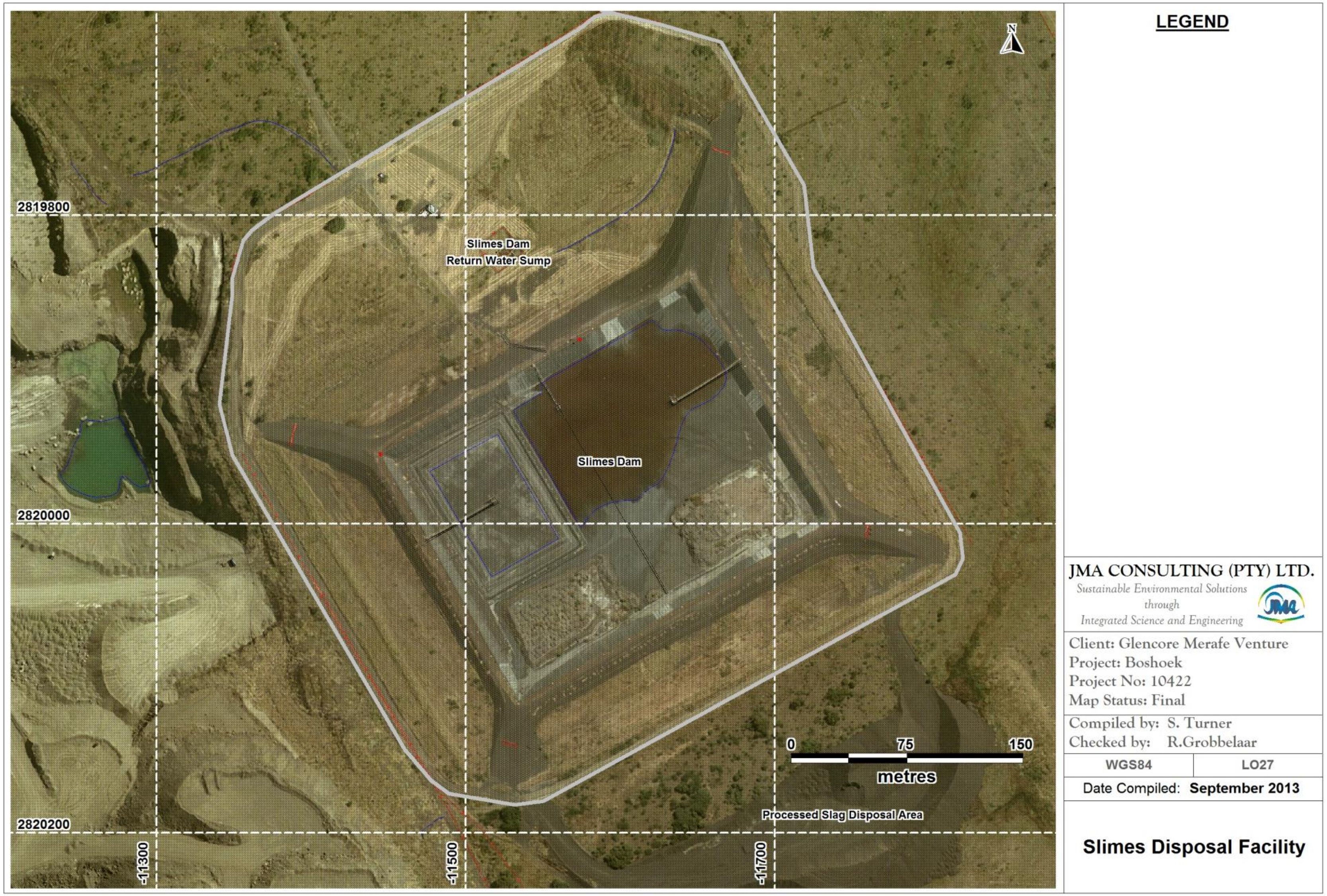

Figure 3.2.5.6(b): Slimes/Slurry Disposal Facility Layout

3.2.5.7 Sewage Treatment Plant

There is no sewerage treatment plant at GMBS. The sewage that is generated at GMBS (approximately 50 m^3/day) is pumped to and treated at the Bafokeng Rasimone Sewage Treatment Work(s), located to the north-east of the GMBS operations. The locality of the BRPM sewerage treatment plant is indicated on Figure 3.2.5.7(a).

The Bafokeng Rasimone Sewage Treatment Work has been registered by the Department of Water Affairs and Forestry in terms of Section 12A and 26 of the Water Act (Act 54 of 1956) as a **Class C Work** for the operation of water care works used for purification, treatment or disposal of effluent. The registration certificate is dated 19-10-2003 and is attached as APPENDIX VII to the Process and Materials Characterization Specialist Report – **APPENDIX 3.2(C)** to this report.

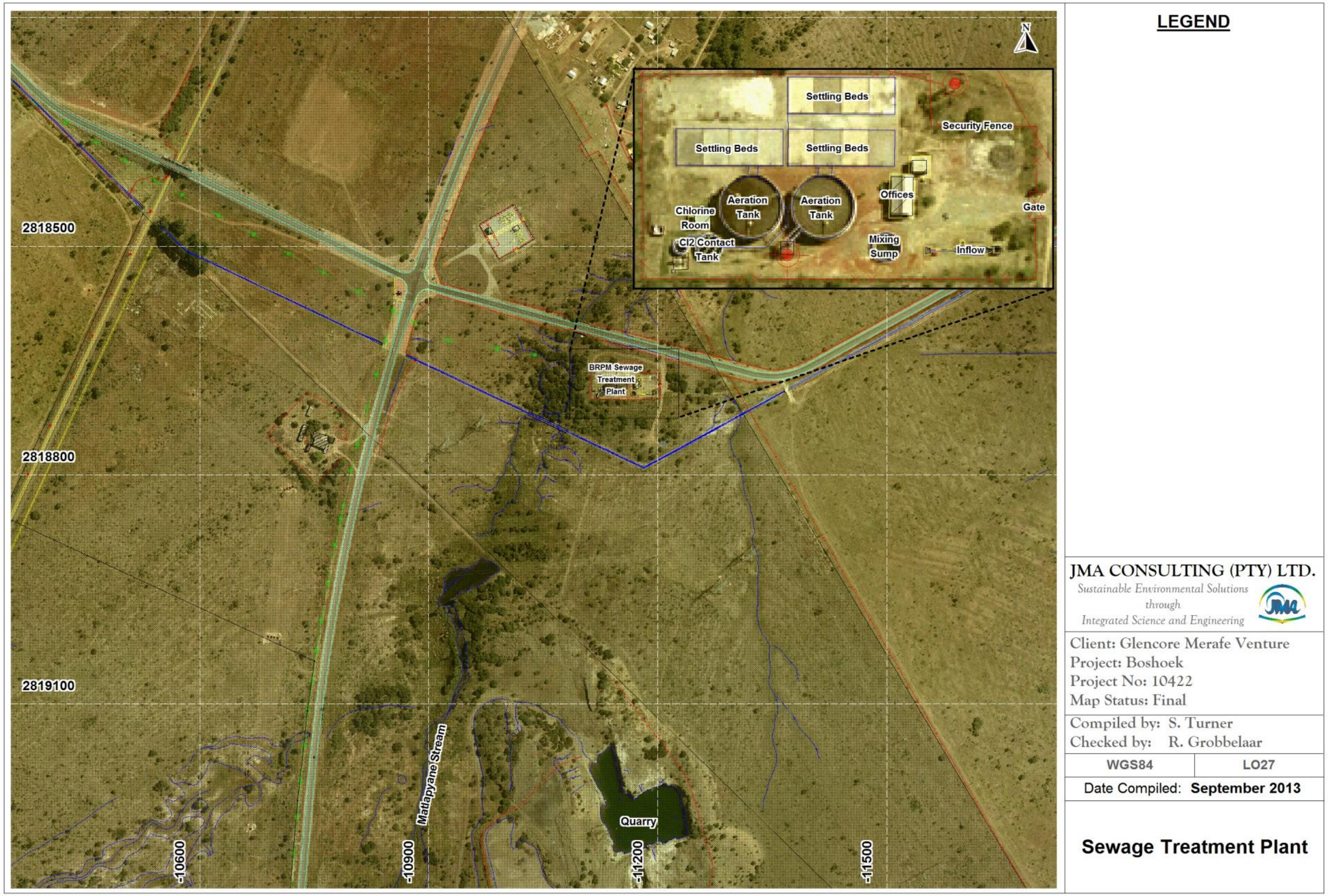

Figure 3.2.5.6(a): Sewage Plant Layout

3.2.6 Water Use and Management Facilities

The following aspects will be discussed in more detail in this section:

- Potable Water Supply
- Process Water Supply
- Process Water Reticulation
  - North Pit Void 1 to Jig Plant and Spiral Plant Tailings Quarry Dam
  - Furnace Clarifier Slurry to Slurry/Slimes Dam
  - Slurry/Slimes Dam Return Water to Process Water Dams 101 & 102
  - Jig Plant Tailings to Jig Plant and Spiral Plant Tailings Quarry Dam
  - Jig Plant Tailings Return Water to MEP Jig Plant Process Water Dam
  - Spiral Plant Tailings to Jig Plant and Spiral Plant Tailings Quarry Dam
  - Spiral Plant Tailings Return Water to Spiral Plant Water Reservoir
  - Plant Dirty Water PCD to Process Water Dams 101 & 102
  - Plant Storm Water PCD to Process Water Dams 101 & 102
- Process Water Storage
  - Process Water Dam 101
  - Process Water Dam 102
  - HSEC Reservoir (used for garden irrigation)
  - Sinter Plant Slurry Pit
  - MEP Jig Plant Process Water Dam
  - Slimes Dam Return Water Sump
  - Current Jig Plant and Spiral Plant Tailings Quarry Dam
  - Old Jig Plant and Spiral Plant Tailings Quarry Dam
  - North Pit Final Void 1
  - North Pit Final Void 2
- Recreational Water Use
  - Recreation Dam 1
  - Recreation Dam 2
- Storm Water Management
  - Storm Water Diversion at South Pit
  - Storm Water Diversion at North Pit
  - Storm Water Diversion at Concentrator
  - Storm Water Diversion at Slurry Disposal Facility
  - Storm Water Diversion at Jig Tailings Quarry
  - Storm Water Diversion at Concentrator Tailings Quarry
  - Storm Water Diversion at Smelting Plant
  - Storm Water Canals at Smelting Plant
  - Plant Dirty Water PCD
  - Plant Storm Water PCD
- Ground Water Management
  - Dewatering of South Pit
  - Dewatering of North Pit
  - Raw Materials and Product Stockpiles Liner Systems
  - Slag Stockpiling and Disposal Facility Underdrains
  - Slurry/Slimes Facility Liner System
  - Process Water Dams Liner Systems
  - Pollution Control Dams Liner Systems
  - Jig and Spiral Tailings Quarry Underdrains
- Water Treatment Plant (polluted process and storm water)

3.2.6.1 Potable Water Supply

Potable water is obtained from Magalies Water, a water services provider. The water comes in through the Magalies Water Pipe line and is distributed from the on-site storage tanks to the various end use points. Details on volumes used and reticulation are discussed under the section dealing with the site water balance.

3.2.6.2 Process Water Supply

The smelter currently receives process water from Magalies Water, recycled water from the Plant Dirty Water PCD, the Plant Storm Water PCD, the North Pit Void 1, the two Tailings Disposal Quarries, as well as from 4 boreholes. Water use related to ground water abstraction is authorized in the GMBS Water Use License.

3.2.6.3 Process Water Reticulation

Process water is re-cycled and re-used at GMBS. The main process water reticulation systems are listed below.

- North Pit Void 1 to Jig Plant and Spiral Plant Tailings Quarry Dam
- Furnace Clarifier Slurry to Slurry/Slimes Dam
- Slurry/Slimes Dam Return Water to Process Water Dams 101 & 102
- Jig Plant Tailings to Jig Plant and Spiral Plant Tailings Quarry Dam
- Jig Plant Tailings Return Water to MEP Jig Plant Process Water Dam
- Spiral Plant Tailings to Jig Plant and Spiral Plant Tailings Quarry Dam
- Spiral Plant Tailings Return Water to Spiral Plant Water Reservoir
- Dirty Water PCD to Process Water Dams 101 & 102
- Plant Storm Water PCD to Process Water Dams 101 & 102

Process water, once in the system, is deemed contaminated water and could impact on the environment as a result of spillages and/or leakages from dams and reservoirs, or leakages from pipes. The quality of the process waters at GMBS is discussed in the section dealing with process water storage.

The localities of the main process water reticulation pipe lines at GMBS are shown on Figure 3.2.6.3(a). Of particular importance are the localities where process water pipe lines cross over streams and wetlands as these crossings represent water uses which need to be authorized.

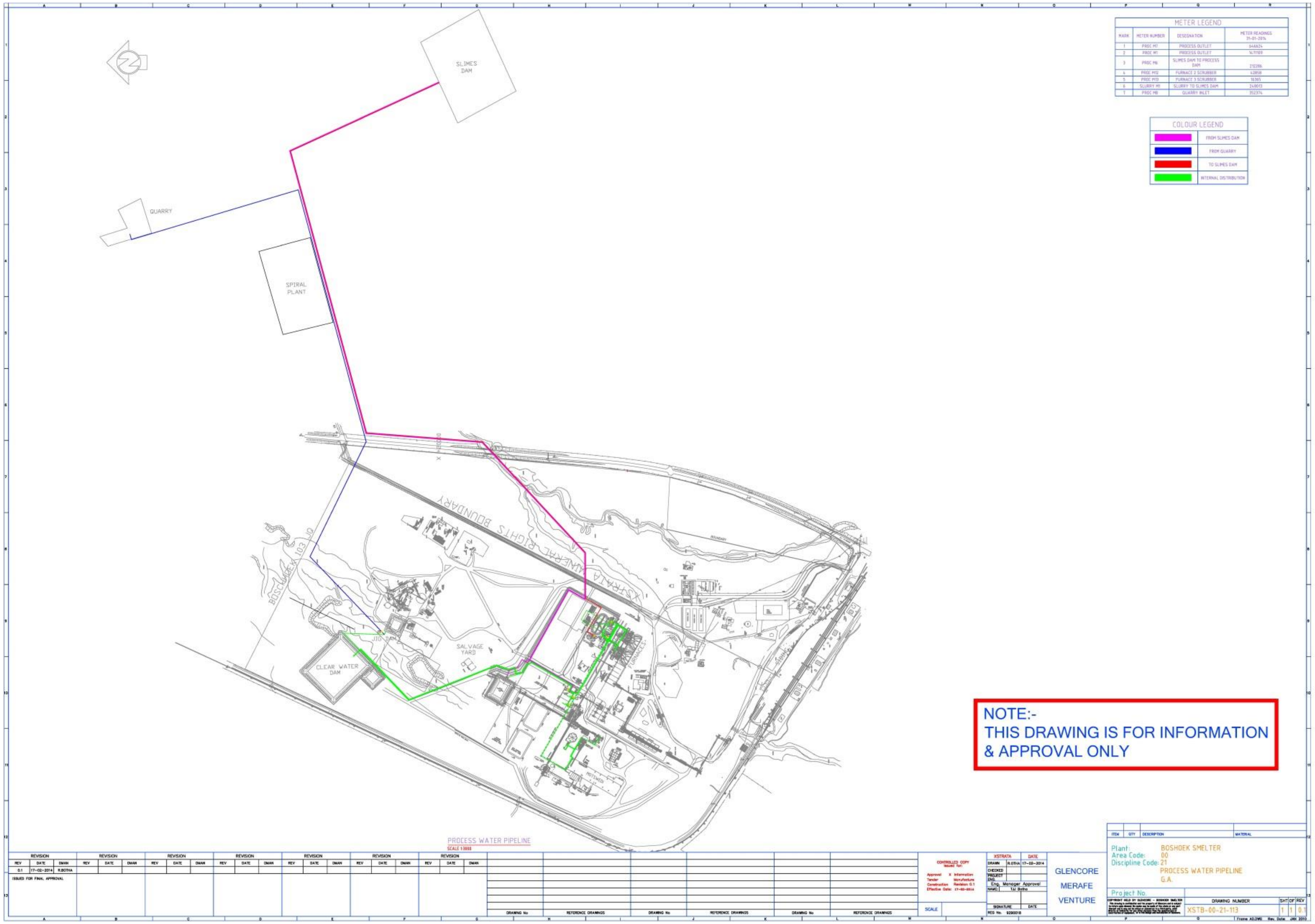

Figure 3.2.6.3(a): Localities of Main Process Water Reticulation Pipe Lines at GMBS