Closure component	Closure cost assessment
Pipelines	■ Provision was made to remove the slurry and return water pipelines between the No. 1 and 2 tailings dam site and the new tailings processing plant at the Minpro complex. ■ The cost for the removal and disposal of the concrete plinths are included in the rate for the removing of the pipelines.
Fencing	■ No allowance made.
Waste disposal	■ A 2.5 percent allowance was made for the sorting and screening of waste. ■ It was assumed that all demolition waste is inert and could be disposed of at a local permitted general waste site. ■ A nominal allowance was made for a haul distance of 50 km.

7.1.3 Rehabilitation of the footprint of the No 1 and 2 tailings dam and associated historical waste disposal facility

Closure component	Closure cost assessment
General	■ The cost for demolition and removal of all infrastructure forms part of the tailings reprocessing project and that only the footprint rehabilitation of the tailings dam and the adjacent Luka waste site rehabilitation forms part of this project.
Dismantling of processing plant and related structures	■ Not applicable.
Demolition of re-inforced concrete buildings and structures	■ Not applicable.
Demolition of steel buildings and structures	■ Not applicable.
Demolition of offices, workshops and residential buildings	■ Not applicable.

Closure component	Closure cost assessment
Demolition and rehabilitation of railway lines	■ Not applicable.
Rehabilitation of access and haul roads	■ Not applicable.
River diversions	■ Not applicable.
Pipelines	■ Not applicable.
Fencing	■ Not applicable.
Waste disposal	■ Not applicable.

7.1.4 Expansion of opencast mining

Closure component	Closure cost assessment
General	■ No permanent structures will be erected as part of this project.
Dismantling of processing plant and related structures	■ Not applicable.
Demolition of re-inforced concrete buildings and structures	■ Not applicable.
Demolition of steel buildings and structures	■ Not applicable.
Demolition of offices, workshops and residential	■ Not applicable.

Closure component	Closure cost assessment
buildings	
Demolition and rehabilitation of railway lines	■ Not applicable.
Rehabilitation of access and haul roads	■ Included a part of general surface rehabilitation. ■ Allowance was made for the removal of the temporary tarred road acting as detour around pit 9U_B.
River diversions	■ Not applicable.
Pipelines	■ Allowance was made for the removal of the temporary water pipeline used for the dewatering of the pits.
Fencing	■ Not applicable.
Waste disposal	■ Not applicable.

7.2 Mining areas and residue deposits

7.2.1 No. 5 tailings dam

Closure component	Closure cost assessment
General	■ No. 5 tailings dam will be developed in three phases over a period of approximately 30 years. ■ Construction will start mid-2012. ■ Based on the preliminary development schedule, it was assumed that only Phase 1 of the new No. 5 tailings dam will be developed within the first 10 years after development started.

Closure component	Closure cost assessment
	■ Starter wall construction will commence in Year 1 and be completed by the end of Year 2. ■ Deposition on Phase 1 tailings dam will only commence in Year 3. ■ Construction of Phase 2 will only commence mid-2022, or in the 11th year after Phase 1 construction started.
Open pit reclamation including final voids and ramps	■ Not applicable.
Sealing of shafts, adits and inclines	■ Not applicable.
Reclamation of overburden and spoils	■ Not applicable.
Rehabilitation of processing waste deposits and evaporation ponds (non-polluting potential)	■ Not applicable.
Rehabilitation of processing waste deposits and evaporation ponds (polluting potential)	■ No. 5 tailings dam ▪ The tailings dam will be constructed with outer slopes at an overall outer slope of 1:4. Assuming that no inter-bench slope is steeper than 18 degrees (1:3), it was assumed that no reshaping of the side slopes will be done to reduce the side slopes. ▪ No allowance was made for the capping of tailings dam as it was assumed that boundary control measures will be implemented to limit the spreading of possible contaminants. The size of the facility further makes it uneconomical and impractical to cap the facility due to the amount of capping material that would be required. ▪ Boundary control measures would be sufficient to limit the spreading of possible contaminants and to meet water quality requirements that are still to be agreed with the Department of Water Affairs (DWA). ▪ The details of the boundary control measures will be discussed under water management. ▪ Allowance was made for the amelioration of the tailings as a growth medium and vegetation establishment directly in the

Closure component	Closure cost assessment
	platinum tailings. ▪ No concurrent rehabilitation would be effectively implemented during Phase 1. Therefore the extent of the tailings dam to be rehabilitated at an unscheduled closure situation (during the first 10 years) will be the full extent of the tailings dam at that specific moment in time. ▪ Scheduled closure would require the top surface of the tailings dam and a portion of the side slopes to be vegetated. ■ Return water dams ▪ The return water dams will remain in place for some period post closure to serve as evaporation dams for intercepted seepage. Once seepage has decreased to acceptable levels, the return water dams can be decommissioned and the area rehabilitated. ▪ Allowance was made to remove silt and contaminated material from underneath the liner and dispose of on top of the tailings dam. ▪ The liner will be removed and disposed of at an approved waste disposal facility. ▪ General shaping and levelling will be conducted to cut the earth walls back into the dam basin and profile the area. ▪ Allowance was made for vegetation will be re-established on the disturbed footprint area.
Reclamation of subsided areas	■ Not applicable.

7.2.2 Re-processing of the No. 1 and 2 tailings dam

Closure component	Closure cost assessment
General	■ The No. 1 & 2 tailings dam footprint will be rehabilitated as part of a separate project.
Open pit reclamation including final voids and	■ Not applicable.

Closure component	Closure cost assessment
ramps	
Sealing of shafts, adits and inclines	■ Not applicable.
Reclamation of overburden and spoils	■ Not applicable.
Rehabilitation of processing waste deposits and evaporation ponds (non-polluting potential)	■ Not applicable.
Rehabilitation of processing waste deposits and evaporation ponds (polluting potential)	■ Not applicable. The No 1&2 tailings dam footprint will be rehabilitated as part of a separate project.
Reclamation of subsided areas	■ Not applicable.

7.2.3 Rehabilitation of the footprint of the No 1 & 2 tailings dam and associated historical waste disposal facility

Closure component	Closure cost assessment
General	■ Assume infrastructure will be developed during Year 1 and vegetation stripping on tailings dam will start. ■ Hydro monitoring (re-pulping of tailings with high-pressure water) of the tailings dam will only start in Year 2 in Phase 1 (trial period). ■ Hydro monitoring will take place at a rate of 0.7Mt/ for a period of six months as part of phase 1 (trial period) and 1.6 Mt/annum over a period of 32 years as part of phase 2.
Open pit reclamation including final voids and ramps	■ Not applicable.

Closure component	Closure cost assessment
Sealing of shafts, adits and inclines	■ Not applicable.
Reclamation of overburden and spoils	■ Not applicable.
Rehabilitation of processing waste deposits and evaporation ponds (non-polluting potential)	■ Not applicable.
Rehabilitation of processing waste deposits and evaporation ponds (polluting potential)	■ No concurrent rehabilitation would be effectively implemented on the tailings dam footprint until the full extent of the No 1&2 tailings dam has been removed. ■ No additional allowance was made to remove any residual tailings or contaminated material from the tailings dam footprint. ■ General shaping and levelling will be conducted on the footprint to smooth the surface and to reinstate natural drainage patterns. ■ Provision was made to rip the footprint to alleviate compaction. ■ Allowance was made for vegetation re-establishment on the footprint area. A higher rate for vegetation establishment was used, similar to that used on the tailings dams, as it is assumed that the in-situ soil might require higher levels of amelioration than normal topsoil.
Reclamation of subsided areas	■ Not applicable.

7.2.4 Expansion of opencast mining

Closure component	Closure cost assessment
General	■ It is assumed that development will be start mid-2012. ■ Mining of all pits 9U_B will be completed during year 1 and pit 14M and 15M will be completed within 2 years.

Closure component	Closure cost assessment
Open pit reclamation including final voids and ramps	■ Strip mining with a roll-over of material will be conducted. ■ Topsoil and overburden of the initial boxcut is stripped and stockpiled as mining progresses. ■ Material from initial boxcut will be stockpiled near the position of the final void. ■ A cut is 30 m wide with 3 cuts or a 90 m wide strip open at any time (void to be backfilled at closure). Pit depth varies from 0 m to a maximum depth of 60 m. It was assumed that cuts across the pit is 160 m long for Pit 14M and 90 m long for Pit 15M. ■ It was assumed that a cut is 25 m wide with 3 cuts or a 75 m wide strip open at any time (void to be backfilled at closure). Pit depth varies from 0m to a maximum depth of 35 m for Pit 9U_B ■ Final void will be backfilled on closure with overburden. Pits are overfilled (approximately 20%) to allow for the settlement of soil and to avoid ponds being formed on the backfilled area. ■ Approximately 1 m of topsoil will be replaced over the overburden. ■ No allowance is made for vegetation re-establishment as the vegetation re-establishes naturally after the topsoil is replaced. Maintenance an aftercare would address any problem areas with vegetation re-establishment should some areas not fully re-establish naturally. ■ Allowance was made for ripping and re-establishment of vegetation on stockpile footprint areas and haul roads.
Sealing of shafts, adits and inclines	■ Not applicable.
Reclamation of overburden and spoils	■ All material will be backfilled in the pit void with no residual material remaining. ■ Allowance is made to rip the stockpile footprint areas and to re-establish vegetation on these footprint areas. ■ The area (footprint) for access and haul road rehabilitation were included under this item as rehabilitation will be similar.
Rehabilitation of processing waste deposits	■ Not applicable.

Closure component	Closure cost assessment
and evaporation ponds (non-polluting potential)	
Rehabilitation of processing waste deposits and evaporation ponds (polluting potential)	■ Not applicable.
Reclamation of subsided areas	■ Assume not applicable due to 20 percent overfilling of the pits.

7.3 General surface reclamation

7.3.1 No. 5 tailings dam

Closure component	Closure cost assessment
General Surface Rehabilitation	■ A nominal allowance of 1 000 m^3 was made to remove tailings spills along tailings pipelines. ■ General shaping and levelling will be conducted on all infrastructural footprint areas to backfill voids and to smooth the surface and facilitate natural drainage. ■ Allowance was made to rip footprint areas to alleviate compaction. ■ The in-situ soil would be a suitable growth medium and thus no allowance was made to import topsoil. ■ Provision was made for soil amelioration and vegetation re-establishment on the footprint areas.

7.3.2 Re-processing of the No 1 & 2 tailings dam

Closure component	Closure cost assessment
General Surface Rehabilitation	■ No allowance was made for the new tailings processing plant footprint as it was assumed that the new plant will be within the existing Minpro complex footprint and are therefore covered by the existing allowance for the larger Minpro plant

Closure component	Closure cost assessment
	complex. ■ A nominal allowance of 1 000 m^3 was made to remove tailings spills along tailings pipelines. ■ General shaping and levelling will be conducted on other infrastructural footprint areas, including areas where residual tailings were removed. This allows for backfilling of voids, smoothing of the surface and facilitates natural drainage. ■ Allowance was made to rip footprint areas to alleviate compaction. ■ The in-situ soil would be a suitable growth medium and thus no allowance was made to import topsoil. ■ Provision was made for soil amelioration and vegetation re-establishment on the footprint areas.

7.3.3 Rehabilitation of the footprint of the No 1 & 2 tailings dam and associated historical waste disposal facility

Closure component	Closure cost assessment
General surface Rehabilitation	■ Tailings footprint area ▪ No allowance is made for the tailings footprint area. ▪ A nominal allowance of 1 000 m^3 was made to remove tailings spills along tailings pipelines. ▪ General shaping and levelling will be conducted on all infrastructural footprint areas to backfill voids and to smooth the surface and facilitate natural drainage. ▪ Allowance was made to rip footprint areas to alleviate compaction. ■ Historical Luka waste disposal site ▪ The historical waste site is assumed to be approximately 1 ha in size based on the 1998 Metago report. ▪ Small dumps of topsoil and building rubble are dumped around the historical site.

Closure component	Closure cost assessment
	■ Allowance is made to import the residual waste from the surrounding areas into the final void of the historical site. ■ Allowance was made to import a 250 mm layer of topsoil over the historical waste site. ■ Surrounding areas where residual waste was removed will be ripped to alleviate compaction. ■ Vegetation will be re-established on all disturbed (waste site and surrounding) areas.

7.3.4 Expansion of opencast mining

Closure component	Closure cost assessment
General Surface Rehabilitation	■ Not applicable as all disturbed areas surrounding the pits are included under the item for the footprints of stockpile and overburden areas.

7.4 Water management

7.4.1 No. 5 tailings dam

Closure component	Closure cost assessment
General	■ Boundary control measures will be implemented around the tailings dam to limit seepage. ■ The boundary control measures allowed for includes a combination of a seepage interception drain with an hydraulic barrier to limit seepage spreading from the tailings dam.
Install cut-off trench	■ A cut-of trench with hydraulic barrier of approximately 8 500 m was assumed. ■ The cut-off will have an average depth of 4 m. ■ Minimal blasting was assumed based on the assumption that if blasting will be required, the rock itself will act as a cut-off or barrier against the seepage of water.

Closure component	Closure cost assessment
	■ Water from the trench will be pumped to the return water dams that will act as evaporation dams.
Pumping cost for 30 years	■ Provision was made for the pumping cost of water from the trench to the evaporation dam. ■ A volume of 1 000 cubic meters per day will be pumped from the trench. ■ The cost was assumed to be R2.00 per cubic meter per year.

7.4.2 Re-processing of the No. 1 & 2 tailings dam

Closure component	Closure cost assessment
Water management	■ Assumed no provision is required

7.4.3 Rehabilitation of the footprint of the No 1 & 2 tailings dam and associated historical waste disposal facility

Closure component	Closure cost assessment
Water management	■ Assumed no provision is required

7.4.4 Expansion of opencast mining

Closure component	Closure cost assessment
Water management	■ Assumed no provision is required

7.5 Post-closure aspects

Closure component	Closure cost assessment
General	■ Post closure allowances has been made for the four projects combined and not per individual project as it is assumed that these allowances will be done as part of that for the whole of the mine.
Surface water monitoring	■ An overall allowance was made for the monitoring of six surface water monitoring positions, on a quarterly basis, for a period of five years post closure. This is additional to the existing allowances for the Impala.
Ground water monitoring	■ An overall allowance was made for the monitoring of six groundwater monitoring positions, on a quarterly basis. This is additional to the existing allowances for the Impala. Based on the assumption for boundary control measures around the tailings dam, a monitoring period of 30 years was used for groundwater monitoring. This corresponds to the allowance of 30 years for pumping from the boundary control measures around the tailings dam.
Reclamation monitoring	■ An allowance has been included for the reclamation monitoring of all areas that has to be footprint areas and dumps for a five year period.
Care and maintenance	■ Care and maintenance of the rehabilitated areas and dumps, over a five year period, has been assumed.

7.6 Additional allowances

Closure component	Closure cost assessment
Preliminary and general	■ Additional allowance of 12 percent of the total for infrastructural and related aspects (sub-total 1 on summary costing table) has been made, thus aligned to the DMR guidelines.
Contingencies	■ An additional allowance of 10 percent of the total for infrastructure and related aspects (sub-total 1 on summary costing table) has been made, thus aligned to the DMR guidelines.

8.0 MATTERS REQUIRING FURTHER ATTENTION

The following matters require attention in future closure cost updates, to ensure that closure cost estimates are as realistic and accurate as possible, have been identified:

- More clarity on the final positioning and exact infrastructure of the tailings reprocessing plant;
- Detailed information on the direction in which the No. 1 and 2 tailings dam will be hydro monitored and would concurrent rehabilitation of the remaining footprint on some "cleaned" areas are possible while hydro monitoring still continues on other areas;
- It is recommended that detailed rehabilitation plans be developed for all areas prior to the commencement of any rehabilitation activities; and
- Detailed source-pathway-receptor modelling should be done for the tailings facility to confirm the exact requirement or efficiency of the conceptualised boundary control measures around the tailings dam or highlight additional or alternative measures required.

9.0 CONCLUSIONS

The closure costs as reflected in this report have been based on information obtained from Metago and/or Impala. In those cases where the required information was not available, estimates were made based on experience and benchmarked against similar facilities. Unit rates for the costing were obtained from Golders' existing data base and/or from rehabilitation and demolition practitioners. Where required, these were adapted to reflect site-specific conditions. Rates are comparable to those used for determination of the closure costing for Impala's entire Rustenburg Operations (June, 2011).

Notwithstanding the above, if the closure measures are implemented as envisaged, the reflected costs provide a good indication of the costs for the scheduled closure situation as calculated at the end of June 2011 and should provide a good basis for making the required financial provision. The ten year forecast of closure costs over the first ten years after construction started is based on the assumption that all projects will start at in mid-2012 after approval for these has been obtained from the authorities.

J Swart
Reclamation and Closure

SAP Brown
Reclamation and Closure

JS/SAPB/zvw

Reg. No. 2002/007104/07
Directors: FR Sutherland, AM van Niekerk, SAP Brown, L Greyling

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APPENDIX A

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GOLDER ASSOCIATES AFRICA (PTY) LTD

APPENDIX B

Closure costing 2010 - battery limits

APPENDIX C

Unit rates used

UNIT RATES FOR DEMOLITION, RECLAMATION AND RELATED WORK - 2011

Ref nr	Cost Item	Currency	Unit Rate	Unit	Notes
1	**Concrete**				
1.1	Heavy concrete thickness greater than 750 mm	Rands	R 1,200.00	/m³	Demolition cost, excludes screening & sorting and disposal of waste
1.2	Medium concrete thickness between 750 and 250 mm	Rands	R 600.00	/m³	Demolition cost, excludes screening & sorting and disposal of waste
1.3	Light concrete thickness less than 250 mm	Rands	R 375.00	/m³	Demolition cost, excludes screening & sorting and disposal of waste
1.4	Strip footing	Rands	R 126.00	/m	
1.5	Column footing	Rands	R 263.00	/no	
1.6	Bases and floors after removal of super structures	Rands	R 200.00	/m³	
1.7	Heavy duty floors and bases after removal of super structure	Rands	R 550.00	/m³	(500 mm thickness)
2	**Steel structures**				
2.1	Super structures, steel buildings and related infrastructure				
2.1.1	Cable/pipe racks	Rands	R 48.00	/m²	
2.1.2	Light plant buildings	Rands	R 96.00	/m²	
2.1.3	Medium plant buildings	Rands	R 360.00	/m²	
2.1.4	Medium/heavy plant buildings	Rands	R 1,200.00	/m²	
2.1.5	Heavy plant buildings	Rands	R 1,600.00	/m²	
2.2	Steel structures (permanent shed type)				
2.2.1	0m – 5m high	Rands	R 50.00	/m²	
2.2.2	5m – 10m high	Rands	R 80.00	/m²	
2.2.3	10m – 15m high	Rands	R 100.00	/m²	
2.2.4	15m – 20m high	Rands	R 123.00	/m²	
2.4	Sorting and screening	Rands	R 2.50	%	
2.5	Disposal of demolition waste				
2.5.1	Disposal of inert demolition waste	Rands	R 300.00	/m³	Benign - 100 km away
2.5.2	Disposal of inert demolition waste	Rands	R 150.00	/m³	Inert - 50 km away
2.5.3	Disposal of hazardous waste	Rands	R 1,275.00	/m³	Hazardous waste (such as tar)
2.6	Cladding / sheeting	Rands	R 20.00	/m²	
2.7	Crane hire and use	Rands	R 35,000.00	/d	120 t crane
2.8	Steel tanks with rubber lining				
2.8.1	0-5m	Rands	R 10,000.00	/no	Diameter
2.8.2	5-10m	Rands	R 25,000.00	/no	Diameter
2.8.3	10-15m	Rands	R 35,000.00	/no	Diameter
2.8.4	15-20m	Rands	R 50,000.00	/no	Diameter
2.9	Decontamination of equipment				
2.9.1	Decontamination of equipment	Rands	R 2.50	%	Of overall dismantling of steel structure
2.9.2	Decontamination of equipment	Rands	R 5.00	%	
3	**Brick buildings and structures**				
3.1	Normal one storey brick buildings	Rands	R 275.00	/m²	(2 - 3 m high)
3.2	Normal double storey brick buildings	Rands	R 475.00	/m²	(>3 m in height)
3.4	Single brick wall (110mm)	Rands	R 10.00	/m²	
3.5	Double brick wall (220mm)	Rands	R 15.00	/m²	
3.6	Temporary Buildings	Rands	R 130.00	/m²	
3.7	Permanent Shed type (large)	Rands	R 128.00	/m²	
3.8	Substations	Rands	R 450.00	/m²	
3.9	Car ports (excludes paving)	Rands	R 85.00	/m²	
3.10	Ceilings	Rands	R 20.00	/m²	
3.11	Timber structures	Rands	R 5.00	/m²	
4	**Plant and related equipment**				
4.1	Overland conveyors	Rands	R 250.00	/m	
4.2	Suspended conveyors	Rands	R 500.00	/m	includes footings, etc
4.3	Overland power lines	Rands	R 25.10	/m	
4.4	Sub-stations	Rands	R 450.00	/m²	
4.5	Plant /Steel superstructures				
4.5.1	Plant/steel superstructures: light	Rands	R 650.00	/t	
4.5.2	Plant/steel superstructures: medium	Rands	R 900.00	/t	
4.6.1	Plant/steel superstructures: medium to heavy	Rands	R 1,000.00	/t	
4.6.2	Plant/steel superstructures: heavy	Rands	R 1,200.00	/t	
4.7	Pipework				
4.7.1	Overland steel pipeline on plinths (<200mm)	Rands	R 25.00	/m	5m plinth spacing, includes disposal of waste @ 10km
4.7.2	Overland steel pipeline on plinths (200mm-350mm)	Rands	R 45.00	/m	5m plinth spacing, includes disposal of waste @ 10km
4.7.3	Overland steel pipeline on plinths (350mm-500mm)	Rands	R 75.00	/m	5m plinth spacing, includes disposal of waste @ 10km
4.8	Cabling	Rands	R 1.30	/m	
5	**Roads, paving and walkways**				
5.1	Remove tar roads with 500mm layerworks	Rands	R 45.00	/m²	Excluding disposal of tar
5.2	Gravel road with engineered surface	Rands	R 28.00	/m²	major gravel roads
5.3	Removal and disposal of hard shrink and paving	Rands	R 35.00	/m²	
5.4	Minor gravel roads	Rands	R 5.00	/m²	minor gravel roads
5.5	Concrete slabs	Rands	R 125.00	/m²	
5.6	Removal of gunited embankments	Rands	R 75.00	/m²	
6	**Railway lines**				
6.1	Electrified	Rands	R 275.00	/m	
6.2	Non-electrified	Rands	R 200.00	/m	
6.3	Plug adit / & seal pens lock	Rands	R 30,000.00	sum	
6.4	Sealing of shaft	Rands	R 1,140,000.00	sum	4.5m diameter
6.5	Sealing of shaft	Rands	R 1,390,000.00	sum	5.5m diameter
6.6	Sealing of shaft	Rands	R 1,770,000.00	sum	7m diameter
6.7	Seal incline shaft	Rands	R 125,000.00	sum	
6.8	Reshape HRD	Rands	R 100,000.00	/ha	
6.9	Breach dam wall & reshape to 1:3	Rands	R 200.00	/m	approx 5m high @ 1:2
6.10	Profiling of footprint areas	Rands	R 3,200.00	/ha	Minimal dozing, no backfilling of excavations
6.11	Plug surface hole	Rands	R 200,000.00	sum	
7	**Reclamation of disturbed areas**				
7.1	Shaping/leveling of areas from which infrastructure has been removed (general) to 500 mm	Rands	R 50,000.00	/ha	includes stockpiling of material. Backfilling of excavations and final profiling @ ave 500mm over footprint area
7.2	Shaping/leveling of areas from which infrastructure has been removed (general) to 750 mm	Rands	R 75,000.00	/ha	includes stockpiling of material. Backfilling of excavations and final profiling @ ave 750mm over footprint area
7.3	Establishment of vegetation (general)	Rands	R 12,500.00	/ha	
7.4	Import top soil (250mm)	Rands	R 92,500.00	/ha	2500m³ over 2km average @ R37/m³
7.5	Establishment of vegetation in on tailings	Rands	R 17,500.00	/ha	
7.6	Clean-up of contaminated areas/soils to 250 mm average depth	Rands	R 80,000.00	/ha	(1-2km)
7.7	Ripping of footprint areas (general - dozer with 3 ripper tines to 500mm)	Rands	R 6,500.00	/ha	
7.8	Importation of cover material (500mm)	Rands	R 185,000.00	/ha	5000m³ over 2km average @ R37/m³
7.9	Remove concrete liner from dam	Rands	R 50.00	/m²	
7.10	Ripping of footprint areas to alleviate compaction (general)	Rands	R 6,500.00	/ha	
7.11	Establish vegetation on backfilled pit area	Rands	R 4,000.00	/ha	Additional only to areas where natural revegetation from topsoil stripping and replacing are insufficient
7.12	Rip and establish vegetation on stockpile footprint areas and haul roads	Rands	R 5,000.00	/ha	
8	**Earthworks**				
8.1	Dozing to profile dumps	Rands	R 12.00	/m³	
8.2	Excavation	Rands	R 15.00	/m³	
8.3	Load and haul (1km)	Rands	R 25.00	/m³	For smaller volumes
8.4	Load and haul (1 - 2 km free haul)	Rands	R 32.00	/m³	For smaller volumes
8.5	Load and haul (3-4 km free haul)	Rands	R 40.00	/m³	For smaller volumes
8.6	Extra over rates for overhaul outside free haul distance	Rands	R 7.00	/m³km	
8.7	Stormwater routing along outer slopes/upper surface	Rands	R 2,000.00	/ha	
8.8	Backfilling of final void	Rands	R 18.00	/m³	large volumes, part dozing part load and haul
8.9	Deep ripping (1 ripper tine to depth of 1m)	Rands	R 16,500.00	/ha	
8.10	Placement of topsoil	Rands	R 10.00	/m³	Topsoil (approx 1m) dozed back over overburden
8.11	Removal and disposal of liner	Rands	R 8.50	/m²	
9	**Fencing**				
9.1	Erect of security fencing	Rands	R 125.00	/m	
9.2	Erect of stock fencing	Rands	R 35.00	/m	
9.3	Dismantling of security fencing	Rands	R 25.00	/m	
9.4	Dismantling of stock fencing	Rands	R 10.00	/m	
9.5	Dismantling of concrete palisade	Rands	R 110.00	/m	
10	**Post-closure aspects**				
10.1	Surface water	Rands	R 60,000.00	/yr	six monitoring points on a quarterly basis
10.2	Groundwater	Rands	R 60,000.00	/yr	six monitoring points on a quarterly basis
10.3	Reclamation monitoring	Rands	R 2,250.00	/ha	5 years
10.4	Care and maintenance	Rands	R 14,500.00	/ha	5 years
11	**Other**				
11.1	Not applicable	Rands	R 0.00		
11.2	Sum	Rands	R 1.00	sum	

APPENDIX D

Closure costing spreadsheets

Impala Platinum: New tailings and opencast expansion - closure costs as at June 2011

	INFRASTRUCTURE AND MINING RELATED ASPECTS	Scheduled Closure	Unscheduled Year 1	Unscheduled Year 2	Unscheduled Year 3	Unscheduled Year 4	Unscheduled Year 5	Unscheduled Year 6	Unscheduled Year 7	Unscheduled Year 8	Unscheduled Year 9	Unscheduled Year 10
1	Infrastructural aspects	R 7,261,710.50	R 6,136,719.88	R 6,548,349.63	R 6,184,434.63	R 6,184,434.63	R 6,184,434.63	R 6,184,434.63	R 6,184,434.63	R 6,184,434.63	R 6,184,434.63	R 6,184,434.63
2	Mining aspects	R 30,782,200.00	R 16,843,138.00	R 13,609,408.00	R 4,708,410.00	R 5,406,740.00	R 5,997,070.00	R 6,700,200.00	R 7,411,605.00	R 8,434,535.00	R 9,483,540.00	R 10,254,645.00
3	General surface reclamation	R 553,800.00	R 553,800.00	R 553,800.00	R 553,800.00	R 553,800.00	R 553,800.00	R 553,800.00	R 553,800.00	R 553,800.00	R 553,800.00	R 553,800.00
4	Water management	R 39,750,000.00	R -	R -	R 12,870,000.00	R 12,870,000.00	R 16,110,000.00	R 16,110,000.00	R 18,255,000.00	R 18,255,000.00	R 19,980,000.00	R 19,980,000.00
	SUB-TOTAL 1 (for infrastructure and related aspects)	**R 78,347,710.50**	**R 23,533,657.88**	**R 20,711,557.63**	**R 24,316,644.63**	**R 25,014,974.63**	**R 28,845,304.63**	**R 29,548,434.63**	**R 32,404,839.63**	**R 33,427,769.63**	**R 36,201,774.63**	**R 36,972,879.63**
5	Post-closure aspects	R 14,385,000.00	R 3,811,500.00	R 2,188,312.50	R 2,580,875.00	R 2,983,062.50	R 4,633,750.00	R 5,259,375.00	R 5,402,375.00	R 5,956,500.00	R 5,974,375.00	R 6,993,250.00
	SUB-TOTAL 2 (for post-cosure aspects)	**R 15,823,500.00**	**R 3,811,500.00**	**R 2,188,312.50**	**R 2,580,875.00**	**R 2,983,062.50**	**R 4,633,750.00**	**R 5,259,375.00**	**R 5,402,375.00**	**R 5,956,500.00**	**R 5,974,375.00**	**R 6,993,250.00**
6	**ADDITIONAL ALLOWANCES**											
6.1	Preliminary and General (6%)	R 4,700,862.63	R 1,412,019.47	R 1,242,693.46	R 1,458,998.68	R 1,500,898.48	R 1,730,718.28	R 1,772,906.08	R 1,944,290.38	R 2,005,666.18	R 2,172,106.48	R 2,218,372.78
6.2	Contingencies (10%)	R 7,834,771.05	R 2,353,365.79	R 2,071,155.76	R 2,431,664.46	R 2,501,497.46	R 2,884,530.46	R 2,954,843.46	R 3,240,483.96	R 3,342,776.96	R 3,620,177.46	R 3,697,287.96
	SUB-TOTAL 3 (for additional allowances)	**R 12,535,633.68**	**R 3,765,385.26**	**R 3,313,849.22**	**R 3,890,663.14**	**R 4,002,395.94**	**R 4,615,248.74**	**R 4,727,749.54**	**R 5,184,774.34**	**R 5,348,443.14**	**R 5,792,283.94**	**R 5,915,660.74**
	Grand-Total (for sub-total 1+2+3)	**R 106,706,844.18**	**R 31,110,543.14**	**R 26,213,719.35**	**R 30,788,182.77**	**R 32,000,433.07**	**R 38,094,303.37**	**R 39,535,559.17**	**R 42,991,988.97**	**R 44,732,712.77**	**R 47,968,433.57**	**R 49,881,790.37**

[illegible]

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Europe	+ 356 21 42 30 20
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solutions@golder.com
www.golder.com

Golder Associates Africa (Pty) Ltd
PO Box 13776, Hatfield, 0028
Ditsela Place
1204 Park Street
Hatfield, Pretoria
Gauteng
South Africa
T: [+27] (12) 366 0100

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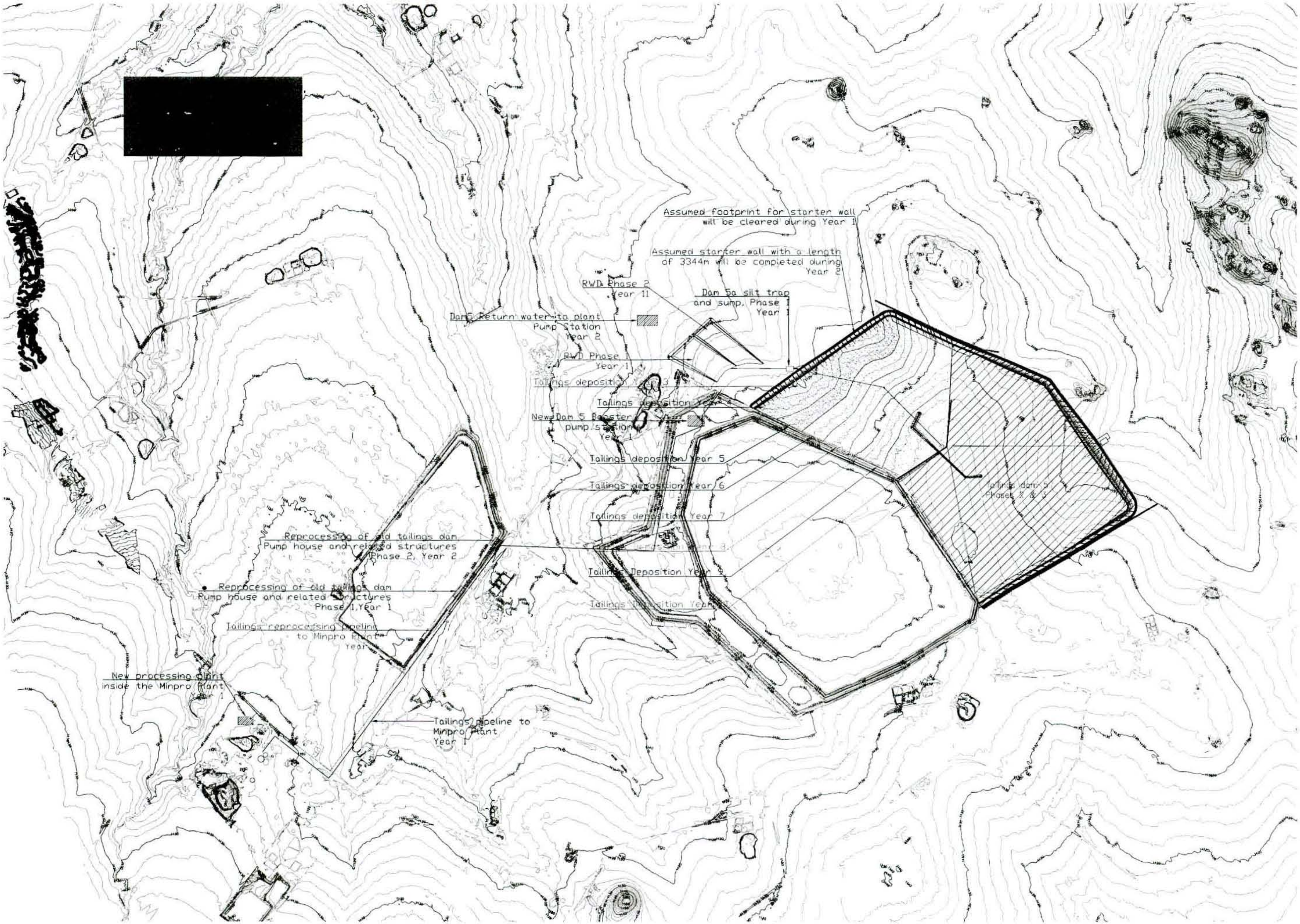
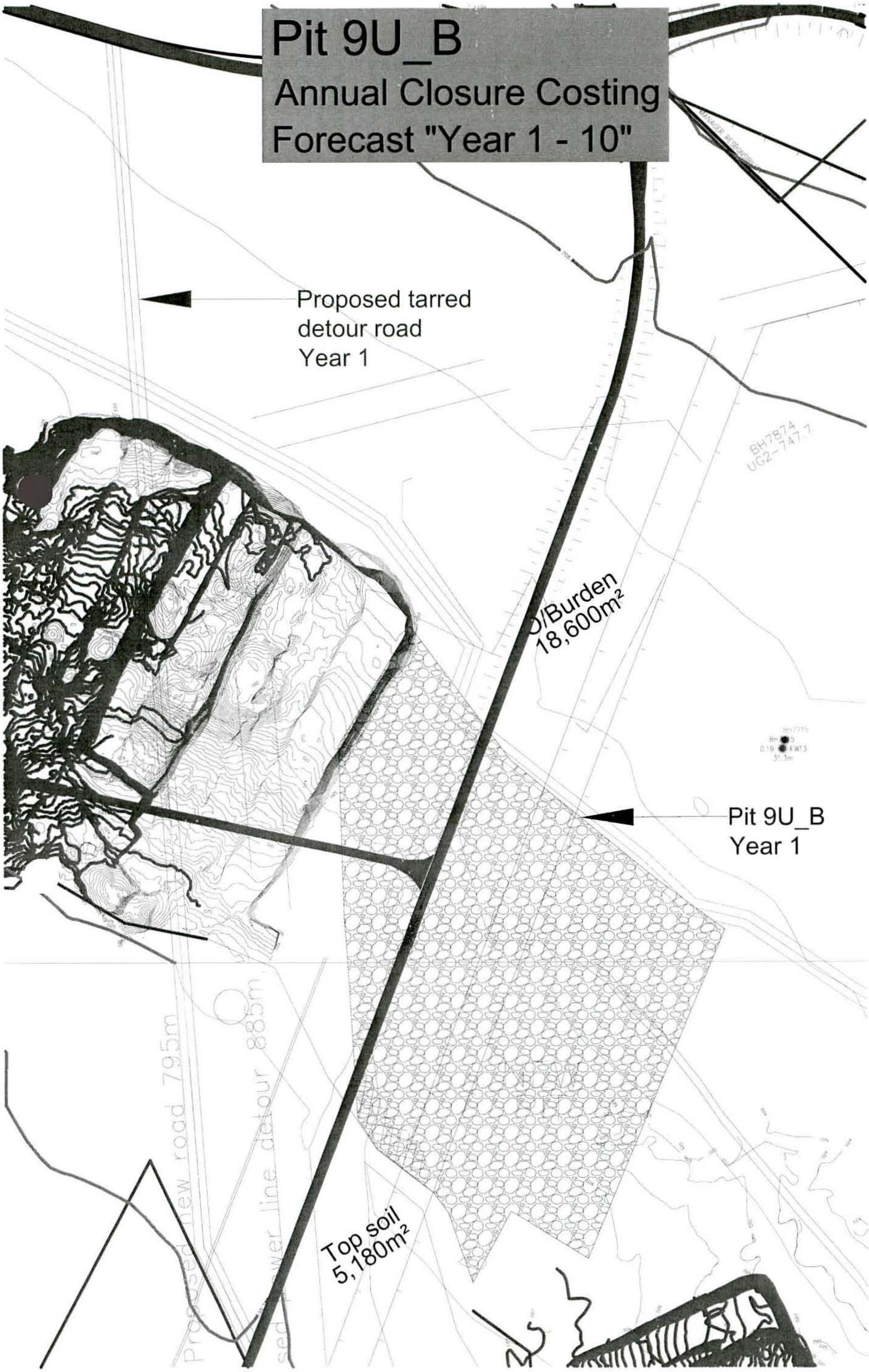

[redacted]
Assumed footprint for starter wall will be cleared during Year 1
Assumed starter wall with a length of 3344m will be completed during Year 2
RWD Phase 2 Year 11
Dam 5a silt trap and sump, Phase 1 Year 1
Dam5 Return water to plant Pump Station Year 2
RWD Phase 1 Year 1
Tailings deposition Year 3
Tailings deposition Year 4
New Dam 5 Booster pump station Year 1
Tailings deposition Year 5
Tailings deposition Year 6
Tailings deposition Year 7
Tailings Deposition Year 9
Reprocessing of old tailings dam Pump house and related structures Phase 2, Year 2
Reprocessing of old tailings dam Pump house and related structures Phase 1, Year 1
Tailings reprocessing pipeline to Minpro Plant Year
New processing plant inside the Minpro Plant Year 1
Tailings pipeline to Minpro Plant Year 1

Pit 14M and 15M
Annual Closure Costing
Forecast "Year 1 - 10"
KFN6
Year 1
Year 2
Year 1
Year 2
KATLWAHONG SCHOOL FOR DEAF AND BLIND
PORTION 21
PORTION 22
PORTION
RE of PORTION
Pit 14M
Pit 15M3
22000


Pit 9U_B
Annual Closure Costing
Forecast "Year 1 - 10"
Proposed tarred
detour road
Year 1
O/Burden
18,600m²
Pit 9U_B
Year 1
Top soil
5,180m²

APPENDIX Q:TAILINGS DAM PRE-FEASIBILITY STUDY AND ADDENDUM LETTERS

- Pre-feasiblity study
- Addendum letter 1
- Addendum letter 2

Up Front Engineering Design Report for the New Tailings Disposal Facility at Impala Platinum Mine, Rustenburg

Report Prepared for

Impala Platinum Limited

Report Number 414226/4rev1

Report Prepared by

srk consulting

March 2012

Up Front Engineering Design Report for the New Tailings Disposal Facility at Impala Platinum Mine, Rustenburg

Impala Platinum Limited

SRK Consulting (South Africa) (Pty) Ltd.
265 Oxford Rd
Illovo 2196
Johannesburg
South Africa

e-mail: johannesburg@srk.co.za
website: www.srk.co.za

Tel: +27 (0) 11 441 1248
Fax:+27 (0) 11 880 8086

SRK Project Number 414226/4

March 2012

Compiled by:

A Schoeman
Technologist

Email: akirsten@srk.co.za

Peer Reviewed by:

HAC Meintjes
Partner

Authors:

Johan Boshoff; Aréte Schoeman; Peter Shepherd

Table of Contents

List of Tables

List of Figures

Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa)(Pty) Ltd (SRK) by Impala Platinum Limited (Impala). The opinions in this Report are provided in response to a specific request from Mr Hercules Smit to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

1 Introduction and Scope of Report

The existing tailings dam No. 4 is unable to accommodate the planned increase in deposition tonnages and would exceed the maximum allowable rate of rise as determined in the Mid life investigation, (SRK Report 369694/2 dated July 2009). A new tailings storage facility is therefore required to accommodate the spill over tailings tonnages.

Impala Platinum Mine is situated approximately 15 km north of Rustenburg in the vicinity of Phokeng in the North West Province (Refer Figure 2-2). Mining began in 1968 and construction of the first tailings disposal facility (Tailings Dam 1) started during the same year. Later on, as tonnages increased, Tailings Dam 2 was built as an addition to Tailings Dam 1. In 1974, after a period of heavy rainfall, a flow failure occurred from the South Eastern wall of Tailings Dam 1. Following this event Tailings Dams 1 and 2 were remediated and have been dormant since. Tailings Dam 3 was used for disposal of all tailings until the larger Tailings Dam 4 complex including the so-called Buttress Dams became operational.

All aspects of the design and associated specialist investigations will be undertaken in compliance with the Department of Minerals and Resources (DMR), Mines Health and Safety Inspectorate Guideline for Compliance of a Mandatory Code of Practice on Mine Residue Depositions (31st May 2001), National Water Act (NWA), Department of Water and Environmental Affairs (DWAE) and the South African Bureau of Standards Code of Practice for Mine Residue (SANS 10286:1998). Additional, more stringent, quality standards applied by Impala Platinum to their tailings dams will be included thereby ensuring that both Impala Platinum internal standards and national best practice will be met.

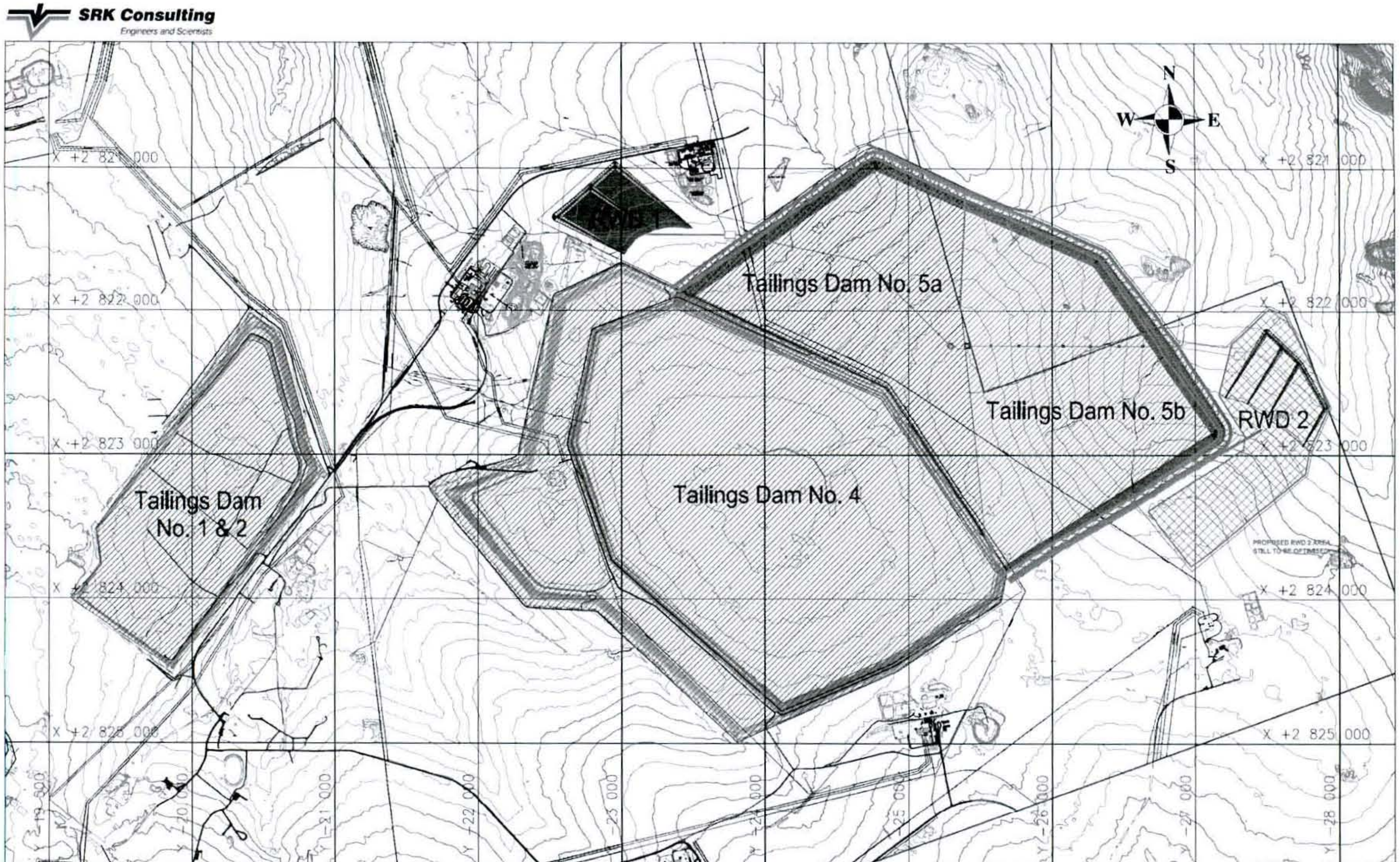
The current project scope includes (Figure 2-1):

- Tailings delivery at a restricted rate of rise as indicated in the midlife investigation report (SRK report 369694/2, July 2009) must be adhered to for a predetermined period after which deposition at the total production rate will occur on the new tailings storage facility.
- Tailings dam No. 5 – Phase 1: Tailings delivery of the remaining tonnes which cannot be deposited onto the existing tailings dam No. 4 must be deposited onto the tailings dam No. 5a area of the tailings dam.
- Tailings dam No. 5 – Phase 2: When level 1138m.a.m.s.l is reached on tailings dam No. 5 Phase 1, deposition will be discontinued and deposition will commence on the Tailings dam No. 5 Phase 2 area of the new tailings dam. Tailings dam No. 5 Phase 2 will be developed up to elevation 1138m.a.s.l.
- Tailings dam No. 5: Deposition of tailings will now commence over the entire Tailings dam area (Phases 1 and 2) up to elevation 1153m.a.m.s.l.

2 Terms of Reference

SRK Consulting was appointed to undertake the project in terms of Impala Platinum Mine Order Number 4500738410, dated 04/05/2010. The terms of reference were to undertake a Pre-Feasibility Study and Upfront Engineering Work for a New Tailings Storage Facility at Impala Platinum Rustenburg. This report contains the pre-feasibility design portion of the new tailings storage facility.

Figure 2-1: Scope of Work

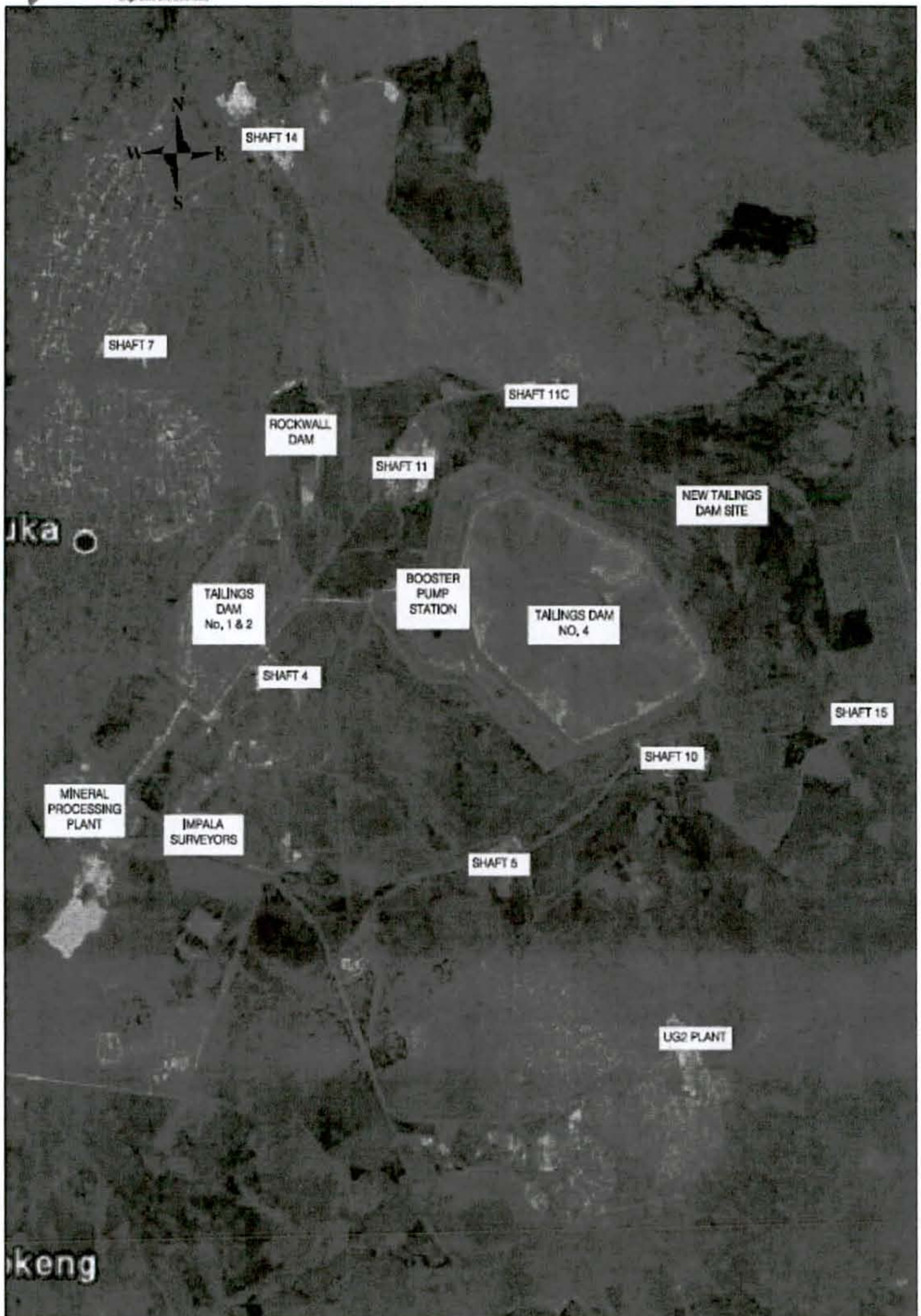


Project No.	Datum: CAPE 1880	IMPALA PLATINUM MINE	Date:	Scale:
414226	Projection: TM	FIGURE SHOWING SCOPE OF WORK	10 01 2011	1:35 000
	Central Meridian / Zone: LO27		Compiled by: BENE	Fig No. 2.1

Revision: A Date: 10 01 2011

Figure 2-2: Locality Plan

SRK Consulting



Project No.		Date:	Scale:
414226	IMPALA PLATINUM MINE LOCALITY PLAN	29 07 2010	NTS
		Compiled by: Scha	Fig No. 2.2

Revision: A Date: 05 04 2005

3 Design Criteria

The prescribed design criteria indicated from the client and assumed or calculated parameters used are listed below:

- The design of the new tailings dam facility should be for a tailings dam sited as per the Site Selection report, (SRK Report 414226/1, August 2010) and the Pre-Feasibility Report. (SRK Report 414226/2, April 2011).
- The capacity assessment of the tailings dam should be conducted at a production rate of approximately 20 Mtpa of the combined tailings streams as per the LOM plan submitted to SRK.
- Life of Facility should be for approximately 30 years at a mine production of 20 Mtpa considering remainder capacity on the existing tailings dam and future capacity of the new tailings dam.
- The new tailings dam must be able to accommodate the remainder of tailings which cannot be deposited onto the existing tailings dam due to rate of rise constraints. The rate of rise constraints used are listed in the Mid Life Investigation report (SRK Report 369694/2, July 2009). The allowable rate of rise on Dam No. 4 was capped at 2.7 m/yr.
- The tailings will be hydraulically deposited onto the tailings dam at a slurry density of 1.55 t/m^3.
- It is planned to deposit a combination of tailings streams namely, UG2 tailings, Merensky open cast, slag and UG2 with the chrome fraction removed.
- Volumetric calculations will be based on a hydraulically placed in situ dry density of the slimes of 1.7 t/m^3.
- The rate of rise of the new facility will be limited to 2.5m per year.
- The Geotechnical parameters for the tailings material have been based on parameters from laboratory testing and also parameters obtained from tailings testing (similar ore body and type) that have been done at Marula Platinum Mine.
- The tailings dam will be constructed by means of the conventional spigot disposal method below and above the starter wall.
- The tailings dam will be constructed with an average outer slope of 1V:4H. The upstream method of wall raising will be employed.
- The decant system will be two vertical intake towers and two outfall structures. The system will comprise of single intermediate intakes to facilitate pool control during early development of the tailings dam. The final intake towers will comprise of two single intake towers.
- There will be two concrete lined silt trap structures as the site has a natural water divide resulting in two low points along the perimeter of the tailings dam. A twin compartment silt trap structure will be installed upstream of the return water dam in Tailings dam No. 5 Phase 1 and at the low point along the eastern flank of the tailings dam in Tailings dam No. 5 Phase 2, to trap suspended solids. The silt trap will be designed with twin compartments and will be concrete lined in order to facilitate alternate cleaning and operation of each compartment. The silt trap on the eastern side of the tailings dam will transport the penstock outlet, solution trench and drain outlet water to the return water dam via a pressured pipeline and pump system that will the change to a gravity pipeline and decant into the trench leading to the Tailings dam No. 5 Phase 1 silt trap.

- The return water dam will be lined with a geomembrane lining system and only be sized for the new tailings dam, not considering the existing tailings dam.
- The solution trench along the northern flank of the existing tailings dam No.4 will be converted into an interface drain.

4 Site Data

4.1 Battery Limits

The following battery limits apply:

- SLR Consulting (previously called Metago Environmental Engineers) was appointed to do an Environmental Impact Assessment (EIA) in order to amend the Environmental Management Report (EMP).
- Downstream battery limit. The outlet flange of the return water pipeline at the central plant.
- Upstream battery limit. The booster pump station.
- The seal of existing exploration and any other boreholes on the TSF footprint will be carried out by the Mine.

4.2 Climate Data

The Impala new TSF is situated in the North West Province approximately 15km to the North of Rustenburg. The area has a subtropical climate which means humid summers and cool winters. The temperatures range from 22℃ to 35℃ in summer and 2℃ to 20℃ in winter. It is a summer rainfall region with afternoon thunder storms from August to March.

The meteorological data used for the Impala Platinum Facility is indicated below (Table 4-1).

Table 4-1: Meteorological Data for Impala Platinum Tailings Facility

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Average Rainfall (mm)	120.1	96.9	90.3	43.7	15.8	7	5.1	8	17.3	49.6	87.1	111.9	652
PERCENTILE													
10^{th}	50.9	33.3	26.9	4.8	0	0	0	0	0	15.8	32.9	40.5	205
30^{th}	76.8	59.9	53.1	16.7	1.1	0	0	0	2.2	29.0	51.2	80.0	370
70^{th}	148.4	114.0	111.9	57.6	18.3	1.3	1.1	9.0	17.5	58.7	110.0	133.8	782
90^{th}	200.2	177.4	164.5	95.3	42.6	21.8	15.5	29.9	45.3	94.0	147.3	185.2	1219
Evaporation (mm) (Lake)	163	139	133	101	83	68	73	98	130	158	158	165	1750

Notes: *MAP – Mean Annual Precipitation

As can be seen from Table 4-1 above, the evaporation data greatly exceed the monthly rainfall that is received within the project area. Even the 90^{th} percentile monthly rainfall which is an above average wet year, still does not exceed the mean annual evaporation (MAE) of 1750 mm.

From the figures below (Figure 4-1,Figure 4-2 and Figure 4-3), it is observed that major storage within the Return water dams (RWDs) only occurs in the 90th percentile monthly rainfall scenario which is above average rainfall conditions.

- Figure 4-1 shows the storage in RWD 1 during the Phase 1 development.
- Figure 4-2 shows the combined storage in RWD 1 and RWD 2 during the Phase 2 development.
- Figure 4-3 shows the combined storage in RWD 1 and RWD 2 during the combined tailings dam development. The big difference between Figure 4-2 and Figure 4-3 is that the tailings deposition rate increased from 625,000t/month to 1,666,666t/month and the associated return water to the process plants correspondingly is higher.

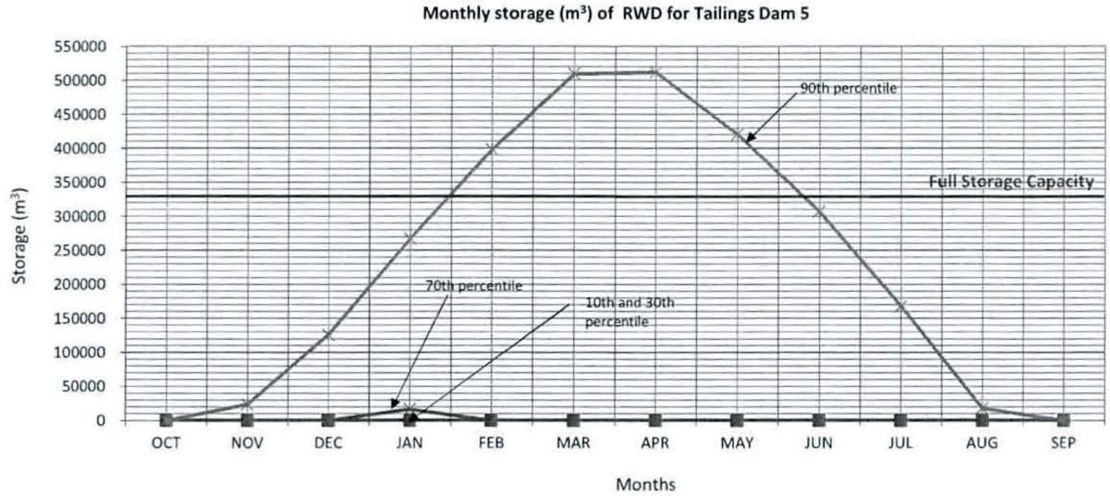


Figure 4-1 RWD 1: storage summary at Tailings dam 5 Phase 1

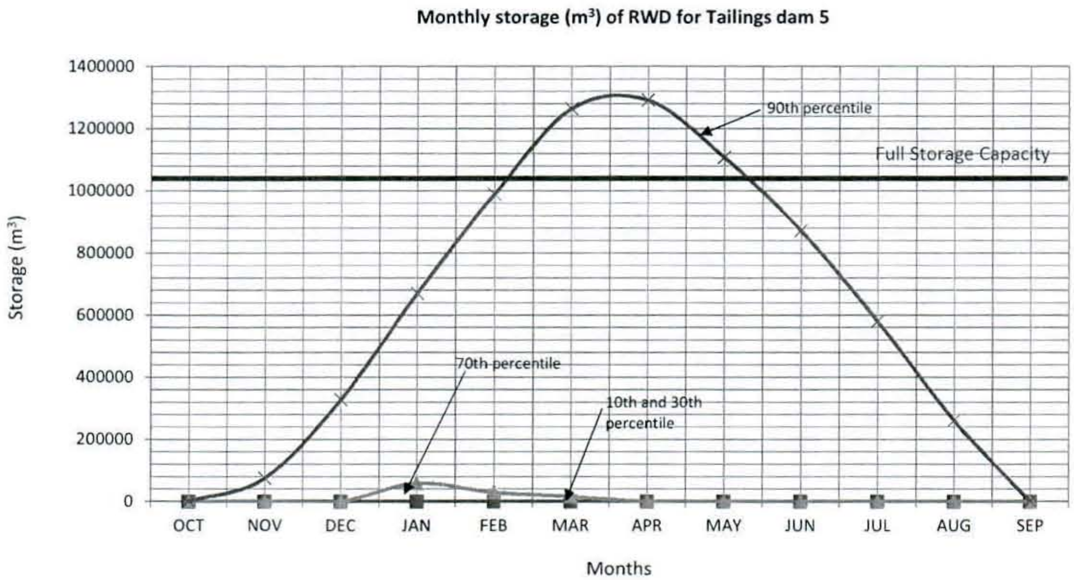


Figure 4-2 RWD 1&2: storage summary at Tailings dam 5 catering for Phase 2

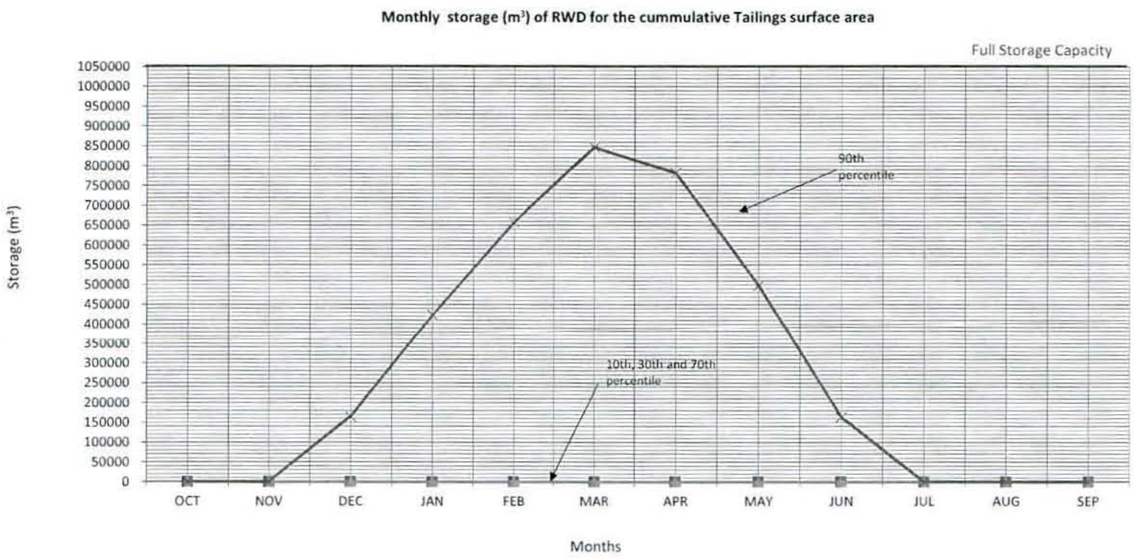


Figure 4-3 RWD storage summary for the cumulative Tailings dam area

The 1-day maximum storm rainfall depths were calculated using the 'Design Rainfall' program for various recurrence intervals are shown in Table 4-2.

Table 4-2: 1-day Maximum Rainfall Depths (mm) from design rainfall using selected recurrence intervals

Storm Recurrence Interval (year)	1:2	1:5	1:10	1:20	1:50	1:100
Depth (mm)	62	85	102	143	161	178

5 Geotechnical Investigation

Refer to Appendix 3 for the Geotechnical Investigation Report. For easy reference, the conclusions and recommendations of the report are cited below.

5.1 Report Conclusions and Recommendations

- The entire site is underlain by black turf clay which is typical for the Rustenburg area. The clay is highly expansive and it is necessary to take this into account in the design and construction of the facilities. The average clay thickness is 1.4m and it overlies weathered norite with rock consistency from an average depth of 2.5m, although this does vary from outcrop to greater than 3.3m.

- The relatively low permeability, as determined from the laboratory testing of the black turf clay compacted to 98% Proctor density, indicates that it may be used for construction of starter walls and the lining of the return water dams. However, due to the high plasticity of the clay, specialist compaction plant such as sheep's foot or grid rollers will be required for compaction. Also, the earthworks should, if possible, take place during the dry season due to the difficult workability of the clay when saturated and difficult access for construction vehicles. A method based specification, which would require field trials, should be considered for the compaction.

- The c' and φ' values determined from the laboratory testing of the clay were inconclusive in two of the three tests. It is recommended that c' and φ' values of 0kPa and 25° be used for design purposes. Since it is considered prudent to be conservative, due to the potential construction problems which are likely to be encountered in the field and the possibility of future soil movement due to seasonal expansion and contraction.
- The depth of excavation required for the silt traps, solution trenches, penstock pipelines and penstock structures will exceed the depths excavated in the present investigation, in which TLB refusal usually occurred at depths between 2m and 3m. The variability of depth of hard rock indicates that it is probable that some blasting of the norite rock will be required from depths ranging between 2m and about 4m. In the few outcrop and shallow rock areas which may occur at the positions of the above structures (such as at the silt trap S2 site, blasting will be required from surface or shallow depth of 1m.
- Further investigation in the form of core drilling is recommended at the final sites of the Penstock Towers, where loads are likely to be high and where settlement should be restricted to the minimum. Two of the test pits for the towers showed the presence of a diabase dyke and, in addition to drilling, trenching using a large tracked excavator is recommended to trace the position of the dyke relative to the structures.

5.2 Basin seepage evaluation

5.2.1 Review of the basin permeability test results from the geotechnical report

A copy of the geotechnical test results are attached in Table 5-1. The permeability test results values vary between 2.7e-10m/s and 1.4e-8m/s. The permeability test results can be interpreted as follows as shown in Figure 5-1 and Figure 5-2.

- In Figure 5-1 is shown the full permeability database. The average permeability assessed on a log basis is 1.7e-9m/s.
- In Figure 5-2 is shown the full database excluding the highest permeability value of 1.4e-8m/s. The average permeability assessed on a log basis is 1.4e-9m/s.

The laboratory permeability values have to be interpreted for the full scale field conditions. It is recommended to downgrade the laboratory values to field values by one order of magnitude.

There are two possible scenarios which can be recommended using the database from site:

- The first scenario is to use an average permeability for the tailings dam basin. In this scenario the average permeability to be used will be 2×10^{-8}m/s.
- The second scenario is to use an average permeability for 91% of the tailings dam basin of 1×10^{-8}m/s and for 9% of the tailings dam basin to use a permeability of 5×10^{-8}m/s.

The first scenario is recommended as the preferred scenario.

Table 5-1: Summary of laboratory test results

Test pit	Depth (m)	FIND		Grading %				GM	USCS	In situ dry density kg/m3	NMC %	SG	Void ratio	c'	φ'	Proctor		Permeability (m/s)	
		LL%	PI (overall)	Clay	Silt	Sand	Gravel									Density kg/m3	OMC%	In situ	98% Proctor
IRWD03	0.5-1.0	71	45(42)	52	23	23	2	0.29	CH	1280	36.6	2.85	1.237	41	7	1333	33.7		1.70E-09
IRWD03	1.6	NP	NP	1	12	53	33	1.75	SM										
IRWD10	0.5	70	48(45)	52	24	23	1	0.27	CH	1348	30.6	2.78	1.06						
IRWD 14	2.1	52	28 (16)	8	16	62	14	1.34	SC										
IRWD 24	0.2-0.5	69	42 (40)	52	26	21	2	0.25	CH										
ISOL01	0.65	56	31(30)	47	25	28	0	0.28	CH										
ISOL10	0.6	79	50(48)	56	27	14	3	0.21	CH	1425	18.4	2.73	0.918	17	9			1.30E-09	
ISOL17	0.5-0.8	74	42(39)	55	22	20	2	0.26	CH	1307	29.4	2.85	1.176	46	10	1347	28.5		5.00E-09
ISOL23A	0.8	70	40 (38)	55	24	17	4	0.28	CH	1097	38.2	2.87	1.61	7	19			1.60E-09	
ITP21	0.55	83	57(54)	62	20	17	2	0.24	CH	1161	33.8	2.76	1.32	4	18			3.10E-10	
ITP40A	0.5-0.8	81	52(50)	54	28	16	2	0.2	CH	1293	31.6	2.65	1.052	17	12	1336	30.2		8.90E-10
ITP43A	0.3-0.6	75	45(41)	52	23	23	2	0.32	CH	1373	27.7	2.71	0.967	25	20	1412	27.7		3.90E-09
ITP50	1.2	78	44(39)	54	22	20	4	0.36	CH	1338	33.5	2.76	1.059						
IFPN1D	0.6	73	45(41)	47	29	20	4	0.35	CH	1142	35.6	2.73	1.333	12	12			1.40E-08	
IFPN2A	0.4-0.7	64	33 (31)	50	25	23	2	0.29	CH	1371	28	2.82	1.051	16	24	1397	28.9		4.00E-09
IST1A	0.8	77	44(43)	57	25	16	1	0.17	CH	1360	24.5	2.75	1.021	43	11			2.70E-10	
IST1B	0.5-1.0	80	49(46)	61	17	19	3	0.28	CH	1410	30.5	2.85	1.253	19	14	1309	29.1		1.10E-09
IST1C	2	42	23(2)	1	2	29	68	2.57	GW										
IST2A	1.6	57	34(30)	33	44	18	6	0.36	CH										
ITPN2	0.9	72	40 (39)	58	26	16	1	0.16	CH										

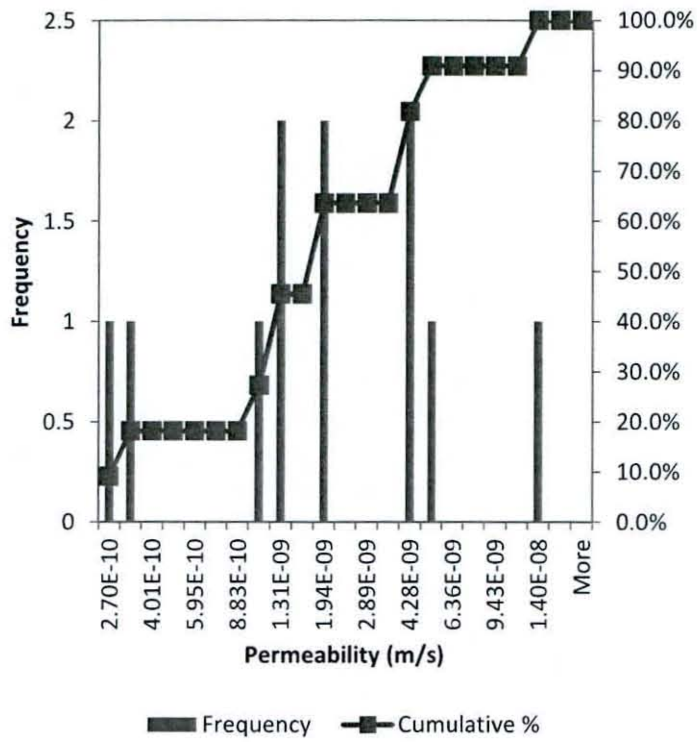


Figure 5-1: Full permeability database

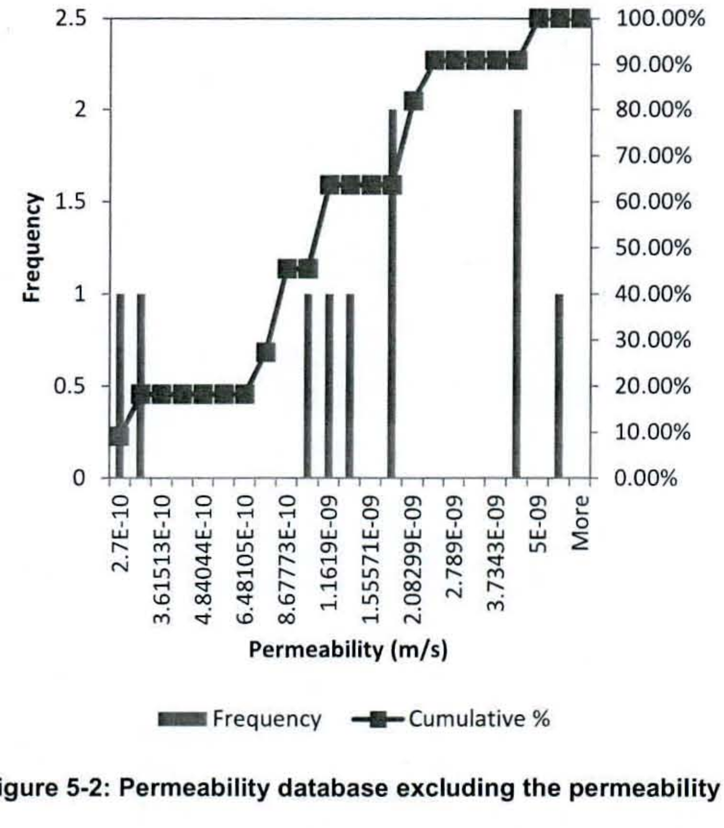


Figure 5-2: Permeability database excluding the permeability test result of 1.4e-8m/s

Seepage modelling was undertaken on a representative cross-section of the tailings dam. This shows that at full tailings dam height the hydraulic gradient is about 0.98, if the permeability values of the tailings are also considered. However, it is recommended for the geohydrological model that a seepage hydraulic gradient of 1 be used relative to the tailings dam section of the model development.

5.2.2 Alternative basin permeability interpretation

In the above section, the results of the permeability database were used making the key assumption that the variability in permeability test results monotonically represents the site variability. As a first interpretation, this is a reasonable interpretation. There is another possible interpretation to use experience and results of monitoring. The test results presented in Figure 5-1 show the range of variability which is quite extensive. Basically the average, on a log basis, of the lower end of the permeability values is 2.9 x 10^{-10}m/s. This value when downgraded to field conditions will be about 2.9 x 10^{-9}m/s, which is close to the value normally use for black cotton soils or turf of 1 x 10^{-9}m/s.

6 Groundwater Investigation

The following information has been received from SLR Consulting (preciously called Metago Water Geosiences) as a summary of the work that has been done regarding the Environmental Impact Assessment study.

6.1 Scope

Metago Water Geosciences was appointed to assess potential impacts of the extended tailings storage facility on the groundwater system(s). This summary represents the initial conceptualization of the aquifer systems at the Rustenburg operation of Impala.

6.2 Baseline Hydrogeology

Crystalline material, such as the norites and pyroxenites of the Bushveld Complex, comprises of (a) an unweathered and intact rock matrix with negligible matrix porosity and permeability, and (b) planes of discontinuity in the rock matrix, including both faults and joint planes (collectively referred to as fractures). The infiltration and flow of groundwater in such systems is controlled by the prevailing complex fracture network and can vary in space and time. Such conditions relate to structurally controlled flow systems. However, these fractures are often in-filled by precipitates from late-phase fluids (i.e. vein infill).

The following two layer aquifer model conceptualises the Bushveld Complex aquifers at a regional scale:

- A shallow weathered aquifer system (i.e. intergranular water table aquifer) which might be laterally connected to alluvial aquifers associated with river systems.
- A deeper fractured bedrock aquifer system.

The shallow unconfined, phreatic (or water table) aquifer comprises of the saprolite (that formed as a result of intensive and in-situ weathering processes) to saprock (differentially weathered and fractured upper bedrock underlying the saprolite) zones. The soil and saprolite are collectively termed the regolith. The saprolite and saprock are generally treated as a single weathered aquifer unit, referred to as the weathered overburden, which varies in thickness from 12 to 50m and is derived from the in-situ decomposition of the underlying noritic rocks. The degree/intensity of chemical weathering or more specifically the spatial and depth variations thereof, control the geometry of the shallow weathered aquifer profile. The weathered overburden is considered to have low to moderate transmissivity but high storativity. However, much higher transmissivities (T) of up to 500 m^2/d and storativities in the range of 0.15 have been determined for highly transmissive aquifer zones (comprising the shallow weathered and underlying fractured aquifer system) such as the Brits Graben structures within the Bushveld Complex.

The unweathered and fractured semi-confined bedrock aquifer consists of fractured norites, anorthosites and pyroxenites underlying the upper weathered aquifer. The intact bedrock matrix has a very low matrix hydraulic conductivity and its effective hydraulic conductivity is determined by fractures and mine voids. Groundwater flows through interconnected fracture systems with the potential of rapid vertical groundwater flow from the weathered overburden (and surface water bodies) to greater depths along interconnected conductive zones. The underlying solid and unweathered crystalline rocks are generally characterized by very low porosity and high hydraulic conductivity values if fractures are intersected. Water is generally stored and transmitted in fractures and fissures within a relatively impermeable matrix.

6.3 Baseline Groundwater Flow

The infiltration of water from the shallow weathered aquifer system to the deeper fractured bedrock aquifer system is strongly heterogeneous and requires permeable soils, or permeable horizons (i.e. 'infiltration routes'), as well as 'open' and interconnected fracture systems in the bedrock. Hydraulic continuity must exist between groundwater reservoir(s) in the overlying horizons (or weathered overburden) and the underlying bedrock. The fracture zones act as conduits for deeper flows from groundwater reservoirs located in upper permeable soils or the weathered overburden. The impacts on the shallow weathered aquifer system may be negligible away from the immediate vicinity of the mining areas, given the hydrogeological characteristics of the weathered aquifer and the spatial heterogeneity in hydraulic connectivity between the shallow weathered aquifer and the deeper fractured aquifer. The general fact that the weathered and alluvial aquifers along the river courses support most irrigation and domestic water-supply boreholes despite being undermined by existing mines indicates limited interaction between the shallow and deep aquifer systems.

Within the mine lease areas and immediately above under-mined zones, the shallow weathered aquifer may be drained due to slow vertical leakage to the dewatered, deeper fractured aquifer. However, the shallow aquifer has the potential to be replenished relatively quickly during sustained rainfall periods.

Predominantly lateral groundwater flow in the shallow aquifer occurs driven by topographic gradients and/or localised recharge mounds due to e.g. irrigation, leakage from tailings storage facilities, etc. Due to mine dewatering the local groundwater flow directions in the deeper fractured aquifer are generally re-directed towards the underground and open pit mines. This results in locally different groundwater flow directions for the shallow and deeper aquifer systems.

6.4 Hydrogeology at Impala

A report by VSA Earth Resource Consultants (2005), entitled 'Update of the Environmental Regional Numerical Model' summarises the findings of all preceding groundwater studies and documents the results of the modelling projects commissioned by Impala. Groundwater monitoring data analysed for the period 1987 to the present indicated that:

- Temporal groundwater level data, measured over a 15 year period in monitoring boreholes, show very little variations with average draw-downs of less than 2m.
- Selected boreholes in the vicinity of the tailings storage facility and the slag dump show a rise in water level possibly a result of seepage from these facilities.
- Selected boreholes showing a slight drop in groundwater level may be influenced by underground mining operations. However, abstraction (i.e. mine dewatering) from No. 11 and No. 4 Shaft complexes were measured to be in the order of 1-2 l/s, while the abstraction from Shaft 7A was in the order of 0,7 l/s.

- Groundwater flows regionally towards the northwest in the direction of the Elands River, with local groundwater mounds present in the vicinity of the tailings storage facilities and the slag dump.
- Groundwater contamination (i.e. elevated sulphate concentrations) was associated with the tailings storage facilities, the slag dump and acid plant at Minpro as well as Omnia phosphates facilities. Elevated sulphate levels were also associated with the Shaft No7A and Shaft 12 and 14 Complexes.
- Elevated nitrate values were observed in some of the village boreholes and were attributed to pit latrines as well as the lack of an efficient sewage system within the village. The same boreholes in the Ga Luka Village, however, presented much lower sulphate concentrations of 15 – 100 mg/l.
- Simulation indicated that the sulphate plume is migrating along the groundwater gradient generally to the north. Higher flow velocities are associated with the stream sediments and the migration rates of potential pollutants increased significantly in such sediments along river courses.

The report(s) concluded by stating that:

- The deeper seated underground mine is in poor hydraulic continuity with the shallow weathered and fractured aquifers.
- As a result, the potential impacts associated with the underground mine on groundwater levels within the shallow weathered aquifer was considered to be insignificant/minor.

7 Tailings Geochemical Characterisation

No formal geochemical tests were conducted as part of this study.

8 Site Selection

A desktop site selection study was carried out by SRK in July 2010 (SRK Report 414226/1 August 2010) to identify potential tailings dam sites within the vicinity of the Mine. Environmental impacts such as the location of graves and local settlements were also considered.

8.1 Site Options

Three sites were considered as possible tailings sites. Figure 8-1 shows these sites which lie within the available area. The factors considered in the identification of the preferred site were:

Impoundment capacity
Starter embankment size
Foundation seepage potential
Water diversion requirements
Pumping distance and head
Downstream environmental risks
Capital and operating costs
Proximity to local settlements and streams.
Liabilities after closure

The current tailings dam site and the site to the immediate North East of the current site were identified as the most favourable site during a site selection study. (Figure 8-2) A more detailed description of the site selection process is reported on in SRK report 414226/1 dated August 2010.

Figure 8-1: Three possible sites for selection

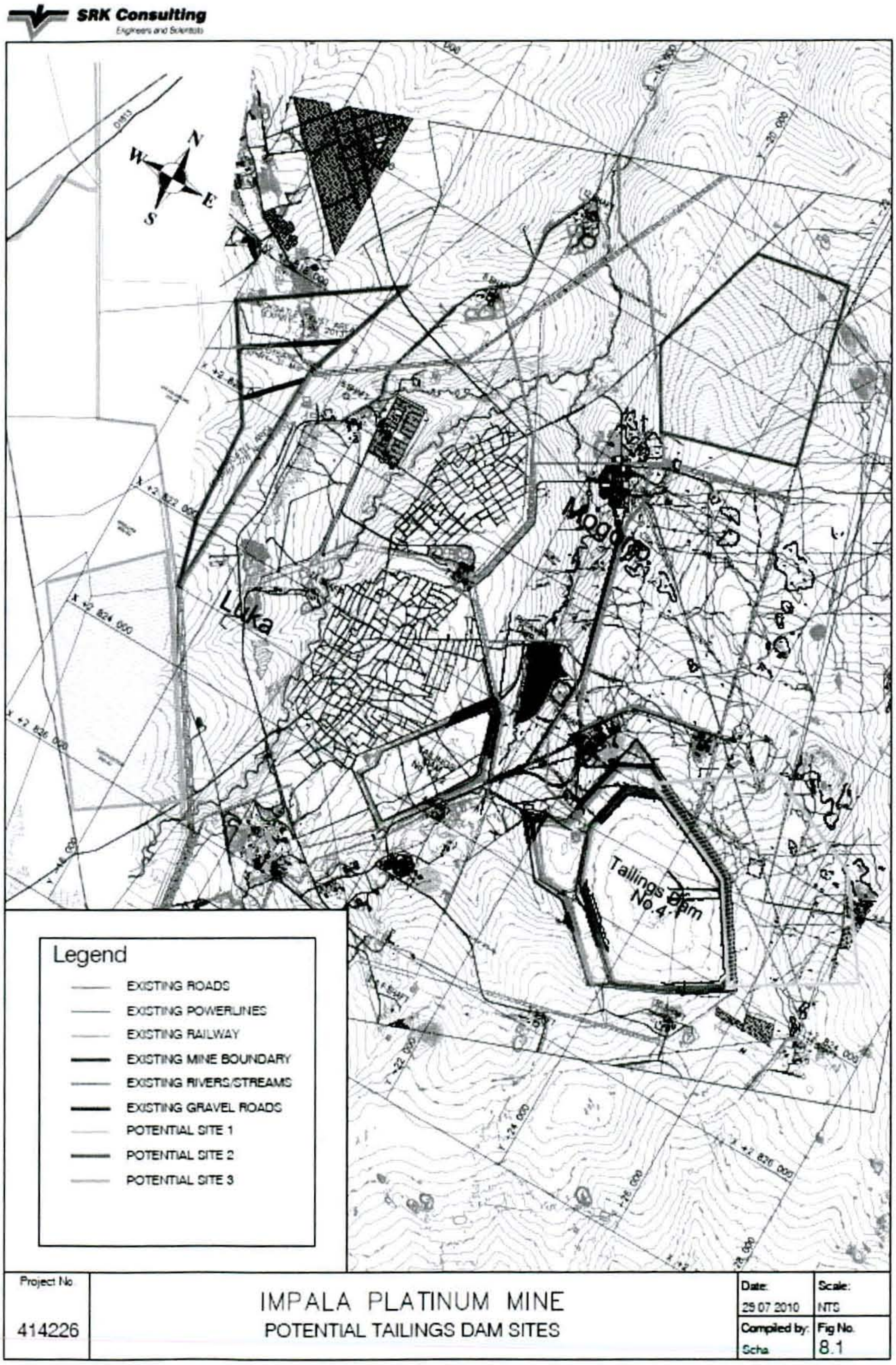
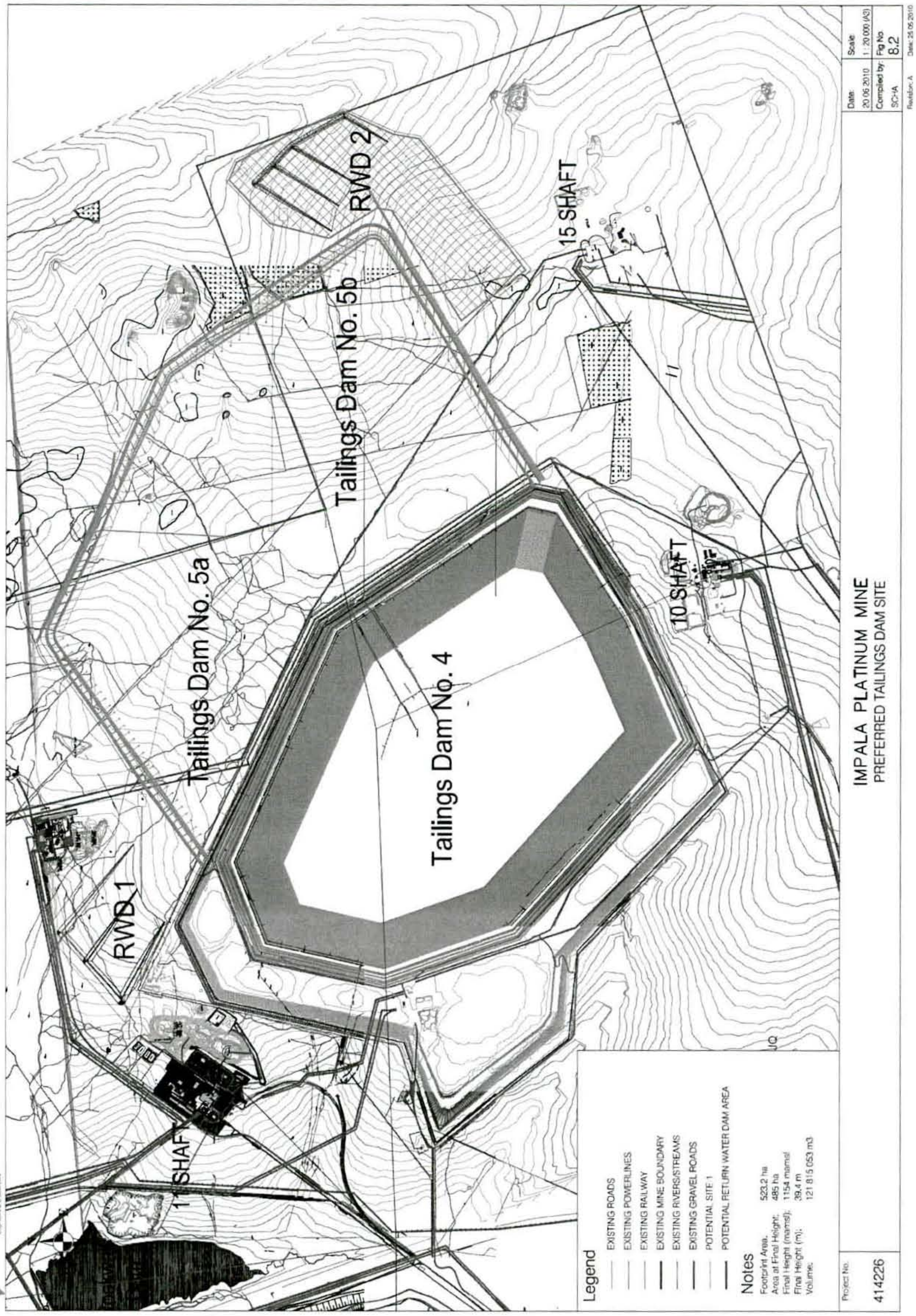


Figure 8-2: Selected Site for the new Impala tailings dam



9 Tailings Storage Facility Construction Method

The proposed wall building method for the tailings dam above the starter wall is the upstream wall building method. This method of wall building does not require a larger footprint area as the tailings dam height increases as tailings material is used for wall building and no imported material has to be sourced from borrow areas or alternative sources. The tailings dam wall is lifted in wall raises that depend on the in-situ strength of previously deposited tailings which have gained strength through pore water dissipation.

The facility will be constructed at an overall wall slope of 1V: 4H.

9.1 Capacity Assessment

9.1.1 New Tailings Dam

The new tailings dam development will be phased as described below.

Tailings dam No. 5 Phase 1 includes the development of the new tailings dam up to 1138 m.a.m.s.l. after which Tailings dam No. 5 Phase 2 will commence until both phases are at elevation 1138 m.a.m.sl. After consolidation of the two phases, the third phase of the tailings dam development will include the construction of the two penstock towers and development of the tailings up to elevation 1154 m.a.m.s.l.

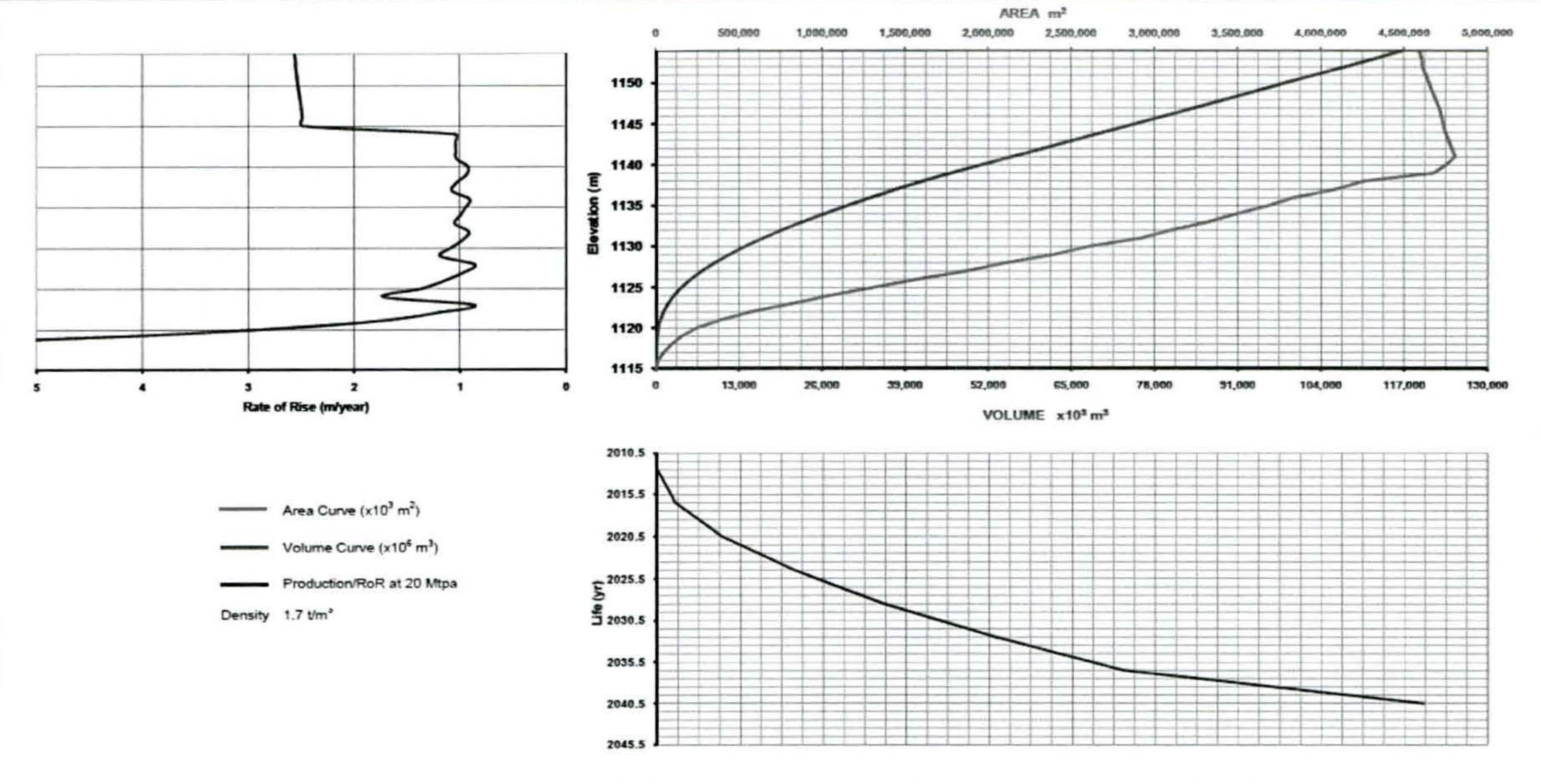
An average in situ dry density of 1.7 t/m^3 will be used for the volumetric modelling as stated in the Design Criteria.

Based on the site boundaries, several volumetric models were developed to accommodate the remaining LOM tailings, also utilising the volume remaining on the existing tailings dam No.4.

Table 9-1: Capacity Assessment Summary

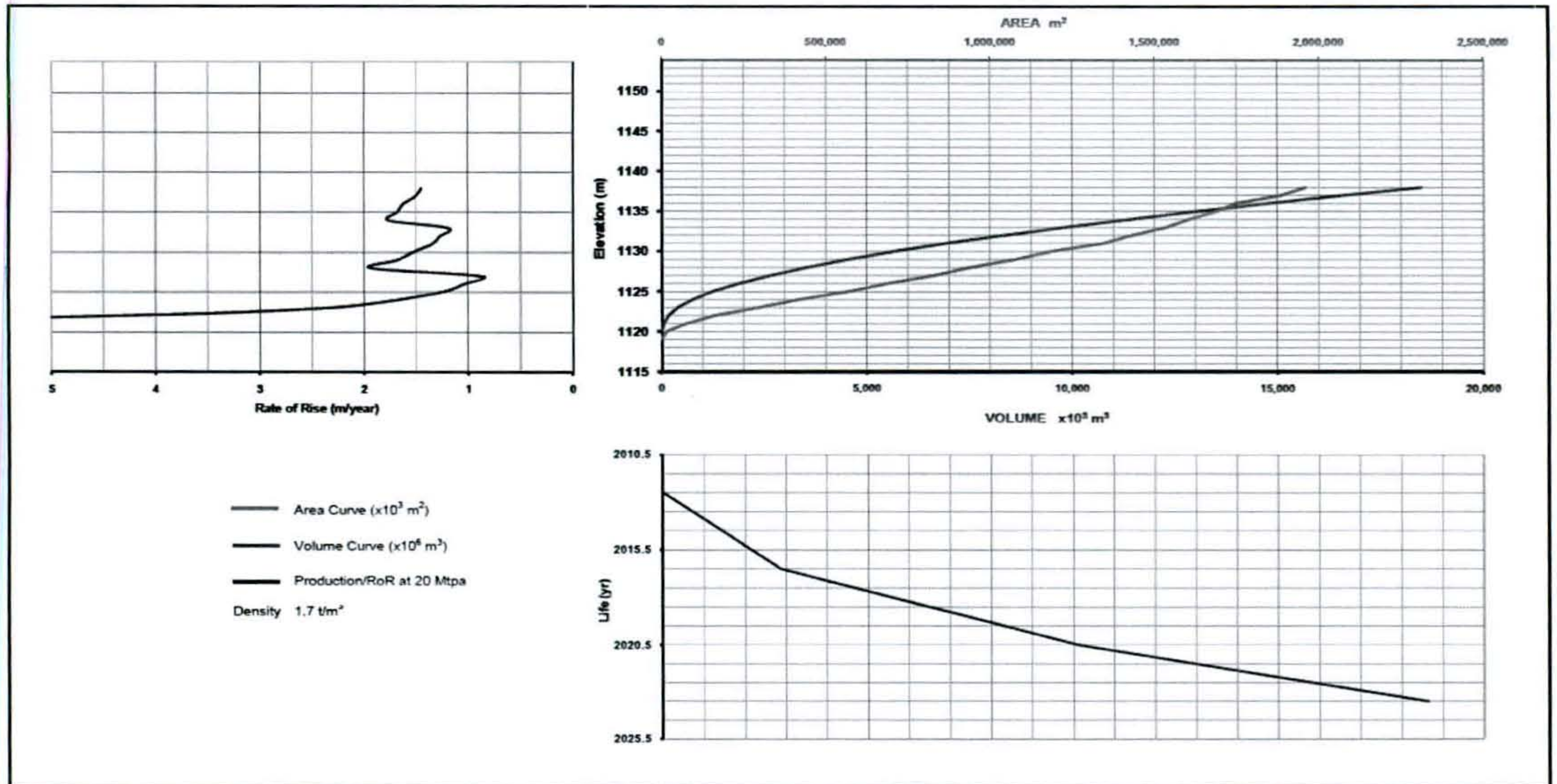
	Existing TSF	Tailings dam No. 5 Phase 1	Tailings dam No. 5 Phase 2	Tailings dam No. 5
Final Elevation (m.a.m.s.l)	1240	1138	1138	1154
Starter wall Volume (m^3)	0	44,000	535,000	0
Tailings Volume (m^3)	241,205,775	18,506,556	23,387,123	75,000,129
Tailings Ton (t)	410,049,818	31,461,145	39,758,109	127,500,219
Footprint Area (m^2)	4,347,551	2,275,000	2,800,000	5,075,000
Final RoR (m/yr)	2.5	1.45	0.89	2.56
Life (years)	26	10.7	7.49	9.9

Figure 9-1: Stage Capacity Curve: Total Volume



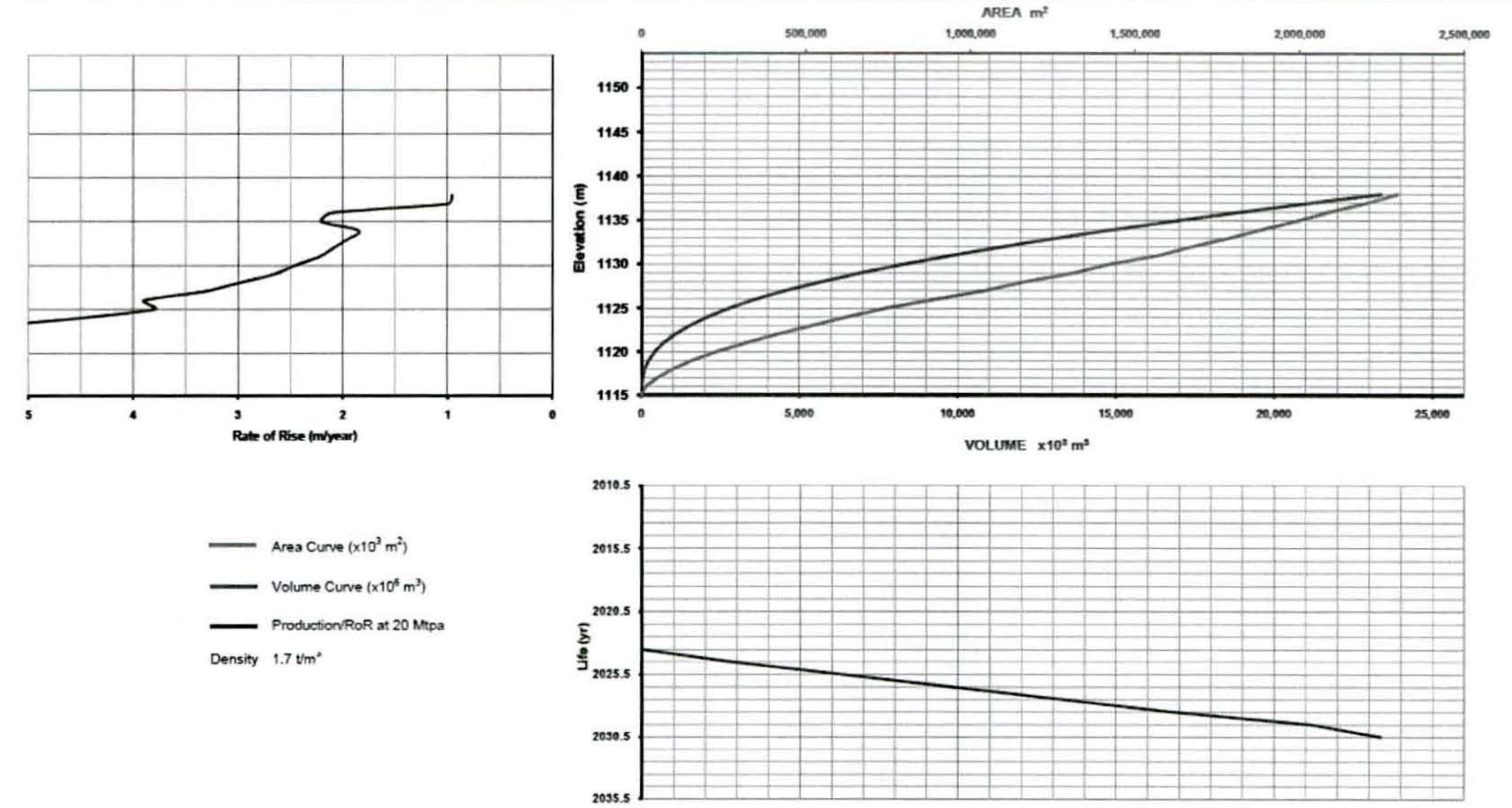
JOB No. 414226	srk consulting	**IMPALA PLATINUM** Tailings Dam No. 5 Extension - Total Stage Capacity Curve **MAX 1154 mamsl @ 1.7 t/m³ Dry Density**	FIG No. 9.1

Figure 9-2: Stage Capacity Curve: Tailings dam No. 5 Phase 1



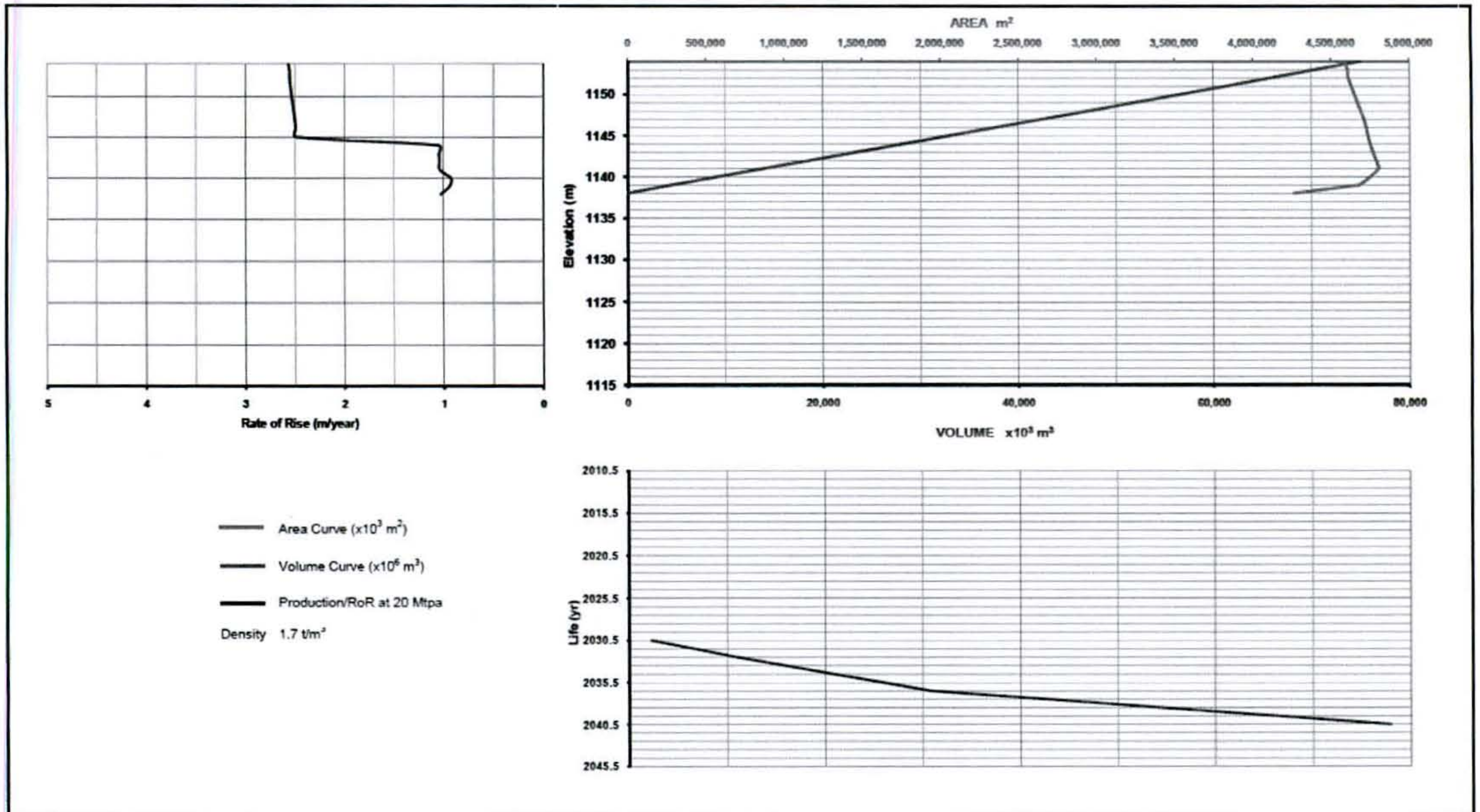
JOB No. 414226	srk consulting	**IMPALA PLATINUM** Tailings Dam No. 5 Extension - Phase 1 Stage Capacity Curve **To 1138 mamsl @ 1.7 t/m³ Dry Density**	FIG No. 9.2

Figure 9-3: Stage Capacity Curve: Tailings dam No. 5 Phase 2



JOB No. 414226	srk consulting	IMPALA PLATINUM Tailings Dam No. 5 Extension - Phase 2 Stage Capacity Curve To 1138 mamsl @ 1.7 t/m³ Dry Density	FIG No. 9.3

Figure 9-4: Stage Capacity Curve: Tailings dam No. 5



JOB No. 414226	srk consulting	IMPALA PLATINUM Tailings Dam No. 5 Extension - Phase 3 Stage Capacity Curve **MAX 1154 mamsl @ 1.7 t/m³ Dry Density**	FIG No. 9.4

10 Safety Classification

The SANS Code of Practice for Mine Residue, SANS 10286:1998 , requires that all mine residue deposits be classified into one or a combination of the following safety categories:

- High hazard
- Medium hazard
- Low hazard

The classification is based on the anticipated configuration of the residue deposit at the end of its design life. In order to classify an impoundment/residue deposit, an evaluation of its "zone of influence" according to guidelines set out in SANS 10286:1998 (SABS 0286), must be determined. The safety category of the impoundment is then determined using the zone of influence and applying of the code which is reproduced below as Table 10-1.

Table 10-1: SANS 10268: 1998 Table 2 - Safety Classification Criteria

1	2	3	4	5
No. of Residents in Zone of Influence	**No. of Workers in Zone of Influence 1)**	**Value of Third Party Property in Zone of Influence 2)**	**Depth to Underground Workings 3)**	**Classification**
0	<10	0 – R2 Million	> 200m	Low hazard
1 –10	11 – 100	R2 – R20 Million	50m – 200m	Medium hazard
>10	>100	>R20 Million	< 50m	High Hazard

1. Not including workers employed solely for the purpose of operating the deposit.
2. The value of third party property should be the replacement value in 1996 terms.
3. The potential for collapse of the residue deposit into the underground workings effectively extends the zone of influence to below ground level.

It should be noted that the costs in the above-mentioned Table 10-1 are 1998 costs and need to be escalated to current day costs.

A zone of influence was determined for the residue disposal facility and is presented in Figure 10-1.

Mining infrastructure including a shaft falls within the zone of influence. It is anticipated that people in excess of 100 in number would be in this area, depending on the time of day when a failure takes place. The tailings dam therefore classifies as a **High Hazard** dam with a low risk of occurrence.

SANS 10286:1998 requires that a risk analysis be carried out for all deposits that have a medium to high hazard classification. This includes qualitative safety assessments, quantitative analysis of the risks as well as a list of recommendations where necessary to reduce the risk.

In terms of SANS 10286:1998, a management system to control the risks and to monitor the construction and operation of the dams must be implemented by Impala Platinum Mine. By implementing risk reduction measures through proper design, construction management and operational procedures, the dam could have a low risk of failure, specifically when the phreatic surface is maintained at a low elevation as per the current conditions.

The risk assessment will be done as part of the detail design phase of the project. Data from the current tailings dam can be used for the flow failure analysis.

Figure 10-1: Zone of Influence Final Tailings Dam Complex

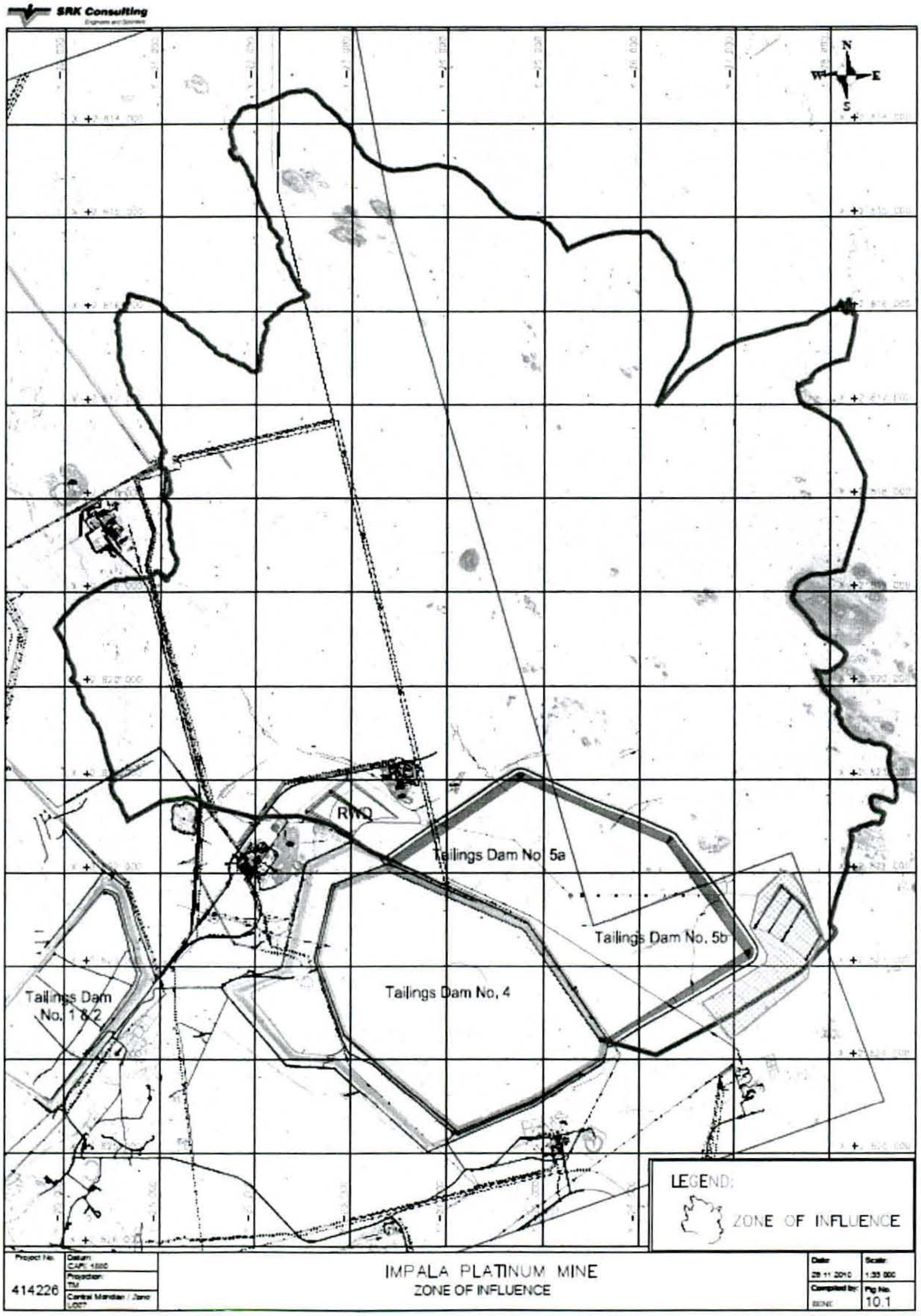
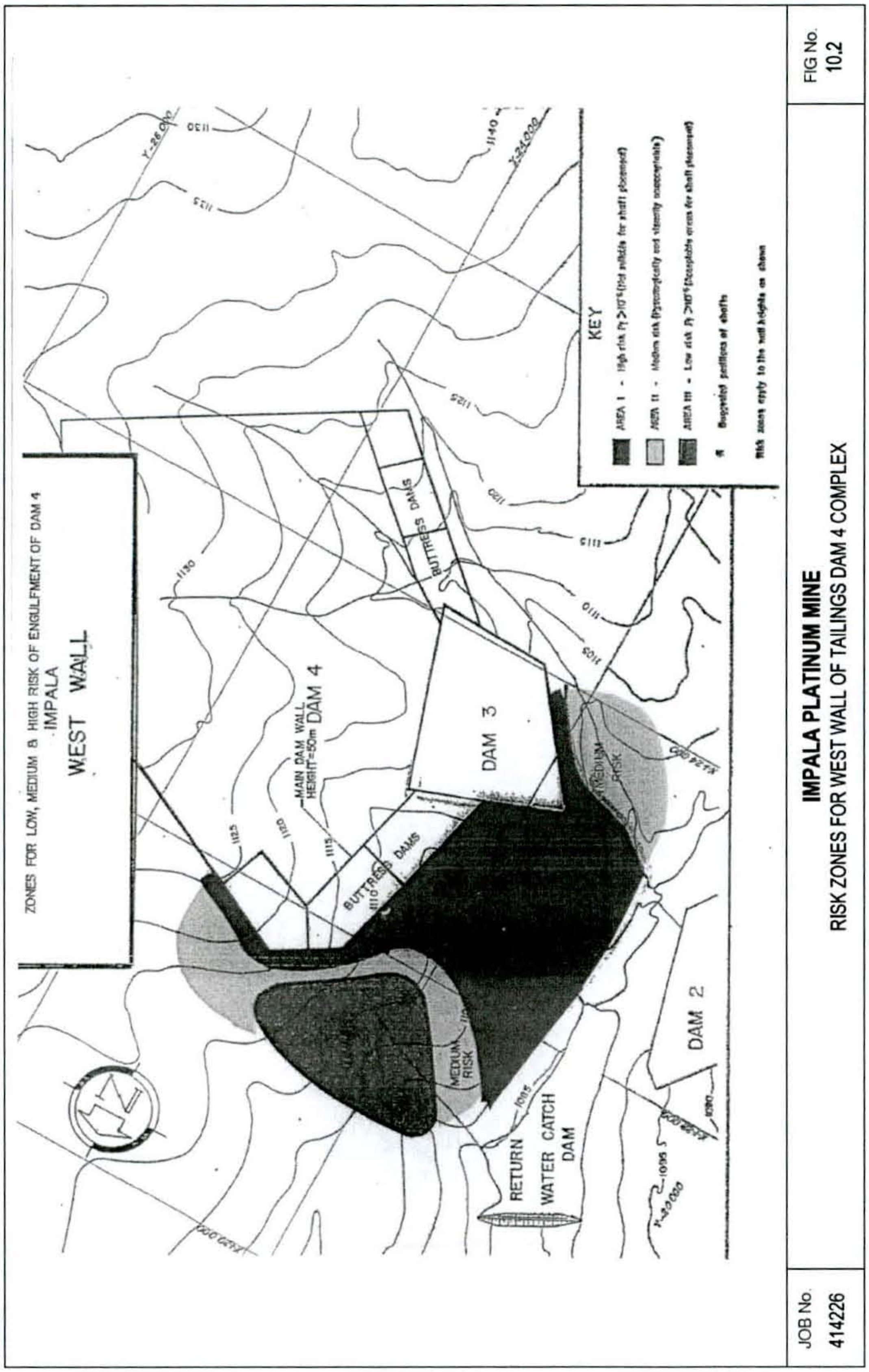


Figure 10-2: Zone of Influence Tailings Dam No.4 West Wall



SRK Consulting
Engineers and Scientists

Figure 10-3: Tailings Dam No.4 Extent of Possible Flow Slide

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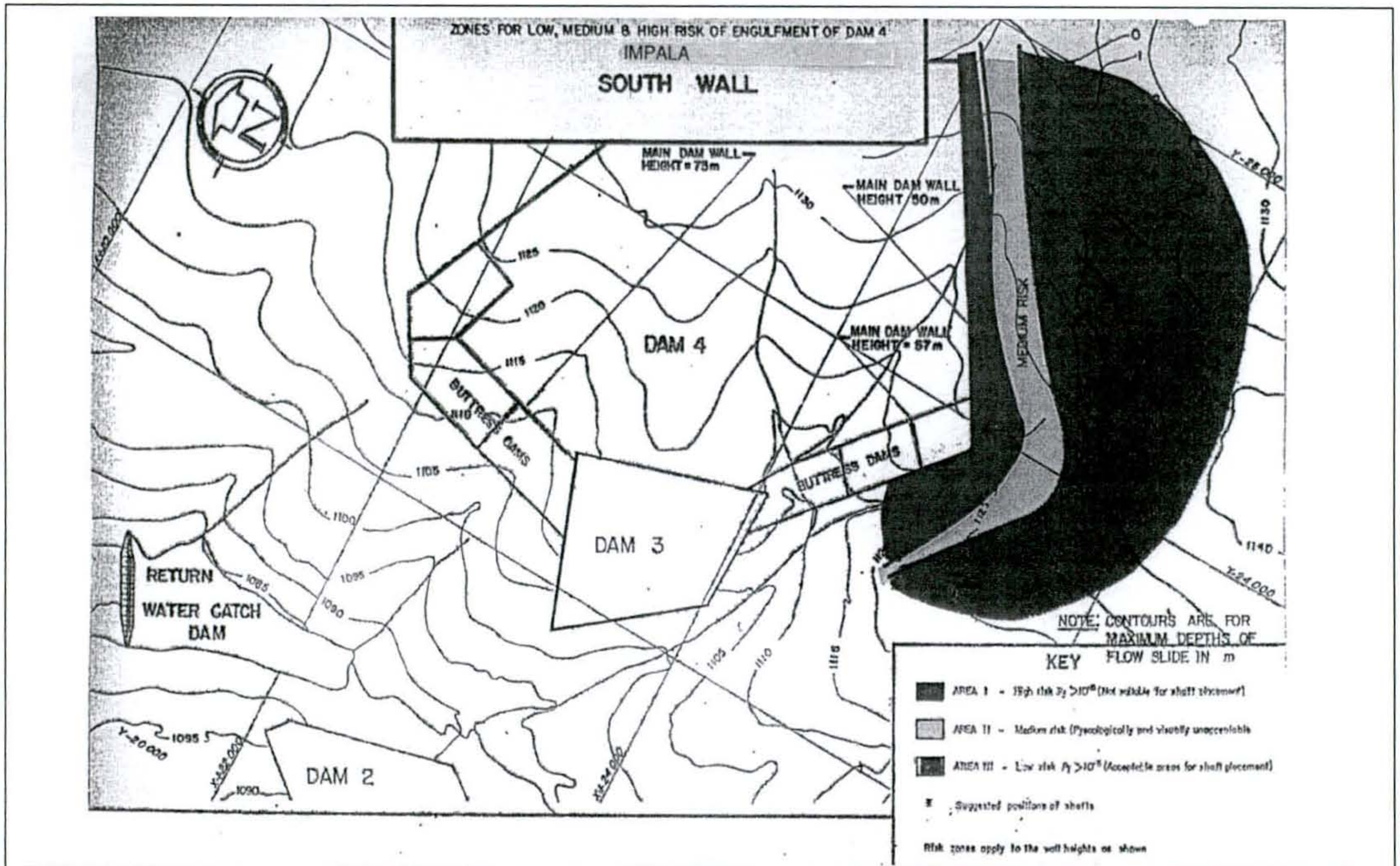


JOB No. 414226	IMPALA PLATINUM MINE RISK ZONES FOR SOUTH WALL OF TAILINGS DAM 4 COMPLEX	FIG No. 10.3

11 Tailings Dam Features

Please refer to Appendix 1 of this report for the conceptual design drawings. The following sections describe and explain the function of each of the tailings storage facility features.

11.1 Starter Wall

The starter wall will be constructed from waste rock and will have a downstream slope of 1V:3H and an upstream slope of 1V:2H. The waste rock volume required for the Tailings dam No. 5 Phase 1 starter wall is approximately 44 000 m3 and for the Tailings dam No. 5 Phase 2 starter wall approximately 535 000 m3.

The starter wall for the Tailings dam No. 5 Phase 1 development will be constructed with a crest elevation of 1123 m.a.m.s.l and for the Tailings dam No. 5 Phase 2 development with a crest elevation of 1129 m.a.m.s.l.

11.2 Tailings Dam Slopes

11.2.1 Inputs from the slope erosion study

This section was provided by the Greenco study.

Erosion modelling was conducted for erosivity during peak discharge periods, such as at 2 year, 10 year, 20 year, 50 year and 100 year storm events, but the data suggest that the erosivity is independent of slope angle or slope length, which is counter-intuitive. However, the RUSLE (Revised Universal Soil Loss Equation) modelling of predicted soil loss on an annual basis looking at vegetation cover, slope length and slope gradient delivered good results.

The RUSLE modelling showed that there are fairly strict guidelines that should be followed for the specific tailings material in terms of slope length and slope angle. Average annual soil losses should not exceed 20 t/Ha and should ideally be <10 t/Ha. Table 11-1 below summarises the most pertinent combinations of slope angle and slope length scenarios to achieve the minimal erosive loss targets at different vegetation cover scenarios.

Table 11-1: Erosion study related to slope angles

Vegetation cover	Soil loss target (tons/ha)	Slope length (m)	Max slope angle (°)
50%	10	8	7
	10	12	7
	10	16	7
	20	8	20
	20	12	14
	20	16	13
	20	20	10
	20	24	10
60%	10	8	12
	10	12	7
	10	16	7
	10	20	7
	20	8	30

Vegetation cover	Soil loss target (tons/ha)	Slope length (m)	Max slope angle (°)
	20	12	20
	20	16	18
	20	20	15
	20	24	13

Ultimately, the slope length/gradient combinations will depend on the inherent nutrient status of the tailings substrate, it's proneness to dispersion, the amelioration methods used in rehabilitation and the management available to maintain rehabilitation. Lastly, the combinations will depend on the footprint area available and the final height of the TSF.

The new TSF should have slopes not exceeding 15-18° (1:3.5-1:3), provided that slope lengths do not exceed 16m to 20m and that a serious undertaking is made to maintain vegetation contact cover (LOI) at >60%. The recommended slopes indicate maximum slope at any point, not average slope.

11.2.2 Proposed tailings slope geometry

The tailings dam will have an overall slope of 1 vertical to 4 horizontal, thus giving an overall angle of approximately 14 degrees. The inter-bench slopes have not yet finally been designed. The A-Greenco recommendations will be considered as far as possible in the assessment of the inter-bench slopes. As recognized in the A-Greenco assessment, the slope vegetation is an essential success factor in slope protection. These two factors will be considered in the final selection of the inter-bench slopes.

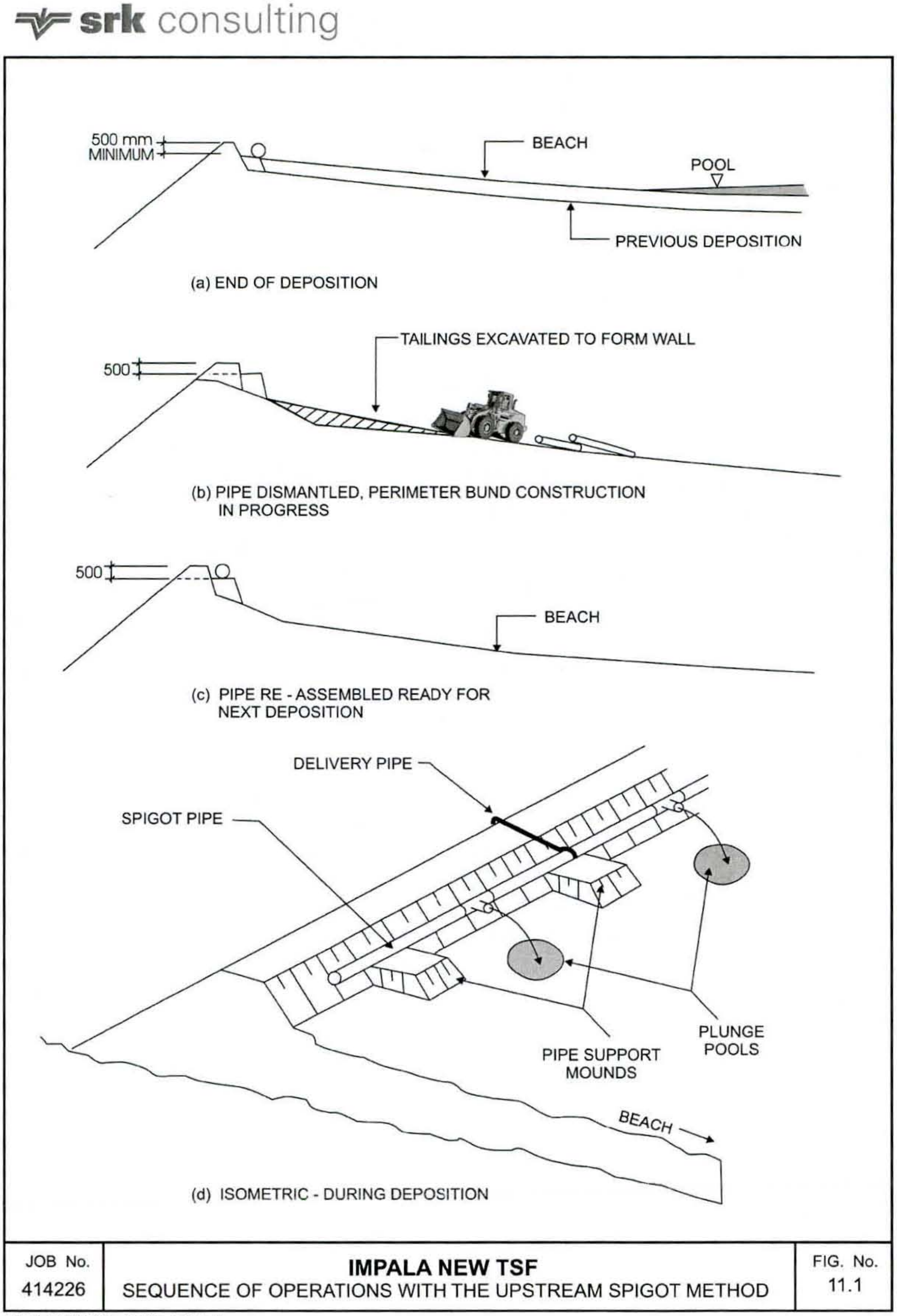
11.3 Paddock Walls and Sizing

Paddocks are required around the Tailings facility in order to safely store dirty surface flows from the tailings dam side slopes after a potential rain event and to contain pipe spillages occurring on the tailings dam step-ins. A paddock comprises of a square/rectangular shaped storage compartment of excavated earth which is unlined and is located at the toe of a tailings dam. The paddock wall height will be 1m high around the perimeter of the tailings dam complex.

11.4 Tailings Deposition

The conventional spigot method of deposition will be employed on the new tailings dam. Typically the spigot line is positioned on the crest of the tailings dam. With each deposition a section of the spigot pipe is dismantled and moved to one side to allow the raising of the perimeter bund which is usually constructed of the beach tailings. The sequence of operations is illustrated in Figure 11-1. In the course of a deposition cycle, a batch of adjacent spigots is opened, sufficient to cater for the slurry flow rate. As the beach falls, spigots at one end of the batch are opened while the equivalent number at the other end is closed so that the deposition gradually moves along the spigot pipe and around the tailings dam.

Figure 11-1: Sequence of Tailings Deposition



J: Proj \ 414226 \ 8 Graphics\Figure 11.1.cdr

11.4.1 Decant System

In order to ensure that supernatant and storm water does not accumulate on top of the MTD the facility has been designed with gravity decant systems. The following penstock decant systems are used.

Two large bore penstock tunnels with internal dimensions of 1.8m high by 0.9m wide are to be constructed from Class 35MPa/19mm reinforced concrete from the 40m high penstock towers to the penstock outlets situated downstream of the tailings dam's starter wall. Both penstock tunnels will be equipped with intermediate side intake structures to allow for the decanting of the pool until the height of the tailings on the tailings dam has reached the elevation of the penstock towers.

A system consisting of six and seven intermediate penstock intake structures and two final intake structures have been provided along the length of the penstock tunnels to facilitate the decanting of supernatant and storm water. All the intermediate intake structures are connected to the penstock tunnels via flexible 2m long 600mm diameter HDPE pipes to protect the tunnels against any differential settlement which the side inlets may experience.

The intermediate and final penstock intake structures will be sealed off (through the installation of a 2m high non-shrink grout plug) as and when deposition has progressed sufficiently to permit this. At the same time the conical inlets to the penstock tunnels will also be sealed through the installation of non-shrink grout plugs to ensure the long term structural integrity of the tunnels.

The two final penstock intake structures will be utilised for decanting water from the tailings dam by progressively extending their heights by means of conventional penstock rings until the pool has reached the lowest decanting portholes of the penstock towers. Once this elevation has been reached, the final intake structures will be sealed and water will be decanted through the towers' portholes.

The flow from the penstock tunnels will flow into splitter boxes, which will break the velocity of the decanted water. The decant water will then report to a silt trap structure from where the water will flow into the respective RWD.

11.4.2 Intake Structures

The intermediate and final penstock intake structures for the tailings dam will be constructed with a reinforced concrete base and a single 510mm diameter intake raised with standard pre-cast penstock rings. The intermediate intake structures are located along the penstock tunnels at intervals to ensure that during initial operations supernatant and storm water can be decanted.

Provision has been made in the design of the intermediate and final intake structures that they can be grouted closed after the installation of a steel plate over their intake gratings. This will prevent the ingress of tailings into the penstock tunnels once the deposition of tailings has progressed to the position of a specific intake structure. At the same time the conical side inlets into the penstock tunnels will also be grouted up.

Feeder channels located in the tailings dam basin will allow stormwater to be intercepted and decanted into the intermediate penstock intakes.

11.5 Silt Traps

Two twin compartment concrete lined silt traps have been provided, one for Tailings dam No. 5 Phase 1 and one for Tailings dam No. 5 Phase 2. The purpose of the silt trap is to reduce the amount of suspended solids that would otherwise enter the return water dam. The silt trap has been designed with twin compartments in order to facilitate alternate cleaning and operation of each compartment. The flow from the dissipater structure is directed to either one or the other compartment by means of sluice gates.

11.6 Storm water Diversion Infrastructure

Regulation 704 of the National Water Act (NWA), 36 of 1998 regarding separation of clean and dirty water systems within mining environments prohibits clean water from entering a dirty water environment (mining development). As a result of any respective mining development the clean water environment catchments are reduced and the natural flow path is obstructed by the above mentioned development. Therefore in order to separate the clean water from the dirty water environment, clean water diversion structures in the form of canals, berms are constructed so that the clean water is safely diverted away and discharged into the environment or nearby water course. All clean water diversion infrastructure is to be sized according to the 1:50 year storm rainfall event according to Regulation 704 of the NWA no 36 of 1998.

Refer to Figure 11-2 on the next page for the three clean and dirty separation catchments. The channels will be unlined with side slopes of 1v:3h.

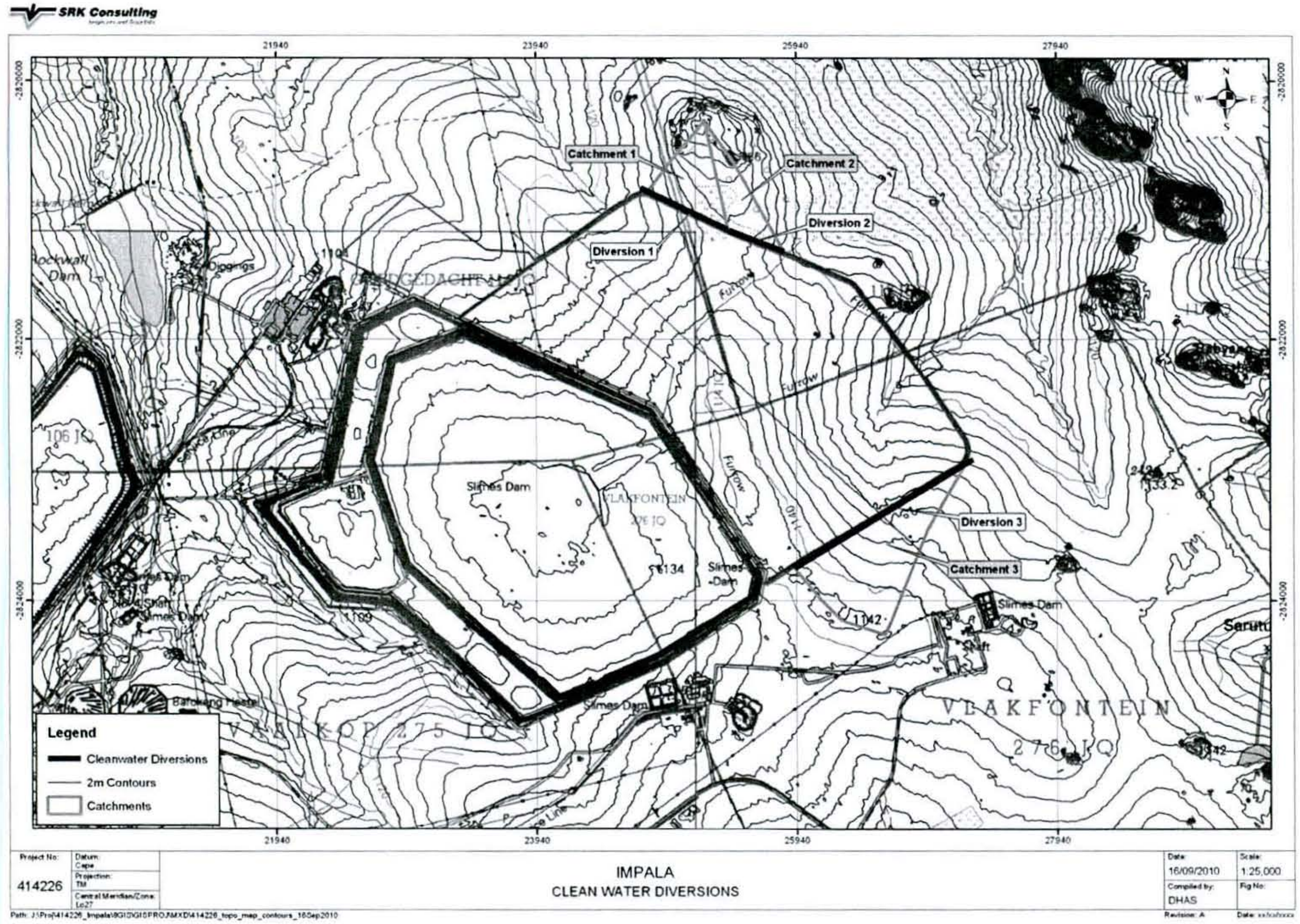


Figure 11-2: Clean and Dirty Water Separation

11.7 Under drainage

Drainage of the spigotted tailings wall is of paramount importance. Excess pore water due to underflow build-up is released through the consolidation process. The excess water is then managed by means of an under drainage system designed to induce consolidation of the spigotted tailings material as quickly as possible.

The drainage system for this project consists of a main drain and trench (curtain) drain parallel to the starter walls, placed approximately 50m upstream of the inner toe. An interface drain will be used at the interface between Tailings Dam 4 and the new tailings dam extension.

The drains will comprise four basic elements:

- Filter sand - in contact with the tailings material
- Filter gravel - in contact with the filter sand (6 mm stone)
- Filter gravel - in contact with the 6mm filter gravel (19 mm stone)
- Slotted “Drainex” pipe - concentrate and conduct the drained water.
- Unslotted “Drainex” pipe – collect the drainage water from the drains to the solution trench.
- 1.5 mm HDPE geomembrane lining the drainage trenches

Each of the drain outlets will decant into a concrete lined solution trench. Water from the solution trench will then flow towards the silt traps where the suspended solids will remain.

11.7.1 Toe Drain

A toe drain is provided along the full perimeter of the tailings dam on the inside of the starter and toe walls. The toe drain consists of a 600mm deep, 700mm wide trench with two protection berms on each side. The trench, up to the berms is lined with a 1.5 mm HDPE lining to prevent any seepage emanating from the drain and to prevent the ingress of fine clay/sand particles into the drain which would lead to eventual clogging of the drain. The drain comprises two 160mmNB slotted Drainex pipes which runs parallel with the starter wall toe. The pipes are surrounded by a 300mm layer of 19mm stone which is overlain by a 150mm layer of 6mm stone and a 150mm layer of graded filter sand inside the trench. On top of the trench another 300mm layer of graded filter sand is placed between the protection bunds with overlaying 300mm coarse grained tailings.

Drain outlets comprising 160NB unslotted Drainex pipes are provided from the toe drain to the solution trench at approximately 50m intervals.

11.7.2 Chimney and Trench Drains

The chimney drains are constructed with standard 1m diameter Rocla manhole rings filled with 6mm stone. The base of each chimney inlet consists of a concrete base filled with 19mm stone. The outlets from the base of each chimney consists of a 160mmNB slotted Drainex pipe inside the basin of the dam and a 160mmNB unslotted Drainex pipe from the upstream toe of the starter wall to the solution trench. The chimneys are provided at 50m intervals around the dam, and at a position of approximately 50m in from the centre line of the toe drain.

The trench drain is provided along the sections of the tailings dam perimeter to fulfil the needs of a chimney drain in this area.

The trench drain consists of a 600mm deep, 700mm wide trench lined with 1.5 mm HDPE and also Bidim containing two 160mm NB slotted Drainex pipes. The pipes are surrounded by a 300mm thick layer of 19mm stone which is overlain by a 150mm thick layer of 6mm stone. The Bidim is folded over the 6mm stone and the remaining 150mm of the trench is backfilled with coarse tailings which protrudes 100mm above natural ground and extends 300mm on either side of the trench and serves as a protection layer.

A layer of Bidim is provided between the 6mm stone and the coarse tailings which is then folded back before installation of the vertical curtain drain. Outlets are provided along the trench drain from one of the 160mmNB slotted Drainex pipes from the trench drain at intervals which follows the contours to the solution trench. The second 160mmNB slotted Drainex pipe leads into the chimney drains at either end of the trench drain.

11.7.3 Interface Drain

An interface drain system; consisting of a collector drain and an interface drain will be constructed along the northern and eastern toe perimeter of the existing tailings dam to control the phreatic surface along this interface with the new extension.

An interface vertical drain is provided along the full length of the interface. The existing solution trench will be converted to an interface drain. The trench will be lined with 1.5 mm HDPE lining which prevent any seepage emanating from the drain and the ingress of fine clay/sand particles into the drain which would lead to eventual clogging of the drain. The drain comprises of two 160mm NB slotted Drainex pipes which run for the total length of the pipe and ends up in the current tailings dam solution trench. The pipes are surrounded by a 300mm layer of 19mm stone which is overlain by a 150mm layer of 6mm stone and a 200mm layer of graded filter sand and a 300mm coarse protection layer on top of the ground level.

11.8 Access Walkway Structure

A timber catwalk structure will be installed to provide access from the final intake structure along the intermediate intake structures.

The catwalk structure will be constructed of timber supports spaced at 2.4m centres along the walkway structure. The walkway itself will consist of three timber planks fixed to the intermediate supports. A galvanised safety chain will be provided on both sides of the walkway for safety reasons.

A timber platform will surround the decant structure. This structure will be equipped with safety chains, steel cages over the open intakes, belts, signage etc at all times.

The catwalk structure will be progressively raised as the tailings dam rises by extending the timber uprights and relocating the timber planking at a higher elevation.

11.9 Access Road

Access around the tailings dam and return water dam is provided by means of a 6m wide access road, constructed from in situ material ripped and re-compacted.

Access onto the tailings dam initially is provided by means of access ramps. The access ramps have been placed such that entry of delivery pipelines onto the dam is in close proximity to an access ramp. In addition the access ramps have been placed close to valve stations.

12 Hydrological Assessment

12.1 Tailings dam No. 5 Phase 1

12.1.1 Water Balance

The Tailings Dam Facility will comprise of three phases, namely Tailings dam No. 5 Phase 1, Tailings dam No. 5 Phase 2 and Tailings dam No. 5. The following should be noted:

The Return Water Design for tailings dam No. 5 Phase 2 is based on the capacity required for the final arrangement of the tailings dam.

The management of water at the Impala Tailings Dam forms an important aspect in calculating the sizes of the penstock towers as well as the return water dam. The principals of managing water can be described as follows and the management is carried out in accordance with the requirements of Regulation 704 of the South African National Water Act (Act 36 of 1998) as is presented in Figure 12-1.

- Divert clean storm water run-off away from the Tailings dam complex.
- Contain and re-use the dirty water emanating from the Tailings dam complex.

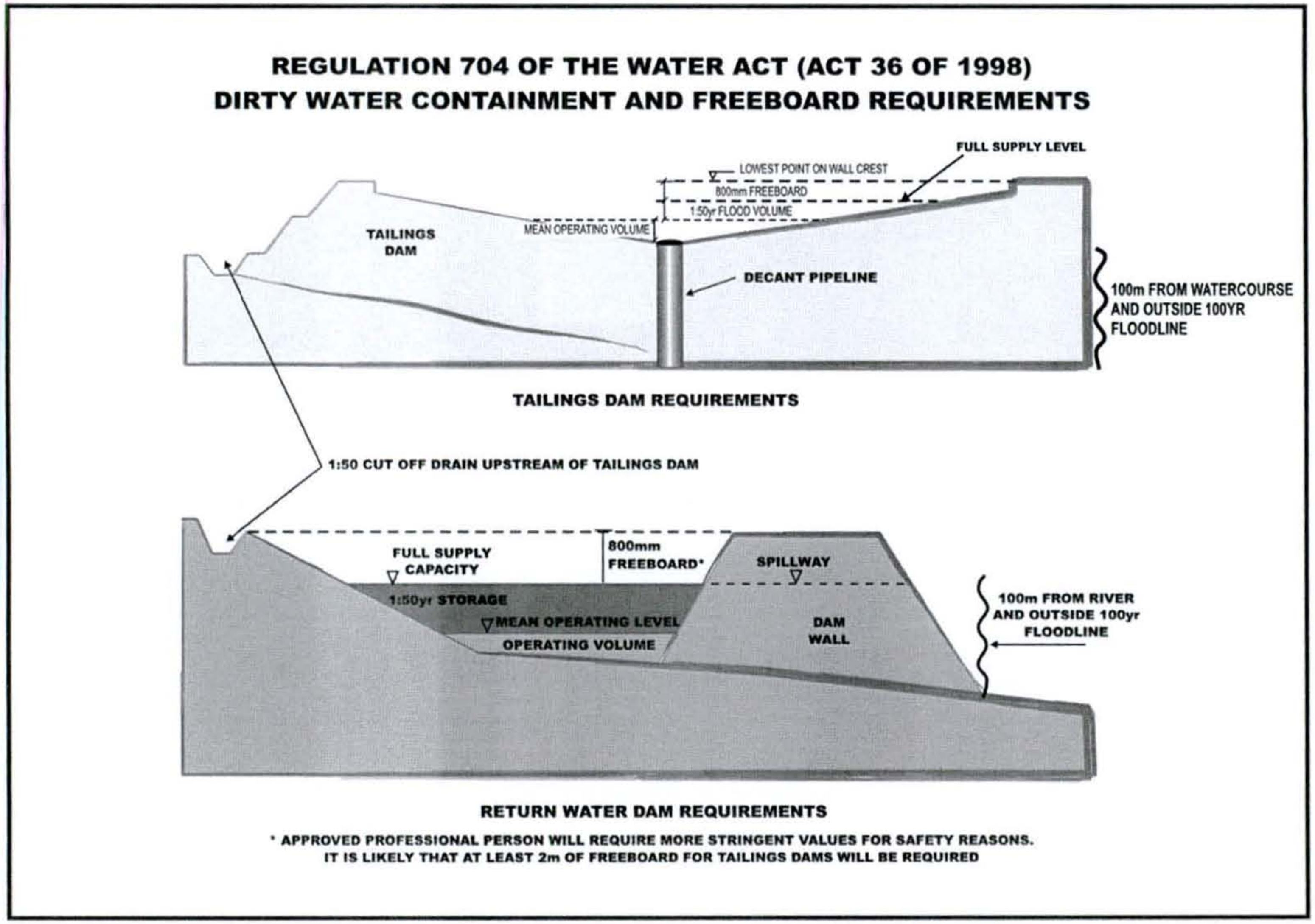
The input information to the Phase 1 monthly water balance can be seen in Table 12-1 below.

Table 12-1: Monthly Tailings Dam Water Balance Information (Tailings dam No.5 Phase 1)

Dry Slimes (max)	405,000 tpm
Slurry Density	1.55
SG (Dry Solids)	3.2 t/m^3
Volume Slurry Water pumped to the Tailings Dam	379,688 m^3/month
Area of the Tailings Dam	2,300,000m^2
Approximate Area of Pool	345,000 m^2
Approximate Area of Wet Beach	1,495,000 m^2
Approximate Area of Dry Beach	460,000 m^2
Evapo transpiration Factor from Wet Beach	0.8
Evapo transpiration Factor from Dry Beach	0.4
Number of Penstock Towers	1
Penstock outlet pipe critical slope	0.005 m/m

The water balance diagram for average monthly conditions is presented in Figure 12-2 and Figure 12-3, considering two basin seepage rates.

Figure 12-1: Dirty Water Containment and Freeboard Requirements



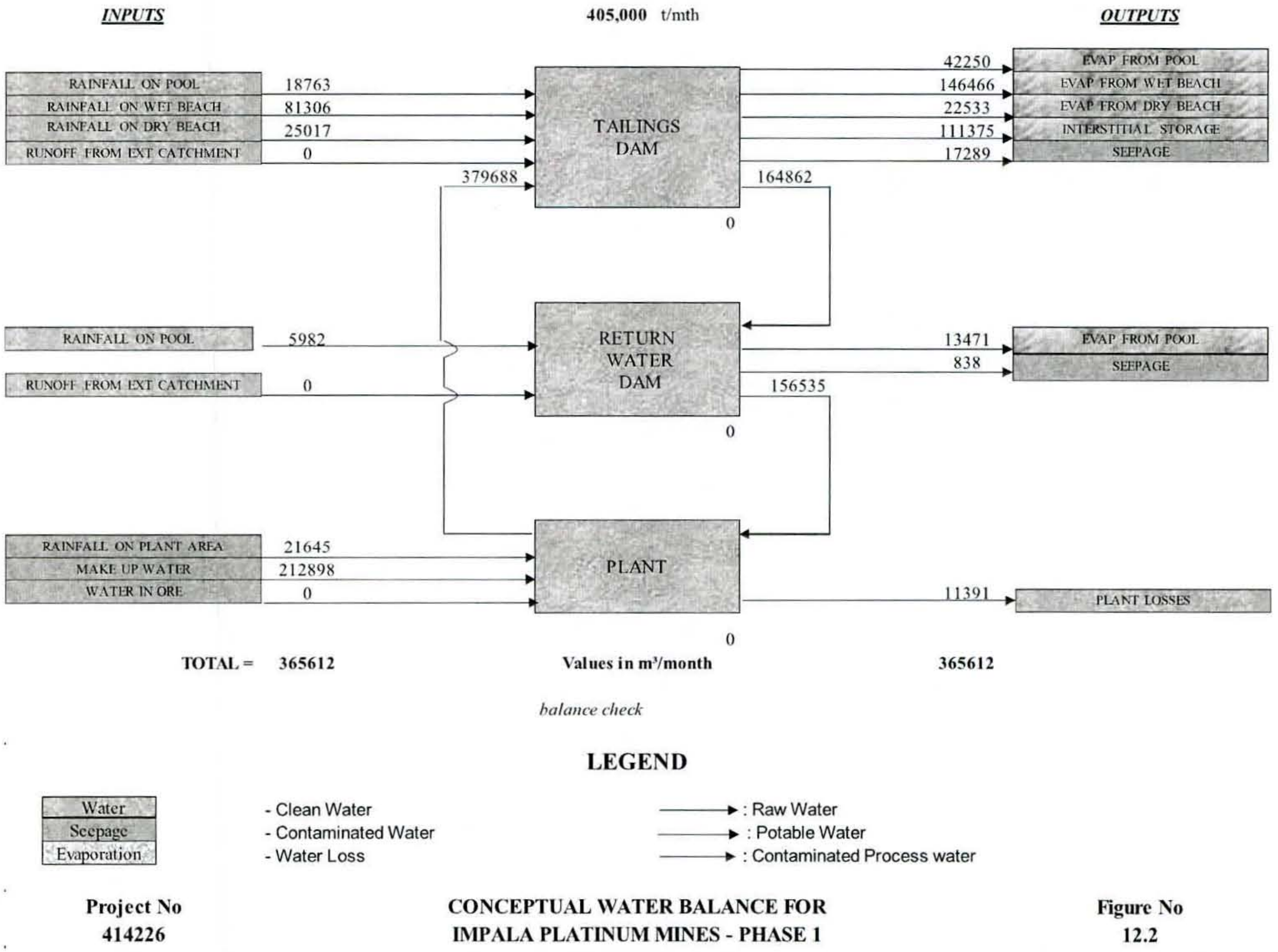


Figure 12-2: Average Monthly Water Balance for Impala Platinum Mine (Tailings dam No. 5 Phase 1) : basin permeability: 2.9e-9m/s

***The average consumption per month is **$0.5m^3/t$**.

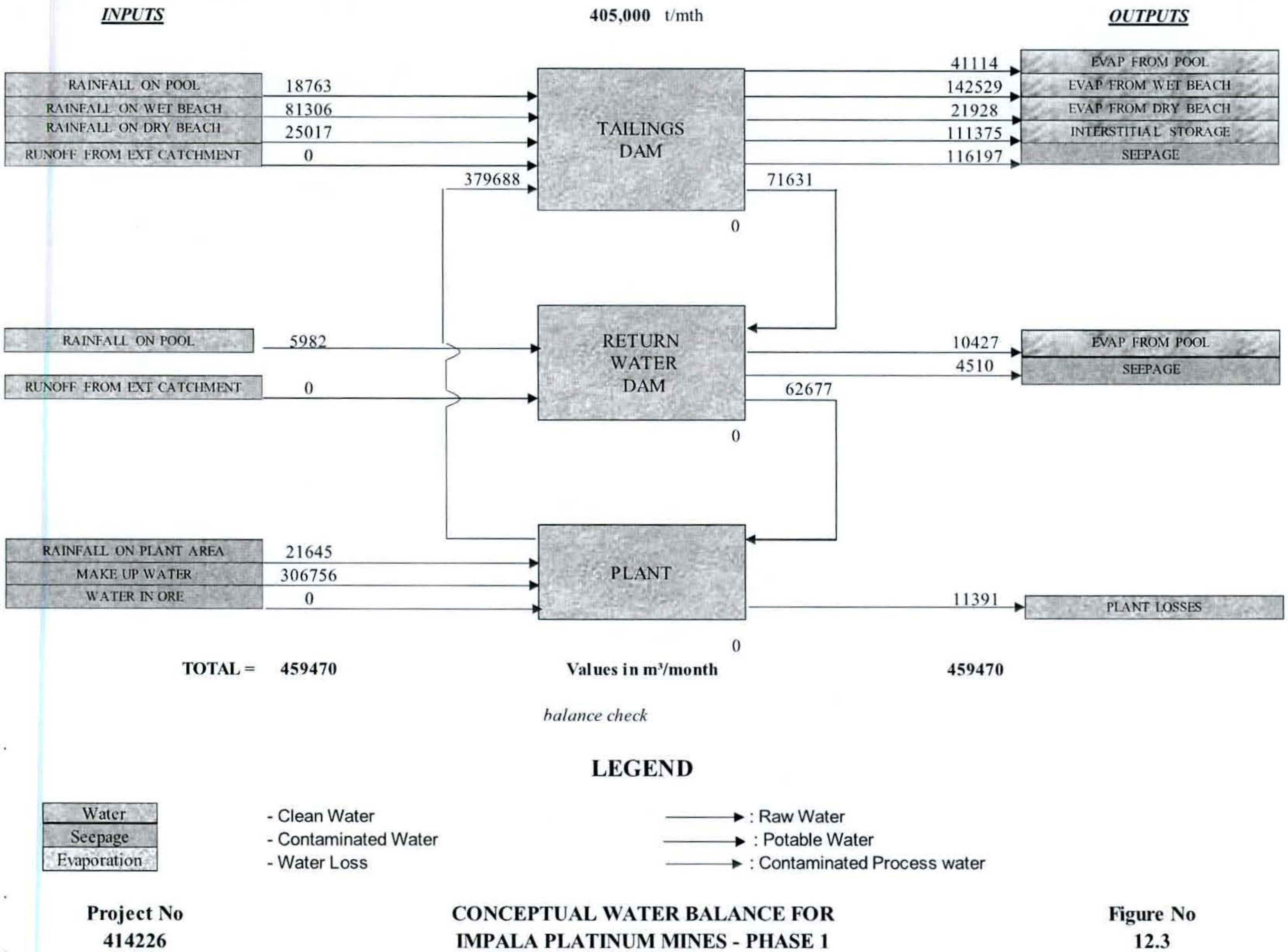


Figure 12-3: Average Monthly Water Balance for Impala Platinum Mine (Tailings dam No. 5 Phase 1): basin permeability: 2e-8m/s

12.1.2 Sizing of Tailings Dam Decant System

The number of penstocks required was determined by calculating the storm runoff from the slimes dam surface, and then calculating the discharge required to drain this volume of water from the dam over a certain time frame. Each penstock tower has a maximum capacity of $2m^3/s$.

If a single tower is used to decant the 1:100 year storm event (338,853 m^3), with the underlying decant pipeline sized at 1200 mm, it would take 48 hours to decant the entire volume.

Sizing of the diameter of the penstock outlet pipes are shown in Table 12-2 below.

Table 12-2: Penstock and Penstock Outlet Pipe Detail

Description	Primary
Number of penstock inlets required	1
Penstock outlet pipe capacity	2.0 m^3/s
Penstock outlet pipe slope	0.005 m/m
Penstock outlet pipe diameter	1.2 m ND minimum
Velocity in Penstock outlet pipe at Flow = 1.31 m^3/s	2.28 m/s
Depth of flow in penstock outlet pipe	50.7 % of diameter = 0.61 m
Number of days to drain 1:100 year storm	2

12.1.3 Silt trap sizing

The purpose of a Silt trap is to trap sediments from the outflow of the Tailings dam facility before it enters the Return water dam, thus ensuring the Return water dam does not silt up at a rapid rate. The required silt trap length will be 30m and the width 11.5 m and depth 1.5 m.

12.2 Tailings dam No. 5 Phase 2

12.2.1 Water Balance

The input information to the monthly water balance can be seen in Table 12-3 below for the Phase 2 area of the site only.

Table 12-3: Monthly Tailings Dam Water Balance Information for the Phase 2 area of the site

Dry Slimes (max)	625,000 tpm
Slurry Density	1.55
SG (Dry Solids)	3.2 t/m^3
Volume Slurry Water pumped to the Tailings Dam	585,938 m^3/month
Area of the Tailings Dam	2,800,000m^2
Approximate Area of Pool	420,000 m^2
Approximate Area of Wet Beach	1,820,000 m^2
Approximate Area of Dry Beach	560,000 m^2
Evapotranspiration Factor from Wet Beach	0.8
Evapotranspiration Factor from Dry Beach	0.4
Number of Penstock Towers	1
Penstock outlet pipe critical slope	0.005 m/m

The water balance diagram for average monthly conditions is presented in Figure 12-4, for the Phase 2 area of the site only. It should be noted that the Phase1 area of the tailings dam will still receive rainfall and there will be ongoing seepage from the tailings. Therefore a supplementary water balance is required to assess the water to be returned from RWD 1. This volume of water from RWD 1 will be the difference between the results of the larger footprint and the smaller Phase 2 footprint (Figure 12-4 and Figure 12-6). Similarly the differences between the water pumped from the return water dam as shown in Figure 12-5 and Figure 12-8, will be pumped on average from the RWD 1.

12.2.2 Sizing of Tailings Dam Decant System

The number of penstocks required was determined by calculating the storm runoff from the slimes dam surface, and then calculating the discharge required to drain this volume of water from the dam over a certain time frame. Each penstock tower has a maximum capacity of $2m^3/s$.

If a single tower is used to decant the 1:100 year storm event (412,517 m^3), with the underlying decant pipeline sized at 1200 mm, it would take 58 hours to decant the entire volume.

Sizing of the diameter of the penstock outlet pipes are shown in Table 12-4 below.

Table 12-4: Penstock and Penstock Outlet Pipe Detail

Description	Primary
Number of penstock inlets required	1
Penstock outlet pipe capacity	2.0 m^3/s
Penstock outlet pipe slope	0.005 m/m
Penstock outlet pipe diameter	1.2 m ND minimum
Velocity in Penstock outlet pipe at Flow = 1.60 m^3/s	2.39 m/s
Depth of flow in penstock outlet pipe	57.3 % of diameter = 0.69 m
Number of days to drain 1:100 year storm	2.5

12.2.3 Silt trap sizing

The purpose of a Silt trap is to trap sediments from the outflow of the Tailings dam facility before it enters the Return water dam, thus ensuring the Return water dam does not silt up at a rapid rate. The required silt trap length will be 35m.

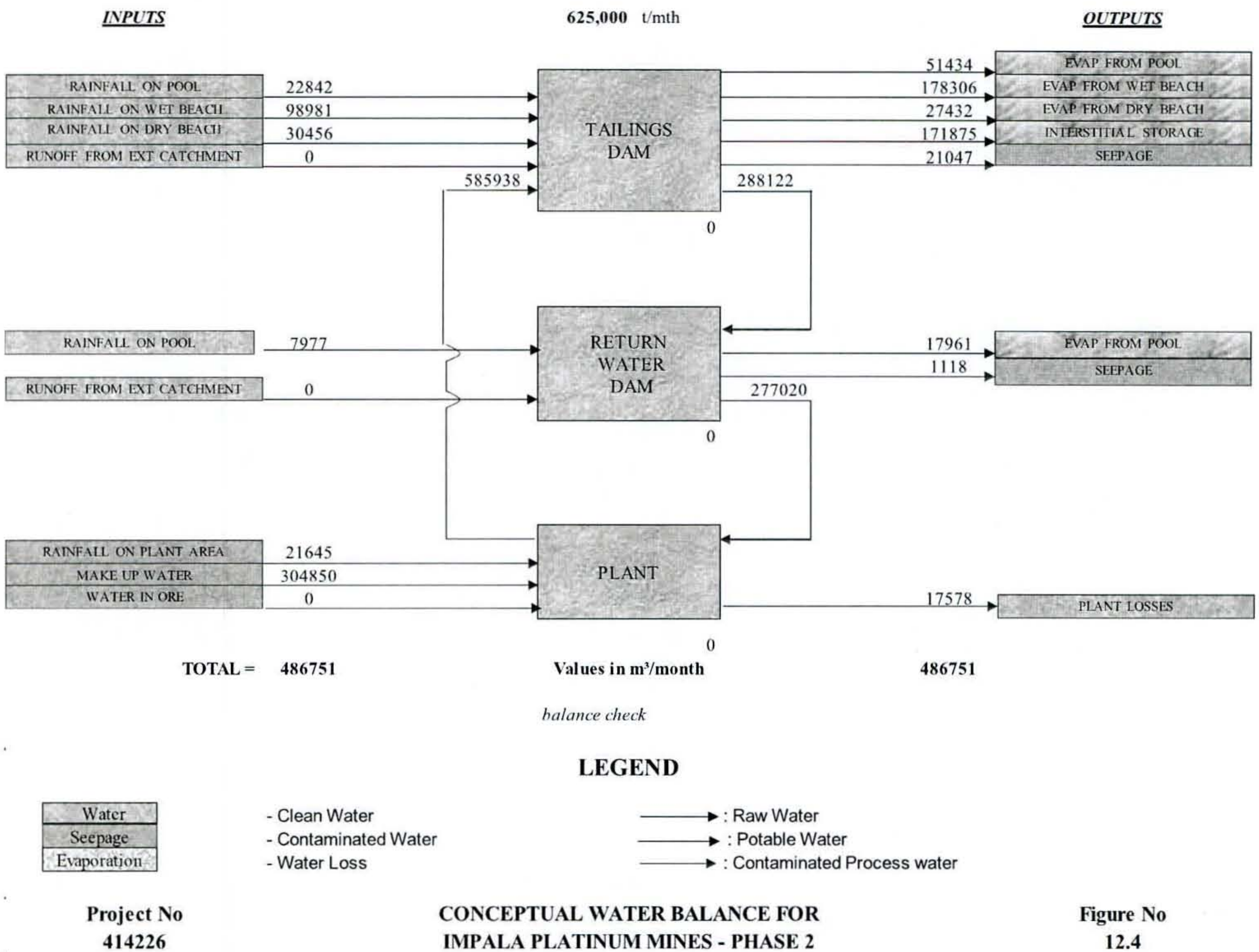


Figure 12-4 Average Monthly Water Balance for Impala Platinum Mine (Tailings dam No.5 Phase 2 of the site only): basin permeability of 2.9e-9m/s

***The average consumption per month is **0.46m^3/t**.

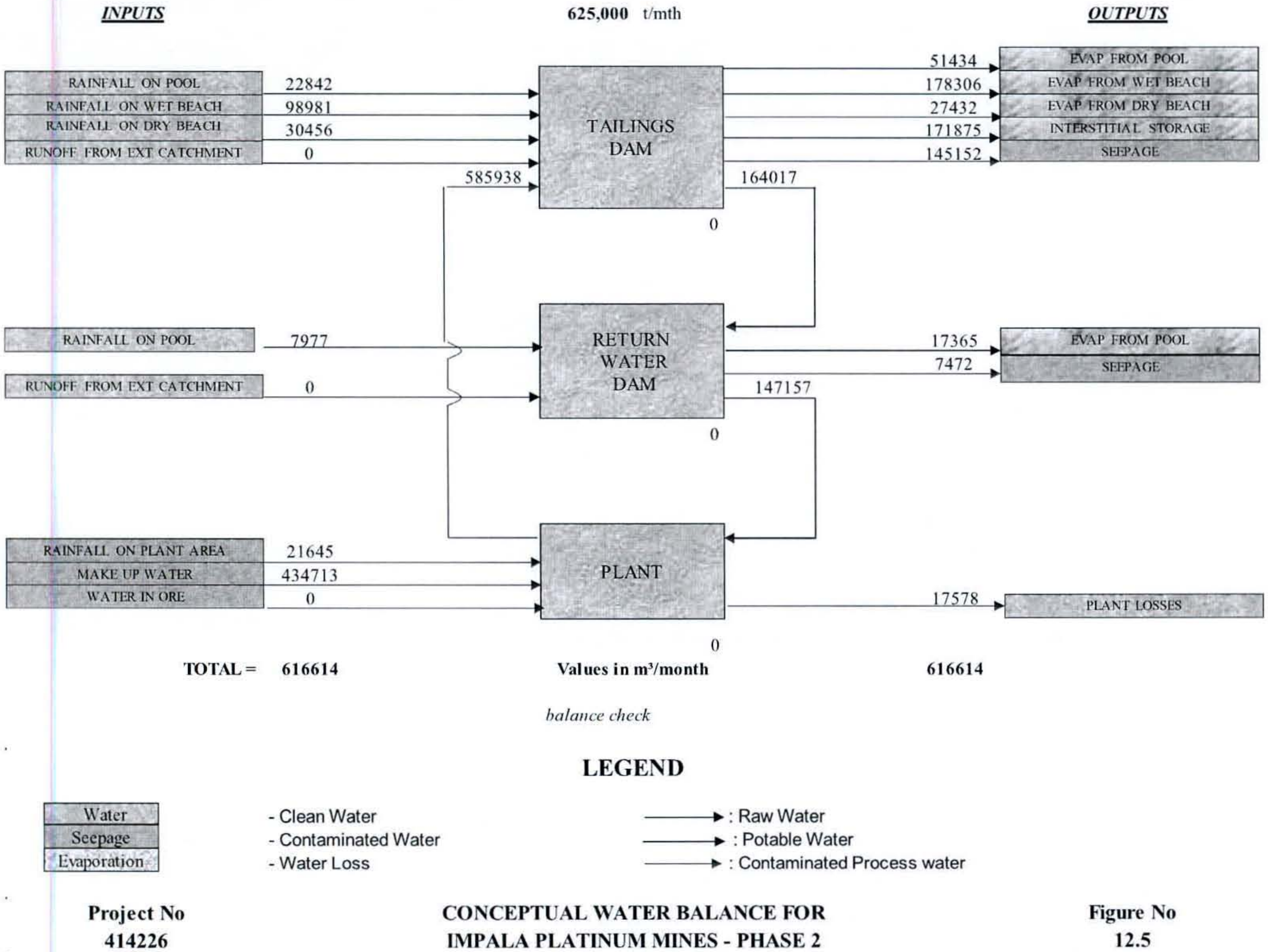


Figure 12-5 Average Monthly Water Balance for Impala Platinum Mine (Tailings dam No.5 Phase 2 of the site only): basin permeability of 2e-8m/s

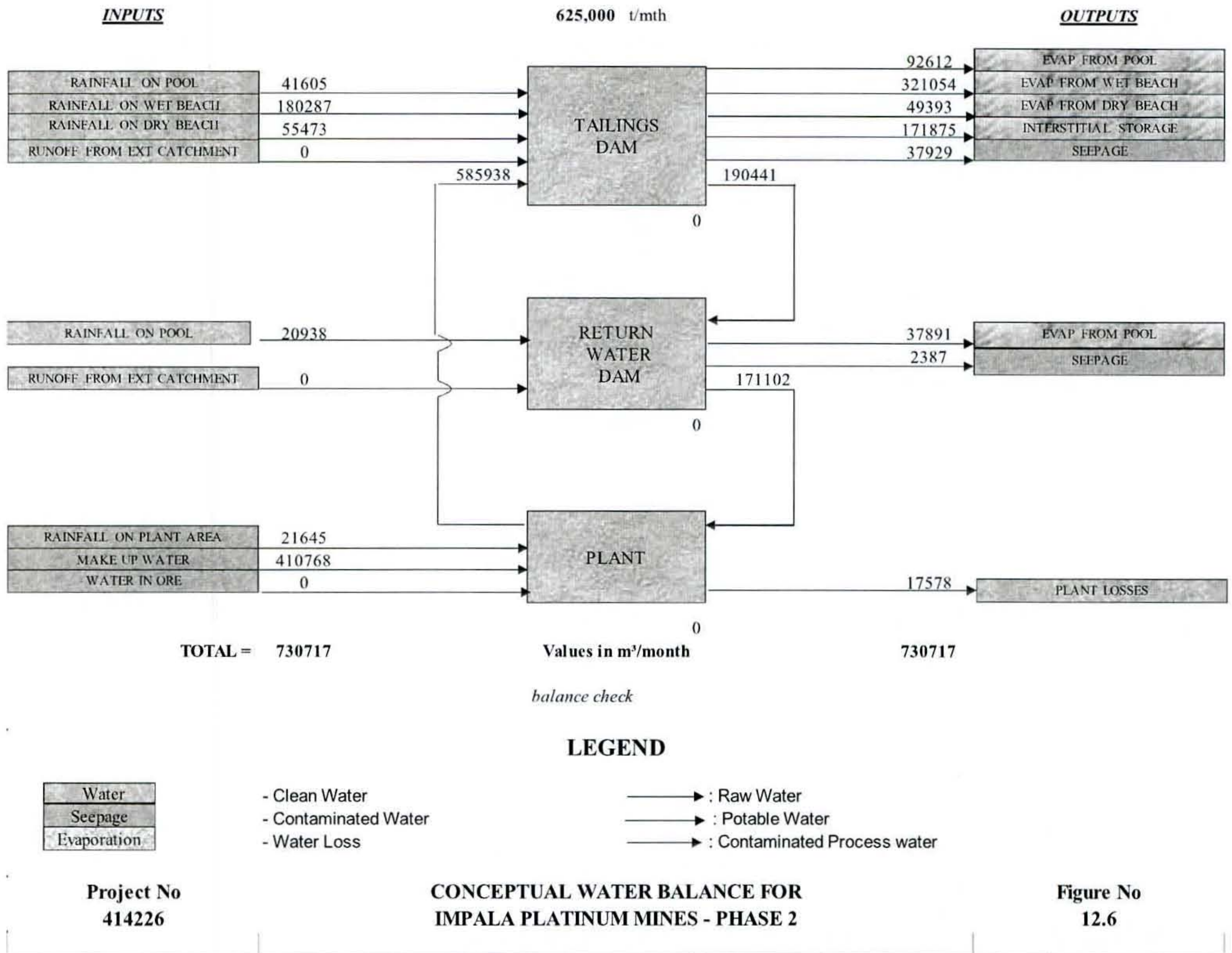


Figure 12-6 Average Monthly Water Balance for Tailings dam No.5 Phase 2 of the Phase1 and Phase 2 sites: basin permeability of 2.9 e-9m/s

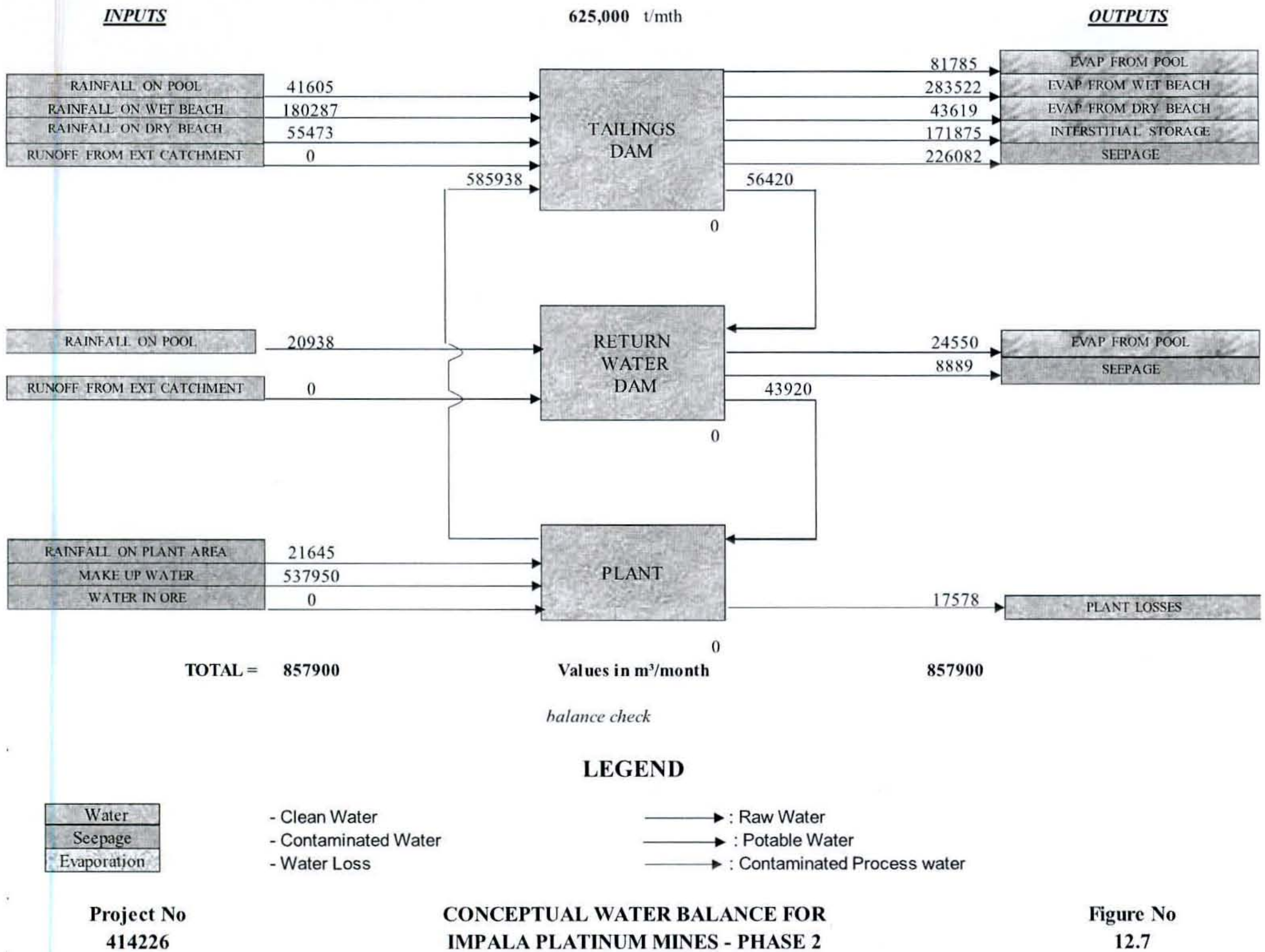


Figure 12-7 Average Monthly Water Balance for Tailings dam No.5 Phase 2 of the Phase1 and Phase 2 sites: basin permeability of 2e-8m/s

12.3 Tailings dam No. 5

12.3.1 Water Balance

Table 12-5: Monthly Tailings Dam Water Balance Information

	% OF POOL,WET AND DRY BEACH	TAILINGS DAM NO. 5 Phase 1	TAILINGS DAM NO. 5 Phase 2	TAILINGS DAM NO. 5
Dry Slimes (max)		405,000 tpm	625,000 tpm	**1,666,666 tpm**
Slurry Density		1.55		**1.55**
SG (Dry Solids)		3.2 t/m^3		**3.2 t/m^3**
Volume Slurry Water pumped to the Tailings Dam		379,688 m^3/month	585,938 m^3/month	**1,562,499 m^3/month**
Average monthly consumption		201,022m^3	290,329m^3	**705,985m^3**
Area of the Tailings Dam		2,300,000m^2	2,800,000m^2 (active and 2,300,000 less active)	**5,100,000 m^2**
Approximate Area of Pool	15	345,000 m^2	420,000 m^2	**765,000 m^2**
Approximate Area of Wet Beach	65	1,495,000 m^2	1,820,000 m^2	**3,315,000 m^2**
Approximate Area of Dry Beach	20	460,000 m^2	560,000 m^2	**1,020,000 m^2**
Evapo transpiration Factor from Wet Beach		0.8		**0.8**
Evapo transpiration Factor from Dry Beach		0.4		**0.4**
Number of Penstock Towers		1	1	**2**
Penstock outlet pipe critical slope		0.005 m/m		**0.005 m/m**

The water balance diagram for average monthly conditions is presented in Figure 12-8. This shows the flow to both return water dams in one block. It is planned to operate the tailings dam so that 50% of the supernatant water is collected in each of the two return water dams.