APPENDIX Q: SURFACE WATER ASSESSMENT

Memorandum

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Subject:	Mamatwan IRP – Surface Water Impact Assessment		

1. IMPACT ASSESSMENT, MITIGATION AND MONITORING

Informed by the mine plan layout, baseline hydrology, the water balance, design specifications for the storm water management measures, and the water balance, the potential impacts of the proposed mine activities on surface water receptors as well as the sensitivity of the surface water resources are discussed in this section and presented along with a summary of mitigation measures and monitoring requirements. The surface water impacts are assessed according to the three main stages of the project namely the construction phase, the operation phase and the closure phase, as well as the major activities within those phases.

Impacts are assessed cumulatively where possible, in that the assessment takes into account the currently impacted environment.

Various design mitigation measures are provided and the potential unmitigated impacts (worst-case scenario), and residual impacts of the project after considering the design mitigation measures proposed within this report are qualitatively assessed in this section.

1.1 SITE SENSITIVITY

The local surface water resources are of medium sensitivity. The project area is located in the low-lying areas of quaternary catchment D41K, which are largely rural. The catchment is mostly taken up by rural areas where natural flows are through preferential flow and natural drainage as such, the probability of the catchment self-rehabilitating is high. The catchment is mostly taken up by rural areas where natural flows are through preferential flow and natural drainage. However, a number of mines exists in this catchment have and have altered the natural catchment. The nature of the streams (non-perennial in nature and intermittently flowing) around this area implied that they are less impacted by these mine activities.

1.2 IMPACT DESCRIPTION

Identification of the impact of the major proposed activities on the surface water resources have been carried out and their description is provided in subsections below.

1.2.1 Surface Water Resources Contamination due to Mining activities.

Several contamination sources exist in all project activities and in various phases that have the potential to contaminate surface water resources in unmitigated scenario. In the construction, decommissioning and closure phases these potential pollution sources are temporary and diffuse in nature. Although these sources

may be temporary, the potential pollution may be long term. The operational phase will present the longer-term potential pollution sources.

1.2.2 Soil Erosion and Sedimentation

Site clearing, digging of trenches and topsoil removal will be undertaken during construction of various infrastructures such as the beneficiation plant, offices, workshops, the discard stockpile, and open pit might lead to erosion and consequently siltation of watercourses.

The project could cause water resources pollution through sediment transport and other chemical parameters from runoff from the surface operations. The impact of sedimentation is directly linked to erosion, as eroded soil particles will end up in nearby watercourses as sedimentation. The resultant consequences of sedimentation may be elevated turbidity that is likely to impact macroinvertebrates and other aquatic species.

1.2.3 Alteration of Drainage and Flow due to Mine Surface Infrastructure

Natural drainage across the project area is via preferential flow paths (natural drainage line). The development of the mine will alter the affected area's hydrologic response and, potentially, the entire catchment. Development of the mine and associated surface infrastructure implies that beneficial vegetation will be replaced by impervious surfaces, reducing the site's pre-developed evapotranspiration and infiltration rates. The proposed mine infrastructure covers 0.28% of quaternary catchment D41K.

With adequate rehabilitation and closure, some of the catchment is returned to self-sustaining systems, and natural drainage patterns will be restored.

1.3 IMPACT ASSESSMENT PER PHASE

1.3.1 Construction Phase

A summary of impacts and contributing activities including mitigation measures are provided in Table 1 -1.

Table 1-1 Summary of Project Activities, Interaction, Potential Impacts and Mitigation Measures to Surface Water Resources (Construction Phase)

Construction Phase			
Impact	**Project Activities**	**Impact Description**	**Mitigation Measures**
Water Quality Deterioration	Clearing the surface and site preparations of • A top-cut stockpile and associated mobile crushing and screening plant • Stormwater management infrastructure • Water pipeline to transfer water • Upgrading the railway line and railway loadout station	Deterioration of water quality as a result of the following • Clearing the surface and site preparations for the mine infrastructure will result in the exposure of soil surfaces to erosion factors. During rainfall events, runoff from the exposed site will transport the eroded soil material into the nearby water resources. • Uncontrolled spills of contaminants such as fuel and oils from moving vehicles and machinery, and subsequent washing away of these into the surface water resources.	• Drip trays should be placed under all standing machinery. • Oil recovered from any vehicle or machinery on-site should be collected, stored and disposed of by accredited vendors for recycling. • Traffic and movement over stabilised areas should be controlled (minimised and kept to specific paths), and damage to stabilised areas should be repaired timeously. • A water quality monitoring plan must be formulated before construction.
Soil Erosion and Sedimentation	Initial earthworks linked to Site clearing, stripping and stockpiling of soil resources, preparations and construction of • A top-cut stockpile and associated mobile crushing and screening plant • Stormwater management infrastructure • Water pipeline to transfer water • Upgrading the railway line and railway loadout station	• Site clearing, digging of trenches, and topsoil removal will be undertaken during the construction of various mine infrastructure such as mine plant, beneficiating plant, which might lead to erosion and consequently siltation of watercourses. • The project could cause water resources pollution through sediment transport and other chemical parameters from runoff from the surface operations. • The risk of sedimentation is directly linked to the risk of erosion, as eroded soil particles will end up in nearby watercourses as sedimentation.	• Construction must be undertaken during the dry season (i.e., between April and August). This will significantly reduce the potential for sedimentation through erosion due to construction activities. • Concurrent rehabilitation of disturbed land and revegetation should be carried out to minimise the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff.
Alteration of Flow and Drainage	Construction of stormwater management infrastructure	• A reduction of runoff water quantity to the surface water resources system will occur due to mine infrastructure. The catchment area for runoff will be reduced by 0.28%.	• The development of a stormwater infrastructure will result in positive impacts such as pollution control however clean water must be released into the environment to minimize alteration of natural drainage flow

Impact Rating

Impact rating has been undertaken for the identified impacts are presented from Table 1 -2 to Table 1 -4.

Table 1-2 : Impact summary – Surface Water Resources Contamination in Construction Phase

Issue: Surface Water Resources Contamination		
Phases: Construction Phase		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance	Minor change or disturbance
Duration	Medium-term	Short-term
Extent	Beyond Site	Site Boundary
Consequence	Medium	Low
Probability	Probable	Conceivable
Significance	Medium	Low
Nature of cumulative impacts	Construction activities that include the use of vehicles and machinery in nearby watercourses, storage of chemicals, fuels and materials as well as the storage of domestic and industrial waste have the potential to result in contamination of the water resource. Soluble construction materials also have the potential to dissolve in runoff from the area. This can result in the increase of dissolved solids in downstream waterbodies during periods of rainfall and subsequent flow resulting in a water quality impact. However, considering the temporary nature of the construction phase, the cumulative impact is assessed to be MEDIUM.	
Degree to which impact can be reversed	All assessed watercourses are dry for large periods of the year allowing for long periods of time to address any spills before flow begins. This impact is likely to occur only during the construction phase with negligible impacts foreseen beyond the construction period.	
Degree to which impact may cause irreplaceable loss of resources	Low as this area receives low rainfall.	
Residual impacts	The residual impact is considered to be LOW with only moderate impacts on the environment.	

Table 1-3: Impact summary – Soil Erosion and Sedimentation in Construction Phase

Issue: Surface Water Resources Contamination		
Phases: Construction Phase		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance	Minor change or disturbance
Duration	Medium-term	Short-term
Extent	Beyond Site	Site Boundary
Consequence	Medium	Low
Probability	Probable	Conceivable
Significance	Medium	Low

Nature of cumulative impacts	MMT Mine has been long operational. Due to movement of vehicles and machinery on a daily basis it is expected that uncompacted surfaces take a huge area and may contribute to an increased soil erosion and downstream sedimentation.
Degree to which impact can be reversed	The impact can be reversed through the application of mitigation measures such as scheduling of vehicle movement and compaction of loose soils.
Degree to which impact may cause irreplaceable loss of resources	Low as this area receives low rainfall insufficient to cause sedimentation.
Residual impacts	The residual impact is considered to be low.

Table 1-4: Impact summary – Alteration of Natural Drainage Patterns and Flow during Construction Phase

Issue: Alteration of Natural Drainage Patterns and Flow		
Phases: Construction Phases		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance	Minor change or disturbance
Duration	Medium-term	Short-term
Extent	Beyond Site	Site Boundary
Consequence	Medium	Low
Probability	Probable	Conceivable
Significance	Medium	Low
Nature of cumulative impacts	There is no stormwater infrastructure in the mine, therefore there are no cumulative impacts	
Degree to which impact can be reversed	In the context of the affected quaternary catchments this is considered to be a medium severity because the reduction will not result in a substantial deterioration in the water reserve and downstream water uses.	
Degree to which impact may cause irreplaceable loss of resources	The absence of a stormwater infrastructure will result in irreversible impacts. Therefore, the impacts of alteration of flow are considered low as compared to impacts of not having a stormwater infrastructure.	
Residual impacts	The residual impact is considered to be Low.	

1.3.2 Operational Phase

A summary of impacts and contributing activities including mitigation measures are provided in Table 1-5.

Table 1-5: Summary of Project Activities, Interaction, Potential Impacts and Mitigation Measures to Surface Water Resources (Operational Phase)

Operational Phase			
Impact	Project Activities	Impact Description	Mitigation Measures
Water Quality Deterioration	Operating • A top-cut stockpile and associated mobile crushing and screening plant • Stormwater management infrastructure • Upgrading the railway line and railway loadout station • WRD	Deterioration of water quality as a result of the following: • Potential contamination due to runoff generated from the box cut stockpile, railway line and railway loadout station. • Spillage of operational fuel, lubricants, cement or leaks from moving vehicle and equipment around the WRD, top-cut stockpile and railway line. • Potential spills of dirty water from PCDs and dirty water pipelines during potential heavy storms. • Residue from the dirty water circuit, chemicals, non-mineralised waste (hazardous, general, radioactive), and concrete wash water. • Seepage and leaching of harmful parameters such as nitrates from topcut stockpiles, which may deteriorate site groundwater qualities which in turn through groundwater- surface water interaction may deteriorate surface water qualities.	• Drip trays should be placed under all standing machinery. • Water quality monitoring as per the described monitoring plan specified in Section 1.5. • A stormwater management plan has been designed to minimize the potential to contaminate surface water and separates dirty and clean water must be developed. • The stormwater design recommended that the mine adopt a practice of utilising (reusing). The mine will have to abstract and reuse the amount of water that based on PCD option selected (SLR, 2021). • The abstraction rate recommended will ensure that the risk of spill is minimized.
Soil Erosion and Sedimentation	• Operating a top-cut stockpile and associated mobile crushing and screening plant	• Increased soil erosion emerging from uncompacted soils around the pit and stockpiles.	• A service/maintenance plan must be compiled and implemented. The plan must encompass procedures to minimise soil erosion impacts on the surrounding environment. • Concurrent rehabilitation is encouraged during the operation of the mine to minimise the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff
Alteration of	• Moving vehicles	Impacts on hydrological regime due to operational	• A stormwater management plan has been

Operational Phase			
Flow and Drainage	during operation phase could result in compacted surfaces. • Operation of Stormwater management infrastructure • Make-up water requirement for processing	activities such as: • Reduced runoff reporting to downstream receptors • There may be a need to abstract make up water from the Vaal Gamgara Water scheme for processing.	designed to channels runoff and separate dirty and clean water must be formulated as per the requirements of GN704. • Clean water must be allowed to flow back into the natural environment. • Re-use of water from the PCDs must be prioritised as well as the use of water from Middelplaats Shaft.

Impact Rating

Impact rating has been undertaken for the identified impacts are presented from Table 1 -6 to Table 1 -8.

Table 1-6 : Impact summary – Surface Water Resources Contamination in Operational Phase

Issue: Surface Water Resources Contamination		
Phases: Operational Phase		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance	Minor change or disturbance
Duration	Long-term	Long-term
Extent	Beyond Site	Site Boundary
Consequence	High	Medium
Probability	Probable	Conceivable
Significance	High	Medium
Nature of cumulative impacts	MMT Mine has been long operational and there are several cumulative impacts resulting from existing mining infrastructure such as WRD, open pits, Adams pit etc. Operation of the proposed infrastructure means that the impacts may be inflated resulting in the cumulative impact assessed to be HIGH.	
Degree to which impact can be reversed	All assessed watercourses are dry for large periods of the year allowing for long periods of time to address any spills before flow begins. The impacts can be reversed through a water quality monitoring plan to pinpoint areas of concerns as mining progresses, and waste and spill management procedure.	
Degree to which impact may cause irreplaceable loss of resources	The impact has potential to cause and irreplaceable loss to the stream habitats and downstream receptors.	
Residual impacts	The residual impact is considered to be Medium with only moderate impacts on the environment.	

Table 1-7: Impact summary – Soil Erosion and Sedimentation in Operational Phase

Issue: Surface Water Resources Contamination		
Phases: Operational Phase		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance	Minor change or disturbance
Duration	Medium-term	Short-term
Extent	Beyond Site	Site Boundary
Consequence	Medium	Low
Probability	Probable	Conceivable
Significance	Medium	Low
Nature of cumulative impacts	MMT Mine has been long operational. Due to movement of vehicles and machinery on a daily basis it is expected that uncompacted surfaces take a huge area and may contribute to an increased soil erosion and downstream	

	sedimentation.
Degree to which impact can be reversed	The impact can be reversed through the application of mitigation measures such as scheduling of vehicle movement and compaction of loose soils.
Degree to which impact may cause irreplaceable loss of resources	Low as this area receives low rainfall insufficient to cause sedimentation. Propper decommissioning and closure techniques will allow the environment to self-rehabilitate and return to its former natural state.
Residual impacts	The residual impact is considered to be low.

Table 1-8: Impact summary – Alteration of Natural Drainage Patterns and Flow during Operational Phase

Issue: Alteration of Natural Drainage Patterns and Flow		
Phases: Operation Phases		
Criteria	Without Mitigation	With Mitigation
Intensity	Minor change or disturbance	No Change or Disturbance
Duration	Short-term	Long-term
Extent	Whole site boundary	A part of the boundary
Consequence	Medium	Very Short
Probability	Probable	Unlikely
Significance	Medium	Very Low
Nature of cumulative impacts		
Degree to which impact can be reversed	In the context of the affected quaternary catchments this is considered to be a medium severity because the reduction will not result in a substantial deterioration in the water reserve and downstream water uses.	
Degree to which impact may cause irreplaceable loss of resources	There is no irreplaceable loss of surface water resources foreseen due to this impact	
Residual impacts	The residual impact is considered to be low.	

1.3.3 Decommissioning Phase

A summary of impacts and contributing activities including mitigation measures are provided in Table 1-9.

Table 1-9: Summary of Project Activities, Interaction, Potential Impacts and Mitigation Measures to Surface Water Resources (Closure and Decommissioning Phase)

Closure-Decommissioning Phase			
Impact	**Project Activities**	**Impact Description**	**Mitigation Measures**
Water quality Deterioration	Cessation of the mining and the removal and demolition of surface infrastructure and rehabilitation. • Top-cut stockpile and associated mobile crushing and screening plant • Stormwater management infrastructure • Water pipeline to transfer water • Railway line and railway loadout station	• Removal and handling of hazardous waste offsite and waste storage facilities, damage to waste handling facilities resulting in water quality deterioration. • Impacts on water quality due to maintenance activities around the watercourses.	• Drip trays should be placed under all standing machinery. • Water quality monitoring as per the described monitoring plan specified in Section 1.5.
Soil Erosion and Sedimentation		• Increased soil erosion emerging from uncompacted soils around the demolished mine.	• Decommissioning activities must be undertaken during the dry season (i.e., between April and August). This will significantly reduce the potential for sedimentation and erosion. • Concurrent rehabilitation of disturbed land should be carried out to minimise the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff.
Alteration of Flow and Drainage (Positive Impact)		• With adequate rehabilitation and closure, some of the catchment is returned to a self-sustaining system. Return of natural drainage patterns as a result of freely draining topography.	• No mitigation required since this is a positive impact the natural environment is rehabilitated.

Impact Rating

Impact rating has been undertaken for the identified impacts are presented from Table 1 -10 to Table 1 -12.

Table 1-10: Impact summary – Surface Water Resources Contamination in Decommissioning and Closure Phase

Issue: Surface Water Resources Contamination		
Phases: Decommissioning and Closure Phases		
Criteria	Without Mitigation	With Mitigation
Intensity	Moderate change or disturbance	Minor change or disturbance
Duration	Medium-term	Short-term
Extent	Whole site	A part of the site
Consequence	Medium	Medium
Probability	Possible	Conceivable
Significance	Medium	Low
Nature of cumulative impacts	Surface water resources are receptors of fine materials and contaminants arising from the demolition of infrastructure and from earthworks transported through rainwater and surface runoff. This may be deposited in watercourses causing siltation and contaminating river water with chemical pollutants. However, considering the temporary nature of the decommissioning and closure phase, the cumulative impact is assessed to be MEDIUM.	
Degree to which impact can be reversed	The impact can be fully reversed because once the decommissioning and closure period is completed and area occupied by all the proposed infrastructure is rehabilitated.	
Degree to which impact may cause irreplaceable loss of resources	Low as this area receives low rainfall that can wash away finer material into nearby watercourses	
Residual impacts	The residual impact is considered to be VERY LOW with only minor impacts on surrounding receptors.	

Table 1-11: Impact summary – Soil Erosion and Sedimentation in Decommissioning and Closure Phase

Issue: Soil Erosion and Sedimentation		
Phases: Decommissioning and Closure Phases		
Criteria	Without Mitigation	With Mitigation
Intensity	Prominent change or disturbance	Moderate change or disturbance
Duration	Long-term	Medium-term
Extent	Whole Site	Beyond Site Boundary

Consequence	Medium	Medium
Probability	Probable	Possible
Significance	High	Medium
Nature of cumulative impacts	The area receives low rainfall and MMT Mine has been long operational. Mining infrastructure such as WRD and Adams pit are likely going to contribute to the cumulative impacts and as such the cumulative impacts on surface water resources are assessed to be L.	
Degree to which impact can be reversed	The Vlermuisleegte River is located approximately 2.5 km away from the mining area and is dry for large periods of the year allowing for long periods of time to address any spills or any other contamination before flow begins.	
Degree to which impact may cause irreplaceable loss of resources	Medium as this area receives low rainfall.	
Residual impacts	The residual impact is considered to be Medium with only moderate impacts on the environment.	

Table 1-12: Impact summary – Alteration of Natural Drainage Patterns and Flow during Decommissioning and Closure Phase

Issue: Alteration of Natural Drainage Patterns and Flow		
Phases: Decommissioning and Closure Phases		
Criteria	Without Mitigation	With Mitigation
Intensity	Minor change or disturbance	No Change or Disturbance
Duration	Short-term	Very Low
Extent	Whole site boundary	A part of the boundary
Consequence	Medium	Ver Short
Probability	Probable	Unlikely
Significance	Medium	Very Low
Nature of cumulative impacts	There are no foreseen cumulative impacts.	
Degree to which impact can be reversed	In the context of the affected quaternary catchments this is considered to be a medium severity because an increase of runoff will result in a substantial boost of water reserve and downstream water uses.	
Degree to which impact may cause irreplaceable loss of resources	There is no foreseen loss of water resources because this is a positive impact	
Residual impacts	The residual impact is considered to be medium with moderate impacts on surrounding watercourses	

1.4 ADDITIONAL MITIGATION MEASURES

In addition to the measures presented and discussed throughout the impact assessment section, the following management measures should be implemented:

- Good housekeeping practices must be implemented and maintained by clean-up of accidental spillages, as well as ensuring all dislodged material like run-of-mine stockpile are kept within the confined storage footprints. In addition clean-up material and materials safety data sheets for chemical and hazardous substances should be kept on site for immediate clean-up of accidental spillages of pollutants;
- Regularly schedule inspection and maintenance of water management facilities, to include inspection of drainage structures and liners for any in channel erosion or cracks; de-silting of silt traps/sumps and PCDs; and any pumps and pipelines should be maintained according to manufacturer's specifications;
- Vehicles and plant equipment servicing must be undertaken within suitably equipped facilities, either within workshops, or within bunded areas, from which any stormwater is conveyed to a pollution control dam, after passing through an oil and silt interceptor;
- Pollutant storage – any substances which may potentially pollute surface water must be stored within a suitably sized bunded area and where practicable covered by a roof to prevent contact with rainfall and/or runoff;
- Water conservation and water demand management (WC/WDM) measures to ensure that as much water as is possible, is collected and reused; and
- From operations onwards, grading of disturbed area and application of the final layers of growth medium, must be contoured as far as can be achieved in a safe and practical manner; and vegetation of disturbed areas including seeding should be performed immediately following application of the growth medium to avoid erosion.

1.5 MONITORING AND REPORTING RECOMMENDATIONS

A monitoring programme is an essential tool to identify any risks of potential impacts as they arise and to assist in impact management plans. Monitoring should be implemented throughout the life of the project. Recommendations on surface water monitoring are presented in Table 1 -13 below.

Table 1-13: Surface Water Monitoring Programme

Description	Monitoring Location	Frequency of sampling	Frequency of Reporting
Soil Erosion			
Soil erosion and sedimentation monitoring in all soil erosion potential sources	Cleared and compacted areas where the infrastructure will be built. The downstream areas of dams and road crossings.	Monitoring of erosion should occur during construction after every rainstorm or flood event, and during the operational phase monthly during first the wet season or during routine maintenance inspections, as applicable.	After every major rainstorm / flood. Monthly monitoring report compiled by the appointed ECO during the construction phase.
Surface Water Quality			
Ensure that water quality monitoring is implemented up and downstream at the periphery of the 200 m working area	Fourteen water quality monitoring points have been established and provided in the water quality assessment section.	Motoring should be undertaken quarterly.	Reporting should be undertaken after each sampling activity.

Description	Monitoring Location	Frequency of sampling	Frequency of Reporting
Ensure that monitoring is implemented up and downstream at the periphery of the 100 m working area	Monitoring must be undertaken at precisely the same locality as the pre-construction, operation and closure phases monitoring.	Once a month for six months after completion of construction.	Monthly report should be compiled.
Leakage events			
A leak and spill management plan must be formulated to monitor and detect as soon as possible. Site walkovers to determine the condition of facilities and identify any leaks or overflows, blockages, overflows, and system malfunctions for immediate remedial action	Roads and areas where vehicles commute and areas where chemical storage containers are located. Areas where leakage is visible/detected.	Identification of any leakage events should occur monthly during the rehabilitation and construction phase, or directly after a leakage has been detected and for the operational phase, during maintenance activities	Monthly monitoring report compiled by the appointed ECO during the construction, operational and closure phases; and Report should be compiled for three phases of the project.
Infrastructure Monitoring			
Inspection of the temporary channels, and bridges for signs of erosion, cracking and silting to ensure the performance of these remains acceptable.	All proposed infrastructure	Daily during maintenance	Daily. Should erosion occur, measures should be reinstated.

The monitoring plan should be reviewed periodically to ensure the appropriateness of sites and sampling frequency during operation.

Table 1-14: Surface Water Quality Parameters of Concern

Parameters	
pH	Nitrate as N
Electrical conductivity	Ammonia
Total dissolved solids	Potassium
Total suspended solids	Nickel
Aluminium	Manganese
Calcium	Magnesium
Fluoride as F	Iron
Total alkalinity as $CaCO_3$	Copper
Chloride as Cl	Lead
Sulphate as SO_4	Sodium
Uranium	*E.coli*

2. CONCLUSIONS

A summary of the measures developed to ensure compliance to legislative and design standards are provided throughout this report. A monitoring programme is an essential tool to identify any risks of potential impacts as they arise and to assist in impact management plans by assessing if mitigation measures are operating effectively. Monitoring should be implemented throughout the life of the project

All measures implemented for the mitigation of impacts, should be regularly reviewed as best practice and as compliance with various licences issued on site by authorities. The purpose of the mitigation measures is to ensure that the pre-mining / current water resource status is not deteriorated by the mining activities. The project can continue if all mitigation and monitoring measures are to be implemented.