6. ENVIRONMENTAL MANAGEMENT PROGRAMME

6.1 CONSTRUCTION PHASE

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
Access Brown Shaft II Access and maintenance Roads and the Conveyor belt				
Soils	To ensure that the construction of the access and haul roads and conveyor belt has the least possible effect on the immediate soils.	All topsoil removed from the roads will be used to construct a push up berm along the roads. The push up berm will not be more than one meters high. The topsoil used to construct the berm will be used during rehabilitation of the roads. Use areas of degraded status as much as possible to construct the access and haul roads	The mine manager through the environmental co-ordinator will oversee the construction activities and ensure that the above stipulations are adhered to	Immediately after removal of topsoil and while stockpiling the topsoil and during the construction phase
Vegetation	Ensure that the activities does not impacts detrimentally on the surrounding vegetation	Dust suppression should be done for the prevention of vegetation from being affected by the dust generated from the construction sites	The ECO will ensure that the mine adheres to the condition.	During the construction phase and throughout the life of the mine
Surface Water	Surface water quality: To ensure that the runoff water from the mine access and haul roads during construction does not adversely affect clean water	The roads will be constructed such that the berms are used as diversion structures. The berms will be constructed such that any exit point for the water will have silt trap that will settle the silt from the roads before allowing the water to enter the clean water environment.	The Mine manager or his representative will inspect the positioning and construction of the push-up walls and the storm water diversion structures, and ensure that the monitoring inspections are conducted, and maintenance is conducted timeously.	During the construction of the access and maintenance roads and conveyor belt.

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
	environment.			
Air Quality	To ensure that the air quality of the mine and surroundings is not unduly affected by the construction of the access and haul roads	A water cart will be used to wet all affected areas during the construction phase. Watering for dust suppression will be undertaken twice daily.	The Mine manager will appoint a responsible person to oversee the watering of all affected areas.	Twice daily
Sensitive Landscape	Ensure that the construction of maintenance road and the conveyor belt infrastructure does not have a negative impact on wetland areas.	The mine manager will inform all personnel and new recruitment's of the importance of the wetlands as indicated in this document. All wetland areas will be avoided. A buffer zone as recommended by a wetland specialist will be adhered to during the construction of the access and haul roads. No access or haul roads will be constructed within the buffer zone. If the above cannot be attained, all affected wetlands will be marked and soils removed from such areas will be stockpiled separately and used for rehabilitation after mining. A water use licence will also be obtained from the Department of Water Affairs for Shaft Complex and associated Infrastructure falling within 500 of the wetland areas. In addition to the above, the following must be undertaken: Minimize the removal of/damage to vegetation in riparian and wetland areas The construction of roads and the conveyor belt in or adjacent to the	The Mine manager will appoint a responsible person to comply with the requirements as set out in the action plan.	During the construction of the access and maintenance roads and conveyor belt. .

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
		wetland/riparian zone is to be managed and strictly controlled to minimize damage to wetlands Wetlands disturbed during construction should be re-vegetated using site-appropriate indigenous vegetation and/or seed mixes Alien vegetation should not be allowed to colonize the disturbed wetland areas Rehabilitation of disturbed wetland habitat should commence immediately after construction is completed Debris and sediment trapping, as well as energy dissipation control structures, should be put in place where storm water enters the wetland		
Visual Aspects	To ensure that the mining activities have the least possible impact on the visual surroundings.	All surface mining activities will be performed on the smallest possible areas. The construction activities will be undertaken during day time. If any work must be done during night time, arrangements will be made with the relevant land owners.	The Mine manager will ensure that the mining activities conform to the stipulations as set out in this document.	During the construction of the access and maintenance roads and conveyor belt.

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
Excavation of the Shaft and Construction of associated Infrastructure				
Geology	To ensure that the construction of the Shaft does not have detrimental impacts on the geology	No mitigation measures can be undertaken for the predicted impact. However the mine will use removed material to backfill the shaft. All remaining carbonaceous material will be placed at the bottom of the Shaft and should be backfilled with the rest of the overburden material. This will reduce the exposure of the carbonaceous material to free oxygen, hence limiting the formation of acid mine generation.	The mine manager and ECO will ensure that the removed material are properly stockpiled and used for rehabilitation.	During the construction phase of the mine
Topography	To ensure that the construction of the Shaft does not have detrimental impacts on the topography	The Most suitable location for the Shaft area has been chosen in terms of the Geology so as to have a minimal footprint as possible.	The mine manager and ECO will ensure that the removed material are properly stockpiled and used for rehabilitation.	During the construction phase of the mine
Soils	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the soils	Stockpile topsoil to appropriate height hence reducing loss of fertility. Avoid activity at stockpiles. Use of topsoil for rehabilitation of the backfilled opencast pits, hence rehabilitated areas can be used for other purposes.	The ECO will ensure that the topsoil is stockpiled separately from other overburden and that it is stockpiled in terms of recommendation from the soil specialist	During the construction phase of the mine
		Topsoil removed must be stockpiled as per the recommendation from the soil specialist. Use the stockpiled topsoil or soils remove from successive cuts cover the backfilled area. The topsoil used to cover the areas must be seeded with the recommended seed mix to ensure natural vegetation remaining in the soil (seed bank) is re-established.	The mine manager and ECO will ensure that the removed materials are properly used during rehabilitation.	During the construction phase of the mine
Natural	Ensure that the activity does not	Dust suppression should be done for the	The ECO will ensure that the mine	During the construction phase and

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
vegetation	impacts detrimentally on surrounding vegetation	prevention of vegetation from being affected by the dust generated from the construction sites	adheres to the condition.	throughout the life of the mine
Animal Life	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the animal life	The rehabilitation of the disturbed areas must be conducted such the rehabilitated areas will encourage the migration of animals back into the rehabilitated areas.	The mine manager and ECO will ensure that the removed materials are properly used during rehabilitation.	During the construction phase of the mine
Surface water	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the surface water	Divert clean runoff water away from the initial box cuts. Construct a pollution control dam in which all dirty water from the underground workings will be pumped into.	The mine manager and ECO will ensure that the water management structures are constructed and that they are well maintained.	During the construction phase of the mine
Air Quality	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the air quality	Conduct dust suppression daily. Enforce appropriate speed limits for the mine vehicles. Implement a dust and noxious gas minimisation strategy.	The ECO must keep records of the monitoring data and will ensure that any recommendations from the monitoring reports are adhered to.	During the construction phase of the mine
Noise	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the noise	Direct line of sight from receptors, as illustrated in the noise report, to be obscured by a berm/barrier (pink line in figure) for both day and night-time operations. The material, location, and dimensions of the barrier must be constructed as per recommendation by the noise specialist.	The ECO must ensure compliance of the condition.	During the construction phase of the mine
Vibration and Blasting	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the noise and vibration	Best practises must be used during blasting to ensure that the ground vibration and air blast pressure is within acceptable limits. Undertake a full risk assessment in order	The mine manager will ensure that a suitably qualified and competent blaster is employed at the mine	During the construction phase of the mine

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
		to address the aspects and to put proper controls in place.		
		Proper stemming and use of stemming material. Blasts can be delayed when prevailing wind is blowing towards the area of concern and not leaving blasts standing for long periods of time.	The mine manager will ensure that a suitably qualified and competent blaster is employed at the mine	During the construction phase of the mine
		Ensure that the mine employees are issued with earplugs and that they are instructed to use them. Educate employees on the dangers of hearing loss due to mine machinery noise. Undertake an ambient noise monitoring programme and any deviation from the normal and acceptable levels should be addressed promptly	The mine manager and safety officer will ensure that the action plan is adhered to	During the construction phase of the mine
Visual Effects	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the visual effects	A perimeter berm will be constructed around the shaft to shield the shaft away from the nearby traffic and farm owners. Ensure that the shaft and associated infrastructure are removed or rehabilitated during the decommissioning phase.	The mine manager and opencast manager will ensure that the perimeter berms is constructed	During the construction phase of the mine
Sensitive Landscape	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the sensitive	Ensure that all temporary wetland zones are identified and demarcated. No mining will be allowed within a distance specified by the wetland specialist from the wetland zones i.e. a maximum of one hundred metres from	The ECO must ensure that all sensitive landscapes are identified and their functionality determined. The ECO will ensure that a rehabilitation plan for all wetlands to be affected is put in place	During the construction phase of the mine

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
		the edge of the wetlands. On addition to the above, the following will be undertaken: Minimize the removal of/damage to vegetation in riparian and wetland areas No stockpile areas should be located in or within 50 m of the wetlands During the construction and operation phases erosion and siltation measures should be implemented		
Construction of workshops/offices complex at the mine				
Topography	To ensure that the buildings in the complex do not have detrimental impacts on the local topography of the area	The workshop/office buildings will be constructed to have heights that are within acceptable standards and that will not have detrimental effects on the surrounding land users.	The buildings will be designed and approved by the mine management and technical team before construction. The mine manager and safety officer will be responsible for ensuring that the buildings are constructed according to design specifications.	Before and during the construction of the buildings
Soils	Ensure that the construction of the complex do not have detrimental impacts on the soils of the affected area	All removed soils will be stockpiled separately and used during the rehabilitation of the complexes. The height of the stockpiles will be such that the fertility and seed bank of the soils are sustained.	The height of the stockpile will be determined before construction and this will be conveyed to the construction team. The Environmental Co-ordinator (ECO) will monitor the construction of the complexes.	Before and during the construction of the buildings
Land Use and Capability	Ensure that the construction of the complex do not have detrimental impacts on the after mining land use and capability	The area will be rehabilitated such that it approximate the pre-mining land use and capability	The rehabilitation of the area will be planned during its construction phase. The ECO will ensure that the rehabilitation plan for the area is compiled.	Before the construction of the buildings

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
Surface Water	Ensure that the construction of the complex does not have detrimental impacts on the surface water environment	Divert all dirty water within the construction site to a temporary storage dam for settling of the silt. Divert all clean water away from the workshop area to the nearby stream. All waste generated during the construction activities either from the site or the construction crew camp will be collected in bins and disposed properly. A temporary area will be dedicated for the emergency repair of vehicles until a proper workshop is constructed	The positions and size of the temporary dams will be determined before the construction of the complexes. The ECO will ensure that the construction undertaken as per action plan.	Before the construction of the buildings
Air Quality	Ensure that the construction of the complex does not have detrimental impacts on the air quality	Water carts will be used or the suppression of dust from the construction site.	The ECO will ensure that dust suppression is conducted during construction activities and that the dust suppression efficiency is ensured.	Dust suppress at least twice daily
Noise	Ensure that the construction of the complex does not have detrimental impacts on the nose levels within the vicinity of the construction site	Well serviced vehicles will be used on site. Work will be conducted during the day and will be stopped at night time. Arrangements will be made with the land owner if work will be continued at night.	The mine manager will ensure that competent contractors are employed for the construction of the complexes	Before and during construction of the complex.
	Ensure that the construction of the complex does not have detrimental impacts on the noise levels within the vicinity of the construction site	Direct line of sight from receptors, as illustrated in the noise report, to be obscured by a berm/barrier (pink line in figure) for both day and night-time operations. The material, location, and dimensions of the barrier must be constructed as per recommendation by the noise specialist.	The ECO must ensure compliance of the condition.	During the construction and operational phases of the mine
Sensitive	Ensure that the construction	The complexes will be sited such that	The mine manager and ECO must ensure	Before and during construction of

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
Landscapes	activities do not have detrimental impacts on the wetland areas	they are away from the recommended buffer zones of the identified wetland areas. Note that the currently sited complexes are away from the wetland zones. Operation & storage of equipment in the riparian and wetland zones to be prevented No construction camps should be allowed in or within 50 m of the wetlands Construction should preferably take place during the low flow/winter months in order to minimise the risk of sediment and debris being washed into wetlands	that the sitting of the complexes for the contractors avoids the identified wetland areas	the complex
Construction of the Overburden Stockpiling Areas and Associated Water Management Structures, PCD, Ventilation Shaft and the dirty water and raw water pipeline				
Topography	To ensure that the Overburden Stockpiling Areas, pollution control dam, ventilation shaft and pipelines do not have detrimental impacts on the local topography patterns.	Ensure that the structures are constructed to have heights that are within acceptable standards and that will not have detrimental effects on the surrounding land users and owners.	The overburden stockpiling areas, water management structures and pipelines will be designed by suitably qualified persons before their construction. The ECO and the mine manage will ensure that the structures are constructed to design specifications	Before and during construction of the complex
Soils	Ensure that the construction of the overburden stockpiling areas, associated water management structures, pollution control dam, ventilation shaft and pipelines do not have detrimental impacts on the soils of the affected area and its	All removed soils will be stockpiled separately and used during the rehabilitation of the disturbed areas. The height of the stockpiles will be such that the fertility and seed bank of the soils are sustained. Activities should be limited to area of disturbance. Where required the	The height of the stockpile will be determined before construction and this will be conveyed to the construction team. The Environmental Coordinator (ECO) will monitor the construction of the structured.	Before and during the construction of the buildings

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
	surrounds.	compacted soils should be disked to an adequate depth and re-vegetated with indigenous plants. Soil from the pipeline trench and pollution control dam should be used for the rehabilitation of disturbed areas.		
	Ensure that during construction hydrocarbon contamination of the soils is minimised or prevented	Truck, machinery and equipment will be regularly serviced to reduce risk of leaks. Any leakages should be reported and treated immediately in a reputable manner with spill kits which should be provided for on site. For large spills a hazardous materials specialist will called in.		
Land Capability	Ensure that the construction of the overburden stockpiling areas, associated water management structures, pollution control dam, ventilation shaft and pipelines do not affect the ability of the mine to revert the land to decide after mining land use	The area will be rehabilitated such that it approximate the pre-mining land use and capability is achieved	The ECO will ensure that during construction all necessary measures are undertaken to ensure that the disturbed areas is protected.	Before and during construction of such structures
Surface Water	Ensure that the construction of the structures do not have detrimental impacts on the surface water environment	Divert all dirty water within the construction site to a temporary storage dams for settling of the silt. Divert all clean water away from the construction sites area to the nearby stream. All waste generated during the construction activities either from the site or the construction crew camp will be collected in bins and disposed properly.	The positions and size of the temporary dams will be determined before the construction of the complexes. The sizes of the waste collection and management facilities will be determined. The ECO will ensure that the construction undertaken as per action plan.	Before and during the construction of the structures

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
		Facilities for the management of sewage waste (conservancy tanks) and grey water will be installed on site A temporary area will be dedicated for the emergency repair of vehicles until a proper workshop is constructed Construct the pollution control facilities as per the mining plan. These facilities will be constructed to be in compliance with the designs specifications of a suitably qualified civil engineer. Design and construct the pipeline infrastructure in accordance with the designs specifications recommended by the qualified engineer in order to avoid any negative impacts on the tributaries of the Bankspruit. Gabion mattresses should be used to avoid erosion. Design and construct the Vent shaft infrastructure in accordance with the designs specifications recommended by the qualified engineer in order to avoid any negative impacts on the tributary of the Spookspruit.		
Groundwater	Ensure that the future use of the area does not have a detrimental impacts on the groundwater regime	Use suitably qualified engineers to design the overburden stockpiles, pollution control facilities and pipelines. These structures must also be constructed according to the design specifications. If groundwater is encountered during the construction of the pipeline trench, the	The Mine Manager and the ECO will ensure that the designs and construction undertaken as per action plan.	Before and during the construction of the structures

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
		trench invert level should be sloped to facilitate drainage.		
Air Quality	Ensure that the construction of the structures do not have detrimental impacts on the air quality	Water carts will be used or the suppression of dust from the construction site.	The ECO will ensure that dust suppression is conducted during construction activities and that the dust suppression efficiency is ensured.	Dust suppress at least twice daily
Noise	Ensure that the construction of the structures do not have detrimental impacts on the noise quality	Well serviced vehicles will be used on site. Work will be conducted during the day and will be stopped at night time. Arrangements will be made with the land owner if work will be continued at night. It is recommended that no mining activity takes place 250m within a receptors property. If mitigation of noises at certain receptors is not technical feasible or possible, the receptor must either be relocated or the boundary of noisy activity moved.	The mine manager will ensure that competent contractors are employed for the construction of the complexes	During the construction and operation of the complex.
	To ensure that the construction of the shaft and associated infrastructure does not have detrimental impacts on the noise	Direct line of sight from receptors, as illustrated in the noise report, to be obscured by a berm/barrier (pink line in figure 7-12) for both day and night-time operations. The material, location, and dimensions of the barrier must be constructed as per recommendation by the noise specialist.	The ECO must ensure compliance of the condition.	During the construction phase of the mine
Sensitive Landscapes	Ensure that the construction activities (Pipelines and ventilation shaft) do not have detrimental impacts on the identified wetland areas	The structures will be sited such that they are away from the recommended buffer zones of the identified wetland areas. If the structures are within the wetland areas, a water use licence will obtained	The mine manager and ECO must ensure that the construction of the structures is at the designed positions and that all legal requirements are met before construction of the structures.	Before and during construction of the complex

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule
		before construction of such structures. Minimize the removal of/damage to vegetation in riparian and wetland areas Operation & storage of equipment in the riparian and wetland zones to be prevented. No construction camps should be allowed in or within 50 m of the wetlands Construction should preferably take place during the low flow/winter months in order to minimise the risk of sediment and debris being washed into wetlands. During the construction and operation phases erosion and siltation measures should be implemented (e.g. temporary silt traps downstream of construction areas should be employed) Design and construct the pipeline infrastructure in accordance with the designs specifications recommended by the qualified engineer in order to avoid any negative impacts on the tributaries of the Bankspruit and Spookspruit. Gabion mattresses should be used to avoid erosion.		
ISSUES RAISED BY INTERESTED AND AFFECTED PARTIES				
No issues have been raised by Interested and Affected parties during the Scoping Phase. Any comments received during the Draft EIA consultation period, will be incorporated into the Final EIA.				

6.2 OPERATIONAL PHASE

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule	Annual Cost
Systematic Removal of the Target Coal Seams by Underground Mining Methods					
Topography	To ensure that the removal of coal by underground mining methods do not detrimentally affect the topographical patterns of the area mined.	The Solomon's safety factor of 1,6 for the underground pillars will be used for the pillar. This will prevent the disruption of the overlaying geological structure hence limiting the impact on the coal seam strata and preventing subsidence of the area. No areas with surface infrastructure will be undermined. If the areas cannot be avoided, a higher safety factor approved by a suitably qualified person e.g., qualified and competent rock engineer. The use of mechanical continuous miners during the removal of the coal seam will ensure that blasting is kept to a minimum, and only utilised in areas where dolerite is encountered. This reduces the possibility of fracturing of the overlying or underlying strata during mining. All undermined areas with surface infrastructure will be monitored for subsidence. If subsidence does occur despite the use of the recommended safety factor, Anglo will ensure that the incident is investigated and cause of the incident found. Based on the findings, measures such as increasing the safety factor will	The mine manager through the safety officer, surveyor and mining operators and the environmental co-ordinator will ensure that the action is adhered to.	During mining using underground mining methods	

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule	Annual Cost
		be undertaken to prevent reoccurrence of pillar failure. Areas with subsidence will be identified and reshaped to free draining topography. The rehabilitated areas will then be monitored on a regular basis.			
Natural vegetation	Ensure that the activity does not impact detrimentally on the natural vegetation	Dust suppression should be done for the prevention of the vegetation from being affected by the dust generated from the construction sites	The ECO will ensure that the mine adheres to the condition.	During the construction phase and throughout the life of the mine	
Groundwater/ Sensitive Landscapes	To minimise impacts of mining on groundwater	Static groundwater levels of boreholes around the proposed mining operation, including existing boreholes within a zone of two kilometres from the mine, will be measured on a quarterly basis. If it can be proven that the mining operation is indeed affecting the quantity of groundwater available to certain users, the affected parties will be compensated. If it can be proven that the mining operation is indeed affecting the quantity of groundwater available to wetland areas, Anglo Operations will be liable for rehabilitation of the affected wetland.	The Mine manager or his representative will keep record of the monitoring data for the proposed mine.	During the mining of the proposed underground reserves	
Air Quality	To ensure that the employees' health is not affected by the dust generated at the mine workings.	Dust suppression will be undertaken in the mine workings. The employees will be issued with dust masks and instructed to use them.	The Mine manager will appoint a responsible person to oversee the action plan is adhered to.	Dust suppression should done as when necessary and the employees must use their dust masks when working in dusty areas	
Noise	To ensure that the employees'	The employees will be issued with	The Mine manager and safety officer will	The employees must use their	

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule	Annual Cost
	health is not affected by the noise levels generated at the mine workings.	earplugs and instructed to use them. A buffer distance of 900 meters for a directional ventilation fan facing any receptor during the night-time (data taken from a reasonably "loud" fan, facing a receptor i.e. a worst case scenario) must be adhered to. If a directional ventilation fan is proposed closer than this distance, other mitigation options need to be investigate including, changing the direction, implementing an acoustical shielding or implementing a berm/barrier.	appoint a responsible person to oversee the action plan is adhered to.	earplugs when working is noisy areas During the construction and operational phase of the mine	
Sites of archaeological and cultural importance	Based on the Heritage Impact Assessment Report, no site of significant archaeological or cultural interest has been identified over the proposed Access Brown Shaft II area.				
Use of Conveyor belt for the Transportation of Coal					
Soils and Natural Vegetation	To ensure that during the transportation of coal contamination of soils and vegetation is minimised.	All conveyors used for the transportation of coal must be covered during coal transportation. All spilled coal along the conveyors will be cleared within one day of spillage.	The mine manager and safety officer will ensure that the length of the conveyor is inspected regularly.	Trucks will be covered when transporting coal and spillages will be cleared within one day of spillage	
Natural vegetation	Ensure that the activity does not impacts detrimentally on the vegetation	All spilled coal along the conveyors will be cleared within one day of spillage.	The ECO will ensure that the mine adheres to the condition.	During the construction phase and throughout the life of the mine	
Noise	Ensure that the use of the	If applicable haul roads to be used	The mine manager and safety officer will	During the operational phase of	

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule	Annual Cost
	access and haul roads do not have detrimental impacts on the nearby receptors	during the night-times should be routed as far as possible away from a receptor.	ensure that the vehicles obey the recommendations made in this action plan.	the mine	
Noise and vibration	Ensure that the property and owners of such properties are not detrimentally affected by the blasting conducted at the mine.	A qualified blasting expert will be employed to design the blasting such that nearby residents are not affected by vibration, air blast and fly rock.	The mine manager, safety officer, environmental co-ordinator and qualified blaster will ensure that the mine comply with the recommendations made in this action plan.	During the construction and operational phases of the mine	
Sensitive landscape	Ensure that the use and maintenance of the roads do not result in detrimental impacts of the identified wetland areas	Any wetlands that could have been disturbed during construction should be re-vegetated using site-appropriate indigenous vegetation and/or seed mixes Alien vegetation should not be allowed to colonize the disturbed wetland areas Rehabilitation of disturbed wetland habitat should commence immediately after construction is completed Where vegetation removal has occurred adjacent to the new roads, monitoring should take place to ensure successful re-establishment of natural vegetation. Alien vegetation should be removed from these disturbed areas on an on-going basis to ensure the successful re-vegetation by indigenous species	The mine manager and environmental co-ordinator will ensure that the mine comply with the recommendations made in this action plan.	During the construction and operational phase of the mine	
Use of Workshop Buildings, Office and Other Associated Infrastructure					
Surface Water	Ensure that the use of the buildings do not result in the contamination of the environment by the waste	Solid waste generated from the buildings will be collected at three bins (foods, paper and cardboard) and either	The ECO will ensure that the workshops and offices have the waste collection system in place in order to adhere to the action plan.	During the operational phase of the mine	

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule	Annual Cost
	generated from the site.	recycled or collected by contractor for disposal to a registered municipal landfill site. Sewage from the ablution facilities at the offices will be drained into a septic tank that will be connected to a conservancy tank. A contractor will be employed to collected and dispose of the waste into a municipal sewage treatment plant. Used oil from the workshops will separated via oil separators and stored in drums for collection by a contractor, who will either recycle or properly dispose of the oils. The water from the separated oils will be re-used at the workshops. All areas to be used for the handling of hydrocarbon waste will have concreted walls and floors. Used rags and filters will be stored in drums dedicated for such waste. Other recyclable waste such as tyres and scrap metal will be sorted in the scrap yards and sold to recycling companies.			
Operation of the Water Management Structures (Pollution control dam and pipelines)					
Topography	Ensure that the operation of the pollution control dam, pipelines and diversion structures do not have	The pollution control dam will be designed, constructed and operated to have profile that will easily blend with the surrounding topography	The mine manager and the mine engineer with the assistance of the ECO will ensure that the dam and diversion trenches are constructed and operated in accordance	During the operational phase of the mine	

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule	Annual Cost
	detrimental effect on the local topography		with the designs approved by the Department of Water Affairs.		
Natural vegetation	Ensure that the operation of the pollution control dam, pipelines and diversion structures do not have detrimental effect on the surrounding natural vegetation	Limit the operation of the pollution control dam and diversion structures to area of disturbance and re-vegetate impacted areas as soon as possible.	The mine manager and the mine engineer with the assistance of the ECO will ensure that the pollution control dam and diversion structures is constructed and operated in accordance with the action plan	During the operational phase of the mine	
Soils	Ensure that the operation of the pollution control dam, pipelines and diversion structures do not have detrimental effect on the surrounding soils	The pollution control dam and its associated structures should be limited to area of disturbance. Where required the compacted soils should be disked to an adequate depth and re-vegetated with indigenous plants.	The mine manager and the mine engineer with the assistance of the ECO will ensure that the pollution control dam and diversion structures is constructed and operated in accordance with the action plan. The pipelines will be installed with leak detection systems.	During the operational phase of the mine	
Surface Water	Ensure that the transportation of water through the pipeline does not detrimentally impact on the surrounding water environment.	The pipelines will be installed with a leak detection system. Any spillages should be reported and treated immediately in a reputable manner.	The mine manager and the mine engineer with the assistance of the ECO will ensure that the dam and pipelines are operated according to the approved design reports.	During the operational phase of the mine	
Surface Water	Ensure that the operation of the pollution control dam, pipelines and diversion structures do not have detrimental effect on the surrounding water environment	The mine will ensure that water management facilities are operated adequately in accordance with GN704. All silt build up will be cleaned out over dry season preferably at the silt traps to be constructed at the entrance point of the dam. The integrity of lining and management structures will be tested regularly.	The mine manager and the mine engineer with the assistance of the ECO will ensure that the action plan is adhered to.	During the operational phase of the mine	
Groundwater	Ensure that the operation of the pollution control dam, pipelines and diversion	The pollution control dam and diversion structures will be designed, constructed and operated to have a lining and an	The mine manager and the mine engineer with the assistance of the ECO will ensure that the action plan is adhered to.	During the operational phase of the mine	

Environmental Component	Objectives/specific goals	Action	Technical and Management Options	Time Schedule	Annual Cost
	structures do not have detrimental effect on the surrounding groundwater environment	emergency subsurface drain that will capture seepage water. Any leakage will be returned to the pollution control dam and the leaking area repaired. The pollution control dam and diversion structures will be operated in accordance with GN704 requirements			
Topography	Ensure that the operation of the pollution control dam, pipelines and diversion structures do not have detrimental effect on the local topography	The pollution control dam and pipelines will be designed, constructed and operated to have profile that will easily blend with the surrounding topography	The mine manager and the mine engineer with the assistance of the ECO will ensure that the dam, pipelines and diversion trenches are constructed and operated in accordance with the designs approved by the Department of Water Affairs.	During the operational phase of the mine	
Natural vegetation	Ensure that the operation of the pollution control dam, pipelines and diversion structures do not have detrimental effect on the surrounding natural vegetation	Limit the operation of the pollution control dam and diversion structures to area of disturbance and re-vegetate impacted areas as soon as possible.	The mine manager and the mine engineer with the assistance of the ECO will ensure that the pollution control dam, pipelines and diversion structures is constructed and operated in accordance with the action plan	During the operational phase of the mine	
Sensitive landscape	Ensure that the use of the pipelines do not result in detrimental impacts of the identified wetland areas	The pipelines will be installed with a leak detection system to detect spillages early. The pipelines should be regularly inspected and maintained. Any spillages should be reported and treated immediately in a reputable manner.	The mine manager and the mine engineer with the assistance of the ECO will ensure that the pipelines are constructed and operated in accordance with the action plan	During the operational phase of the mine	
ISSUES RAISED BY INTERESTED AND AFFECTED PARTIES					
No issues have been raised by Interested and Affected parties during the Scoping Phase. Any comments received during the Draft EIA consultation period, will be incorporated into the Final EIA.					

6.3 DECOMMISSIONING PHASE

Most of the impacts identified for the operational phase will continue during the decommissioning phase, hence all mitigation and environmental management programmes planned for the operational phase will be continued throughout the decommissioning phase.

However new impacts will emanate from the areas that has been removed of the surface infrastructure. These will virtually involve the entire mining area where rehabilitation is either been done or has been done. Below is the programme to manage any new impacts that may arise from the mining area either being rehabilitated or area that has just been rehabilitated. Note that some of the mitigation measures will be applicable for the areas being rehabilitated during the operational phase.

6.3.1.1 Infrastructure Areas

All concrete, steel works and structures will be removed so that the land can be returned to as near as practically possible to its original state. Concrete work that extends below ground level will be removed to a metre below the surface. Concrete, brick and mortar will be used as backfilling material in the shaft area. Steel will be sold as scrap metal.

All rehabilitated areas will be shaped to be free draining without concentrating flow such that erosion occurs, fertilised and a mixture of indigenous and pasture grasses will be planted. Following this rehabilitation the infrastructure areas will have a capability similar to the pre-mining environment.

All rehabilitated areas will be maintained for a period of 3 years, where after the frequency will be reassessed. Vegetation cover will be maintained by annual application of fertiliser combined with biennial cutting or burning for the first three years. After this period, fertilizer will be applied as and when required.

Maintenance with respect to erosion will be conducted on a minimum three monthly basis if and where required. This frequency will be reassessed after a 3-year period. The final rehabilitated surface will be stable, self-sustaining and erosion-free.

All roads not required for residential or farming purposes, and overland conveyors will be removed and the ground restored as above.

6.3.1.2 Roads, Railways and Overland Conveyors

All infrastructure associated with the mining operation will be removed and the surface on which it was situated to be returned, as close as is practically possible, to the original land use.

6.3.1.2.1 Roads

- Access and maintenance roads will be rehabilitated. All gravel roads will be graded to remove foundation material to the final voids or a facility for disposal. The roads will be cross-ripped to 300 mm at right angles to the natural slope, fertiliser added as per soil requirements and vegetated with a seed mix of indigenous and pasture grasses. Maintenance will be conducted on the rehabilitated areas.

6.3.1.3 Workshops and Stores

The bulk of the activity in removing the workshops, stores and administration buildings will be the demolition and disposal of concrete structures. Metal will be removed and sold. Rubble will either be removed to the co-disposal facility or used as shaft backfill and all scrap metal will be cleared from the area and sold.

If any soils are contaminated with hydrocarbons, they will be bio-remediated.

6.4 Mine Closure

Objective	:	To minimise all impacts of mining on the environment during and after closure.
Specific Goals	:	Ensure that surface water exiting the property will not have a significant increase in water born pollutants measured against the incoming surface water. Maintain post mining land use as grazing land. Ensure that the area is free of erosion and have a sustainable vegetation cover. Ensure that the ground water within the surrounding areas is fit for use. Ensure that the interested and affected parties are not detrimentally affected by the mine

6.4.1 Spread of Groundwater Pollution Post mining

Predictions in the previous sections regarding groundwater pollution have been based on the assumption that the rehabilitated pit will be a constant source of sulphate pollution of 2000 mg/l, representing a worst-case scenario. With appropriate measures, the oxidation rate of pyrite can be limited, resulting in lower starting concentrations. Furthermore, the migration of the pollution plume from the void can also be limited by surface rehabilitation measures preventing excessive infiltration of groundwater to the mined area. Thus, , further reduction is achievable.

To minimise the effect of groundwater pollution on the receiving environment, the following measures are suggested:

The final mine topography should be engineered such that runoff is directed away from the rehabilitated area.

Mining should remove all coal and as little as possible should be left in the underground.

Coal bearing mining wastes must be placed in the lowest practical areas and flooded as soon as possible for similar reasons.

Furthermore, the underground should be flooded as soon as possible to bar oxygen from reacting with remaining pyrite.

Quarterly groundwater sampling must be done to establish a database of plume movement trends and to aid eventual mine closure. It is essential to provide a reliable database to facilitate eventual closure of the mining operation.

Leaving a final void in the underground areas must be investigated. Once final mining plans are available, it will be essential to model this option.

Regular sampling and chemical analyses of the groundwater is imperative to establish a sound database:

Groundwater in all boreholes within a distance of less than two kilometres must be sampled regularly to establish a database against which future groundwater levels can be compared.

Sampling must be preferably quarterly, but at least twice annually, following the dry – and rainy seasons.

If it is found during such a sampling event that groundwater from any extraction borehole is polluted beyond acceptable standards, alternative water will have to be supplied to the affected party.

6.4.2 Final Rehabilitation (Erosion and Dust Control)

All rehabilitated areas will have been seeded with a recommended seed mix. No erosion is expected to occur following vegetation establishment, thus no dust control will be necessary.

6.4.3 Final Rehabilitation (Roads and Final Voids)

No roads will remain in place after the decommissioning phase. Note that the roads will be graded during this phase, in order to remove any fine carbonaceous material build-up from the roads. These will then be ripped to 150mm, at 90° to the inherent slope, and seeded with a seed mix recommended in this document.

Volumetric modelling of the material to be removed from the opencast pit indicates that the shaft will be rehabilitated to surface and subsequent shaping of the pit will allow for the re-establishment of natural runoff patterns, thus the area will be free draining.

No final voids or water management dams will remain after mining.

6.4.4 Final Land Use

All topsoil material removed from the mining area will be replaced during the rehabilitation of the area. It is not normally immediately possible to restore arable land to its former capability. However, it is possible to upgrade disturbed land to grazing land. In view of the above, the final land use for the Access Brown Shaft II will be grazing land.

6.4.5 Interested and affected parties

In addition to the above, Anglo Operations Limited will on a regular basis communicate with the interested and affected parties. A most efficient way of communication with the interested and affected parties will be determined on commencement of mining and will be used by the mine during operational and closure phase of the mine. Records of such communication will be kept at the mine offices.

SECTION SEVEN

Environmental Awareness Plan

7. ENVIRONMENTAL AWARENESS PLAN

7.1 ENVIRONMENTAL AWARENESS PLAN

In terms of section 33(j) of the National Environmental Management Act, 107 of 1998, Environmental Impact Assessment Regulations 2010, Anglo Operations Limited must compile and implement an environmental awareness plan. The above-mentioned environmental awareness plan must describe the manner in which the mine (in this case Access Brown Shaft II) will inform their employees of any environmental risk which may result from their work and the manner in which the environmental risks will be addressed to avoid pollution or/and degradation of the environment. This document, therefore concerns the details of the environmental awareness plan for Anglo Operations Limited at Access Brown Shaft II as required by the National Environmental Management Act, 107 of 1998. In view of the above, Anglo Operations Limited has developed an environmental awareness plan for the proposed Access Brown Shaft II, which is explained in more detail below.

Note that the responsible person will revise these environmental awareness procedures from time to time. The date of commencement of the revised procedure will always be indicated to prevent confusion, in this case after the issuing of environmental authorization to Anglo Operations Limited.

This Environmental Awareness (Standard Training Procedure) sets out the mine's training objectives regarding to environmental awareness. It is a stand-alone procedure, which serves to improve awareness, training and competency in the environmental field. It contains no detail on the actual training initiatives but rather serves to ensure that a responsible person is appointed to deal with and increase environmental awareness on the mine.

7.1.1 Environmental Awareness Plan

7.1.1.1 Definitions and Abbreviations

The following standard definitions and abbreviations can be found in this procedure

Table 18:Standard definitions and abbreviations for the environmental awareness plan

Term	Definition
EMS	Environmental Management System
STD	Standard
SHE	Safety, Health & Environmental
ISO	International Standard of Organisations
	All definitions in ISO 14001 Standard
HOD	Head of Department
PTO	Planned Task Observation

7.1.1.2 Purpose

- To ensure that staff are competent through Environmental training. Competence will only be proven through assessment by relevant line supervisors/management.
- Training is essential to ensure that the responsibilities in EMS can be fulfilled at each relevant function and level, and to meet the challenge of continual improvement. It is essential that key personnel whose work may create a significant impact on Environment be trained.
- Resources for training should ensure that adequate competent personnel are available to cover any eventuality.
- To explain and aid the personnel involved in training with regards to EMS.
- To clarify the EMS training and ensure that all employees are correctly instructed with regards the environment.

7.1.1.3 Scope

This procedure sets out the mine's training objectives with regard to environmental awareness and EMS. It is a stand-alone procedure which serves to improve awareness, training and competency in the environmental field. It contains no detail on the actual training initiatives, but rather serves to ensure that a responsible person is appointed to deal with and increase environmental awareness on the mine.

7.1.1.4 Description of Activity

No	Activity / Procedure	Roles and responsibility
1.	**GENERAL** Awareness training must include the potential consequences of departure from specified operating procedures as well as significant environmental impacts, actual or potential, of their work activities. Training will be appropriate to the activity of individual employees.	
2.	**INDUCTION PROGRAMME** Training programmes shall, be established and maintained for colliery personnel contractors and visitors, refer to Training Standard Procedures PT007 & PT008 – Induction procedures.	Training Manager
	Training shall include the following: • Administrative requirements and procedures which will include the EMS and Emergency Procedures. • The computer system and the	Environmental Coordinator & Training Manager

	operation of the computer (inputs and outputs) as relevant to the tasks of the trainee (where applicable). • Resource conservation and environmental reporting and general environmental awareness for mine related environmental issues.	
	Contractors that are employed on the colliery must, prior to any starting of working activities, complete the contractor's pack. This package requires the contractor to perform SHE Risk assessments on the activities to be undertaken. The entire risk assessment process and the applicable EMS procedures are referenced within the contractor's package.	Environmental Coordinator
	Environmental Induction slides/presentation shall be revised annually. Induction is valid for the period of year hence refresher shall be done after 365 days. Oil Spill Response training shall be part of induction program..	Training Manager
3.	**TRAINING NEEDS**	
	Training and awareness needs shall be identified as per the significant impact impact per job category.	Training Manager and Section Heads
	Training needs shall be identified through: • Performance appraisal; • Analysis of non-conformances and incidents; • Audit findings and recommendations; • At time of recruitment (in the work place); • Training needs analysis; • Impact/Aspect Register • Additions to scope in services provided; • The updating of procedures (quality, technical and administrative).	Training Manager and Section Heads
	Training needs will also be identified through work performance, request by employee and work area review as per Training Procedure 004 – Identification of Training Needs. Once training needs have been established it is up to the supervisor to notify the Training	Section Heads

	Department of the requirements. The training department will then identify pertinent and relevant courses (if not already done so by employee/supervisor) and schedule training accordingly.	
	A training matrix will be generated from Training needs analysis.	Training Manager
	Monthly Environmental Theme will be distributed to all in the mine including contractors. Environmental Days celebrations are done to enhance awareness to employees and local communities (water week, environmental Week, Arbor week etc.). Daily Safety, Health and Environmental bulletin is used to communicate environmental tips to all employees.	Environmental Coordinator
4.	**TRAINING PLANNING**	
	Identified and agreed training needs shall be included in budgets and processed as described below. Course attendance (other than at the internal induction courses) shall be scheduled on the basis of the importance of task contribution to the maintenance, effectiveness and improvement of the objectives.	Section Heads
	Training expenses, including conferences and symposia would be checked and approved by the Head of Department. The Training Department shall complete a course authorisation form and ensure that the procedures are followed regarding course bookings, confirmations and payments.	HODs
	Planning of training for job specific training (done through training needs analysis) will be co-ordinated between the Training Manager and the relevant Section Heads. This will result with on time training schedule for job specific training on the mine.	Training Manager
	The Trainee shall : Obtain approval from the Head of Department Request Training Department to make official booking.	Training Manager And Section Heads
	External training courses shall be accessed through : Attendance by, and the formal reports and recommendations of, staff Recommendation by known competent	Employees

	external personnel Review of course content, presenters, location and facilities by knowledgeable personnel	
5.	**EMS TRAINING**	
	Colliery Personnel:	Training Manager
	All employees, current and new, and contractors will undergo induction, a part of which is environmental awareness training and includes the environmental policy. Depending on a person's job category training will be performed on significant aspects pertinent to his/her area of work. The job category is linked to the environmental training needs analysis matrix of Bank Colliery. At the end of this training, personnel will be required to complete the awareness test and the level of awareness assessed by the Training Department. Re-testing or induction may be required if test was failed.	
	All personnel performing tasks which can cause significant or major environmental impacts shall be competent on the basis of training, education and/or experience.	Training Manager
	Visitors:	
	All visitors to any controlled access areas of the Colliery will undertake a shorter "visitors induction", which highlights the main safety and environmental aspects relevant to short term visitors at the mine.	
	EMS Representatives:	
	The EMS Representatives shall have additional EMS knowledge requirements. The EMS Representatives shall receive the training required to manage the EMS efficiently in their areas of responsibility. Such skills include the operation of the SHE legal register and the electronic database (PIVOT V6-Training Manual 1.03), as well as thorough knowledge of the environmental procedures.	Section Heads
	Standard Procedures:	
	Employees and contractors shall be made aware of Environmental Standard Operating procedure related to their activities which might have environmental impacts e.g. waste management, oil management etc.	Section Heads

	Evaluation and Competence:	
	Definition: The Training Department and Line Management's role is to ensure that all mine regulations and procedures required by the various indicated legislation (paragraph 6) are such that theoretical knowledge and operational skills all pivot around competency. A competent person means a person who: 1). a) is qualified by virtue of his/her knowledge, training, skills and experience to organise the work and its performance; b) is familiar with the provisions of legislation applicable to his/her work; c) has been trained to recognise any potential or actual danger (significant aspects) to the environment, but also safety and health, in the performance of the work; and/or 2) is in the possession of the appropriate certificates of competency where such certificate is required by these regulations or legislations.	Environmental Coordinator
	Competency does not merely mean showing or training an employee on a task so that he knows how to do it. Proving competency, the employee must know the Who, What, When, How and Why pertaining to the task as well as the hazards and risks associated with performing the task.	Section Heads
	Capacity and awareness training will be carried out by Environmental Coordinator and Training Manager and evaluation of awareness and competency training (implementation of training in the work place) will be carried out by the Line Managers through PTOs or through approved accredited training providers. Awareness and competence will also be reviewed during audits, events of an emergency, and incident. Typical competence assessments include training programmes both formal and informal, PTOs, questioning employees, experience, checklists, qualifications and ability to do the work. Gaps identified shall be referred to Training department.	Section Heads
	This awareness plan shall be kept up to date.	Training Manager and Environmental Coordinator

7.1.1.5 Legal Requirements

- Employment Equity Act 55 of 1998 – AREAS WHERE EMPLOYMENT EQUITY ARE DEFINED, INCLUDING TRAINING & DEVELOPMENT
- National Environmental Management Act 77 of 1998 – RECOMENDATIONS FOR INSTITUTIONAL CO-OPERATION
- Mine Health & Safety Act 29 of 1996 – COMPETENT PERSON TRAINING
- Section 39(3) (c) of the MPRDA- Environmental Awareness Plan

7.1.1.6 Records

The following records shall be maintained by the Training Department:

- Personnel qualifications
- Training needs and Training Matrix
- Certificates
- Licenses
- Training programmes/courses attended
- Staff induction

Performance appraisals are kept by the Human Resources Department due to their sensitive nature.

Copies of checklists and PTO's will be kept by the relevant sections and the training department.

All foregoing records will be maintained in the employee's personnel files, Training Department records section and Site Manager's records where applicable. Induction training is the responsibility of the Training Manager as well as all other forms of external training facilities/courses/venues etc. EMS training is co-responsibility shared with the Environmental Co-ordinator.

8. CONCLUSION AND RECOMMENDATIONS

The purpose of this final chapter is to:

Summarise the main recommendations of the impact assessment to mitigate significant negative impacts and enhance benefits,

Briefly discuss how the objectives of the report have been met,

Provide an indication of how complete the information in this report is for decision-making purposes.

8.1 KEY RECOMMENDATIONS

The key recommendations = relate to significant impacts and potential significant impacts of the proposed project. These recommendations are outlined below.

8.1.1 Recommendations Relating to Impacts on Soils

Topsoil from the overburden stockpiling site, access/haul roads and pollution control dam sites should be stripped prior to use of the area and the stripped topsoil must be used for rehabilitation after the use of the sites.

As far as possible, stripped topsoil should be stockpiled upslope of the each site.

The topsoil stockpiles must be placed upslope or outside the dirty water areas.

The broad soil groups suitable for rehabilitation purposes should be stockpiled separately from less suitable broad soil groups and all topsoil must be stockpiled separately from the subsoil material.

Soil depth and volumes to be used during rehabilitation must comply with the rehabilitation budget.

Wetland degradation should be prevented. All infrastructure should be constructed and designed by a qualified engineer.

8.1.2 Recommendations Relating to Impacts on vegetation and fauna (biodiversity)

The land use of the area is dominated by cultivation and grazing and old mined out areas. Infrastructure will be placed on a historically disturbed area hence impacts on the natural vegetation will not be extensive.

8.1.3 Recommendations Relating to Impacts on surface water

It is recommended that all dirty water emanating from the infrastructure area be contained, clean water be diverted away from the dirty water areas of the infrastructure area. All dirty water

management structures must be designed to handle water from flood events (1:50 and 1:100 year flood event).

8.1.4 Recommendations Relating to Impacts on Groundwater

Since it is inevitable that a mining operation of this scale will impact on the groundwater regime, measures to manage and reduce these impacts to the absolute minimum must be considered. The identified negative impacts of reduction of the groundwater levels during mining and the spread of groundwater pollution after closure of the underground will be addressed in the following paragraphs.

Lowering of Groundwater Levels during Mining

Since the drawdown or the groundwater levels during mining could influence some boreholes, the following measures are recommended:

In the event of groundwater encountered during the adit development, precementation can and should be used to restrict inflow thereby negating excessive drawdown.

The static level of groundwater in all boreholes within a distance of less than one kilometre must be measured regularly to establish a database against which future groundwater levels can be compared.

Such measurements must be made preferably quarterly, but at least twice annually, following the dry and rainy seasons.

In the event of unacceptable decrease of the yield of any affected boreholes, alternative water supply should be supplied to the affected parties until such time that the groundwater recovers following closure of the pit.

It is highly recommended that board-and-pillar mining be used in the construction phase with the pillars being left intact with sufficient strength to keep the overlying strata from collapsing in the decommissioning phase.

Spread of Groundwater Pollution Post-mining

Predictions in the previous sections regarding groundwater pollution have been based on the assumption that the rehabilitated pit will be a constant source of sulphate pollution of 2000 mg/l, representing a worst-case scenario. With appropriate measures, the oxidation rate of pyrite can be limited, resulting in lower starting concentrations. Furthermore, the migration of the pollution plume from the void can also be limited by surface rehabilitation measures preventing excessive infiltration of groundwater to the mined area. Thus , further reduction is achievable.

To minimise the effect of groundwater pollution on the receiving environment, the following measures are suggested:

The final mine topography should be engineered such that runoff is directed away from the rehabilitated area.

Mining should remove all coal and as little as possible should be left in the underground.

Coal bearing mining wastes must be placed in the lowest practical areas and flooded as soon as possible for similar reasons.

Furthermore, the underground should be flooded as soon as possible to bar oxygen from reacting with remaining pyrite.

Quarterly groundwater sampling must be done to establish a database of plume movement trends and to aid eventual mine closure. It is essential to provide a reliable database to facilitate eventual closure of the mining operation.

Leaving a final void in the underground areas must be investigated. Once final mining plans are available, it will be essential to model this option.

Regular sampling and chemical analyses of the groundwater is imperative to establish a sound database:

- Groundwater in all boreholes within a distance of less than two kilometres must be sampled regularly to establish a database against which future groundwater levels can be compared.

- Sampling must be preferably quarterly, but at least twice annually, following the dry – and rainy seasons.

If it is found during such a sampling event that groundwater from any extraction borehole is polluted beyond acceptable standards, alternative water will have to be supplied to the affected party.

Impacts Indirectly Related to Mining

During all phases of mining, vehicles and personnel will be operative in the underground. Minor spills such as diesel, petrol and oil could results from machinery operations. Also, domestic water and waste disposal could also affect the groundwater quality. The following is thus recommended:

It must be ensured that a credible company removes used oil after vehicle servicing.

A sufficient supply of absorbent fibre should be kept at the site to contain accidental spills.

Used absorbent fibre must be land-farmed, using approved methodologies.

Domestic waste water, especially sewage, must either be treated at site according to accepted principles, or removed by credible contractors.

Solid waste must similarly either be stored at site on an approved waste dump, or removed by credible contractors.

8.1.5 Recommendations Relating to Impacts on Noise

With all mitigation options adhered to, an acceptable ***Low significance*** during construction and operational phase will be achieved. Therefore it is recommended that mitigation options are implemented or adhered to.

Quarterly noise monitoring should also be conducted by an acoustic consultant for the first year of operation. This monitoring is to take place over a period of 24 hours in 10 minute bins, with the resulting data co-ordinated with wind speeds as measured on site. These samples should be collected at **NSD03** - **NSD06** receptors, taking into consideration the current ambient soundscape.

Annual feedback regarding noise monitoring should be presented to all stakeholders and other Interested and Affected parties in the area. Noise monitoring must be continued as long as noise complaints are registered.

8.1.6 Recommendations Relating to Impacts on Air Quality

Careful consideration must be given to the relationship of activities on-site to sensitive areas beyond the property boundary. Some of the factors that should be taken into account in the process layout to reduce dust impacts are:

placing dust generating activities where maximum protection can be obtained from natural features;

locating dust generating activities where prevailing winds will blow dust away from the receiving community; and minimising the need to transport and handle materials by placing adequate storage facilities close to processing areas.

The location of dust generating activities will change during the different phases of the project and therefore, the relationship with receivers around the site. It is important that the minimisation of dust through site design is addressed at each phase of the operation.

Dust control at processes and plant could be affected through installation of mechanical ventilation systems, wet suppression systems and vacuum sweeping to name but a few.

Control measures essential to ensure the health of employees will have a dual effect in that it will also mitigate the environmental impact.

8.1.7 Recommendations Relating to Interested and Affected Parties

Most impacts on interested and affected parties that may result from the proposed project are related to environmental components such as surface water, air quality, noise etc, which have been addressed above. Any issues received further will be addressed in the final EIA/EMP.

8.2 OBJECTIVES OF THIS REPORT

The objectives for this report were outlined in Section 1.4. These objectives were as follows:

Present information to the authorities about the proposed project.

Provide information regarding alternatives that have been considered by Anglo Operations (Pty) Limited.

Show how interested and affected parties will be afforded the opportunity to contribute to the project, to comment on the findings of the impact assessment and show that their issues were considered.

Describe the baseline environment. A description of the receiving environment is given in Section 3.

Describe the extent of environmental consequences for the construction, operating and closure phases. A summary of the impact assessment findings, for construction, operation and decommissioning, is given in Section 5.

Proposed Mitigation Measures for impacts that are considered significant. Mitigation Measures are outlined in Section 5 . A summary of recommendations is given in Section 8.1 above.

Describe the environmental feasibility of the proposed project – the potential negative impacts relating to environment can be mitigated appropriately while significant socio-economic benefits to the country could be realised if the project proceeds.

Present findings of the EIA/EMP in a manner that facilitates decision-making. The completeness of information for decision-making is outlined in Section 8.4 below.

8.3 Environmental Feasibility of the Proposed Project

Based on the environmental assessment conducted as described in this Report, there are no significant environmental impacts associated with the proposed project that cannot be mitigated.

8.4 Completeness of Information

The environment that is likely to be affected by the proposed Access Brown Shaft II project was detailed in section 3. Due the area being disturbed by mining activity and is currently a mining area, the approved EMPR was used to determine what had existed in the area as well as all relevant specialist studies were conducted to determine the status quo of the environment within and around the proposed Access Brown Shaft II project area.

Hence no knowledge gaps exist in terms of the current state of the environment. There is however some limitations with regard to the determination of the future state of the studied environmental aspects.

SECTION EIGHT

Statutory Requirements

9. STATUTORY REQUIREMENTS

All activities within the proposed area has been evaluated and activities listed in terms of the EIA Regulations and Section 24 (7) of the National Environmental Management Act, 1998 (Act 107 of 1998) have been identified and relevant authorisation have been applied for.

Any other statuary requirements identified by the interested and affected parties will be verified and if necessary relevant authorisations applied for.

10. COMMENT REPLY SHEET

Geovicon Environmental (Pty) Ltd
P. O. Box 4050
MIDDELBURG
1050
Reg. No.: 2006/030830/07

Tel: 013 243 0542
Fax: 086 632 4936
Cell: 082 359 5604
E-mail: geovicon@iafrica.com

COMMENT REPLY SHEET

(Ref no: 17/2/3N-206)

Name:
Contact Details:
Interest in the project:
Comments:

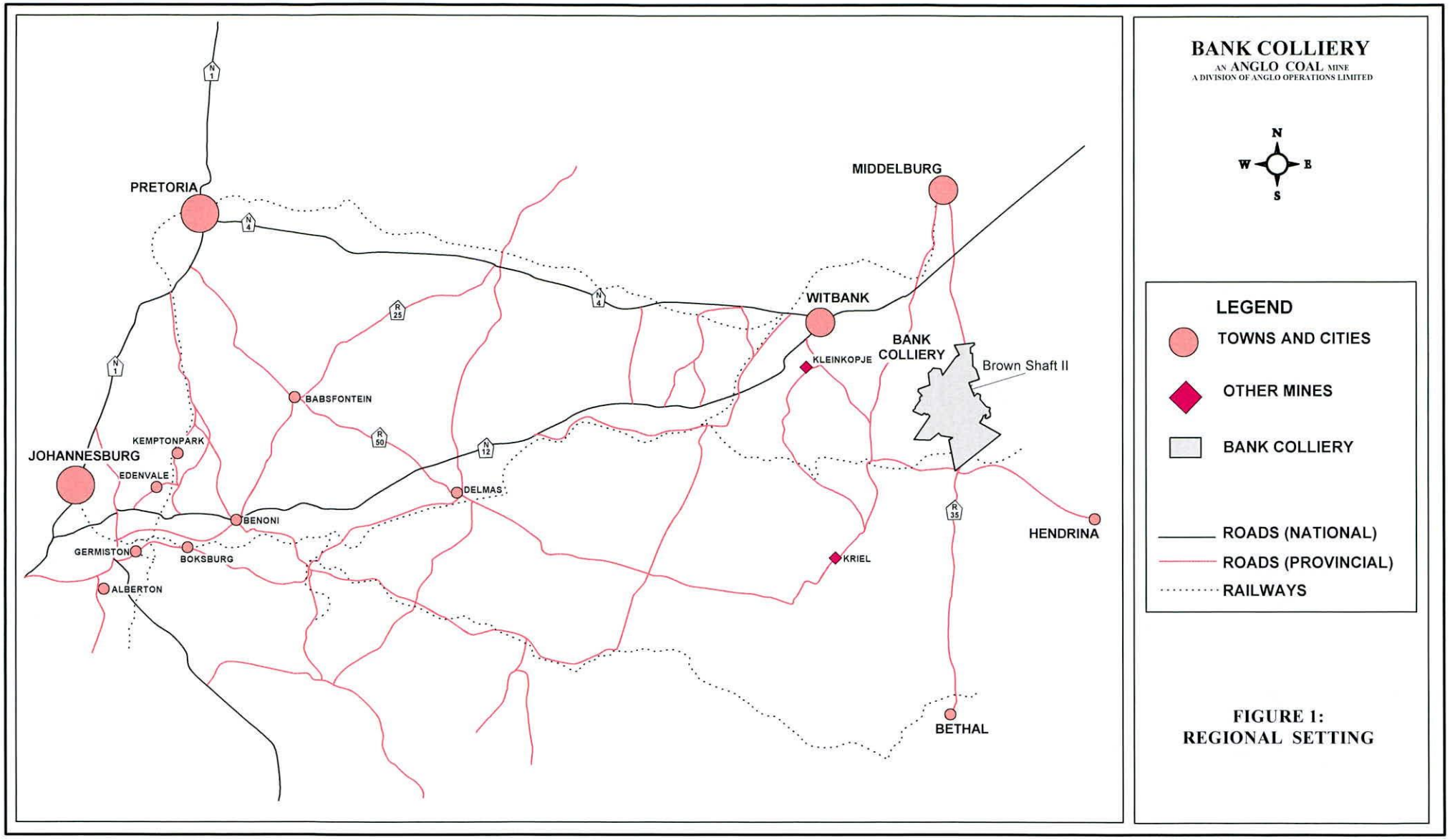
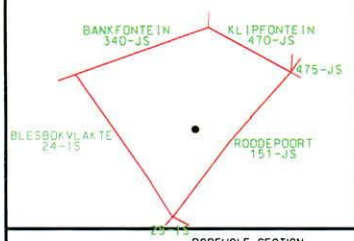


FIGURE 1:
REGIONAL SETTING

LOCALITY PLAN



ANGLO COAL GEOLOGICAL SERVICES
ANGLO COAL DIVISION
a member of the Anglo American plc group

PROJECT BANK COLLIERY
FARM Wolvenfontein 471-JS
DISTRICT Middelburg
PROVINCE Transvaal
TOPO SHEET

BOREHOLE No. CBC2924

COORDINATES Y -51202.00
COORDINATES X 2877191.00 SHEET No. 1 of 2
SURFACE ELEVATION 1627.40
DRILLER Zaaiman Explodrilling
DATE COMMENCED 08/05/96 DATE COMPLETED 09/05/96
DIAMETER OF CORE 60mm CASING LEFT IN HOLE m.
LOGGED BY M.Nel DATE 09/05/96
SAMPLED BY M.Nel DATE 09/05/96
F/S ANALYSIS BY A.C.C.L DATE 30/05/96
COAL ANALYSIS BY A.C.C.L DATE 30/05/96
SPECIAL ANALYSIS BY DATE
Logsheet generated 21/ 2/2008

APPROVED BY ..... VICE PRESIDENT - GEOLOGY

BOREHOLE SECTION

DEPTH	SECTION	WIDTH	RECORD OF STRATA
0.00			
1.00		1.00	SOIL, yellow, sandy
		7.82	NO RECOVERY, brown
8.82		0.71	SHALE, brown, soft, highly weathered
9.53		0.38	SANDSTONE, shaly, interlaminated, interbedded, slightly weathered
9.91		0.16	SANDSTONE, brown, shaly, soft, highly weathered
10.07		1.31	SANDSTONE, shaly, interlaminated, interbedded, slightly weathered
11.38		0.36	SANDSTONE, brownish-grey, shaly, interlaminated, interbedded, weak rock, highly weathered
11.74		0.33	SANDSTONE, medium grained, fissile, highly weathered Shaly break
12.07		2.17	SANDSTONE, greenish-white, very coarse grained, massive, slightly weathered, abundant glauconite staining Moderately weathered bottom 60cm
14.24		0.52	SANDSTONE, whitish-green, coarse grained, massive, coarsening up, abundant glauconite staining Base of Weathering
14.76		0.27	SANDSTONE, whitish-green, medium grained, massive, abundant glauconite staining
15.03		0.27	GRIT, greenish-white, glauconite Middle 10cm coarse grained sandy
15.30		0.15	SANDSTONE, greenish-white, medium grained, fining up, glauconite Bottom 2cm - grit band
15.45			

BOREHOLE SECTION

DEPTH	SECTION	WIDTH	RECORD OF STRATA
15.45			
15.66		0.21	SHALE, dark grey
17.03		1.37	SHALE / SANDSTONE, interlaminated, interbedded
18.24		1.21	COAL No. 4a Seam
18.33		0.09	SANDSTONE, light grey, carbonaceous, gritty With carbonaceous wisps and streaks
18.70		0.37	SANDSTONE, light grey, medium grained, fine grained, massive With carbonaceous wisps top half
18.84		0.14	SILTSTONE, grey
19.11		0.27	SANDSTONE, medium grained, fining up Silty zones, some laminae
19.48		0.37	GRIT, white, massive Carbonaceous at bottom 4cm
20.34		0.86	SHALE, carbonaceous Not sampled
21.37		1.03	COAL No. 4 Upper Seam
21.48		0.11	SHALE, carbonaceous In parts coaly
22.89		1.41	SHALE, dark grey With some scattered grit bands
23.18		0.29	COAL, mixed, interlaminated, interbedded
23.90		0.72	SHALE Some grit bands, laminae and lenses
23.98		0.08	SHALE, black, carbonaceous
24.01		0.03	SANDSTONE, coarse grained, massive 3cm sandy band
27.94		3.93	COAL No. 4 Seam
29.86		1.92	SANDSTONE, whitish-grey, coarse grained With some carbonaceous zones and laminae
30.68		0.82	SANDSTONE, white, very coarse grained, massive
34.98		4.30	SANDSTONE, coarse grained, medium laminated, coarsening up
37.35		2.37	SHALE / SANDSTONE, interlaminated, interbedded
37.73		0.38	SHALE, dark grey With scattered grit fragments

BOREHOLE SECTION

DEPTH	SECTION	WIDTH	RECORD OF STRATA
37.73			
39.52		1.79	SILTSTONE, grey, shaly
		4.82	SHALE Silty in parts
44.34		0.23	SHALE / SANDSTONE, interlaminated, interbedded
44.57		0.48	SHALE, dark grey
45.05		0.29	SHALE With some gritty lenses and laminae
45.34		0.34	SHALE, sandy
45.68		0.24	SANDSTONE, fine grained, rare pyrite nodules
45.92		0.38	SHALE, carbonaceous With carbonaceous and shaly wisps
46.30		5.54	COAL No. 2 Seam
51.84		0.32	GRIT With some rock fragments
52.16		1.06	COAL No. 1 Seam
53.22		0.06	DWYKA TILLITE, Pale white Reworked
53.28		0.57	PRE-KAROO ROCK, Pale white, with slickensides extremely widely spaced dips at 45 degrees
53.85			EOH

SECTION OF COAL SEAM

DEPTH	SECTION	WIDTH	DESCRIPTION	% COR REC	SAMPLE WIDTH	SAMPLE No.
17.03		1.37	SHALE / SANDSTONE, interlaminated, interbedded. Roof of No. 4a Seam			
		0.92	70% COAL, dull lustrous. 30% COAL, dull, 10-40% bright.	100	1.21	2924J
17.95		0.29	30% COAL, dull. 40% COAL, 40-60% bright. 30% COAL, dull, shaly. Floor			
18.24		0.09	SANDSTONE, light grey, carbonaceous, gritty. With carbonaceous wisps and streaks.			
20.34		0.86	SHALE, carbonaceous. Not sampled. Roof of No. 4 Upper Seam			
		0.50	60% COAL, dull lustrous. 40% COAL, dull.	100	1.03	2924I
20.84		0.28	80% COAL, dull. 10% COAL, dull lustrous. 10% COAL, dull, shaly.			
21.12						
21.37		0.25	65% COAL, 40-60% bright. 25% COAL, dull. 10% COAL, dull lustrous, occasional calcite on cleats. Floor			
		0.11	SHALE, carbonaceous. In parts coaly.			

ANALYSIS OF COAL SEAM

RD	YIELD % FRACT	YIELD % CUMUL	MOISTURE % FRACT	MOISTURE % CUMUL	ASH % FRACT	ASH % CUMUL	VOLATILE % FRACT	VOLATILE % CUMUL	FIXED CARB % FRACT	FIXED CARB % CUMUL	C.V. MJ/kg FRACT	C.V. MJ/kg CUMUL	SULPHUR % FRACT	SULPHUR % CUMUL	SW.No CUMUL	ROGA CUMUL	AFT °C (RED) DEF	AFT °C (RED) HEM	AFT °C (RED) FLOW	H.I. CUMUL	A.I. CUMUL
		2924J	25.0x0.0x100.0		RD=1.43		Width=1.21														
RAW		100.0		4.2		14.3		21.2		60.4		27.54		1.27							
		2924I	25.0x0.0x100.0		RD=1.79		Width=1.03														
RAW		100.0		3.2		44.0		16.3		36.5		15.36		0.35							

FIGURE 2a

ANGLO COAL GEOLOGICAL SERVICES
ANGLO COAL DIVISION
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BOREHOLE No. CBC2924

SHEET No. **2 of 2**

SECTION OF COAL SEAM				% COR REC	SAMPLE WIDTH	SAMPLE No.
DEPTH	SECTION	WIDTH	DESCRIPTION			
		0.03	SANDSTONE, coarse grained, massive. 3cm sandy band. Roof of No. 4 Seam.			
24.01						
		0.27	25% COAL, dull, shaly.			
24.28						
		0.58	75% COAL, dull, 10-40% bright. 75% COAL, dull lustrous. 10% COAL, 10-40% bright. 15% COAL, dull, with slickensides extremely widely spaced.	100	1.89	2924H
24.86						
25.04		0.18	30% LIMESTONE. 40% COAL, dull. 30% COAL, dull lustrous.			
		0.86	15% COAL, 10-40% bright. 45% COAL, dull, occasional calcite staining.			
25.90						
		0.38	40% COAL, dull lustrous. 25% COAL, silty.			
26.28			60% COAL, dull. 15% COAL, dull lustrous.	100	2.04	2924G
		0.98	60% COAL, dull. 15% COAL, dull lustrous. 25% COAL, dull, shaly, occasional calcite staining.			
27.26						
		0.68	30% COAL, 40-60% bright. Devolatilized? 60% COAL, dull. 10% COAL, dull, shaly. Floor.			
27.94						
		1.92	SANDSTONE, whitish-grey, coarse grained. With some carbonaceous zones and laminae.			
		0.38	SHALE, carbonaceous. Some sandy lenses throughout. Roof of No. 2 Seam.			
46.30						
		0.52	60% COAL, dull, 10-40% bright. 30% COAL, dull. 10% COAL, dull lustrous.	100	1.38	2924F
46.82						
47.02		0.20	COAL, dull lustrous.			
47.19		0.17	COAL, dull, 10-40% bright.			
		0.49	80% COAL, dull. 20% COAL, dull lustrous.			
47.68						
		0.29	LIMESTONE, carbonaceous, rare pyrite nodules. Raw sample.	100	0.29	2924E
47.97						
		1.00	5% COAL, 10-40% bright. 45% COAL, dull lustrous. 50% COAL, dull.	100	1.00	2924D
48.97						
49.17		0.20	SANDSTONE, fine grained, carbonaceous, shaly. (Raw sample)			
		0.76	15% COAL, dull, 10-40% bright. 80% COAL, dull. 5% COAL, dull lustrous.	100	0.96	2924C
49.93						
		0.66	30% COAL, dull, 10-40% bright. 50% COAL, dull.			
50.59			20% COAL, dull lustrous.	100	1.91	2924B
		1.07	20% COAL, dull, 40-60% bright. 50% COAL, dull. 30% COAL, dull lustrous, rare calcite staining.			
51.66						
51.84		0.18	30% SHALE, coaly. 20% COAL, 40-60% bright. 50% COAL, dull, few calcite staining. Floor.			
		0.32	GRIT With some rock fragments.			
		0.32	GRIT With some rock fragments.			
52.16			Roof of No. 1 Seam.			
		1.06	60% COAL, dull. 10% SHALE, coaly. 10% COAL, 10-40% bright. 20% COAL, dull lustrous.	100	1.06	2924A
53.22			Floor.			
		0.06	DWYKA TILLITE, Pale white Reworked.			

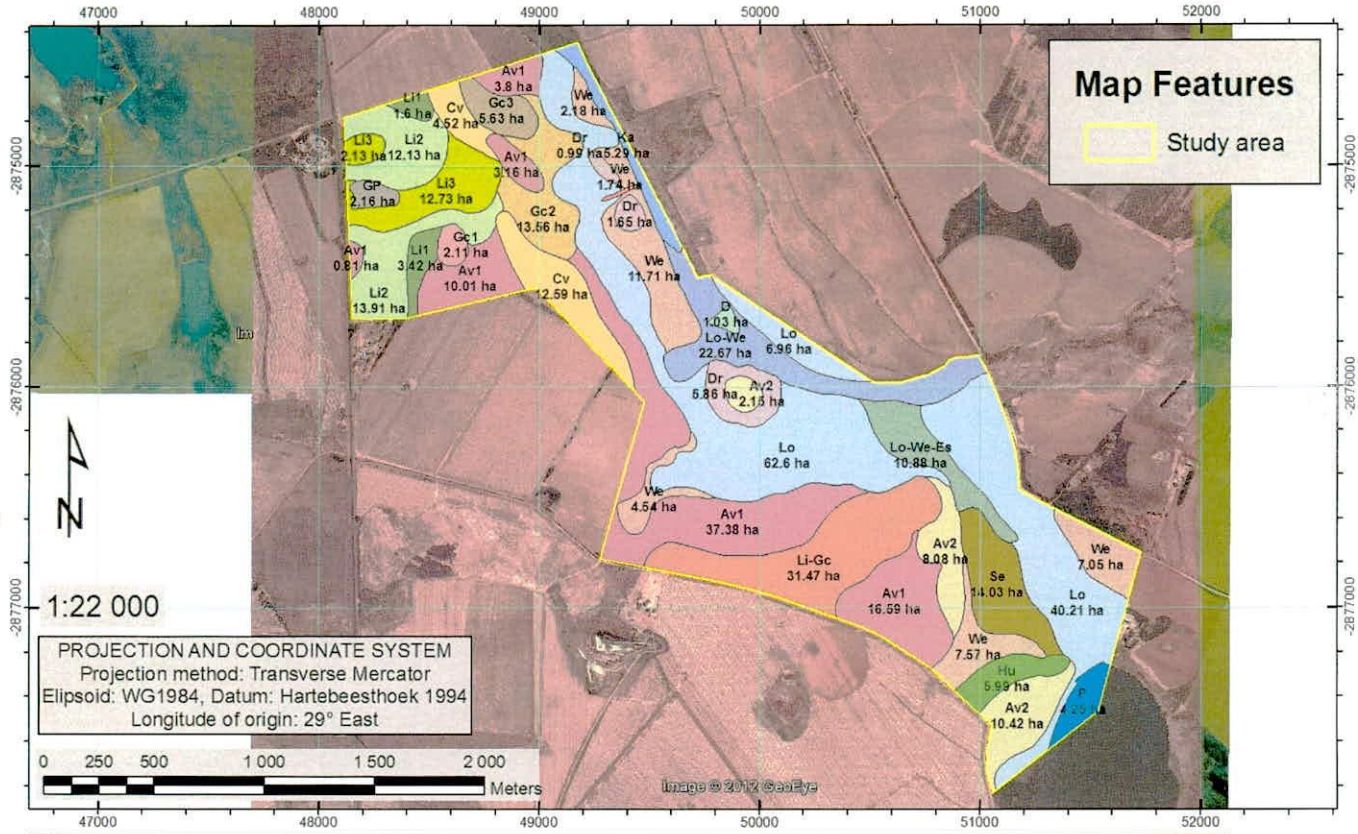
SPECIALS

ANALYSIS OF COAL SEAM

RD	YIELD % FRACT	YIELD % CUMUL	MOISTURE % FRACT	MOISTURE % CUMUL	ASH % FRACT	ASH % CUMUL	VOLATILE % FRACT	VOLATILE % CUMUL	FIXED CARB % FRACT	FIXED CARB % CUMUL	C.V. MJ/kg FRACT	C.V. MJ/kg CUMUL	SULPHUR % FRACT	SULPHUR % CUMUL	SW.No CUMUL	ROGA CUMUL	AFT °C (RED) DEF	AFT °C (RED) HEM	AFT °C (RED) FLOW	H.I. CUMUL	A.I. CUMUL
		2924H		25.0x0.0x100.		RD=1.54		Width=1.89													
F1.40	5.2	**5.2**	2.7	**2.7**	7.9	**7.9**	27.9	**27.9**	61.5	**61.5**	30.23	**30.23**	0.81	**0.81**							
F1.50	44.4	**49.6**	3.3	**3.2**	12.1	**11.6**	22.9	**23.4**	61.8	**61.7**	27.96	**28.20**	0.41	**0.45**							
F1.60	19.8	**69.3**	3.1	**3.2**	20.7	**14.2**	19.9	**22.4**	56.3	**60.2**	24.34	**27.10**	0.57	**0.49**							
F1.70	8.5	**77.9**	2.8	**3.1**	26.7	**15.6**	20.5	**22.2**	50.0	**59.1**	21.45	**26.48**	0.49	**0.49**							
F2.00	8.8	**86.7**	2.6	**3.1**	41.5	**18.2**	21.0	**22.1**	35.0	**56.6**	16.03	**25.42**	1.90	**0.63**							
S2.00	13.3	**100.0**	1.6	**2.9**	59.6	**23.7**	29.5	**23.1**	9.4	**50.3**	7.40	**23.02**	3.77	**1.05**							
		2924G		25.0x0.0x100.		RD=1.69		Width=2.04													
F1.40	5.4	**5.4**	1.8	**1.8**	10.1	**10.1**	31.6	**31.6**	56.6	**56.6**	29.94	**29.94**	0.75	**0.75**							
F1.50	10.9	**16.2**	1.6	**1.7**	16.8	**14.6**	26.4	**28.1**	55.2	**55.6**	26.78	**27.83**	0.50	**0.58**							
F1.60	21.1	**37.4**	1.5	**1.6**	23.3	**19.5**	18.9	**22.9**	56.4	**56.1**	24.22	**25.79**	0.34	**0.45**							
F1.70	21.1	**58.5**	1.5	**1.5**	33.5	**24.5**	18.0	**21.1**	47.1	**52.8**	20.07	**23.72**	0.31	**0.40**							
F2.00	32.6	**91.1**	2.4	**1.8**	46.0	**32.2**	16.0	**19.3**	35.7	**46.7**	14.95	**20.58**	0.51	**0.44**							
S2.00	9.0	**100.0**	1.7	**1.8**	72.6	**35.8**	9.4	**18.4**	16.2	**44.0**	3.25	**19.03**	1.80	**0.56**							
		2924F		25.0x0.0x100.		RD=1.57		Width=1.38													
F1.35	16.4	**16.4**	1.9	**1.9**	6.5	**6.5**	33.4	**33.4**	58.3	**58.3**	31.48	**31.48**	0.63	**0.63**	**2.0**						
F1.40	18.0	**34.4**	1.9	**1.9**	9.2	**7.9**	28.9	**31.0**	60.0	**59.2**	30.26	**30.84**	0.72	**0.68**	**1.5**						
F1.45	10.4	**44.8**	1.7	**1.8**	13.4	**9.2**	26.0	**29.9**	58.9	**59.1**	28.67	**30.34**	0.89	**0.73**							
F1.50	12.0	**56.8**	1.9	**1.8**	18.0	**11.1**	24.4	**28.7**	55.7	**58.4**	26.76	**29.58**	0.81	**0.74**							
F1.60	9.4	**66.1**	1.4	**1.8**	23.7	**12.8**	23.1	**27.9**	51.7	**57.4**	24.43	**28.85**	0.54	**0.72**							
F1.70	8.1	**74.3**	1.4	**1.7**	34.0	**15.2**	17.8	**26.8**	46.7	**56.3**	20.58	**27.95**	0.43	**0.68**							
S1.70	25.8	**100.0**	1.0	**1.5**	58.1	**26.2**	13.3	**23.3**	27.6	**48.9**	11.18	**23.63**	2.20	**1.07**							
		2924E		25.0x0.0x100.0		RD=2.01		Width=0.29													
F1.70	0.0	**0.0**																			
S1.70	100.0	**100.0**	0.8	**0.8**	62.2	**62.2**	37.1	**37.1**	0.1	**-0.1**	2.89	**2.89**	0.60	**0.60**							
		2924D		25.0x0.0x100.		RD=1.46		Width=1.00													
F1.35	9.2	**9.2**	2.6	**2.6**	7.0	**7.0**	31.4	**31.4**	59.0	**59.0**	31.15	**31.15**	0.48	**0.48**	**1.0**						
F1.40	16.7	**25.9**	2.6	**2.6**	8.4	**7.9**	26.2	**28.0**	62.8	**61.5**	30.24	**30.56**	0.42	**0.44**	**0.5**						
F1.45	19.6	**45.5**	2.7	**2.7**	11.2	**9.3**	24.3	**26.4**	61.8	**61.6**	29.17	**29.96**	0.46	**0.45**							
F1.50	12.5	**58.0**	2.5	**2.6**	16.4	**10.8**	26.3	**26.4**	54.8	**60.2**	27.04	**29.34**	0.99	**0.57**							
F1.60	11.0	**69.0**	2.3	**2.6**	21.0	**12.5**	19.9	**25.3**	56.8	**59.6**	25.20	**28.67**	0.78	**0.60**							
F1.70	23.5	**92.5**	2.2	**2.5**	22.5	**15.0**	20.2	**24.0**	55.1	**58.5**	24.39	**27.59**	0.98	**0.70**							
S1.70	7.6	**100.0**	2.0	**2.5**	42.0	**17.0**	22.4	**23.9**	33.6	**56.6**	18.34	**26.89**	20.30	**2.18**							
		2924C		25.0x0.0x100.0		RD=1.84		Width=0.96													
F1.70	0.0	**0.0**																			
S1.70	100.0	**100.0**	1.2	**1.2**	48.5	**48.5**	22.0	**22.0**	28.3	**28.3**	14.59	**14.59**	0.12	**0.12**							
		2924B		25.0x0.0x100.		RD=1.57		Width=1.91													
F1.35	3.3	**3.3**	1.7	**1.7**	9.6	**9.6**	34.2	**34.2**	54.5	**54.5**	30.39	**30.39**	0.65	**0.65**	**2.5**						
F1.40	10.8	**14.1**	1.8	**1.8**	10.2	**10.1**	28.1	**29.5**	59.9	**58.6**	29.78	**29.92**	0.42	**0.47**	**1.5**						
F1.45	14.4	**28.6**	1.7	**1.7**	13.2	**11.6**	25.1	**27.2**	60.1	**59.4**	29.10	**29.51**	0.38	**0.43**							
F1.50	10.2	**38.7**	1.6	**1.7**	17.5	**13.2**	21.6	**25.8**	59.3	**59.3**	26.74	**28.78**	0.39	**0.42**							
F1.60	27.1	**65.9**	1.5	**1.6**	24.1	**17.7**	19.8	**23.3**	54.6	**57.4**	24.01	**26.82**	0.29	**0.36**							
F1.70	16.4	**82.2**	1.5	**1.6**	32.3	**20.6**	25.9	**30.4**	47.1	**55.9**	20.93	**25.64**	0.33	**0.36**							
S1.70	17.8	**100.0**	0.9	**1.5**	50.4	**25.9**	15.0	**20.7**	33.8	**51.9**	13.92	**23.56**	1.27	**0.52**							
		2924A		25.0x0.0x100.		RD=1.72		Width=1.06													
F1.35	9.0	**9.0**	2.1	**2.1**	9.8	**9.8**	37.7	**37.7**	50.4	**50.4**	30.69	**30.69**	0.57	**0.57**	**2.0**						
F1.40	10.1	**19.1**	1.9	**2.0**	13.0	**11.5**	34.3	**35.9**	50.8	**50.6**	29.34	**29.98**	0.69	**0.63**	**1.5**						
F1.45	10.5	**29.6**	2.0	**2.0**	15.7	**13.0**	28.5	**33.3**	53.8	**51.8**	27.95	**29.26**	0.72	**0.66**							
F1.50	8.2	**37.8**	2.0	**2.0**	19.2	**14.3**	26.7	**31.8**	52.2	**51.8**	26.51	**28.66**	0.43	**0.61**							
F1.60	12.2	**50.0**	1.7	**1.9**	25.3	**17.0**	25.9	**30.4**	47.1	**50.9**	24.14	**27.56**	0.52	**0.59**							
F1.70	9.2	**59.2**	1.5	**1.8**	34.5	**19.7**	22.2	**29.1**	41.8	**49.3**	20.42	**26.45**	0.51	**0.58**							
S1.70	40.8	**100.0**	1.1	**1.5**	64.3	**37.9**	13.7	**22.8**	20.9	**37.7**	8.70	**19.21**	0.61	**0.59**							

FIGURE 2b

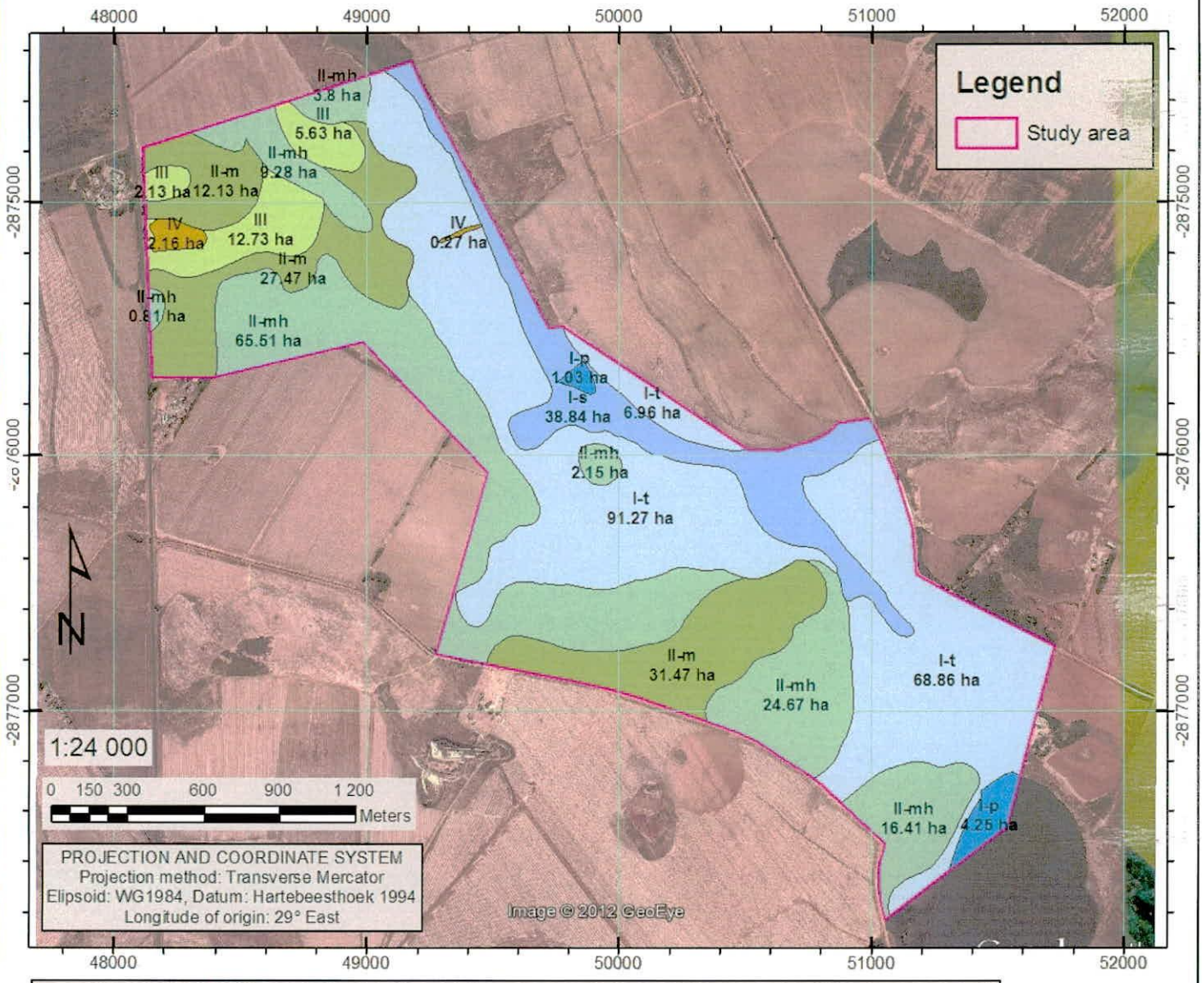
FIGURE 3 : DETAILED SOIL-LANDFORM MAP OF PARTS OF PORTIONS 0, 1, 5, 7, 8, 10 AND 18 OF THE FARM WOLVENFONTEIN 471 JS, MIDDELBURG, MPUMALANGA



SOIL-LANDFORM LEGEND

MAP UNIT	LANDFORM COMPONENT	SOIL COMPONENT	AREA (ha)	AREA (%)
Hu	Gently to moderately sloping midslopes (3-6% slope)	Moderately deep to deep (80-120 cm), well-drained, dark red, apedal, sandy clay loam of the Hutton form, on weathered rock	5.99	1.40
Li1	Level to gently sloping crests or upper midslopes (1-2% slope)	Deep (100-140 cm), well-drained, red, apedal, sandy loam or sandy clay loam on hard plinthite of the Lichtenburg form	5.02	1.17
Li2	Level to gently sloping midslopes (2-5% slope)	Moderately deep (60-90 cm), well-drained, red, apedal, sandy loam or sandy clay loam on hard plinthite of the Lichtenburg form; many, hard Fe-Mn concretions in subsoil	26.04	6.09
Li3	Level to gently sloping crests or upper midslopes (1-2% slope)	Shallow (30-50cm), well-drained, dark red, apedal, sandy loam or sandy clay loam on hard plinthite of the Lichtenburg form; few to many, hard Fe-Mn concretions	14.86	3.47
Gc1	Level to gently sloping crests (1-3% slope)	Deep (100-120 cm), well-drained, yellow-brown, apedal, sandy loam or sandy clay loam on hard plinthite of the Glencoe form	2.11	0.49
Gc2	Gently to moderately sloping midslopes (2-8% slope)	Moderately deep (50-100 cm), well-drained, yellow-brown, apedal, sandy loam or sandy clay loam on hard plinthite of the Glencoe form	13.56	3.17
Gc3	Gently to moderately sloping midslopes (4-8% slope)	Shallow (30-50 cm), well-drained, yellow-brown, apedal, sandy loam on hard plinthite of the Glencoe form, few to many, hard Fe-Mn concretions	5.63	1.32
Li-Gc	Gently sloping midslopes (2-5% slope)	Association of shallow to moderately deep (40-60 cm), well-drained, red or yellow-brown sandy loam or sandy clay loam on hard plinthite; few to many, hard Fe-Mn concretions	31.47	7.36
Cv	Gently to moderately sloping midslopes (2-6% slope)	Deep to very deep (100->150 cm), well-drained, yellow-brown, apedal, sandy loam to sandy clay loam of the Clovelly form on weathered sandstone	17.11	4.00
Av1	Gently to moderately sloping crests or midslopes (1-6% slope)	Moderately deep to deep (effective depth 80-130 cm), moderately well-drained, yellow-brown, apedal, sandy loam or sandy clay loam on soft plinthite deep subsoil of the Avalon form	71.75	16.78
Av2	Gently sloping footslopes (2-4 % slope)	Moderately deep (effective depth 60-90 cm), moderately well- drained, yellow-brown, mottled, apedal, sandy loam or sandy clay loam on soft plinthic deep subsoil of the Avalon form	20.65	4.83
We	Gently to moderately sloping footslopes and valley bottom (1-8% slope)	Shallow (effective depth 30-40 cm), poorly drained, grey brown, sandy loam or sandy clay loam topsoil on plinthic, sandy clay loam subsoil of the Westleigh form	34.79	8.14
Lo	Gently to moderately sloping footslopes (4-8% slope); uneven surface roughness in places in the form of erosion channels	Shallow (effective depth 30-40 cm), somewhat poorly drained, grey-brown or grey, loamy sand or sandy loam topsoil and E horizon, on grey, plinthic, sandy clay loam deep subsoil of the Longlands form	109.77	25.66
Lo-We	Level valley bottom (0-1% slope); uneven surface roughness in places in the form of erosion channels and overburden deposits	Association of poorly drained soils with shallow effective depth (10-40 cm): (i) grey, loamy sand or sandy loam topsoil and E horizon, over grey, plinthic, sandy clay loam deep subsoil of the Longlands form, and (ii) grey, sandy loam or sandy clay loam topsoil, on plinthic, sandy clay loam subsoil of the Westleigh form; water tables commonly present, associated with Katspruit form in places, sandy or loamy overburden in places	22.67	5.30
Lo-We-Es	Level valley bottom (0-1% slope); uneven surface roughness in places in the form of erosion channels and overburden deposits	Association of somewhat poorly to poorly drained soils with shallow effective depth (10-40 cm): (i) grey, loamy sand or sandy loam topsoil and E horizon, over grey, plinthic, sandy clay loam deep subsoil of the Longlands form; (ii) grey, sandy loam or sandy clay loam topsoil on plinthic, sandy clay loam subsoil of the Westleigh form; and (iii) loamy sand topsoil and E horizon, over grey-brown, strong prismatic, sandy clay subsoil of the Estcourt form	10.88	2.54
Se	Gently sloping footslopes (2-4 % slope)	Shallow (effective depth 20-30 cm), greyish brown, finely mottled, weak to moderate blocky, sandy clay loam over, greyish brown, mottled, strong angular blocky, sandy clay loam or sandy clay subsoil of the Sepane form	14.03	3.28
Ka	Level valley bottom (0-1% slope)	Deep soil materials: very poorly drained, dark grey, sandy loam or sandy clay loam topsoil on grey, gleyed sandy clay of the Katspruit form	5.29	1.24
Dr	Gently to moderately sloping midslopes and footslopes (4-8% slope)	Shallow (30-40 cm) somewhat poorly drained, dark grey, mottled, sandy loam on hard plinthite of the Dresden form, associated with similar soil of the Wasbank form	8.50	1.99
GP	Miscellaneous land class: Gravel pit		2.16	0.50
E	Miscellaneous land class: Erosion		0.27	0.06
D	Dam		1.03	0.24
P	Pan		4.25	0.99
		TOTAL	427.83	100.0

FIGURE 4 : CURRENT LAND CAPABILITY MAP OF PARTS OF PORTIONS 0, 1, 5, 7, 8, 10 AND 18 OF THE FARM WOLVENFONTEIN 471 JS, MIDDELBURG, MPUMALANGA



LEGEND: CURRENT LAND CAPABILITY				
LAND CAPABILITY MAP UNITS	**DESCRIPTION**	**MAP UNITS**	**AREA (ha)**	**% OF AREA**
I-p	Class I – Wetland: permanent	D, P	5.28	1.23
I-s	Class I – Wetland: seasonal	Ka, Lo-We, Lo-We-Es	38.84	9.08
I-t	Class I – Wetland: temporary	Lo, We, Se, Dr	167.09	39.07
II-mh	Class II – Arable land: moderately high potential	Hu, Li1, Gc1, Cv, Av1, Av2	122.63	28.67
II-m	Class II – Arable land: moderate potential	Li2, Gc2, Li-Gc	71.07	16.62
III	Class III – Grazing land	Li3, Gc3	20.49	4.79
IV	Class IV – Wilderness land	GP, E	2.43	0.56
		Total	**427.83**	**100.0**

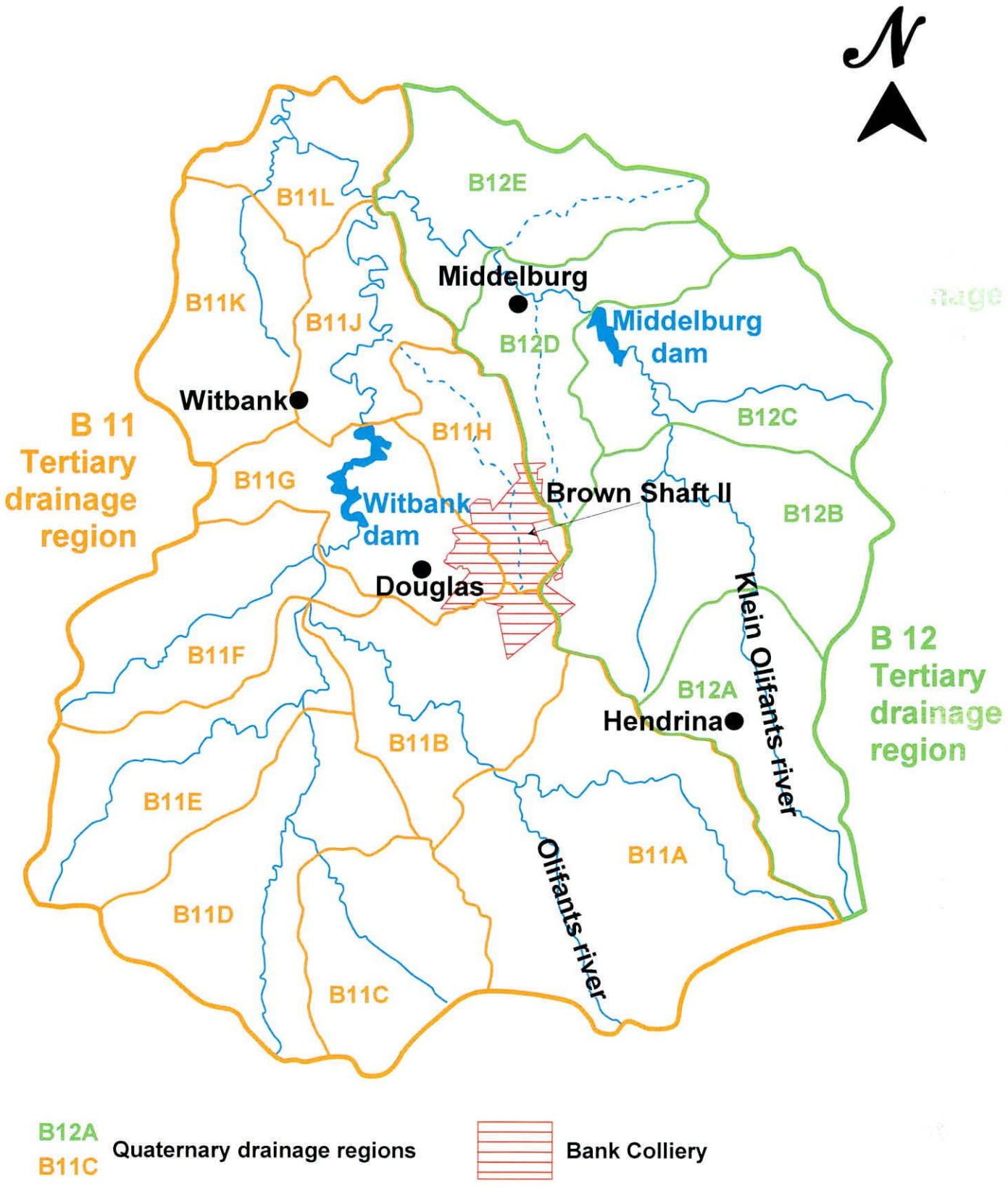


Figure 5: Tertiary and quarternary drainage regions in the vicinity of Bank Colliery's Brown shaft II (situated in Water Management Area number 4)

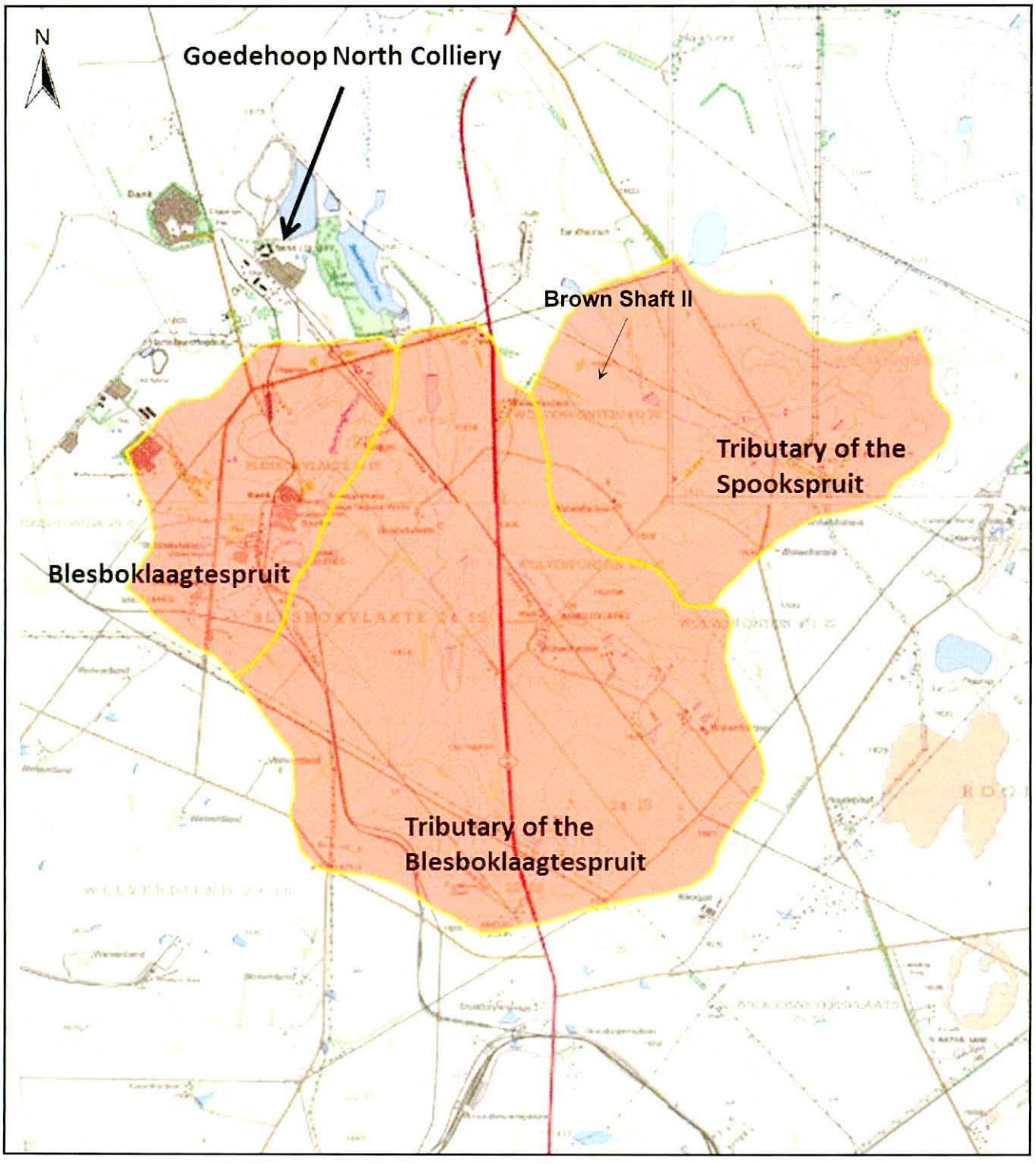


Figure 6: Catchment Delineation for the Proposed Brown Shaft II underground mining project

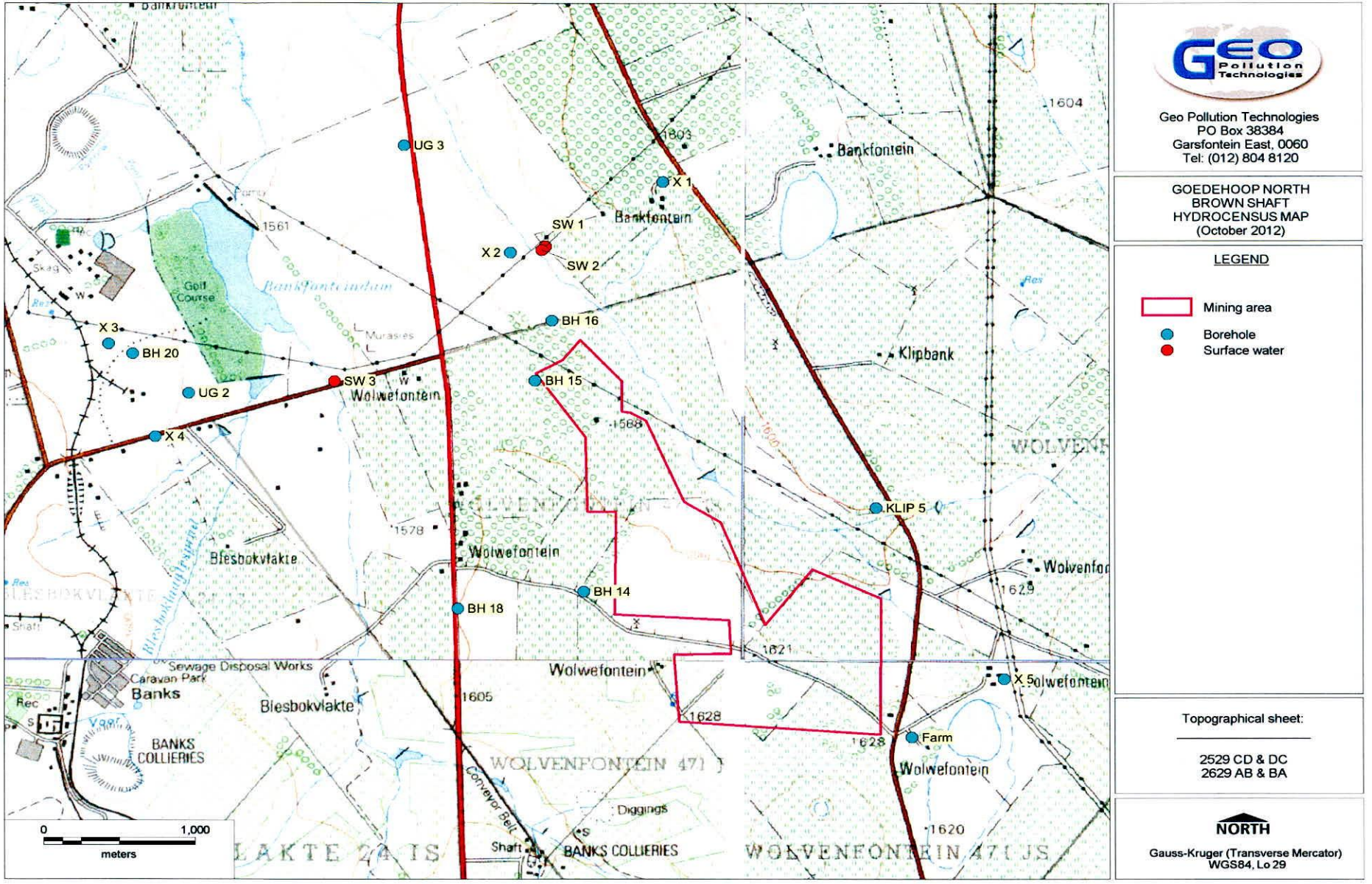


Figure 7: Positions of Hydrocensus Monitored Points

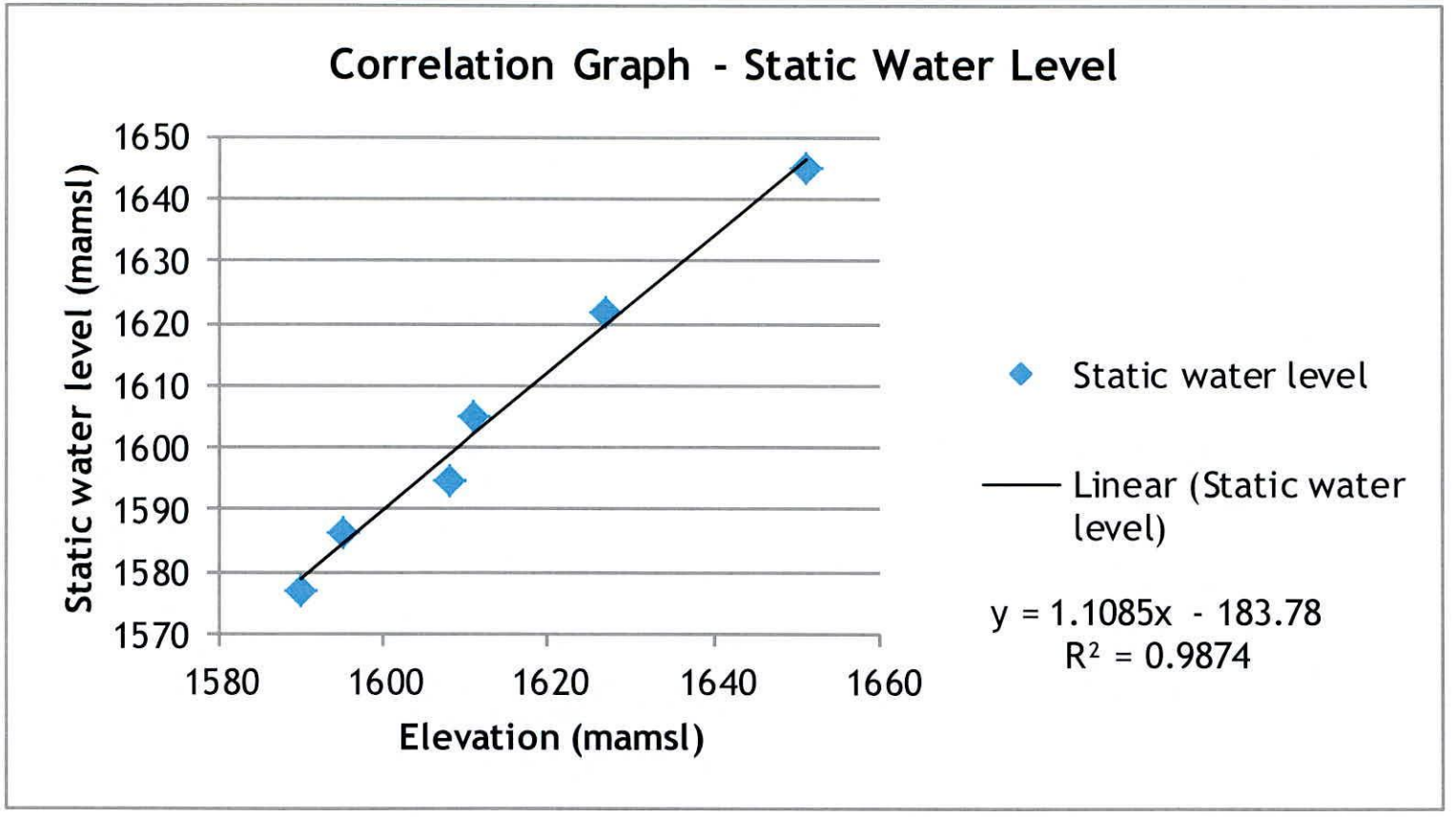


Figure 8: Correlation Graph

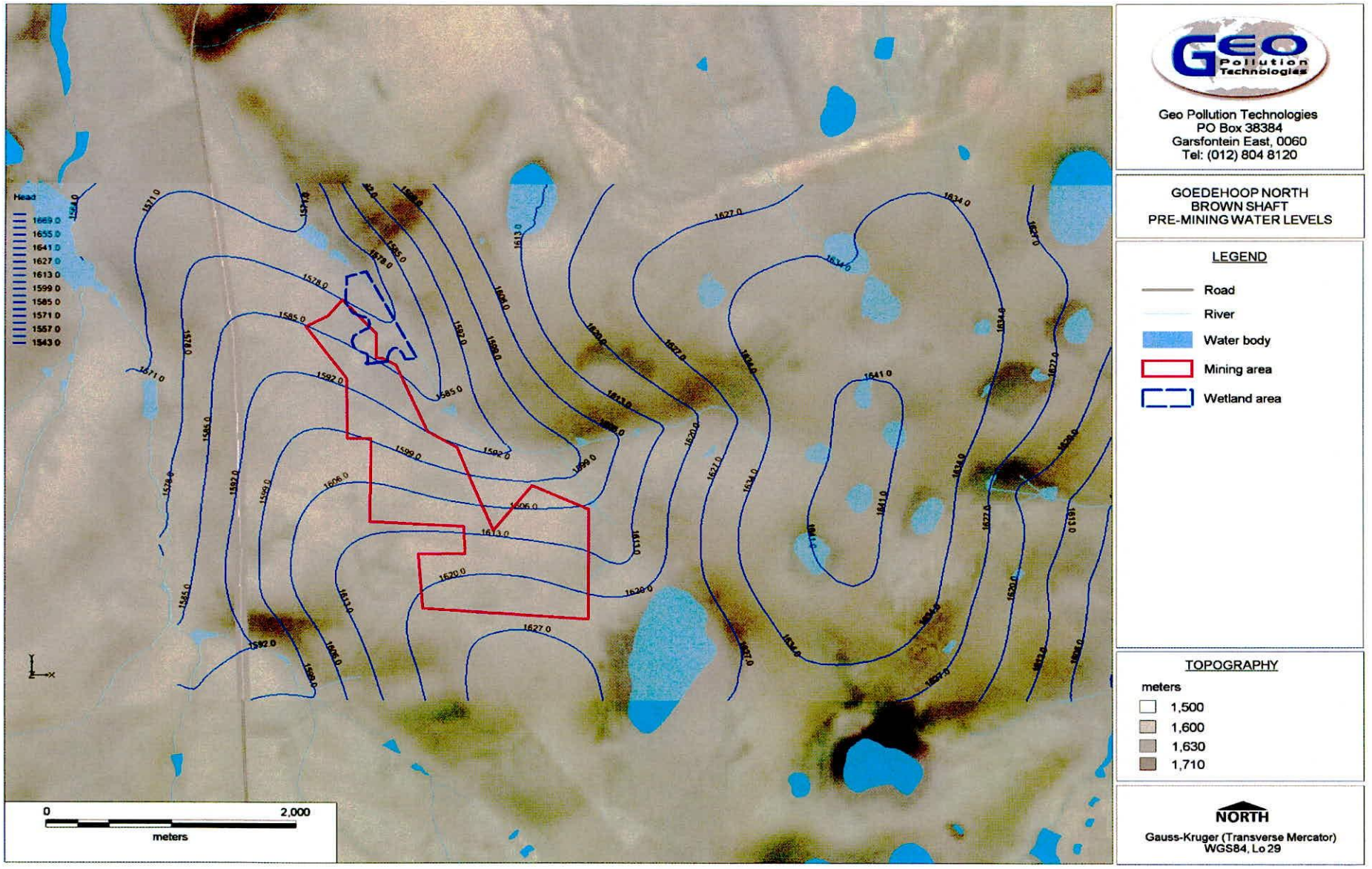


Figure 9: Static Groundwater Levels - Pre mining

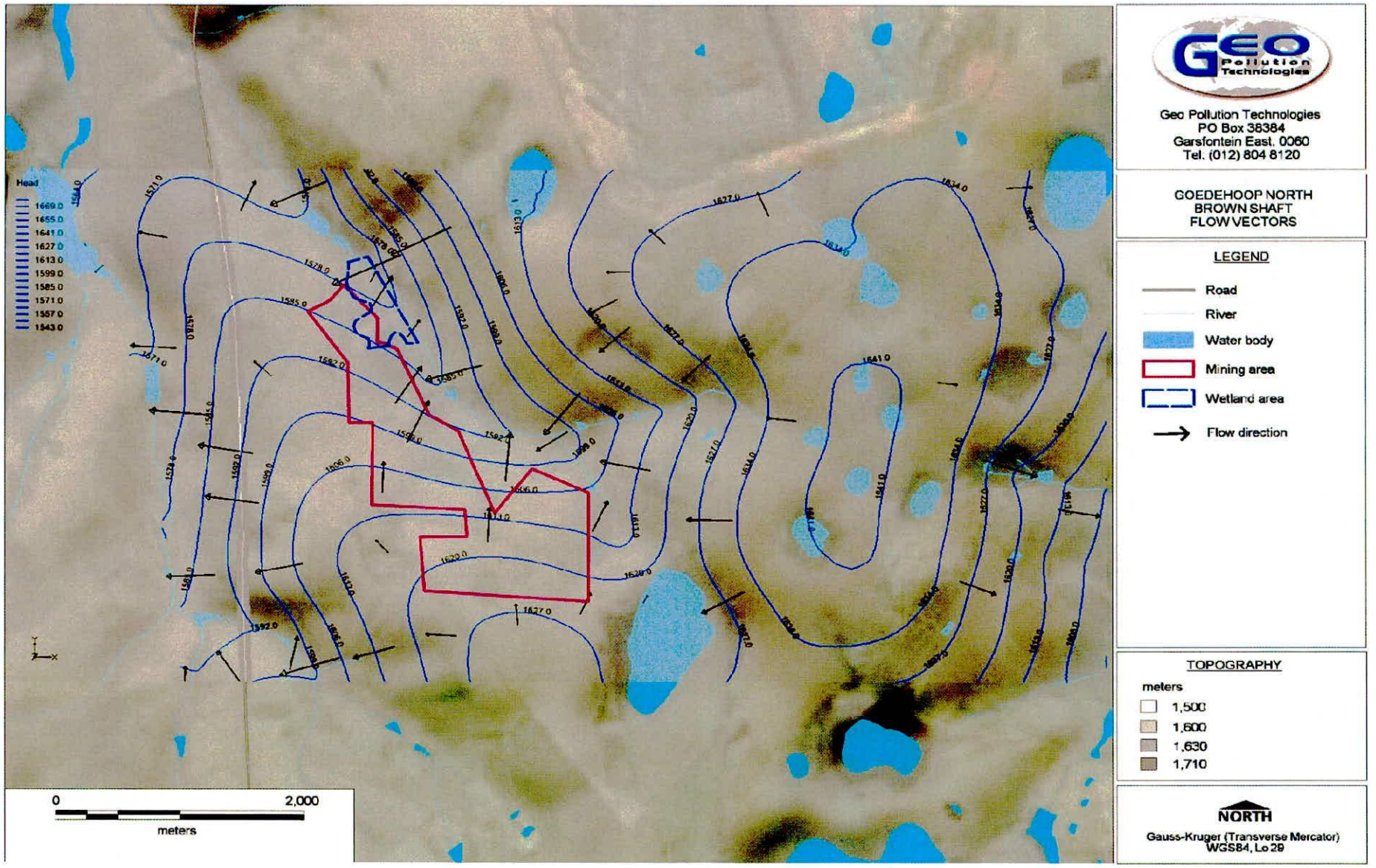


Figure 10: Groundwater flow directions - Pre mining

Sample Nr.	BH14	BH15	BH16	BH18	BH20	KLIP5	UG3	X3	X5	Class 0 (ideal)	Class I (acceptable)	Class II (maximum)
Ca	12.40	5.45	27.50	52.60	39.80	9.61	242.00	9.17	52.40	< 80	80 - 150	150 - 300
Mg	3.62	2.70	11.50	24.90	20.70	7.90	61.60	5.92	26.90	< 30	30 - 70	70 - 100
Na	21.20	8.67	12.10	38.40	60.60	17.20	41.10	11.10	14.00	< 100	100 - 200	200 - 400
K	3.11	2.97	3.79	11.10	5.98	4.44	7.49	2.74	7.79	< 25	25 - 50	50 - 100
Mn	0.00	0.00	0.00	0.86	0.38	0.13	3.36	0.22	1.25	< 0.1	0.1 - 1.0	1.0 - 2.0
Fe	0.00	0.52	0.02	0.90	0.05	0.00	0.12	0.00	0.07	< 0.1	0.1 - 0.2	0.2 - 2
F	0.00	0.00	0.00	0.46	23.60	0.00	1.13	0.00	0.00	< 1.0	1.0 - 1.5	1.5 - 3.5
NO_3	14.87	0.00	1.24	0.00	0.49	27.80	0.49	0.00	0.00	< 25	25 - 44	44 - 88
Al	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 0.15	0.15 - 0.5	-
HCO_3	36.59	30.48	141.00	411.66	330.02	40.24	222.78	76.50	360.61	-	-	-
Cl	34.00	6.50	8.60	18.00	11.00	30.00	28.00	7.40	6.50	< 100	100 - 200	200 - 600
SO_4	1.30	14.00	13.00	4.95	5.40	6.63	783.00	3.17	2.71	< 200	200 - 400	400 - 600
TDS by sum	122.00	60.00	158.00	406.00	348.00	136.00	1268.00	86.00	346.00	< 450	450 - 1000	1000 - 2400
M-Alk($CaCO_3$)	30.00	25.00	116.00	338.00	272.00	33.00	183.00	63.00	297.00	-	-	-
pH	6.52	6.73	7.57	7.25	7.76	6.69	7.35	7.66	7.70	6.0 - 9.0	5.0 - 9.5	4.0 - 10.0
EC	16.60	8.61	25.30	64.60	53.40	20.60	150.00	13.80	52.90	70	70 - 150	150 - 370
Cat/An Bal. %	2.46	0.02	1.56	-4.86	-4.53	-2.37	-3.91	-0.95	-4.20	-	-	-

Notes:

Class 0: Ideal quality

Class I: Target quality

Class II: Moderate effects

Exceeding maximum allowable concentration - adverse effects

na- not analysed

All concentrations are presented in mg/l, EC is presented in mS/m

0 = below detection limit of analytical technique

Figure 11: Results of Major Cation and Anion Analyses

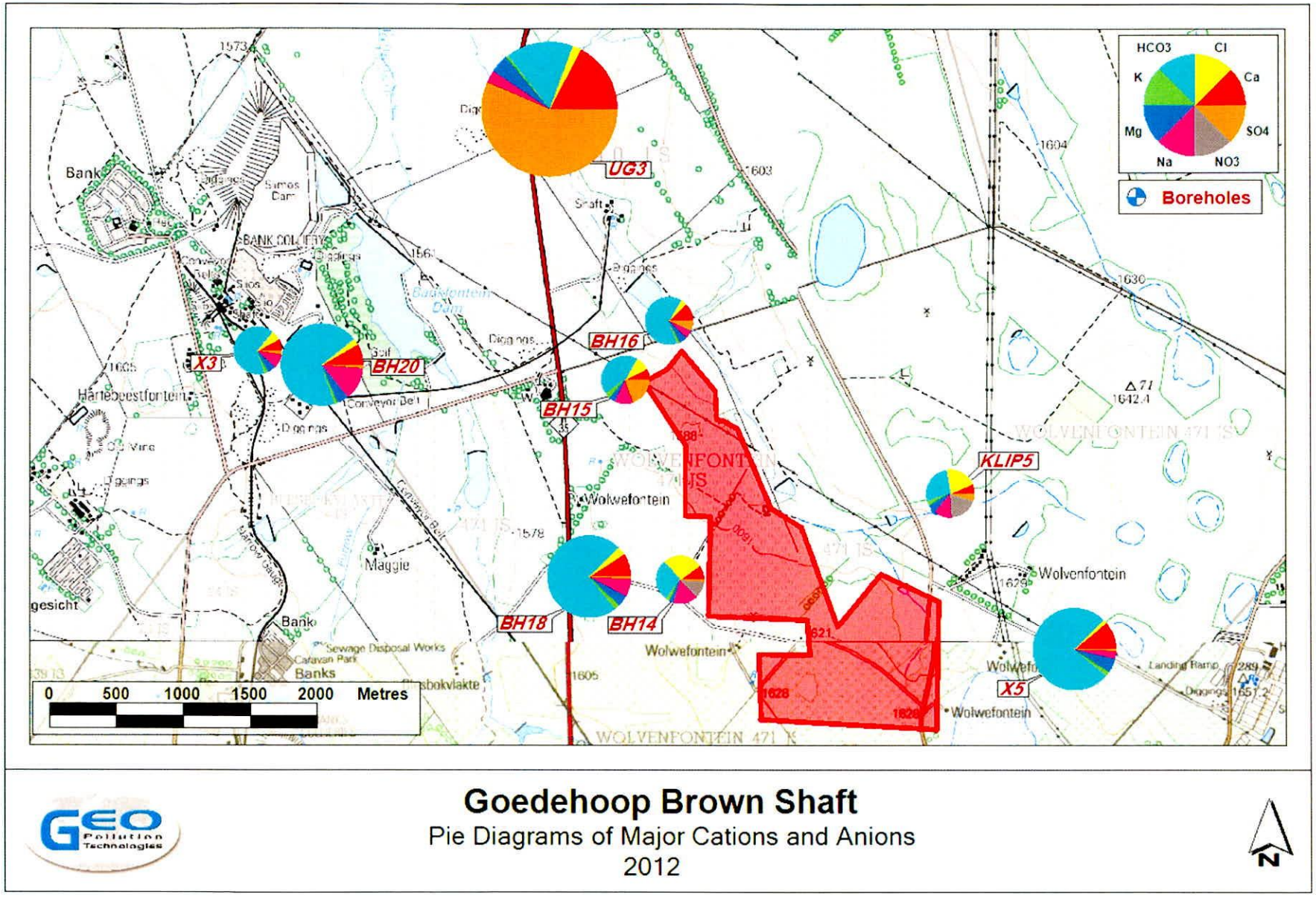


Figure 12: Pie Diagrams

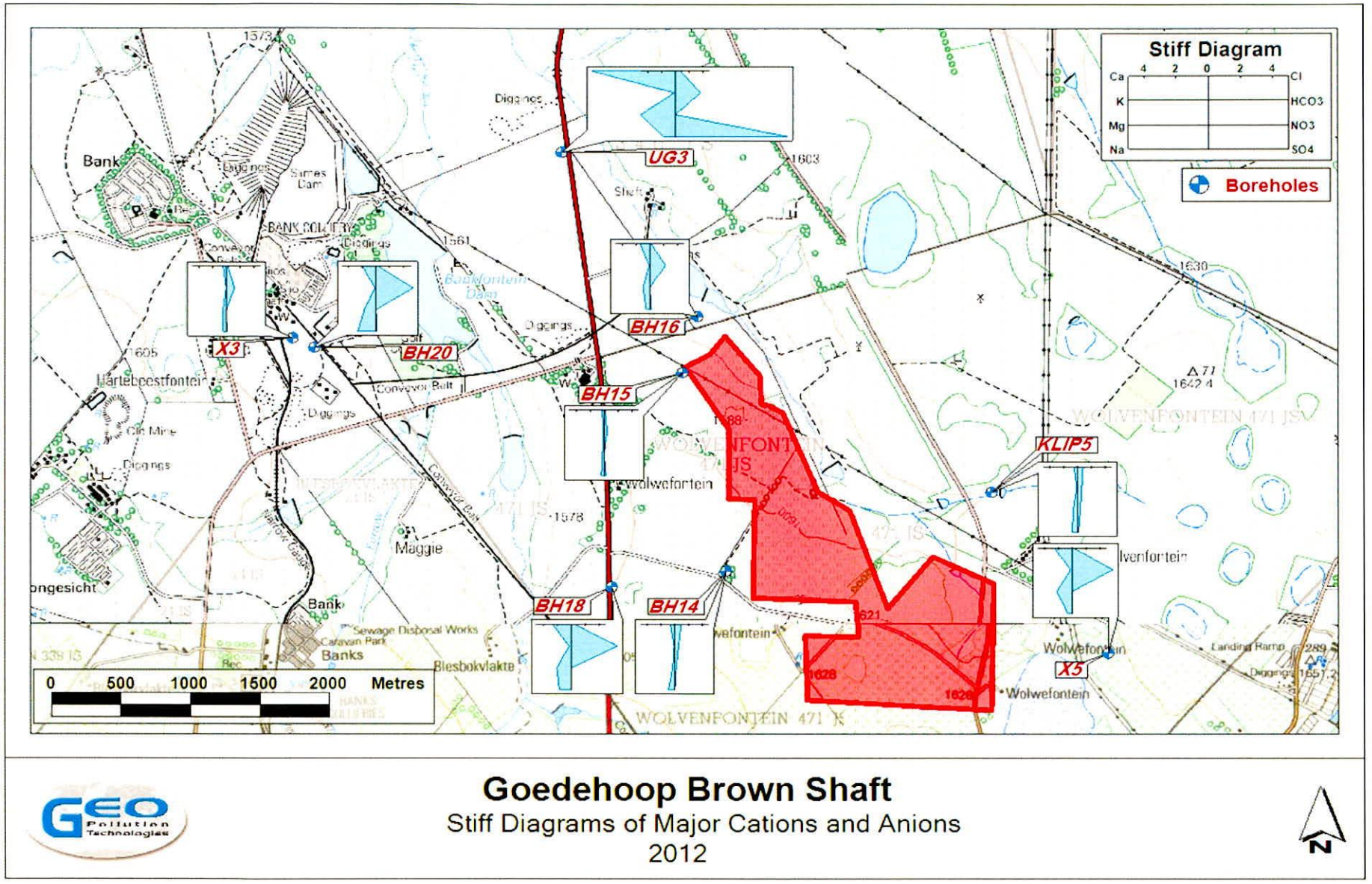


Figure 13: Stiff Diagram

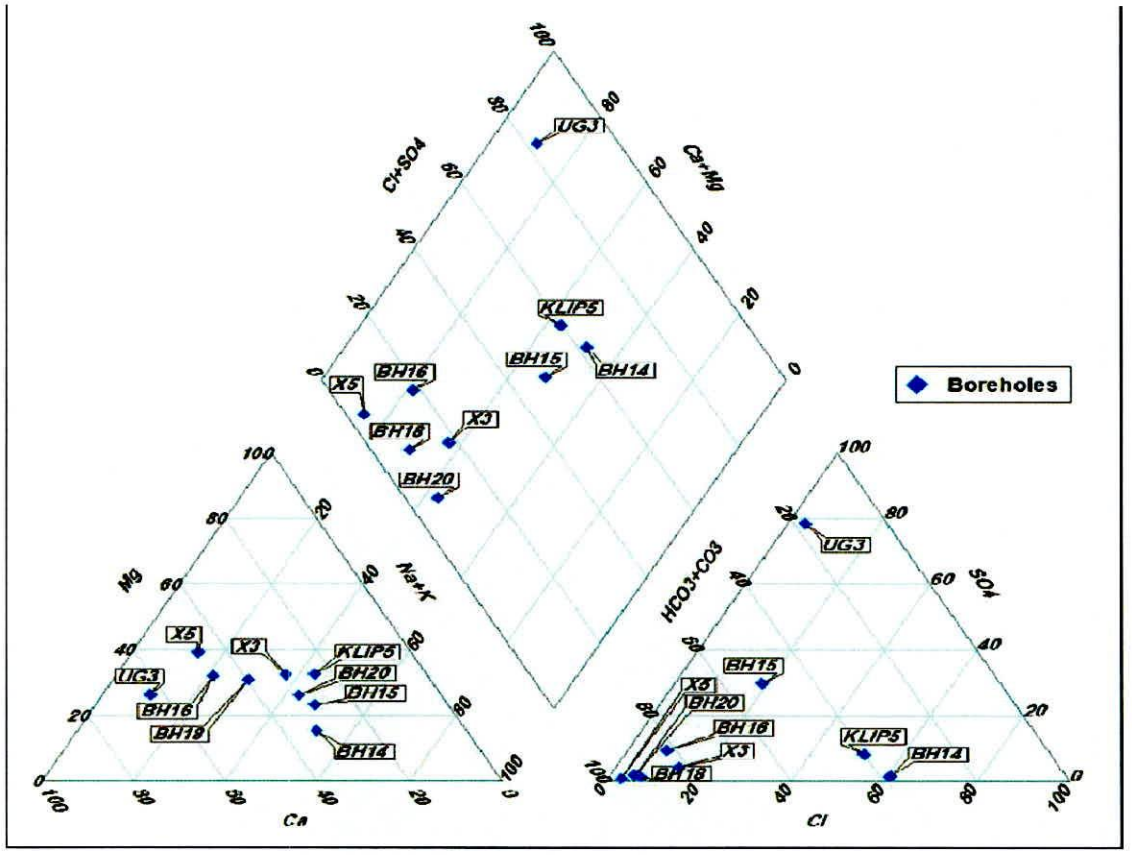


Figure 14: Piper diagram

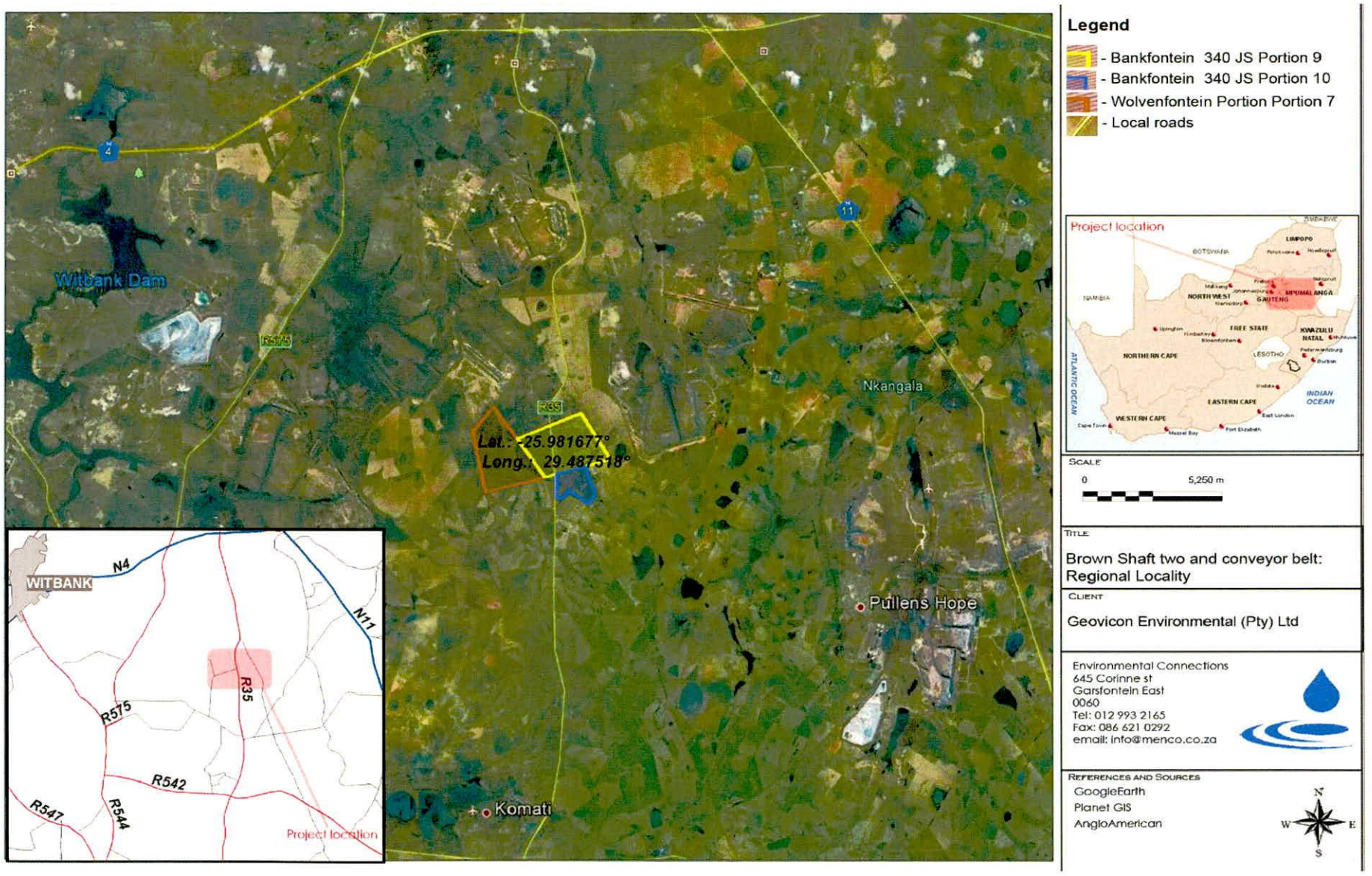


Figure15: Site map indicating the regional locality of the proposed development

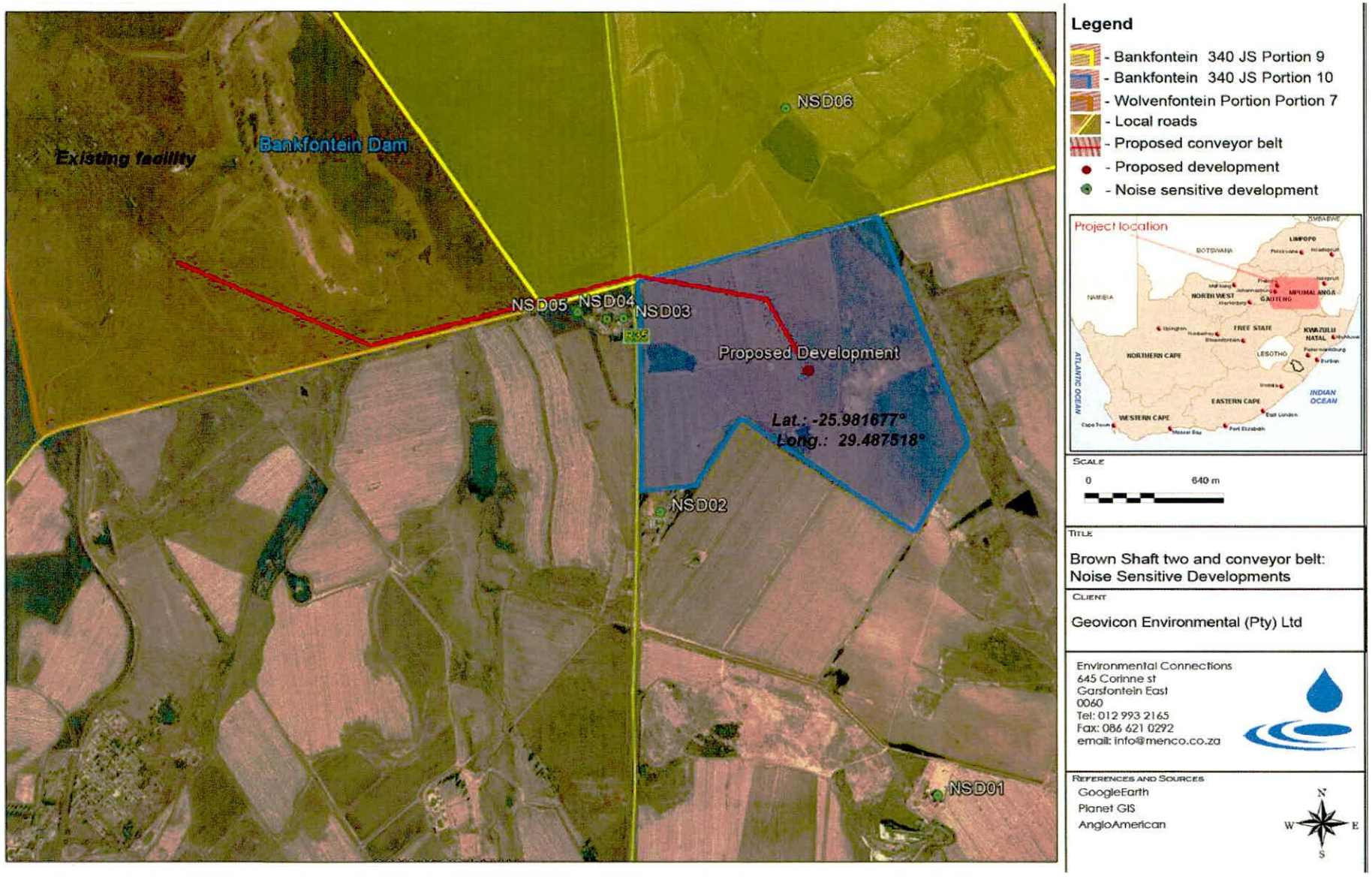


Figure 16: Aerial image indicating potentially noise-sensitive receptors near proposed development

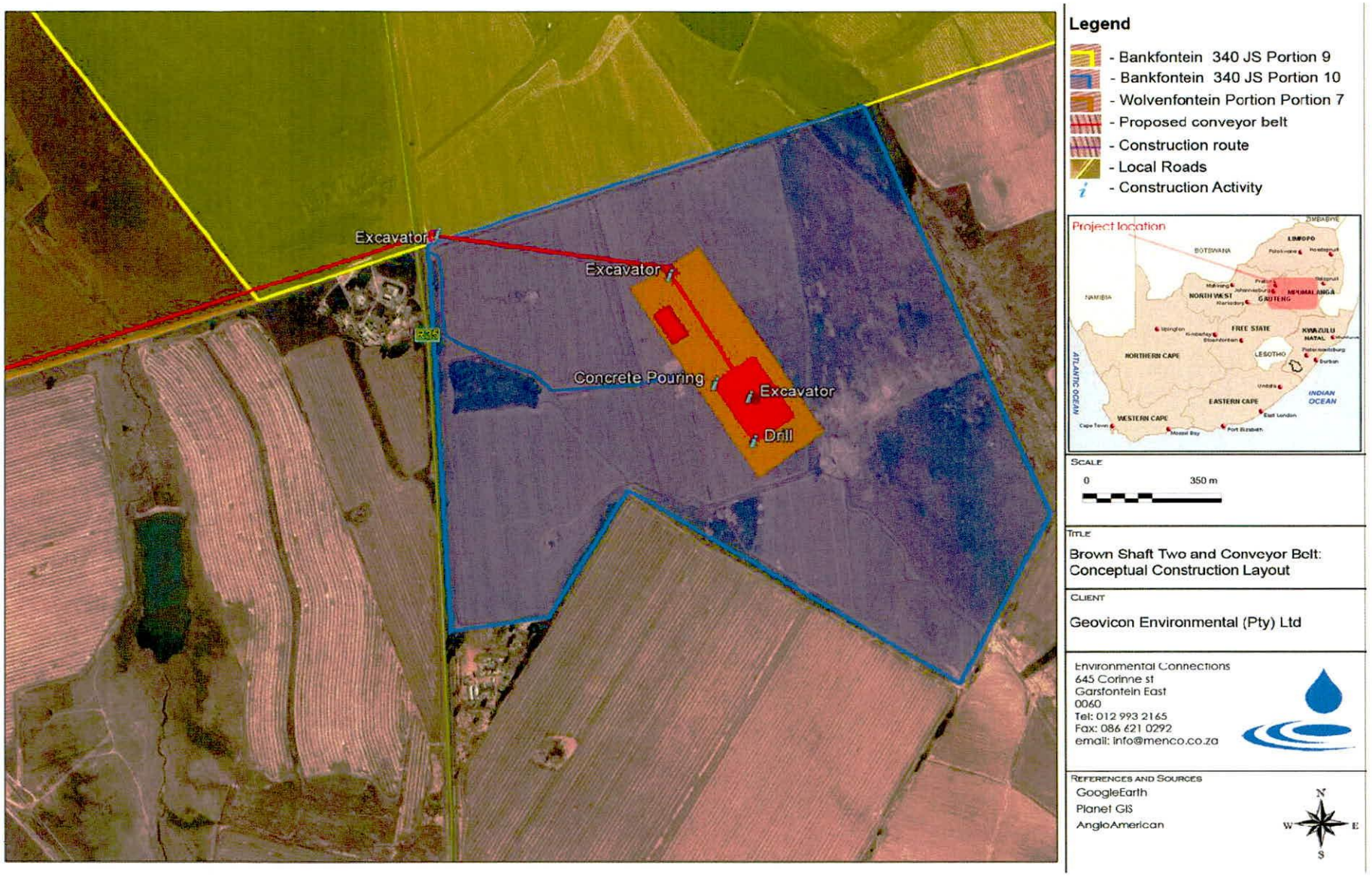


Figure 17: Conceptual construction layout

Appendix 1

Study of the Soil-Landform Resources of the Proposed Access Brown Shaft II Project Area

SPECIALIST STUDY REPORT

ANGLO OPERATIONS LTD: BROWN SHAFT 2

DETAILED SOIL-LANDFORM STUDY OF SELECTED WETLAND AND ADJOINING TERRESTRIAL AREAS ON PARTS OF PORTIONS 0, 1, 5, 7, 8, 10 AND 18 OF THE FARM WOLVENFONTEIN 471 JS, MIDDELBURG, MPUMALANGA

ASSESSMENT OF LANDFORM AND SOIL INDICATORS

Prepared by

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DR EBEN VERSTER (Pr Sci Nat Soil Science)

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JULY 2012

EXECUTIVE SUMMARY

1. During May 2012 a detailed soil-landform study of Portion 7 of the farm Wolvenfontein 471 JS, south of Middelburg, Mpumalanga plus the footprint of a conveyor belt on Portions 5 and 9 of the farm Bankfontein 340 JS had been done in order to inform an impact assessment process. (Report by Verster & Schoeman, 2012). Subsequently the area on Portion 7 had been expanded towards the south to include parts of Portions 0, 1, 5, 8, 10, and 18 with the purpose to supply detailed soil-landform data and evaluations on wetlands and terrestrial sites. This entire project area, known as Brown Shaft 2, covers an area of about 430 ha. The survey was conducted in accordance with standard procedures. Key findings are as follows:
2. Due to a mean annual rainfall of about 700 – 750mm, warm summers and frosty winters, the climate resources are highly favourable for arable summer crop farming, high potential summer grazing, hay production and the re-vegetation of mined land. The climate can be categorized as C2. (Climate more fully described by Verster & Schoeman, 2012.)
3. Agricultural land use activities such as grazing by cattle and maize farming are currently apparent. (See report by Verster & Schoeman, 2012.)
4. The soil-landform map (see **FIGURE 1**) shows the distribution of 22 map units, while the accompanying legend **(TABLE 3**) indicates the soil components as well as the position (terrain unit and slope class) they occupy in the landscape. The project area comprises a gently to moderately sloping crest-midslope-footslope-valley bottom hillslope sequence related to the extensive soil-landform system of the Highveld Plateau. The land surface is covered by a toposequence of soils consisting of moderately deep to deep (80-120 cm), well-drained, red, apedal, sandy clay loam of the **Hutton form** (map unit Hu) overlying saprolite; deep (100-140 cm), moderately deep (60-90 cm) or shallow (30-50 cm), well-drained, red apedal, sandy loam to sandy clay loam overlying hard plinthite of the **Lichtenburg form** (units Li1, Li2 and Li3); similar depth phases of well-drained, yellow-brown apedal, sandy loam to sandy clay loam overlying hard plinthite of the **Glencoe form**, (units Gc1, Gc2 and Gc3); deep to very deep, well-drained, yellow-brown apedal, sandy loam to sandy clay loam of the **Clovelly form** (unit Cv); moderately deep to deep, moderately well-drained, yellow-brown apedal, sandy loam to sandy clay loam on soft plinthic deep subsoil of the **Avalon form** (units Av1 and Av2); shallow effective depth, somewhat poorly drained, greyish sand to light loam on soft plinthic deep subsoil of the **Longlands form** (unit Lo); shallow effective depth, mainly poorly drained, soft plinthic, sandy loam to sandy clay loam of the **Westleigh form** (unit We); duplex soil of the **Estcourt form**, para-duplex soil of the **Sepane form** (unit Se); plus poorly drained, dark coloured, loam to clay of the **Katspruit form** (unit Ka) in bottomland sites. Some of the above soils are closely associated in the landscape and were subsequently mapped in associations, e.g. unit Li-Gc, unit Lo-We and unit Lo-We-Es. Shallow, sandy loam topsoil on hard plinthite of the **Dresden form** (unit Dr), whereas a gravel pit (unit GP), an eroded area (unit E), a farm dam (unit D) and a part of a pan (unit P) had also been demarcated. The leaching status of the upland soils has been taken as either meso- or dystrophic, Morphological properties and derived characteristics of the soils are summarised in **TABLES 1** and **2** respectively. The size of each map unit is shown in **TABLE 3**.
5. An assessment of land suitability was conducted using the soil, slope and climatic parameters (though climate has been taken as uniform over the site) for arable uses (for example physical agricultural potential - **TABLE 5**) on the basis of internationally recognised criteria and attributes limiting their suitability (**TABLE 4**). Two kinds of capability assessments had therefore been performed: (i) an agricultural classification

consisting of eight classes (**TABLE 5**); and (ii) the system prescribed by the Chamber of Mines comprising four classes. By combining these two systems as well as using the wetland identification nomenclature, the following assessment of land capability (**TABLE 6**) could be made:

LAND CAPABILITY MAP UNITS	LAND CAPABILITY	SOIL-LANDFORM MAP UNIT	AREA (ha)	AREA (%)
I-p	Class I – Wetland: permanent	D, P	5.28	1.23
I-s	Class I – Wetland: seasonal	Ka, Lo-We, Lo-We-Es	38.84	9.08
I-t	Class I – Wetland: temporary	Lo, We, Se, Dr	167.09	39.07
II-mh	Class II – Arable land: moderately high potential	Hu, Li1, Gc1, Cv, Av1, Av2	122.63	28.67
II-m	Class II – Arable land: moderate potential	Li2, Gc2, Li-Gc	71.07	16.62
III	Class III – Grazing land	Li3, Gc3	20.49	4.79
IV	Class IV – Wilderness land	GP, E	2.43	0.56
		TOTAL	**427.83**	**100.0**

FIGURE 2 exhibits the distribution of these classes.

6. **TABLE 7** explains the type of indicators (terrain and soil) used in this study for wetland identification:

MAP UNIT	WETLAND ZONE	INDICATORS				
		TERRAIN UNIT	SOIL			PRESENCE OF SURFACE WATER (at time of survey)
			Grey matrix colours within 50 cm	Mottles within 50 cm	Soil form	
D, P	Permanent	Valley bottom	No soil			Observed
Ka	Seasonal	Valley bottom	Strongly expressed as G horizon	Few, except rusty root holes	Indicator of seasonal wetland	Observed in places
Lo-We	Seasonal	Valley bottom	Moderately expressed from 30-40 cm	Common	Indicator of seasonal wetland	Observed in places
Lo-We-Es	Seasonal	Valley bottom	Strongly expressed from 30-50 cm	Common	Indicator of seasonal wetland	Uncommon
We	Temporary	Footslope/ Valley bottom	Moderately expressed from 30-40 cm	Common	Indicator of temporary wetland	Uncommon
Lo	Temporary	Footslope	Strongly expressed as E horizon	Few	Indicator of temporary wetland	Uncommon; in places, e.g. below pan
Se	Temporary	Footslope	Marginally to weakly expressed	Common	Indicator of temporary wetland	Not observed
Dr	Temporary	Midslope, Footslope	Marginally to weakly expressed as grey topsoil	Few	Indicator of temporary wetland (in terrain setting)	Not observed

As indicated above, the spatial distribution of the wetlands is shown in **FIGURE 2**, whereas a preliminary assessment of the present ecological status is given in **TABLE 8**. In general, a moderately modified ecological status could be ascribed to the wetlands of the Brown Shaft 2 area.

7 Any mining operations and uses of the terrain will undoubtedly impact negatively on the soil-landform resources. Several potentially significant impacts such as degradation of the wetlands, loss of prime agricultural land and topsoil, changing of the landsurface, soil erosion by water, soil compaction, chemical soil pollution and dustiness could be identified. These have been described in full for Portion 7 (Verster & Schoeman, 2012), and may be regarded as valid for the entire Brown Shaft 2 project area. However for this report, the two first-mentioned impacts have been specifically reiterated (**TABLE 9**).

8. Several management options in the form of mitigation measures have been recommended (**TABLE 10**) which apparently would result in a measurable reduction in certain instances. The exclusion of the wetland zones, occupying 211 ha or 49% of the overall site, from mining activities is highly recommended. In turn, map units composed of prime agricultural land cover 190 ha or 45 %. In view of the need of protecting the limited high to moderate potential agricultural land/topsoil resources in the country, the significance is assessed to be medium with and high without mitigation. Normal mitigation options such as the selection of lower agricultural potential land for coal mine development should, however, be the preferred option.

9. The following monitoring actions are recommended:

   - Possible degradation of the wetlands
   - Erosion of stockpiled materials and loading zones including haulage roads and other compacted areas
   - Chemical pollution of mine seepage, soil and groundwater resources
   - Evaluation of a free draining surface (due to compaction of soil surface materials) before topsoil is replaced during the rehabilitation process
   - Replacing of topsoil evenly over the footprint during rehabilitation
   - A post-mining soil assessment to evaluate and map the post-mining land capability which should also serve as required data for closure application.

CONTENTS

1. INTRODUCTION

1.1 Background and objectives

Pedoplan International Consultants were approached by Geovicon to conduct a detailed soil-landform assessment of selected wetland areas on parts of Portions 0, 1, 5, 7, 8, 10, and 18 of the farm Wolvenfontein 471 JS, south of Middelburg, Mpumalanga. This request was preceded by a soil-landform study of parts of Portion 7 plus the footprint of a conveyor belt on Portions 5 and 9 of the farm Bankfontein 340 JS in an attempt to inform an impact assessment process (Verster & Schoeman, 2012). For the purpose of this wetland investigation, the latter study forms an integral part thereof. The objective was as follows:

- To conduct a detailed assessment of the soil-landform resources, comprising identification, description, classification and mapping of the soil-terrain types in order to identify and delineate the wetlands as well as assessing the agricultural potential of the terrestrial sites.

1.2 Study approach

The project area, as shown in **FIGURE 1** is approximately 430 ha in extent. The soils were examined on a grid of approximately 50 to 200 m (Portion 7) plus by means of seven transects for the remainder of the project area, both by means of hand auger observations to a depth of 150 cm unless prevented by rock or ferricrete. At each observation point, the soils were described in a standard manner, and the present land use practice, condition of the land surface, slope class and other relevant hillslope features noted. The soils were identified, described and classified in accordance with the South African Taxonomic System (Soil Classification Working Group, 1991). A total of 138 observations were logged and geo-referenced. Soil boundaries were mapped by interpolation, aided by a Google Earth image with 5 m contours. For the subdivision of landforms into terrain units, the system of the Soil Classification Working Group (1991) was used. The study was also conducted in compliance with the methodology as prescribed by the Department of Water Affairs (2005) for the identification and delineation of wetlands. The maps were digitised by PedoGIS, Pretoria who also supplied the size of each map unit.

2. PRE-MINING LAND USE

Currently grazing by cattle and maize production are the predominant land uses. Grass harvesting was evident in places. Land use categories are only described for Portion 7 (TABLE 1 and spatially shown in FIGURE 1; Verster & Schoeman, 2012).

3. CLIMATE

For a brief description of the climate, see report for Portion 7 (Verster & Schoeman, 2012).

4. SOIL AND LANDFORM RESOURCES

4.1 Landform

The project area forms part of the Highveld Plateau. The latter constitutes a remnant of an old, high altitude (1600 m above sea level), gently undulating land surface, with pans in places. It is

mainly underlain by coal bearing shale and sandstone of the Vryheid formation (Geological Survey, 1986).

On a meso scale, the land surface is predominantly composed of level to gently sloping (1-3% slope) crests (about 5% in extent), gently to moderately sloping (3-8% slope) midslopes (about 70%), gently to moderately sloping (2-8% slope) footslopes (about 20%), and a level (0-2%) bottomland (about 5%). (See **FIGURE 1** and **TABLE 3** for the distribution and description of terrain units.)

4.2 Soil

Individual profile descriptions are summarised in **TABLE 1** while other selected properties and derived characteristics are shown in **TABLE 2**. A generalised description is also given in the soil-landform legend (**TABLE 3**).

The overall soil pattern is one of a plinthic catena – it represents the soil pattern of a large part of the Highveld Plateau. In this pattern, soil differentiation is in accordance with the concept of a drainage toposequence. An interesting phenomenon is the widespread occurrence of hard plinthite (ferricrete) in subsoil zones – an estimated 25% of the project area. The soils are:

(1) Crests and midslopes sites consist *inter alia* of well-drained, mesotrophic or dystrophic, red, apedal, sandy loam to sandy clay loam overlying hard plinthite of the **Lichtenburg form** with varying depth features, i.e. deep (map unit Li1; extent 5.0 ha) grading into moderately deep (unit Li2; 26.0 ha) and shallow (unit Li3; 14.8 ha) phases. Many, small and medium sized, hard Fe-Mn concretions are present in the subsoil in places. Mainly midslope sites are covered by moderately deep to deep, well-drained, mesotrophic or dystrophic, red, apedal, sandy clay loam of the **Hutton form** overlying saprolite (unit Hu; 6.0 ha), as well as several mesotrophic or dystrophic, yellow-brown, apedal soils, viz. (i) well-drained, sandy loam to sandy clay loam overlying hard plinthite of the **Glencoe form** with varying depth features, namely deep (map unit Gc1; extent 2.1 ha) grading into moderately deep (unit Gc2; 13.5 ha) and shallow (unit Gc3; 5.6 ha) phases; (ii) deep to very deep, well-drained, sandy loam to sandy clay loam of the **Clovelly form** overlying sandstone if within 150 cm of the surface (unit Cv; 17.1 ha); and (iii) moderately deep to deep, sandy loam to sandy clay loam on soft plinthite deep subsoil of the **Avalon form** (unit Av1; 71.7 ha; unit Av2; 20.6 ha). In one instance, an association of shallow to moderately deep, soils of the Lichtenburg and Glencoe forms (unit Li-Gc; 31.5 ha) was demarcated.

(2) In footslope sites, two soil forms dominate, alone or in association: (i) somewhat poorly drained, dark grey to grey, loamy sand or sandy loam topsoil and E horizon overlying greyish, plinthic, sandy clay loam deep subsoil of the **Longlands form** (unit Lo; 109.8 ha); and (ii) poorly drained, sandy loam to sandy clay loam topsoil on greyish, plinthic, sandy clay loam subsoil of the **Westleigh form** (unit We; 34.8 ha). An isolated occurrence of somewhat poorly drained, grey-brown, structured, sandy clay loam to sandy clay of the **Sepane form** occurs in the south (unit Se; 14.0 ha).

(3)The bottomlands are dominated by the following: (i) an interwoven association of poorly drained occurrences of dark grey sandy loam over grey or white loamy sand (**Longlands form**) and dark grey, massive, sandy loam or sandy clay loam topsoil on strongly mottled or gleyed, sandy clay loam or sandy clay (**Westleigh form**, unit Lo-We; 22.7 ha); (ii) a similarly interwoven association of poorly drained occurrences of dark grey, sandy loam over grey or white, loamy sand (**Longlands form**), dark grey, massive, sandy loam or sandy clay loam topsoil on strongly mottled or gleyed, sandy clay loam or sandy clay

of the **Westleigh form** and grey, loamy sand over prismatic clay (**Estcourt form**) (unit Lo-We-Es; 10.9 ha), and (iii) a small area with dark grey, sandy clay loam topsoil over gleyed, sandy clay loam or sandy clay of the **Katspruit form** (unit Ka; 5.3 ha).

(3) Three small sites of the **Dresden form** (dark grey to grey, sandy loam or sandy clay loam topsoil on hard plinthite; unit Dr; 8.5 ha) were demarcated, whereas a gravel pit (unit GP), an eroded area (unit E), a farm dam (unit D) and a pan (unit P) are also spatially shown in **FIGURE 1**.

The leaching status of the loamy soils of the Hutton, Lichtenburg, Glencoe, Clovelly and Avalon forms has been taken as either mesotrophic or dystrophic. According to the Land Type Survey Staff (1987), their Profile 62 had been classified as a mesotrophic member of the Hutton form. Furthermore, all the soils exhibit very acid soil reactions, while the fertility status is low (**TABLE 3**).

TABLE 1: Characteristics and classification of dominant soils

MAP SYMBOL	SOIL FORM AND FAMILY	GENERALISED PROFILE DESCRIPTION
Hu	Hutton 2100/1100 sandy loam / sandy clay loam	*Orthic A horizon:* 20-30 cm thick; reddish brown, massive, friable, sandy loam or sandy clay loam (clay content 15-25%); gradual transition to *Red apedal B1 horizon*: 80-120 cm deep, red, apedal, friable to firm, sandy clay loam (clay content 20-28%); underlain by weathered rock
Li	Lichtenburg 2100/1100 sandy loam	*Orthic A horizon:* 20-30 cm thick; reddish brown, massive, friable, sandy loam (clay content 15-20%); gradual transition to *Red apedal B1 horizon*: 40-110 cm deep, red or yellow-red, apedal, friable to firm, sandy loam or sandy clay loam (clay content 18-25%); underlain, in places *via* an iron-manganese concretion-rich layer of about 20 cm thick, or abruptly by *Hard plinthic B2 horizon: reddish*, cemented iron-manganese hardpan
Gc	Glencoe 2100/1100 sandy loam	*Orthic A horizon:* 20-30 cm thick, dark brown, massive, friable, sandy loam (clay content 15-20%); gradual transition to *Yellow-brown apedal B1 horizon*: 40-120 cm deep, yellow-brown, massive, friable to firm, sandy loam to sandy clay loam (18-15% clay): underlain, commonly *via* an iron-manganese concretion-rich layer of about 20 cm thick, or abruptly by *Hard plinthic B horizon*
Cv	Clovelly 2100/1100 sandy loam	*Orthic A horizon:* 20-30 cm thick; dark brown, massive, friable, sandy loam (clay content 15-20%); gradual transition to *Yellow-brown apedal B horizon*: 70->120 cm deep, yellow-brown, massive, friable to firm, sandy loam to sandy clay loam (clay content 15-23%); merging into *C horizon*; weathered, mottled sandstone in places
Av	Avalon 2100/1100 sandy loam	*Orthic A horizon*: 20-30 cm thick, dark grey brown, massive, friable, sandy loam (clay content 15-20%); gradual transition to *Yellow-brown apedal B1 horizon*: 60-120 cm deep, yellow-brown, massive, friable to firm, sandy clay loam (clay content 20-25%); gradual to clear transition *Soft plinthic B2 horizon*: >50 cm thick, variegated, mottled (many, medium, distinct, reddish, orange, yellowish, greyish), massive, firm, sandy clay loam (clay content 25-30%); merging into *C horizon*: highly weathered, mottled sandstone in places

Lo	Longlands 1000 loamy medium sand to sandy loam	*Orthic A horizon*: 30-40 cm thick, very dark grey brown, massive, friable, loamy medium sand to sandy loam (clay content 10-16%); gradual transition to *E horizon*: 60-100 cm deep, light grey, massive, friable, loamy medium sand to sandy loam (clay content 8-20%); clearly overlying *Soft plinthic B horizon*: >50 cm thick, greyish, mottled (many, medium, distinct, yellowish, greyish), massive, firm, sandy clay loam (clay content 20-35%); merging into *C horizon*: highly weathered, mottled sandstone in places
We	Westleigh 2000 sandy loam to sandy clay loam	*Orthic A horizon*: 30-40 cm thick, very dark greyish brown, massive to weakly structured, friable to firm, sandy loam to sandy clay loam (clay content 15-25%); clear transition to *Soft plinthic B horizon*: > 50 cm thick, dark greyish brown, many distinct yellowish and orange mottles, weakly to moderately structured, firm, sandy clay loam (clay content 30-35%)
Ka	Katspruit 1000 sandy loam to sandy clay loam	*Orthic A horizon*: 30-50 cm thick, very dark greyish brown to black, massive to weakly structured, firm, sandy loam to sandy clay loam (clay content 18-35%); gradually overlying *G horizon*: >50 cm thick, dark greyish to greyish, weakly to moderately structured, firm, sandy clay loam to sandy clay (clay content 25-40%); high watertables present
Dr	Dresden 1000 sandy loam	*Orthic A horizon:*< 30 cm thick, dark greyish brown, strongly mottled, massive, friable, sandy loam (clay content 15-20%), abruptly overlying *Hard plinthic B horizon*
Se	Sepane 1210 sandy clay loam	*Orthic A horizon:* 20-30 cm thick, greyish brown, finely mottled, weak to moderate blocky, sandy clay loam (clay content 20-25%), sharply overlying *Pedocutanic B horizon with signs of wetness;* >50 cm thick, greyish brown, mottled, strong angular blocky sandy clay loam or sandy clay

TABLE 2: Derived soil properties and interpretive information of dominant soils

SOIL PROPERTIES	Hutton	Lichten-burg	Glencoe	Clovelly	Avalon	Longlands	Westleigh	Katspruit	Dresden	Sepane
Water seepage capacity of subsoil or underlying material	Rapid	Rapid-Moderate	Rapid-Moderate	Rapid-Moderate	Moderate	Slow	Slow	Very slow	Slow	Slow
Water table (position, condition and duration)	None	None	Hard plinthite, temporary, intermediate periods after rain events	None	Deep subsoil, temporary, intermediate periods after rain events	Subsoil, temporary, intermediate periods after rain events	Subsoil, temporary, long periods after rain events	From surface. long periods during year	Topsoil, hard plinthite, temporary after rain events	Subsoil, temporary, intermediate periods after rain events
General fertility status	Low	Low	Low	Low	Low	Very low	Low	Low	Low	Moderate
pH class (topsoil)	5.0-6.0	5.0-6.0	5.0-6.0	5.0-6.0	5.0-6.0	5.0-6.0	5.5-6.5	6.0-7.0	5.0-6.0	6.0-7.0
Natural erosion hazard - water	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Moderate-High	Moderate
Swell-shrink potential of soil	Low	Low	Low	Low	Low	Low	Low	Low-Moderate	Low	Low-Moderate
Compaction potential	Moderate-High	Moderate-High	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low
Stability of soil	High	High	High	High	High	Moderate	Moderate-High	Moderate	High	Moderate

Adsorption capacity of pollutants	High	High, if deep	High, if deep	High, if deep	Moderate	Low	Moderate	Moderate-High	Low	Moderate-High
Dust potential	Moderate-High	Moderate-High	Moderate-High	Moderate-High	Moderate	Low	Moderate	Low	Moderate-High	Low-Moderate

4.3 Soil-landform map

The distribution of the soil-landform resources is given on the detailed soil-landform map (**FIGURE 1**). The map legend, also contained in **TABLE 3**, indicates the dominant soil components as well as the position (hillslope unit and slope class) they occupy in the landscape. The sizes of map units are shown in **TABLE 3**.

TABLE 3: Soil-landform map units

MAP UNIT	LANDFORM COMPONENT	SOIL COMPONENT	AREA (ha)	AREA (%)
Hu	Gently to moderately sloping midslopes (3-6% slope)	Moderately deep to deep (80-120 cm), well-drained, dark red, apedal, sandy clay loam of the Hutton form, on weathered rock	5.99	1.40
Li1	Level to gently sloping crests or upper midslopes (1-2% slope)	Deep (100-140 cm), well-drained, red, apedal, sandy loam or sandy clay loam on hard plinthite of the Lichtenburg form	5.02	1.17
Li2	Level to gently sloping midslopes (2-5% slope)	Moderately deep (60-90 cm), well-drained, red, apedal, sandy loam or sandy clay loam on hard plinthite of the Lichtenburg form; many, hard Fe-Mn concretions in subsoil	26.04	6.09
Li3	Level to gently sloping crests or upper midslopes (1-2% slope)	Shallow (30-50cm), well-drained, dark red, apedal, sandy loam or sandy clay loam on hard plinthite of the Lichtenburg form; few to many, hard Fe-Mn concretions	14.86	3.47
Gc1	Level to gently sloping crests (1-3% slope)	Deep (100-120 cm), well-drained, yellow-brown, apedal, sandy loam or sandy clay loam on hard plinthite of the Glencoe form	2.11	0.49
Gc2	Gently to moderately sloping midslopes (2-8% slope)	Moderately deep (50-100 cm), well-drained, yellow-brown, apedal, sandy loam or sandy clay loam on hard plinthite of the Glencoe form	13.56	3.17
Gc3	Gently to moderately sloping midslopes (4-8% slope)	Shallow (30-50 cm), well-drained, yellow-brown, apedal, sandy loam on hard plinthite of the Glencoe form; few to many, hard Fe-Mn concretions	5.63	1.32
Li-Gc	Gently sloping midslopes (2-5% slope)	Association of shallow to moderately deep (40-60 cm), well-drained, red or yellow-brown sandy loam or sandy clay loam on hard plinthite; few to many, hard Fe-Mn concretions	31.47	7.36
Cv	Gently to moderately sloping midslopes (2-6% slope)	Deep to very deep (100->150 cm), well-drained, yellow-brown, apedal, sandy loam to sandy clay loam of the Clovelly form on weathered sandstone	17.11	4.00
Av1	Gently to moderately sloping crests or midslopes (1-6% slope)	Moderately deep to deep (effective depth 80-130 cm), moderately well-drained, yellow-brown, apedal, sandy loam or sandy clay loam on soft plinthite deep subsoil of the Avalon form	71.75	16.78

Av2	Gently sloping footslopes (2-4 % slope)	Moderately deep (effective depth 60-90 cm), moderately well- drained, yellow-brown, mottled, apedal, sandy loam or sandy clay loam on soft plinthic deep subsoil of the Avalon form	20.65	4.83
We	Gently to moderately sloping footslopes and valley bottom (1-8% slope)	Shallow (effective depth 30-40 cm), poorly drained, grey brown, sandy loam or sandy clay loam topsoil on plinthic, sandy clay loam subsoil of the Westleigh form	34.79	8.14
Lo	Gently to moderately sloping footslopes (4-8% slope); uneven surface roughness in places in the form of erosion channels	Shallow (effective depth 30-40 cm), somewhat poorly drained, grey-brown or grey, loamy sand or sandy loam topsoil and E horizon, on grey, plinthic, sandy clay loam deep subsoil of the Longlands form	109.77	25.66
Lo-We	Level valley bottom (0-1% slope); uneven surface roughness in places in the form of erosion channels and overburden deposits	Association of poorly drained soils with shallow effective depth (10-40 cm): (i) grey, loamy sand or sandy loam topsoil and E horizon, over grey, plinthic, sandy clay loam deep subsoil of the Longlands form, and (ii) grey, sandy loam or sandy clay loam topsoil, on plinthic, sandy clay loam subsoil of the Westleigh form; water tables commonly present; associated with Katspruit form in places; sandy or loamy overburden in places	22.67	5.30
Lo-We-Es	Level valley bottom (0-1% slope); uneven surface roughness in places in the form of erosion channels and overburden deposits	Association of somewhat poorly to poorly drained soils with shallow effective depth (10-40 cm): (i) grey, loamy sand or sandy loam topsoil and E horizon, over grey, plinthic, sandy clay loam deep subsoil of the Longlands form; (ii) grey, sandy loam or sandy clay loam topsoil on plinthic, sandy clay loam subsoil of the Westleigh form; and (iii) loamy sand topsoil and E horizon, over grey-brown, strong prismatic, sandy clay subsoil of the Estcourt form	10.88	2.54
Se	Gently sloping footslopes (2-4 % slope)	Shallow (effective depth 20-30 cm), greyish brown, finely mottled, weak to moderate blocky, sandy clay loam over, greyish brown, mottled, strong angular blocky, sandy clay loam or sandy clay subsoil of the Sepane form	14.03	3.28
Ka	Level valley bottom (0-1% slope)	Deep soil materials: very poorly drained, dark grey, sandy loam or sandy clay loam topsoil on grey, gleyed sandy clay of the Katspruit form	5.29	1.24
Dr	Gently to moderately sloping midslopes and footslopes (4-8% slope)	Shallow (30-40 cm) somewhat poorly drained, dark grey, mottled, sandy loam on hard plinthite of the Dresden form; associated with similar soil of the Wasbank form	8.50	1.99
GP	Miscellaneous land class: Gravel pit		2.16	0.50
E	Miscellaneous land class: Erosion		0.27	0.06
D	Dam		1.03	0.24
P	Pan		4.25	0.99
		TOTAL	**427.83**	**100.0**

5. LAND CAPABILITY EVALUATION

Land evaluation is the process of the assessment of land performance when used for specified purposes. The rating of land is invariably dependent on one or more soil-landform parameters (climate taken as uniform over the project area) as described in **TABLES 1**, **2** and **3**; for example, dryland agriculture to slope, ease of cultivation, depth of soil, presence of rockiness, fertility level, etc. (rainfall efficiency taken into consideration). The most important limitations of each map unit affecting their suitability are shown in **TABLE 4**.

TABLE 4: Limitations of map units influencing the suitability for agricultural/ environmental land uses

MAP UNIT	DOMINANT LIMITATIONS
Hu	Agricultural: high fertilization requirements Environmental: moderate due to compaction; moderate dust potential
Li1	Agricultural: high fertilization requirements Environmental: moderate due to compaction; moderate dust potential
Li2	Agricultural: moderate due to soil depth; high fertilization requirements Environmental: moderate due to compaction; moderate dust potential
Li3	Agricultural: severe due to soil depth; high fertilization requirements Environmental: moderate due to compaction; moderate dust potential
Gc1	Agricultural: high fertilization requirements Environmental: moderate due to compaction; moderate dust potential
Gc2	Agricultural: moderate due to soil depth; high fertilization requirements Environmental: moderate due to compaction; moderate dust potential
Gc3	Agricultural: severe due to soil depth Environmental: moderate due to compaction; moderate dust potential
Li-Gc	Agricultural: limited depth; high fertilization requirements Environmental: moderate dust potential
Cv	Agricultural: high fertilization requirements Environmental: moderate dust potential
Av1	Agricultural: high fertilization requirements Environmental: none
Av2	Agricultural: moderate due to effective soil depth; high fertilization requirements Environmental: marginal wetland in places
We	Agricultural: severe due to effective soil depth; wetness Environmental: wetland
Lo	Agricultural: severe due to effective soil depth; wetness; low clay content Environmental: wetland; low clay content
Lo-We	Agricultural: severe due to effective soil depth; wetness; low clay content Environmental: wetland; low clay content
Lo-We-Es	Agricultural: severe due to effective soil depth; wetness; low clay content Environmental: wetland; low clay content
Se	Agricultural: severe due to effective soil depth; wetness Environmental: wetland; low clay content
Ka	Agricultural: wetness; wetland Environmental: wetland
Dr	Agricultural: very severe due to soil depth; wetness Environmental: soil depth; wetness
GP	Agricultural: no soil Environmental: no soil
E	Agricultural: gully; eroded soil Environmental: gully; eroded soil

5.1 Suitability for dryland agricultural use

In this study to assess suitability for agriculture, the rating process has been based on the land capability system and diagnostic criteria as described by Scotney *et al.*, 1987 and Schoeman *et al.*, 2002. Due to the nature of this study only the **physical suitability for agriculture** has been appraised (**TABLE 5**). Climate with its C2 rating is regarded as uniform over the project area. (The map units can therefore not be ranked into capability classes higher than class II.)

TABLE 5: Land capability assessment

MAP UNIT	LAND CAPABILITY CLASS*	PHYSICAL AGRICULTURAL POTENTIAL	MAP UNIT	LAND CAPABILITY CLASS*	PHYSICAL AGRICULTURAL POTENTIAL
Hu	II	Moderately high	We	VI	Very low
Li1	II	Moderately high	Lo	VI	Very low
Li2	III	Moderate	Lo-We	V	Very low
Li3	IV	Low	Lo-We-Es	V	Very low
Gc1	II	Moderately high	Se	V	Very low
Gc2	II	Moderate	Ka	V	Very low
Gc3	IV	Low	Dr	VI	Very low
Li-Gc	III	Moderate	GP	VII	Very low-None
Cv	II	Moderately high	E	VII	Very low-None
Av1	II	Moderately high			
Av2	II	Moderately high			

*System based on eight classes with I the highest and VIII the lowest

5.2 Land capability according to the Chamber of Mines' guidelines

According to these guidelines for the classification of land (2007), their land capability subdivisions reflect four classes, viz. class I (wetland), class II (arable land) class III (grazing land), and class IV (wilderness land). For the project area, these classes are shown in **FIGURE 2** and explained in **TABLE 6** albeit with a difference: the arable class is complemented with its agricultural land capability rating (**TABLE 5**), and wetland identification by the different classes of wetlands (see **5.3** below).

TABLE 6: Land capability (Chamber of Mines' guidelines)

LAND CAPABILITY MAP UNITS	LAND CAPABILITY	SOIL-LANDFORM MAP UNIT	AREA (ha)	AREA (%)
I-p	Class I – Wetland: permanent	D, P	5.28	1.23
I-s	Class I – Wetland: seasonal	Ka, Lo-We, Lo-We-Es	38.84	9.08
I-t	Class I – Wetland: temporary	Lo, We, Se, Dr	167.09	39.07
II-mh	Class II – Arable land: moderately high potential	Hu, Li1, Gc1, Cv, Av1, Av2	122.63	28.67
II-m	Class II – Arable land: moderate potential	Li2, Gc2, Li-Gc	71.07	16.62
III	Class III – Grazing land	Li3, Gc3	20.49	4.79
IV	Class IV – Wilderness land	GP, E	2.43	0.56
		TOTAL	**427.83**	**100.0**

6. WETLAND IDENTIFICATION AND DELINEATION

In essence, the wetland identification and delineation process is a land evaluation procedure where physical indicators of land (soil, terrain and vegetation) are utilised in terms of the requirements of wetland recognition. According to the Department of Water Affairs and Forestry (2005), the object of the delineation procedure is to identify the outer edge of the temporary zone. From this information it is then possible to comment on the location and possible impacts on wetlands. For this project soil and terrain have been used to indicate the presence of wetland areas.

6.1 Wetland identification

The wetland results and indicators by which they were identified are listed in **TABLE 7**. Map units D and P represent permanent; units Ka, Lo-We and Lo-We-Es seasonal; and units Lo, We, Se and Dr temporary wetland zones.

TABLE 7: Wetland zones and indicators of the Brown Shaft 2 project area

MAP UNIT	WETLAND ZONE	INDICATORS				
		TERRAIN UNIT	SOIL			PRESENCE OF SURFACE WATER (at time of survey)
			Grey matrix colours within 50 cm	Mottles within 50 cm	Soil form	
D, P	Permanent	Valley bottom	No soil			Observed
Ka	Seasonal	Valley bottom	Strongly expressed as G horizon	Few, except rusty root holes	Indicator of seasonal wetland	Observed in places
Lo-We	Seasonal	Valley bottom	Moderately expressed from 30-40 cm	Common	Indicator of seasonal wetland	Observed in places
Lo-We-Es	Seasonal	Valley bottom	Strongly expressed from 30-50 cm	Common	Indicator of seasonal wetland	Uncommon

We	Temporary	Footslope/ Valley bottom	Moderately expressed from 30-40 cm	Common	Indicator of temporary wetland	Uncommon
Lo	Temporary	Footslope	Strongly expressed as E horizon	Few	Indicator of temporary wetland	Uncommon; in places, e.g. below pan
Se	Temporary	Footslope	Marginally to weakly expressed	Common	Indicator of temporary wetland	Not observed
Dr	Temporary	Midslope, Footslope	Marginally to weakly expressed as grey topsoil	Few	Indicator of temporary wetland (in terrain setting)	Not observed

6.2 Wetland delineation

Three wetland zones (map units I-p, I-s and I-t) had been delineated as shown by **FIGURE 2**.

6.3 Preliminary assessment of present ecological status (PES)

Although PES assessments for this project are primarily based on soil and land surface factors, references are also made of human-induced aspects such as eutrophication, overgrazing and weed infestation (**TABLE 3**).

TABLE 8: Present condition of wetlands in the Brown Shaft 2 project area according to ecological status (after Duthie, 1999)

MAP UNIT	WETLAND ZONE	TERRAIN UNIT AND SLOPE	DOMINANT SOIL FORM AND FAMILY	PRESENT ECOLOGICAL STATUS*	AREA (ha)
D, P (I-p)	Permanent wetland	Valley bottom; level	Not determined	**B**: Only slightly modified due to some degree of water eutrophication (nitrogen leaching from lands)	5.28
Ka (I-s)	Seasonal wetland	Valley bottom; level	Katspruit 1000	**C**: Moderately modified in places due to overgrazing, weeds	5.29
Lo-We (I-s)	Seasonal wetland	Valley bottom; level	Longlands 1000 Westleigh 2000	**C**: Moderately modified due to erosion and surface deposits, overgrazing, weeds	22.67
Lo-We-Es (I-s)	Seasonal wetland	Valley bottom; level	Longlands 1000 Westleigh 2000 Estcourt 1100	**C**: Moderately modified due to erosion and surface deposits, overgrazing, weeds	10.88
We (I-t)	Temporary wetland	Footslope/valley bottom; gently to moderately sloping	Westleigh 2000	**C**: Moderately modified due to surface erosion, overgrazing, weeds	34.79
Lo (I-t)	Temporary wetland	Footslope; gently to moderately sloping	Longlands 1000	**C**: Moderately modified due to erosion, overgrazing, weeds	109.77
Se (I-t)	Temporary wetland	Footslope; gently sloping	Sepane 1210	**C**: Moderately modified due to surface erosion, overgrazing, weeds	14.03
Dr (I-t)	Temporary wetland	Midslope/Footslope; gently to moderately sloping	Dresden 1000	**C**: Moderately modified due to surface erosion, overgrazing, weeds	8.50

*Key to the Present Ecological Status categories (after Duthie, 1999):

A Unmodified or approximates natural conditions
B Largely natural with a few modifications
C Moderately modified, with some loss of natural habitats
D Largely modified, a large loss of natural habitats and basic ecosystem functions
E Seriously modified, extensive loss of habitats and ecosystem functions
F Critically modified, the modifications have resulted in almost complete loss of habitat

7. IMPACT ASSESSMENT

This assessment deals with potential negative impacts of mining-related land uses on the soil-landform resources of the project area. A complete discussion of possible impacts such as degradation of wetlands, loss of high potential agricultural land/topsoil, changing of landsurface, soil erosion, soil compaction, chemical soil pollution, soil microbiological degradation and dustiness had already been specified for Portion 7 (Verster & Schoeman, 2012), and may be regarded as valid for the entire Brown Shaft 2 project area. However for this report, the two first-mentioned impacts are specifically reiterated (**TABLE 9**).

7.1 Degradation of wetlands

It is certain that any mining development within a wetland would ultimately lead to degradation. The several wetland sites labeled P, Ka, Lo-We, Lo-We-Es, We, Lo, Se and Dr represent sensitive areas of high significance and should ideally be excluded (and isolated by means of embankments, where necessary) from any mining activity to minimise impacts. Obvious mitigation measures would have to be put in place such as maintaining effective water runoff control measures and refraining from disturbing land or storing residues in the proximities of these sensitive areas. The significance of potential impacts is rated as medium to low with and high without mitigation.

7.2 Loss of high potential agricultural land/topsoil

Land comprising moderately high or moderate agricultural potential is perceived as a sensitive area. The construction of mining infrastructure will have a long-term (and in most cases permanent) impact on agricultural productivity. As shown in **TABLE 6**, map units Hu, Li1, Gc1, Cv, Av1, Av2, Li2, Gc2 and Li-Gc are occupied by moderately high and moderate potential agricultural land respectively and may be described as prime agricultural land. These map units cover about 190 ha or 45% of the total area. In view of the need of protecting the limited high to moderate potential agricultural land/topsoil resources in the country, the significance is assessed to be medium with and high without mitigation. Normal mitigation options such as the selection of lower agricultural potential land for development, however, are of limited extent (**FIGURE 1**).

TABLE 9: Summary of selected potentially negative impacts on the soil-landform resources

NATURE OF NEGATIVE IMPACT	EXTENT	DURATION	PROBABILITY OF OCCURRENCE	CONFIDENCE	SIGNIFICANCE	
					WITH MITIGATION	WITHOUT MITIGATION
Degradation of wetlands	Site - International	Long term	Definite	High	Medium-Low	High

Loss of potential arable land/topsoil	Local-National	Long term/ Permanent	Definite	High	Medium	High

8. MITIGATION MEASURES

It is highly probable that the environmental impacts of mining activities on the soil-landform resources can be reduced by the diligent implementation of relatively easy and practically attainable mitigation measures. The management and mitigation actions recommended in order to minimise degradation of the environment are listed in **TABLE 10.**

TABLE 10: Selected mitigation measures for the Brown Shaft 2 project

NEGATIVE IMPACT	MITIGATION MEASURES
Degradation of wetlands	▪ Delineation of wetlands by means of pegging before commencement of development is necessary. ▪ Avoid development in wetland zones. ▪ Avoid the dumping of materials, spills and the run-on of polluted water into wetland zones. ▪ Construction of isolative embankments where necessary. ▪ To this end, design, implement and maintain effective water runoff control measures. ▪ Refrain from disturbing land in the proximities of wetland zones.
Loss of prime agricultural land/topsoil	▪ Where necessary, strip topsoil clean from underlying non-topsoil materials such as weathered sandstone, hard or soft plinthite. ▪ Stripping and stockpiling of A horizon (30 cm topsoil) separately from subsoil. ▪ Selection of sites of lower potential soils for development whenever possible. ▪ During rehabilitation, soil amelioration should be done by liming and fertilizer applications based on soil analysis.

9. CONCLUSIONS AND RECOMMENDATIONS

The soil and landform resources of the proposed Brown Shaft 2 project area (430 ha in extent) were identified, classified and mapped in detail.

9.1 Climate-soil-landform resources

- Due to a mean annual rainfall of 700 – 750 mm, warm summers and frosty winters, the climate resources are highly favourable for arable summer crop farming, high potential summer grazing, hay production and the re-vegetation of mined land. The climate has been categorized as C2.
- The gently to moderately sloping land surface is covered by a toposequence of soils consisting of moderately deep to deep, red apedal, sandy clay loam overlying saprolite of the Hutton form; deep, moderately deep or shallow, red apedal, sandy loam to sandy clay loam overlying hard plinthite of the Lichtenburg form; similar depth phases of yellow-brown apedal, sandy loam to sandy clay loam overlying hard plinthite of the Glencoe form: deep to very deep, yellow-brown apedal, sandy loam to sandy clay loam of the Clovelly form; moderately deep or deep, yellow-brown apedal,