WONDERSTONE LIMITED
DRIEKUIL SECTION 102 APPLICATION

GROUNDWATER SCOPING REPORT

DRAFT REPORT

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PROJECT DETAILS

PROJECT:	Wonderstone Limited – Driekuil Section 102 Application
Report Title:	Groundwater Scoping Report
Client:	EnviroGistics
Client Contact	Tanja Bekker
Project Number	ILEH-EG W-GW 05-21
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INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on assessment techniques, which are limited by information available, time and budgetary constraints relevant to the type and level of investigation undertaken, and Irene Lea Environmental and Hydrogeology cc reserve the right to modify aspects of the report including the recommendations if and when new information may become available from on-going research, monitoring and further work in this field pertaining to the investigation.

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This report must not be altered or added to without the prior written consent of the author.

Irene Lea M.Sc. Pr. Sci. Nat

11 March 2022

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LIST OF ACRONYMS USED

BH	Borehole
CMR	Converted Mining Right
DWS	Department of Water and Sanitation
DWAF	Former Department of Water Affairs and Forestry
EAP	Environmental Assessment Practitioner
EMP	Environmental Management Plan
iLEH	Irene Lea Environmental and Hydrogeology cc
IWWMP	Integrated Water and Waste Management Plan
mamsl	Metres above mean sea level
MAP	Mean Annual Precipitation
MPRDA	Minerals and Petroleum Resources Development Act (Act 28 of 2002).
NEMWA	National Environmental Management Waste Act, Act No. 59 of 2008
NOMR	New Order Mining Right
mbgl	Metres below ground level
SANS	South African National Standards
SWL	Static Water Level
T Cr	Total Chromium
WRD	Waste Rock Dump
WST	Wonderstone
WUL	Water Use License

1 INTRODUCTION

1.1 Project Description

The Wonderstone Limited (WST) operations are situated 10km north of the town of Ottosdal in the North West Province, as indicated on Figure 1. WST currently mines pyrophyllite, an aluminium silicate also referred to as Wonderstone, on Portion 44 of the farm Gestoptefontein 349 IO through opencast mining methods under a converted mining right (CMR) (NW 30/1/2/2/398). The extent of the CMR is indicated in red on Figure 1.

The current mining activities consist of a main quarry, low grade stockpiles, a plant facility, a powder plant facility, a residential and a hostel area that was largely rehabilitated as well as historic quarries. The bulk of the material mined is beneficiated to produce high-precision components manufactured on site. A large waste rock dump (WRD) is situated adjacent to the main quarry. WST considers this material as low grade ore.

In addition to the mining right discussed above, WST also holds a New Order Mining Right (NOMR) (NW30/5/1/2/2/397MR) over various portions of the farms Gestoptefontein and Driekuil. The extent of the NOMR is indicated in purple on Figure 1. The NOMR covers an area of 4 595ha.

WST is in the process of consolidating its existing mining rights in an attempt to ease administrative duties and compliance requirements. As part of this process, WST is applying to abandon some of the areas currently included and authorised in the NOMR area. Based on forecasts completed, WST only intends using a select portion of the approved NOMR for future mining activities. The extent of the proposed consolidated mining right is shown on Figure 1.

The project will be undertaken as a Section 102 Amendment Application in terms of the Minerals and Petroleum Resources Development Act (Act 28 of 2002) (MPRDA). As part of this process, WST intends to apply to add the selected portions of the approved NOMR to the CMR (MR398).

This project is undertaken in consultation with Envirogistics (Pty) Ltd, the Environmental Assessment Practitioner (EAP) appointed to the project.

1.2 Project Activities Considered

The project activities pertinent to the groundwater baseline assessment that will be considered as part of the Section 102 application include the following (Envirogistics, 2022):

- WST will continue mining from the exiting Wonderstone opencast pit using the existing methods of mining. Five additional mining blocks will be included in this mine plan (see Figure 1). These mining blocks include:
    - Block 1N: This is the existing mining area, covering an area of approximately 15ha. Mining will take place in this area between 2022 and 2027.
    - Block 2N: covering an area of 2.5ha and will be mined between 2027 and 2033.
    - Block 3N: covering an area of 2.1ha and will be mined between 2029 and 2037.
    - Block 4N: covering an area of 2.1ha and will be mined between 2032 and 2041.
    - Block 5N: covering an area of 2ha and will be mined between 2036 and 2044.
    - Block 6N: covering an area of 2.9ha and will be mined between 2040 and 2046.
- Unusable pyrophyllite will be transported to the low-grade stockpile for possible future use.
- Two areas are demarcated for the temporary storage of topsoil/overburden/waste rock of 3.4 and 3.2ha in size. These areas will be managed as a new waste rock dump (WRD). This material will be used for backfilling of opencast pits in future as part of the rollover method of mining.
- Existing haul roads will be used. These will be extended to the new mining area.
- Dust control on haul roads will be done with a water bowser. Water is extracted from the Driekuilspuit Dam, as authorised by the existing and approved water use license (WUL).

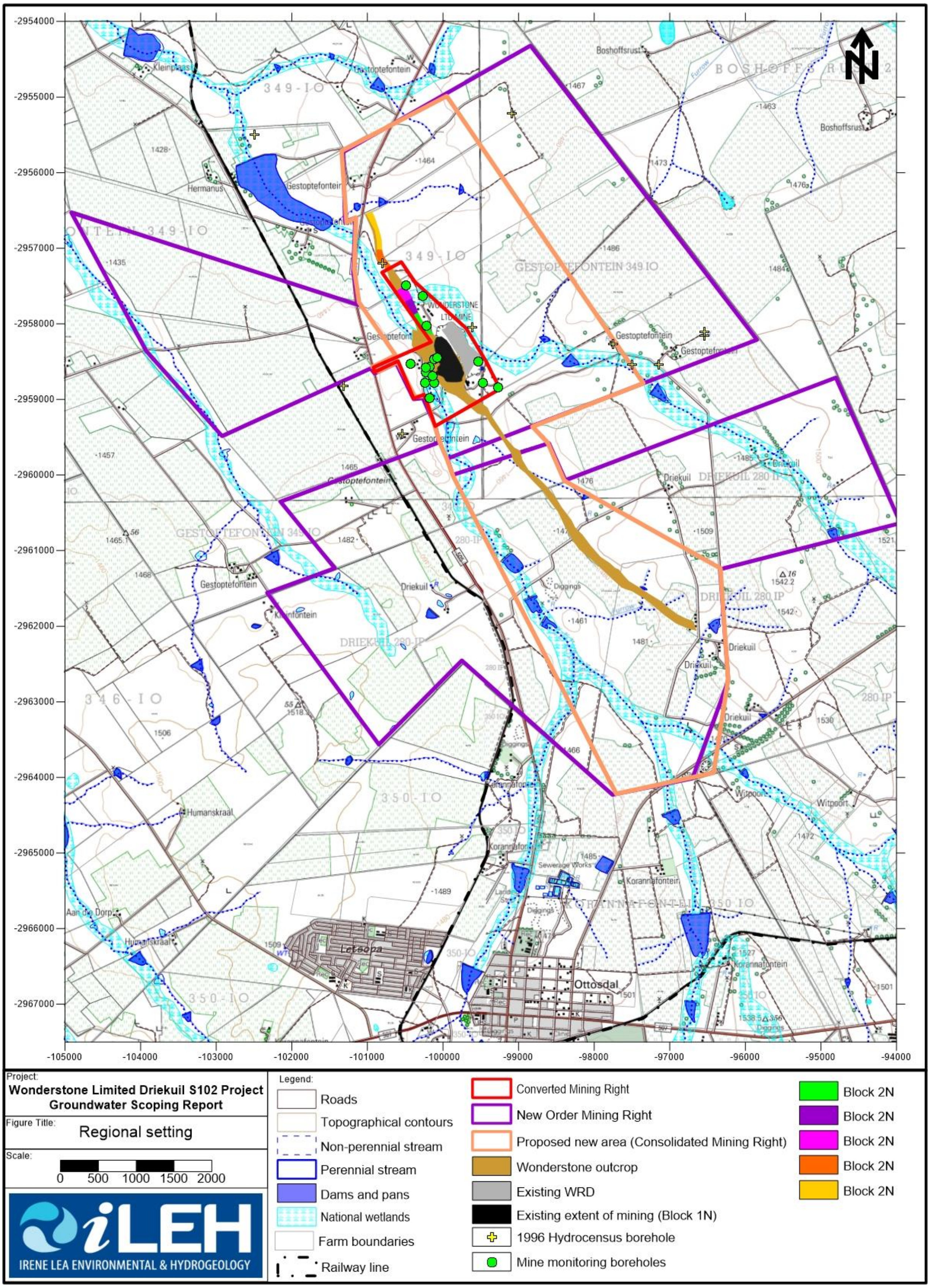

Figure 1 Project location map

1.3 Details of the Specialist

Irene Lea is the hydrogeologist who will complete the project. She has 30 years' experience in the field of geohydrology. She has a M.Sc. degree in Geohydrology and is a registered Professional Natural Scientist (400107/97). Her focus includes numerical groundwater flow and contaminant transport modelling, water treatment, integrated water and waste management strategies, rehabilitation and closure projects, environmental management systems and risk assessments. An abbreviated CV is presented in Appendix 1.

1.4 Declaration of independence

iLEH has no direct or indirect beneficial interest or contingent in Wonderstone Limited or Envirogistics at present or in the past. iLEH will be paid a fee by Envirogistics for completing the assessment in accordance with normal professional consulting practice. Payment of these fees is in no way contingent upon the conclusions or opinions expressed in this report.

2 SCOPE OF WORK

The scoping phase of the project entails the completion of a baseline desktop study for the proposed NOMR and including the consolidated mining right area. The aim is to identifying site sensitivities and constraints related to the hydrogeology. The scoping phase deliverable is the compilation of data in both report and GIS format, of which the primary outcome is a sensitivity map of the entire proposed site. The purpose of the Scoping Phase is to identify and map all relevant environmental sensitivities within the project area. The sensitivity map is supported with a scoping report outlining baseline data and the results of the sensitivity mapping. The scoping report includes a detailed description of the methodology followed as well as the results and conclusions of the scoping phase assessment.

3 PROJECT METHODOLOGY AND INFORMATION ASSESSED

The following activities were completed as part of the scoping phase of the project:

- A short project inception discussion was held with Envirogistics at the start of the project.
- The available dataset was evaluated in order to plan for the study.
- Information specifically was drawn from a groundwater impact assessment completed in 2020 for the converted mining right area (iLEH, 2020).
- A baseline geohydrological report was prepared, based on the information gathered during scoping. The report focuses on potential sensitivities related to groundwater as well as potential impacts identified and addresses the aquifers present, including geological/hydrological features that may be a constraint or fatal flaw during the project.
- The available information was used to identify possible impacts on groundwater.
- The baseline report includes a geohydrological constraints and fatal flaw analysis and highlights information gaps that will be used to plan for the EIA phase of the project.
- A geohydrological sensitivity map was be compiled in GIS format for inclusion in the overall sensitivity map for the Scoping Phase of the project.
- No fieldwork was completed as part of the scoping phase of the EIA.

4 GROUNDWATER BASELINE ASSESSMENT

4.1 Geological setting

4.1.1 Regional Geology

According to WST (2008) and Letsolo (2019), the pyrophyllite (wonderstone) mined at the operations is hosted in a pale green acidic lava of the Syferfontein Formation of the Dominion Reef.

The pyrophyllite is metamorphosed volcanic ash interbedded with the lava. The ore is grey to black in colour and was deposited as massive fine grained body. On surface where weathering has taken place, the pyrophyllite is light grey in colour, but the colour gets darker deeper in the deposit. The ore body strikes in a north-south direction and dips at approximately 35° to the west. The thickness of the main lens of pyrophyllite is 190m and includes small inclusions of lava up to 20m thick. Geological action has tilted the deposit so that the laminations in the body dip at about 80°.

The geological setting for the sub-catchment in which the mine is situated is indicated on Figure 2. The figure indicates the extent of the host rock that comprises tuff, quartz feldspar porphyry of the Syferfontein Formation. The host rock is faulted to the west by NNW-SSE trending faults. Basement granites outcrops to the north and west.

4.1.2 Local geology

Exploration borehole data made available by WST to conceptualise the aquifers present suggests that the soil consists of a coarse grained volcanic ash that weathers to a clay. Alternating layers of fine and coarse volcanic ash is typically found to a depth of 50m.

This stratification is thought to reduce the vertical permeability of the rock formations underlying the operations. From depths greater than 50m, increased porosity may be encountered due to slumping structures. The felsic host rock becomes relatively homogenous from depths greater than 100m. Exploration borehole information further suggests that pyrite beds are present intermittently in the mining area.

The primary permeabilities of the pyrophyllite and lavas is low and is not expected to transmit groundwater at significant rates. Groundwater is therefore associated with fractures, faults and joints.

Exploration borehole logs however suggest that some joints are infilled by kaolin. Groundwater strikes and rest water levels measured in the exploration boreholes indicate that groundwater is associated with the limit of weathering as well as with open joints in the hard rock.

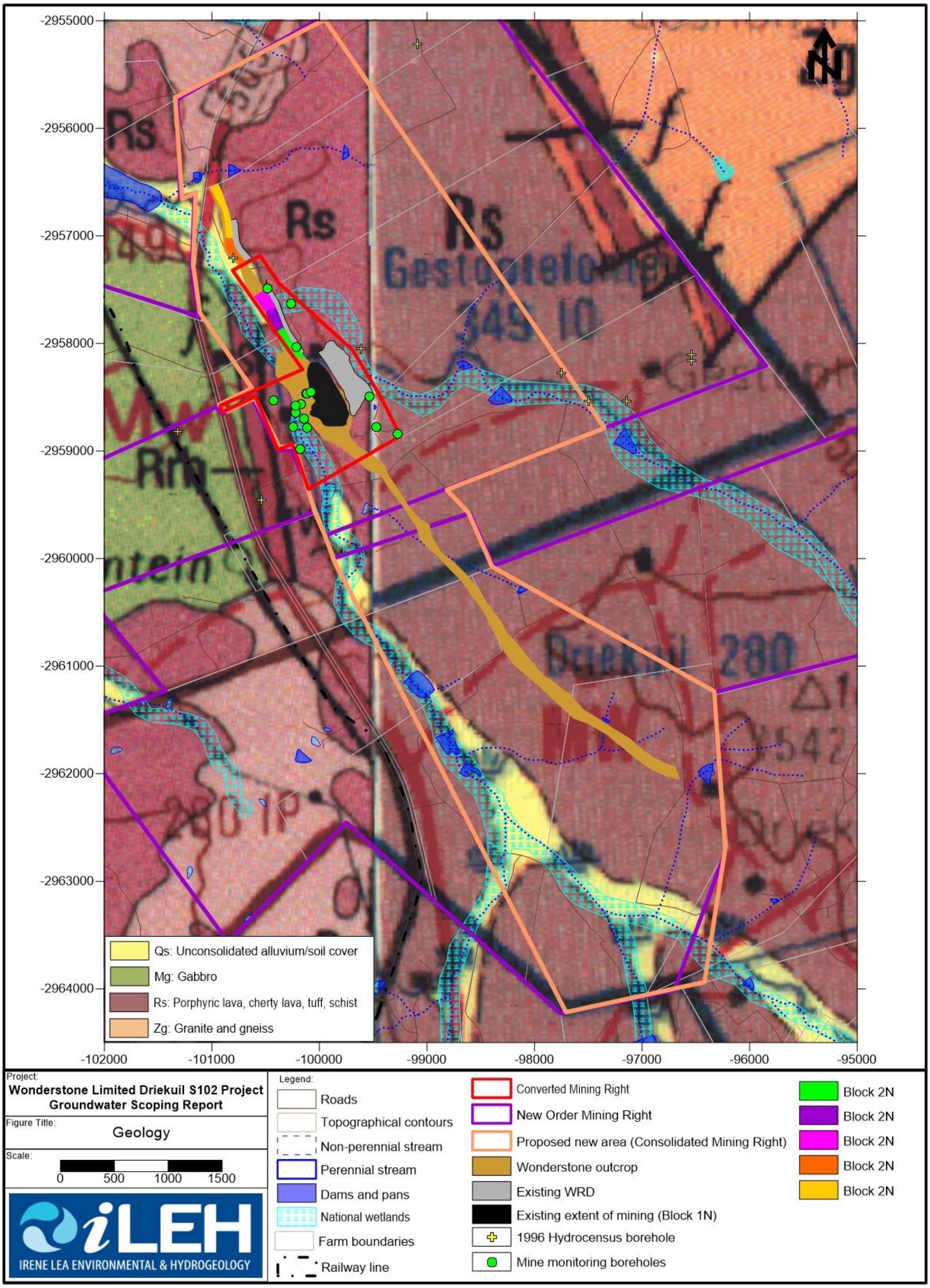

Figure 2 **Geological setting**

4.2 Hydrogeology

4.2.1 Boreholes present

A hydrocensus was not completed during the scoping phase of the EIA. In order to characterise private groundwater use around the WST mining area, and thus potential sensitive receptors, data from the 1997 EMP was used (WST, 1997). Discussions with WST during 2020 suggests that these boreholes are most likely still in used by surrounding farmers. No new private boreholes are known to the WST personnel.

During the 1997 hydrocensus 12 private boreholes were identified. Details regarding these boreholes are presented in Table 1 and their locations are shown on Figure 3. These boreholes were drilled to depths of up to 50m and are used for agricultural and domestic purposes.

WST currently monitors seventeen boreholes on a regular basis. Available details for these boreholes are presented in Table 2 and their locations are shown on Figure 3. The majority of the mine's monitoring boreholes were drilled to depths of between 90 and 100 meters, thus deeper than the private boreholes.

4.2.2 Aquifers present

Groundwater occurrence is typically associated with two geological features in this setting. The first is groundwater seepage that collects along the zone of transition between weathered and hard rock. This is the case at WST, as recorded in the exploration borehole drilling discussed above. Groundwater level monitoring however suggests that groundwater in the shallow weathered zone is not persistent over the site. It is thought that shallow groundwater occurrence is linked to the presence of surface water bodies and wetlands. Based on the exploration borehole data made available the average depth to the limit of weathering is 20m.

The main groundwater flow in this area is associated with secondary fracturing, faulting and joints in the lavas and pyrophyllite deposits present in the mining area. The primary porosity, permeability and storage characteristics of these rocks are low. It is thought that the groundwater potential in this area is low and that zones of higher permeability is limited, especially in the surrounding host rock (WST, 1997).

Based on monitoring information, groundwater flow is in a westerly to north westerly direction towards the Driekuilspruit (iLEH, 2020).

The localised fractured aquifers in the rocks are thought to be restricted to contact zones between intrusions and the host rock as well as with joints, faults and fractures in competent lavas and pyrophyllite. Groundwater in the fractured aquifer system is drained from storage in the overlying weathered aquifer as well as through recharge of rainwater and from watercourses. This aquifer is reported to have a low groundwater potential, especially in the host rock. Flow paths may however be controlled by the orientation of fractures and faults.

4.3 Water use

The water resources available to the mine include groundwater abstracted from two boreholes (WBN010 and WBH13), surface water pumped from the Driekuilspruit Dam and process water that recycled and reused in the plant.

The water available in the Driekuilspruit is not reliable, as the water course is non-perennial and dries up seasonally. Under these conditions, the mine relies on groundwater supply from the two boreholes. The mine's water supply boreholes WBN010 and WBH13 were drilled to depths of 110m and 22m respectively. Groundwater abstracted from borehole WBH010 is used for potable supply and water abstracted from borehole WBH13 is used to augment the process water especially during the dry season.

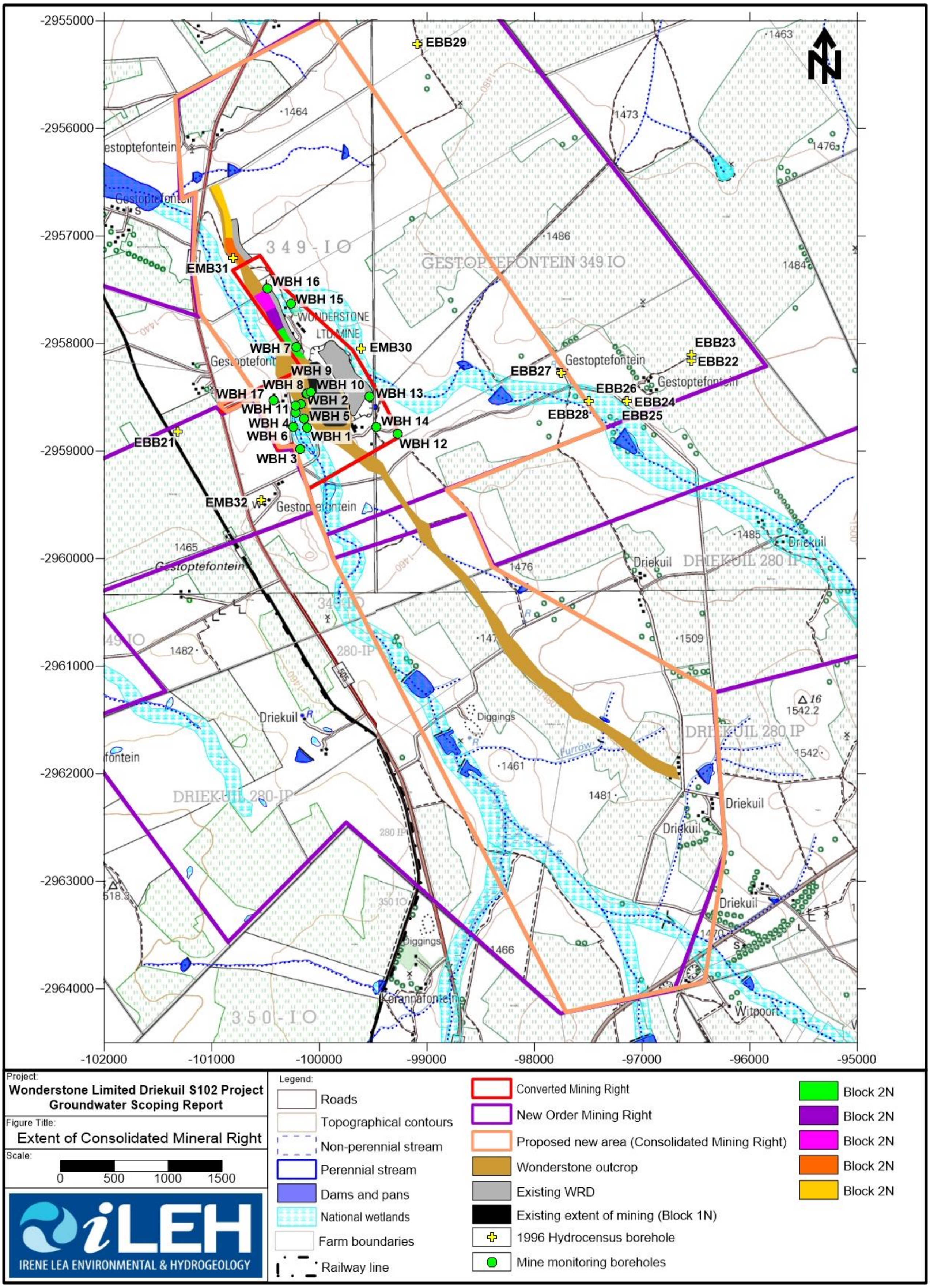

Figure 3 Map indicating borehole locations

Table 1 1997 EMP Hydrocensus boreholes (WST, 1997)

ID	X	X	Elevation (mamsl)	Depth	Sample No	Equipment	Use	Description
EBB20	-102495,19	-2955494,3	1442		EB1	Windpump	Domestic	Background BH, farm NW of mine, taken at house
EBB21	-101318,08	-2958818,2	1450		EB2	Powerhead	Domestic	East of railway line taken at blue tank next to tar road
EBB22	-96542,10	-2958161,4	1476	51,0	EB3	Submersible pump	Domestic	Next to reservoir
EBB23	-96542,52	-2958106,0	1476		EB4	Submersible pump	Agricultural	100m south of B22
EBB24	-97141,23	-2958536,1	1476	31,4	EB5	Submersible pump	Agricultural	Mr C Badenhorst's house
EBB25	-97141,23	-2958536,1	1475	45,9	EB6	Submersible pump	Domestic	Mr C Badenhorst's house
EBB26	-97141,23	-2958536,1	1475	36,2	EB7	Submersible pump	Domestic	Mr C Badenhorst's house
EBB27	-97748,24	-2958272,6	1475	17,4	EB8	Hand pump	Domestic	At workers compound
EBB28	-97498,42	-2958538,9	1461	36,9	EB10	Windpump	Agricultural	Small windmill in void next to reservoir, sampled from trough
EBB29	-99087,59	-2955213,4	1465		EB11	Windpump	Agricultural	Farm north of WS
EMB30	-99611,72	-2958048,9	1432		EB12	Windpump	Agricultural	WST monitoring BH NE of waste dump in neighbour's farm
EMB31	-100798,58	-2957205,0	1441		EB13	Windpump	Agricultural	WST monitoring BH Through fence near B15

Table 2 WST Current monitoring borehole information

BH ID	X-Coordinate	Y-Coordinate	Elevation (mamsl)	BH Depth (m)	Average depth to groundwater (m)
WBH 1	-100113	-2958784	1456		3,30
WBH 2	-100172	-2958567	1449	93,5	3,95
WBH 3	-100175	-2958979	1450	100,0	4,87
WBH 4	-100222	-2958646	1449		
WBH 5	-100140	-2958696	1450	2,7	
WBH 6	-100239	-2958780	1452	100,0	2,99
WBH 7	-100212	-2958031	1447	100,0	3,65
WBH 8	-100120	-2958469	1450	27,8	10,46
WBH 9	-100118	-2958469	1450		
WBN010	-100080	-2958454	1453	110,0	8,07
WBH 11	-100224	-2958576	1450		
WBH 12	-99274	-2958842	1469		11,6
WBH13	-99531	-2958496	1467	22,0	7,85
WBH 14	-99473	-2958778	1473	95,0	16,05
WBH 15	-100263	-2957633	1456	96,0	5,98
WBH 16	-100486	-2957490	1452	61,0	13,14
WBH 17	-100424	-2958532	1462		3,06

4.4 Groundwater quality

The results of the groundwater monitoring database indicate that the main quarry and to a lesser extent the WRD impacts most significantly on groundwater quality. Contamination originating from these areas are characterised by elevated TDS, Al, Mn, T Cr and Cu (iLEH, 2020).

The groundwater quality monitoring database made available by WST was used to establish groundwater quality trends for the mining area.

Groundwater sampled at the existing Main Quarry in Mining Block 1N indicates acidic conditions with pH levels below 5 units (sample WBN010 in Table 3). This suggests that opencast mining activities could result in acid mine drainage if not managed effectively.

The average concentrations for major cations and anions (Table 3) indicate that low salt concentrations prevail. All elements meet with the WST WUL conditions, with the exception of pH for boreholes WBN010 and WBH8. Both of these boreholes are situated immediately adjacent to the main quarry.

Average metal concentrations for significant metals in the WST monitoring database are presented in Table 4. Metal concentrations do not form part of the WUL requirements for the operations. WST does however include metal analysis as part of its routine monitoring programme. The average concentrations are compared to the SANS241:2015 Drinking Water Standards in Table 4. Evaluation of the information suggests that elevated total chromium concentrations in groundwater is of concern, especially in the vicinity of the existing WRD.

Monitoring results further indicate that mining activities result in an increase in aluminium concentrations in groundwater. Elevated concentrations of copper and manganese were also recorded.

Based on the evaluation of the groundwater quality monitoring database, it is concluded that aluminium, copper, manganese and potentially total chromium are indicator metals for the mining area.

Table 3 Average groundwater quality: Major cations and anions

Element	WUL Condition	WBN010	WBH13	WBH1	WBH14	WBH16	WBH17	WBH2	WBH3	WBH6	WBH7	WBH8
Calcium (mg/l Ca)	<150	3,9	15,9	49,7	9,6	34,0	25,0	20,0	30,3	6,7	17,5	5,5
Magnesium (mg/l Mg)	<100	2,0	6,2	14,8	4,4	3,5	3,2	12,7	7,8	3,3	1,8	3,8
Sodium (mg/l Na)	<200	4,5	16,6	25,2	10,8	30,0	5,6	51,8	13,5	26,5	29,6	15,2
Potassium (mg/l K)		1,2	2,9	7,9	3,8	2,8	4,7	8,6	3,3	5,3	1,3	1,5
Total Alkalinity (mg/l $CaCO_3$)		8,0	50,0	160,7	46,0	133,0	84,0	122,8	129,4	77,3	86,6	9,3
Chloride (mg/l Cl)	<200	8,4	24,1	46,7	16,8	29,0	16,0	66,2	13,2	19,4	14,7	32,7
Sulphate (mg/l SO_4)	<400	22,4	13,9	23,2	0,2	37,0	0,2	24,6	4,3	0,1	6,4	17,7
Fluoride (mg/l F)	<1	0,51	0,11	0,10	0,10	0,30	0,50	0,18	0,24	0,23	0,78	0,10
Nitrate (mg/l NO_3)	<10	1,49	3,49	1,10	0,10	0,10	0,10	0,15	0,95	0,40	0,10	0,10
Electrical Conductivity (mS/m)	<150	10,10	24,11	51,07	17,90	43,20	28,90	52,06	31,67	157,33	24,08	17,63
Total Dissolved Solids (mg/l)		68,2	149,1	286,7	134,0	270,0	200,0	286,4	162,3	157,3	135,2	100,7
pH	6 - 9,5	**4,9**	6,1	7,5	7,2	7,6	7,0	7,0	7,5	7,9	7,7	**5,7**

Table 4 Average groundwater quality: Significant metal concentrations

Element	SANS241:2015 Standard	WBN010	WBH13	WBH1	WBH14	WBH16	WBH17	WBH2	WBH3	WBH6	WBH7	WBH8
Aluminium (mg/l Al)	<0,3	**0,50**	0,03	0,02	0,05	0,04	0,04	0,18	0,02	0,20	0,01	0,02
Iron (mg/l Fe)	<2 (Chronic health)	0,09	0,08	0,11	0,24	0,37	1,80	0,32	**2,42**	0,96	0,22	0,15
Manganese (mg/l Mn)	<0,4 (Chronic Health)	0,18	0,03	**0,57**	0,04	**0,60**	**1,10**	**0,45**	**0,62**	**0,51**	0,20	**0,90**
Total Chromium (mg/l Cr)	<0,05	**0,07**	**0,08**	**0,08**	**0,09**	**0,13**	**0,13**	**0,06**	**0,07**	**0,08**	**0,06**	**0,07**
Copper (mg/l Cu)	<2	**2,65**	0,01	0,01	0,01	0,01	0,02	0,03	0,01	0,02	0,01	0,02
Zinc (mg/l Zn)	-	0,35	0,01	0,01	0,01	0,02	0,02	0,02	0,03	0,04	0,01	0,06

5 HYDROGEOLOGICAL SENSITVITIES

5.1 Impact on groundwater availability

Information from the existing mining activities (Block 1N) confirms that mining activities have not intersected the shallow or deeper groundwater tables. No mine dewatering is therefore taking place. Similar mining methods will be deployed in the new mining blocks (Block 2N – 6N). As such, the impact of mine dewatering on groundwater availability is not considered significant at this stage of the project. It is noted that WST has committed that no dewatering will take place and that all mining will cease above the groundwater level.

5.2 Deterioration of groundwater quality during the operational phase

Surface and groundwater monitoring data from the Block 1N mining area confirms that there is a risk acid mine drainage associated with the mining activities. This process is driven by the presence of pyrite in the ore body. In addition, sampling of runoff collected from the existing main quarry void confirms acidic conditions and elevated salt and metal concentrations in leachate associated with the mining activities. The existing WRD is also impacting on groundwater quality, as is demonstrated by the current monitoring programme. Future placement of waste rock must therefore be carefully managed.

Based on feedback received from the hydrological specialist study undertaken for this project, it is reported that the risk of acid mine drainage is reduced with backfilling of mined out areas. WST has committed to the roll over method of mining, which includes backfilling of mined-out areas during the operational phase. The extent to which acid mine drainage and the associated poor quality leachate will remain a threat to groundwater under these commitments will be evaluated in more detail in the EIA phase of the project.

5.3 Impact on baseflow to streams

Future mining is planned north the current Block 1N mining activities, parallel to the Driekuilspruit. The mining is planned within 200m of the river. The potential impact of contaminated groundwater reaching the Driekuilspruit during the operational phase and post-closure will therefore be assessed during the EIA phase of the project. This impact will be evaluated in terms of the estimated groundwater contribution to the salt load on the Driekuilspruit.

In addition to stream baseflow, Zimpande (2022) reports that groundwater flow in shallow aquifers play an important role in wetland functioning. Due to the presence of shallow soils in the mining area, the recharge of water to wetlands from the shallow aquifer is an important mechanism to wetland functioning. This aspect will be evaluated in more detail during the EIA phase of the project.

5.4 Risk of decant

Based on the current understanding of method of mining, the risk of decant from the pit is more likely associated with uncontained surface runoff than with groundwater seepage. This is due to the fact that the groundwater table has not been intersected during current mining activities. The impact of uncontrolled surface runoff on groundwater quality will therefore be assessed during the EIA phase of the project.

WST has further committed to not mine below the groundwater table at Blocks 2N – 6N. The risk of decant from future mining areas is therefor also considered low, based on the current understanding of the project. This will be evaluated in more detail during the EIA phase of the project, especially in mining areas near watercourses.

5.5 Long-term impact on groundwater quality

The long-term impact of mining and mine waste management will be evaluated during the EIA phase of the project. In order to identify the optimal groundwater management plan, a number of rehabilitation scenarios will be developed in consultation with the EAP and WST and evaluated during the impact assessment phase of the project.

5.6 Residual impacts

The impact of mining activities that will not be fully rehabilitated during mine decommissioning on groundwater quality will be assessed during the EIA phase of the project. Of specific note is the impact of the existing WRD, which is likely to remain in place or only be partially rehabilitated.

5.7 Potential cumulative impacts

The potential cumulative impacts of existing mining at Block 1N and the planned future mining from Blocks 2N – 6N on groundwater will be assessed. During this assessment, the rehabilitation scenarios to be developed will be considered. The outcome of the assessment will be used to develop the preferred rehabilitation strategy aimed at eliminating or minimising long-term impacts.

5.8 Sensitivity map – Hydrogeology

Based on the findings of the scoping study discussed here, a sensitivity map was generated for the hydrogeology to be affected by the project. The hydrogeological sensitivity map is presented in Figure 4 and the components thereof are summarised in Table 5.

Table 5 Sensitivity rating: Hydrogeology

Sensitivity Rating	Description	Hydrogeological component identified	Motivation
Least Concern	The proposed mining activities will not affect the current status. These features would be the preferred alternative for mining or infrastructure placement.	Remainder of greater project area not affected by the ratings below.	This area excludes groundwater receptors or sensitive areas identified during scoping.
Low	The proposed development will have not have a significant effect on the inherent feature status and sensitivity.	The ore body	The current mine plan focusses on the northern section of the ore body outcrop. The full length of the ore body is however assigned a low sensitivity due to possible future mining in these areas.
Low		Hydrocensus boreholes identified in 1996 that are up gradient of the proposed mining activities	Private boreholes are considered sensitive receptors. The location, condition and groundwater use from these boreholes will be confirmed during the EIA phase. Boreholes up gradient of the mining activities are however not likely to be affected by mining activities.
High	The proposed development will negatively influence the current status of the feature.	The planned future mining Blocks 2N – 6N and the areas identified for the temporary placement of waste rock.	Based on monitoring of the existing mining at Block 1N, mining activities are likely to result in acid mine drainage and contamination of groundwater if not carefully managed. Groundwater contamination is also currently associated with the placement of waste rock.
High		Hydrocensus boreholes identified in 1996 down gradient of the proposed mining activities	Private boreholes are considered sensitive receptors. The location, condition and groundwater use from these boreholes will be confirmed during the EIA phase. Boreholes down gradient of the mining activities could be affected by mining

Sensitivity Rating	Description	Hydrogeological component identified	Motivation
			activities and this will be confirmed in the EIA phase of the project.
Very High	The proposed development will negatively significantly influence the current status of the feature.	Hydrocensus boreholes identified in 1996 located within or immediately adjacent to the proposed mining activities	Private boreholes are considered sensitive receptors. The location, condition and groundwater use from these boreholes will be confirmed during the EIA phase. Boreholes within the mining area could be destroyed or groundwater quality may deteriorate as a result of the impact of mining and this will be confirmed in the EIA phase of the project.
Very High		Existing mining activities in Block 1N and the existing WRD.	The current mine water monitoring programme confirms that these areas are impacting on groundwater quality. If not managed with care, these existing impacts could result in unacceptable long-term deterioration in groundwater quality.

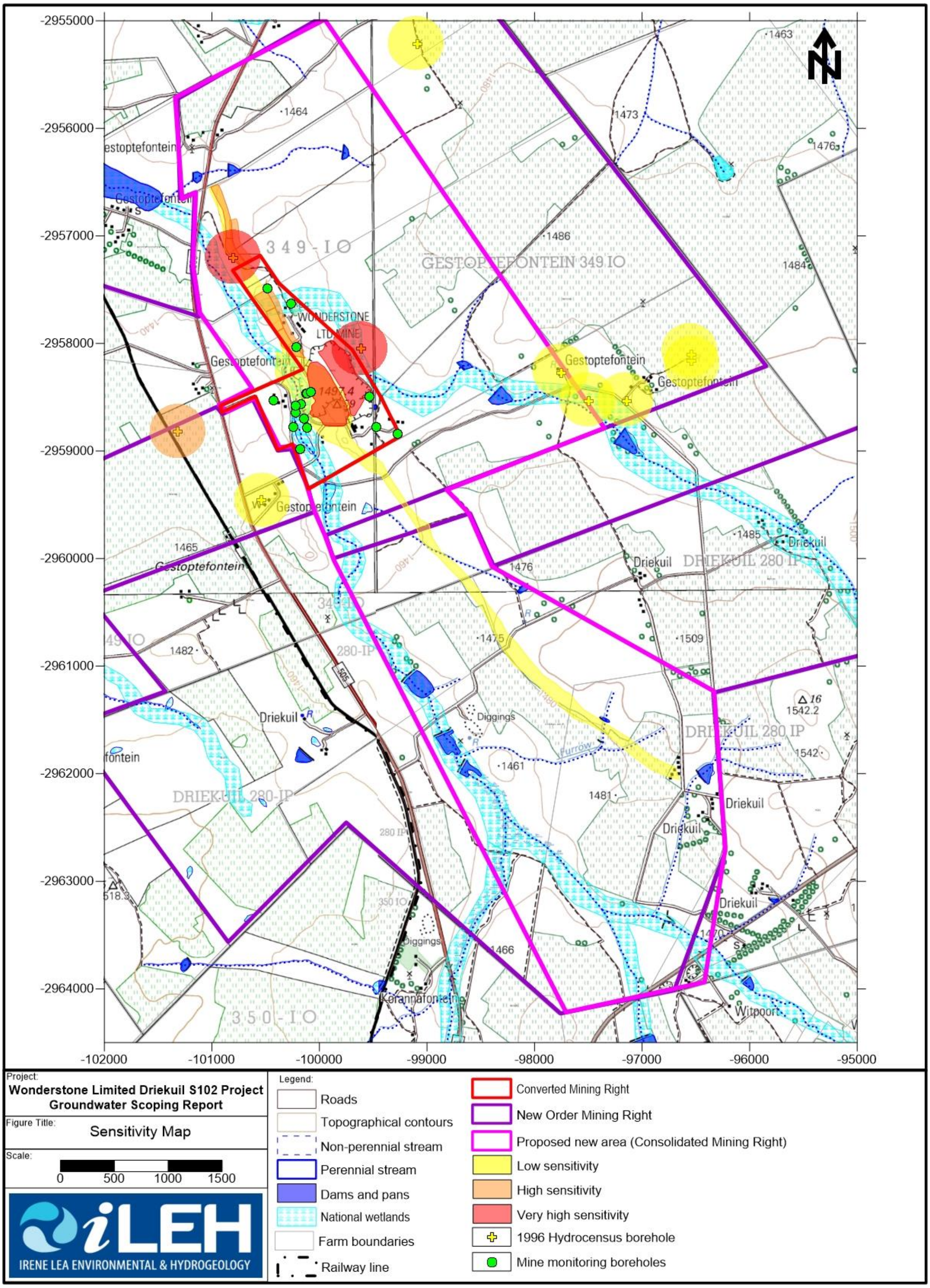

Figure 4 Hydrogeological sensitivity map

6 AREAS TO BE AVOIDED

Based on the results of the scoping phase of the project, it is recommended that the following areas are avoided as part of the planning and design phase of the project:

- The proposed mining activities are in close proximity to the Driekuilspruit. Based on the current monitoring programme at Block 1N (existing Main Quarry), it is likely that the planned future mining activities could impact on groundwater quality entering the river as baseflow. The shallow aquifer is also thought to recharge wetlands in the area. In order to minimise these impacts, it is recommended that no mining or mine waste deposition takes place within the 1:100 year floodline of the river and its associated watercourses. Specific attention must be given to the design of surface runoff at the new mining areas, especially associated with the placement of mine waste rock. The stormwater management plan must prevent obstruction of water courses and the ponding of water over the disturbed mining areas.
- Existing private boreholes should also be protected during the project. The 1996 hydrocensus data must be confirmed and the locations of private boreholes identified must be re-evaluated against the mine plan for the project. Private boreholes that fall within the mining areas must be flagged for action. If private boreholes will be destroyed or significantly impacted during mining, negotiations must be entered into with borehole owners to explore groundwater management options.

7 ASSUMPTIONS, UNCERTAINTIES AND DATA GAPS

The findings of the hydrogeological scoping study are based on the information presented in this report. The report is therefore based on the following assumptions and limitations:

- The locations and use of private boreholes is based on a hydrocensus undertaken in 1996. This information is considered outdated, but could have significance in terms of the impact of mining on sensitive receptors. A hydrocensus must there be undertaken over the NOMR to identify and establish existing private boreholes and groundwater use.
- Aquifer conceptualisation will be based on information available from the existing mining area at Block 1N. Should the outcome of the impact assessment phase indicate adverse impacts on groundwater, additional monitoring boreholes must be drilled and tested. Monitoring of additional boreholes must be used as an early trigger for groundwater management plans.
- The risk of acid mine drainage and the quality of leachate draining from the mining areas is based on current monitoring information from the existing mining area. It is recommended that a composite rock sample is taken from the mining area for acid base accounting and leach tests in order to improve the level of confidence in long-term impact assessments.

8 PROJECT FINDINGS

The project findings are summarised in Table 6 below. The impact assessment methodology used to prepare Table 6 is presented in Appendix 2.

Table 6 Summary of hydrogeological impacts

Project stage	Impact	Comment	Rating
Construction Operational Cumulative impacts	Groundwater contamination from mining activities and mine waste rock placement	Available monitoring information suggests that existing mining activities and waste rock deposition causes groundwater contamination. If left unmanaged, these could result in adverse impacts during the operational phase, especially to sensitive receptors such as the Driekuilspruit and existing private groundwater users. The operational impact of contaminated groundwater on the salt load to the Driekuilspruit and its tributaries will be specifically assessed during the EIA phase of the project.	Medium negative
Post-closure Cumulative impacts Residual impacts	Groundwater contamination from mining activities and mine waste rock placement	If the impacts of mining and mine waste deposition are not carefully planned and managed during the construction phase, significantly adverse impacts on groundwater quality is anticipated in the long-term post closure, especially if the cumulative impact of mining is considered. Measures will be developed during the EIA phase of mining to minimise any long-term impacts identified. The long-term impact of contaminated groundwater on the salt load to the Driekuilspruit and its tributaries will be specifically assessed during the EIA phase of the project.	High negative
Post-closure Cumulative impacts Residual impacts	Risk of decant	The risk of decant is more likely associated with uncontained surface runoff than with groundwater seepage. The impact of uncontrolled surface runoff from the mining area or ponding of unmanaged surface runoff over disturbed areas will be assessed during the EIA phase.	Medium negative

9 IMPLICATIONS OF PROJECT FINDINGS

The project findings indicate that it is important to quantify the anticipated impacts on groundwater during the EIA phase of the application. This will enable the establishment of buffer zones, identify unacceptable residual and cumulative impacts after mitigation and the development of a sound groundwater monitoring programme. The impact assessment must include numerical groundwater flow and contaminant transport modelling to ensure that regional as well as long-term impacts are investigated and the impact of groundwater management measures can be determined.

The objective of the groundwater management programme to be developed as part of the EIA phase of project must focus on reducing the ratings presented in Table 6 to within acceptable levels.

10 PROPOSED MANAGEMENT MEASURES FOR INCLUSION IN EMP

10.1 Management plan to protect groundwater availability

The 1996 hydrocensus will be updated during the EIA phase of the project in order to confirm the locations and private groundwater uses within the NOMR. The results of the assessment will be used to prepare a final management plan to protect groundwater availability. The management plan will include an assessment of the impact of groundwater abstraction by WST for use at the operations.

Hydrocensus boreholes identified will be included in the groundwater monitoring programme to be developed for the project. Both groundwater levels and quality monitoring will be undertaken in the hydrocensus boreholes.

In addition to the potential impacts on private groundwater users, recharge from the shallow aquifer to wetlands must be protected to ensure good wetland functioning. Measures will be developed during the EIA phase of the project to achieve this.

10.2 Management plan to prevent contamination of groundwater

Groundwater management will focus on reducing the volume of leachate that is available for infiltration to the aquifers through control of stormwater runoff into the mining area and containment of dirty runoff and seepage in suitably designed facilities. No ponding will be allowed over disturbed areas.

Specific groundwater management measures will be developed to reduce the impacts of existing and planned future mine waste deposition. A number of management options will be tested to develop the preferred alternative in this regard.

The amendments to the existing groundwater monitoring programme based on the outcome of the groundwater impact assessment must be considered for implementation. The groundwater monitoring information is crucial to gauging the effectiveness of groundwater management measures. It is further important to establish trends with reliable information that can be used to develop mine closure strategies and apply for closure.

11 CONDITIONS FOR ENVIRONMENTAL AUTHORISATION

The following hydrogeological conditions for environmental authorisation should be considered:

- No mining activities should take place within the 1:100 year flood line of the Driekuilspruit and its associated water courses.
- The outcome of the EIA phase hydrocensus must be used to re-assess the impact of mining on existing groundwater use and the possible exclusion zones to protect this groundwater use.
- Surface water runoff must be carefully managed to prevent ponding of water over disturbed areas.
- A sound groundwater monitoring programme must be implemented and maintained for the project. The monitoring programme must consider the indicator elements identified for the mining area as well as groundwater levels and on-site rainfall measurements.

12 MONITORING REQUIREMENTS

The groundwater monitoring requirements for the project are summarised in Table 7. The monitoring programme design and format will be finalised during the EIA phase of the project.

Table 7 Proposed groundwater monitoring requirements

Component	Comment	Proposed monitoring requirement
Private boreholes confirmed as part of a 2022 hydrocensus	Groundwater is the sole source of water supply to landowners within the project area. Existing groundwater use must therefore be protected.	Private boreholes within the NOMR must be identified and monitored during prior to the commencement of any mining activities. Both groundwater levels and quality must be included in the monitoring programme. The monitoring frequency, list of elements for analysis and reporting requirements will be finalised during the EIA phase of the project.
WST monitoring boreholes	The current monitoring programme must be evaluated and adjusted against the outcome of the groundwater impact assessment. Should results dictate, additional monitoring boreholes must be drilled and used for early detection of adverse impacts on groundwater.	Both groundwater levels and quality must be included in the monitoring programme. The monitoring frequency, list of elements for analysis and reporting requirements will be finalised during the EIA phase of the project.

13 PROFESSIONAL OPINION

In my professional opinion, the most significant impact of the project on the hydrogeology is the operational and long-term impacts on groundwater quality associated with mining and mine waste deposition. Surface source of contamination can be managed by implementing good housekeeping and safety measures. The extent and the impact of groundwater management measures to reduce and/or eliminate impacts associated the project must therefore be confirmed during the EIA phase of the project. With a sound groundwater management and monitoring programme, the project can be authorised. WST must however demonstrate that they have the technical and financial means to protect the aquifers during the project, as groundwater is the sole water resource to the landowners within the project area.

To this regard, the areas to be avoided are listed in Section 6 with reliable information that can be used to develop mine closure strategies and apply for closure; the provisional hydrogeological management measure are discussed in Section 10 and the proposed monitoring programme is listed in Table 7 above.

14 CONSULTATION PROCESS

No formal consultation process was undertaken during the scoping phase of the groundwater specialist study. Discussions are underway with landowners in order to plan for the 2022 hydrocensus.

15 PLAN OF STUDY FOR EIA

A groundwater specialist study will be undertaken as part of the impact assessment phase of the project to investigate the key potential issues identified during scoping. These key issues have been identified based on:

- The legal requirements;
- The nature of the receiving environment and the proposed activities discussed above;
- · Professional experience of the hydrogeologist.

The assessment of impacts will be based on the professional judgement of the hydrogeologist, site assessments, a planned hydrocensus, sampling of rock material for leach and acid base accounting tests, conceptualisation and numerical groundwater flow and contaminant transport modelling. Assumptions, limitations and sources of information will be clearly identified. The knowledge of local people will, where possible, be incorporated into the study, especially in terms of private groundwater use. The description of the approach will include a short discussion of the appropriateness of the methods used in the hydrogeologist study. The assessment of the data will be based on accepted scientific techniques as well as professional expertise and experience.

15.1 Description of the Affected Environment or Baseline

A description of the affected hydrogeological environment will be provided, both at a site-specific level and for the wider region. The latter will provide an appropriate context, especially in terms of regional groundwater use. It is essential that the uniqueness or irreplaceability of the groundwater resources is understood in the context of the surrounding region at a local, regional scale. This will largely be based on the results of the proposed numerical modelling.

The study will provide a sufficiently comprehensive description of the existing hydrogeological setting to ensure that a detailed assessment of the potential impacts of the proposed development can be made. The baseline will include data collected during field surveys as well as desktop studies.

15.2 Assessment of abandonment areas

As part of the EIA phase of the project, the areas currently included in the NOMR which are to be abandoned will be visited to confirm whether or not mining activities have taken place. If any disturbances are identified that could impact on groundwater, a management plan will be developed for implementation.

15.3 Hydrocensus and rock sampling

A hydrocensus will be completed as part of the EIA phase of the project to update the 1996 hydrocensus data. The objective of the hydrocensus will be to confirm current private groundwater use in relation to the project. This information will be used to update the current understanding of the sensitive receptors for the area.

A composite rock sample will be taken for acid base accounting and leach tests in order to improve the understanding of acid mine drainage and the impact of poor quality leachate on groundwater quality.

15.4 Impact Identification and Assessment

Clear statements identifying the potential environmental impacts of the proposed project will be presented. This includes potential impacts of the planning, construction, operational, rehabilitation, decommissioning and closure phases of the project. The study will clearly identify the potential direct, indirect and cumulative environmental impacts associated with the hydrogeology. The assessment of these impacts will specifically take into account any private groundwater use in the surrounding area.

Direct impacts that require a quantitative assessment will be assessed following the impact assessment methodology laid out by Envirogistics. The significance of impacts will be assessed both without and with assumed effective mitigation and/or rehabilitation. Indirect and cumulative impacts will be described qualitatively. The study will comparatively assess environmental impacts of the proposed mining activities, groundwater abstraction for use at the mine and mine waste deposition. The study will indicate any significant adverse hydrogeological impacts which cannot be mitigated and which will jeopardise the project and/or groundwater use in a particular area. All conclusions will be thoroughly backed up by scientific evidence.

15.5 Management Measures

The study will recommend practicable groundwater management measures or management actions that effectively minimise or eliminate negative impacts, enhance beneficial impacts, and assist mine design. If appropriate, the study will differentiate between essential mitigation measures, which must be implemented and optional mitigation measures, which are recommended (“nice-to-haves”). Unsubstantiated recommendations for further studies will be avoided.

The study will recommend appropriate monitoring and review programmes to track the efficacy of mitigation measures.

The study will indicate the environmental acceptability of the proposed project (and alternatives if applicable), i.e. whether the impacts are acceptable or not. A comparison between the “no-project” alternative and the proposed development alternative(s) will also be included.

15.6 Terms of Reference for the Groundwater Specialist Study

This study will address aspects associated with groundwater identified in the scoping phase. The following is proposed:

- Identify, describe and map groundwater resources (aquifers) in the area that may be affected by the proposed activities and obtain a holistic understanding of the interactions between surface water and wetland resources and the aquifer(s) in the area.
- Undertake a hydrocensus within the NOMR to identify existing private groundwater use. During the hydrocensus, borehole ownership details, borehole depth, construction, abstraction rates, groundwater levels and groundwater quality will be measured and/or recorded.
- Take groundwater samples from selected hydrocensus boreholes for chemical analysis at an accredited laboratory in order to establish the baseline groundwater quality for the project site;
- Construct a conceptual model for the sub-catchment in which the project falls, which demonstrates the interaction between mining and associated activities and the aquifer(s) present.
- Construct and calibrate a groundwater flow and contaminant transport model for the sub-catchment in which the project is situated. The model will be used as a groundwater impact assessment and prediction tool.
- Identify and assess potential impacts on groundwater resources, including impacts associated with the construction, operation, decommissioning and post closure phases of the proposed project. Specific focus will be placed on residual and/or cumulative impacts on groundwater.
- Propose practicable measures to manage/rehabilitate potentially negative impacts and enhance positive impacts of the project;
- ·Recommend monitoring measures to ensure the correct implementation and adequacy of recommenced mitigation measures;
- ·Make recommendations for closure planning.

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APPENDIX 1 SPECIALIST CV

ABBREVIATED CV Irene Lea

Personal Information

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Employment

Current Position:

Consulting Hydrogeologist
Sole Proprietor, Irene Lea Environmental and Hydrogeology cc (ILEH)
September 2009 – Present

Previous Employment:

Pamodzi Gold and its predecessors – Group Environmental Manager (Dec 2002 – July 2009)
Groundwater Consulting Services – Water Unit Manager (Jan 1996 – Nov 2002)
CSIR – Staff Hydrogeologist (January 1992 – December 1995)

Professional Registration

Professional Natural Scientist (SACNASP, Reg. No. 400107/97)

Education

B.Sc. Geology and Mathematics, University of Stellenbosch, 1988 - 1990
B.Sc. (Hons) Geology, University of Stellenbosch, 1992
M.Sc. Geohydrology, Institute for Groundwater Studies, University of the Free State, 1996 - 1997

Experience

The project will be completed by Irene Lea. She has 30 year's experience in the hydrogeological field and in mine water management. She has a M.Sc. in Geohydrology and is a registered Professional Natural Scientist. Her focus includes numerical groundwater flow and contaminant transport modelling, integrated water and waste management strategies, mine water and salt balances, rehabilitation and closure projects, the development of environmental management programmes and risk assessments. A project that she managed was nominated and short listed for a Nedbank Green Mining Award in 2006.

Recent Projects

Groundwater flow and contaminant transport modelling:

- AECI Modderfontein Industrial Complex, Groundwater Impact Assessment (SRK, 2012)
- Exxaro Arnot Colliery – Groundwater Impact Assessment (Golder and Associates, 2012)
- Transalloys Industrial site – Groundwater Impact Assessment (Jones & Wagener, 2012)
- Tschudi Copper Mine – Dewatering and groundwater supply (Jones & Wagener, 2012)
- Harmony Kalgold – Optimisation of abstraction boreholes and TSF EIA (Jones & Wagener, 2013)
- Fry Metals – Contaminant Transport Model to evaluate rehabilitation options (Rison, 2013)
- Assmang Chrome - Machadodorp Works Contaminant Transport Model (ESS, 2014)
- Sebilo Resources – Perth Manganese Numerical Groundwater Model (Sebilo Resources, 2014)
- Rand Gold Mali Loulo Mine – Updated Groundwater Impact Assessment (Digby Wells Environmental, 2015)
- South Deep – Numerical simulations for the closure of a Tailings Storage Facility (Rison, 2015)
- Dwarsrivier Mine – Groundwater flow and contaminant transport model (EnviroGistics, 2015)
- Withok Tailings Storage Facility – Numerical simulations for re-commissioning of TSF (Ergo Mining, 2015)
- Dwarsrivier Mine WULA – Numerical groundwater model to assess impacts (Assmang Chrome, 2015)
- Fry Metals – Contaminant Transport Model update (Rison, 2015)
- De Wittekranz Project - Numerical groundwater model to assess impacts (EIMS, 2015)
- Tetra4 Virginia Gas Project – Groundwater specialist input and numerical modelling (EIMS, 2016)
- DRD Gold – Numerical groundwater model for Withok Tailings Storage facility (Beric Robinson Tailings, 2016)
- Tetra4 Virginia Gas Project – Follow-up numerical modelling (EIMS, 2017)
- City of Cape Town Kalbaskraal Waste Disposal Project – Numerical modelling (Cliffe Decker Hofmeyr, 2017)
- Lephalale Coal Mines – Geohydrological modelling (ASST, 2017)
- Dwarsrivier Mine – Follow-up numerical groundwater flow and contaminant transport model (Envirogistics, 2017)
- Prieska Copper Mine – Geohydrological impact assessment, including numerical modelling (ABS Africa, 2017)
- Umsimbithi eMakhazeni Project - Geohydrological impact assessment, including numerical modelling (Kongiwe, 2018)
- City of Cape Town Kalbaskraal Waste Disposal Project – Numerical modelling (Cliffe Decker Hofmeyr, 2018)
- Vardocube Mining – Geohydrological impact assessment, including numerical modelling (ABS Africa, 2018)
- Assmang Manganese Cato Ridge – Numerical groundwater flow and contaminant transport model (Assmang Manganese, 2018)
- eMakazeni Mining Project - Numerical groundwater flow and contaminant transport model (Kongiwe, 2018)
- Leslie 1 Project – Numerical groundwater flow and contaminant transport model (Kongiwe, 2018)
- City of Cape Town Kalbaskraal Waste Disposal Project – Numerical modelling (Cliffe Decker Hofmeyr, 2018)
- Dwarsrivier Mine –Numerical groundwater flow and contaminant transport model (Envirogistics, 2018)
- Assmang Chrome Machadodorp Works - Numerical groundwater flow and contaminant transport mod (Assmang, 2018)
- Assore – Numerical groundwater flow and contaminant transport model – RMDC and ZCM operations (Assore, 2019)
- Kranspan Colliery – Numerical groundwater flow and contaminant transport model (ABS Africa, 2019)
- DRD Gold – Numerical groundwater flow and contaminant transport modeling: Soweto Cluster and Marievale Projects (Kongiwe, 2019)
- South32 – Wolvekrans Mega Project – Geohydrological specialist study (NTC Group, 2019-2021)
- AEMFC – Vlakfontein Mine North Block Geohydrological Risk Assessment (EIMS, 2019)
- Envirogistics – Groundwater impact assessment – Wonderstone operations (Assore, 2020)
- Dwarsrivier Chrome Mine – Groundwater impact assessment – Historical TSF removal project (Dwarsrivier Chrome Mine, 2020)
- Prieska Copper and Zinc Mine – Groundwater impact assessment – Brine management scenarios (ABS Africa, 2020)
- Sudor Coal – Groundwater impact assessment (NTC, 2020)
- Universal Coal Ubuntu Colliery – Numerical groundwater flow and contaminant transport modelling (Groundwater Abstract, 2020)
- Assore – Numerical groundwater flow and contaminant transport model updates: RMDS and ZCM operations (Assore, 2021)
- Dwarsrivier Chrome Mine – Annual numerical groundwater model update (Dwarsrivier Chrome Mine 2020 – 2023)
- ARM Machadodorp Works - Numerical groundwater flow and contaminant transport model update (ARM, 2021)
- eMakazeni Mining Project – Update of numerical groundwater modelling (Groundwater Abstract, 2021)
- Dwarsrivier Chrome mine – Khulu Tailings Storage Facility Project (Envirogistics, 2021 - 2022)
- DRD Reclamation of several TSF – Geohydrological impact assessment (Groundwater Abstract, 2022)

Integrated Water and Waste Management:

- Sebilo Resources – Perth Manganese water use license application (Sebilo, 2014)
- Vantage Goldfields – Water Balance: Lily and Barboork Mines (Vantage Gold, 2015)
- Dwarsrivier Mine – Integrated Water Monitoring Programme (Assmang Chrome, 2015)
- RK Boerdery – Water balance for piggery (Batho Environmental, 2015)
- Sakura JV Indonesia – Groundwater study (Assmang Ltd, 2015)
- PMG Mining – Water balance of manganese mine (Globesight, 2016)
- Sebilo – Perth Manganese Mine – Water Use License Application (Sebilo, 2016)
- Transnet – Confidential technical report review (DMT Kai Batla, 2016)
- Tswane Metropolitan Municipality – Tswane Agri-Hub Baseline Hydrogeological Study (DMT Kai Batla, 2016)
- Afrisam South Africa – Ulco Cement Factory Hydrogeological Investigation (MojaTerre, 2016)
- City of Cape Town – Kalbaskraal Waste Disposal Facility Geohydrological Modelling (Cliffe Decker Hofmeyer, 2017)
- Sebilo Resources – Perth Mine Waste Classification (Sebilo Resources, 2017)
- Zeerust Chrome Mine – Tailings Waste Classification Study (AMTIT, 2017)
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- Beeshoek Iron Ore Mine – Water and Salt Balance (Envirogistics, 2017)
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- New Kleinfontein Mine – Water and Salt Balance (NTC Group, 2017)
- Zeerust Chrome Mines – Basic Assessment Report -Groundwater (Envirogistics, 2018)
- Rustenburg Minerals Development Corporation – Basic Assessment Report – Groundwater (Envirogistics, 2018)
- Dwarsrivier Chrome Mine – Water Balance Study (Envirogistics, 2018)
- Beeshoek Mine -Water Balance Study (Envirogistics, 2018)
- Gold One New Kleinfontein Mine – Water Balance Study (NTC, 2018)
- Beeshoek Mine – Water and Salt Balance and Water Conservation and Demand Management Plan (Envirogistics, 2019)
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- ARM Alloys – Machadodorp Works Water and Salt Balance (ARM Alloys, 2019)
- ESKOM Ash Facility – Review of validity of closure liability calculation (Markus Reichardt, 2020)
- Wonderstone Mine – Water and Salt Balance (Envirogistics, 2020)
- Beeshoek Iron Ore Mine – Water and Salt Balance (Envirogistics, 2020)
- ARM Machadorp Smelter – Water and Salt Balance (Envirogistics, 2020)
- RMIPPPP 50 MW Gas Power Project Basic Assessment Report (ABS Africa, 2020)
- Beeshoek Mine – Water and Salt Balance and Water Conservation and Demand Management Plan (Envirogistics, 2020 and 2021)
- Upper Jukskei River Catchment Management Plan for the City of Johannesburg – Geohydrology component (Fourth Element, 2021)
- The Mineral Corporation – Geohydrological Opinion, Phase 2 Technical Due Diligence – Waterberg Project (TMC, 2021)
- Eskom Majuba Power Station – Geohydrological Basic Assessment (EIMS, 2022)

Environmental Management:

- Management of the construction of a river diversion (Pamodzi Gold, 2006)
- Minxcon Competent Person's Report (Bema Gold, 2006)
- Management of the construction and commissioning of a 10 ML/d mine water treatment plant (Pamodzi Gold, 2008/2009)
- Standard Bank Due Diligence (Pamodzi Gold, 2009)
- Environmental Baseline Assessment: Perth Manganese Prospect (Sebilo Resources, 2010)
- Prospecting Right EMP: Aquarius Chieftans and Valhallah Prospect (SRK Consulting, 2011)
- NI43-101 Technical Report - Hydrogeology: Homeland Energy (SRK Consulting, 2011)
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- Keegan Resources - Esaase Gold Project, Ghana – Gap Analysis and ESIA (Epoch Resources, 2013)
- Sebilo Resources – Quantum for Rehabilitation (Sebilo, 2014)
- Pembani Group – Evaluation of the Carolina Operations water related liabilities (Pembani, 2014)
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- African Mining Trust – Zeerust, Wonderstone and RMDC Quantum for Rehabilitation (2013 – 2017)
- Dwarsrivier Chrome Mine – Assessment of Quantum for Rehabilitation (Assore, 2018)
- AMT – Updated of Quantum for Rehabilitation for three operations (AMT, 2018)
- African Mining Trust – Wonderstone Quantum for Rehabilitation evaluation (Assore, 2020)

APPENDIX 2 RISK ASSESSMENT METHODOLOGY USED

The evaluation of impacts is conducted in terms of the criteria detailed by Envirogistics, as detailed below. The various environmental impacts and benefits of this project are discussed in terms of impact status, extent, duration, probability, and intensity. Impact significance is regarded as the sum of the impact extent, duration, probability and intensity and a numerical rating system has been applied to evaluate impact significance. Therefore, an impact magnitude and significance rating is applied to rate each identified impact in terms of its overall magnitude and significance

In order to adequately assess and evaluate the impacts and benefits associated with the project, it was necessary to develop a methodology that would scientifically achieve this and to reduce the subjectivity involved in making such evaluations. To enable informed decision-making, it is necessary to assess all legal requirements and clearly defined criteria in order to accurately determine the significance of the predicted impact or benefit on the surrounding natural and social environment.

Impact Status

The nature or status of the impact is determined by the conditions of the environment prior to construction and operation. A discussion on the nature of the impact will include a description of what causes the effect, what will be affected and how it will be affected. The nature of the impact can be described as negative, positive or neutral.

Status of Impact

Rating	Description	Quantitative rating
Positive	A benefit to the receiving environment.	P
Neutral	No cost or benefit to the receiving environment.	-
Negative	A cost to the receiving environment.	N

Impact Extent

The extent of an impact is considered as to whether impacts are either limited in extent or if it affects a wide area or group of people. Impact extent can be site specific (within the boundaries of the development area), local, regional or national and/or international.

Extent of Impact

Rating	Description	Quantitative rating
Low	Site Specific; Occurs within the site boundary.	1
Medium	Local; Extends beyond the site boundary; Affects the immediate surrounding environment (i.e. up to 5 km from the Project Site boundary).	2
High	Regional; Extends far beyond the site boundary; Widespread effect (i.e. 5 km and more from the Project Site boundary).	3
Very High	National and/or international; Extends far beyond the site boundary; Widespread effect.	4

Impact Duration

The duration of the impact refers to the time scale of the impact or benefit.

Duration of Impact

Rating	Description	Quantitative rating
Low	Short term; Quickly reversible; Less than the project lifespan; 0 – 5 years.	1
Medium	Medium term; Reversible over time; Approximate lifespan of the project; 5 – 17 years.	2
High	Long term; Permanent; Extends beyond the decommissioning phase; >17 years.	3

Impact Probability

The probability of the impact describes the likelihood of the impact actually occurring.

Probability of Impact

Rating	Description	Quantitative rating
Improbable	Possibility of the impact materialising is negligible; Chance of occurrence <10%.	1
Probable	Possibility that the impact will materialise is likely; Chance of occurrence 10 – 49.9%.	2
Highly Probable	It is expected that the impact will occur; Chance of occurrence 50 – 90%.	3
Definite	Impact will occur regardless of any prevention measures; Chance of occurrence >90%.	4
Definite and Cumulative	Impact will occur regardless of any prevention measures; Chance of occurrence >90% and is likely to result in in cumulative impacts	5

Impact Intensity

The intensity of the impact is determined to quantify the magnitude of the impacts and benefits associated with the proposed project.

Intensity of Impact

Rating	Description	Quantitative rating
Maximum Benefit	Where natural, cultural and / or social functions or processes are positively affected resulting in the maximum possible and permanent benefit.	+ 5
Significant Benefit	Where natural, cultural and / or social functions or processes are altered to the extent that it will result in temporary but significant benefit.	+ 4
Beneficial	Where the affected environment is altered but natural, cultural and / or social functions or processes continue, albeit in a modified, beneficial way.	+ 3
Minor Benefit	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are only marginally benefited.	+ 2
Negligible Benefit	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are negligibly benefited.	+ 1
Neutral	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are not affected.	0
Negligible	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are negligibly affected	- 1
Minor	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are only marginally affected.	- 2
Average	Where the affected environment is altered but natural, cultural and / or social functions or processes continue, albeit in a modified way.	- 3
Severe	Where natural, cultural and / or social functions or processes are altered to the extent that it will temporarily cease.	- 4
Very Severe	Where natural, cultural and / or social functions or processes are altered to the extent that it will permanently cease.	- 5

Impact Significance

The impact magnitude and significance rating are utilised to rate each identified impact in terms of its overall magnitude and significance.

Impact Magnitude and Significance Rating

Impact	Rating	Description	Quantitative rating
Positive	High	Of the highest positive order possible within the bounds of impacts that could occur.	+ 12 – 16
	Medium	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. Other means of achieving this benefit are approximately equal in time, cost and effort.	+ 6 – 11
	Low	Impacts is of a low order and therefore likely to have a limited effect. Alternative means of achieving this benefit are likely to be easier, cheaper, more effective and less time-consuming.	+ 1 – 5
No Impact	No Impact	Zero impact.	0
Negative	Low	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts, mitigation is either easily achieved or little will be required, or both. Social, cultural, and economic activities of communities can continue unchanged.	- 1 – 5
	Medium	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. In the case of adverse impacts, mitigation is both feasible and fairly possible. Social cultural and economic activities of communities are changed but can be continued (albeit in a different form). Modification of the project design or alternative action may be required.	- 6 – 11
	High	Of the highest order possible within the bounds of impacts that could occur. In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time-consuming or a combination of these. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt.	- 12 - 16