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ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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Appendices

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Appendix 2: Maps

Appendix 3: Public Participation Report

Appendix 4: Specialist Reports

Appendix 5: Environmental Management Programme

Appendix 6: Financial Provision Report

Appendix 7: Tetra4 Well Closure and Rehabilitation Guideline

Appendix 8: Major Hazardous Installation Reports

Appendix 9: Application Form Revision and PASA correspondence

Appendix 10: Stormwater Dam Water Monitoring Report

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Appendix 12: Environmental Authorisation dated 18 May 2023

Appendix 13: Appeals Submitted against Environmental Authorisation

Appendix 14: DFFE Ministers Appeal Decision

1 EXECUTIVE SUMMARY (NON-TECHNICAL)

In 2022, Tetra4 (the applicant) commenced with an application for Environmental Authorisation for the Cluster 2 gas production activities which would form an extension to the existing Cluster 1 gas production being undertaken near Virginia in the Free State Province. The application followed a full Scoping and Environmental Impact Assessment process which culminated in a positive Environmental Authorisation being issued which was subsequently appealed. The timelines and related aspects of the application process are detailed below.

As indicated above, appeals were subsequently lodged against the decision which included new information that was not submitted during the previous EIA phase public consultation period (i.e. independent Expert Critique of certain specialist studies at the appeal phase). Seven grounds of appeal were raised by the appellants. Based on the DFFE Ministers consideration of the grounds appeal the DFFE Minister issued an Appeal decision dated 1 August 2024. Within the DFFE Ministers Decision, 5 grounds of appeal were dismissed while 2 grounds of appeal were upheld with recommendations that the Applicant undertake further investigations, update the EIA Report,

undertake a further 30-day public review of the updated EIA Report, and submit the updated EIA Report for reconsideration to the Competent Authority (in this case the Department of Mineral Resources and Energy). This updated EIA Report has been prepared to address the recommendations and shortcomings identified in the Ministers decision and includes updates to the following:

1. Updated Climate Change Specialist Study to include the following:
    a. Address the issues raised by the Expert Critique relating to the GHG emissions calculations;
    b. Provide a more detailed analysis of the impacts of climate change on the various activities associated with the construction and operation of the project, and on the environment and affected communities; and
    c. Expand further on more recent information relating to LNG as a viable "bridging fuel" for reducing GHG emissions;
2. Consideration of climate change impacts in the delineation of the 1:100-year floodline and how the climate change predicted floodlines may impact the proposed development.
3. Updated Geohydrological (groundwater) Impact Specialist Study following additional baseline aquifer characterisation, detail on deep confined aquifer and associated water quality, discussions on the gas well stratigraphy, construction methods and associated hydrogeology impacts and potential source terms of the proposed activities is clearly defined.

Following incorporation and reconsideration of the additional information, there are no material changes to the identified impacts, the relevant impact assessment significance levels, or the mitigation measures previously put forward in the original EIA Report. The additional information gathered and considered in the updated specialist studies reinforces / supports the outcomes presented in the original EIA Report.

Changes to the original EIA Report and EMPr are reflected in blue text for ease of reference.

This non-technical executive summary provides a high-level overview of this updated Environmental Impact Assessment Report. The reader is urged to consult later sections of this report should more specific information or detail be required on various aspects.

1.1 PROJECT OVERVIEW

Tetra4 (Pty) Ltd (a wholly owned subsidiary of Renergen) holds a Gas Production Right (Ref: 12/4/1/07/2/2) that was granted in 2012 which spans approximately 187 000 hectares for the development of natural gas production operations near the town of Virginia in the Free State Province. Within the approval of the Production Right, the 2010 Environmental Management Programme (EMPr) was approved which was applicable to a large portion of the Production Right area.

On 21 September 2017, the Department of Mineral Resources and Energy (DMRE) issued an integrated environmental authorisation ("Cluster 1 EA" – reference number 12/04/07) to Tetra4 in terms of the National Environmental Management Act (Act 107 of 1998 – NEMA) and the National Environmental Management Waste Act (Act 59 of 2008 – NEMWA). The Cluster 1 EA authorises the development of "Cluster 1" of the Project. In this EA approval, various new wells and pipelines, booster and compressor stations, a Helium and Liquid Natural Gas (LNG) Facility and associated infrastructure was approved which comprises the first gas field for development within the approved Production Right area.

Following the successful commencement of Cluster 1, Tetra4 wishes to expand the natural gas operations, to be located within the approved production right area and overlapping with the Cluster 1 project. The Cluster 2 application area covers a total of ~27 500 hectares. This planned expansion to the existing approved production activities will involve up to 300 new production wells, ~480km of gas transmission pipelines and associated infrastructure, 3 compressor stations and an additional new combined LNG and Liquid Helium (LHe) plant

("LNG/LHe Plant") and associated infrastructure as part of the "Cluster 2" expansion of the Project to meet the future production requirements. This updated Environmental Impact Assessment Report follows on from the Scoping Report and previous EIA Report and is prepared as part of an integrated environmental authorisation and waste management licence for the Cluster 2 development.

The proposed development infrastructure triggers various listed activities in terms of the NEMA Listing Notices 1, 2 and 3 as well as the National Environmental Management Waste Act (Act 59 of 2008 – NEMWA) and a full Scoping and Environmental Impact Assessment process is being undertaken. The relevant WUL and AEL applications are being / will be submitted for the licencing requirements under the NWA and NEMAQA respectively. As part of this EIA Report, certain amendments have been made to the approved EMPr existing approved Environmental Management Programme (EMPr) to include the Cluster 2 project as well as required amendments to mitigation measures that were identified during this assessment process. This amended EMPr would replace the current approved EMPr for the Production Right and Cluster 1.

1.2 NEED FOR THE PROJECT

Tetra4 has successfully commenced operation of the Cluster 1 Helium and Methane gas production operations with proven resources gas (Helium and Methane). Helium is one of the most sought-after products to be produced and processed by the proposed Cluster 2 gas production development. Helium has numerous uses other than making balloons float which includes medical applications, manufacturing and cryogenics as well as space travel. Liquid Natural Gas (LNG - Methane) is produced both worldwide and domestically at relatively low cost and is cleaner burning with lower CO_2 emissions than coal, petrol, diesel or propane fuels which currently dominate the energy production sector in South Africa and many other countries. As Helium and Methane occur together in the underground reserves, the project will produce both products simultaneously and therefore it is not possible to target either gas individually.

1.3 PROJECT DESCRIPTION AND INFRASTRUCTURE

The Tetra4 Production Right is located within the Virginia Gas Field. Within the Virginia Gas Field geological profile, fault systems associated with closely spaced zones of fractures and joints provide for preferential pathways for gas to reach the surface. Once the gas target areas are intersected by drilling the feed gas will flow passively out of the wells at a low pressure of ~0.4 psi (pounds per square inch) and with a temperature in the range between 10 º and 30 ºC. For comparison, the atmospheric pressure at sea level is 14.7 psi which is far greater than the gas being passively released from this gas field. Due to the very low gas pressure in the wells, a group of ~10 wells will be linked via underground pipelines to a surface booster station which provides a suction pressure on the wells to enhance flow. The booster stations then boost the pressure in main underground transmission pipelines to the compressor stations where the pressure is again increased to transfer the gas via underground trunklines to the gas processing, storage and distribution plant (LNG/LHe Plant).

1.3.1 DRILLING

Exploration wells will be drilled and, if successful, converted into production wells. As the exact location of exploration well drilling cannot be identified at this stage owing to the nature of exploration models being continually refined, this study has followed the approach of assessing well corridors (600 m wide or 300 m on either side of known target fault lines). Exploration drilling entails the use of a truck, trailer or skid mounted drill rig to drill to varying depths (~380 m to ~880 m) along known fault lines in order to strike the gas reserve.

Drill rigs typically require temporary clearance or disturbance of an area of 50 m x 50 m to set up the rig and begin drilling activities which take approximately 3 to 4 months per well. Immediately after the drilling, testing of the gas volumes and compositions is undertaken which takes approximately 7 to 14 days. All exploration boreholes must be drilled and cased in accordance with applicable international standards and best practice guidelines and will be sealed with a combination of steel casing and grouting (cement) to ensure there is no mixing of gas or deep saline water with the shallower freshwater aquifers.

The drilling of exploration boreholes is a temporary and short-lived activity and the equipment to be used during drilling activities includes a truck/trailer or skid mounted drill rig, excavator, dozer, grader, water cart, light

motor vehicle for transport of personnel and chemical toilets. Exploration boreholes that are successful (gas producing) will be turned into production wells by installing a valve within an underground concrete bunker with a manhole surface area of ~1.5 m^2. Unsuccessful exploration wells will be safely decommissioned and rehabilitated. All wells that are drilled and used for production purposes are strengthened with a combination of casing and grouting to average depths of 300 m to prevent any interplay between deep and shallow groundwater resources.

1.3.2 PIPELINES

~480 km of underground gas pipelines will be constructed to link the ~300 production wells to the compressor stations and LNG/LHe Plant. Pipelines will be a combination of high-pressure steel as well as low-pressure high-density polyethylene (HDPE) and will be installed at a minimum depth of 1.5 m below surface level. The pipeline will be installed using a back-actor and TLB. Pipeline servitude corridors (10 m wide) will be maintained free of woody plants to prevent disturbance of the pipeline by root growth and ensure access by Tetra4 personnel for regular inspection and infrequent maintenance. Pipelines will be marked with concrete markers and adhere to industry standards and will have low point drains at strategic locations for testing and pipeline maintenance.

1.3.3 GAS INLINE STATIONS

To transport gas via pipelines from the production wells to the LNG/LHe Plant, various inline infrastructure is required to monitor, measure and control gas flow through the pipelines and this includes booster stations, pigging stations, low point drains and compressor stations.

The booster stations will occupy an area of ~10 m x 14 m and a total of 28 booster stations may be constructed. Inline pigging stations are installed to allow for regular cleaning and inspection of the pipelines near river crossings. The pigging stations allow for insertion of probes or cleaning “pigs” (plugs) at regular intervals to perform regular maintenance and in total approximately 14 pig launcher/receiver pairs may be constructed.

Raw gas received at the compressor stations will be filtered to remove dust and moisture. Once filtered, the gas from the compressors will be piped for final processing to the LNG/LHe Plant. A total of 3 compressor stations will be constructed and the footprint for a compressor station will be approximately 60 m x 60 m.

1.3.4 LNG AND HELIUM PLANT

The LNG/LHe facility is a facility to convert the Helium and Methane into a liquid form for storage before being transported by road tankers to offtake suppliers. The Cluster 2 LNG/LHe Plant will be constructed directly adjacent to the existing Cluster 1 plant which is currently under construction on the remaining extent of the farm Mond Van Doornrivier 38 and adjacent to the R30 Road and the Sandrivier bridge. A Major Hazardous Installation (MHI) study has been undertaken on the pipelines and plant which concluded that an accidental release of methane will not impact on any residential area or sensitive receptor.

The LNG/LHe plant comprises of the following process units:

- Gas Treatment and Boosting System;
- Helium Separation Unit;
- Gas Liquefaction System;
- LHe Storage (~2x100 m^3);
- LNG Storage (~11x300 m^3); and
- LHe and LNG road tanker loading bays.

The area to be occupied by the proposed Cluster 2 LNG/LHe plant in the operational phase is ~9.6 hectares while an additional ~15.8 hectare area directly adjacent to the Plant will be cleared during the construction phase for various contractor laydown areas, offices, parking, waste storage, etc. This latter area will be rehabilitated following construction.

1.4 SPECIALIST STUDIES

Several specialist studies have been commissioned to investigate key issues and impacts and findings from these studies are included in this report. The specialist study reports are included in Appendix 4. A list of the specialist studies conducted to inform this EIA process is included below:

- Soils and Agriculture
- Air Quality and Health Risk
- Climate Change and Green House Gas (updated following Ministers Appeal Decision)
- Economic
- Financial Provision for Rehabilitation, Decommissioning and Closure
- Geohydrology / Groundwater (updated following Ministers Appeal Decision)
- Heritage and Palaeontology
- Hydrology / Surface Water (updated following Ministers Appeal Decision)
- Noise
- Social
- Terrestrial Biodiversity
- Visual
- Wetland and Aquatic

1.5 IMPACTS IDENTIFIED AND SUMMARY OF IMPACT ASSESSMENT

A list of biophysical and socio-economic impacts that have been identified and assessed as well as the pre-mitigation environmental risk, post mitigation environmental risk and final significance when applying a priority factor is presented below.

Discipline	Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
Air Quality	Air Quality - Increase in air quality impacts due to construction of the road/pipeline	Construction	-9	-6.8	-8
	Air Quality - Increase in air quality impacts due to construction of the wells and booster stations	Construction	-10	-6.8	-8
	Air Quality - Increase in air quality impacts due to construction of the plant and compressor stations	Construction	-11	-7.5	-8
	Air Quality - Increase in air quality impacts due to the operation of vehicles on unpaved roads	Operation	-12	-7.5	-8
	Air Quality - Increase in air quality impacts due to operation of the booster stations	Operation	-12	-8.3	-8
	Air Quality - Increase in air quality impacts due to operation of the plant	Operation	-7.5	-7.5	-8
	Air Quality - Increase in air quality impacts due to decommissioning and closure	Decommissioning	-11	-7.5	-8
Climate Change	Climate Change risk due to Scope 1 & 2 construction	Construction	-8	-7	-9

Discipline	Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
	Climate Change risk due to Scope 1 & 2 construction	Operation	-12	-11	-15
Noise	Noise - Increase in noise levels due to construction of the pipeline	Construction	-11	-7.5	-8
	Noise - Increase in noise levels due to construction of the wells and Blower Stations	Construction	-12	-8.3	-8
	Noise - Increase in noise levels due to construction of the Plant and Compressor Stations	Construction	-8.3	-7.5	-8
	Noise - Increase in noise levels due to Blower Station operation	Operation	-9	-6	-6
	Noise - Increase in noise levels due to Plant and Compressor Station operation	Operation	-9	-6	-6
	Noise - Increase in noise levels	Decommissioning	-11	-7.5	-8
Geohydrology	Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area.	Construction	-4	-1.8	-2
	Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.	Construction	-8.3	-4.5	-6
	Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	Construction	-12	-7.5	-9
	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Construction	-8.3	-4.5	-6
	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Operation	-18	-12	-15
	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Operation	-18	-12	-15
	Groundwater pollution as a result of wastewater spills and seepage from the evaporation dams.	Operation	-12	-7.5	-9
	Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	Operation	-12	-7.5	-9
	Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	Operation	-8.3	-4.5	-6
	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Operation	-12	-7.5	-9

Discipline	Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
	Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.	Operation	-12	-7.5	-9
	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.	Decommissioning	-16	-9	-11
	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) borehole closure and decommissioning phase.	Decommissioning	-16	-9	-11
	Groundwater pollution as a result of wastewater spills and seepage from the evaporation dams.	Decommissioning	-6.5	-2.3	-3
	Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	Decommissioning	-6.5	-2.3	-3
	De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.	Decommissioning	-6.5	-2.3	-3
Hydrology	Hydrology - Loss of watercourse vegetation	Construction	-3	-1.5	-2
	Erosion	Construction	-6	-3	-3
	Stormwater contamination	Construction	-7	-3	-3
	Alien and/or Invasive Vegetation	Construction	-6.5	-1.8	-2
	Alterations of the river banks and river bed	Construction	-6.8	-3.5	-4
	Erosion	Operation	-5.5	-2.8	-3
	Stormwater contamination	Operation	-9	-3.5	-4
	Alien and/or Invasive Vegetation	Operation	-9.8	-4	-5
	Erosion	Decommissioning	-5	-2.5	-3
	Stromwater contamination	Decommissioning	-9	-3.5	-4
	Alien and/or Invasive Vegetation	Decommissioning	-6.5	-1.8	-2
Heritage & Palaeontology	Impact on unidentified heritage resources	Construction	-3	-5.5	-8
	Impact on burial grounds and graves	Construction	-16	-6	-8
	Impact on historic to recent sites with possible graves	Construction	-11	-6	-8
	Impact on structures of medium heritage significance	Construction	10.5	-5	-6
	Impact on palaeontology	Construction	-18	-8	-11
Social	Impact on livelihoods	Construction	-15	-11	-14
	Impact on livelihoods	Operation	-18	-15	-21
	Impact of servitudes on land values	Operation	-21	-15	-21
	Uncertainty in terms of land tenure, access control, etc.	Planning	-16	-8.3	-10
	Nuisance factor due to increase in ambient dust and noise levels	Construction	-13	-10	-11
	Changes in travel patterns	Construction	-13	-9	-10

Discipline	Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
	Damage to farm roads, existing services, and infrastructure	Construction	-15	-10	-11
	Damage to farm roads, existing services, and infrastructure	Operation	-14	-13	-16
	Impacts on livelihoods due to behaviour of contractors	Construction	-11	-6.8	-8
	Impacts on safety and security of local residents	Construction	-13	-11	-17
	Impacts on safety and security of local residents	Operation	-19	-14	-18
	impacts on sense and spirit of place	Construction	-15	-10	-14
	impacts on sense and spirit of place	Operation	-20	-20	-28
	Impacts on the social licence to operate	Construction	-12	11	14
	Impacts on the social licence to operate	Operation	-15	13	16
	Increase in social pathologies	Construction	-11	-10	-11
	Public perceptions about safety associated with gas production	Operation	-12	-6.8	-7
	Contribution to economy of South Africa	Operation	22.5	23.8	27
	Secondary economic opportunities	Construction	11	17.5	20
	Secondary economic opportunities	Operation	13	18.8	21
	Potential opportunity for education, skills development, and training	Operation	13	18.8	21
Visual	Impact on Existing Agricultural Landscape Character	Construction	-8	-8	-9
	Impact on Existing Agricultural Landscape Character	Operation	-4	-4	-5
	Impact on Existing Agricultural Landscape Character	Decommissioning	-10	-1	-1
	Impact on Existing Natural Landscape Character	Construction	-8	-3	-3
	Impact on Existing Natural Landscape Character	Operation	-7.5	-3.5	-4
	Impact on Existing Natural Landscape Character	Decommissioning	-5.3	-2	-2
	The visual impact on views from local roads	Construction	-8	-5.3	-6
	The visual impact on views from local roads	Operation	-11	-7.5	-8
	The visual impact on views from local roads	Decommissioning	-10	-1	-1
	Change of Natural of Views from Homesteads	Construction	-12	-4.5	-5
	Change of Natural of Views from Homesteads	Operation	-6	-4	-5
	Change of Natural of Views from Homesteads	Decommissioning	-10	-1	-1
	The visual impact on views from local homesteads due to Lighting	Construction	-8	-1	-1
	The visual impact on views from local homesteads due to Lighting	Operation	-11	-1.8	-2
	The visual impact on views from local homesteads due to Lighting	Decommissioning	-8	-1	-1
Terrestrial	Temporary disturbance of wildlife due to increased	Planning	-3.5	-2	-2

Discipline	Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
	human presence and possible use of machinery and/or vehicles.				
	Destruction, further loss and fragmentation of the vegetation community	Construction	-11	-9	-11
	Introduction of alien species, especially plants	Construction	-7.5	-6	-7
	Erosion due to storm water runoff and wind	Construction	-7.5	-6.8	-8
	Displacement of faunal community due to habitat loss, direct mortalities and disturbance (road collisions, noise, light, dust, vibration and poaching).	Construction	-9	-7.5	-8
	Environmental pollution due to potential leaks, discharges, pollutant leaching into the surrounding environment	Operation	-9	-5.5	-6
	Continued fragmentation, further loss and fragmentation of the vegetation community	Operation	-11	-8.3	-10
	Vegetation loss due to erosion and encroachment by alien invasive plant species	Operation	-8.3	-4.5	-5
	Potential leaks, discharges, pollutant from activities leaching into the surrounding environment	Operation	-9	-7.5	-8
	Continued displacement and fragmentation of the faunal community (including threatened or protected species) due to ongoing anthropogenic disturbances (noise, dust and vibrations) and habitat degradation/loss (litter, road mortalities and/or poaching).	Operation	-12	-5.5	-6
	Continued encroachment of vegetation community by alien invasive plant species as well as erosion due to disturbed soils	Decommissioning	-7.5	-4.5	-5
	Continued displacement and fragmentation of the faunal community (including potential threatened or protected species) due to ongoing habitat degradation/loss (infringement, litter, road mortalities and/or poaching).	Decommissioning	-7.5	-4.5	-5
Hydropedology	Construction of compressors and wells	Construction	-7.5	-7.5	-8
	Construction of pipelines and transmission loop	Construction	-6	-6	-7
	Operation of Compressor and Wells	Operation	-8.3	-5.5	-6
	Operation of pipelines and transmission loop	Operation	-7.5	-5	-6
	Decommissioning of Compressors and Wells	Decommissioning	-6	-6	-7
	Decommissioning of pipelines and transmission loop	Decommissioning	-4	-4	-5
Wetlands	Exploration Wells - Habitat	Planning	-4	-2.3	-3

Discipline	Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
	Exploration Wells - Water Quality	Planning	-4	-2.3	-2
	Exploration Wells - Flow	Planning	-3	-1.5	-2
	Pipelines and Transmission loop - Habitat	Construction	-7.5	-4	-5
	Pipelines and Transmission loop - Water Quality	Construction	-3.5	-3.5	-4
	Pipelines and Transmission loop - Flow	Construction	-3	-3	-3
	Compressors Station CS1 - Habitat	Construction	-8.3	-5	-6
	Compressors Station CS1 - Water Quality	Construction	-3.5	-3.5	-4
	Compressors Station CS1 - Flow	Construction	-3	-3	-3
	Compressors Station CS1 - Habitat	Construction	-3	-3	-3
	Compressors Station CS1 - Water Quality	Construction	-3	-3	-3
	Compressors Station CS1 - Flow	Construction	-3	-2.5	-3
	Compressors CS2 - Habitat	Construction	-4	-4	-5
	Compressors CS2 - Water Quality	Construction	-3.5	-3.5	-4
	Compressors CS2 - Flow	Construction	-3	-3	-3
	Compressors CS3 - Habitat	Construction	-3.8	-3	-3
	Compressors CS3 - Water Quality	Construction	-3.5	-3.5	-4
	Compressors CS3 - Flow	Construction	-3	-3	-3
	Compressors CS3 - Habitat	Construction	-4	-4	-5
	Compressors CS3 - Water Quality	Construction	-3.5	-3.5	-4
	Compressors CS3 - Flow	Construction	-3	-3	-3
	Powerlines - Habitat	Construction	-5.5	-3	-3
	Powerlines - Water Quality	Construction	-2	-1.3	-1
	Powerlines - Flow	Construction	-2.5	-1.3	-1
	Access Roads - Habitat	Construction	-4.5	-3	-3
	Access Roads - Water Quality	Construction	-6.8	-4	-4
	Access Roads - Flow	Construction	-3.5	-2	-2
	LNG/LHe Plant - Habitat	Construction	-4	-3	-3
	LNG/LHe Plant - Water Quality	Construction	-3.5	-2.5	-3
	LNG/LHe Plant - Flow	Construction	-3	-2.5	-3
	Pipelines and Transmission loop - Habitat	Operation	-4	-2.5	-3
	Pipelines and Transmission loop - Water Quality	Operation	-3.5	-2	-2
	Pipelines and Transmission loop - Flow	Operation	-3	-1	-1
	Compressors Station CS1 - Habitat	Operation	-9.8	-6	-7
	Compressors Station CS1 - Water Quality	Operation	-3.5	-3.5	-4
	Compressors Station CS1 - Flow	Operation	-4	-4	-4
	Compressors Station CS1 - Habitat	Operation	-6.8	-3.5	-4
	Compressors Station CS1 - Water Quality	Operation	-3.5	-3.5	-4
	Compressors Station CS1 - Flow	Operation	-3	-1	-1
	Compressors CS2 - Habitat	Operation	-8.3	-3	-3
	Compressors CS2 - Water Quality	Operation	-3	-2	-2
	Compressors CS2 - Flow	Operation	-4.5	-2	-2
	Compressors CS3 - Habitat	Operation	-7.5	-4	-5
	Compressors CS3 - Water Quality	Operation	-3.5	-3.5	-4
	Compressors CS3 - Flow	Operation	-4	-4	-4

Discipline	Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
	Compressors CS3 - Habitat	Operation	-7.5	-4	-5
	Compressors CS3 - Water Quality	Operation	-3.5	-3.5	-4
	Compressors CS3 - Flow	Operation	-4	-4	-4
	Powerlines - Habitat	Operation	-5	-3.5	-4
	Powerlines - Water Quality	Operation	-1	-1	-1
	Powerlines - Flow	Operation	-1	-1.3	-1
	Access Roads - Habitat	Operation	-9	-4.5	-5
	Access Roads - Water Quality	Operation	-5	-4	-4
	Access Roads - Flow	Operation	-5	-3.5	-4
	LNG/LHe Plant - Habitat	Operation	-4.5	-4	-4
	LNG/LHe Plant - Water Quality	Operation	-3.5	-3.5	-4
	LNG/LHe Plant - Flow	Operation	-3	-3.5	-4
	Pipelines and Transmission loop - Habitat	Decommissioning	-7.5	-4	-5
	Pipelines and Transmission loop - Water Quality	Decommissioning	-3.5	-3.5	-4
	Pipelines and Transmission loop - Flow	Decommissioning	-3	-3	-3
	Compressors Station CS1 - Habitat	Decommissioning	-8.3	-5	-6
	Compressors Station CS1 - Water Quality	Decommissioning	-3.5	-3.5	-4
	Compressors Station CS1 - Flow	Decommissioning	-3	-3	-3
	Compressors Station CS1 - Habitat	Decommissioning	-3	-3	-3
	Compressors Station CS1 - Water Quality	Decommissioning	-3	-3	-3
	Compressors Station CS1 - Flow	Decommissioning	-3	-2.5	-3
	Compressors CS2 - Habitat	Decommissioning	-4	-4	-5
	Compressors CS2 - Water Quality	Decommissioning	-3.5	-3.5	-4
	Compressors CS2 - Flow	Decommissioning	-3	-3	-3
	Compressors CS3 - Habitat	Decommissioning	-3.8	-3	-3
	Compressors CS3 - Water Quality	Decommissioning	-3.5	-3.5	-4
	Compressors CS3 - Flow	Decommissioning	-3	-3	-3
	Compressors CS3 - Habitat	Decommissioning	-4	-4	-5
	Compressors CS3 - Water Quality	Decommissioning	-3.5	-3.5	-4
	Compressors CS3 - Flow	Decommissioning	-3	-3	-3
	Powerlines - Habitat	Decommissioning	-5	-3	-3
	Powerlines - Water Quality	Decommissioning	-2	-1.3	-1
	Powerlines - Flow	Decommissioning	-2.5	-1.3	-1
	Access Roads - Habitat	Decommissioning	-4.5	-3	-3
	Access Roads - Water Quality	Decommissioning	-6	-4	-4
	Access Roads - Flow	Decommissioning	-3.5	-2	-2
	LNG/LHe Plant - Habitat	Decommissioning	-4	-3	-3
	LNG/LHe Plant - Water Quality	Decommissioning	-3.5	-2.5	-3
	LNG/LHe Plant - Flow	Decommissioning	-3	-2.5	-3
Economic	GGP Impact	Construction	16	16	18
	Employment Impacts	Construction	13	13	15
	Forex savings	Construction	-9.8	-9.8	-11
	Fiscal Income	Construction	12	12	14
	Economic development per capita	Construction	15	15	17
	Country and Industry Competitiveness	Construction	16	16	18
	Black Economic Transformation	Construction	14	14	16
	Alternative Land-use	Construction	8.75	8.75	10
	Need and Desirability	Construction	15	15	17
	Impact on individual farmland values	Construction	-7.5	-7.5	-8
	GGP Impact	Operation	23.8	23.8	33

Discipline	Impact	Phase	Pre-mitigation ER	Post-mitigation ER	Final Significance
	Employment Impacts	Operation	17	17	23
	Forex savings	Operation	18	18	25
	Fiscal Income	Operation	17	17	23
	Economic development per capita	Operation	17	17	23
	Country and Industry Competitiveness	Operation	20	20	28
	Black Economic Transformation	Operation	16	16	22
	Alternative Land-use	Operation	11.3	11.3	15
	Need and Desirability	Operation	20	20	28
	Impact on individual farmland values	Operation	-9	-9	-12
	GGP Impact	Decommissioning	-13	-13	-13
	Employment Impacts	Decommissioning	-13	-13	-13
	Forex savings	Decommissioning	-23	-23	-23
	Fiscal Income	Decommissioning	-23	-23	-23
	Economic development per capita	Decommissioning	-13	-13	-13
	Country and Industry Competitiveness	Decommissioning	-18	-18	-18
	Black Economic Transformation	Decommissioning	-16	-16	-16
	Alternative Land-use	Decommissioning	-15	-15	-15
	Need and Desirability	Decommissioning	-15	-15	-15
	Impact on individual farmland values	Decommissioning	8.25	8.25	8
	GGP Impact	Rehab and closure	-23	-23	-23
	Employment Impacts	Rehab and closure	-23	-23	-23
	Forex savings	Rehab and closure	-23	-23	-23
	Fiscal Income	Rehab and closure	-23	-23	-23
	Economic development per capita	Rehab and closure	-23	-23	-23
	Country and Industry Competitiveness	Rehab and closure	-15	-15	-15
	Black Economic Transformation	Rehab and closure	-16	-16	-16
	Alternative Land-use	Rehab and closure	-19	-19	-19
	Need and Desirability	Rehab and closure	-18	-18	-18
	Impact on individual farmland values	Rehab and closure	8.25	8.25	8

1.6 PUBLIC PARTICIPATION

The public participation process for this application has been undertaken in accordance with the requirements of the NEMA EIA Regulations, and in line with the principles of Integrated Environmental Management (IEM). IEM implies an open and transparent participatory process, whereby stakeholders and other I&APs are afforded an opportunity to comment on the project and have their views considered and included as part of project planning.

The PPP commenced on 20 May 2022 with an initial notification and call to register for a minimum period of 30 days. The initial notification was undertaken in English, Afrikaans and Sesotho and was given in the following manner:

- Registered letters, faxes, emails and sms's: Notification were distributed to all pre-identified I&APs including government organisations, NGOs, relevant municipalities, ward councillors, landowners and other organisations that may be interested or affected.
- Advertisements describing the proposed project and EIA process were published in the Vista Newspaper with circulation in the vicinity of the study area. The initial advertisements were placed in the Vista newspaper in English, Afrikaans and Sesotho on the 19 May 2022 with a government gazette published (also in 3 languages) on 1 July 2022.

- A1 Correx site notices in English, Afrikaans and Sesotho were placed at 78 locations within and around the application area from 16 May 2022 to 19 May 2022.
- A3 posters in English, Afrikaans and Sesotho were placed at local public gathering places in Welkom, Theunissen and Virginia (Welkom Public Library, Retail Spar, Retail Pick n Pay, Virginia Public Library, Theunissen Magistrates Court and Masilo (Theunissen) Public Library).

Subsequent to the call to register notification, the scoping report was made available to registered I&APs in the following manner:

- Registered letters with details on where the scoping report can be obtained and/or reviewed, public meeting date and time, EIMS contact details as well as the public review comment period;
- Facsimile notifications with information similar to that in the registered letter described above;
- Email notifications with a letter attachment containing the information described above; and/or
- SMS notifications to inform I&APs of the Scoping Report availability and where additional information could be obtained in order to participate.

The scoping report was made available for public review from 29 July 2022 to 30 August 2022 for a period of at least 30 days. During the Scoping Report public review period open days and meetings were held with I&AP's as follows:

- Tuesday 23 August 2022: Community Meeting (Stilte Primary School) 12H00-14H00
- Tuesday 23 August 2022: Community Meeting (Adamsons Vley Primary School) 16H00-18H00
- Wednesday 24 August 2022: Farmers Focus Group Open Day (Goldfields Game Ranch) 10H00-16H00
- Wednesday 24 August 2022: Farmers Focus Group Meeting (Goldfields Game Ranch) 17H00-19H00
- Thursday 25 August 2022: Public Open Day (NG Church Virginia) 10H00-17H00

The EIA report was made available for public review from 6 December 2022 to 24 January 2023 for a period of at least 30 days. During the EIA Report public review period open days and meetings were held with I&AP's as follows:

- 10 January 2023: Community Meeting (Stilte Primary School) 12H00-14H00
- 10 January 2023: Community Meeting (Adamsons Vley Primary School) 16H00-18H00
- 10 January 2023: Farmers Focus Group Meeting (Goldfields Game Ranch) 17H00-19H00
- 10 January 2023: Public Meeting (NG Church Virginia) 12H00-14H00

This updated EIA Report will be made available for a period of at least 30 days and focus group, and public meetings will be undertaken during this period.

A summary of the comments received to date as well as how these comments were addressed is provided below.

Table 1: Summary of comments received to date and how comments were addressed.

Comment Summary	How comment was addressed
Concerns of water availability and quality to farmers and air quality impacts of the proposed project.	The geohydrological specialist and air quality specialist reports have assessed the impact on water quality and availability as well as the air quality impacts (including health risks).
I&AP deregistration requests.	I&APs who formally requested to be registered were removed from the database.

Comment Summary	How comment was addressed
I&AP registration requests.	I&APs who formally requested to be registered were added to the database for further notifications during upcoming application comment periods.
Eskom Holdings SOC Limited (Transmission) requested a Google Earth (.kmz) file.	The requested information was shared with Eskom.
Notification of ongoing Oryx Solar Power Plant PV Authorization application from another EAP (Environamics) within Cluster 2 project area, locality map sharing and BID documents, Scoping Report and recently EIA report for comment.	Tetra4 and EIMS have taken note of this application for a PV project within the Cluster 2 application area and note that there is minimal impact on the project as a whole.
Some individuals as well as contractors have expressed their interest in potential employment and business opportunities from the proposed development.	Work seekers (be it individual jobs or contractors) have been directed to the Tetra4 website which contains a link for interested vendors etc. Community members seeking employment (jobs) were informed of the Tetra4 personnel who are responsible for collecting CV's, ID's etc to ensure that their interest is captured. All job or contract seekers were informed that the application is still underway and that the project commencement is dependent on the final decision from the PASA/DMRE.
Transnet commented that the proposed development does not affect their pipeline servitudes in the region.	No further actions required.
SAHRA provided formal comment indicating that the project is supported based on the information submitted.	No further actions required.
Query regarding website document accessibility.	EIMS provided the needed assistance with obtaining the relevant documentation which was resolved satisfactorily.
Requests by certain members of the local community for jobs as well as other specific services such as electricity, skills upliftment, etc.	These comments were raised during the community focus group meeting with the Adamsons Vley community. The community was informed that Tetra4 is currently in the process of providing certain basic services such as water and electricity to the community as part of the Social and Labour Plan commitments. This is an ongoing process throughout the project implementation and would be extended to other communities in due course. The community acknowledged that the water and solar electricity project was currently underway in their community.
Concerns by a local NGOs - Vaal Environmental Justice Alliance (VEJA) and Gold and Uranium Belt Impact Sensoring Organisation – GUBICO about the living standards of the community members.	It was confirmed that Tetra4 was aware of the poor living standards of some communities and therefore as part of the SLP commitments, certain upliftment programs had been initiated and are ongoing.

Comment Summary	How comment was addressed
NGO - Vaal Environmental Justice Alliance (VEJA) highlighted the possible confusion regarding Tetra4 vs Renergen and how the two companies relate to this project as the sign outside the existing plant says Renergen however the applicant in the application is Tetra4.	Clarification was provided that Tetra4 is a wholly owned subsidiary of Renergen and whilst the applicant in this application is Tetra4, this does not pose any legal constraints on the project. This report includes a clear statement that Tetra4 is a wholly owned subsidiary of Renergen.
Concerns that impact on landowners seem to have been underestimated.	All specialists have been provided with this comment and have considered this comment in light of their preliminary impact assessment findings. This has been thoroughly considered and assessed by the relevant specialists as well as the EAP in this EIA Report with minor amendments to certain impacts. Additional mitigation measures have been put forward to fully address the impact findings.
Concerns regarding the project's impacts on the safety, livelihoods and land value for landowners.	These safety, livelihoods and land value concerns have been given specific attention in the EIA report and detailed mitigation measures to address these concerns have been included. In addition, specific conditions have been put forward for inclusion in the decision to ensure that priority is given to impacts on safety, livelihoods and land value. Lastly, Tetra4 has revised the landowner contract terms to provide more specific attention to these concerns including annual compensation for the life of the project (per hectare rate), commitments to hold specific negotiations with each affected landowner to ensure infrastructure is sited in such a manner so as to minimise impacts on existing land use and lastly to ensure that all reasonable safety measures are continually in place.
Access road degradation concerns from landowners.	Degradation of access roads has been thoroughly considered and mitigated in this report and associated EMPr. This includes a pre-construction survey by the landowner and Tetra4 of all private access roads to be utilised by the project including photographic and video documentation of the pre-construction state. A similar post construction survey will be undertaken to document any degradation of access roads which if identified, will be to Tetra4s account. It is acknowledged that each landowner has a specific access road construction methodology, and this will be documented and complied with if any repairs are required.
Request by a landowner for more detail on infrastructure specific location and timing of the project aspects.	Where possible, infrastructure specific locations or at least limitations to where infrastructure will not be located has been provided in the Scoping Report and this EIA Report. The project description has been reviewed and updated where possible to include

Comment Summary	How comment was addressed
	more information on location and timing of certain activities.
Request by a landowner for more detail on logistics regarding access and maintenance of Tetra4 infrastructure on farmlands as well as contractual concerns.	Following this concern relating to the initial landowner contract, Tetra4 have undertaken a revision of the contract to be more specific in addressing the various landowner concerns. Tetra4 shall share a copy of the revised contract with the relevant landowners. In terms of access for inspections and maintenance during the operational phase, the expected frequency is as follows: • Production wells: Monthly (worst case) • Pipeline Servitude: Annually for inspections unless landowner raises concerns or there is an emergency (leak detected). • Booster Station: Monthly • Low Point Drains: Monthly • Pigging Stations: Six monthly (bi-annually) • Compressor Stations: Daily security inspections.
Concerns from a landowner that this project would negatively impact on his farm which is his primary investment for his future as well as his descendants. This landowner did not wish to discuss anything and wished to state that he is opposed to the project.	The landowner's objection to the project has been formally recorded in the PPR (Appendix 3) and no further comments were received during the EIA phase.
The Department of Water and Sanitation provided comments on the EIA and EMPr which focussed on the need to obtain approval under the National Water Act for any Section 21 activities.	The DWS was thanked for their comments and the necessary water use licence application has been submitted for consideration by the DWS.
The landowner of the farm Blaauwdrift 188 (Portion 3) shared a township registration dated 12 October 1956 which covers this farm portion and the landowner indicated that he was in the process of negotiating the sale of his farm along with the township rights and therefore the landowner is objecting to the drilling of wells on this farm portion.	It is recommended that Tetra4 refrains from drilling any Cluster 2 wells on this property until such time as the legal status of the township and rights of the landowner are adequately addressed. A condition of authorisation has been recommended to this effect (refer to Section 13.4) and this restrictive condition has been included in the EMPr (Sections 5.3.1 and 5.3.2 of the EMPr).
Concern from the landowner and Managing Director of a commercial agricultural operation (Optavit Boerdery) that the application does not contain specific location, extent and/or routing detail of project infrastructure on each property. This concern is elaborated upon in a written submission and the overall conclusion by the landowner is that the application is premature without including such	All comments were responded to individually and are included in the PPR (Appendix 3 of this EIA report).

Comment Summary	How comment was addressed
detailed information and should only be undertaken once this information is available.	
African Carbon Energy (Pty) Ltd submitted various comments during the public meeting, landowner meeting and a written submission.	All comments were responded to individually and are included in the PPR (Appendix 3 of this EIA report).

1.7 IMPACT STATEMENT

The findings of the specialist studies (including the relevant updated specialist studies) conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Based on the nature and extent of the proposed project, the limited level of disturbance predicted as a result of the production activities, the findings of the specialist studies, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team and the EAP that the significance levels of the identified negative impacts can generally be reduced to an acceptable level by implementing the recommended mitigation measures and the project should be authorized and that compliance with the EMPr must be strictly adhered to.

2 INTRODUCTION

In 2022, Tetra4 (the applicant) commenced with an application for Environmental Authorisation for the Cluster 2 gas production activities which would form an extension to the existing Cluster 1 gas production being undertaken near Virginia in the Free State Province. The application followed a full Scoping and Environmental Impact Assessment process which culminated in a positive Environmental Authorisation being issued (Appendix 12). The timelines and related aspects of the application process are detailed below.

As indicated above, appeals were subsequently lodged against the decision which included new information that was not submitted during the previous EIA phase public consultation period (i.e. independent Expert Critique of certain specialist studies at the appeal phase). Refer to Appendix 13 for copies of the appeals that were submitted. Seven grounds of appeal were raised by the appellants. Based on the Ministers consideration of the grounds appeal the Minister issued an Appeal decision dated 1 August 2024 (Appendix 14). Within the Ministers Decision, 5 grounds of appeal were dismissed while 2 grounds of appeal were upheld with recommendations

that the Applicant undertake further investigations, update the EIA Report, undertake a further 30-day public review of the updated EIA Report, and submit the updated EIA Report for reconsideration to the Competent Authority (in this case the Department of Mineral Resources and Energy). This updated EIA Report has been prepared to address the recommendations and shortcomings identified in the Ministers decision and includes updates to the following:

1. Updated Climate Change Specialist Study to include the following:
    a. Address the issues raised by the Expert Critique relating to the GHG emissions calculations;
    b. Provide a more detailed analysis of the impacts of climate change on the various activities associated with the construction and operation of the project, and on the environment and affected communities; and
    c. Expand further on more recent information relating to LNG as a viable "bridging fuel" for reducing GHG emissions;
2. Consideration of climate change impacts in the delineation of the 1:100-year floodline and how the climate change predicted floodlines may impact the proposed development.
3. Updated Geohydrological (groundwater) Impact Specialist Study following additional baseline aquifer characterisation, detail on deep confined aquifer and associated water quality, discussions on the gas well stratigraphy, construction methods and associated hydrogeology impacts and potential source terms of the proposed activities is clearly defined.

Tetra4 (Pty) Ltd holds a Gas Production Right (Ref: 12/4/1/07/2/2) that was granted in 2012 which spans approximately 187 000 hectares for the development of natural gas production operations around the town of Virginia in the Free State Province. Within the approval of the Production Right, the 2010 Environmental Management Programme (EMPr) was approved and was applicable to a large portion of the Production Right area.

On 21 September 2017, the Department of Mineral Resources and Energy (DMRE) issued an integrated environmental authorisation ("Cluster 1 EA" – reference number 12/04/07) to Tetra4 in terms of the National Environmental Management Act (Act 107 of 1998 – NEMA). The Cluster 1 EA (amended on 26 August 2019 and 1 September 2020) authorises the development of "Cluster 1" of the Project. In this EA approval, various new production wells and pipelines, booster and compressor stations, a Helium and LNG Facility and associated infrastructure was approved which comprises the first gas field for development within the approved Production Right area. The Cluster 1 EA also authorises certain waste management activities as per the List of Waste Management Activities (Government Notice 921, as amended) published under the National Environmental Management: Waste Act 59 of 2008 (NEMWA).

Furthermore, the following licences have been issued to Tetra4 in respect of Cluster 1 of the Project:

- Atmospheric Emission Licence (AEL) dated 15 July 2022 (reference: LDM/AEL/YMK/014) for the Storage and Handling of Petroleum Products [Category 2: Subcategory 2.4 of the Listed Activities (Government Notice 893, as amended) published under the National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA)] by the Lejweleputswa District Municipality; and
- Water Use Licence (WUL) dated 22 January 2019 (reference: 08/C42K/CI/8861) for the construction of pipelines for the Project in terms of section 21(c&i) water uses of the National Water Act 36 of 1998 (NWA) by the Department of Water and Sanitation (DWS).

Following the successful commencement of Cluster 1 (which is now operational in 2022), Tetra4 aim to expand the natural gas operations, to be located within the approved production right area and around the Cluster 1 project, to be designated as 'Cluster 2'. This Cluster 2 application area covers a total of ~27 500 hectares which overlaps with a large part of the Cluster 1 area. This planned expansion to the existing approved production activities will involve up to 300 new production wells, ~480km of gas transmission pipelines and associated infrastructure, 3 compressor stations, and an additional new combined Liquid Natural Gas (LNG) and Liquid Helium (LHe) plant ("LNG/LHe Plant") and associated infrastructure as part of the "Cluster 2" expansion of the

Project in order to meet the future production requirements. This EIA Report is prepared as part of an integrated environmental authorisation and waste management licence for the Cluster 2 development.

The proposed development infrastructure triggers various listed activities in terms of the NEMA Listing Notices 1, 2 and 3 as well as the National Environmental Management Waste Act (Act 59 of 2008 – NEMWA) and a full Scoping and Environmental Impact Assessment process is required. The relevant WUL and AEL applications are being submitted for the triggers under the NWA and NEMAQA respectively. The culmination of this study and application process is an amendment to the existing approved Environmental Management Programme (EMPr) to include the Cluster 2 activities and relevant updates to the impact management actions. This will provide for a single environmental management plan that covers the previously approved Production Right activities (exploration), Cluster 1 activities and now also Cluster 2 activities. An MPRDA Section 102 amendment of the EMPr will be applied for on completion of the NEMA and NEMWA integrated application process.

2.1 REPORT STRUCTURE

This report has been compiled in accordance with the 2014 NEMA EIA Regulations, as amended. An overview of the report legislative requirements for this report and the specific sections that correspond to the applicable requirements, is provided in Table 2 below. The DFFE Ministers decision and recommendations based on the appeals and where the DFFE Ministers findings are addressed in this report are presented in Table 3 below.

Table 2: Report structure in terms of Appendix 3 of the NEMA EIA Regulations

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(1)(a):	Details of – i. The EAP who prepared the report; and ii. The expertise of the EAP, including a curriculum vitae;	Section 2.2 Appendix 1
Appendix 3(1)(b):	The location of the development footprint of the activity on the approved site as contemplated in the accepted scoping report, including: i. The 21-digit Surveyor General code of each cadastral land parcel; ii. Where available, the physical address and farm name; iii. Where the required information in items (i) and (ii) is not available, the coordinates of the boundary of the property or properties;	Section 3 and 4
Appendix 3(1)(c):	A plan which locates the proposed activity or activities applied for as well as the associated structures and infrastructure at an appropriate scale, or, if it is- i. A linear activity, a description and coordinates of the corridor in which the proposed activity or activities is to be undertaken; or ii. On a land where the property has not been defined, the coordinates within which the activity is to be undertaken;	Section 4
Appendix 3(1)(d):	A description of the scope of the proposed activity, including – i. All listed and specified activities triggered and being applied for; and ii. A description of the associated structures and infrastructure related to the development;	Section 4 and 4.2

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(1)(e):	A description of the policy and legislative context within which the development is located and an explanation of how the proposed development complies with and responds to the legislation and policy context;	Section 5
Appendix 3(1)(f):	A motivation for the need and desirability for the proposed development, including the need and desirability of the activity in the context of the preferred development footprint within the approved site as contemplated in the accepted scoping report;	Section 6
Appendix 3(1)(g):	A motivation for the preferred development footprint within the approved site as contemplated in the accepted scoping report;	Section 4, 7 and 10, 13.2
Appendix 3(1)(h):	A full description of the process followed to reach the proposed development footprint within the approved site as contemplated in the accepted scoping report, including– i. Details of the development footprint alternatives considered; ii. Details of the public participation process undertaken in terms of regulation 41 of the Regulations, including copies of the supporting documents and inputs; iii. A summary of the issues raised by interested and affected parties, and an indication of the manner in which the issues were incorporated, or the reasons for not including them; iv. The environmental attributes associated with the development footprint alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; v. The impacts and risks identified including the nature, significance, consequence, extent, duration and probability of the impacts, including the degree to which these impacts – a. Can be reversed; b. May cause irreplaceable loss or resources; and c. Can be avoided, managed or mitigated; vi. The methodology used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks; vii. Positive and negative impacts that the proposed activity and alternatives will have on the environment and on the community that may be affected focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; viii. The possible mitigation measures that could be applied and level of residual risk; ix. If no alternative development footprints for the activity were investigated, the motivation for not considering such; and	Section 7, 8, 9 and 10

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	x. A concluding statement indicating the location of the preferred alternative development footprint within the approved site as contemplated in the accepted scoping report;	
Appendix 3(1)(i):	A full description of the process undertaken to identify, assess and rank the impacts the activity and associated structures and infrastructure will impose on the preferred development footprint on the approved site as contemplated in the accepted scoping report through the life of the activity, including- i. A description of all environmental issues and risks that were identified during the environmental impact assessment process; and ii. An assessment of the significance of each issue and risk and an indication of the extent to which the issue and risk could be avoided or addressed by the adoption of mitigation measures;	Section 7, 8, 9 and 10
Appendix 3(1)(j):	An assessment of each identified potentially significant impact and risk, including- i. Cumulative impacts; ii. The nature, significance and consequences of the impact and risk; iii. The extent and duration of the impact and risk; iv. The probability of the impact and risk occurring; v. The degree to which the impact and risk can be reversed; vi. The degree to which the impact and risk may cause irreplaceable loss of resources; and vii. The degree to which the impact and risk can be mitigated;	Section 10
Appendix 3(1)(k):	Where applicable, a summary of the findings and recommendations of any specialist report complying with Appendix 6 to these Regulations and an indication as to how these findings and recommendations have been included in the final assessment report	Section 13
Appendix 3(1)(l):	An environmental impact statement which contains- i. A summary of the key findings of the environmental impact assessment: ii. A map at an appropriate scale which superimposes the proposed activity and its associated structures and infrastructure on the environmental sensitivities of the preferred development footprint on the approved site as contemplated in the accepted scoping report indicating any areas that should be avoided, including buffers; and	Section 13.3

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	iii. A summary of the positive and negative impacts and risks of the proposed activity and identified alternatives.	
Appendix 3(1)(m):	Based on the assessment, and where applicable, recommendations from specialist reports, the recording of proposed impact management outcomes for the development for inclusion in the EMPr as well as for inclusion as conditions of authorisation;	Section 13.4
Appendix 3(1)(n):	The final proposed alternatives which respond to the impact management measures, avoidance, and mitigation measures identified through the assessment;	Section 13.2
Appendix 3(1)(o):	Any aspects which were conditional to the findings of the assessment either by the EAP or specialist which are to be included as conditions of authorisation;	Section 13
Appendix 3(1)(p):	A description of any assumptions, uncertainties and gaps in knowledge which relate to the assessment and mitigation measures proposed;	Section 14
Appendix 3(1)(q):	A reasoned opinion as to whether the proposed activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation;	Section 13
Appendix 3(1)(r):	Where the proposed activity does not include operational aspects, the period for which the environmental authorisation is required and the date on which the activity will be concluded and the post construction monitoring requirements finalised;	N/A *(Operational phase is anticipated to be 20 years)*
Appendix 3(1)(s)	An undertaking under oath or affirmation by the EAP in relation to- i. The correctness of the information provided in the reports; ii. The inclusion of comments and inputs from stakeholders and I&APs; iii. The inclusion of inputs and recommendations from the specialist reports where relevant; and iv. Any information provided by the EAP to interested and affected parties and any responses by the EAP to comments or inputs made by interested or affected parties;	Section 15 Section 16
Appendix 3(1)(t):	*[Para. (t) substituted by GN 326/2017 and deleted by GN 517/2021]*	N/A

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(1)(u):	An indication of any deviation from the approved scoping report, including the plan of study, including- i. Any deviation from the methodology used in determining the significance of potential environmental impacts and risks; and ii. A motivation for the deviation;	N/A - No deviations from the approved Scoping Report.
Appendix 3(1)(v):	Any specific information that may be required by the competent authority; and	In terms of the Scoping Report approval letter from DMRE: 1. Financial provision to be determined according to the Regulations Pertaining to Financial Provisions for Prospecting, Exploration, Mining or Production Operations (2015); and 2. The Provincial Department of Environmental Affairs must be included in the Public Participation process to solicit comment. The Financial Provision Report is included in Appendix 6 and the Provincial Department of Environmental Affairs is included in the public participation process to solicit comment.
Appendix 3(1)(w):	Any other matters required in terms of section 24(4)(a) and (b) of the Act.	N/A – no further matters to those already listed above and included in this report.

Table 3: DFFE Ministers decision on the appeal and where the Ministers findings are addressed in this report.

Ministers Decision on Appeal	Section in this Report
3.2.2.1 The CCA should be expanded upon in order to include the following: • Specifically address the issues raised by the Expert Critique relating to the GHG emissions calculations; • Provide a more detailed analysis of the impacts of climate change on the various activities associated with the construction and operation of the project, and on the environment and affected communities; and • Expand further on more recent information relating to LNG as a viable "bridging fuel" for reducing GHG emissions.	Section 6.2.3, Section 9.14.1 to Section 9.14.4.6 and Section 9.14.9.2
3.2.2.2 Consideration to climate change and the impacts on river hydrology be considered before the application is processed, specifically in areas prone to flooding, and flood damage and where site infrastructure will be developed.	Section 9.8
3.2.2.3 The potential hydrogeological impacts (source terms) of the applicant's activities is not clearly defined (i.e. will the PCDs be lined, what will the water quality be, and where does the water come from). How source terms were applied in the numerical model is also not well understood. Details of the construction of the gas wells regarding possible leakage of deep groundwater into the shallow aquifer are not addressed. Details of the stratigraphy and hydrogeology of the gas wells are required, as well as the deep confined aquifer and the associated water quality. The presence of gas indicates that the deeper aquifers are confined and there are no details of piezometric pressures and water quality. This data must be available from the gas resource evaluation.	Section 9.9 and Section 9.10
3.2.3 The revised EIAr and EMPr must be subject to a PPP to allow registered I&APs an opportunity to review and comment thereon as required by the 2014 EIA Regulations. Comments received from I&APs, as well as responses thereto by the applicant, must be incorporated into the final EIAr for submission to the DMRE for reconsideration of the EA application. In this regard, the timeframes prescribed by the 2014 EIA Regulations, in respect of PPP and decision-making must be adhered to.	This revised EIA Report and EMPr will be subject to public participation and thereafter submitted to the Competent Authority for reconsideration.

2.2 DETAILS OF THE EAP

EIMS is appointed by Tetra4 to assist in preparing and submitting the integrated EA and WML application, Scoping and EIA Reports, and undertaking a Public Participation Process (PPP) in support of the proposed Cluster 2 Gas Production EA Application. EIMS is a private and independent environmental management-consulting firm that was founded in 1993. EIMS has in excess of 28 years' experience in conducting EIA's, including EIA's relating to gas exploration and production operations.

In terms of Regulation 13 of the EIA Regulations (GNR 982) as amended, an independent EAP, must be appointed by the applicant to manage the application. EIMS and the compiler of this report are compliant with the definition of an EAP as defined in Regulations 1 and 13 of the EIA Regulations, as well as Section 1 of the NEMA. This includes, inter alia, the requirement that EIMS is:

- Objective and independent;
- Has expertise in conducting EIA's;
- Comply with the NEMA, the environmental regulations and all other applicable legislation;
- Considers all relevant factors relating to the application; and
- Provides full disclosure to the applicant and the relevant environmental authority.

The details of the EIMS consultant (EAP) who compiled this Report are as follows:

Table 4: EAP Details.

Name	**Brian Whitfield**
Tel No:	+27 11 789 7170
Fax No:	+27 86 571 9047
E-mail:	Tetracluster2@eims.co.za
Professional Registrations:	• Professional Natural Scientist with the South African Council for Natural Scientific Professions - SACNASP (400447/13). • Registered EAP with the Environmental Assessment Practitioners Association of South Africa - EAPASA (2022/4496).

Brian is a Principal Consultant at EIMS and has over 21 years of experience in environmental consulting. He holds a BSc (Botany and Zoology) and a BSc Honours degree in Botany from the University of the Witwatersrand. Brian's broad range of experience includes managing and/or undertaking projects in various sectors, including Energy, Mining, Oil & Gas, Water and Infrastructure. He is conversant with the South African environmental legislation as well as sustainability auditing, including Equator Principles, IFC Performance Standards and World Bank EHS guidelines. Brian's other experience includes Site Assessments, Water-use licensing, Environmental Monitoring and Auditing, Due Diligence Assessments, Competent Persons Reporting, Environmental Management Plans and Strategic Environmental Assessments. The Curriculum Vitae of the EAP included in Appendix 1.

2.3 SPECIALISTS

As part of this EIA application, several specialist studies have been commissioned to investigate key impacts that require further investigation. A list of the specialist studies is included in Table 5.

Table 5: List of specialist studies to inform this EIA application.

Specialist Discipline	Company/Organisation
Agriculture and Hydropedology	The Biodiversity Company
Air Quality & Health Risk & GHG/Climate Change	Airshed Planning Professionals
Economic	Strategy4Good
Financial Provision update	MineLock Environmental Engineers
Geohydrology	Gradient Groundwater Consulting
Heritage and Palaeontology	PGS Heritage
Hydrology	SMEC South Africa
Noise	Airshed Planning Professionals
Social	Equispectives Research and Consulting Services
Terrestrial Biodiversity	The Biodiversity Company
Visual	Environmental Planning and Design
Wetland and Aquatic	The Biodiversity Company

The specialist studies involved the gathering of data relevant to identifying and assessing environmental impacts that may occur as a result of the proposed project. These impacts were assessed according to pre-defined impact rating methodology detailed in Section 10.1. Mitigation / management measures to minimise potential negative impacts or enhance potential benefits are put forward in this EIA Report and have considered the public input and specialist final considerations of all available information to date. The specialist reports are included in Appendix 4.

3 DESCRIPTION OF THE PROPERTY

Details of the application area, the location as well as the properties are included in Table 6 below.

Table 6: Locality details.

<table>
<tr><td>Farm Names</td><td>The application area covers a number of farm portions and whilst not all portions of parent farms are necessarily included in this application a summary of the parent farm names is presented below for ease of reference:
Adamsons Vley No. 655, Annex Glen Ross No. 562, Annex Grusde No. 474, Annex Mooivlakte No. 208, Blaauwdrift No. 188, Bloemhoek No. 509, Boschluis Spruit No. 278, Braklaagte No. 41, Brakspruit No. 121, Bruintjies Hoogte No. 367, Bryan No. 561, Cabriere No. 215, Carlo No. 596, Damplaats No. 341, Dankbaarheid No. 16, De Klerks Kraal No. 231, Die Mond No. 479, Digito No. 642, Doorn River No. 330, Doorndeel No. 236, Enkeldoorn No. 360, Frisgewaag No. 550, Glen Ross No. 734, Grusde No. 229, Hakkies No. 695, Hakkies No. 742, Harmonie No. 579, Helpmekaar No. 47, Jonkers Rust No. 72, Jordaan No. 1, Jordaans Rust No. 59, Kaalpan No. 65, Kalkoenkrans No. 225, Klein Palmiet Kuil No. 407, Klein Pan No. 320, Kleinbegin No. 134, Kovno No. 235, Langlaagte No. 110, Leeuwaarden No. 171, Leeuwbult No. 52, Leeuwbult No. 580, Lekkerlewe No. 643, Middelplaas No. 583, Mond Van Doornrivier No. 38, Mooifontein No. 639, Mooivlakte No. 199, Mooivlei No. 357, Nortier No. 361, Palmietkuil No. 548, Palmietkuil No. 328, Paulina No. 470, Richelieu No. 135, Rondehoek No. 200, Siberia No. 464, Spoorleggerswoning 54 No. 167, Stille Woning No. 703, Terra Blanda No. 155, Toulon No. 368, Vaalbank No. 190, Vlakpan No. 358, Welgelegen No. 382, Weltevrede No. 638, Weltevreden No. 443, Zoetendal No. 243, Zonderzorg No. 342, Zonderzorg No. 640</td></tr>
<tr><td>Application Area (Ha)</td><td>The Cluster 2 application area covers a total of ~27 500 hectares.</td></tr>
<tr><td>Magisterial District</td><td>The proposed project falls within the Masilonyana and Matjhabeng Local Municipalities, in the Lejweleputswa District Municipality, Free State Province.</td></tr>
<tr><td>Distance and direction from nearest towns</td><td>The site boundary is ~5km south west of the town of Virginia, ~9km south the town of Welkom and ~16km north of the town of Theunissen. The geographic coordinates at the approximate centre of the application area are 28°10'20.47"S and 26°43'50.79"E.</td></tr>
<tr><td>Farm Name, Number and Portion as well as 21-digit Surveyor General Code</td><td>
<table>
<tr><th>Farm Name, Number and Portion</th><th>21 Digit Surveyor General Code</th></tr>
<tr><td>Adamsons Vley 655 (Portion 0)</td><td>F03500000000065500000</td></tr>
<tr><td>Adamsons Vley 655 (Portion 1)</td><td>F03500000000065500001</td></tr>
<tr><td>Adamsons Vley 655 (Portion 2)</td><td>F03500000000065500002</td></tr>
<tr><td>Annex 3 No 478 (Portion 0)</td><td>F03300000000047800000</td></tr>
<tr><td>Annex Glen Ross 562 (Portion 0)</td><td>F03300000000056200000</td></tr>
<tr><td>Annex Glen Ross 562 (Portion 1)</td><td>F03300000000056200001</td></tr>
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Annex Glen Ross 562 (Portion 7)	F03300000000056200007
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Richelieu 135 (Portion 0)	F03300000000013500000
Rondehoek 200 (Portion 0)	F03300000000020000000
Rondehoek 200 (Portion 1)	F03300000000020000001
Rondehoek 200 (Portion 3)	F03300000000020000003
School Site No 178 (Portion 0)	F03300000000017800000
Semper Idem No 588 (Portion 0)	F03300000000058800000
Spoorleggerswoning 167 (Portion 0)	F03300000000016700000
Stille Woning 703 (Portion 0)	F03500000000070300000
Teacher's Residence No 286 (Portion 0)	F03300000000028600000
Terra Blanda 155 (Portion 0)	F03300000000015500000
The Prairie No 93 (Portion 1)	F03900000000009300001
The Prairie No 93 (Portion 2)	F03900000000009300002
Toulon 368 (Portion 0)	F03300000000036800000
Vaalbank 190 (Portion 1)	F03300000000019000001
Vermeulenskraal No 223 (Portion 2)	F03500000000022300002
Vermeulenskraal No 223 (Portion 6)	F03500000000022300006
Vermeulenskraal No 223 (Portion 9)	F03500000000022300009
Vierhoek No 630 (Portion 0)	F03300000000063000000
Vlakpan 358 (Portion 0)	F03300000000035800000
Vlakpan 358 (Portion 1)	F03300000000035800001
Vlakpan 358 (Portion 2)	F03300000000035800002
Vlakpan 358 (Portion 3)	F03300000000035800003
Walkersvlei No 133 (Portion 0)	F03900000000013300000
Welgelegen 382 (Portion 0)	F03300000000038200000
Welgelegen 382 (Portion 10)	F03300000000038200010
Welgelegen 382 (Portion 11)	F03300000000038200011
Welgelegen 382 (Portion 20)	F03300000000038200020
Welgelegen 382 (Portion 21)	F03300000000038200021
Welgelegen 382 (Portion 26)	F03300000000038200026
Welgelegen 382 (Portion 28)	F03300000000038200028
Welgelegen 382 (Portion 5)	F03300000000038200005
Welgelegen 534 (Portion 2)	F03300000000053400002
Weltevrede 638 (Portion 0)	F03300000000063800000
Weltevreden 443 (Portion 14)	F03300000000044300014
Weltevreden 443 (Portion 2)	F03300000000044300002
Weltevreden 443 (Portion 3)	F03300000000044300003
Weltevreden 443 (Portion 4)	F03300000000044300004
Weltevreden 443 (Portion 5)	F03300000000044300005
Weltevreden 443 (Portion 6)	F03300000000044300006
Weltevreden 443 (Portion 9)	F03300000000044300009
Werda No 587 (Portion 0)	F03300000000058700000
Wolvepan No 85 (Portion 7)	F03900000000008500007
Wolvepan No 85 (Portion 9)	F03900000000008500009
Yatala No 73 (Portion 0)	F03500000000007300000
Zoetendal 243 (Portion 0)	F03300000000024300000
Zoetendal 243 (Portion 1)	F03300000000024300001

	Zonderzorg 342 (Portion 0)	F03300000000034200000
	Zonderzorg 640 (Portion 0)	F03300000000064000000

The farms and portions included within the application area are depicted in Figure 1 to Figure 4 overleaf.

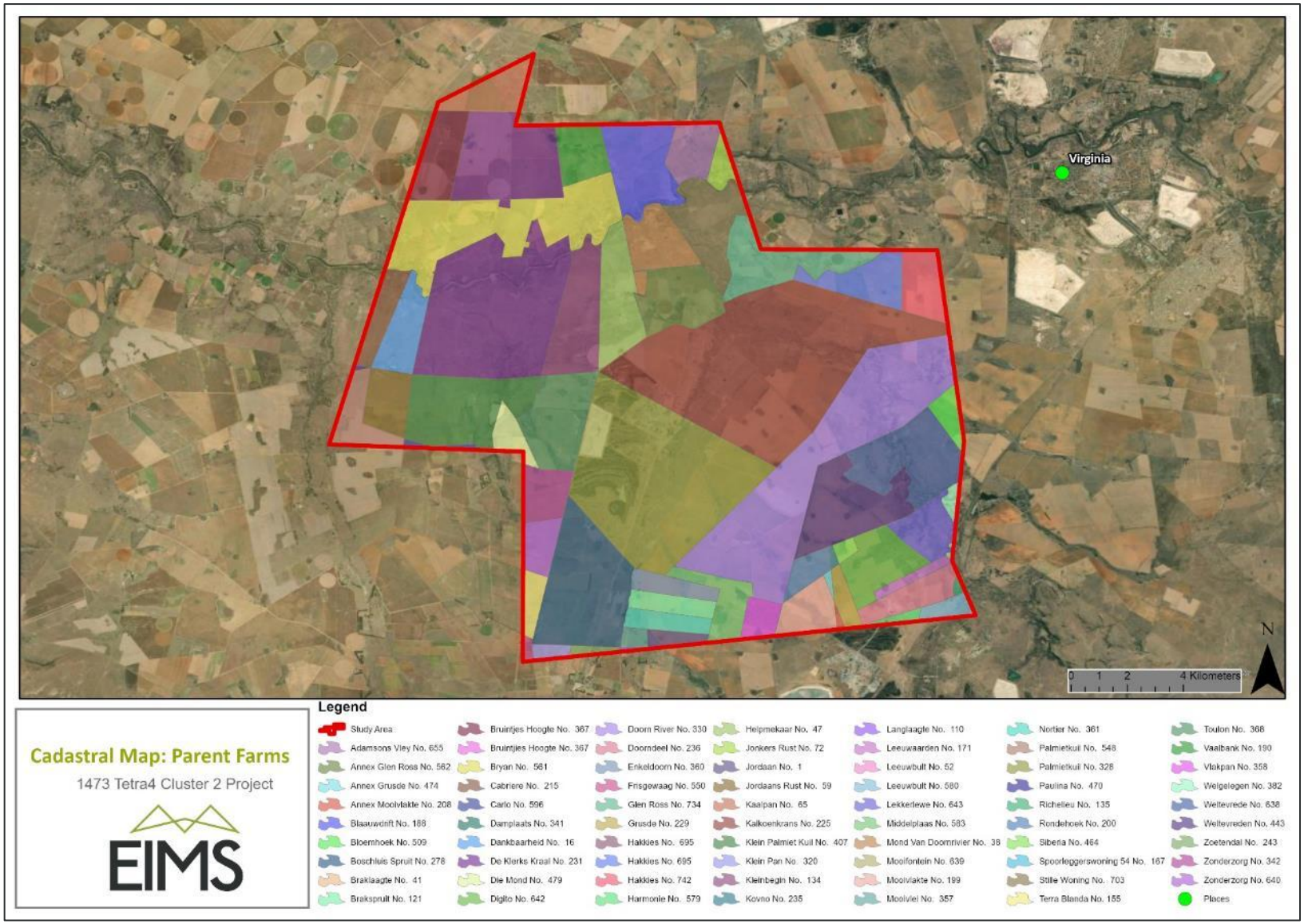


Figure 1: Parent farms included in the application area.

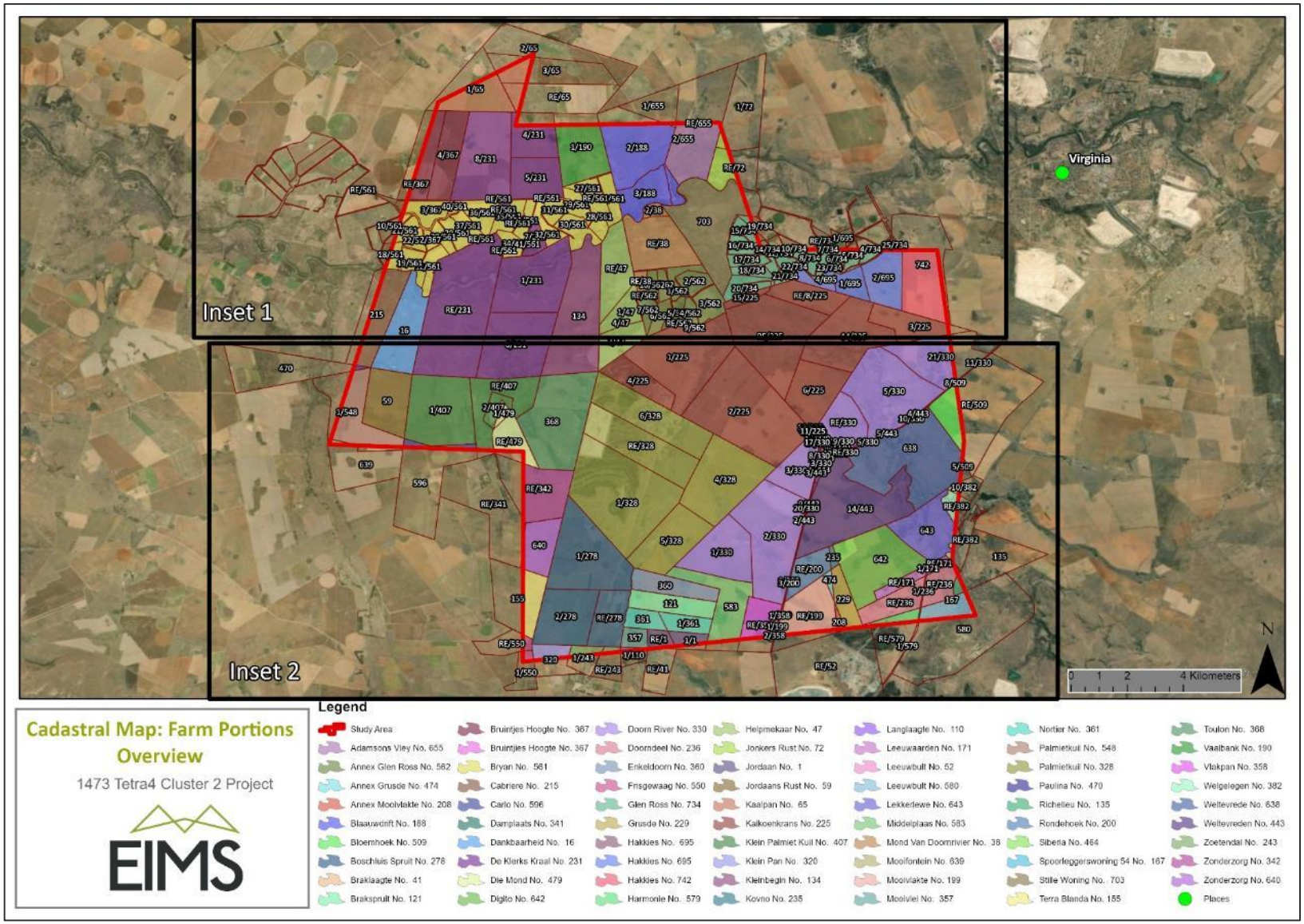


Figure 2: Overview of parent farms and portions included in the application area.

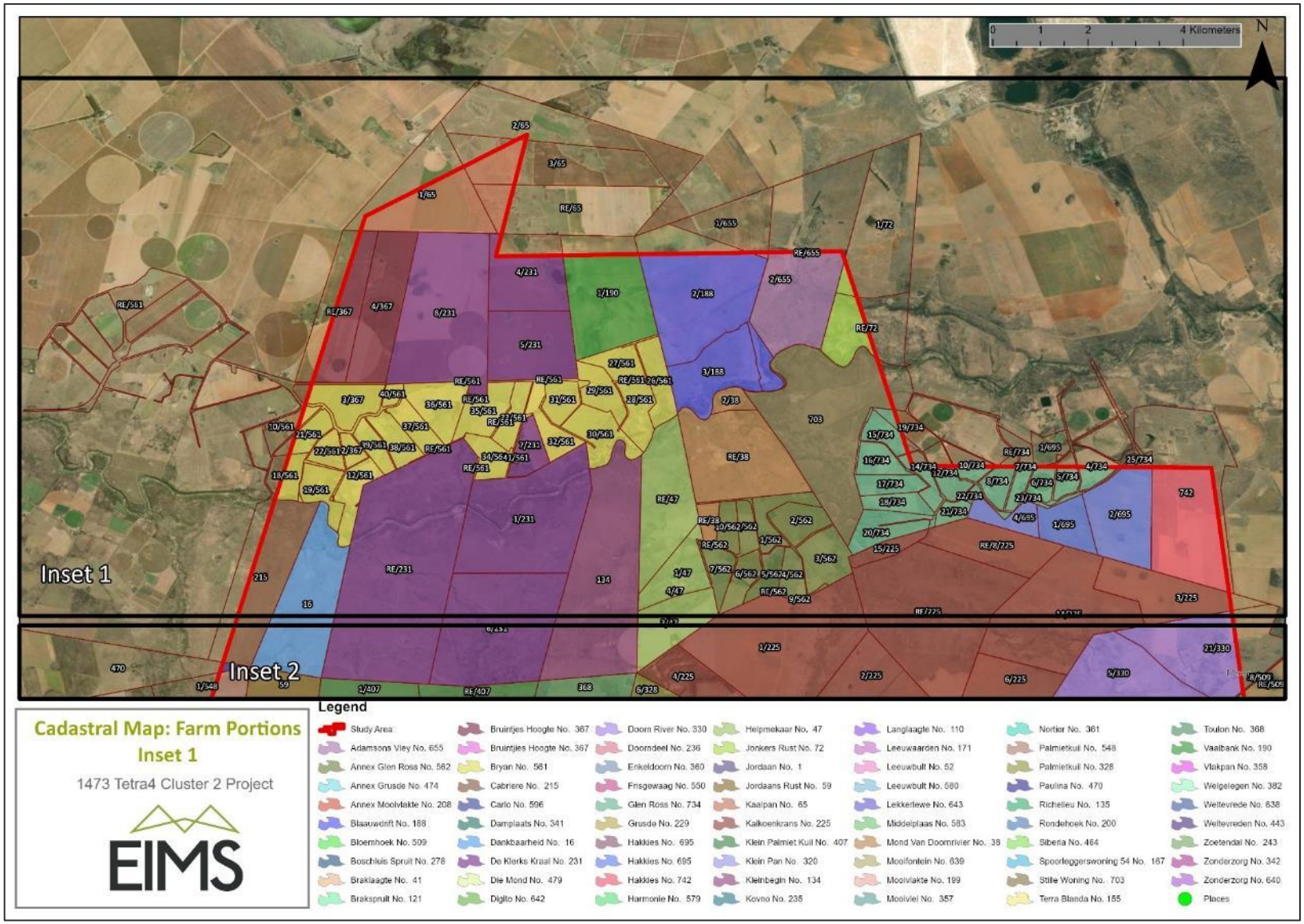


Figure 3: Inset 1 map of parent farms and portions included in the application area.

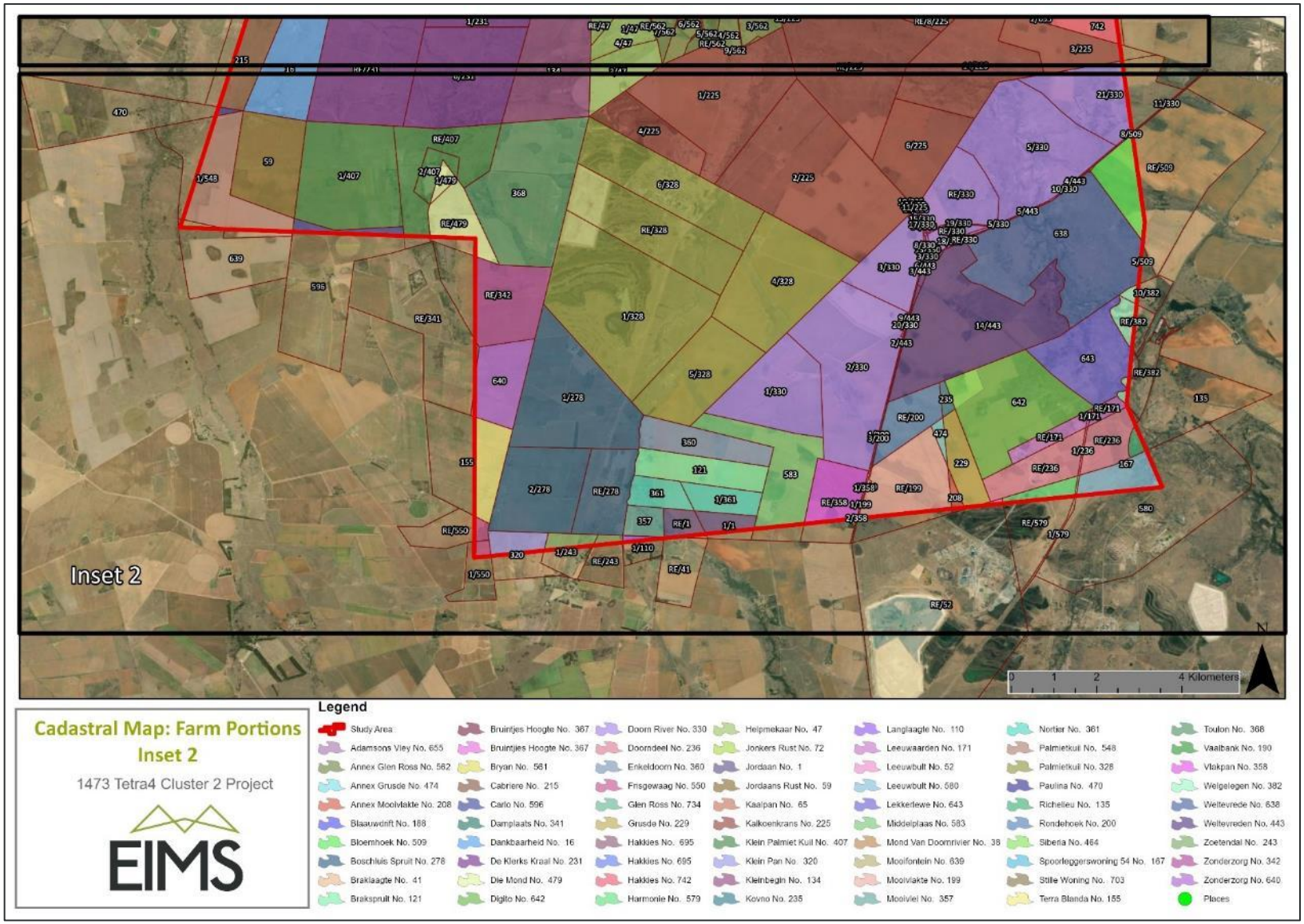


Figure 4: Inset 2 map of parent farms and portions included in the application area.

4 DESCRIPTION AND SCOPE OF THE PROPOSED ACTIVITY

This section contains a detailed description of the proposed Cluster 2 Gas Production Project with its associated infrastructure. At the end of this section, the applicable listed activities relating to the project are presented.

4.1 PROJECT DESCRIPTION

This section provides a description of the proposed Tetra4 Cluster 2 gas production activities which is aimed at facilitating the readers understanding of the proposed project related activities, their spatial and temporal extent and contextualise the resultant impacts, where relevant.

4.1.1 PROPOSED CLUSTER 2 PROJECT

Tetra4 wish to expand the natural gas (LNG/LHe) production operations, to be located within the approved production right area and around the Cluster 1 project (Figure 5). It is important to note that Figure 5 shows the full extent of the 2010 Production Right area (blue outline) while the 2011 accompanying EMPr to the Production Right was prepared based on a detailed assessment of the reduced area (green outline). The 2011 approved EMPr allows for exploration activities within the area of assessment (green outline). Cluster 1 and Cluster 2 both fall within the Production Right boundary as well as the area assessed in preparation of the Production Right EMPr.

The Cluster 2 application area covers a total of ~27 500 hectares. This planned expansion to the existing approved production activities will involve:

- Up to 300 new production wells;
- Gas transmission pipelines and associated infrastructure (such as booster stations, low point drains, pigging stations, etc.);
- 3 compressor stations; and
- An additional new combined Liquid Natural Gas (LNG) and Liquid Helium (LHe) plant (“LNG/LHe Plant”) and associated infrastructure.

It is not possible at this time to identify specific locations of the production wells due to the nature of the exploration phase. During the exploration drilling campaign, gas composition, geology etc is assessed at each exploration well and this data is continually reassessed (modelled) to guide the future exploration campaign (i.e. location of future exploration wells). Only when viable gas reserves are found at a particular exploration well, can the exploration wells be converted into production wells and thereafter, the exact placement of pipelines and associated infrastructure can be determined. It is for this reason that 600m wide well transects have been identified along the targeted geological fractures, fissures and/or faults where gas is more likely to be encountered. Similarly, 300m wide pipeline transects have also been identified to connect the various well transects to the LNG/LHe plant area. These 600m and 300m wide transects will allow for detailed assessments of any sensitivities therein so that deviations to the proposed wells and pipelines can be made. The Cluster 2 study area and associated transects within which infrastructure will be positioned are presented in Figure 6.

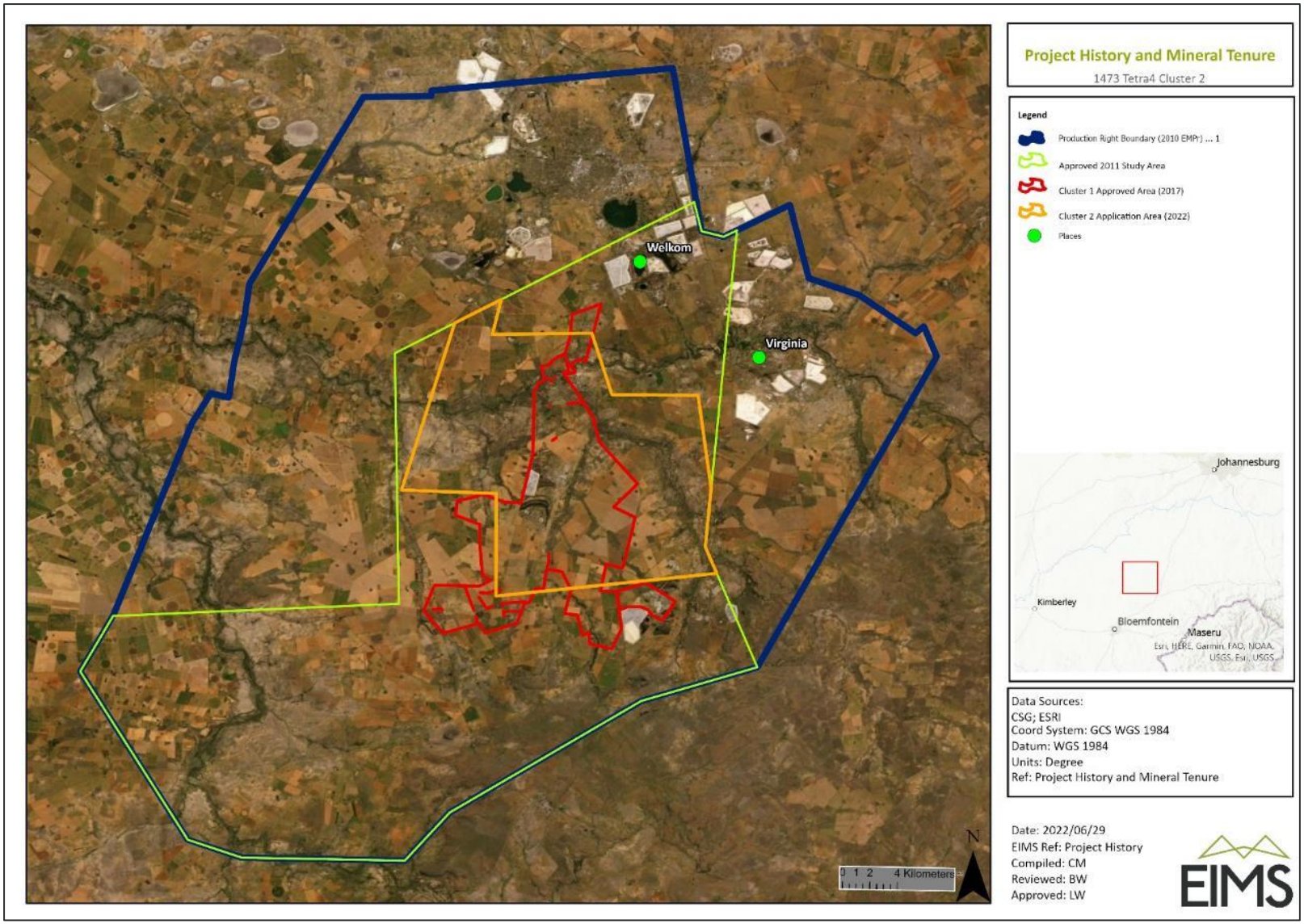


Figure 5: Project history and mineral tenure.

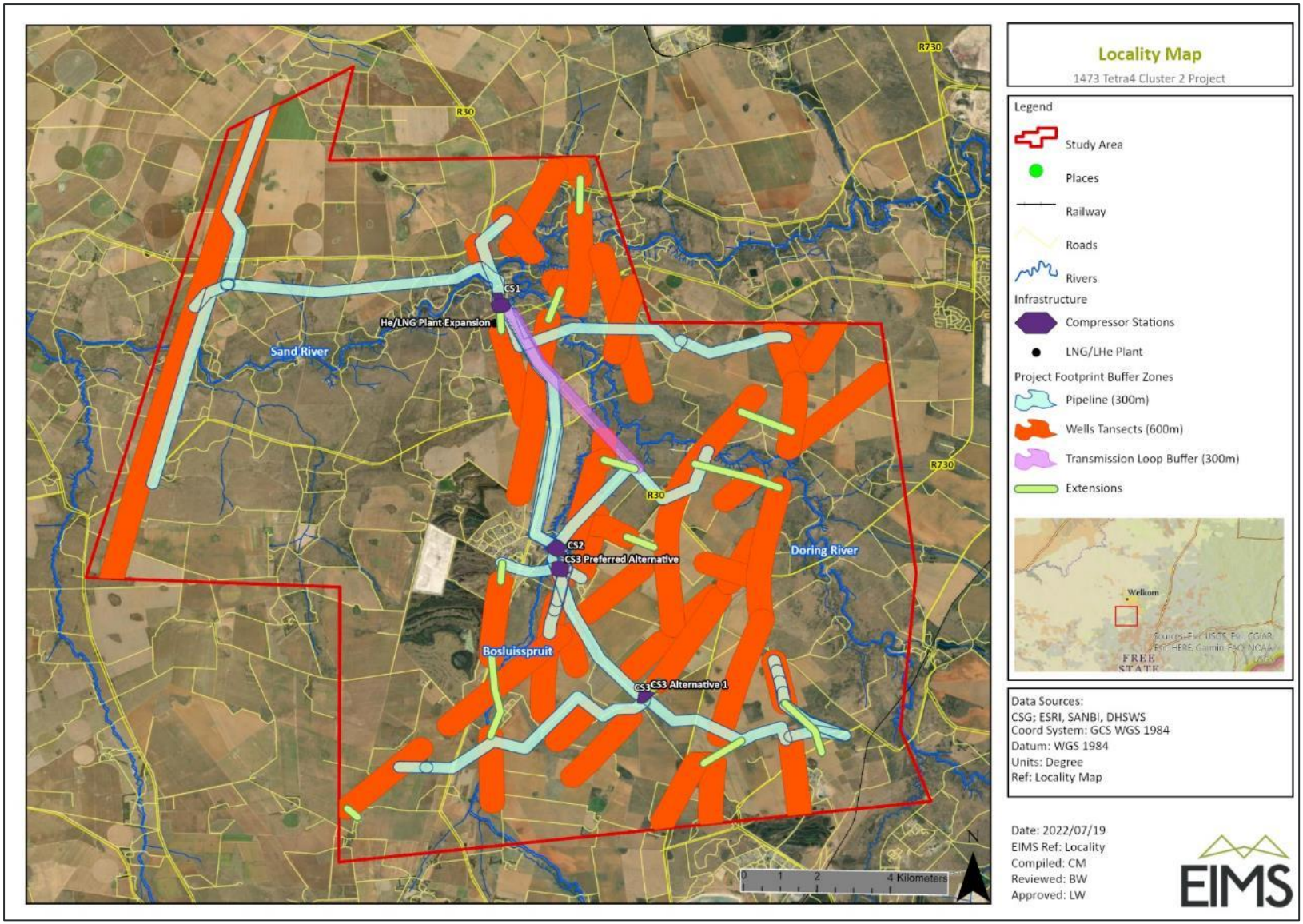


Figure 6: Cluster 2 study area and proposed infrastructure footprint transects.

4.1.2 THE GAS RESOURCE

The Tetra4 Production Right is located within the Sand River Play or Virginia Gas Field. Despite not being clearly defined, the field is composed predominantly of Karoo, Ventersdorp and Witwatersrand Supergroup lithologies complete with younger dolerite intrusions. Major fault systems associated with closely spaced zones of fractures and joints provide for preferential pathways for a combination of abiogenic and biogenic gas to reach the surface.

As such, the resulting gas at the surface is a direct emission from the major fault or from minor secondary faults linked to a major fault. In this regard, it is thought that the primary source of gas originates from the Witwatersrand Supergroup or shallower Karoo. The gas is presumed to be a mix of both abiogenic gas from the mantle, and biogenic gas originating from ancient fissure waters, coal beds of the Ecca Group of the Karoo Supergroup as well as ancient algal mats within the shallow marine/lacustrine Witwatersrand Supergroup deposits.

Once the gas target areas are intersected, the feed gas will flow passively out of the wells at a low pressure of ~0.4 barg[1] (gauge pressure) and with a temperature in the range between 10 º and 30 ºC. The feed gas will be compressed upstream of the helium process units by 3 inline compressor stations (designated as 'CS' in the maps in this report) which will be located at strategic points along the gas pipeline routes as shown in Figure 6. A gas pre-treatment will remove condensate (water) as well as traces of sulfur, mercury and C3+ gas components (e.g. propanes, butanes, pentanes) which could cause possible damage to the downstream process equipment. The hydrogen sulphide and CO_2 are washed out in the amine process. The process causes these acid gases to be absorbed in the amine solution. The amine solution then goes through a regenerator to produce a lean amine mixture and an associated waste stream which is flared and is of a minimal volume owing to the fact that the gas is very sweet in general and not sour. Mercury removal is also a precaution and happens in the process to protect downstream equipment. The mercury removal is a regenerative adsorption process which will require specialist waste removal offsite once the beds become saturated and the waste will be disposed of at a suitably registered waste disposal facility. The gas extraction and processing are discussed further in Section 4.1.3 below.

4.1.3 GAS PRODUCTION METHOD

Gas production encompasses the exploration drilling for viable gas resources with specific focus on existing geological fractures followed by the extraction of gas through production wells. From the production wells, a gas gathering network of pipes, booster stations, metering stations, pigging stations and compressor stations transports the gas to the LNG/LHe Plant where gas processing, storage and distribution is undertaken.

Gas production is accomplished by extracting gas occurring in fractures, fissures and/or faults within the Ventersdorp and Witwatersrand supergroups located at depths of between approximately 380 to 880 meters (m). Construction of the gas gathering pipelines for Cluster 1 is completed and the LNG/LHe processing facility was recently commissioned and going operational now. Cluster 1 is therefore well on the way to producing up to 50 tons of LNG and 375 kg of LHe per day. Cluster 2 of the project aims to expand upon Cluster 1 production by increasing natural gas production. This is achieved through the expansion of the gas gathering infrastructure and the production capacities. The project consists of two components namely, (1) gas gathering and (2) the LNG/LHe processing plant. The targeted total feed gas flow from Cluster 2 production wells is estimated at ~45 million-standard cubic feet per day (MMSCFD) by 2026 and the aim is to produce gas at this volume for up to 20 years.

The gas is to be collected from a group of wells located in the well transects shown in Figure 6 and transported to a single feed point whereafter it is piped to the processing plant (LNG/LHe plant). Each group of ~10-12 gas production wells will feed into a common booster station. From the ~28 booster stations the gas will be fed into a gas transmission pipeline (trunkline) towards a compressor station. The compressor stations' outlets will then be combined through a trunkline into the single tie-in feed point within the proximity of the Plant.

[1] Barg: a unit of gauge pressure, i.e. pressure in bars above ambient or atmospheric pressure.

The Cluster 2 project entails a total of ~ 300 production wells which, when combined, will produce a total of ~45 MMSCFD[2]. The wells will be located within the identified zones with the number of wells informed by the total gas requirements and expected well gas capacity. The current plan is to drill vertical or incline wells ~300m apart along the fault lines and within the identified and assessed well transect areas.

The Cluster 2 gas field will have 3 x ~15MMSCFD zones each with one compressor station. Approximately 10-12 production wells will be grouped and will be routed to a common booster station and thereafter feed to a compressor station. Power to the booster stations will be provided from nearby existing Eskom power sources or alternatively a gas engine. Should Eskom power be used, the design of the powerlines or connections would be according to Eskom specific standards and dependent on the voltage requirements, locations, etc.

The gas gathering network will comprise primarily of HDPE pipelines buried at least 1.5 m below plough level (or adjusted in consultation with landowners) in order to ensure minimal disruption to existing agricultural activities. Sensitive environmental features, land-uses and infrastructure will be avoided as far as practically possible. However, it is practically impossible to avoid all sensitive features (including tar road crossings and river crossings). In the case where the pipeline will cross dirt roads an open cut trench technique will be used with suitable reinstatement of the road thereafter. To ensure that the integrity of tar roads is not compromised, horizontal directional drilling (HDD) will be used to lay the pipe underneath the road. Similarly, HDD will be used for perennial river crossings to lay the pipeline approximately 6m underneath the riverbeds. Non-perennial stream crossings will utilise opencut methodology during the dry season with suitable reinstatement and rehabilitation of the river bed.

4.1.3.1 EXPLORATION DRILLING

DRILLING TIMEFRAMES:

- **Physical drilling process = ~3 to 4 months**
- **Flow volumes and gas composition tests = ~7 – 14 days after drilling**

Exploration wells will be drilled and, if successful, converted into production wells. As the exact location of exploration well drilling cannot be identified at this stage, this study has followed the approach of assessing well corridors (600 m wide or 300 m on either side of known target fractures, fissures and/or faults). Exploration drilling entails the use of a truck, trailer or skid mounted drill rig to drill to varying depths (~380 m to ~880 m) along known fault lines to strike the gas reserve. Although uncommon, blowout or blowback of water and/or gas is prevented using a blowout diverter which is installed in the drill line (on surface) and the blowout diverter valves safely redirect any water and/or gas to a discharge line for safe disposal. In addition, firefighting equipment and personnel are present during the drilling operation.

Drill rigs typically require temporary clearance or disturbance of an area of 50 m x 50 m in order to set up the rig and begin drilling activities. All exploration boreholes must be drilled and cased in accordance with applicable international standards and best practice guidelines[3], and will be sealed with a combination of casing and grouting to ensure vertical isolation of the gas and/or any deep saline water from both the surrounding geology and freshwater hydrological regime. In addition to the drill rig, lined sumps will be required to store and recirculate water for the drilling process. A maximum of 6000 litres of water per day per well is required for drilling purposes and will be sourced from the municipality and not from the surrounding environment.

The proposed gas-producing wells will be drilled using percussions methods and prior to drilling, the gas well construction methodology is submitted to the Regulator (PASA) for review and approval before drilling commences. The initial well diameter will be 10 – 12" to a depth of 70m, as illustrated in Figure 7. A 9 – 10" wellbore casing (conductor casing) will be installed in this section of the well to stabilise the unconsolidated Aeolian sands. The diameter of the well will be decreased to 7 – 8" at depths of 300 - 450m in the Karoo Formation sediments. The depth of this diameter casing will be determined by the depth of the contact between the Karoo and Ventersdorp or Witwatersrand Supergroups. A 6" casing will be installed in this section of the

[2] To contextualize this volume of gas, if all of the ~45 MMSCFD gas was converted to electricity in the highest efficiency generator station, it would produce about 270 MW.

[3] Internationally accepted best practice should be applied and reference should be made to the relevant British Oil and Gas and/or the API guidelines and standards.

well. The annulus between the well and the casing will be sealed with cement to the depth of this contact. The well will be continued to a depth of 500 – 700m, depending on the presence and depth of gas-bearing fractures intersected. The diameter of the well at this depth will be 4 – 5". This section of the well will be left uncased.

The well cementation and casing process involves the following:

- Cementation and isolation of all water-bearing formations (i.e. sandstones, coal, etc.) prior to the continuation of drilling.
- Casings will be seamless Carbon Steel ASTM A106 Grade B threaded pipe.
- All fittings, including final casing flanges, plugs, or couplings, will be made from carbon steel (or an appropriate material for fittings) and will be capable of withstanding the required pressure.
- Casing connections will be threaded and minimum casing size is 202mm inner diameter.
- Wall thickness will be sufficient to carry the weight of the casing pipe at the threaded joints. The wall thickness will be sufficient to ensure that the pipe maintains a minimum Schedule 40 or higher.
- Provision for 48-hour standing time after the cementation of each casing section, in order to allow enough time for the cement to sufficiently set and develop full compressive strength.

If an exploration borehole proves unsuccessful (i.e. no viable gas flow) it will be concrete sealed and cased when the depth of the boreholes intersected deeper saline aquifers and/or gas as specified in the well closure and rehabilitation guideline (Appendix 7). All unsuccessful wells will be cut of at least 1m below surface and the area rehabilitated to pre-drilling conditions to allow for existing land use to continue unobstructed. If an exploration borehole proves successful (i.e. sufficient gas flow) it will be converted into a production well (as described below) and added to the network of gas producing wells for Cluster 2. The drilling of exploration boreholes is a temporary and short-lived activity (~3-4 months) and the equipment to be used during drilling activities includes a truck/trailer or skid mounted drill rig, excavator, dozer, grader water cart, light motor vehicle for transport of personnel and chemical toilets.

The physical drilling process takes around 3 to 4 months to complete a single well and drilling per property will be prioritized as far possible. Following drilling Tetra4 tests flow volumes and gas composition for a further 7 – 14 days. Planned drilling will be communicated to landowners in advance of any planned work.

If the geology allows, then the footprint of the drill site can be contained in the same exploration work area (i.e. drilling more than one exploration well from the same drill pad disturbance area). However, should the same site be used, it cannot be done in parallel but rather in sequence i.e. one well drilled and completed then followed by another thereby extending the time on the property.

4.1.3.2 WELL SITE CONNECTION

All wells that are drilled and used for production purposes are strengthened with a combination of casing and grouting to average depths of 300 m, depending on the different flow zones intersected, to prevent any interplay between deep and shallow aquifers (Figure 7). The casing and grouting ensure that the gas is isolated from surrounding geology and promotes the preferential flow of gas from the formation through the well and up to the surface. As the gas is naturally lighter than air, it rises naturally to the surface and no well stimulation is required. The combination of casing and grouting also serves to ensure that gas is isolated and prevented from interacting with the geohydrological regime. This means that water from the deeper saline aquifer cannot migrate into the shallower freshwater aquifer and similarly gas cannot contaminate the shallow groundwater. The production well flange and well head will be located within the concrete well chamber which will be below ground.

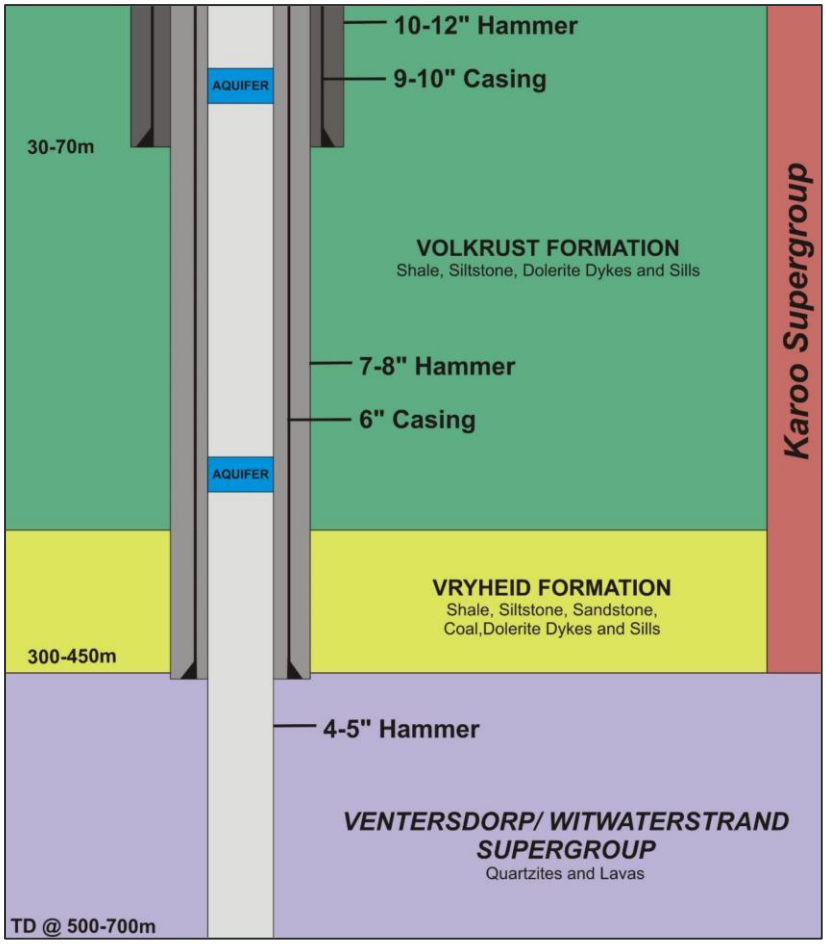


Figure 7: Schematic section depicting typical well construction.

Due to low gas pressures in the wells, groups of ~10-12 wells will be included as an inlet to a booster station to provide vacuum suction. The booster stations will be connected via ~480 km of pipelines to centralised infield reciprocating gas compressor stations. Pipelines will consist of high-pressure steel or low-pressure HDPE depending on site conditions and installed at a minimum depth of 1.5 m below surface level (1.5m to top of pipe). The pipeline will be installed using a back-actor and TLB in most areas with horizontal directional drilling in areas where roads, flowing rivers or other constraints require this method. Servitude corridors (10 m wide) will be maintained free of woody plants to prevent disturbance of the pipeline by root growth and ensure access by Tetra4 personnel for regular inspection and infrequent maintenance. Pipelines will be marked with concrete markers (Figure 8) and adhere to ASME B31.8 (Section 851.7) and will have low point drains at strategic locations for testing and pipeline maintenance. The location of low point drains will be determined in consultation with the affected landowner to ensure minimal disturbance to the landowners' day to day activities.

Figure 8: Typical pipeline servitude and pipe marker.

Production wells will be placed within a secured precast well chamber with manhole for access. Minimal mechanical infrastructure will be placed within the precast well chamber other than the wellhead, connecting pipeline, an isolation valve and sample point. The surface infrastructure for the manhole would be 1,4 m x 1,1 m and the manhole surface height will be ~0,25 m (25 cm). Where production wells are located within agricultural crop areas, the surface manholes will be moved outside of the crop areas to reduce impacts on farming in the long term the surface manholes will be located on the boundaries of the crop areas in consultation with the respective landowners. This will be accomplished by connecting a horizontal subterranean pipeline to the production well. Figure 9 provides a typical example of the construction of a pre-cast subterranean well chamber and Figure 15 shows the typical design drawings of the Cluster 2 precast well chambers.

Figure 9: Typical example of a pre-cast well chamber.

4.1.3.3 **GAS INLINE STATIONS**

In order to transport gas via pipelines from the wellheads to the Plant, various inline infrastructure is required to monitor, measure and control gas flow through the pipelines and this includes booster stations, pigging stations and compressor stations. Localised inline gas booster stations will be installed for each cluster of 7-10 wells which will feed pressurised gas via pipelines from the production wells to the compressor stations. The booster stations will occupy an area of 10 m x 14 m (Figure 16) and a total of 28 booster stations are expected to be constructed.

Inline pigging stations (Figure 10) are installed near river crossings to allow for regular cleaning and inspection of the pipelines. The pigging stations allow for insertion of probes or cleaning pigs (plugs) in order to perform regular maintenance. There are approximately 4 major river crossings but with multiple pipe branches. In total

there should be approximately 14 pig launcher/receiver pairs. Pigging stations occupy an area of approximately 5 m x 5 m (~25 m^2) each.

Low Point Drains (Figure 11) are installed along the pipeline to allow periodic maintenance of the pipeline whereby any condensate is able to be removed from the pipeline where the pipeline has a low point (gravity collection of condensates). Approximately 240 low point drains will be installed, and each occupies an area of ~1.5 m^2. Low point drains will not be positioned in arable fields or wildlife camps.

Figure 10: View of an existing pigging station constructed as part of Cluster 1.

Figure 11: View of an existing low point drain constructed as part of Cluster 1.

Raw gas received at the compressor stations will be filtered to remove dust and moisture using a combination of a water filter and an activated carbon filter that absorbs dust and unwanted organic compounds. Once filtered, the gas from the compressors will be dried to 7 pounds per MMSCF adjacent to the compressor stations, and then piped for final processing to the LNG/LHe Plant. The footprint for a compressor station including the gas drier station will be approximately 60 m x 60 m (Figure 12 and Figure 17).

Figure 12: Example of Compressor Station just recently constructed as part of Cluster 1.

4.1.3.4 COMBINED HELIUM AND LIQUID NATURAL GAS PLANT

Feed gas from the centralised reciprocating infield compressor stations will be discharged into the combined LNG/LHe Plant. The LNG/LHe facility is a modularized facility to convert the Feed Gas into LNG and LHe which will be stored onsite before being transported by road tankers to offtake suppliers.

The Cluster 2 LNG/LHe Plant will be constructed directly adjacent to the Cluster 1 plant which is currently under construction on the remaining extent of the farm Mond Van Doornrivier 38. A Major Hazardous Installation (MHI) study shall inform the relevant safety measures to be implemented at the facility.

The LNG/LHe plant comprises of the following process units:

- Gas Treatment and Boosting System;
- Helium Separation Unit;
- Gas Liquefaction System;
- LHe Storage (~2x100 m^3);
- LNG Storage (~11x300 m^3); and
- LHe and LNG road tanker loading bays.

The area occupied by the proposed Cluster 2 LNG/LHe plant in the operational phase is ~9 hectares while additional areas would be cleared during the construction phase for various contractor laydown areas, offices, parking, waste storage, etc. A breakdown of the approximate area to be occupied by the LNG/LHe Plant and temporary laydown areas is shown in Table 7 below and an overview provided in Figure 13.

Table 7: Approximate LNG/LHe Plant and laydown area.

Aspect	Total Ha	Total Ha
LNG/LHe Plant Cluster 2 (Permanent)	~9.6	~25.4

Aspect	Total Ha	Total Ha
Laydown areas for drilling contractors, gas gathering contractors, plant contractors, parking, offices, etc. (Temporary)	~15.8	

Figure 13: Area to be impacted by the LNG/LHe Plant (green filled area) and laydown areas (clear white outline).

The plant will include a small sewage treatment works as well as stormwater infrastructure to separate clean and dirty water. Clean water will be diverted into the environment while dirty water will be diverted into an evaporation pond of approximately 1005 m^3. Treated effluent from the sewage treatment plant will also be directed to the evaporation pond from where water will be pumped into a reverse osmosis plant and then stored in the fire water and service water tanks for reuse. The fire water and service water tanks are linked and therefore, recirculating to service water tank is taken off for use in the system. The fire water tank is maintained at a minimum level to ensure fire water availability. No discharge of polluted water will take place and all waste products from the sewage treatment works (sludge) and the reverse osmosis plant will be collected by a registered waste contractor for offsite disposal at a suitably licenced facility.

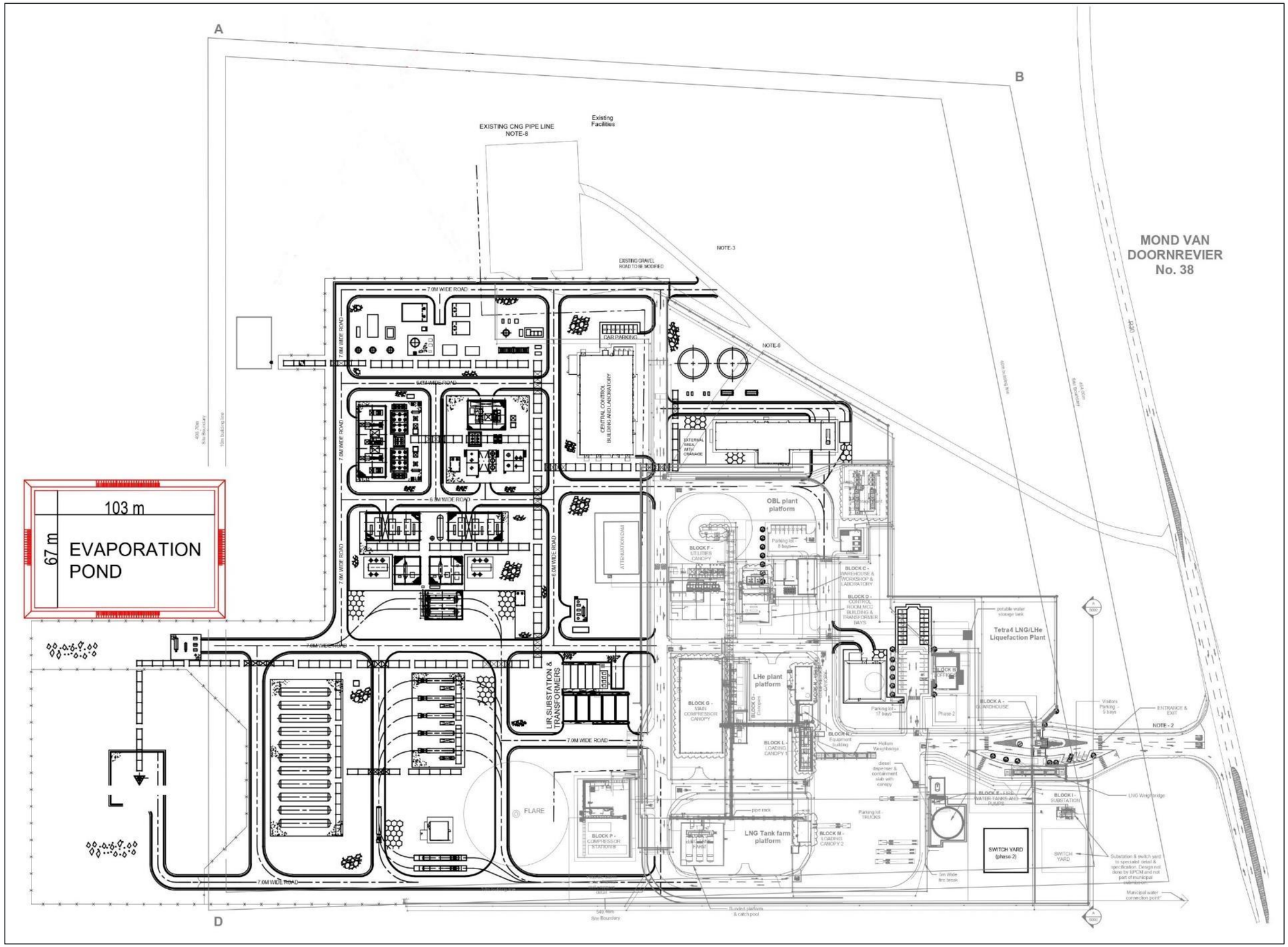


Figure 14: Preliminary layout of the Cluster 2 Plant extension to Cluster 1 Plant

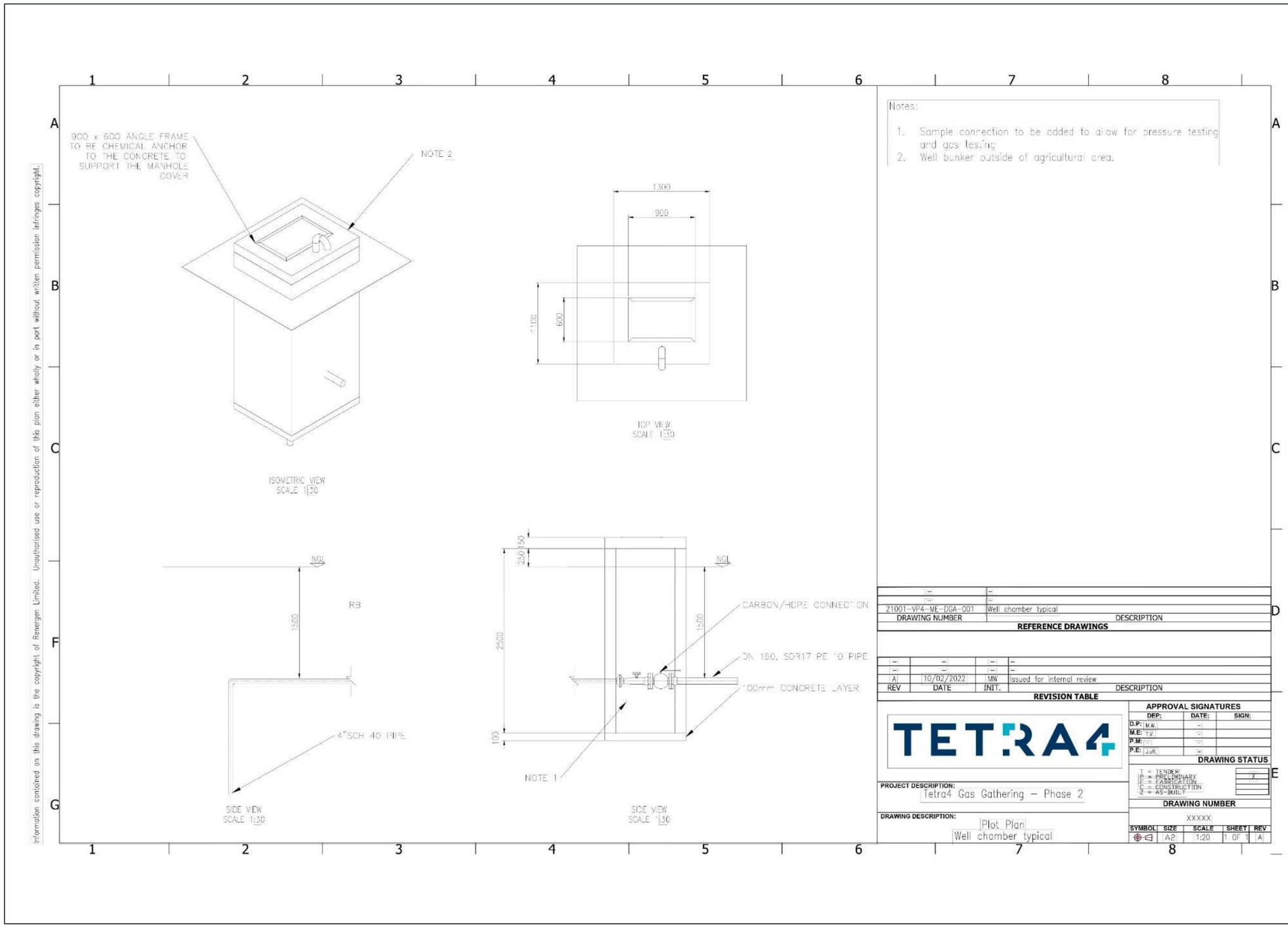


Figure 15: Typical subterranean precast well chamber layout

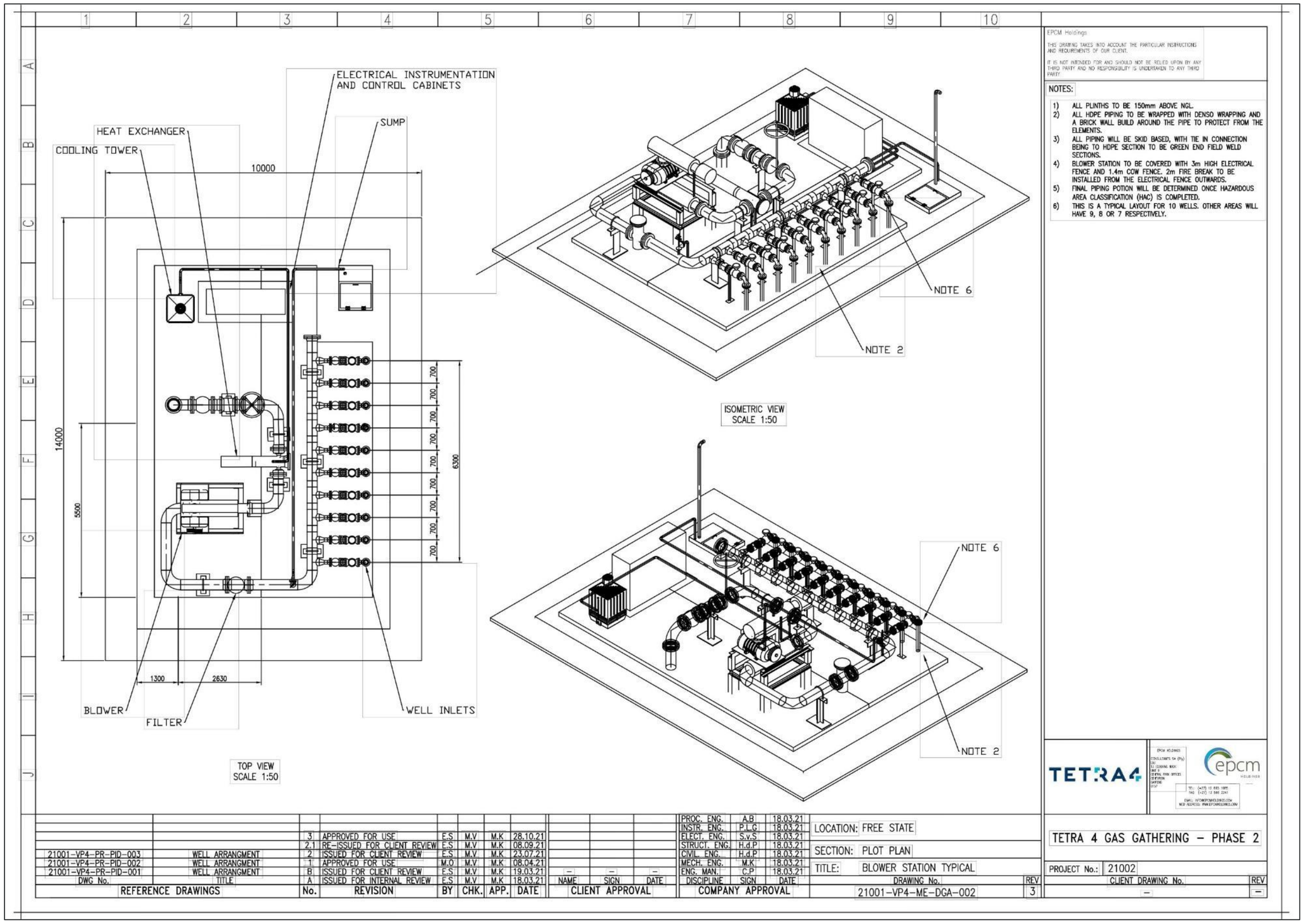


Figure 16: Typical booster station layout

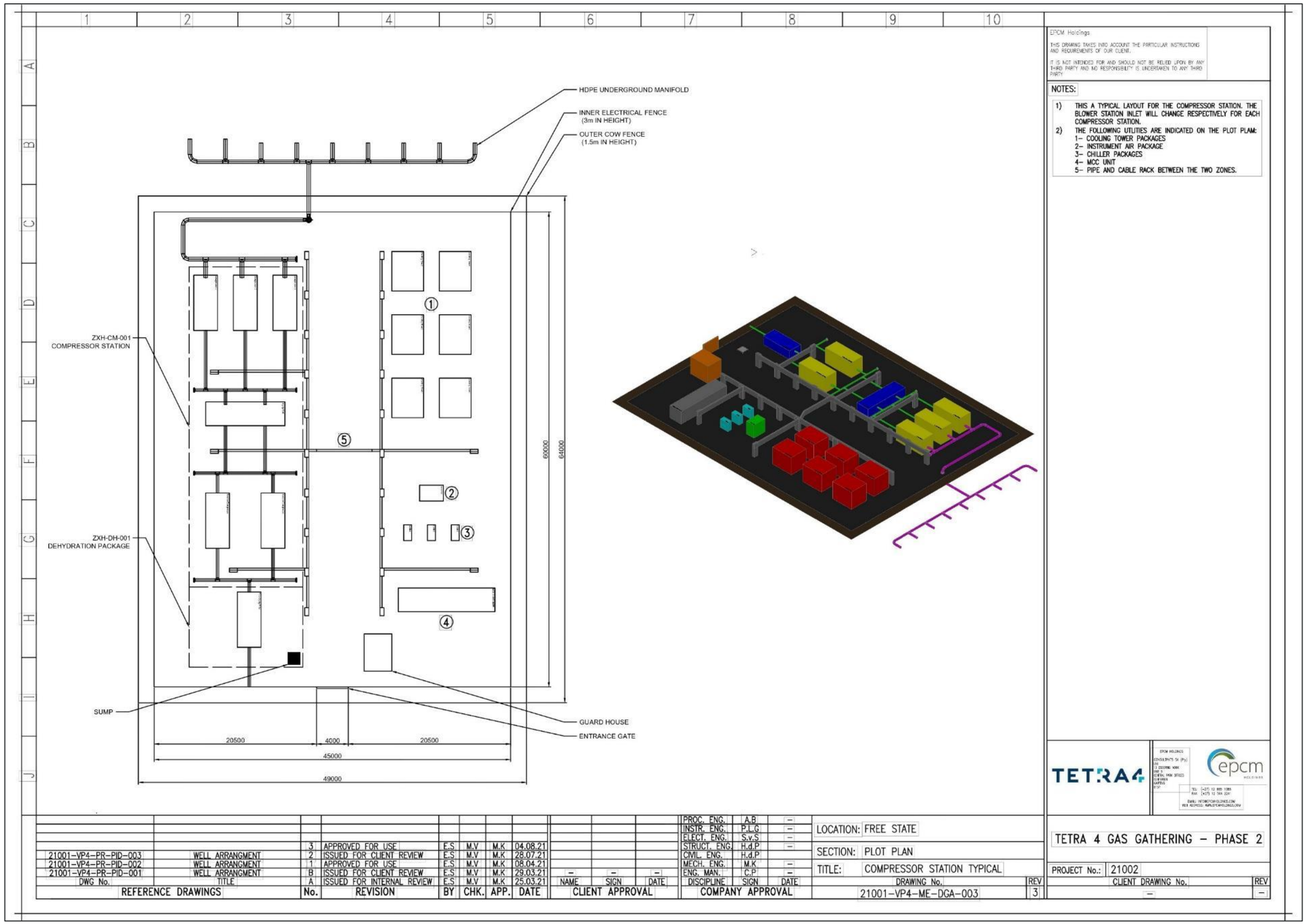


Figure 17: Typical compressor station layout

4.1.4 SURFACE INFRASTRUCTURE

The proposed Cluster 2 project expansion requires various surface infrastructure as listed below:

- Access roads (temporary / permanent);
- Pipelines and powerlines;
- Coalescer filter or knockout drum at each booster station;
- Pipe markers (approximately every 100 m of the pipeline, where feasible);
- Wellheads;
- Booster pumps (where required);
- Inline booster compressors or infield reciprocating compressors;
- Gas driers;
- Fencing and security (booster stations, compressor stations and LNG/LHe Plant infrastructure);
- Combined helium and LNG plant;
- LNG/LHe storage and dispensing units;
- Chemical storage;
- Temporary hazardous waste storage (including but not limited to waste water recirculation at drill sites and waste containing hydrocarbons such as used oil and filters, diesel, lubricants, grease, etc.);
- Temporary general waste storage;
- Contractors' laydown areas around the LNG/LHe Plant area; and
- Permanent offices, storage areas and workshops.

In broad summary, infrastructure required for the Cluster 2 gas field development is split between:

a) Gas Gathering Network: infrastructure required for gas extraction and transport at well sites (including compressor stations); and

b) Gas Processing: infrastructure required for gas processing and transport of final product.

4.1.5 CONTRACTORS' LAYDOWN AREAS, OFFICES AND ABLUTION FACILITY

As the gas gathering network is spread over an extensive area, it is proposed that the contractor's laydown areas and offices will be centrally located adjacent to the LNG/LHe Plant. During peak construction, there will be approximately 1000 temporary workers and temporary ablution facilities will be provided. Thereafter approximately 55 operational employees will be catered for at the LNG/LHe plant area and ablution facilities connected to a sewage treatment works will be provided. The laydown areas, offices and ablutions facility will be temporary whereby the offices will serve as the base of operations for coordinating the operation and the ablution facilities will serve as a change room and ablution facility for employees while on site. Construction materials such as aggregate and concrete will be sourced from licenced suppliers and delivered to site as and when required.

No overnight accommodation of employees (except for security personnel) will be permitted at the Plant and other site areas during the construction phase. Normal construction working hours will be limited between ~6 am and ~6 pm (sunrise to sunset) from Monday to Saturday while the working hours for the commissioning phase of the LNG/LHe Plant and compressor stations may extend into the evening periods.

4.1.6 SITE ACCESS CONTROL

Access to the individual well sites, compressor stations, and combined helium and LNG plant will be controlled through a single entrance and exit point at each site. Well sites will be accessed via existing access roads (as far as possible) and the plant via the existing security-controlled access road leading off the R30. All booster stations, compressor stations, and the combined LNG/LHe plant will be fenced off with 1.8 m high razor diamond mesh fencing or an equivalent product. All visitors to the site will be required to sign in at the security check point located at the Plant. All employees will be required to retain proof of identification whilst on site and all vehicles will be branded for identification purposes.

The following specific conditions have been put forward for inclusion in the decision to address access control and safety while the EMPr contains additional conditions in this regard:

- Farm safety must be a priority and the landowners and Tetra4 must agree on security measures prior to construction on their farms.
- Tetra4 must consult with landowners about any new work or potential changes that may take place on their properties.
- Protocols on farm access, compensation, communication, and road maintenance must be agreed upon and be in place before construction commences. The affected landowners must have input in the development of these protocols.
- A grievance mechanism and claims procedure must be in place and shared with all the stakeholders before the construction commences.
- Tetra4 must share the works schedule per property prior to commencement of any activity onsite. This communication will include details of the respective contractors that are appointed, provide the affected landowners with a project schedule for their respective properties and any changes to the schedule must be formally communicated in writing to the affected landowners prior to implementing such changes.

4.1.7 ROADS

Access to the LNG/LHe Plant will be via the R30, a surfaced two-lane provincial road which links to the R73 and the town of Virginia. The access off the R30 is currently being upgraded to ensure safe entry with the installation of slip lanes.

Exploration and production wells will be accessed via existing access roads where possible. Some existing gravel roads may require temporary widening or reinforcement for larger construction vehicles such as drill rigs. Where there is no existing access to exploration wells, temporary gravel access will be constructed and if required, a suitable surface reinforcing will be temporarily installed to prevent damage to the environment (e.g. stone compacted layer). Any temporary access roads will be rehabilitated following completion of the construction activities requiring those temporary roads. The following serves as a guideline to how private access roads will be documented and maintained:

- Prior to the commencement of the construction period, both the landowner and a representative of Tetra4 will take video footage and/or photographs of the road condition of the access roads.
- After the construction period an access road inspection by both the landowner and Tetra4 will be undertaken. Tetra4 will be obliged to rehabilitate and/or reconstruct the access roads in the same condition as reflected in the initial photographs and/or video footage at its costs.

Production well sites will require permanent light delivery vehicle (LDV) access for security and maintenance purposes and where no existing roads occur, permanent single lane access will be constructed. Where existing or new access roads traverse drainage lines or streams, culverts will be installed.

4.1.8 POWER SUPPLY

For the Cluster 2 LNG/LHe Plant, electrical power will be obtained from a new dedicated overhead powerline. A new 132 kV dual loop-in-loop-out powerline of approximately 4 km in length to the Theseus-Oryx 132 kV Line will be required and will likely be a 247 (double circuit) tower structure (Figure 18). The proposed powerline will feed into a new 40 MVA substation at the LNG/LHe Plant. This proposed 132 kV power line will be constructed in the powerline corridor shown in Figure 6.

Important Note: This powerline will be applied for separately (separate Basic Assessment application) as the environmental authorisation will be ceded to Eskom on completion of construction. Therefore although the power supply is described in this section, this S&EIA application does not include the relevant listed activities relating to powerlines nor shall this be assessed in detail within this report.

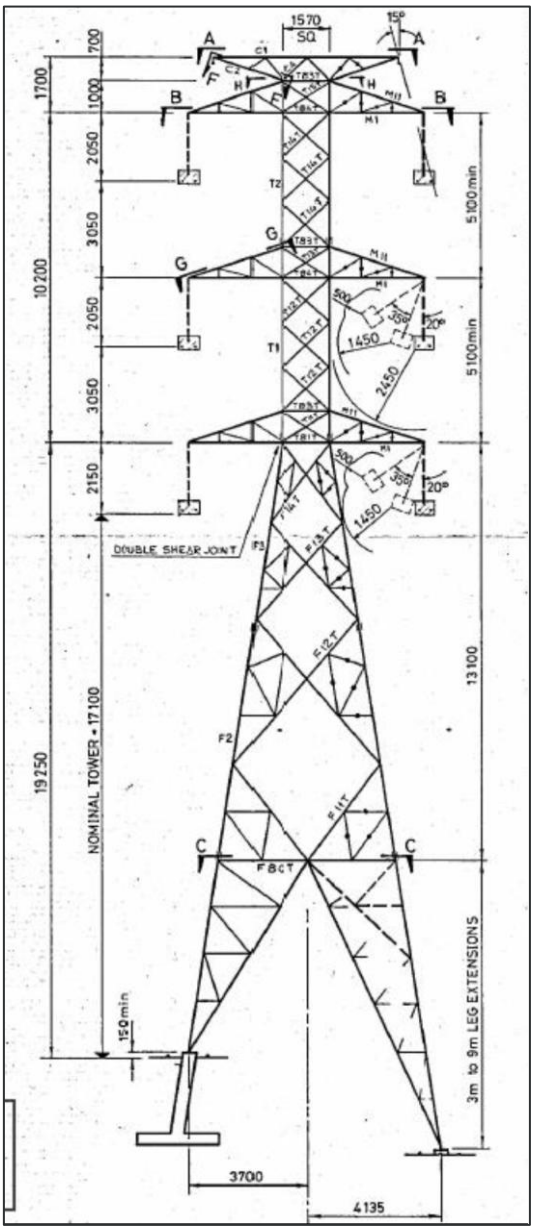


Figure 18: Typical transmission tower outline drawing.

The compressor stations will require a medium voltage substation connection from existing Municipal/Eskom lines (11 kV / 33 kV switchboard to a 400 V switchboard). The booster stations will require 220 V (low voltage) and will be powered by either solar PV, LNG generator or municipal pole mounted transformers.

4.1.9 WATER MANAGEMENT

Water management for the proposed Cluster 2 Project refers to the water demand for exploration and limited water demand for production activities, the source of water as well as the management of waste water such as condensate and formation water.

4.1.9.1 **WATER REQUIREMENTS**

Water for construction, drilling, Plant operation, drinking and domestic purposes will be sourced from existing municipal supply (refer to Municipal letter included in Appendix 11) which is piped into the existing Cluster 1 plant service water tank. The current approved Cluster 1 volume of water supplied by the Municipality is sufficient due to reuse of water and therefore does not require adjustment.

4.1.9.2 **WASTE WATER**

Waste water from the Cluster 2 Project will consist of either condensate (waste water from condensation out of the gas) or very rarely, formation water (a natural layer of water inside gas reservoirs). The amount of waste water to be produced during the Cluster 2 gas drilling, production and processing activity is as per the schematic diagram in Figure 22 below. The condensate and any formation water encountered will be disposed of as per the legislative requirements which includes disposal by a licensed contractor at a suitably registered waste disposal facility.

A Storm Water Management Plan (SWMP) for the plant area has been developed which ensures separation of clean and dirty water. Clean water will be diverted back into the environment in a controlled manner to prevent scouring, sedimentation or erosion from forming, while dirty water will be collected and stored within a lined evaporation pond for treatment and reuse. Waste water management within the LNG/LHe Plant will include:

- A small sewage water treatment works (SWTW) to pre-treat the site domestic wastewater before it enters the main reverse osmosis Water Treatment Works.
- A reverse osmosis water treatment works (RO-WTW) to treat all wastewater at the LNG/Helium Plant site with reuse of treated water (no discharge to environment).

The wastewater from the Plant (rainfall, process water, etc) will be stored in a lined evaporation pond (Figure 14 and Figure 19) before being treated for reuse. Treated water will be stored in the Service/Firewater Tank for recirculation in the plant operations. Small volumes of brine from the 2 X WTW's will be collected by a service provider for offsite disposal. The water quality within the proposed Cluster 2 evaporation pond will be similar to that which is currently stored in the Cluster 1 evaporation pond which, based on laboratory test results has elevated Total Suspended Solids, Chemical Oxygen Demand and Total Organic Carbon. All other parameters analysed are within acceptable limits. Refer to Appendix 10 For a copy of the laboratory results.

The proposed SWTW can store a maximum of 45 m^3 of wastewater (i.e. pre-treated) and a maximum of 36 m^3 of treated water at any one time. The SWTW can treat a maximum of 30 m^3 on any given day as per design flow with normal operation only 20 m^3 per day. A schematic representation of the proposed SWTW is shown in Figure 20.

The main RO-WTW will have a 5 m^3 feed tank which will be supplied with effluent from an evaporation pond (1005 m^3). The brine/concentrate tank will be 100 litres while the product tank will be 5m^3. Recovered effluent/service water will be pumped from the product tank to the Service/Fire water storage tank (clean water capacity 1407 m^3). The feed tank, product tank and concentrate tank will be JoJo (Roto) tanks. The service/fire water tank will be a steel reservoir. A schematic representation of the proposed RO-WTW is shown in Figure 21.

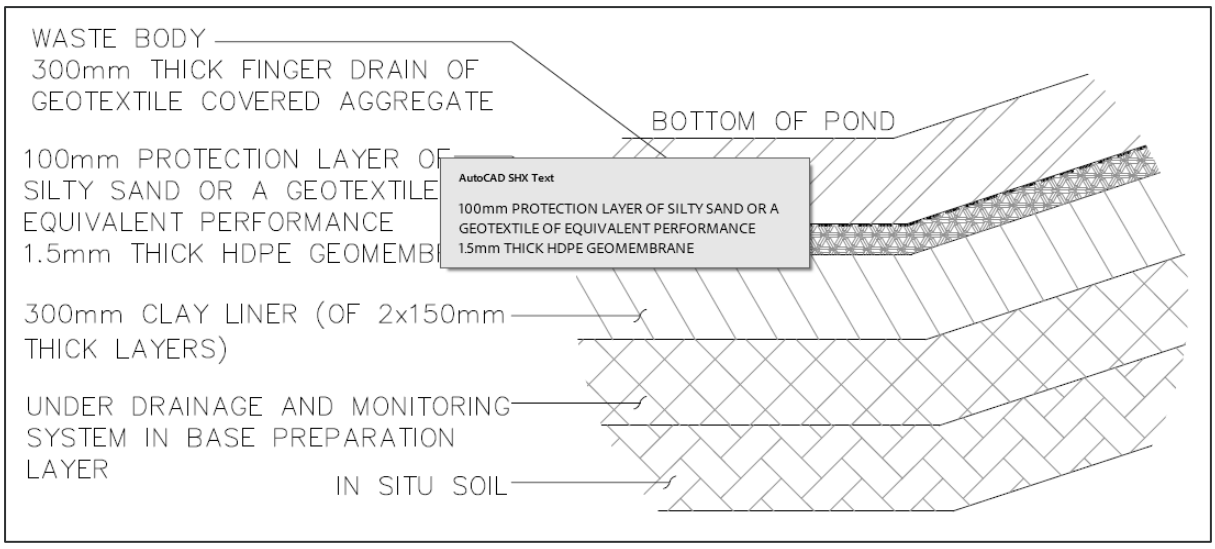


Figure 19: Evaporation Pond liner design.

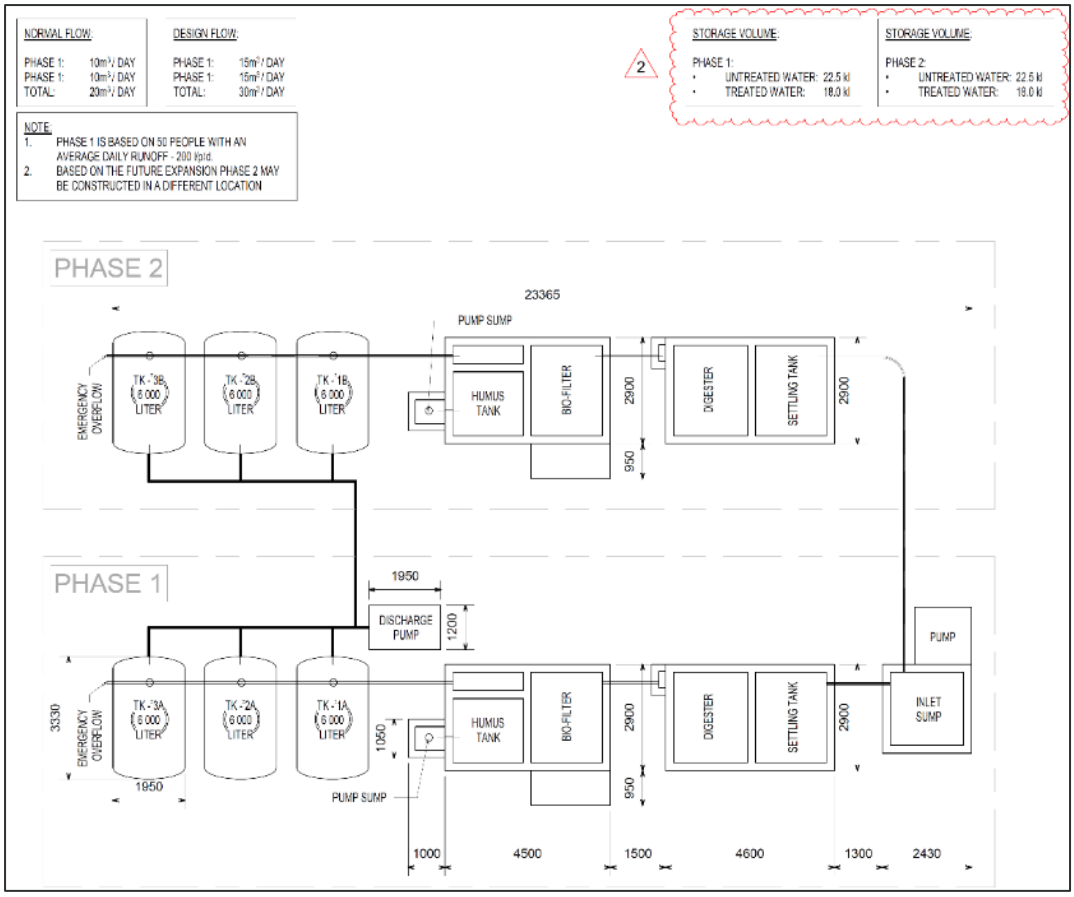
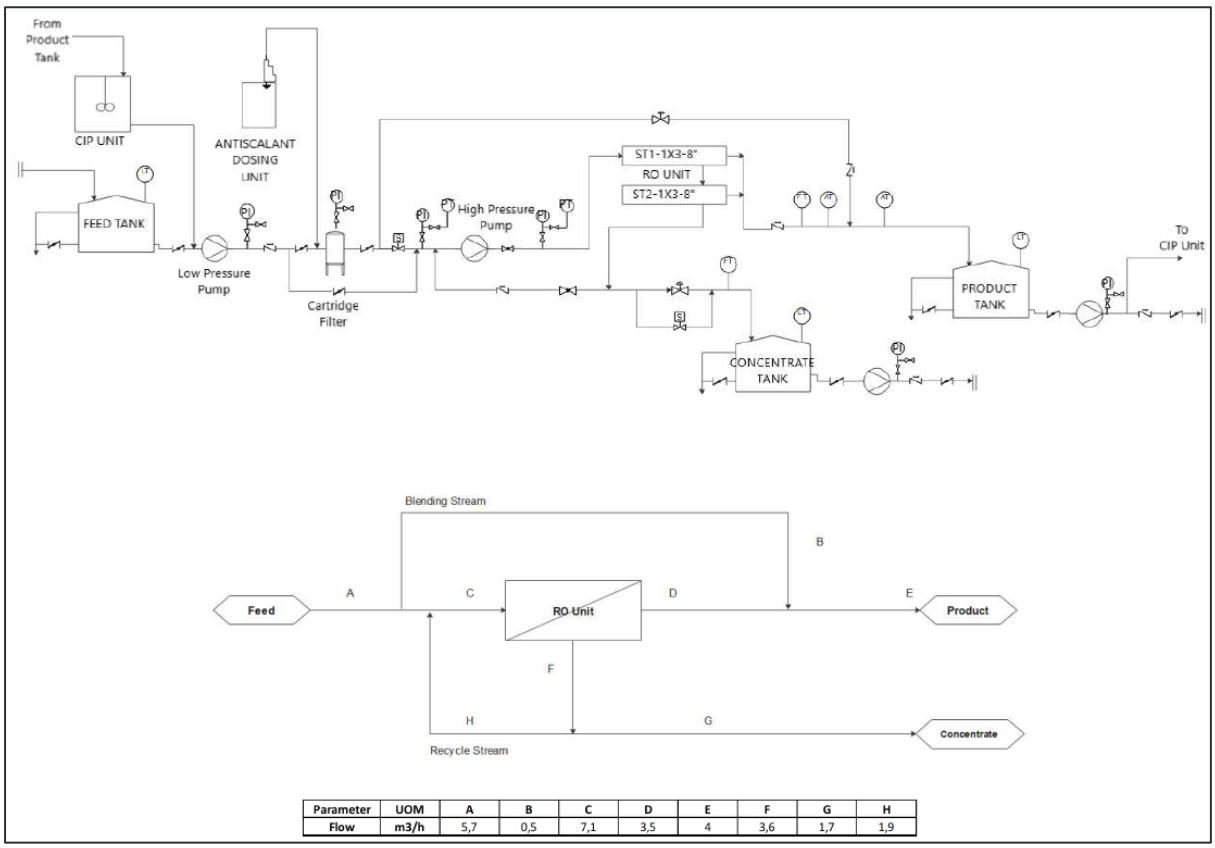
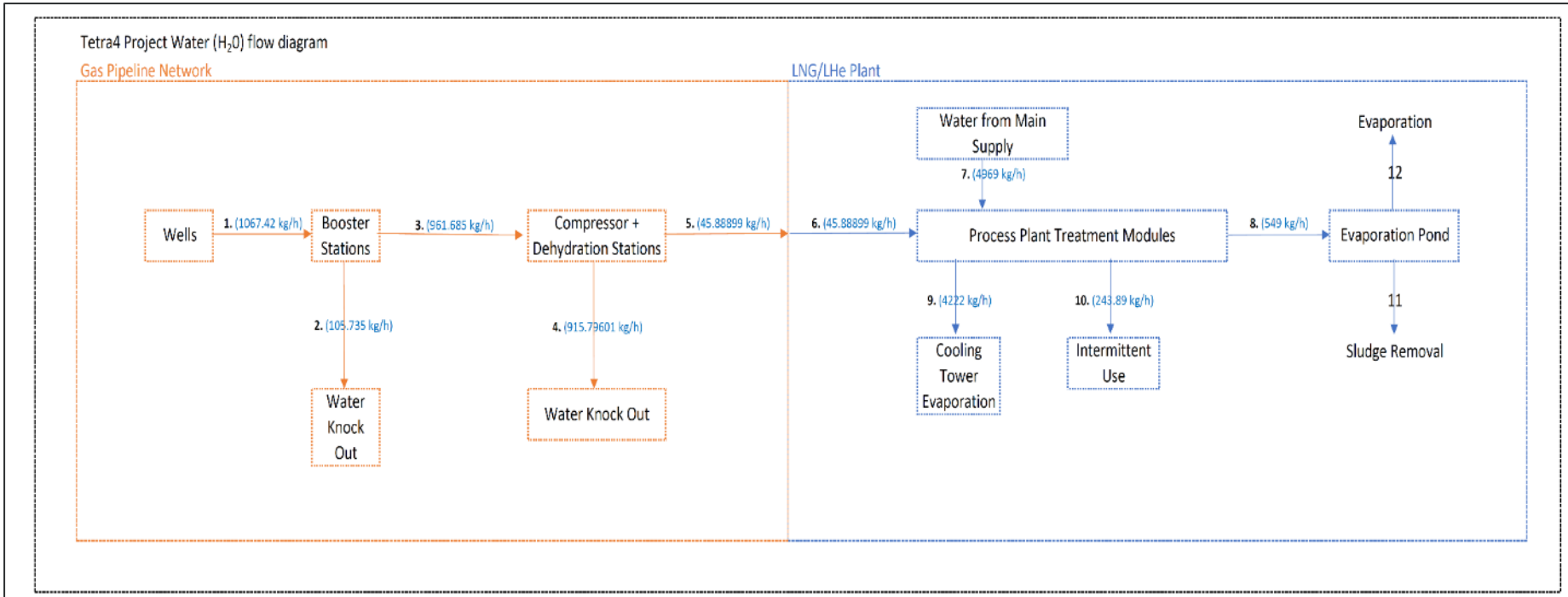


Figure 20: Typical schematic of the proposed sewage water treatment works.



Parameter	UOM	A	B	C	D	E	F	G	H
Flow	m3/h	5,7	0,5	7,1	3,5	4	3,6	1,7	1,9

Figure 21: Typical schematic of the proposed reverse osmosis treatment works.



Process Stream	Flow (H2O)		Description
1	1 067	kg/h	Natural flow from the wellhead. This is an estimation based on historic information and fluctuates per well. However, for the purposes of the water balance an average is used.
2	106	kg/h	Booster station features two potential knock-out points: 1) inlet filter and 2) blower unit and associated heat exchanger. The expected knock-out comes primarily from the blower unit.
3	962	kg/h	Combined flow from the 10 blower stations per compressor station.
4	916	kg/h	Compressor station features dehydration package designed to remove majority of water content in the stream.
5	46	kg/h	Feed gas to process plant.
6	46	kg/h	Feed gas to process plant.
7	4 969	kg/h	Service water and potable water are self-produced inside the Plant from water imported. Continuous Service Water consumption is for cooling water system make-up.
8	549	kg/h	Flowrate to be defined based on final plot plan during detailed design. Oily Water flowrate estimated assuming 25,4 mm as first flush. Water sent to evaporation pond in 24 h.
9	4 222	kg/h	Evaporated Cooling Water from Cooling Towers
10	244	kg/h	Potable water discontinuous consumption is 292 l/h to buildings and 13600 l/h to eye washes and safety showers. Assume average consumption with balance of water.

Figure 22: Water balance showing the potential amount of waste water produced during gas production and processing.

4.1.10 WASTE MANAGEMENT

The design philosophies for waste management are based on applicable legislation, in particular NEMWA, DWAF (DWS) best practice guidelines, and currently accepted good industry practice for waste management. Principles of waste minimisation at source, segregation for reuse, recycling and treatment or disposal will be applied to the handling of waste, wherever possible. The waste (general and hazardous) generated during construction and operations will be addressed as detailed below.

4.1.10.1 **GENERAL WASTE**

The following types of general waste (produced mainly during construction, with minimal amounts post construction/ operation) will be generated by the proposed Cluster 2 Project:

- Domestic solid waste;
- Scrap metal; and
- Construction waste.

The Cluster 2 Project will utilise a temporary general waste storage facility and all waste will be collected by an approved, licenced waste contractor for removal and final disposal at a registered general waste disposal facility. No new landfills will be directly established by the project within the project boundaries.

4.1.10.2 **HAZARDOUS WASTE**

Hazardous waste, including but not limited to hydrocarbon containing waste (used oil and filters, diesel, lubricants, and grease) will be stored in clearly marked skip bins (solids) and containers (liquids). These skip bins/ containers will be placed in an isolated area on a hard, impervious surface. When full, the bins/ containers will be collected by a contractor for safe disposal or recycling companies which will be appointed to collect waste. A waste disposal certificate will be required from the contractor to ensure safe disposal.

Drilling waste will consist of wastewater and drilling mud. This waste will be stored in lined sumps adjacent to the drill rig and once drilling is completed, the waste will be removed from site and adequately disposed of at an appropriately licenced waste disposal facility.

Condensate (including effluent from the filters and drop out water) removed from gas processing at the various stations described previously will also be stored in clearly marked containers (should it not be within DWS livestock watering and irrigation standards) for final disposal offsite at a registered hazardous waste disposal facility by a licensed contractor.

Mercury and other trace metals are absorbed by the membranes and guard beds equipped at the plant which are designed to last for approximately 10 years before requiring replacement. These membranes and waste guard beds will be collected by a licenced contractor for safe disposal at a registered hazardous waste disposal site. Records of all final waste disposal certificates will be kept.

Other liquid waste such as sewage and domestic waste water will be generated and will be treated onsite at the plant area in the sewage treatment plant. The effluent from the sewage treatment plant will be directed to the evaporation pond from where waste water will be treated in a reverse osmosis treatment system for reuse within the plan operations.

4.1.11 PROJECT SCHEDULING

The Cluster 2 project will comprise of two components namely the gas gathering network and the LNG/LHe Plant. The full field well development will comprise 3 phases/groups of wells during which exploration and drilling will be undertaken. The first phase will target ~15 MMSCFD of gas followed by the second phase of ~30 MMSCFD and finally the third phase of ~45 MMSCFD. The construction of the gas gathering network (including pipelines, booster and compressor stations, etc) will commence in ~May 2023 and be completed by ~October 2025 or as the production well development progresses. Construction of the LNG/LHe plant and associated infrastructure will commence in ~March 2023 and be completed by ~February 2026. The operational (gas production) timeframe for the project is approximately 20 years (~2026 to ~ 2046).

4.2 LISTED AND SPECIFIED ACTIVITIES TRIGGERED

The NEMA, NEMWA, NWA and NEMAQA listed activities triggered by the Cluster 2 Gas Production Project are presented in Table 8 below.

Table 8: Applicable Listed Activities

Activity No	Activity Description	Applicability
NEMA LISTING NOTICE 1 ACTIVITIES		
NEMA GNR 983 Activity 12	The development of- (i) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 100 square metres; or **(ii) infrastructure or structures with a physical footprint of 100 square metres or more;** where such development occurs- **(a) within a watercourse;** (b) in front of a development setback; or **(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse;-** excluding- (aa) the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such development activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such development occurs within an urban area; (ee) where such development occurs within existing roads, road reserves or railway line reserves; or (ff) the development of temporary infrastructure or structures where such infrastructure or structures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared.	This project comprises linear activities such as pipelines (with associated low point drains, pigging, booster and compressor stations) and access roads which will impact on watercourses or within 32 m of a watercourse when in proximity to these areas.
NEMA GNR 983 Activity 16	The development and related operation of facilities for the desalination of water with a design capacity to produce more than 100 cubic metres of treated water per day.	The Reverse Osmosis Plant (RO Plant) will remove salts from the wastewater in the evaporation pond and therefore fulfils the function of “desalination” of water. The RO Plant will produce ~100 m^3/day of treated water which shall be reused within the production processes. The treated water will be stored in the service/fire water tanks.
NEMA GNR 983 Activity 19	The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or	This project comprises extensive linear activities such as pipelines (with associated low point drains,

Activity No	Activity Description	Applicability
	rock of more than 10 cubic metres from a watercourse; but excluding where such infilling, depositing, dredging, excavation, removal or moving- (a) will occur behind a development setback; (b) is for maintenance purposes undertaken in accordance with a maintenance management plan; (c) falls within the ambit of activity 21 in this Notice, in which case that activity applies; (d) occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or (e) where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies.	pigging, booster and compressor stations) and access roads which will require infilling or depositing of more than 10 m^3 of material to or from a watercourse when in proximity to these areas.
NEMA GNR 983 Activity 21D	Any activity including the operation of that activity which requires an amendment or variation to a right or permit in terms of section 102 of the Mineral and Petroleum Resources Development Act, as well as any other applicable activity contained in this Listing Notice or in Listing Notice 3 of 2014, required for such amendment.	In terms of the MPRDA, a Section 102 EMPr amendment will be required to include the Cluster 2 activities and any specific mitigation measures into the approved Cluster 1 EMPr.
~~**NEMA GNR 983 Activity 24**~~	~~The development of a road-~~ ~~(i) for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Government Notice 545 of 2010; or~~ ~~(ii) with a reserve wider than 13,5 meters, or where no reserve exists where the road is wider than 8 metres;~~ ~~but excluding a road-~~ ~~(a) which is identified and included in activity 27 in Listing Notice 2 of 2014;~~ ~~(b) where the entire road falls within an urban area; or~~ ~~(c) which is 1 kilometre or shorter.~~	Approximately 480 km of access roads may be required to service the various project infrastructure (~300 wells, pipelines, booster and compressor stations, etc.) although these roads will not be wider than ~2 m and many will only be 2-spoor tracks. **Following the EIA investigations, this listed activity has been confirmed to be not applicable to this application. No roads wider than 8 m will be constructed and consequently this activity has been removed from the revised application form (Appendix 9).**
NEMA GNR 983 Activity 27	The clearance of an area of 1 hectare or more, but less than 20 hectares of indigenous vegetation, except where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan.	The LNG/LHe Plant and laydown area will be ~25.4 ha and the cumulative clearance for wells, compressor stations, blower stations, etc are ~100-150 ha. Pipelines and access roads are linear activities and therefore excluded from this listed activity and the calculation of vegetation clearance.

Activity No	Activity Description	Applicability
NEMA GNR 983 Activity 28	Residential, mixed, retail, commercial, industrial or institutional developments where such land was used for agriculture, game farming, equestrian purposes or afforestation on or after 01 April 1998 and where such development: (i) will occur inside an urban area, where the total land to be developed is bigger than 5 hectares; or (ii) will occur outside an urban area, where the total land to be developed is bigger than 1 hectare; excluding where such land has already been developed for residential, mixed, retail, commercial, industrial or institutional purposes.	The LNG/LHe Plant expansion is on land previously used for agricultural activities (grazing) and covers an area greater than 1 hectare (outside urban area).
NEMA GNR 983 Activity 34	The expansion of existing facilities or infrastructure for any process or activity where such expansion will result in the need for a permit or licence or an amended permit or licence in terms of national or provincial legislation governing the release of emissions, effluent or pollution, excluding- (i) where the facility, infrastructure, process or activity is included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case the National Environmental Management: Waste Act, 2008 applies; (ii) the expansion of existing facilities or infrastructure for the treatment of effluent, wastewater, polluted water or sewage where the capacity will be increased by less than 15 000 cubic metres per day; or (iii) the expansion is directly related to aquaculture facilities or infrastructure where the wastewater discharge capacity will be increased by 50 cubic meters or less per day.	The relevant AEL application will be submitted for the Cluster 2 specific emissions and scheduled processes.
NEMA GNR 983 Activity 48	The expansion of- (i) infrastructure or structures where the physical footprint is expanded by 100 square metres or more; or (ii) dams or weirs, where the dam or weir, including infrastructure and water surface area, is expanded by 100 square metres or more; where such expansion occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding- (aa) the expansion of infrastructure or structures within existing ports or harbours	The expansion to gas production activities under the Production Right from Cluster 1 to Cluster 2 will result in infrastructure such as wells, booster stations, compressor stations, pipelines, roads etc. being located within the regulated area of a watercourse.

Activity No	Activity Description	Applicability
	that will not increase the development footprint of the port or harbour; (bb) where such expansion activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 23 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such expansion occurs within an urban area; or (ee) where such expansion occurs within existing roads, road reserves or railway line reserves.	
NEMA GNR 983 Activity 51	The expansion and related operation of facilities for the storage, or storage and handling, of a dangerous good, where the capacity of such storage facility will be expanded by more than 80 cubic metres.	Expansion to storage of LNG at the LNG/LHe Plant complex from Cluster 1 to Cluster 2 activities. The Cluster 2 plant will include 3300 m^3 of storage of LNG. Liquid Helium is not a listed dangerous good and therefore does not apply to this listed activity.
NEMA GNR 983 Activity 56	The widening of a road by more than 6 metres, or the lengthening of a road by more than 1 kilometre- (i) where the existing reserve is wider than 13,5 meters; or (ii) where no reserve exists, where the existing road is wider than 8 metres; excluding where widening or lengthening occur inside urban areas.	Existing roads may require lengthening by more than 1km however this is dependent on the location of the exploration wells which cannot be specifically located at this point.
NEMA GNR 983 Activity 59	The expansion and related operation of facilities or infrastructure for the refining, extraction or processing of gas, oil or petroleum products where the installed capacity of the facility will be increased by 50 cubic metres or more per day, excluding facilities for the refining, extraction or processing of gas from landfill sites.	The Cluster 2 Gas Production Project will add an additional 3300 m^3 of LNG and 200 m^3 of Helium to the Cluster 1 production volumes.
NEMA GNR 983 Activity 60	The expansion and related operation of facilities or infrastructure for the bulk transportation of dangerous goods- (i) in gas form, outside an industrial complex, by an increased throughput capacity of 700 tons or more per day; (ii) in liquid form, outside an industrial complex or zone, by an increased throughput capacity of 50 cubic metres or more per day; or (iii) in solid form, outside an industrial complex or zone, by an increased throughput capacity of 50 tons or more per day.	Cluster 2 will expand upon the existing approved Cluster 1 gas production by adding an additional 45 MMSCFD to the overall gas production under the Production Right.
NEMA GNR 983 Activity 67	Phased activities for all activities- (i) listed in this Notice, which commenced on or after the effective date of this Notice or similarly listed in any of the previous NEMA notices, which commenced on or after the effective date of such previous NEMA Notices;	The Cluster 2 project (up to 300 production wells, pipelines, compressor and booster stations) will be constructed in a phased manner which may on their

Activity No	Activity Description	Applicability
	excluding the following activities listed in this Notice- 17(i)(a-d); 17(ii)(a-d); 17(iii)(a-d); 17(iv)(a-d); 17(v)(a-d); 20; 21; ...; 24(i); 29; 30; 31; 32; 34; 54(i)(a-d); 54(ii)(a-d); 54(iii)(a-d); 54(iv)(a-d); 54(v)(a-d); 55; 61; 64; and 65; or (ii) listed as activities 5, 7, 8(ii), 11, 13, 16, 27(i) or 27(ii) in Listing Notice 2 of 2014 or similarly listed in any of the previous NEMA notices, which commenced on or after the effective date of such previous NEMA Notices; where any phase of the activity was below a threshold but where a combination of the phases, including expansions or extensions, will exceed a specified threshold.	own not trigger a listed activity but when combined, exceed the threshold for clearance of vegetation.
NEMA LISTING NOTICE 2 ACTIVITIES		
NEMA GNR 984 Activity 4	The development and related operation of facilities or infrastructure, for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of more than 500 cubic metres.	The LNG/LHe Plant will store 3300 m^3 of LNG which is classified as a dangerous good. Note that LHe is not classified as a dangerous good.
NEMA GNR 984 Activity 5	The development and related operation of facilities or infrastructure for the processing of a petroleum resource, including the beneficiation or refining of gas,	The LNG/LHe Plant will be constructed for Cluster 2 which serves the purpose of beneficiation/refining

Activity No	Activity Description	Applicability
	oil or petroleum products with an installed capacity of 50 cubic metres or more per day, excluding activities which are included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case the National Environmental Management: Waste Act, 2008 applies.	of gas with an installed capacity of more than 50 m^3/day.
NEMA GNR 984 Activity **7**	The development and related operation of facilities or infrastructure for the bulk transportation of dangerous goods- (i) in gas form, outside an industrial complex, using pipelines, exceeding 1 000 metres in length, with a throughput capacity of more than 700 tons per day; (ii) in liquid form, outside an industrial complex, using pipelines, exceeding 1 000 metres in length, with a throughput capacity of more than 50 cubic metres per day; or (iii) in solid form, outside an industrial complex, using funiculars or conveyors with a throughput capacity of more than 50 tons per day.	Cluster 2 will include the development and operation of gas pipelines exceeding 1 000 metres in length, with a throughput capacity of more than 700 tons per day.
NEMA GNR 984 Activity **15**	The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan.	The LNG/LHe Plant and laydown area is ~25.4 ha and the cumulative clearance for wells, compressor stations, blower stations, etc are ~100-150 ha. Pipelines are linear activities and therefore excluded from this listed activity.
NEMA LISTING NOTICE 3 ACTIVITIES		
~~**GNR 985**~~ ~~**Activity 4**~~	~~The development of a road wider than 4 metres with a reserve less than 13,5 metres.~~ ~~b. Free State~~ ~~i. Outside urban areas:~~ ~~(aa) A protected area identified in terms of NEMPAA, excluding disturbed areas;~~ ~~(bb) National Protected Area Expansion Strategy Focus areas;~~ ~~(cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;~~ ~~(dd) Sites or areas identified in terms of an international convention;~~ ~~(ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;~~ ~~(ff) Core areas in biosphere reserves; or~~	Approximately 480 km of access roads may be required to service the various project infrastructure (~300 wells, pipelines, booster and compressor stations, etc.) although these roads will not be wider than ~2 m and many will only be 2-spoor tracks. **Following the EIA investigations, this listed activity has been confirmed to be not applicable to this application. No roads wider than 4 m will be constructed in CBA area and consequently this activity has been removed from the revised application form (Appendix 9).**

Activity No	Activity Description	Applicability
	~~(gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core areas of a biosphere reserve, excluding disturbed areas; or~~ ~~ii. Inside urban areas:~~ ~~(aa) Areas zoned for use as public open space;~~ ~~(bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose; or~~ ~~(cc) Areas within urban protected areas.~~	
GNR 985 **Activity 10**	The development and related operation of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage occurs in containers with a combined capacity of 30 but not exceeding 80 cubic metres. b. Free State i. Outside urban areas: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) National Protected Area Expansion Strategy Focus areas; (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (dd) Sites or areas identified in terms of an international convention; (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (ff) Core areas in biosphere reserves; (gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core areas of a biosphere reserve; or (hh) Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; or ii. Inside urban areas: (aa) Areas zoned for use as public open space; or (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose.	The Cluster 2 LNG/LHe Plant will store ~3300 m^3 of LNG which is defined as a dangerous good and the facility is located in an ESA defined area.
GNR 985 **Activity 12**	The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan.	Sections of the project footprint (pipelines, wells, booster stations and/or compressor stations fall within CBA areas and watercourses where more than 300 m^2 will be cleared of vegetation.

Activity No	Activity Description	Applicability
	b. Free State i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; ii. Within critical biodiversity areas identified in bioregional plans; iii. On land, where, at the time of the coming into effect of this Notice or thereafter such land was zoned open space, conservation or had an equivalent zoning; or iv. Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland	
GNR 985 Activity 14	The development of- (i) dams or weirs, where the dam or weir, including infrastructure and water surface area exceeds 10 square metres; or (ii) infrastructure or structures with a physical footprint of 10 square metres or more; where such development occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour. Free State i. Outside urban areas: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) National Protected Area Expansion Strategy Focus areas; (cc) World Heritage Sites; (dd) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (ee) Sites or areas identified in terms of an international convention; (ff) Critical biodiversity areas or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (gg) Core areas in biosphere reserves; or	Sections of the project footprint (pipelines, wells, booster stations and/or compressor stations fall within CBA areas and watercourses and infrastructure in these areas will exceed the 10 m^2 threshold.

Activity No	Activity Description	Applicability
	(hh) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; or ii. Inside urban areas: (aa) Areas zoned for use as public open space; or (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority, zoned for a conservation purpose.	
GNR 985 **Activity 18**	The widening of a road by more than 4 metres, or the lengthening of a road by more than 1 kilometre. b. Free State i. Outside urban areas: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) National Protected Area Expansion Strategy Focus areas; (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (dd) Sites or areas identified in terms of an international convention; (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (ff) Core areas in biosphere reserves; (gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; or (hh) Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; or ii. Inside urban areas: (aa) Areas zoned for use as public open space; or (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose.	There are CBA areas overlapping with certain well and pipeline transects, and existing roads may require lengthening by more than 1 km however this is dependent on the location of the exploration wells which cannot be specifically located at this point.
GNR 985 **Activity 22**	The expansion and related operation of facilities or infrastructure for the storage, or storage and handling of a dangerous good, where such storage facilities or infrastructure will be expanded by 30 cubic metres or more but no more than 80 cubic metres. b. Free State	The Cluster 2 LNG/LHe Plant will store ~3300 m^3 of LNG which is defined as a dangerous good and the facility is located in an ESA defined area.

Activity No	Activity Description	Applicability
	i. Outside urban areas: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) National Protected Area Expansion Strategy Focus areas; (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (dd) Sites or areas identified in terms of an international convention; (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (ff) Core areas in biosphere reserves; (gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; or (hh) Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland; or ii. Inside urban areas: (aa) Areas zoned for use as public open space; (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose; or (cc) Areas on the watercourse side of the development setback line or within 100 metres from the edge of a watercourse where no such setback line has been determined.	
GNR 985 **Activity 23**	The expansion of- (i) dams or weirs where the dam or weir is expanded by 10 square metres or more; or (ii) infrastructure or structures where the physical footprint is expanded by 10 square metres or more; where such expansion occurs- (a) within a watercourse; (b) in front of a development setback adopted in the prescribed manner; or (c) if no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding the expansion of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour. b. Free State	Expansion of the gas production pipeline network for Cluster 2 will result in some sections of the pipeline being located within CBA areas and watercourses and will exceed the 10 m^2 threshold.

Activity No	Activity Description	Applicability
	i. Outside urban areas: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) National Protected Area Expansion Strategy Focus areas; (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (dd) Sites or areas identified in terms of an international convention; (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (ff) Core areas in biosphere reserves; or (gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; or ii. Inside urban areas: (aa) Areas zoned for use as public open space; or (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose.	
NEMWA LISTED ACTIVITIES		
NEMWA Category A1	The storage of general waste in lagoons.	Drilling waste (drill mud) will be stored in lagoons at each of the exploration drill sites. Although previous samples of drill mud were classified as hazardous waste, there remains the possibility that certain exploration wells will be drilled through rock strata that does not result in a hazardous classification. Therefore this activity is applied for.
NEMWA Category A6	The treatment of general waste using any form of treatment at a facility that has the capacity to process in excess of 10 tons but less than 100 tons per day calculated as a monthly average, excluding the treatment of organic waste using composting and any other organic waste treatment.	Drilling waste (drill mud) will be stored in lagoons and the liquid fraction (water) removed from the solid fraction (drill cuttings or mud) which constitutes “treatment”. Although previous samples of drill mud were classified as hazardous waste, there remains the possibility that certain exploration wells will be drilled through rock strata that does not result in a hazardous classification. Therefore this activity is applied for.
NEMWA Category A7	The treatment of hazardous waste using any form of treatment at a facility that has the capacity to process in excess of 500kg but less than 1 ton per day calculated as a	Drilling waste (drill mud) will be stored in lagoons and the liquid fraction (water) removed from the

Activity No	Activity Description	Applicability
	monthly average, excluding the treatment of effluent, wastewater, sewage or organic waste using composting or any other organic waste treatment.	solid fraction (drill cuttings or mud) which constitutes "treatment". Previous samples of drill cuttings (drill mud) were classified as hazardous and therefore it can be expected that this may represent a similar situation for the new exploration wells (albeit this may not apply in all exploration wells).
NEMWA Category A12	The construction of a facility for a waste management activity listed in Category A of this Schedule (not in isolation to associated waste management activity).	The construction of lagoons for the storage of drilling muds.
NEMWA Category A13	The expansion of a waste management activity listed in Category A or B of this Schedule which does not trigger an additional waste management activity in terms of this Schedule.	The Cluster 2 Plant and laydown areas will be located directly adjacent to the Cluster 1 plant and will share waste management facilities which will require expansion to the storage areas for general and hazardous waste.
NEMWA Category A14	The decommissioning of a facility for a waste management activity listed in Category A or B of this Schedule.	On completion of exploration drilling at each drill site, the lagoons will be decommissioned and rehabilitated.
NEMWA Category B1	The storage of hazardous waste in lagoons excluding storage of effluent, wastewater or sewage.	Drilling mud will be stored in lagoons at each exploration well and this drill waste falls within the hazardous class of wastes due to the chemical properties of the underlying rock strata.
NEMWA Category B10	The construction of a facility for a waste management activity listed in Category B of this Schedule (not in isolation to associated waste management activity).	The construction of lagoons for the storage of drilling muds.
NEMWA Category B11	The establishment or reclamation of a residue stockpile or residue deposit resulting from activities which require a mining right, exploration right or production right in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).	Drilling mud is classified as a residue deposit or residue stockpile in terms of the NEMWA. This activity will therefore be triggered.
NEMWA Category C1	The storage of general waste at a facility that has the capacity to store in excess of 100m^3 of general waste at any one time, excluding the storage of waste in lagoons or temporary storage of such waste.	During construction, general waste will be stored by various contractors in the laydown area/camp and will store more than 100 m^3 when combined. *Note: This NEMWA trigger does not require a waste management licence but rather requires registration and compliance with the Norms and Standards.*

Activity No	Activity Description	Applicability
NEMWA Category C2	The storage of hazardous waste at a facility that has the capacity to store in excess of 80m^3 of hazardous waste at any one time, excluding the storage of hazardous waste in lagoons or temporary storage of such waste.	During construction, hazardous waste will be stored by various contractors in the laydown area/camp and will store more than 80 m^3 when combined. *Note: This NEMWA trigger does not require a waste management licence but rather requires registration and compliance with the Norms and Standards.*
NEMWA Category C6	The sorting, shredding, grinding, crushing, screening or baling of general waste at a waste facility that has an operational area that is 1000m^2 and more.	The waste storage and separation area during construction will be greater than 1000 m^2 (33 m X 33 m). *Note: This NEMWA trigger does not require a waste management licence but rather requires registration and compliance with the Norms and Standards.*
NWA Section 21 Activities		
NWA Section 21 (c&i)	impeding or diverting the flow of water in a watercourse and/or altering the bed, banks, course or characteristics of a watercourse.	Pipelines and associated infrastructure (due to their linear nature) will be constructed within the regulated area of a watercourse. An amendment to the existing Cluster 1 WUL will be undertaken to include the relevant Cluster 2 water uses.
NWA Section 21 (g)	Disposing of waste in a manner which may detrimentally impact on a water resource.	A general authorisation (GA) will be registered for the evaporation pond as the volumes of this pond fall within the ambit of a GA. A similar GA registration has already been obtained for the Cluster 1 evaporation pond at the LNG/LHe Plant.
NEMAQA Scheduled Activities		
NEMAQA Sub-category 2.4	Storage and Handling of Petroleum Products	The relevant AEL application will be submitted for the Cluster 2 scheduled processes under the NEMAQA.

5 POLICY AND LEGISLATIVE CONTEXT

This section provides an overview of the governing legislation identified which may relate to the proposed project. The primary legal requirement for this project stems from the need for an EA to be granted by the competent authority, which is the DMRE (PASA being the delegated authority), in accordance with the requirements of both the NEMA and MPRDA. In addition, there are numerous other pieces of legislation governed by many acts, regulations, standards, guidelines and treaties on an international, national, provincial and local level, which should be considered in order to assess the potential applicability of these for the proposed activity. The key legislation applicable to this project is discussed in the subsections below.

5.1 CONSTITUTION OF THE REPUBLIC OF SOUTH AFRICA

The constitution of any country is the supreme law of that country. The Bill of Rights in chapter 2 section 24 of the Constitution of South Africa Act (Act No. 108 of 1996) makes provisions for environmental issues and declares that: *"Everyone has the right -*

a) to an environment that is not harmful to their health or well-being; and

b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:

***i.** prevent pollution and ecological degradation;*

***ii.** promote conservation; and*

iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development"

The EIA and associated impact mitigation actions are conducted to fulfil the requirement of the Bill of Rights.

5.2 THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT (MPRDA)

The MPRDA aims to make provision for equitable access to and sustainable development of the nation's mineral and petroleum resources. The MPRDA outlines the procedural requirements that need to be met to acquire mineral and petroleum rights in South Africa.

In terms of Section 83 of the MPRDA, a Production Right must be issued prior to the commencement of any gas production activities. However, several amendments have been made to the MPRDA. These include, but are not limited to, the amendment of Section 102, concerning amendment of rights, permits, programmes and plans, to requiring the written permission of the Minister for any amendment or alteration; and the Section 5A(c) requirement that landowners or land occupiers receive twenty-one (21) days' written notice prior to any activities taking place on their properties. One of the most important amendments requires all mining and production related activities to follow the full NEMA process as per the EIA Regulations which came into effect on 4 December 2014 for any new applications. A Production Right is subject to prescribed terms and conditions and is valid for the period specified in the right, which periods, each of which may not exceed 30 years, and becomes effective on the effective date.

In support of the integrated EA&WML application, the applicant is required to conduct an EIA process comprising of the preparation of environmental Scoping and EIA Reports, an EMPr, as well as Interested and Affected Party (I&AP) consultations, all of which must be submitted to the PASA for adjudication. This report has been compiled in accordance with Section 23 and Appendix 3 of the EIA Regulations (2014, as amended) in order to satisfy the criteria for an Environmental Impact Assessment (EIA) Report.

5.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA)

The main aim of the National Environmental Management Act, 1998 (Act 107 of 1998 – NEMA) is to provide for co-operative governance by establishing decision-making principles on matters affecting the environment. In terms of the NEMA EIA Regulations, the applicant is required to appoint an EAP to undertake the EIA process, as well as conduct the public participation process towards an application for EA. In South Africa, EIA's became

a legal requirement in 1997 with the promulgation of regulations under the Environment Conservation Act (ECA). Subsequently, NEMA was passed in 1998. Section 24(2) of NEMA empowers the Minister and any MEC, with the concurrence of the Minister, to identify activities which must be considered, investigated, assessed and reported on to the competent authority responsible for granting the relevant EA. On 21 April 2006, the Minister of Environmental Affairs and Tourism (now Department of Forestry, Fisheries and the Environment – DFFE) promulgated regulations in terms of Chapter 5 of the NEMA. These regulations, in terms of the NEMA, were amended a number of times between 2010 and 2022. The NEMA EIA Regulations, 2014, as amended, are applicable to this project. Exploration and Production activities officially became governable under the NEMA EIA Regulations in December 2014 with the competent authority identified as the DMRE.

The objective of the EIA Regulations is to establish the procedures that must be followed in the consideration, investigation, assessment and reporting of the listed activities that are triggered by the proposed project. The purpose of these procedures is to provide the competent authority with adequate information to make informed decisions which ensure that activities which may impact negatively on the environment to an unacceptable degree are not authorised, and that activities which are authorised are undertaken in such a manner that the environmental impacts are managed to acceptable levels.

In accordance with the provisions of Sections 24(5) and Section 44 of the NEMA the Minister has published Regulations (GN R. 982) pertaining to the required process for conducting EIA's in order to apply for, and be considered for, the issuing of an EA. These EIA Regulations provide a detailed description of the EIA process to be followed when applying for EA for any listed activity.

An environmental Scoping and Impact Assessment process is reserved for activities which have the potential to result in significant impacts which are complex to assess. Scoping and Impact Assessment studies accordingly provide a mechanism for the comprehensive assessment of activities that are likely to have more significant environmental impacts. Figure 23 below provides a graphic representation of all the components of a full EIA process. The listed activities the proposed project triggers and consequently requires authorisation prior to commencement are detailed in Section 0 (Table 8).

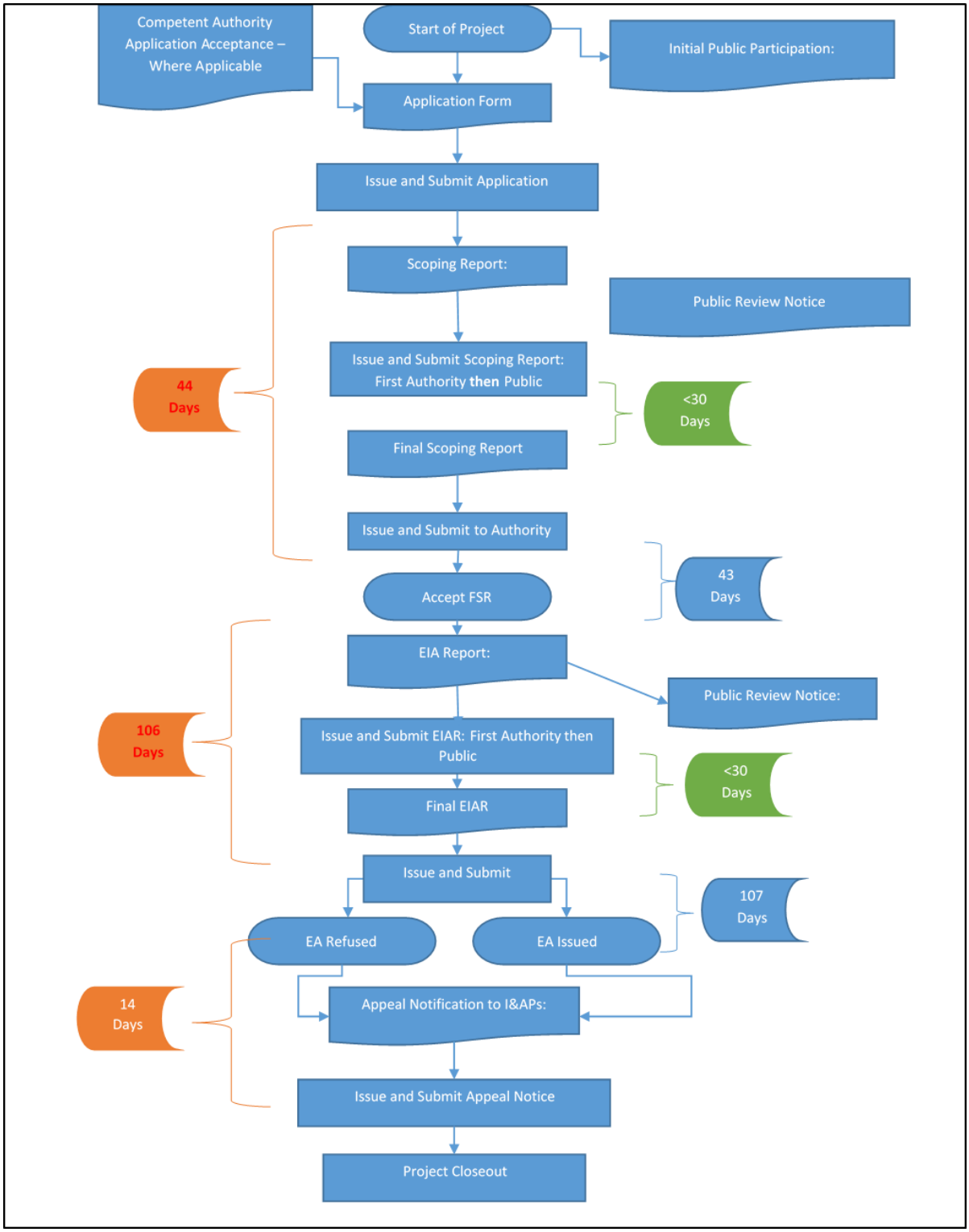


Figure 23: EIA process diagram.

5.4 THE NATIONAL WATER ACT (NWA)

The National Water Act, 1998 (Act 36 of 1998 – NWA) makes provision for two types of applications for water use licences, namely individual applications and compulsory applications. The NWA also provides that the responsible authority may require an assessment by the applicant of the likely effect of the proposed licence on the resource quality, and that such assessment be subject to the NEMA EIA Regulations. A person may use water if the use is –

- Permissible as a continuation of an existing lawful water use (ELWU);
- Permissible in terms of a general authorisation (GA);
- Permissible under Schedule 1; or
- Authorised by a licence.

These water use processes are described in Figure 24.

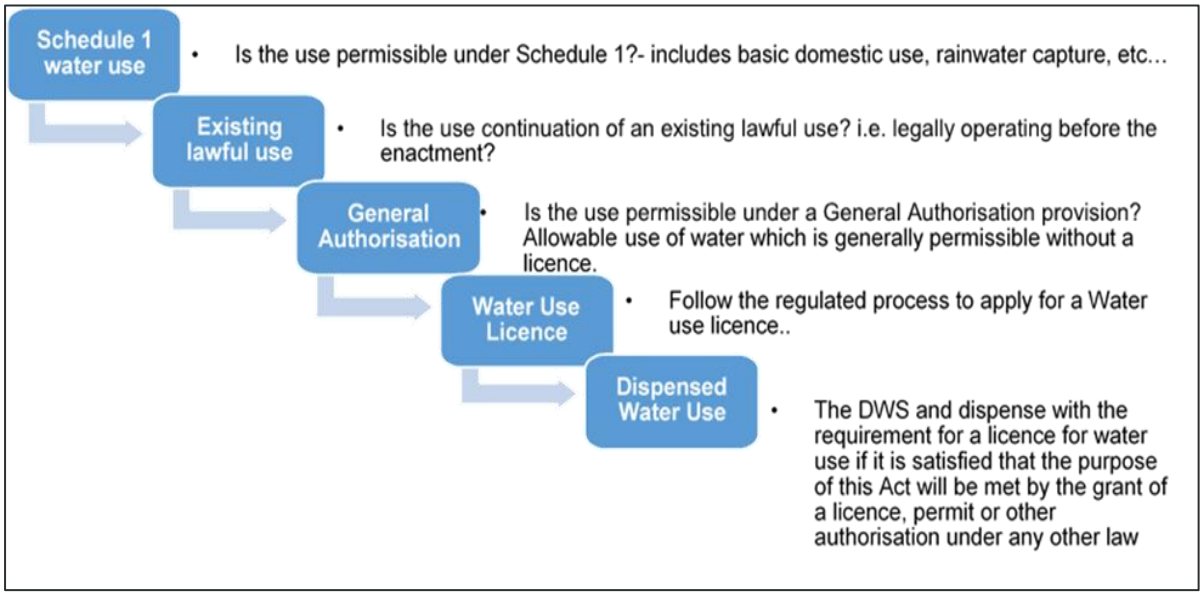


Figure 24: Authorisation processes for new water uses

The NWA defines 11 water uses in Section 21 of the Act. A water use may only be undertaken if authorised by the Department of Human Settlements Water and Sanitation (DHSWS). The water uses for which an authorisation or licence can be issued include:

a) Taking water from a water resource;

b) Storing water;

c) Impeding or diverting the flow of water in a watercourse;

d) Engaging in a stream flow reduction activity contemplated in section 36;

e) Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);

f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduits;

g) Disposing of waste in a manner which may detrimentally impact on a water resource;

h) Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i) Altering the bed, banks, course or characteristics of a watercourse;

j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

k) Using water for recreational purposes.

The proposed Cluster 2 Gas Production Project includes extensive linear infrastructure which will impact on water resources in certain areas. The main water use that will be applicable is the Section 21 (c&i) uses for

activities within proximity (or within) the regulated area of a watercourse. A watercourse is defined in terms of the Act as follows:

a) a river or spring;

b) a natural channel in which water flows regularly or intermittently;

c) a wetland, lake or dam into which, or from which, water flows; and

d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse,

and a reference to a watercourse includes, where relevant, its bed and banks;

The regulated area of a watercourse for section 21(c) or (i) of the Act water uses is similarly defined in terms of the Act as follows:

a) The outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;

b) In the absence of a determined 1 in 100-year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or

c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

As part of this EIA process, specialist input was obtained to delineate the watercourses as well as the 1 in 100-year floodlines and based on this input, the relevant water uses have been identified and are currently being applied for. The required water use licencing process is running concurrently with the EIA process.

5.4.1 CATCHMENT MANAGEMENT STRATEGIES

South Africa is divided into nineteen Water Management Areas (WMAs). The delegation of water resource management from central government to catchment level is achieved by establishing Catchment Management Agencies (CMAs) at WMA level. Each CMA progressively develops a Catchment Management Strategy (CMS) for the protection, use, development, conservation, management and control of water resources within its WMA. This is to ensure that on a regional scale, water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner for the benefit of all persons. The main instrument that guides and governs the activities of a WMA is the Catchment Management Strategy (CMS) which, while conforming to relevant legislation and national strategies, provides detailed arrangements for the protection, use, development, conservation, management and control of the region's water resources. According to the DHSWS water management areas delineations, the Cluster 2 Gas Production Project is situated in primary catchment (C) of the Vaal River drainage system which covers a total area of approximately 246 674.5 km^2. The resource management falls under the Vaal Water Management Area (WMA5) which spans portions of the North West Province, northern Free State as well northern sections of the Northern Cape. The application area is situated within quaternary catchments C42K (nett surface area of 668.0 km^2) and C42L (nett surface area of 510.8 km^2), falls within hydrological zone E and has an estimated mean annual runoff (MAR) of between 10.0 to 13.0 mcm (million cubic metres) (WR 2012).

5.5 THE NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT (NEMWA)

On 2 June 2014, the National Environmental Management: Waste Amendment Act came into force. Waste is accordingly no longer governed by the MPRDA but is subject to all the provisions of the National Environmental Management: Waste Act, 2008 (NEMWA).

Section 16 of the NEMWA must also be considered which states as follows:

1. A holder of waste must, within the holder's power, take all reasonable measures to-

    a) "Avoid the generation of waste and where such generation cannot be avoided, to minimise the toxicity and amounts of waste that are generated;

b) *Reduce, re-use, recycle and recover waste;*

c) *Where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner;*

d) *Manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise, odour, or visual impacts;*

e) *Prevent any employee or any person under his or her supervision from contravening the Act; and*

f) *Prevent the waste from being used for unauthorised purposes.*"

These general principles of responsible waste management will be incorporated into the requirements in the EMPr to be implemented for this project. Waste can be defined as either hazardous or general in accordance with Schedule 3 of the NEMWA (2014) as amended. "Schedule 3: Defined Wastes" has been broken down into two categories – Category A being hazardous waste; and Category B being general waste.

In order to attempt to understand the implications of these waste groups, it is important to ensure that the definitions of all the relevant terminologies are defined:

- Hazardous waste: means "*any waste that contains organic or inorganic elements or compounds that may, owning to the inherent physical, chemical or toxicological characteristic of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within business waste, residue deposits and residue stockpiles*."
- Residue deposits: means "*any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right*."
- Residue stockpile: means "*any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, mineral processing plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated within the mining area for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or, production right or an old order right, including historic mines and dumps created before the implementation of this Act*."
- General waste: means "*waste that does not pose an immediate hazard or threat to health or to the environment and includes – domestic waste; building and demolition waste; business waste; inert waste; or any waste classified as non-hazardous waste in terms of the regulations made under Section 69*."

Furthermore, the NEMWA provides for specific waste management measures to be implemented, as well as providing for the licensing and control of waste management activities. The Cluster 2 Gas Production Project triggers waste management activities in terms of Category A as well as Category B of GN 921, the latter of which states that "*a person who wishes to commence, undertake or conduct an activity listed under this Category, must conduct an environmental impact assessment process, as stipulated in the environmental impact assessment regulations made under section 24(5) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) as part of a waste management licence application*."

The listed waste activities that are triggered by the project, and which form the basis of this integrated waste management licence application, are presented in Section 0 (Table 8).

The Waste Classification and Management Regulations (GNR 634) pertain to waste classification and management, including the management and control of residue stockpiles and residue deposits from a prospecting, mining, exploration or production operation which is relevant to the proposed project. The purpose of these Regulations is to –

- Regulate the classification and management of waste in a manner which supports and implements the provisions of the Act;

- Establish a mechanism and procedure for the listing of waste management activities that do not require a Waste Management Licence;
- Prescribe requirements for the disposal of waste to landfill;
- Prescribe requirements and timeframes for the management of certain wastes; and
- Prescribe general duties of waste generators, transporters and managers.

Waste classification, as presented in Chapter 4 of these regulations, entails the following:

- Wastes listed in Annexure 1 of these Regulations do not require classification in terms of SANS 10234;
- Subject to sub regulation (1), all waste generators must ensure that the waste they generate is classified in accordance with SANS 10234 within one hundred and eighty (180) days of generation;
- Waste must be kept separate for the purposes of classification in terms of sub regulation (2), and must not be mixed prior to classification;
- Waste-must be re-classified in terms of sub regulation (2) every five (5) years, or within 30 days of modification to the process or activity that generated the waste, changes in raw materials or other inputs, or any other variation of relevant factors;
- Waste that has been subjected to any form of treatment must be re-classified in terms of sub regulation (2), including any waste from the treatment process; and
- If the Minister reasonably believes that a waste has not been classified correctly in terms of sub regulation (2), he or she may require the waste generator to have the classification peer reviewed to confirm the classification.

Furthermore, Chapter 8 of the Regulations stipulates that unless otherwise directed by the Minister to ensure a better environmental outcome, or in response to an emergency so as to protect human health, property or the environment –

- Waste generators must ensure that their waste is assessed in accordance with the Norms and Standards for Assessment of Waste for Landfill Disposal set in terms of section 7(1) of the Act prior to the disposal of the waste to landfill;
- Waste generators must ensure that the disposal of their waste to landfill is done in accordance with the Norms and Standards for Disposal of Waste to Landfill set in terms of section 7(1) of the Act; and
- Waste managers disposing of waste to landfill must only do so in accordance with the Norms and Standards for Disposal of Waste to Landfill set in terms of section 7 (1) of the Act.

Tetra4 has recently undertaken a waste classification study of the drill waste to in order to determine the waste class (general or hazardous). The reason for this study was to confirm if the current practice for Cluster 1 exploration drilling whereby all drill waste is being disposed of as hazardous waste to Holfontein Waste Disposal Facility is justifiable or if only a particular fraction of the waste would be hazardous. Samples were taken from various depths during the drilling operation to determine if one of more of the lithologies (rock layers) contained hazardous levels of relevant elements. Ironically, all lithologies being drilled through resulted in a type 3 hazardous waste rating. As such, the storage and disposal of the drill waste must be handled accordingly and therefore the relevant waste listed activities for storage are being applied for as part of this application. As there are no suitably licenced waste disposal facilities near to the application area, this waste will continue to be disposed of at Holfontein Waste Disposal Facility until (and if) such time as another facility is identified.

5.6 THE NATIONAL ENVIRONMENTAL MANAGEMENT AIR QUALITY ACT (NEMAQA)

The National Environmental Management: Air Quality Act (Act No. 39 of 2004 as amended – NEMAQA) is the main legislative tool for the management of air pollution and related activities. The Object of the Act is:

- To protect the environment by providing reasonable measures for –
    i. the protection and enhancement of the quality of air in the republic;
    ii. the prevention of air pollution and ecological degradation; and
    iii. securing ecologically sustainable development while promoting justifiable economic and social development; and
- Generally, to give effect to Section 24(b) of the constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people.

The NEMAQA mandates the Minister of Environment to publish a list of activities which result in atmospheric emissions and consequently cause significant detrimental effects on the environment, human health and social welfare. All scheduled processes as previously stipulated under the Air Pollution Prevention Act (APPA) are included as listed activities with additional activities being added to the list. The updated Listed Activities and Minimum National Emission Standards were published on the 22nd November 2013 (Government Gazette No. 37054).

According to the NEMAQA, air quality management control and enforcement is in the hands of local government with District and Metropolitan Municipalities as the licensing authorities. Provincial government is primarily responsible for ambient monitoring and ensuring municipalities fulfil their legal obligations, with national government primarily as policy maker and co-ordinator. Each sphere of government must appoint an Air Quality Officer responsible for co-ordinating matters pertaining to air quality management. Given that air quality management under the old Act was the sole responsibility of national government, local authorities have in the past only been responsible for smoke and vehicle tailpipe emission control.

The National Pollution Prevention Plans Regulations were published in March 2014 (Government Gazette 37421) and tie in with the National Greenhouse Gas (GHG) Emission Reporting Regulations which took effect on 3 April 2017. In summary, the Regulations aim to prescribe the requirements that pollution prevention plans of greenhouse gases declared as priority air pollutants, need to comply with in terms of the NEMAQA. The Regulations specify who needs to comply, and by when, as well as prescribing the content requirements. Tetra4 has an obligation to report on the GHG emissions under these Regulations. There is also a requirement to account for the amount of pollutants discharged into the atmosphere (total emissions for one or more specific GHG pollutants) by 31 March each year.

As part of this EIA application, an Air Quality and GHG study has been undertaken and an amendment to the Cluster 1 AEL will be undertaken to include the Cluster 2 relevant aspects once a decision is made on this application.

5.6.1 NATIONAL DUST CONTROL REGULATIONS

Dustfall is assessed for nuisance impact and not for inhalation health impact. The National Dust Control Regulations (Department of Environmental Affairs, 2013) prescribes measures for the control of dust in residential and non-residential areas. Acceptable dustfall rates are measured (using American Standard Testing Methodology (ASTM) D1739:1970 or equivalent) at and beyond the boundary of the premises where dust originates. In addition to the dustfall limits, the National Dust Control Regulations prescribe monitoring procedures and reporting requirements. Dust that may be created from the Cluster 2 project (including but not limited to the construction phase) will be managed in accordance with these Regulations.

5.7 THE NATIONAL HERITAGE RESOURCES ACT (NHRA)

The National Heritage Resources Act (Act 25 of 1999 – NHRA) stipulates that cultural heritage resources may not be disturbed without authorisation from the relevant heritage authority. Section 34(1) of the NHRA states that, "*no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…*" The NHRA is utilised as the basis for the identification, evaluation and management of heritage resources and in the case of Cultural Resource Management (CRM) those resources specifically impacted on by development as stipulated in Section 38 of NHRA, and those developments administered through the NEMA, MPRDA and the Development Facilitation Act (FDA) legislation. In the latter cases the feedback from the relevant heritage resources authority is required by the State and Provincial Departments managing these Acts before any authorisations are granted for a development. The last few years have seen a significant change towards the inclusion of heritage assessments as a major component of Environmental Impact Processes required by the NEMA and MPRDA.

The NEMA 23(2)(b) states that an integrated environmental management plan should, "*…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage*". A study of subsections (23)(2)(d), (29)(1)(d), (32)(2)(d) and (34)(b) and their requirements reveals the compulsory inclusion of the identification of cultural resources, the evaluation of the impacts of the proposed activity on these resources, the identification of alternatives and the management procedures for such cultural resources for each of the documents noted in the Environmental Regulations. A further important aspect to be taken into account of in the EIA Regulations under the NEMA relates to the Specialist Report requirements (Appendix 6 of EIA Regulations 2014, as amended).

The MPRDA defines 'environment' as it is in the NEMA and, therefore, acknowledges cultural resources as part of the environment. Section 39(3)(b) of this Act specifically refers to the evaluation, assessment and identification of impacts on all heritage resources as identified in Section 3(2) of the NHRA that are to be impacted on by activities governed by the MPRDA. Section 40 of the same Act requires the consultation with any State Department administering any law that has relevance on such an application through Section 39 of the MPRDA. This implies the evaluation of Heritage Assessment Reports in Environmental Management Plans or Programmes by the relevant heritage authorities.

In accordance with the legislative requirements and EIA rating criteria, the regulations of the South African Heritage Resources Agency (SAHRA) and Association of Southern African Professional Archaeologists (ASAPA) have also been incorporated to ensure that a comprehensive and legally compatible Heritage Report is compiled.

5.8 NATIONAL ENVIRONMENTAL MANAGEMENT BIODIVERSITY ACT (NEMBA)

The National Environmental Management Biodiversity Act (Act No. 10 of 2004 – NEMBA) provides for the management and conservation of South Africa's biodiversity within the framework of the NEMA as well as the protection of species and ecosystems that warrant national protection. Within the framework of this act, various regulations are promulgated which provide specific requirements and management measures relating to protecting threatened ecosystems, threatened or protected species as well as the control of alien and invasive species. A summary of these regulations is presented below.

5.8.1.1 NATIONAL LIST OF ECOSYSTEMS THAT ARE THREATENED AND NEED OF PROTECTION (GN 1002 OF 2011)

The NEMBA provides for listing of threatened or protected ecosystems in one of the following categories:

- Critically Endangered (CR) ecosystems, being ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation;
- Endangered (EN) ecosystems, being ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems;

- Vulnerable (VU) ecosystems, being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems; and
- Protected ecosystems, being ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed as critically endangered, endangered or vulnerable.

The Biodiversity Specialist has assessed whether any of these threatened or protected ecosystems occur within the study area and provided recommendations on how the development should be reduced in certain area. Permits for protected species under the NEMBA may also be required and this requirement for pre-construction surveys and permit applications has been included in the EMPr.

5.8.1.2 THREATENED OR PROTECTED SPECIES REGULATIONS (GN R 152 OF 2007)

The purpose of these regulations is to -

(a) further regulate the permit system set out in Chapter 7 of the Biodiversity Act insofar as that system applies to restricted activities involving specimens of listed threatened or protected species;

(b) provide for the registration of captive breeding operations, commercial exhibition facilities, game farms, nurseries, scientific institutions, sanctuaries and rehabilitation facilities and wildlife traders;

(c) provide for the regulation of the carrying out of a specific restricted activity, namely hunting;

(d) provide for the prohibition of specific restricted activities involving specific listed threatened or protected species;

(e) provide for the protection of wild populations of listed threatened species; and

(f) provide for the composition and operating procedure of the Scientific Authority.

5.8.1.3 ALIEN AND INVASIVE SPECIES LIST

This Act is applicable since it protects the quality and quantity of arable land in South Africa. Loss of arable land should be avoided and declared Weeds and Invaders in South Africa are categorised according to one of the following categories, and require control or removal:

- Category 1a Listed Invasive Species: Category 1a Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be combated or eradicated;
- Category 1b Listed Invasive Species: Category 1b Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be controlled;
- Category 2 Listed Invasive Species: Category 2 Listed Invasive Species are those species listed by notice in terms of section 70(1)(a) of the Act as species which require a permit to carry out a restricted activity within an area specified in the Notice or an area specified in the permit, as the case may be; and
- Category 3 Listed Invasive Species: Category 3 Listed Invasive Species are species that are listed by notice in terms of section 70(1)(a) of the Act, as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of Act, as specified in the Notice.

Alien and invasive species (AIS) control has been included as a management measure in the EMPr. Tetra4 will be required to continually monitor their development footprint areas for the presence of AIS and implement suitable control measures to prevent further establishment or spread of these species.

5.9 THE CONSERVATION OF AGRICULTURAL RESOURCES ACT (CARA)

The Conservation of Agricultural Resources (Act 43 of 1983) aims to provide for the conservation of the natural agricultural resources of the Republic by the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the

vegetation and the combating of weeds and invader plants. In order to achieve the objectives of this Act, control measures related to the following may be prescribed to land users to whom they apply:

- The cultivation of virgin soil;
- The utilisation and protection of land which is cultivated;
- The irrigation of land;
- The prevention or control of waterlogging or salination of land;
- The utilisation and protection of vleis, marshes, water sponges, water courses and water sources;
- The regulating of the flow pattern of run-off water;
- The utilisation and protection of the vegetation;
- The grazing capacity of veld, expressed as an area of veld per large stock unit;
- The maximum number and the kind of animals which may be kept on veld;
- The prevention and control of veld fires;
- The utilisation and protection of veld which has burned;
- The control of weeds and invader plants;
- The restoration or reclamation of eroded land or land which is otherwise disturbed or denuded;
- The protection of water sources against pollution on account of farming practices;
- The construction, maintenance, alteration or removal of soil conservation works or other structures on land; and
- Any other matter which the Minister may deem necessary or expedient in order that the objects of this Act may be achieved.

Further, different control measures may be prescribed in respect of different classes of land users or different areas or in such other respects as the Minister may determine. Impacts on the agriculture and soil, biodiversity and water resources have been identified with regards to this project, and mitigation and management measures recommended.

5.10 ENVIRONMENT CONSERVATION ACT (ECA)

The Environment Conservation Act (Act 73 of 1989 – ECA) was, prior to the promulgation of the NEMA, the backbone of environmental legislation in South Africa. To date the majority of the ECA has been repealed by various other Acts, however Section 25 of the Act and the Noise Regulations (GN R. 154 of 1992) promulgated under this section are still in effect. These Regulations serve to control noise and general prohibitions relating to noise impact and nuisance.

5.10.1 NOISE CONTROL REGULATIONS, 1992 (GN R.154)

In terms of section 25 of the ECA, the National Noise Control Regulations (GN R. 154 – NCRs) published in Government Gazette No. 13717 dated 10 January 1992, were promulgated. The NCRs were revised under GN R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations. Provincial noise control regulations have been promulgated in Gauteng, Free State and Western Cape Provinces.

The NCRs will need to be considered in relation to the potential noise that may be generated mainly during the construction phase of the proposed project. The two key aspects of the NCRs relate to disturbing noise and noise nuisance.

Section 4 of the Regulations prohibits a person from making, producing or causing a disturbing noise, or allowing it to be made produced or caused by any person, machine, device or apparatus or any combination thereof. A disturbing noise is defined in the Regulations as "*a noise level which exceeds the zone sound level or if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more*."

Section 5 of the NCRs in essence prohibits the creation of a noise nuisance. A noise nuisance is defined as "*any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person".* The South African National Standard 10103 also applies to the measurement and consideration of environmental noise and should be considered in conjunction with these Regulations.

5.10.2 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from mines, industry and roads. They are:

- South African National Standard (SANS) 10103:2008 – 'The measurement and rating of environmental noise with respect to annoyance and to speech communication';
- SANS 10210:2004 – 'Calculating and predicting road traffic noise';
- SANS 10328:2008 – 'Methods for environmental noise impact assessments';
- SANS 10357:2004 – 'The calculation of sound propagation by the Concave method';
- SANS 10181:2003 – 'The Measurement of Noise Emitted by Road Vehicles when Stationary'; and
- SANS 10205:2003 – 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful per se. A noise impact assessment has been undertaken for this project and the findings utilised in the impact assessment and associated management measures in the EMPr.

5.11 THE SPATIAL PLANNING AND LAND USE MANAGEMENT ACT (SPLUMA)

The Spatial Planning and Land Use Management (Act 16 of 2013 – SPLUMA) is set to aid effective and efficient planning and land use management, as well as to promote optimal exploitation of minerals and mineral resources. The SPLUMA was developed to legislate for a single, integrated planning system for the entire country. Therefore, the Act provides a framework for a planning system for the country and introduces provisions to cater for development principles; norms and standards; inter-governmental support; Spatial Development Frameworks (SDFs) across national, provincial, regional and municipal areas; Land Use Schemes (LUS); and municipal planning tribunals.

Tetra4 is in the process of undertaking the relevant rezoning or land use change applications for the Plant.

5.12 OCCUPATIONAL HEALTH AND SAFETY ACT

The Occupational Health and Safety Act (Act 85 of 1993 - OHSA) provides for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work; to establish an advisory council for occupational health and safety; and to provide for matters connected therewith. Worker safety will form part of the contractors safety requirements and be guided by the OHSA. This would entail a full health and safety file including but not limited to pre-mobilization medical assessments, work environment and task specific risk assessments and method statements etc. Once the plant is in operation worker safety will be covered by the Tetra4 safety philosophy, risk assessments and Standard Operating Procedures which are all required to comply with the OHSA and or Mine

Health and Safety Act (dependent on the specific aspect of the production operations). Therefore safety of all personnel will be guided by overarching South African legislation.

The Major Hazard Installation Regulations (GNR 692 of 30 July 2001) are promulgated under the OHSA and apply to employers, self-employed persons and users, who have on their premises, either permanently or temporarily, a major hazard installation or a quantity of a substance which may pose a risk that could affect the health and safety of employees and the public.

A "major hazard installation" means an installation-

a) where more than the prescribed quantity of any substance is or may be kept, whether permanently or temporarily; or

b) where any substance is produced, processed, used, handled or stored in such a form and quantity that it has the potential to cause a major incident;

Major Hazard Installation (MHI) risk assessments have been undertaken on both the gas transmission infrastructure as well as the LNG Plant and the reports are included in Appendix 8. A summary of the findings and recommendations of the MHI studies are as follows:

- Gas transmission infrastructure:
    - The pipeline route does not pose any fatality risk to the public.
    - The societal risk is zero.
    - There should not be any restriction on land-use planning in the area of the pipeline route other than to prevent possible damage to the sub-surface pipelines.
    - Tetra4 Pipeline Route should NOT be classified as an MHI.
    - Future development of the pipeline route does not have to be subjected to an MHI risk assessment given that the maximum pressure in any part of the pipeline route does not exceed 30bar.
- LNG Plant:
    - The maximum extent of the 1% consequence lethality zone is 594m, which will not impact on any residential area or sensitive receptor.
    - The risk posed to the public is lower than $1x10^{-7}$ fatality/person/year (f/p/y).
    - The societal risk is well below the tolerable level in terms of SANS 1461:2018 and thus broadly acceptable.
    - The maintenance plan for the CNG and LNG facilities must be maintained.
    - The site emergency plan must be reviewed in accordance with SANS 1514:2018.
    - There should not be any restriction on land-use planning outside the perimeter of Tetra4 except in the case of development within the 10^{-7}f/p/y risk zone, where such development will involve vulnerable members of the public (children, those with mobility difficulties or those unable to recognise physical danger), in which case advise against development should be obtained from the local authorities.
    - The Tetra4 LNG Plant should be classified as an MHI.

5.13 BASIC CONDITIONS OF EMPLOYMENT ACT

The Basic Conditions of Employment Act (Act 75 of 1997) gives effect to the right to fair labour practices referred to in section 23(1) of the Constitution by establishing and making provision for the regulation of basic conditions of employment; and thereby to comply with the obligations of the Republic as a member state of the International Labour Organisation. The Basic Conditions of Employment Amendment Act, No 20 of 2013 was published and became effective on 1 September 2014.

5.14 LABOUR RELATIONS ACT

The Labour Relations Act (Act 66 of 1995) aims to promote economic development, social justice, labour peace and democracy in the workplace. It sets out to achieve this by fulfilling the primary objectives of the Act, which are to give effect to and regulate the fundamental rights conferred by section 27 of the Constitution, including the right to fair labour practices, to form and join trade unions and employer's organisations, to organise and bargain collectively, and to strike and lock out; to provide a framework for regulating the relationship between employees and their unions on the one hand, and employers and their organisations on the other hand. At the same time it also encourages employers and employees to regulate relations between themselves; and to promote orderly collective bargaining, collective bargaining at sectoral level, employee participation in decision-making in the workplace and the effective resolution of labour disputes.

5.15 EMPLOYMENT EQUITY ACT

The Employment Equity Act (Act 55 of 1998) promotes equity in the workplace, ensures that all employees receive equal opportunities and that employees are treated fairly by their employers. The law protects employees from unfair treatment and any form of discrimination. The law states that an employer may not discriminate against an employee directly or indirectly through employment policy or practice on the grounds of race, gender, pregnancy, marital status, family responsibility, ethnic or social origin, colour, sexual orientation, age, disability, religion, HIV status, conscience, belief, political opinion, culture, language, and birth.

The law aims to redress injustices of the past by implementing affirmative action measures. According to the legislation, it isn't unfair discrimination to promote affirmative action consistent with the Act or to prefer or exclude any person on the basis of an inherent job requirement.

5.16 PROMOTION OF EQUALITY AND PREVENTION OF UNFAIR DISCRIMINATION

The Promotion of Equality and Prevention of Unfair Discrimination Act (Act 4 of 2000) gives expression to the right to equality. Section 8 stipulates that no person may be unfairly discriminated against on the grounds of gender, expressly including gender-based violence. Section 8 of the Act goes onto prohibit any limitation of women's access to social services, such as health or education, and the denial or systemic inequality of access to opportunities.

5.17 FIREARMS CONTROL ACT

Firearm Control Act (Act no. 60 of 2000) and associated amendments establishes the procedures under which a firearm is permitted. It includes the provisions for permitting procedures for persons in South Africa who seek to obtain a firearm, including procedures for ensuring competency and associated licencing and permits as well as procedures to terminate firearm licences. Any safety and/or security personnel working on the project must comply with the Firearms Control Act where relevant and ensure that their actions always consider the safety of the public.

5.18 NATIONAL ENERGY ACT

The National Energy Act (Act 34 of 2008) provides to ensure that diverse energy resources are available, in sustainable quantities and at affordable prices, to the South African economy in support of economic growth and poverty alleviation, taking into account environmental management requirements and interactions amongst economic sectors; to provide for energy planning, increased generation and consumption of renewable energies, contingency energy supply, holding of strategic energy feedstocks and carriers, adequate investment in, appropriate upkeep and access to energy infrastructure; to provide measures for the furnishing of certain data and information regarding energy demand, supply and generation; to establish an institution to be responsible for promotion of efficient generation and consumption of energy and energy research; and to provide for all matters connected therewith. Importantly, the Department of Energy (DoE) is mandated to provide for energy planning and measures for the furnishing of certain data and information regarding energy demand, supply and generation.

The objectives of this Act are to:

a) Ensure uninterrupted supply of energy to the Republic;

b) Promote diversity of supply of energy and its sources;

c) Facilitate effective management of energy demand and its conservation;

d) Promote energy research;

e) Promote appropriate standards and specifications for the equipment, systems and processes used for producing, supplying and consuming energy;

f) Ensure collection of data and information relating to energy supply, transportation and demand;

g) Provide for optimal supply, transformation, transportation, storage and demand of energy that are planned, organised and implemented in accordance with a balanced consideration of security of supply, economics, consumer protection and a sustainable development;

h) Provide for certain safety, health and environment matters that pertain to energy;

i) Facilitate energy access for improvement of the quality of life of the people of Republic;

j) Commercialise energy related technologies;

k) Ensure effective planning for energy supply, transportation and consumption; and

l) Contribute to sustainable development of South Africa s economy.

The Act provides for the establishment of the South African National Energy Development Institution (SANEDI), whose functions include:

Energy efficiency –

i. Undertake energy efficiency measures as directed by the Minister;

ii. Increase energy efficiency throughout the economy;

iii. Increase the gross domestic product per unit of energy consumed; and

iv. Optimise the utilisation of finite energy resources;

Energy research and development -

i. Direct, monitor, conduct and implement energy research and technology development in all fields of energy, other than nuclear energy;

ii. Promote energy research and technology innovation; and

iii. Provide for –

    a. training and development in the field of energy research and technology development;

    b. establishment and expansion of industries in the field of energy; and

    c. commercialisation of energy technologies resulting from energy research and development programmes;

iv. Register patents and intellectual property i n its name resulting from its activities;

v. Issue licences to other persons for the use of its patents and intellectual property;

vi. Publish information concerning its objects and functions;

vii. Establish facilities for the collection and dissemination of information in connection with research, development and innovation;

viii. Undertake any other energy technology development related activity as directed by the Minister, with the concurrence of the Minister of Science and Technology;

ix. Promote relevant energy research through cooperation with any entity, institution or person equipped with the relevant skills and expertise within and outside the Republic;

x. Make grants to educational and scientific institutions in aid of research by their staff or for the establishment of facilities for such research;

xi. Promote the training of research workers by granting bursaries or grants in aid for research;

xii. Undertake the investigations or research that the Minister, after consultation with the Minister of Science and Technology, may assign to it; and

xiii. Advise the Minister and the Minister of Science and Technology on research in the field of energy technology.

In addition to the Liquid Helium (LHe) production, Liquid Natural Gas (LNG) is one of the other products the Cluster 2 Gas Production Project will produce. LNG will be utilised mainly as an energy source supplied to end users within South Africa and abroad. The processing and supply of this LNG will be subject to the conditions and requirements of this Act, and the gas production on the whole will contribute to the South African economy and promote development in technologies pertaining to helium and LNG extraction and processing.

5.19 GAS ACT

The Gas Act (Act 48 of 2001) aims to promote the orderly development of the piped gas industry; to establish a national regulatory framework; to establish a National Gas Regulator as the custodian and enforcer of the national regulatory framework; and to provide for matters connected therewith. The Tetra4 Production Right (inclusive of the existing Cluster 1 and the proposed Cluster 2 gas field) will contribute towards the development of the gas industry in South Africa.

5.20 GAS MASTER PLAN AND INTEGRATED RESOURCE PLAN

The SA Government has published a Gas Master Plan in December 2021 for comments from the public. The background to the Master Plan is the following (quoted directly from the plan): "*The National Development Plan (NDP) envisions that by 2030 South Africa will have an energy sector that promotes economic growth and development through adequate investment in energy infrastructure. At just 2.6% of the country's total energy mix, South Africa's natural gas market is small, but with all its inherent benefits, it has the potential to completely change the economy by stimulating economic growth and development, stability, and job creation. The meaningful addition of natural gas to the country's energy mix will rejuvenate an overburdened, out-dated energy infrastructure and reduce cyclical energy shortfalls. Perhaps even more importantly, it will stimulate the economy by allowing business and industry to lower their energy and operational spend while also creating significant numbers of new jobs and skills development opportunities. Considering that nearly 90% of South Africa's existing natural gas demand is supplied by a single entity, namely Sasol Gas, the associated economic and employment risks of limited supply options, development and sourcing of alternative natural gas resources are high. It is imperative to ensure economic and employment stability within the natural gas sector by introducing more suppliers. Southern Africa's gas potential has been revealed by major discoveries that, when developed, widen options for greater regional energy trade. South Africa's gas resource potential remains to be quantified but raises the prospect of possible domestic production in the longer term. Globally the natural gas industry has moved into a supply surplus, favouring a larger role for gas as a clean fossil fuel in many countries' energy policies. A challenge in developing the gas sector is to bring gas demand and supply on stream at the same time and spread geographically to stimulate broader localized demand through South Africa. Without such localized gas demand, it is difficult to develop distributed gas supply and without such distributed gas supply it is difficult to develop localized gas demand. One way of breaking this impasse is to create significant "anchor" gas demand through the development of a gas-to-power programme. In pursuit of adding generating capacity, lowering carbon emissions, enhancing energy security and supporting industrial development, South Africa has taken the first steps in a gas-to-power programme to be executed under the Integrated Resource Plan 2019, aiming to increase the national energy mix natural gas contribution from 2.6% to 15.7% by 2030*."

5.21 OTHER APPLICABLE ACTS AND LOCAL OR INTERNATIONAL GUIDELINES OR STANDARDS

Other applicable acts and guidelines include: The DFFE Public Participation Guidelines; The Free State Nature Conservation Ordinance 8 of 1969; The National Veld and Forest Fire Act 101 of 1998; and Masilonyana and Matjhabeng Local Municipalities Integrated Development Plans. In addition, the municipal planning documents such as the Local Municipality By-laws on Spatial Planning and Land Use Management are also applicable to the project. These Acts, Ordinances, plans and guidelines have been considered in the preparation of this report.

In addition to the relevant provincial or local guidelines, there exists various international guidelines or standards that have relevance to this project and application, and these are described below.

5.21.1 IFC PERFORMANCE STANDARDS

The International Finance Corporation (IFC) is an international financial institution that offers investment, advisory, and asset management services to encourage private sector development in developing countries. The IFC is a member of the World Bank Group (WBG) and is headquartered in Washington, D.C., United States. It was established in 1956 as the private sector arm of the WBG to advance economic development by investing in strictly for-profit and commercial projects that purport to reduce poverty and promote development.

The IFC's stated aim is to create opportunities for people to escape poverty and achieve better living standards by mobilizing financial resources for private enterprise, promoting accessible and competitive markets, supporting businesses and other private sector entities, and creating jobs and delivering necessary services to those who are poverty-stricken or otherwise vulnerable. Since 2009, the IFC has focused on a set of development goals that supported projects are expected to target. Its goals are to increase sustainable agriculture opportunities, improve health and education, increase access to financing for microfinance and business clients, advance infrastructure, help small businesses grow revenues, and invest in climate health.

The IFC is owned and governed by its member countries but has its own executive leadership and staff that conduct its normal business operations. It is a corporation whose shareholders are member governments that provide paid-in capital and which have the right to vote on its matters. Originally more financially integrated with the WBG, the IFC was established separately and eventually became authorized to operate as a financially autonomous entity and make independent investment decisions. It offers an array of debt and equity financing services and helps companies face their risk exposures, while refraining from participating in a management capacity. The corporation also offers advice to companies on making decisions, evaluating their impact on the environment and society, and being responsible. It advises governments on building infrastructure and partnerships to further support private sector development.

The IFC’s Sustainability Framework articulates the Corporation’s strategic commitment to sustainable development and is an integral part of IFC’s approach to risk management. The Sustainability Framework comprises IFC’s Policy and Performance Standards on Environmental and Social Sustainability, and IFC’s Access to Information Policy. The Policy on Environmental and Social Sustainability describes IFC’s commitments, roles, and responsibilities related to environmental and social sustainability. IFC’s Access to Information Policy reflects IFC’s commitment to transparency and good governance on its operations and outlines the Corporation’s institutional disclosure obligations regarding its investment and advisory services. The Performance Standards (PSs) are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities. In the case of its direct investments (including project and corporate finance provided through financial intermediaries), IFC requires its clients to apply the PSs to manage environmental and social risks and impacts so that development opportunities are enhanced. IFC uses the Sustainability Framework along with other strategies, policies, and initiatives to direct the business activities of the Corporation to achieve its overall development objectives. The PSs are often also be applied by other financial institutions and therefore these PSs are discussed in Table 9 in terms of the applicability of the various PSs to this Tetra4 Cluster 2 development proposal.

Table 9: IFC Performance Standards applicability to this project.

<table>
<tr><th colspan="4">Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts</th></tr>
<tr><td>Overview</td><td colspan="3">Performance Standard 1 underscores the importance of managing environmental and social performance throughout the life of a project. An effective Environmental and Social Management System (ESMS) is a dynamic and continuous process initiated and supported by management, and involves engagement between the client, its workers, local communities directly affected by the project (the Affected Communities) and, where appropriate, other stakeholders.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To identify and evaluate environmental and social risks and impacts of the project.
➢ To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities, and the environment.
➢ To promote improved environmental and social performance of clients through the effective use of management systems.
➢ To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately.
➢ To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.</td></tr>
<tr><td rowspan="9">Aspects</td><td>1.1</td><td>• Policy</td><td rowspan="9"><u>Consideration of PS1 to this project:</u>
The South African NEMA EIA Regulations are specifically geared towards ensuring that a projects environmental and social risks and impacts are identified and assessed in order to put forward suitable impact management actions and outcomes for final decision making by the Competent Authority.
This EIA Report includes a detailed assessment of this PSs aspects relating to environmental and social risks and impacts and the culmination of an EMPr containing the relevant mitigation measures which are aimed at limiting the final significance of each identified impact. Throughout the EIA application process, stakeholder engagement has been undertaken to solicit input from I&APs and ongoing stakeholder engagement and communication will be ongoing during the lifecycle of the project.</td></tr>
<tr><td>1.2</td><td>• Identification of Risks and Impacts</td></tr>
<tr><td>1.3</td><td>• Management Programmes</td></tr>
<tr><td>1.4</td><td>• Organisational Capacity and Competency</td></tr>
<tr><td>1.5</td><td>• Emergency Preparedness and Response</td></tr>
<tr><td>1.6</td><td>• Monitoring and Review</td></tr>
<tr><td>1.7</td><td>• Stakeholder Engagement</td></tr>
<tr><td>1.8</td><td>• External Communication and Grievance Mechanism</td></tr>
<tr><td>1.9</td><td>• Ongoing Reporting to Affected Communities</td></tr>
<tr><td colspan="4">Performance Standard 2: Labour and Working Conditions;</td></tr>
<tr><td>Overview</td><td colspan="3">Performance Standard 2 recognises that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers.</td></tr>
</table>

<table>
<tr><td>Objectives</td><td colspan="3">➢ To promote the fair treatment, non-discrimination, and equal opportunity of workers.
➢ To establish, maintain, and improve the worker-management relationship.
➢ To promote compliance with national employment and labour laws.
➢ To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain.
➢ To promote safe and healthy working conditions, and the health of workers.
➢ To avoid the use of forced labour.</td></tr>
<tr><td rowspan="5">Aspects</td><td>2.1</td><td>• Working Conditions and Management of Worker Relationship
• Human Resources Policy and Management
• Working Conditions and terms of Engagement
• Workers organisation
• Non- Discrimination and Equal Opportunity
• Retrenchment
• Grievance Mechanism</td><td rowspan="5"><u>Consideration of PS2 to this project:</u>
This project will require a number of temporary as well as permanent workers during the various project phases. In terms of South African labour legislation (OHSA/MHSA), it will be obligatory on Tetra4 and all sub-contractors to ensure that workers operate in a safe working environment and that employment contracts are fair and reasonable.</td></tr>
<tr><td>2.2</td><td>• Protecting the Workforce
• Child Labour
• Forced Labour</td></tr>
<tr><td>2.3</td><td>• Occupational health and Safety</td></tr>
<tr><td>2.4</td><td>• Workers Engaged by Third Parties</td></tr>
<tr><td>2.5</td><td>• Supply Chain</td></tr>
<tr><td colspan="4">Performance Standard 3: Resource Efficiency and Pollution Prevention</td></tr>
<tr><td>Overview</td><td colspan="3">Performance Standard 3 recognises that increased economic activity and urbanisation often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. There is also a growing global consensus that the current and projected atmospheric concentration of greenhouse gases (GHG) threatens the public health and welfare of current and future generations. At the same time, more efficient and effective resource use and pollution prevention and GHG emission avoidance and mitigation technologies and practices have become more accessible and achievable in virtually all parts of the world.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To avoid or minimise adverse impacts on human health and the environment by avoiding or minimising pollution from project activities.
➢ To promote more sustainable use of resources, including energy and water.</td></tr>
</table>

	➢ To reduce project related GHG emissions.		
Aspects	3.1	• Policy Resource Efficiency • Greenhouse Gases • Water Consumption	**Consideration of PS3 to this project:** The various pollution sources and associated impacts of this project have been identifieid in this EIA. A detailed Climate Change Assessment (Scope 1, 2 & 3) has been undertaken to quantify the GHG emissions. Water efficiency through the recycling and reuse of water at the LNG/LHe Plant will be undertaken. Surface and groundwater pollution during drilling operations will be prevented through the casing of the drillholes which prevents interplay between the gas resource and shallower freshwater aquifers. Various procedures and plans are already in place (from Cluster 1 development) which put forward management actions for general and hazardous waste, pesticide use and management, etc.
	3.2	• Pollution Prevention • Air Emissions • Stormwater • Waste Management • Hazardous Materials Management • Pesticide use and Management	
Performance Standard 4: Community Health, Safety, and Security			
Overview	Performance Standard 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts.		
Objectives	➢ To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances. ➢ To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.		
Aspects	4.1	• Community Health and Safety • Infrastructure and Equipment Design and Safety • Hazardous Materials Management and Safety • Ecosystem Services • Community Exposure to Disease • Emergency Preparedness and Response	**Consideration of PS4 to this project:** The aspects included in this PS are considered in this project EIA and mitigation measures included in the EMPr. Specialist studies have identified and assessed the potential health and safety impacts on surrounding communities and include the Social Impact Assessment as well as the Major Hazardous Installation (MHI) assessments for the pipelines as well as the LNG/LHe Plant. In addition, an Emergency Preparedness and Response Procedure (Document Ref: T4-PP-SHERQ-040) has been prepared for the gas production operations. The following specific condition has been included in the recommendationed conditions of authorisation to ensure that community health and safety is specifically considered: • All workers must be educated on the need to ensure safety of surrounding communities and the public in general. Road safety legislation must be complied with at all times with additional consideration of the World Bank Group Environmental Health and Safety Guidelines. A community health and safety plan inclusive of a Traffic Management Plan will be
	4.2	• Security Personnel	

			developed based on risks identified in consideration of community health and safety. • Risks associated with the potential use of security personnel will be assessed prior to operations and a security management plan will be developed if required and in accordance with IFC Performance Standard 4.
Performance Standard 5: Land Acquisition and Involuntary Resettlement			
Overview	Performance Standard 5 recognises that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) as a result of project-related land acquisition and/or restrictions on land use.		
Objectives	➢ To avoid, and when avoidance is not possible, minimise displacement by exploring alternative project designs. ➢ To avoid forced eviction. ➢ To anticipate and avoid, or where avoidance is not possible, minimise adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. ➢ To improve, or restore, the livelihoods and standards of living of displaced persons. ➢ To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.		
Aspects	5.1	• Displacement • Physical Displacement • Economic Displacement • Private Sector Responsibilities under Government Managed Resettlement	**<u>Consideration of PS5 to this project:</u>** Due to the nature of this gas production project, the wells, pipelines and associated infrastructure will impact on existing land users (mainly farm lands as well as lawful occupiers of land including host communities). Socio-economic sensitivities within the proposed development areas have been identified (such as noise, visual, land use, etc.) as a primary means of avoidance however the final placement of infrastructure will be negotiated with affected parties to ensure minimal impact on existing land use. Tetra4 has compiled a Stakeholder Engagement Procedure (Document Ref: T4-PP-SHERQ-048). The intention of this procedure is to stipulate measures for effective engagement and the recording of engagement with relevant stakeholders. This document is applicable to all parties undertaking Works as or on behalf of Tetra4 within the Virginia Production Right area. The document highlights the requirements of all parties with regards to stakeholder engagement, the establishment and maintenance of good working relationships and recording of stakeholder interactions during any Works undertaken. In addition, a contractual document (Access Use and Servitude Agreement) is shared with affected

			stakeholders for negotiation prior to commencement with construction. Agreements are reached with affected parties in terms of suitable compensation (per hectare per year) during both the construction, operational and decommissioning phases of the project.
Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources			
Overview	Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development.		
Objectives	➢ To protect and conserve biodiversity. ➢ To maintain the benefits from ecosystem services. ➢ To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.		
Aspects	6.1	• Protection and Conservation of Biodiversity	**<u>Consideration of PS6 to this project:</u>** Due to the extensive spatial distribution of the project infrastructure, various sensitive environmental features occur within the proposed project footprint and include CBAs, ESAs, rivers, wetlands, pristine vegetation, etc. Specialist assessments have been undertaken to identify and assess the projects impact on sensitive biodiversity areas and include a Biodiversity Impact Assessment and Wetland and Aquatic Impact Assessment. Various levels of mitigation are put forward by the specialist studies based on the sensitivity of the receiving environment. Alien and invasive species will be controlled throughout the lifecycle of the project through the implementation of the Declared Weeds and Invasive Alien Plant Management Procedure (Document Ref: T4-PP-SHERQ-038).
Performance Standard 7: Indigenous People			
Overview	Performance Standard 7 recognizes that Indigenous Peoples, as social groups with identities that are distinct from mainstream groups in national societies, are often among the most marginalized and vulnerable segments of the population. In many cases, their economic, social, and legal status limits their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development. Indigenous Peoples are particularly vulnerable if their lands and resources are transformed, encroached upon, or significantly degraded.		
Objectives	➢ To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. ➢ To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. ➢ To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner.		

<table>
<tr><td></td><td colspan="3">➢ To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle.
➢ To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present.
➢ To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.</td></tr>
<tr><td rowspan="4">Aspects</td><td>7.1</td><td>• General
• Avoidance of Adverse Impacts
• Participation and Consent</td><td rowspan="4"><u>Consideration of PS7 to this project:</u>
As per IFC Guidance Note 7, in this Performance Standard, the term "Indigenous Peoples" is used in a generic sense to refer to a distinct social and cultural group possessing the following characteristics in varying degrees:
• Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
• Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
• Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture; or
• A distinct language or dialect, often different from the official language or languages of the country or region in which they reside.
With due consideration of the above accepted definition in IFC Guidance Note 7 and as per the international instruments under the United Nations (UN) Human Rights Conventions, no indigenous peoples are present within the study area and therefore PS7 is not triggered by this proposed development and no further assessment in this regard is required.</td></tr>
<tr><td>7.2</td><td>• Circumstances Requiring Free, Prior, and Informed Consent
• Impacts on Lands and Natural Resources Subject to Traditional Ownership or Under Customary Use
• Critical Cultural Heritage
• Relocation of Indigenous Peoples from Lands and Natural Resources Subject to Traditional Ownership or Under Customary Use</td></tr>
<tr><td>7.3</td><td>• Mitigation and Development Benefits</td></tr>
<tr><td>7.4</td><td>• Private Sector Responsibilities Where Government is Responsible for Managing Indigenous Peoples Issues</td></tr>
<tr><td colspan="4">Performance Standard 8: Cultural Heritage</td></tr>
<tr><td>Overview</td><td colspan="3">Performance Standard 8 recognizes the importance of cultural heritage for current and future generations.</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To protect cultural heritage from the adverse impacts of project activities and support its preservation.
➢ To promote the equitable sharing of benefits from the use of cultural heritage.</td></tr>
<tr><td>Aspects</td><td>8.1</td><td>• Protection of Cultural Heritage in Project Design and Execution</td><td><u>Consideration of PS8 to this project:</u>
A detailed Heritage Impact Assessment as well as a Palaeontological Impact Assessment have been</td></tr>
</table>

			undertaken by suitably qualified specialists. Various cultural heritage resources have been identified within the study area and specific mitigation measures for each (depending on significance) put forward. Chance Finds and Heritage Protection Procedure (Document Ref: T4-PP-SHERQ-037) has been prepared by Tetra4 for implementation by relevant project roleplayers.

5.21.2 WORLD BANK (WB) AND INTERNATIONAL FINANCE CORPORATION (IFC) GUIDELINES

5.21.2.1 **WB ENVIRONMENTAL HEALTH AND SAFETY GUIDELINE FOR LIQUEFIED NATURAL GAS FACILITIES**

The EHS Guidelines for Liquefied Natural Gas (LNG) Facilities include information relevant to LNG base load liquefaction plants, transport (by sea and land), storage, regasification (including floating storage regasification units), peak shaving terminals, and LNG fuelling facilities. The key issues identified for LNG facilities related to environmental issues, occupational health and safety issues, and community health and safety issues.

The following environmental issues should be considered as part of a comprehensive assessment and management program that addresses project-specific risks and potential impacts. Potential environmental issues associated with LNG facilities include the following:

- Hazardous material management;
- Wastewater discharges;
- Air emissions;
- Waste management;
- Noise generation;
- LNG transport related issues; and
- LNG fuelling related issues.

Occupational health and safety issues associated with LNG facilities operations include the following:

- Fires and explosions;
- Roll-over within tanks;
- Contact with cold surfaces;
- Chemical hazards; and
- Confined spaces.

Community health and safety impacts during the operation of LNG facilities or transport of LNG are related to potential accidental natural gas leaks, in either liquid or gas form. Additionally, security of the LNG facility to prevent unauthorised access is important.

5.21.2.2 **IFC EHS GUIDELINES FOR ONSHORE OIL AND GAS DEVELOPMENT**

The EHS Guidelines for Onshore Oil and Gas Development include information relevant to seismic exploration, exploration and production drilling, development and production activities, transport activities including flowlines and pipelines, other facilities including pump stations, metering stations, pigging stations, compressor stations and storage facilities, ancillary and support operations, and decommissioning. Similar to the above WB guideline for LNG facilities, the key issues identified for onshore gas developments related to environmental issues, occupational health and safety issues, and community health and safety issues.

Potential environmental issues associated with onshore gas development projects include the following:

- Air emissions;
- Wastewater discharges;
- Solid and liquid waste management;
- Noise generation;
- Terrestrial impacts and project footprint;
- Impacts on subsoil and aquifers;
- Spills;
- Spill Response Planning; and
- Energy efficiency and resource conservation.

In addition to the typical OHS issues of large industrial activities, the following additional issues relate to onshore gas development projects:

- Asset Integrity Management;
- Fire and explosion;
- Air quality;
- Hazardous materials;
- Transportation;
- Well blowouts; and
- Emergency preparedness and response.

Community health and safety impacts during the construction and decommissioning of onshore gas developments include:

- Physical hazards;
- Exposure to emissions;
- Security; and
- Impacts on land use.

5.21.2.3 IFC ENVIRONMENTAL NOISE GUIDELINE

The IFC General Environmental Health and Safety Guidelines on noise address impacts of noise beyond the property boundary of the facility under consideration and provides noise level guidelines. The IFC states that noise impacts should not exceed the levels presented in Table 10, or result in a maximum increase above background levels of 3 dBA at the nearest receptor location off-site (IFC, 2007). For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level is not detectable. Δ = 3 dBA is therefore a useful significance indicator for a noise impact.

It is further important to note that the IFC noise level guidelines for residential, institutional and educational receptors correspond with the SANS 10103 guidelines for urban districts.

Table 10: IFC noise level guidelines.

Area	One Hour LAeq (dBA) 07:00 to 22:00	One Hour LAeq (dBA) 22:00 to 07:00
Industrial receptors	70	70
Residential, institutional and educational receptors	55	45

5.21.3 GHG AND CLIMATE CHANGE

Greenhouse gases (GHG) are "those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the GHG effect. Water vapour (H_2O), CO_2, nitrous oxide (N_2O), methane (CH_4) and O_3 are the primary greenhouse gases in the earth's atmosphere. Moreover, there are a number of entirely human-made GHG gases in the atmosphere, such as the halocarbons and other chlorine and bromine containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) (IPCC, 2007). Human activities since the beginning of the Industrial Revolution (taken as the year 1750) have produced a 40% increase in the atmospheric concentration of carbon dioxide, from 280 ppm in 1750 to 406 ppm in early 2017 (NOAA, 2017). This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle (NOAA, 2017). Anthropogenic CO_2 emissions (i.e., emissions produced by human activities) come from combustion of fossil fuels, principally coal, oil, and natural gas, along with deforestation, soil erosion and animal agriculture (IPCC, 2007).

The International Finance Corporation (IFC) lists methods that countries and projects can reduce GHG impacts. These include carbon financing; improvement of energy efficiency; GHG sinks and reservoir protection and improvements; that environmentally friendly agriculture and forestry be encouraged; the increased use of renewable energy methods; implementation of carbon capture and sequestration methods; and improved waste management (recovery and use of methane emissions) as well as reducing GHG emissions from vehicle use and industrial, construction and energy production processes (IFC, 2007). Carbon financing may have much potential in developing countries as well as sustainable agriculture and forestry practices (IFC, 2012), and when supported by governments may be a way of reducing the country's GHG impacts, where projects receive carbon credits and financing for reducing GHG emissions and installing more environmentally friendly alternatives. Because different industries contribute various amounts of GHG emissions, the IFC performance standards suggests that for industrial processes the CO_2-equivalent (CO_2-e) emissions per year do not exceed 100 000 tonnes, this including direct (Scope 1) and indirect (Scope 2) sources (IFC, 2012).

5.21.3.1 **INTERNATIONAL AGREEMENTS**

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change (UNFCCC) as a framework for international cooperation to combat climate change by limiting average global temperature increases and the resulting climate change, and coping with impacts that were, by then, inevitable.

By 1995, countries launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed country parties to emission reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. As agreed in Doha in 2012, the second commitment period began on 1 January 2013 and would end in 2020 (UNFCCC, 2017) but due to lack of ratification has not come into force.

The Paris Agreement was adopted by 196 Parties at Conference of the Parties (COP) 21 in Paris, on 12 December 2015 and commenced 4 November 2016. The Paris Agreement (2016) builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and

adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives.

The Paris Agreement is founded on the idea of countries improving on their climate change strategies in 5-year cycles. The Paris Agreement requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts. The Paris Agreement proposes that Parties submit long-term low greenhouse gas emission development strategies (LT-LEDS) by 2020 but this was not mandatory.

Parties will take stock of the collective efforts in relation to progress towards the goal set in the Paris Agreement and to inform the preparation of NDCs. There will also be a global stocktake every 5 years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties. Ethiopia submitted their first NDC to the UNFCCC secretariat and ratified the Paris agreement on 9 March 2017. Existing Parties were expected to submit their updated NDC in 2020; and new Parties their original NDCs. Parties are to submit updated NDCs every 5 years. As of May 2021, there are 192 parties that have submitted their NDCs and 8 parties that have submitted their second NDC. There are only 191 Parties to the Paris Agreement; Eritrea has not become a Party to the Paris Agreement but has submitted its first NDC.

Countries as part of the Paris agreement established an enhanced transparency framework (ETF). ETF is to start in 2024 and all countries will need to openly report on all activities untaken and progress in climate change mitigation, adaptation measures as well as any support provided or received. ETF also sets out a procedure for reviewing submitted reports. The information provided as part of the ETF will be used as an input for the global stocktake which will assess the collective progress towards the long-term climate goals.

5.21.3.2 GLOBAL GHG EMISSION INVENTORY

The proposed Tetra4 Cluster 2 operations would most likely fall under the category of "energy" for the global GHG inventory. According to the "mitigation of climate change" document as part of the Intergovernmental Panel on Climate Change (IPCC) fifth Assessment Report (AR5) (IPCC, 2014) the 2010 global GHG emissions were 49 (±4.5) Gt CO_2-e, of which 35% (17 Gt CO_2-e) was a result of the energy sector. The World Resources Institute Climate Watch global GHG emissions from the "industrial processes" sector were 2.7711 Gt CO_2-e in 2016 (6% of total anthropogenic GHG emissions).

5.21.3.3 SOUTH AFRICA'S STATUS IN TERMS OF CLIMATE CHANGE AND QUANTIFICATION OF GREENHOUSE GASES

5.21.3.3.1 PARIS AGREEMENT - NATIONALLY DETERMINED CONTRIBUTION

South Africa ratified the UNFCCC in August 1997 and acceded to the Kyoto protocol in 2002, with effect from 2005. However, since South Africa is an Annex 1 country it implies no binding commitment to cap or reduce GHG emissions. The South African Intended Nationally Determined Contribution (INDC) was completed in 2015 and submitted to the UNFCCC on 1 November 2016. This was undertaken to comply with decision 1/CP.19 and 1/CP.20 of the Conference of the Parties to the UNFCC. This document describes South Africa's INDC on adaptation, mitigation and finance and investment necessities to undertake the resolutions.

As part of the adaption portion the following goals have been assembled:

1. Goal 1: Development and implementation of a National Adaption Plan. The implementation of this will also result in the implementation of the National Climate Change Response Plan (NCCRP) per the 2011 policy.

2. Goal 2: In the development of national, sub-national and sector strategy framework, climate concerns must be taken into consideration.
3. Goal 3: An official institutional function for climate change response planning and implementation needs to be assembled.
4. Goal 4: The creation of an early warning, vulnerability, and adaptation monitoring system
5. Goal 5: Develop policy regarding vulnerability assessment and adaptation needs.
6. Goal 6: Disclosure of undertakings and costs with regards to past adaptation strategies.

As part of the mitigation portion the following have been, or can be, implemented at National level:

- The approval of 79 (5 243 MW) renewable energy Independent Power Producer (IPP) projects as part of a Renewable Energy Independent Power Producer Procurement Programme (REI4P). An additional 6 300 MW is being deliberated.
- A “Green Climate Fund” has been created to back green economy initiatives. This fund will be increased in the future to sustain and improve successful initiatives.
- It is intended that by 2050 electricity will be decarbonised.
- Carbon Capture and Sequestration (or Carbon Capture and Storage) (CCS).
- To support the use of electric and hybrid electric vehicles.
- Reduction of emissions can be achieved through the use of energy efficient lighting; variable speed drives and efficient motors; energy efficient appliances; solar water heaters; electric and hybrid electric vehicles; solar photovoltaic; wind power; CCS; and advanced bioenergy.

A draft update of the first NDC was published for public comment on the 30th of March 2021 and the final updated of the first NDC was published and submitted to the UNFCCC on the 27th of September 2021 in preparation for the 26th Conference of the Parties (to held in Glasgow, Scotland in November 2021). The final update of the first NDC South Africa has not submitted its second NDC to UNFCCC. The draft document describes South Africa’s NDC on adaptation, mitigation and finance and investment necessities to undertake the resolutions with updated revisions to the adaptation goals and mitigation targets.

As part of the updated adaption portion the following goals have been assembled:

1. Goal 1: Enhance climate change adaptation governance and legal framework.
2. Goal 2: Develop an understanding of the impacts on South Africa of 1.5 and 2°C global warming and the underlying global emission pathways through geo-spatial mapping of the physical climate hazards, and adaptation needs in the context of strengthening the key sectors of the economy. This will provide the scientific basis for strengthening the national and provincial governments’ readiness to respond to climate risk.
3. Goal 3: Implementation of National Climate Change Adaptation Strategy (NCCAS) adaptation interventions for the period 2021 to 2030, where priority sectors have been identified as biodiversity and ecosystems; water; health; energy; settlements (coastal, urban, rural); disaster risk reduction, transport infrastructure, mining, fisheries, forestry and agriculture.
4. Goal 4: Mobilise funding for adaptation implementation through multilateral funding mechanisms.
5. Goal 5: Quantification and acknowledgement of the national adaptation and resilience efforts.

As part of the mitigation portion the following have been, or can be, implemented at National level:

- The approval of 79 (5 243 MW) renewable energy Independent Power Producer projects as part of a Renewable Energy Independent Power Producer Procurement Programme. An additional 6 300 MW is being deliberated.

- A “Green Climate Fund” has been created to back green economy initiatives. This fund will be increased in the future to sustain and improve successful initiatives.
- It is intended that by 2050 electricity will be decarbonised.
- CCS.
- To support the use of electric and hybrid electric vehicles.
- Reduction of emissions can be achieved through the use of energy efficient lighting; variable speed drives and efficient motors; energy efficient appliances; solar water heaters; electric and hybrid electric vehicles; solar photovoltaic (PV); wind power; CCS; and advanced bioenergy.
- Updated targets based on revised 100-year global warming potential (GWP) factors (published in the Annex to decision 18/CMA.1 of the IPCC 5th assessment report) and based on exclusion of land sector emissions arising from natural disturbance. The updated NDC mitigation targets, consistent with South Africa’s fair share, are presented in Table 11.

Table 11: South Africa's NCD mitigation targets.

Year	Target	Corresponding period
2025	South Africa’s annual GHG emissions will be in a range between 398 - 510 Mt CO_2-e.	2021-2025
2030	South Africa’s annual GHG emissions will be in a range between 398 - 440 Mt CO_2-e.	2026-2030

5.21.3.3.2 NATIONAL CLIMATE CHANGE RESPONSE POLICY

The National Climate Change Response White Paper stated that in responding to climate change, South Africa has two objectives: to manage the inevitable climate change impacts and to contribute to the global effort in stabilising GHG emissions at a level that avoids dangerous anthropogenic interference with the climate system. The White Paper proposes mitigation actions, especially a departure from coal-intensive electricity generation, be implemented in the short- and medium-term to match the GHG trajectory range. Peak GHG emissions are expected between 2020 and 2025 before a decade long plateau period and subsequent reductions in GHG emissions.

The White Paper also highlighted the co-benefit of reducing GHG emissions by improving air quality and reducing respiratory diseases by reducing ambient particulate matter, ozone and SO_2 concentrations to levels in compliance with NAAQS by 2020.

In order to achieve these objectives, the Department of Forestry, Fisheries and Environment (DFFE) has appointed a service provider to establish a national GHG emissions inventory, which will report through SAAQIS.

The draft Climate Change Bill was published for comment on the 8th of June 2018 and introduced to parliament on the 18th of February 2022 (B9-2022). The Bill is aligned with international policies guidelines and South Africa’s Nationally Determined Contribution and aim to reduce GHG emissions as primary driver to anthropogenic climate change. The aim of the Bill is to achieve an effective climate change response through a long-term just transition to a low carbon economy that is climate resilient and allows for sustainable development of South Africa. When in force, the Bill will:

- Establish provincial and municipal forums on climate change which will be responsible for coordinating climate change response actions in each province.
- Strengthen the establishment of the Presidential Climate Change Coordinating Commission (4PC). Although, the 4PC has already been established and has been working for the Government since December 2020, however, its establishment only carries legal force after the Bill becomes an Act.

- Within one year of the coming into force of the Act, establish a National Adaptation Strategy. This strategy will guide South Africa's adaptation to the impacts of climate change and develop adaptation scenarios which anticipate the likely impacts over the short, medium, and long term.
- Determine a national GHG emissions trajectory, which must be reviewed every five years, and which indicates an emissions reduction objective.
- Put in place a 5-yearly sectoral emission targets for identified sectors and sub-sectors. The sectoral targets must be aligned with the national GHG emissions trajectory and include quantitative and qualitative GHG emission reduction goals.
- Bring into force the carbon budget allocation mechanism, which will replace the current National Pollution Prevention Plan mechanism which is enforced under the National Environmental Management: Air Quality Act (NEM:AQA). The carbon budget will be linked to the Carbon Tax Act, in relation to carbon tax rates which will be charged on emissions above the carbon budget.

The Bill is nearing the end of its parliamentary process having been passed by the National Council of Provinces and been returned to the National Assembly for concurrence. It is likely to be enacted during the operational lifetime of the Tetra4 Cluster 2, if not before.

5.21.3.3.3 GREENHOUSE GAS EMISSIONS REPORTING

Regulations pertaining to GHG reporting using the National Atmospheric Emissions Inventory System (NAEIS) were published in 2017 (Republic of South Africa, 2017) (as amended by GN R994, 11 September 2020). The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only.

The South African Greenhouse Gas Emission Reporting System (SAGERS) web-based monitoring and reporting system will be used to collect GHG information in a standard format for comparison and analyses. The system forms part of the national atmospheric emission inventory component of South African Atmospheric Emission Licensing and Inventory Portal (SAAELIP). Tetra4 operations will have to report their GHG emissions to SAGERS since there is no threshold for annual GHG emissions reporting for the Natural Gas producers as per the amended GHG reporting guidelines (GG43712, 7 September 2020).

The DFFE is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the IPCC default emission figures may be used to populate the SAAQIS GHG emission factor database. These country specific emission factors will replace some of the default IPCC emission factors. Technical guidelines for GHG emission estimation have been issued.

Also, the Carbon Tax Act (No 15 of 2019) (Republic of South Africa, 2019) includes details on the imposition of a tax on the CO_2-e of GHG emissions. Certain production processes indicated in Annexure A of the Declaration of Greenhouse Gases as Priority Pollutants (Republic of South Africa, 2017) with GHG more than 0.1 mega tonnes (Mt) or million metric tonnes, measured as CO_2-e, are required to submit a pollution prevention plan to the Minister for approval.

5.21.3.3.4 NATIONAL GHG EMISSIONS INVENTORY

South Africa is perceived as a global climate change contributor and is undertaking steps to mitigate and adapt to the changing climate. DFFE is categorised as the lead climate change institution and is required to coordinate and manage climate related information such as development of mitigation, monitoring, adaption, and evaluation strategies (DEA, 2019). This includes the establishment and updating of the National GHG Inventory. The National Greenhouse Gas Improvement Programme (GHGIP) has been initiated; it includes sector specific targets to improve methodology and emission factors used for the different sectors as well as the availability of data.

The 2000 to 2017 National GHG Inventory was prepared using the 2006 IPCC Guidelines (IPCC, 2006) based on updated sector information and emission estimation techniques. According to the 4th Biennial Update Report to the UNFCCC (DFFE, 2021), the total GHG emissions in 2017 were estimated at approximately 512.14 million metric tonnes CO_2-e (excluding Forestry and Other Land Use [FOLU]). This was a 14.2% increase from the 2000

total GHG emissions (excluding FOLU) and 2.8% decrease from the 2015 total GHG emissions (excluding FOLU). FOLU is estimated to be a net carbon sink which reduces the 2017 GHG emissions to 482.02 million metric tonnes CO_2-e. The estimated GHG emissions (excluding FOLU) for 2017 showed the Industrial Processes and Product Use (IPPU) sector contributed 6.3% to the total GHG emissions (excluding FOLU). The estimated CO_2-e emissions (excluding FOLU) for 2017 for the IPPU sector is 32.08 million metric tonnes.

6 NEED AND DESIRABILITY OF THE PROPOSED ACTIVITY

This section detailing the need and desirability of the project was obtained from Tetra4 as well as the Economic specialist.

Tetra4 has commenced with the Cluster 1 Helium and Methane gas production operations with proven resources of both products. Helium is one of the core products to be produced and processed by the proposed Cluster 2 gas production development. Tetra4 plans to sell this product to an entity that will distribute the gas nationally and internationally. Given that South Africa imports helium at present, the substitution of the importation of this gas with a local product will be of benefit to the country s economy.

LNG is produced both worldwide and domestically at relatively low cost and is cleaner burning with lower CO_2 emissions than coal, petrol, diesel or propane fuels. Natural gas vehicles show an average reduction in ozone forming emissions of 80 percent compared to petrol vehicles. Table 12 below are some features about both helium and LNG, potential project benefits, as well as a brief of the need and desirability of these gases.

Table 12: Helium and LNG properties and uses.

Helium Properties and Uses	LNG Properties and Uses
Helium is one of the most common elements in the universe. It is called a noble gas because it doesn't chemically interact with other elements. Its atomic number is 2 and the weight is 4.002. In its natural state, it doesn't have any smell, taste or colour.	LNG is clear, colourless, and odourless. LNG is non-corrosive and non-toxic. The potential hazards of LNG are the result of its basic properties including its cryogenic nature and dispersion and flammability characteristics.
Occurrence and Discovery	**Occurrence and Discovery**
Helium can be found all over the universe, although it isn't widely distributed on Earth. Its most frequent form is gas. It shares many characteristics with other noble gases. Helium doesn't form compounds easily with other elements. It is also very stable and has many important uses. Its symbol in the periodic table is "He". Its stability and non-reactive nature make it the perfect tool for handling unstable materials. The element was discovered in 1868 during a solar eclipse. It took scientists 30 years to extract and isolate the gas from the uranium ore clevite.	Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly including varying amounts of other higher alkanes, and sometimes a small percentage of carbon dioxide, nitrogen, hydrogen sulphide, or helium. It is formed when layers of decomposing plant and animal matter are exposed to intense heat and pressure supplied by existing under the surface of the Earth over millions of years. The energy that the plants originally obtained from the sun is stored in the form of chemical bonds in the gas.
The gas is not prevalent on Earth. It is usually extracted from natural gas and the typical amount found in natural gas deposits ranges from 2 to 7%. It didn't take long for governments to realize its usefulness in military operations. Access to it was restricted during the two World Wars. In its purest form, the element doesn't pose any health risks.	Natural gas is found in deep underground rock formations or associated with other hydrocarbon reservoirs in coal beds and as methane clathrates. Petroleum is another resource and fossil fuel found in close proximity to and with natural gas. Most natural gas was created over time by two mechanisms: biogenic and thermogenic. Biogenic gas is created by methanogenic organisms in marshes, bogs, landfills, and shallow sediments. Deeper in the earth, at greater temperature and pressure, thermogenic gas is created from buried organic material.
Inhaling excessive amounts has its risks. The danger is the gas functions as an asphyxiate. Inhaling helium from pressure tanks can damage the lungs. The	Most natural gas comes from three types of wells namely natural gas and condensate wells, oil wells, and coal bed methane wells.

Helium Properties and Uses	LNG Properties and Uses
variants found in weather balloons may have other elements that are unhealthy to breathe.	
Helium Properties	**LNG Properties**
Its atomic number indicates there are two electrons and two protons in a neutral helium atom. Its most vital properties are density, melting and boiling points, state of matter and atomic mass. The density is 101.325 kilopascals (kPa) and 0.1786 grams per litre at 32°F (0.0°C). Its atomic mass is 4.0026 grams per mole.	Quantities of natural gas are measured in normal cubic meters (corresponding to 0 °C at 101.325 kPa) or in standard cubic feet (corresponding to 16 °C and 14.73 psia). The gross heat of combustion of $1m^3$ of commercial quality natural gas is around 39 MJ (10.8 kWh), but this can vary by several percent.
Solid and liquid helium can only manifest in high and low temperature settings. Either condition cannot manifest under normal pressures. -272°C (0.95 Kelvin) is the melting point. The boiling point is -268°C (4.22 Kelvin).	The burning of natural gas produces far lower amounts of sulfur dioxide and nitrous oxides than other fossil fuels.
One of the more interesting uses of helium is in cryogenics. This field is concerned with low temperature phenomena and its production. Most of the helium produced today is used for cryogenics.	Gas is an important transitionary fuel as countries around the world look for reliable, affordable, safe and low carbon alternatives to coal and nuclear, and ways of supporting renewable energy sources.
Common uses of Helium	**Common uses of LNG**
Evidence shows that the human voice can be changed with a bit of helium. The gas is also used as light weight aircraft fuel. The element is usually combined with hydrogen in air balloons. Hydrogen alone is fine, but helium makes the balloon safer to use. The same gas is used by caisson workers too as the divers use oxygen and helium during their dives. The combination provides them with the atmosphere necessary to survive in high pressure environments.	LNG or more specifically CNG is used as a motor fuel instead of petroleum products, since it has a number of advantages, the most important being to provide the industry with cleaner, more environmentally friendly fuel, as well as offering business and consumers a cost-effective alternate energy source. Although vehicles can use natural gas as either a liquid or a gas, most vehicles use the gaseous form compressed to pressures above 200 bar. Tetra4 already has a pilot project whereby busses are powered with gas in the region.
Helium Medical Applications	**LNG and Transportation**
Helium can also be used for breathing observation. It is essential in treating ailments such as asthma, emphysema and other conditions that affect breathing. The gas is usually used to treat diseases that affect the lungs. Hospital MRI scans reply on liquefied helium. When the element is set at -269°C (the low boiling point), it becomes usable in cooling the MRI magnet.	LNG is liquefied natural gas. CNG is compressed natural gas. The key point – and the reason there are two fuels, not one – is that gas has different energy densities in different states. One unit of liquid gas energy takes up 3 times less volume than one unit of compressed gas energy. More fuel can be stored onboard a vehicle using LNG because the fuel is stored as a liquid, making its energy density greater than that of CNG. This makes LNG well suited for Class 7 and 8 trucks requiring a greater range.
Acute and chronic forms of respiratory ailment treatments have helium components. In almost all cases, oxygen and helium are used together. This	Besides use in road vehicles, it is also used in aerial vehicles. Compressed natural gas has been used in

Helium Properties and Uses	LNG Properties and Uses
combination gets to the lungs much quicker. Helium in different forms and combinations are used in medical instrumentations and nuclear medicine.	some aircraft like the Aviat Aircraft Husky 200 CNG and the Chromarat VX 1 KittyHawk.
Helium in Manufacturing and Cryogenics	**LNG in Power Generation**
Of the 2014 world helium total production of about 32 million kg (180 million standard cubic meters) helium per year, the largest use (about 32% of the total in 2014) was in cryogenic applications, most of which involves cooling the superconducting magnets in medical MRI scanners and NMR spectrometers (Wikipedia). Helium is used as a shielding gas in arc welding processes on materials that at welding temperatures are contaminated and weakened by air or nitrogen. Helium is used as a protective gas in growing silicon and germanium crystals, in titanium and zirconium production, and in gas chromatography, because it is inert (Wikipedia).	Natural gas is a major source of electricity generation through the use of cogeneration, gas turbines and steam turbines. Natural gas is also well suited for a combined use in association with renewable energy sources such as wind or solar. Particularly high efficiencies can be achieved through combining gas turbines with a steam turbine in combined cycle mode. Natural gas burns more cleanly than other hydrocarbon fuels, such as oil and coal, and produces less carbon dioxide per unit of energy released. For transportation, burning natural gas produces about 30 percent less carbon dioxide than burning petroleum. For an equivalent amount of heat, burning natural gas produces about 45 percent less carbon dioxide than burning coal for power.
Helium in Space Technology	**Domestic Uses for LNG**
NASA space programs use the gas to fuel their shuttles. Liquid fuels are volatile. They are packed with corrosive material that could destroy a spacecrafts casing. To avoid this problem, a craft is filled with helium gas. The same process is used in blimps and air balloons. It is preferred to hydrogen as it is not flammable. The element is also used to keep nuclear reactors cool.	Natural gas dispensed in a residential setting can generate temperatures in excess of 1100 °C making it a powerful domestic cooking and heating fuel. In much of the developed world it is supplied through pipes to homes, where it is used for many purposes including ranges and ovens, gas heated clothes dryers, heating / cooling, and central heating. Heaters in homes and other buildings may include boilers, furnaces, and water heaters.
Other Helium Applications	**Other LNG Applications**
Helium neon lasers use the element extensively. These instruments are used for barcode reading. The same element is needed to monitor small fractures in ships and other vehicles.	Natural gas is a major feedstock for the production of ammonia, via the Haber process, for use in fertilizer production.
Helium dating is relied on to date rocks that contain uranium and titanium. The gas is used for protection during germanium crystal and silicon production. It is valued as a protective gas because of its inert nature.	Natural gas is also used in the manufacture of fabrics, glass, steel, plastics, paint, and other products.
Helium**'s** properties also make it ideal for observation in quantum mechanics. Its structure is basic and easy to study. Numerous mathematical processes are used to assess subatomic particle behaviour. Using these techniques, neutrons, electrons and protons can be studied. However, these tests cannot	Natural gas can be used to produce hydrogen, with one common method being the hydrogen reformer. Hydrogen has many applications: it is a primary feedstock for the chemical industry, a hydrogenating agent, an important commodity for oil refineries, and the fuel source in hydrogen vehicles.

Helium Properties and Uses	LNG Properties and Uses
determine their actions 100% accurately. This is due to the nature of quantum mechanics.	

6.1 POTENTIAL PROJECT BENEFITS

The expected benefits of the proposed project to the South African economy and especially the Free State Province will be:

- LNG is devoid of some of the criteria pollutants contained in crude oil and coal and thus produces significantly less carbon dioxide emissions making it a cleaner fossil fuel energy source, an alternative to renewable energy;
- Large capital investment for the gas production infrastructure with associated local and regional benefits to the economy (drilling; setting the gas producing wells, pipeline, LNG/LHe plant; etc.);
- Local business opportunities whereby there is potential to make use of empowered local contracting companies;
- Training and transferring experience and skills to local people employed;
- Social benefits such Tetra4 s Social and Labour Plan (SLP) interventions and other social responsibility programmes;
- Will prompt further investigations on gas production and use in South Africa as well as other industries that would have beneficial use of the gas (e.g.: fertilizer production, gas powered vehicles, etc);
- Promotion of gas as a bridging fuel towards South Africa achieving the renewable energy use targets as opposed to the extensive use of fossil fuels in the short to medium term;
- Reduce the amount of Helium and LNG that South Africa needs to import; and
- Possible international investment into the country.

6.2 ECONOMIC FACTORS IN FAVOUR OF THE PROJECT

6.2.1 POSITIVE ECONOMIC IMPACTS

The economic impact is based on the optimum production year principle, which is one specific year. In this regard, 6 years from today, namely 2028. The basis for selection is that in that year Tetra4 will be in full production as is anticipated in the Cluster 2 expansion. Table 13 below provides an overview of the economic costs as a basis of assessment and rows are numbered in the last column and the pertinent rows discussed in more detail hereunder.

Table 13: Potential economic benefits as calculated by the economic specialist and Tetra4.

Phase 2	Methane/LNG	Helium		Row #
Assume steady state date	2028	2028	Total	
Daily Volume - 1000 Standard Cubic Feet	40 000	4 000	44 000	1
Yearly Volume - 1000 Standard Cubic Feet - 265 workdays	9 000 000	900 000	9 900 000	2
US Dollar Price per 1000scf	15	250	#N/A	3
Turnover in US Dollars (incl maint days) pa	135 000 000	225 000 000	360 000 000	4
Rand:USD Exchange (2028)	18.4	18.4	18.4	5
Turnover in Rand pa - Rand million	2 490	4 151	6 641	6
% GDP:Turnover - Estmated natural gas	55%	55%	55%	7
GDP (Economic Value Added by Tetra 4) pa Rand Million	1 370	2 283	3 653	8
Add GDP Multiplier	1.87	1.87	1.87	9
National GDP Addition - R Million	2 558	4 263	6 822	10
Estimated Direct Employment	457	761	1 218	11
Employment Multiplier	3.80	3.80	3.80	12
Total Employment	1 733	2 889	4 623	13
GGP Matjhabeng - 2028 Est (Rand Million)	53 221	53 221	53 221	14
% relative to GGP including mulitpliers	5%	8%	12.8%	15
Estimated Employment in Matjhabeng	80 211	80 211	80 211	16
% Additional employment relative to Matjhabeng	2.2%	3.6%	5.8%	17
New Investment over 2 years (Rounded off) - Rand Million			13 000	18
Deduct for imports (Equipment, Fabrication and Installation)			6 500	19
Annualise (Above investment over two years)			3 250	20
Estimated national investment multiplier			1.87	21
New investment after leakage and added multipliers per annum			6 078	22
Average investment in Matjabeng per annum			10 644	23
% New Investment relative to Matjabeng Economy pa			57%	24
Average Current Account last 10 years			(127 176)	25
Tetra4 potential Mitigation to Current Account			6000	26
Tetra4 potential Mitigation to Current Account %			5%	27

The key findings in Table 13 above are outlined below.

- In row 8, in an optimal year for Cluster 2, Tetra4 could add an additional R3.65 billion to the local economy. Including multipliers, this additional GDP could increase to R6.8 billion. Relative to the Matjhabeng economy, this is a 13% addition to GDP. Subject to economic multiplier leakage, this is a significant additional amount to the local economy.
- Row 11 shows that an additional 1 218 jobs could be created, and after multipliers this could amount to 4 623 jobs throughout the country. Relative to the local economy, this is an addition of just over 5% and needs to be considered as a significantly positive impact.
- The employment multiplier is higher than the GDP multiplier because the gas and helium industry is capital intensive, meaning its cost per job created is high, and as the cost per job in downstream industries are lower, thus the multiplier is in favour of job-creation downstream. In simple terms this means that one job created by Tetra4 has the potential of creating almost 4x as many formal jobs.
- A further factor is that the project could save SA R6.6 billion in foreign exchange per annum – foreign exchange earnings in a stable currency are important for a country as it is an indication of wealth – the more stable currency a country possesses, the higher the quality of its financial standing in the world which results in better trading relations and less expensive cost of capital.

6.2.2 DEMAND FOR HELIUM

The demand for a product or service is defined as a consumer's desire to purchase goods and services and willingness to pay a price for such goods or services. The processing of helium is a high priority for Tetra4 and the demand for this gas is important for the assessment of this expansion. A detailed discussion on what Helium is as well as its many uses is included in Table 12. A summary of the commercial uses of Helium is shown in Figure 25.

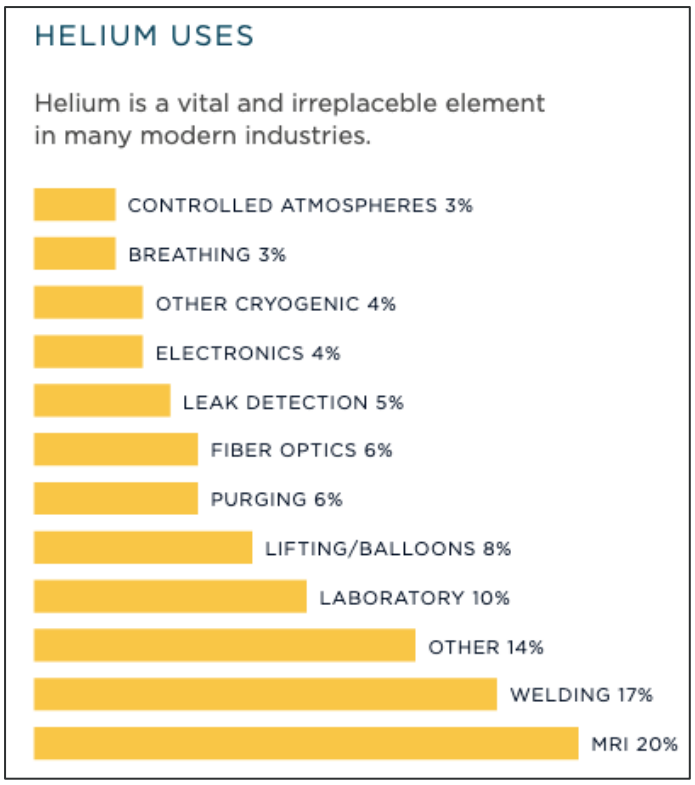


Figure 25: Uses of Helium.

Helium is a non-renewable natural resource that is mostly recovered from natural gas deposits. Thus, helium is typically a by-product of natural gas fields. It is important to note that helium is found in recoverable quantities in only a few locations around the world, many of which are being depleted.

In the gas fields of Virginia in the Free State, the source of helium for this study is indicated as being unique given the high helium content in the gas field. This makes this development a potential “game changer” in the helium industry in that Tetra4 could produce helium as its prime product, with methane potentially being a by-product. This is a different strategy to how helium is currently recovered worldwide. The uniqueness of this situation is that as pressure increases on reducing gas production worldwide, helium production will also decline. However, in the case of Tetra4, as said, this status quo is reversed, meaning that the Virginia Gas fields may well become a significant strategic helium resource in the world.

When looking at the future uses of helium, there is overwhelming evidence that this element with its rare properties will continue to be in demand. Research is showing that helium is increasingly used in the health industry, and as a coolant in the military and rocket industries. In addition, helium is targeted as a coolant in the potential new nuclear energy generators using fusion, as opposed to fission. In addition, increasing consumption of helium in the electronics and semiconductor industry is expected.

The importance of the demand for helium is that an economic need and desirability would be low if a sufficient demand now, or in the future, could not be established. In this regard, all indications are that the demand for helium is strong and sustainable, thus contributing strongly to the economic need and desirability of this expansion.

The global supply and demand for Helium is shown in Figure 26 was sourced from the Edison Research Group as published on Renergen’s website. It shows a possible slight oversupply of helium in next few years, but thereafter demand is likely to outstrip supply (all things being equal).

A few independent forecasts for the global growth in demand for helium are mentioned below:

- Energy Industry Review, an energy magazine in Europe, predicts a 4 % CAGR between 2019 and 2027.

- Mordor Intelligence, an independent research company, also predicted growth at 4 % CAGR between 2021 and 2026.
- Global Newswire, an independent market analyst reporting on listed investments, predicts the growth to be 4.5 % to 2030.
- Various other sources put the growth rate of helium much higher than the three sources above - at between 5-11 % CAGR based on the continued increase in scientific and technological innovation.

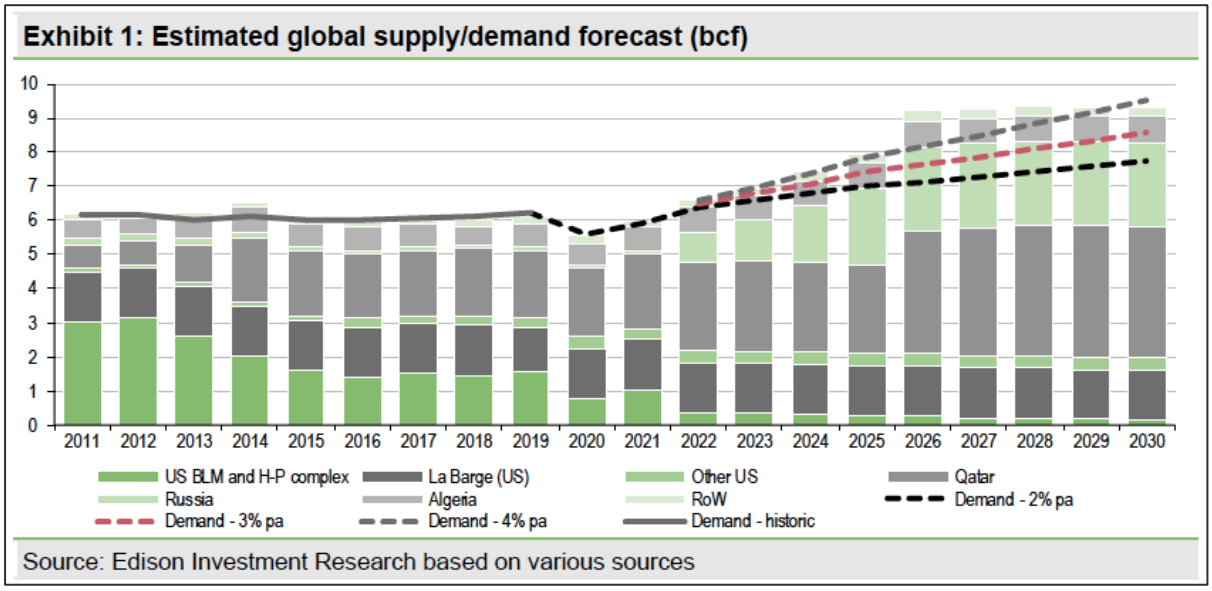


Figure 26: Global demand and supply of Helium in Billion Cubic Feet.

6.2.3 DEMAND FOR NATURAL GAS

In this and the section below, the need for natural gas is discussed. Note that natural gas is largely composed of methane, and the gas fields under discussion yields methane as its primary gas. Thus, in discussing natural gas, a discussion of methane is implicit.

The self-evident nature of the need for natural gas is stated in the list of items below (not an exhaustive list):

- The electric power sector uses natural gas to generate electricity. For example, natural gas accounted for 40% of U.S. electricity generation in 2020, as opposed to 3% in SA.
- The industrial sector uses natural gas as a fuel for heating, as a feedstock to produce chemicals, fertilizer and hydrogen, and many other applications.
- The residential sector uses natural gas for heating, cooking and other applications.
- The commercial sector needs natural gas to heat buildings and water, to operate refrigeration and cooling equipment, to cook, to dry clothes, and to provide outdoor lighting. Some consumers in the commercial sector also use natural gas as a fuel in combined heat and power systems.
- The transportation sector uses natural gas as a fuel to operate compressors that move natural gas through pipelines and as a vehicle fuel in the form of compressed natural gas and liquefied natural gas.

At present gas still plays a significant role in the production of energy in the world. Gas makes up 25% of the world's electricity production and in addition, the growth in the demand for gas appears to be stable.

In South Africa, natural gas plays a relatively small part in contributing to electricity generation. Gas is not regarded as a cleaner energy than "green energy" sources, for example solar, water and wind, but is undoubtedly "cleaner" than coal. As a "bridging" source of energy, there is sufficient cause to rate gas as economically needed and desirable. Gas processing in SA could therefore be favoured in the short and medium term, however, it is very likely that at some future point, targets will be set to reduce gas production (although not Helium) in the

same manner as targets are being set to reduce coal production today. Presently, the Integrated Resource Plan 2019 aims to increase the national energy mix natural gas contribution from 2.6% to 15.7% by 2030.

Whereas a framework for future power generation in South Africa is set out in the Nationally Determined Contribution, energy policies for South Africa are provided in the Integrated Resource Plan (IRP) as developed by the Department of Mineral Resources and Energy's (DMRE). These energy policies are based on the demand in electricity and what energy generation types should be procured to meet that demand, along with the generation capacity, timing, and cost. The IRP acts as the government's roadmap for expanding capacity in the electricity sector, setting targets for all technologies, including renewable energy. The 2023 update of the IRP (IRP-2023) includes two key timeframes. The first focuses on the period leading up to 2030, primarily aimed at addressing existing generation capacity constraints and bridging the electricity supply gap. The second horizon spans from 2031 to 2050, concentrating on the country's long-term electricity strategy to inform future policy decisions.

The IRP 2030 projection for electricity demand is 1.3% per annum for the first 10 years, with a 0.3% per annum up to 2050. The production of thermal energy in SA is expected to decrease by 10.5 GW by 2030, with a decrease of 25% in the current energy generation potential due to the shutting down of coal-fired power stations. Although the aim is to eventually replace fossil fuels completely, there is a strong case to use natural gas in the interim to replace coal for baseload capacity.

The concern with natural gas is around the leaking methane emissions, occurring mainly during the extraction, processing, and transportation of natural gas. The estimated Scope 1 and 2 CH_4 emissions from the operational phase at Cluster 2 accounts for 78% of the total CO_2-eq emissions. Even though CH_4 emissions are 28 times more effective than CO_2 at trapping heat in the atmosphere over a 100-year timescale (US EPA, 2024a), studies show gas has a lower life cycle GHG impact than coal with a lifetime of roughly a decade (PACE, 2015). According to the UK Department for Environment Food & Rural Affairs (DEFRA), natural gas releases 46% less CO_2-eq lifecycle emissions compared to coal-fired facilities and 49% less than diesel-fired facilities for the same electricity generation rate. The IPCC reports, based on the median value, indicate natural gas to result in less than 51% direct- and 40% lifecycle CO_2-eq emissions compared to CO_2-eq emissions from coal (Schlömer S., 2014).

The projects' contribution to the national CO_2-eq is only 0.09%, and 0.12% to the national energy sector CO_2-eq.

6.2.4 A SUSTAINABLE AND COMPETITIVE LOCAL GAS AND HELIUM INDUSTRY IN SOUTH AFRICA

A further factor in favour of Tetra4's expansion application is the potential for the development of a sustainable and competitive gas and helium industry in South Africa. When a country has a comparative advantage economically, such as gold for example historically in SA, that advantage creates economic wealth that then translates into a better quality of life for that country's citizens. Since the advent of the use of oil and gas worldwide, SA has had a comparative disadvantage as it did not possess those natural resources. That meant SA had to (and still does) import most of its oil and gas, which meant that foreign reserves had to be used to pay for such imports. That in itself not only resulted in a decrease in GDP, but it also caused a reduction in the country's foreign reserves.

It can be argued that even though SA had been blessed with significant mineral resources, the lack of oil and gas had been the country's Achilles heel. The historic increase in the cost of gas and oil and weakening of the SA Rand had brought about a persistent "imported" inflation to the SA economy for many decades, and unless SA creates its own less expensive and clean energy, the country will remain less economically competitive than it could be. Ironically, the commodity that SA has in abundance, coal, is today considered as an undesirable commodity because of its effect on warming the earth. Thus, SA faces ominous comparative disadvantages in the generation of future energy - the lack of natural gas, the small amount of energy that can be produced from green energy in the foreseeable future, and the undesirable nature of coal as an energy source. There is thus a strong case to be made for a much stronger natural gas industry in South Africa.

SA historically did not have a helium producer, and to that extent the advent of Tetra4's helium production is in fact the establishment of a helium industry in this country. Thus, starting from a zero base for helium, one could therefore argue that the need and desirability of the advent of a helium sector in SA is beyond significantly high.

Figure 27 provides an overview/snapshot of the natural gas sector in SA where the supply chain of the piped-gas industry is broadly categorised into three levels, namely upstream, mid-stream and downstream. The upstream level of the piped-gas industry includes gas exploration and production activities. The midstream level comprises transmission and distribution of gas, while the downstream level consists of gas reticulation and trading activities. Sasol Gas is the dominant gas enterprise in South Africa, and it plays a major role in production, transmission and distribution. There are not that many rivals in the South Africa gas sector and therefore the sector may not be as efficient a sector as in countries with robust competition.

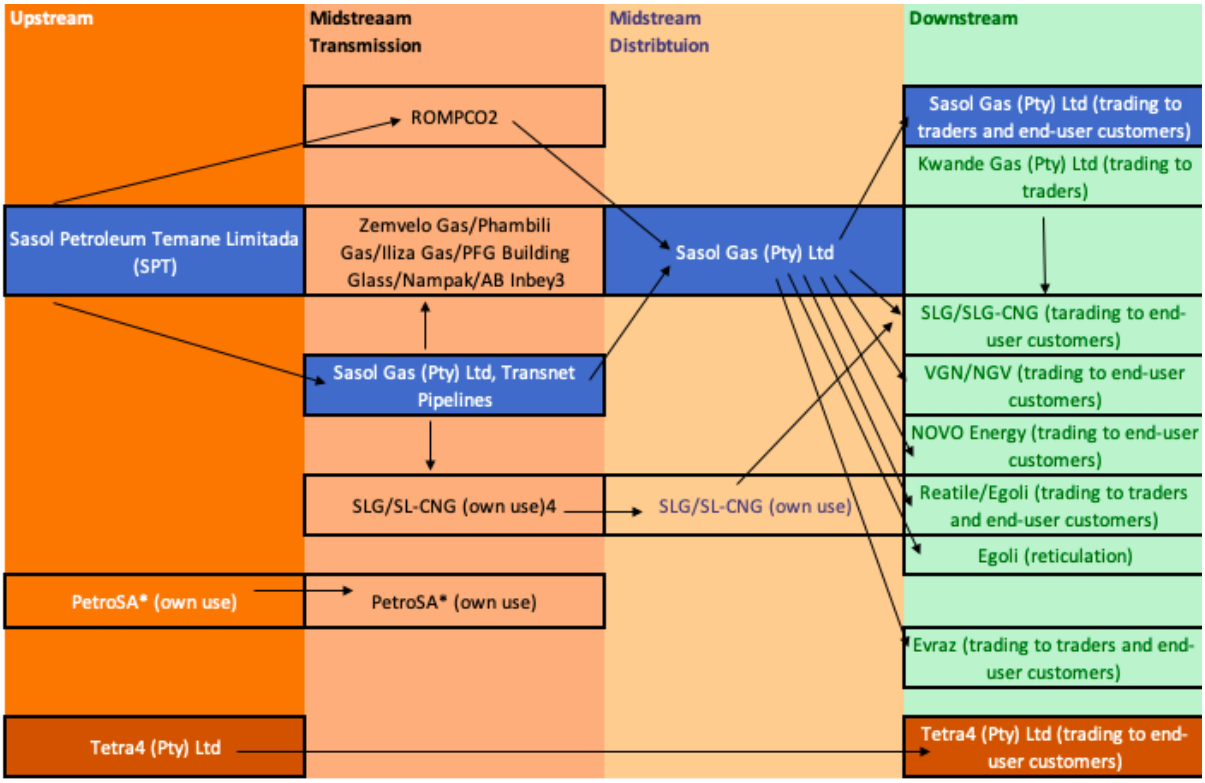


Figure 27: South Africa natural gas sector overview.

Prior to Tetra4, there were only two suppliers of gas. The first is Sasol Gas that imports natural gas from the Mozambique to Secunda via the transmission pipeline owned by the Republic of Mozambique Pipeline Investing Company (ROMPCO). The transmission pipeline is 865 kilometres long with a 26-inch diameter, and a capacity of 147 million Gigajoules per annum. Sasol Synfuels, which is a coal-based synthetic fuels manufacturing facility, produces methane-rich gas in its plant in Secunda. Synthetic gas is produced through coal gasification and natural gas reforming through the utilisation of Sasol's proprietary technologies.

The other supplier, PetroSA, is a state-owned entity, owned by the Central Energy Fund, and was the only producer of indigenous natural gas. Its offshore producing gas field is in the Bredasdorp basin and provides feedstock for PetroSA's Gas-to-Liquids (GTL) plant. It produces for its own exclusive use. However, this field is close to being depleted, and further developments of the field have been undertaken to supply feedstock for the GTL plant. In 2011, PetroSA was granted approval to explore additional gas reserves of the coast of Mossel Bay, in which drilling activities have been ongoing.

From the above brief overview of the gas sector in SA, the need and desirability of a further gas supplier to increase the competitiveness of the SA gas sector is undoubted. In this regard the economic need and desirability of the Tetra4 expansion becomes even more evident.

6.3 ARGUMENTS NEUTRAL OR AGAINST THE PROJECT.

6.3.1 NATURAL GAS

There is more consensus than ever that GHG's cause global warming. In this regard, SA at COP 26 had pledged to reduce its GHG emissions by reducing its dependence on coal as a source of energy in favour of renewable energy sources. In addition to this, economically, SA runs the risk of being sanctioned by the international community should it persist with an intransigence regarding the use of coal.

Natural gas is therefore seen by many in the country as a "bridging" source of energy because it emits almost 50 % less CO_2 than coal. Considering only tailpipe emissions, natural gas is 15-30 % cleaner than fuel when it is burned. Thus, if SA converts its coal fired stations to natural gas tomorrow, it will save a considerable amount of GHG emissions. Thus, natural gas is certainly a cleaner energy source than coal, and therefore relative to coal, must be considered as more desirable in this context.

However, detractors of prioritising natural gas over "green" renewable energy point out two particular arguments against natural gas over green energy:

1. Natural gas still emits CO_2, and hence the problem of mostly eradicating greenhouse gas emissions globally remains unresolved if natural gas continues to be a source of electricity.
2. In addition to this, natural gas is composed of 70-90 % methane, a potent greenhouse gas and major contributor to global warming. The argument is put forward that 2-3 % of methane escapes during processing, transmission and reticulation. These fugitive emissions add to global warming.

Proponents of cleaner energy in South Africa have advocated that the country bypasses natural gas developments in its entirety and concentrate on renewables like solar, wind and hydropower. Furthermore a number of gas operators appear eager to enter the SA gas market, and although that could be of major benefit in the reduction of the use of coal, at some future point the debate will intensify regarding the emissions of GHG emissions in the gas industry vs that of other cleaner energy sources.

Economically, common sense does indicate that natural gas offers an interim solution for the climate change target challenges in SA in the short to medium term. In the long term, it is very possible that even natural gas usage becomes an undesirable commodity, as is the case with coal at present. That stated, an economic need and desirability assessment must consider the current generation, and although not discounting future generations, the economics of gas production in SA at present has a strong case.

6.3.2 HELIUM

Where the Tetra4 expansion is different from the typical gas producer is in the concentrations of helium in its gas reserves. Whereas an economic cut-off as low as 0.05 % helium in natural gas has been proven to be economically viable, Tetra4 has indicated that its helium concentrations are high – between 2-4 %. Helium cannot be extracted without the natural gas (methane) and while natural gas may be replaced or phased out in future, the natural gas will still be extracted to extract helium. The importance of helium both locally and globally as well as the high concentrations of the helium in this particular gas resource provide strong motivation for the need and desirability of this project despite the natural gas being extracted too.

6.4 NEED AND DESIRABILITY ANALYSIS

The needs and desirability analysis component of the "Guideline on need and desirability in terms of the EIA Regulations (Notice 819 of 2014)" includes, but is not limited to, describing the linkages and dependencies between human well-being, livelihoods and ecosystem services applicable to the area in question, and how the proposed development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, loss of heritage site, opportunity costs, etc.). Table 14 present the needs and desirability analysis undertaken for the project.

Table 14: Needs and desirability analysis for the proposed Cluster 2 Gas Production Project.

Ref No.	Question	Answer
1	**Securing ecological sustainable development and use of natural resources**	
1.1	How were the ecological integrity considerations taken into account in terms of: Threatened Ecosystems, Sensitive and vulnerable ecosystems, Critical Biodiversity Areas, Ecological Support Systems, Conservation Targets, Ecological drivers of the ecosystem, Environmental Management Framework, Spatial Development Framework (SDF) and global and international responsibilities.	A number of specialist studies have informed this application and environmental impact assessment and include: • Air Quality and GHG Study • Geohydrological Study • Terrestrial Biodiversity Study • Aquatic and Wetland Study These studies assisted in identifying any Threatened Ecosystems, Sensitive and vulnerable ecosystems, Critical Biodiversity Areas, Ecological Support Systems, Conservation Targets and Ecological drivers of the ecosystem. Where sensitive species or ecosystem drivers were identified, relevant mitigation measures were put forward to prevent or minimise the impacts.
1.2	How will this project disturb or enhance ecosystems and / or result in the loss or protection of biological diversity? What measures were explored to avoid these negative impacts, and where these negative impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	The nature of this project means that it covers an extensive area however the permanent surface infrastructure is significantly reduced due to the pipelines being underground. Where infrastructure is to be constructed or installed in natural areas, various measures are put forward to mitigate the impacts on biological diversity. The mitigation measures have been developed in consultation with the relevant specialists as mentioned above. Existing and future alien and invasive species will be controlled which will enhance the opportunities for indigenous and beneficial species in the environment.
1.3	How will this development pollute and / or degrade the biophysical environment? What measures were explored to either avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	
1.4	What waste will be generated by this development? What measures were explored to avoid waste, and where waste could not be avoided altogether, what measures were explored to minimise, reuse and / or recycle the waste? What measures have been explored to safely treat and/or dispose of unavoidable waste?	This development will generate various general and hazardous waste, the majority of which will be generated during the construction phase. The general waste will be stored in designated areas and through the process of recovery and recycling, the volume of general waste being disposed to landfill will be minimised. The hazardous portion of the waste stream will also be adequately stored prior to disposal at a suitably licenced hazardous waste disposal facility.
1.5	How will this project disturb or enhance landscapes and / or sites that constitute the nation's cultural heritage? What measures were explored to firstly avoid these impacts, and where impacts could not be avoided	A specialist heritage and palaeontological study has been commissioned in order to identify sites of cultural heritage or palaeontological significance. The identified sites including suitable buffers will be identified as highly sensitive / no-go areas to prevent adverse impacts in these areas.

Ref No.	Question	Answer
	altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	In addition to the above, a chance find procedure has been put forward by the specialist should any unidentified sites of cultural heritage or palaeontological significance be identified during the construction process.
1.6	How will this project use and / or impact on non-renewable natural resources? What measures were explored to ensure responsible and equitable use of the resources? How have the consequences of the depletion of the non-renewable natural resources been considered? What measures were explored to firstly avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	It is acknowledged that due to the nature of gas resources, an onshore (potentially non-renewable) gas resource will be depleted. It has not yet been conclusively determined if this gas field is biogenic (renewable) or thermogenic (non-renewable). Gas production will however contribute significantly to the country's economy as well as the transition from dirtier energy production (coal) to renewable energy production in the future. Locally produced gas will also result in a reduced need for these resources to be imported. Therefore, at present, this gas resource is still needed within South Africa.
1.7	How will this project use and / or impact on renewable natural resources and the ecosystem of which they are part? Will the use of the resources and / or impacts on the ecosystem jeopardise the integrity of the resource and / or system taking into account carrying capacity restrictions, limits of acceptable change, and thresholds? What measures were explored to firstly avoid the use of resources, or if avoidance is not possible, to minimise the use of resources? What measures were taken to ensure responsible and equitable use of the resources? What measures were explored to enhance positive impacts?	
1.7.1	Does the proposed project exacerbate the increased dependency on increased use of resources to maintain economic growth or does it reduce resource dependency (i.e. de-materialised growth)?	The proposed project will provide an opportunity for South Africa to move away from dirtier energy (coal) while transitioning to a more renewable energy source. This can be translated into a "reduced dirty resource dependency".
1.7.2	Does the proposed use of natural resources constitute the best use thereof? Is the use justifiable when considering intra- and intergenerational equity, and are there more important priorities for which the resources should be used?	The harvesting of this gas resource would constitute a better use thereof as it is currently not being harvested in this area (other than by Tetra4) for any commercial beneficial use. In fact, several historically drilled gold prospecting boreholes are undergoing uncontrolled release of Methane into the atmosphere without being flared or burned (to only release CO_2 which is a lower order GHG pollutant). Due to growing global geopolitical uncertainty and increasingly constrained transit of international goods, South Africa would be well positioned to increase local production of gas as opposed to relying on importation thereof.
1.7.3	Do the proposed location, type and scale of development promote a reduced dependency on resources?	The location, type and scale of the proposed development promotes a reduced dependency on the importation of gas resources from other countries. It will further provide an opportunity to reduce dependency on more harmful resources

Ref No.	Question	Answer
		such as coal for energy production. As such, this project should not be viewed in isolation in terms of resources but in a holistic manner both nationally and globally.
1.8	How were a risk-averse and cautious approach applied in terms of ecological impacts:	
1.8.1	What are the limits of current knowledge (note: the gaps, uncertainties and assumptions must be clearly stated)?	In order to prevent repetition, the reader is directed to the assumptions and limitations presented in Section 14.
1.8.2	What is the level of risk associated with the limits of current knowledge?	No limits to current knowledge for any potential significant impacts have been identified. The level of risk is therefore deemed to be low.
1.8.3	Based on the limits of knowledge and the level of risk, how and to what extent was a risk-averse and cautious approach applied to the development?	As preferred drilling locations and associated infrastructure such as pipelines cannot be identified at this stage due to the nature of exploration activities (i.e. updated exploration model based on initial drilling to inform subsequent drilling), a strategic assessment of transects (300m to 600m wide) has been undertaken as part of this EIA process in order to identify areas of high sensitivity and no-go areas. The sensitivity planning approach will guide the preferred placement of wells and other infrastructure and will additionally be guided by specific landowner consultations and negotiations. In this manner, a risk-averse and cautious approach is able to be more fully realised in future project planning.
1.9	**How will the ecological impacts resulting from this development impact on people's environmental right in terms following?**	
1.9.1	Negative impacts: e.g. access to resources, opportunity costs, loss of amenity (e.g. open space), air and water quality impacts, nuisance (noise, odour, etc.), health impacts, visual impacts, etc. What measures were taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	The application and proposed development footprint occur predominantly on properties that are commercial agricultural concerns. The well placing will be discussed and agreed with each affected landowner prior to commencement of drilling and where necessary, appropriate compensation negotiated. Furthermore, as mentioned above, this EIA process has been undertaken at a more strategic level assessment of the receiving environment within proposed development corridors which allows input from numerous specialist disciplines to identify highly sensitive or no-go areas which can then be excluded from development where necessary. The positive impact of job creation has been identified by the social specialist and the requirement for local upliftment in the form of employment creation or social programmes put forward.
1.9.2	Positive impacts: e.g. improved access to resources, improved amenity, improved air or water quality, etc. What measures were taken to enhance positive impacts?	
1.10	Describe the linkages and dependencies between human wellbeing, livelihoods and ecosystem services applicable to the area in question and how the development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, loss of heritage site, opportunity costs, etc.)?	The impact on third party wellbeing, livelihoods and ecosystem services is not of a high negative significance as the predominant land use of the affected properties is commercial agriculture as mentioned above, and the site sensitivities from a socio-economic and biophysical point of view have been identified and or mitigation measures put forward which must be considered prior to the final placement of infrastructure. Furthermore, landowner negotiations prior to final

Ref No.	Question	Answer
		placement of infrastructure will additionally be undertaken to limit any negative impacts on human wellbeing, livelihoods and/or ecosystems.
1.11	Based on all of the above, how will this development positively or negatively impact on ecological integrity objectives / targets / considerations of the area?	As described above, this project is anticipated to have a low overall impact on the ecological integrity objectives or targets as consideration of these aspects will be undertaken prior to final placement of infrastructure.
1.12	Considering the need to secure ecological integrity and a healthy biophysical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being proposed), resulted in the selection of the "best practicable environmental option" in terms of ecological considerations?	An area assigned a Very High terrestrial theme sensitivity has been delineated on the farm Adamsons Vley 655 (Portion 0) based on the presence of a protected faunal species. Previous attempts to relocate this species have been unsuccessful and in situ conservation remains the preferred outcome. This area should exclude any surface development infrastructure. Consultation and communication with the lead or implementing agent for the sensitive species, Endangered Wildlife Trust (EWT), must be implemented before any construction proximal to the specific area. Monitoring and Management of the species will be crucial throughout the lifetime of the project and must be discussed and implemented in conjunction with the EWT.
1.13	Describe the positive and negative cumulative ecological / biophysical impacts bearing in mind the size, scale, scope and nature of the project in relation to its location and existing and other planned developments in the area?	Refer to Section 10 of this report.
2	**Promoting justifiable economic and social development**	
2.1	**What is the socio-economic context of the area, based on, amongst other considerations, the following:**	
2.1.1	The IDP (and its sector plans' vision, objectives, strategies, indicators and targets) and any other strategic plans, frameworks or policies applicable to the area,	Details of the IDP's for the Lejweleputswa District Municipality (LDM) as well as the Matjhabeng and Masilonyana Local Municipalities are included in Section 9.4. The proposed project will promote and support the sustainability of existing business in the local and regional economy and assist in increasing local beneficiation and shared economic growth, through extending the output production of gas.
2.1.2	Spatial priorities and desired spatial patterns (e.g. need for integrated of segregated communities, need to upgrade informal settlements, need for densification, etc.),	
2.1.3	Spatial characteristics (e.g. existing land uses, planned land uses, cultural landscapes, etc.), and	
2.1.4	Municipal Economic Development Strategy ("LED Strategy").	
2.2	Considering the socio-economic context, what will the socio-economic impacts be of the development (and its separate elements/aspects), and specifically also on the socio-economic objectives of the area?	This project will result in positive socio-economic impacts in the local, regional and national economy. Refer to the impact assessment in Section 10 in this report.

Ref No.	Question	Answer
2.2.1	Will the development complement the local socio-economic initiatives (such as local economic development (LED) initiatives), or skills development programs?	The proposed Cluster 2 project will indirectly assist with increasing the gas production project which will ensure that the community projects initiated by Tetra4 under their Social and Labour Plan will also have an increased life. This will complement the local socio-economic initiatives identified for the area.
2.3	How will this development address the specific physical, psychological, developmental, cultural and social needs and interests of the relevant communities?	Tetra4 is currently in the process of providing certain basic services such as water and electricity to the Adamsons Vley community as part of the Social and Labour Plan commitments for Cluster 1. This is an ongoing process throughout the project implementation and would be extended to other communities in due course and where possible. During the Scoping phase focus group consultation with the Adamsons Vley community, the community members acknowledged that the water and solar electricity project was currently underway in their community. They have been provided with a new borehole, pump and storage tanks for water. In addition, solar PV for lighting is being installed on the houses. Should Cluster 2 be approved and implemented, there would be further opportunities for SLP upliftment in the long term.
2.4	Will the development result in equitable (intra- and inter-generational) impact distribution, in the short- and long-term? Will the impact be socially and economically sustainable in the short- and long-term?	None of the identified impacts are anticipated to have a high negative impact significance post mitigation. It is therefore not anticipated that this project will result in negative equitable impact distribution in the short- and long-term.
2.5	**In terms of location, describe how the placement of the proposed development will:**	
2.5.1	Result in the creation of residential and employment opportunities in close proximity to or integrated with each other.	The proposed Cluster 2 development will be an extension to the current Cluster 1 development and will promote further employment opportunities (to a limited extent) both locally and regionally. This project is not anticipated to have a material impact on the need for transport of people and good or impact on access to public transport.
2.5.2	Reduce the need for transport of people and goods.	
2.5.3	Result in access to public transport or enable non-motorised and pedestrian transport (e.g. will the development result in densification and the achievement of thresholds in terms of public transport),	
2.5.4	Compliment other uses in the area,	The Cluster 2 project will be an extension of the existing Cluster 1 project and therefore will complement the existing activities in the area.
2.5.5	Be in line with the planning for the area.	Refer to item 2.1.1 of this table (above).
2.5.6	For urban related development, make use of underutilised land available with the urban edge.	Not applicable. The proposed project is not located in an urban area.
2.5.7	Optimise the use of existing resources and infrastructure,	The Cluster 2 project will be an extension of the existing Cluster 1 project and therefore will complement the existing activities and resources in the area.
2.5.8	Opportunity costs in terms of bulk infrastructure expansions in non-priority areas (e.g. not aligned with the bulk infrastructure planning for the settlement that reflects the spatial reconstruction priorities of the settlement),	

Ref No.	Question	Answer
2.5.9	Discourage "urban sprawl" and contribute to compaction / densification.	This project is located in a rural setting and is not anticipated to have an impact on or any control over urban sprawl in the nearby towns.
2.5.10	Contribute to the correction of the historically distorted spatial patterns of settlements and to the optimum use of existing infrastructure in excess of current needs,	Refer to items 2.5.7 – 2.5.9 of this table (above).
2.5.11	Encourage environmentally sustainable land development practices and processes	This project will have a minimal impact on the current land uses in the application area as the pipeline network is subterranean while the production wells are insignificantly small in area (less than $2m^2$ each). This will allow for existing land uses to continue while this gas development project is ongoing.
2.5.12	Take into account special locational factors that might favour the specific location (e.g. the location of a strategic mineral resource, access to the port, access to rail, etc.),	The proposed Cluster 2 project is an extension of the existing Cluster 1 gas production project and falls within the approved Production Right area.
2.5.13	The investment in the settlement or area in question will generate the highest socio-economic returns (i.e. an area with high economic potential).	As mentioned in 2.5.11 above, this project will not sterilise existing land uses and therefore it will in fact result in higher economic returns per land area as both agriculture and gas production can occur simultaneously.
2.5.14	Impact on the sense of history, sense of place and heritage of the area and the socio-cultural and cultural-historic characteristics and sensitivities of the area, and	The proposed development is an extension of the existing gas production operations in the area and therefore will have a minimal impact on the existing sense of place. Furthermore, a detailed Heritage Impact Assessment is included in this assessment which has identified numerous existing cultural and heritage sites which allows for their protection from negative impacts.
2.5.15	In terms of the nature, scale and location of the development promote or act as a catalyst to create a more integrated settlement?	The proposed project will indirectly contribute to continued employment in the region, as well as projects implemented from Tetra4s SLP.
2.6	**How was a risk-averse and cautious approach applied in terms of socio-economic impacts:**	
2.6.1	What are the limits of current knowledge (note: the gaps, uncertainties and assumptions must be clearly stated)?	Refer to Section 14 of this report.
2.6.2	What is the level of risk (note: related to inequality, social fabric, livelihoods, vulnerable communities, critical resources, economic vulnerability and sustainability) associated with the limits of current knowledge?	The level of risk is considered low as the project is not expected to have far reaching negative impacts on socio-economic conditions.
2.6.3	Based on the limits of knowledge and the level of risk, how and to what extent was a risk-averse and cautious approach applied to the development?	Specific emphasis was placed on the potential socio-economic impacts. Engagements with affected communities and landowners were undertaken to understand the dynamic socio-economic environment and the risks associated with the project. Valuable feedback was received and thereafter specific conditions of the authorisation have been put forward to ensure that pre-emptive attention is given to these impacts at all times. In essence, no development is to take place

Ref No.	Question	Answer
		on a particular property until such time as the landowner has been thoroughly consulted, signed contracts in place and suitable compensation made for any adverse impacts on livelihoods.
2.7	**How will the socio-economic impacts resulting from this development impact on people's environmental right in terms following:**	
2.7.1	Negative impacts: e.g. health (e.g. HIV-Aids), safety, social ills, etc. What measures were taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	Refer to the impact assessment in Section 10 of this report. Both positive and negative socio-economic impacts have been identified and relevant mitigation measures put forward to reduce negative impacts and enhance positive impacts as far as practicable.
2.7.2	Positive impacts. What measures were taken to enhance positive impacts?	
2.8	Considering the linkages and dependencies between human wellbeing, livelihoods and ecosystem services, describe the linkages and dependencies applicable to the area in question and how the development's socioeconomic impacts will result in ecological impacts (e.g. over utilisation of natural resources, etc.)?	
2.9	What measures were taken to pursue the selection of the "best practicable environmental option" in terms of socio-economic considerations?	
2.10	What measures were taken to pursue environmental justice so that adverse environmental impacts shall not be distributed in such a manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons (who are the beneficiaries and is the development located appropriately)? Considering the need for social equity and justice, do the alternatives identified, allow the "best practicable environmental option" to be selected, or is there a need for other alternatives to be considered?	
2.11	What measures were taken to pursue equitable access to environmental resources, benefits and services to meet basic human needs and ensure human wellbeing, and what special measures were taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination?	The potential impact on existing land uses has been identified from the start of this application process and an assessment of this impact as well as mitigation measures put forward to prevent undue negative impacts in this regard. Refer to the impact assessment in Section 10 of this report.
2.12	What measures were taken to ensure that the responsibility for the environmental health and safety consequences of the development has been addressed throughout the development's life cycle?	Refer to the impact assessment in Section 10 of this report. The EIA and EMPr will specify timeframes within which mitigation measures must be implemented.
2.13	**What measures were taken to:**	
2.13.1	Ensure the participation of all interested and affected parties.	

Ref No.	Question	Answer
2.13.2	Provide all people with an opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation,	Notwithstanding the detailed description of the stakeholder consultation process included in Section 8 of this report, the consultation process has been undertaken in 3 languages (English, Afrikaans and Sesotho), published in newspaper advertisements, erection of 78 site notices (in all three languages), direct emails, faxes, SMSs and registered letters where contact information was available. Furthermore, public and focus group meetings were undertaken during the Scoping phase with translators available for all 3 languages and another round of meetings will be undertaken during the EIA phase during which any additional consultation requirements of the I&APs will be identified and addressed where necessary.
2.13.3	Ensure participation by vulnerable and disadvantaged persons,	
2.13.4	Promote community wellbeing and empowerment through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means,	
2.13.5	Ensure openness and transparency, and access to information in terms of the process,	
2.13.6	Ensure that the interests, needs and values of all interested and affected parties were taken into account, and that adequate recognition were given to all forms of knowledge, including traditional and ordinary knowledge,	
2.13.7	Ensure that the vital role of women and youth in environmental management and development were recognised and their full participation therein will be promoted?	
2.14	Considering the interests, needs and values of all the interested and affected parties, describe how the development will allow for opportunities for all the segments of the community (e.g. a mixture of low-, middle-, and high-income housing opportunities) that is consistent with the priority needs of the local area (or that is proportional to the needs of an area)?	
2.15	What measures have been taken to ensure that current and / or future workers will be informed of work that potentially might be harmful to human health or the environment or of dangers associated with the work, and what measures have been taken to ensure that the right of workers to refuse such work will be respected and protected?	Workers will be educated on a regular basis as to the environmental and safety risks that may occur within their work environment. Furthermore, adequate measures will be undertaken to ensure that the appropriate personal protective equipment is issued to workers based on the areas that they work and the requirements of their job. Their right to refuse work (if considered dangerous) will be included in the education programme.
2.16	**Describe how the development will impact on job creation in terms of, amongst other aspects:**	
2.16.1	The number of temporary versus permanent jobs that will be created.	This Cluster 2 project is an extension to the existing Cluster 1 project which is nearing completion of construction. This would therefore provide further employment opportunities to those temporary employees on the Cluster 1 project and who's contracts may be nearing completion. The specialist economic impact assessment identified that economy-wide job creation after multipliers may be as high as 4 600 and multiplying that by the SA
2.16.2	Whether the labour available in the area will be able to take up the job opportunities (i.e. do the required skills match the skills available in the area).	
2.16.3	The distance from where labourers will have to travel.	
2.16.4	The location of jobs opportunities versus the location of impacts.	

Ref No.	Question	Answer
2.16.5	The opportunity costs in terms of job creation.	6:1 dependency ratio, then the amount of people that could benefit from the cumulative job creation could be as high as 28 000. The current workers travel from the local area (~20-40 km) to the Cluster 1 project, and it is therefore expected that similar travel requirements will apply to the Cluster 2 project.
2.17	**What measures were taken to ensure:**	
2.17.1	That there were intergovernmental coordination and harmonisation of policies, legislation and actions relating to the environment.	The Scoping and EIA Process requires governmental departments to communicate regarding any application. In addition, all relevant departments are notified at various phases of the project by the EAP and any feedback received from government departments is considered where relevant.
2.17.2	That actual or potential conflicts of interest between organs of state were resolved through conflict resolution procedures.	
2.18	What measures were taken to ensure that the environment will be held in public trust for the people, that the beneficial use of environmental resources will serve the public interest, and that the environment will be protected as the people's common heritage?	Environmental attributes that may be impact by this project have been identified and where relevant, specialist input has been solicited to ensure that a rigorous impact assessment process is undertaken. Where positive impacts on the interests of the public have been identified (e.g. job creation, impact on existing land use, etc.), mitigation measures are put forward to enhance positive impacts and/or reduce negative impacts.
2.19	Are the mitigation measures proposed realistic and what long-term environmental legacy and managed burden will be left?	The Cluster 1 EMPr construction mitigation measures have been tested in the real world as construction of Cluster 1 has recently been completed. The EIA specialist team has assessed these Cluster 1 management measures for adequacy and where relevant made amendments or additions. Furthermore, based on concerns raised by the affected landowners, additional measures have been put forward to strengthen measures and thereby reduce negative impacts.
2.20	What measures were taken to ensure that the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects will be paid for by those responsible for harming the environment?	Tetra4 provides annual updates of their Cluster 1 financial provisioning to the Competent Authority and the provision will be adjusted to reflect the Cluster 2 costs.
2.21	Considering the need to secure ecological integrity and a healthy bio-physical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being proposed), resulted in the selection of the best practicable environmental option in terms of socio-economic considerations?	Refer to Section 7 wherein a description of the process followed to reach the proposed preferred site.

Ref No.	Question	Answer
2.22	Describe the positive and negative cumulative socio-economic impacts bearing in mind the size, scale, scope and nature of the project in relation to its location and other planned developments in the area?	Refer to the impact assessment and mitigation measures in Section 10 of this Report.

7 PROJECT ALTERNATIVES

The assessment of the identified alternatives is a key aspect of the success of the EIA process. All reasonable and feasible alternatives must be identified and screened to determine the most suitable alternatives to prevent unnecessary impacts on the receiving environment. There are however some constraints that must be considered when identifying feasible alternatives for a project of this scope. Such constraints include social, environmental, and financial related issues that will be considered in the evaluation of the alternatives. Alternatives can typically be identified according to:

- Activity alternatives;
- Location alternatives;
- Design and layout alternatives;
- Process alternatives; and
- The No Action alternative (No-go Alternative).

For any alternative to be considered feasible such an alternative must meet the need and purpose of the development proposal without presenting significantly high associated impacts. Essentially, alternatives represent different means of meeting the general purpose and need of the proposed project through the identification of the most appropriate and feasible method of development, all of which are discussed below.

Alternatives can also be distinguished into discrete or incremental alternatives. Discrete alternatives are overall development options, which are typically identified during the pre-feasibility, feasibility and or scoping phases of the EIA process (DEAT; 2004). Incremental alternatives typically arise during the EIA process and are usually suggested as a means of addressing identified impacts. These alternatives are closely linked to the identification of mitigation measures and are not specifically identified as distinct alternatives.

7.1 ACTIVITY ALTERNATIVES

The current land uses within the Cluster 2 study area and surroundings comprise of the existing Tetra4 Cluster 1 gas production project along with mining and agriculture. Gas production operations, as a land use, is often viewed as directly competing and eventually replacing existing land uses. However, a mixed land use approach consisting of gas production and agriculture as has been demonstrated within the Cluster 1 project is feasible and achievable. Current agricultural activities within the Cluster 1 study area are able to continue within the vicinity of the gas production activities, particularly because the proposed pipeline network is below ground at a depth that allows for continued agricultural practises including ploughing. The surface infrastructure of the gas production network is extremely small compared to the overall application area (even on an individual property) however lessons learned from the final siting (location) of the surface infrastructure in Cluster 1 has resulted in a more refined approach for Cluster 2.

Mixed land use consisting of conservation and gas production is unlikely to coexist due to certain land use restrictions within national parks/ nature reserves and buffer areas as per the National Environmental Management: Protected Areas Act (2003) (NEMPPA). However, there are currently no conservation areas (e.g. IBAs, nature reserves, etc.) within the Cluster 2 study area, as well as no known plans for the expansion of any IBAs or nature reserves within or adjacent to the Cluster 2 study area. The Goldfields Game Ranch as well as a number of privately owned game farms occur within the study area however these are not designated as formal protected areas, IBAs, nature reserves, etc. Therefore, the proposed gas production activity in conjunction with current agricultural and mining land uses has been assessed considered in view of the above. No additional activity alternatives are identified.

7.2 LOCATION ALTERNATIVES

Location alternatives can apply to the entire Cluster 2 project (e.g. the strategic decision to locate the proposed development in the Free State within the Lejweleputswa District where there is an existing Production Right held by Tetra4), as well as the specific individual components of the proposed developments (e.g. the location

of wells, pipelines, booster and compressor stations and the LNG/LHe plant including any associated infrastructure within the study area).

Tetra4 currently holds an approved Production Right (12/4/1/07/2/2) which spans approximately 187 000 hectares to develop gas fields around the town of Virginia in the Free State Province. Cluster 2 is the second phase of site-specific assessments for expanded production activities planned within the Production Right area. Cluster 1 which has just recently gone into gas production operation involved/involves exploration drilling activities, establishment of production wells, connection of production wells with pipelines and construction and operation of two compressor stations and the first LNG/LHe gas beneficiation plant. The Cluster 1 exploration program has provided sufficient data to unequivocally confirm the viability of gas production in the area. Location alternatives can be considered from a macro- or microscale. From a macro location perspective the production is driven by the presence of the target resource and therefore this activity cannot be undertaken in other areas due to the absence of the target resource (fractures, faults and/or fissures in the geological structure).

The Cluster 2 project will expand upon this existing Cluster 1 operation and where possible pipelines, compressor stations and the LNG/LHe Plant will be constructed adjacent to the Cluster 1 infrastructure to prevent unnecessary and further disturbance of existing land uses.

In summary, the location of Cluster 2 must be within the approved Production Right area as per the proposed study area and the Cluster 1 operation has confirmed the viability of the project in this area. Therefore an entirely different location within South Africa is not a feasible macro-alternative that can be further interrogated. Micro-alternatives for various infrastructure has however been considered in light of the consultation feedback from the scoping process and is discussed in more detail in the subsections below.

During the scoping phase consultation, certain landowners voiced their concerns around the location of certain aboveground infrastructure on their properties which has the potential to interfere with existing land use. These concerns focussed on the following:

- Cultivated lands:
    - Above ground infrastructure such as production wells, low point drains, pigging stations, booster stations, pipe markers etc pose an obstacle to the heavy farming equipment that is used. For example combine harvesters cannot easily navigate around these obstacles which consequently results in reduced cultivated areas to avoid such infrastructure entirely.
    - The timing of construction is important since cultivated lands require sowing and harvesting during certain seasons.
- Game farming camps:
    - Certain game farms rely on hunting as a form of income. Therefore the timing of construction activities as well as access for maintenance during operations needs to take into consideration the hunting season and or existing or planned hunts.
    - Certain game farms have been re-established from previous cultivated lands or grasslands into a more biodiverse ecosystem with trees, shrubs and grasses and stocked with a variety of game animals. The effort and costs involved to achieve this land use have been considerable and any disturbances or destruction of the current environment on these farms will result in negative impacts on the landowners.
    - Servitudes running through established forest or thicket areas result in a clearing of the trees along the 10m wide servitude. This has a negative visual impact on the sense of place as well as impacts on the foraging or behaviour of certain game species.
- Visual/sense of place and noise:
    - Construction activities within close proximity to farmsteads etc result in a negative visual perception as well as noise irritation.

- Safety and security:
    - Safety and security in farming areas is a well-known concern and risk and the project will require farm access by several unknown personnel to the landowners at various stages of the project implementation.

7.2.1 WELL SITES

The proposed Cluster 2 project involves 300 new production wells located within various 600 m wide transects in the application area as shown in Figure 6. These transects have been delineated based on underlying geological features (known fractures/fault lines) which are the most suitable location to intercept gas reserves. Directional drilling methods are employed to intercept the fault lines which requires drilling some distance away from the actual fault lines. As such, a 300 m buffer was applied along these known fault lines which resulted in the 600 m wide transects within which the exploration drilling will be undertaken. As not all exploration wells are gas bearing, the number of exploration wells will exceed the production wells by a factor of roughly 25 % (i.e. ~400 exploration wells to result in ~300 production wells). These non-gas bearing wells will not require pipeline connections and will be decommissioned and rehabilitated once confirmed to be non-gas bearing.

Although the final positions of the proposed exploration wells are subject to change during the exploration campaign as new data becomes available, the final well locations will remain within the 600 m well transects and will be guided by the sensitivities identified from the specialist assessments as well as the concerns raised by the landowners to position the well sites in such a manner to avoid adverse impact as far as possible. The final sensitivity mapping approach is detailed in Section 11 while the measures to address landowners' concerns are listed below.

1. Exploration drilling sites will be negotiated and agreed with the affected landowners prior to final siting and appropriate compensation will additionally be agreed upon contractually and provided on an annual basis during construction and operations.
2. If the geology allows, then the footprint of more than one drill well can be contained in the same exploration drill site. However, should the same site be used, it cannot be done in parallel but rather in sequence i.e. one well drilled and completed then followed by another thereby extending the time on the property with appropriate compensation adjustments where relevant.
3. Where a production well surface infrastructure would negatively impact on existing land use (cultivated areas, game farming, etc), the well will be connected underground (1.5m deep) to the offtake pipeline with the surface well chamber being located some distance away from the actual well. For example the well chamber could be located along the fence lines or similar area so as not to interfere with ongoing land use.
4. Several specific measures to address safety and security risks have been put forward as recommendations for inclusion in the decision and in order to prevent significant duplication in this report, refer to Section 13.4.

7.2.2 PIPELINE ROUTES (SERVITUDES AND INLINE INFRASTRUCTURE)

Further to the above well site location alternative description, the pipeline routes are largely dependent on the location of the gas-bearing wells in order to connect these wells to the main gas trunklines leading to the compressor stations. The assessed pipeline transects are 300 m wide (Figure 6) and within these areas, the final siting of the pipelines will be determined. The final pipeline routes will be guided by the sensitivities identified from the specialist assessments as well as the concerns raised by the landowners to position the pipelines and above ground inline infrastructure in such a manner to avoid adverse impact as far as possible. The final sensitivity mapping approach is detailed in Section 11 while the measures to address landowners' concerns are listed below.

1. Pipelines and associated inline infrastructure will be negotiated and agreed with the affected landowners prior to final siting and appropriate compensation will additionally be agreed upon contractually and provided on an annual basis during construction and operations.

2. All pipelines will be buried at least 1.5m below ground (to top of pipe).
3. Tetra4 will investigate alternatives methods for the removal of condensation water in the pipelines with the intention to limit or reduce the number of low point drains in the system which require regular maintenance. This may include nitrogen purging lines to flush out the system.
4. A number of specific measures to address safety and security risks have been put forward as recommendations for inclusion in the decision and in order to prevent significant duplication in this report, refer to Section 13.4.

7.2.3 COMPRESSOR STATIONS

Three compressor stations are required within the Cluster 2 gas pipeline network and must be located within the transmission pipeline transects in order to be able to tie into the pipelines. The three compressor stations (CS) are numbered CS1, CS2 and CS3 as shown in Figure 6. At this early stage in the project, the electricity supply to the CS3 site on the farm Doorn River 330 (Portion 2) is uncertain and therefore an alternative site has been considered. This alternative site is located adjacent to the existing Cluster 1 compressor station A (CSA) on the farm Palmietkuil 328 (Portion 6) where power supply is available.

These location alternatives for CS3 are referred to as:

- **CS3_L1** (Doorn River 330 (Portion 2))
- **CS3_L2** (Palmietkuil 328 (Portion 6))

From an engineering cost perspective, the CS3_L2 (Palmietkuil) location would require more expensive piping in the southern gas transmission network to strengthen the pipe network however the risk of not having sufficient electricity for the CS3_L1 (Doorn Rivier) location would outweigh the additional costs.

During the scoping consultation process, the Doorn Rivier landowner provided a list of concerns relating to the project and specifically the compressor stations. These concerns along with specialist input have been considered in the preferred alternative analysis in Section 13.2.

7.2.4 LNG/LHE PLANT

The location of the Cluster 2 plant has been selected for two main reasons namely:

1. The approved Cluster 1 plant has been constructed in this location with access off the R30 and in addition, certain infrastructure such as offices, ablution, waste storage and treatment can be shared by the Cluster 2 plant. Therefore the Cluster 2 plant location has been sited directly adjacent to the existing Cluster 1 plant which will prevent unnecessary further disturbances and impacts in other locations.
2. Tetra4 is the legal owner of the farm on which the plant complex is proposed (remaining extent of the farm Mond van Doornrivier 38), and the sensitivities of the farm are well known with no highly sensitive areas to be impacted on.

As the most suitable location for the Cluster 2 plant has already been identified, no location alternatives for the Cluster 2 Plant were assessed.

7.3 DESIGN AND LAYOUT ALTERNATIVES

Design and layout alternatives ensure the consideration of different design and spatial configurations of the proposed development within a specific location, to enhance the positive impacts and to reduce the negative impacts. The proposed Cluster 2 gas production project is foremost guided by the location of existing gas bearing geological fractures/faults (well transects) with the location of the LNG/LHe plant being situated adjacent to the existing Cluster 1 plant. The pipelines and compressor stations connect the production wells and ultimately to the plant and therefore due consideration has been given to the placement and orientation of required infrastructure and activities. The sensitivity planning approach as described in Section 11 as well as the measures to address impacts on landowners described in Section 7.2 above for the well and pipeline transects will guide the final layout position of the various infrastructure. The layout of surface infrastructure, access roads, and

associated surface structures will undergo a micro siting exercise whereby environmental features on site as well as current land uses, and infrastructure are considered towards ensuring that the proposed Cluster 2 project activities avoid areas of high environmental sensitivity and minimise infringement on existing infrastructure and land use as much as possible.

The surface infrastructure to be constructed for the Cluster 2 production wells shall undergo a design change from what was constructed in the Cluster 1 development due to security issues as well as visual impacts. There are 19 production wells in Cluster 1 which were equipped in line with globally accepted practice designs. There have however been various instances of theft of infrastructure due to the visibility thereof and remote locations of some of the wells. These Cluster 1 production well designs are also more visually intrusive. As there will be approximately 300 production wells in the Cluster 2 development, the production well chamber designs have been altered to a concrete bunker type design which is largely underground. This will result in a far lower visual impact as well as a smaller aboveground constructed footprint per well (1,4 m x 1,1 m concrete manhole with a height aboveground of ~0.25m).

7.4 PROCESS ALTERNATIVES

Process alternatives imply the investigation of alternative processes or technologies that can be used to achieve the same goal for the proposed gas production development. This includes using environmentally friendly designs or materials and reusing scarce resources like water and non-renewable energy sources. No specific process alternatives have been identified for the Cluster 2 project as the existing Cluster 1 development has proven processes in place. In addition, certain preferential process alternatives have already been incorporated into the project design such as the site water treatment facility to allow for water treatment, recovery and conservation. Similarly any boiloff gas within the LNG tanks is captured for reprocessing as opposed to venting to atmosphere. Therefore no additional process alternatives have been assessed.

7.5 TECHNOLOGY ALTERNATIVES

The selection of the techniques to be adopted for the construction and operation of the gas production infrastructure has considered the requirements for gas wells (i.e. drill depths, well string casing, maximising gas collection, etc.); pipeline function and efficiency; as well as helium and LNG processing, storage and distribution. Based on the experience and lessons learned from the Cluster 1 development, no further technology alternatives are proposed.

7.6 NO GO ALTERNATIVE

The “No Go” or “No Action” alternative refers to the alternative of not embarking on the proposed project at all. This alternative would imply that the current status quo without the proposed Cluster 2 gas production development would continue (albeit the existing Cluster 1 gas production operation would continue). It is important to note that the No Go alternative is the baseline against which all other alternatives and the development proposal are assessed (i.e. Cluster 1 operation is included in the baseline condition).

When considering the No Go alternative, the impacts (both positive and negative) associated with any other specific alternative, or the current project proposal would not occur and in effect the impacts of the No Go alternative are therefore inadvertently assessed by assessing the other alternatives. In addition to the direct implications of retaining the status quo there are certain other indirect impacts, which may occur should the No Go alternative be followed. The No Go alternative as a specific alternative is not considered feasible and has been scoped out at this EIA phase assessment.

7.7 SENSITIVITY PLANNING APPROACH

As described in Section 7.2 above and detailed in Section 11, the sensitivity planning approach will guide the final location of the proposed wells, pipelines and related infrastructure.

8 STAKEHOLDER ENGAGEMENT

The Public Participation Process (PPP) is a requirement of several pieces of South African legislation and aims to ensure that all relevant Interested and Affected Parties (I&APs) are consulted, involved and their comments are considered, and a record included in the reports submitted to the Authorities. The process ensures that all stakeholders are provided this opportunity as part of a transparent process which allows for a robust and comprehensive environmental study. The PPP for the proposed project needs to be managed sensitively and according to best practises to ensure and promote:

- Compliance with international best practice options;
- Compliance with national legislation;
- Establishment and management of relationships with key stakeholder groups; and
- Involvement and participation in the environmental study and authorisation/approval process.

The purpose of the PPP and stakeholder engagement process is to:

- Introduce the proposed project;
- Explain the authorisations required;
- Explain the environmental studies already completed and yet to be undertaken (where applicable);
- Solicit and record any issues, concerns, suggestions, and objections to the project;
- Provide opportunity for input and gathering of local knowledge;
- Establish and formalise lines of communication between the I&APs and the project team;
- Identify all significant issues for the project; and
- Identify possible mitigation measures or environmental management plans to minimise and/or prevent negative environmental impacts and maximize and/or promote positive environmental impacts associated with the project.

8.1 GENERAL APPROACH TO PUBLIC PARTICIPATION

The PPP for the proposed project has been undertaken in accordance with the requirements of the NEMA EIA Regulations (2014), and in line with the principles of Integrated Environmental Management (IEM). IEM implies an open and transparent participatory process, whereby stakeholders and other I&APs are afforded an opportunity to comment on the project and have their views considered and included as part of project planning.

At the start of the application process, an initial I&AP database was compiled based on known key I&AP's (previous Cluster 1 application, affected landowners, Organs of State, etc.), Windeed searches and other stakeholder databases. The I&AP database includes amongst others, landowners, communities, regulatory authorities and other special interest groups. The database has been continually updated as and when new I&AP's show interest in the application.

National, Provincial and Local Government Authorities as well as State Owned Entities (SOE's) were notified of the proposed project and include:

- Eskom Holdings SOC Limited
- Free State Department of Agriculture& Rural Development
- Free State Department of Cooperative Governance and Traditional Affairs
- Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs
- Free State Department of Mineral Resources and Energy
- Free State Department of Police, Roads and Transport

- Free State Department of Public Works and Infrastructure
- Free State Department of Water and Sanitation
- Free State Development Corporation
- Free State Heritage Resources Authority
- Lejweleputswa Development Agency
- Lejweleputswa District Municipality
- Masilonyana Local Municipality
- Matjhabeng Local Municipality
- National Department of Agriculture, Land Reform and Rural Development
- National Department of Forestry, Fisheries and Environment
- National Department of Transport
- National Department of Water and Sanitation
- National Energy Regulator of South Africa (NERSA)
- National House of Traditional Leaders
- Petroleum Agency of South Africa (PASA)
- Sedibeng Water
- South African Heritage Resources Agency
- South African National Biodiversity Institute
- South African National Roads Agency Ltd: Eastern Region
- Transnet SOC Limited

Non-Governmental Organisations (NGOs) and Non-Profit Organisations (NPOs) including:

- African Conservation Trust
- Afriforum
- Birdlife South Africa
- Centre for Environmental Rights
- Conservation South Africa
- Earthlife Africa
- Endangered Wildlife Trust
- Federation for Sustainable Environment
- Gold and Uranium Belt Impact Sensoring Organisation
- Groundwork South Africa
- Vaal Environmental Justice Alliance
- Wildlife and Environment Society of South Africa
- World Wildlife Fund

In addition to the above, attempts to consult with directly affected landowners, adjacent landowners, community and farming representatives, occupiers of land, etc. were made. A total of 78 site notices and a

number of A3 posters were placed in and around the study area in conspicuous area in an attempt to solicit input from any I&AP's who were not pre-identified and registered on the I&AP database.

8.2 INITIAL NOTIFICATION

The PPP commenced on 20 May 2022 with an initial notification and call to register for a period of 30 days. The initial notification was undertaken in English, Afrikaans and Sesotho and was given in the following manner:

8.2.1 REGISTERED LETTERS, FAXES AND EMAILS

Notification letters, faxes, and emails were distributed to all pre-identified I&APs including government organisations, NGOs, relevant municipalities, ward councillors, landowners and other organisations that might be interested or affected.

The notification letters included the following information to I&APs:

- The purpose of the proposed project;
- High level list of anticipated activities to be authorised;
- Scale and extent of activities to be authorised;
- Information on the intended production operation to enable I&APs to assess/surmise what impact the activities will have on them or on the use of their land;
- Details of the affected properties (including details of where a locality map and other information could be obtained including a Background Information Document (BID) in the 3 languages);
- Summary of the relevant legislation pertaining to the application process;
- Initial registration period timeframes;
- A request for I&APs to confirm that they wish to be registered on the database moving forward as in terms of the POPI Act, if pre-identified I&AP's do not confirm this, they will be removed from the database moving forward; and
- Contact details of the EAP.

8.2.2 NEWSPAPER ADVERTISEMENTS / GOVERNMENT GAZETTE

Advertisements describing the proposed project and EIA process were published in the Vista Newspaper with circulation in the vicinity of the study area. The initial advertisements were placed in the Vista newspaper in English, Afrikaans and Sesotho on the 19 May 2022 with a government gazette published (also in 3 languages) on 1 July 2022. The newspaper adverts included the following information:

- Project name;
- Applicant name;
- Project location description including a map;
- Nature of the activity and application;
- Where additional information could be obtained; and
- Relevant EIMS contact person and contact details for the project.

8.2.3 SITE NOTICE PLACEMENT

A1 Correx site notices in English, Afrikaans and Sesotho were placed at 78 locations within and around the application area from 16 May 2022 to 19 May 2022. The on-site notices included the following information:

- Project name;
- Applicant name;

- Project location;
- Map of proposed application area;
- Project description;
- Legislative requirements; and
- Relevant EIMS contact person and contact details for the project.

8.2.4 POSTER PLACEMENT

A3 posters in English, Afrikaans and Sesotho were placed at local public gathering places in Welkom, Theunissen and Virginia (Welkom Public Library, Retail Spar, Retail Pick n Pay, Virginia Public Library, Theunissen Magistrates Court and Masilo (Theunissen) Public Library.

The notices and posters afforded I&APs who may be interested in the project with the opportunity to register for the project as well as to submit any issues/queries/concerns and indicate the contact details of any other potential I&APs that should be contacted. The contact person at EIMS and contact details were stated on the posters. Comments/concerns and queries were encouraged to be submitted in either of the following manners:

- Electronically (fax, email);
- Telephonically; and/or
- Written letters (postal).

8.3 SCOPING PHASE PUBLIC PARTICIPATION

Notification regarding the availability of the Scoping Report for public review was given in the following manner to all registered I&APs:

- Registered letters with details on where the scoping report could be obtained and/or reviewed, public meeting date and time, EIMS contact details as well as the public review comment period;
- Facsimile notifications with information like that in the registered letter described above;
- Email notifications with a letter attachment containing the information described above; and/or
- Summarised SMS notifications with relevant contact details and where more information could be obtained.

Hard copies of the report were made available in the Virginia Public Library and the Welkom Public Library, and an electronic copy was made available on the EIMS website. The scoping report was made available for public review from 29 July 2022 to 30 August 2022 and during this period, various meetings and open days were held as follows:

- Tuesday 23 August 2022: Community Meeting (Stilte Primary School) 12H00-14H00
- Tuesday 23 August 2022: Community Meeting (Adamsons Vley Primary School) 16H00-18H00
- Wednesday 24 August 2022: Farmers Focus Group Open Day (Goldfields Game Ranch) 10H00-16H00
- Wednesday 24 August 2022: Farmers Focus Group Public Meeting (Goldfields Game Ranch) 17H00-19H00
- Thursday 25 August 2022: Public Open Day (NG Church Virginia) 10H00-17H00

8.4 EIA PHASE PUBLIC PARTICIPATION

Notification regarding the availability of the EIA Report and associated appendices for public review was given in the following manner to all registered I&APs:

- E-mail notifications containing an attached letter with details on where the EIA report could be obtained and/or reviewed, public meeting date and time, EIMS contact details as well as the public review comment period;
- Facsimile notifications with information like that in the letter described above; and
- Summarised SMS notifications with relevant contact details and where more information could be obtained.

Hard copies of the report were made available in the Virginia Public Library and the Welkom Public Library, and an electronic copy was made available on the EIMS website. The EIA report was made available for public review from 2 December 2022 to 24 January 2023 and during this period, various meetings were held as follows:

- Tuesday 10 January 2023: Community Meeting (Stilte Primary School) 12H00-14H00
- Tuesday 10 January 2023: Community Meeting (Adamsons Vley Primary School) 16H00-18H00
- Wednesday 11 January 2023: Public Open Day (NG Church Virginia) 12H00-14H00
- Wednesday 11 January 2023: Farmers Focus Group Public Meeting (Goldfields Game Ranch) 17H00-19H00

8.5 PUBLIC PARTICIPATION PROGRESS

Comments raised to date have been addressed in a transparent manner and included in the Public Participation Report (Appendix 3). All comments have been considered in the drafting of this final EIA Report. Please note that where relevant, personal information was omitted from the public domain due to the restrictions imposed by the Protection of Personal Information Act (Act 4 of 2013 - POPIA).

A summary of the comments received to date as well as how these comments were addressed is provided below.

Table 15: Summary of comments received to date and how comments were addressed.

Comment Summary	How comment was addressed
Concerns of water availability and quality to farmers and air quality impacts of the proposed project.	The geohydrological specialist and air quality specialist reports have assessed the impact on water quality and availability as well as the air quality impacts (including health risks).
I&AP deregistration requests.	I&APs who formally requested to be registered were removed from the database.
I&AP registration requests.	I&APs who formally requested to be registered were added to the database for further notifications during upcoming application comment periods.
Eskom Holdings SOC Limited (Transmission) requested a Google Earth (.kmz) file.	The requested information was shared with Eskom.
Notification of ongoing Oryx Solar Power Plant PV Authorization application from another EAP (Environamics) within Cluster 2 project area, locality map sharing and BID documents, Scoping Report and recently EIA report for comment.	Tetra4 and EIMS have taken note of this application for a PV project within the Cluster 2 application area and note that there is minimal impact on the project as a whole.
Some individuals as well as contractors have expressed their interest in potential employment	Work seekers (be it individual jobs or contractors) have been directed to the Tetra4 website which contains a link for interested vendors etc. Community

Comment Summary	How comment was addressed
and business opportunities from the proposed development.	members seeking employment (jobs) were informed of the Tetra4 personnel who are responsible for collecting CV's, ID's etc to ensure that their interest is captured. All job or contract seekers were informed that the application is still underway and that the project commencement is dependent on the final decision from the PASA/DMRE.
Transnet commented that the proposed development does not affect their pipeline servitudes in the region.	No further actions required.
SAHRA provided an interim comment that a comment is to be provided once a HIA and draft EIA Report are made available for comment.	The HIA and EIA report will be uploaded to the SAHRIS website once the EIA comment period commences.
Query regarding website document accessibility.	EIMS provided the needed assistance with obtaining the relevant documentation which was resolved satisfactorily.
Requests by certain members of the local community for jobs as well as other specific services such as electricity, skills upliftment, etc.	These comments were raised during the community focus group meeting with the Adamsons Vley community. The community was informed that Tetra4 is currently in the process of providing certain basic services such as water and electricity to the community as part of the Social and Labour Plan commitments. This is an ongoing process throughout the project implementation and would be extended to other communities in due course. The community acknowledged that the water and solar electricity project was currently underway in their community.
Concerns by a local NGOs - Vaal Environmental Justice Alliance (VEJA) and Gold and Uranium Belt Impact Sensoring Organisation – GUBICO about the living standards of the community members.	It was confirmed that Tetra4 was aware of the poor living standards of some communities and therefore as part of the SLP commitments, certain upliftment programs had been initiated and were ongoing.
NGO - Vaal Environmental Justice Alliance (VEJA) highlighted the possible confusion regarding Tetra4 vs Renergen and how the two companies relate to this project as the sign outside the existing plant says Renergen however the applicant in the application is Tetra4.	Clarification was provided that Tetra4 is a wholly owned subsidiary of Renergen and whilst the applicant in this application is Tetra4, this does not pose any legal constraints on the project. This report includes a clear statement that Tetra4 is a wholly owned subsidiary of Renergen.
Concerns that impact on landowners seem to have been underestimated.	All specialists were provided with this comment and have considered this comment in light of their preliminary impact assessment findings. This has been thoroughly considered and assessed by the relevant specialists as well as the EAP in this EIA Report with minor amendments to certain impacts. Additional mitigation measures have been put forward to fully address the impact findings.

Comment Summary	How comment was addressed
Concerns regarding the project's impacts on the safety, livelihoods and land value for landowners.	These safety, livelihoods and land value concerns have been given specific attention in this EIA report and detailed mitigation measures to address these concerns have been included. In addition, specific conditions have been put forward for inclusion in the decision to ensure that priority is given to impacts on safety, livelihoods and land value. Lastly, Tetra4 has revised the landowner contract terms to provide more specific attention to these concerns including annual compensation for the life of the project (per hectare rate), commitments to hold specific negotiations with each affected landowner to ensure infrastructure is sited in such a manner so as to minimise impacts on existing land use and lastly to ensure that all reasonable safety measures are continually in place. It is understood that Tetra4 is in the process of consulting with the landowners on the contract terms in order to finalise the contract with landowner input.
Access road degradation concerns from landowners.	Degradation of access roads has been thoroughly considered and mitigated in this report and associated EMPr. This includes a pre-construction survey by the landowner and Tetra4 of all private access roads to be utilised by the project including photographic and video documentation of the pre-construction state. A similar post construction survey will be undertaken to document any degradation of access roads which if identified, will be to Tetra4s account. It is acknowledged that each landowner has a specific access road construction methodology and this will be documented and complied with if any repairs are required.
Request by a landowner for more detail on infrastructure specific location and timing of the project aspects.	Where possible, infrastructure specific locations or at least limitations to where infrastructure will not be located has been provided in the Scoping Report and this EIA Report. The project description has been reviewed and updated where possible to include more information on location and timing of certain activities.
Request by a landowner for more detail on logistics regarding access and maintenance of Tetra4 infrastructure on farmlands as well as contractual concerns.	Following this concern relating to the initial landowner contract, Tetra4 have undertaken a revision of the contract to be more specific in addressing the various landowner concerns. Tetra4 is currently soliciting input from landowners on the revised contract prior to finalisation of the contract. In terms of access for inspections and maintenance during the operational phase, the expected frequency is as follows: • Production wells: Monthly (worst case)

Comment Summary	How comment was addressed
	• Pipeline Servitude: Annually for inspections unless landowner raises concerns or there is an emergency (leak detected). • Booster Station: Monthly • Low Point Drains: Monthly • Pigging Stations: Six monthly (bi-annually) • Compressor Stations: Daily security inspections.
Concerns from a landowner that this project would negatively impact on his farm which is his primary investment for his future as well as his descendants. This landowner did not wish to discuss anything and wished to state that he is opposed to the project.	The landowner's objection to the project has been formally recorded in the PPR (Appendix 3) and no further comments were received during the EIA phase.
The Department of Water and Sanitation provided comments on the EIA and EMPr which focussed on the need to obtain approval under the National Water Act for any Section 21 activities.	The DWS was thanked for their comments and was assured that the necessary water use licence application was currently being undertaken.
The landowner of the farm Blaauwdrift 188 (Portion 3) shared a township registration dated 12 October 1956 which covers this farm portion and the landowner indicated that he was in the process of negotiating the sale of his farm along with the township rights and therefore the landowner is objecting to the drilling of wells on this farm portion.	It is recommended that Tetra4 refrains from drilling any Cluster 2 wells on this property until such time as the legal status of the township and rights of the landowner are adequately addressed. A condition of authorisation has been recommended to this effect (refer to Section 13.4) and this restrictive condition has been included in the EMPr (Sections 5.3.1 and 5.3.2).
Concern from the landowner and Managing Director of a commercial agricultural operation (Optavit Boerdery) that the application does not contain specific location, extent and/or routing detail of project infrastructure on each property. This concern is elaborated upon in a written submission and the overall conclusion by the landowner is that the application is premature without including such detailed information and should only be undertaken once this information is available.	All comments were responded to individually and are included in the PPR (Appendix 3 of this EIA report).
African Carbon Energy (Pty) Ltd submitted various comments during the public meeting, landowner meeting and a written submission.	All comments were responded to individually and are included in the PPR (Appendix 3 of this EIA report).

A table of comments and responses is included as Appendix B7 of the attached Public Participation Report (PPR) and Appendix B8 of the attached PPR includes the proof of correspondence. The comments and concerns received to date have been considered in the compilation of this EIA Report as well as the updated EMPr.

9 ENVIRONMENTAL ATTRIBUTES AND BASELINE ENVIRONMENT

A baseline assessment of the receiving environment upon which an activity or development is proposed is an important aspect of the EIA process as it provides a description of the current status and trends in environmental factors of a proposed project against which predicted changes can be compared and evaluated, as well as baseline information against which the potential impacts can be monitored. The baseline environmental attributes include biophysical, socio economic, and cultural aspects of a application area, which are presented below for the Cluster 2 study area.

9.1 TOPOGRAPHY

The topography of the greater application area is generally flat and can be classified as a central interior plain or plateau. Large dolerite intrusions are observed throughout the study area and because of its relative resistance to erosion, the Karoo dolerite sheets generally give rise to very prominent high-standing topographic features (DWAF, 2004). The relief of the area varies between 0 – 130 m. The landscape gradually flattens out towards the lower laying drainage system in the north-west (approximate elevation low of 1280 mamsl), while the southern and south-eastern perimeters are shaped by scattered outcrops with a regional topographical high point recorded as 1540 mamsl.

The lowest topographical elevation on-site is recorded as ~1280 mamsl which is situated towards the western and eastern borders where the Sandrivier enters and exists the gas production right boundary and form part of the on-site drainage system. The highest topographical point recorded on site is approximately 1405 mamsl and forms part of the quaternary catchment boundary and groundwater/ surface water divide to the southern and south-western portion of the study area. On-site gradients are variable, but generally gentle with the average slope calculated at ~0.8 % and an elevation loss of 130 m over a lateral distance of 16 km in a north-south orientation whereas an average slope of ~0.4 % and elevation loss of 70 m over a lateral distance of 17.5 km is calculated in an east- west orientation. Figure 28 depicts a topographical cross-section (south-western aspect) of the greater study area.

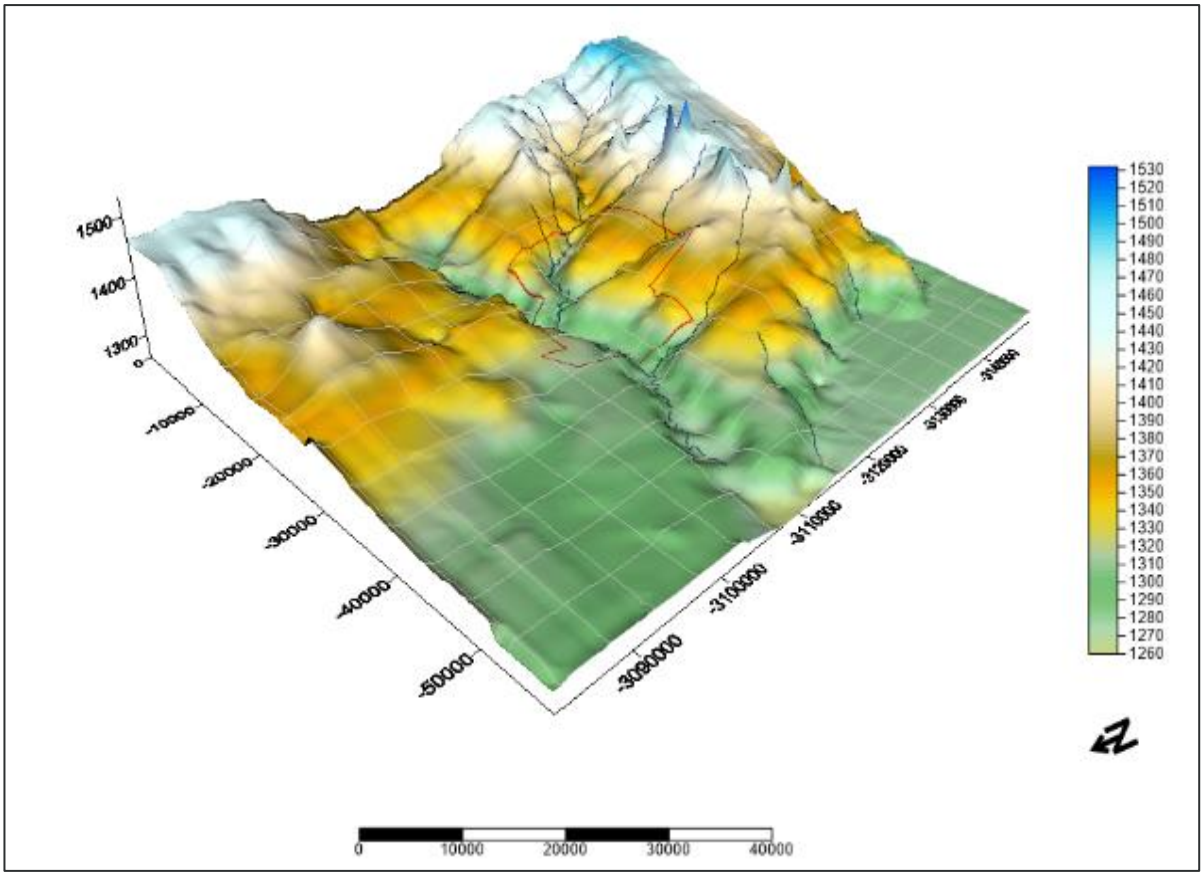


Figure 28: Topographical cross-sections of the greater application area.

9.2 DRAINAGE AND CATCHMENT

The greater study is situated in primary catchment (C) of the Vaal River drainage system which covers a total area of approximately 246 674.5 km^2. The resource management falls under the Vaal Water Management Area (WMA5) which spans portions of the North West Province, northern Free State as well northern sections of the Northern Cape. An overview of the study area with respect to the quaternary catchments and wetland areas is included in Figure 29.

The application area is situated within quaternary catchments C42K (nett surface area of 668 km^2) and C42L (nett surface area of 510.8 km^2), falls within hydrological zone E and has an estimated mean annual runoff (MAR) of between 10 to 13 mcm (million cubic metres) (WR 2012). The hydrology of the region is characterised by predominately perennial watercourses with the regional drainage occurring in a general west to north-western direction via the Sandrivier and Doornrivier both of which are traversing the study area from east to west (Sandrivier) and southeast to northwest (Doornrivier). A non-perennial drainage, Bosluisspruit, also traverses the study area and generally drains the catchment in a northern direction. The Doornrivier converges with the Sandrivier approximately 1.3 km to the northeast of the study area from where it flows in a general westerly direction before joining the Vetrivier roughly ~ 30 km downstream of the application area. Major surface water features being fed by the drainage system(s) of this quaternary catchment include the Bloemhof Dam situated <100 km to the northwest.

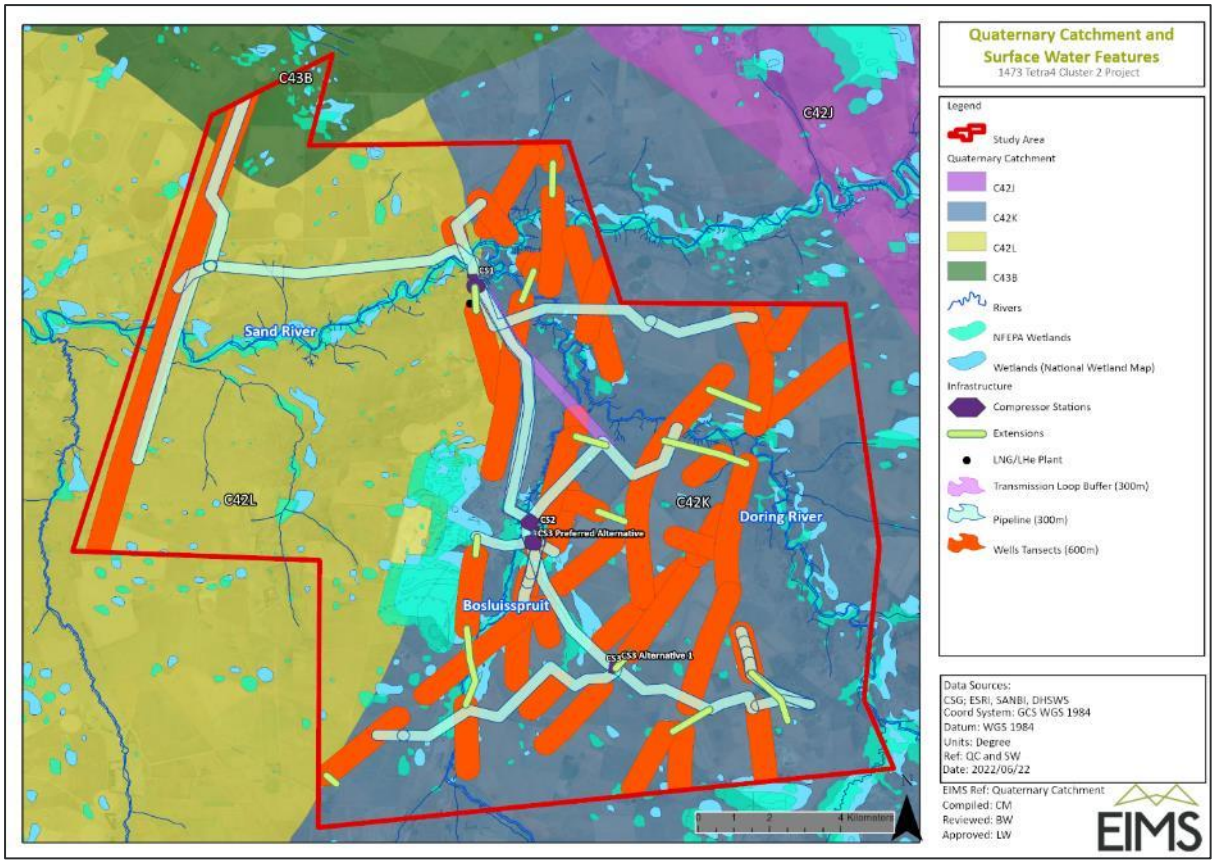


Figure 29: Study area in relation to quaternary catchments and drainage areas.

9.3 CLIMATE

The study area's rainfall is strongly seasonal, and the weather pattern reflects a typical summer rainfall region, with > 80 % of precipitation occurring as convective thunderstorms from October to March. Patched rainfall and evaporation data were sourced from the WR2012 database (Rainfall zone 4C4) and span a period of some 90 years (1920 – 2009). The calculated mean annual precipitation (MAP) for this rainfall zone is 521 mm/a, with the 5th percentile of the data set (roughly equivalent to a 1:20 year drought period) calculated at 343.38 mm/a while the 95th percentile (representing a 1:20 flood period) is calculated at 752.43 mm/a. The highest MAP for the 90 years of rainfall data was recorded as 860.3 mm (1942) while the lowest MAP of 264 mm was recorded during 2006.

Both catchment areas are categorised under evaporation zone 19C which have a mean annual evaporation (s-pan) ranging between 1600 mm/a to 1680 mm/a. The highest evaporation is usually experienced in December (215 mm) while the lowest evaporation is in June (61 mm). The peak rainfall months are December and January, and the annual evaporation volumes are more than threefold the annual precipitation.

9.4 SOCIAL

According to NEMA, environment refers to the surroundings in which humans exist. When viewing the environment from a socio-economic perspective the question can be asked what exactly the social environment is. Different definitions for social environment exist, but a clear and comprehensive definition that is widely accepted remains elusive. Barnett & Casper (2001) offers the following definition of human social environment:

> *"Human social environments encompass the immediate physical surroundings, social relationships, and cultural milieus within which defined groups of people function and interact. Components of the social environment include built infrastructure; industrial and occupational structure; labour markets; social and economic processes; wealth; social, human, and health services; power relations; government; race relations; social inequality; cultural practices; the arts; religious*

institutions and practices; and beliefs about place and community. The social environment subsumes many aspects of the physical environment, given that contemporary landscapes, water resources, and other natural resources have been at least partially configured by human social processes. Embedded within contemporary social environments are historical social and power relations that have become institutionalized over time. Social environments can be experienced at multiple scales, often simultaneously, including households, kin networks, neighbourhoods, towns and cities, and regions. Social environments are dynamic and change over time as the result of both internal and external forces. There are relationships of dependency among the social environments of different local areas, because these areas are connected through larger regional, national, and international social and economic processes and power relations."

Environment-behaviour relationships are interrelationships (Bell, Fisher, Baum & Greene, 1996). The environment influences and constrains the behaviour of people, but behaviour also leads to changes in the environment. The impacts of a project on people can only be truly understood if their environmental context is understood. The baseline description of the social environment includes a description of the area within a provincial, district and local context that will focus on the identity and history of the area as well as a description of the population of the area based on a number of demographic, social and economic variables.

9.4.1 DESCRIPTION OF THE AREA

The proposed site for the Cluster 2 project is located in Wards 9 and 24 of the Matjhabeng Local Municipality and Ward 6 of the Masilonyana Local Municipality that forms part of the Lejweleputswa District Municipality in the Free State Province. The baseline description of the environment will include these areas. Figure 30 shows the location of the proposed Cluster 2 project as well as some social and physical infrastructure in the area and Figure 31 shows a broad overview of the land cover in the study area.

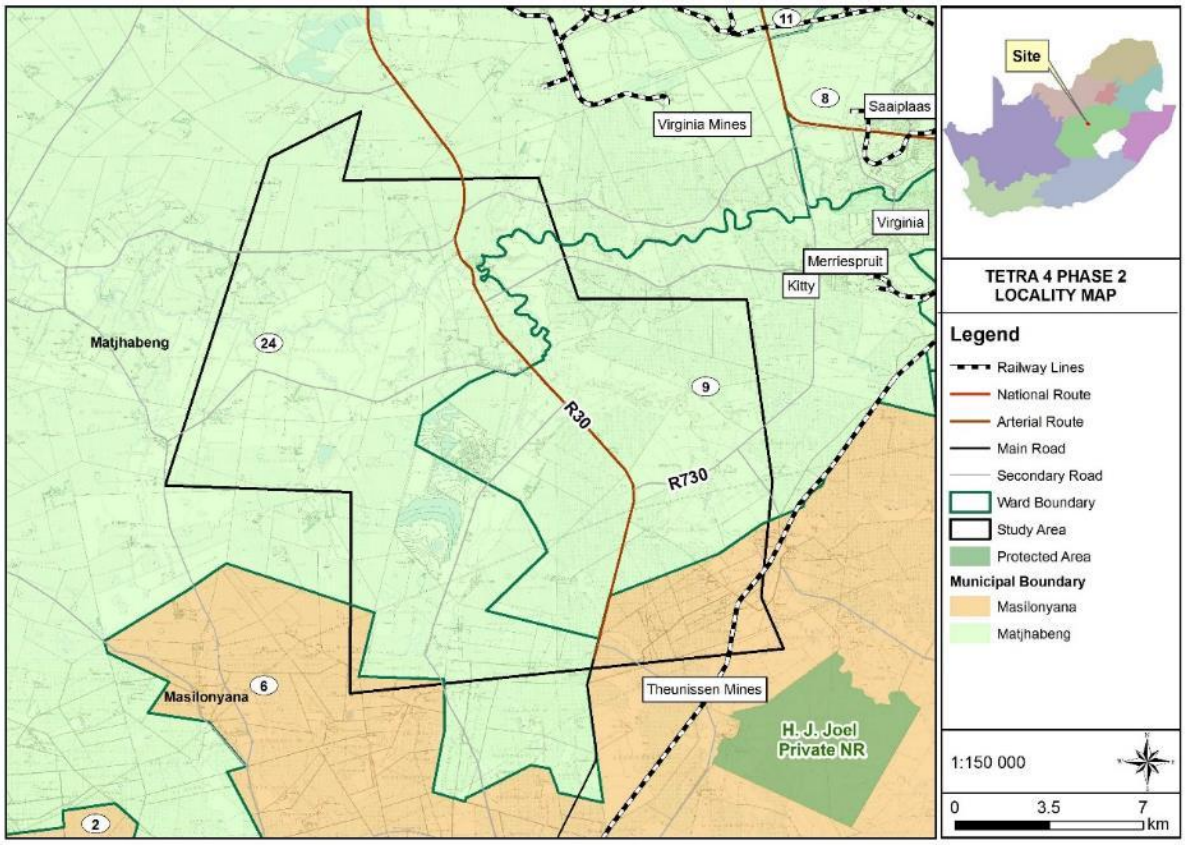


Figure 30: Location of the proposed Cluster 2 Project in relation to Municipal Wards.

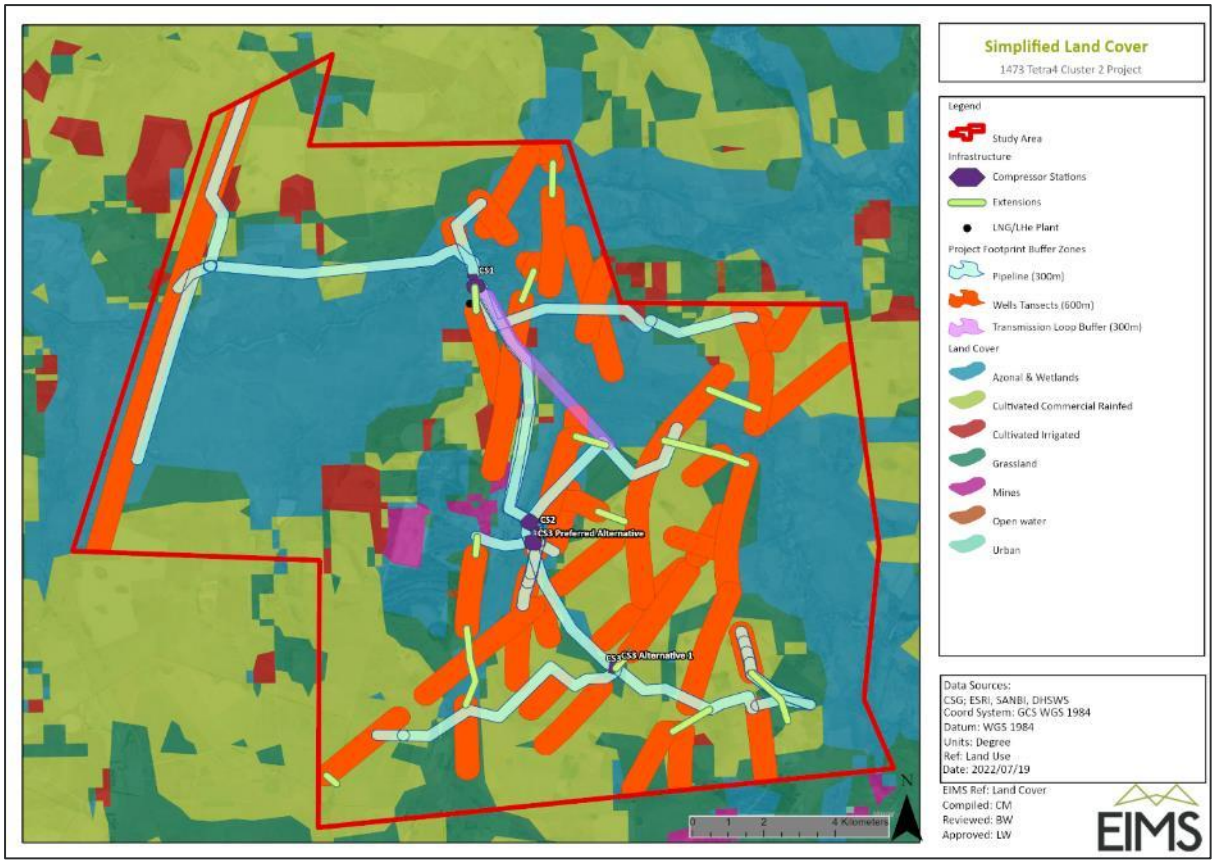


Figure 31: Broad overview of land cover in the study area.

9.4.2 LEJWELEPUTSWA DISTRICT MUNICIPALITY

The Lejweleputswa District Municipality (LDM) is situated in the north western part of the Free State and borders the North West Province to the north; the Fezile Dabi and Thabo Mofutsanyane District Municipalities to the north-east and east respectively; the Xhariep District Municipality and Mangaung Metropolitan Municipality to the south; and the Northern Cape Province to the west. The LDM is accessible from Johannesburg, Cape Town, Klerksdorp and Kimberley through one of South Africa's main national roads, the N1. The district covers an area of 32 286 km^2 and make up almost a third of the Free State province. It consists of the Masilonyana, Matjhabeng, Nala, Tokologo and Tswelopele Local Municipalities (www.lejweleputswa.co.za).

The economy of the district relies heavily on the gold mining sector which is dominant in the Matjhabeng and Masilonyana Local Municipalities (Lejweleputswa DM IDP 2021/22). The mining sector is on a downward trend and many businesses that have traditionally depended on the mining sector have either closed down are in the process of closing down. The other municipalities are dominated by agriculture.

9.4.3 MATJHABENG LOCAL MUNICIPALITY

The main towns in the Matjhabeng Local Municipality are Welkom, Odendaalsrus, Virginia, Hennenman, Allanridge and Ventersburg (www.matjhabeng.fs.gov.za). The economy of the municipality is centred on mining activities in and around Welkom, Allanridge, Odendaalsrus and Virginia. Manufacturing aimed at the mining sector exists to a limited extent in the aforementioned towns, with other activities being limited. Other main economic sectors include manufacturing, tourism, agriculture, gold jewellery, transportation (logistics), and retail (Matjhabeng LM IDP 2022/2023).

9.4.4 MASILONYANA LOCAL MUNICIPALITY

The main towns in the Masilonyana Local Municipality are Theunissen, Brandfort, Winburg, Verkeerdevlei and Soutpan (www.masilonyana.fs.gov.za). It is a semi-rural municipality that is dependent on agriculture and mining

as the key drivers of its economy (Masilonyana LM IDP 2019/20). In 2016 the mining sector contributed about 52.4 % to the municipality's economic output, but only about 8 % of the employment in the municipality. With the decline in the mining sector the municipality plans to turn its focus on tourism. The municipality prides itself on its tourism destinations.

9.4.5 DESCRIPTION OF THE POPULATION

The baseline description of the population will take place on three levels, namely provincial, district and local. Impacts can only truly be comprehended by understanding the differences and similarities between the different levels. The baseline description will focus on the Matjhabeng Local Municipality and the Masilonyana Local Municipality in the Lejweleputswa District Municipality in the Free State Province (referred to in the text as the study area), as these are the areas that will be most affected by the proposed project. Where possible, the data will be reviewed on a ward level – Ward 9 and 24 of the Matjhabeng LM and Ward 6 of the Masilonyana LM. The data used for the socio-economic description was sourced from Census 2011. Census 2011 was a de facto census (a census in which people are enumerated according to where they stay on census night) where the reference night was 9-10 October 2011. The results should be viewed as indicative of the population characteristics in the area and should not be interpreted as absolute.

The following points regarding Census 2011 must be kept in mind (www.statssa.co.za):

- Comparisons of the results of labour market indicators in the post-apartheid population censuses over time have been a cause for concern. Improvements to key questions over the years mean that the labour market outcomes based on the post-apartheid censuses must be analysed with caution. The differences in the results over the years may be partly attributable to improvements in the questionnaire since 1996 rather than to actual developments in the labour market. The numbers published for the 1996, 2001, and 2011 censuses are therefore not comparable over time and are different from those published by Statistics South Africa in the surveys designed specifically for capturing official labour market results.
- For purposes of comparison over the period 1996–2011, certain categories of answers to questions in the censuses of 1996, 2001 and 2011, have either been merged or separated.
- The tenure status question for 1996 has been dropped since the question asked was totally unrelated to that asked thereafter. Comparisons for 2001 and 2011 do however remain.
- All household variables are controlled for housing units only and hence exclude all collective living arrangements as well as transient populations.
- When making comparisons of any indicator it must be considered that the time period between the first two censuses is five years and that between the second and third census is ten years. Although Census captures information at one given point in time, the period available for an indicator to change is different.

9.4.6 POPULATION AND HOUSEHOLD SIZES

According to the Community Survey 2016, the population of South Africa is approximately 55,7 million and has shown an increase of about 7.5 % since 2011. The household density for the country is estimated on approximately 3.29 people per household, indicating an average household size of 3-4 people (leaning towards 3) for most households, which is down from the 2011 average household size of 3.58 people per household. Smaller household sizes are in general associated with higher levels of urbanisation.

The greatest increase in population since 2011 has been on local level (Table 16), but still lower than the national average. Population density refers to the number of people per square kilometre and the population density on a national level has increased from 42.45 people per km^2 in 2011 to 45.63 people per km^2 in 2016. In the study area the population density has increased since 2011 with the highest density in the Matjabeng LM.

Table 16: Population density and growth estimates (sources: Census 2011, Community Survey 2016).

Area	Size in km²	Population 2011	Population 2016	Population density 2011	Population density 2016	Growth in population (%)
Free State Province	129,825	2,745,590	2,834,714	21.15	21.83	3.25
Lejweleputswa DM	31,930	627,626	649,964	19.66	20.36	3.56
Matjhabeng LM	5,155	406,461	428,843	78.85	83.19	5.51
Masilonyana LM	6,796	63,334	66,084	9.32	9.72	4.34

The number of households in the study area has increased on all levels (Table 17). The proportionate increase in households were greater than the increase in population on all levels and exceeded the growth in households of 12.3 % on a national level. The average household size has shown a decrease on all levels, which means there are more households, but with less members.

Table 17: Household sizes and growth estimates (sources: Census 2011, Community Survey 2016).

Area	Households 2011	Households 2016	Average household size 2011	Average household size 2016	Growth in households (%)
Free State Province	823,316	946,639	3.33	2.99	14.98
Lejweleputswa DM	183,163	219,014	3.43	2.97	19.57
Matjhabeng LM	123,195	149,021	3.30	2.88	20.96
Masilonyana LM	17,575	22,802	3.60	2.90	29.74

The total dependency ratio is used to measure the pressure on the productive population and refer to the proportion of dependents per 100 working-age population. As the ratio increases, there may be an increased burden on the productive part of the population to maintain the upbringing and pensions of the economically dependent. A high dependency ratio can cause serious problems for a country as the largest proportion of a government's expenditure is on health, social grants and education that are most used by the old and young population.

The total dependency ratio in the Masilonyana LM is higher than on district or provincial level (Table 18), while in the Matjhaneng LM the total dependency ratio is lower that on district or provincial level. The same trend applies to the youth, aged and employment dependency ratios. Employed dependency ratio refers to the proportion of people dependent on the people who are employed, and not only those of working age. The employed dependency ratio for the Matjhabeng LM is lower than on district and provincial level, while for the Masilonyana LM it is higher. This suggests high levels of poverty in the Masilonyana area.

Table 18: Dependency ratios (source: Census 2011).

Area	Total dependency	Youth dependency	Aged dependency	Employed dependency
Free State Province	52.88	44.48	8.39	76.34
Lejweleputswa DM	51.33	43.71	7.61	77.16
Matjhabeng LM	46.93	40.09	6.85	75.46
Ward 9	31.92	24.88	7.04	68.37
Ward 24	31.54	29.01	2.53	69.84
Masilonyana LM	54.99	45.99	9.00	82.14
Ward 6	40.36	33.35	7.01	88.18

Poverty is a complex issue that manifests itself in economic, social and political ways. To define poverty by a unidimensional measure such as income or expenditure would be an oversimplification of the matter. Poor people themselves describe their experience of poverty as multidimensional. The South African Multidimensional Poverty Index (SAMPI) (Statistics South Africa, 2014) assess poverty on the dimensions of health, education, standard of living and economic activity using the indicators child mortality, years of schooling, school attendance, fuel for heating, lighting and cooking, water access, sanitation, dwelling type, asset ownership and unemployment.

The poverty headcount refers to the proportion of households that can be defined as multi-dimensionally poor by using the SAMPI's poverty cut-offs (Statistics South Africa, 2014). The poverty headcount has increased on all levels since 2011 (Table 19), indicating an increase in the number of multi-dimensionally poor households.

The intensity of poverty experienced refers to the average proportion of indicators in which poor households are deprived (Statistics South Africa, 2014). The intensity of poverty has increased slightly on all levels. The intensity of poverty and the poverty headcount is used to calculate the SAMPI score. A higher score indicates a very poor community that is deprived on many indicators. The SAMPI score has increased in the Masilonyana LM area, indicating that households in this area might be getting poorer. In the Matjhabeng LM area the SAMPI score has decreased, suggesting an improvement in some respects relating to poverty in this area.

Table 19: Poverty and SAMPI scores (sources: Census 2011 and Community Survey 2016).

Area	Poverty headcount 2011 (%)	Poverty intensity 2011 (%)	SAMPI 2011	Poverty headcount 2016 (%)	Poverty intensity 2016 (%)	SAMPI 2016
Free State Province	5.5	42.2	0.023	5.5	41.7	0.023
Lejweleputswa DM	5.6	42.8	0.024	4.8	42.2	0.020
Matjhabeng LM	5.5	43.0	0.024	4.3	41.8	0.018
Masilonyana LM	5.3	41.8	0.022	6.5	41.8	0.027

9.4.7 POPULATION COMPOSITION, AGE, GENDER AND HOME LANGUAGE

In all the areas under investigation, the majority of the population belongs to the Black population group (Figure 32), but the proportions differ. Ward 24 has the highest proportion of people belonging to the Black population group, while Ward 9 has the highest proportion of people belonging to the White population group.

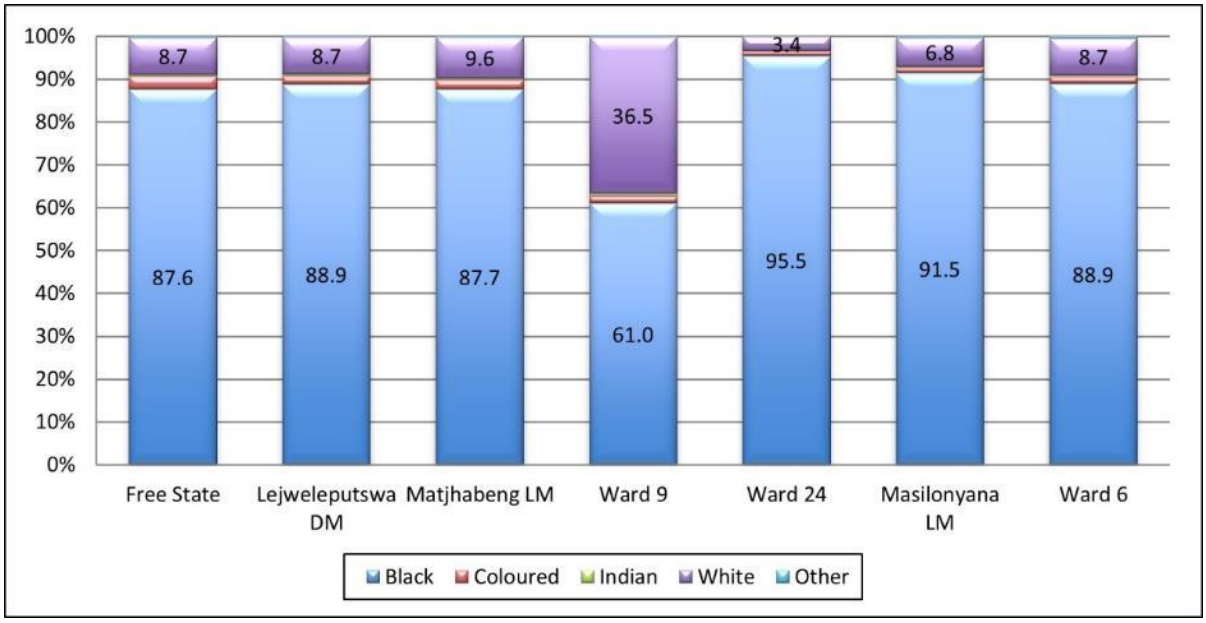


Figure 32: Population distribution (shown in percentage, source: Census 2011).

The average age on local level is higher than on district and provincial level (Table 20). The highest average age is in Ward 9 of the Matjhabeng LM.

Table 20: Average age (source: Census 2011).

Area	Average Age (in years)
Free State Province	28.38
Lejweleputswa DM	28.52
Matjhabeng LM	28.89
Ward 9	32.84
Ward 24	30.46
Masilonyana LM	28.73
Ward 6	31.21

The age distribution of the areas under investigation shows that the population in on a ward level tend to be older than on district or provincial level, with a greater proportion of people aged between 35 years to 64 years (Figure 33).

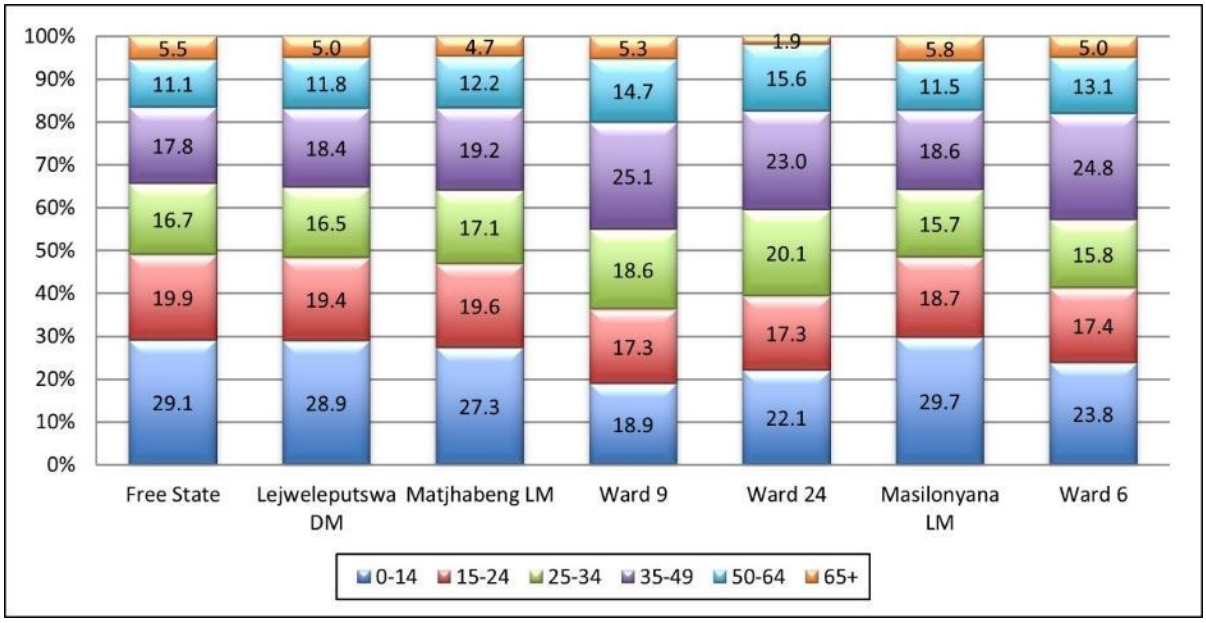


Figure 33: Age distribution (shown in percentage, source: Census 2011).

9.4.8 GENDER

The gender distribution on provincial, district and local level is balanced (Figure 34), but on a ward level there is a bias towards males. A higher incidence of males is usually found in mining areas and all three the wards have mining areas that appear to have residences for mine workers.

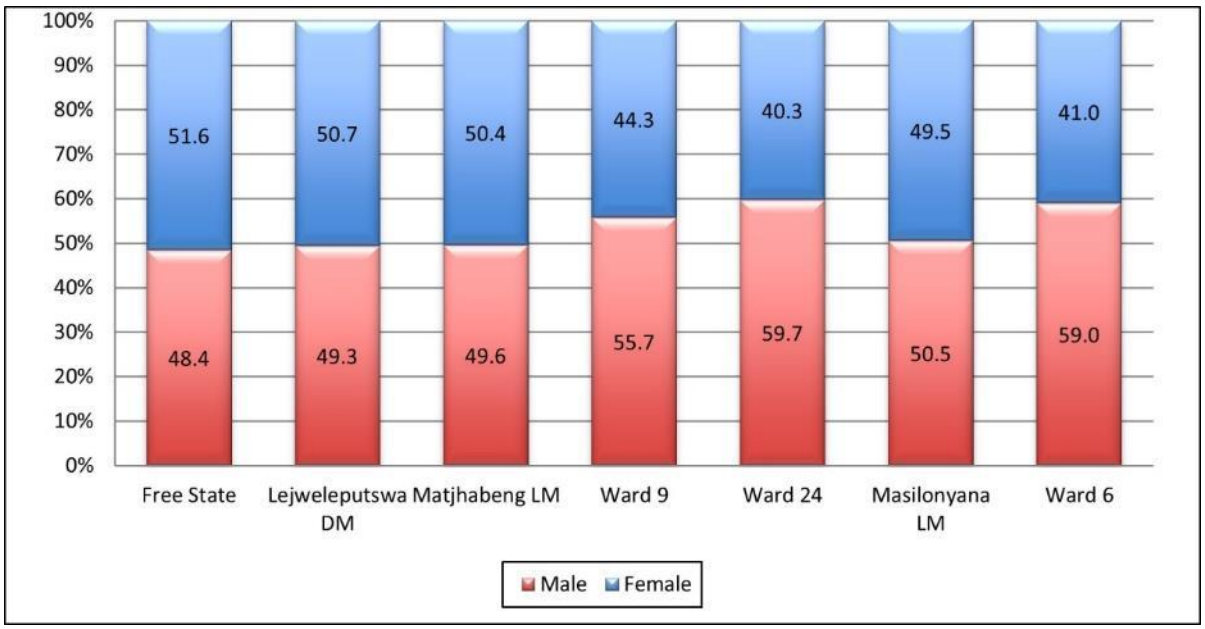


Figure 34: Gender distribution (shown in percentage, source: Census 2011).

9.4.9 LANGUAGE

Almost two thirds of people in the region have Sesotho as home language (Figure 35), except in Ward 9 where it is only about a third of people. In Ward 9 more than 40% of people have Afrikaans as home language. Almost a fifth of people in Ward 24 has IsiXhosa as home language, suggesting a high incidence of migrant mine workers residing in this ward. Based on the predominant languages in the area, the notifications for this application have been distributed in English, Afrikaans and Sesotho.

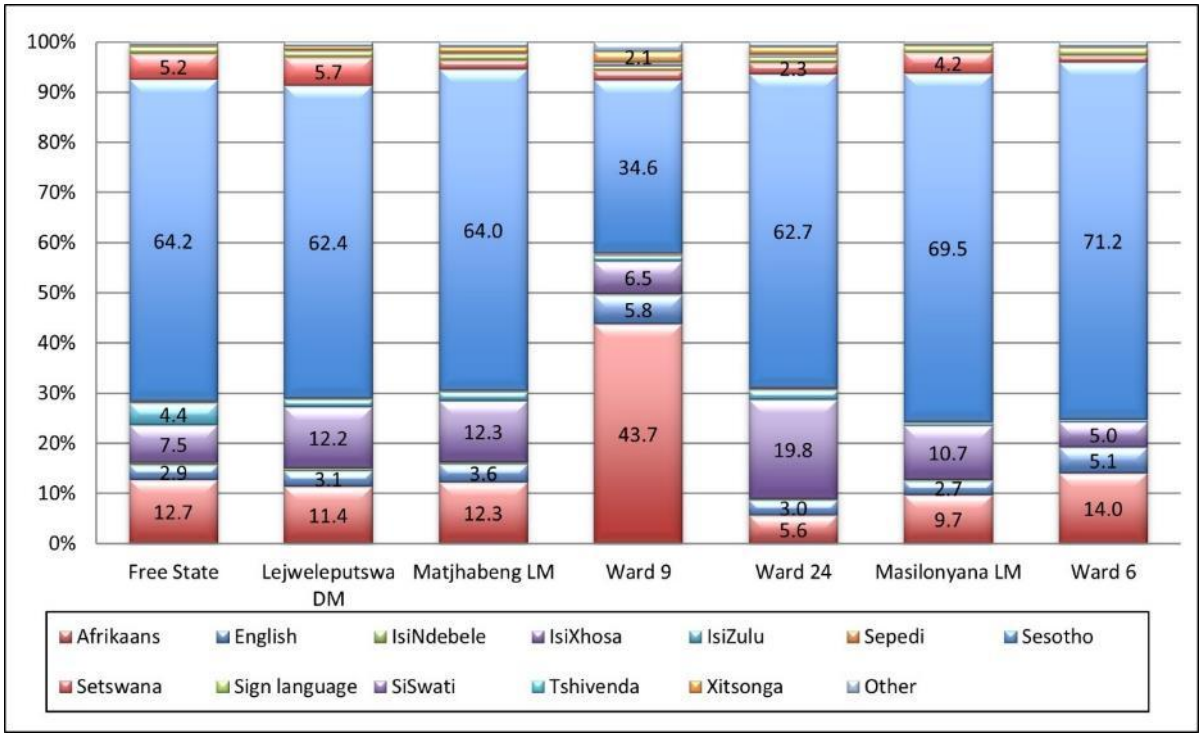


Figure 35: Language distribution (shown in percentage, source: Census 2011).

9.4.10 EDUCATION

Figure 36 shows the education profiles for the areas under investigation for those aged 20 years or older. Ward 9 has the highest proportion of people who have completed Grade 12 or higher, while more than 70 % of people in Wards 6 and 24 have not completed secondary school.

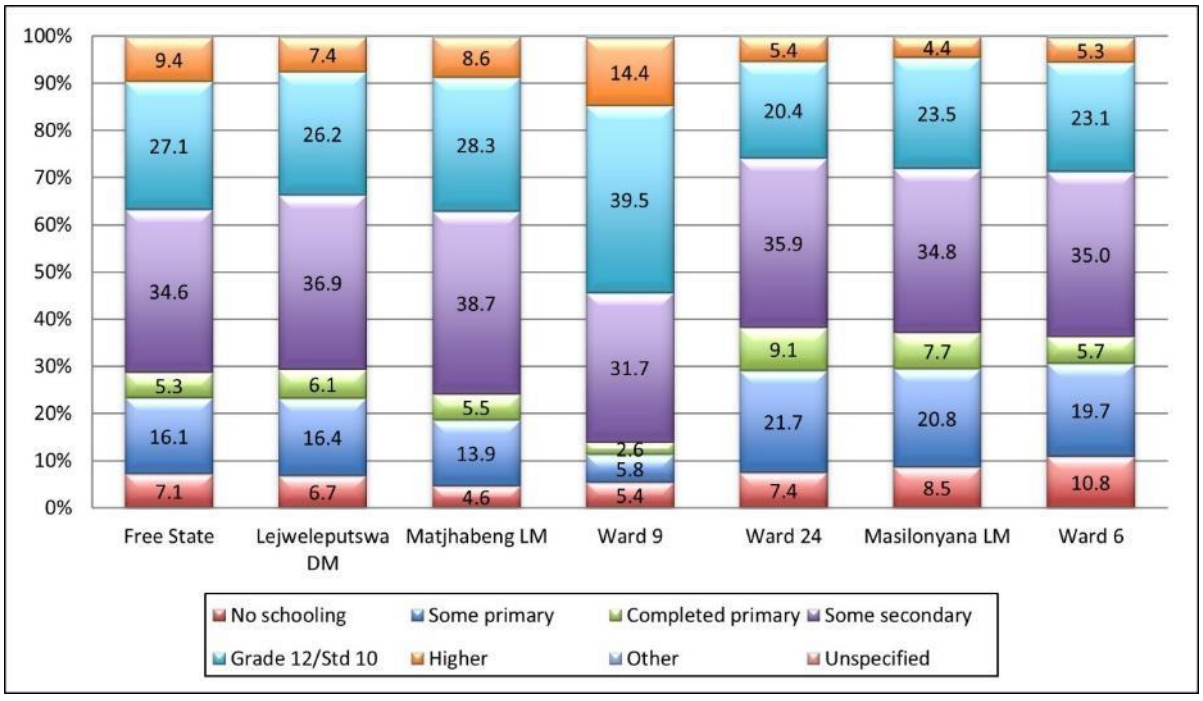


Figure 36: Education profiles (those aged 20 years or older, shown in percentage, source: Census 2011).

9.4.11 EMPLOYMENT

Ward 6 has the lowest proportion of people of economically active age (aged between 15 years and 65 years) that are employed (Figure 37), while Wards 9 and 24 have the highest proportions. Since 2010 employment in the gold mining industry showed a steady decline from 157 019 in 2010 to 94 399 in 2020 (www.mineralscouncil.org.za). As such the proportion unemployed people in the area are likely to have increased since 2011.

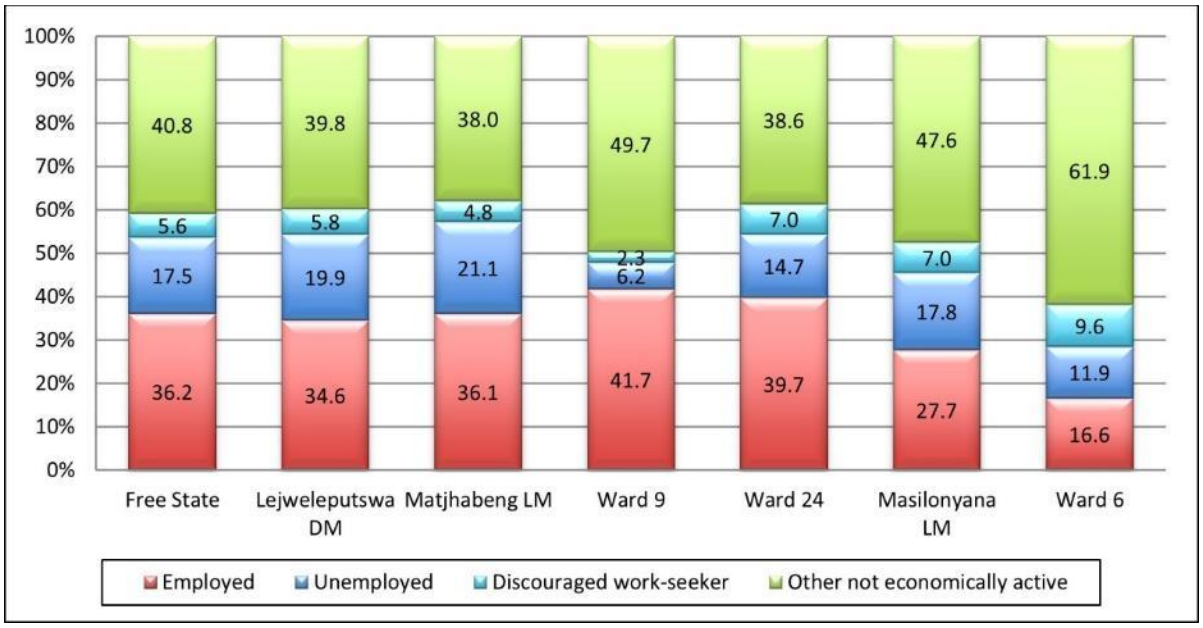


Figure 37: Labour status (those aged between 15 - 65 years, shown in percentage, source: Census 2011).

Most of the employed people in the areas under investigation work in the formal sector (Figure 38). Ward 9 has the highest proportion of people working in the formal sector while Ward 6 has the highest proportion of people working for private households.

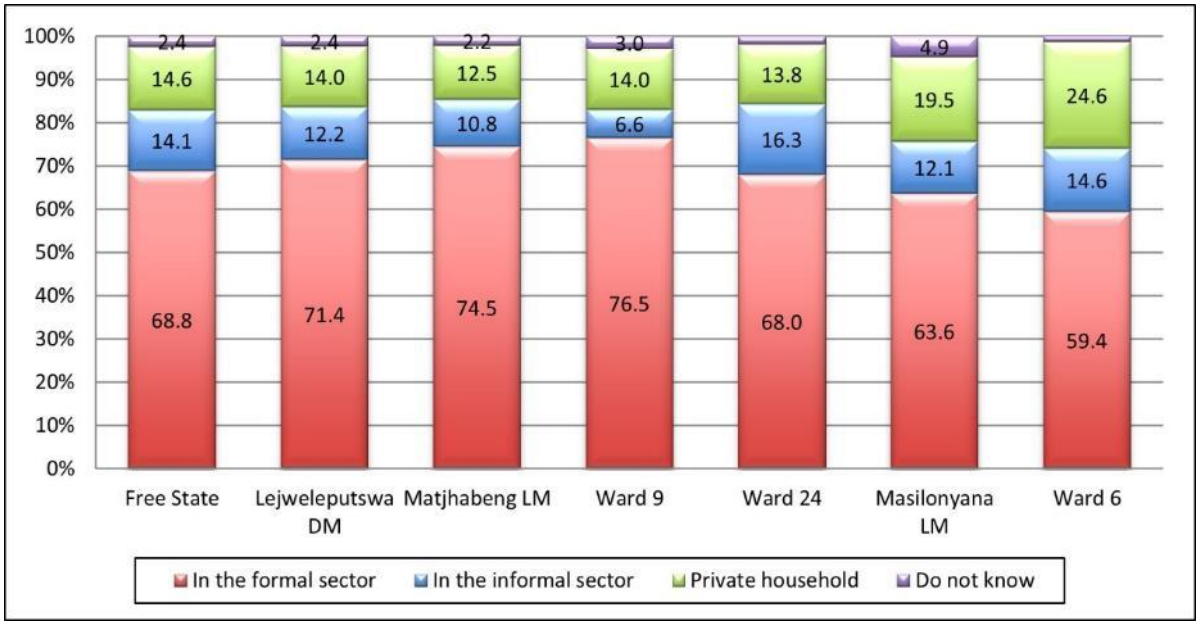


Figure 38: Employment sector (those aged between 15 - 65 years, shown in percentage, source: Census 2011).

9.4.12 HOUSEHOLD INCOME

Ward 24 has the highest proportion of households that have no annual household income (Figure 39), while Ward 9 has the highest average household income.

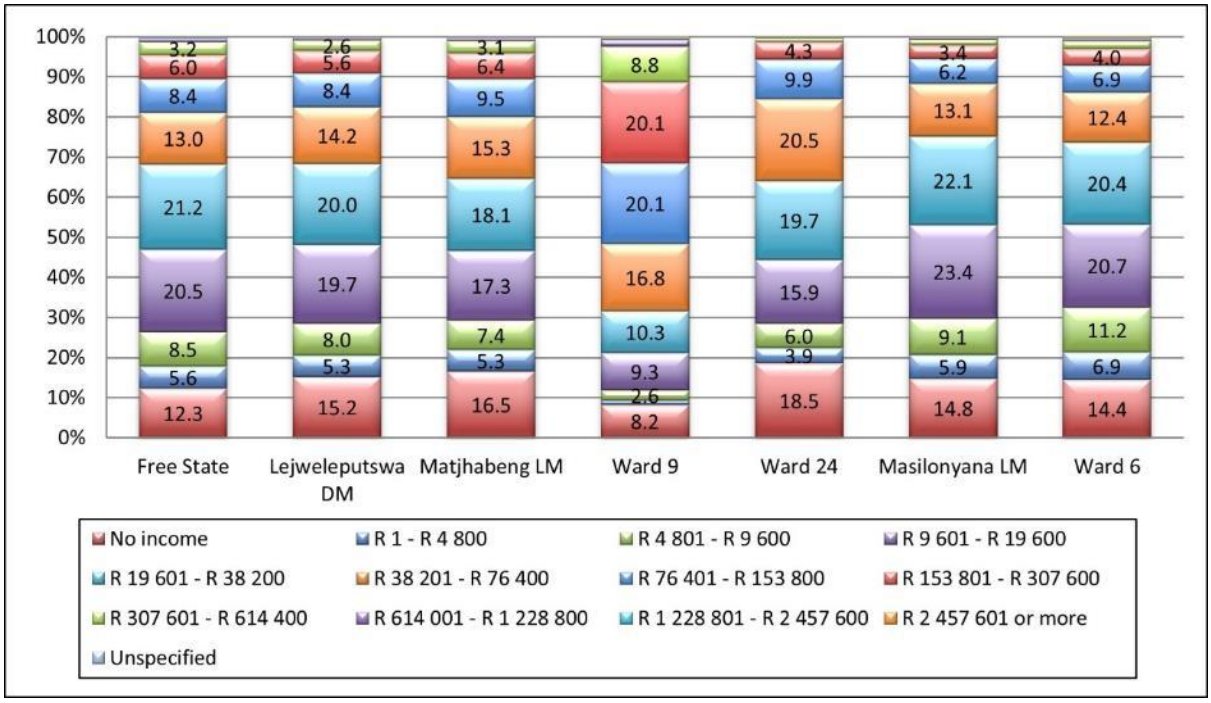


Figure 39: Annual household income (shown in percentage, source: Census 2011).

9.4.13 HOUSING

On a ward level most households live in areas classified as urban. Wards 24 and 6 have the highest incidence of households living on farms. In Ward 24 almost a quarter of households live on farms. Ward 9 includes a large portion of the town of Virginia.

Table 21: Geotypes (source: Census 2011, households).

Area	Urban	Tribal/Traditional	Farm
Free State Province	84.5	8.8	6.7
Lejweleputswa DM	93.9	0.0	6.1
Matjhabeng LM	97.7	0.0	2.3
Ward 9	94.2	0.0	5.8
Ward 24	75.2	0.0	24.8
Masilonyana LM	91.4	0.0	8.6
Ward 6	87.4	0.0	12.6

Most households live in formal residential areas (Figure 40), with about a quarter of households in Ward 6 and a third of households in Ward 24 residing in collective living quarters. Just over a quarter of households in Ward 24 live in informal residential areas.

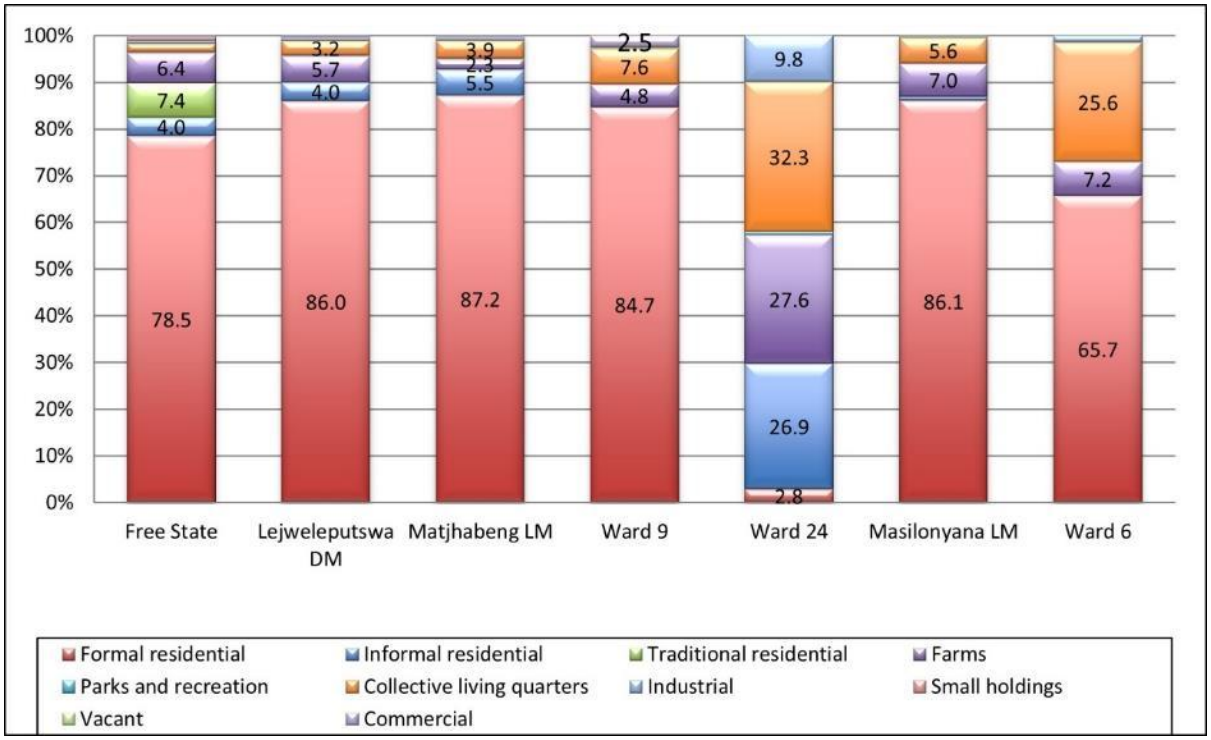


Figure 40: Enumeration area types (persons, shown in percentage, source: Census 2011).

Most of the dwellings in the area are houses or brick/concrete block structures that are on a separate yard, stand or farm (Figure 41), except in Ward 24 where about a third of the dwellings are informal and a fifth live in a flat or an apartment in a block of flats.

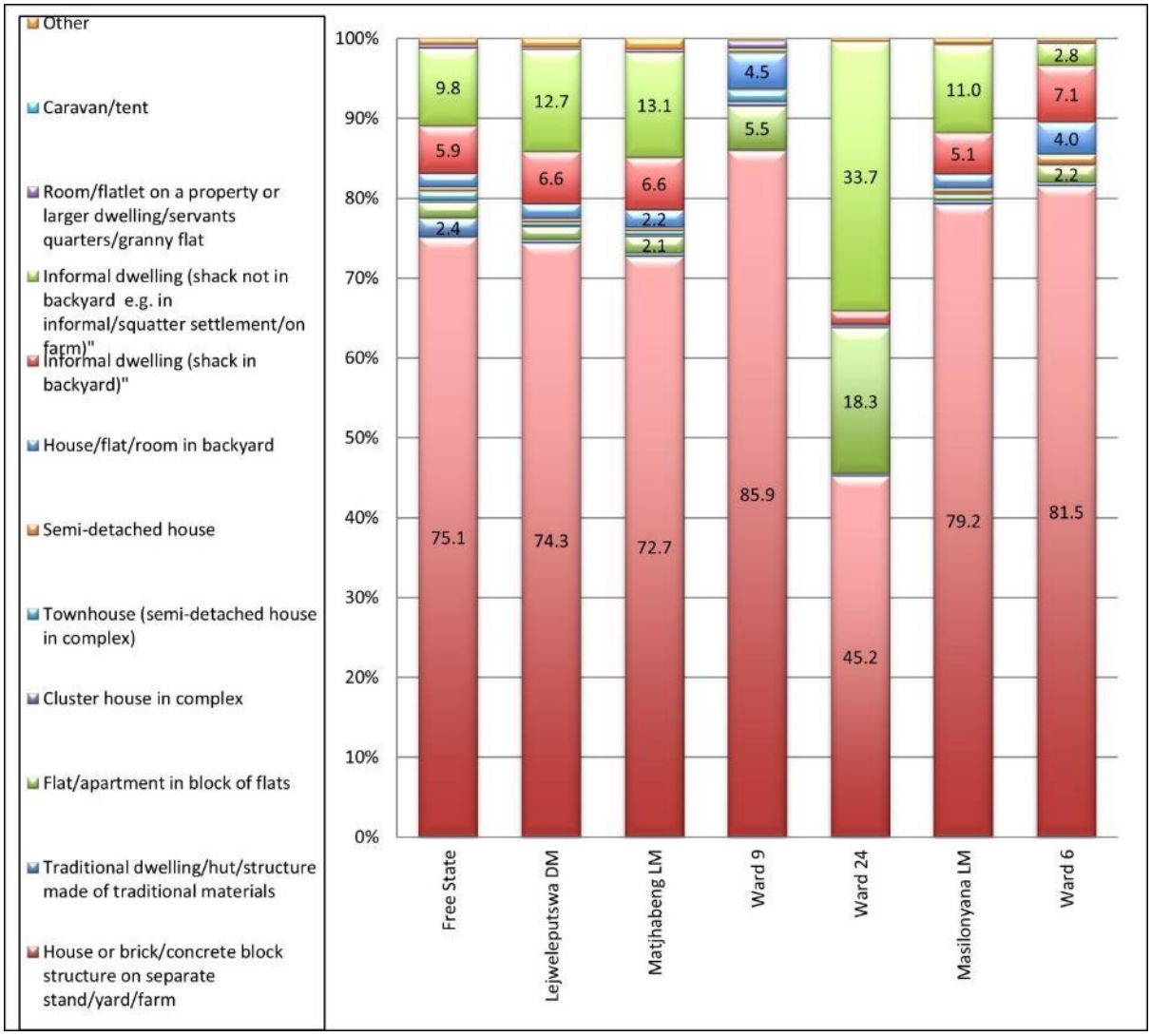


Figure 41: Dwelling types (shown in percentage, source: Census 2011).

Ward 24 has the largest proportion of households that are renting their dwellings (Figure 42), with more than half of the households renting, while Ward 6 has the largest proportion of households that own their dwellings and have paid them off in full.

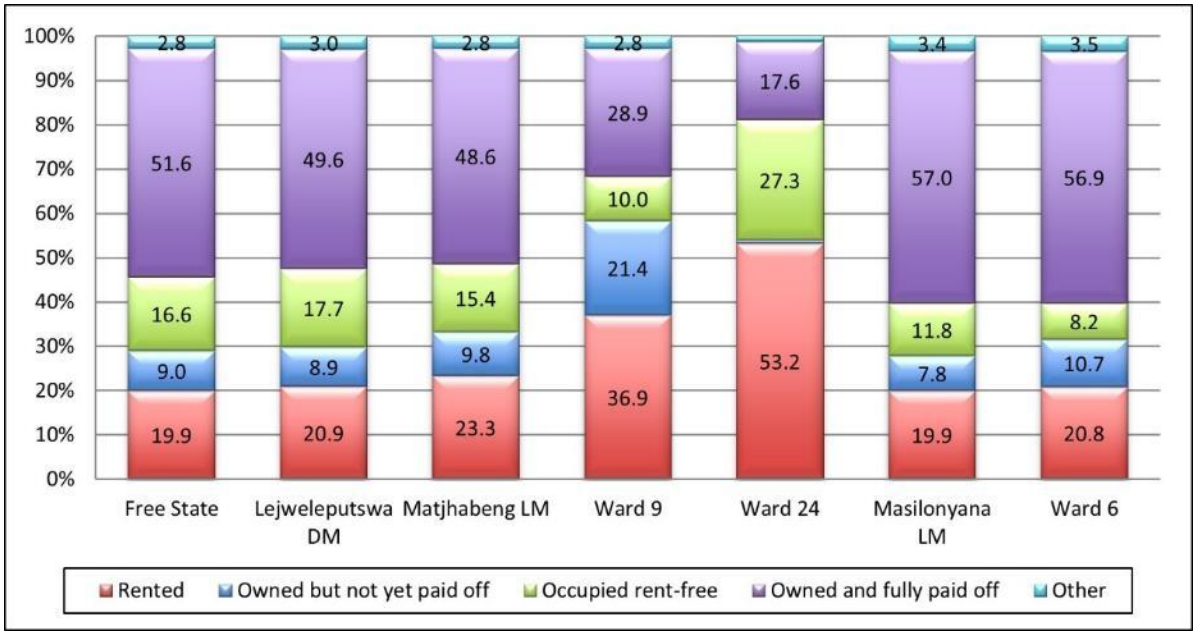


Figure 42: Tenure status (shown in percentage, source: Census 2011).

9.4.14 HOUSEHOLD SIZE

Household sizes on a ward level in the Matjhabeng LM tend to be smaller than on local, district or provincial level (Figure 43), with approximately 50 % or more of households on ward level consisting of one or two people, compared to just over 40 % on local, district and provincial level. In Ward 6 of the Masilonyana LM households' sizes tend to be larger than on local, district or provincial level.

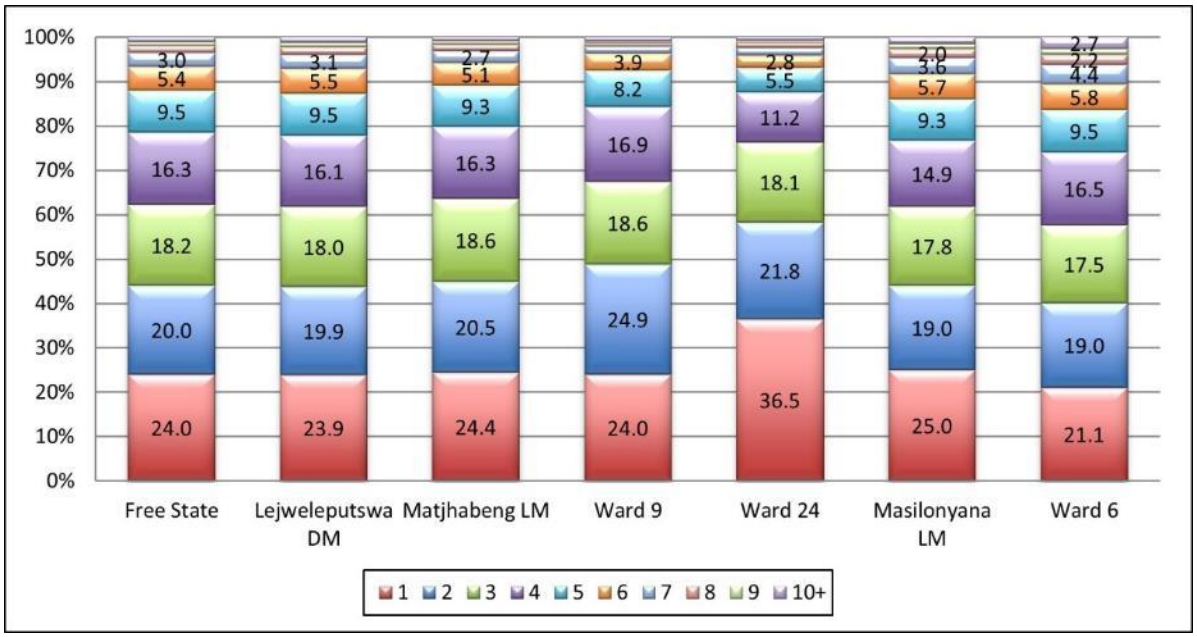


Figure 43: Household size (shown in percentage, source: Census 2011).

9.4.15 ACCESS TO WATER AND SANITATION

Ward 24 has the lowest incidence of households that access to water from a local or a regional water scheme, but the highest incidence of households that get their water from a borehole or another source (Figure 44).

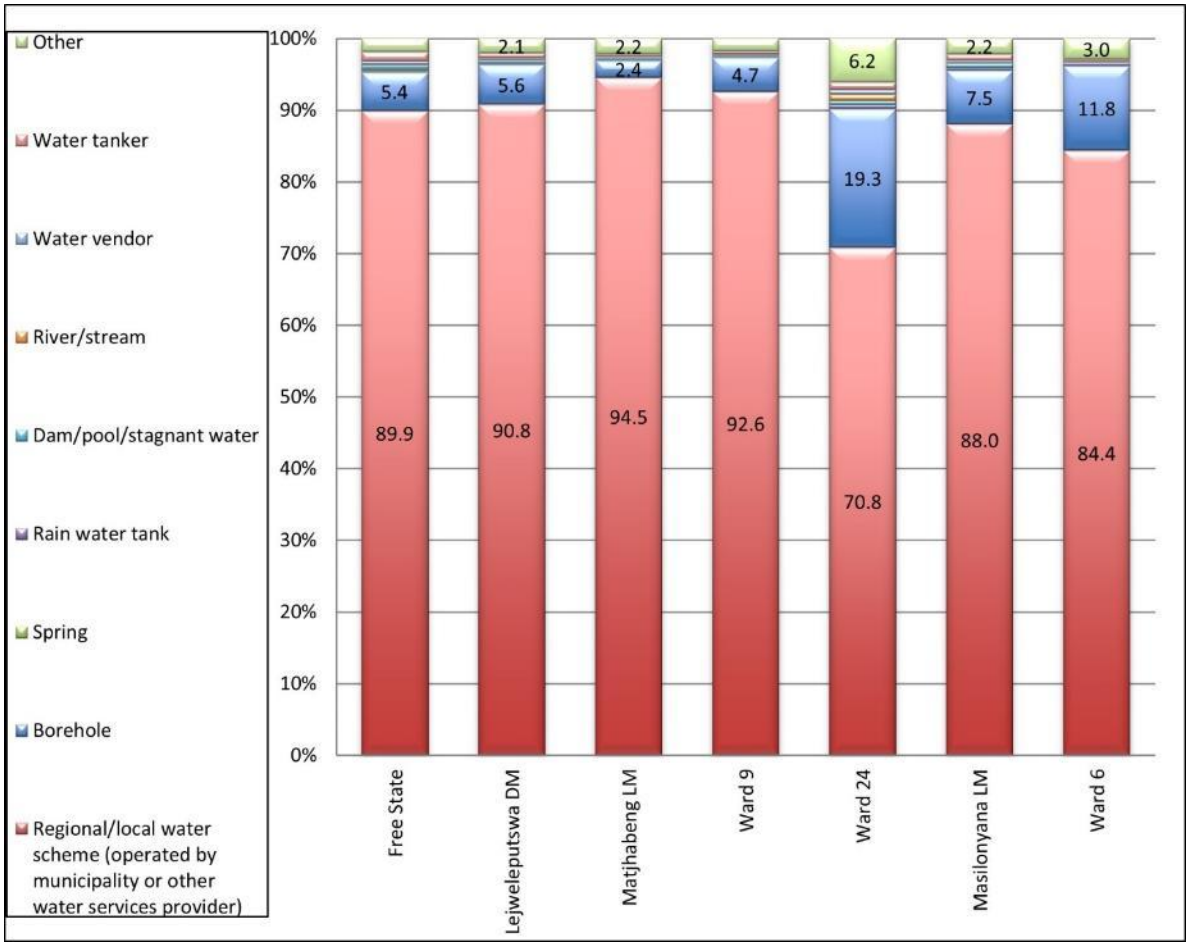


Figure 44: Water source (shown in percentage, source: Census 2011).

Access to piped water, electricity and sanitation relate to the domain of Living Environment Deprivation as identified by Noble et al (2006). Almost 90 % of households in Ward 9 has access to piped water inside the dwelling (Figure 45). In Ward 6 more than 90 % of households have access to water insider their dwelling or stand, compared to almost 80 % in Ward 24.

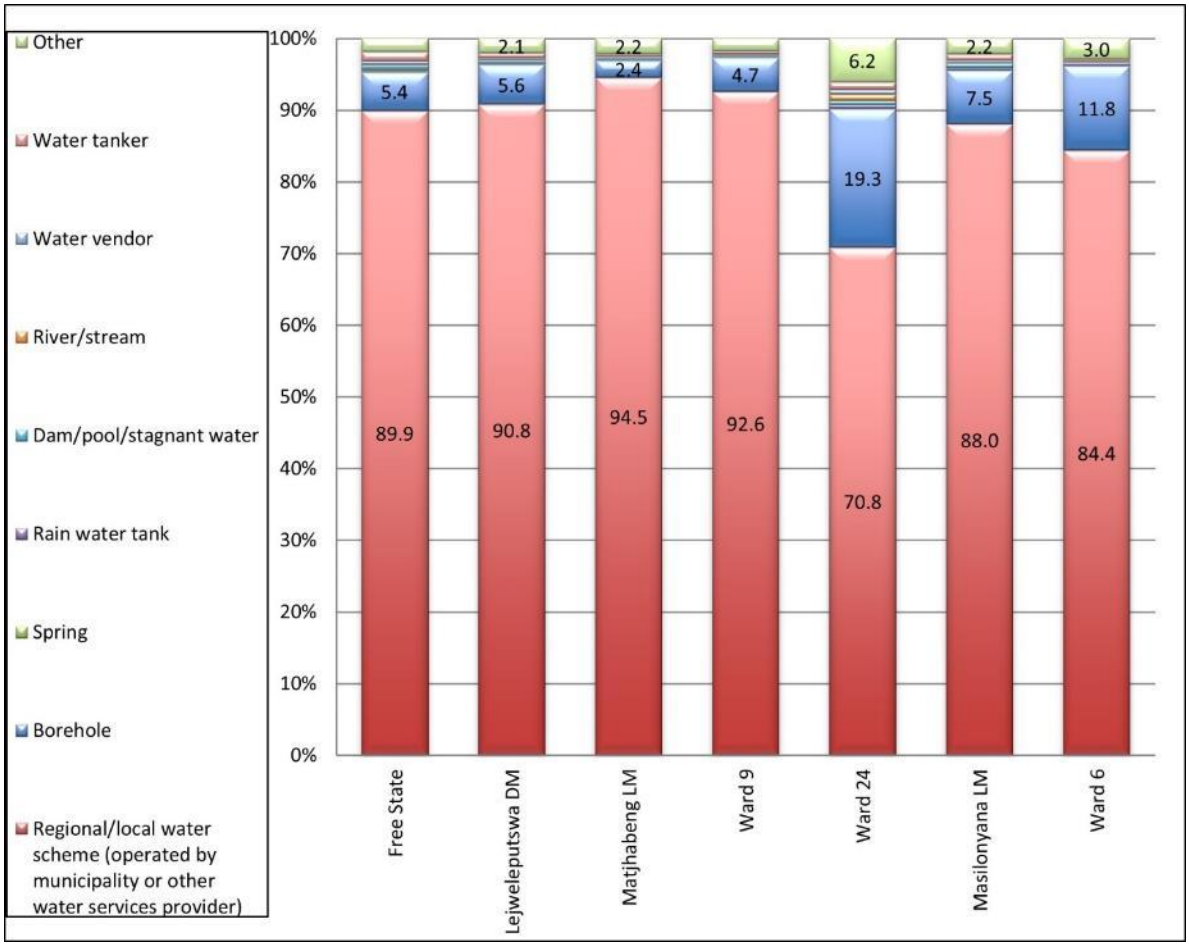


Figure 45: Piped water (shown in percentage, source: Census 2011).

The highest incidence of households that do not have access to any sanitation services is in Ward 24 (Figure 46), with approximately a third of the households in the ward having access to pit toilets without ventilation.

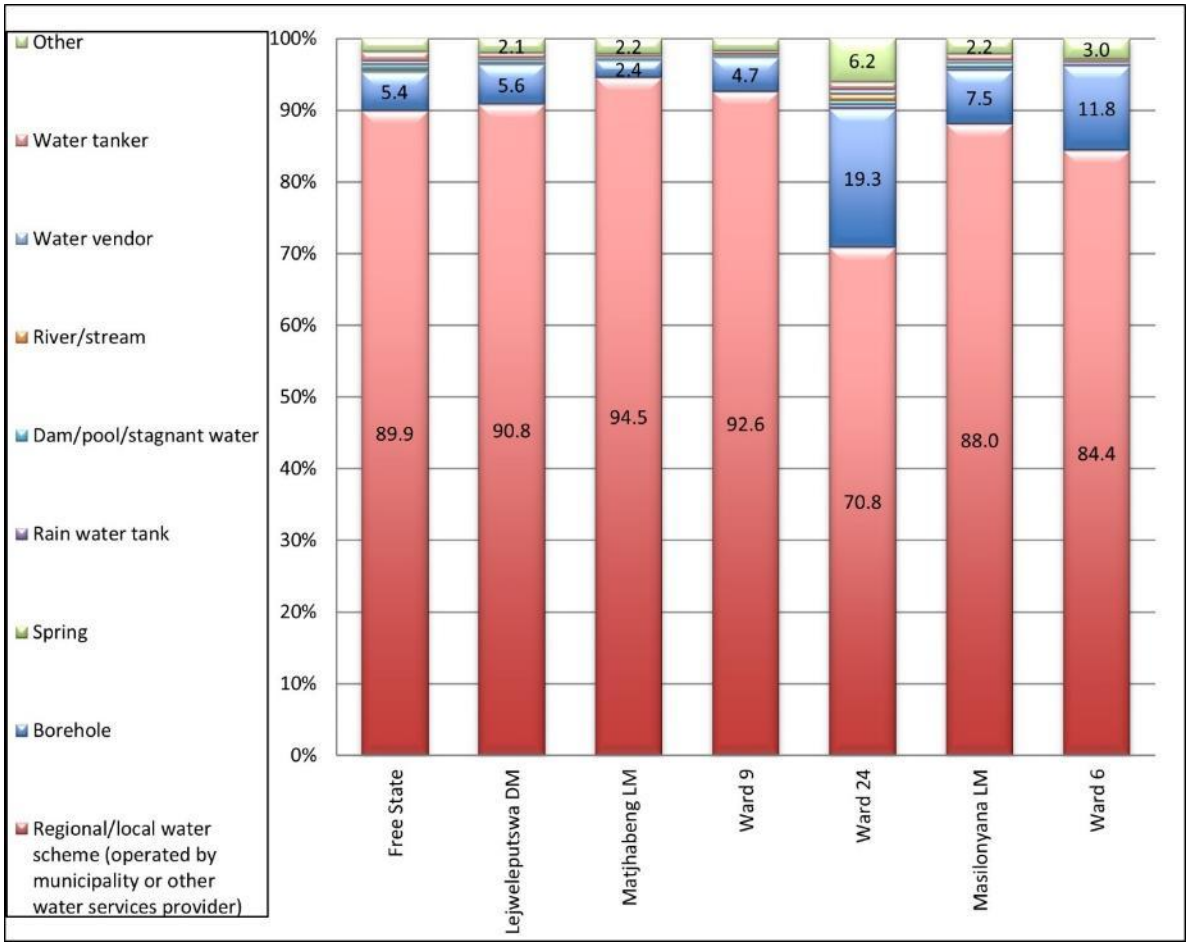


Figure 46: Sanitation (shown in percentage, source: Census 2011).

9.4.16 ENERGY

Electricity is seen as the preferred lighting source (Noble et al, 2006) and the lack thereof should thus be considered a deprivation. Even though electricity as an energy source may be available, the choice of energy for cooking may be dependent on other factors such as cost. More than 80 % of households have access to electricity as energy source for lighting (Figure 47), with candles the second most used source.

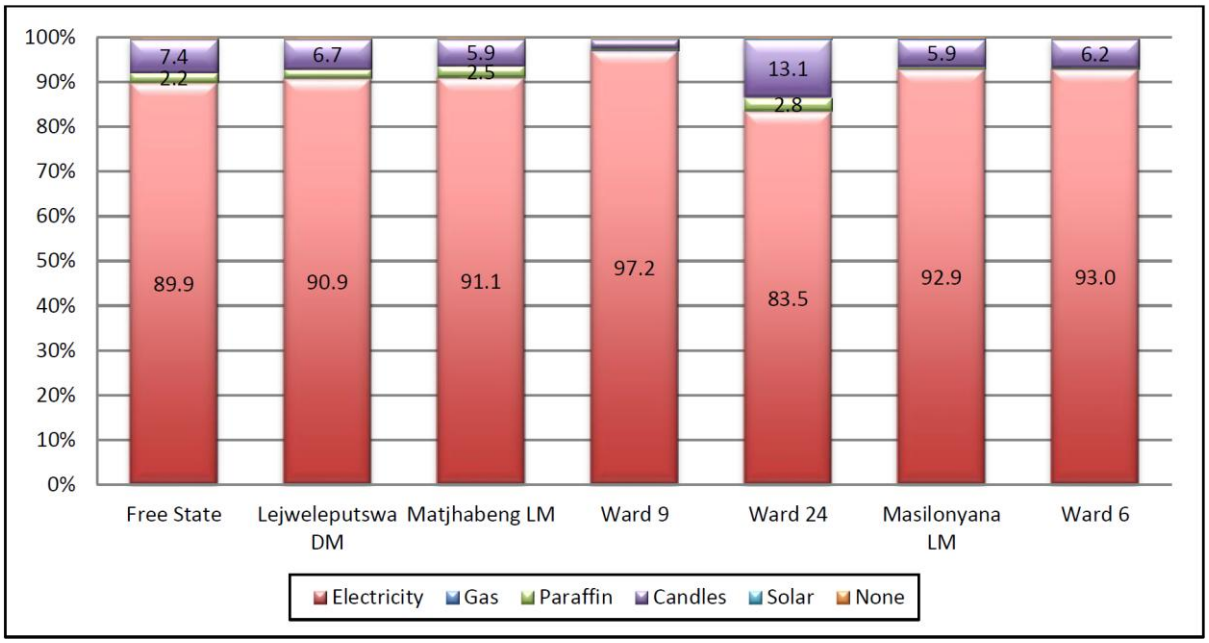


Figure 47: Energy source for lighting (shown in percentage, source: Census 2011).

9.4.17 REFUSE REMOVAL

Wards 6 and 24 have the lowest incidence of households that have their refuse removed at least once a week by a local authority or private company (Figure 48), with almost a third of households in Ward 24 having no rubbish disposal.

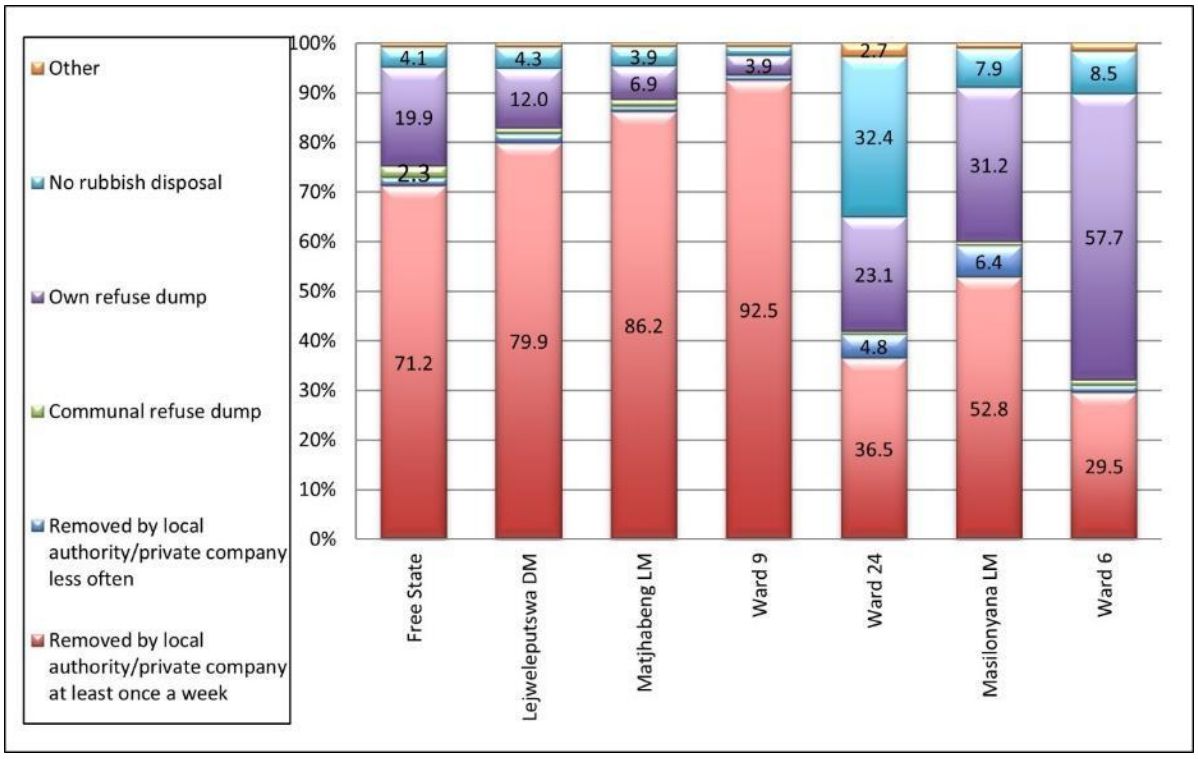


Figure 48: Refuse removal (shown in percentage, source: Census 2011).

9.5 ECONOMIC ENVIRONMENT

An economic impact assessment has been conducted by Strategy4Good and the final report included in Appendix 4. The sub-sections below provide an overview of the economic baseline applicable to this project. As

the majority of the study area falls within the Matjhabeng Local Municipality which is also a significantly larger municipality than the Masilonyana Local Municipality, the economic impacts of the project have been compared to the Matjhabeng Local Municipality.

9.5.1 NATIONAL ECONOMY

In the broader receiving environment, the national economy is under much stress and in a receiving environment of this nature it would be commonplace to observe that all desirable economic development would be urgent for SA. In this regard, the Cluster 2 development should be viewed as a significant benefit to the SA economy. An estimated 2.6 million people lost their jobs due to the pandemic and the current unemployment rate is ~34%. Socio-economic indicators are likely to continue to decline and therefore Tetra4 and its suppliers could expect a disproportionate amount of job applications.

9.5.2 LOCAL ECONOMY

The total GGP of the Matjhabeng municipality is estimated at R45 billion at present and this can be considered as a large economy by size in South Africa. SA's GDP is just under R5 000 billion rand and although Matjhabeng's economy is only ~1 % of that amount, it needs to be compared to the 0,2 % of the average municipality in SA. Thus, Matjhabeng's economy is 5 times larger than the average municipality in SA and hence could be considered as a relatively big economy in the country. The significance of this is that the local area has a reasonable economic base that could sustain itself and as a rule ought to provide in some of Tetra4's supplier and procurement needs.

As shown in Figure 49 to Figure 52 below, the local economy's GDP growth rates had been mostly negative between 2005-2014. As the data for the local economy's performance was not available after 2014, a look at the SA GDP growth rate shows that nationally there were no signs to indicate that the economy was improving. One could therefore assume that the local economy may also not have experienced strong growth, albeit that higher commodity prices may have had a positive impact locally in 2021 (that year's statistic not in the graph.)

From the figures below it can also be seen that the mining industry made up 56 % of the local economy in 2014. Compare this to national mining contribution to GDP of less than 10 %. The Government sector, which is not a propulsive industry, is the next biggest economic sector in Matjhabeng. The critical sector for economic success namely the manufacturing sector is very small in that economy.

Mining output in the local economy is showing a downward trend at a rate of 1.5 % per year. Figure 52 shows that Matjhabeng had been hit hard by declining gold production. Its workforce had been halved since the golden years of the 1990's and this had led to high unemployment rates.

The area's population is large with well over 400 000 inhabitants. The population growth rate in Matjhabeng was estimated at 0,5 % in the last decade, compared to 1,5 % in SA, which indicates that the Gold Fields is not a major in-migration area at present. This can only be ascribed to the area's inability to absorb jobseekers in the economy prompting less people to in-migrate. As is the case in the rest of South Africa, the Matjhabeng unemployment rate is high, bordering on 40 %.

Due to the urbanised nature of Matjhabeng, it's Agricultural Sector is small contributing less than 2 % to its economy. The agricultural sector in the region is much larger as is expected in the Free State, averaging 5 % of GDP.

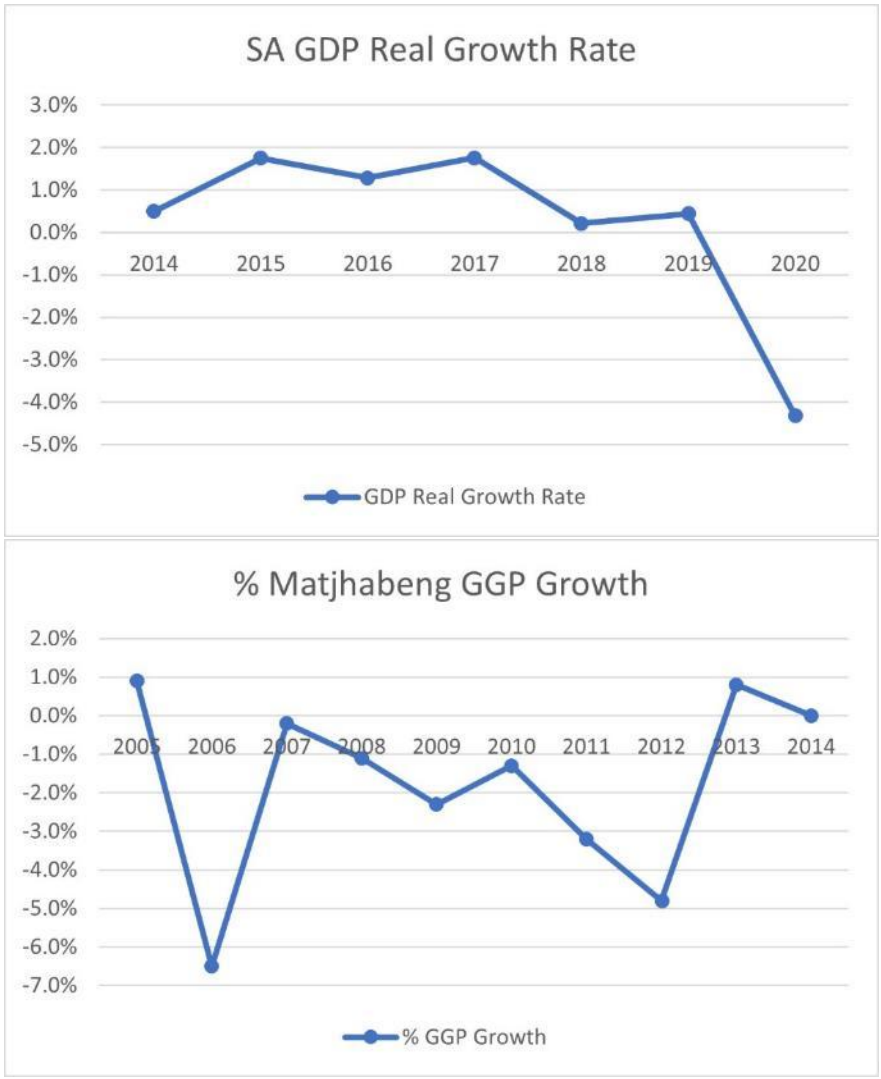


Figure 49: Key economic graphs.

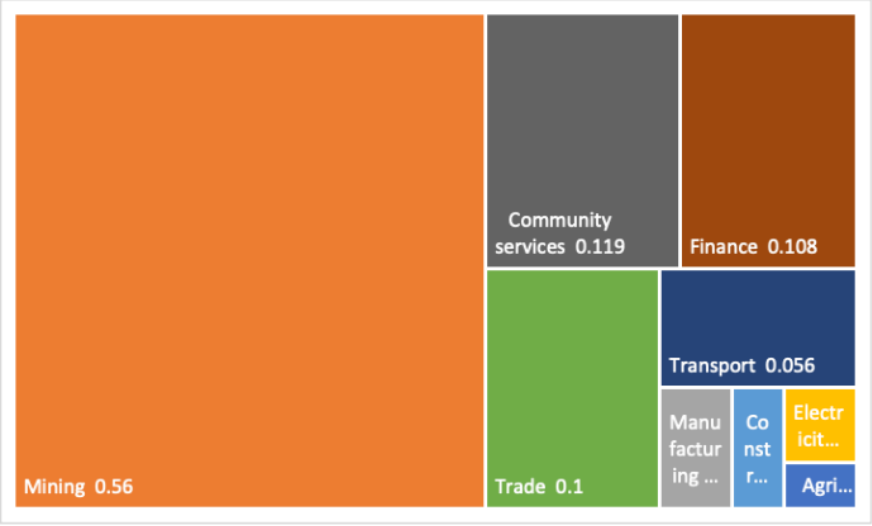


Figure 50: Structure of Matjhabeng economy by economic output 2014 – sector specific.

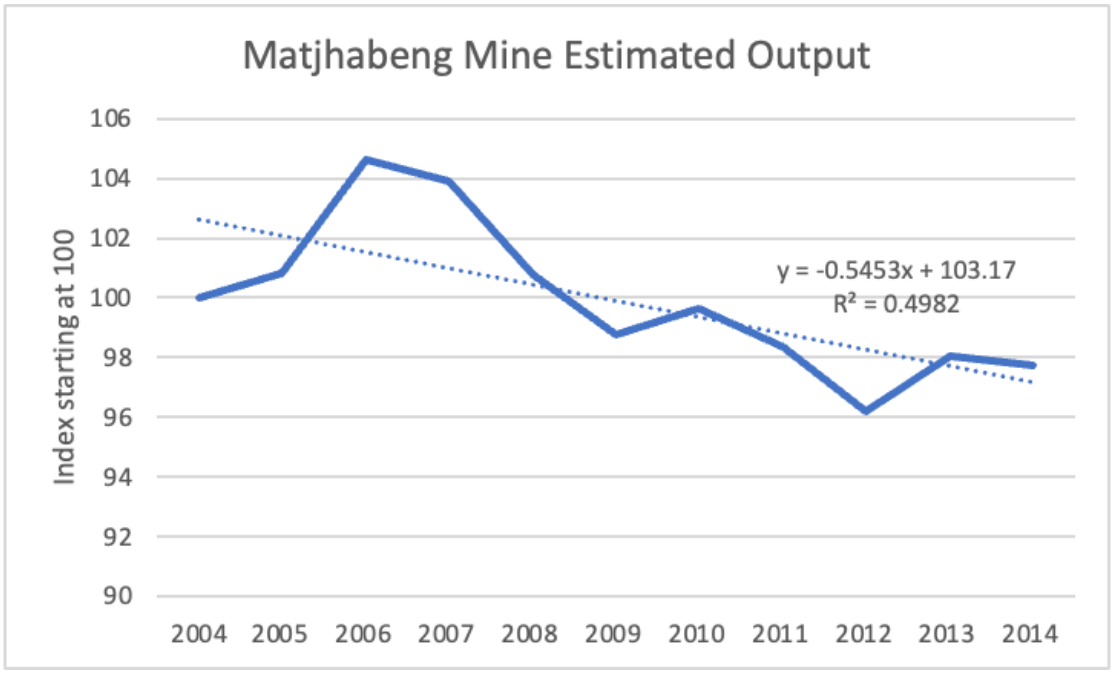


Figure 51: Structure of Matjhabeng economy by economic output 2014 – overall output.

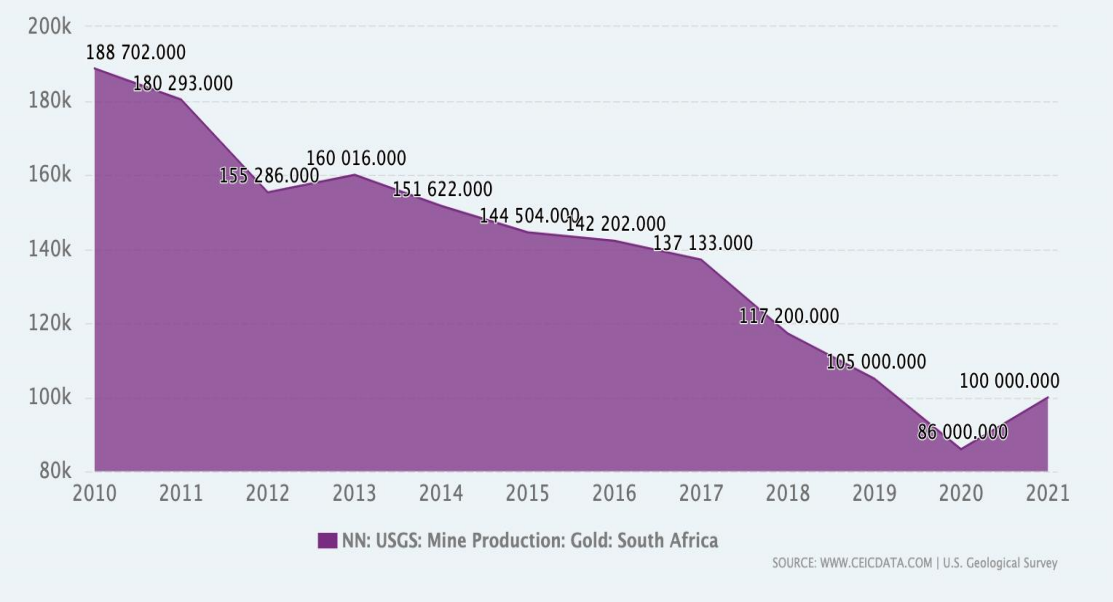


Figure 52: South African gold production.

9.5.2.1 STRENGTHS OF THE LOCAL ECONOMY

The local economy is considered to have the following strong points:

- Matjhabeng has a relatively large GGP compared to other municipalities, which ought to leverage possibilities for further development in the area.
- The road infrastructure from Matjhabeng that connects it to both the Johannesburg markets and Durban ports is of a very high quality, which makes import and export linkages more efficient than for many other municipalities in the country.
- Barring further mine closures, Matjhabeng may be finding a new economic equilibrium which ought to increase business confidence and investment in the area.

- The 2014/15 IDP indicates that the average household income has increased, which ought to contribute to social stability.
- The IDP also states that educational levels in the area have improved substantially, and a better-educated population is crucial for economic development.
- The IDP furthermore states that Matjhabeng has a Human Development Index (HDI) of 0.66, which is one of the highest in the Free State and just above the average SA HDI. However, the country's HDI is still low compared to that of developed countries, and it requires much improvement before Matjhabeng could be a significantly competitive economy.

9.5.2.2 WEAKNESSES OF THE LOCAL ECONOMY

- Matjhabeng is dependent on one propulsive industry, namely mining. With an undiversified economy it is thus vulnerable to the prospects of mining.
- The Matjhabeng municipality itself does not seem to have a strong set of financial statements. Its current liabilities exceed its current assets by a large margin, and it has been recording deficits (losses) for the last few years. In addition to this, it also had qualified audits which does not bode well for the financial management of the municipality.
- Other weaknesses are in alignment with what most of SA is experiencing at present:
    - Long term decline in business confidence;
    - Unreliable electricity supply;
    - Low growth economic environment;
    - Generally low investment environment;
    - High unemployment;
    - Unplanned urbanisation;
    - Crime;
    - Apparent government inefficiencies.

In summary, Matjhabeng has a relatively large economy compared to that of other SA municipalities, but its GGP has been declining for years. Although the local economy still has a measure of critical mass that could provide continued private consumption expenditure which could sustain it for quite some time, it requires new investments to sustain itself. The Matjhabeng economy is by all accounts finding a new equilibrium – an economy that is adjusting to declines in mining employment and a stagnating population. The increase in government expenditure and perennial agricultural activities are keeping the municipality's decline in check, but if more mines close down its GGP and formal employment is set to decline more. At present it is not sure what the impact of higher commodity prices are on the local economy. An investment such as that of Tetra4 will undoubtedly improve the economic prospects for the local economy.

9.6 CULTURAL AND HERITAGE RESOURCES

A Specialist Heritage and Palaeontology Impact Assessment study has been undertaken to inform this application and the final report included in Appendix 4. Based on the historical and archaeological overview, the previous assessments undertaken in the area as well as the fieldwork undertaken as part of this application, the heritage assessment findings are summarised below:

- Thirty-five (35) heritage sites which were previously identified for a 2016/2017 assessment, fall within the footprint areas of the current proposed Tetra4 Cluster 2 Gas Production Project. These comprised:
    - 10 graves and burial grounds (TET 1, TET 7-8, TET 11, TET 15, TET 19, TET 22, SSL/BET/72, SITE 2, SITE 19);

- 11 structures (TET 2-3, TET 9, TET 27, SSL/BET/25-26, SSL/BET/36, SITE 1A, SITE 1B, SITE 20-21); and
- 14 historic to recent sites with possible graves (TET 4-6, TET 13-14, TET 25a, TET 25b, TET 26, SSL/BET/37-39, SSL/BET/53, SSL/BET/60, SSL/BET/66).

- During the current field assessment, a further thirty-seven (37) heritage sites were recorded as detailed below:
  - 6 sites containing burial grounds and graves (T0003, T0009, T0010, T0013, T0024, T0029);
  - 8 sites historic to recent sites with possible graves (T0007, T0008, T0011, T0015, T0023, T0026, T0027, T0028); and
  - 23 structures (T0001, T0002, T0004, T0005, T0014, T0016, T0017, T0018, T0019, T0020, T0021, T0022, T0025, T0030, T0031, T0033, T0034, T0036, T0037, T0038, T0039, T0040, T0041).

The combined seventy-two (72) identified heritage sites (as described above) were then assigned a sensitivity rating as either high, medium, low or none as follows:

- 37 sites were rated as having high heritage significance (IIIA): TET 1, TET 7-8, TET 11, TET 15, TET 19, TET 22, SSL/BET/72, SITE 2, SITE 19, TET 4-6, TET 13-14, TET 25a, TET 25b, TET 26, SSL/BET/37-39, SSL/BET/53, SSL/BET/60, SSL/BET/66, T0003, T0009, T0010, T0013, T0024, T0029, T0007, T0008, T0011, T0015, T0023, T0026, T0027, T0028;
- 12 sites were rated as having medium heritage significance (IIIB): TET 2, TET 3, TET 9, SITE 1A, SITE 1B, SITE 20, SITE 21, T0014, T0015, T0021, T0040, T0041;
- 13 sites were rated as having low heritage significance (IIIC): TET 27, SSL/BET/25, SSL/BET/26, SSL/BET/36, T0016, T0017, T0018, T0019, T0020, T0022, T0025, T0037, T0038; and
- 10 sites were rated as having no research potential or other cultural significance (NCW): T0001, T0002, T0004, T0005, T0030, T0031, T0033, T0034, T0036, T0039.

A set of photographs of each of the heritage sites can be viewed in the heritage specialist report. The location of the identified heritage sites are superimposed on the project infrastructure areas in Figure 53 with the relevant insets included in Figure 54 to Figure 63.

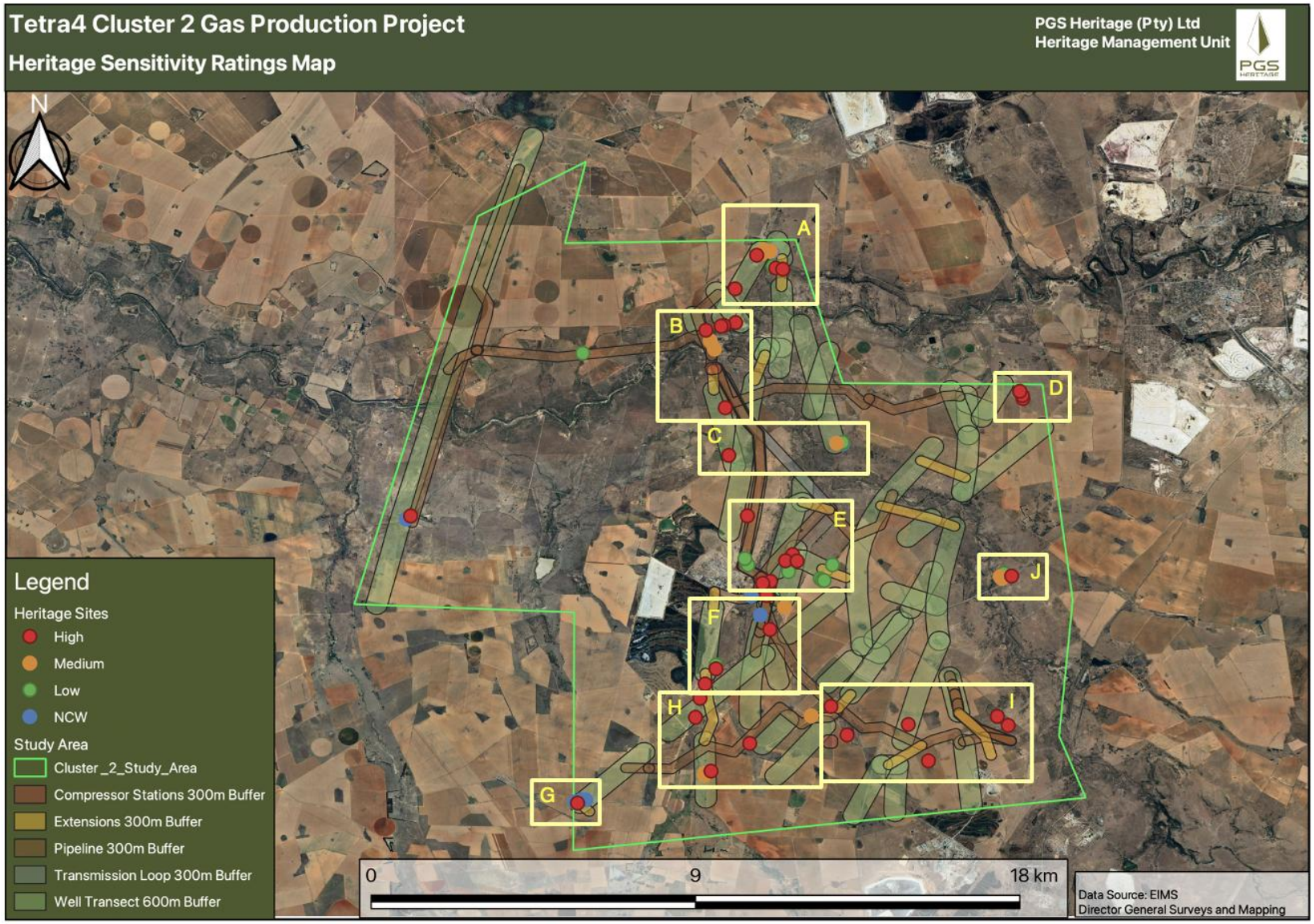


Figure 53: Map showing heritage sensitivity rating of identified heritage resources.

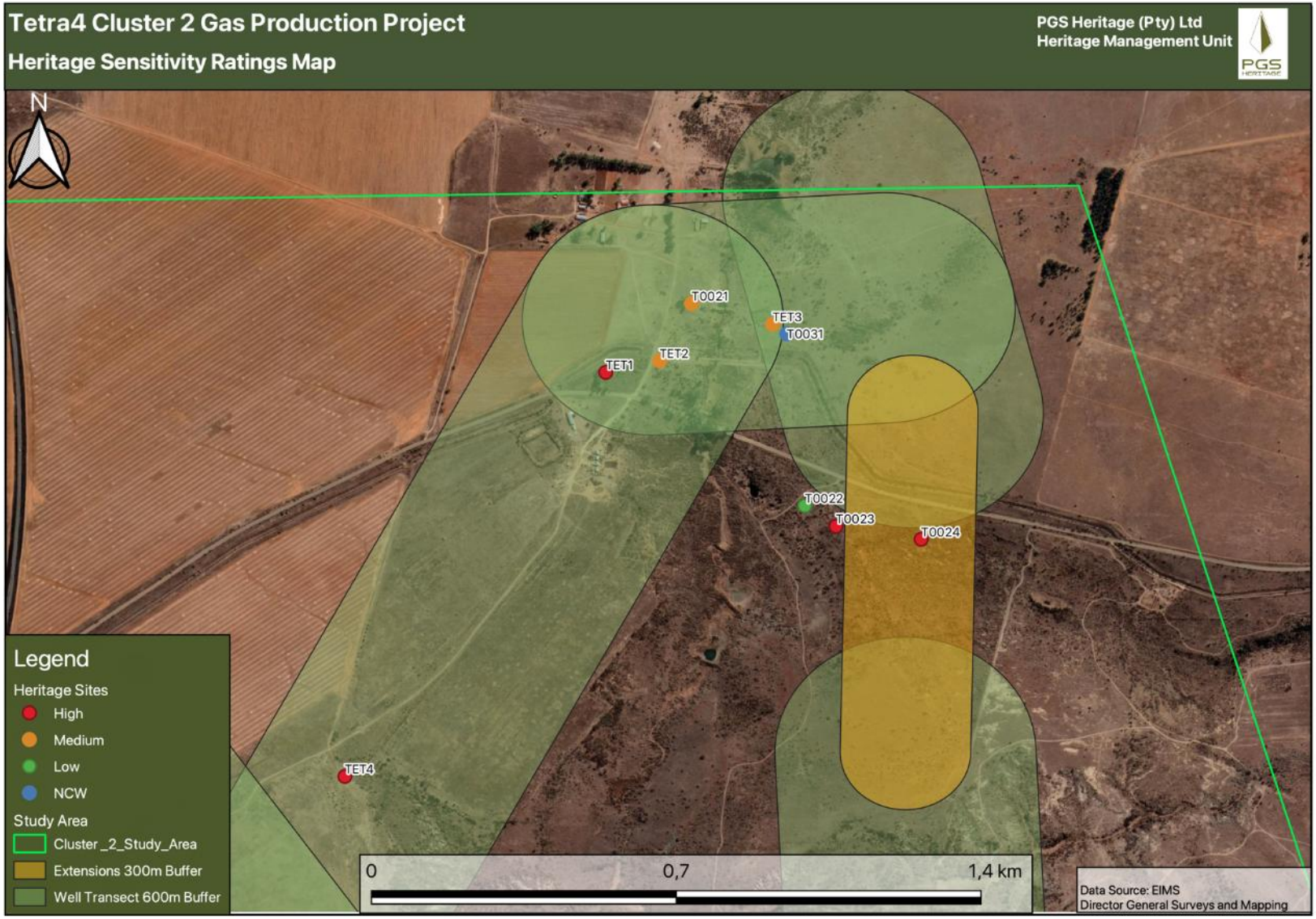


Figure 54: Heritage sensitivity rating of identified heritage resources - Inset A.

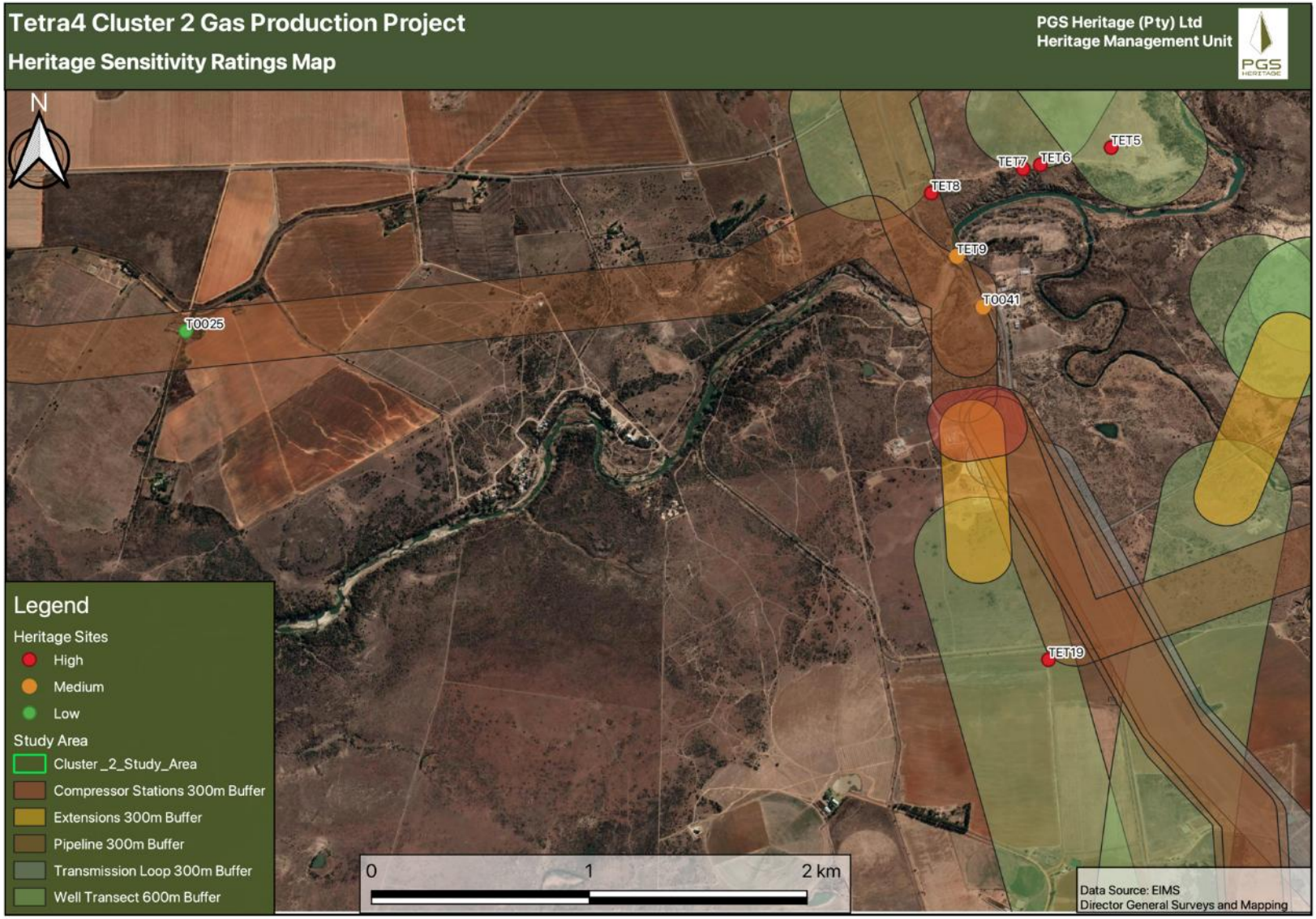


Figure 55: Heritage sensitivity rating of identified heritage resources - Inset B.

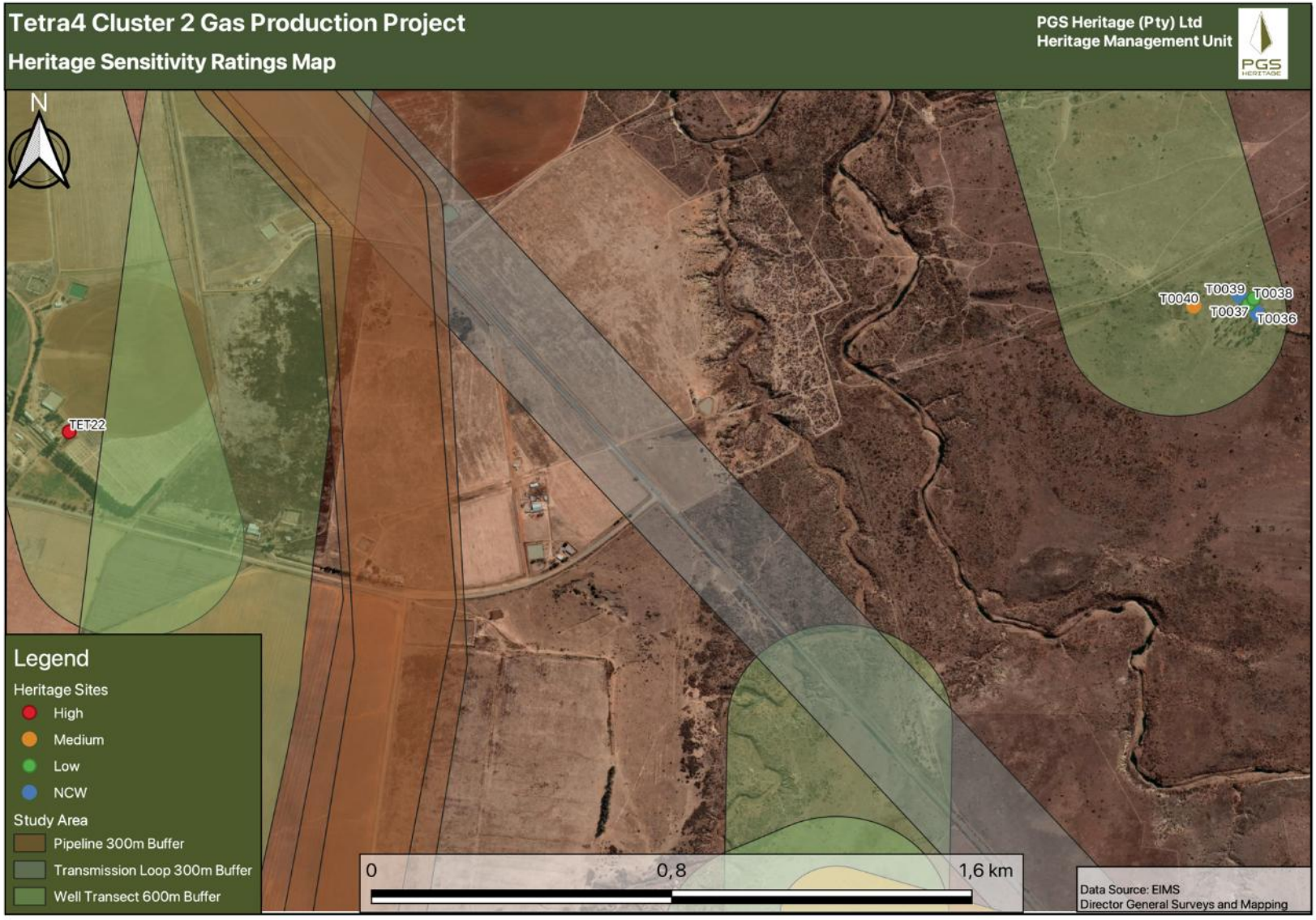


Figure 56: Heritage sensitivity rating of identified heritage resources - Inset C.

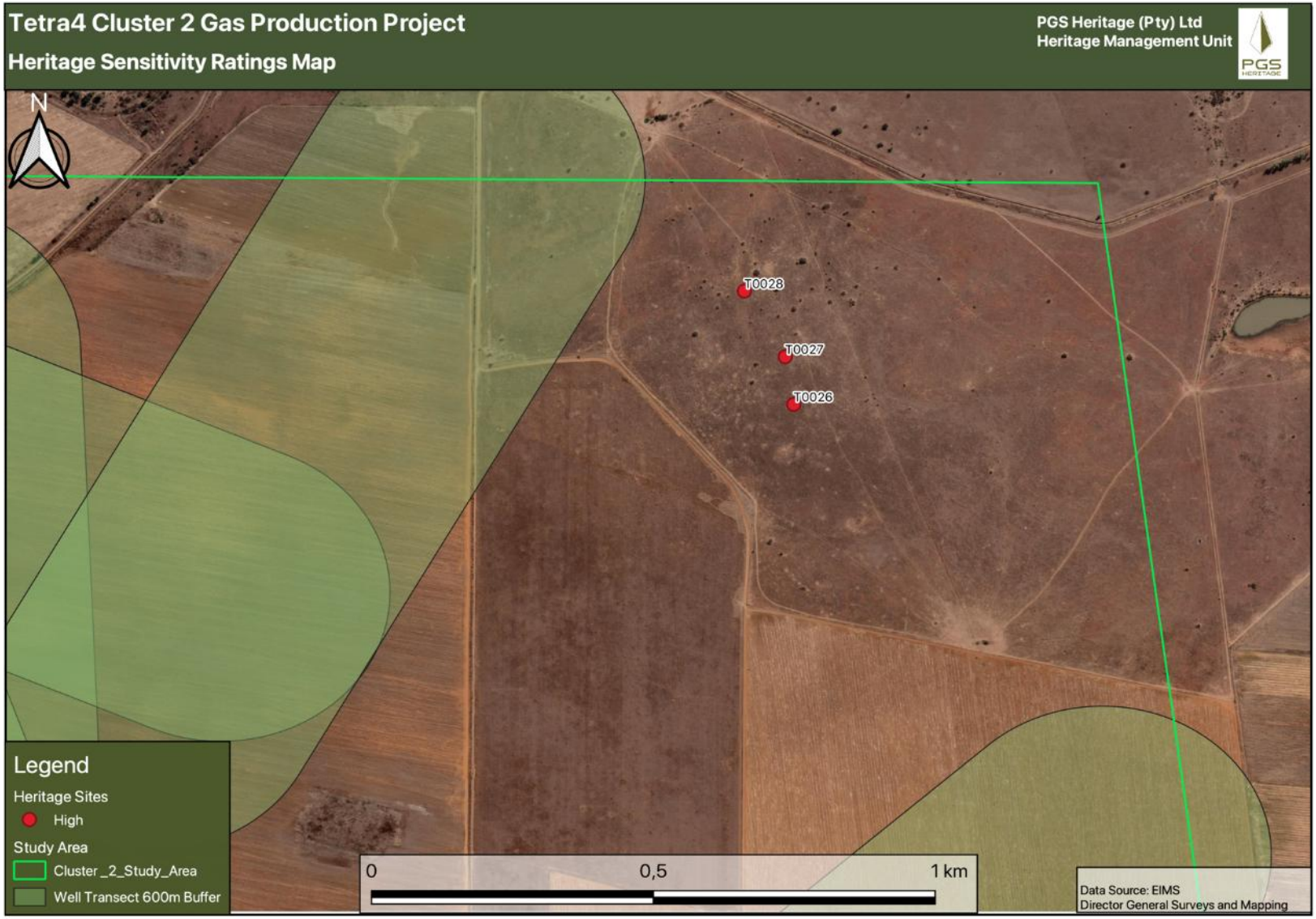


Figure 57: Heritage sensitivity rating of identified heritage resources - Inset D.

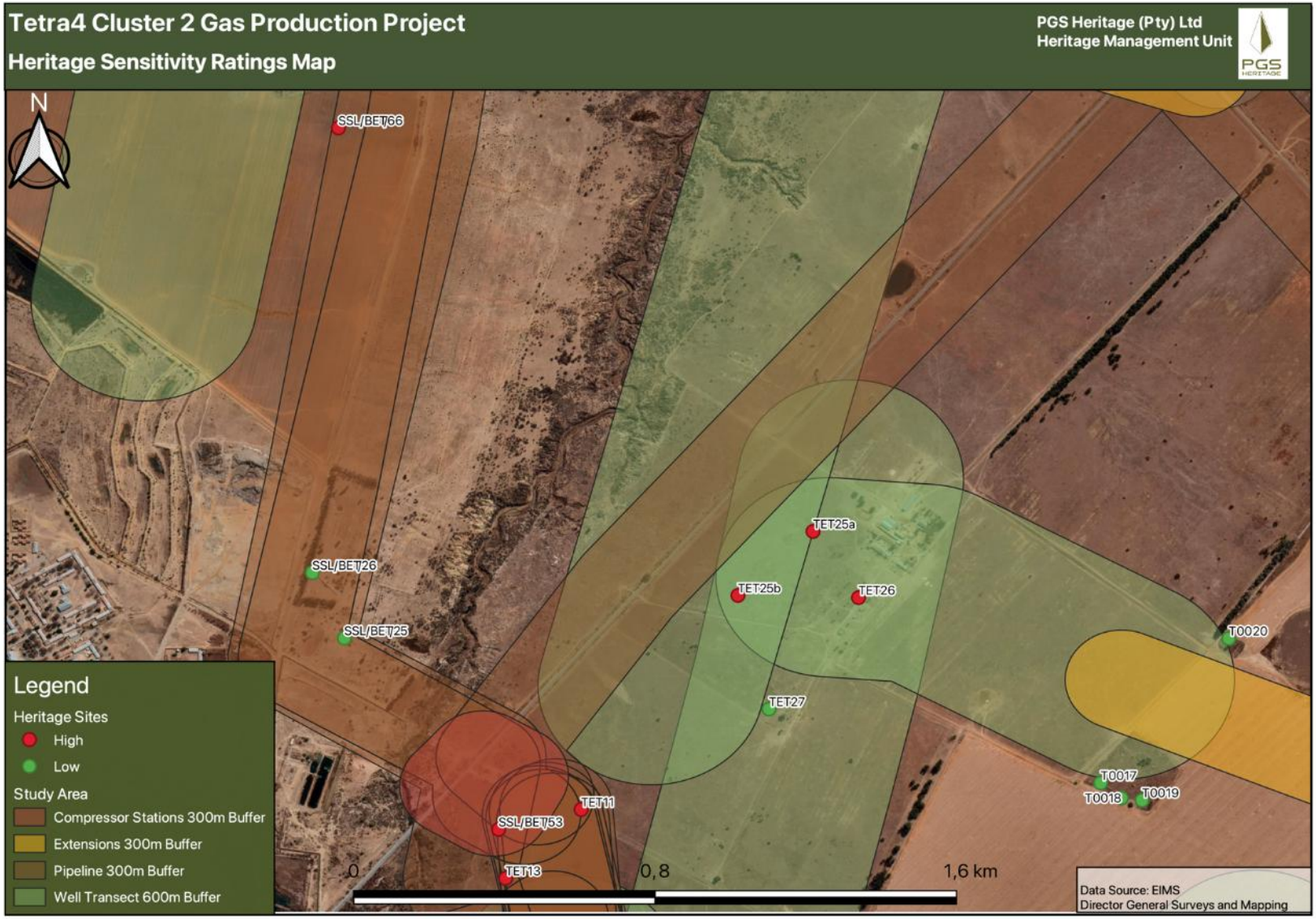


Figure 58: Heritage sensitivity rating of identified heritage resources - Inset E.

Figure 59: Heritage sensitivity rating of identified heritage resources - Inset F.

Figure 60: Heritage sensitivity rating of identified heritage resources - Inset G.

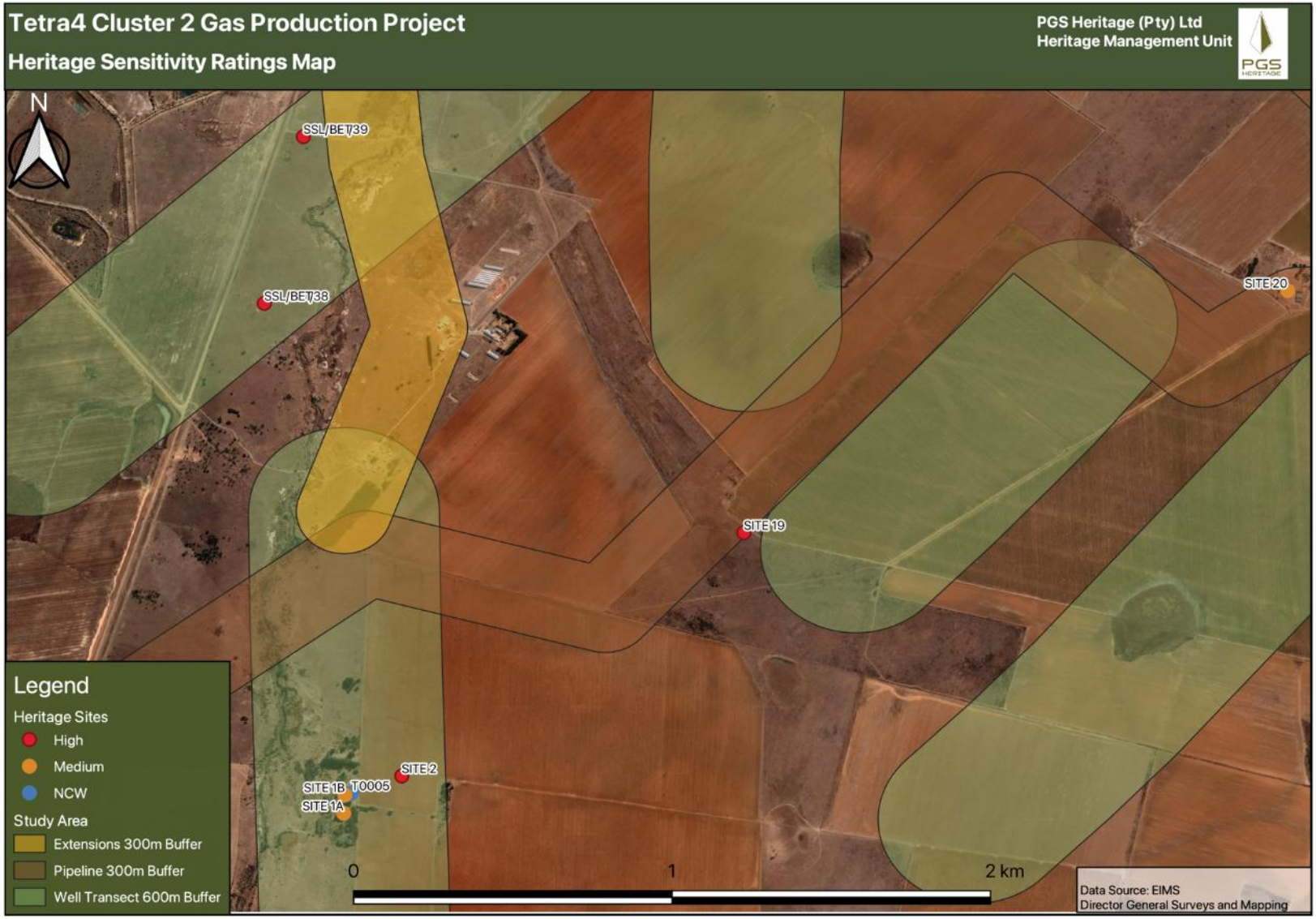


Figure 61: Heritage sensitivity rating of identified heritage resources - Inset H.

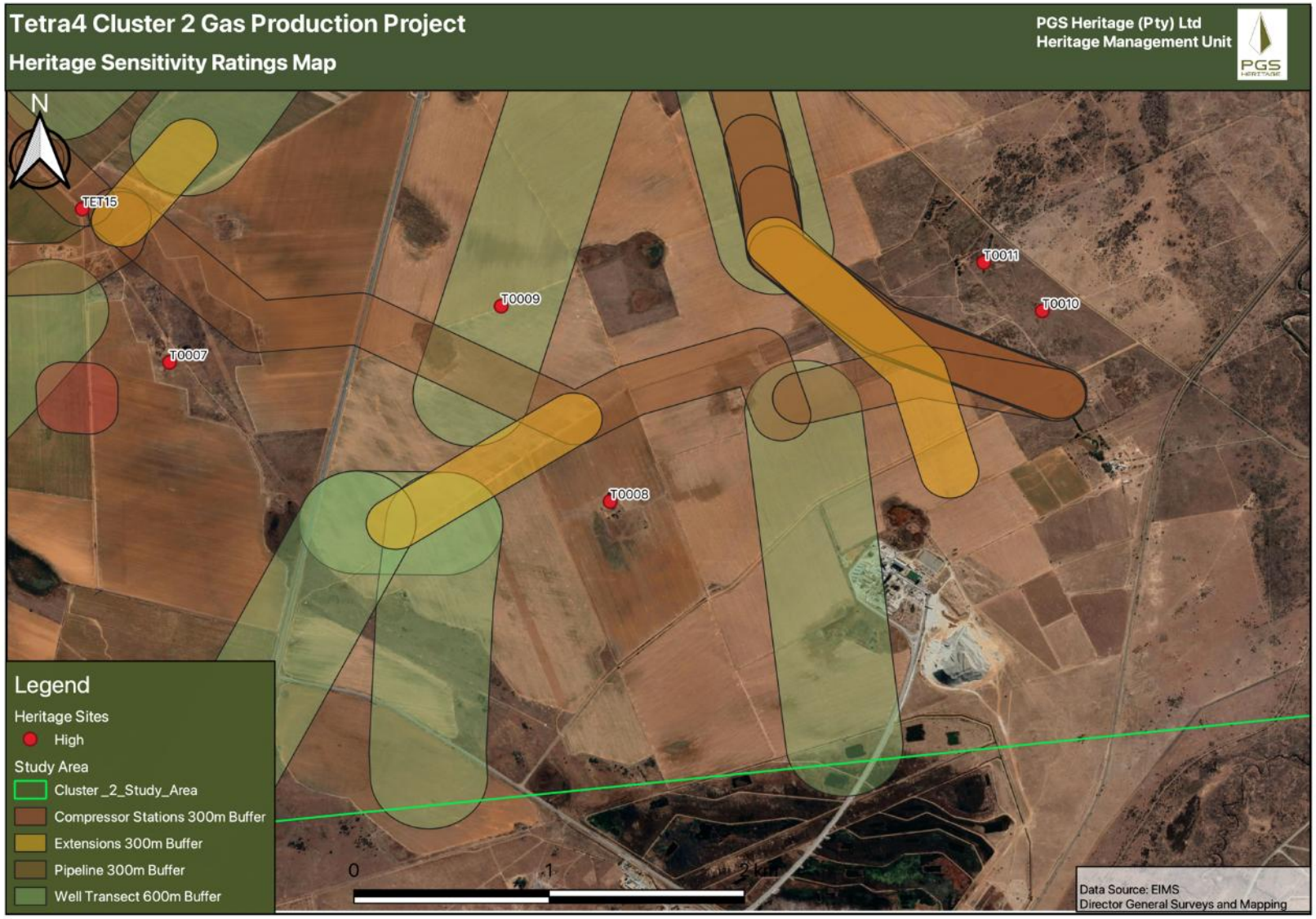


Figure 62: Heritage sensitivity rating of identified heritage resources - Inset I.

Figure 63: Heritage sensitivity rating of identified heritage resources - Inset J.

A Palaeontological study was undertaken by Elize Butler (February 2022) and the study indicates the proposed Cluster 2 development is underlain by Quaternary sediments as well as Permian aged sandstone and shale of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup). According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of Quaternary sediments in this area is Moderate, while that of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) is Very High.

A 2-day site-specific field survey of the development footprint was conducted on foot and by a motor vehicle on 26 to 27 February 2021. No visible evidence of fossiliferous outcrops was found in the development footprint and thus an overall medium palaeontological significance is allocated to the development footprint. It is therefore considered by the specialist that the proposed development will not lead to detrimental impacts on the palaeontological reserves of the area and construction of the development may be authorised in its whole extent.

9.7 SOILS AND LAND CAPABILITY

According to the land type database (Land Type Survey Staff, 1972 - 2006) the assessment corridor to be focused on falls within the Ae40, Bd20, Dc8, Dc9 and Dc12 land types. The Ae land type mostly consist of apedal (yellow/red), duplex soils characterised with high clay contents and shallow profiles associated with partially weathered/ un-weathered material with the possibility of other soils occurring throughout. Lime is generally present in low-lying areas. The Bd land type consists of mostly apedal and duplex soils with miscellaneous land classes including rocky areas with Mispah and Oakleaf soils forms according to the SA soil classification working group (1990). The Dc land types is characterised with duplex, transitional young alluvial soil deposits with occasional red soils, some saturated profiles, shallow soils, and intrusive hard rocks. The terrain units and expected soils for the Ae40 land type is illustrated in Figure 64 and Table 22 respectively. Similarly, those for the Bd20 land type is depicted in Figure 65 and Table 23; Dc8 land type in Figure 66 and Table 24; Dc9 land type in Figure 67 and Table 25 and Dc12 in Figure 68 and Table 26 respectively.

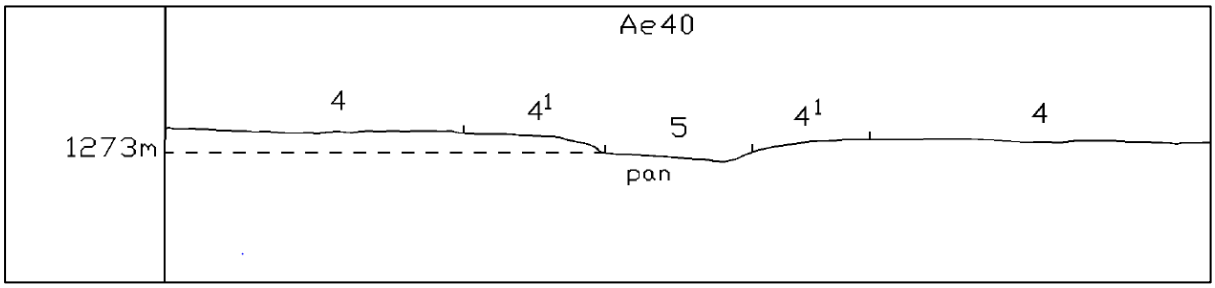


Figure 64: Illustration of land type Ae40 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 22: Soils expected at the respective terrain units within the Ae 40 land type (Land Type Survey Staff, 1972 - 2006).

Terrain Units					
4 (92%)		**4 (1) (4%)**		**5 (4%)**	
Hutton	89 %	Swartland	25 %	Katspruit, Rensburg	75 %
Clovelly	7 %	Mispah	50 %	Swartland	25 %
Bainsvlei	2 %	Oakleaf	25 %		
Avalon	2 %				

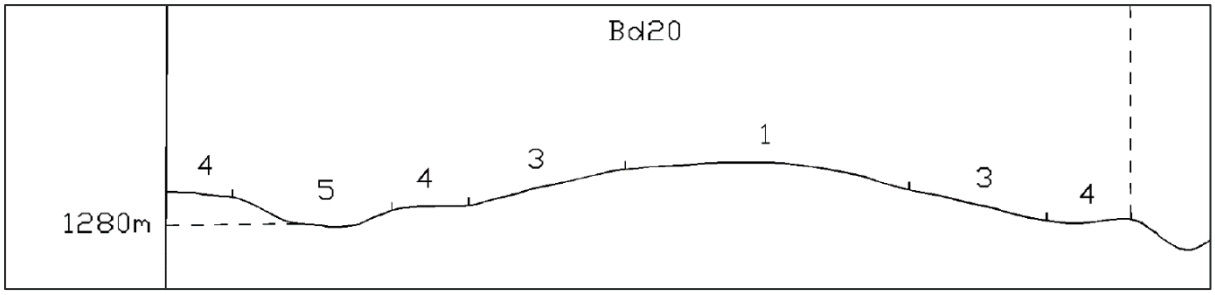


Figure 65: Illustration of land type Bd 20 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 23: Soils expected at the respective terrain units within the Bd 20 land type (Land Type Survey Staff, 1972 - 2006).

Terrain Units							
1 (55%)		**3 (40%)**		**4 (3%)**		**5 (2%)**	
Clovelly	65 %	Clovelly	45 %	Hutton	50 %	Valsrivier	55 %
Avalon	30 %	Avalon	20 %	Valsrivier	18 %	Arcadia, Rensburg	30 %
Arcadia, Rensburg	1 %	Hutton	25 %	Avalon	10 %	Oakleaf	10 %
Katspruit	1 %	Valsrivier	8 %	Clovelly	5 %	Katspruit	10 %
Valsrivier	3 %	Arcadia, Rensburg	1 %	Oakleaf	5 %		
		Katspruit	1 %	Arcadia, Rensburg	1 %		

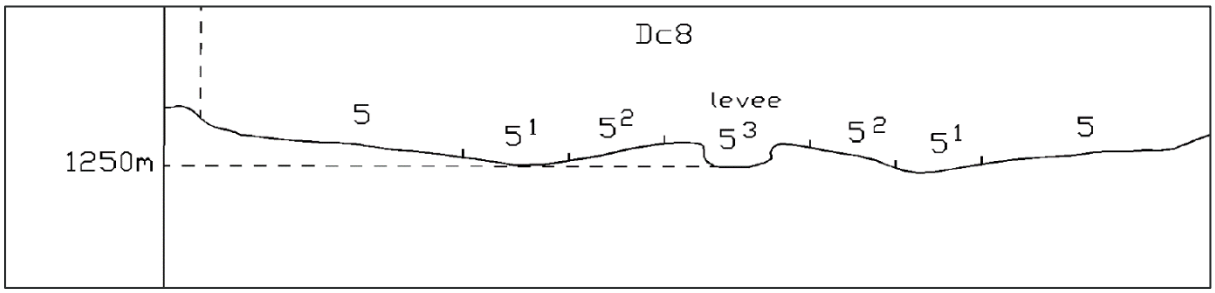


Figure 66: Illustration of land type Dc 8 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 24: Soils expected at the respective terrain units within the Dc 8 land type (Land Type Survey Staff, 1972 - 2006).

Terrain Units							
5 (44%)		**5(1) (40%)**		**5 (2) 27%)**		**5 (3) (16%)**	
Arcadia	42 %	Arcadia	41 %	Oakleaf	66 %	Dundee	7 %
Valsrivier	48 %	Rensburg	59 %	Valsrivier	32 %	Stream beds	28 %
Sterkspruit	6 %			Stream beds	2 %	Fernwood	22 %
Katspruit	1 %					Oakleaf	13 %
Bonheim	4 %						

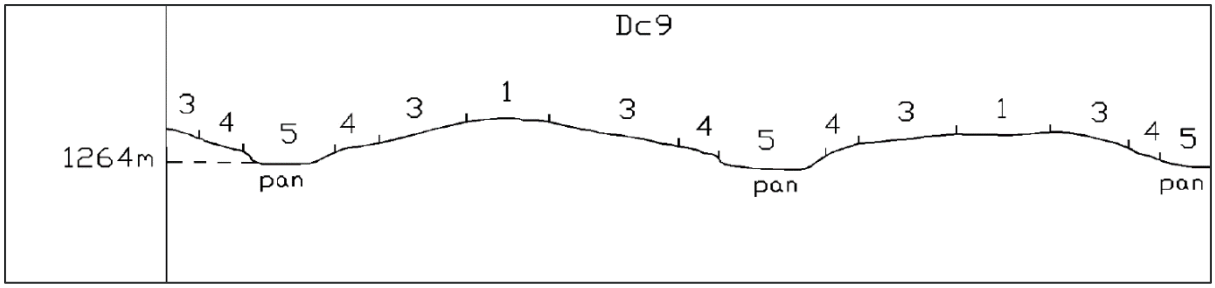


Figure 67: Illustration of land type Dc 9 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 25: Soils expected at the respective terrain units within the Dc 9 land type (Land Type Survey Staff, 1972 - 2006).

Terrain Units							
1 (10%)		**3 (27%)**		**4 (41%)**		**5 (22%)**	
Hutton	100 %	Hutton	88 %	Swartland	28 %	Willowbrook	91 %
		Clovelly	11 %	Valsrivier	24 %	Valsrivier	5 %
		Oakleaf	1 %	Oakleaf	23 %	Arcadia	2 %
				Sterkspruit	17 %	Sterkspruit	1 %
				Arcadia	4 %	Mispah	1 %
				Estcourt	3 %		
				Mispah	1 %		

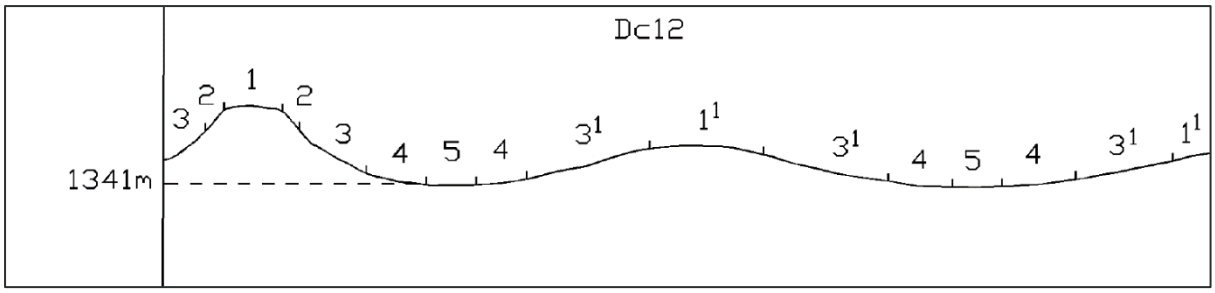


Figure 68: Illustration of land type Dc 12 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 26: Soils expected at the respective terrain units within the Dc 12 land type (Land Type Survey Staff, 1972 - 2006).

Terrain Units													
1 (3%)		**1 (1) (20%)**		**2 (1%)**		**3 (6%)**		**3 (1) (38)**		**4 (24)**		**5 (8)**	
Rocks	33%	Mispah	37%	Rocks	60%	Rocks	33%	Swartland	34%	Bonheim	29%	Oakleaf	41%
Mayo	23%	Swartland	19%	Mispah	30%	Mayo	25%	Mispah	18%	Swartland	27%	Katspruit	27%
Mispah	21%	Glenrosa	13%	Glenrosa	10%	Swartland	17%	Bonheim	14%	Valsrivier	15%	Stream beds	13%
Glenrosa	13%	Westleigh	12%			Mispah	17%	Valsrivier	9%	Arcadia	15%	Valsrivier	6 %
Swartland	10%	Mayo	6%			Glenrosa	8%	Glenrosa	7%	Sterkspruit	4%	Bonheim	5 %
		Bonheim	5%					Arcadia	7%	Mispah	4%	Glenrosa	4 %
		Valsrivier	3%					Westleigh	5%	Mayo	3%	Mayo	4 %

Terrain Units													
1 (3%)		1 (1) (20%)		2 (1%)		3 (6%)		3 (1) (38)		4 (24)		5 (8)	
		Rocks	3%					Mayo	3%	Glenrosa	2%		
		Hutton	2%					Hutton	2%	Rocks	1%		

The slope percentage of the application area has been calculated and is illustrated in Figure 69. The majority of the assessment area is characterised by a slope percentage between 0 and 20%, with some smaller patches within the application area characterised by a slope percentage above 40. This illustration indicates mostly a uniform area with few undulating slopes, mountainous areas and ridges. The Digital Elevation Model (DEM) of the application area is included in Figure 70.

The land potential level for the application areas is level 6 (these land potential levels are defined as having restricted to very restricted potentials, regular, moderate and/or severe limitations due to soil, slope, temperatures or rainfall.

Fifteen land capabilities have been digitised by (DAFF, 2017) across South Africa, of which ten land capability classes are located within the proposed infrastructure transects/ corridors, including;

- Land Capability 1 to 5 (very low to low);
- Land Capability 6 to 8 (moderately low to moderate); and
- Land Capability 8 to 10 (moderate to moderate high).

The baseline findings and the sensitivities as per the Department of Agriculture, Forestry and Fisheries (DAFF, 2017) national raster file concur with one another. According to the DEA Screening Tool (2022) land capability was identified as very low to moderate high and the farming field crop sensitivity as high to very high in some areas (Figure 72).

Where proposed infrastructure is located within high and very high sensitivity agricultural land uses, stakeholder engagement with the landowners can be undertaken to compensate for the loss of any high-productivity crop fields. Furthermore, it is advisable to rearrange proposed components around high/very high sensitivity crop fields to ensure the conservation thereof where possible.

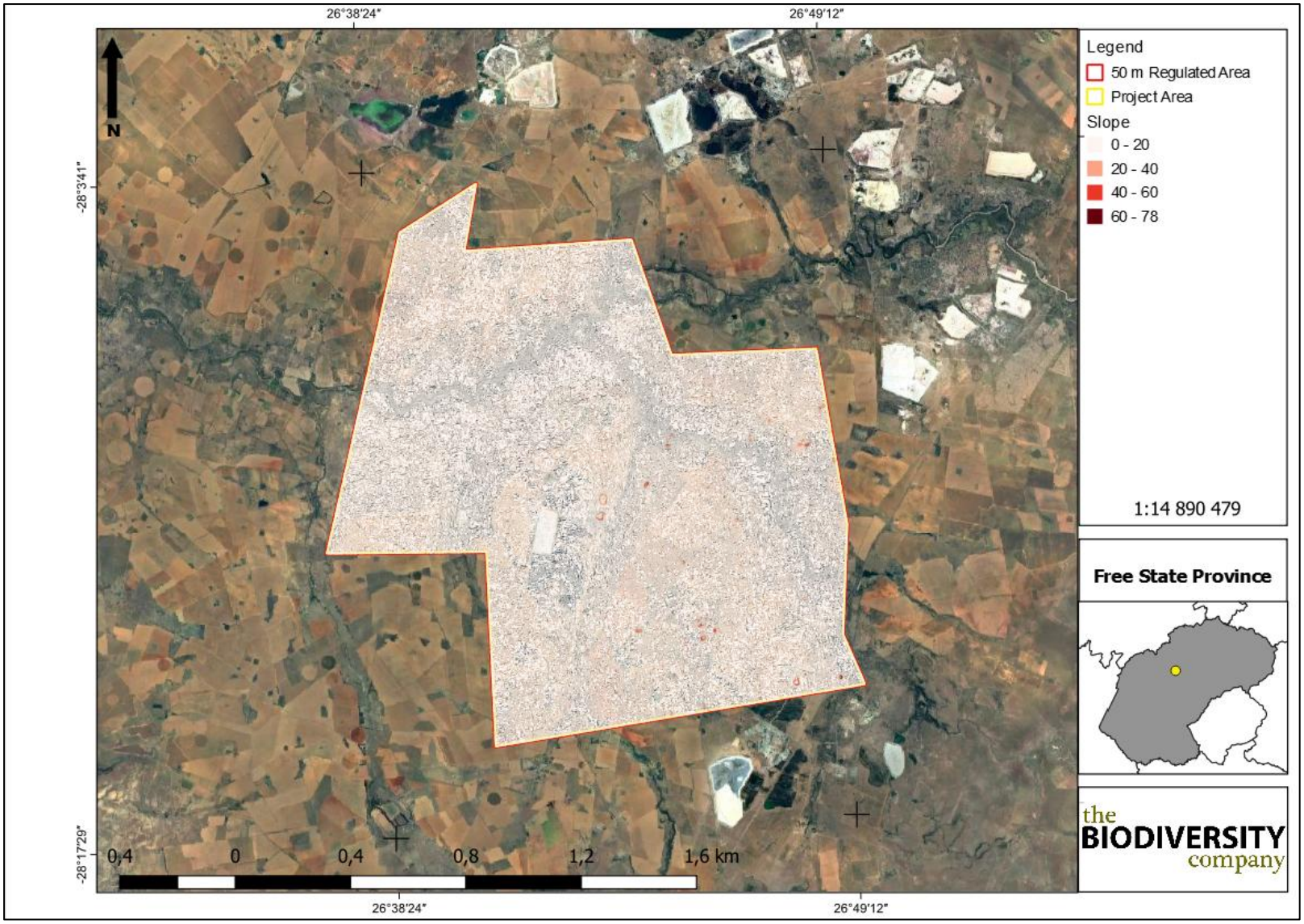


Figure 69: Slope percentage map for the assessment area.

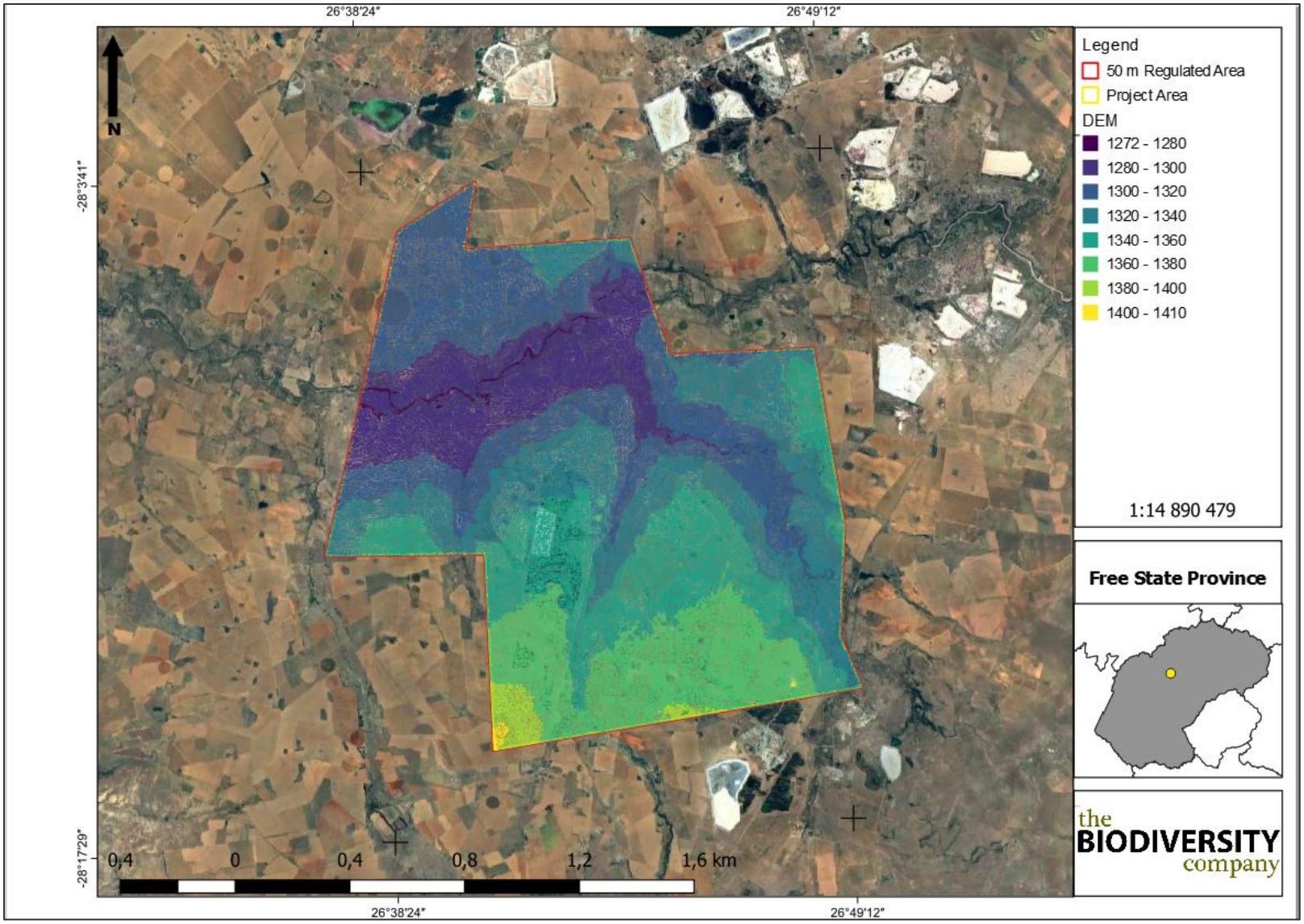


Figure 70: Elevation map for the assessment area.

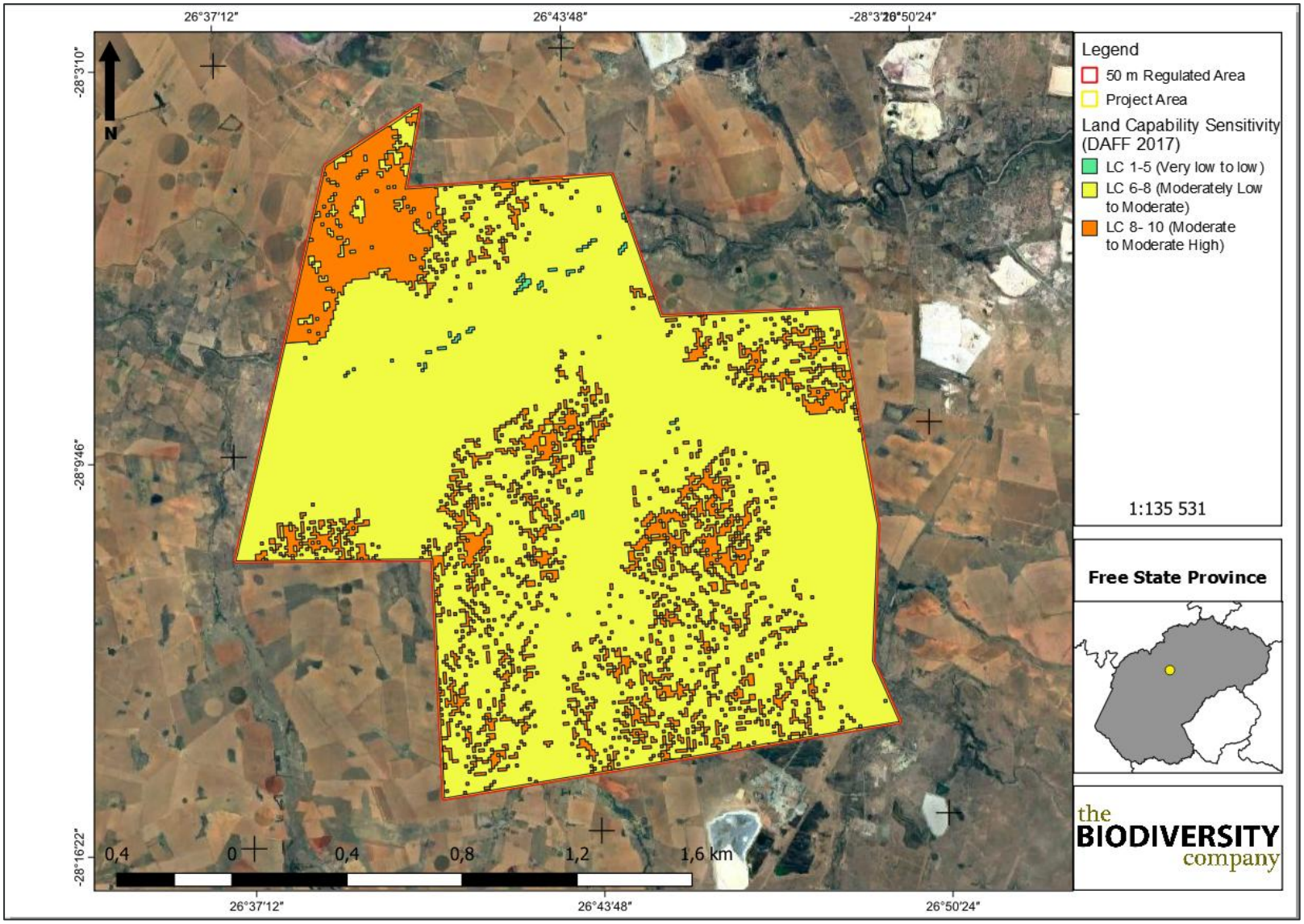


Figure 71: Land Capability Sensitivity (DAFF, 2017).

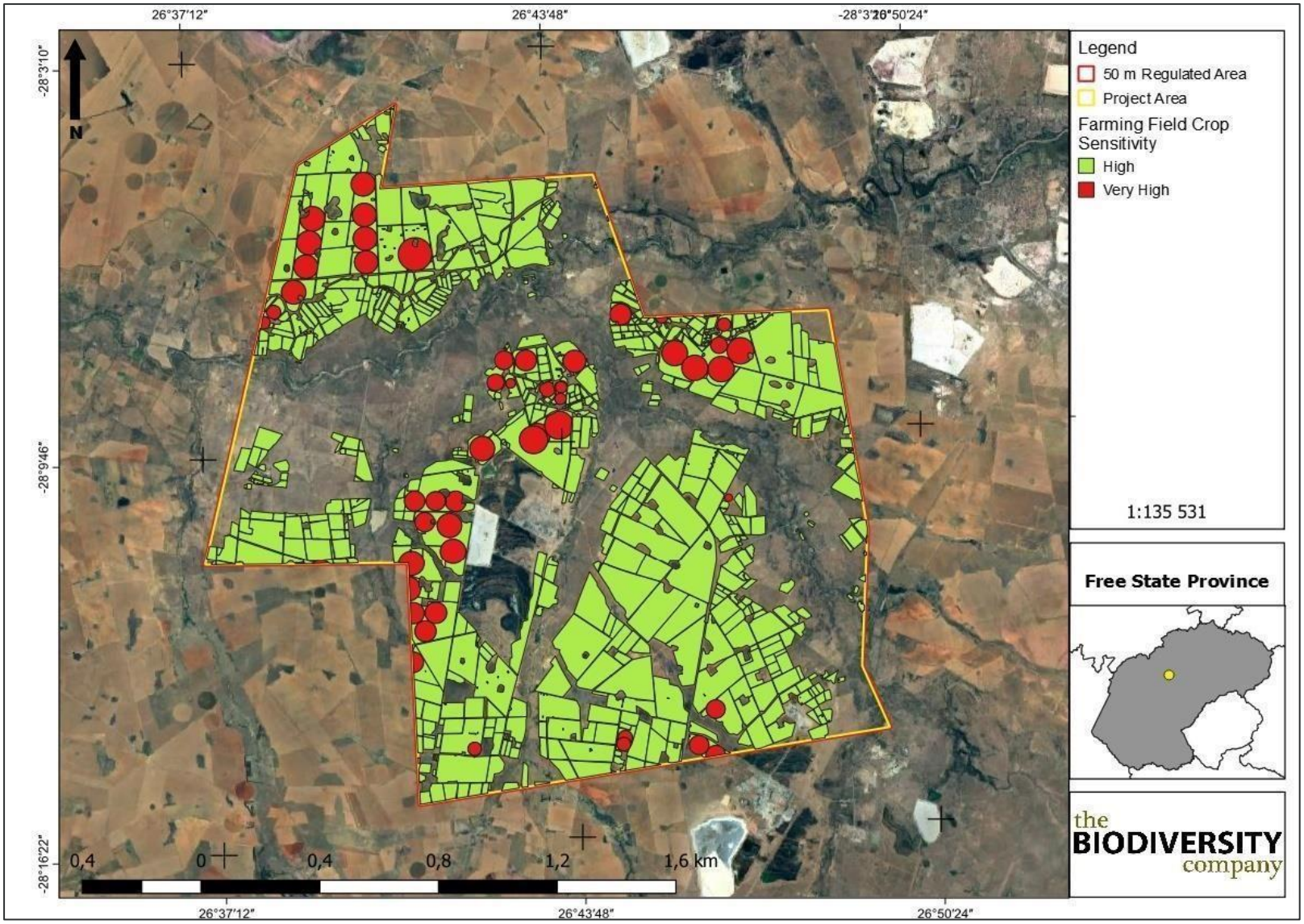


Figure 72: Farming Field crop Sensitivity (DEA, 2022).

9.8 HYDROLOGY AND FLOODLINES

The application area is located within the 42K, 42L and 43K quaternary catchment areas as defined by Water Resources of South Africa, 2005 study (WR 2005). The main drainage features traversing the application area include the Bosluisspruit River, Doring River and the Sand River, of which the Sand River is the major system originating in the east and draining south-west past Welkom and the Project site.

Based on the observations made from Google Earth Pro satellite imagery (Google Earth, 2022) and the site visit that was conducted on the 13th of April 2022 by the Hydrological specialist (SMEC South Africa), the application area comprises mostly of farmlands with some bush areas in-between. In general, based on the available topographic survey data, the application area is generally flat (<10% slope). According to the "SANRAL Drainage Manual, 6th Edition", the soils in the application area have a moderately low to moderately high internal drainage capacity and generalised SCS soil grouping classification for South Africa. Soils that are well drained produce a lower stormflow response than poorly drained soils.

The delineation of catchment areas draining to the above-mentioned rivers was undertaken using the topography of the area defined by SRTM DEM data. A catchment area is generally defined as that area from which all rainfall will drain into a drainage system through surface flow, to a common point.

The focus of the reporting on this section is on the major points of the major rivers, however, the application area has multiple small tributaries that drain into the major rivers at multiple points along the major rivers; these were individually considered as flow change locations in the river modelling so that the peak flow at the downstream end of a river doesn't represent the entire river. The catchment areas are shown in Figure 73.

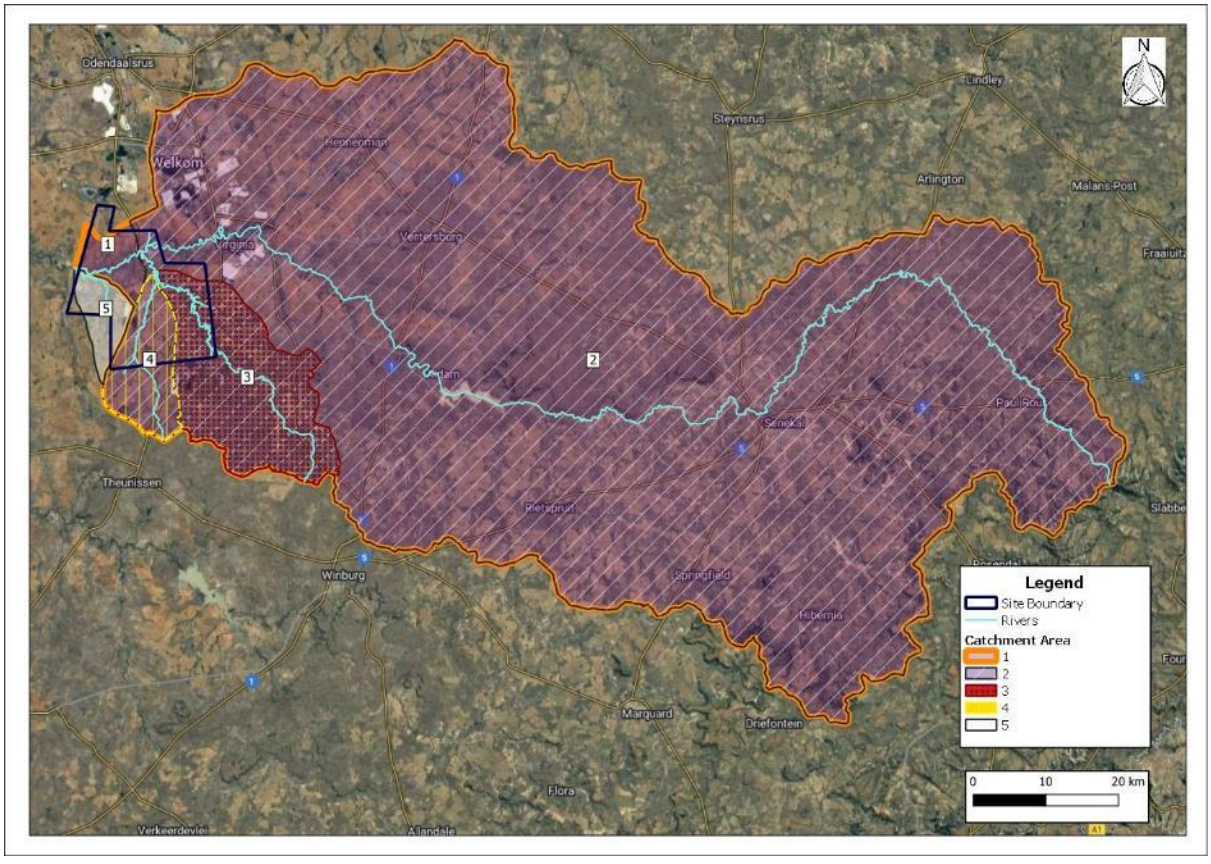


Figure 73: Catchment areas.

The physical properties of the various catchment areas shown in Figure 73 are summarized in Table 27.

Table 27: Catchment Area Physical Properties.

Description	Unit	1	2	3	4	5
Size of Catchment Area	km²	7118	7054	442	155	68
Hydraulic length of Catchment	km	251	217	58	29	20
Average Stream Slope	m/m	0.0013	0.0012	0.0032	0.0055	0.0079

The following methodology was used in the hydrological analysis to determine flood peaks:

- Five flood estimation methods were selected as relevant to the catchment areas under consideration, being the Standard Design Flood Method (SDF), Rational Method (RM), Alternative Rational Method (ARM), Unit Hydrograph Method (UHM) and the Empirical Method developed by Midgley and Pitman.
- Table 3.2 from the SANRAL Drainage Manual shown in Figure 74 indicates the applications and limitations of the flood estimation methods.
- Input data for these methods was developed as follows:
    - Design rainfall depths were obtained from Water Research Commission Project Number K5/1060 (2002) for Welkom/Sandvet Station (South African Weather Bureau (SAWB) Number 0328308A) for the majority of small catchment areas inside the project area. For the larger catchment areas (1 and 2) that fall within multiple rainfall stations, an average of the MAPs was considered using the arithmetic mean method.
    - The considered rainfall stations are:
        - Paul Roux (SAWB No. 0330797W) with MAP of 614mm;
        - Senekal (SAWB No. 0553762 W) with MAP of 625mm;
        - Ventersberg (SAWB No. 0329215W) with MAP of 546mm; and
        - Welkom/Sandvet (SAWB No. 0328308A) with MAP of 496mm.

        These stations have an average record of 80 years between them.
    - The catchment area was delineated using the 30 m SRTM DEM topographical data, using QGIS software.
    - The project area is located in SDF Basin number 7, Veld type zone 4 and Kovács region K4.
    - The design flood peaks for various return periods were then estimated for both methods using the above inputs. The Utility Programs for Drainage Software (from University of Pretoria) was used to calculate the flood peaks. The program was developed specifically for South African rainfall conditions.

Method	Input data	Recommended maximum area (km²)	Return period of floods that could be determined (years)	Reference paragraph
Statistical method	Historical flood peak records	No limitation (larger areas)	2 – 200 (depending on the record length)	3.4
Rational methods	Catchment area, watercourse length, average slope, catchment characteristics, design rainfall intensity (3 alternative methods)	Usually < 15, depends on method of calculating rainfall intensity	2 – 200, PMF	3.5.1
Unit Hydrograph method	Design rainfall, catchment area, watercourse length, length to catchment centroid (centre), mean annual rainfall, veld type and synthetic regional unit hydrographs	15 to 5000	2 – 100, PMF	3.5.2
Standard Design Flood method	Catchment area, watercourse length, slope and SDF basin number	No limitation	2 – 200	3.5.3
SCS-SA method	Design rainfall depth, catchment area, Curve Number=f(soils, land cover), catchment lag	< 30	2 - 100	3.5.4
Empirical methods	Catchment area, watercourse length, distance to catchment centroid, mean annual rainfall	No limitation (larger areas)	10 – 100, RMF	3.6

Figure 74: Table 3.2 extracted from the SANRAL Drainage Manual.

The peak flows used for floodline determination were calculated using 5 standard methods applied in South Africa as described in the Hydrological Specialist Report included in Appendix 4. Based on the legislation relevant to this study, peak flows resulting from the 1:100-year event were used in floodline modelling. A summary of the calculated peak flows (before and after Climate Change), for the various catchment areas (Figure 73) are presented below and are based on the calculations and inputs indicated in the Hydrological Specialist Report included in Appendix 4.

Table 28: 1:100-year Peak Flow Rates (m^3/s) – before and after climate change impacts

Flood Estimation	Peak Flowrates (m^3/s)				
	1	2	3	4	5
Standard Design Flood (before Climate Change)	3045	3022	745	502	325
Standard Design Flood (after Climate Change)	4456	4402	1088	733	475

The baseline climatic conditions as well as future climate conditions based on projected climate change were considered in the modelling of the 1:100 year floodlines (refer to Hydrological specialist report in Appendix 4 for detail on the climate change considerations). Floodline modelling was undertaken to determine the 1:100-year floodlines (baseline and climate change adjusted) for the major rivers within the application area. The 1:100-year floodlines (including and excluding climate change projections) are indicated in Figure 75 and the floodlines are considered the regulated area of a watercourse in which any activities will require the requisite water use authorisations. As can be seen in Figure 75, the variation between the baseline floodline projection compared to the climate change projection is minimal and therefore there are no changes required to the impact assessment or water use licencing requirements.

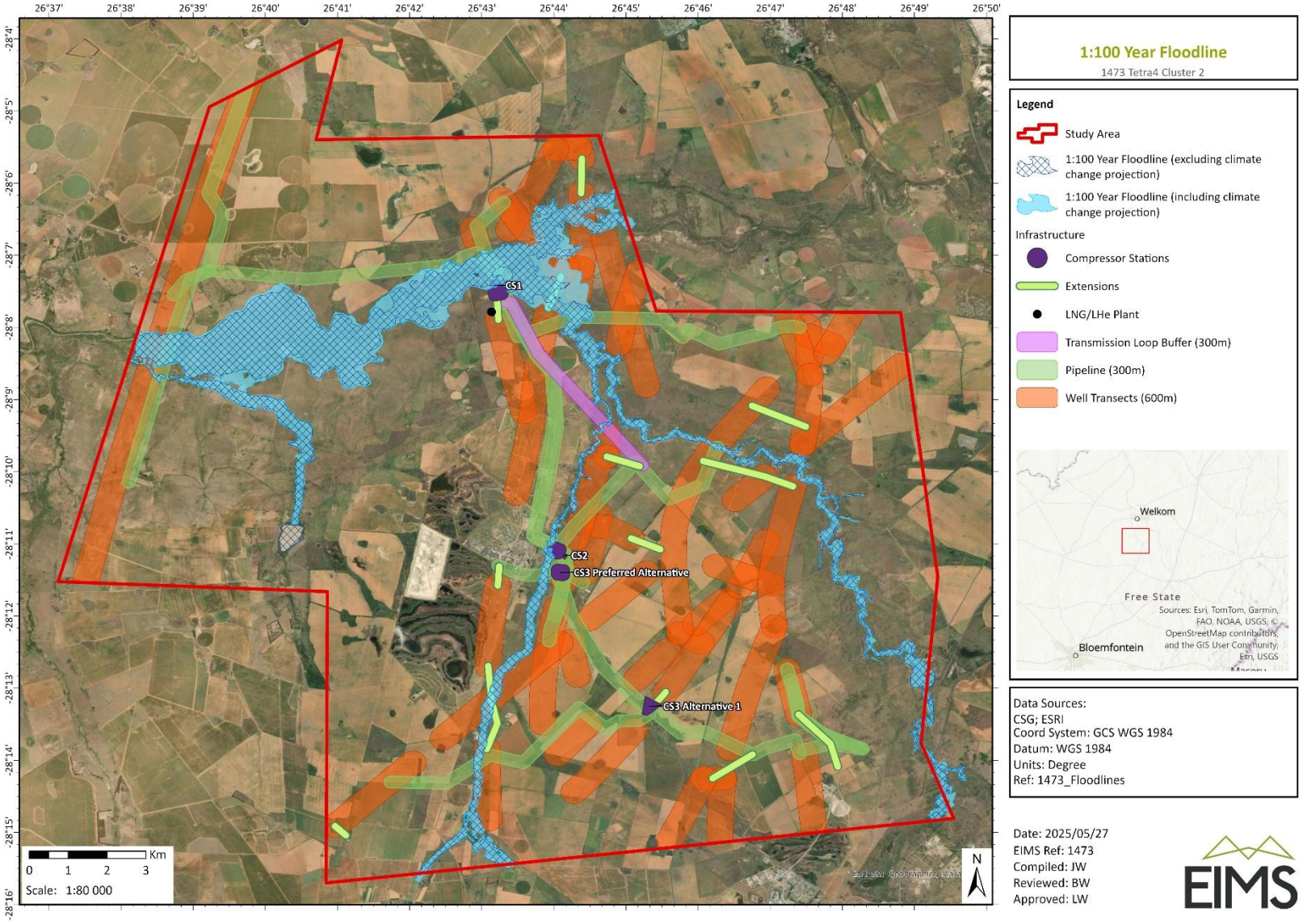


Figure 75: 1:100-year floodlines showing the extent of floodlines including and excluding climate change projections.

9.9 GEOLOGICAL SETTING

The following sections summarises the regional and local geology.

9.9.1 REGIONAL GEOLOGY

Although the project area's surficial geology comprises mostly aeolian sands, quaternary deposits and isolated outcrops of the Karoo Supergroup i.e., dolerite and sandstone/ shales, the greater study area is generally also underlain by rocks of the Witwatersrand Supergroup as well as the Ventersdorp Supergroup. The primary source of gas originates from the Witwatersrand Supergroup as well as the shallower Karoo sediments (Lea, 2017). Figure 76 represents a regional geological cross section (Shango, 2016). It can be inferred from exploration borehole geological logs that the estimated depth of the unconsolidated material on-site is approximately 11.0m (Lea, 2017).

The Witwatersrand Supergroup is a sedimentary deposition across the stable granite-gneiss basement which commenced around 3 billion years ago. In stratigraphic terms the Witwatersrand sequence is divided into two divisions, the lower dominantly marine, slate rich West Rand Group and the upper dominantly alluvial sandstone rich Central Rand Group (Johnson, 2006). The Witwatersrand Supergroup depth within the study area was inferred from exploration borehole geological logs and is estimated at an average depth of >1600.0mbgl (Lea, 2017).

The Ventersdorp Supergroup uncomfortably overlies the Witwatersrand Supergroup. This Group is very thick, more than 4500.0m. The lower Kliprivierberg Group is mafic lava and tuff while the upper Platberg Group is conglomerates and breccia on top of Kliprivierberg, with intermediate and felsic lava higher, with quartzite, shale and siltstone layers in between (Johnson, MR. Anhauser, CR., Thomas, RJ., 2006). The Ventersdorp Supergroup depth within the study area was inferred from exploration borehole geological logs and is estimated at an average depth of >1120.0mbgl. Gas will be extracted from deep-seated fracture zones associated with the Ventersdorp lavas and Witwatersrand quartzites (Lea, 2017).

The Karoo Super Group is the largest stratigraphic unit in Southern Africa covering almost two thirds of the land surface. The supergroup consists of a sequence of units, mostly of nonmarine origin, deposited between the Late Carboniferous and Early Jurassic, a period of about 120 million years. The Karoo Supergroup consist of argillaceous rocks of the Beaufort Group i.e. lower Adelaide Subgroup (Late Permian) and an upper Tarkastad Subgroup, the Permian Ecca Group which consist largely of shales and sandstones as well as the Dwyka Group (Late Carboniferous to Early Permian) which consists mainly of diamictite (tillite). The Ecca Group underlies the Beaufort Group in all known outcrops and exposures and follows conformably after the Dwyka Group in certain sections, however in some localities overlies unconformably over older basement rocks (Schlüter and Thomas, 2008). The Karoo Supergroup (which include the Beaufort as well as Ecca Groups) depth within the study area was inferred from exploration borehole geological logs and is estimated at an average depth of 300.0mbgl. Refer to Table 29 for a summary of the regional stratigraphical sequence.

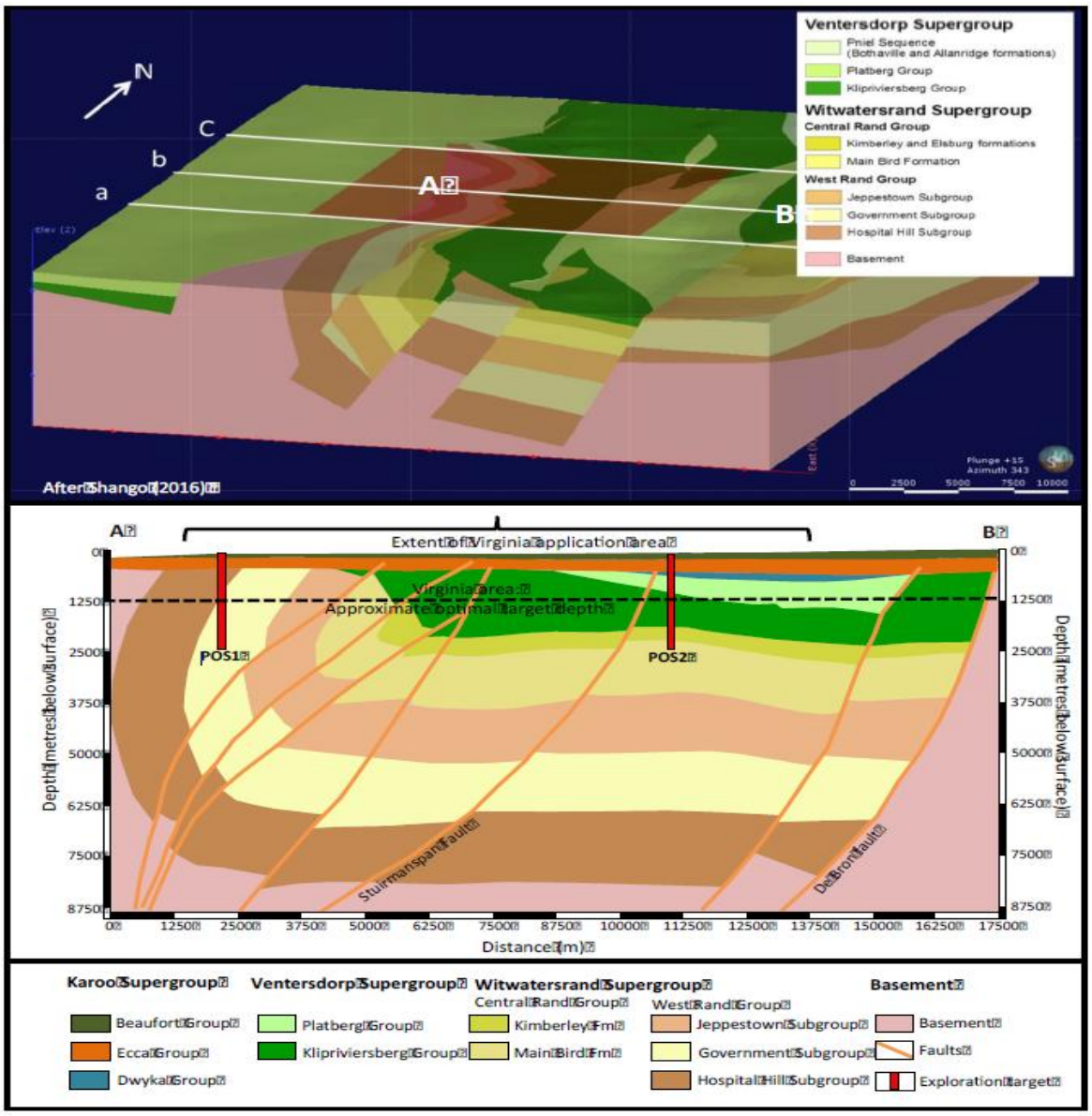


Figure 76: Cross section of the regional geology (after Shango, 2016).

Table 29: Regional stratigraphical sequence.

Lithology	Average depth (m)	Description
Aeolian sand and alluvium	8	Quaternary unconsolidated surficial calcrete, pebbles, gravel, sand and clay
Karoo Supergroup - Ecca and Beaufort Group shales and sandstones	301	Blue-grey mudstone and shale interbedded with very fine to coarse-grained sandstone. Subordinate conglomerate may be present
Dolerite (Sill)	335	Karoo-age dolerite sills and dykes
Karoo Supergroup – Ecca and Dwyka Tillite in places	437	Glaciated bedrock including tillite, diamictite, sandstone, mudstone and conglomerates.
Ventersdorp Supergroup Lava	805	Volcanic and sedimentary deposits, unconformibly overlain on the Witwatersrand Supergroup. The Klipriviersberg Group comprises lava and tuff, while the Platberg Group consists of clastic and chemical sediments.

Witwatersrand Supergroup Quartzite	1130	Quartzite, conglomerate and subordinate shale that hosts gold-bearing reefs. Central Rand Group quartzites are prevalent in the project area.

Notes: Lithology descriptions after *i*LEH (2017)

9.9.2 LOCAL GEOLOGY

According to the 1:250 000 geological maps (2826: Winburg), a large portion of the study area's surficial geology comprises aeolian sands and quaternary deposits as shown in Figure 77. Isolated patches within the study area are also covered by alluvial sand deposits which is mainly associated with the Sand and Doringriver floodplains and constrained by drainage patterns and riparian zones. The site is underlain by the Adelaide Subgroup (Vpa) consisting of alternating layers of bluish-grey, greenish-grey or greyish-red mudrock and grey, very fine to medium-grained, lithofeldspathic sandstone, the Vryheid Formation (Pv) which consists mainly of fine grained mudstone, carbonaceous shale with alternating and coarse grained, bioturbated immature sandstones respectively as well as the Volksrust Formation (PVo) which consists of grey to black, silty shale with thin, usually bioturbated, siltstone or sandstone lenses and beds, particularly towards its upper and lower boundaries. The Dwyka Group consists mainly of diamictite (tillite) which is generally massive with little jointing, but it may be stratified in places. Various historical and recently drilled exploration boreholes were utilised in order to gather site specific geological data (refer to Figure 78). The geological database, summarising the local stratigraphical sequence, was applied to incorporate site specific geological information into the conceptual and numerical groundwater model development as shown in Figure 79, Figure 80 and Figure 81.

9.9.3 STRUCTURAL GEOLOGY

Large dolerite intrusions in the form of dykes and sills are observed throughout the study area as depicted in Figure 88. The Karoo sediments in this portion of the WMA are much intruded by sub accordant sheets, and to a lesser extent by near-vertical dykes of Karoo dolerite (DWAF, 2004). The Karoo Basin is characterised by a vast network of post-Karoo intrusive dolerite (Jd) sills and dykes that rapidly intruded at 183.0 to 182.3Ma (Svensen et al., 2012). The intrusive Karoo dolerite suite represents a shallow feeder system which occurs as an interconnected network of dykes, sills as well as sheets which typically form resistant caps of hills compromising softer sedimentary strata (Chevallier and Woodford, 1999). Exploration data evaluated suggest dykes are relatively thin, usually not wider than 5.0m while sills may be as thick as 100.0m. On a regional scale various dykes can be observed which may have an impact on the local hydrogeological regime as it can serve as potential preferred pathways for groundwater flow and contaminant transport. Deep fault zones that will be targeted for gas production are associated with the Central Rand Group and Ventersdorp lavas.

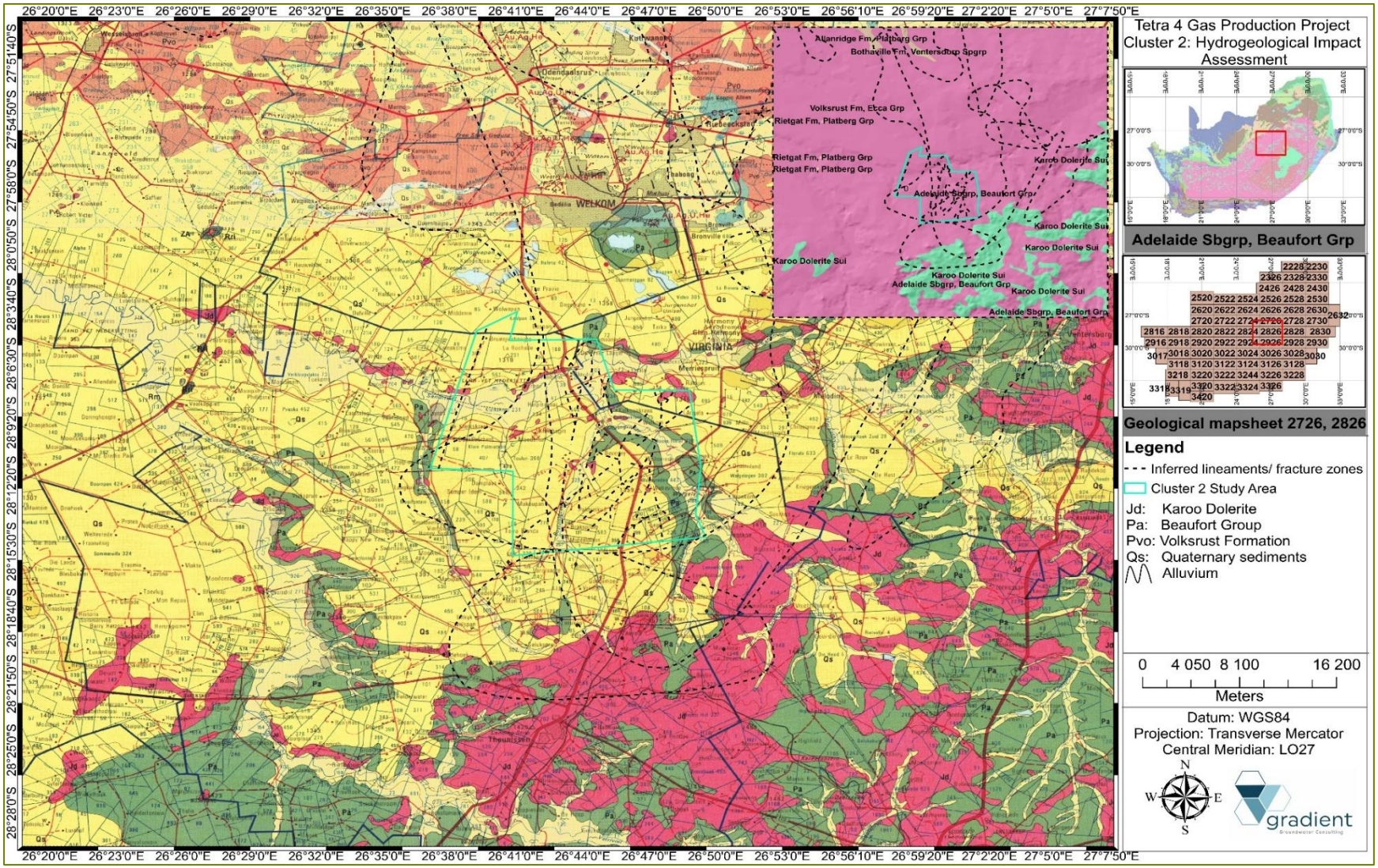


Figure 77: Regional geology and stratigraphy (Geological map sheet 2826: Winburg).

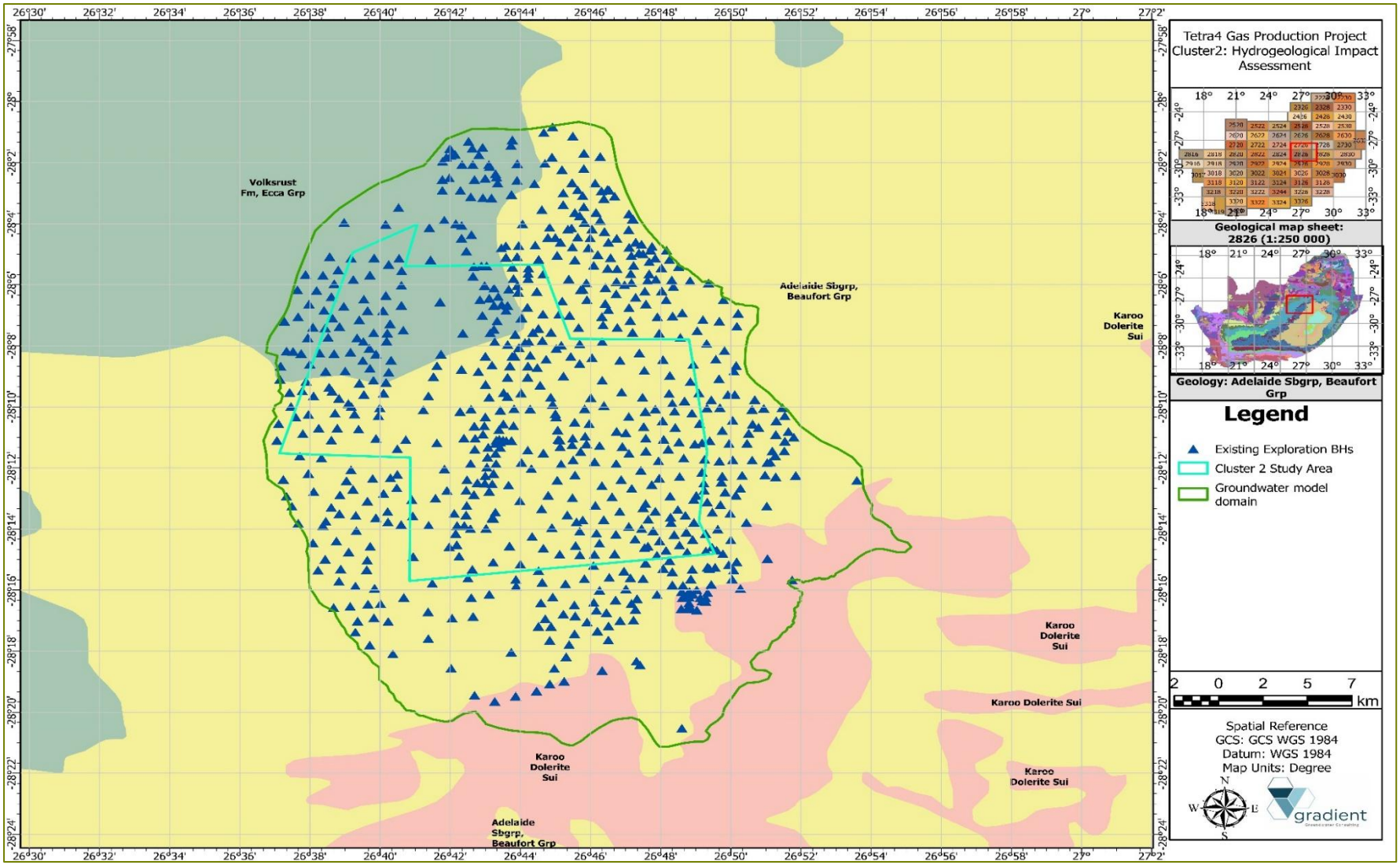


Figure 78: Spatial distribution map of regional geological exploration boreholes.

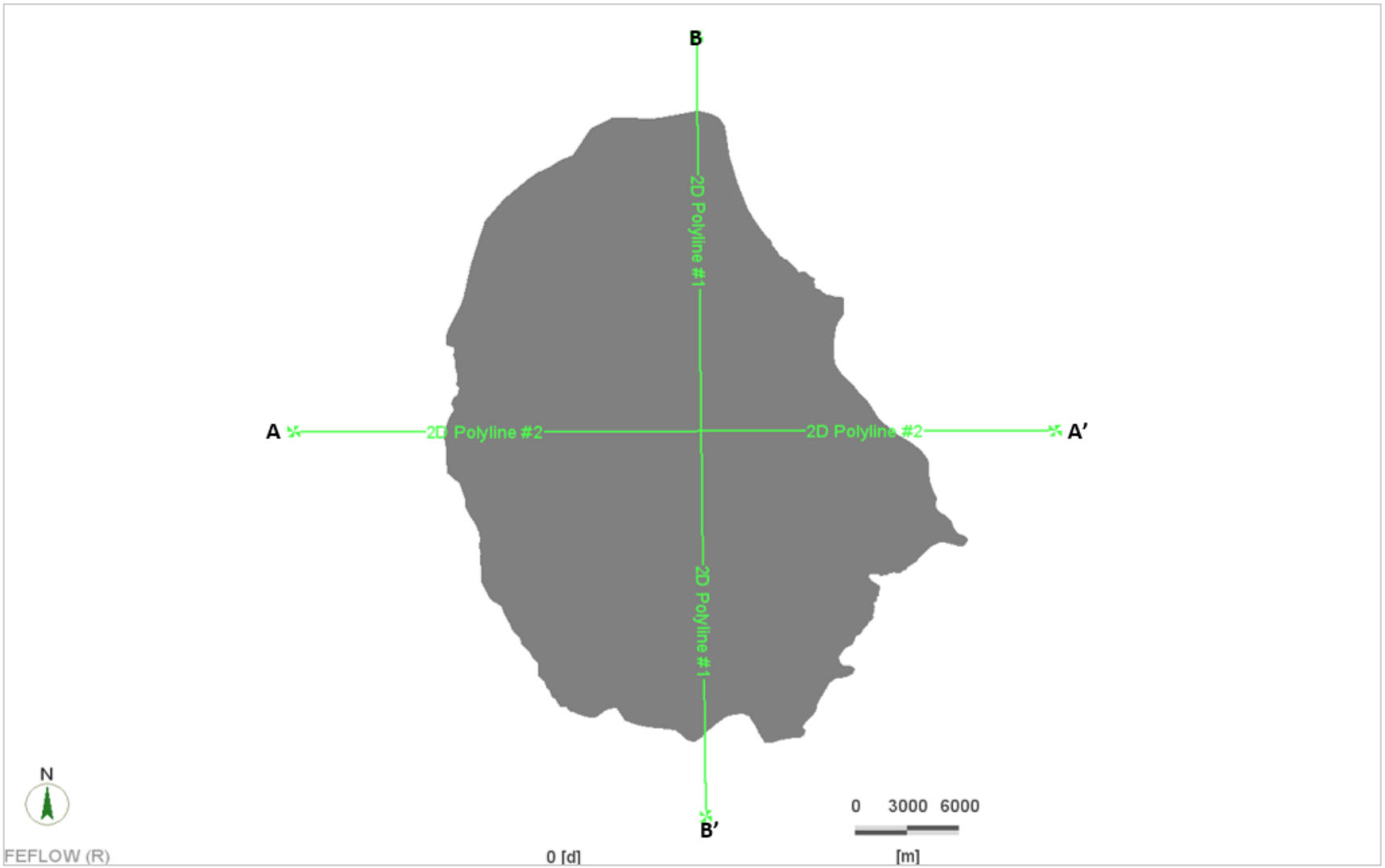


Figure 79: Plan view of the modelled domain with relevant geological cross sections.

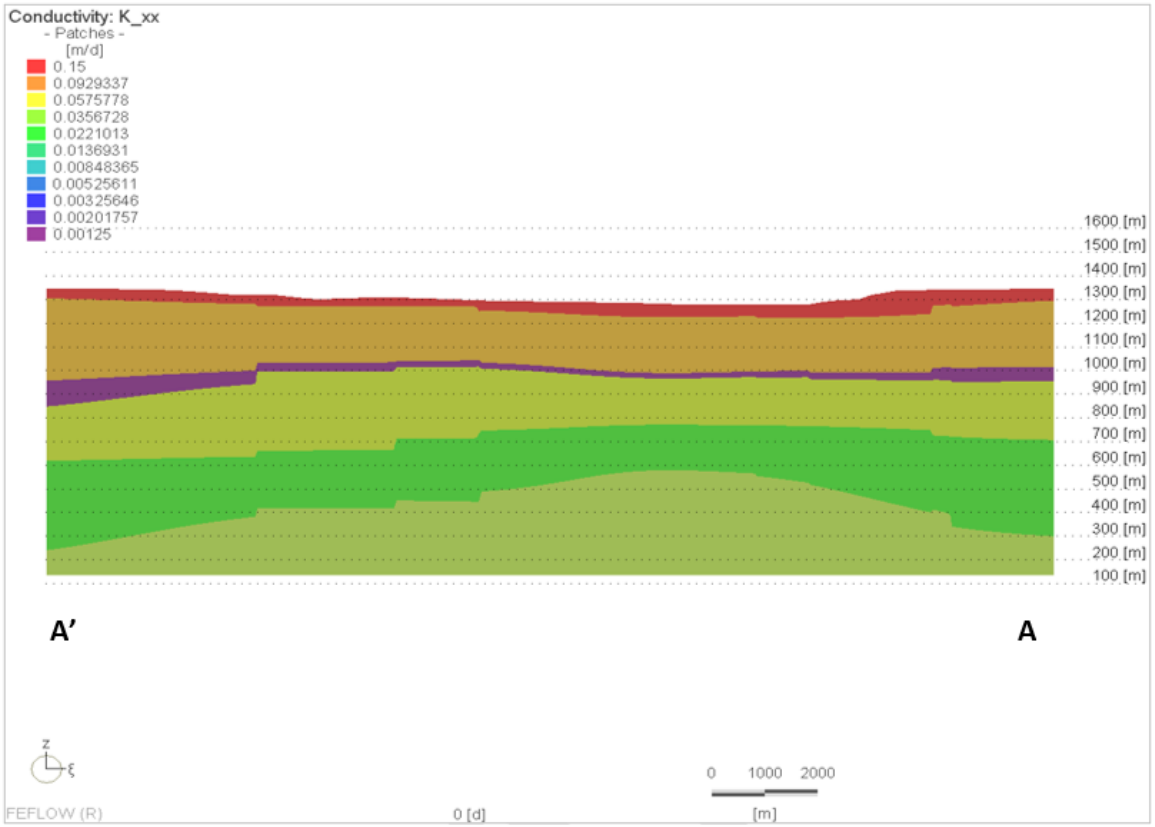


Figure 80: Model cross section A-A' depicting stratigraphical sequence.

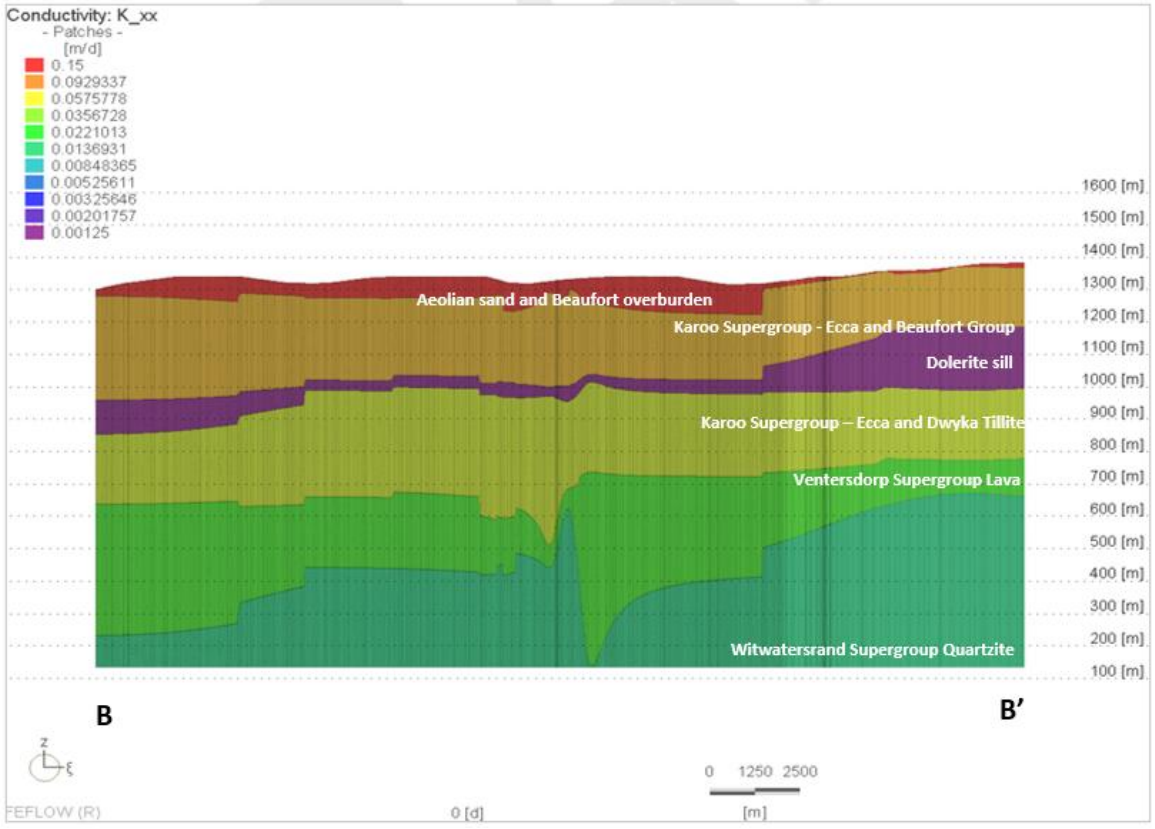


Figure 81: Model cross section B-B' depicting stratigraphical sequence (refer to Figure 5 10).

9.10 GROUNDWATER (GEOHYDROLOGY)

The groundwater (geohydrology) study was undertaken by Gradient Groundwater Consulting and the updated report which addresses the Ministers Appeal decision recommendations is included in Appendix 4. The baseline geohydrological features are presented in the subsections below.

9.10.1 HYDROCENSUS

A hydrocensus user survey within the greater study area was conducted during March 2022 as well as in October 2024 where relevant hydrogeological baseline information was gathered. The aim of the hydrocensus survey is to determine the ambient and background groundwater conditions and applications and to identify potential sensitive environmental receptors, i.e., groundwater users in the direct vicinity of the gas production operations. A total of 171 geosites were visited and recorded which include surface water and groundwater receptors i.e. boreholes, artesian wells, wind pumps as well as surface water features were visited as part of the hydrocensus user survey which are largely applied for livestock watering and domestic water supply purposes. Relevant hydrocensus information is summarised in Table 30 (2022 hydrocensus user survey) and Table 31 (2024 hydrocenus user survey). Figure 86 depicts the spatial distribution of geosites visited as part of the hydrocensus user surveys while Figure 87 indicate the various groundwater status and applications.

Of the boreholes recorded, the majority are in use (~75.0%) while ~23.0% are not currently being utilized. Approximately 2.0% of boreholes allocated could not be visited due to access challenges. Most boreholes recorded are being applied for livestock watering and domestic water supply purposes (~35.0%) while domestic and household purposes which are combined with either irrigation or livestock purposes account for >16.0%. A small number of boreholes are also being applied for either monitoring or industrial purposes (~5.0%) while ~27.0% of boreholes do not have an application and are not currently being utilized. Refer to Figure 84 for a summary of groundwater applications. According to the Middle Vaal ISP (DWAF, 2004), most boreholes are being applied for irrigation and small-town water supply.

Most boreholes visited are equipped with submersible pumps and account to 54.0%, while 18.0% of boreholes were fitted either with a wind pump, mono pump (2.0%), handpump (1.0%) or solar pump (1.0%). An average of 22.0% of boreholes are not equipped as indicated in Figure 85.

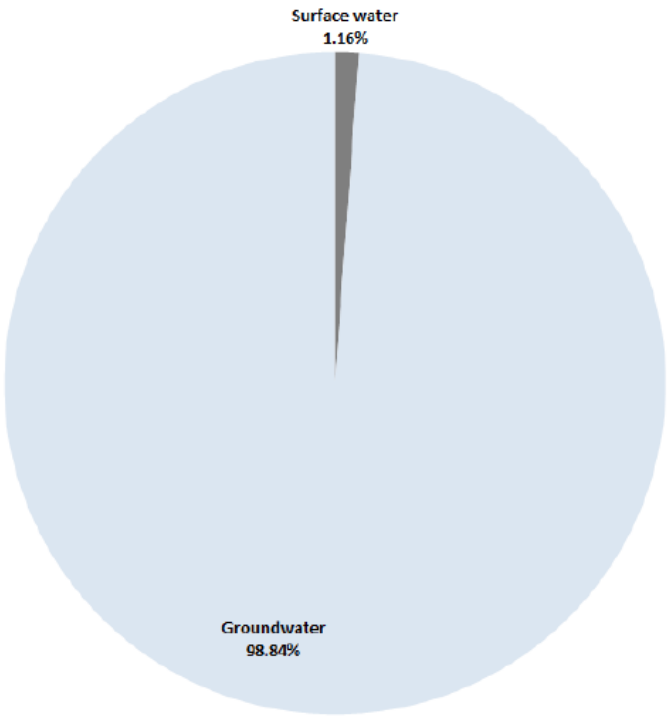


Figure 82: Hydrocensus user survey: Geosite type.

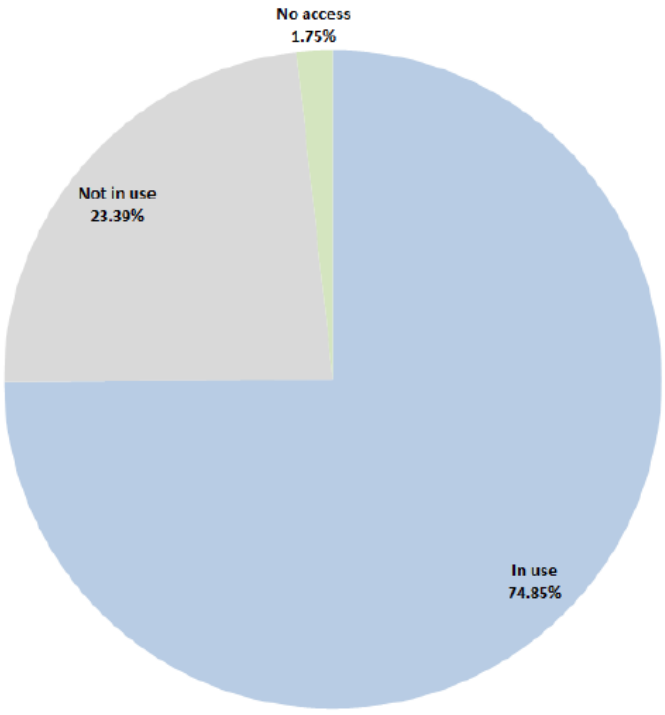


Figure 83: Hydrocensus user survey: Groundwater status.

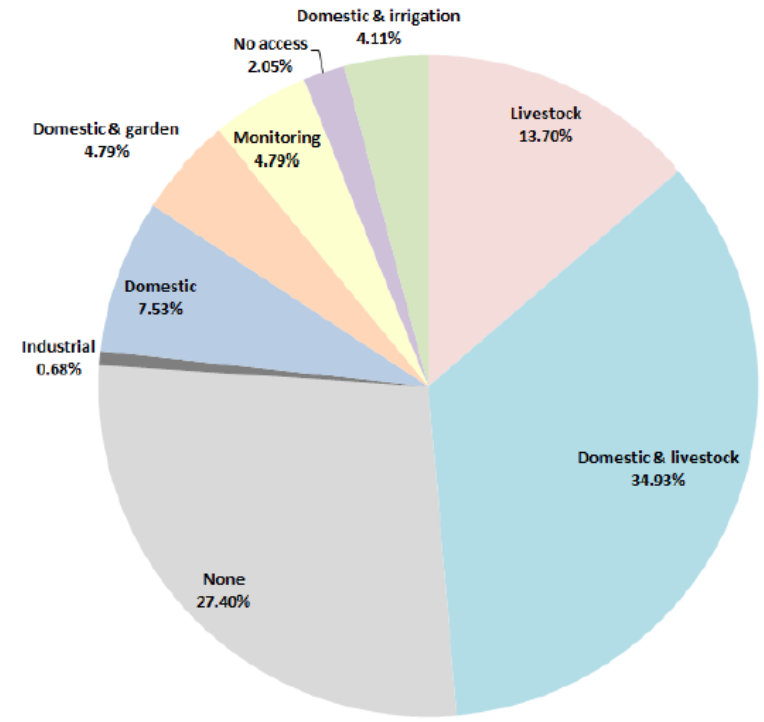


Figure 84: Hydrocensus user survey: Groundwater application.

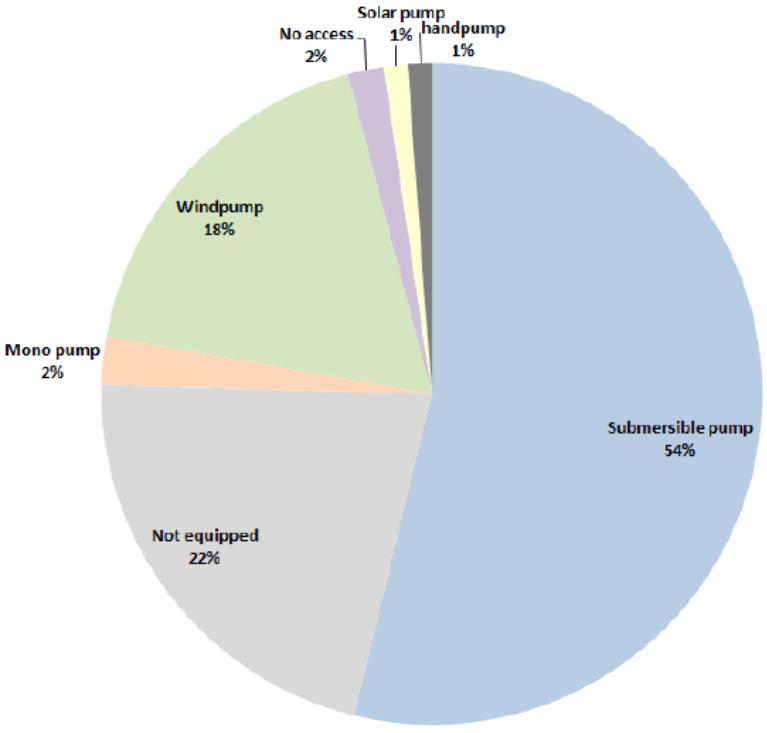


Figure 85: Hydrocensus user survey: Equipment type.

Table 30: Hydrocensus user survey: relevant information for geosites visited as part of the 2022 survey.

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
HBH1	-28.14362	26.80863	NAWL		Borehole	In use	Submersible pump		Livestock	Flooded Area
HBH2	-28.12872	26.80516	NAWL		Borehole	In use	Windpump		Domestic & livestock	
HBH3	-28.12768	26.80522	NAWL		Borehole	In use	Submersible pump		Domestic & livestock	ROCLA
HBH4	-28.12407	26.80630	NAWL		Borehole	In use	Submersible pump		Domestic & livestock	ROCLA
HBH5	-28.11982	26.80036	NAWL		Borehole	In use	Submersible pump		Domestic & livestock	ROCLA
HBH6	-28.12005	26.79521	1.52	30	Borehole	In use	Submersible pump		Domestic & garden	
HBH7	-28.12940	26.77388	NAWL		Borehole	Not in use	No access		None	Blocked
HBH8	-28.15651	26.79403	NAWL		Borehole	In use	Submersible pump		Livestock	
HBH9	-28.15477	26.78428	10.87	30	Borehole	In use	Submersible pump		Livestock	
HBH10	-28.11906	26.81375	NAWL		Borehole	In use	Submersible pump		Industrial	ROCLA
HBH11	-28.11540	26.81199	NAWL		Borehole	In use	Submersible pump		Domestic	
HBH12	-28.13337	26.76153	13.65	30	Borehole	In use	Submersible pump		Domestic & livestock	
HBH13	-28.13200	26.76094	12.35	70	Borehole	In use	Submersible pump		Domestic & livestock	
HBH14	-28.12823	26.75381	16.65		Borehole	In use	Submersible pump		Domestic & livestock	
HBH15	-28.12852	26.75373	17.74		Borehole	In use	Submersible pump		Domestic & livestock	
HBH16	-28.13105	26.75641	25.40	45	Borehole	In use	Submersible pump		Domestic & livestock	
HBH17	-28.12700	26.75455	11.55	40	Borehole	In use	Submersible pump		Domestic & livestock	
HBH18	-28.13405	26.75741	16.47	40	Borehole	Not in use	Not equipped		None	Open
HBH19	-28.13356	26.75760	NAWL		Borehole	In use	Submersible pump		Domestic & livestock	
HBH20	-28.08584	26.75406	1.10	70	Borehole	In use	Submersible pump		Domestic & livestock	
HBH21	-28.09424	26.73133	2.67		Borehole	Not in use	Not equipped		None	Open
HBH22	-28.11837	26.71244	NAWL		Borehole	Not in use	Not equipped		None	Closed
HBH23	-28.10725	26.70513	3.16	18	Borehole	Not in use	Not equipped		None	Open
HBH24	-28.11683	26.70197	8.50		Borehole	In use	Submersible pump		Domestic & livestock	
HBH25	-28.11792	26.68013	24.20		Borehole	In use	Submersible pump		Domestic & livestock	
HBH26	-28.12714	26.65699	NAWL		Borehole	Not in use	Not equipped		None	Closed
HBH27	-28.12845	26.65437	1.40		Borehole	In use	Submersible pump		Domestic & livestock	
HBH28	-28.06977	26.66653	5.02	40	Borehole	In use	Submersible pump		Domestic	
HBH29	-28.07050	26.66551	NAWL		Borehole	In use	Mono pump		Livestock	
HBH30	-28.07475	26.67059	NAWL		Borehole	In use	Submersible pump		Livestock	
HBH31	-28.10189	26.64343	0.00		Borehole	In use	Not equipped		Domestic & garden	Artesian
HBH32	-28.09055	26.65710	NAWL		Borehole	In use	Mono pump		Domestic & garden	

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
HBH33	-28.11279	26.63522	15.70		Borehole	In use	Submersible pump		Domestic & garden	
HBH34	-28.12682	26.69912	26.04	60	Borehole	In use	Submersible pump		Domestic & livestock	
HBH35	-28.11991	26.69965	3.70	20	Borehole	In use	Submersible pump		Domestic & garden	
HBH36	-28.06441	26.66184	2.66	18	Borehole	In use	Submersible pump		Domestic & garden	
HBH37	-28.06606	26.66227	3.18	20	Borehole	In use	Submersible pump		Domestic & garden	
HBH38	-28.18060	26.64045	2.94	50	Borehole	In use	Submersible pump		Livestock	
HBH39	-28.16963	26.63504	8.26	40	Borehole	In use	Submersible pump		Domestic & livestock	
HBH40	-28.16964	26.63456	8.75	16	Borehole	Not in use	Not equipped		None	Open
HBH41	-28.14747	26.72413	NAWL	80	Borehole	In use	Submersible pump		Domestic & irrigation	
HBH42	-28.14750	26.72416	NAWL	80	Borehole	In use	Submersible pump		Domestic & irrigation	
HBH43	-28.15102	26.72540	NAWL		Borehole	Not in use	Not equipped		None	No access
HBH44	-28.15038	26.72384	8.46	50	Borehole	In use	Submersible pump		Domestic & livestock	
HBH45	-28.15055	26.72382	8.40	50	Borehole	In use	Submersible pump		Domestic & livestock	
HBH46	-28.14817	26.72182	14.50		Borehole	In use	Submersible pump		Domestic & livestock	
HBH47	-28.14472	26.73037	NAWL		Borehole	In use	Solar pump		Domestic & livestock	
HBH48	-28.17827	26.74558	11.03		Borehole	In use	Submersible pump		Domestic & livestock	
HBH49	-28.17886	26.74621	7.12		Borehole	In use	Submersible pump		Domestic & livestock	
HBH50	-28.18372	26.74679	NAWL		Borehole	In use	No access		Domestic & livestock	No access
HBH51	-28.19216	26.72884	NAWL		Borehole	In use	No access		Monitoring	No access
HBH52	-28.18767	26.73012	1.08	10	Borehole	In use	Not equipped		Monitoring	Open
HBH53	-28.18655	26.73110	2.80	5	Borehole	In use	Not equipped		Monitoring	Open
HBH54	-28.24539	26.71029	7.98		Borehole	In use	Submersible pump		Domestic & livestock	
HBH55	-28.24598	26.71291	NAWL		Borehole	In use	Submersible pump		Domestic & livestock	
HBH56	-28.21266	26.69929	1.79	30	Borehole	Not in use	Not equipped		None	Open
HBH57	-28.25142	26.74366	NAWL		Borehole	Not in use	Not equipped		None	Blocked
HBH58	-28.25125	26.74377	7.95		Borehole	In use	Submersible pump		Domestic & livestock	
HBH59	-28.25111	26.74382	8.35		Borehole	In use	Submersible pump		Domestic & irrigation	
HBH60	-28.24983	26.74353	12.90		Borehole	In use	Submersible pump		Domestic & irrigation	
HBH61	-28.24970	26.74315	12.55		Borehole	In use	Submersible pump		Domestic & irrigation	
HBH62	-28.22459	26.80767	12.70	30	Borehole	In use	Windpump		Livestock	
HBH63	-28.20166	26.78398	NAWL		Borehole	In use	Windpump		Livestock	
HBH64	-28.21076	26.78479	NAWL		Borehole	No access	Windpump		No access	
HBH65	-28.21203	26.79141	NAWL		Borehole	No access	Windpump		No access	
HBH66	-28.21220	26.78951	NAWL		Borehole	No access	Windpump		No access	

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
HBH67	-28.21859	26.75478	NAWL		Borehole	Not in use	Not equipped		None	Open. Bees.
HBH68	-28.22435	26.75422	NAWL		Borehole	In use	Windpump		Domestic & livestock	
HBH69	-28.22273	26.75010	1.67		Borehole	In use	Submersible pump		Domestic & livestock	
HBH70	-28.22878	26.74097	3.10		Borehole	In use	Windpump		Domestic & livestock	
HBH71	-28.19508	26.74163	NAWL		Borehole	In use	Windpump		Domestic & livestock	
HBH72	-28.19312	26.73970	1.75		Borehole	Not in use	Not equipped		None	Open
HBH73	-28.19301	26.73964	1.63		Borehole	In use	Mono pump		Domestic & livestock	
HBH74	-28.22959	26.80025	NAWL		Borehole	In use	Windpump		Domestic & livestock	
HBH75	-28.23077	26.80533	NAWL		Borehole	In use	Windpump		Domestic & livestock	
HBH76	-28.09771	26.73687	NAWL		Borehole	Not in use	Handpump		None	
SRD	-28.12263	26.70925	N/A		Surface water	N/A	N/A		N/A	Sandrivier downstream point
SRU	-28.10651	26.73623	N/A		Surface water	N/A	N/A		N/A	Sandrivier upstream point

Notes:
N/A: Not applicable
NAWL: No access to water level
****Contact details for relevant landowners have been recorded, however this information will be made available on request as it is protected by the Protection of Personal Information Act, 2013 (POPIA)**

Table 31: Hydrocensus user survey: relevant information for geosites visited as part of the 2024 survey.

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
HBH 161	-28.08858	26.73558	2.20		Borehole	In Use	Mono pump		Domestic	
HBH 159	-28.08745	26.73073	8.04		Borehole	In Use	Windpump		Domestic & livestock	
HBH 190	-28.07487	26.67060	3.36		Borehole	In Use	Submersible pump		Domestic	Automatic Float Switch / Pump 24/7 during planting season - Pivot
HBH 191	-28.07050	26.66555	4.11		Borehole	In Use	Submersible pump		Domestic	Pump 1 x pd for 7-5 h
HBH 186	-28.07994	26.66407	6.20		Borehole	In Use	Submersible pump		Irrigation	Automatic Float Switch / Pump 24/7 during planting season - Pivot
HBH 188	-28.07389	26.69870	3.69		Borehole	Not in Use	Not Equipped		None	Possible Collapsed

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
HBH 187	-28.07589	26.71036	NAWL	5.85	Borehole	Not in Use	Submersible pump		None	
HBH 192	-28.07726	26.71039	6.19		Borehole	In Use	Windpump		Domestic	
HBH 185	-28.07550	26.71388	8.10	30	Borehole	In Use	Solar pump		Domestic	Solar pump.
HBH 193	-28.07540	26.71435	8.61	80	Borehole	Not in Use	Not Equipped		None	
HBH 199	-28.12519	26.64163	6.44		Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1x pd for 3h - 25000 to 30000 L pd
HBH 180	-28.12453	26.64343	10.00	32.53	Borehole	Not in Use	Not Equipped		None	
HBH 181	-28.12470	26.64352	10.78	23.83	Borehole	Not in Use	Not Equipped		None	
BH 3 DDK	-28.16213	26.66035	32.61		Borehole	In Use	Windpump		Domestic & livestock	
HBH 194	-28.16296	26.65305	11.74		Borehole	In Use	Windpump		Livestock	
BH 1 DDK	-28.16716	26.66031	16.66		Borehole	In Use	Windpump		Livestock	
BH 2 KLPK	-28.17369	26.68213	5.51		Borehole	Not in Use	Not Equipped		None	
HBH 195	-28.17092	26.67996	3.86	38.15	Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1x pd for 8h
HBH 196	-28.24546	26.71033	13.15	13.85	Borehole	Not in Use	Not Equipped		None	
HBH 197	-28.24557	26.71066	14.15	18	Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1x pd for 3h
BH 2 BOS 278 0	-28.24598	26.71292	11.73	26	Borehole	In Use	Submersible pump		Domestic & irrigation	Current: Pump 1x pd for 8h Planting Season: Pump 24/7
BH 2 BOS 278 2	-28.22336	26.70576	5.22		Borehole	Not in Use	Windpump		None	Sibanye mine supply water to farmer
HBH 135	-28.22730	26.72159	42.13		Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1x pd for 3h
HBH 137	-28.22991	26.73038	NAWL		Borehole	In Use	Windpump		Livestock	
HBH 136	-28.21125	26.73142	7.19		Borehole	In Use	Windpump		Livestock	
BH MOV	-28.24672	26.76825	6.78	37.3	Borehole	Not in Use	Not Equipped		None	
HBH 149	-28.24129	26.77019	3.08	52.76	Borehole	Not in Use	Not Equipped		None	
BH 3 MVL	-28.24176	26.77052	6.78	31.8	Borehole	Not in Use	Not Equipped		None	
HBH 198	-28.11798	26.68012	19.40	49.18	Borehole	Not in Use	Not Equipped		None	
HBH 163	-28.20290	26.64291	12.21		Borehole	In Use	Submersible pump		Domestic & livestock	Current: Pump every 2nd day for livestock for 3h Planting Season: Pump 3 months per year 24/7 when planting - Pivot

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
HBH 200	-28.20139	26.65805	4.34		Borehole	In Use	Submersible pump		Irrigation	Current: Pump every 2nd day for livestock for 3h Planting Season: Pump 3 months per year 24/7 when planting - Pivot
HBH 1645	-28.22122	26.67334	6.84		Borehole	In Use	Submersible pump		Irrigation	Current: Pump every 2nd day for livestock for 3h Planting Season: Pump 3 months per year 24/7 when planting - Pivot
HBH 201	-28.16963	26.63507	8.96	30	Borehole	In Use	Submersible pump		Domestic & livestock	
HBH 178	-28.17027	26.60951	4.41		Borehole	In Use	Submersible pump		Domestic & livestock	
HBH 166	-28.18181	26.76878	4.53	21.52	Borehole	Not in Use	Not Equipped		None	
BH 2 DDR	-28.18179	26.78140	5.39	34.1	Borehole	Not in Use	Not Equipped		None	
BH 2 DRR	-28.18186	26.78145	5.01	11.4	Borehole	Not in Use	Not Equipped		None	
BH 3 DRR	-28.18549	26.78080	5.52		Borehole	In Use	Windpump		Livestock	
BH 1 DRR	-28.19014	26.78088	8.20		Borehole	Not in Use	Windpump		None	
HBH 202	-28.18104	26.78060	13.31	44.39	Borehole	Not in Use	Not Equipped		None	
HBH 203	-28.27801	26.71489	18.13	60	Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1X pd for 5h
HBH 204	-28.27730	26.71795	8.41		Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1X pd for 5h
HBH 205	-28.31111	26.74324	NAWL		Borehole	In Use	Submersible pump		Livestock	
HBH 114	-28.30193	26.74312	NAWL		Borehole	Not in Use	Windpump		None	
HBH 125	-28.26804	26.67350	5.15		Borehole	In Use	Windpump		Livestock	
HBH 123	-28.27317	26.69540	4.69	38	Borehole	In Use	Submersible pump		Irrigation	Planting Season: Pump 1X pd for 12h - Have 2 pump in
HBH 124	-28.27297	26.69471	4.60	35	Borehole	Not in Use	Submersible pump		None	
HBH 130	-28.27903	26.69258	5.89		Borehole	In Use	Submersible pump		Irrigation	Planting Season: Pump 1X pd for 12h - Use as back up pump
HBH 129	-28.27726	26.68714	5.56	18.28	Borehole	In Use	Submersible pump		Irrigation	Planting Season: Pump 1X pd for 12H
HBH 128	-28.26253	26.69294	5.50		Borehole	In Use	Windpump		Irrigation	
HBH 127	-28.25532	26.67986	7.34		Borehole	Not in Use	Windpump		None	

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
HBH 119	-28.26786	26.70028	5.14		Borehole	In Use	Windpump		Livestock	
HBH 120	-28.26775	26.70218	13.85		Borehole	In Use	Submersible pump		Domestic	
HBH 118	-28.26952	26.70053	5.37		Borehole	In Use	Windpump		Livestock	
HBH 122	-28.26731	26.70009	6.06		Borehole	In Use	Submersible pump		Domestic & livestock	
HBH 116	-28.23821	26.71827	4.70		Borehole	Not in Use	Windpump		None	
HBH 117	-28.24192	26.73159	3.21		Borehole	In Use	Windpump		Livestock	
HBH 151	-28.25538	26.75884	6.98	44.25	Borehole	Not in Use	Not Equipped		None	
BH GLR	-28.13207	26.77029	11.58	30	Borehole	In Use	Submersible pump		Domestic	Pump 1X per week for 5H
BH 1 GLR	-28.13375	26.79048	6.55		Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1X pd for 8H
HBH 168	-28.13460	26.77929	4.95	48	Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1X pd for 4H
HBH 206	-28.13106	26.75650	15.20		Borehole	In Use	Submersible pump		Domestic & livestock	Pump 1X pd for 6H
HBH 207	-28.12670	26.75457	25.20		Borehole	In Use	Submersible pump		Domestic	Automatic Float Switch
HBH 208	-28.13339	26.76155	14.93	24.28	Borehole	Not in Use	Not Equipped		None	
HBH 209	-28.13201	26.76096	11.65	35	Borehole	In Use	Submersible pump		Domestic & livestock	
HBH 210	-28.13407	26.75744	15.89	20.99	Borehole	Not in Use	Not Equipped		None	
HBH 211	-28.13360	26.75759	15.87	45	Borehole	In Use	Submersible pump		Domestic & livestock	Pump 3X per week for 4H
HBH 212	-28.12873	26.80519	9.46		Borehole	In Use	Windpump		Livestock	
BH 2 HAK	-28.13681	26.80747	6.45	24.25	Borehole	Not in Use	Not Equipped		None	
HBH 138	-28.15011	26.76916	8.86		Borehole	In Use	Windpump		Livestock	
HBH 167	-28.12028	26.80224	24.33		Borehole	Not in Use	Submersible pump		None	
HBH 213	-28.21268	26.69928	3.87	30.03	Borehole	Not in Use	Not Equipped		None	
HBH 214	-28.21028	26.60866	9.54	30	Borehole	In Use	Submersible pump		Domestic	Pump every second day for 2H
12A	-28.27250	26.74197	9.89		Borehole	In use	Equipped		Domestic & livestock	Robert have previous sample data
BH04	-28.11950	26.72231			Borehole	In use	Equipped		Domestic & livestock	Borehole also utilised for monitoring purposes
BH17C	-28.14753	26.71414	12.24	60	Borehole	In use	Equipped		Livestock	Borehole also utilised for monitoring purposes

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
AVO1	-28.09539	26.73217			Borehole	In use	Equipped		Domestic	This site was drilled by Tetra4 for use by the local community. Borehole also utilised for monitoring purposes.
BR26B	-28.10730	26.70517			Borehole	In use	Not Equipped		Monitoring	
7A	-28.15336	26.71242			Borehole	In use	Equipped		Domestic	Water is used for domestic purposes by the nearby community. Borehole also utilised for monitoring purposes
7B	-28.14756	26.72417	12.12		Borehole	In use	Equipped		Domestic	Borehole also utilised for monitoring purposes
11A	-28.19314	26.73970			Borehole	In use	Equipped		Livestock	Borehole also utilised for monitoring purposes
11B	-28.19206	26.74042			Borehole	In use	Equipped		Domestic	Borehole also utilised for monitoring purposes
OB	-28.22934	26.75741			Borehole	In use	Not Equipped		Monitoring	
15D	-28.27739	26.64169	5.71		Borehole	In use	Equipped		Livestock	Borehole also utilised for monitoring purposes
15C	-28.27614	26.64281			Borehole	In use	Equipped		Domestic	Water is used by the nearby community for domestic purposes. Borehole also utilised for monitoring purposes
15A	-28.27368	26.64421			Borehole	In use	Equipped		Domestic	Borehole also utilised for monitoring purposes
25A	-28.28703	26.74206			Borehole	In use	Equipped		Domestic & livestock	Borehole also utilised for monitoring purposes
Kal2_1	-28.17840	26.74535	7.70		Borehole	In use	Equipped		Domestic & livestock	Borehole also utilised for monitoring purposes
BH01	-28.12723	26.71919			Borehole	In use	Not Equipped		Monitoring	Borehole also utilised for monitoring purposes
MON MVDRE1	-28.12801	26.72016			Borehole	In use	Not Equipped		Monitoring	
16B	-28.14819	26.72186	13.89		Borehole	In use	Equipped		Irrigation	Borehole also utilised for monitoring purposes

Site ID	Latitude	Longitude	Water level (mbgl)	Borehole depth (mbgl)	Site type	Site status	Equipment	Property Owner**	Water application	Field notes
24A	-28.15353	26.73250	8.00		Borehole	In use	Equipped		Domestic	Borehole also utilised for monitoring purposes
24B	-28.15169	26.73694			Borehole	In use	Equipped		Livestock	Borehole also utilised for monitoring purposes
8A			7.45		Borehole	In use	Equipped		Livestock	Borehole also utilised for monitoring purposes
BH8	-28.11837	26.72098			Borehole	In use	Equipped		Domestic	Borehole also utilised for monitoring purposes

Notes:

N/A: Not applicable

NAWL: No access to water level

**** Contact details for relevant landowners have been recorded, however this information will be made available on request as it is protected by the Protection of Personal Information Act, 2013 (POPIA)**

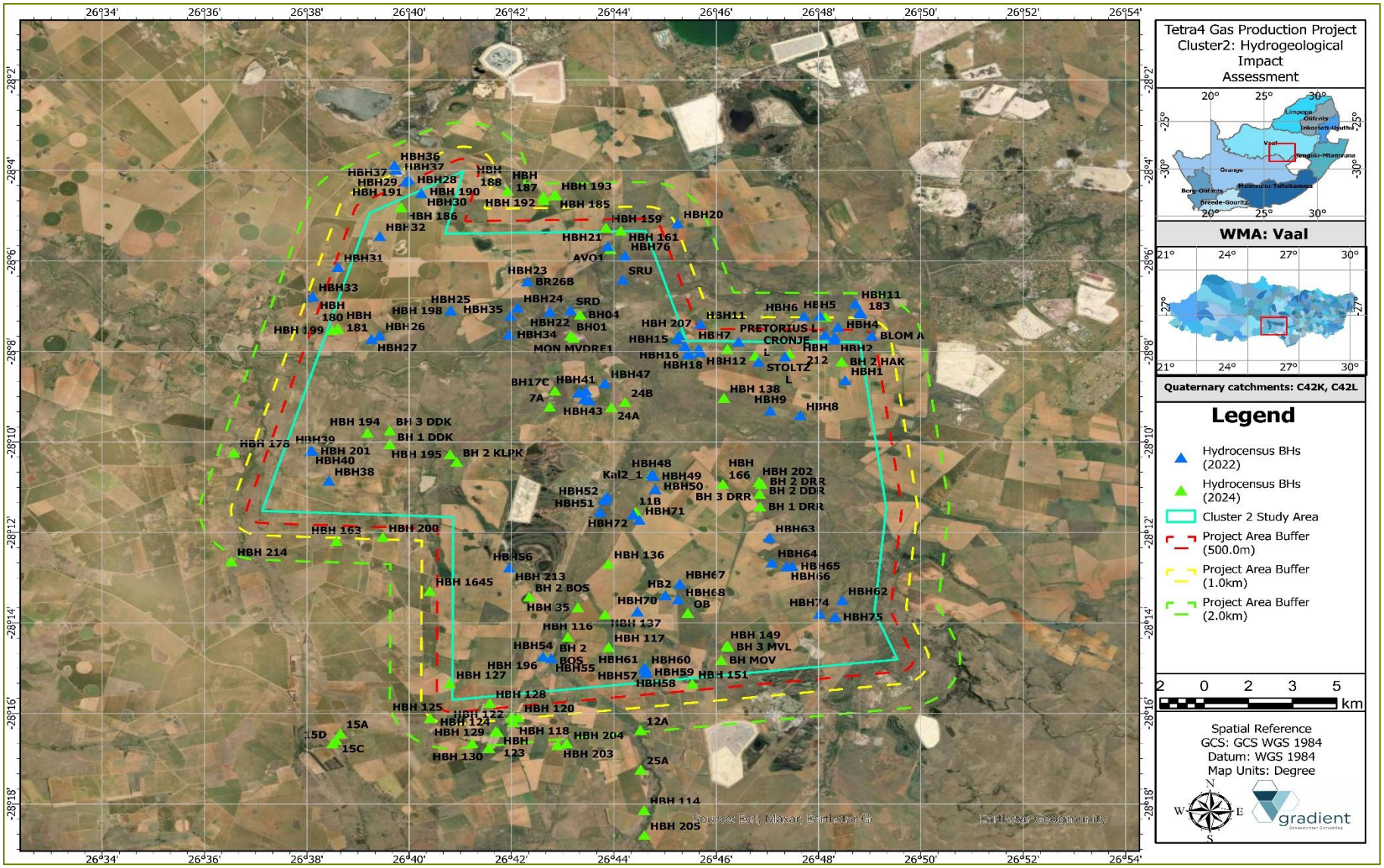


Figure 86: Spatial distribution map of the geosites visited as part of the 2022 and 2024 hydrocensus user surveys.

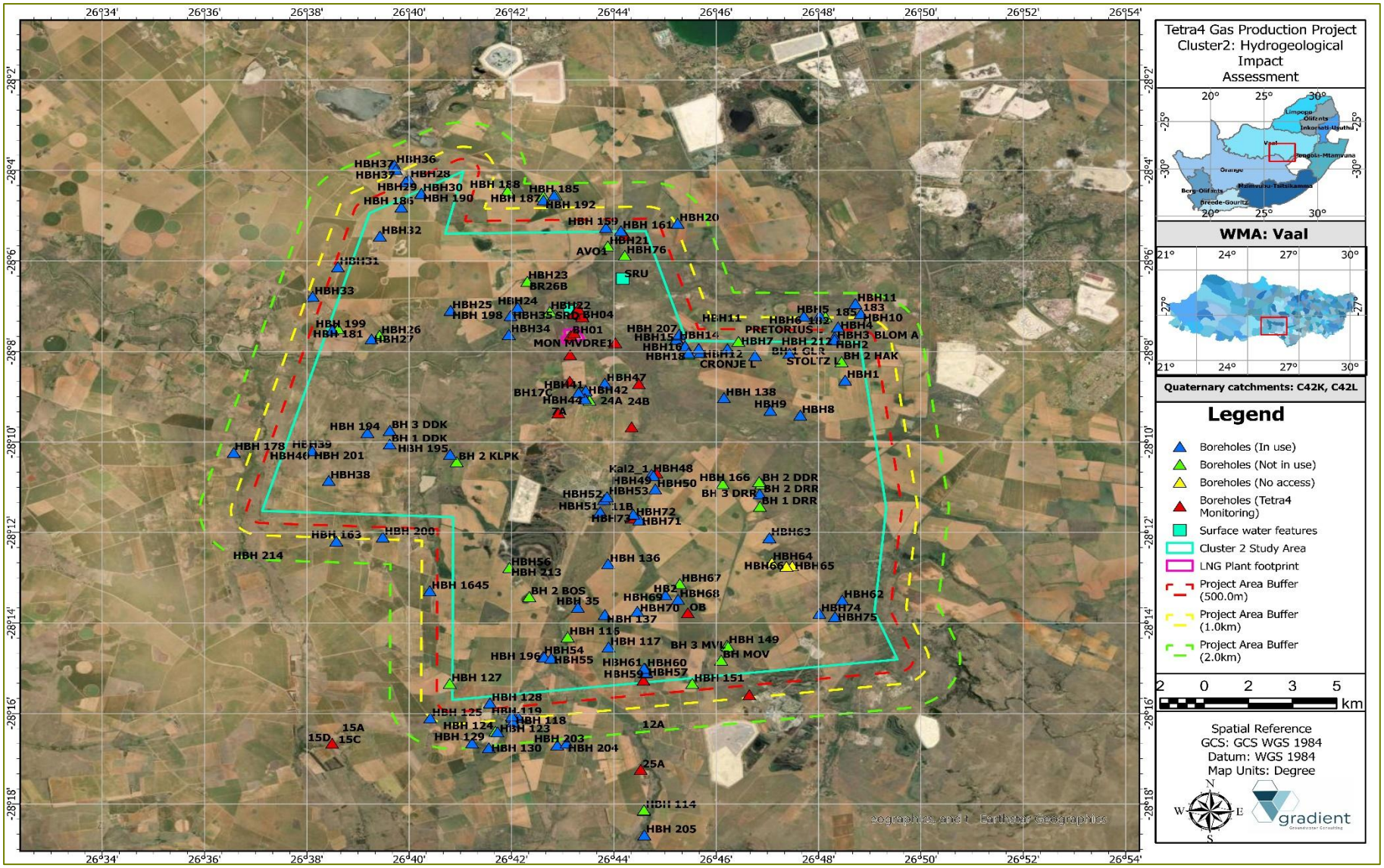


Figure 87: Spatial distribution map of the groundwater status and application.

9.10.2 AQUIFER CHARACTERISATION

In order to gather representative on-site aquifer data and relevant information a site characterisation phase was conducted where new monitoring boreholes i.e., site characterisation boreholes were established and subjected to aquifer tests to obtain site representative aquifer parameters and hydraulic properties. The latter was incorporated into the numerical groundwater flow model development and calibration process. All site characterisation work was performed in accordance with SANS 10299-4:2003 standards: Development, maintenance and management of groundwater resources. The following sub-sections summarises the site characterisation and fieldwork conducted.

9.10.2.1 **GEOPHYSICAL SURVEY**

A geophysical survey was conducted during October 2024 wherein the sub-strata in the direct vicinity of the study area were investigated by applying the magnetic and electro-magnetic (EM) geophysical exploration techniques which were applied according to traverse array design for delineation of sub-surface lineaments and identification of potential preferential groundwater flow pathways to be targeted for monitoring boreholes. Figure 88 shows a Total Magnetic Intensity (TMI) map of the greater study area with geological lineaments transecting the project site clearly delineated. The latter was used in combination with structural geological interpretation to plan the geophysical survey and traverse layout. Refer to Table 32 for a summary of geophysical traverse coordinates, traverse lengths, station spacings as well as approximate orientations and potential targets. Figure 89 indicates the geophysical traverse array in relation to earmarked site characterisation gaps identified as week as existing geosites recorded as well as project boundary. To follow a brief description and interpretation of geophysical traverses at which drilling targets were executed. All geophysical survey graphs and interpretation including raw data and field-notes are summarised in the appendices to the Geohydrological Specialist report contained in Appendix 4.

Table 32: Geophysical traverse summary (Datum: WGS84).

Traverse ID	Start		Approximate Length (m)	Potential target	Station spacing (m)	Potential anomalies	Drilling target	Approximate orientation
	Latitude	Longitude						
Traverse T4L01	-28.210299	26.718890	400.00	SW-NE striking lineament	10.00	290m	RTBH01	N-S
Traverse T4L02	-28.220152	26.715513	600.00	SW-NE striking lineament	10.00	70m, 350m	n/a	NE-SW
Traverse T4L03	-28.227395	26.712563	600.00	SW-NE striking lineament	10.00	500m	n/a	SW-NE
Traverse T4L04	-28.114075	26.651247	300.00	N-S striking lineament	10.00	200m	n/a	E-W
Traverse T4L05	-28.121882	26.648155	300.00	N-S striking lineament	10.00	180.00	RTBH04	SE-NW
Traverse T4L06	-28.167441	26.631815	300.00	N-S striking lineament	10.00	190m	RTBH05	E-W
Traverse T4L07	-28.166528	26.624882	400.00	N-S striking lineament	10.00	280m	n/a	E-W
Traverse T4L08	-28.168632	26.623755	300.00	W-E striking lineament	10.00	None	n/a	E-W
Traverse T4L09	-28.207595	26.781354	200.00	N-S striking lineament	10.00	90m, 170m	RTBH08	NW-SE
Traverse T4L10	-26.782248	-28.207770	100.00	SW-NE striking lineament	10.00	None	n/a	W-E
Traverse T4L11	-28.166306	26.768910	200.00	NW-SE striking lineament	10.00	140m	n/a	SW=NE
Traverse T4L12	-28.164963	26.769849	350.00	NW-SE striking lineament	10.00	60m, 190m	n/a	NW-SE
Traverse T4L13	-28.168011	26.779978	400.00	NW-SE striking lineament	10.00	120m	n/a	NW-SE
Traverse T4L14	-28.168910	26.787345	400.00	NW-SE striking lineament	10.00	130m	n/a	NW-SE

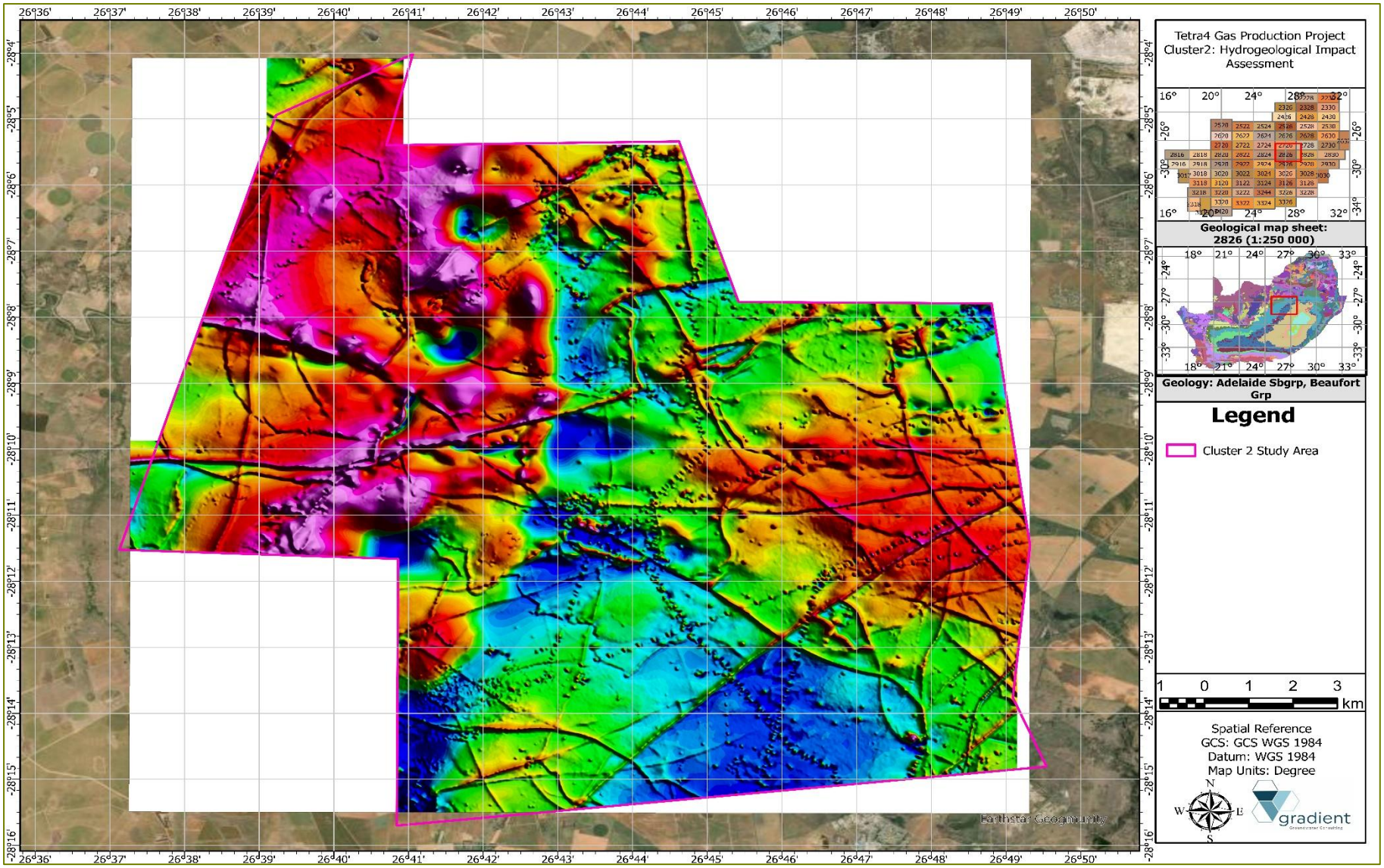


Figure 88: Total Magnetic Intensity (TMI) map of the greater study area indicating regional structural activity.

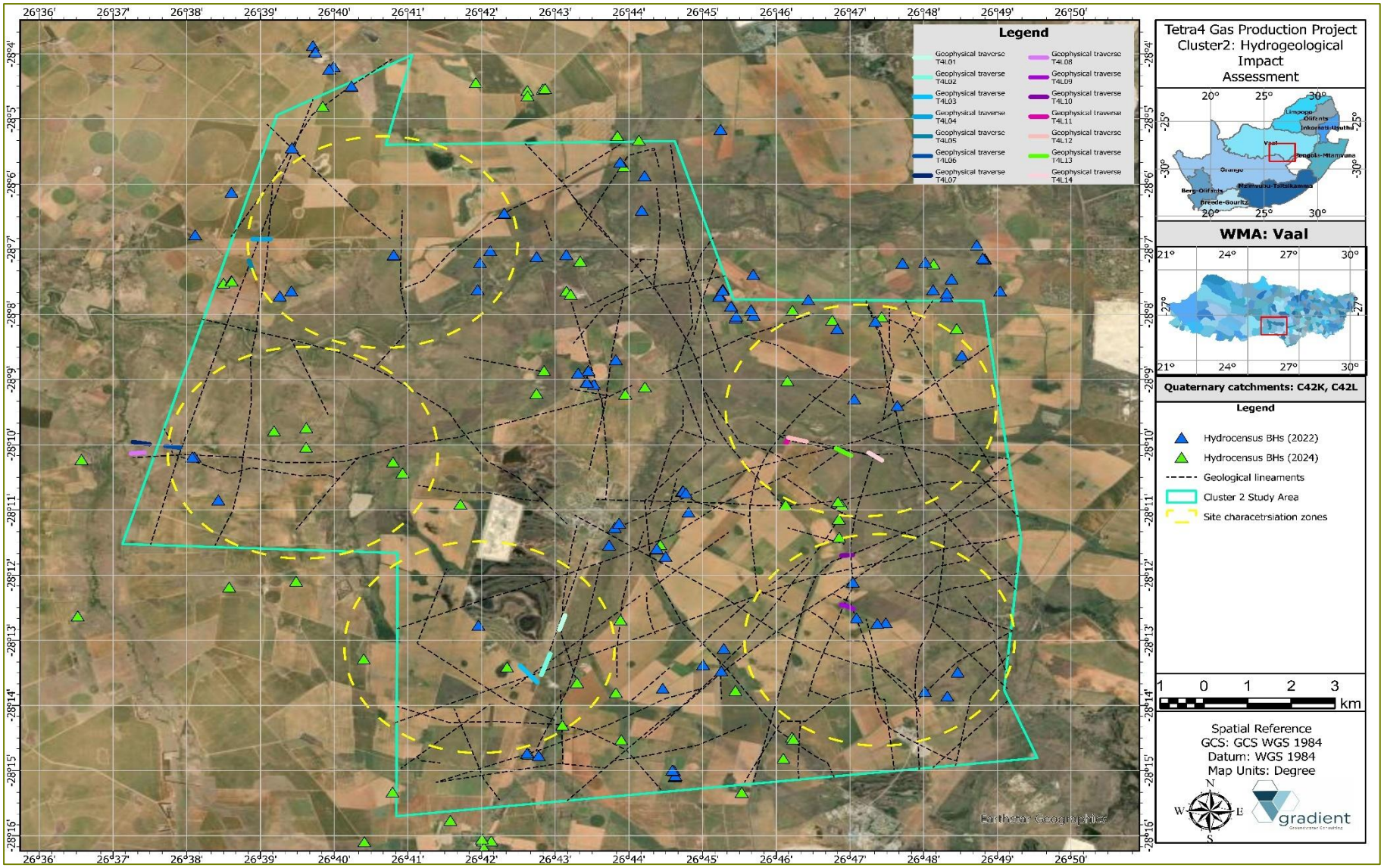


Figure 89: Geophysical traverse array in relation to geosites recorded as well as gap zones delineated.

9.10.2.1.1 TRAVERSE T4L01

Traverse T4L01 was surveyed over a lateral distance of 400.0m (10 m-electrode spacing) and was conducted in an approximate north-south orientation targeting a southwest-northeast striking geological lineament. A prominent magnetic low zone can be observed between stations 10.0-40.0m and again at stations 280.0 – 290.0m. The second magnetic anomaly is also associated with an increase in the electro-magnetic field on its perimeter. Accordingly, station 290.0m was identified as drilling position RTBH01, targeting a potential preferred groundwater flow pathway which may act as contaminant transport mechanism. Refer to

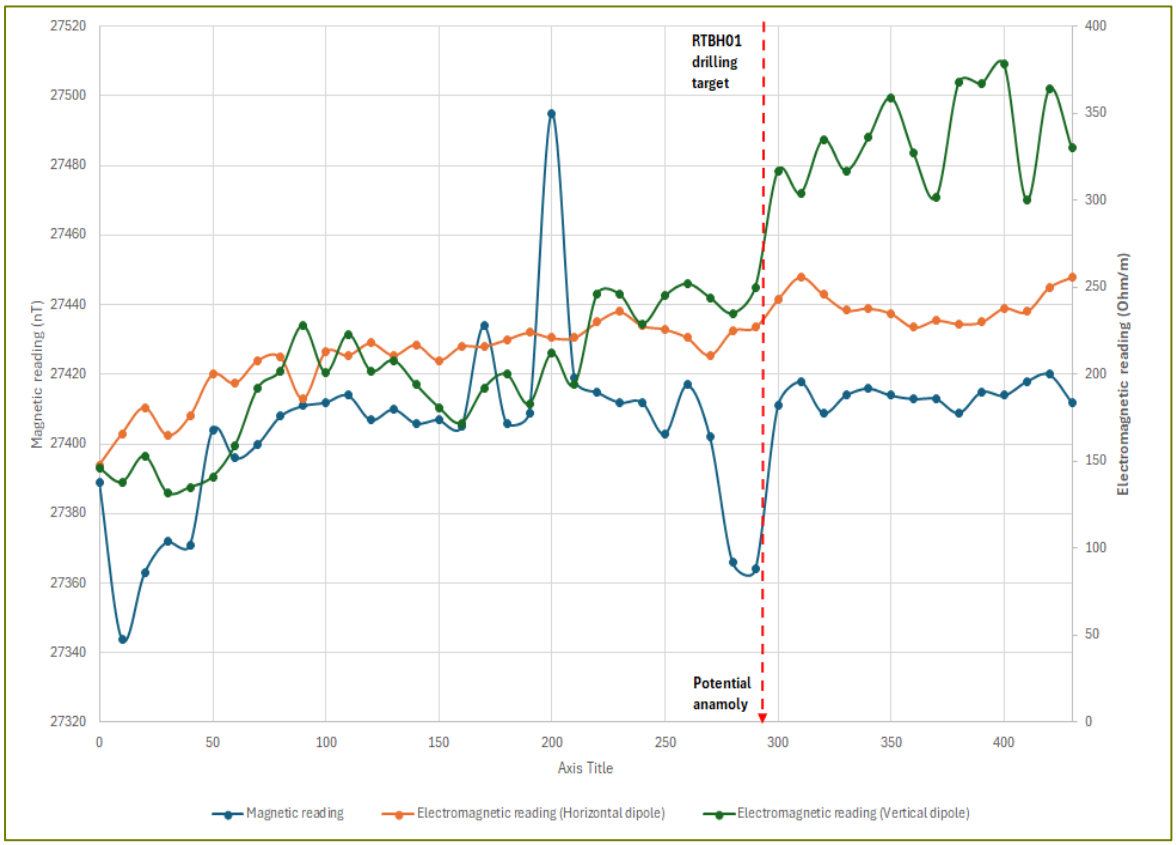


Figure 90 for the magnetic curve and electro-magnetic profile summarising relevant information.

9.10.2.1.2 TRAVERSE T4L05

Traverse T4L05 was surveyed over a lateral distance of 300.0m (10 m-electrode spacing) and was conducted in an approximate southeast-northwest orientation targeting a north-south striking geological lineament. A prominent increase in the measured magnetic field can be observed at station 180.0m. The latter can be inferred as a potential contact zone between the Vryheid host and a possible dolerite sill and outcrop with a magnetic signature. The electro-magnetic profiles suggest a slight decrease in the vertical dipole reading associated with a slight increase in the horizontal dipole reading. Accordingly, station 180.0m was identified as drilling position

RTBH04, targeting a potential geological contact which may act as contaminant transport mechanism. Refer to

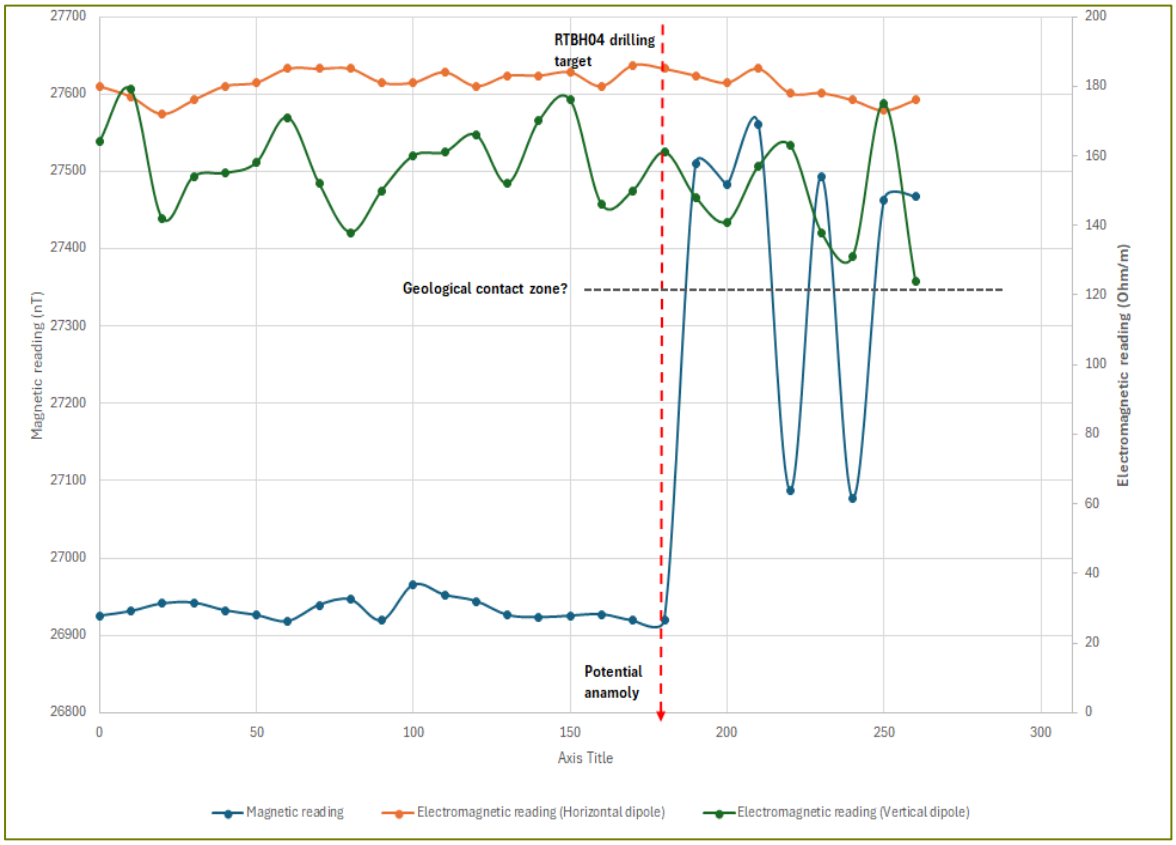


Figure 91 for the magnetic curve and electro-magnetic profile summarising relevant information.

9.10.2.1.3 TRAVERSE T4L06

Traverse T4L06 was surveyed over a lateral distance of 300.0m (10 m-electrode spacing) and was conducted in an approximate east-west orientation targeting a north-south striking geological lineament. A steep dip in the magnetic reading followed by a sharp increase above the regional average can be observed between stations 180.0-210.0m. This anomaly is generally associated with a dyke structure and is inferred as such. The electro-magnetic profiles indicate a decrease in the vertical dipole reading with an increase in the horizontal dipole reading also associated with this anomaly. Accordingly, station 190.0m was identified as drilling position RTBH05, targeting the weathered perimeter of a potential dyke structure which may act as a preferred

groundwater flow pathway and mechanism for contaminant transport. Refer to

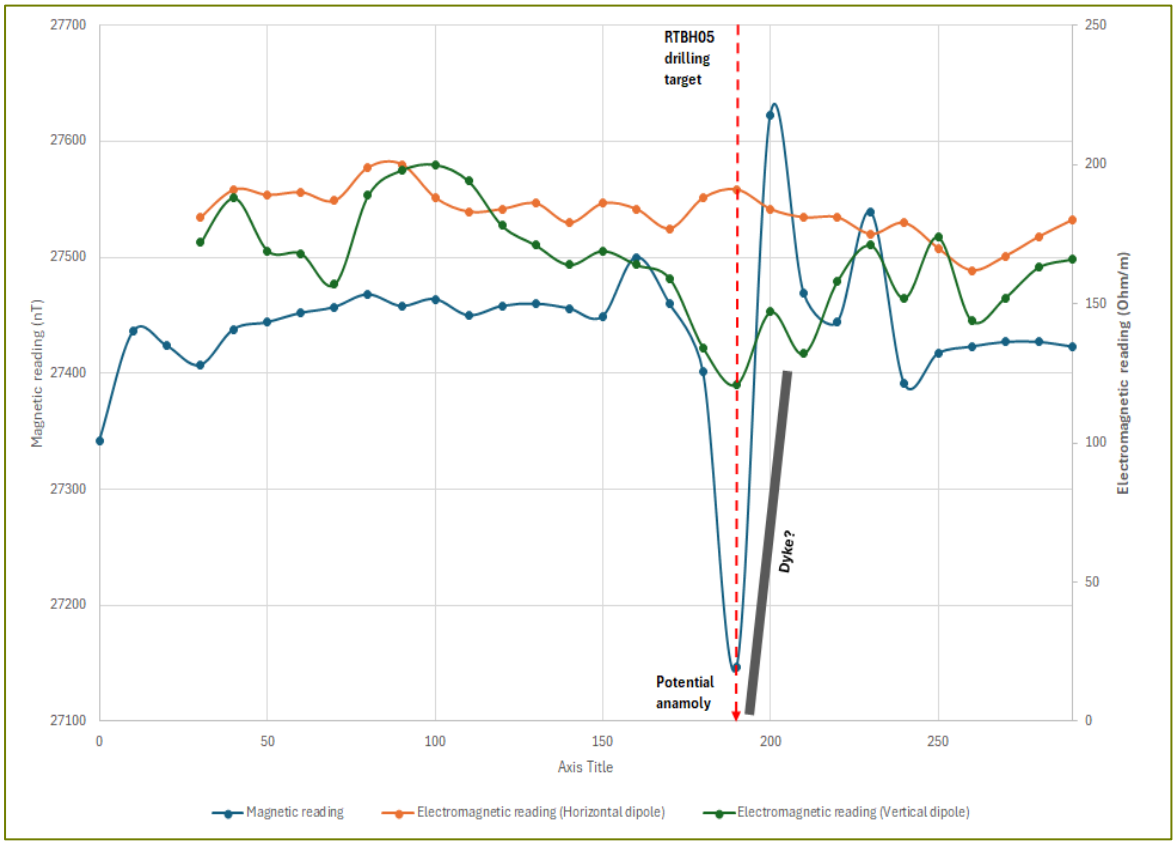


Figure 92 for the magnetic curve and electro-magnetic profile summarising relevant information.

9.10.2.1.4 TRAVERSE T4L09

Traverse T4L09 was surveyed over a lateral distance of 200.0m (10 m-electrode spacing) and was conducted in an approximate northwest-southeast orientation targeting a north-south striking geological lineament. Although the initial magnetic readings along the first segment of the traverse are quite erratic, a magnetic low can be observed between station 90.0-130.0m. The electro-magnetic profiles indicate a decrease in the vertical dipole reading with an increase in the horizontal dipole reading also associated with this anomaly. Accordingly, station 190.0m was identified as drilling position RTBH05, targeting the weathered perimeter of a potential dyke structure which may act as a preferred groundwater flow pathway and mechanism for contaminant transport.

Refer to

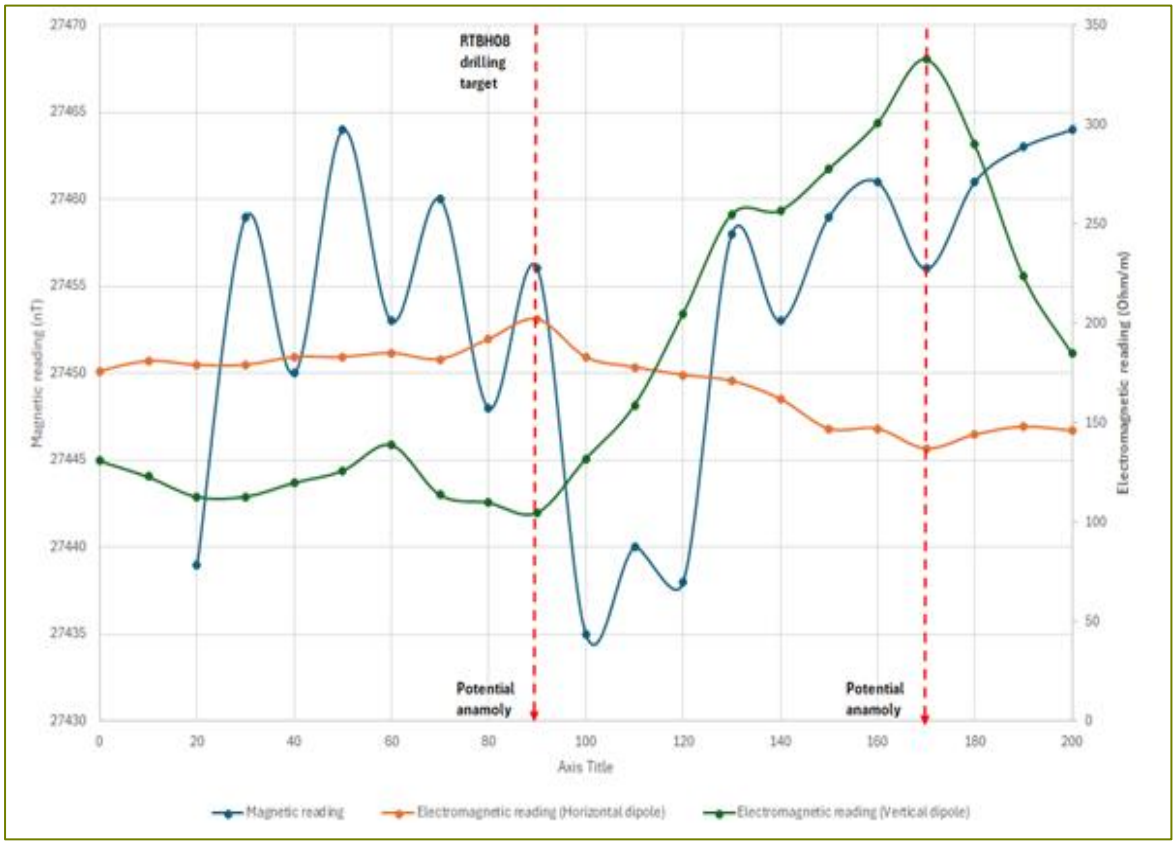


Figure 93 for the magnetic curve and electro-magnetic profile summarising relevant information.

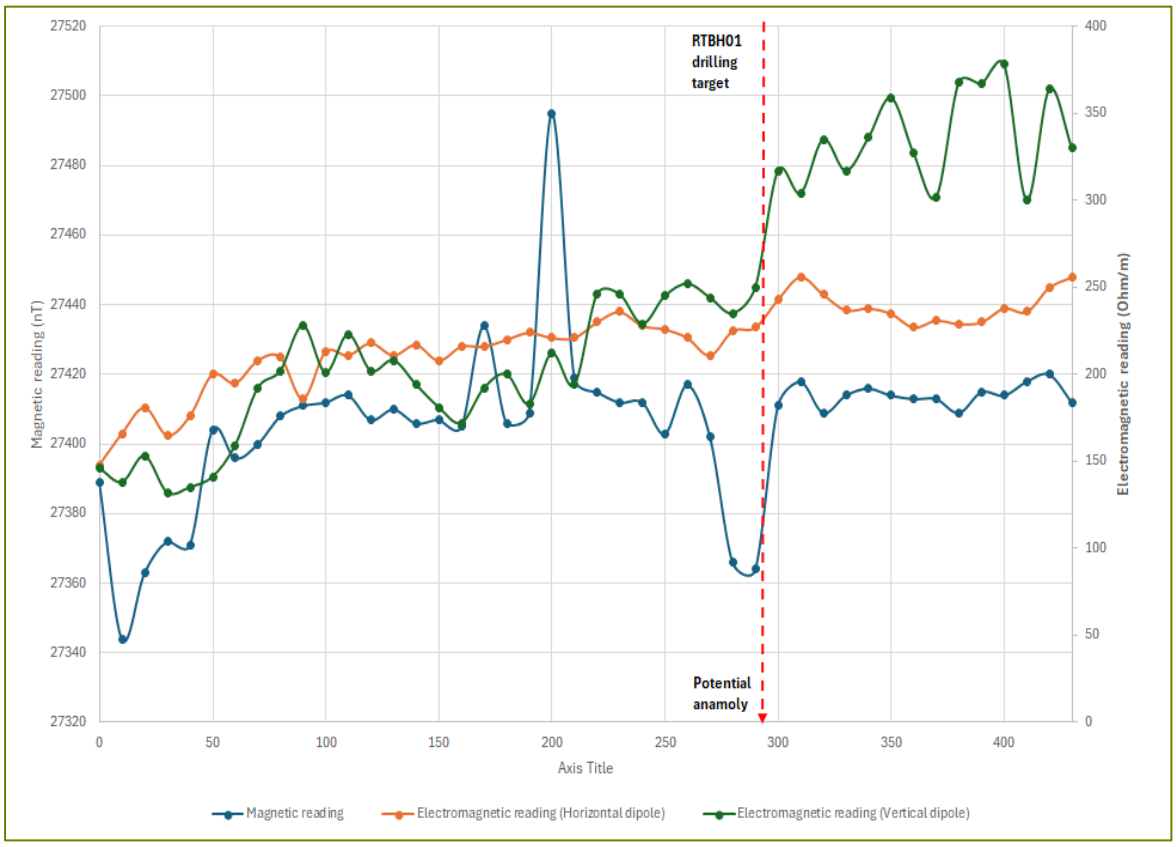


Figure 90: Geophysical traverse T4L01: Magnetic curve as well as electro-magnetic profile with relevant information.

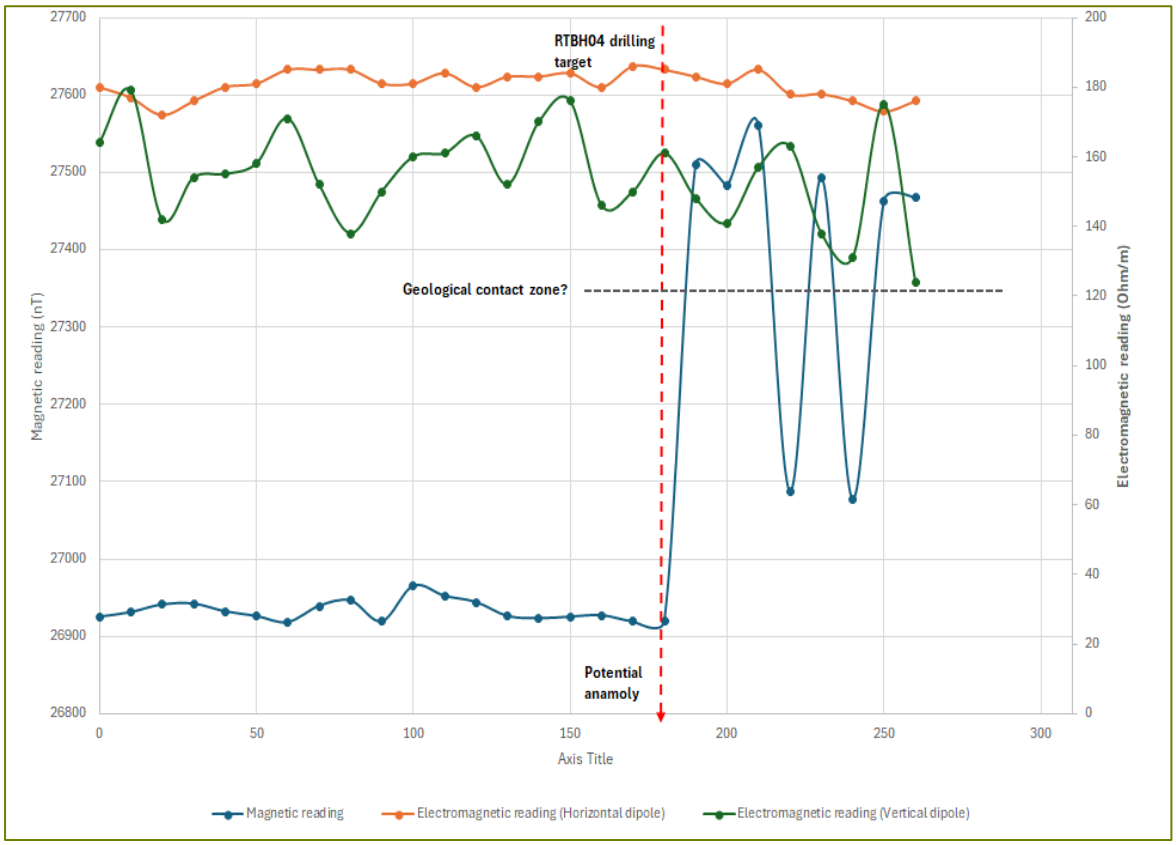


Figure 91: Geophysical traverse T4L05: Magnetic curve as well as electro-magnetic profile with relevant information.

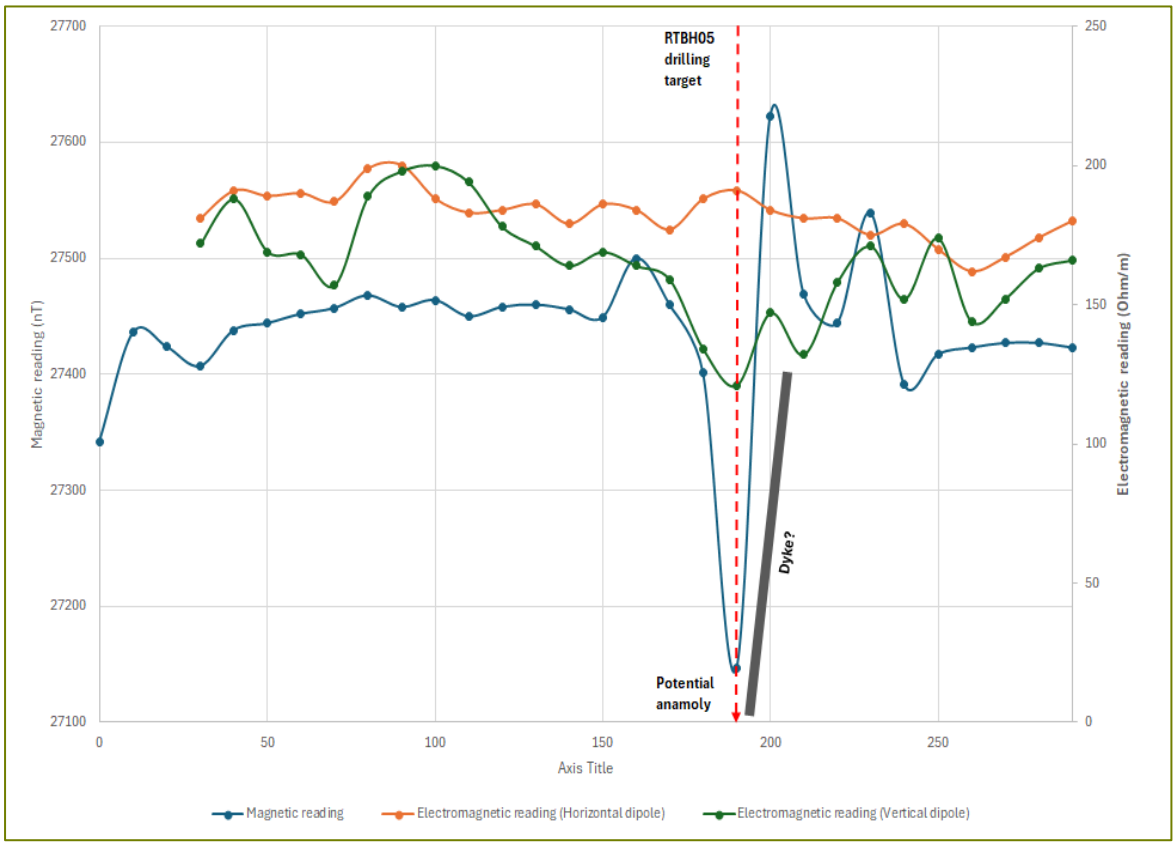


Figure 92: Geophysical traverse T4L06: Magnetic curve as well as electro-magnetic profile with relevant information.

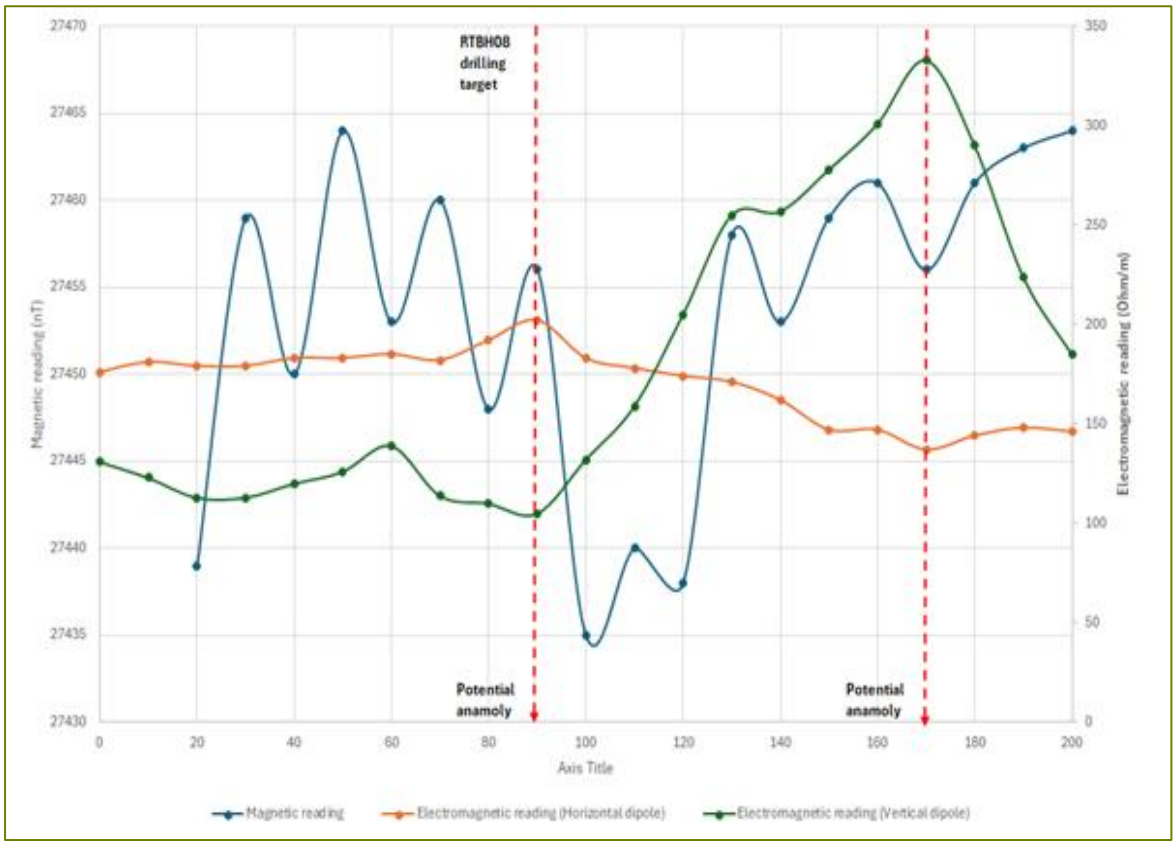


Figure 93: Geophysical traverse T4L09: Magnetic curve as well as electro-magnetic profile with relevant information.

9.10.2.2 DRILLING

Following the geophysical survey, five drilling targets were identified and incorporated as part of the drilling program which was initiated during January 2025. The drilling technique applied is percussion drilling and the rationale for the placement and drilling of the new boreholes was based on the objectives of the study which include geological and hydrogeological site characterisation. Results from the geophysical survey and site accessibility for the drill rig were considered in the placement of the boreholes. Drilling objectives and placement is summarised in Table 33 whereas borehole technical information is tabulated in Table 34.

Figure 94 shows the newly drilled borehole positions in relation to existing geosites identified. Geological logs of the newly drilled boreholes as well as drilling field-notes are included in the Geohydrological Specialist report contained in Appendix 4.

Table 33: Drilling targets and objectives.

BH ID	Latitude	Longitude	Aquifer target	Borehole purpose
RTBH 01	-28.212736	26.718075	Fractured aquifer (confined)	Site characterisation and monitoring
RTBH 04	-28.120242	26.647642	Fractured aquifer (confined)	Site characterisation and monitoring
RTBH 05	-28.167142	26.629660	Fractured aquifer (confined)	Site characterisation and monitoring

RTBH 08	-28.207812	26.782083	Fractured aquifer (confined)	Site characterisation and monitoring
RTBH 10	-28.177746	26.764675	Fractured aquifer (confined)	Site characterisation and monitoring

Table 34: Relevant borehole information summary.

BH ID	BH depth (mbgl)	Static Water level (mbgl)	Borehole diameter (OD Ø)	Casing type	Casing diameter (OD Ø)	Collar height (mm)	Water strike (mbgl)	Blow yield (l/s)
RTBH 01	88.00	8.57	215.0mm(0-24m); 165.0mm (24m-EOH)	Steel	177 (0-24m)	100.00	26/27	0.13
RTBH 04	100.00	7.00	215.0mm(0-24m); 165.0mm (24m-EOH)	Steel	177 (0-24m)	100.00	Seepage (13/14)	None
RTBH 05	100.00	8.93	215.0mm(0-24m); 165.0mm (24m-EOH)	Steel	177 (0-24m)	100.00	91/92	0.55
RTBH 08	100.00	4.29	215.0mm(0-24m); 165.0mm (24m-EOH)	Steel	177 (0-24m)	100.00	Seepage (17/18)	n/a
RTBH 10	100.00	5.52	215.0mm(0-24m); 165.0mm (24m-EOH)	Steel	177 (0-24m)	100.00	39/40	1.38

Notes: EOH = End of Hole.

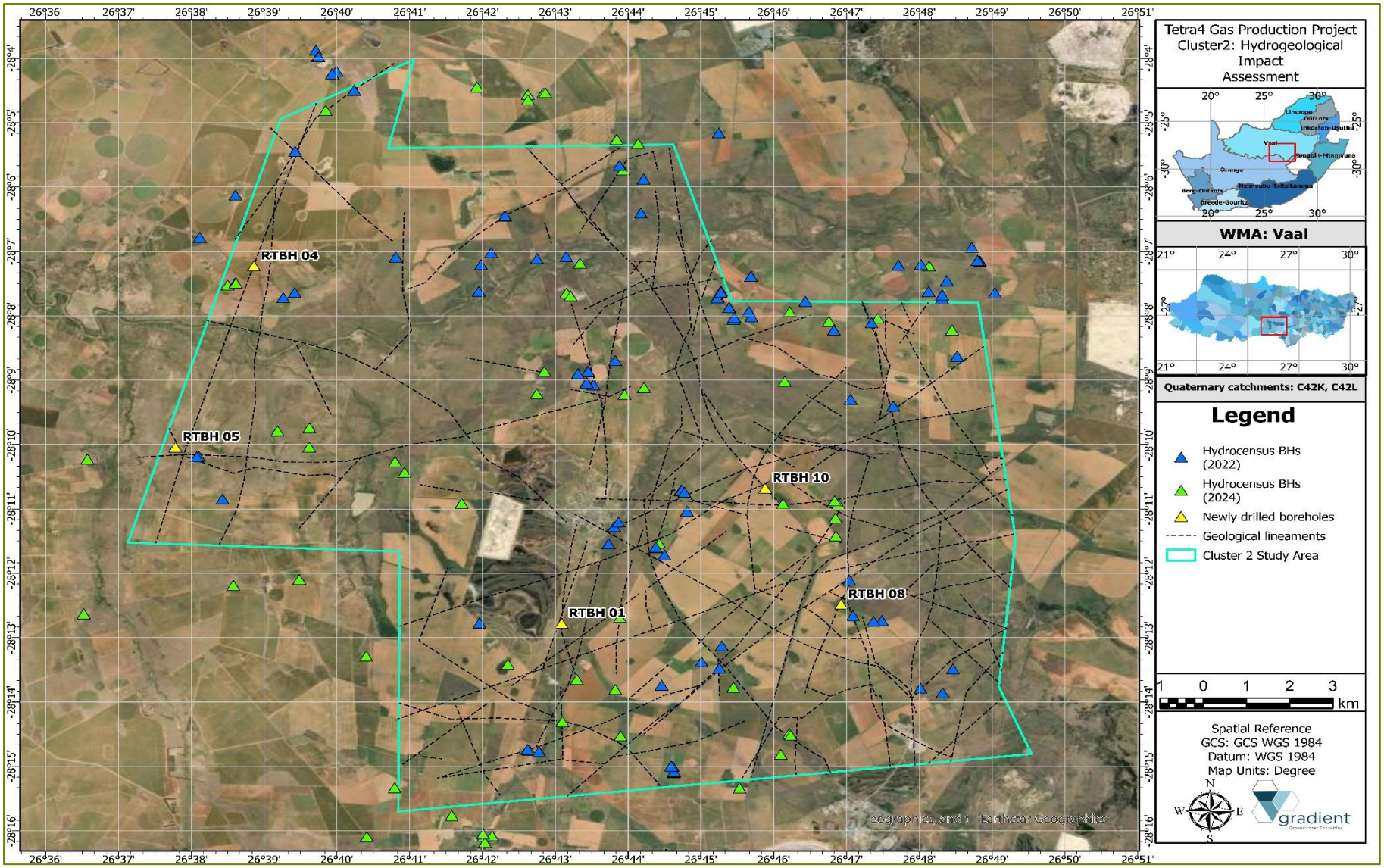


Figure 94: Map depicting new drilled site characterisation borehole positions in relation to geosites recorded.

To follow is a brief description of each site characterisation borehole drilled.

9.10.2.2.1 DRILLING LOCALITY RTBH01

Borehole locality RTBH01 was drilled at a 165.0mm (6.50”) diameter to a depth of 88.0 meters below ground level (mbgl). The borehole was reamed to a diameter of 215.0mm (8.50”) and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 24.0mbgl. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of a thin (1.0-3.0m) topsoil and hill wash layer followed by highly weathered Beaufort Group formations up to a depth of 16.0mbgl which is followed by more competent Volksrust formations to the end of the hole (EOH). A seepage zone was encountered at a depth of between 16.0 – 17.0m and a major water strike (blow yield = 0.13l/s) was encountered at approximately 27.0mbgl. After borehole development, the static water level was recorded at 8.57mbgl.

9.10.2.2.2 DRILLING LOCALITY RTBH04

Borehole locality RTBH04 was drilled at a 165.0mm (6.50”) diameter to a depth of 100.0mbgl. The borehole was reamed to a diameter of 215.0mm (8.50”) and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 24.0mbgl. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of a thin (1.0-4.0m) topsoil and hill wash layer followed by highly weathered Beaufort Group formations up to a depth of 18.0mbgl which is followed by more competent Volksrust formations to a depth of approximately 92.0mbgl after which a dolerite intrusion was encountered to the end of the hole. A seepage zone was encountered at a depth of between 13.0 – 14.0m, however the water ingress was not enough to perform a blow yield measurement. After borehole development, the static water level was recorded at 7.0mbgl.

9.10.2.2.3 DRILLING LOCALITY RTBH05

Borehole locality RTBH05 was drilled at a 165.0mm (6.50”) diameter to a depth of 100.0 meters below ground level (mbgl). The borehole was reamed to a diameter of 215.0mm (8.50”) and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 24.0mbgl. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of highly weathered Beaufort Group formations up to a depth of 11.0mbgl which is followed by more competent Volksrust formations to a depth of approximately 90.0mbgl after which a dolerite intrusion was encountered to the end of the hole. A seepage zone was encountered at a depth of between 15.0 – 16.0m and a major water strike (blow yield = 0.56l/s) was encountered at approximately 92.0mbgl. After borehole development, the static water level was recorded at 8.93mbgl.

9.10.2.2.4 DRILLING LOCALITY RTBH08

Borehole locality RTBH08 was drilled at a 165.0mm (6.50”) diameter to a depth of 100.0mbgl. The borehole was reamed to a diameter of 215.0mm (8.50”) and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 24.0mbgl. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of a thin (1.0-3.0m) topsoil and hill wash layer followed by highly weathered Beaufort Group formations up to a depth of 18.0mbgl which is

followed by more competent Volksrust formations to the end of the hole. A seepage zone was encountered at a depth of between 45.0 – 46.0m, however the water ingress was not enough to perform a blow yield measurement. After borehole development, the static water level was recorded at 4.29mbgl.

9.10.2.2.5 DRILLING LOCALITY RTBH10

Borehole locality RTBH10 was drilled at a 165.0mm (6.50") diameter to a depth of 100.0 meters below ground level (mbgl). The borehole was reamed to a diameter of 215.0mm (8.50") and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 24.0mbgl. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of a thin (1.0-4.0m) topsoil and hill wash layer followed by highly weathered Beaufort Group formations up to a depth of 34.0mbgl which is followed by more competent Volksrust formations to the end of the hole. A major water strike (blow yield = 1.38l/s) was encountered at approximately 39.0mbgl. After borehole development, the static water level was recorded at 5.52mbgl.

9.10.2.3 **AQUIFER TESTING**

Following the drilling phase, the newly established site characterisation boreholes, including existing monitoring boreholes, were subjected to hydraulic testing i.e., Constant Discharge(CD) pump during March 2025 in order to supplement published aquifer parameter data that was available for the site conditions and setting. Important parameters that can be obtained from borehole test pumping include Hydraulic Conductivity (K), Transmissivity (T) and Storativity (S). These parameters are defined as follows (Krusemann and De Ridder, 1991):

i. Hydraulic Conductivity (K): This is the volume of water that will move through a porous medium in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. It is normally expressed in metres per day (m/d).

ii. Transmissivity (T): This is the rate of flow under a unit hydraulic gradient through a cross-section of unit width over the full, saturated thickness of the aquifer. Transmissivity is the product of the average hydraulic conductivity and the saturated thickness of the aquifer. Transmissivity is expressed in metres squared per day (m^2/d).

iii. Storativity (S): The storativity of a saturated confined aquifer is the volume of water released from storage per unit surface area of the aquifer per unit decline in the component of hydraulic head normal to that surface. Storativity is a dimensionless quantity.

Transmissivity can also be calculated by using the Cooper-Jacob (Cooper & Jacob, 1946) equation for drawdown in confined aquifers as given below:

Equation: Transmissivity (Cooper-Jacob).

$$T = \frac{2.3Q}{4\pi\Delta s}$$

where:

T = Transmissivity (m^2/d).

Q = Flow of water per unit of time (m^3/d).

Δs = Drawdown difference of one log cycle.

Refer to Table 35 for a technical summary of hydraulic testing conducted while Table 36 provides the aquifer hydraulic parameter estimations. Figure 95 shows the boreholes subjected to hydraulic testing in relation to existing geosites identified. Borehole specific drawdown and recovery data are included in Appendix D.

Table 35: Constant discharge aquifer tests summary.

Basic Information								
BH ID	Borehole depth (mbgl)	Tested yield (ℓ/s)	Constant discharge duration (min.)	Water level (mbgl)	Pump depth inlet	Available Drawdown (m)	Drawdown reached (m)	% Drawdown used
7B	40.00	1.76	240.00	12.12	30.00	17.88	16.46	92.06
16B	30.00	1.44	120.00	13.89	20.00	6.11	5.99	98.04
17C	60.00	2.22	150.00	12.24	55.00	42.76	13.71	32.06
24A	45.00	0.92	90.00	8.00	40.00	32.00	33.91	97.58
Kal2_1	40.00	0.20	240.00	7.70	30.00	22.30	19.49	87.40
RTBH 01	88.00	0.26	480.00	8.57	75.00	66.43	29.59	44.54
RTBH 05	100.00	0.26	480.00	8.93	75.00	66.07	17.03	25.78
RTBH 08	100.00	0.26	120.00	2.05	75.00	72.95	72.95	100.00
RTBH 10	100.00	0.56	480.00	5.52	75.00	69.48	6.63	9.54

Table 36: Aquifer tests: Hydraulic parameter estimation.

BH ID	Potential hydrostratigraphical unit targeted	HYDROSOLV analysis		FC analysis	Results	
		Constant discharge Transmissivity (m^2/d)	Recovery Transmissivity (m^2/d)	Constant discharge Transmissivity (m^2/d)	Average Transmissivity (m^2/d)	Hydraulic conductivity (m/d)
7B	Beaufort Group formation	1.67	1.86	1.75	1.76	0.117
16B	Quaternary sediments, alluvial deposit	12.18	9.59	9.45	11.00	0.550
17C	Geological lineament	10.60	9.02	8.50	9.37	0.375
24A	Karoo formation matrix	0.16	0.29	0.60	0.35	0.017
Kal2_1	Karoo formation matrix	0.18	0.19	0.50	0.29	0.014
RTBH 01	Karoo formation matrix	0.20	0.19	0.35	0.25	0.012
RTBH 05	Dolerite intrusion	0.80	0.66	0.90	0.79	0.039
RTBH 08	Dolerite intrusion in close proximity	0.03	0.03	0.30	0.12	0.006
RTBH 10	Volksrust formation	2.04	5.36	2.00	3.13	0.157
Minimum		**0.03**	**0.03**	**0.30**	**0.12**	**0.006**
Maximum		**12.18**	**9.59**	**9.45**	**11.00**	**0.55**
Geometric mean		**0.74**	**0.84**	**1.26**	**1.04**	**0.05**
Harmonic mean		**0.18**	**0.19**	**0.73**	**0.43**	**0.02**
Standard deviation		**4.50**	**3.71**	**3.41**	**3.96**	**0.18**

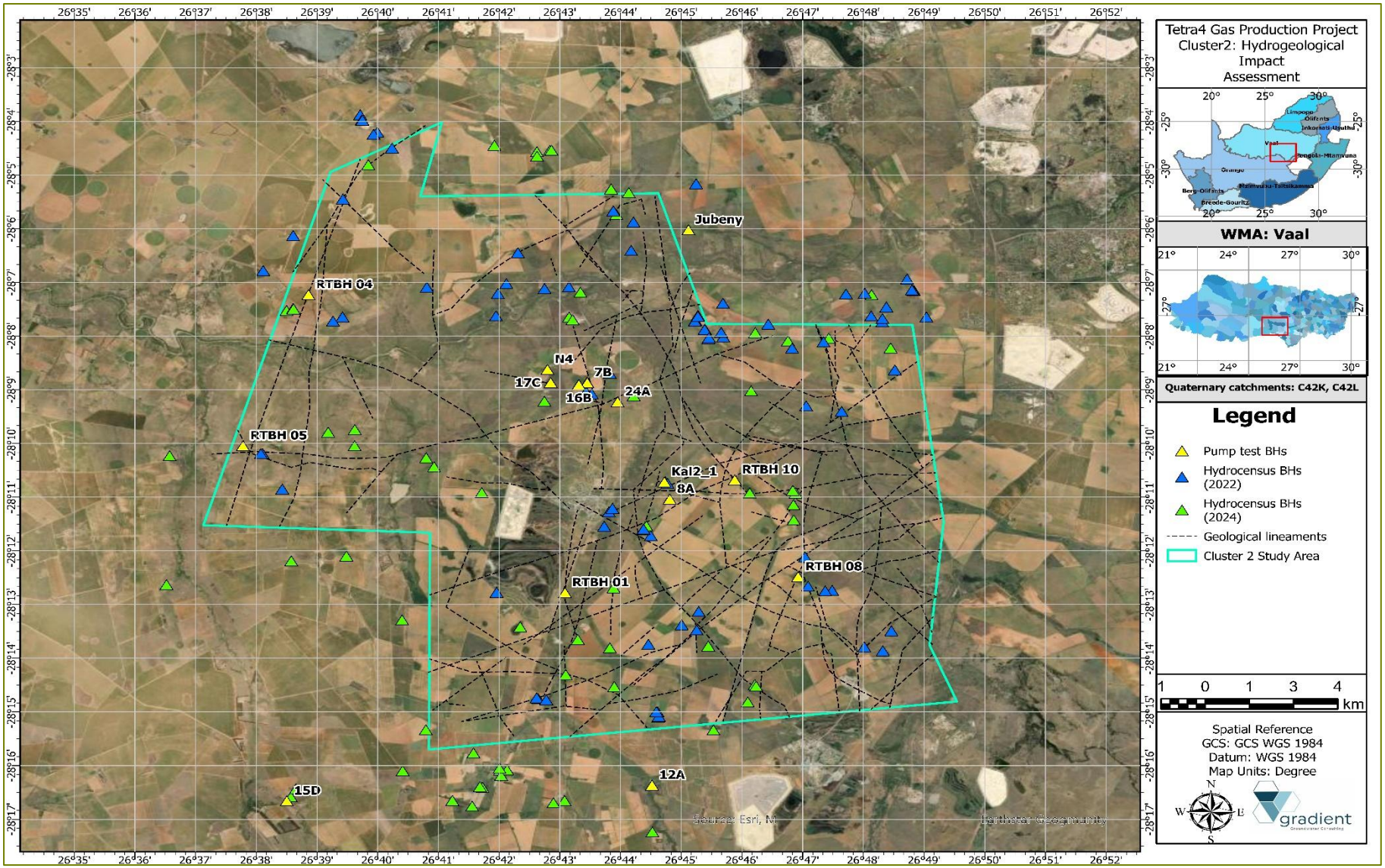


Figure 95: Map indicating boreholes subjected to constant discharge aquifer tests in relation to existing hydrocensus geosites.

To follow is a brief description of the constant discharge tests performed on newly established site characterisation boreholes along with analysis and interpretation of the water level drawdown and recovery curves.

9.10.2.3.1 CONSTANT RATE TEST BOREHOLE RTBH01

A static water level of 8.57mbgl was measured at testing locality RTBH01. Four calibration step tests of 0.18l/s, 0.26l/s, 0.37l/s and 0.50l/s were conducted, followed by a constant discharge test at a rate of 0.26l/s. A maximum drawdown depth of 29.59 meter below datum level (mbsl) was reached after a pump duration of 8-hours, representing ~45.0% of available drawdown utilised. Borehole recovery observed was good with a 90% recovery of pre-testing water levels obtained within the pumping duration. Refer to Table 37 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 96 depicts the Theiss method displacement time curve fitment while Figure 97 shows the Theiss method recovery curve fitment. The average transmissivity was calculated as 0.25m^2/d with the hydraulic conductivity calculated as 0.012m/d. Gathered site characterisation information suggest that this borehole is targeting the Karoo matrix formation, hence the sluggish seepage volumes observed.

Table 37: Aquifer tests summary: borehole RTBH01.

Method	T (m^2/day)	S
Jacob	0.20	0.0014
Theis	0.18	0.001773
Recovery	0.1918	-

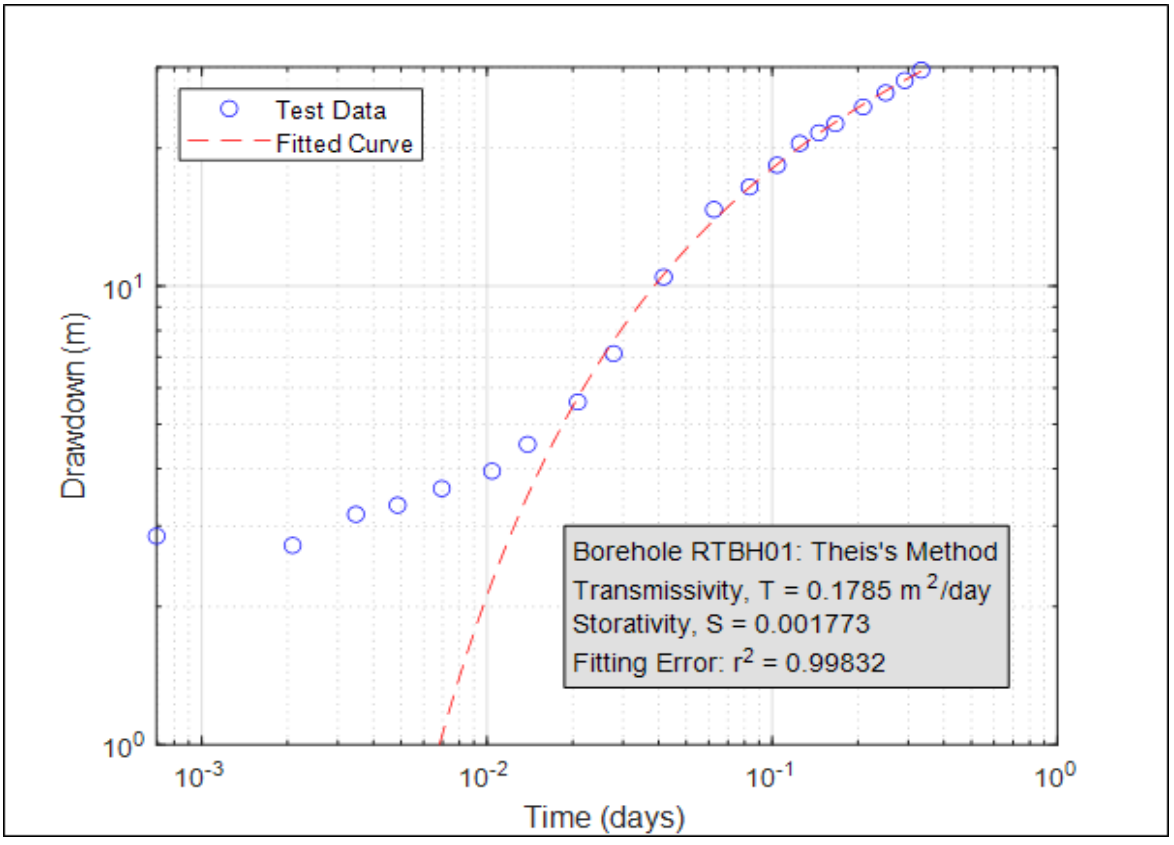


Figure 96: Aquifer tests: Theiss method displacement time curve for borehole RTBH01.

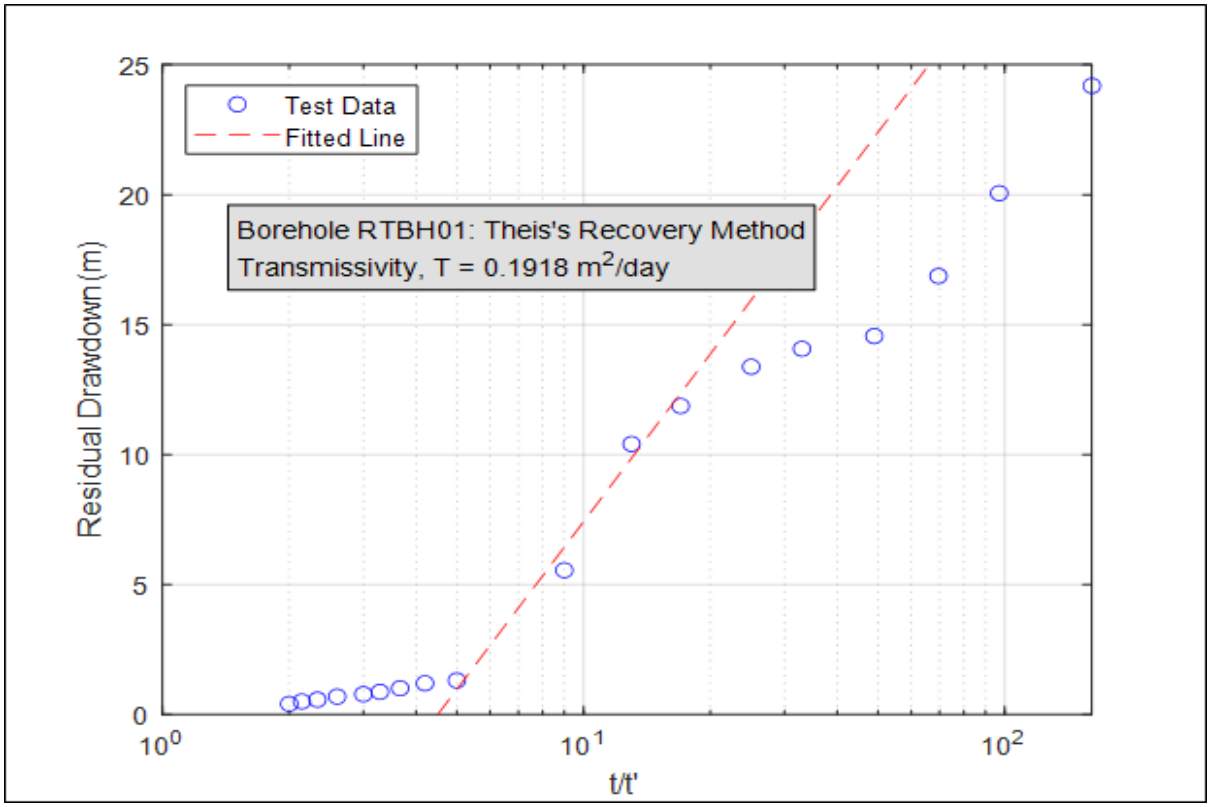


Figure 97: Aquifer tests: Theiss method recovery curve for borehole RTBH01.

9.10.2.3.2 CONSTANT RATE TEST BOREHOLE RTBH04

A static water level of 7.00mbgl was measured at testing locality RTBH04. Due to the low yield of the borehole, only one step test could be conducted, while no constant discharge test was initiated. The latter can be attributed to only seepage encountered during the drilling phase with no major water strike targeted.

9.10.2.3.3 CONSTANT RATE TEST BOREHOLE RTBH05

A static water level of 8.93mbgl was measured at testing locality RTBH05. Four calibration step tests of 0.18l/s, 0.22l/s, 0.30l/s and 0.75l/s were conducted, followed by a constant discharge test at a rate of 0.26l/s. A maximum drawdown depth of 17.03mbsl was reached after a pump duration of 8-hours, representing >20.0% of available drawdown utilised. Borehole recovery observed was good with a 90% recovery of pre-testing water levels obtained within the pumping duration. Refer to Table 38 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 98 depicts the Theiss method displacement time curve fitment while Figure 99 shows the Theiss method recovery curve fitment. The average transmissivity was calculated as 0.79m^2/d with the hydraulic conductivity calculated as 0.04m/d. Gathered site characterisation information suggest that this borehole is targeting a dolerite intrusion encountered deeper.

Table 38: Aquifer tests summary: borehole RTBH05.

Method	T (m^2/day)	S
Jacob	0.80	0.00001
Theis	0.64	0.000032
Recovery	0.6625	-

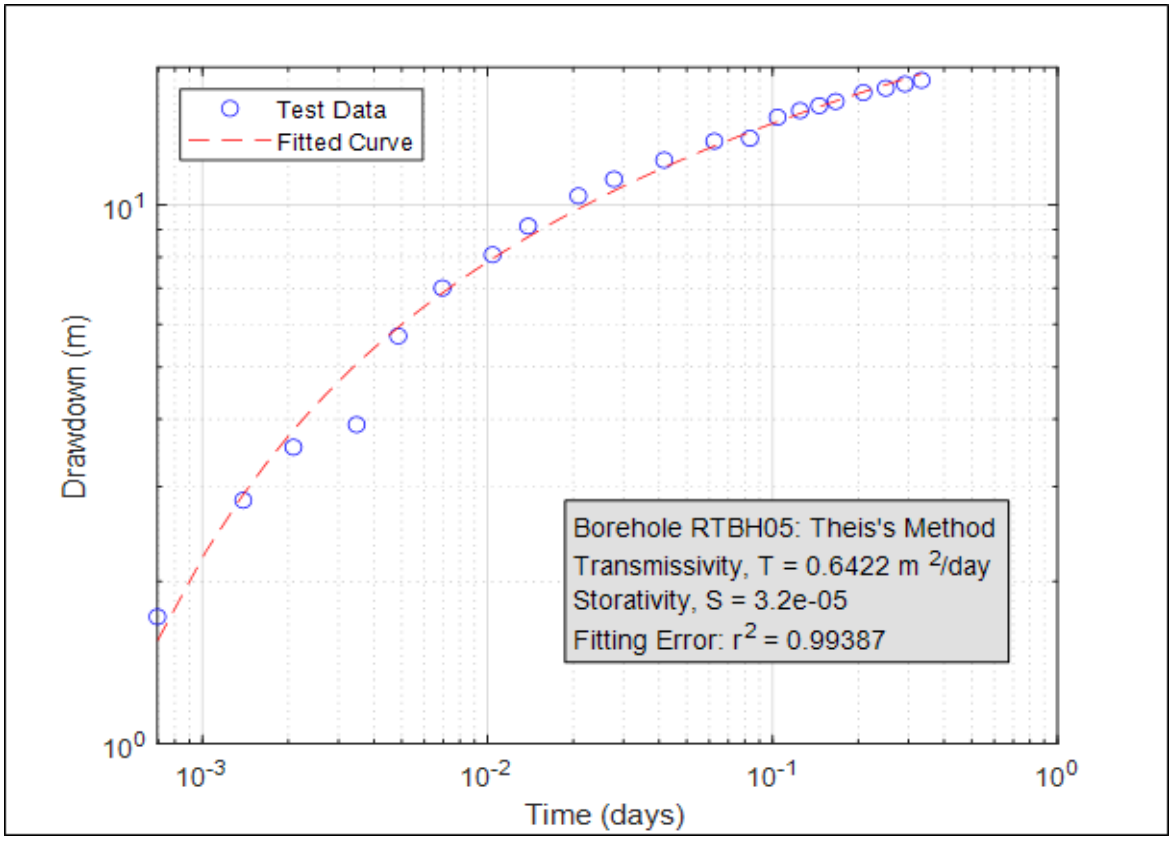


Figure 98: Aquifer tests: Theiss method displacement time curve for borehole RTBH05.

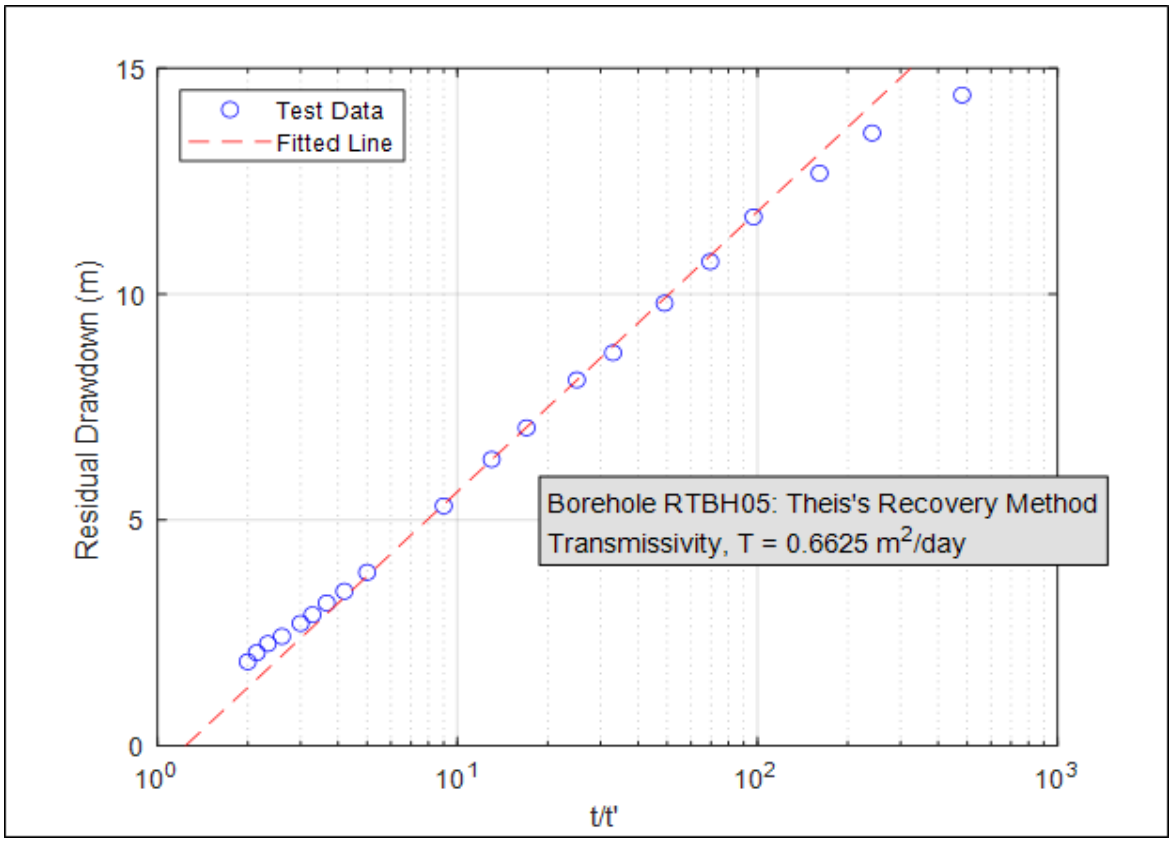


Figure 99: Aquifer tests: Theiss method recovery curve for borehole RTBH05.

9.10.2.3.4 CONSTANT RATE TEST BOREHOLE RTBH08

A static water level of 4.29mbgl was measured at testing locality RTBH08. Due to the low yield of the borehole, no calibration step tests could be conducted and the test directly went into a constant discharge phase (0.26l/s). A maximum drawdown depth of 75.25mbsl was reached after a pump duration of 2.5-hours, representing >90.0% of available drawdown utilised. Refer to Table 39 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 100 depicts the Theiss method displacement time curve fitment while Figure 101 shows the Jacob's method displacement curve fitment. The average transmissivity was calculated as 0.12m^2/d with the hydraulic conductivity calculated as 0.006m/d. Gathered site characterisation information suggest that this borehole is targeting the Karoo matrix formation, hence the sluggish seepage volumes observed.

Table 39: Aquifer tests summary: borehole RTBH08.

Method	T (m^2/day)	S
Jacob	0.03	0.0001
Theis	0.03	0.000069

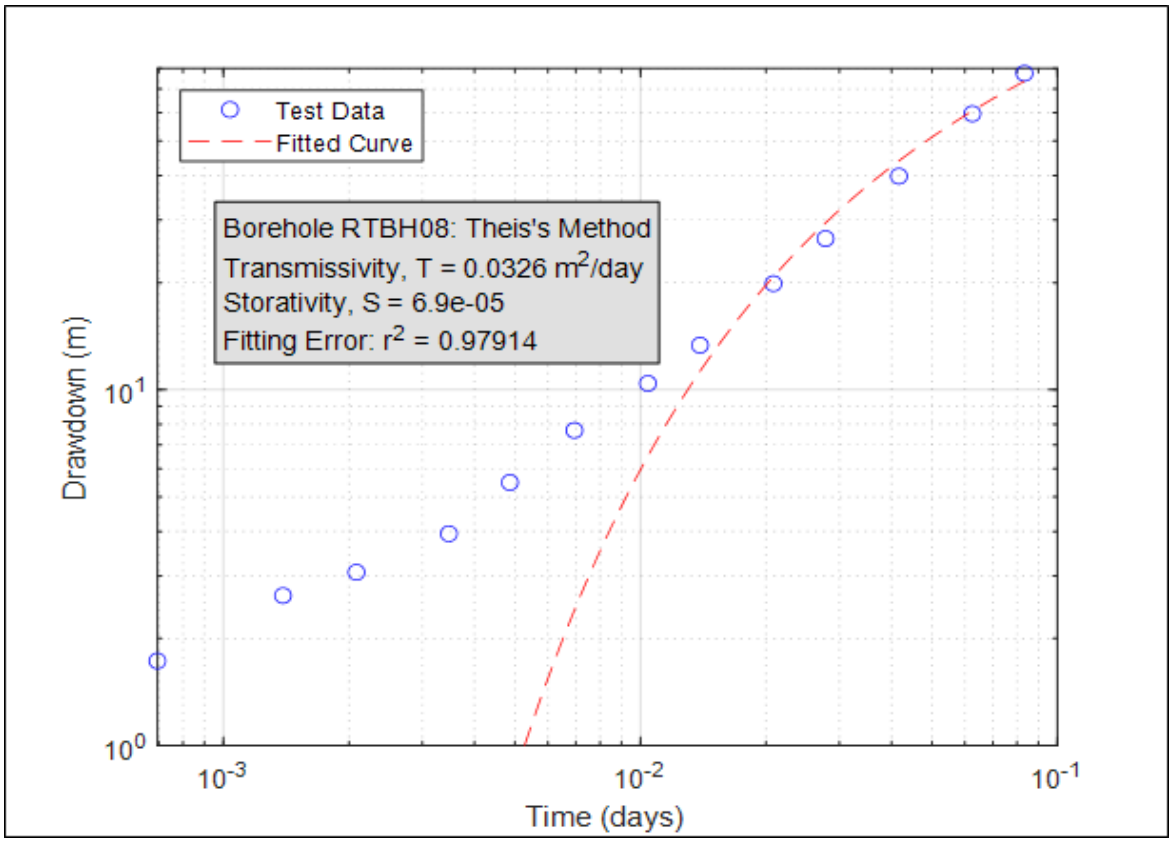


Figure 100: Aquifer tests: Theiss method displacement time curve for borehole RTBH08.

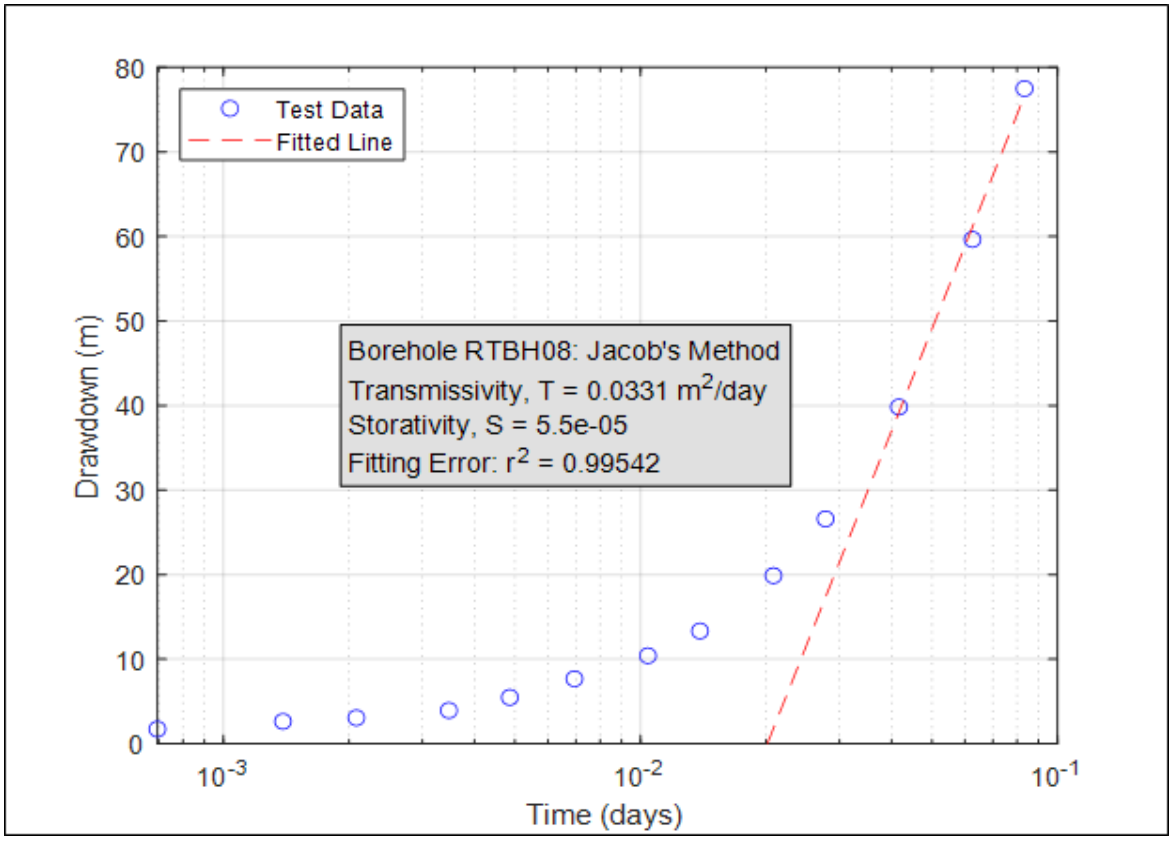


Figure 101: Aquifer tests: Jacob's method displacement curve for borehole RTBH08.

9.10.2.3.5 CONSTANT RATE TEST BOREHOLE RTBH10

A static water level of 5.52mbgl was measured at testing locality RTBH10. Four calibration step tests of 0.28l/s, 0.50l/s, 0.75l/s and 1.30l/s were conducted, followed by a constant discharge test at a rate of 0.56l/s. It should be noted that the pump testing equipment could not be lowered past ~27.0mbgl due to an obstruction in the borehole. A maximum drawdown depth of 6.63mbsl was reached after a pump duration of 8-hours, representing >25.0% of available drawdown utilised. Borehole recovery observed was good with a 90% recovery of pre-testing water levels obtained within the pumping duration. Refer to Table 40 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 102 depicts the Neuman method displacement time curve fitment while Figure 103 shows the Theiss method recovery curve fitment. The average transmissivity was calculated as 3.13m^2/d with the hydraulic conductivity calculated as 0.15m/d. Gathered site characterisation information suggest that this borehole is targeting the Volksrust formation aquifer.

Table 40: Aquifer tests summary: borehole RTBH10.

Method	T (m^2/day)	S	Sy	β
Neuman	2.04	0.0001	0.001938	0.02
Recovery	5.36	-	-	-

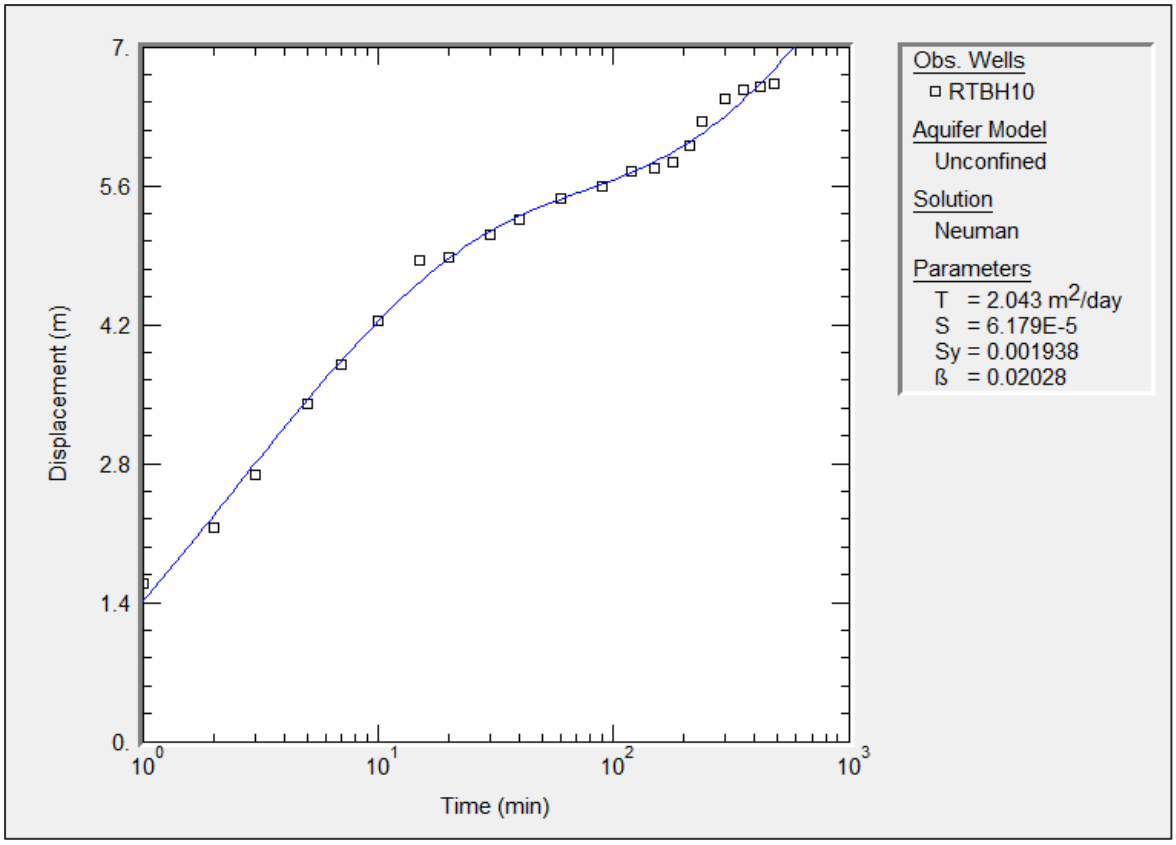


Figure 102: Aquifer tests: Neuman method displacement time curve for borehole RTBH10.

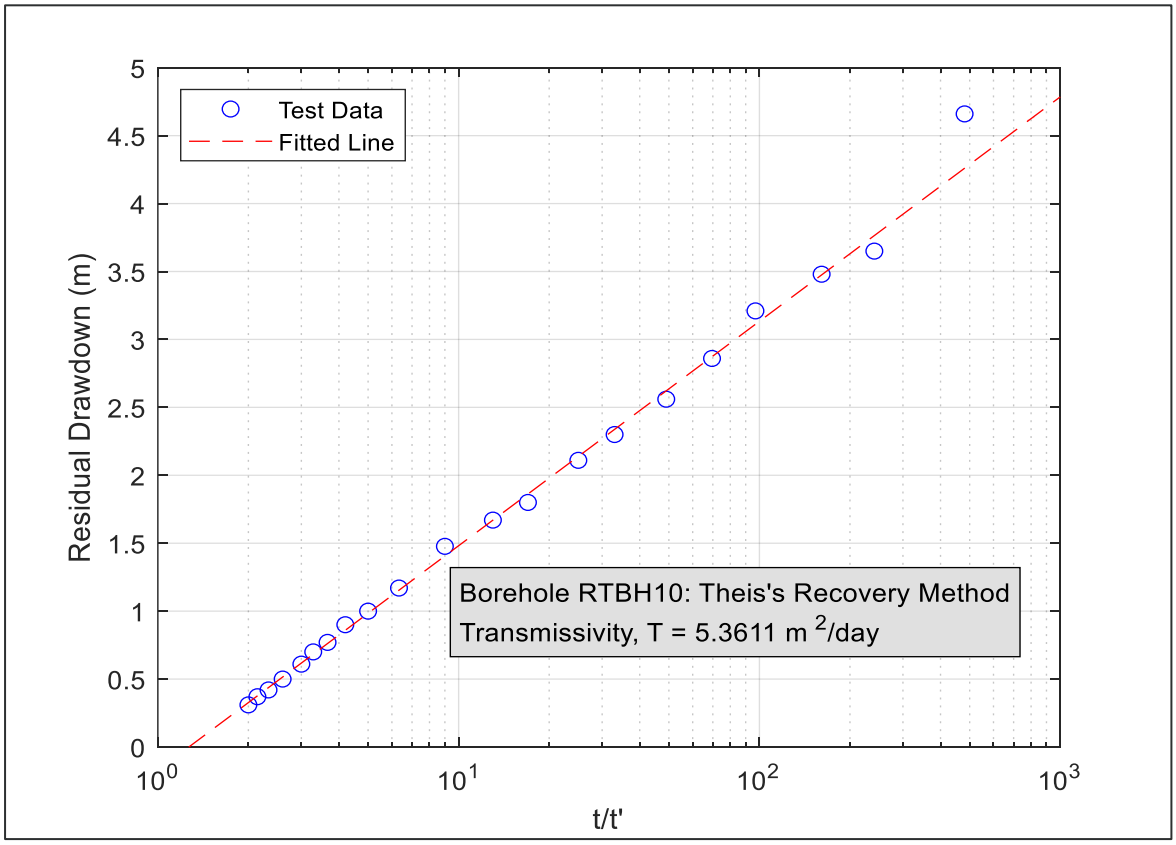


Figure 103: Aquifer tests: Theiss method recovery curve for borehole RTBH10.

To follow is a brief description of the constant discharge tests performed on existing monitoring boreholes along with analysis and interpretation of the water level drawdown and recovery curves. It should be noted that the majority of boreholes tested are privately owned and currently applied for domestic and/or livestock purposes. Thus, due to logistical constraints the constant discharge pump test was performed with existing equipment and fitment of a variable speed drive (VSD) to maintain a constant discharge rate, no calibration step tests could be performed.

9.10.2.3.6 CONSTANT RATE TEST BOREHOLE 7B

A static water level of 12.12mbgl was measured at testing locality 7B. A constant discharge test was performed at a rate of approximately 1.76l/s for a duration of 4 hours. A maximum drawdown depth of 16.46mbsl was reached during the pump test duration representing >90.0% of available drawdown utilised. Borehole recovery observed was good with a 90% recovery of pre-testing water levels obtained within the pumping duration. Refer to Table 41 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 104 depicts the Walton's method displacement time curve fitment while Figure 105 shows the Theiss method recovery curve fitment. The average transmissivity was calculated as 1.76m^2/d with the hydraulic conductivity calculated as 0.11m/d. Gathered site characterisation information suggest that this borehole is targeting the Beaufort formation aquifer.

Table 41: Aquifer tests summary: borehole 7B.

Method	T (m^2/day)	S	r/L	L (m)	c (days)	K' (m/day)
Walton	1.67	0.0012	0.38	5.26	16.57	0.60
Recovery	1.86	-	-	-	-	-

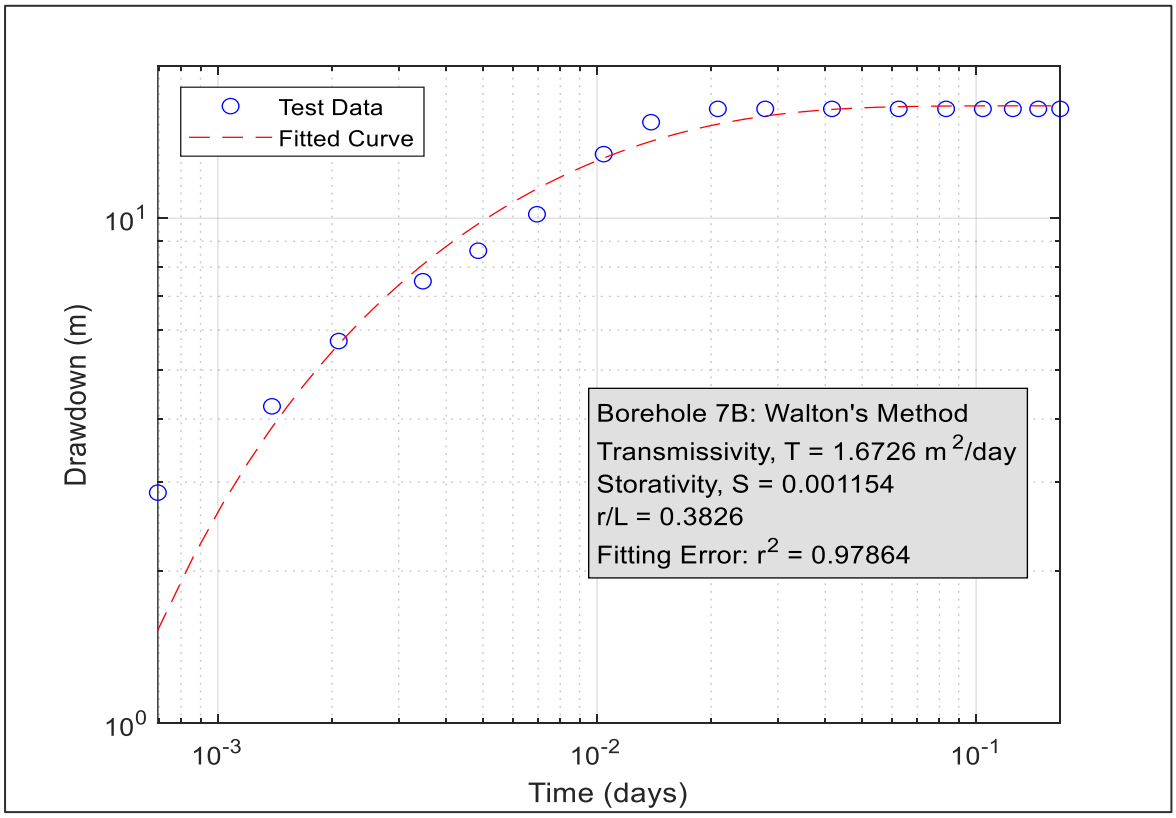


Figure 104: Aquifer tests: Walton's method displacement time curve for borehole 7B.

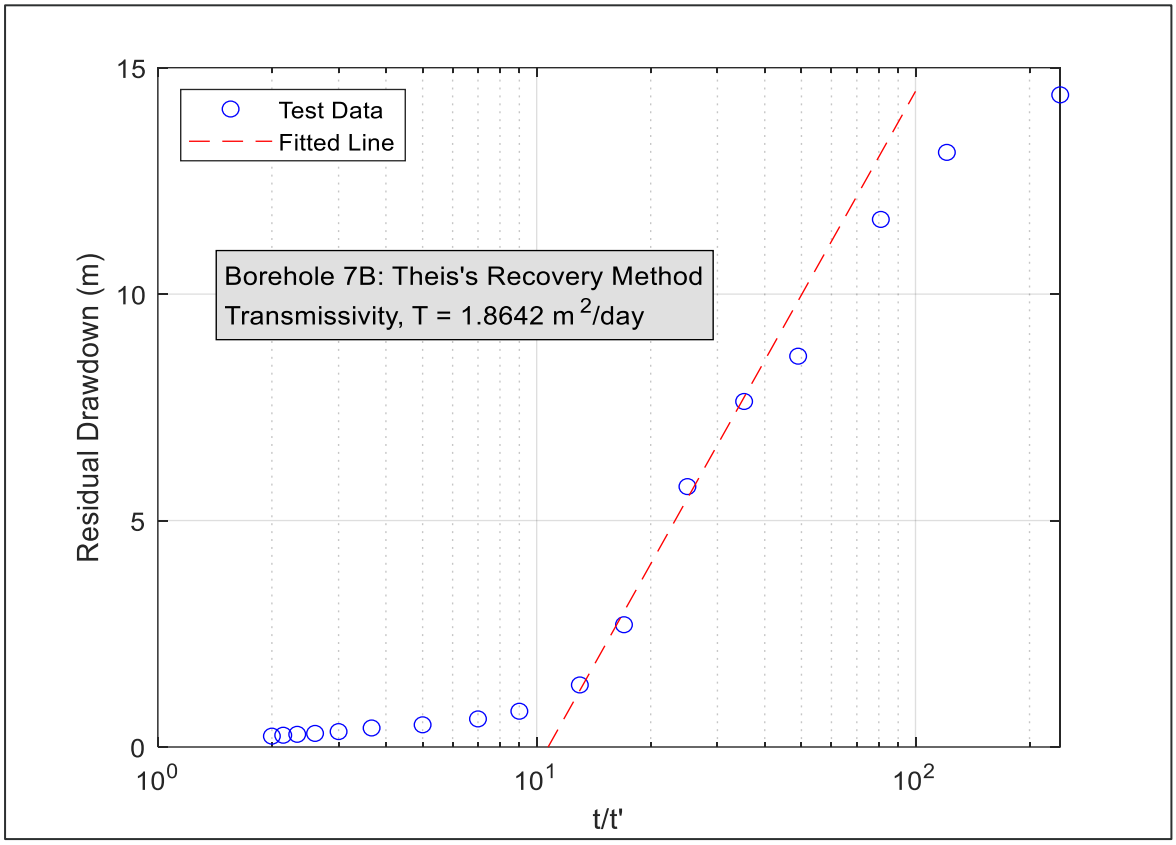


Figure 105: Aquifer tests: Theiss method recovery curve for borehole 7B.

9.10.2.3.7 CONSTANT RATE TEST BOREHOLE 17C

A static water level of 12.24mbgl was measured at testing locality 17C. A constant discharge test was performed at a rate of approximately 2.22l/s for a duration of 2.5 hours, after which the test was interrupted by a power failure. A maximum drawdown depth of 13.71mbsl was reached during the pump test duration representing >30.0% of available drawdown utilised. Borehole recovery observed was not so good with a 65% recovery of pre-testing water levels obtained within the pumping duration. Refer to Table 42 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 106 depicts the Theiss method displacement time curve fitment while Figure 107 shows the Theiss method recovery curve fitment. The average transmissivity was calculated as 9.37m^2/d with the hydraulic conductivity calculated as 0.375m/d. Gathered site characterisation information suggest that this borehole is targeting a regional geological lineament.

Table 42: Aquifer tests summary: borehole 17C.

Method	T (m^2/day)	S
Jacob	10.60	0.0178
Theis	10.61	0.01779
Recovery	9.023	-

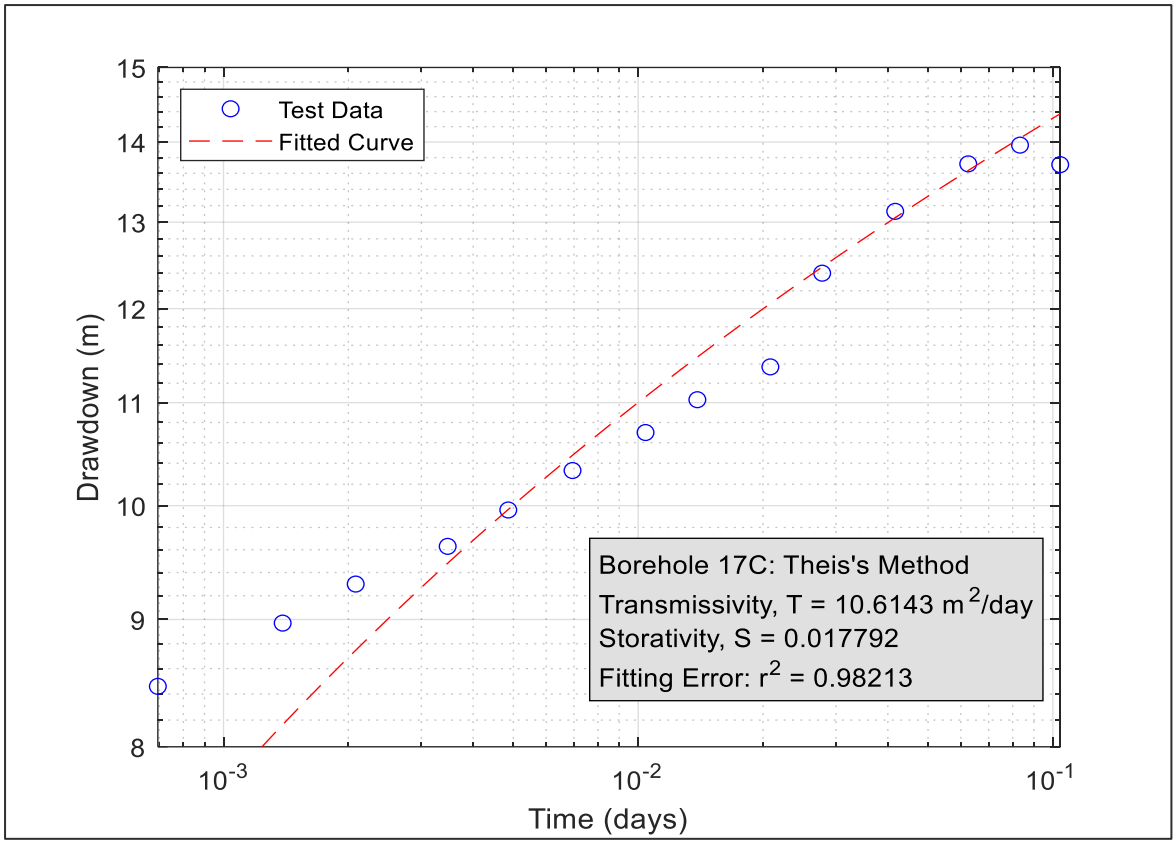


Figure 106: Aquifer tests: Theiss method displacement time curve for borehole 17C.

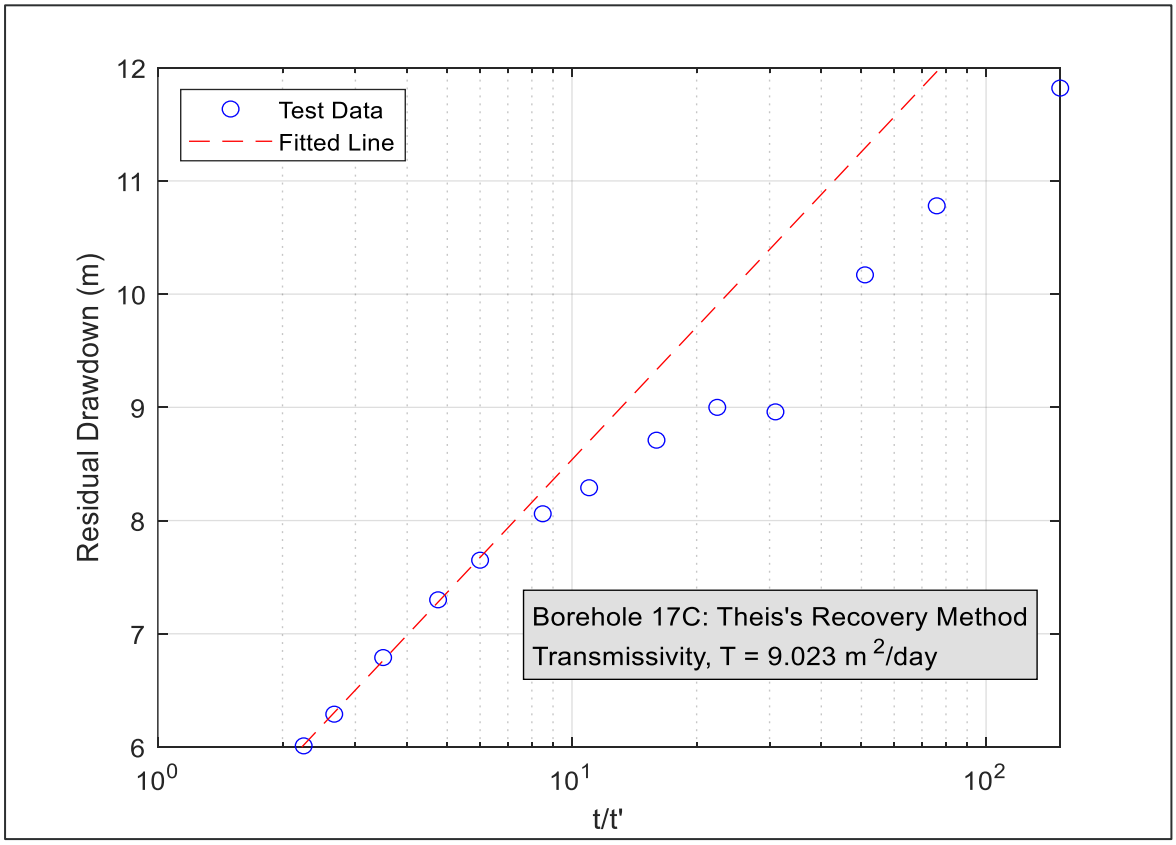


Figure 107: Aquifer tests: Theiss method recovery curve for borehole 17C.

9.10.2.3.8 CONSTANT RATE TEST BOREHOLE 24A

A static water level of 8.0mbgl was measured at testing locality 24A. A constant discharge test was performed at a rate of 0.92l/s for a duration of an hour. A maximum drawdown depth of 33.91mbsl was reached during the pump test duration, representing >95.0% of available drawdown utilised. Borehole recovery observed was good with a 90% recovery of pre-testing water levels obtained within the pumping duration. Refer to Table 43 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 108 depicts the Walton's method displacement time curve fitment while Figure 109 shows the Theiss method recovery curve fitment. The average transmissivity was calculated as 0.35m^2/d with the hydraulic conductivity calculated as 0.017m/d. Gathered site characterisation information suggest that this borehole is targeting the Karoo matrix formation, hence the sluggish seepage volumes observed.

Table 43: Aquifer tests summary: borehole 24A.

Method	T (m^2/day)	S	r/L	L (m)	c (days)	K' (m/day)
Walton	0.16	0.0001	0.9836	4.26	117.2694	0.085273766
Recovery	0.29	-	-	-	-	-

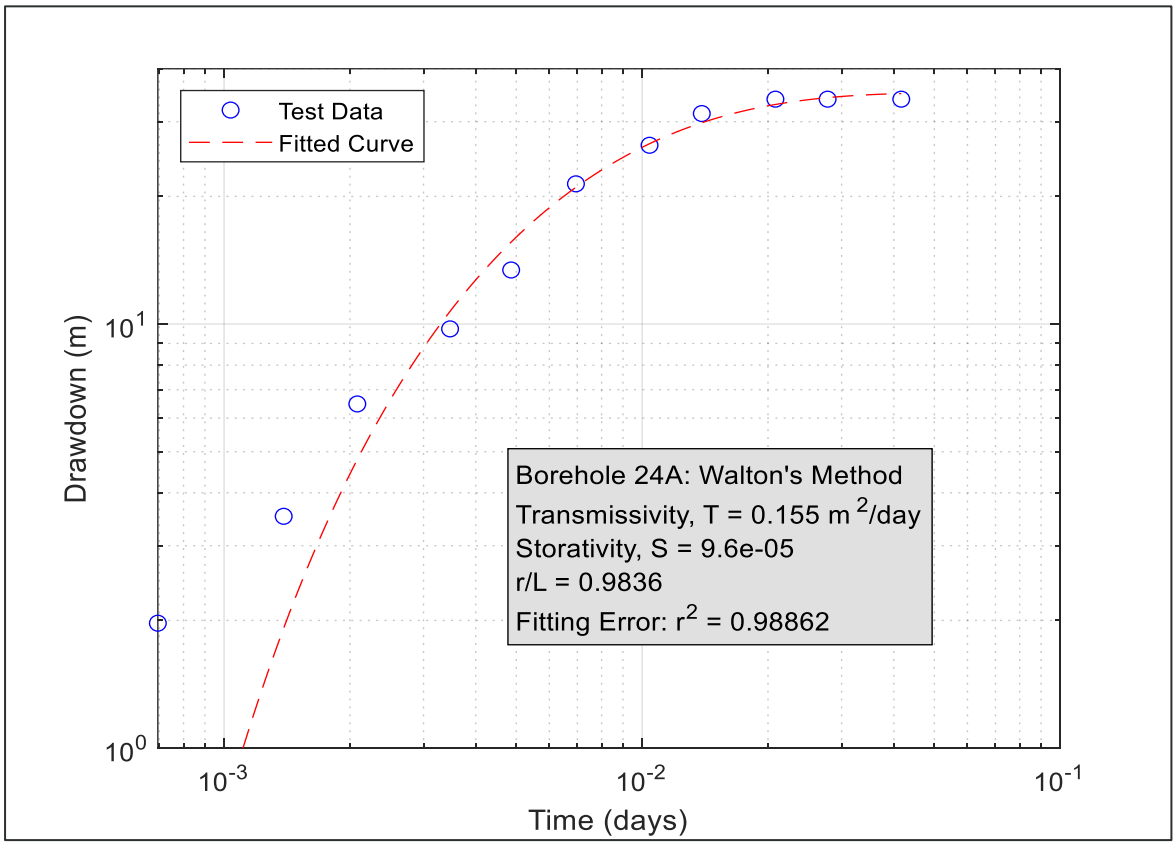


Figure 108: Aquifer tests: Walton's method displacement time curve for borehole 24A.

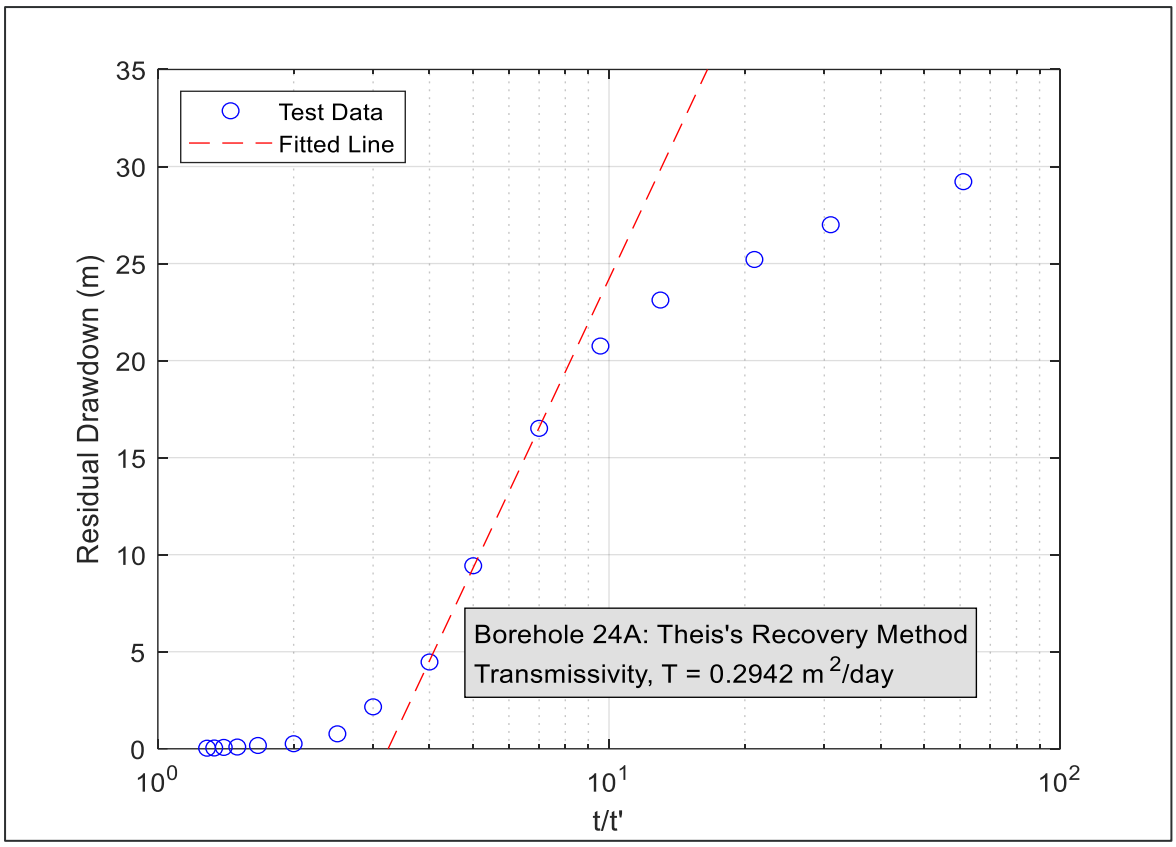


Figure 109: Aquifer tests: Theiss method recovery curve for borehole 24A.

9.10.2.3.9 CONSTANT RATE TEST BOREHOLE KAL 2.1

A static water level of 7.70mbgl was measured at testing locality Kal2.1. Three calibration step tests of 0.20l/s, 0.30l/s, 0.40l/s and 0.75l/s were conducted, followed by a constant discharge test at a rate of 0.20l/s. A maximum drawdown depth of 19.49mbsl was reached after a pump duration of 4-hours representing >85.0% of available drawdown utilised. Borehole recovery observed was good with a 90% recovery of pre-testing water levels obtained within the pumping duration. Refer to Table 44 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 110 depicts the Theiss method displacement time curve fitment while Figure 111 shows the Theiss method recovery curve fitment. The average transmissivity was calculated as 0.29m^2/d with the hydraulic conductivity calculated as 0.014m/d. Gathered site characterisation information suggest that this borehole is targeting the Karoo matrix formation, hence the sluggish seepage volumes observed.

Table 44: Aquifer tests summary: borehole Kal2.1.

Method	T (m^2/day)	S
Jacob	0.09	0.00001
Theis	0.18	0.000017
Recovery	0.1896	-

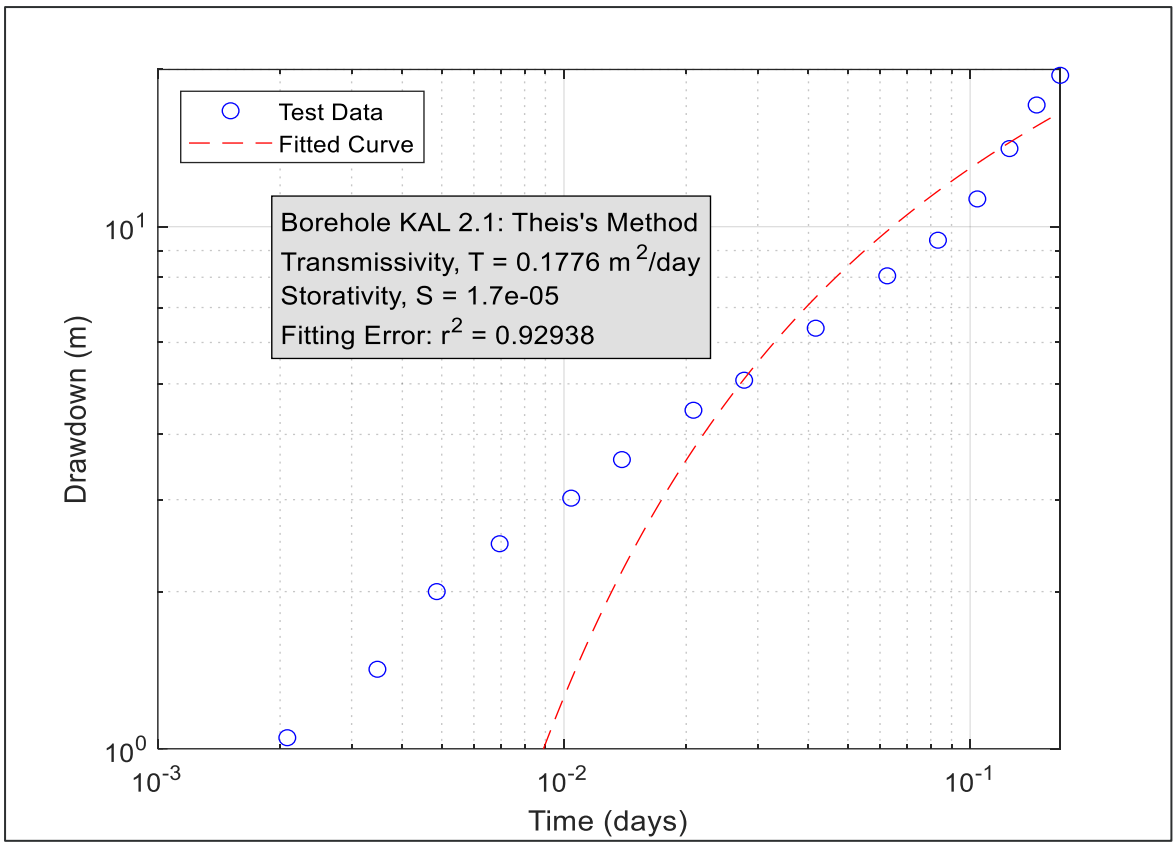


Figure 110: Aquifer tests: Theiss method displacement time curve for borehole Kal 2.1.

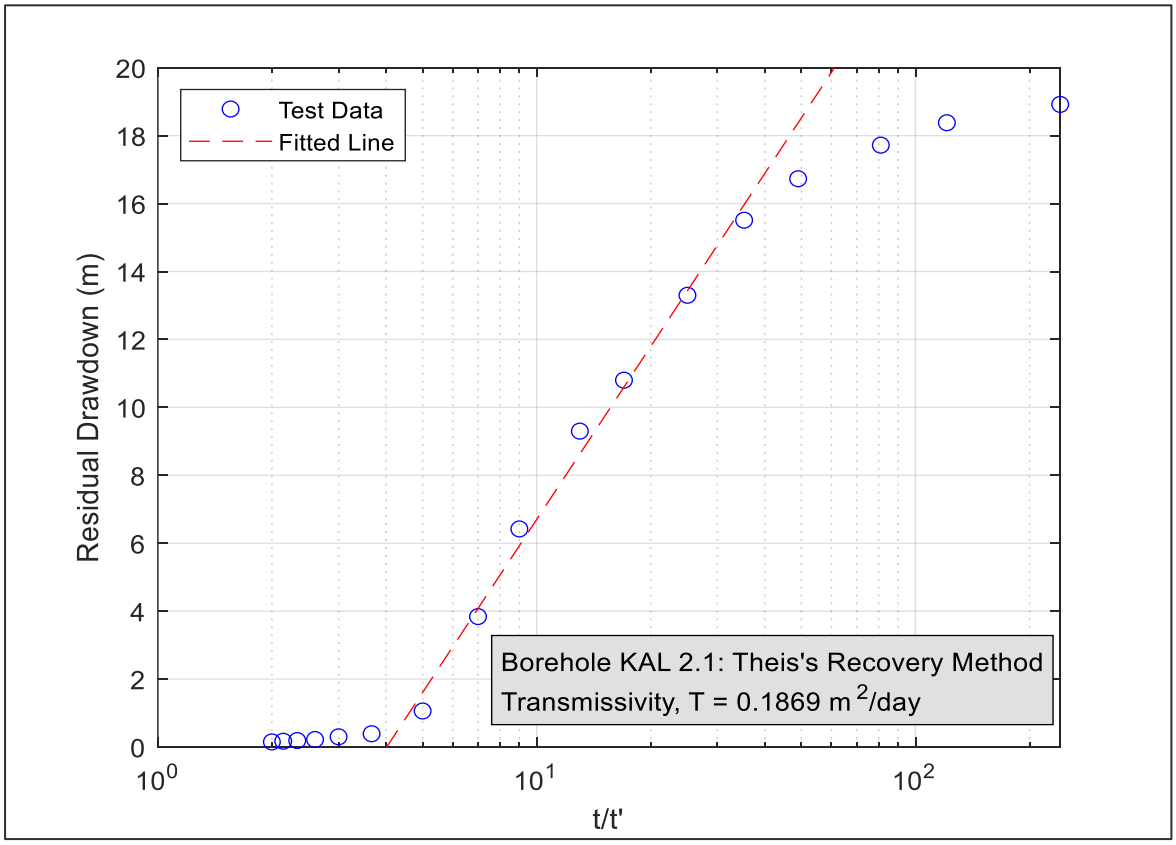


Figure 111: Aquifer tests: Theiss method recovery curve for borehole Kal 2-1.

9.10.2.3.10 CONSTANT RATE TEST BOREHOLE 16B

A static water level of 13.89mbgl was measured at testing locality 16B. A constant discharge test was performed at a rate of 1.44l/s for a duration of two hours. A maximum drawdown depth of 5.99mbsl was reached during the pump test duration, representing >95.0% of available drawdown utilised representing >95.0% of available drawdown utilised. Borehole recovery observed was good with a 90% recovery of pre-testing water levels obtained within the pumping duration. Refer to Table 45 for a summary of hydraulic parameters inferred from the constant discharge pump test. Figure 112 depicts the Theiss method displacement time curve fitment while Figure 113 shows the Theiss method recovery curve fitment. This borehole indicate the highest transmissivity calculated from all testing localities with an average transmissivity value calculated at 11.0m^2/d and the hydraulic conductivity calculated at 0.55m/d. Gathered site characterisation information suggest that this borehole is targeting the shallow quaternary sediments and alluvial deposit aquifer unit.

Table 45: Aquifer tests summary: borehole 16B.

Method	T (m^2/day)	S
Jacob	14.53	0.00001
Theis	12.18	0.000033
Recovery	9.5857	-

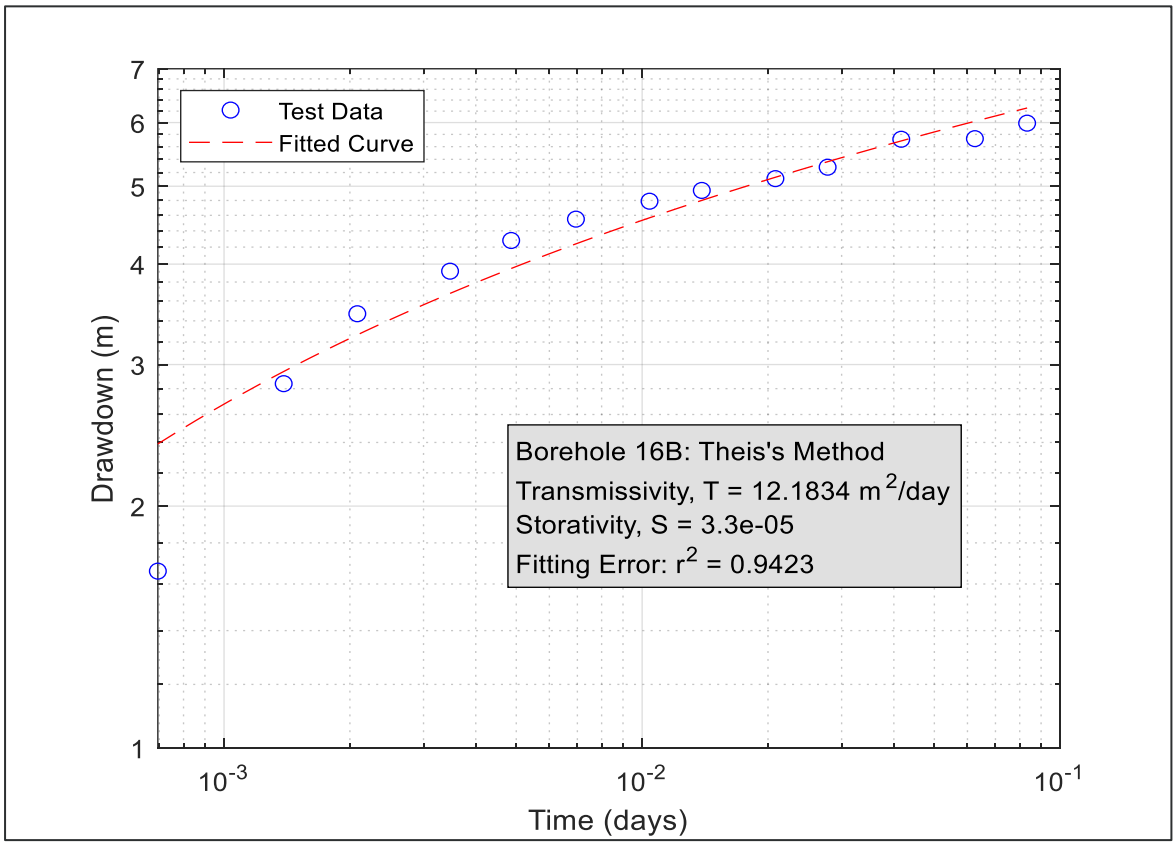


Figure 112: Aquifer tests: Theiss method displacement time curve for borehole 16B.

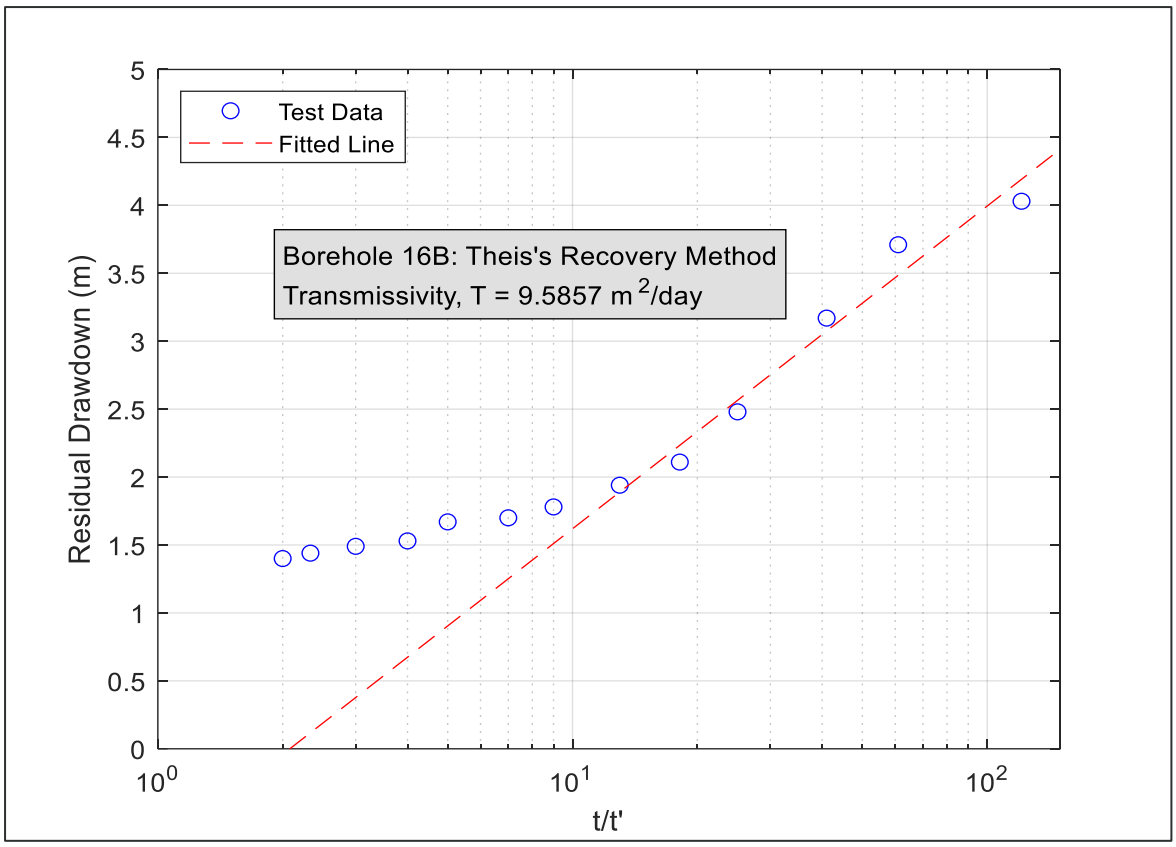


Figure 113: Aquifer tests: Theiss method recovery curve for borehole 16B.

9.10.3 GROUNDWATER FLOW EVALUATION

The following sub-sections outline the groundwater flow dynamics of the study area.

9.10.3.1 **UNSATURATED ZONE**

The thickness of the unsaturated or vadose zone was determined by subtracting the undisturbed static water level elevation from corresponding surface topography. The latter will govern the infiltration rate, as well as effective recharge of rainfall to the aquifer. Furthermore, the nature of the formation(s) forming the unsaturated zone will significantly influence the mass transport of surface contamination to the underlying aquifer(s). During the wet-season evaluation the unsaturated zone within the study area were in the order of 0 (fully saturated to surface) to >21.0m with a mean thickness of approximately ~8.91m. During the dry-season evaluation the unsaturated zone within the study area were in the order of 2.20 to 19.40.0m with a mean thickness of approximately ~7.17m. The variation in the vadose zone thickness and extent observed, can potentially be attributed to the variations in rainfall hence recharge experienced within these periods. It should be noted that due to the argillaceous nature of the host aquifer(s) the shallow water levels observed at some of the borehole localities can be attributed to clay/silt lenses and be indicative of perched aquifer conditions and not necessarily represent the vadose zone.

9.10.3.2 **DEPTH TO GROUNDWATER**

A distribution of borehole water levels recorded as part of the hydrocensus user survey conducted as well as monitoring borehole water levels measured were considered and used to interpolate local groundwater elevation and hydraulic head contours as summarised in Table 46 and Figure 114 (wet-season) as well as Table 47 and Figure 115 (dry-season).

During the wet-season evaluation, artesian conditions were observed at three of the boreholes visited namely HBH31, 21B as well as 8B which can be indicative of semi-confined to confined aquifer conditions present or perched aquifer conditions. The minimum water level was recorded at 0.0mbgl, while the deepest water level

was measured at borehole locality Mon-HDR1 (26.71mbgl). The average water level is calculated at 8.91mbgl which is much shallower than the regional average water level of ~23.0mbgl (Aquiworx, 2014).

During the dry-season evaluation the minimum water level was recorded at 2.20mbgl (HBH161), while the deepest water level was measured at borehole locality HBH136 (42.13mbgl). The average water level is calculated at 7.86mbgl which is much shallower than the regional average water level of ~23.0mbgl (Aquiworx, 2014).

A groundwater observation borehole situated within the study area have been measured at ~25.0mamsl. This confirms the hypothesis that the deep, fractured aquifer unit have been locally depressurised by years of dewatering from underground mining operations targeting these zones for gold beneficiation.

Table 46: Regional water level summary (Wet-season).

Site ID	Topographical Elevation (mamsl)	Water level (mbgl)	Groundwater Elevation (mamsl)
HBH6	1308.35	1.52	1306.83
HBH9	1314.33	10.87	1303.46
HBH12	1317.12	13.65	1303.47
HBH13	1317.12	12.35	1304.77
HBH14	1306.16	16.65	1289.51
HBH15	1306.16	17.74	1288.42
HBH16	1311.92	25.40	1286.52
HBH17	1306.16	11.55	1294.61
HBH18	1312.93	16.47	1296.46
HBH20	1341.47	1.10	1340.37
HBH21	1316.68	2.67	1314.01
HBH23	1313.61	3.16	1310.45
HBH24	1296.78	8.50	1288.28
HBH25	1306.46	24.20	1282.26
HBH27	1300.84	1.40	1299.44
HBH28	1312.85	5.02	1307.83
HBH31	1308.76	0.00	1308.76
HBH33	1303.06	15.70	1287.36
HBH34	1282.46	26.04	1256.42
HBH35	1293.51	3.70	1289.81
HBH36	1311.04	2.66	1308.38
HBH37	1311.33	3.18	1308.15
HBH38	1338.24	2.94	1335.30
HBH39	1312.52	8.26	1304.26
HBH40	1312.52	8.75	1303.77
HBH44	1318.93	8.46	1310.47
HBH45	1318.93	8.40	1310.53
HBH46	1314.70	14.50	1300.20
HBH48	1325.03	11.03	1314.00
HBH49	1325.03	7.12	1317.91
HBH52	1323.97	1.08	1322.89
HBH53	1323.97	2.80	1321.17
HBH54	1363.06	7.98	1355.08
HBH56	1358.94	1.79	1357.15
HBH58	1373.57	7.95	1365.62
HBH59	1373.57	8.35	1365.22
HBH60	1371.99	12.90	1359.09
HBH61	1371.99	12.55	1359.44
HBH62	1337.84	12.70	1325.14
HBH69	1358.14	1.67	1356.47
HBH70	1360.24	3.10	1357.14
HBH72	1332.90	1.75	1331.15

Site ID	Topographical Elevation (mamsl)	Water level (mbgl)	Groundwater Elevation (mamsl)
HBH73	1332.90	1.63	1331.27
15E	1380.01	2.20	1377.81
21A (BH05)	1281.21	12.48	1268.74
21B	1281.21	0.00	1281.21
21D	1280.00	16.09	1263.91
22A	1282.95	10.64	1272.31
22D (BH09)	1281.21	8.33	1272.89
23C	1373.57	5.42	1368.16
25B	1404.66	9.39	1395.27
8B	1325.03	0.00	1325.03
BD52	1381.39	0.73	1380.66
BH01	1283.95	23.33	1260.63
BH02	1308.60	10.07	1298.53
BH07	1281.69	16.97	1264.73
Mon-2057	1320.23	3.09	1317.14
Mon-F1	1290.60	21.46	1269.14
Mon-F3	1304.74	7.74	1297.00
Mon-F4	1319.62	7.69	1311.93
Mon-HDR1	1283.95	26.71	1257.24
OB	1364.24	0.70	1363.54
Geometric Mean	**1321.87**	**8.91**	**1312.88**
Minimum	**1280.00**	**0.00**	**1256.42**
Maximum	**1404.66**	**26.71**	**1395.27**
Standard deviation	**30.02**	**7.17**	**33.46**
Correlation		**0.98**	

Notes: Boreholes highlighted in green represent the current Tetra 4 monitoring localities.

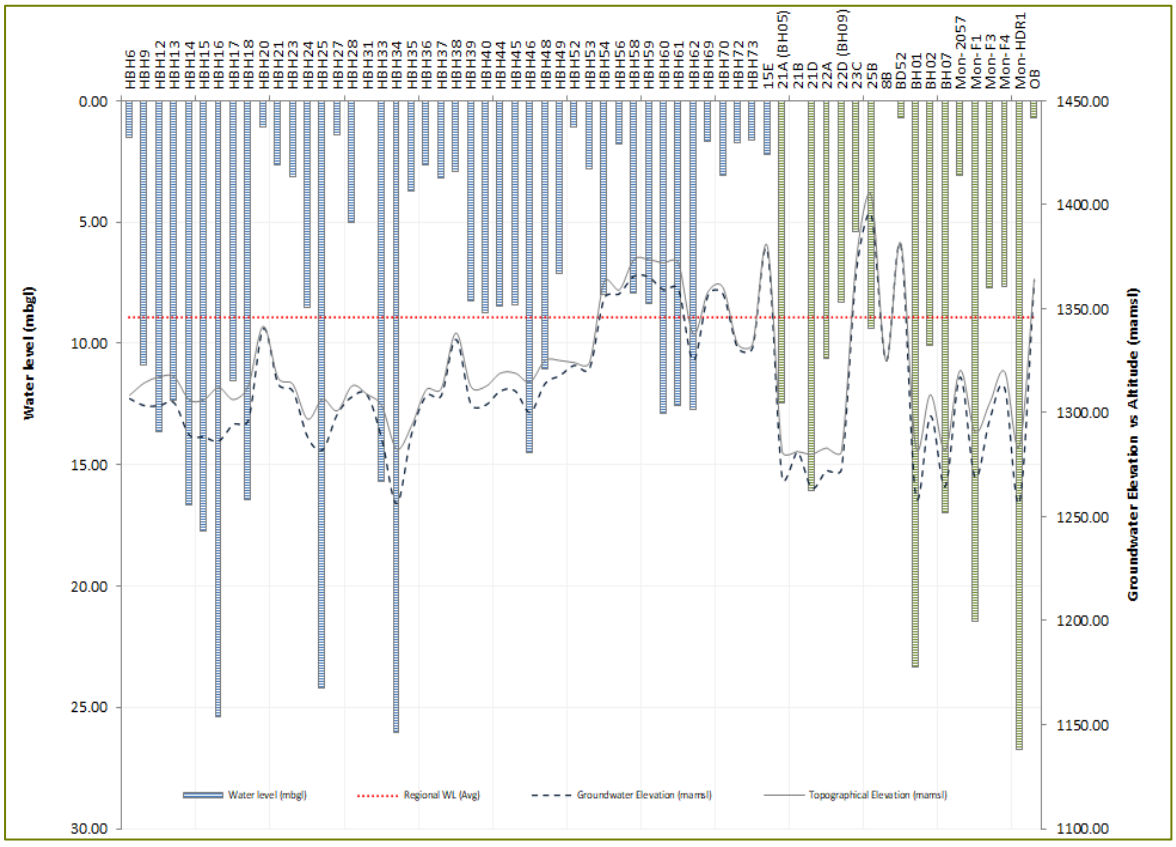


Figure 114: Bar chart indicating regional water level summary (wet-season).

Table 47: Regional water level summary (Dry-season).

Site ID	Topographical Elevation (mamsl)	Water level (mbgl)	Groundwater Elevation (mamsl)
HBH 161	1320.07	2.20	1317.87
HBH 159	1326.36	8.04	1318.32
HBH 190	1315.61	3.36	1312.25
HBH 191	1313.35	4.11	1309.24
HBH 186	1314.19	6.20	1307.99
HBH 188	1328.55	3.69	1324.86
HBH 192	1337.04	6.19	1330.85
HBH 185	1340.00	8.10	1331.90
HBH 193	1340.00	8.61	1331.39
HBH 199	1303.75	6.44	1297.31
HBH 180	1305.31	10.00	1295.31
HBH 181	1305.24	10.78	1294.46
BH 3 DDK	1305.05	32.61	1272.44
HBH 194	1301.79	11.74	1290.05
BH 1 DDK	1301.72	16.66	1285.06
BH 2 KLPK	1318.92	5.51	1313.41
HBH 195	1312.24	3.86	1308.38
HBH 196	1360.68	13.15	1347.53
HBH 197	1360.40	14.15	1346.25
BH 2 BOS 0	1360.00	11.73	1348.27
BH 2 BOS 2	1361.19	5.22	1355.97
HBH 135	1360.07	42.13	1317.94
HBH 136	1342.58	7.19	1335.39
BH MOV	1376.42	6.78	1369.64
HBH 149	1372.93	3.08	1369.85
BH 3 MVL	1373.20	6.78	1366.42
HBH 198	1307.48	19.40	1288.08
HBH 163	1346.62	12.21	1334.41
HBH 200	1345.18	4.34	1340.84
HBH 1645	1362.89	6.84	1356.05
HBH 201	1312.87	8.96	1303.91
HBH 178	1323.00	4.41	1318.59
HBH 166	1342.11	4.53	1337.58
BH 2 DDR	1329.49	5.39	1324.10
BH 2 DRR	1329.47	5.01	1324.46
BH 3 DRR	1334.02	5.52	1328.50
BH 1 DRR	1339.76	8.20	1331.56
HBH 202	1329.76	13.31	1316.45
HBH 203	1385.45	18.13	1367.32
HBH 204	1385.57	8.41	1377.16
HBH 125	1399.70	5.15	1394.55
HBH 123	1380.32	4.69	1375.63
HBH 124	1380.11	4.60	1375.51
HBH 130	1387.81	5.89	1381.92
HBH 129	1390.03	5.56	1384.47
HBH 128	1383.07	5.50	1377.57
HBH 127	1399.84	7.34	1392.50
HBH 119	1379.76	5.14	1374.62
HBH 120	1379.05	13.85	1365.20
HBH 118	1379.96	5.37	1374.59
HBH 122	1379.75	6.06	1373.69
HBH 116	1360.00	4.70	1355.30
HBH 117	1365.56	3.21	1362.35
HBH 151	1380.00	6.98	1373.02

Site ID	Topographical Elevation (mamsl)	Water level (mbgl)	Groundwater Elevation (mamsl)
BH GLR	1314.28	11.58	1302.70
BH 1 GLR	1320.63	6.55	1314.08
HBH 168	1318.19	4.95	1313.24
HBH 206	1313.91	15.20	1298.71
HBH 207	1308.09	25.20	1282.89
HBH 208	1318.94	14.93	1304.01
HBH 209	1317.23	11.65	1305.58
HBH 210	1316.30	15.89	1300.41
HBH 211	1316.46	15.87	1300.59
HBH 212	1328.07	9.46	1318.61
BH 2 HAK	1340.00	6.45	1333.55
HBH 138	1313.54	8.86	1304.68
HBH 167	1311.02	24.33	1286.69
HBH 213	1359.10	3.87	1355.23
HBH 214	1340.00	9.54	1330.46
12A	1380.97	9.89	1371.08
BH17C	1309.35	12.24	1297.11
7B	1313.74	12.12	1301.62
15D	1379.68	5.71	1373.97
Kal2_1	1324.49	7.70	1316.79
16B	1316.16	13.89	1302.27
24A	1317.56	8.00	1309.56
8A	1332.75	7.45	1325.30
RTBH 01	1341.13	8.57	1332.56
RTBH 04	1309.66	7.00	1302.66
RTBH 05	1307.45	8.93	1298.52
RTBH 08	1350.17	4.29	1345.88
RTBH 10	1342.94	5.52	1337.42
Geometric Mean	**1340.40**	**7.86**	**1331.05**
Minimum	**1301.72**	**2.20**	**1272.44**
Maximum	**1399.84**	**42.13**	**1394.55**
Standard deviation	**28.41**	**6.43**	**30.58**
Correlation		**0.98**	

Cells highlighted in red representative of dynamic water levels

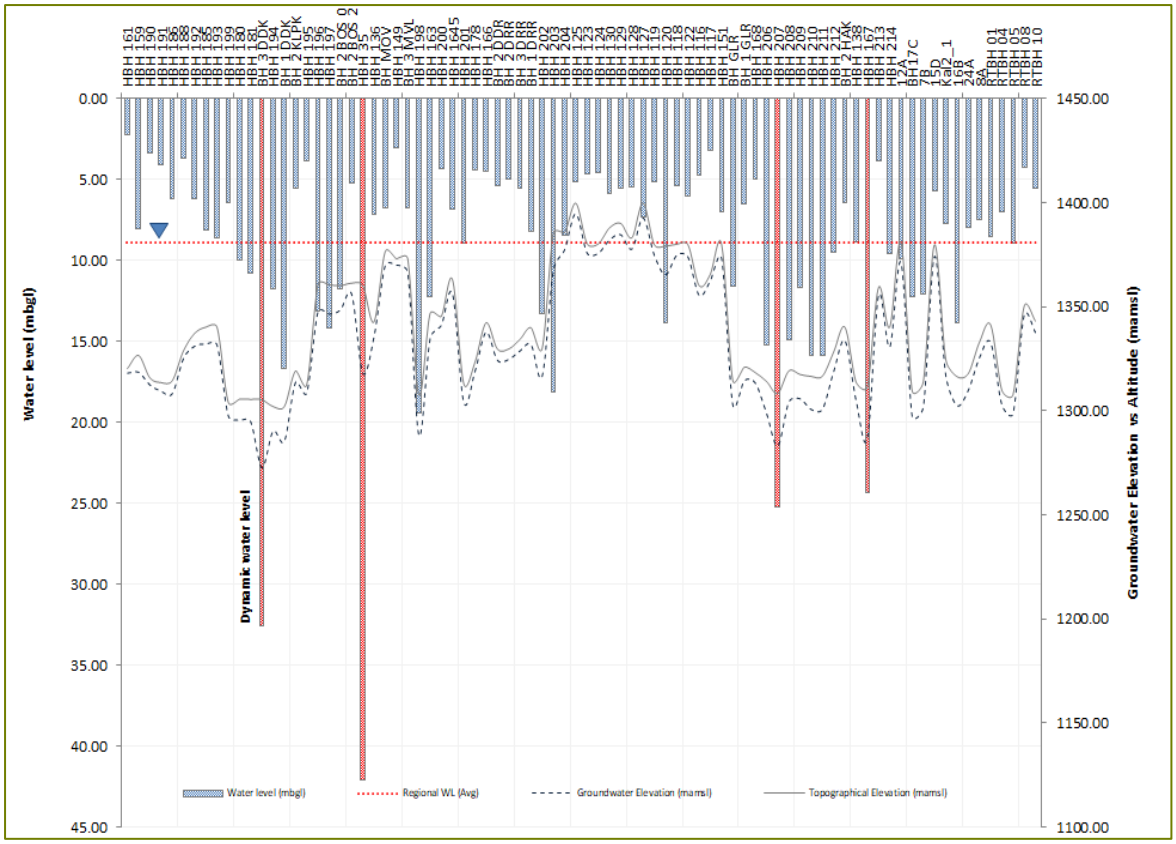


Figure 115: Bar chart indicating regional water level summary (Dry-season).

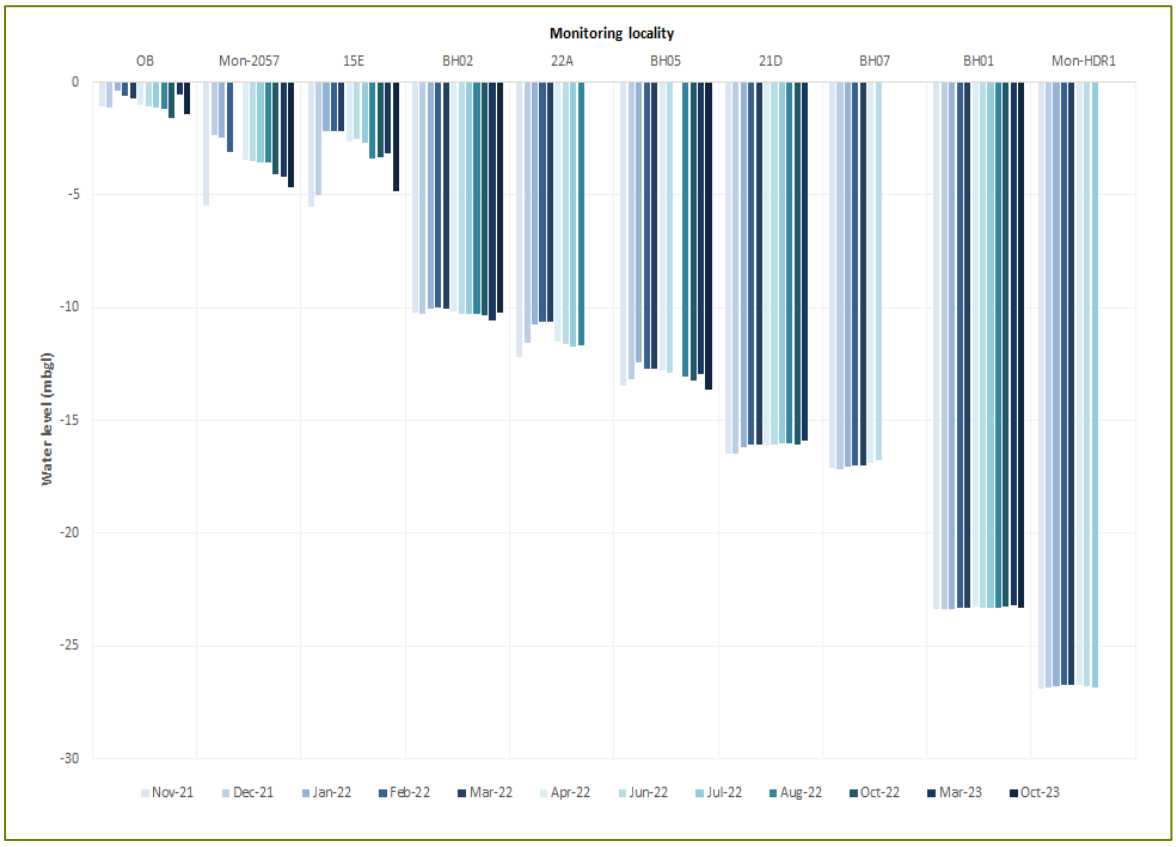


Figure 116: Bar chart indicating time-series water level comparison of the Tetra 4 monitoring boreholes (2021-2024).

Table 48 summarises time-series water levels within the existing Tetra 4 monitoring boreholes by comparing water levels representative of the dry-cycle contribution vs water levels representative of the wet cycle contribution. It is noted that most water levels suggest a decrease in water levels and a recovering trend. The latter can be attributed to the onset of the wet cycle and above average rainfall events experienced with rainfall recharge replenishing aquifer storage. It can be observed that there is a definite relatively quick response to rainfall, suggesting that recharge of the shallow, intergranular aquifer takes place without a prolonged lag effect. The average change in most water levels is <5.0%, which accounts to less than 0.5m, while the relatively low Coefficient of Variation (CV) values derived from statistical analyses suggest that the local groundwater system is in quasi-steady state conditions.

Table 48: Water level statistical summary.

BH ID	Geometric Mean	5th Percentile	95th Percentile	Standard Deviation	Coefficient of Variation (CV)
OB	0.99	0.49	1.49	0.35	0.357
Mon-2057	3.66	2.39	5.06	0.91	0.249
15E	3.30	2.20	5.23	1.18	0.357
BH02	10.22	10.03	10.43	0.15	0.014
22A	11.36	10.64	12.01	0.56	0.050
BH05	13.00	12.57	13.55	0.36	0.028
21D	16.13	15.95	16.47	0.18	0.011
BH07	16.99	16.81	17.14	0.13	0.008
BH01	23.30	23.22	23.36	0.05	0.002
Mon-HDR1	26.79	26.71	26.89	0.07	0.003

9.10.3.3 GROUNDWATER FLOW DIRECTION AND HYDRAULIC GRADIENTS

Analysed data indicate that the surveyed water levels correlate very well to the topographical elevation for both wet-season as well as dry-season contribution as indicated in Figure 117 (R^2 <0.98) and Figure 118 (R^2 <0.98) respectively. Accordingly, it can be assumed that the regional groundwater flow direction is dictated by topography. Bayesian interpolation was used to interpolate the groundwater levels throughout the study area. The inferred groundwater flow direction will be towards the lower laying drainage system(s) traversing the project area from where groundwater will discharge as baseflow. The groundwater flow direction within the southern catchment of the Sandrivier and Doringrivier, also in the vicinity of the proposed plant expansion footprint, will be in a general northern direction, whereas the groundwater flow direction within the northern catchment of the study area will be mostly in a south to southwestern direction as depicted in Figure 119 and Figure 120. Figure 121 indicates the inferred piezometric surface of the fractured aquifer and it is noted that the groundwater flow direction is in a general northern direction[4].

[4] Observation borehole piezometric head applied as part of this assessment was based on hydrochemical signature and the target aquifer should be confirmed.

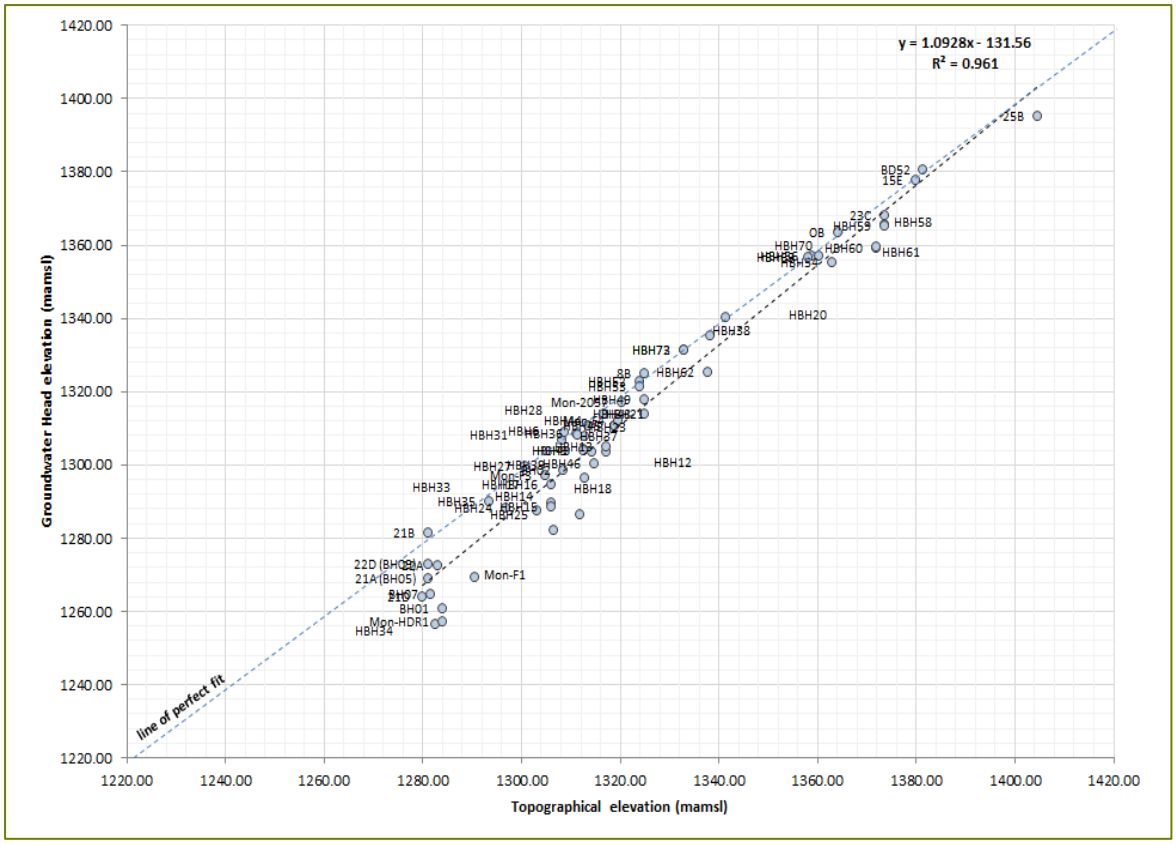


Figure 117: Topographical elevation vs. groundwater elevation correlation graph (Wet season).

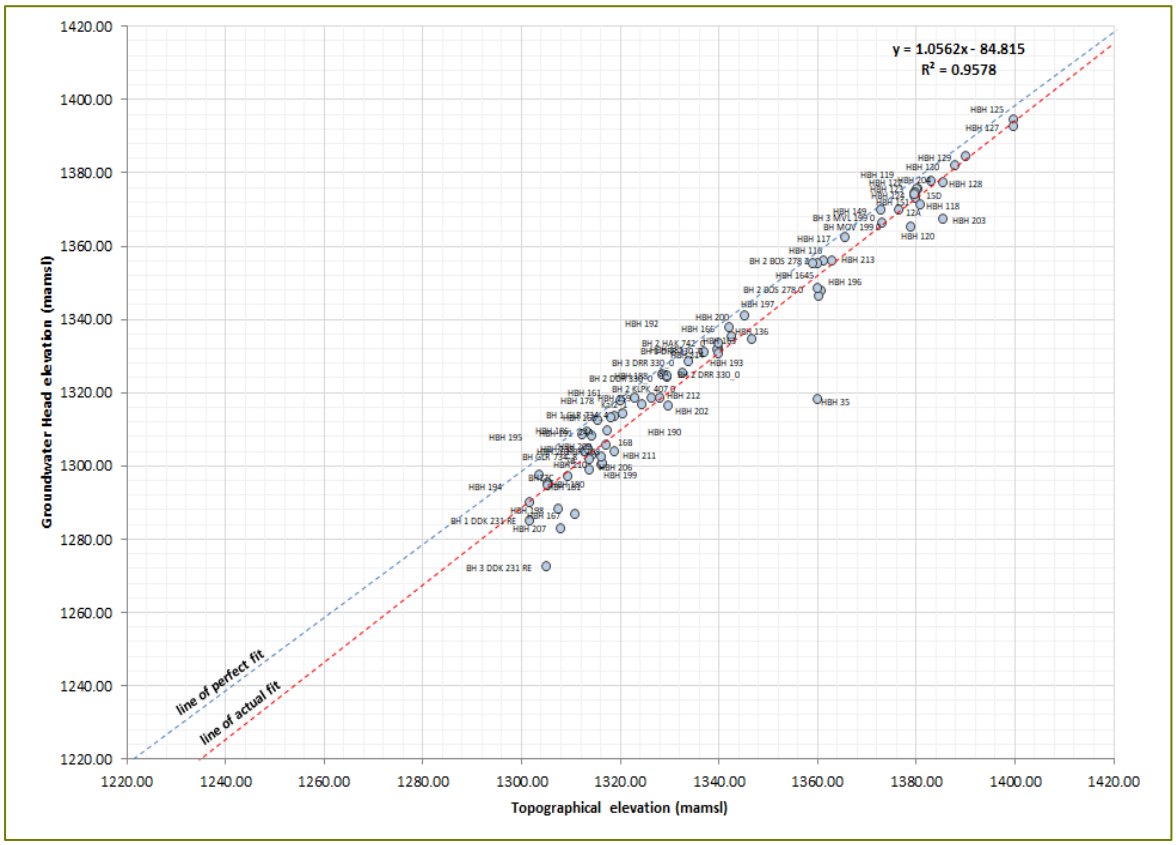


Figure 118: Topographical elevation vs. groundwater elevation correlation graph (Dry season).

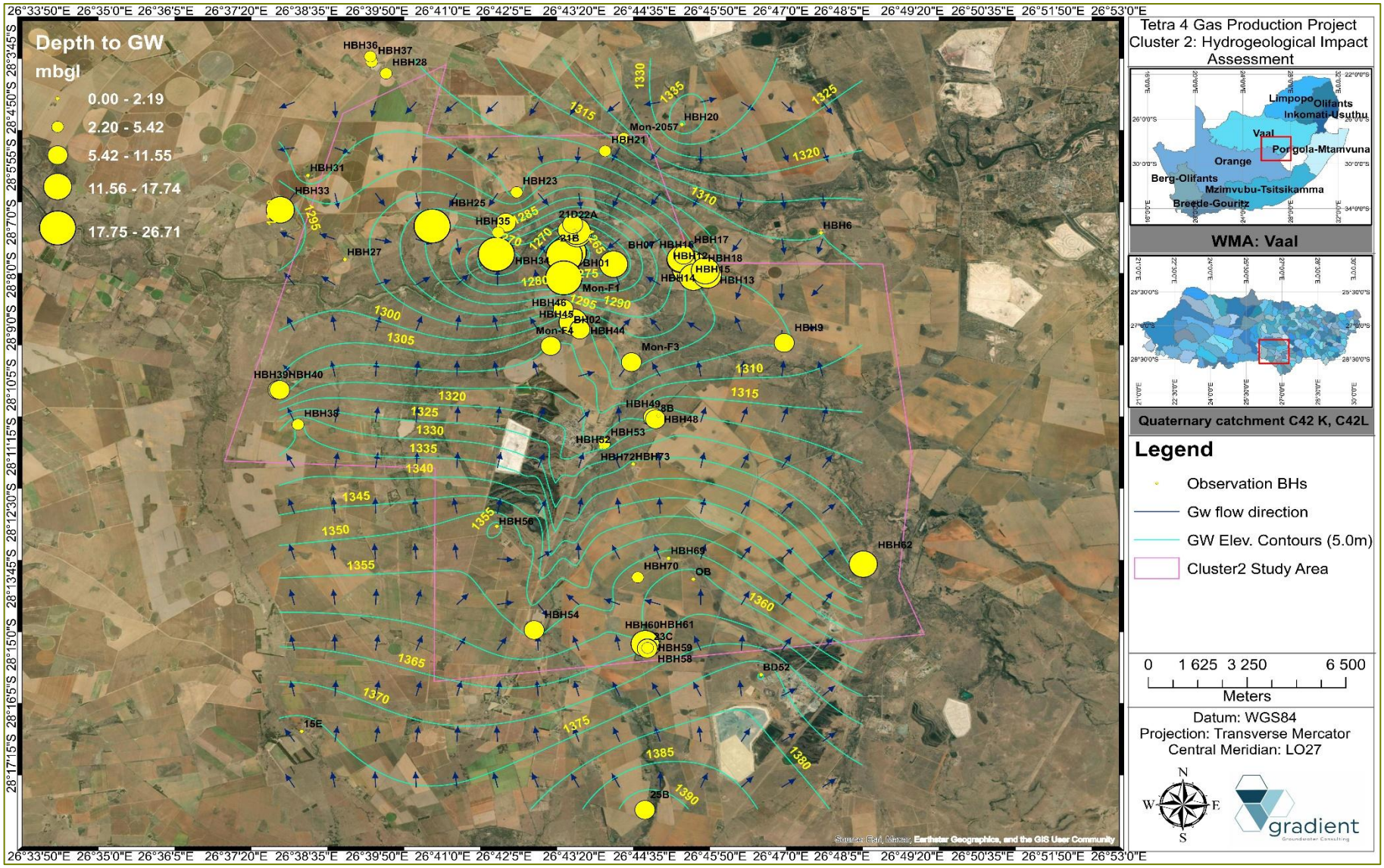


Figure 119: Regional groundwater flow direction and depth to groundwater during the wet season.

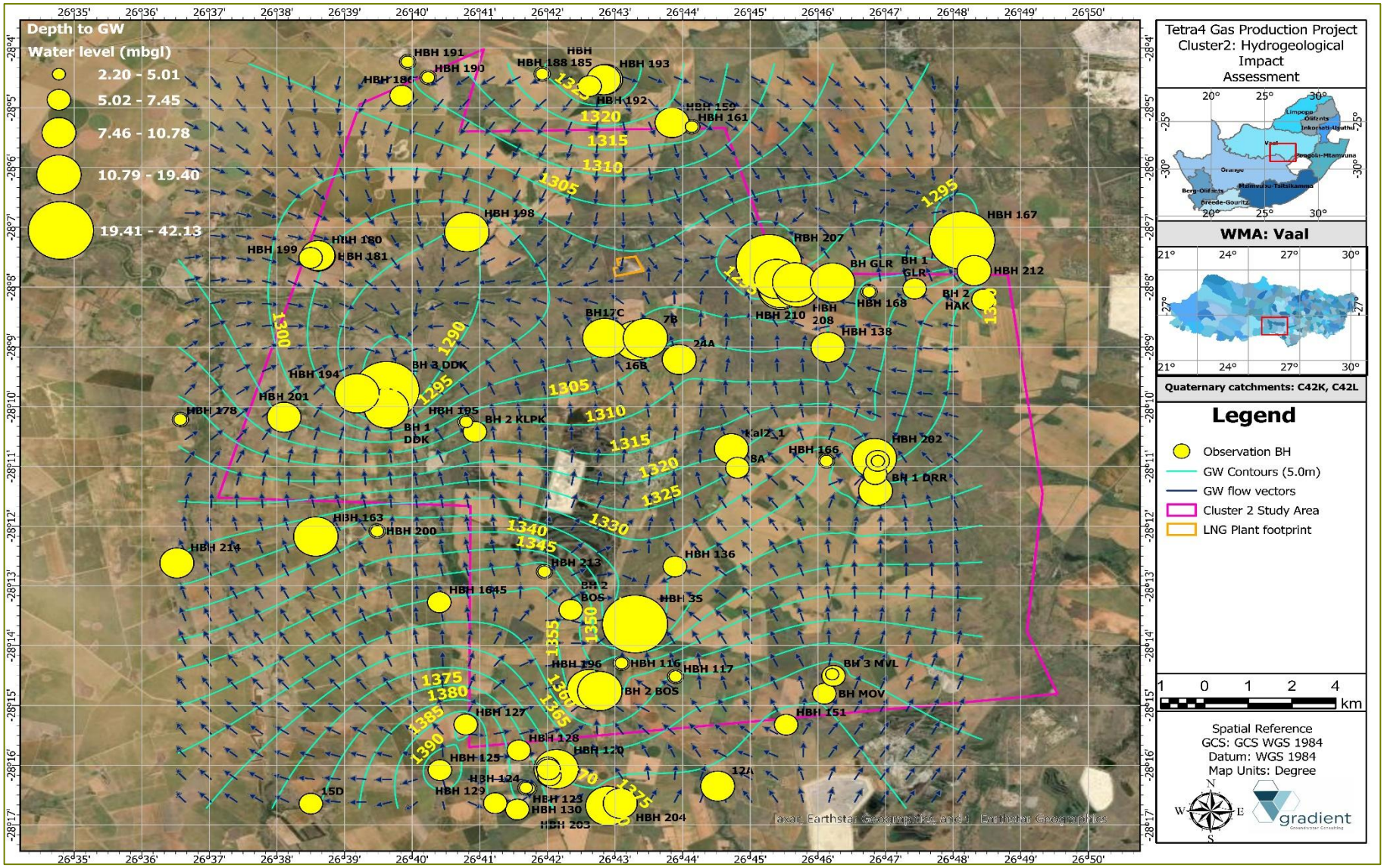


Figure 120: Regional groundwater flow direction and depth to groundwater during the dry season.

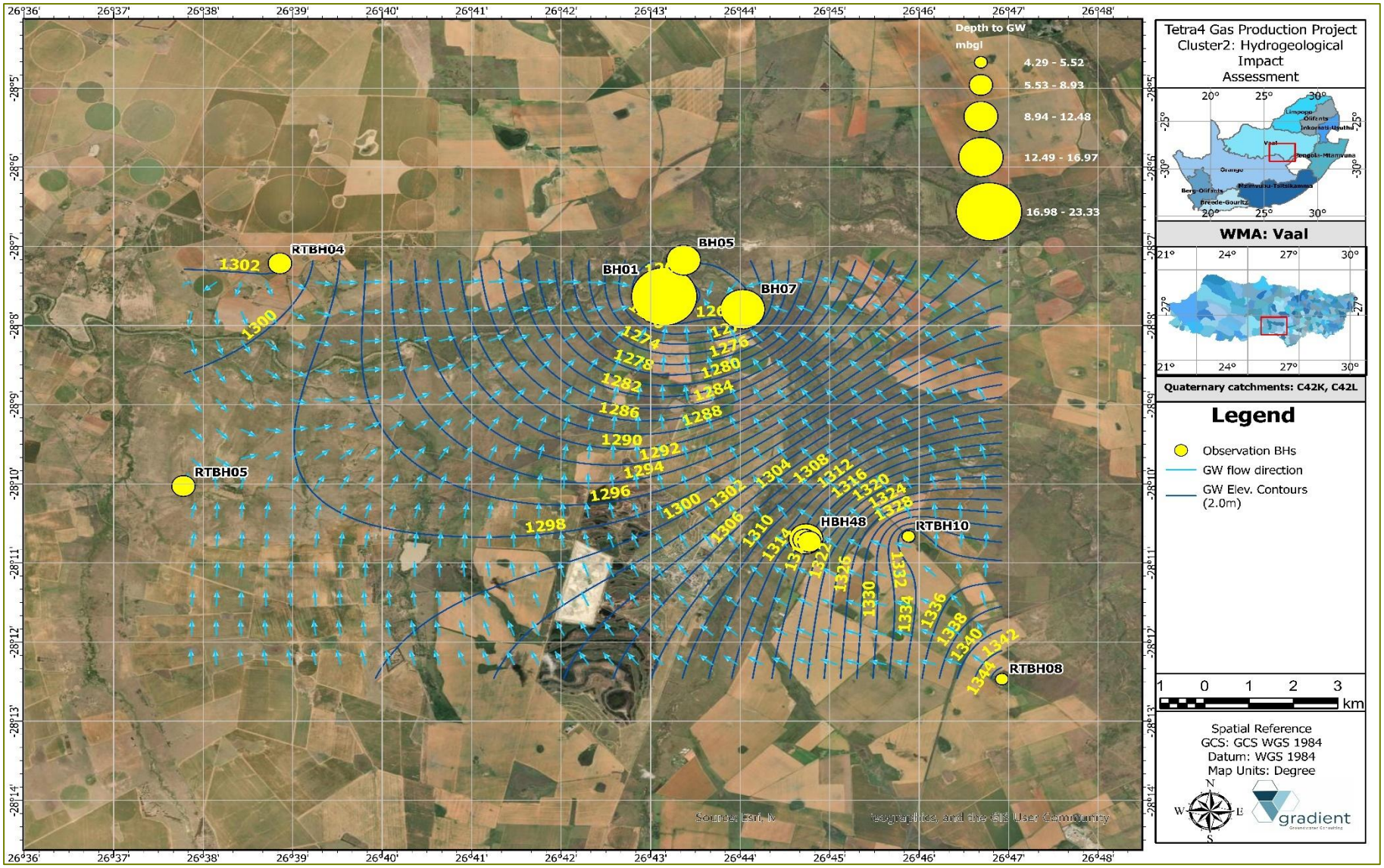


Figure 121: Map depicting the piezometric surface of the deeper, fractured aquifer.

Groundwater flow path lines are lines perpendicular to groundwater contours, flow generally occurs faster where contours are closer together and gradients are thus steeper. The groundwater or hydraulic gradient is the change in the hydraulic head over a certain distance, mathematically it is the difference in hydraulic head over a distance along the flow path between two points. The latter provides an indication of the direction of groundwater flow. The following equation can be applied:

$$i = \frac{dh}{dl}$$

where:

i = Hydraulic gradient (dimensionless).

dh = Is the head loss between two observation wells.

dL = Horizontal distance between two observation points.

The average groundwater gradient (i) of the shallow, weathered aquifer in the vicinity of expansion footprints is relatively flat and calculated at a mean of 0.002 – 0.003 for both wet and dry seasons, with a maximum of 0.003 – 0.004 in a south to north orientation and a minimum of 0.001 in a general east to west orientation as summarised in Table 49 and Table 50 below.

Table 49: Inferred groundwater gradient and seepage direction (Wet season).

Inferred seepage direction	Hydraulic gradient (i)
S to N	0.003
E to W	0.001
SW to NE	0.001
SE to NW	0.002
Minimum	**0.001**
Maximum	**0.003**
Standard deviation	**0.001**
Geometric Mean	**0.002**

Table 50: Inferred groundwater gradient and seepage direction (Dry season).

Inferred seepage direction	Hydraulic gradient (i)
S to N	0.004
E to W	0.001
SW to NE	0.002
SE to NW	0.004
Minimum	**0.001**
Maximum	**0.004**
Standard deviation	**0.001**
Geometric Mean	**0.003**

9.10.3.4 DARCY FLUX AND GROUNDWATER FLOW VELOCITY

The Darcy flux (or velocity) is a function of the hydraulic conductivity (K) and the hydraulic gradient as suggested by Equation 1 below whereas the seepage velocity can be defined as the Darcy flux divided by the effective porosity (Equation 2 below). This is also referred to as the average linear velocity and can be calculated by applying the following equations (Fetter 1994).

Equation 1: Darcy Flux

$$v = Ki$$

Equation 2: Seepage Velocity

$$v = \frac{Ki}{ø}$$

where:

v = flow velocity (m/d).

K = hydraulic conductivity (m/d).

i = hydraulic gradient (dimensionless).

ø = effective porosity.

The expected seepage rate from contamination originating at the proposed plant expansion footprint as well as associated infrastructure is estimated at an average of approximately 1.20 to 1.26m/a, with a maximum distance of ~2.86m/a in a southeastern to northwestern direction as summarised in Table 51 and Table 52 below.

Table 51: Darcy flux and seepage rates (Wet season)[5].

Shallow, intergranular aquifer	Hydraulic gradient (i)	Hydraulic conductivity (K)	Darcy flux (m/d)	Effective porosity	Seepage velocity (m/d)	Seepage velocity (m/a)
S to N	0.003	0.188	0.00060	0.100	0.006	2.202
E to W	0.001	0.188	0.00023	0.100	0.002	0.825
SW to NE	0.001	0.188	0.00025	0.100	0.002	0.908
SE to NW	0.002	0.188	0.00035	0.100	0.003	1.264
Minimum	**0.001**	**0.188**	**0.0002**	**0.100**	**0.002**	**0.825**
Maximum	**0.003**	**0.188**	**0.0006**	**0.100**	**0.006**	**2.202**
Standard deviation	**0.001**	**0.000**	**0.0001**	**0.000**	**0.001**	**0.546**
Geometric Mean	**0.002**	**0.188**	**0.0003**	**0.100**	**0.003**	**1.202**

Table 52: Darcy flux and seepage rates (Dry season).

Shallow, intergranular aquifer	Hydraulic gradient (i)	Hydraulic conductivity (K)	Darcy flux (m/d)	Effective porosity	Seepage velocity (m/d)	Seepage velocity (m/a)
S to N	0.004	0.188	0.00075	0.100	0.008	2.738
E to W	0.001	0.188	0.00020	0.100	0.002	0.724
SW to NE	0.002	0.188	0.00039	0.100	0.004	1.425
SE to NW	0.004	0.188	0.00079	0.100	0.008	2.866
Minimum	**0.001**	**0.188**	**0.0002**	**0.100**	**0.002**	**0.724**
Maximum	**0.004**	**0.188**	**0.0008**	**0.100**	**0.008**	**2.866**
Standard deviation	**0.001**	**0.000**	**0.0002**	**0.000**	**0.002**	**0.900**
Geometric Mean	**0.002**	**0.188**	**0.0005**	**0.100**	**0.005**	**1.687**

9.10.3.5 GROUNDWATER-SURFACE WATER INTERACTION

Groundwater and surface water interaction is an essential component of the hydrological cycle. The hyporheic zone (stream bed) is the zone of most interaction (Adams et. al.,2012). According to records documented by Van Tonder and Dennis (2003), under natural conditions this area exhibits certain regions where there is pronounced interaction between surface and groundwater. The two regimes are therefore well-linked and should be integrated to manage any water-related issues in these catchments. Regional drainages can be generally classified as influent or gaining stream systems as the groundwater head elevation of the water table in the vicinity of the stream is higher than the altitude of the stream bed and, accordingly, there definitely exists groundwater discharge as baseflow to local drainages. The alluvial associated with the floodplains of the Sand -

[5] This estimate does however not take into account all known or suspected zones in the aquifer like preferential flow paths formed by faults and fracture zones or igneous contact zones like the intrusive dykes that have higher transmissivities than the general aquifer matrix. Such structures may cause flow velocities to increase several meters or even tens of meters per year under steady state conditions. Under stressed conditions such as at groundwater abstraction areas the seepage velocities could increase another order of magnitude.

and Doringrivier forms a primary aquifer and is directly connected with surface water resources, especially during high flow conditions (Lea, 2017).

9.10.4 GROUNDWATER QUALITY

The hydrochemical results of the hydrocensus boreholes water samples analysed suggest the overall ambient groundwater quality is good with most macro and micro determinants falling within or below the SANS 241:2015 limits. Groundwater can be described as neutral, saline to very saline and hard to very hard. The groundwater quality is impacted by the geological formations, which were deposited in shallow marine environments and are therefore naturally saline (Lea, 2017).

It is observed that most of the boreholes indicate elevated Nitrate (NO_3) concentrations. The latter may be attributed to the agricultural land-use activities dominating the greater study area with elevated NO_3 concentrations potentially derived from leachate of fertilizer to the local aquifer. It should be noted that elevated nitrate concentrations were also recorded in most of the hydrocensus boreholes identified during the initial groundwater study of 2017. It is noted that the TDS concentration increases towards the northern section of the study area as well as near the drainages present. This can most likely be attributed to the geology within these sections. Refer to Figure 122 for a spatial distribution map of nitrate concentrations per borehole locality analysed. It is noted that borehole localities with elevated NO_3 concentrations are generally situated within or directly down-gradient of planted crop areas as well as near surface water features.

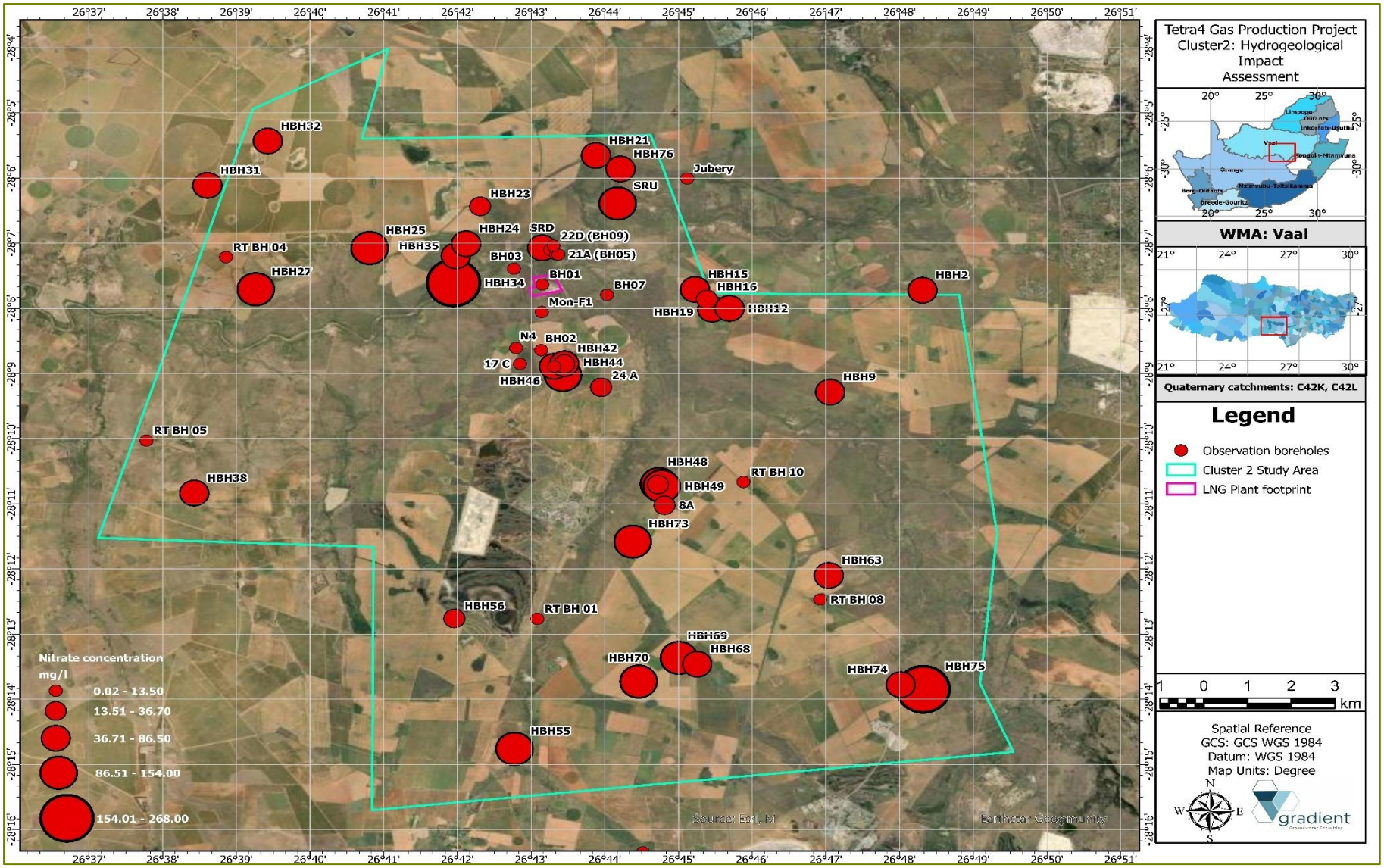


Figure 122: Nitrate (NO_3) spatial distribution (mg/l).

Isolated sampling localities also suggest elevated Calcium (Ca), Magnesium (Mg), Sodium (Na) and Chloride (Cl) concentrations which may be indicative of the intermediate, fractured aquifer unit being targeted by the respective borehole(s), sourcing more stagnant groundwater. The latter may also be indicative of over-abstraction of the respective boreholes which result in more saline matrix water being sourced due to turbulent flow conditions instead of water being sourced from fractures via laminar flow conditions.

Surface water samples include an upstream (SRU) and down-stream (SRD) water sample which were collected from the Sandrivier passing down-gradient of the existing and proposed plant expansion footprint area. The surface water quality can be classified as moderate to good with Aluminum (Al) and Iron (Fe) being slightly elevated. It should be noted that there is not a significant change in the downstream water quality compared to the upstream quality with an increase in Aluminum (Al), however all surface water samples analysed suggest elevated heavy metal concentrations i.e., Al and Fe.

The hydrochemical results of the monitoring boreholes water samples analysed suggest the overall ambient groundwater quality to be moderate with a higher salt load being observed. Groundwater can be described as neutral, saline to very saline and hard to very hard. Most samples analysed suggest elevated Calcium/Magnesium-Chloride concentrations with isolated boreholes (BH04 and BH05) indicating elevated concentrations of Manganese (Mn).

The hydrochemical results of the newly established site characterisation boreholes water samples analysed suggest the overall ambient groundwater quality to be good (RTBH08 and RTBH10) to moderate with a higher salt load being observed at boreholes RTBH01 and RTBH04. Groundwater can be described as neutral, saline to very saline (RTBH01 and RTBH04) and hard to very hard. The latter samples analysed suggest elevated Calcium/Magnesium-Chloride concentrations with isolated boreholes (RTBH01) indicating elevated concentrations of Barium (Ba) while RTBH04 suggest elevated Sulphate (S04), Aluminum (Al) and Iron (Fe) concentrations.

A summary of the water quality analysis for the 2022 and 2024 hydrocensus samples as well as monitoring boreholes is contained in the Geohydrological Specialist report contained in Appendix 4.

In order to evaluate the risk of groundwater containing radioactive substances, earmarked boreholes were subjected to analysis of radionuclides (Gross Alpha and Beta Radioactivity). This method covers the measurement of gross alpha and gross beta particle activities in drinking water. It should be noted that the method is a screening technique for monitoring drinking water supplies for alpha and beta particle activities according to the limits set forth under the Safe Drinking Water Act, PL 93-523, 40 FR 34324, and thereby determining the necessity for further analysis. If radionuclides are present in groundwater, they can be accumulated in the environment and pose a potential hazard to human health since radionuclides and their decay products can be absorbed by the human body through the food chain or water intake (Baeza et al., 2011, Orloff et al., 2004, Poskas *et al*., 2019).

Refer to Table 53 for a summary of the radioactivity analyses results (Gross Alpha/Beta activity) compared to World Health Organisation (WHO) guidelines with a spatial distribution map depicted in Figure 123. It is noted that the overall ambient groundwater quality with reference to radioactive substances is good with the majority of boreholes analysed falling below the WHO limits for Gross Alpha/Beta activity. It is however observed that borehole 11A suggests elevated Gross Alpha activity i.e., 7.57Bq/l which is above the WHO limit of 0.50Bq/l. It should be noted that this borehole is situated in relatively close proximity to a mine tailings disposal facility, which may potentially hold radioactive material sourced from mining processes. As this method provides a rapid screening measurement to indicate whether specific analyses are required, it is suggested that this borehole sample undergo further analysis in order to determine the exact radioactive species and associated risk. Refer to the Geohydrological Specialist report contained in Appendix 4 for the radioactivity analysis test report.

Table 53: Hydrochemistry: Radioactivity analyses results (Gross Alpha/Beta activity) compared to World Health Organisation (WHO) guidelines.

Radioactivity		
Parameter	**Gross Alpha**	**Gross Betha**
WHO Limits	**≤0.50 Bq/L**	**≤1.00 Bq/L**
BH04	<0.18	0.34
11A**	7.57	0.58
25A	0.31	0.30
BR26B	<0.061	<0.24
7A	0.27	0.66
OB	0.41	0.65
15A	0.39	0.52
Mon_MVD_RE_1	<0.075	<0.24
Geometric Mean	**0.16**	**0.47**
Harmonic Mean	**0.12**	**0.38**
5th Percentile	**0.06**	**0.24**
95th Percentile	**0.56**	**2.40**
Standard deviation	**0.19**	**0.95**

Red shaded cells exceed WHO drinking water guidelines.
****Adjusted or corrected water sample radioactivity by applying the K-40 activity rule as per WHO recommendation**

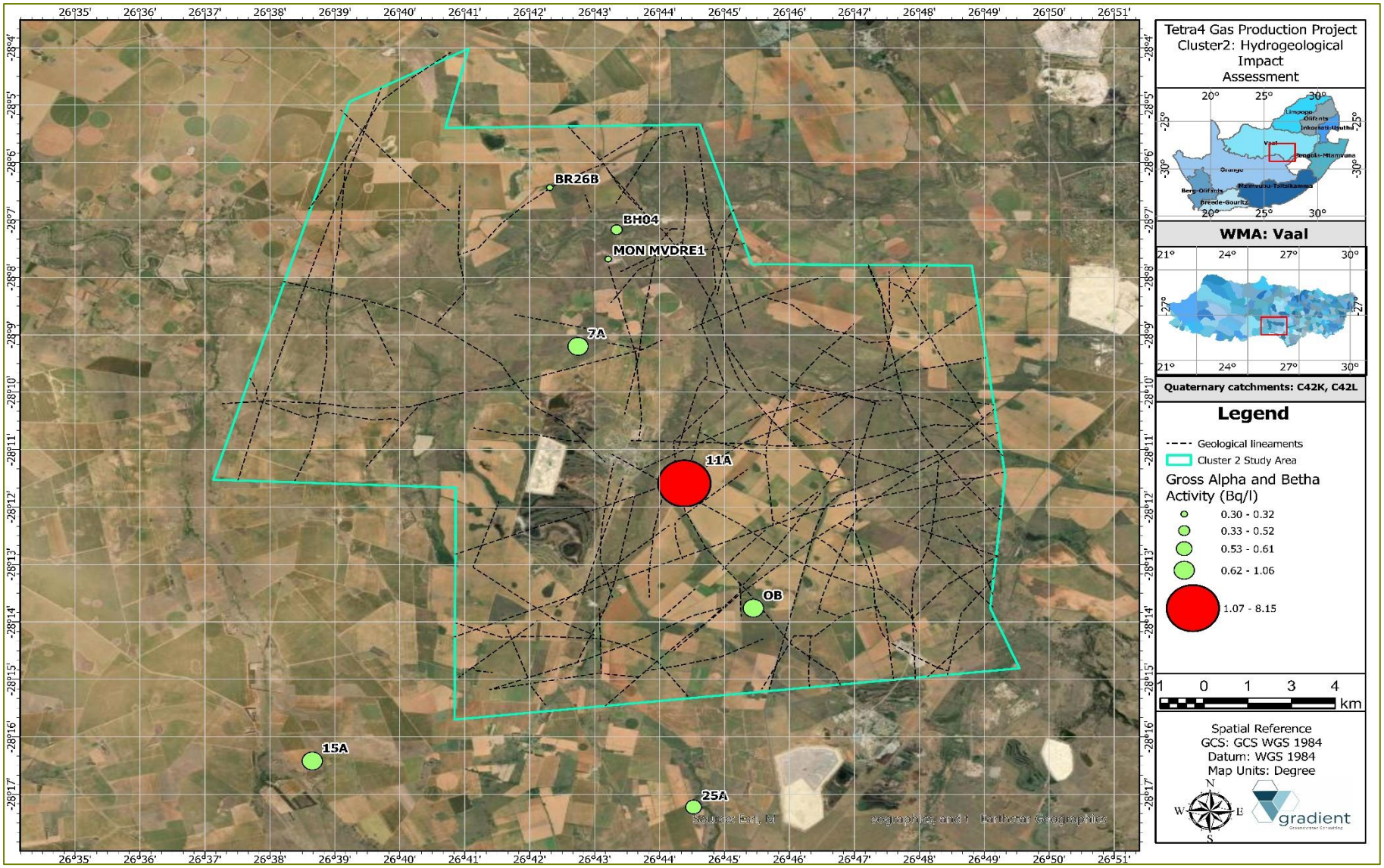


Figure 123: Spatial distribution map of boreholes analysed for Gross Alpha and Beta activity.

9.10.5 GROUNDWATER CONTAMINATION RISK ASSESSMENT

The most widely accepted definition of groundwater contamination is defined as the introduction into water of any substance in undesirable concentration not normally present in water e.g., microorganisms, chemicals, waste or sewerage, which renders the water unfit for its intended use (UNESCO, 1992). The objective of this study is to formulate a risk-based framework from geological and hydrogeological information obtained as part of this investigation. As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required. The GQM Index is obtained by multiplying the rating of the aquifer system management and the aquifer vulnerability. A GQM Index = 4 was calculated for the local aquifer system and according to this estimate, a "Medium" level groundwater protection is required for this aquifer system.

The concept of groundwater vulnerability to contamination by applying the DRASTIC methodology was introduced by Aller et al. (1987) and refined by the US EPA (United States Environmental Protection Agency). DRASTIC is an acronym for a set of parameters that characterise the hydrogeological setting and combined evaluated vulnerability: Depth to water level, Nett Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone and Hydraulic Conductivity. This method provides a basis for evaluating the vulnerability to pollution of groundwater resources based on hydrogeological parameters. Lynch *et al*. (1994) suggests a considerable variation in terms of hydraulic conductivity in hard rock aquifers and revised this methodology to accommodate local aquifer conditions accordingly. According to the DRASTIC index methodology applied, the proposed activities and associated infrastructure's risk to groundwater pollution of the aquifer system(s), is rated as "Moderate".

To evaluate the risk of groundwater contamination of shallow freshwater aquifers which are exploited by farmers etc., potential sources of contamination should be identified, as well as potential pathways and receptors. The pollution linkage concept relies on the identification of a potential pollutant (i.e. source) on-site which is likely to have the potential to cause harm on a receptor by means of a pathway by which the receptor may be exposed to the contaminant.

The following potential sources have been identified:

i. Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.

ii. Migration of stray gas from the production zone to the overlying, potable aquifer(s) during the gas production phase.

iii. Migration of contaminants from the plant expansion waste facilities and associated infrastructure, such as the evaporation dam, into local water resources and host aquifers.

The following aquifer pathways have been identified:

i. Vertical flow through the unsaturated/vadose zone as well as saturated zone to the underlying intergranular and fractured rock aquifers. The rate at which seepage will take place is governed by the permeability of sub-surface soil layers and host-rock formations.

ii. Preferential flow-paths include the contact between the depth of weathering and fresh un-weathered rock, fractures, faults, joints and bedding planes. Secondary fractures may also potentially act as transport mechanisms.

iii. If not adequately sealed and suitably mitigated, gas exploration and production wells will form preferential flow paths and serve as a direct connection between the deeper, fractured aquifer and shallow, potable aquifer unit(s).

The following receptors were identified:

i. Shallow, inter-granular as well as the intermediate, fractured aquifer units situated within the plume migration footprint(s).

ii. Down-gradient drainages and streams including associated riparian zone aquifer system(s) and baseflow contribution.

iii. Private or neighbouring boreholes associated with relevant fracture zones and/or structures(s)if intercepted by the pollution plume migration footprint.

9.10.6 NUMERICAL GROUNDWATER FLOW AND CONTAMINANT TRANSPORT MODEL

The purpose of a groundwater model is to serve as a tool to evaluate various water management options and scenarios. The detail on how the model is constructed and calibrated is included in the Geohydrological Specialist report contained in Appendix 4.

It should be noted that modelling scenarios are based on the worst-case approach to identify the most severe potential outcomes, ensuring preparedness for low-likelihood but high-impact events. A worst-case scenario is a concept in risk management wherein the modeller, considers the most severe possible outcome that can reasonably be projected to occur in a given situation and is a common form of strategic planning. The “worst case” scenario approach is applied to determine the maximum potential and in particular useful when the modelling is associated with high uncertainties (Matthias, K (2011); Haimes, Y (2008)). Thus, although there is some evidence that the deeper, saline-water bearing aquifer, is depressurised, with gradient-driven solute transport unlikely, migration of saline groundwater, along with a poorly constructed and jeopardised production well have been simulated to serve as a worst-case scenario in order to formulate adequate mitigation and management measures.

The model shows the direction of natural groundwater movement which will result in the downstream transportation of any artificially introduced contaminants from a particular source or location. This would result in downstream receptors (e.g. abstraction boreholes, etc) becoming contaminated) if the contaminant source is not suitably mitigated in the first place. The steady state hydraulic heads and groundwater flow direction is presented in Figure 124.

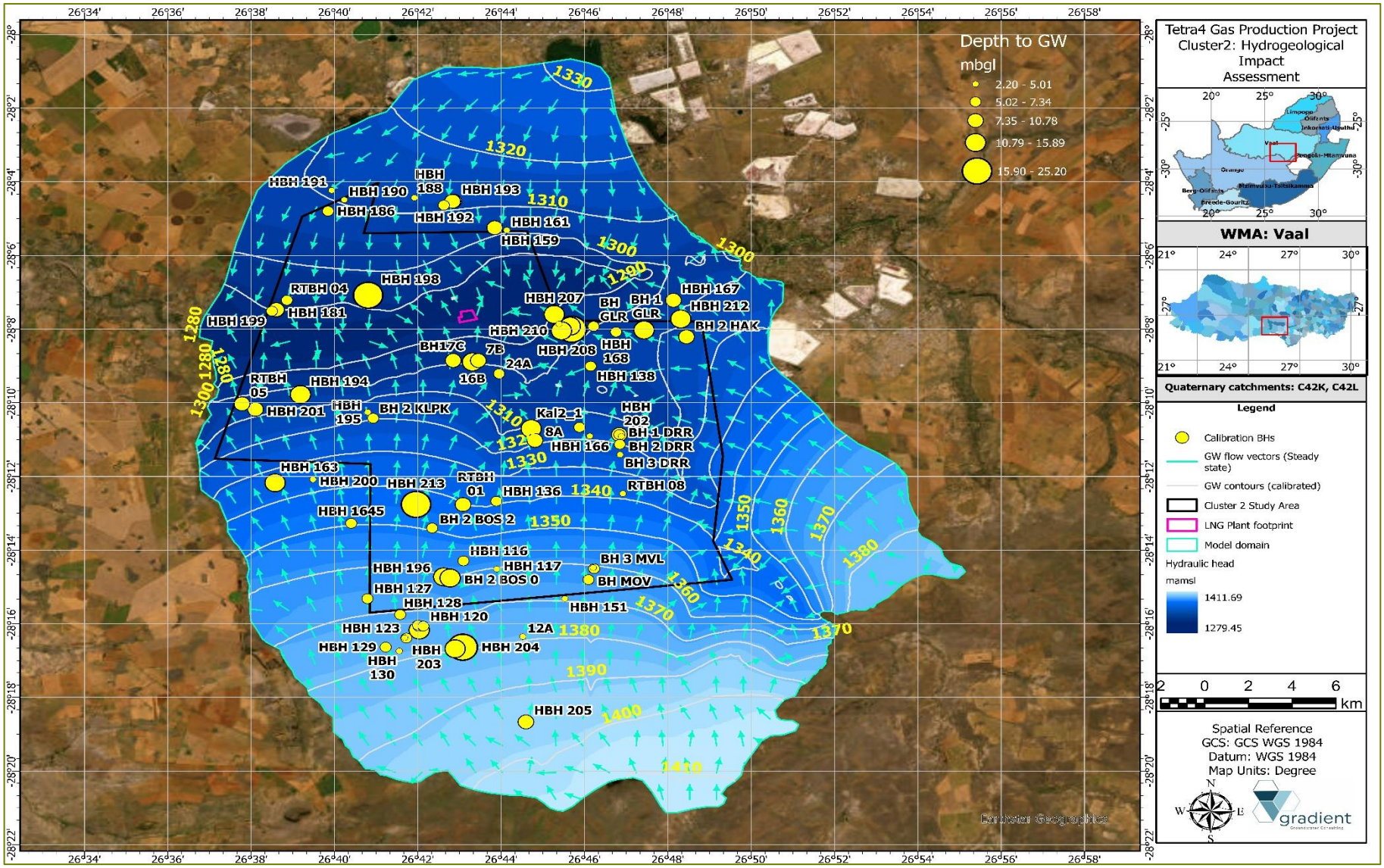


Figure 124: Steady state hydraulic heads and groundwater flow direction.

A contaminant transport scenario was conducted simulating stray methane gas (CH_4) from leaking gas production boreholes. The drilling and operation of gas production wells could result in the migration of stray gas from the deep-seated fracture zones to formations higher up in the geological sequence. This impact has been recorded in the US where hydraulic fracturing, dewatering or a combination of these has occurred (Jackson et al, 2013). It should be stated that Tetra4 does not intend to undertake hydraulic fracturing, or any well stimulation and the existing dataset suggests that no dewatering of produced water will be required. Accordingly, the risk of stray gas migration is therefore expected to be low. It should be noted that this scenario is highly unlikely under natural conditions as the production zone(s) is separated from the shallow and potable Karoo aquifer by very low permeability shale formations which will act as an aquitard towards any groundwater and stray gas migration. This is however provided that well construction, including cementation and the installation of steel casing, is sound. As such, the impact assessment evaluated represents a worst-case scenario and simulates the eventual occurrence once stray gas does reach the shallow aquifer. The mechanisms by which stray gas can migrate into the shallower potable Karoo aquifer include (iLEH, 2017):

- Leakage of stray gas along poorly sealed gas production wells;
- Gas leakage because of an overpressure event and barrier (casing and cementation) failure; and
- Migration of gas from deep-seated fracture zones along fractures and faults.

As methane gas reaches saturation in water at 28 milligrams per litre (mg/L) at atmospheric pressure (Eltschlager and others, 2001), this concentration was applied as source term for this scenario. According to the U.S. Environmental Protection Agency (EPA, 2011) as well as U.S. Department of the Interior, Office of Surface Mining (2011), methane concentrations below 10 mg/L are generally considered safe.

Various management scenarios were modelled for the purposes of planning and decision making with stress periods listed in Table 54:

i. **Scenario 01:** Steady state water balance (∞).

ii. **Scenario 02a:** Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the operational gas production phase.

iii. **Scenario 02b:** Migration of stray methane (CH_4) gas emanating from the production zone to the overlying, potable aquifer(s) during the operations gas production phase.

iv. **Scenario 03:** Migration of the TDS pollution plume emanating from the evaporation dam footprint area during the operational gas production phase.

v. **Scenario 04a:** Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the post-closure and decommissioning phase (50-year and 100-year scenarios).

vi. **Scenario 04b:** Migration of stray methane (CH_4) gas emanating from the production zone to the overlying, potable aquifer(s) during the post-closure and decommissioning phase (50-year and 100-year scenarios).

vii. **Scenario 05:** Migration of the TDS pollution plume emanating from the evaporation dam footprint area during the post-closure and decommissioning phase (50-year and 100-year scenarios).

viii. **Scenario 06:** Mitigation and Management – Evaluating the effect of implementation of a liner or barrier system underneath the evaporation dam on the TDS pollution plume migration.

ix. **Scenario 07:** Evaluating the effect of climatic change i.e., wet vs. dry cycle rainfall scenarios on the TDS pollution plume migration.

Table 54: Summary of model stress-periods.

Stress period	Description
Year01 – Year20	Gas production operational phase
Year 21 – Year 71	50-years post closure
Year 72 – Year 121	100-years post closure

9.10.6.1 SCENARIO 01: STEADY STATE BASELINE WATER BALANCE (∞)

Recharge is assumed the only source of inflow to the system and has been simulated at 2.79E^{+04}m^3/d, while the largest loss to the groundwater system is via groundwater contribution to baseflow, 2.78E^{+04}m^3/d. Water captured as storage equates to 3.20E^{+02}m^3/d while water released from storage is calculated as 2.44E^{+04}m^3/d. The imbalance of the delineated aquifer unit, ignoring internal transfer, is calculated at 1.50E^{+02}m^3/d.

9.10.6.2 SCENARIO 02A: MIGRATION OF SALINE GROUNDWATER FROM THE DEEP, FRACTURED AQUIFER TO THE OVERLYING, POTABLE AQUIFER(S) DURING THE OPERATIONAL GAS PRODUCTION PHASE

This scenario summarises the simulated point source pollution plume migration of saline groundwater emanating from the deep, fractured aquifer should the integrity of the gas production boreholes be jeopardised i.e., leaking boreholes for the operational phase (20-year period).

It should be noted that, due care will be taken to ensure that production boreholes will be properly constructed and adequately sealed, a cautious approach i.e., "worst-case" scenario have been followed during the modelling of leaking boreholes (unmitigated scenario).

The TDS pollution plume extend covers a total area of approximately 634.4ha in the Karoo formations, reaching a maximum distance of ~150.0m in a general north to northeastern direction (southern catchment) and a southwestern direction (northern catchment) propagating in a radial pattern from the gas production borehole(s) towards the lower laying drainage system. The TDS pollution plume extend within the alluvial, riparian zone aquifer covers a total area of approximately 182.37ha, reaching a maximum distance of ~250.0m propagating in a radial pattern from the gas production borehole(s) after a simulation period of 20-years (refer to Figure 128). The pollution plume footprints reported on seems like a large area, however this is the combined zone of impact which is actually scattered throughout the study area and focussed in close proximity to proposed gas exploration and production boreholes. It is noted that the pollution plume does slightly extend beyond the project boundary towards the northern and western perimeters.

The simulation indicates that the following neighbouring boreholes will potentially be intercepted by the simulated pollution plume HBH08, HBH43, HBH63, HBH74, HBH116, HBH136, BH2 DDR, BH2 DRR as well as Stoltz L while monitoring boreholes 11A and BH07 will potentially be impacted on. It is furthermore noted that the simulated pollution plume will potentially intersect local drainages i.e., Sandrivier, Doringrivier as well as Palmietkuilspruit including the associated riparian zone aquifer. It can be observed that regional geological lineaments acts as preferred pathways for groundwater flow and contaminant transport mechanisms.

Figure 127 indicates the expected flow pathways of particles derived from the source points and it is evident that the pollution plume migration in the denser Karoo formations is sluggish while movement in the unconsolidated alluvial deposits of the riparian zone suggest a larger flux. Figure 125 summarises a time-series graph of the TDS mass load contribution to down-gradient receptors. It is evident that source term mass load contribution to existing neighbouring borehole situated near the gas production boreholes is generally below the SANS241:2015 threshold ranging between 400.0-1200.0mg/l, however borehole locality HBH136 suggest an increase in dissolved solids up to a concentration of >5000.0mg/l due to its proximity to the proposed production boreholes. Figure 126 summarises a time-series graph of the TDS mass load contribution to conceptually placed receptors situated in close proximity to simulated gas production boreholes (positioned 50m and 100m from the production boreholes). It can be observed that the TDS mass load contribution ranges between ~1000.0mg/l

to approximately 2500.0mg/l with the mass load contribution a function of the distance to the source or gas production borehole.

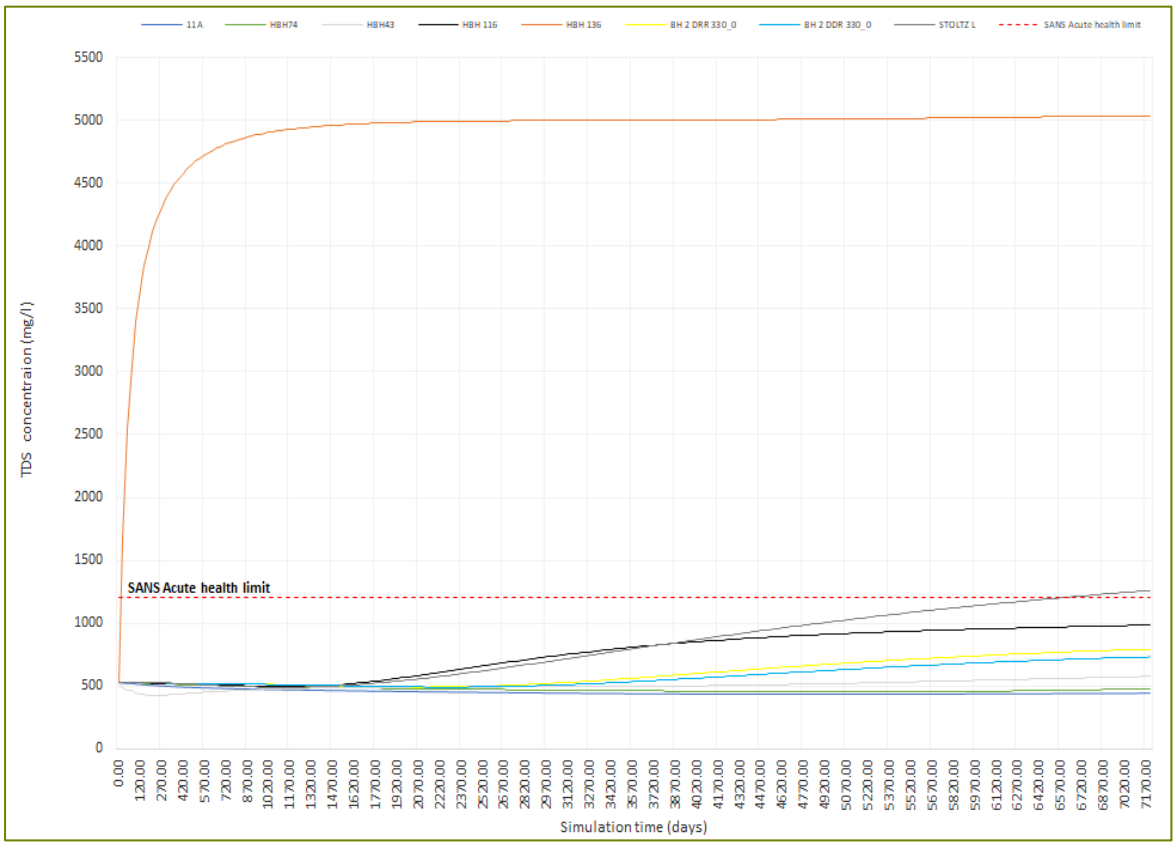


Figure 125: Scenario 02a: Time-series graph indicating the TDS mass load contribution of deeper, fractured and saline aquifer on observation boreholes targetting the potable shallow, intergranular aquifer (Operational phase).

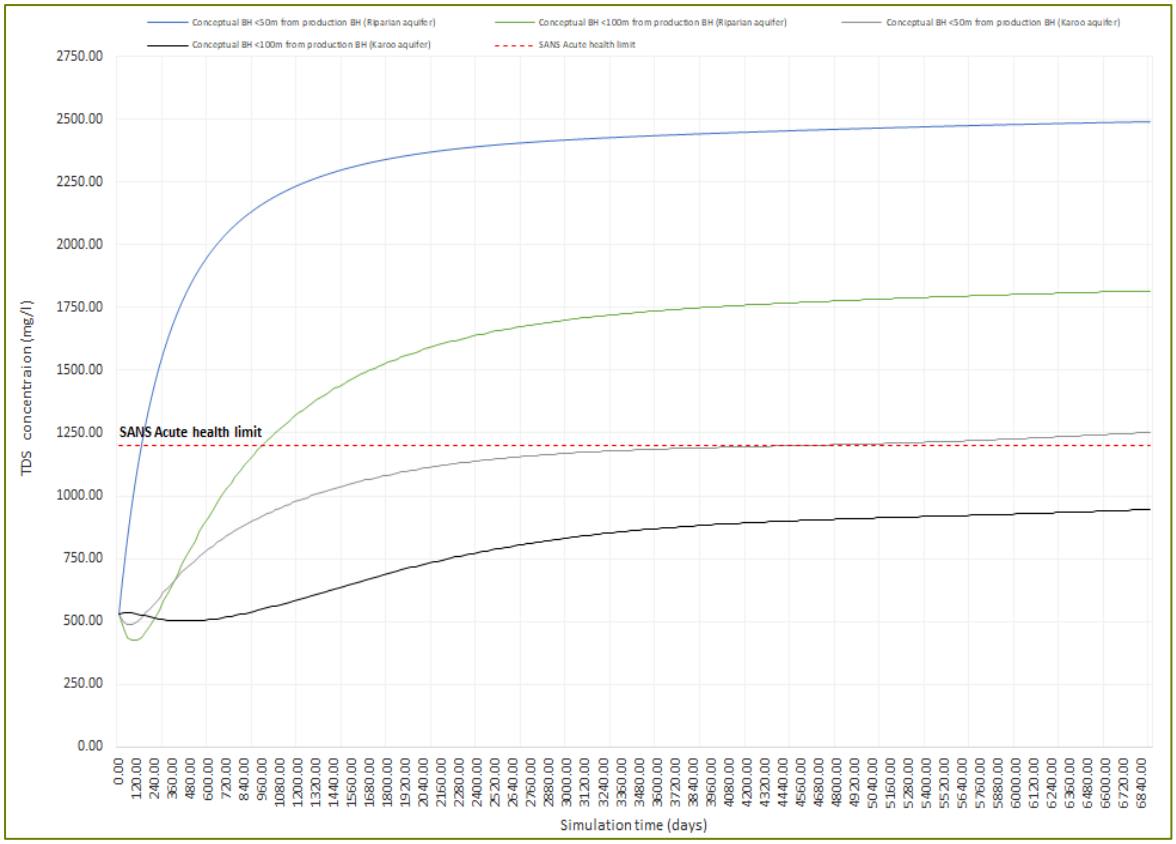


Figure 126: Scenario 02a: Time-series graph indicating the TDS mass load contribution of deeper, fractured (saline) aquifer on conceptual receptors in close proximity to simulated production boreholes (Operational phase).

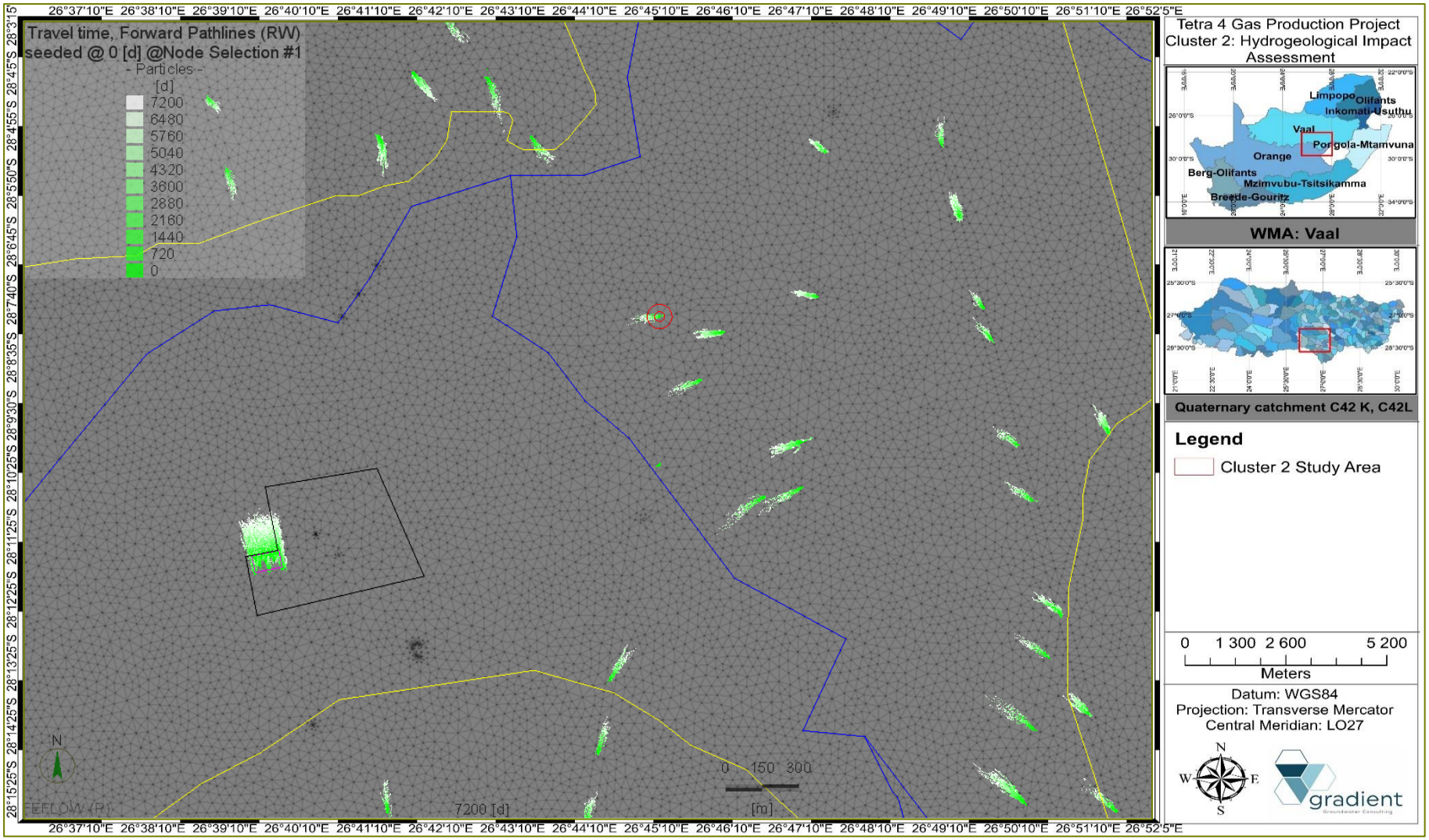


Figure 127: Scenario 02: Simulated particle tracking of contaminants originating from the deeper, fractured aquifer migrating from leaking boreholes within the intergranular aquifer (Operational phase).

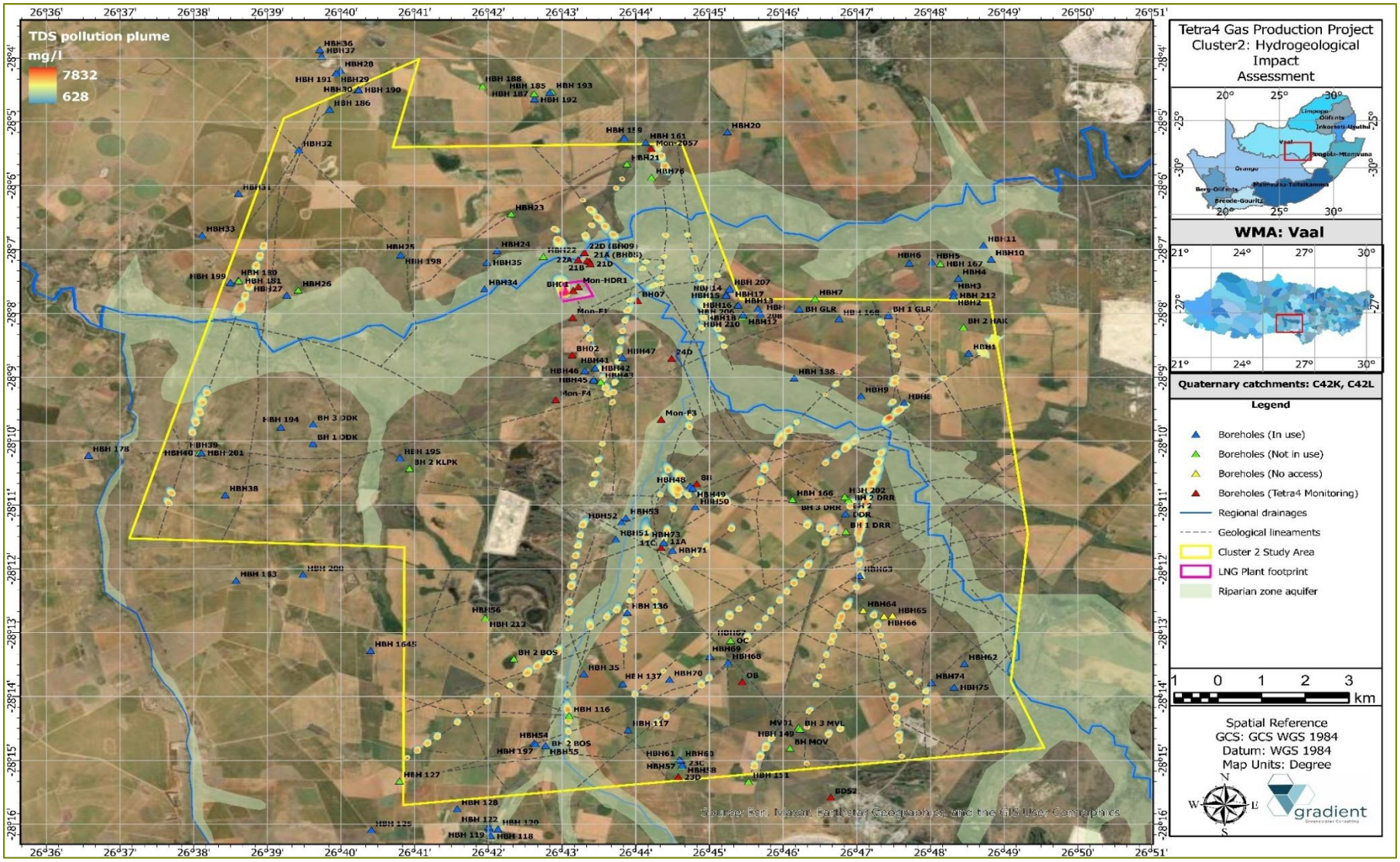


Figure 128: Scenario 02a: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through the intergranular aquifer (Operational phase).

9.10.6.3 SCENARIO 02B: MIGRATION OF STRAY METHANE (CH_4) GAS EMANATING FROM THE PRODUCTION ZONE TO THE OVERLYING, POTABLE AQUIFER(S) DURING THE OPERATIONAL GAS PRODUCTION PHASE

This scenario summarises the simulated point source pollution plume migration of stray methane (CH4) gas emanating from the production zone should the integrity of the gas production boreholes be jeopardised i.e., leaking boreholes.

It should be noted that, due care will be taken to ensure that production boreholes will be properly constructed and adequately sealed, a cautious approach i.e., "worst-case" scenario have been followed during the modelling of leaking boreholes (unmitigated scenario).

The (CH4) pollution plume extend covers a total area of approximately 848.29ha in the Karoo formations, reaching a maximum distance of ~180.0m in a general north to northeastern direction (southern catchment) and a southwestern direction (northern catchment) propagating in a radial pattern from the gas production borehole(s) towards the lower laying drainage system. The CH_4 pollution plume extend within the alluvial, riparian zone aquifer covers a total area of approximately 246.43ha, reaching a maximum distance of ~300.0m propagating in a radial pattern from the gas production borehole(s) after a simulation period of 20-years (refer to Figure 131). It is noted that the pollution plume does slightly extend beyond the project boundary towards the northern and western perimeters. The simulation indicates that the following neighbouring boreholes will potentially be intercepted by the simulated pollution plume HBH08, HBH43, HBH63, HBH74, HBH116, HBH136, BH2 DDR, BH2 DRR as well as Stoltz L while monitoring boreholes

Mon 2057, 11A and BH07 will potentially be impacted on. It is furthermore noted that the simulated pollution plume will potentially intersect local drainages i.e., Sandrivier, Doringrivier as well as Palmietkuilspruit including the associated riparian zone aquifer.

Figure 129 summarises a time-series graph of the CH_4 mass load contribution to down-gradient receptors. It is evident that source term mass load contribution to existing neighbouring borehole situated near the gas production boreholes is generally below the EPA safety threshold (2011) of 10.0mg/l ranging between 0.12-3.90mg/l, however borehole locality HBH136 suggest an increase in the CH_4 concentration of >17.0mg/l due to its proximity to production boreholes. Figure 130 summarises a time-series graph of the CH_4 mass load contribution to conceptually placed receptors situated in close proximity to simulated gas production boreholes (positioned 50m and 100m from the production boreholes). It can be observed that the CH_4 mass load contribution ranges between 2.08mg/l to approximately 7.66mg/l with the mass load contribution a function of the distance to the source or gas production borehole.

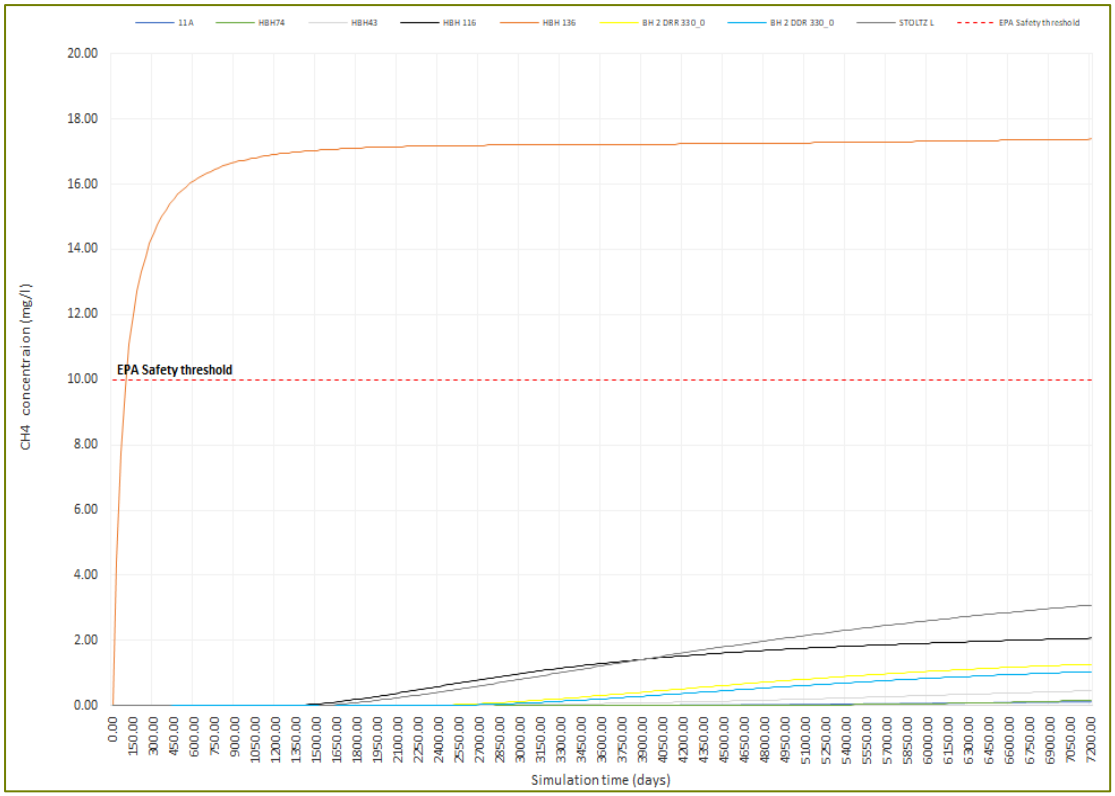


Figure 129: Scenario 02b: Time-series graph indicating the CH_4 mass load contribution of deeper, fractured and saline aquifer on observation boreholes targeting the potable shallow, intergranular aquifer (Operational phase).

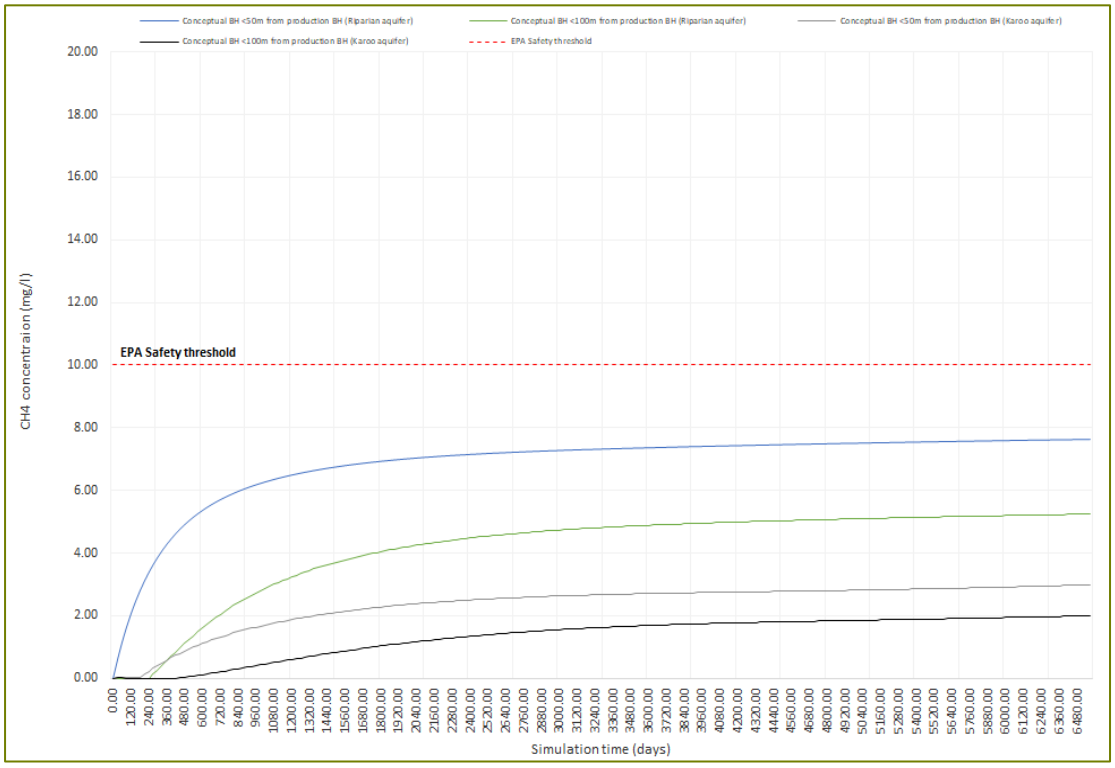


Figure 130: Scenario 02b: Time-series graph indicating the CH_4 mass load contribution of deeper, fractured and saline aquifer on observation boreholes targeting the potable shallow, intergranular aquifer (Operational phase).

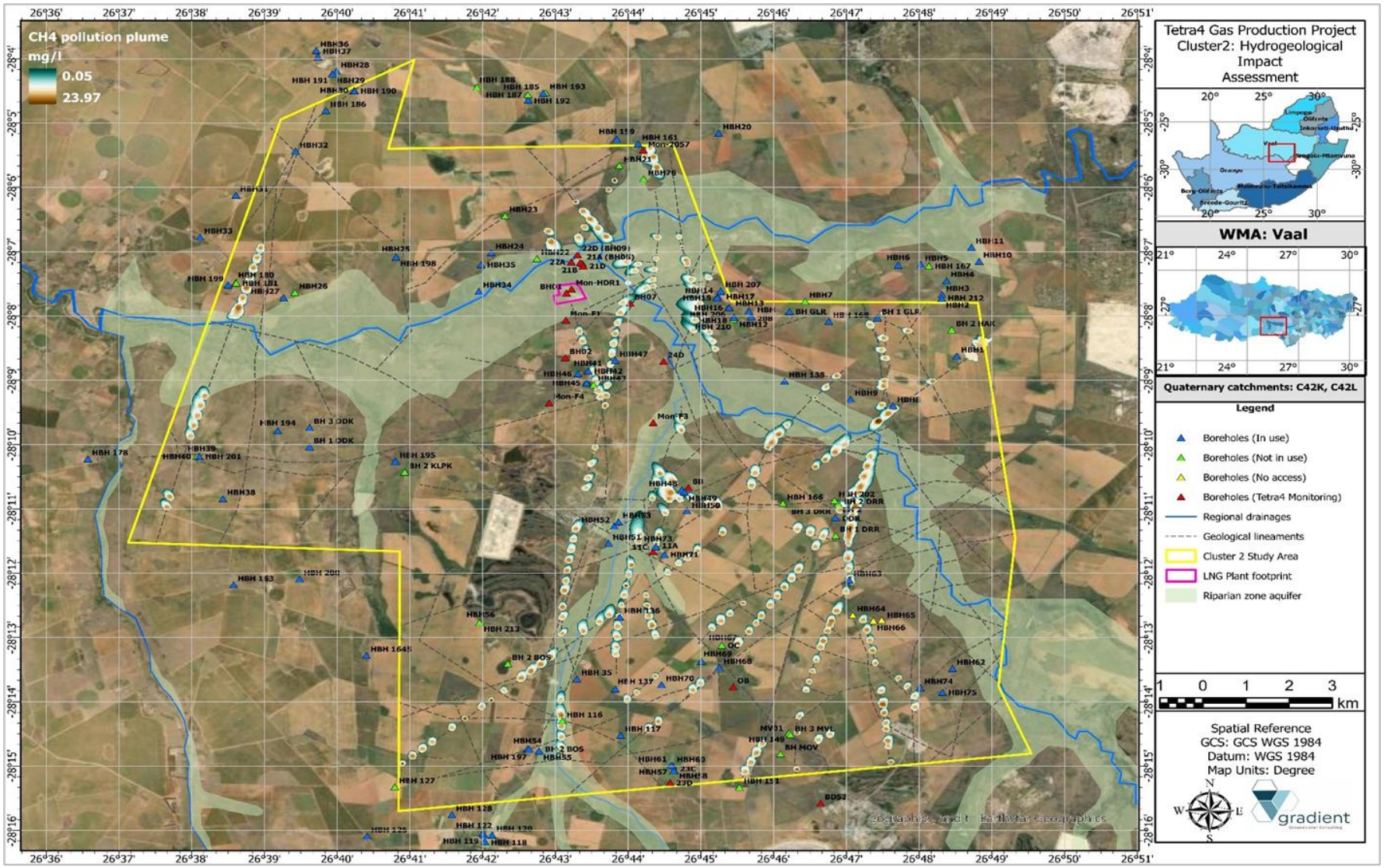


Figure 131: Scenario 02b: CH_4 pollution plume migration of contaminants originating from the production zone and migrating through the intergranular aquifer (Operational phase).

9.10.6.4 SCENARIO 03: MIGRATION OF THE TDS POLLUTION PLUME EMANATING FROM THE EVAPORATION DAM FOOTPRINT AREA DURING THE OPERATIONAL GAS PRODUCTION PHASE

This scenario summarises the simulated pollution plume migration from the evaporation dam footprint for the operational phase. **It should be noted that, although an appropriate liner and barrier system will be implemented underneath the evaporation dam, a cautious approach i.e., "worst-case" scenario has been followed during the modelling of the unlined scenario (unmitigated scenario).**

The TDS pollution plume extent in the unmitigated scenario (i.e. unlined evaporation dam) covers a total area of approximately 23.89ha reaching a maximum distance of ~550.0m in a general north-northwest direction towards the lower laying drainage system(s) after a simulation period of 20-years as depicted in Figure 135. Figure 134 indicates the expected flow pathways of particles derived from the evaporation dam footprint. The simulation indicates that no neighbouring boreholes or local drainages are expected to be impacted on during the operational phase even in this unmitigated (unlined dam) scenario. Despite this limited impact in the unmitigated (unlined evaporation dam) scenario, the risk averse and cautious approach of including a barrier system is still being put forward. Monitoring boreholes which might potentially be intercepted by the pollution plume include BH01 as well as Mon-HDR01.

Figure 132 summarises a time-series graph of the TDS mass load contribution to down-gradient receptors . It is evident that the TDS mass load contribution to down-gradient receptors increase to a concentration of between 1750.0 – 2500.0mg/l, and is a function of the receptor distance from the source. Figure 133 depicts a model cross section of the pollution plume migration within the simulated aquifer. It is evident that the mass transport of the pollution plume is mostly limited to the shallow, intergranular aquifer, however may also migrate to the deeper, fractured aquifer over time.

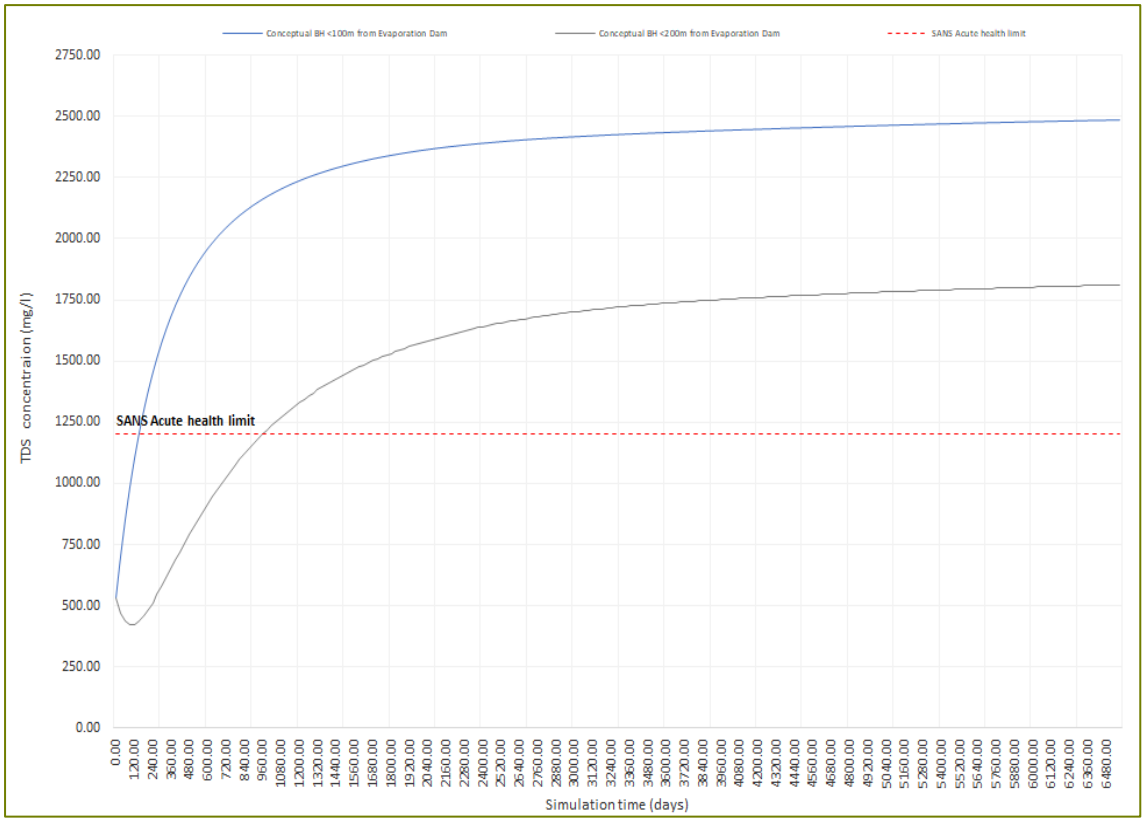


Figure 132: Scenario 03: Time-series graph indicating the TDS mass load emenating from the plant footprint on down-gradient observation boreholes targetting the potable shallow, intergranular aquifer (Operational phase).

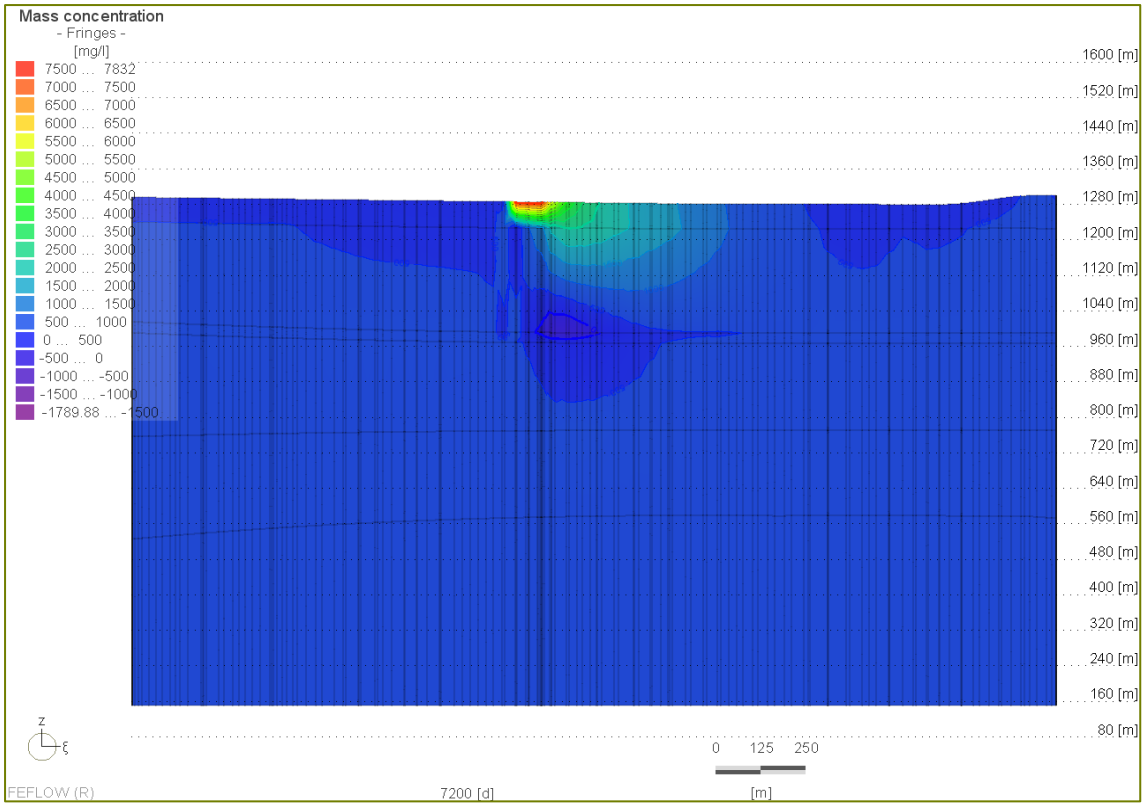


Figure 133: Scenario 03: Model domain 3-D FEM mesh view (cross sectional view south-north orientation A-A') of the TDS pollution plume originating at the evaporation dam footprint (Operational phase).

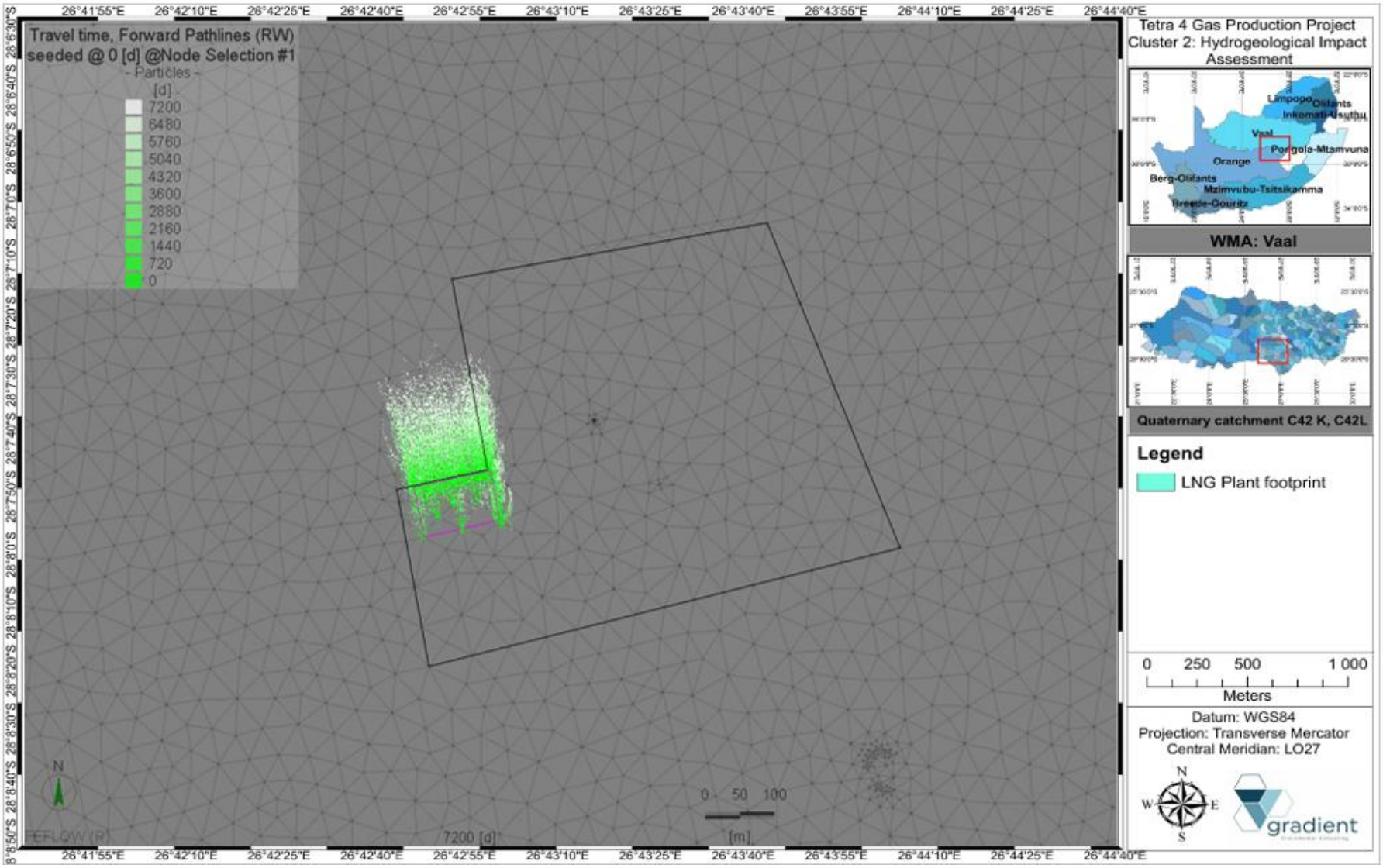


Figure 134: Scenario 03: Simulated particle tracking of contaminants originating from the evaporation dam footprint within the intergranular aquifer (Operational phase).

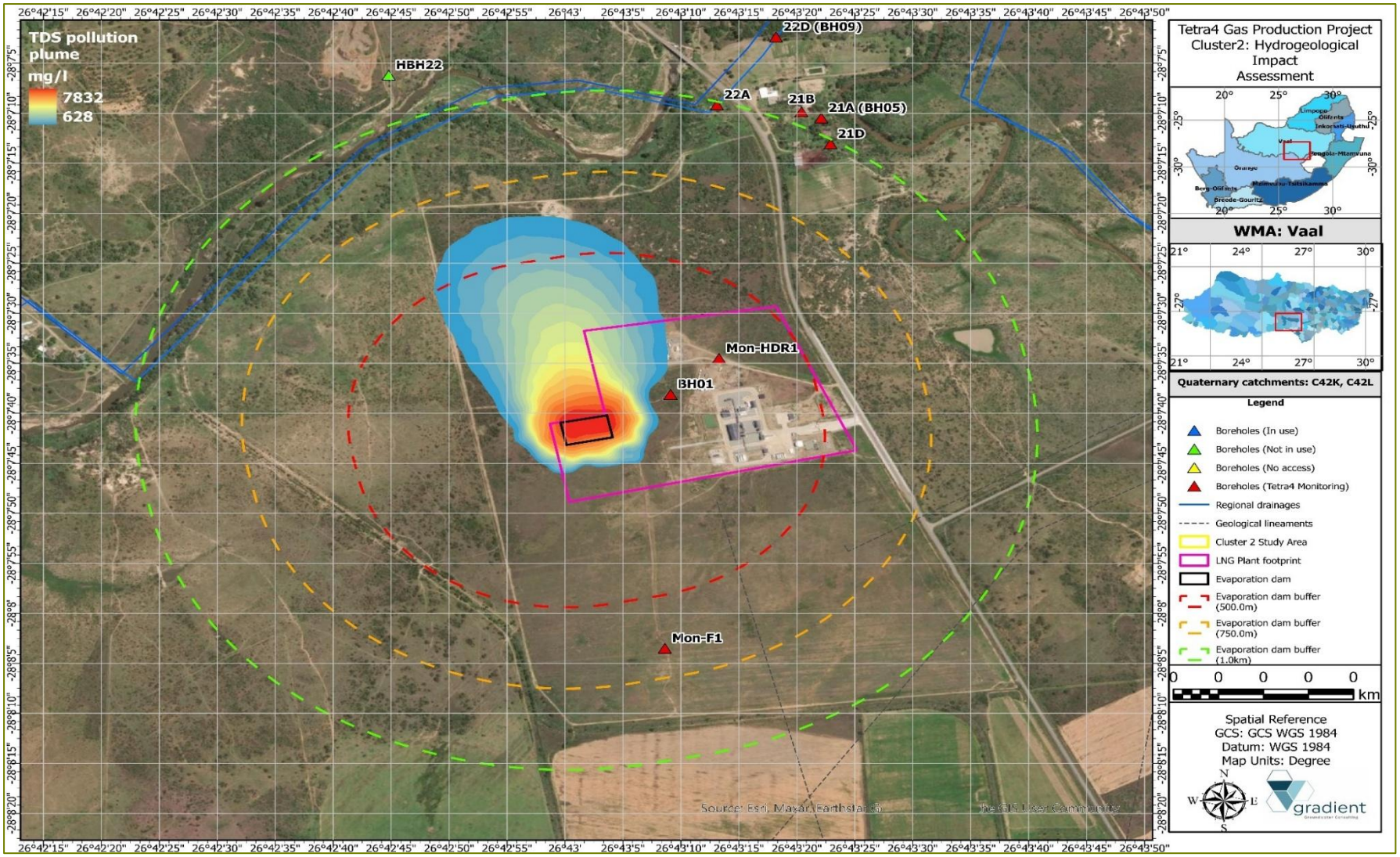


Figure 135: Scenario 03: Simulated particle tracking of contaminants originating from the evaporation dam footprint within the intergranular aquifer (Operational phase).

9.10.6.5 SCENARIO 04A: MIGRATION OF SALINE GROUNDWATER FROM THE DEEP, FRACTURED AQUIFER TO THE OVERLYING, POTABLE AQUIFER(S) DURING THE POST-CLOSURE AND DECOMMISSIONING PHASE (50-YEAR AND 100-YEAR SCENARIOS)

This scenario summarises the simulated point source pollution plume migration of saline groundwater emanating from the deep, fractured aquifer should the integrity of the gas production boreholes be jeopardised i.e., leaking boreholes for the post-closure phase.

After a post-closure simulation period of 50years, the TDS pollution plume extend covers a total area of approximately 1030.26ha in the Karoo formations, reaching a maximum distance of ~180.0m in a general north to northeastern direction (southern catchment) and a southwestern direction (northern catchment) propagating in a radial pattern from the gas production borehole(s) towards the lower laying drainage system. The TDS pollution plume extend within the alluvial, riparian zone aquifer covers a total area of approximately 229.56ha, reaching a maximum distance of ~280.0m propagating in a radial pattern from the gas production borehole(s).

After a post-closure simulation period of 100years, the TDS pollution plume extend covers a total area of approximately 1326.98ha in the Karoo formations, reaching a maximum distance of ~220.0m in a general north to northeastern direction (southern catchment) and a southwestern direction (northern catchment) propagating in a radial pattern from the gas production borehole(s) towards the lower laying drainage system. The TDS pollution plume extend within the alluvial, riparian zone aquifer covers a total area of approximately 266.26ha, reaching a maximum distance of ~300.0m propagating in a radial pattern from the gas production borehole(s) (refer to Figure 138). It is noted that the pollution plume does slightly extend beyond the project boundary towards the northern and western perimeters. The simulation indicates that the following neighbouring boreholes will potentially be intercepted by the simulated pollution plume HBH08, HBH43, HBH63, HBH74, HBH116, HBH136, BH2 DDR, BH2 DRR as well as Stoltz L while monitoring boreholes 11A and BH07 will potentially be impacted on. It is furthermore noted that the simulated pollution plume will potentially intersect local drainages i.e., Sandrivier, Doringrivier as well as Palmietkuilspruit including the associated riparian zone aquifer.

Figure 137 indicates the expected flow pathways of particles derived from the source points and it is evident that the pollution plume migration in the denser Karoo formations is sluggish while movement in the unconsolidated alluvial deposits of the riparian zone suggest a larger flux. Figure 136 summarises a time-series graph of the TDS mass load contribution to down-gradient receptors. It is evident that source term mass load contribution to existing neighbouring borehole situated near the gas production boreholes is generally below the SANS241:2015 threshold ranging between ~400.0-1036.0mg/l, however borehole localities HBH136 and Stoltz L suggest an increase in dissolved solids with concentrations ranging between 1690.0 to up to 5117.0mg/l due to its proximity to production boreholes.

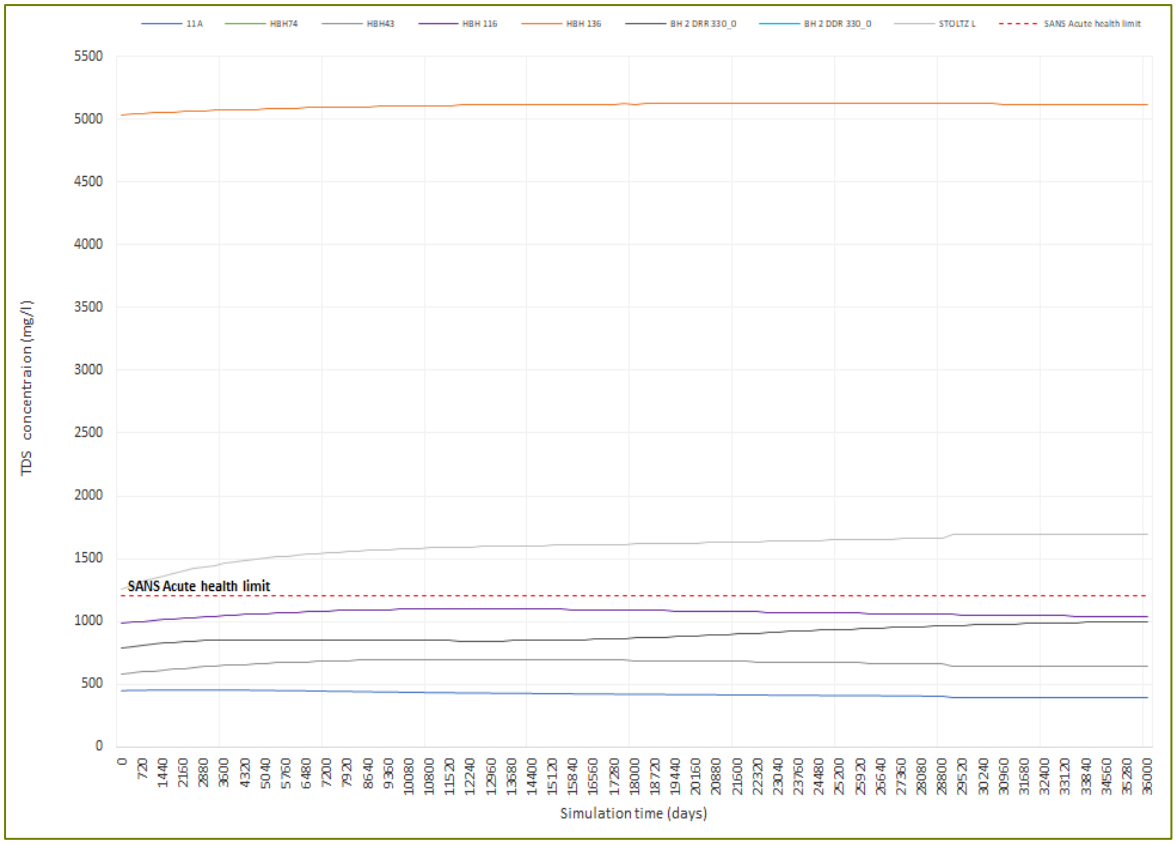


Figure 136: Scenario 04a: Time-series graph indicating the TDS mass load contribution of deeper, fractured and saline aquifer on observation boreholes targetting the potable shallow, intergranular aquifer (Post-closure phase).

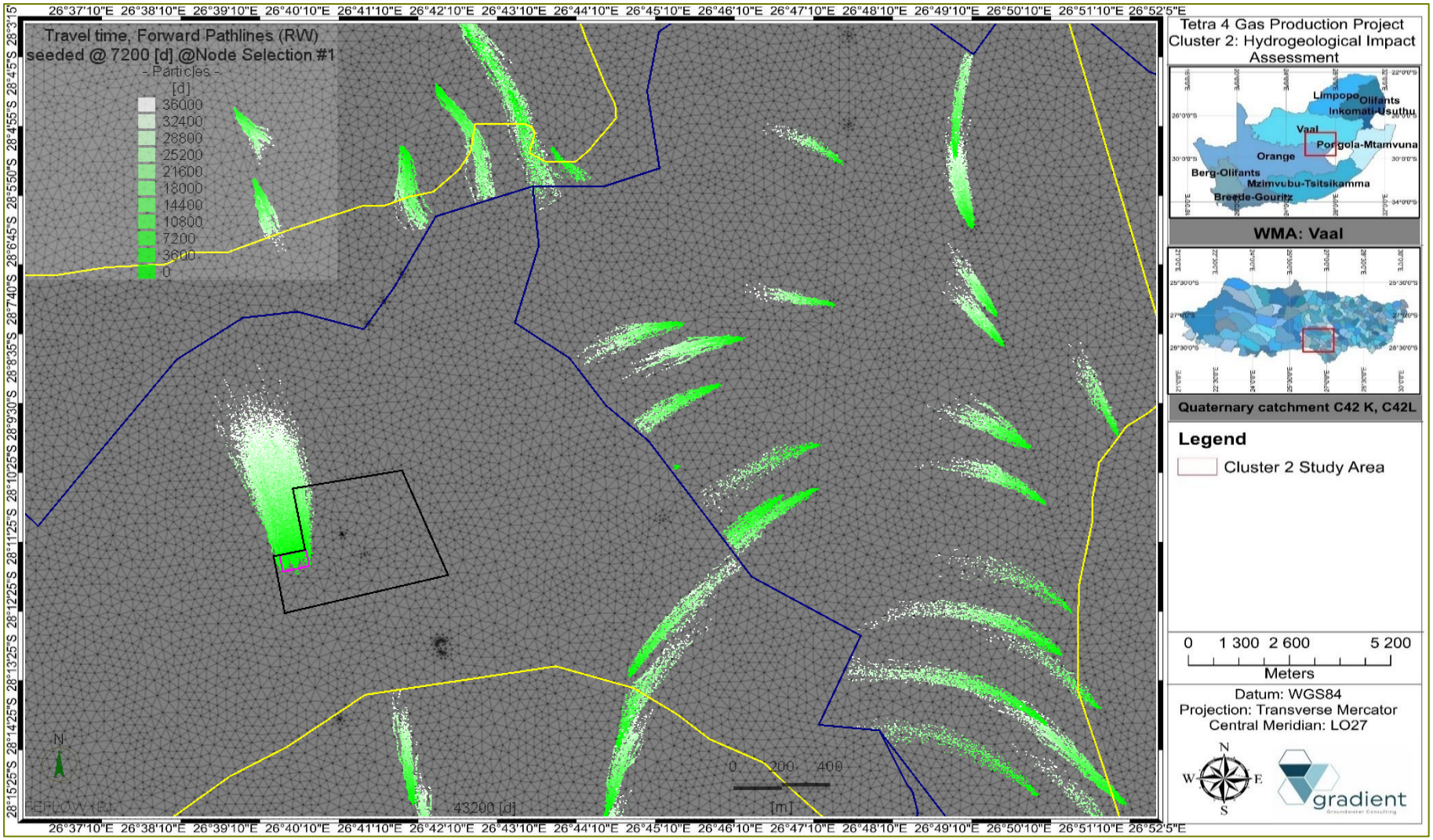


Figure 137: Scenario 04a: Simulated particle tracking of contaminants originating from the deeper, fractured aquifer migrating from leaking boreholes within the intergranular aquifer (Post-closure phase).

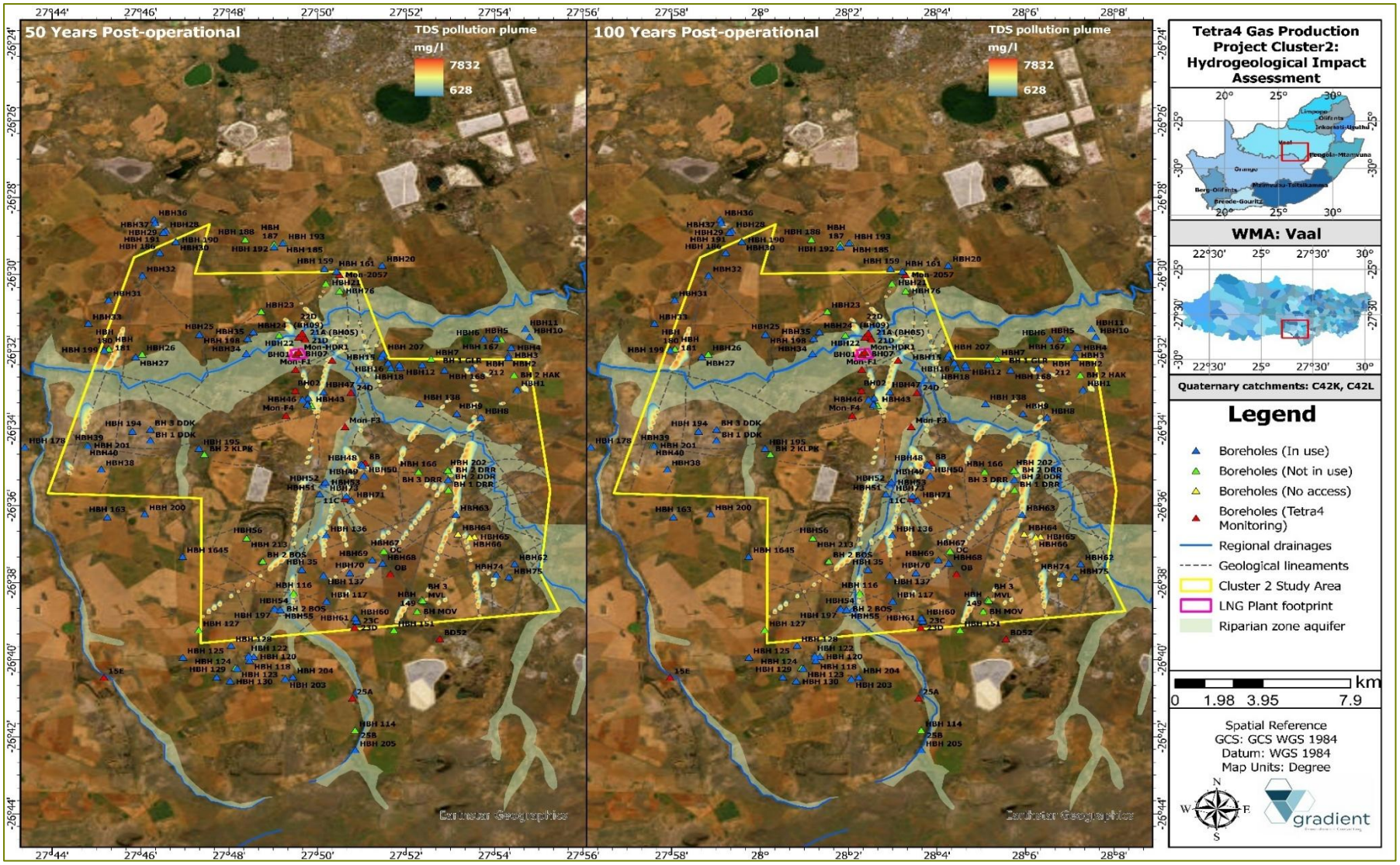


Figure 138: Scenario 04a: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through the intergranular aquifer (Post-closure phase).

9.10.6.6 SCENARIO 04B: MIGRATION OF STRAY METHANE (CH_4) GAS EMANATING FROM THE PRODUCTION ZONE TO THE OVERLYING, POTABLE AQUIFER(S) DURING THE POST-CLOSURE AND DECOMMISSIONING PHASE (50-YEAR AND 100-YEAR SCENARIOS)

This scenario summarises the simulated point source pollution plume migration from of stray methane (CH_4) gas emanating from the production zone should the integrity of the gas production boreholes be jeopardised i.e., leaking boreholes for the post-closure phase

It should be noted that, due care will be taken to ensure that production boreholes will be properly constructed and adequately sealed during decommissioning, a cautious approach i.e., "worst-case" scenario have been followed during the modelling of leaking boreholes (unmitigated scenario).

After a post-closure simulation period of 50 years, the CH_4 pollution plume extend covers a total area of approximately 1399.68ha in the Karoo formations, reaching a maximum distance of ~220.0m in a general north to northeastern direction (southern catchment) and a southwestern direction (northern catchment) propagating in a radial pattern from the gas production borehole(s) towards the lower laying drainage system. The CH_4 pollution plume extend within the alluvial, riparian zone aquifer covers a total area of approximately 459.83ha, reaching a maximum distance of ~320.0m propagating in a radial pattern from the gas production borehole(s).

After a post-closure simulation period of 100years, the CH_4 pollution plume extend covers a total area of approximately 1755.20ha in the Karoo formations, reaching a maximum distance of ~270.0m in a general north to northeastern direction (southern catchment) and a southwestern direction (northern catchment) propagating in a radial pattern from the gas production borehole(s) towards the lower laying drainage system. The CH_4 pollution plume extend within the alluvial, riparian zone aquifer covers a total area of approximately 571.57ha, reaching a maximum distance of ~350.0m propagating in a radial pattern from the gas production borehole(s) (refer to Figure 140). It is noted that the pollution plume does slightly extend beyond the project boundary towards the northern and western perimeters. The simulation indicates that the following neighbouring boreholes will potentially be intercepted by the simulated pollution plume HBH08, HBH43, HBH63, HBH74, HBH116, HBH136, BH2 DDR, BH2 DRR as well as Stoltz L while monitoring boreholes Mon 2057, 11A and BH07 will potentially be impacted on. It is furthermore noted that the simulated pollution plume will potentially intersect local drainages i.e., Sandrivier, Doringrivier as well as Palmietkuilspruit including the associated riparian zone aquifer.

Figure 139 summarises a time-series graph of the CH_4 mass load contribution to down-gradient receptors. It is evident that source term mass load contribution to existing neighbouring borehole situated near the gas production boreholes is generally below the EPA safety threshold (2011) of 10.0mg/l ranging between 0.35-5.07mg/l, however borehole locality HBH136 suggest an increase in the CH_4 concentration of >17.0mg/l due to its proximity to production boreholes.

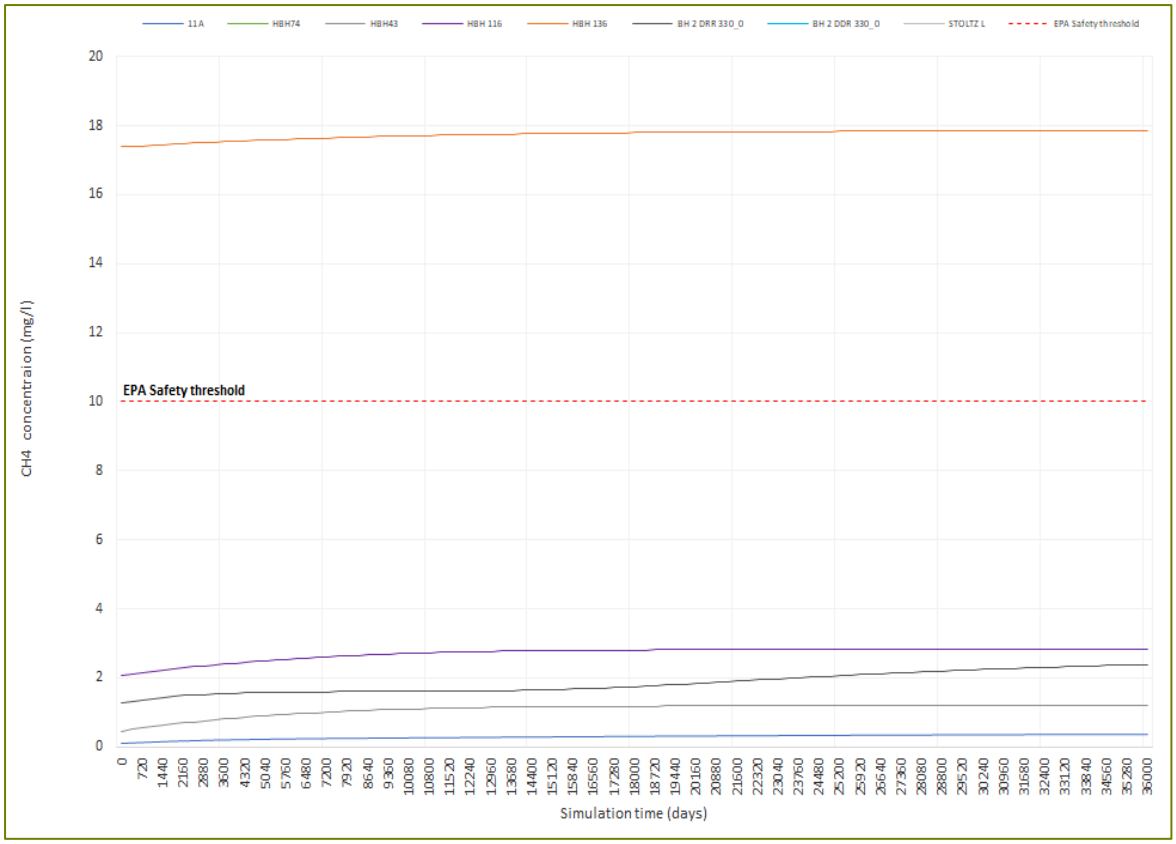


Figure 139: Scenario 04b: Time-series graph indicating the CH_4 mass load contribution of waste facilities on down-gradient receptors.

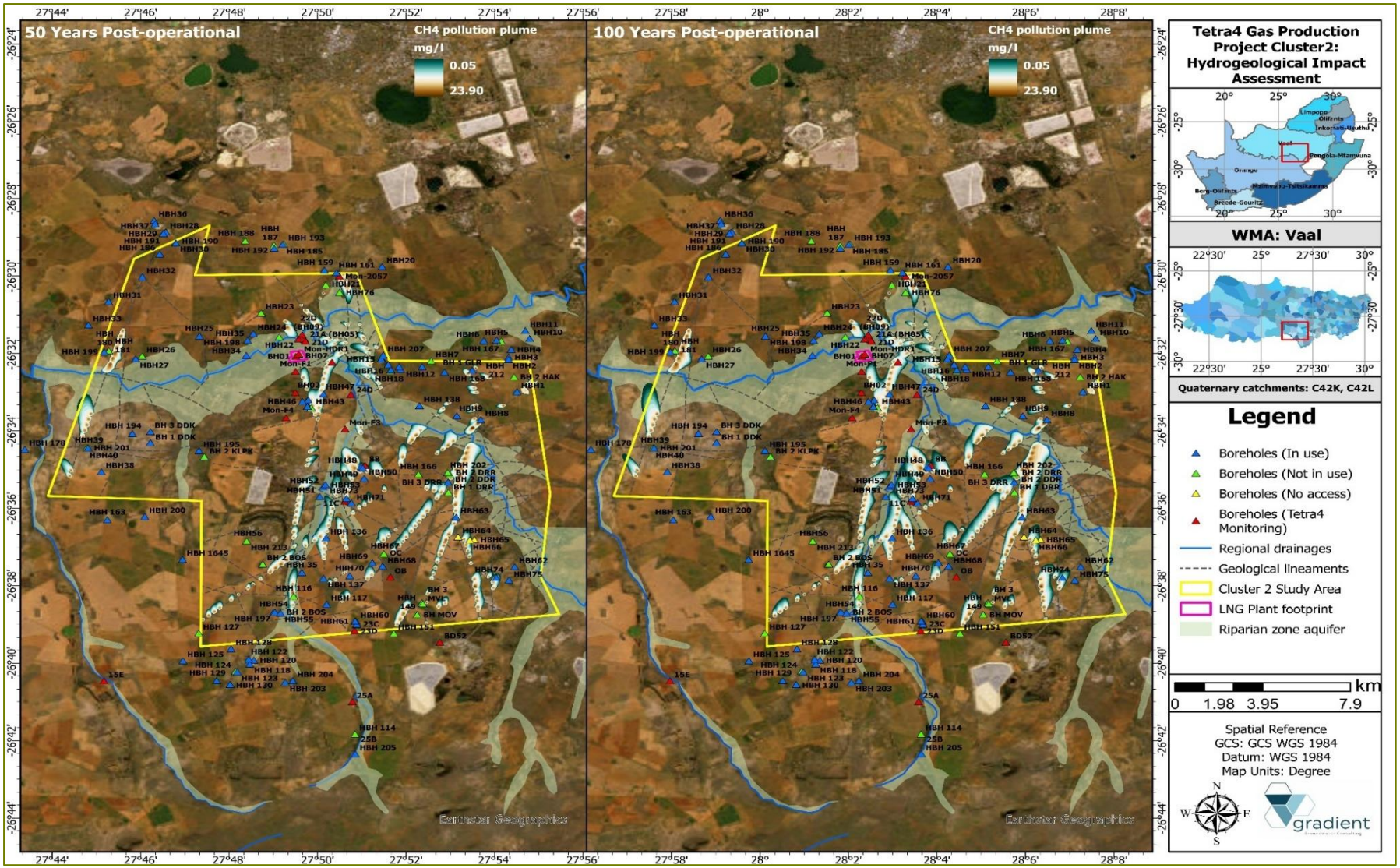


Figure 140: Scenario 04b: CH_4 pollution plume migration of contaminants originating from the production zone and migrating through the intergranular aquifer (Post-closure phase).

9.10.6.7 SCENARIO 05: MIGRATION OF THE TDS POLLUTION PLUME EMANATING FROM THE PLANT FOOTPRINT AREA DURING THE POST-CLOSURE AND DECOMMISSIONING PHASE (50-YEAR AND 100-YEAR SCENARIOS)

This scenario summarises the simulated pollution plume migration from the evaporation dam footprint for the post-closure phase. It should be noted that, although an appropriate liner and barrier system will be implemented underneath the evaporation dam, a cautious approach i.e., "worst-case" scenario has been followed during the modelling of the unlined scenario (i.e. unmitigated scenario during the operational phase and leading to a post closure pollution plume).

The TDS pollution plume extend covers a total area of approximately 43.03ha reaching a maximum distance of ~950.0m in a general north-northwest direction towards the lower laying drainage system(s) after a simulation period of 50-years and covers a total area of approximately 52.90ha reaching a maximum distance of ~1050.0m in a general north-northwest direction towards the lower laying drainage system(s) after a simulation period of 100-years as depicted in Figure 143.

Figure 142 indicates the expected flow pathways of particles for the post-closure simulation period, and it is evident that the pollution plume potentially reaches the local drainages system down-gradient of the evaporation dam footprint during the post-closure phase.

Figure 141 summarises a time-series graph of the TDS mass load contribution to down-gradient receptors. It is evident that the TDS mass load contribution to down-gradient receptors increase to a concentration above the SANS 241:2015 limit of 1200.0mg/l for the post-closure simulation period with the mass load contribution a function of the distance to the source or evaporation dam footprint.

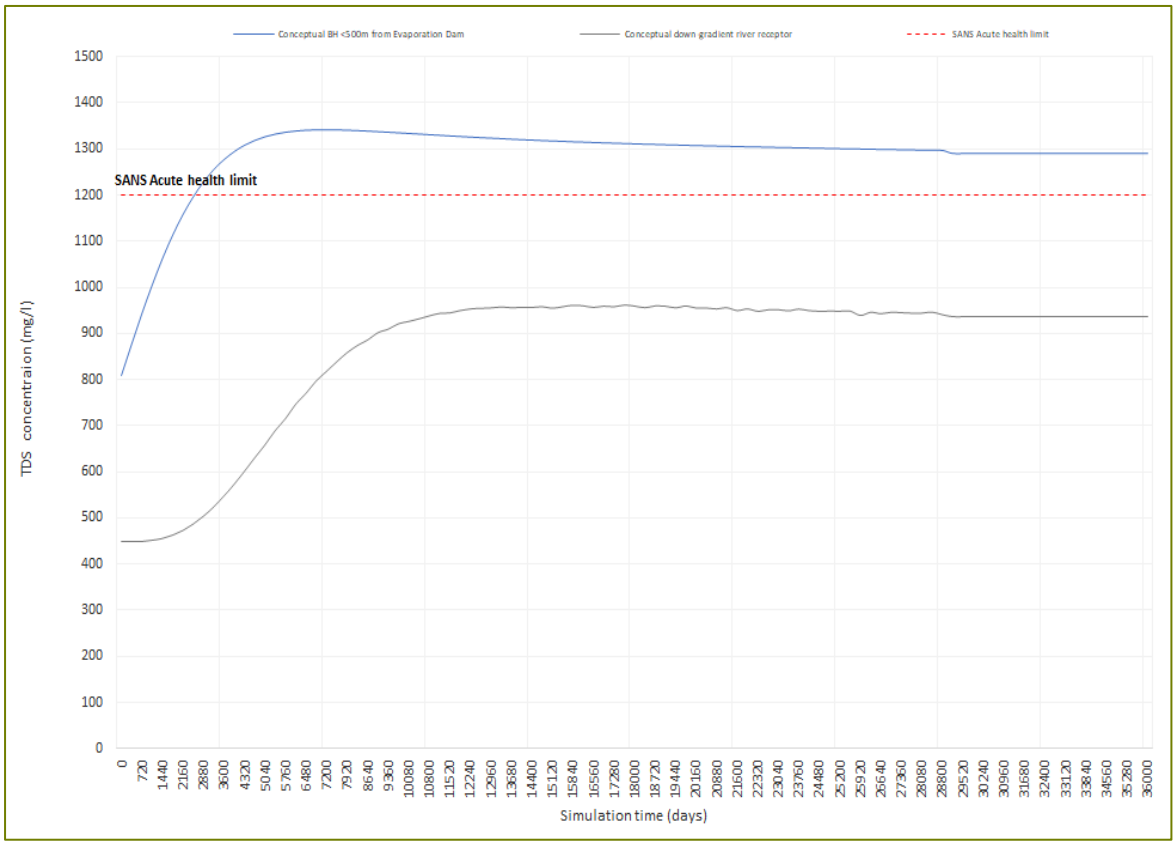


Figure 141: Scenario 05: Time-series graph indicating the TDS mass load emanating from the evaporation dam footprint on down-gradient observation boreholes targetting the potable shallow, intergranular aquifer (Post-closure phase).

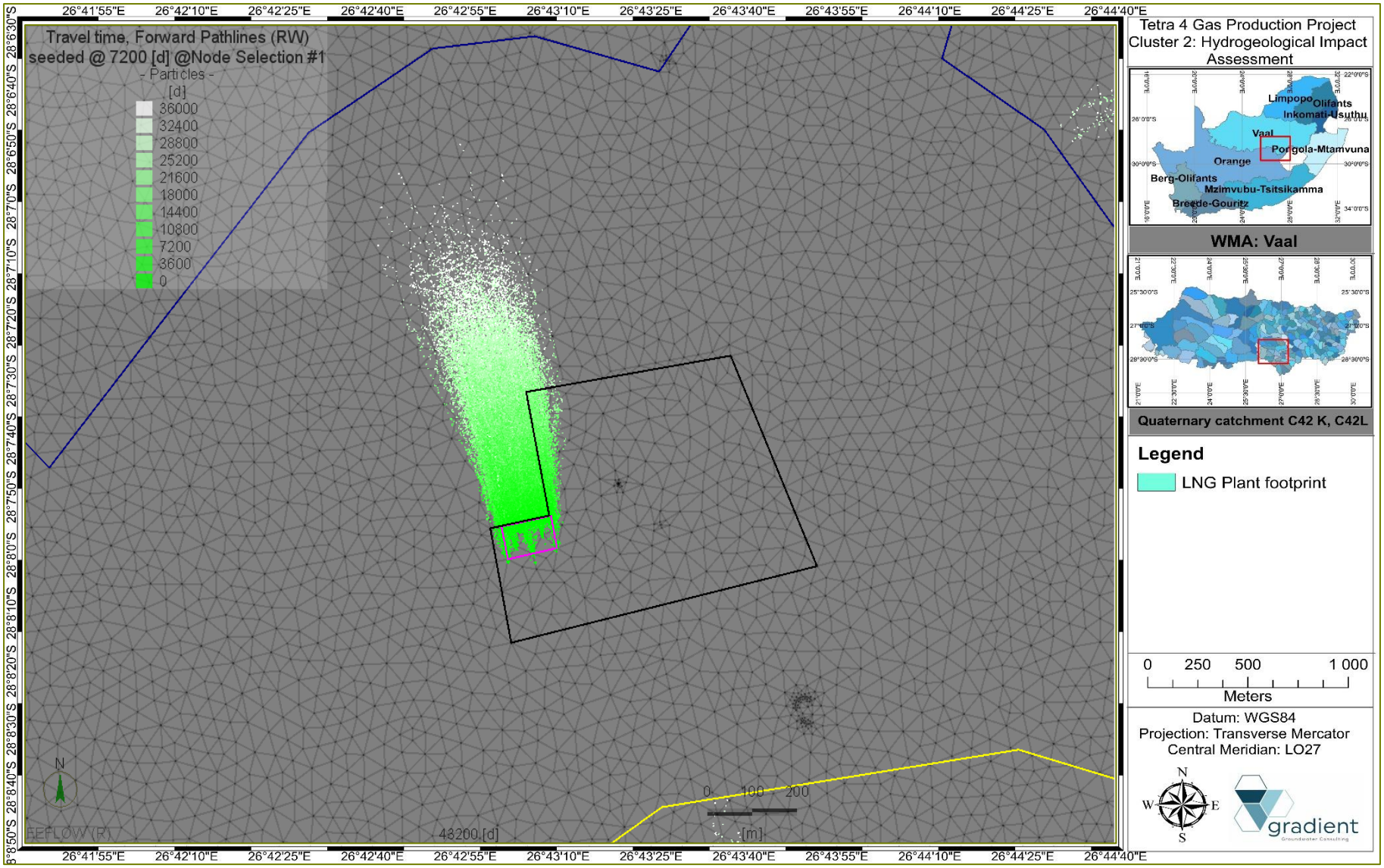


Figure 142: Scenario 05: Simulated particle tracking of contaminants originating from the evaporation dam footprint within the intergranular aquifer (100-years post-closure).

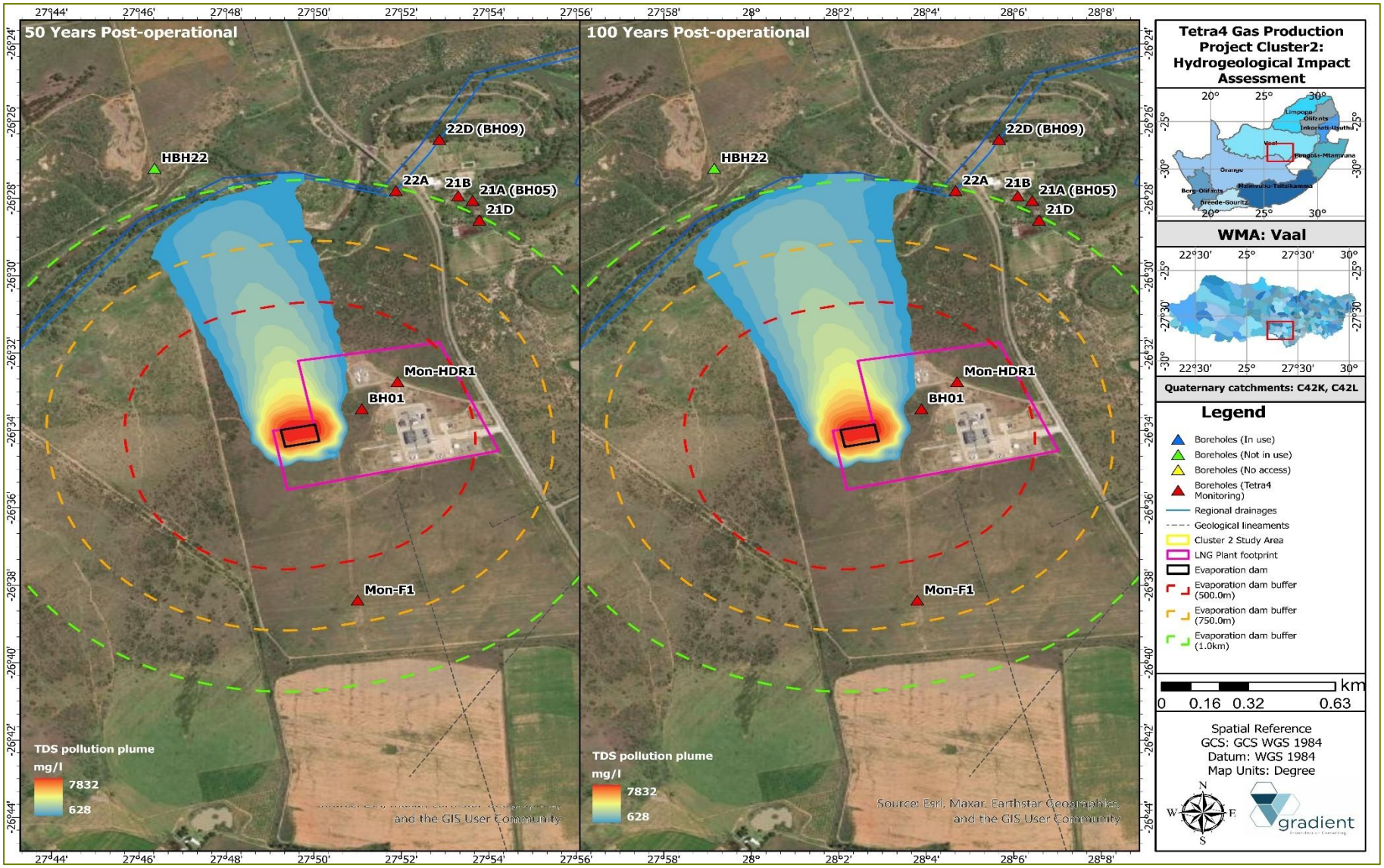


Figure 143: Scenario 05: TDS pollution plume migration of contaminants originating from the evaporation dam footprint within the intergranular aquifer (Post-closure phase).

9.10.6.8 SCENARIO 06: MITIGATION AND MANAGEMENT - EVALUATING THE EFFECT OF IMPLEMENTATION OF A LINER OR BARRIER SYSTEM UNDERNEATH THE EVAPORATION DAM ON THE TDS POLLUTION PLUME MIGRATION

An alternative management and mitigation scenario was simulated to evaluate the remedial options available. A passive management scenario evaluating what the mitigating effect of a liner or barrier system implemented underneath the evaporation dam will have on the pollution plume migration were simulated as depicted in

Figure 144 and Table 55 provides a summary of the mitigatory effect and effectiveness of proposed management alternative on the pollution plume footprint while Figure 145 depicts the effect of the mitigation measures on the mass load contribution to observation boreholes. It is evident that due to the lower conductivity of the liner or barrier system when implemented, the source of contamination is effectively isolated from the groundwater system in the direct vicinity of the evaporation dam footprint and reduces the simulated pollution plume by >50.0% to ~11.58ha. Accordingly, it is recommended that this remedial alternative should be considered best practise for implementation.

Table 55: Mitigation alternatives pollution plume areas and effectiveness.

Mitigation and management scenarios	Combined plume area (pre-mitigation)(km²)	Combined plume area (post-mitigation)(km²)	Improvement (%)
Scenario 06a: implementation of a liner or barrier system underneath the evaporation dam	23.89	11.58	51.53

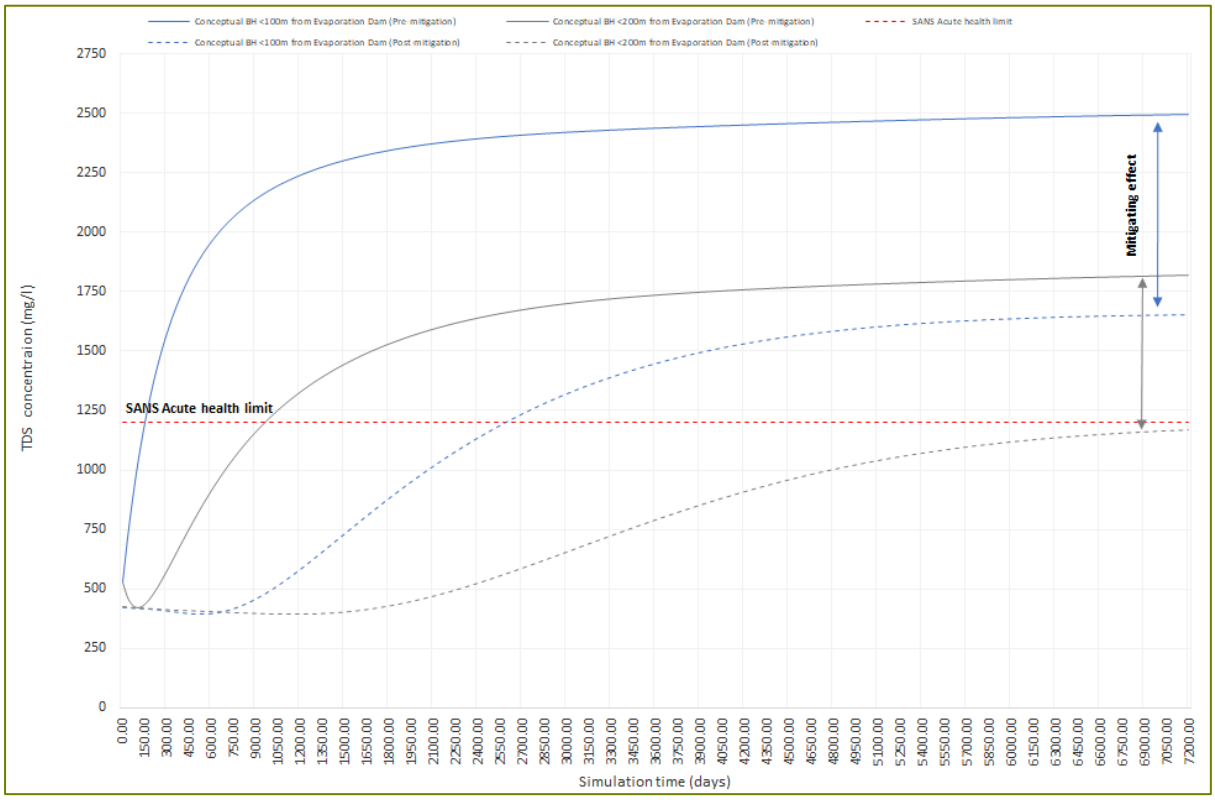


Figure 144: Scenario 06: Time-series graph indicating mass load contribution of the evaporation dam to conceptually placed down-gradient receptors (Pre-mitigation vs Post-mitigation).

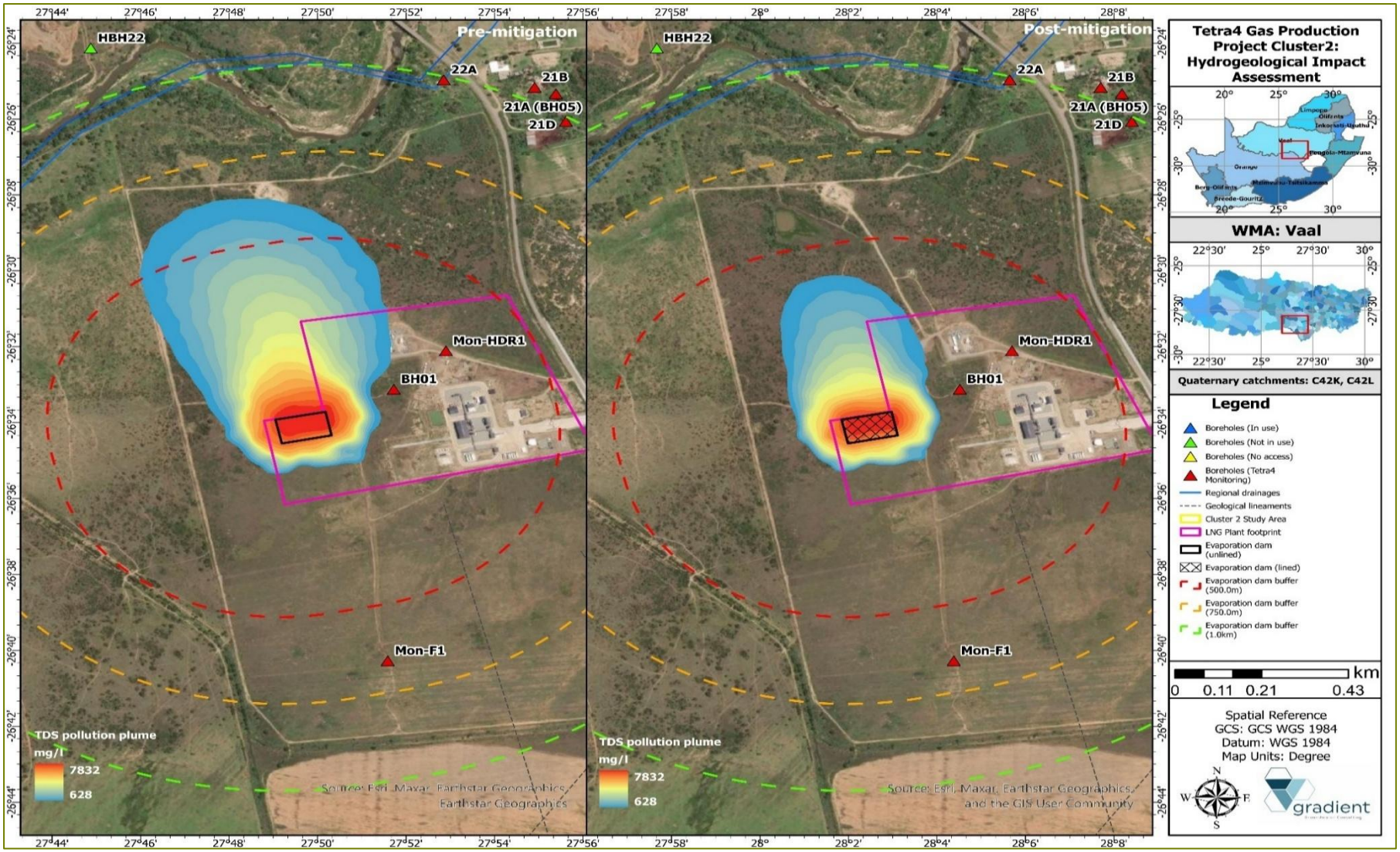


Figure 145: Scenario 06: Mitigation - TDS pollution plume migration of contaminants originating from the evaporation dam footprint within the intergranular aquifer (Pre-mitigation vs Post-mitigation).

9.10.6.9 SCENARIO 07: EVALUATING THE EFFECT OF CLIMATIC CHANGE I.E., WET VS. DRY CYCLE RAINFALL SCENARIOS ON THE TDS POLLUTION PLUME MIGRATION

This scenario evaluates the effect of climatic change i.e., wet vs. dry cycle rainfall scenarios on the TDS pollution plume migration. Wet and dry rainfall season cycles may potentially have an impact on lower or higher recharge volumes reporting to the receiving aquifer and have been simulated as such.

Figure 146 summarises a time-series graph of the TDS mass load contribution to down-gradient receptors for both wet vs. dry cycle rainfall scenarios. It is evident that the TDS mass load contribution to down-gradient receptors increase to a concentration of ~2 875.0mg/l for the wet cycle rainfall scenario where the TDS mass load contribution for the dry cycle rainfall scenario increase to a concentration of ~2645.0mg/l. The latter accounts to an escalation of >8.50% which may be attributed to the higher recharge volumes associated with the wet cycle rainfall scenario. Accordingly, it can be concluded that climatic changes may significantly impact on the pollution plume migration and should be closely monitored. It is recommended that a weather station be established on-site in order to keep record of all rainfall events and assess potential climatic changes.

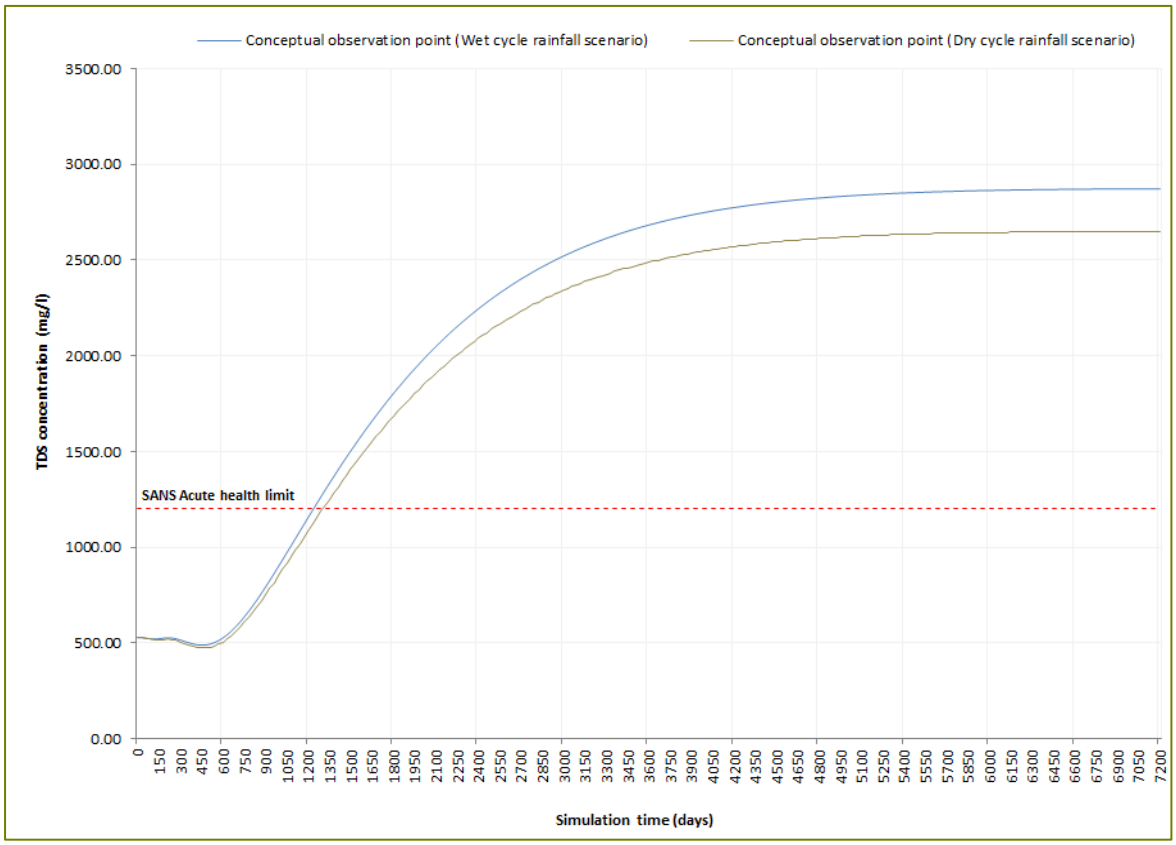


Figure 146: Scenario 07: Time-series graph indicating mass load contribution of the evaporation dam to conceptually placed down-gradient receptors (Wet vs Dry cycle rainfall scenario).

9.10.7 HYDROGEOLOGICAL SENSITIVITY

Based on the findings of the geohydrological specialist study and outcomes of the impact assessment a hydrogeological sensitivity map was generated, highlighting groundwater zones which will be sensitive to contamination and should form part of the monitoring protocol. Refer to Table 56 for a summary of identified hydrogeological sensitive areas with a spatial representation depicted in Figure 147.

Table 56: Hydrogeological sensitivity rating.

Sensitivity rating	Description	Hydrogeological component identified	Motivation	Weighting
Low	The inherent feature status and sensitivity is already degraded. The proposed development will not affect the current status and/or may result in a positive impact. These features would be the preferred alternative for mining or infrastructure placement.	All areas not included in either the moderately of highly sensitive zones as identified.	This area excludes groundwater receptors or sensitive areas identified as part of the assessment.	-1
Moderate	The proposed development will negatively influence the current status of the feature to a moderate degree of modification.	A zone of 450m around the proposed gas production wells situated within the primary porosity aquifer associated with alluvium material deposited in flood plains. A zone of 250m around the proposed gas production wells situated within the Karoo formations. A buffer zone of 50m along identified fault zones traverse the project area.	These aquifers cover a substantial portion of the study area and are limited to a zone of variable width and depth. The alluvial aquifer is specifically vulnerable to contamination as it there is a direct connectivity with rivers and streams and associated high permeability. This aquifer is moderately susceptible to impacts from contaminant sources originating within this buffer zone as point source pollution. The intergranular Karoo aquifer can be classified as a secondary porosity aquifer and is generally unconfined with phreatic water levels. Due to higher effective porosity (n) this aquifer is most susceptible to impacts from contaminant sources. This aquifer is moderately susceptible to impacts from contaminant sources originating within this buffer zone as point source pollution. Fault zones targeted as part of the gas production operation can serve as potential preferred pathways for groundwater flow and contaminant transport.	+1
High	The proposed development will negatively influence the current status of the feature to a high degree of modification.	A zone of 350m around the proposed gas production wells situated within the riparian zone primary porosity aquifer associated with alluvium material deposited in flood plains.	These aquifers cover a substantial portion of the study area and are limited to a zone of variable width and depth. The alluvial aquifer is specifically vulnerable to contamination as it there is a direct connectivity with rivers and streams and associated high permeability. This aquifer is highly susceptible to impacts from contaminant sources originating within this buffer	+1

Sensitivity rating	Description	Hydrogeological component identified	Motivation	Weighting
		A zone of 150m around the proposed gas production wells situated within the Karoo formations.	zone as point source pollution. The intergranular Karoo aquifer can be classified as a secondary porosity aquifer and is generally unconfined with phreatic water levels. Due to higher effective porosity (n) this aquifer is highly susceptible to impacts from contaminant sources originating within this buffer zone as point source pollution.	

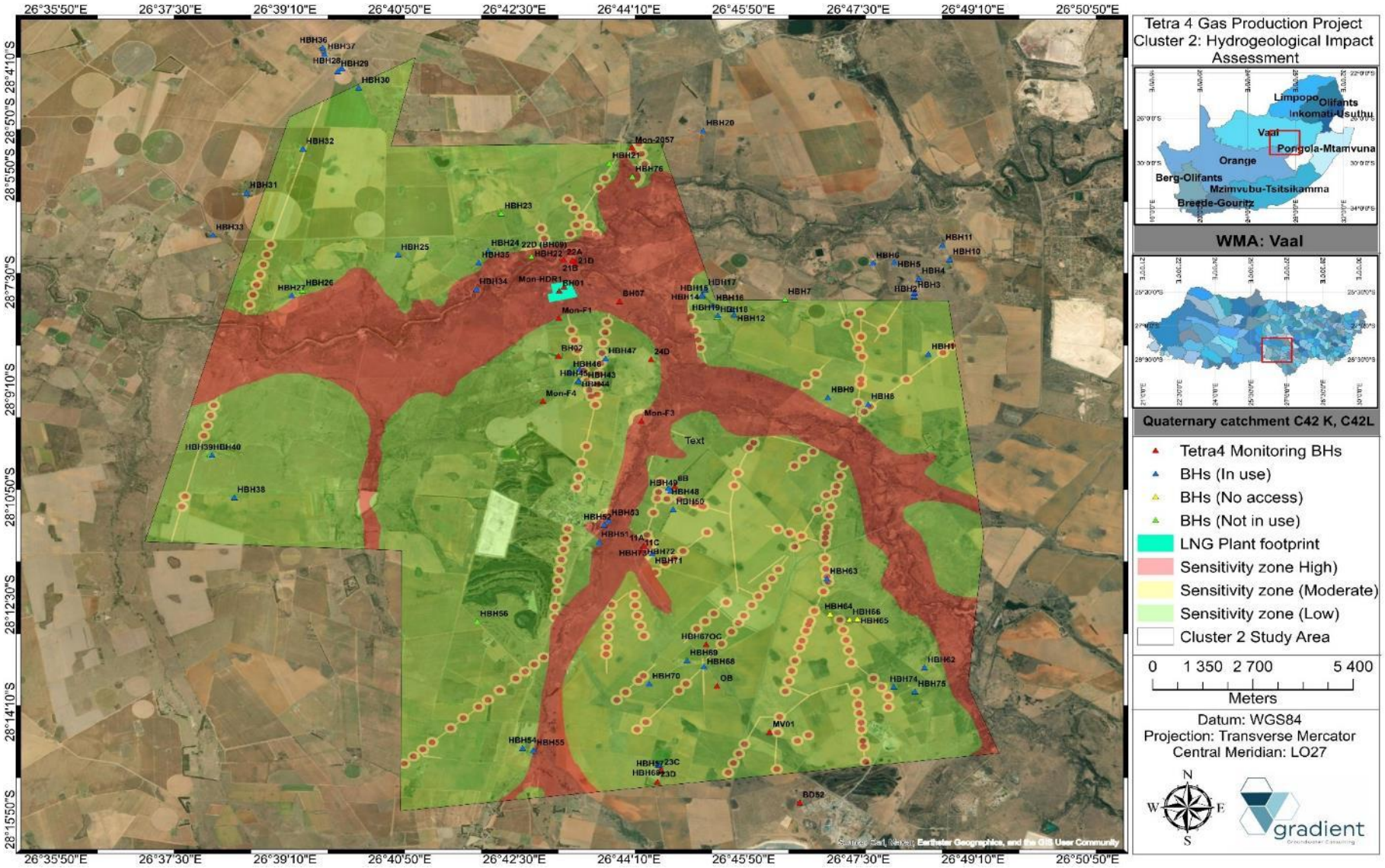


Figure 147: Hydrogeological sensitivity map.

9.11 TERRESTRIAL BIODIVERSITY

Terrestrial Biodiversity has been assessed by The Biodiversity Company (TBC) and the specialist report is included in Appendix 4. The baseline terrestrial biodiversity (flora and fauna) findings are presented in the subsections below.

9.11.1 ECOLOGICALLY IMPORTANT LANDSCAPE FEATURES

The following features describe the general area and habitat, this assessment is based on spatial data that was available from various sources such as the provincial environmental authority and SANBI. The findings of the desktop analysis into sensitive areas and the relevance to this project are listed in Table 57.

Table 57: Desktop spatial features examined.

Desktop Information Considered	Relevant/Irrelevant
Critical Biodiversity Area	Relevant – Intersects CB1, CBA2, ESA1 and ESA2
Ecosystem Threat Status	Relevant – Located within an Endangered and Least Concerned ecosystem
Ecosystem Protection Level	Relevant – Located within a Not Protected and a Poorly Protected ecosystem
Protected Areas	Relevant – Within 5km of a protected area
National Protected Area Expansion Strategy	Relevant –Overlap any NPAES areas
Important Bird and Biodiversity Areas	Irrelevant – Does not overlap IBA, is 29,5 km from the Willem Pretorius Nature Reserve IBA
South African Inventory of Inland Aquatic Ecosystems	Relevant – overlaps with three CR rivers and numerous unclassified wetlands.
National Freshwater Ecosystem Priority Areas	Relevant – overlaps with a true FEPA wetland and an unclassified river.
Strategic Water Source Areas	Irrelevant – Not located within a SWSA, closest SWSA is 122 km away

9.11.2 BIODIVERSITY SPATIAL PLAN (BSP)

Conservation of CBAs is crucial, in that if these areas are not maintained in a natural or near-natural state, biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity compatible land uses and resource uses (SANBI-BGIS, 2017). The proposed development overlaps with an area regarded as CBA1, CBA2, ESA1, ESA2, Other, and Degraded. The application area falls across both a CBA2 and an ESA1 classified area (Figure 148).

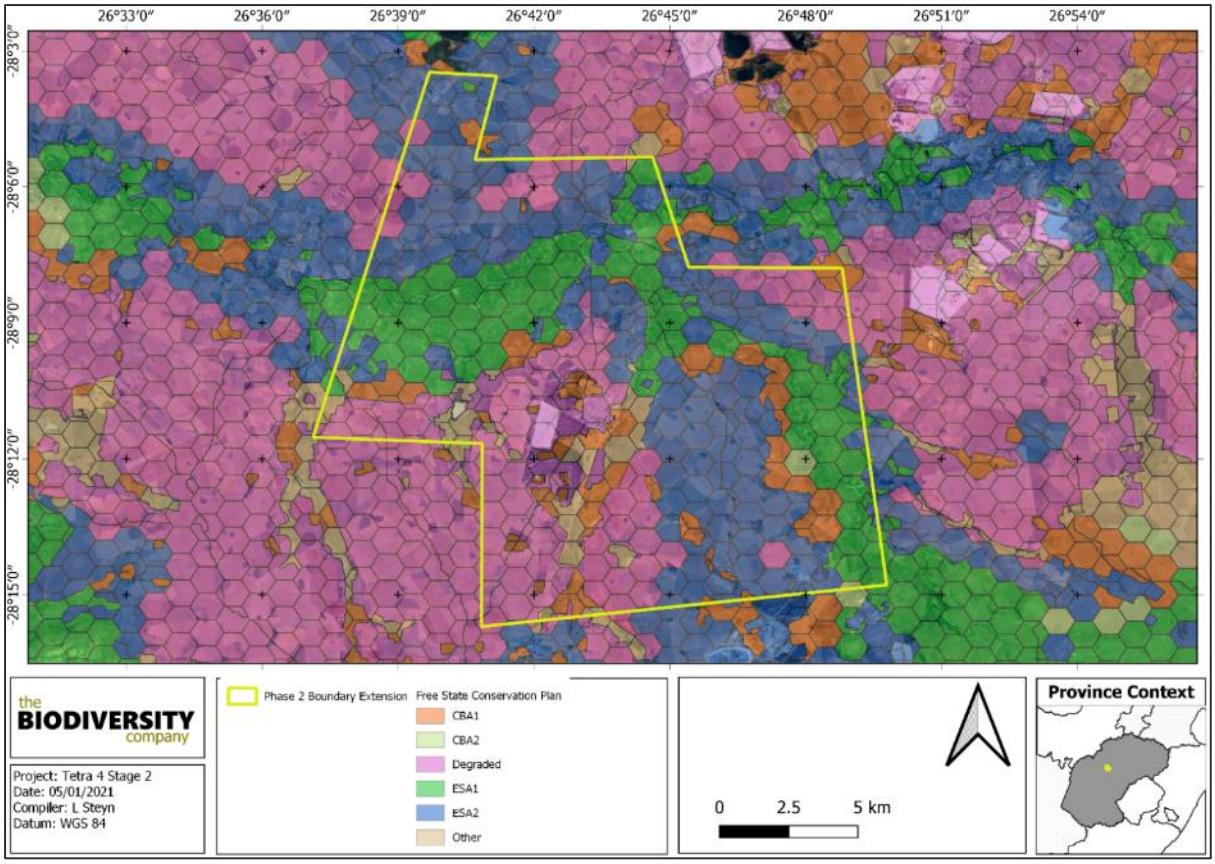


Figure 148: Application area superimposed on the Free State BSP.

9.11.3 THE NATIONAL BIODIVERSITY ASSESSMENT

The National Biodiversity Assessment (NBA) was completed as a collaboration between the SANBI, the DEA (now the DFFE) and other stakeholders, including scientists and biodiversity management experts throughout the country over a three-year period. The purpose of the NBA is to assess the state of South Africa's biodiversity with a view to understanding trends over time and informing policy and decision-making across a range of sectors. The two headline indicators assessed in the NBA are ecosystem threat status and ecosystem protection level which are discussed in more detail in the sub-sections below.

9.11.3.1 **ECOSYSTEM THREAT STATUS**

Ecosystem threat status outlines the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function and composition, on which their ability to provide ecosystem services ultimately depends. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Least Threatened (LT), based on the proportion of each ecosystem type that remains in good ecological condition. The application area was superimposed on the terrestrial ecosystem threat status (Figure 149). According to the spatial dataset the proposed development overlaps with LC and EN ecosystems.

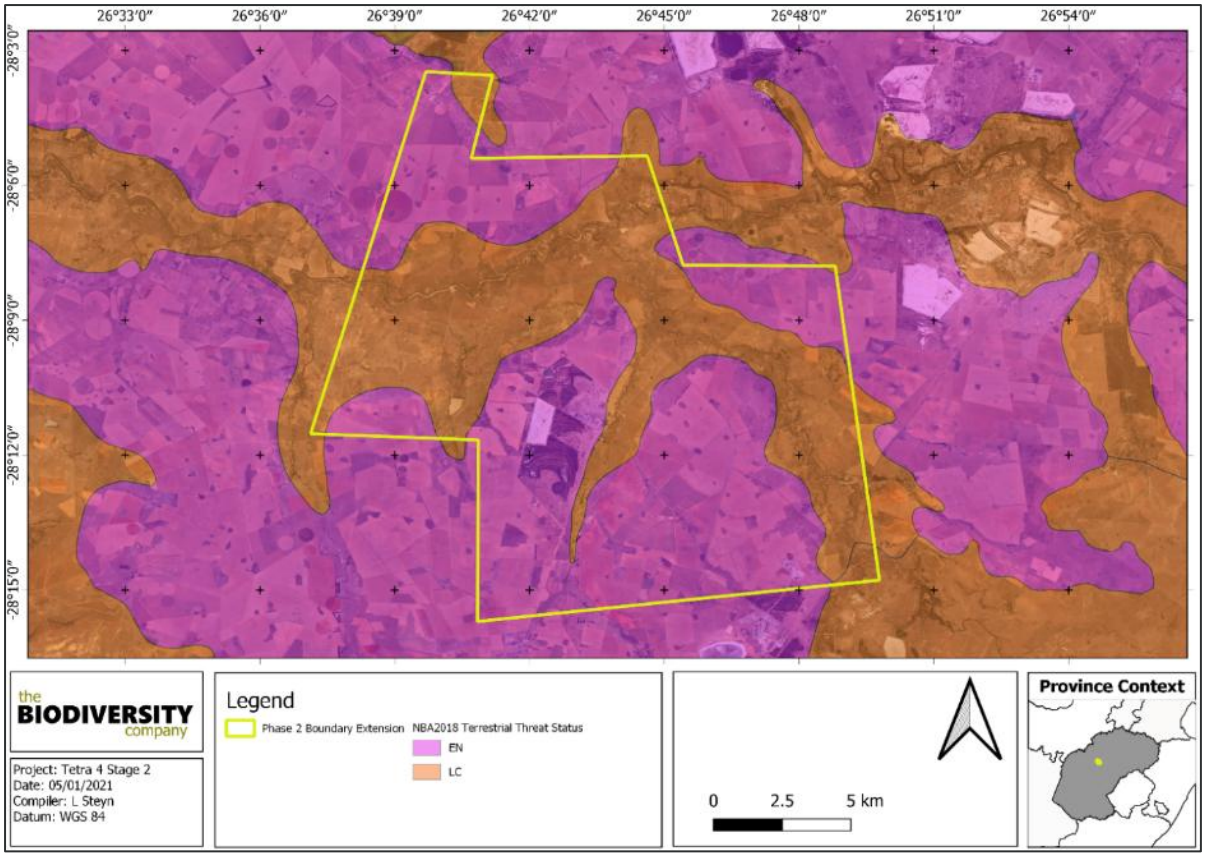


Figure 149: The application area showing the regional ecosystem threat status of the associated terrestrial ecosystems (NBA, 2018).

9.11.3.2 **ECOSYSTEM PROTECTION LEVEL**

Ecosystem protection level tells us whether ecosystems are adequately protected or under-protected. Ecosystem types are categorised as not protected, poorly protected, moderately protected or well protected, based on the proportion of each ecosystem type that occurs within a protected area recognised in the Protected Areas Act. The application area was superimposed on the ecosystem protection level map to assess the protection status of terrestrial ecosystems associated with the development (Figure 150). The application area overlaps with Not Protected (NP) and Poorly Protected (PP) ecosystems.

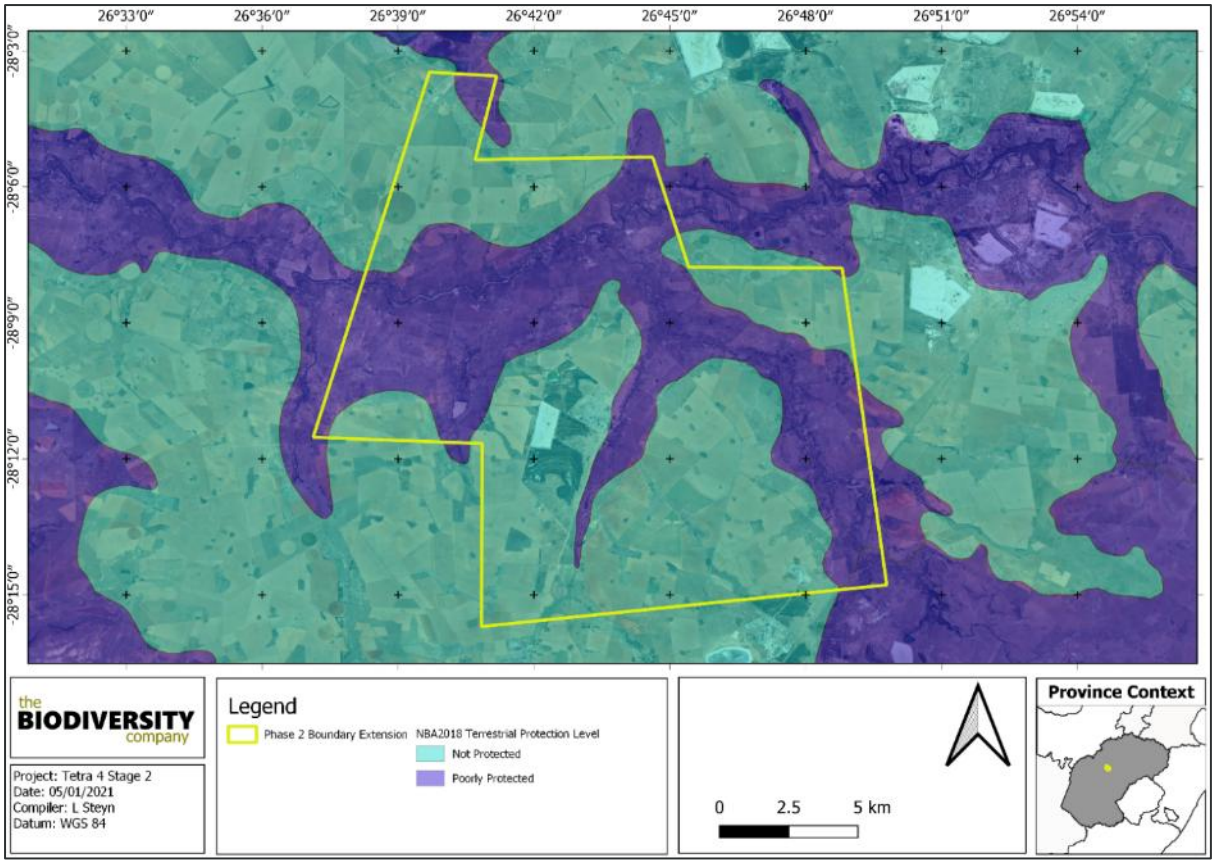


Figure 150: The application area showing the regional level of protection of terrestrial ecosystems (NBA, 2018).

9.11.4 PROTECTED AREAS

According to the protected area spatial datasets, the application area does not occur within any protected area but does overlap with a National Protected Area Expansion Strategy (NPAES) area and is within the 5 km buffer of protected areas. The H.J Joel Private Nature Reserve is found 876 m from the application area (Figure 151). The south-eastern corner of the application area overlaps with a NPAES priority focus area (Figure 152).

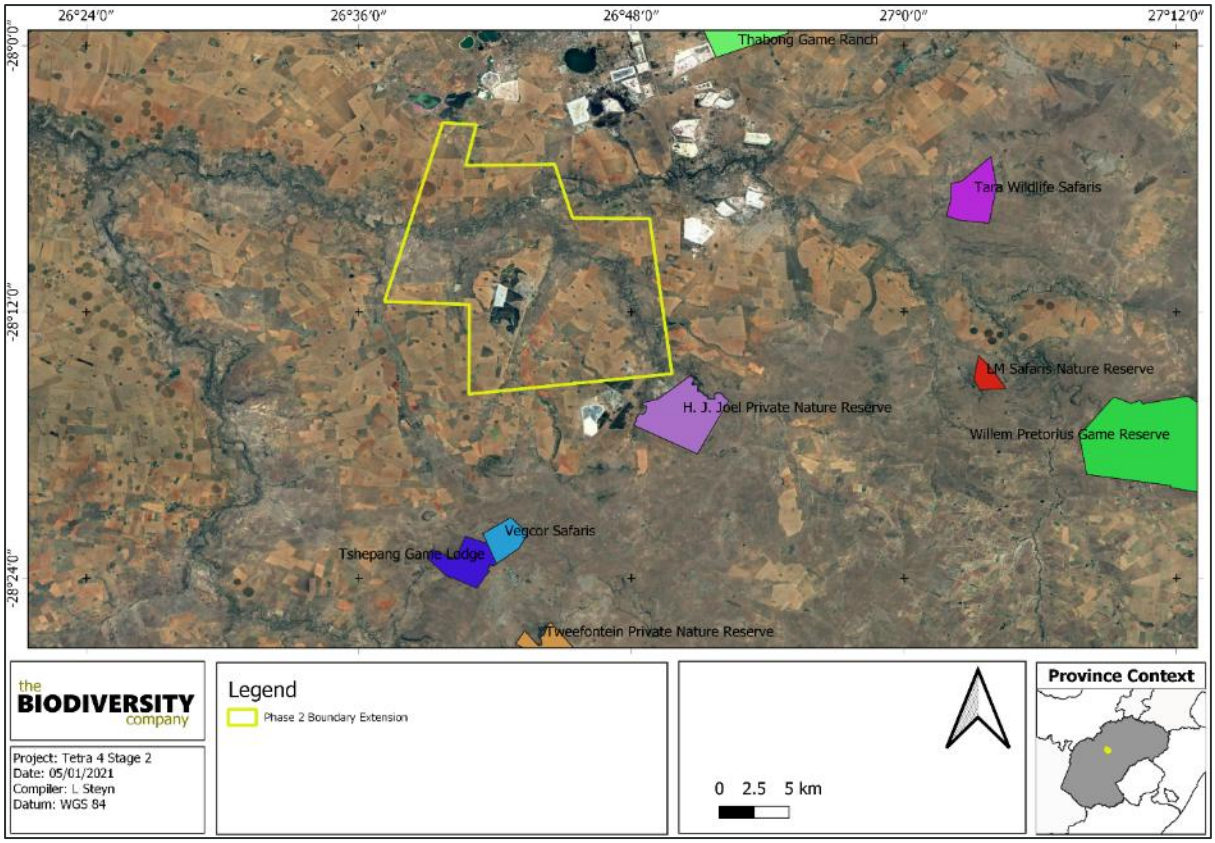


Figure 151: Map illustrating the location of protected areas proximal to the assessment area.

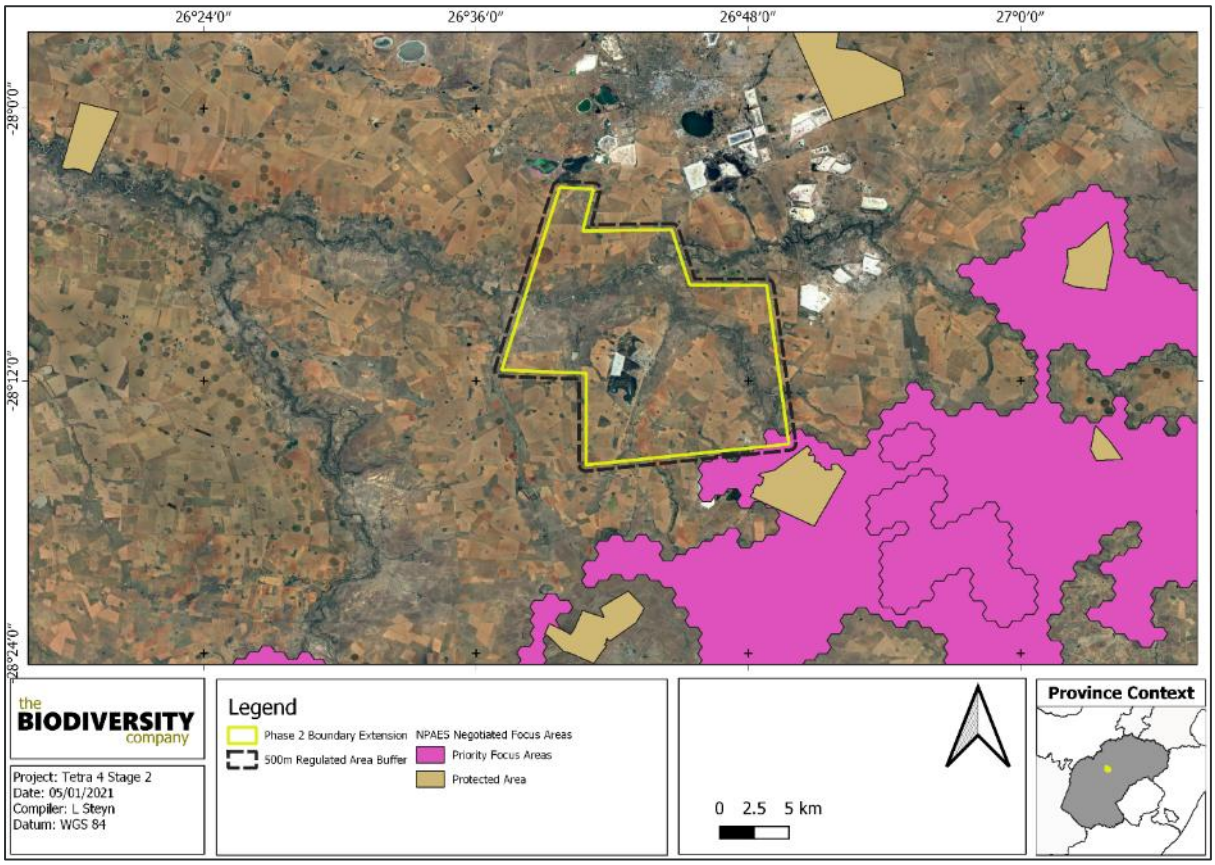


Figure 152: Map illustrating the location of NPAES proximal to the assessment area.

9.11.5 IMPORTANT BIRD AND BIODIVERSITY AREAS (IBAS)

The proposed development does not overlap any IBA (Figure 153). The closest IBA, the Willem Pretorius Nature Reserve, is located approximately 29.5 km to the east.

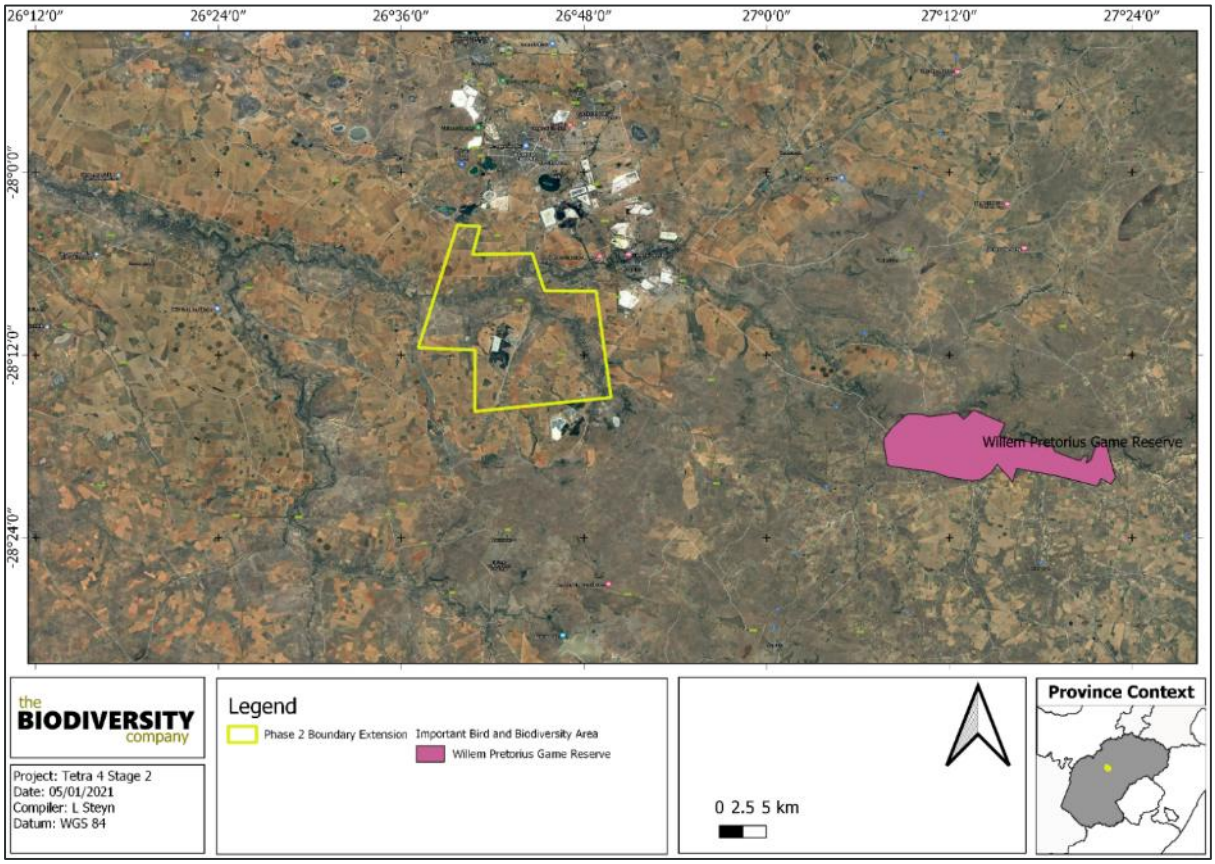


Figure 153: Location of Important Bird and Biodiversity Areas (IBAs) in relation to the assessment area.

9.11.6 HYDROLOGICAL SETTING

Three major river systems assessed as part of the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) overlap with the proposed development area (Sand River, Doring River and Bosluisspruit) (Figure 154). The threat status, protection level and condition of South African rivers and wetlands were released with the National Biodiversity Assessment (NBA) 2018. Ecosystem Threat Status (ETS) are based on the extent to which each type had been altered from its natural condition. Ecosystem types are categorised as CR, EN, VU or LC. Critically Endangered, EN and VU ecosystem types are collectively referred to as 'threatened'. The rivers were all classed as CR, while the wetlands were not evaluated as part of NBA 2018.

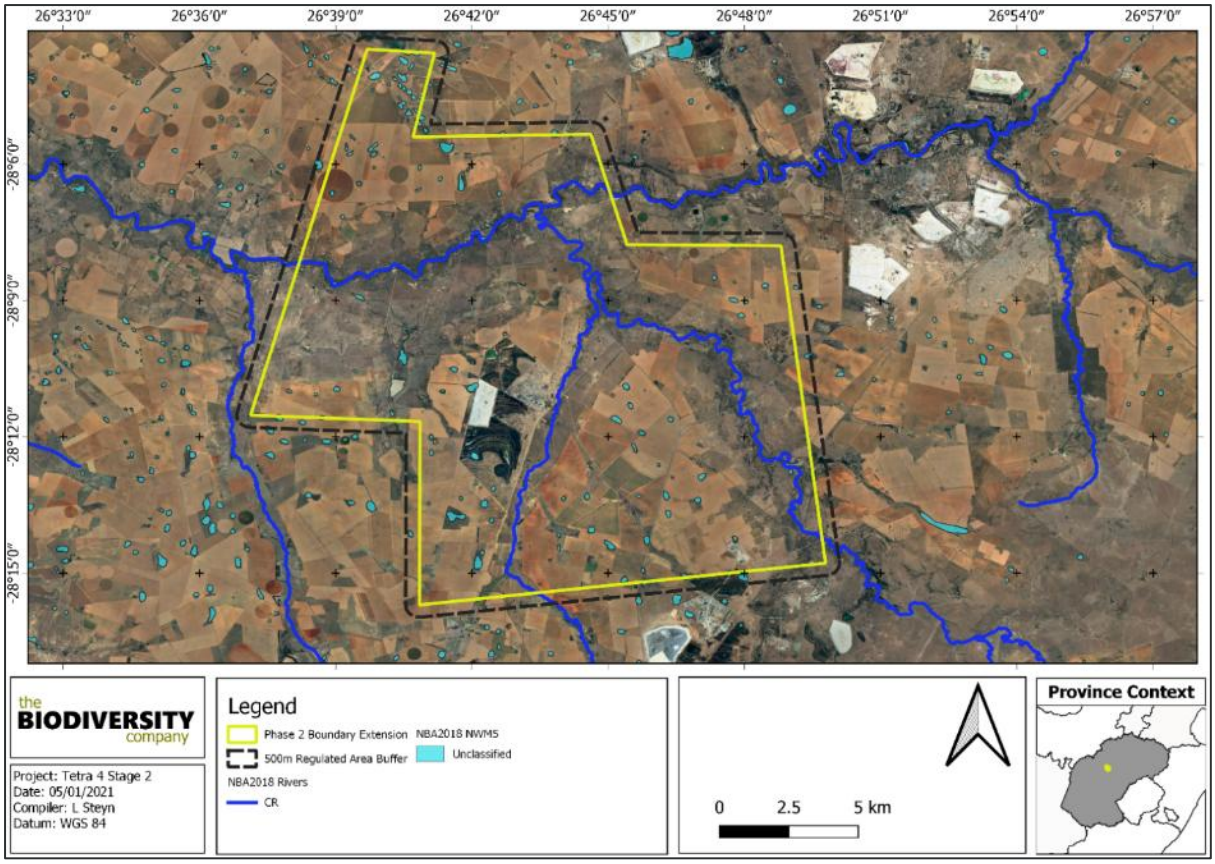


Figure 154: Hydrological context of the assessment area based on the NBA spatial dataset (2018).

Freshwater Ecosystem Priority Areas (FEPAs) (Driver et al., 2011) are intended to be conservation support tools and are envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act (NEM:BA) biodiversity goals. Figure 155 shows the assessment area overlaps with a true FEPA wetland and an unclassified river.

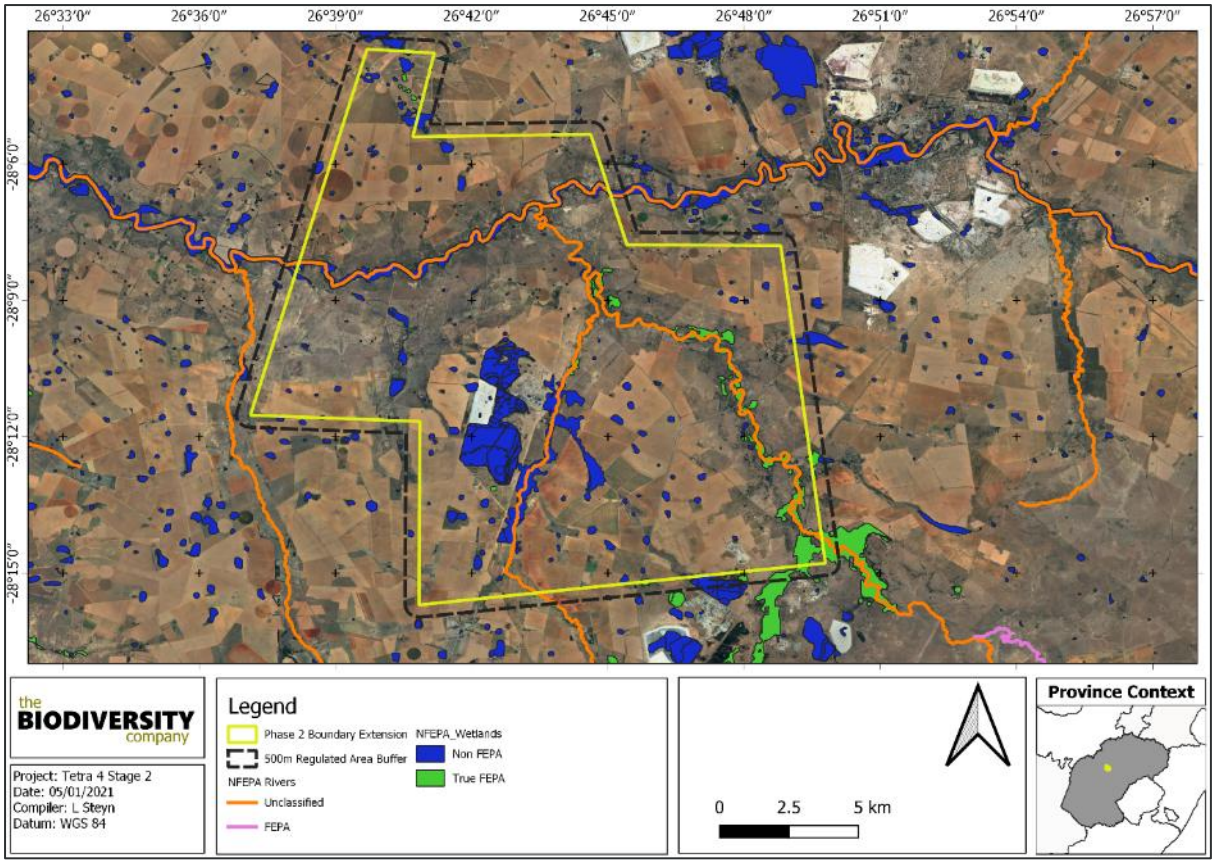


Figure 155: Hydrological context of the assessment area based on the NFEPA spatial dataset (2011).

9.11.7 VEGETATION TYPES

The application area is situated within the Grassland biome. This biome is centrally located in southern Africa, and adjoins all except the desert, fynbos and succulent Karoo biomes (Mucina & Rutherford, 2006). Major macroclimatic traits that characterise the grassland biome include:

- Seasonal precipitation; and
- The minimum temperatures in winter (Mucina & Rutherford, 2006).

The grassland biome is found chiefly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. The topography is mainly flat and rolling but includes the escarpment itself. Altitude varies from near sea level to 2850 m above sea level.

Grasslands are dominated by a single layer of grasses. The amount of cover depends on rainfall and the degree of grazing. The grassland biome experiences summer rainfall and dry winters with frost (and fire), which are unfavourable for tree growth. Thus, trees are typically absent, except in a few localized habitats. Geophytes (bulbs) are often abundant. Frosts, fire and grazing maintain the grass dominance and prevent the establishment of trees.

On a fine-scale vegetation type, the application area overlaps predominantly with the Highveld Alluvial Vegetation (Least Threatened) and Vaal Vet Sandy Grassland (Endangered) as shown in Figure 156.

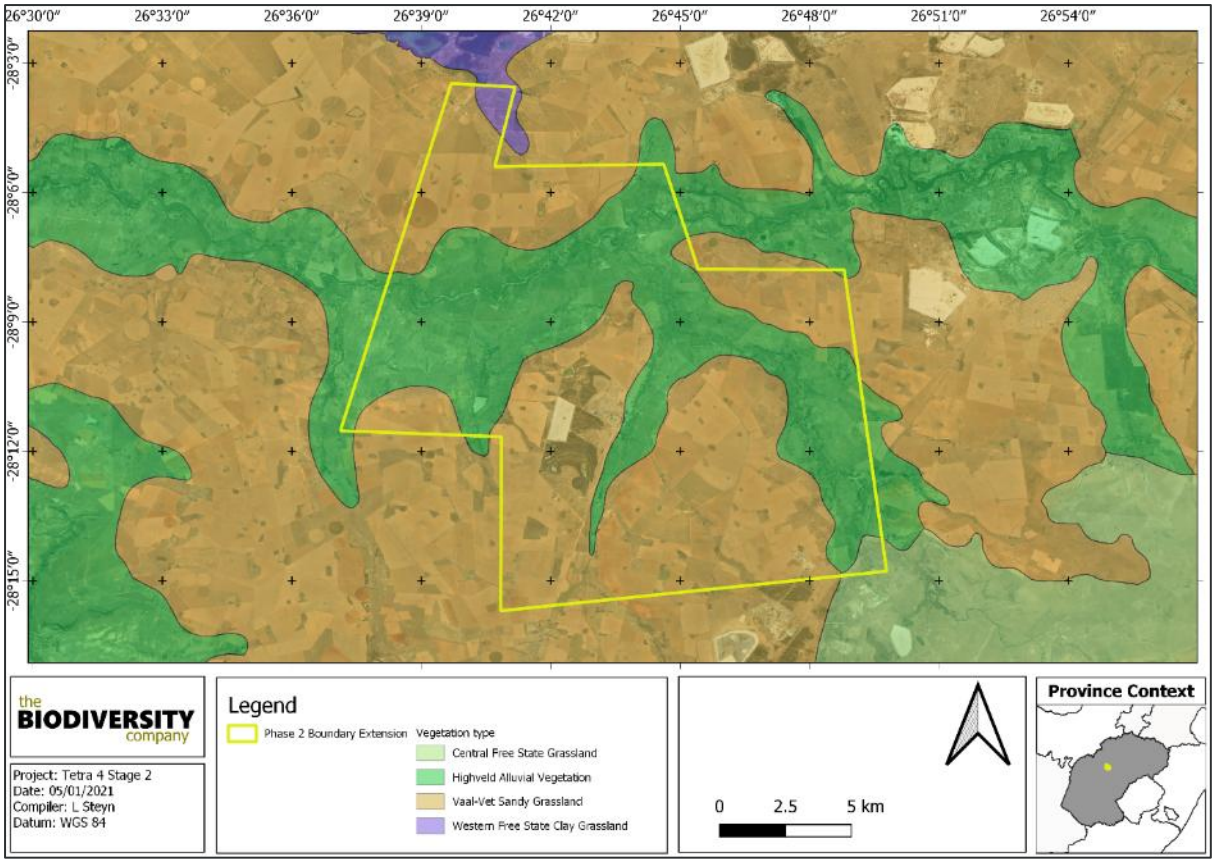


Figure 156: The application area showing the vegetation type based on the Vegetation Map of South Africa, Lesotho & Swaziland (BGIS, 2018).

9.11.8 FLORA ASSESSMENT

This section is divided into three sections:

3. Indigenous Flora;
4. Invasive Alien Plants (IAPs); and
5. Protected Plant Species.

9.11.8.1 **INDIGENOUS FLORA**

The vegetation assessment was conducted throughout the extent of the application area. A total of 122 tree, shrub, herbaceous and graminoid plant species were recorded in the application area during the field assessment (Table 58). Plants listed as Category 1 alien or invasive species under the NEMBA appear in green text. Plants listed in Category 2 or as 'not indigenous' or 'naturalised' according to NEMBA, appear in blue text. The list of plant species recorded is by no means comprehensive, and repeated surveys during different phenological periods not covered may likely yield up to 20 % additional flora species for the application area. However, floristic analysis conducted to date is regarded as a sound representation of the local flora for the application area.

Table 58: Trees, shrub and herbaceous plant species recorded in the application area.

Family	*Scientific Name*	Threat Status (SANBI, 2017)	SA Endemic	Alien Category
Acanthaceae	*Blepharis squarrosa*	LC	Endemic	
Acanthaceae	*Crabbea angustifolia*	LC	Endemic	
Agavaceae	*Chlorophytum cooperi*	LC	Not Endemic	

Family	*Scientific Name*	Threat Status (SANBI, 2017)	SA Endemic	Alien Category
Aizoaceae	*Delosperma herbeum*	LC	Not Endemic	
Amaranthaceae	*Achyranthes aspera*			Naturalized exotic
Amaranthaceae	*Gomphrena celosioides*			Naturalized exotic
Amaryllidaceae	*Ammocharis coranica*	LC-Schedule 6 Protected	Not Endemic	
Amaryllidaceae	*Boophone disticha*	LC Schedule -6 Protected	Not Endemic	
Anacardiaceae	*Schinus terebinthifolius*			Naturalized exotic
Anacardiaceae	*Searsia lancea*	LC	Not Endemic	
Anacardiaceae	*Searsia pyroides var. pyroides*	LC	Not Endemic	
Apocynaceae	*Nerium oleander*			NEMBA Category 1b.
Asclepiadaceae	*Gomphocarpus fruticosus subsp. fruticosus*	LC	Indigenous	
Asparagaceae	*Asparagus cooperi*	LC	Not Endemic	
Asparagaceae	*Asparagus laricinus*	LC	Not Endemic	
Asparagaceae	*Eucomis autumnalis*	LC -Schedule 6 Protected	Not Endemic	
Asphodelaceae	*Aloe dominella*	Near Threatened B1ab(ii,iii,v) (-Schedule 6 Protected)	Endemic	
Asteraceae	*Artemisia afra*	LC	Not Endemic	
Asteraceae	*Berkheya onopordifolia var. onopordifolia*	LC	Not Endemic	
Asteraceae	*Berkheya pinnatifida*	LC	Not Endemic	
Asteraceae	*Bidens pilosa*			Naturalized exotic weed
Asteraceae	*Cirsium vulgare*			NEMBA Category 1b.
Asteraceae	*Conyza bonariensis*			Naturalized exotic
Asteraceae	*Cotula anthemoides*	LC	Not Endemic	
Asteraceae	*Felicia muricata subsp. muricata*	LC	Not Endemic	
Asteraceae	*Geigeria burkei*	LC	Not Endemic	
Asteraceae	*Hilliardiella elaeagnoides*	LC	Not Endemic	
Asteraceae	*Macledium zeyheri*	LC	Not Endemic	
Asteraceae	*Nidorella anomala*	LC	Not Endemic	
Asteraceae	*Schkuhria pinnata*			Naturalized exotic
Asteraceae	*Senecio inornatus*	LC	Not Endemic	
Asteraceae	*Stoebe plumosa*	LC	Not Endemic	
Asteraceae	*Tagetes minuta*			Naturalized exotic

Family	*Scientific Name*	Threat Status (SANBI, 2017)	SA Endemic	Alien Category
Asteraceae	*Xanthium stramonium*			NEMBA Category 1b.
Asteraceae	*Zinnia peruviana*			Naturalized exotic
Cactaceae	*Opuntia ficus-indica*			NEMBA Category 1b.
Cactaceae	*Opuntia stricta*			NEMBA Category 1b.
Campanulaceae	*Wahlenbergia undulata*	LC	Not Endemic	
Cannabaceae	*Celtis africana*	LC	Not Endemic	
Caryophyllaceae	*Pollichia campestris*	LC	Not Endemic	
Commelinaceae	*Commelina africana*	LC	Not Endemic	
Commelinaceae	*Commelina erecta*	LC	Not Endemic	
Commelinaceae	*Cyanotis speciosa*	LC	Not Endemic	
Convolvulaceae	*Cuscuta campestris*			Naturalized exotic
Cucurbitaceae	*Cucumis zeyheri*	LC	Not Endemic	
Ebenaceae	*Diospyros austro-africana*	LC	Not Endemic	
Fabaceae	*Chamaecrista mimosoides*	LC	Not Endemic	
Fabaceae	*Robinia pseudoacacia*			NEMBA Category 1b.
Fabaceae	*Vachellia karroo*	LC	Not Endemic	
Geraniaceae	*Monsonia angustifolia*	LC	Not Endemic	
Hyacinthaceae	*Dipcadi longifolium*	LC	Not Endemic	
Hyacinthaceae	*Ledebouria marginata*	LC	Not Endemic	
Hyacinthaceae	*Schizocarphus nervosus*	LC-Schedule 6 Protected		
Hypoxidaceae	*Hypoxis hemerocallidea*	LC	Not Endemic	
Hypoxidaceae	*Hypoxis iridifolia*	LC	Not Endemic	
Iridaceae	*Gladiolus crassifolius*	LC-Schedule 6 Protected	Not Endemic	
Iridaceae	*Gladiolus permeabilis*	LC-Sched 6 Protected	Endemic	
Malvaceae	*Hermannia depressa*	LC	Not Endemic	
Malvaceae	*Hibiscus trionum*	LC	Not Endemic	
Malvaceae	*Hibiscus trionum*			Naturalized exotic
Malvaceae	*Malva neglecta*			Naturalized exotic
Meliaceae	*Melia azedarach*			NEMBA Category 1b.
Moraceae	*Morus alba*			NEMBA Category 3

Family	*Scientific Name*	Threat Status (SANBI, 2017)	SA Endemic	Alien Category
Myrtaceae	*Eucalyptus camaldulensis*			NEMBA Category 1b
Oxalidaceae	*Oxalis depressa*	LC	Not Endemic	
Pentzia Globosa	*Pentzia globosa*	LC	Not Endemic	
Pinaceae	*Pinus pinaster*			NEMBA Category 2
Poaceae	*Aristida adscensionis*	LC	Not Endemic	
Poaceae	*Aristida canescens subsp. canescens*	LC	Not Endemic	
Poaceae	*Aristida congesta subsp. barbicollis*	LC	Not Endemic	
Poaceae	*Aristida congesta subsp. congesta*	LC	Not Endemic	
Poaceae	*Arundo donax*			NEMBA Category 1b.
Poaceae	*Bambusa sp*			Naturalized exotic
Poaceae	*Bewsia biflora*	LC	Not Endemic	
Poaceae	*Cenchrus ciliaris*	LC	Not Endemic	
Poaceae	*Chloris gayana*	LC	Not Endemic	
Poaceae	*Cortaderia selloana*			NEMBA Category 1b.
Poaceae	*Cymbopogon caesius*	LC	Not Endemic	
Poaceae	*Cynodon dactylon*	LC	Not Endemic	
Poaceae	*Digitaria eriantha*	LC	Not Endemic	
Poaceae	*Eleusine coracana*			Naturalized exotic
Poaceae	*Eragrostis chloromelas*	LC	Not Endemic	
Poaceae	*Eragrostis curvula*	LC	Not Endemic	
Poaceae	*Eragrostis gummiflua*	LC	Not Endemic	
Poaceae	*Eragrostis obtusa*	LC	Not Endemic	
Poaceae	*Eragrostis superba*	LC	Not Endemic	
Poaceae	*Fingerhuthia africana*	LC	Not Endemic	
Poaceae	*Heteropogon contortus*	LC	Not Endemic	
Poaceae	*Hyparrhenia hirta*	LC	Not Endemic	
Poaceae	*Hyperthelia dissoluta*	LC	Not Endemic	
Poaceae	*Melinis repens*	LC	Not Endemic	
Poaceae	*Microchloa caffra*	LC	Not Endemic	
Poaceae	*Panicum maximum*	LC	Not Endemic	

Family	*Scientific Name*	Threat Status (SANBI, 2017)	SA Endemic	Alien Category
Poaceae	*Paspalum dilatatum*	LC	Indigenous	
Poaceae	*Pennisetum clandestinum*			NEMBA Category 1b.
Poaceae	*Phragmites australis*	LC	Not Endemic	
Poaceae	*Pogonarthria squarrosa*	LC	Not Endemic	
Poaceae	*Setaria pumila*	LC	Not Endemic	
Poaceae	*Setaria sphacelata var. Sericea*	LC	Not Endemic	
Poaceae	*Setaria sphacelata var. sphacelata*	LC	Not Endemic	
Poaceae	*Setaria sphacelata var. torta*	LC	Not Endemic	
Poaceae	*Setaria verticillata*	LC	Not Endemic	
Poaceae	*Sporobolus africanus*	LC	Not Endemic	
Poaceae	*Themeda triandra*	LC	Not Endemic	
Poaceae	*Trachypogon spicatus*	LC	Not Endemic	
Poaceae	*Trichoneura grandiglumis*	LC	Not Endemic	
Poaceae	*Urochloa mosambicensis*	LC	Not Endemic	
Polygonaceae	*Persicaria lapathifolia*			Naturalized exotic
Rhamnaceae	*Ziziphus mucronata subsp. mucronata*	LC	Not Endemic	
Rosaceae	*Prunus persica*			Naturalized exotic
Salicaceae	*Populus alba*			NEMBA Category 2
Salicaceae	*Populus deltoides*			Naturalized exotic
Salicaceae	*Salix babylonica*			Naturalized exotic
Scrophulariaceae	*Jamesbrittenia aurantiaca*	LC	Not Endemic	
Scrophulariaceae	*Selago densiflora*	LC	Not Endemic	
Solanaceae	*Datura ferox*			NEMBA Category 1b.
Solanaceae	*Solanum lichtensteinii*	LC	Not Endemic	
Tamaricaceae	*Tamarix chinensis*			NEMBA Category 1b.
Typhaceae	*Typha capensis*	LC	Not Endemic	
Verbenaceae	*Verbena astrigera*			Naturalized exotic
Verbenaceae	*Verbena bonariensis*			NEMBA Category 1b.
Zygophyllaceae	*Tribulus terrestris*	LC	Not Endemic	

9.11.8.2 **INVASIVE ALIEN PLANTS**

Invasive Alien Plants (IAPs) tend to dominate or replace indigenous flora, thereby transforming the structure, composition and functioning of ecosystems. Therefore, it is important that these plants are controlled by means of an eradication and monitoring programme. Some invader plants may also degrade ecosystems through superior competitive capabilities to exclude native plant species.

Fourteen (14) IAP species were recorded within the application area. These species are listed under the Alien and Invasive Species List 2020, Government Gazette No. GN1003 as Category 1b. Category 1b species must be controlled by implementing an IAP Management Programme, in compliance of section 75 of the NEMBA.

9.11.8.3 **PROTECTED PLANT SPECIES**

Several individuals of protected plant species that are protected by the Free State Nature Conservation Ordinance 8 of 1969 were observed in various parts of the application area. According to the list of protected species under Schedule, if any individuals of these plant species are to be disturbed, permits must be obtained from the Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FSDESTEA).

9.11.9 FAUNA ASSESSMENT

Avifauna, Mammal and Herpetofauna observations and recordings fall under this section.

9.11.9.1 **AVIFAUNA**

Eighty-nine (89) (37.7 % of expected) species were recorded in the application area during the survey based on either direct observation, vocalisations, or the presence of visual tracks & signs, (Table 59). Four (4) (red text) species are rated as Species of Conservation Concern (SCC), whereas 75 were listed as protected provincially.

Table 59: A list of avifaunal species recorded for the application area.

Species	Common Name	Regional (SANBI, 2016)	IUCN (2021)	Free State Nature Conservation Ordinance 8 of 1969
Acridotheres tristis	Myna, Common	Unlisted	LC	-
Afrotis afraoides	Korhaan, Northern Black	Unlisted	LC	Schedule 1 Protected
Alopochen aegyptiaca	Goose, Egyptian	Unlisted	LC	Schedule 1/2 Protected
Amadina erythrocephala	Finch, Red-headed	Unlisted	LC	Schedule 1 Protected
Anas erythrorhyncha	Teal, Red-billed	Unlisted	LC	Schedule 1 Protected
Anas sparsa	Duck, African Black	Unlisted	LC	Schedule 1 Protected
Anas undulata	Duck, Yellow-billed	Unlisted	LC	Schedule 1/2 Protected
Anhinga rufa	Darter, African	Unlisted	LC	Schedule 1 Protected
Apus apus	Swift, Common	Unlisted	LC	Schedule 1 Protected
Ardea cinerea	Heron, Grey	Unlisted	LC	Schedule 1 Protected
Ardea intermedia	Egret, Yellow-billed (Intermediate)	Unlisted	LC	Schedule 1 Protected
Ardea melanocephala	Heron, Black-headed	Unlisted	LC	Schedule 1 Protected
Ardea purpurea	Heron, Purple	Unlisted	LC	Schedule 1 Protected
Ardeola ralloides	Heron, Squacco	Unlisted	LC	Schedule 1 Protected
Asio capensis	Owl, Marsh	Unlisted	LC	Schedule 1 Protected
Bostrychia hagedash	Ibis, Hadeda	Unlisted	LC	Schedule 1 Protected
Bubulcus ibis	Egret, Cattle	Unlisted	LC	Schedule 1 Protected

Species	Common Name	Regional (SANBI, 2016)	IUCN (2021)	Free State Nature Conservation Ordinance 8 of 1969
Burhinus capensis	Thick-knee, Spotted	Unlisted	LC	Schedule 1 Protected
Buteo buteo	Buzzard, Common (Steppe)	Unlisted	LC	Schedule 1 Protected
Buteo rufofuscus	Buzzard, Jackal	Unlisted	LC	Schedule 1 Protected
Charadrius tricollaris	Plover, Three-banded	Unlisted	LC	Schedule 1 Protected
Chlidonias hybrida	Tern, Whiskered	Unlisted	LC	Schedule 1 Protected
Chlidonias leucopterus	Tern, White-winged	Unlisted	LC	Schedule 1 Protected
Chrysococcyx caprius	Cuckoo, Diderick	Unlisted	LC	Schedule 1 Protected
Circus macrourus	Harrier, Pallid	NT	NT	Schedule 1 Protected
Columba livia	Dove, Rock	Unlisted	LC	-
Coracias caudatus	Roller, Lilac-breasted	Unlisted	LC	Schedule 1 Protected
Corvus albus	Crow, Pied	Unlisted	LC	-
Corythornis cristatus	Kingfisher, Malachite	Unlisted	Unlisted	Schedule 1 Protected
Cursorius temminckii	Courser, Temminck's	Unlisted	LC	Schedule 1 Protected
Dendrocygna viduata	Duck, White-faced Whistling	Unlisted	LC	Schedule 1 Protected
Egretta ardesiaca	Heron, Black	Unlisted	LC	Schedule 1 Protected
Egretta garzetta	Egret, Little	Unlisted	LC	Schedule 1 Protected
Elanus caeruleus	Kite, Black-shouldered	Unlisted	LC	Schedule 1 Protected
Estrilda astrild	Waxbill, Common	Unlisted	LC	Schedule 1 Protected
Euplectes afer	Bishop, Yellow-crowned	Unlisted	LC	-
Euplectes ardens	Widowbird, Red-collared	Unlisted	LC	-
Euplectes orix	Bishop, Southern Red	Unlisted	LC	-
Euplectes progne	Widowbird, Long-tailed	Unlisted	LC	-
Falco amurensis	Falcon, Amur	Unlisted	LC	Schedule 1 Protected
Falco rupicolus	Kestrel, Rock	Unlisted	LC	Schedule 1 Protected
Fulica cristata	Coot, Red-knobbed	Unlisted	LC	Schedule 1 Protected
Himantopus himantopus	Stilt, Black-winged	Unlisted	LC	Schedule 1 Protected
Hirundo dimidiata	Swallow, Pearl-breasted	Unlisted	LC	Schedule 1 Protected
Lamprotornis bicolor	Starling, Pied	Unlisted	LC	-
Lanius collaris	Fiscal, Common (Southern)	Unlisted	LC	Schedule 1 Protected
Lanius minor	Shrike, Lesser Grey	Unlisted	LC	Schedule 1 Protected
Lybius torquatus	Barbet, Black-collared	Unlisted	LC	Schedule 1 Protected
Melierax canorus	Goshawk, Southern Pale Chanting	Unlisted	LC	Schedule 1 Protected
Merops apiaster	Bee-eater, European	Unlisted	LC	Schedule 1 Protected
Microcarbo africanus	Cormorant, Reed	Unlisted	LC	Schedule 1 Protected
Mirafra africana	Lark, Rufous-naped	Unlisted	LC	Schedule 1 Protected

Species	Common Name	Regional (SANBI, 2016)	IUCN (2021)	Free State Nature Conservation Ordinance 8 of 1969
Myrmecocichla formicivora	Chat, Anteating	Unlisted	LC	Schedule 1 Protected
Netta erythrophthalma	Pochard, Southern	Unlisted	LC	Schedule 1 Protected
Numida meleagris	Guineafowl, Helmeted	Unlisted	LC	Schedule 1/2 Protected
Nycticorax nycticorax	Night-Heron, Black-crowned	Unlisted	LC	Schedule 1 Protected
Oena capensis	Dove, Namaqua	Unlisted	LC	Schedule 1 Protected
Oxyura maccoa	Duck, Maccoa	NT	VU	Schedule 1 Protected
Passer domesticus	Sparrow, House	Unlisted	LC	-
Phoenicopterus roseus	Flamingo, Greater	NT	LC	Schedule 1 Protected
Phoeniculus purpureus	Wood-hoopoe, Green	Unlisted	LC	Schedule 1 Protected
Platalea alba	Spoonbill, African	Unlisted	LC	Schedule 1 Protected
Plectropterus gambensis	Goose, Spur-winged	Unlisted	LC	Schedule 1/2 Protected
Plegadis falcinellus	Ibis, Glossy	Unlisted	LC	Schedule 1 Protected
Plocepasser mahali	Sparrow-weaver, White-browed	Unlisted	LC	-
Ploceus velatus	Masked-weaver, Southern	Unlisted	LC	-
Podiceps nigricollis	Grebe, Black-necked	Unlisted	LC	Schedule 1 Protected
Prinia flavicans	Prinia, Black-chested	Unlisted	LC	Schedule 1 Protected
Pternistis swainsonii	Spurfowl, Swainson's	Unlisted	LC	Schedule 1/2 Protected
Rhinoptilus africanus	Courser, Double-banded	Unlisted	LC	Schedule 1 Protected
Sagittarius serpentarius	Secretarybird	VU	EN	Schedule 1 Protected
Saxicola torquatus	Stonechat, African	Unlisted	LC	Schedule 1 Protected
Spatula hottentota	Teal, Hottentot	Unlisted	LC	Schedule 1 Protected
Spatula smithii	Shoveler, Cape	Unlisted	LC	Schedule 1 Protected
Spilopelia senegalensis	Dove, Laughing	Unlisted	LC	-
Sporopipes squamifrons	Finch, Scaly-feathered	Unlisted	LC	-
Streptopelia capicola	Turtle-dove, Cape	Unlisted	LC	-
Sturnus vulgaris	Starling, Common	Unlisted	LC	Schedule 1 Protected
Tachybaptus ruficollis	Grebe, Little	Unlisted	LC	Schedule 1 Protected
Telophorus zeylonus	Bokmakierie, Bokmakierie	Unlisted	LC	Schedule 1 Protected
Trachyphonus vaillantii	Barbet, Crested	Unlisted	LC	Schedule 1 Protected
Tringa stagnatilis	Sandpiper, Marsh	Unlisted	LC	Schedule 1 Protected
Tyto alba	Owl, Barn	Unlisted	LC	Schedule 1 Protected
Upupa africana	Hoopoe, African	Unlisted	LC	Schedule 1 Protected
Uraeginthus angolensis	Waxbill, Blue	Unlisted	LC	Schedule 1 Protected
Urocolius indicus	Mousebird, Red-faced	Unlisted	LC	Schedule 1 Protected
Vanellus armatus	Lapwing, Blacksmith	Unlisted	LC	Schedule 1 Protected
Vanellus coronatus	Lapwing, Crowned	Unlisted	LC	Schedule 1 Protected

Species	Common Name	Regional (SANBI, 2016)	IUCN (2021)	Free State Nature Conservation Ordinance 8 of 1969
Vidua macroura	Whydah, Pin-tailed	Unlisted	LC	Schedule 1 Protected

9.11.9.2 MAMMALS

Twenty-two (22) mammal species were observed during the survey of the application area (Table 60) based on either direct observation or the presence of visual tracks and signs. Three (3) (in red text) of the species recorded are regarded as SCC. Four (4) mammal species are considered 'captive' species as these were only present within the game farm areas, marked in blue text.

Table 60: Summary of mammal species recorded within the application area.

Species	Common Name	Regional (SANBI, 2016)	IUCN (2021)	Free State Nature Conservation Ordinance 8 of 1969
Antidorcas marsupialis	Springbok	LC	LC	Schedule 2-Protected
Aonyx capensis	Cape Clawless Otter	NT	NT	-
Atilax paludinosus	Water Mongoose	LC	LC	-
Canis mesomelas	Black-backed Jackal	LC	LC	-
Chlorocebus pygerythrus	Vervet Monkey	LC	LC	-
Connochaetes taurinus	Blue Wildebeest	LC	LC	Schedule 2-Protected
Cryptomys hottentotus	Southern African Mole-rat	LC	LC	-
Cynictis penicillata	Yellow Mongoose	LC	LC	-
Damaliscus pygargus	Blesbok	LC	LC	Schedule 2-Protected
Genetta genetta	Small-spotted Genet	LC	LC	-
Giraffa camelopardalis	Giraffe	LC	VU	Schedule 2-Protected
Herpestes sanguineus	Slender Mongoose	LC	LC	-
Hystrix africaeaustralis	Cape Porcupine	LC	LC	-
Kobus leche	Lechwe	Unlisted	NT	-
Leptailurus serval	Serval	NT	LC	-
Lepus saxatilis	Scrub Hare	LC	LC	Schedule 2-Protected
Micaelamys namaquensis	Namaqua Rock Mouse	LC	LC	-
Parahyaena brunnea	Brown Hyaena	NT	NT	-
Raphicerus campestris	Steenbok	LC	LC	Schedule 2-Protected
Sylvicapra grimmia	Common Duiker	LC	LC	Schedule 2-Protected
Tragelaphus strepsiceros	Greater Kudu	LC	LC	Schedule 2-Protected
Xerus inauris	South African Ground Squirrel	LC	LC	-

9.11.9.3 HERPETOFAUNA

9.11.9.3.1 REPTILES

Eleven (11) species of reptiles were recorded in the application area during survey period (Table 61). One SCC, namely *Smaug giganteus* (Sungazer/Giant Dragon Lizard) was recorded during the field assessment. However, there is the possibility of more species being present, as certain reptile species are secretive and require long-term surveys to ensure capture.

Smaug giganteus (Sungazer/Giant Dragon Lizard) is categorised as VU on both a regional and an international scale. Additionally, the species is listed on the Convention on International Trade in Endangered Species (CITES) Appendix II, as well as a Threatened or Protected Species (TOPS). It is endemic to South Africa, where it is found only in the grasslands of the northern Free State and the southwestern parts of Mpumalanga with an estimated EOO (km²) of 37 617 (Alexander et al., 2018). The species is considered to be a habitat specialist, that is highly philopatric (tending to return to or remain near a particular site or area) for burrowing sites. Sungazers/Giant Dragon Lizards also won't easily disperse across the landscape to make new burrows should its habitat be destroyed (Alexander et al., 2018)

Habitat loss due to agriculture is a continuing threat. Large portions of the grassland habitat are underlain by coal beds of varying quality and extent, and exploitation of coal for fuel has and will result in further habitat loss. Another substantial threat to the species is illegal collection for the pet trade to an extent that it is one of the most exported species from South Africa with 1 194 individuals exported between 1985 and 2014 for pet trade (Parusnath *et al*, 2017; UNEP-WCMC, 2017).

A collection of burrows was observed during the field survey however it is presumed that there are several additional burrows. Due to the sensitivity of this species, especially in regard to its illegal collection, no waypoints will be displayed or provided in this report or the specialist report.

Table 61: Summary of reptile species recorded within the application area.

Species	Common Name	Regional (SANBI, 2016)	IUCN (2021)	Free State Nature Conservation Ordinance 8 of 1969
Crotaphopeltis hotamboeia	Red-lipped Snake	LC	LC	-
Dasypeltis scabra	Rhombic Egg-eater	LC	LC	-
Smaug giganteus	Sungazer	VU	VU	Schedule 1 Protected
Boaedon capensis	Brown House Snake	LC	LC	-
Pseudaspis cana	Mole Snake	LC	LC	-
Leptotyphlops scutifrons	Peters' Thread Snake	LC	LC	-
Lygodactylus capensis	Common Dwarf Gecko	LC	LC	-
Panaspis wahlbergii	Wahlberg's Snake-eyed Skink	LC	LC	-
Trachylepis punctatissima	Speckled Rock Skink	LC	LC	-
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	LC	LC	-
Varanus niloticus	Nile Monitor	LC	LC	-

9.11.9.3.2 AMPHIBIANS

Four (4) amphibian species were recorded in the application area (Table 62). One species recorded is a SCCs (shown in red text).

Table 62: Summary of amphibian species recorded within the application area.

Species	Common Name	Regional (SANBI, 2016)	IUCN (2021)	Free State Nature Conservation Ordinance 8 of 1969
Amietia quecketti	Common River Frog	LC	LC	-
Cacosternum boettgeri	Common Caco	LC	LC	-
Pyxicephalus adspersus	Giant Bullfrog	NT	LC	-
Sclerophrys gutturalis	Guttural Toad	LC	LC	-

9.11.10 HABITAT ASSESSMENT AND SITE ECOLOGICAL IMPORTANCE

9.11.10.1 **HABITAT ASSESSMENT**

The main habitat types identified across the application area were initially identified largely based on aerial imagery. These main habitat types were refined based on the field coverage and data collected during the survey and the delineated habitats can be seen in Figure 157 and Figure 158. Emphasis was placed on limiting timed meander searches along the proposed area within the natural habitats and therefore habitats with a higher potential of hosting SCC.

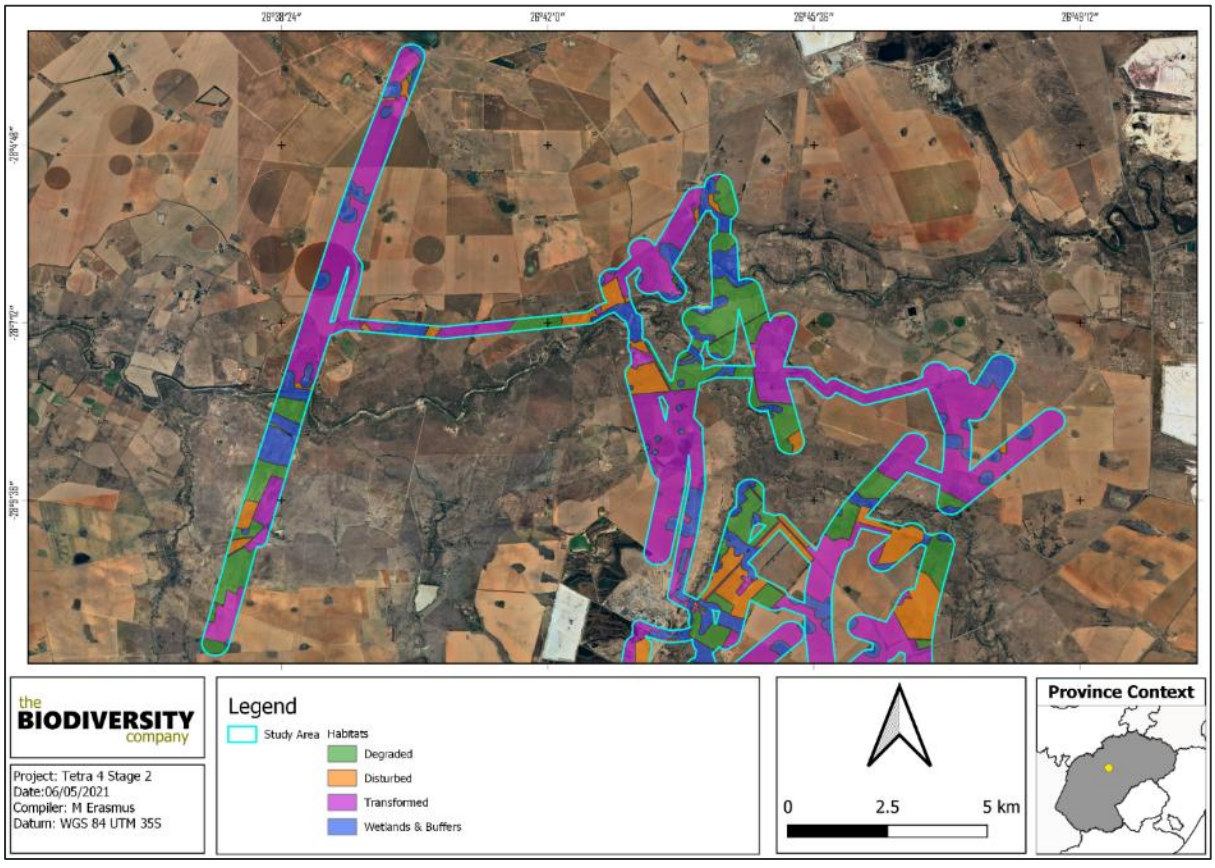


Figure 157: Habitats identified within the application area (northern section).

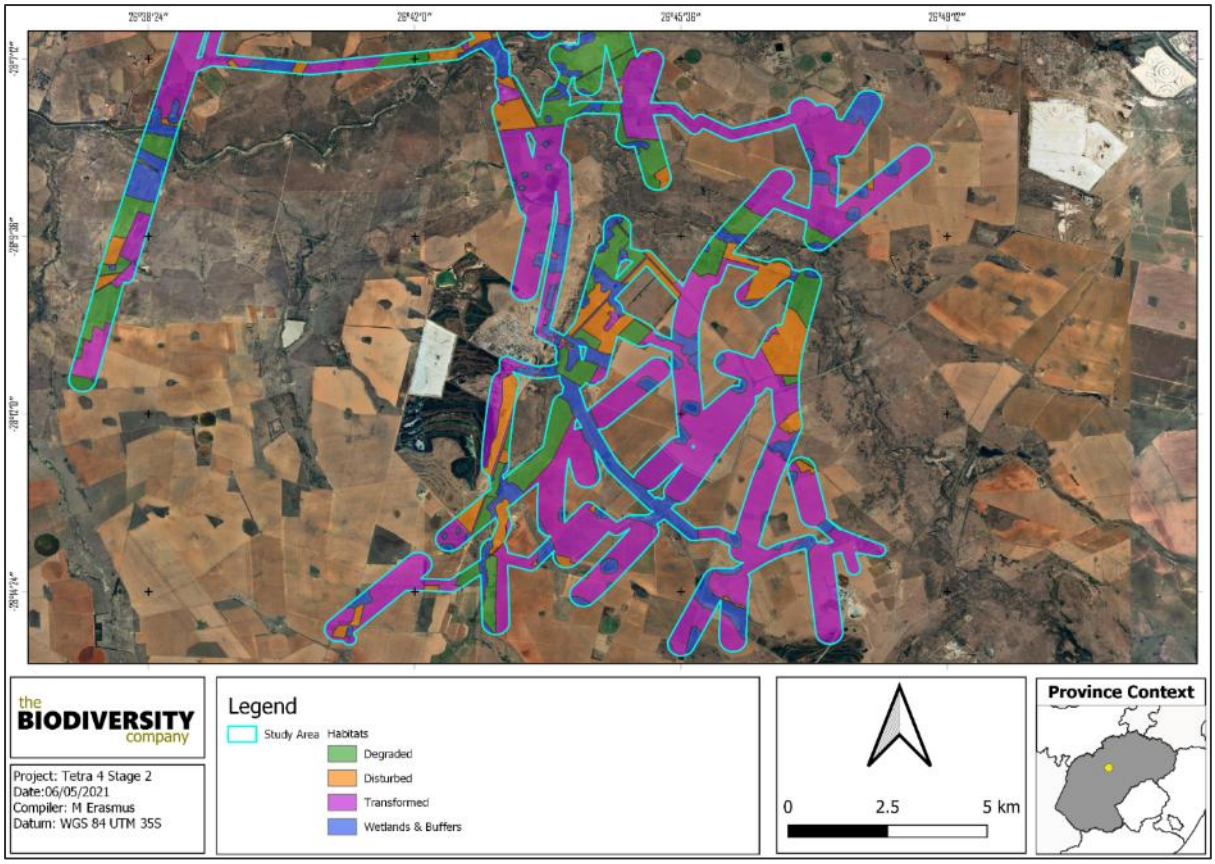


Figure 158: Habitats identified within the application area (southern section).

Degraded Habitat

The degraded habitat includes areas that are connected to and play a crucial role regarding the water resource habitats present. This habitat type is regarded as semi-natural, but disturbed due to fragmentation, grazing by livestock and also human infringement in areas close to roads.

Generally, this habitat unit has intact ecological functioning attributed to faunal communities found in this habitat. The current ecological condition of this habitat, regarding the driving forces, are inconsistent due to the different land uses. Portions of these areas have been disturbed by the historic and current grazing pressure. Additionally, the presence of some disturbances such as AIP presence or edge effect impacts on floral communities have resulted in decreased habitat integrity. The condition difference within this habitat depends on the extent of the disturbance in some areas being more severe, usually related to one being more overgrazed than the other.

Although the habitat unit is not entirely disturbed, ongoing and historic disturbances have resulted in the plant community no longer being fully representative of the reference vegetation. However, the habitat indicators that are known to show 'unhealthy' Dry Highveld Grassland such as grassland dominated by karroid shrubs, or the absence of endangered animal species.

The main ecological characteristics of dry highveld grasslands, which the Vaal Vet Sandy Grassland, is classified as, (SANBI, 2013):

- Climate; fundamentally different from any other grassland systems due to the significant difference in climate. This grassland experiences cold (frost) winters, but a defining difference is the low and highly variable summer rainfall that affects the grassland productivity, due to water being the main factor affecting growth, and not the duration or temperature of the season;
- Fire; plays a role in maintaining these grasslands, however not as important as grazing. Due to its slow growing nature, the grassland recovers slowly from fire events;

- Grazing, a slow growing sweetveld grassland being able to support animal production for most of the year, grazing is an important driver in these systems. and this is the most important ecosystem process that can be managed to maintain biodiversity and productivity in these ecosystems;
- Life-history strategies; due to the environmental conditions, driven primarily by adaptation to drought, the plants persist mainly through being long-lived, perennial plants replacing themselves through seeds or vegetative reproduction;
- Encroachment by invasive woody species; due to the factors limiting encroachment (fire, rainfall and frost) being variable in this grassland, if the biomass is reduced by grazing or decreased fire intensity, bush encroachment by trees such as Vachellia karoo, or woody karroid shrubs (such as Pentzia and Felicia species) can occur.
- Geology; The underlying geology is an important determinant of the biodiversity patterners and processes. Especially dolerite sheets that correlates to high levels of plant species richness and endemism.

The portions of this remaining habitat unit can thus be regarded as incredibly important, not only within the local landscape, but also regionally; it acts as a greenland, used for habitat, foraging area and movement corridors for fauna (including the SCC recorded). The habitat sensitivity of the degraded habitat is regarded as high/very high, mainly due to the role of this habitat to biodiversity within a very fragmented local landscape, not to mention the various ecological datasets.

The management and spatial guidelines for the land use of these grasslands that are relevant to this application area include (SANBI,2013) namely to avoid habitat loss in threatened grassland vegetation types: Threatened vegetation types such as Vaal-Vet Sandy Grassland are highly fragmented and there should be no further habitat loss, or ploughing, in these vegetation types without proper impact assessments.

Water resources (Wetlands, rivers and riparian zones)

This habitat unit represents the water resource habitats with the adjacent vegetation that it is connected to. The riparian habitat unit or riparian zone represents areas associated with the Sand River as well as a small tributary to the river. Although the stream and associated dams are in a relatively modified poor condition with the presence of invasive species, bank erosion and overgrazing/trampling adjacent to the stream, the riparian vegetation serves an important ecological function with high conservation value. Riparian areas have high conservation value and can be considered the most important part of a watershed for a wide range of values and resources. They provide important habitat for a large volume of wildlife and often forage for domestic animals. The vegetation they contain are an important part of the water balance for the hydrological cycle through evapotranspiration. The wetlands (and riparian zones) habitat unit is considered to be of very high ecological sensitivity due to the contribution of the various wetland (and riparian) features to faunal migratory connectivity, ecoservices provision and the unique habitat provided for faunal and floral species. The wetland habitats have been provided by the wetland specialist, and the accompanying wetland report must be consulted for the relevance and sensitivity of these systems which have been included within this report.

Even though somewhat disturbed, the ecological integrity, importance, and functioning of these areas play a crucial role as a water resource system and an important habitat for various fauna and flora, including the SCC recorded. The preservation of this system is an important aspect to consider for the proposed development, even more so due to the high sensitivity of the area according to the various ecological datasets. This habitat needs to be protected and improved due to the role of this habitat as a water resource.

Disturbed Habitat

The disturbed habitat is regarded as areas that has been impacted by edge effects of transformed areas as well as direct impacts from historic and ongoing overgrazing, dumping and infringement. This area has been disturbed and modified from its natural state, it represents habitat that is more disturbed than the 'degraded habitat' area, but not as disturbed as the 'transformed' area. This habitat is regarded as areas that have been impacted more by historic overgrazing, mismanagement, and harmful land use (historic agriculture). These habitats aren't entirely transformed but in a constant disturbed state as they can't recover to a more natural

state due to ongoing disturbances and impacts it receives from grazing and mismanagement. These areas are considered to have a medium sensitivity due to the fact that the areas may be used as a movement corridor and in many cases form a barrier between the more degraded bushveld and the transformed areas.

Transformed Habitat

The transformed habitat unit, which is the largest of the habitat units, represents areas where vegetation cover has been significantly impacted by current and historical mining and agricultural activities as well as through infrastructure associated with the mining/agricultural activities. This habitat unit has no conservation value from an ecological perspective.

9.11.10.2 SITE ECOLOGICAL IMPORTANCE

The biodiversity theme sensitivity as indicated in the DFFE screening report was derived to be Very High. This was based on the CBA 1, ESA 1 & 2 areas as well as the NPAES area. The animal sensitivity was rated as Medium, while the plant sensitivity was rated as Low.

The sensitivity scores identified during the field survey for each terrestrial habitat are mapped. The location and extent of these habitats are illustrated in Figure 159 and Figure 160. All habitats within the assessment area of the proposed project were allocated a sensitivity category (Table 63). The sensitivities of the habitat types delineated are illustrated in 'Very High/High Sensitivity' areas are due to the following, and the guidelines can be seen in Table 64:

- All habitats within the assessment area were observed to be utilised by threatened (local classification) species during the field survey, these species comprised of:
    - One (1) flora species;
    - Four (4) avifaunal species;
    - Three (3) mammal species;
    - One (1) reptile species; and
    - One (1) amphibian species.
- Unique, important (EN Ecosystem CBA1/ESA 1& 2) and very low resilience habitats (water resource); and
- Habitat that is regarded as crucial to the survival of a threatened species.

Table 63: Summary of habitat types delineated within the field assessment area of the application area.

Habitat	Conservation Importance	Functional Integrity	Biodiversity Importance	Receptor Resilience	Site Ecological Importance
Degraded (Sensitive Species)	High	High	Medium	Low	Very High
Degraded	High	Medium	Medium	Low	High
Water Resource	High	Medium	Medium	Very Low	High
Disturbed	Medium	Medium	Medium	Medium	Medium
Transformed	Very Low	Very Low	Very Low	Medium	Very Low

Table 64: Guidelines for interpreting Site Ecological Importance in the context of the proposed development activities.

Site Ecological Importance	Interpretation in relation to development activities
Very High	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e., last remaining populations of species, last

Site Ecological Importance	Interpretation in relation to development activities
	remaining good condition patches of ecosystems/unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted, limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Medium	Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities.
Very Low	Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required.

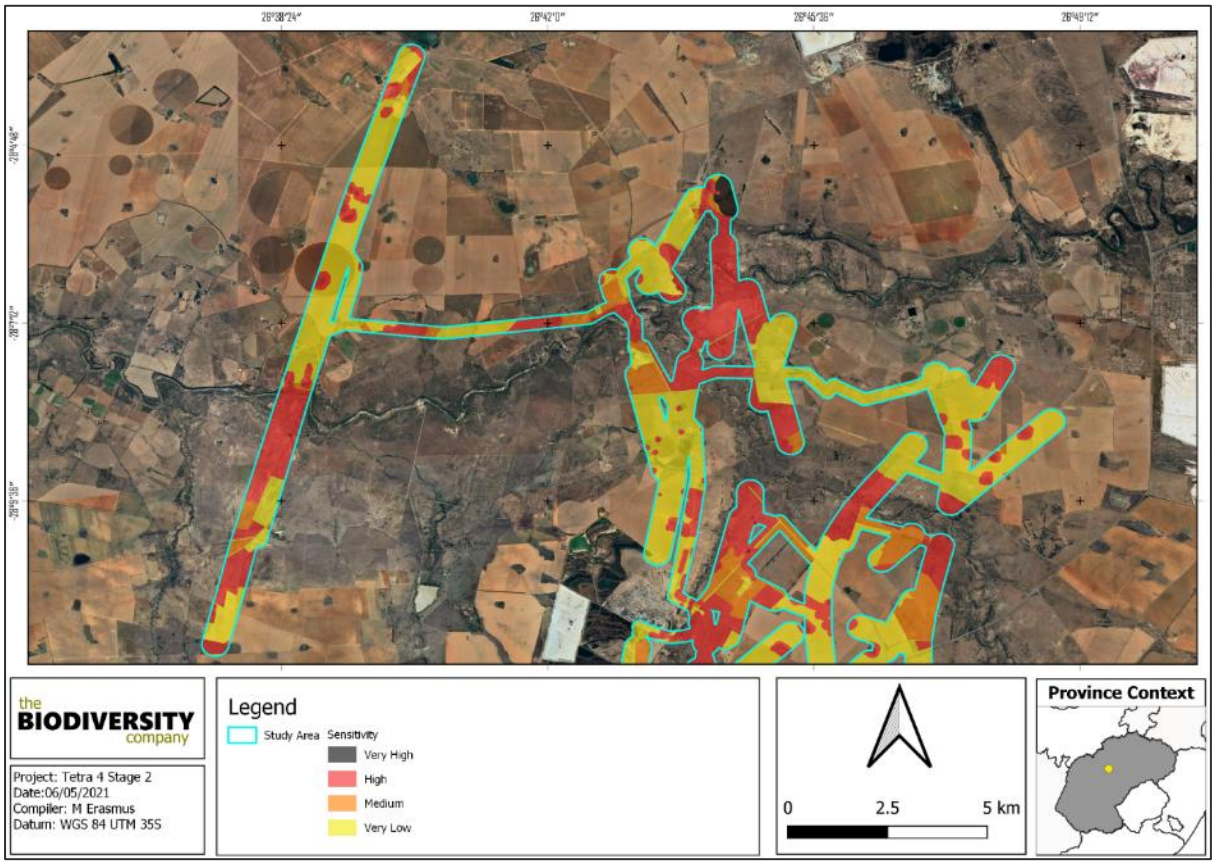


Figure 159: The study area superimposed over the sensitivities in the northern section of the study area.

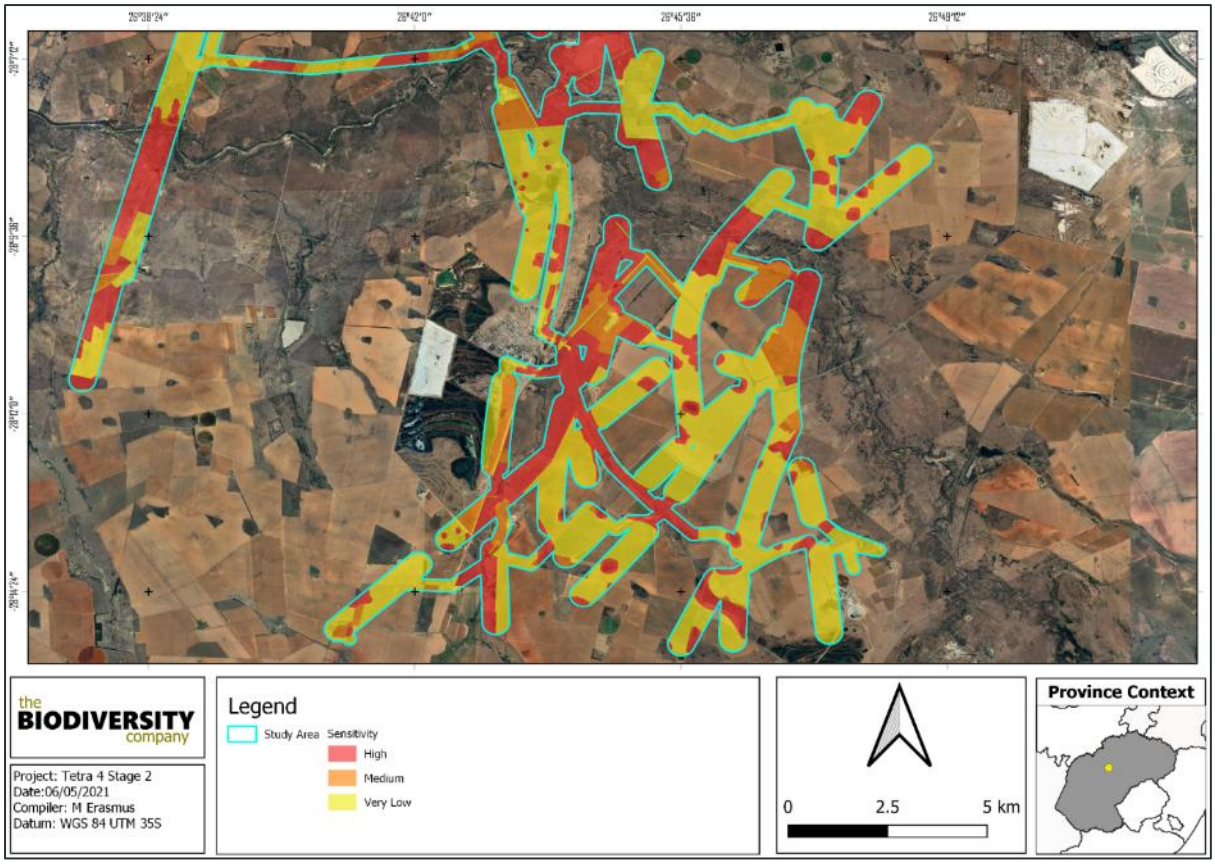


Figure 160: The study area superimposed over the sensitivities in the southern section of the study area.

9.12 AQUATIC AND WETLANDS

The aquatic and wetland environment has been assessed by The Biodiversity Company (TBC) and the specialist report is included in Appendix 4. The baseline aquatic and wetland findings are presented in the subsections below.

9.12.1 WETLAND DELINEATION AND DESCRIPTION

During the site visit four different wetland types were delineated in accordance with the DWAF (2005) guidelines (Figure 161). The four different types were classified as being:

1. Channelled valley bottoms;
2. Unchannelled valley bottoms;
3. Hillslope seeps; and
4. Depression wetlands.

A description of these wetland types is included in the specialist report.

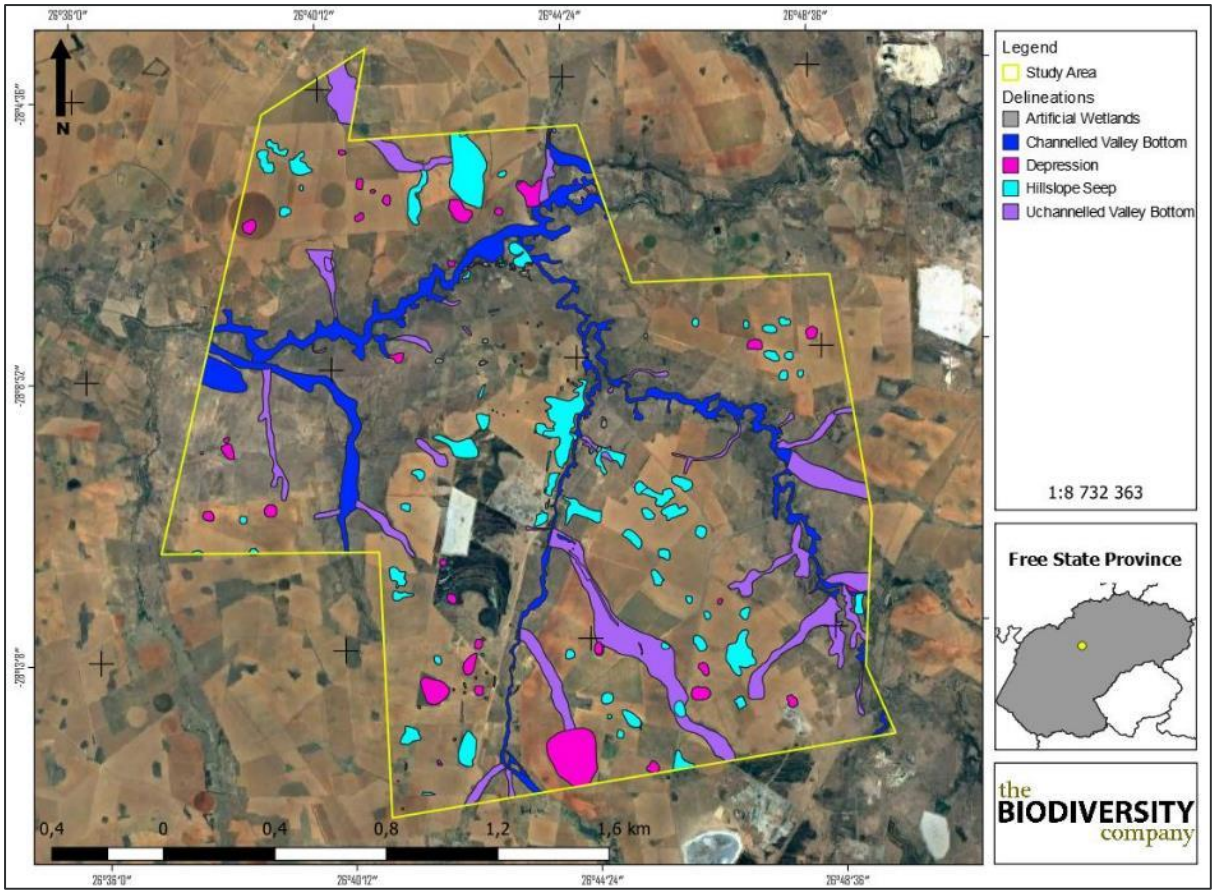


Figure 161: Delineation of wetlands within the study area.

9.12.2 ECOLOGICAL FUNCTIONAL ASSESSMENT

The average ecosystem services scores for the assessed wetlands are presented in Figure 162. The ecosystem services provided by the wetland units identified on site were assessed and rated using the WET-EcoServices method (Kotze et al., 2008). Due to the high number of wetlands identified within the study area the wetlands have not been classified into HGM units. The wetland ecosystem services scores range from “Moderately High” to “Moderately Low”. Ecosystem services contributing to these scores include flood attenuation, streamflow regulation, sediment trapping, phosphate assimilation, nitrate assimilation, toxicant assimilation, erosion control, biodiversity maintenance and tourism and recreation.

The wetlands that scored “Moderately High” ecosystem services were mostly the channelled valley bottoms where water drains into from the catchment areas. The catchments of these systems are predominantly used for agricultural fields were pesticides and herbicides are used to help maintain crop yields These pesticides and herbicides are taken out of the watercourses through the wetlands to help provide cleaner drinking water for the people downstream. The channels also help with streamflow regulation to prevent erosion within the wetlands as well as to regulate flood attenuation. The channelled valley bottoms also have water throughout the year providing important habitat and resources all year round.

Most wetlands scored “Intermediate” ecosystem services scores within the application area. The reason for this score is since the areas around the wetlands are predominately used for agriculture which will release pesticide and herbicides into the wetlands but toxicants from anthropogenic activities are minimal. The wetlands scored “Intermediate” instead of “Moderately High” since the wetland have less vegetation cover and is also more temporarily wet. The lack of water during the dry season as well as the lack of vegetation cover take away habitat for species as well as resources for humans. The wetlands do however play a vital role in sediment trapping, streamflow regulation as well as flood attenuation and was thus score higher than some of the wetlands.

The wetlands that scored the lowest ecosystem services score in this application area of "Moderately Low" were predominantly depression and seep wetlands. Seeps and Depression wetlands do not play a major role in streamflow regulation, flood attenuation and sediment trapping and thus scores lower ecosystem services in general. During the site visit this was evident as well. The depression wetland situated inside the crop fields have little to no hydrophyte vegetation which limits their ability to accumulate toxicants out the water. The lack of vegetation also hinders the wetlands' ability to provide habitat for charismatic species and limits the available resources for human use.

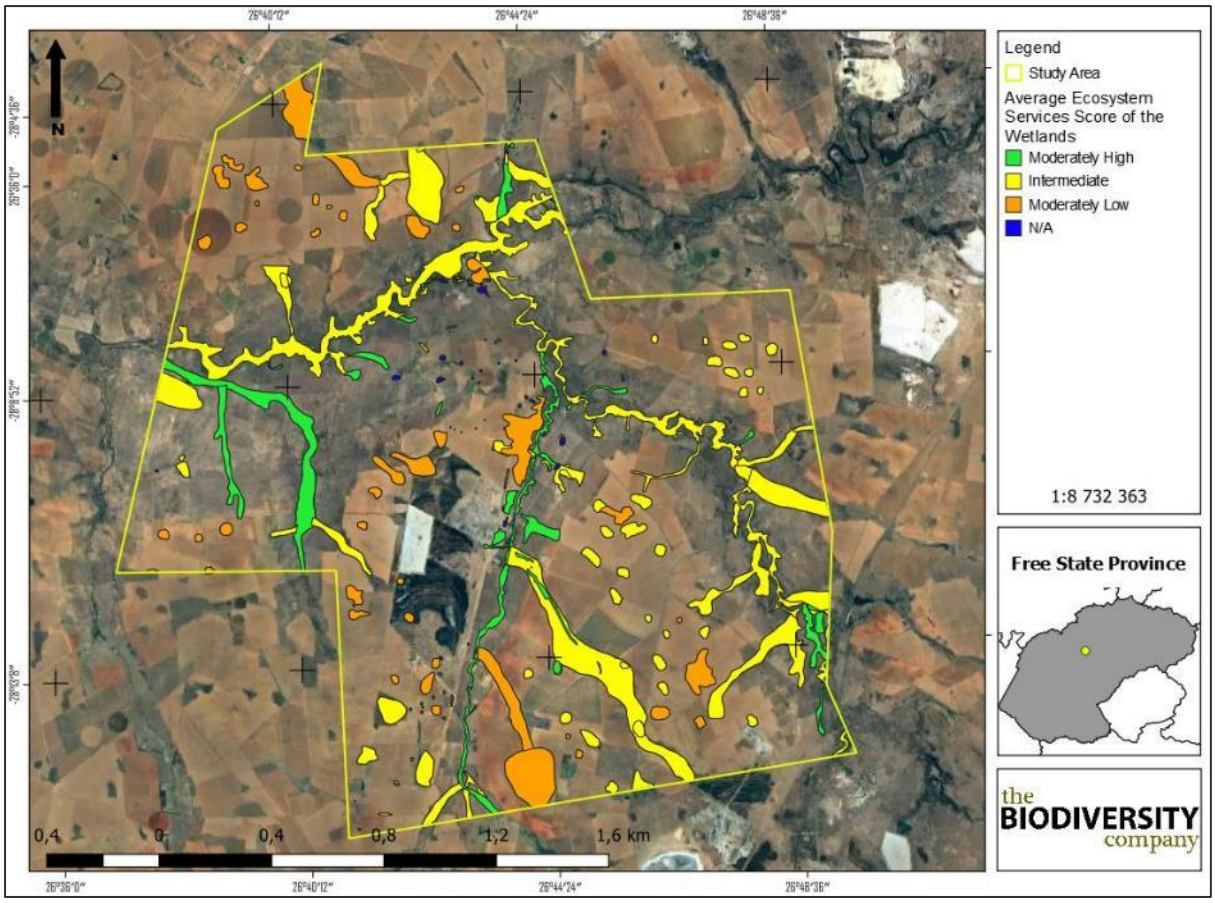


Figure 162: Average ecosystem service scores for the delineated wetland systems.

9.12.3 THE ECOLOGICAL HEALTH ASSESSMENT

The Present Ecological State (PES) for the assessed wetlands is presented in Figure 163. The delineated wetland systems have been scored overall PES ratings ranging of "Moderately Modified" (class C) to "Seriously Modified" (Class E). The wetlands were scored "Seriously Modified" due to multiple agricultural activities inside the wetlands. Many of the wetlands have been stripped of all vegetation and planting have taken place inside the wetland. The agricultural activities in the catchment areas of the wetlands which increased the overland flow of water and increase the possibility of flooding and erosion taking place. Multiple gravel roads, pipes and fences transverse through some of the wetlands modifying the water movement inside the wetlands.

The wetlands that scored "Moderately Modified" PES scores were located within the more natural areas of the study area. The wetlands are not subjected to agricultural activities and is thus in better ecological state. Although no agricultural activities take place inside the wetlands catchment the wetlands are still modified by human impacts. The largest modification will be through overgrazing by wildlife on the game farms. There are also roads and fences crossing through the wetlands and some anthropogenic activities taking place inside the wetlands.

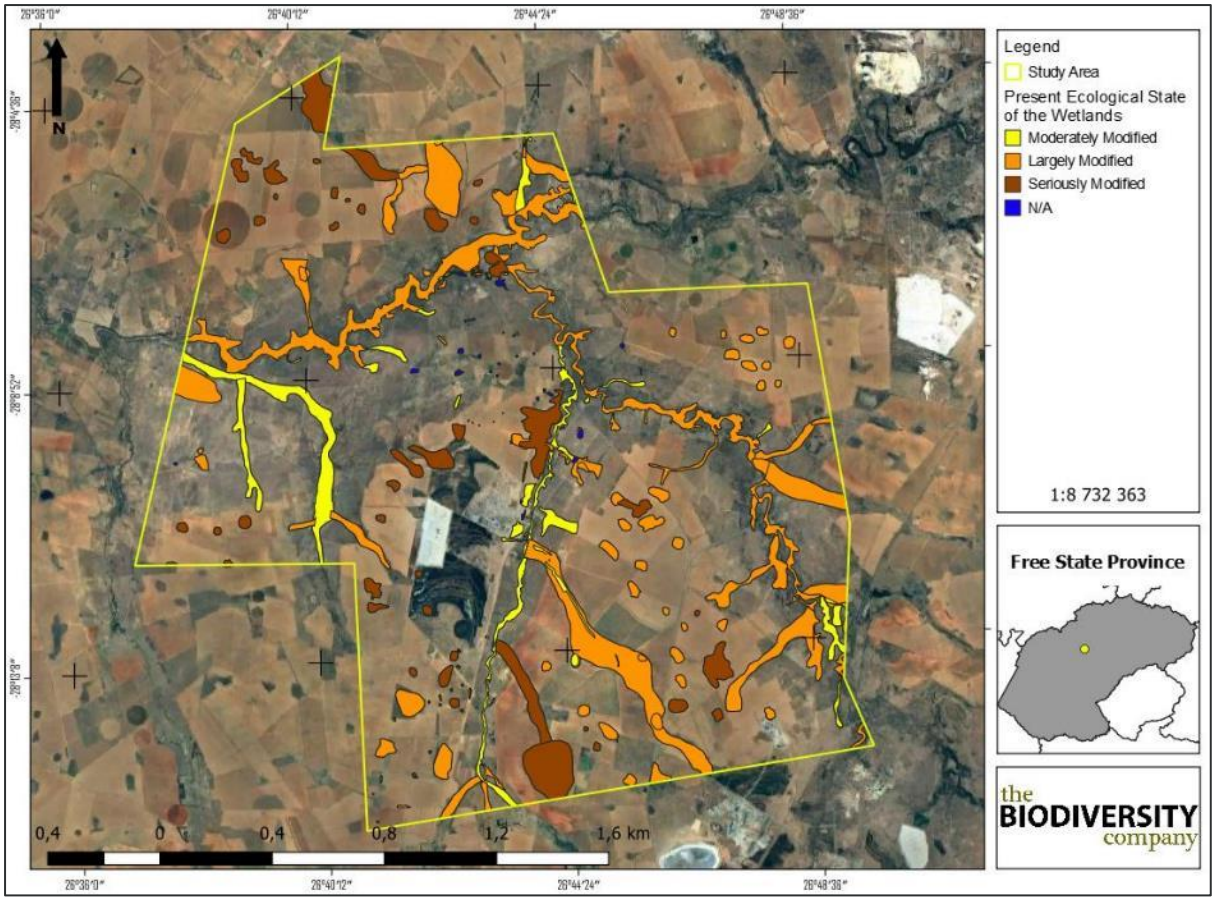


Figure 163: Overall present ecological state of delineated wetlands.

9.12.4 BUFFER REQUIREMENTS

The "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries" (Macfarlane et al. 2014) was used to determine the appropriate buffer zone for the proposed activities. After taking into consideration the different activities the buffer size for the delineated wetlands were calculated as 35 m (Figure 164).

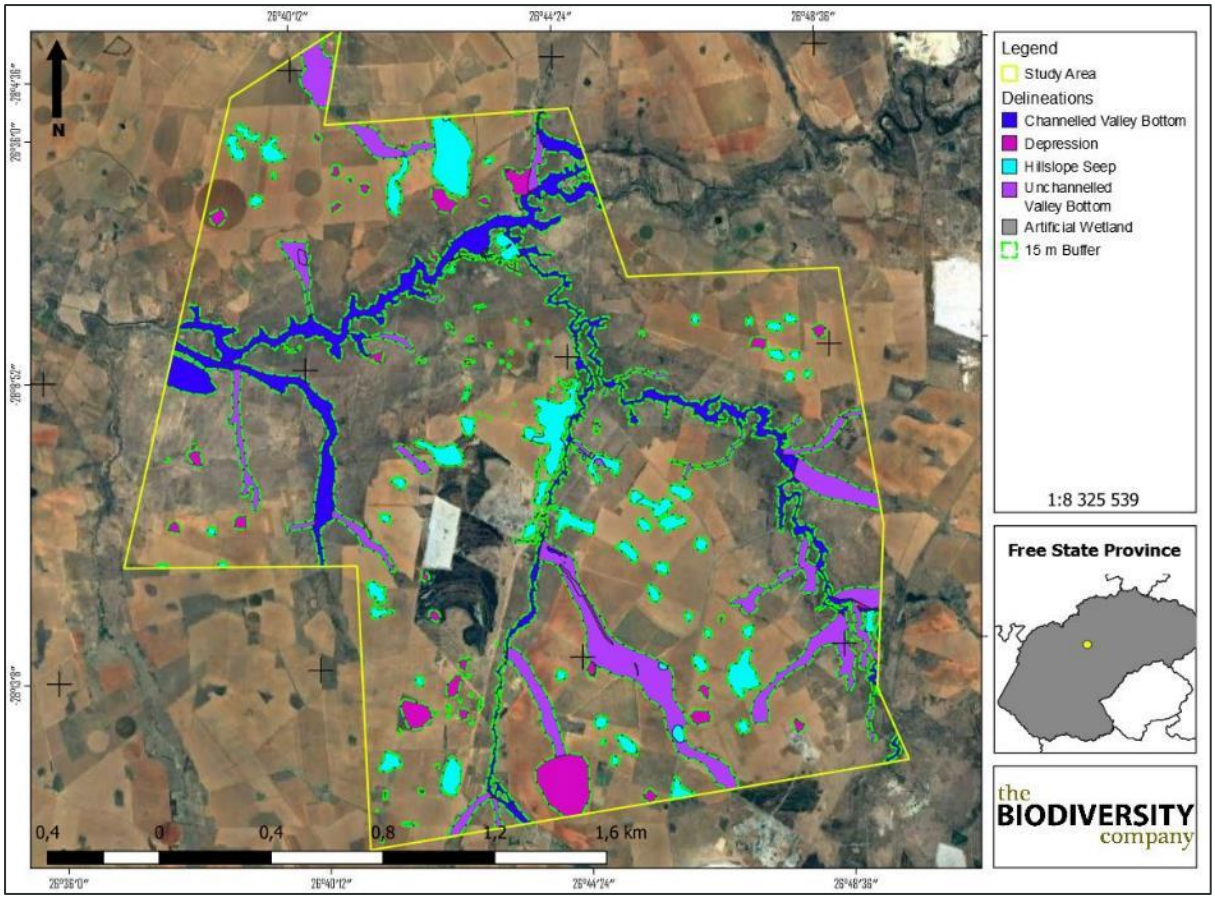


Figure 164: Extent of recommended buffer zones.

9.13 AIR QUALITY AND HEALTH

An air quality study has been undertaken by Airshed Planning Professionals and the specialist report is included in Appendix 4. The air quality findings are presented in the subsections below.

9.13.1 SURFACE WIND FIELD

The wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the yellow area, for example, representing winds in between 4 and 5 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated. The period wind field and diurnal variability in the wind field are shown in Figure 165, while the seasonal variations are shown in Figure 166.

During the 2019 to 2021 period, the wind field was dominated by winds from the north-northeast and northeast, followed by northerly and easterly winds. During the day (6AM – 6PM), the prevailing wind field is from the north to northeast and the west, with less frequent winds from the north-westerly sector, the easterly sector and the south-west. During the night, the wind field shifts to the easterly sector (north-northeast to east-southeast), with very little flow from the westerly sector. Long-term air quality impacts are therefore expected to be the most significant to the south and southwest of the application area. The strongest winds (more than 6 m/s) were also from the north and northeast and occurred mostly during the day, with 15 m/s the highest wind speed recorded. The average wind speed over the three years is 3.7 m/s, with calm conditions occurring for 3.5% of the time (Figure 165).

Seasonally, the wind flow pattern conforms to the period average wind flow pattern. The seasonal wind field shows little seasonal differences in the wind fields. During summer and spring, the dominant winds are from the north-northeast to east, with more frequent westerly winds during spring. Autumn reflects dominant north-

easterly and easterly winds, with a similar wind field during winter, but with more frequent north-north-easterly and east-south-easterly winds (Figure 166).

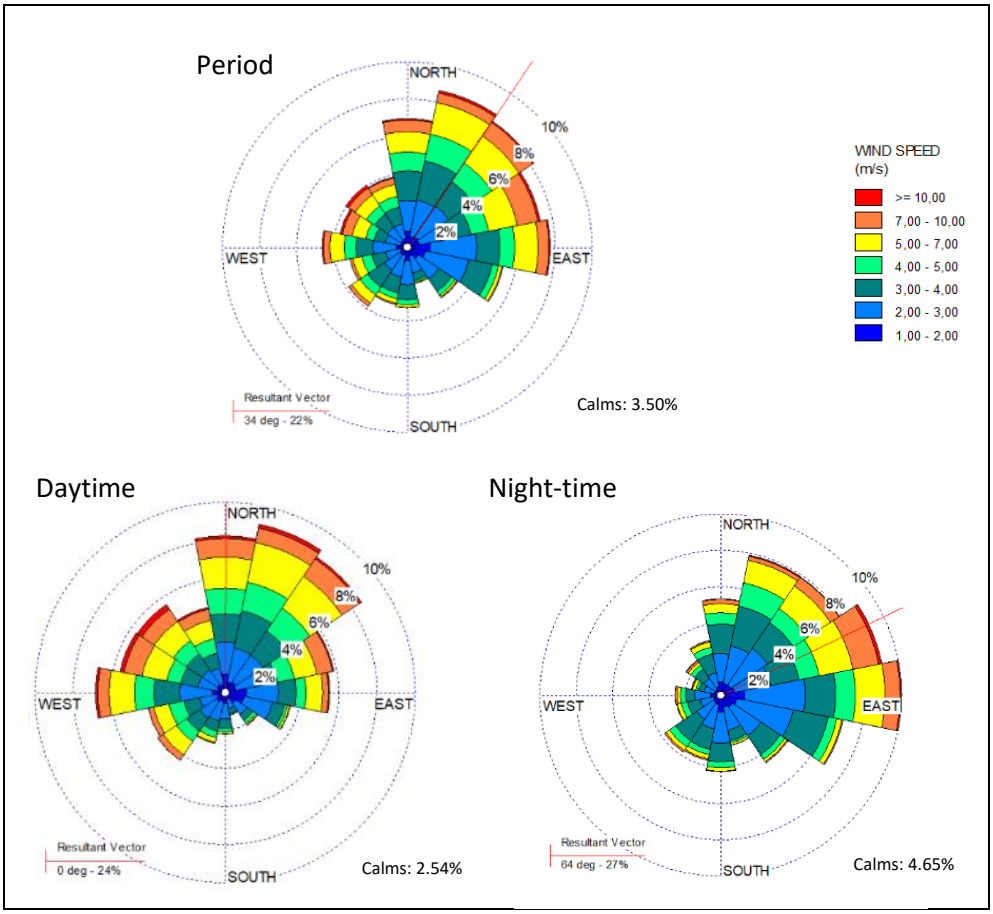
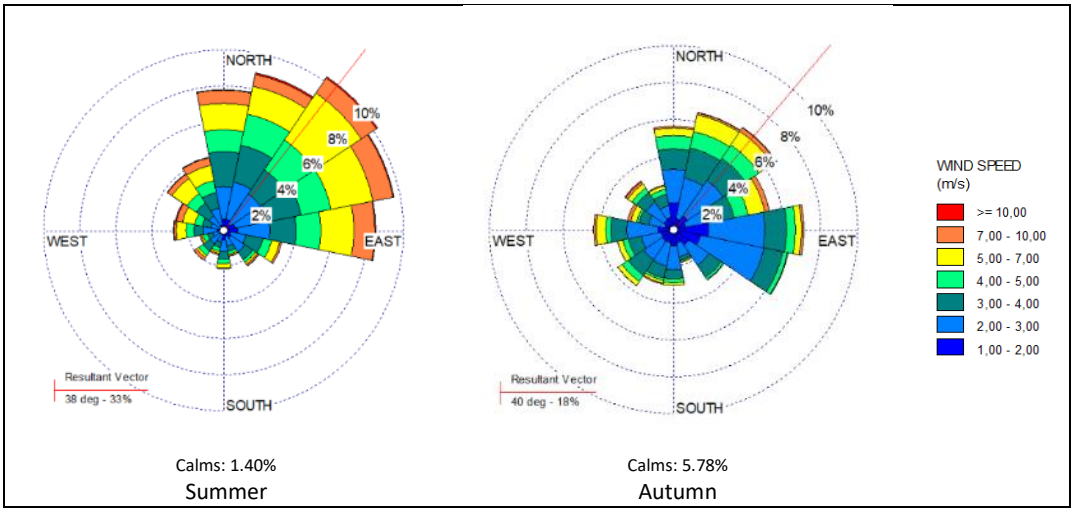


Figure 165: Period, day- and night-time wind roses (SAWS Welkom Data, 2019 to 2021).



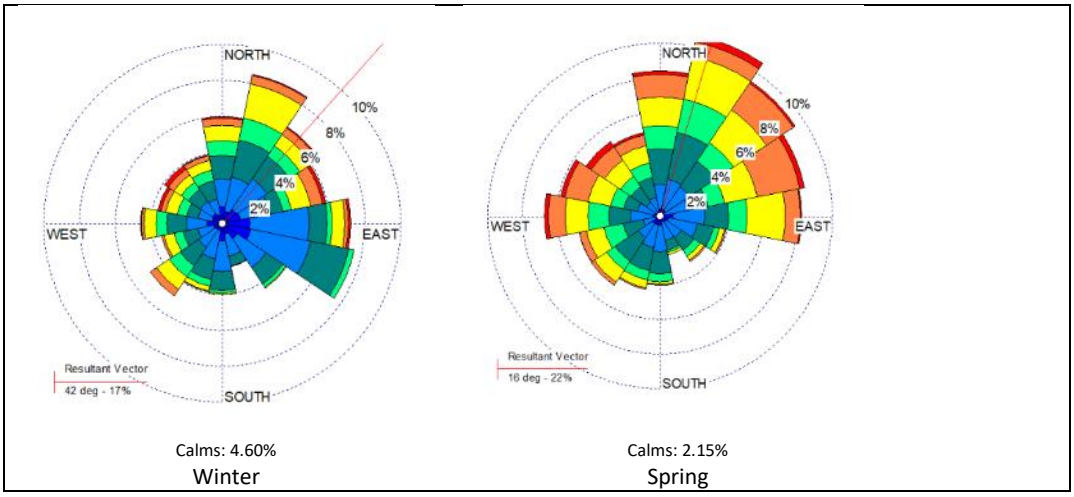


Figure 166: Seasonal wind roses (SAWS Welkom Data, 2019 to 2021).

9.13.2 AMBIENT AIR QUALITY WITHIN THE REGION

9.13.2.1 **SOURCES OF POLLUTION IN THE REGION**

Neighbouring land-use in the surrounding of the proposed project comprises predominantly of agriculture activities. These land-uses contribute to baseline pollutant concentrations via fugitive and process emissions, vehicle tailpipe emissions, household fuel combustion, biomass burning and windblown dust from exposed areas.

9.13.2.1.1 AGRICULTURE

Agriculture is a major land-use activity within and beyond the Project boundary. These activities include crop farming such as maize, and livestock farming. Particulate matter is the main pollutant of concern from agricultural activities as particulate emissions are derived from windblown dust, burning crop residue, and dust entrainment because of vehicles travelling along dirt roads. In addition, pollen grains, mould spores and plant and insect parts from agricultural activities all contribute to the particulate load. Should chemicals be used for crop spraying, they would typically result in odiferous emissions. Crop residue burning is also an additional source of particulate emissions and other toxins. Due to the small scale of farming activities these are regarded to have an insignificant cumulative impact.

Livestock farms, especially cattle, are also significant sources of fugitive dust especially when feedlots are used and the cattle trample in confined areas. Pollutants associated with dairy production for instance include ammonia (NH3), hydrogen sulphides (H_2S), methane (CH_4), carbon dioxide (CO_2), oxides of nitrogen (NO_x) and odour related trace gasses. According to the US-EPA, cattle emit methane through a digestive process that is unique to ruminant animals called enteric fermentation. The calf-cow sector of the beef industry was found to be the largest emitter of methane emissions. Where animals are densely confined the main pollutants of concern include dust from the animal movements, their feed and their manure, ammonia (NH_3) from the animal urine and manure, and hydrogen sulphides (H_2S) from manure pits.

Organic dust includes dandruff, dried manure, urine, feed, mould, fungi, bacteria and endotoxins (produced by bacteria, and viruses). Inorganic dust is composed of numerous aerosols from building, materials and the environment. Since the dust is biological it may react with the defence system of the respiratory tract. Odours and VOCs associated with animal manure is also a concern when cattle are kept in feedlots. The main impact from methane is on the dietary energy due to the reduction of carbon from the rumen. Dust and gasses levels are higher in winter or whenever animals are fed, handled or moved.

9.13.2.1.2 MINING SOURCES

Particulates represent the main pollutant of concern at mining operations. The amount of dust emitted by these activities depends on the physical characteristics of the material, the way in which the material is handled and

the weather conditions (e.g. high wind speeds, rainfall, etc.). Mining of gold, as well as ore extraction and processing plants are all commercial activities situated in the region of the Project.

9.13.2.1.3 DOMESTIC FUEL COMBUSTION

Domestic households are known to have the potential to be one the most significant sources that contribute to poor air quality within residential areas. Individual households are low volume emitters, but their cumulative impact is significant. It is likely that households within the local communities or settlements utilize coal, paraffin and/or wood for cooking and/or space heating (mainly during winter) purposes. Pollutants arising from the combustion of wood include respirable particulates, CO and SO_2 with trace amounts of polycyclic aromatic hydrocarbons (PAHs), in particular benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning have been found to contain about 50 % elemental carbon and about 50 % condensed hydrocarbons.

Coal is relatively inexpensive in the region and is easily accessible due to the proximity of the region to coal mines and the well-developed coal merchant industry. Coal burning emits a large amount of gaseous and particulate pollutants including SO_2, heavy metals, PM including heavy metals and inorganic ash, CO, PAHs (recognized carcinogens), NO_2 and various toxins. The main pollutants emitted from the combustion of paraffin are NO_2, particulates, CO and PAHs.

9.13.2.1.4 BIOMASS BURNING

Biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands. Within the project vicinity, crop-residue burning and wildfires (locally known as veld fires) may represent significant sources of combustion-related emissions. The frequency of wildfires in the grasslands varies between annual and triennial.

Biomass burning is an incomplete combustion process (Cachier, 1992), with carbon monoxide, methane and nitrogen dioxide gases being emitted. Approximately 40 % of the nitrogen in biomass is emitted as nitrogen, 10% is left in the ashes, and it may be assumed that 20 % of the nitrogen is emitted as higher molecular weight nitrogen compounds (Held, et al., 1996). The visibility of the smoke plumes is attributed to the aerosol (particulate matter) content. In addition to the impact of biomass burning within the vicinity of the Project activity, long-range transported emissions from this source can be expected to impact on the air quality between the months of August to October. It is impossible to control this source of atmospheric pollution loading; however, it should be noted as part of the background or baseline condition before considering the impacts of other local sources.

9.13.2.1.5 FUGITIVE DUST SOURCES

These sources are termed fugitive because they are not discharged to the atmosphere in a confined flow stream. Sources of fugitive dust identified in the study area include paved and unpaved roads and wind erosion of sparsely vegetated surfaces.

9.13.2.1.6 UNPAVED AND PAVED ROADS

Emissions from unpaved roads constitute a major source of emissions to the atmosphere in the South African context. When a vehicle travels on an unpaved road the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads vary in relation to the vehicle traffic and the silt loading on the roads. Unpaved roads in the region are mainly haul and access roads.

Emissions from paved roads are significantly less than those originating from unpaved roads, however they do contribute to the particulate load of the atmosphere. Particulate emissions occur whenever vehicles travel over a paved surface. The fugitive dust emissions are due to the re-suspension of loose material on the road surface. Paved roads in the region include the R710, M4, R708 and R30.

9.13.2.1.7 WIND EROSION OF OPEN AREAS

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle

cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne, its erosion potential has to be restored; that is, the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity. Every time a surface is disturbed, its erosion potential is restored (US EPA, 2004). Erodible surfaces may occur as a result of agriculture and/or grazing activities.

9.13.2.1.8 VEHICLE TAILPIPE EMISSIONS

Emissions resulting from motor vehicles can be grouped into primary and secondary pollutants. While primary pollutants are emitted directly into the atmosphere, secondary pollutants form in the atmosphere as a result of chemical reactions. Significant primary pollutants emitted combustion engines include carbon dioxide (CO_2), carbon (C), sulfur dioxide (SO_2), oxides of nitrogen (mainly NO), particulates and lead. Secondary pollutants include NO_2, photochemical oxidants such as ozone, sulfur acid, sulphates, nitric acid, and nitrate aerosols (particulate matter). Vehicle type (i.e. model-year, fuel delivery system), fuel (i.e. oxygen content), operating (i.e. vehicle speed, load) and environmental parameters (i.e. altitude, humidity) influence vehicle emission rates.

Transport in the vicinity of the Project is via trucks and private vehicles along the R710, M4, R708 and R30 roads (which are the main sources of vehicle tailpipe emissions), as well as vehicles and machinery travelling on unpaved and private roads.

9.13.2.2 **AIR QUALITY SAMPLING RESULTS**

Airshed was appointed to sample identified potential pollutants of concern, as stipulated in the Cluster 1 Environmental Management Programme (EMPr), around the Tetra4 Virginia Compression Plant. The passive sampling campaign used Radiello® passive diffusive samplers at three (3) sites around the property and at an upwind background site located near a residential receptor. Sampling and assessment of ambient concentrations include sulfur dioxide (SO_2); nitrogen dioxide (NO_2); hydrogen fluoride (HF) and, total volatile organic compounds (TVOCs).

Passive sampling was conducted at two (2) locations near the boundary of the facility and at a background location close to a nearby residential receptor. Sampling site locations are shown in Figure 167, with the coordinates, elevation and site classification detailed in Table 65.

The aim of the passive sampling campaign was to quantify ambient air pollutant concentrations which could present odour and health issues for Tetra4 personnel and the neighbouring communities. Two 14-day campaigns were conducted at the Tetra4 Virginia Compression Plant, one in summer and one in winter since 2019. Pollutants assessed included SO_2, NO_2, and VOCs.

Table 65: Sampling site coordinates, elevation, and classification.

Site ID	Site location	Latitude	Longitude	Elevation (m)	Classification
TET1	HDR1 Wellhead	-28.12576	26.718934	1 299	Boundary
TET2	HDR1 Compressor	-28.12701	26.719149	1 299	Boundary
TET3	Background site	-28.12011	26.720198	1 296	Residential

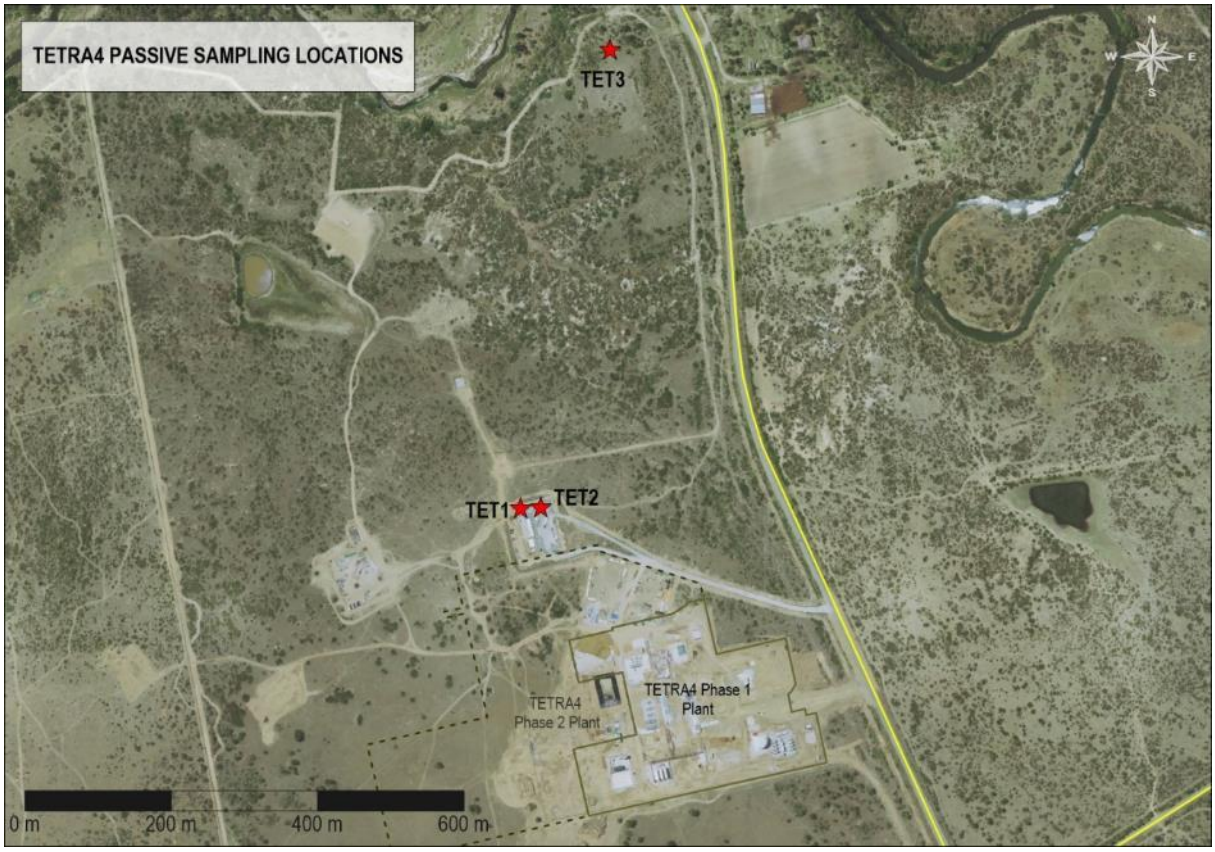


Figure 167: Tetra4 passive sampling locations.

All pollutant concentrations, including the suite of VOC compounds detected, were screened against NAAQS, chronic inhalation reference concentrations, and inhalation unit risk factors (for increased life-time cancer risk) published by international agencies. Extrapolated results from the seven (7) sampling campaigns indicate:

- Low background SO_2 concentrations, falling well within the NAAQSs.
- Background NO_2 concentrations indicate fairly high short-term (hourly) levels but still below the NAAQ limit and well below the annual limit.
- Sampled concentrations of HF are very low.
- Chronic exposure to total VOCs (TVOCs) concentration was less than 6 µg/m^3 at all sites, and therefore lower than the 100 µg/m^3 health-effect screening level.

9.14 CLIMATE CHANGE

The discussions of physical risks of climate change discussed in this section are likely to be relevant to the project as well as to the communities surrounding the project even if the project is not authorised.

9.14.1 VULNERABILITY

The Green Book (CSIR, 2019); was developed to be an online platform providing quantitative scientific evidence on the likely impacts that climate change and urbanisation will have on South Africa's cities and towns. A profile for each local municipality, including individual settlements and neighbourhoods, was built in terms the rates of socio-economic, economic, physical and environmental risks associated with urbanisation, population growth and climate change (Le Roux, et al., 2019). The risk profile was accessed for the Matjhabeng Local Municipality[6].

[6] https://riskprofiles.greenbook.co.za/

The Matjhabeng Local Municipality socio-economic vulnerability score[7] (out of 10) is 5.3 for 1996, reducing to 4.2 for 2011. The lower score in 2011 compared to 1996 indicates improvement of socio-economic factors. A high vulnerability score (closer to 10) indicates a scenario where an undesirable state is present e.g. low access to services, high socio-economic vulnerabilities, poor regional connectivity, environmental pressure or high economic pressures. The Matjhabeng Local Municipality for socio-economic vulnerability ranks 4th out of 19 in the province and 81st out of 213 in the country. The Matjhabeng Local Municipality economic vulnerability score[8] (out of 10) is 7.7 for 1996, increasing to 9.9 for 2011. The economic vulnerability ranks 19th out of 19 in the province and 211th out of 213 in the country. The physical vulnerabilities[9] ranks 4th out of 19 in the province and 50th out of 213 in the country. The environmental vulnerability[10] ranks 13th out of 19 in the province and 102nd out of 213 in the country.

9.14.2 CLIMATE

9.14.2.1 **BASELINE CLIMATE**

Climate change metrics focus on temperature; the number of very hot days (where the maximum temperatures exceed 35°C); rainfall and extreme rainfall events (more than 20 mm of rain occurring within 24 hours). The baseline (1961 to 1990) annual averages for these metrics were accessed for the area near the project site from the South Africa 'Green Book'11 (CSIR, 2019). The metrics include three percentiles[11] (10th, 50th, and 90th) as an indication of the variability within the measured data set.

Baseline annual average temperature was in the range 16.1°C (10th percentile) and 16.3°C (90th percentile) (Figure 168) with the number of very hot days varying between 2 (10th percentile) and 4.5 (90th percentile) days per year (Figure 169). The annual average rainfall range between the 10th and 90th percentiles is 1 079 mm and 1 168 mm (Figure 170). Extreme rainfall days varied between 12.4 (10th percentile) and 13.8 (90th percentile) days per year (Figure 171).

[7] Defined as the vulnerability of households based on household composition; education and health; access to basic services; safety and security.

[8] Defined as the susceptibility of the municipality to external shocks based on economic diversity; size of economy; labour force; gross domestic product (GDP) growth rate; and inequality.

[9] Defined by the physical fabric of connectedness of the settlements within the municipalities and structural robustness.

[10] This indicator represents the balance between preserving the natural environmental and the pressures of population growth, urbanisation, and economic development. The indicator is based on air quality, environmental governance and competition between ecology and the urban environment.

[11] A percentile is a statistical measure to indicate the value below which a given percentage of observations in a group of observations falls. For example, the 90th percentile is the value below which 90% of the observations fall. The 10th percentile is the value below which 10% of the observations fall.

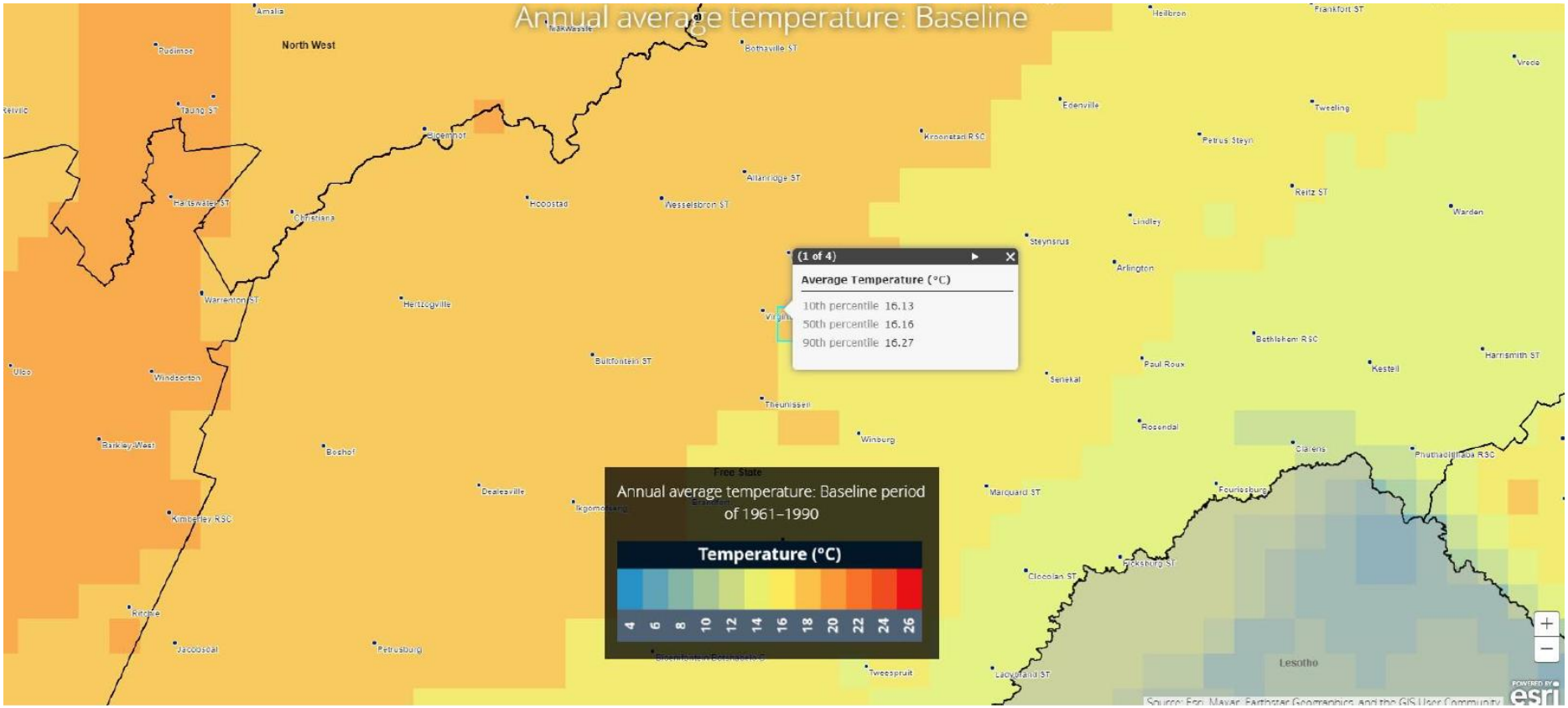


Figure 168: Baseline (1961 to 1990) annual average temperature for the project area (CSIR, 2019).

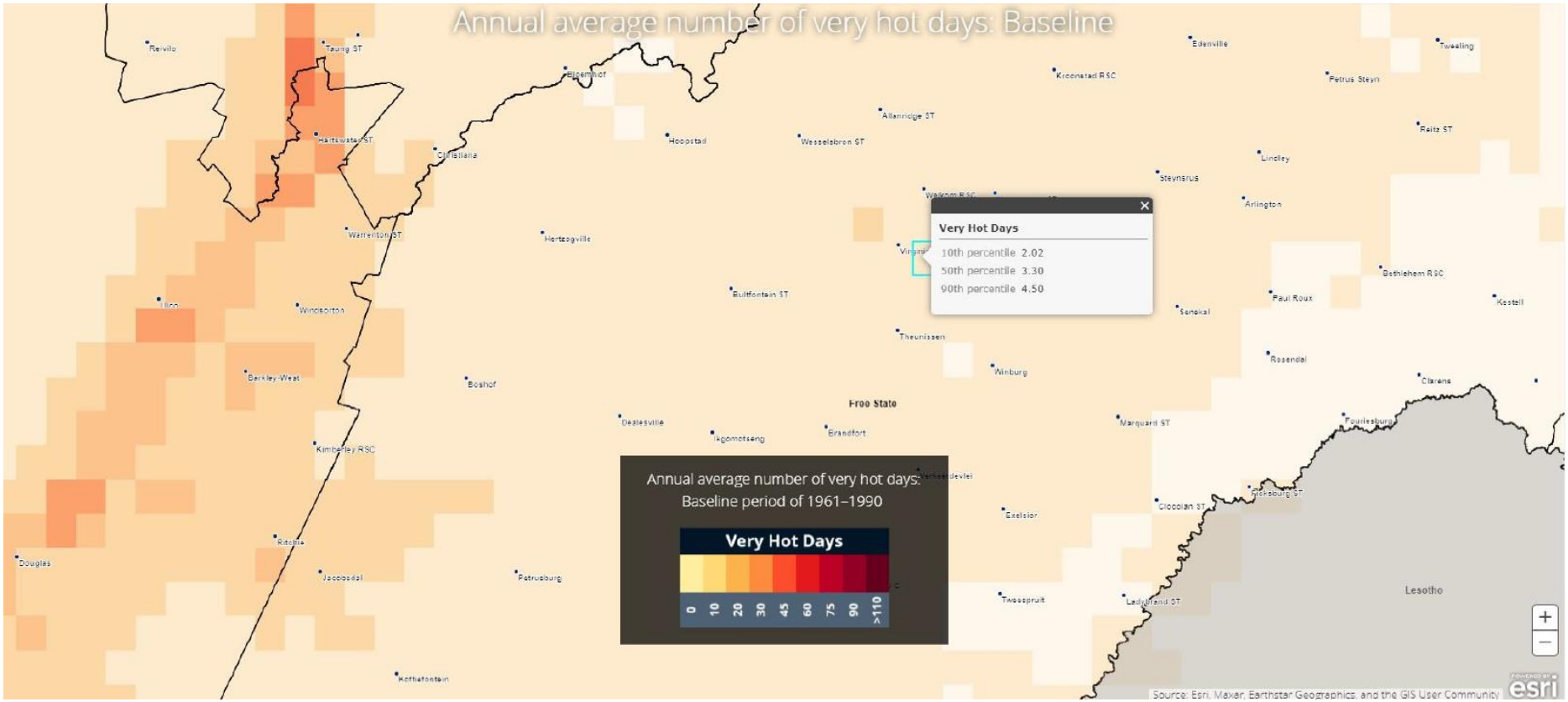


Figure 169: Baseline (1961 to 1990) number of very hot days (>35°C) annually for the project area (CSIR, 2019).

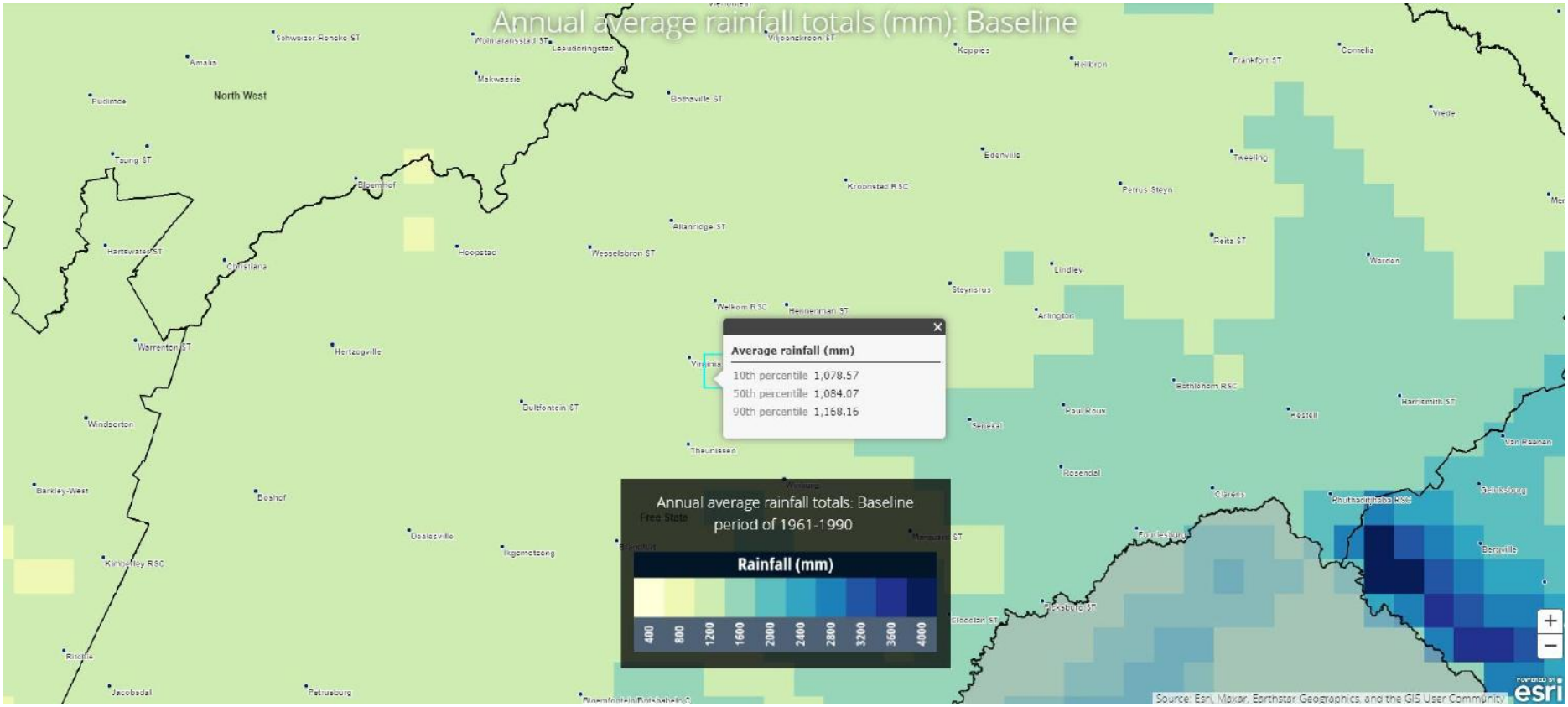


Figure 170: Baseline (1961 to 1990) annual average rainfall for the project area (CSIR, 2019).

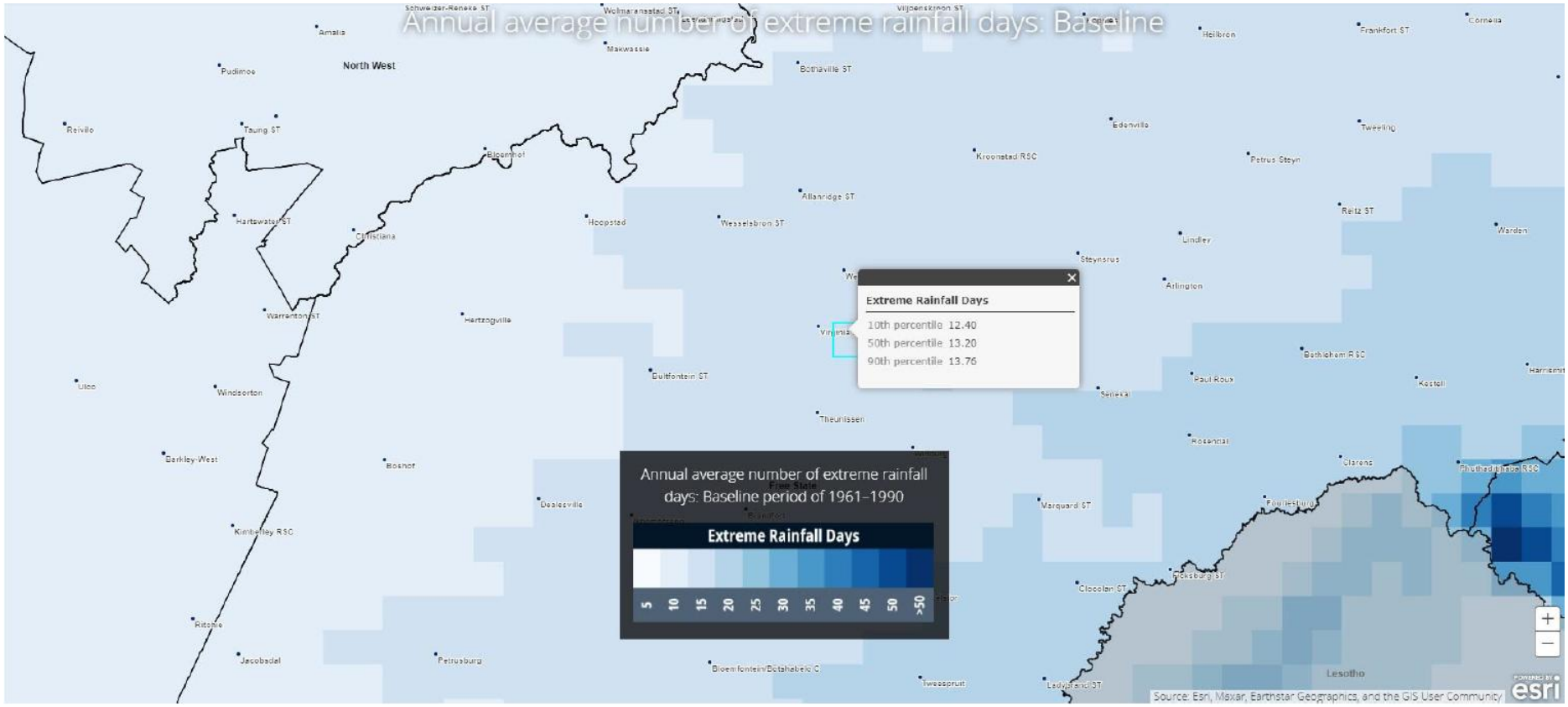


Figure 171: Baseline (1961 to 1990) annual average number of extreme rainfall days (>20 mm in <24 hours) for the project area (CSIR, 2019).

Recent change in climatic conditions near the project site were accessed from MeteoBlue[12] a weather forecasting platform developed at the University of Basel, Switzerland and based on models of National Oceanic and Atmospheric Administration (NOAA) or National Centres for Environmental Prediction (NCEP). The data sets also include historical climate data tracking changes in climate by referencing ERA5, the fifth generation ECMWF (European Centre for Medium-Range Weather Forecasts) atmospheric reanalysis of the global climate, for the period between 1979 to 2021, with a spatial resolution of 30 km. Based on a point selected over the project site, an increasing trend in the annual average temperatures have been observed from 16.9°C in 1979 to 17.5°C in 2023 (Figure 172 – top panel). The lower part the graph shows the so-called warming stripes. Each coloured stripe represents the average temperature for a year - blue for colder and red for warmer years. The change in rainfall over the same period (1979 – 2023) displays a slight decreasing trend from 646 mm in 1979 to 555 mm in 2023 (Figure 173), where the difference from long-term average for each year in the data set is visualised by the stripes in the lower panel of Figure 173 (brown stripes indicate lower than average rainfall and green stripes above average rainfall).

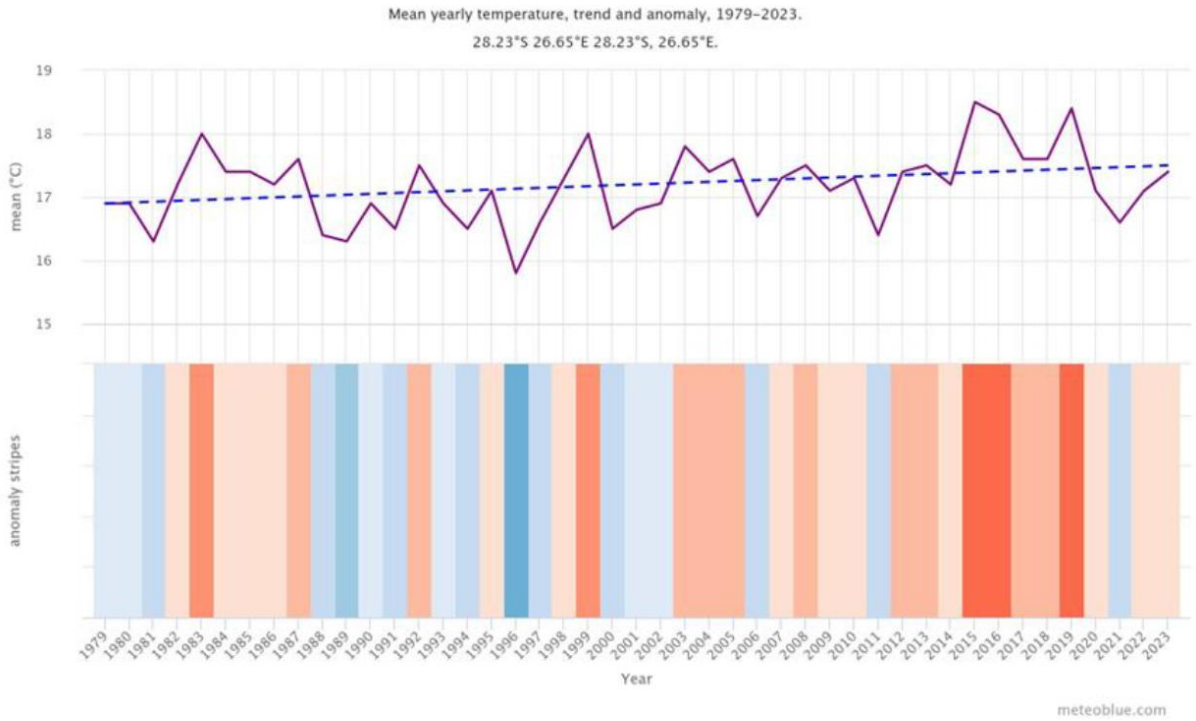


Figure 172: Annual average temperature (top panel) and temperature anomaly (lower panel) between 1979 and 2023 (meteoblue AG, 2024).

[12] https://www.meteoblue.com

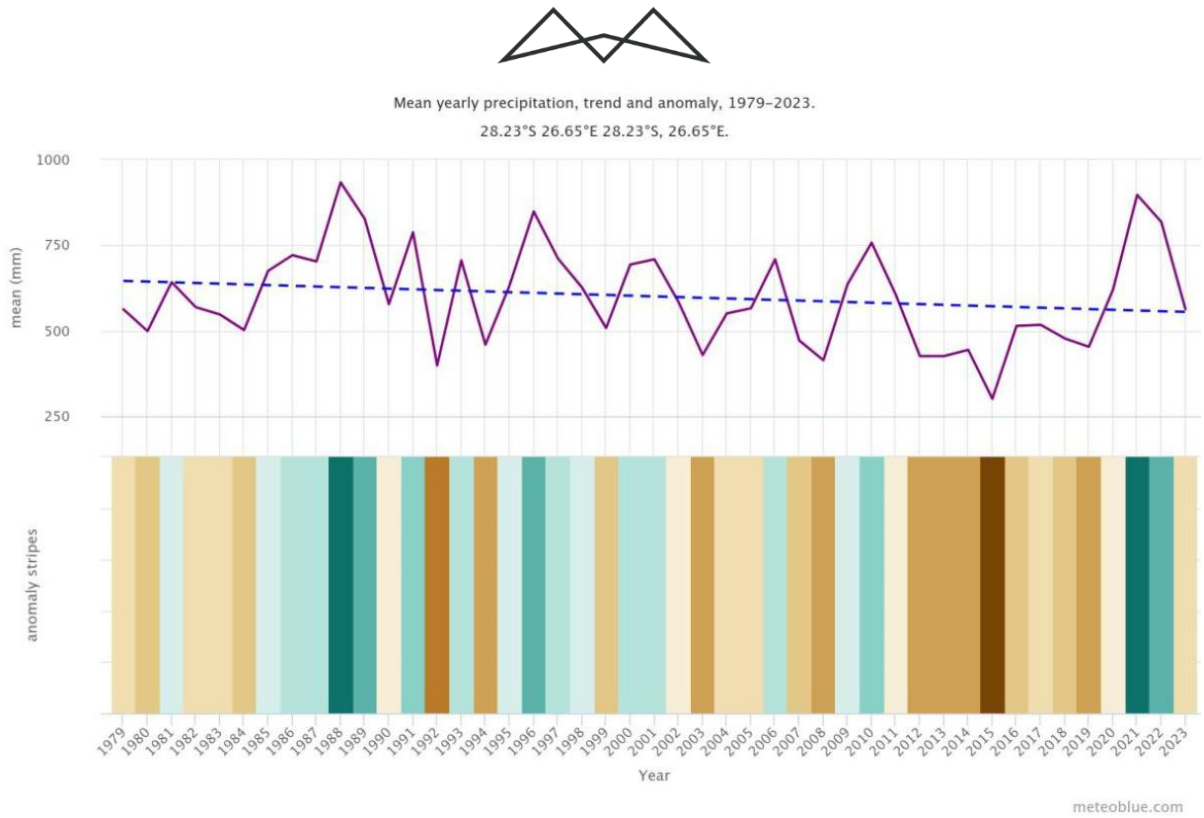


Figure 173: Annual average rainfall (top panel) and rainfall anomaly (lower panel) between 1979 and 2023 (meteoblue AG, 2024).

9.14.2.2 **PROJECTED FUTURE CLIMATE**

In 2017 the South African Weather Services (SAWS) published an updated Climate Change Reference Atlas (CCRA) based on Global Climate Change Models (GCMs) projections (SAWS, 2017). It must be noted that as with all atmospheric models there is the possibility of inaccuracies in the results because of the model's physics and accuracy of input data. The Rossby Centre regional model (RCA4) was used in the predictions for the CCRA which included the input of nine GCMs results. The RCA4 model was used to improve the spatial resolution to 0.44° x 0.44°- the finest resolution GCMs in the ensemble were run at resolutions of 1.4° x 1.4° and 1.8° x 1.2°. Findings from downscaled climatic simulations using six GCMs, at an 8 km x 8 km resolution over South Africa, for the time slab 2021 to 2050 were included in the Green Book (Engelbrecht, 2019).

In both the CCRA and the Green Book, two trajectories are included based on the four Representative Concentration Pathways (RCPs) discussed in the IPCC's fifth assessment report (AR5) (IPCC, 2013). RCPs are defined by their influence on atmospheric radiative forcing in the year 2100. RCP4.5 represents an addition to the radiation budget of 4.5 W/m^2 as a result of an increase in GHGs. The two RCPs selected were RCP4.5 representing the medium-to-low pathway and RCP8.5 representing the high pathway. RCP4.5 is based on a CO_2 concentration of 560 ppm and RCP8.5 on 950 ppm by 2100. RCP4.5 is based on if current interventions to reduce GHG emissions being sustained (after 2100 the concentration is expected to stabilise or even decrease). RCP8.5 is based on if no interventions to reduce GHG emissions being implemented (after 2100 the concentration is expected to continue to increase).

9.14.2.2.1 RCP4.5 TRAJECTORY

The Green Book projected temperature changes in the near future (2021 to 2050) indicate a 50th percentile[13] increase of 2.3°C and a 90th percentile[14] increase of 2.8°C (Figure 174, Engelbrecht, *et al*., 2019). The number of very hot days are expected to increase by 9.7 days per year (50th percentile) to 15.1 days per year (90th percentile) (Figure 175). Between 2021 and 2050 the annual rainfall near the project site is projected to increase

[13] 50th Percentile: This represents the middle or median value in a range of projections. It means that 50% of model projections are lower, and 50% are higher. Think of it as the "most likely" or "typical" outcome (but not necessarily the average).
[14] 90th Percentile: This represents a worst-case or high-end scenario. Only 10% of models predict a greater increase than this value. It is used to assess risk—especially for planning, adaptation, and resilience-building.

by 180 mm per year (50th percentile) (Figure 176, Engelbrecht, et al., 2019), with extreme rainfall days potentially increasing by 1.7 days (50th percentile) in the near future (Figure 177, Engelbrecht, *et al*., 2019).

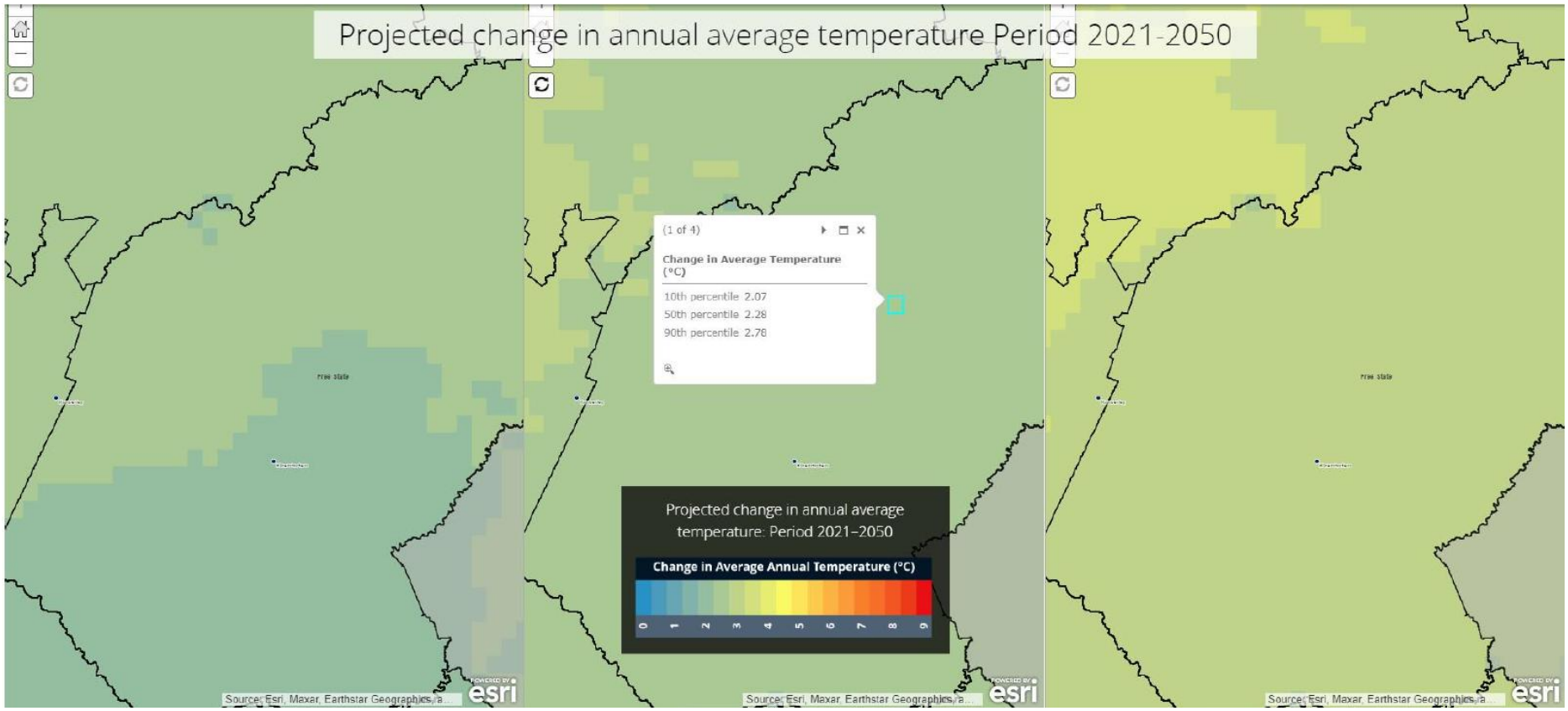


Figure 174: Projected change in annual average temperature for the near future (2021 – 2050) for the RCP4.5 trajectory.

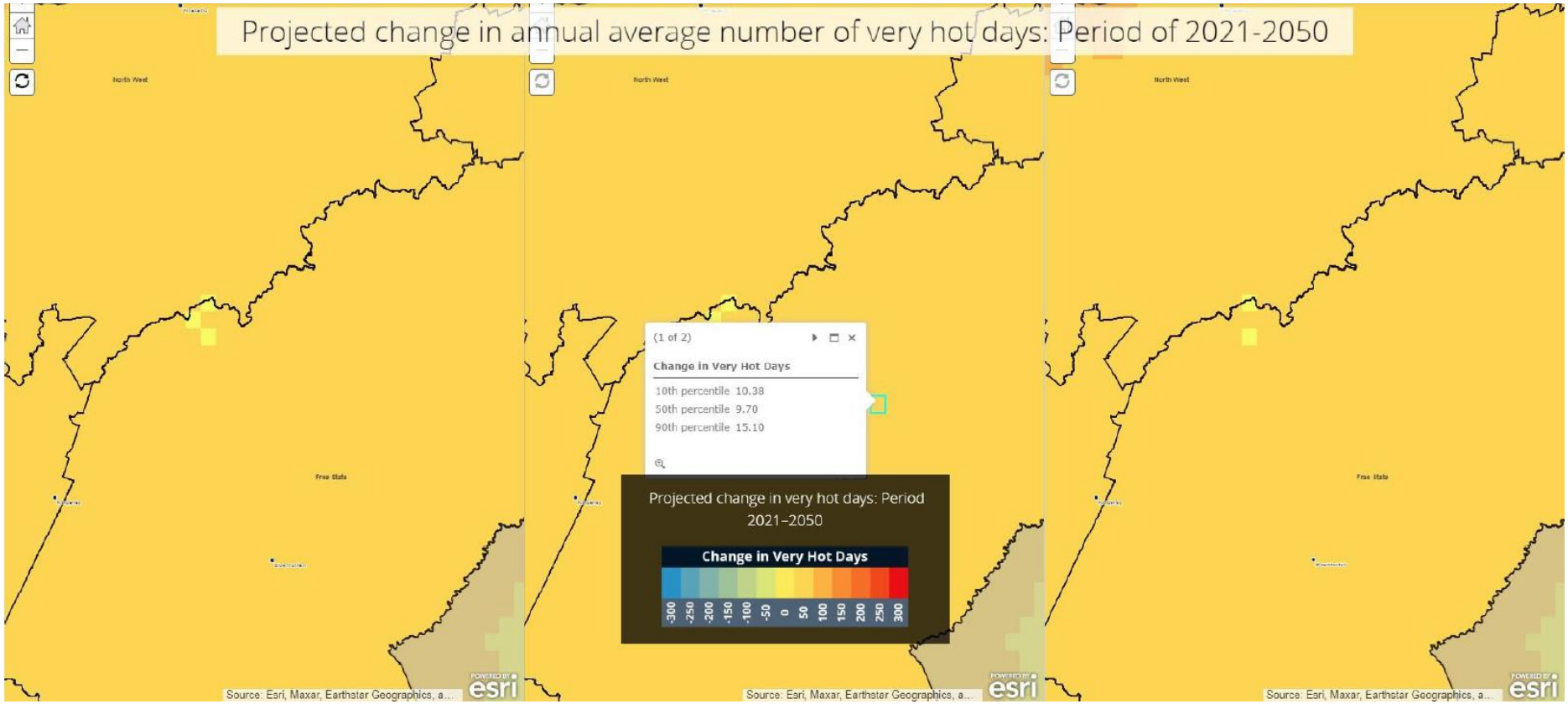


Figure 175: Projected change in very hot days for the near future (2021 – 2050) for the RCP4.5 trajectory.

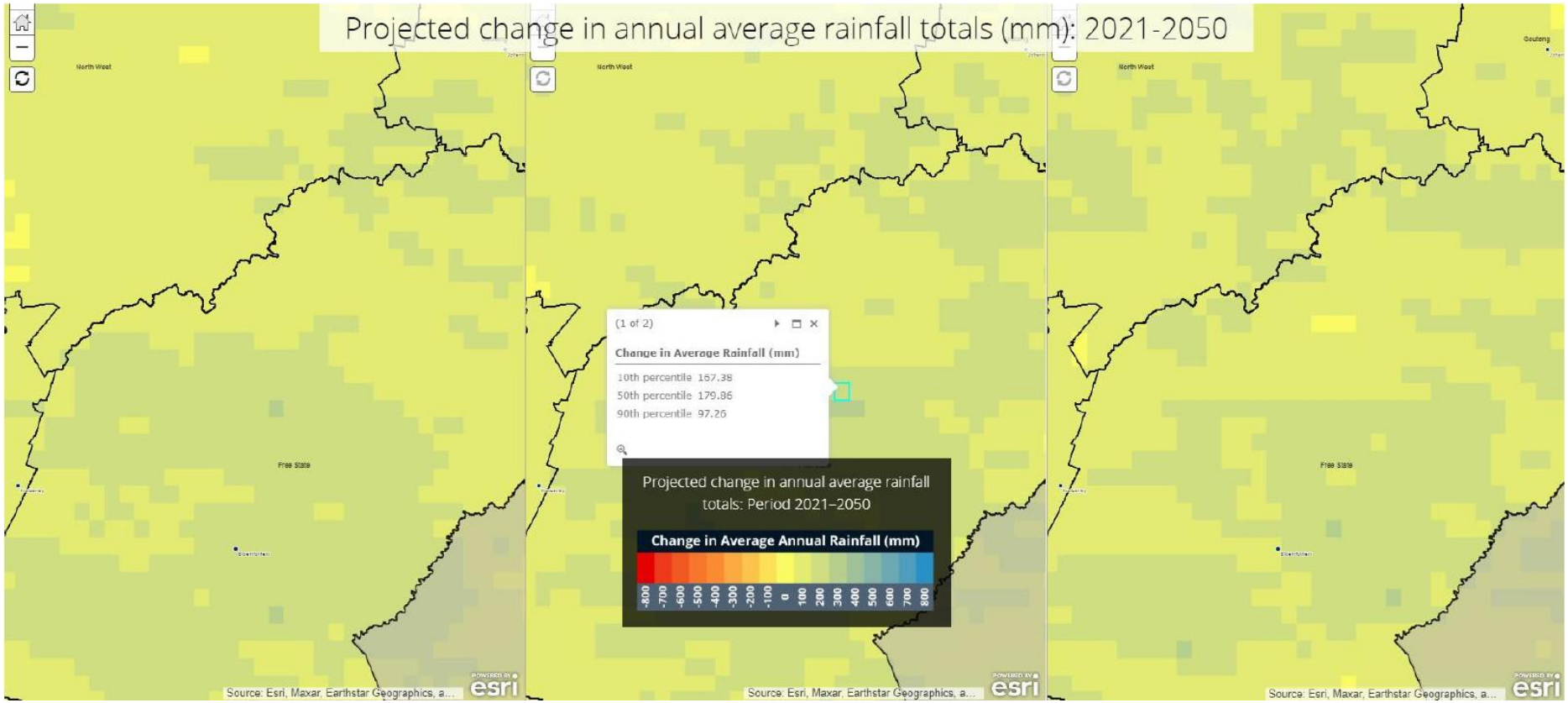


Figure 176: Projected change in annual average rainfall for the near future (2021 – 2050) for the RCP4.5 trajectory.

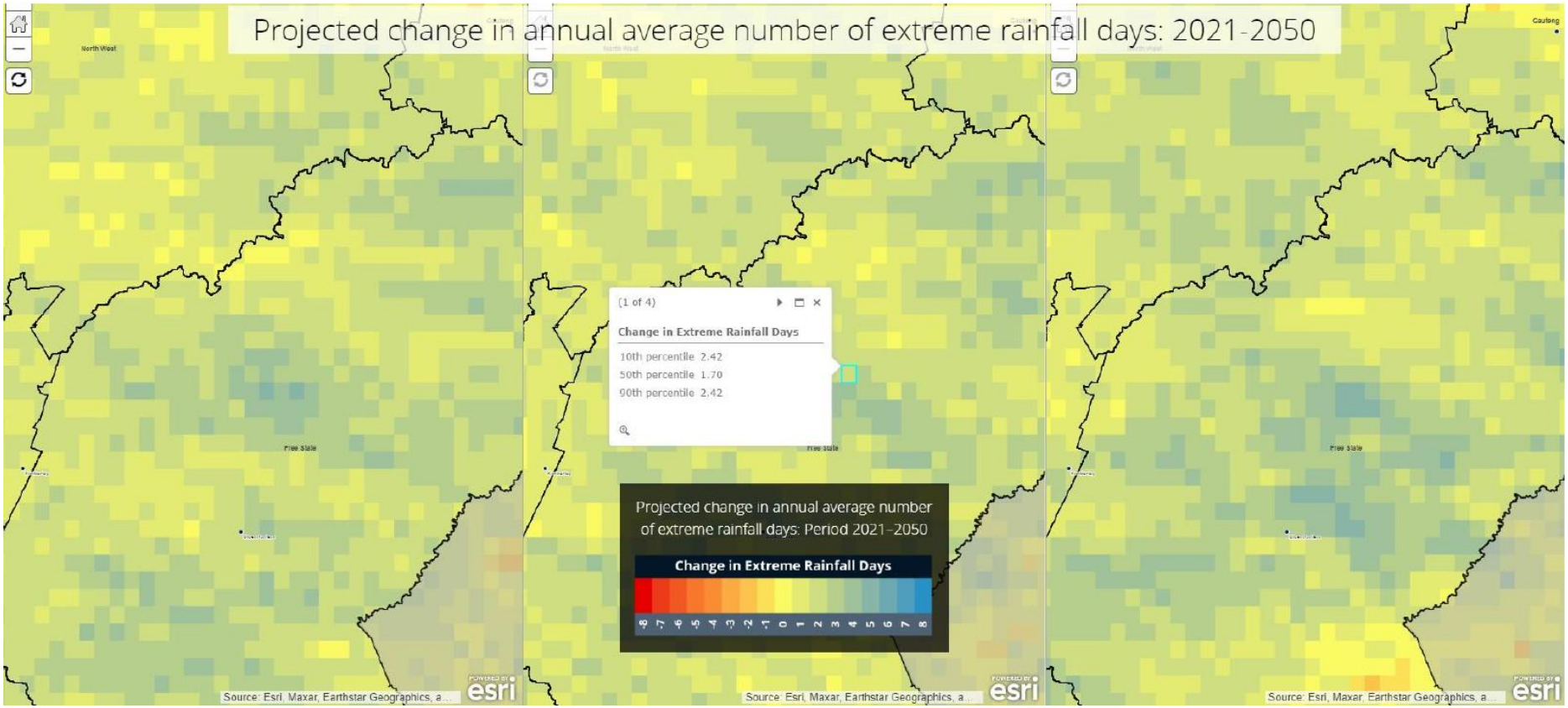


Figure 177: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP4.5 trajectory.

9.14.2.2.2 RCP8.5 TRAJECTORY

The Green Book projected temperature changes in the near future (2021 to 2050) indicate a 50th percentile increase of 2.6°C and a 90th percentile increase of 3.2°C (Figure 178, Engelbrecht, *et al*., 2019). The number of very hot days are expected to increase to 17.1 days per year (50th percentile) (Figure 179). Between 2021 and 2050 the annual rainfall near the project site was projected to increase by 200 mm per year between 2021 and 2050 (50th percentile) (Figure 180, Engelbrecht, *et al*., 2019), with extreme rainfall to increase by 1.5 days (Figure 181, Engelbrecht, *et al*., 2019).

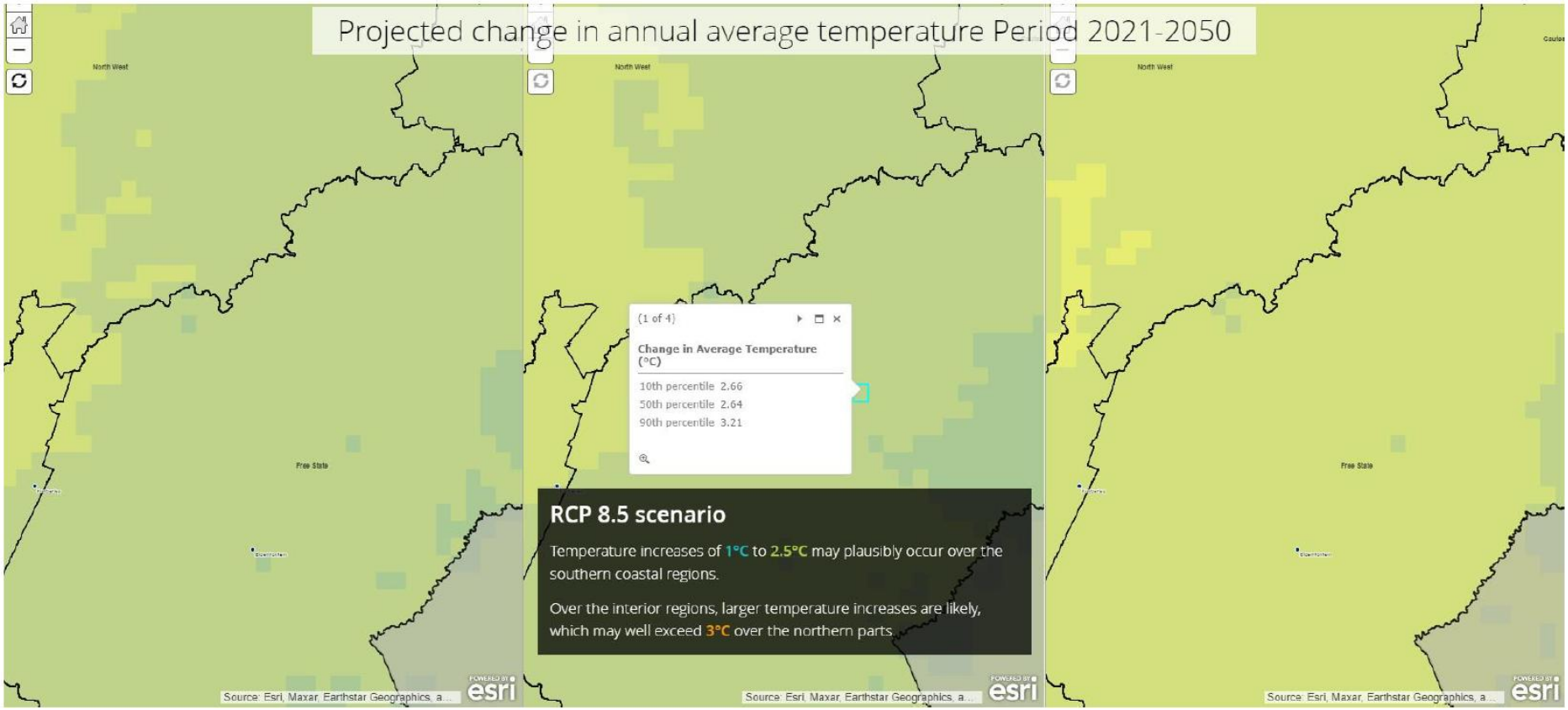


Figure 178: Projected change in annual average temperature for the near future (2021 – 2050) for the RCP8.5 trajectory.

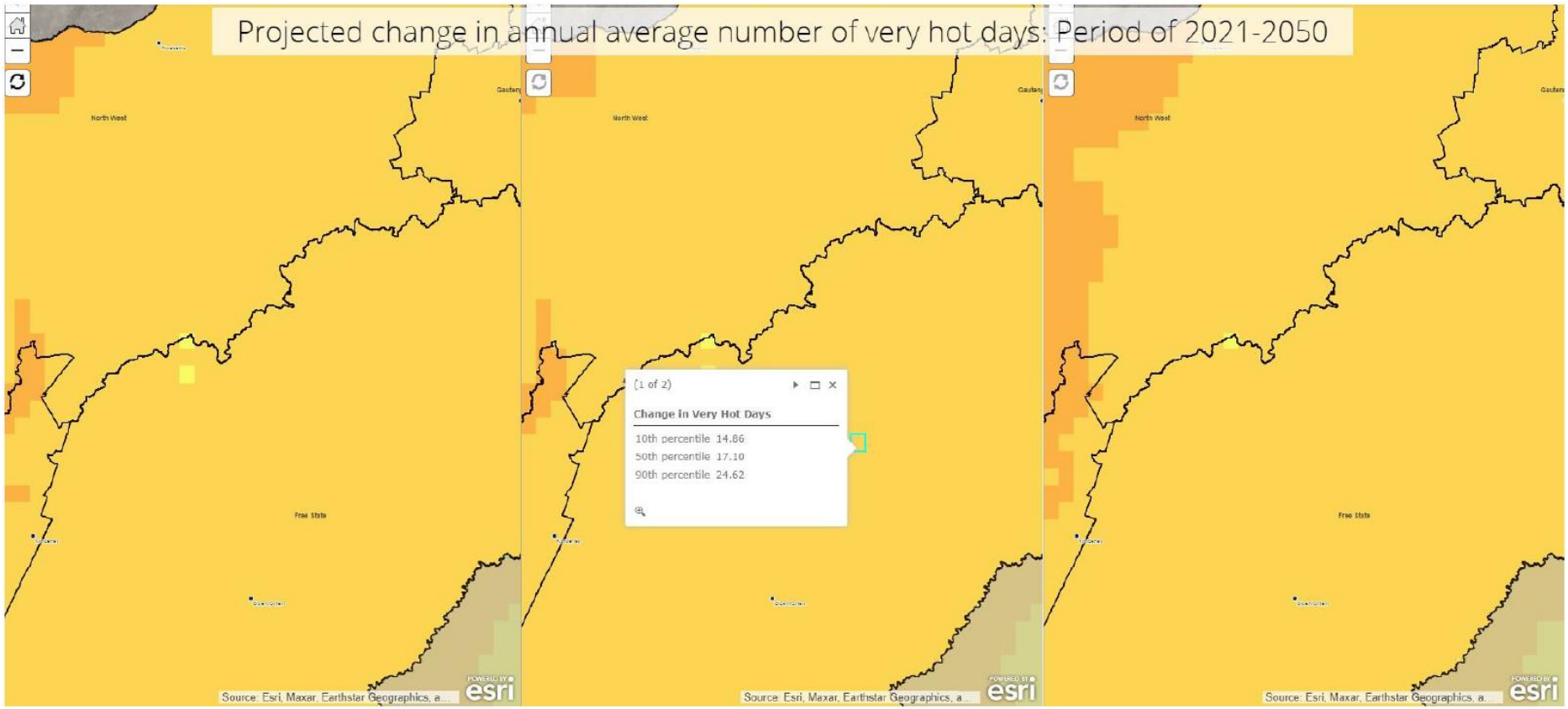


Figure 179: Projected change in very hot days for the near future (2021 – 2050) for the RCP8.5 trajectory.

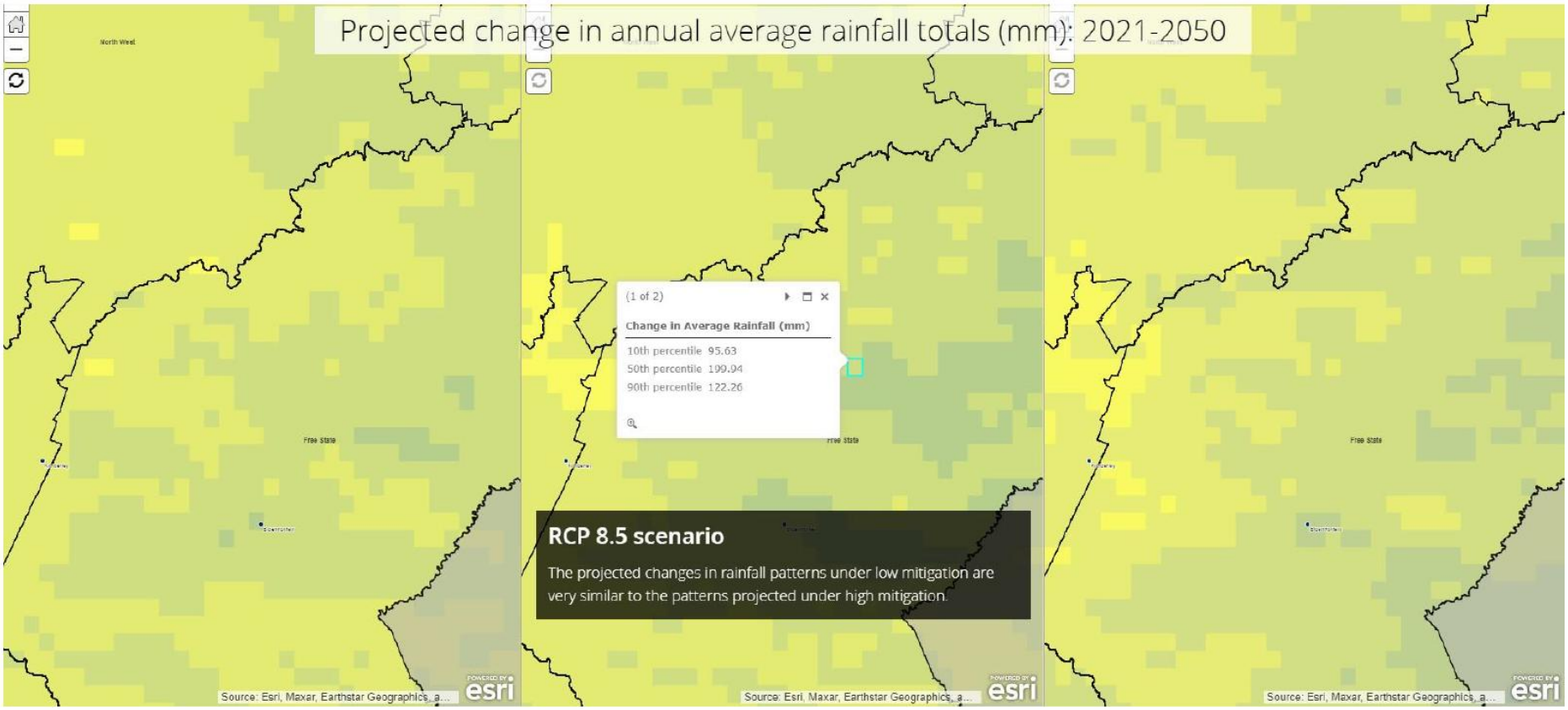


Figure 180: Projected change in annual average rainfall for the near future (2021 – 2050) for the RCP8.5 trajectory.

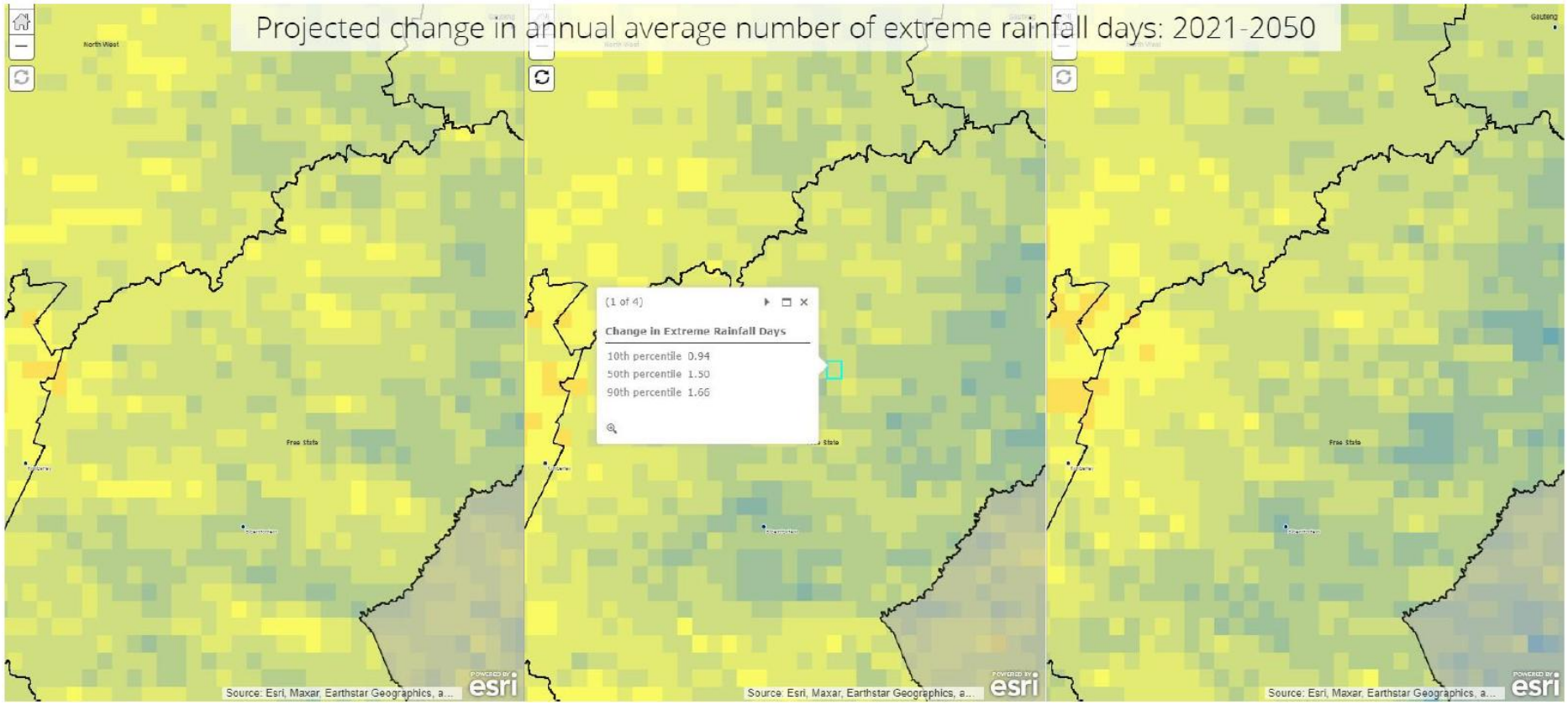


Figure 181: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP8.5 trajectory.

9.14.2.2.3 IPCC'S SIXTH ASSESSMENT REPORT: TEMPERATURE AND RAINFALL PROJECTIONS

The most recent IPCC data are from the Coupled Model Intercomparison Project (CMIP) which were derived from the sixth phase of the CMIPs (CMIP6) and supports the IPCC's Sixth Assessment Report (AR6) which was released on 9 August 2021 (Working Group I), 28 February 2022 (Working Group II) and 4 April 2022 (Working Group III). Projection data is presented at a 1.0º x 1.0º (100 km x 100 km) resolution. The scenarios are the result of complex calculations that depend on how quickly humans curb greenhouse gas emissions, whilst also capturing socioeconomic changes in areas such as population, urban density, education, land use and wealth. For example, a rise in population is assumed to lead to higher demand for fossil fuels and water. Education can affect the rate of technology developments. Emissions increase when land is converted from forest to agricultural land. Each scenario is labelled to identify both the emissions level and the so-called Shared Socioeconomic Pathway, or SSP, used in those calculations. This first scenario is the only one that meets the Paris Agreement's goal of keeping global warming to around 1.5°C above preindustrial temperatures, with warming hitting 1.5°C but then dipping back down and stabilizing around 1.4°C by the end of the century. Projected changes are defined relative to a historical 20-year period (1995 to 2014).

The AR6 projections for the study area for the scenario RCP4.5 indicate an increase in annual average temperatures of 2.4°C for the period 2041 to 2060 and 3.4°C for the period 2081 to 2100. The projections for the RCP8.5 indicate an increase in annual average temperatures of 2.9°C for the period 2041 to 2060, to 6.2°C for the period 2081 to 2100 (IPPC, 2022). The AR6 temperature projections for the period 2041 to 2060 are slightly higher than the AR5 projections (increase in annual average temperatures of 2.3°C for RCP4.5 and 2.6°C for RCP8.5) for the period 2021 to 2050. It should be noted, however, that these projections are based on different projected time frames.

The AR6 projections for rainfall in the study area for RCP4.5 indicate a decrease in annual rainfall of 5.9% for the period 2041 to 2060. The projections for RCP8.5 indicate decrease of rainfall of 8% for the period 2041 to 2060 (IPPC, 2022). The AR5 projections indicate an increase in annual rainfall of 16.6% for the RCP4.5 scenario.

9.14.3 HAZARDS

The Green Book risk profile includes an assessment of projected risk to the Matjhabeng Local Municipality in 2050, mostly based on the low mitigation RCP8.5 climate simulations, and highlights the following:

- For 2050 there is 26 increased fire danger days over the project area (Figure 182);
- There is an increase in drought tendencies (i.e. the number of cases exceeding near-normal per decade) for the period 2035–2064 relative to the 1986–2005 baseline period, under the low mitigation scenario (RCP 8.5). The Standardized Precipitation Index (SPI)[15] is -0.46 (Figure 183). A negative value is indicative of an increase in drought tendencies per 10 years (more frequent than baseline);
- There are no settlements at risk of encountering increasing heat stresses over the project area (Figure 184); and
- There is no significant increase in extreme daily rainfall for the project area (1.005)[16] (Figure 185).

[15] The Standardized Precipitation Index (SPI) is a widely used index to characterize meteorological drought on a range of timescales. SPI index.
[16] A value of more than 1 indicates an increase in extreme daily rainfalls.

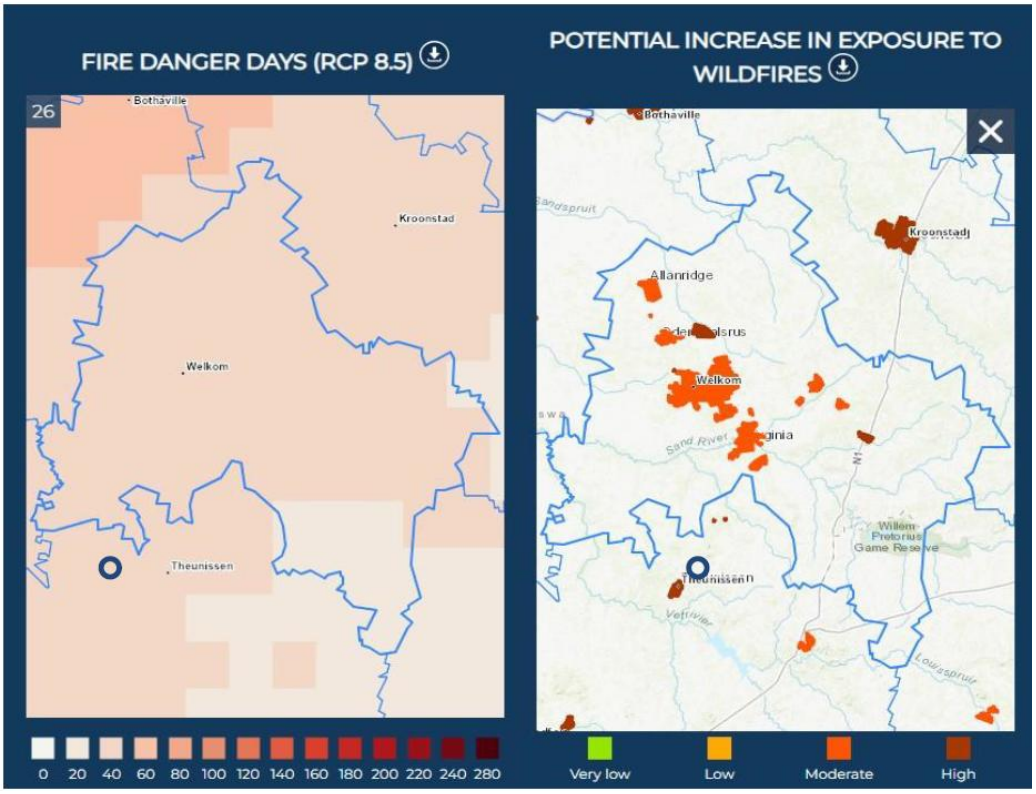


Figure 182: Risk of increased wildfires for Matjhabeng Local Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project).

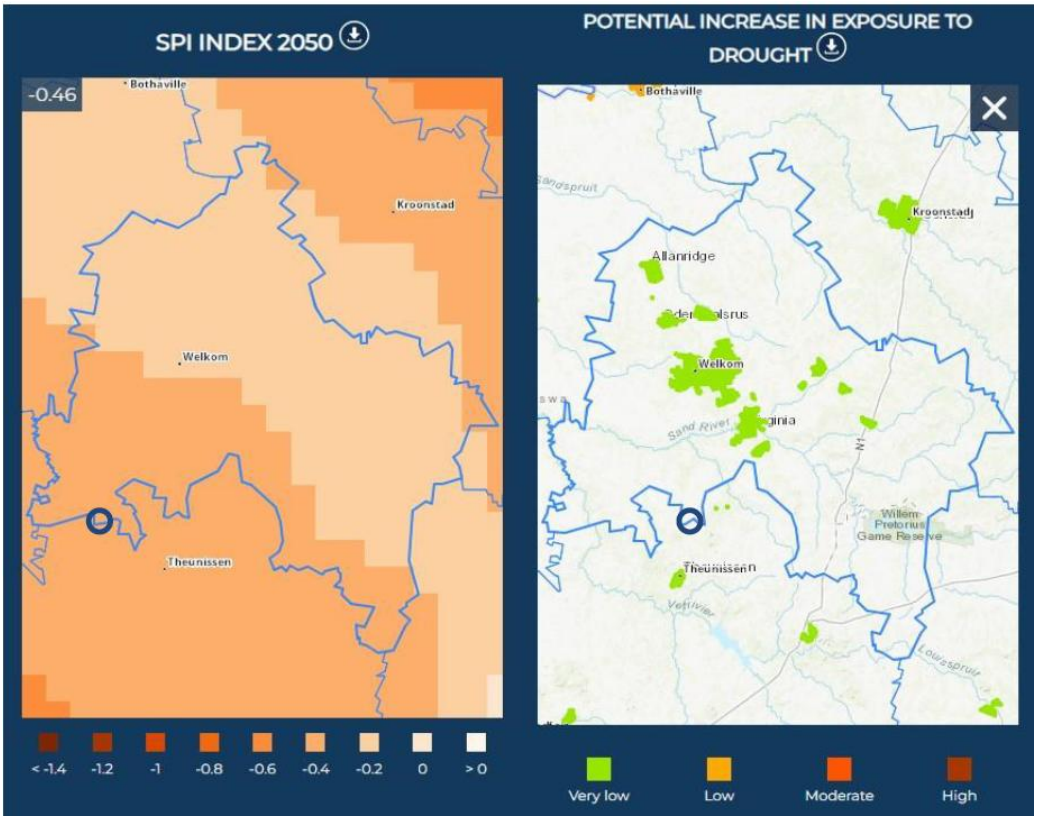


Figure 183: Risk of increased drought tendencies for Matjhabeng Local Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project).

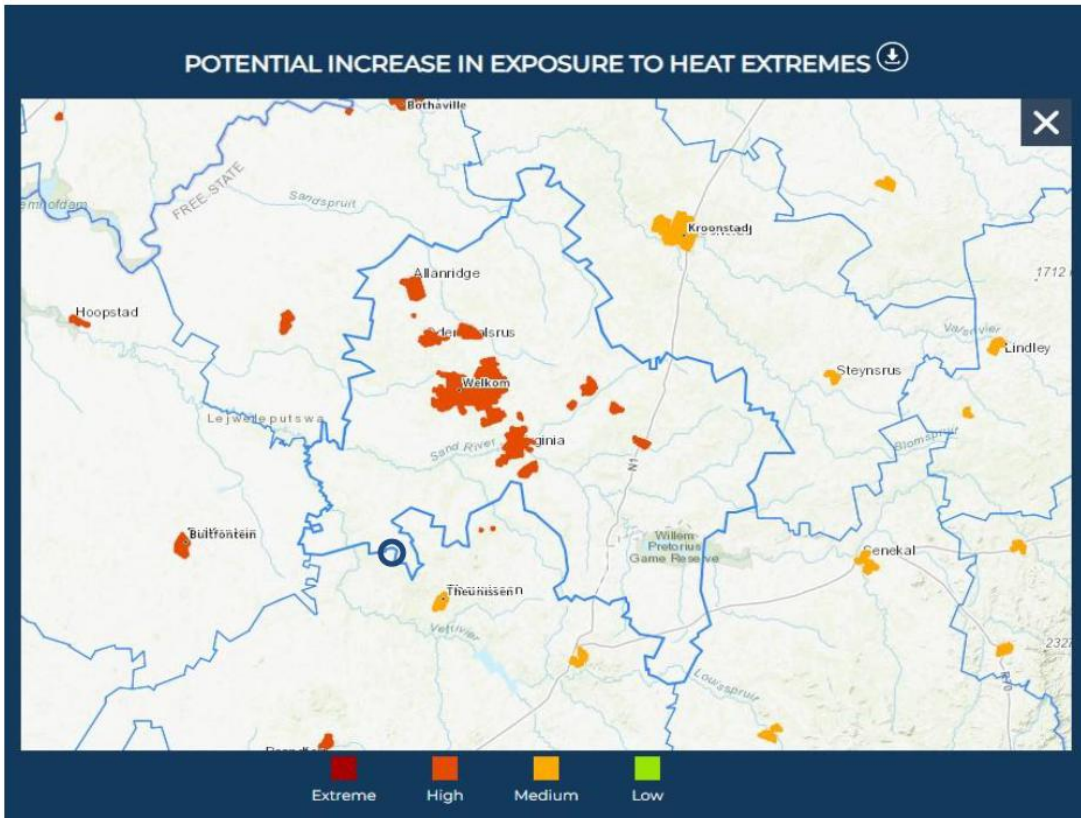


Figure 184: Risk of increased heat extremes for Matjhabeng Local Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project).

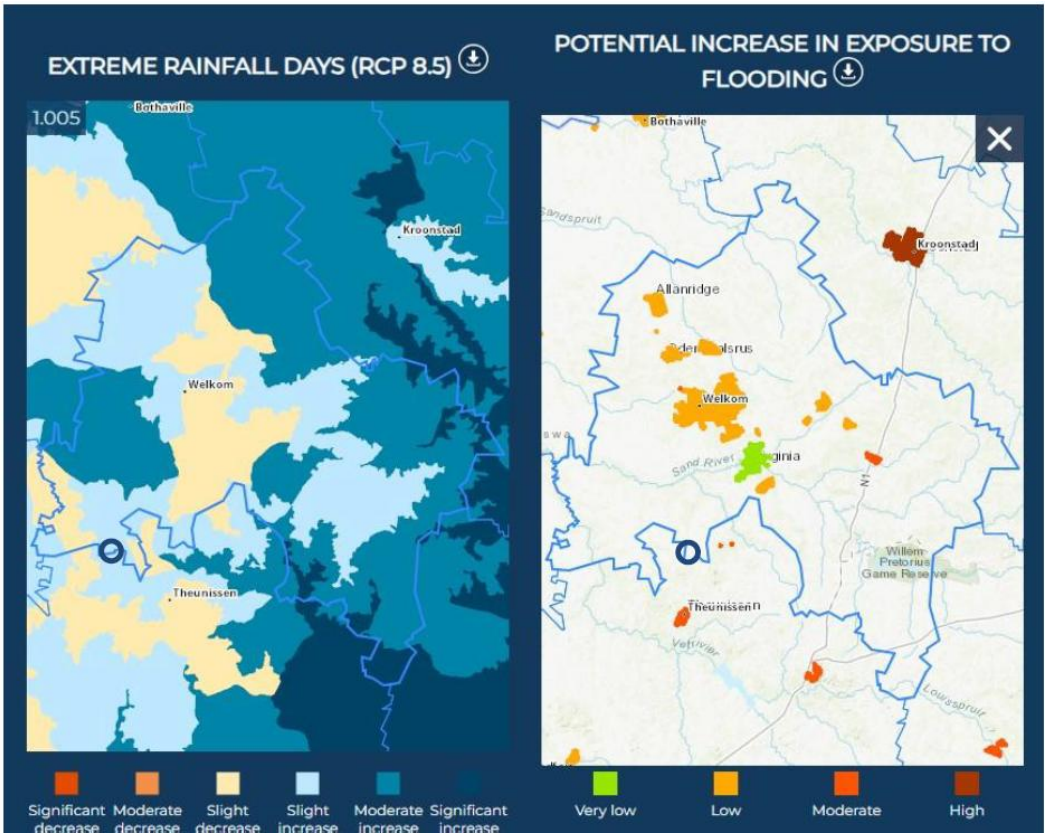


Figure 185: Risk of increased flooding for Matjhabeng Local Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project).

In addition to the hazards identified in the Green Book, Hofste, *et al.*, (2019) currently rate the project area at arid with low water use (Figure 186) with a projection of near normal risk of water stress for the future (2050 based on a conservative low mitigation trajectory) (Figure 187).

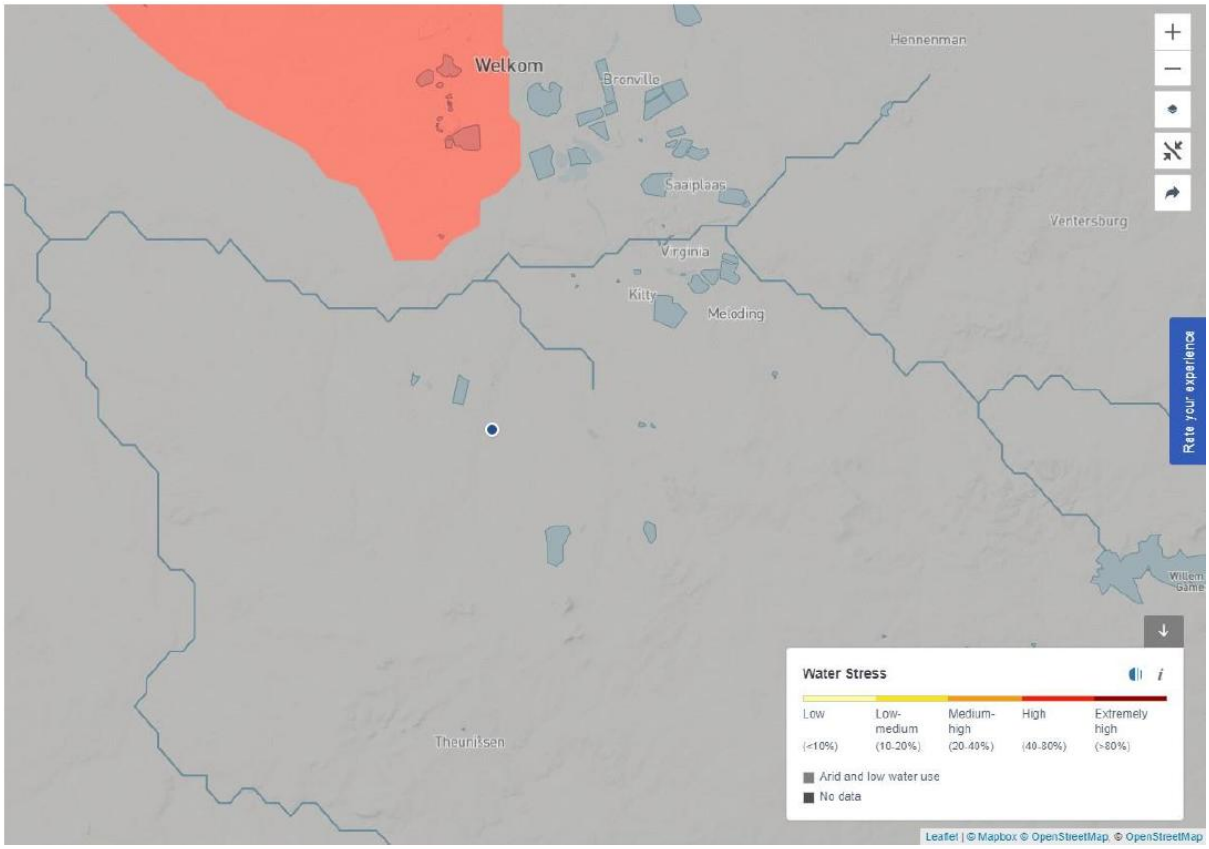


Figure 186: Current water stress for the project area (Hofste, et al., 2019) (blue dot indicates project location).

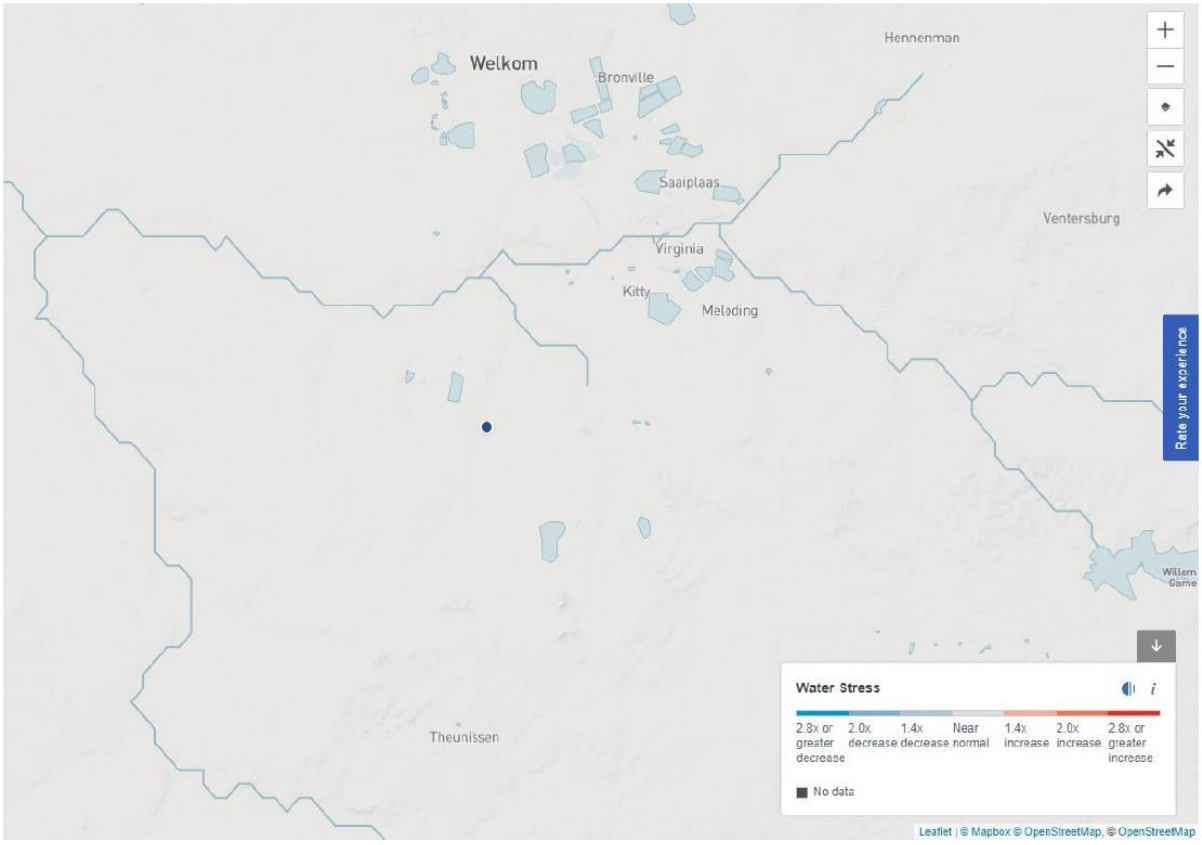


Figure 187: Projected (2050) water stress for the project area (Hofste, et al., 2019) (blue dot indicates project location).

9.14.4 IMPACT OF CLIMATE CHANGE

To understand the impact that climate change might have on the major resources of the Matjhabeng Local Municipality it is first necessary to provide an overview of the current situation, which has been provided for water, economy, and agriculture.

9.14.4.1 **WATER SUPPLY**

9.14.4.1.1 CURRENT RESOURCES

Figure 188 provides the current water supply vulnerability (i.e., demand versus supply) for the Matjhabeng Local Municipality based on the data compiled for the Department of Water and Sanitation (DWS) All Town's Study (Cole, 2017). The current water demand for the municipality is 207 l/p/d (litres per person per day), and exceeds the supply of 144.5 l/p/d, with 100% of all water sourced from surface water.

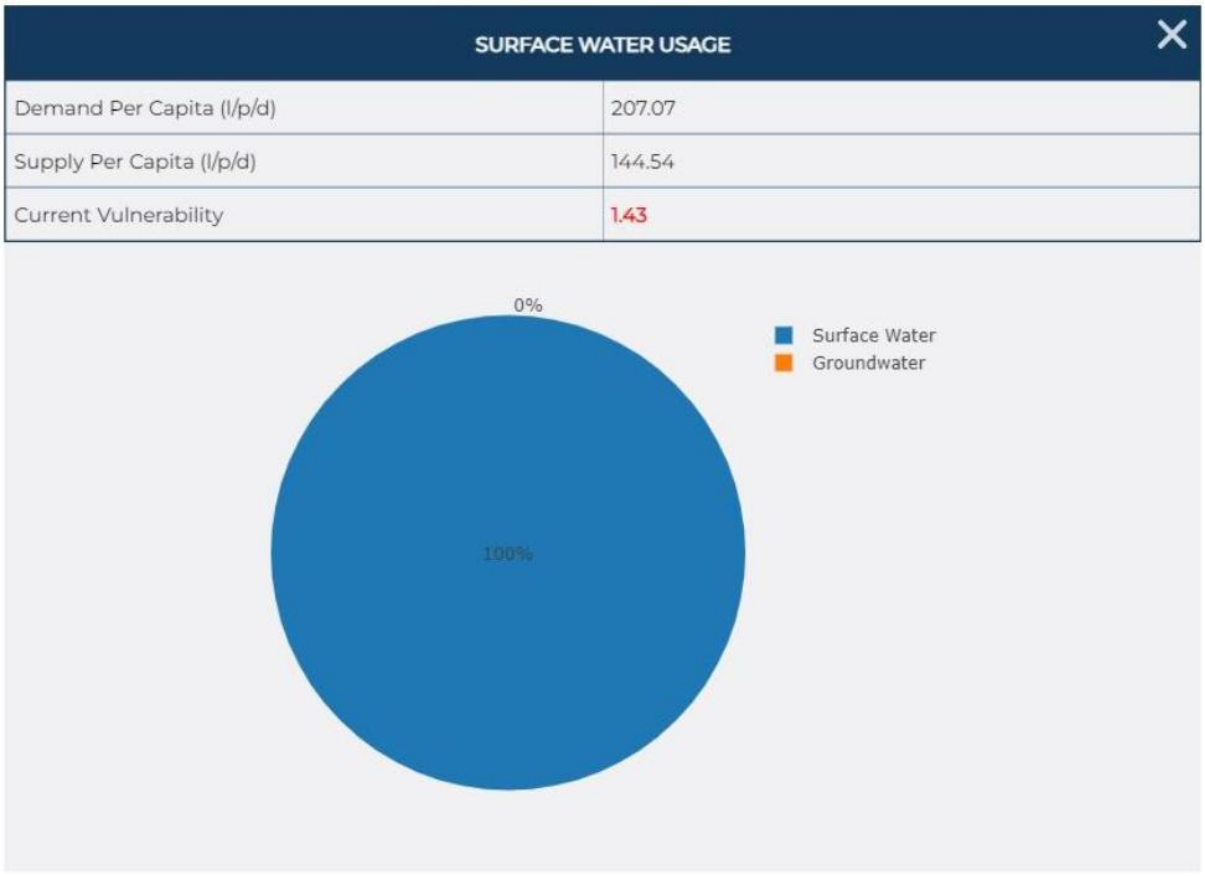
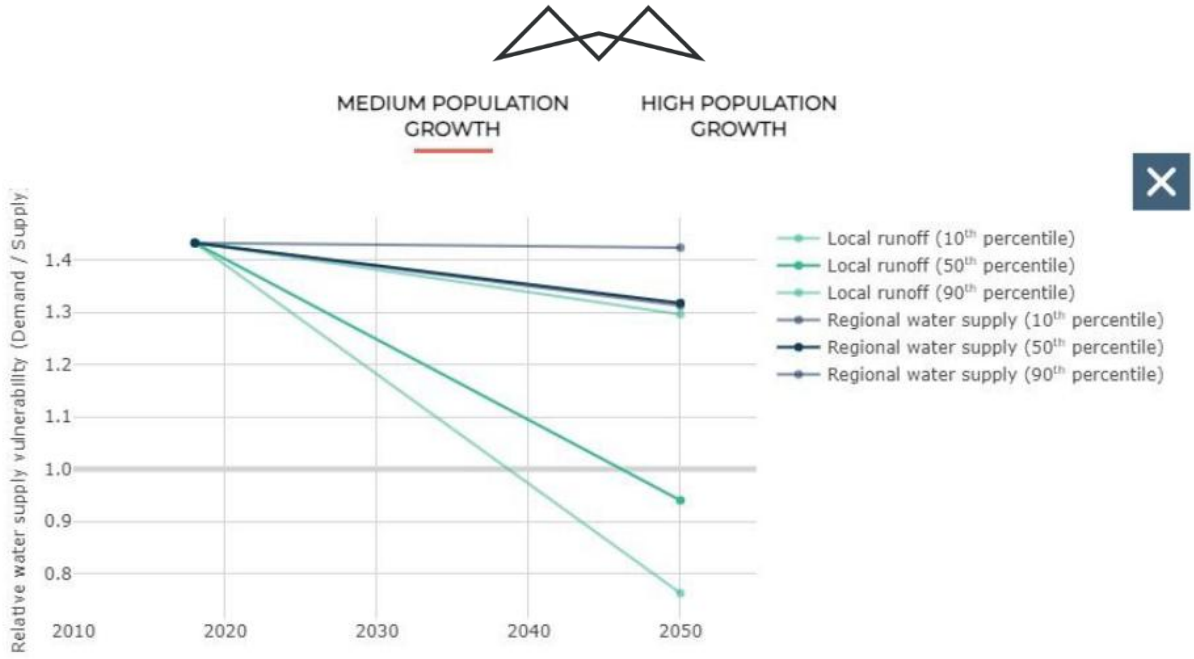


Figure 188: Current water availability for the Matjhabeng Local Municipality.

9.14.4.1.2 IMPACT ON RESOURCES

Figure 189 shows the estimated current and future water supply vulnerability (i.e., the ratio of demand to supply) based on: 1) a local water supply perspective incorporating changes to population growth coupled with exposure to climate risk (based on impacts on local runoff), and 2) a regional water supply perspective (based on impacts of regional water supply assuming supply is part of the integrated regional and national bulk water supply network). The mean annual precipitation for the municipality is predicted to increase by 6.5% for 2050 with a regional urban water supply increase of 11.91%.



VULNERABILITY CONTRIBUTION FACTORS		PERCENTAGE CHANGE
Mean annual precipitation	▲	6.5%
Mean annual evaporation	▲	8.02%
Mean annual runoff	▲	56.82%
Regional urban water supply	▲	11.91%
Population growth	▼	-4.72%

Figure 189: Estimated current and future (2050) water supply vulnerability based on medium population growth for the Matjhabeng Local Municipality.

9.14.4.2 **SURFACE WATER**

9.14.4.2.1 CURRENT SITUATION

The Matjhabeng Local Municipality is within the Vaal Primary Catchment. Figure 190 depicts the current annual and monthly surface water runoff, precipitation and evaporation for the Vaal Primary Catchment associated with the Matjhabeng Local Municipality. Precipitation and evaporation for the municipality is currently 534 mm/yr and 1 615 mm/yr respectively.

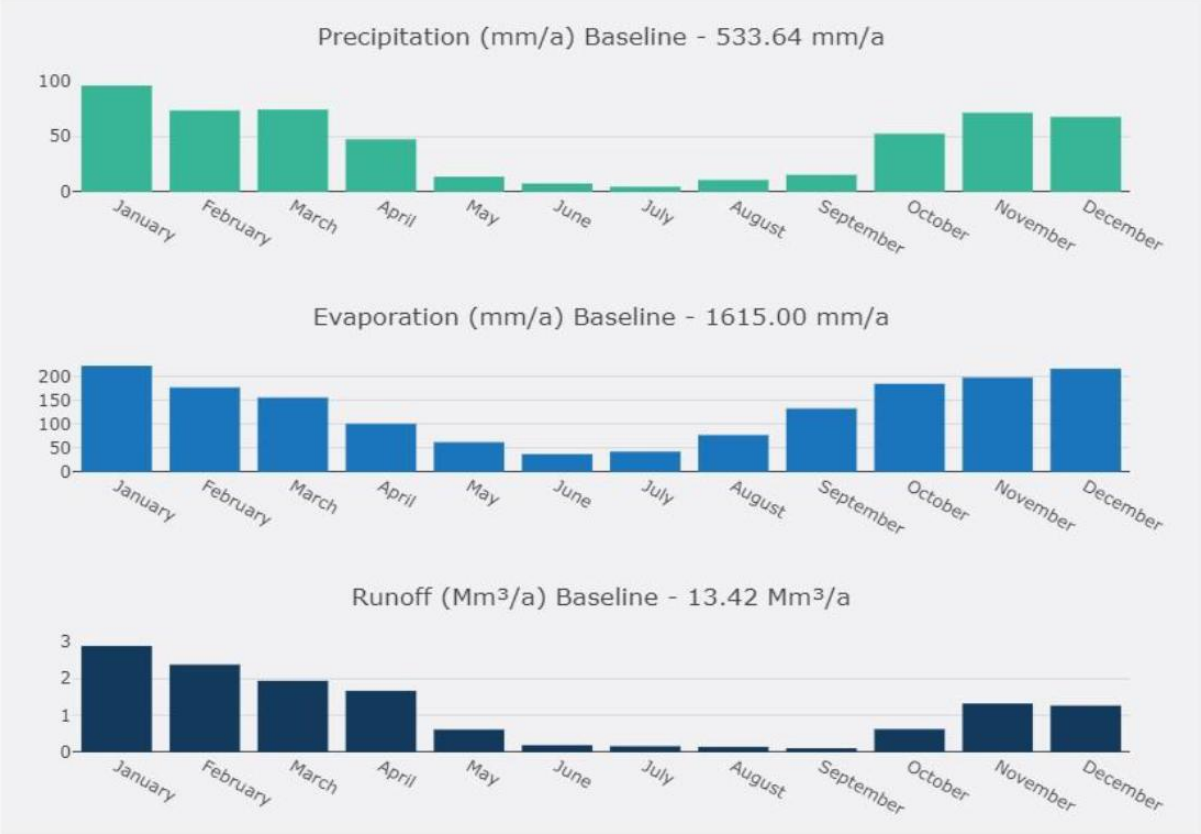


Figure 190: Current annual and monthly surface water runoff, precipitation and evaporation for the Matjhabeng Local Municipality which falls under the Vaal Primary Catchment.

9.14.4.2.2 PROJECTED IMPACT

Figure 191 provides the projected monthly change for future (2050) evaporation, precipitation, and estimated runoff values.

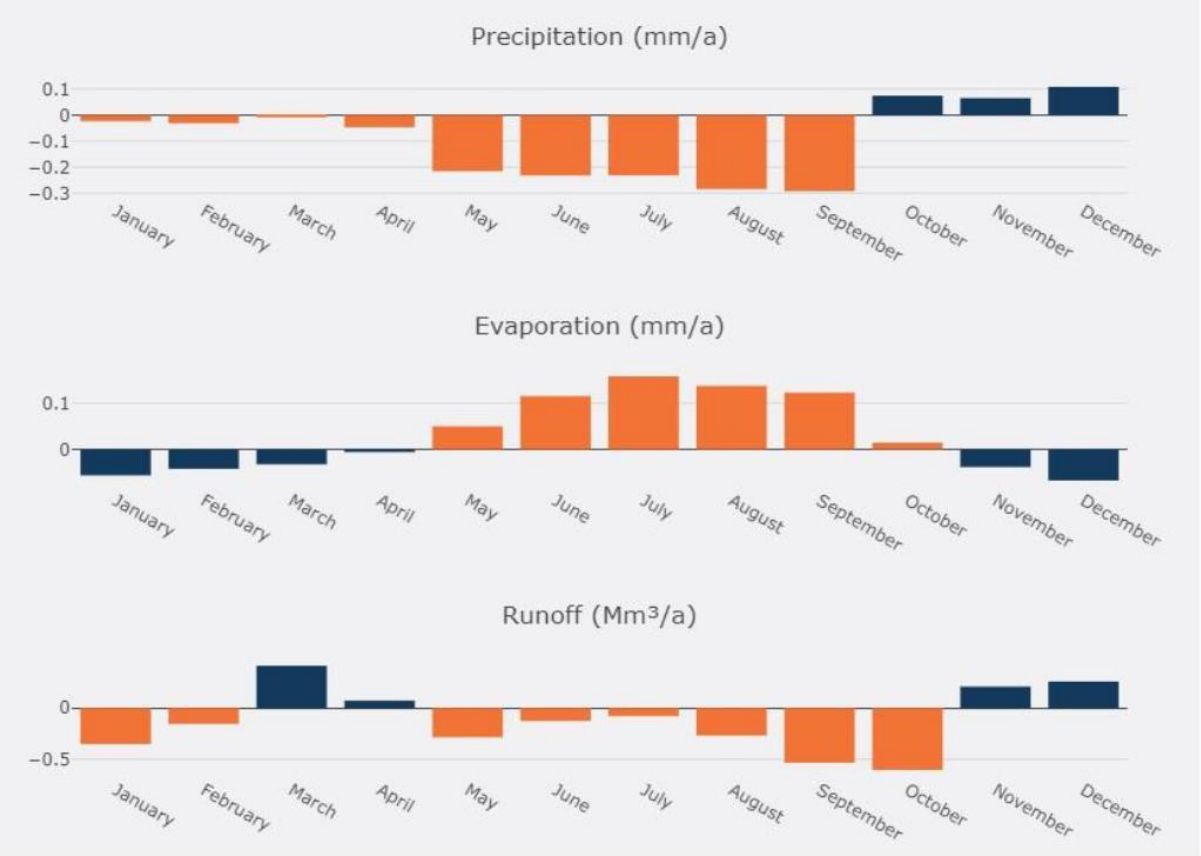


Figure 191: Projected monthly change to future (2050) evaporation, precipitation, and estimated runoff values.

9.14.4.3 **GROUND WATER**

9.14.4.3.1 CURRENT SITUATION

The groundwater recharge potential map indicates the occurrence and distribution of groundwater resources across the municipality, showing distinctive recharge potential zones. The groundwater dependency map indicates where settlements get their main water supply from, be it groundwater, surface water or a combination of both sources. Settlements that rely on groundwater, either entirely or partially, are deemed groundwater dependent. The project area is surface water dependent.

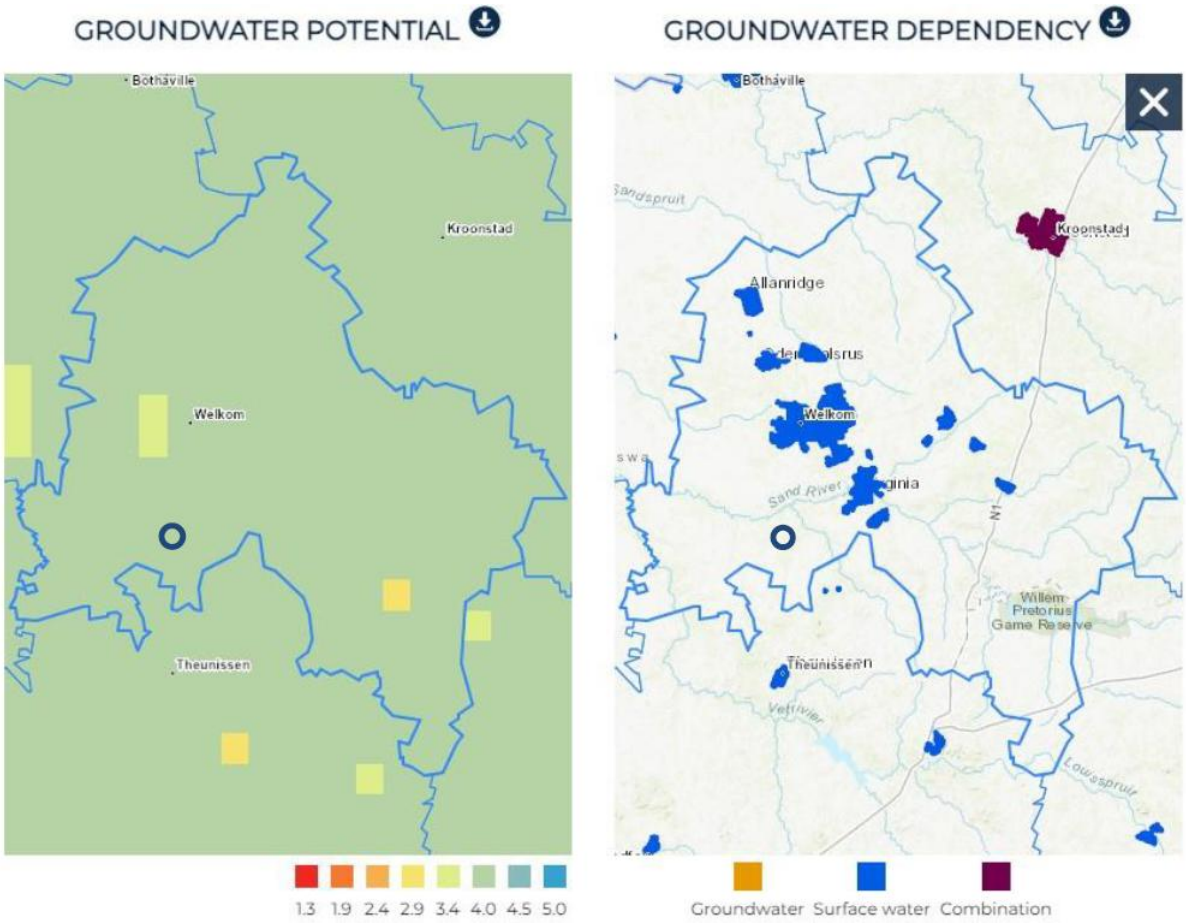


Figure 192: Groundwater potential and dependency for the Matjhabeng Local Municipality (dark blue marker indicates approximate location of the project).

9.14.4.3.2 PROJECTED IMPACT

A groundwater depletion risk map was created to determine which of South Africa's groundwater dependent settlements may be most at risk to groundwater depletion based on decreasing groundwater aquifer recharge potential and significant increases in population growth pressure by 2050. The groundwater depletion risk map (Figure 29) is based on the settlement aquifer recharge potential of the 50th percentile RCP8.5 scenario, and the medium population growth scenario. There is a slight change to groundwater potential in the area.

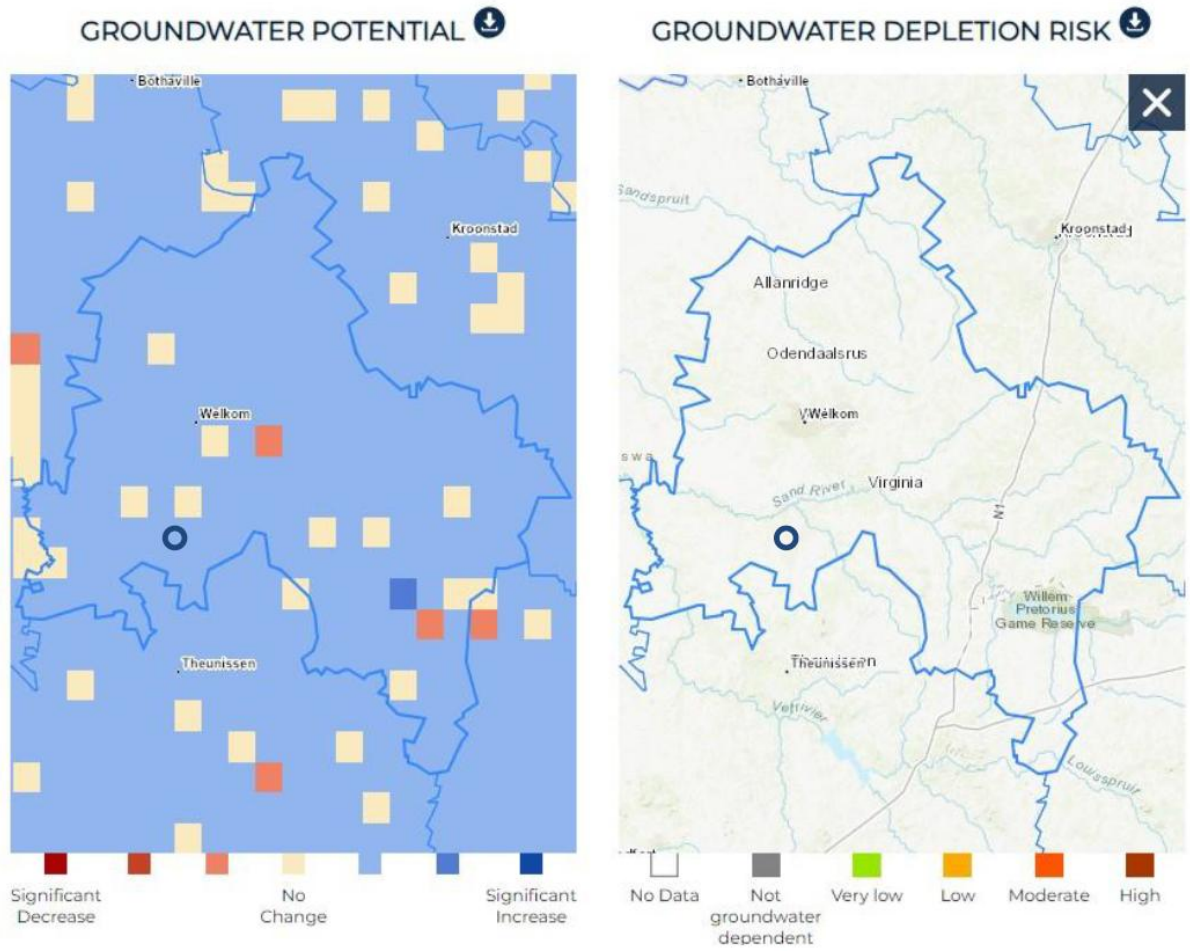


Figure 193: Groundwater potential and depletion for 2050 for the Matjhabeng Local Municipality (dark blue marker indicates approximate location of the project).

9.14.4.4 **ECONOMY**

Figure 194 shows the contribution that the different economic sectors make to the total Gross Value Added (GVA)[17] of the Matjhabeng Local Municipality as well as its national GVA rank (total GVA contribution to the national GVA). The Matjhabeng Local Municipality ranks 15th in the national GVA rank.

[17] Gross value added (GVA) is an economic productivity metric that measures the contribution of a corporate subsidiary, company, or municipality to an economy, producer, sector, or region.

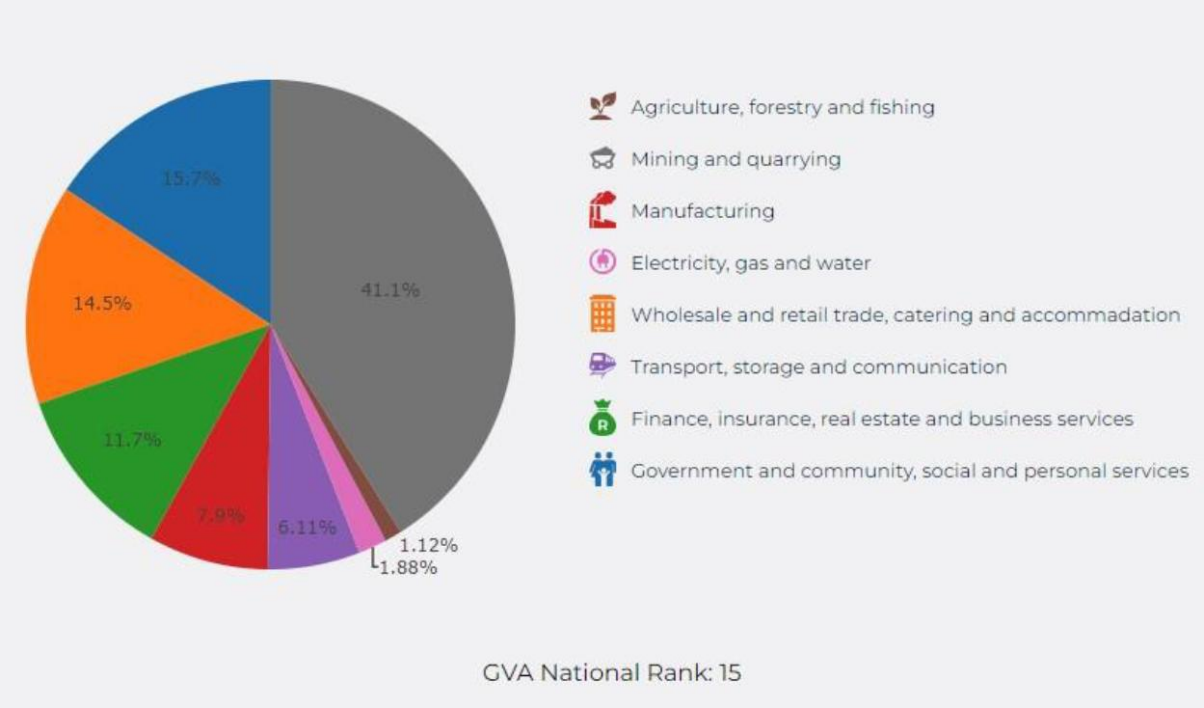


Figure 194: The contribution that the different economic sectors make to the total GVA of the Matjhabeng Local Municipality.

Table 66 summarises the forecasted economic gains or losses for the Matjhabeng Local Municipality, under both the RCP4.5 and RCP8.5 scenarios, for each of the contributing economic sectors.

Table 66: Forecasted economic gains or losses for the RCP4.5 and RCP8.5 scenarios.

RCP 4.5 Impacts		RCP 8.5 Impacts	
Average	0.92% ▲	Average	-0.05% ▼
Agriculture Sector	1.23% ▲	Agriculture Sector	-0.64% ▼
Forestry Sector	1.73% ▲	Forestry Sector	-0.91% ▼
Fishing Sector	1.24% ▲	Fishing Sector	-0.65% ▼
Mining Sector	-0.1% ▼	Mining Sector	-0.03% ▼
Manufacturing Sector	-0.54% ▼	Manufacturing Sector	0.76% ▲
Electricity & Gas Sector	4.78% ▲	Electricity & Gas Sector	1.29% ▲
Water Sector	-1.54% ▼	Water Sector	-0.42% ▼
Service Sector	0.57% ▲	Service Sector	0.17% ▲

9.14.4.5 AGRICULTURE, FORESTRY AND FISHERIES

The main agricultural commodities for the Matjhabeng Local Municipality are maize, beef cattle and milk and cream (Table 67). Agriculture, Forestry and Fishing (AFF) sector contributes 1.12% to Matjhabeng Local Municipality GVA production and 4.28% to Matjhabeng Local total employment. The total AFF GVA production of Matjhabeng Local Municipality contributes 0.51% of the national AFF GVA ranking them as the 62nd biggest contributor (Table 67).

Table 67: Economic contribution of main commodities for Matjhabeng Local Municipality.

MAIN COMMODITIES		
MAIZE FOR GRAIN	BEEF CATTLE	MILK AND CREAM
AFF contributes 1.12% to Matjhabeng GVA production	AFF contributes 4.28% to Matjhabeng total employment	The total AFF GVA production of Matjhabeng Municipality contributes 0.51% to the national AFF GVA, ranking them as the 62nd biggest contributor

The main agricultural commodities for 2050 for the Matjhabeng Local municipality are still maize, beef cattle and milk and cream (under an RCP8.5 low-mitigation scenario) (Table 68). There is the potential increase in maize yield for near future with heat stresses potentially negatively impacting on production towards the end of 2050. There is the potential for increased water availability over the Matjhabeng Local Municipality which, with hot and moist conditions, would cause increased spread of disease and parasites. This could lead to reduced growth and reproduction performance due to heat stress. Hot and moist conditions cause increased spread of disease and parasites. Potential increase in heat stress which could negatively affect conception rates, milk yield and milk quality.

Table 68: Projected economic contribution of main commodities for Matjhabeng Local Municipality.

MAIN COMMODITIES		
MAIZE FOR GRAIN	BEEF CATTLE	MILK AND CREAM
CLIMATE IMPACT		
Change in climate expected: Hotter and wetter with more extreme rainfall events.		
Potential increase in maize yield for near future. However, towards 2050, heat stress can negatively impact on production.	Increased water availability. Hot and moist conditions cause increased spread of disease and parasites. Reduced growth & reproduction performance due to heat stress.	Hot and moist conditions cause increased spread of disease and parasites. Potential increase in heat stress which could negatively affect conception rates, milk yield and milk quality.

9.14.4.6 **OTHER RESOURCES**

The impacts of climate change on other resources are summarised in Table 69.

Table 69: The impacts of climate change on other resources.

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
Transport and Mobility	• Increased rate of infrastructure deterioration leading to pavement failure including cracking, rutting, potholes, flushing, and stripping. • Increased stress on bridges, particularly expansion joints, through thermal expansion and increased movement. • Corrosion of steel reinforcing in concrete structures due to increase in surface salt levels in some locations. • Increased infrastructure maintenance cost for road repair and reconstruction work, causing traffic delays and emergency service response delays. • Increased frequency and intensity of wildfires leading to more road closures. • Increased vehicle accidents, due to low pavement adhesion, leading to higher rates of transport-related fatalities.	• Reduced water resources available for construction and maintenance. • Reduced production of some agricultural produce leading to changes in freight flows in the network.	• Increased rate of infrastructure deterioration, especially in areas with poor infrastructure maintenance history. • Temporary and permanent flooding of road, rail, port and airport infrastructure. • Structural integrity of roads, bridges and tunnels could be compromised by higher soil moisture levels. • Potential destruction of bridges and culverts. • Erosion of embankments and road bases leading to undermining of roads or railways. • Increased risk of landslides, slope failures, road washouts and closures. • Undermining of bridge structures (scouring). • Closure of roadways and tunnels leading to traffic delays. • Transportation system disruptions, impacts to traffic signalling and low water crossings. • Increased weather-related accidents.	• Increased drag on vehicles resulting in increased fuel consumption. • Increased safety risk for pedestrians and cyclists due to flying objects or being uncontrollably dragged by winds, additionally leading to reduced trip making by pedestrians and cyclists.	(Mokonyama & Van Wyk, 2018)
Solid Waste	• Increased risk of combustion at open waste disposal sites and illegal		• Increased risk of flooding due to pressure on stormwater and leachate	• Possible increase in nuisance due to waste dispersed by high winds	(Oelofse, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	dumps and increase in explosion risk associated with methane gas. • Increased rate of decay of putrescible waste resulting in increased odour, breeding of flies, and attracting of vermin. • Increased health and safety concern regarding heat stroke to staff collecting waste. • Increased risk of landfill site instability and failure due to changes in consumption patterns with increased waste creation (i.e., glass, plastic and paper cups).		management systems at landfills. • Increased demand for capacity to cope with large volumes of waste generated by flood events. • Increase in soil saturation causing decreased stability of slopes and landfills linings (if clay or soil based) at waste management facilities. • Inundation of waste releasing contaminants to waterways, pathways and low elevation zones. • Potential loss of value and degradation of paper and cardboard for recycling due to increased moisture content. • Increased flooding causing the risk of localised disruption of waste collection rounds. • Flooding in areas with untreated, dumped waste causing the risk of groundwater contamination. • Increased flooding causing the risk of litter entering the storm water systems.	leading to increased health effects associated with particulate matter (air pollution).	
Stormwater	• Potential risk of undermining the temperature regime of temperature-sensitive stormwater ponds and	• Increased shrinking soils increasing the potential for cracking, increased infiltration and exfiltration of water mains and sewers,	• Increased risk of flooding due to pressure on stormwater systems.	• Increased wind speed and intensity causing changes in rainfall over complex topography including	(Dunker & Van Wyk, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	receiving waters, resulting in a decrease in water quality. • Increased corrosion in stormwater drains due to a combination of higher temperatures, increased strengths, longer retention times, and stranding of solids.	which in turn exacerbates treatment and groundwater or storm water contamination.	• Increased risk of litter entering the stormwater systems. • Increased risk of damage and failure of stormwater systems due to overloading during floods and intense rainfall events. • Failure of stormwater treatment devices during high flow events leading to by-pass and / or flushing of contaminated water. • High wet-weather hydraulic loads and bottlenecks in stormwater and networks due to inflow and sewer infiltration, leading to local inundation and overflows of untreated wastewater. • Increased rainfall causes soil erosion thus damaging underground stormwater systems. • Increased surface and stream erosion causing deposition of sediments in receiving environments. • Stream morphology for undeveloped, developing and fully developed urban areas, may change, hence affecting existing outfall structures and potential stormwater pond locations.	increasing upwind of hills and ranges.	

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
Sanitation	• Increased heat waves, accompanied by dry weather, can exacerbate already stressed water supply systems leading to competition between sectors for water services, affecting sanitation.	• Decrease in water supply for sanitation through decrease in available water to flush sewage systems adequately. • Declining annual rainfall threatening the viability of water-borne sanitation systems, and the capacity of surface water to dilute, attenuate and remove pollution. • Sewers are structurally vulnerable to drying, hence shrinking soils increase the potential for cracking, increased infiltration, and exfiltration, which in turn exacerbates treatment and groundwater or storm water contamination. • Increased corrosion in sewers due to a combination of higher temperatures, increased strengths, longer retention times, and stranding of solids.	• Increased wet-weather hydraulic loads and bottleneck in stormwater and sanitary sewer networks due to inflow and sewer infiltration, causing local inundation and overflows of untreated wastewater. • Increased rainfall and heavy rainfall events increasing the washing of faecal matter into water sources due to flooding of wastewater treatment works. • Increased risk of flooding resulting in both infrastructure damage and contamination of surface and groundwater supplies. • Increased groundwater levels due to flooding, putting risk on sewage treatment plants (which are often positioned on low-lying ground as sewerage systems rely on gravity). • Increased vulnerability of sewerage pipe systems due to their size and complexity, and their exposure to multiple flood damage threats from source, through treatment, to delivery. • Increased vulnerability of pit toilets (widely used in		(Duncker, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
			rural areas) due to flooding, causing serious environmental contamination. • Increase in groundwater recharge and groundwater levels causing flooding of subsurface infrastructure such as pit toilets or septic tanks.		
Information and Communication Technology	• Increased weathering and deterioration of infrastructure resulting in increased maintenance and repair costs. • Heat stress causing structural damage to infrastructure. • Increased energy demands during heatwaves resulting in power outages which can impact on delivery of telecommunications services. • Increases in temperature and higher frequency, duration, and intensity of heat waves increasing the risk of overheating in data centres, exchanges, and base stations, which can result in increased failure rates of equipment. • Increased mean temperature increasing operating temperature of network equipment which	• Decreased precipitation leading to land subsidence and heave, reducing the stability of telecommunications infrastructure above and below ground (foundations and tower structures).	• Increased risk of flooding of low-lying infrastructure, access holes and underground facilities. • Increases in storm frequency or intensity increasing the risk of damage to aboveground transmission infrastructure and impacting on telecommunications service delivery. • Increases in storm frequency leading to more lightning strikes, consequently damaging transmitters, and overhead cables, causing power outages. • Increased cost of insurance for infrastructure in areas with repeated incidents of flooding, as well as withdrawal of risk coverage in vulnerable areas by private insurers.	• Increased risk of storm surges impacting on coastal infrastructure. • Increased storm intensity and frequency impacting on electricity and telecommunications infrastructure.	(Naidoo, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	may cause malfunctions if it surpasses design limits.		• Road closures due to flooding thus inhibiting service and/or restoration efforts. • Rising sea levels and corresponding increases in storm surges, increasing the risk of saline corrosion of coastal telecommunications infrastructure, and leading to erosion or inundation of coastal and underground infrastructure.		
Health	• More exposure to high temperatures causing increased health risks including heat strokes. • Heat waves increase threat of cardiovascular, kidney, and respiratory disorders. • Increase in fire danger days causing increased loss of life and damage to health infrastructure. • Wildfire smoke significantly reducing air quality, both locally and in areas downwind of fires. Smoke exposure increases respiratory and cardiovascular hospitalizations; emergency department visits; medication dispensations for asthma, bronchitis, chest pain, chronic obstructive	• Decreased soil moisture potentially creating more wind-blown dust which has negative impacts on air quality. • Increase in water-borne diseases and diarrhoeal diseases due to inadequate water availability. • Decreased precipitation causing changes in salinity of water, resulting in an increase in algal blooms which can likely lead to increases in food- and waterborne exposures. • Increase in stagnant air, decreasing air quality.	• Wetter climate combined with increased temperatures may have negative health impacts as many diarrhoeal diseases vary seasonally, typically peaking during the rainy season. • Extreme rainfall and higher temperatures increasing the prevalence of fungi and mould indoors, with increased associated health concerns. • Increased flooding increasing the risk of drinking and wastewater treatment facilities being flooded, meaning that diarrhoeal diseases can be transmitted as wastewater systems overflow or drinking water treatment systems are breached.	• Increase in wind-blown dust combined with low humidity causing increased cases of meningitis (Davis, 2014).	(Garland, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	pulmonary disease, and respiratory infections; and medical visits for lung illnesses. • Increased emissions in biogenic volatile organic compounds from vegetation causing increases in air pollution. • Increase in evaporative emissions from cars contributing to exposure to, and health impacts from, air pollution. • Increase in distribution of vector-borne diseases in warmer areas. • Increased water temperatures leading to an increase in algal blooms which can likely lead to increases in food- and waterborne exposures. • Increased temperatures combined with fewer clouds (e.g., from increased subsidence that is projected for parts of South Africa) causing increased exposure to Information and Communication Technology which will have negative impacts on health. • Increased temperatures increasing the reaction between certain pollutants and sunlight and heat,		• Increase in natural disasters (e.g., floods) creating a conducive environment for the occurrence of mental health problems.		

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	resulting in more severe hazardous smog events.				
Energy	• Increased heat causing expansion of overhead cables, and cable sag. Sagging below a certain level result in a reduction in the amount of electricity transmitted. • Increased heat stress on electricity transmission networks (overhead cables). • Increase in heat island effect increasing energy demand for cooling, leading to grid stress. • Increased threat of wildfires causing widespread damage to infrastructure and causing disruptions to service provision.		• Increase in flooding causing damage to electricity transmission and distribution infrastructure, poles, lines and sub-stations. • Increase in frequency and cost of maintenance of concrete structures due to frequent and intense rainfall, flooding, or sea level rise. • Increased repair events increasing stress put on service crews and resulting in delays to power restoration.	• Winds causing damage to energy supply infrastructure as winds cause overhead lines to sag, reducing electricity transmission. • Extreme winds causing poles and trees to fall, causing further damage to energy supply infrastructure such as overhead lines.	(Thambiran & van Wyk, 2018)
Ecosystem Services	• Increased risks of water shortages increasing demand for irrigation of gardens and agriculture. • Increased evapotranspiration rates with rising temperatures, reducing the water available in reservoirs and water available for reliant ecosystems. • Increase in temperature leading to water loss via evapotranspiration resulting in decreased water quality and loss of wetlands.	• Decreased amounts of rainfall reaching ecosystems as settlements use rainwater harvesting techniques for increased household use. • Increased reliance on irrigation and greater demand for water to maintain public open space and gardens. • Reduced planting and pollination leading to greater risk of erosion and soil loss.	• Rainfall in shorter and more violent spells making recharging groundwater difficult. • Increase in intensity of rainfall and flooding leading to increased surface runoff, resulting in increased soil erosion, soil loss and degradation. • Increased rainfall and floods resulting in waterlogged soils which increase the likelihood of crop failure.	• Evapotranspiration rates increase with wind speed, reducing the water available in reservoirs and water available for reliant ecosystems. • Increased rate of fire spread and spotting (the ignition of fires ahead of the main fire front) of fires. • Potential damage to or uprooting of vegetation including trees, which can also damage infrastructure. • Potential wind damage to crops, reducing yield and	(Pieterse & Crankshaw, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	• Loss or degradation of indigenous species, including threatened species or ecosystems. • Increased threat from invasive species as competition for water increases. • Dieback or death of susceptible plants (e.g., street trees) and animals (e.g., fish). • Reduced availability of water and increased evapotranspiration resulting in reductions in harvested area (cropping area), yield (ton/ha) and quality. • Warmer winters resulting in reduced period of dormancy (rest period) in deciduous fruit crops, decreasing the production and quality of associated food products. • Warmer climate resulting in shifts in the growing season and life cycles of various plants, including crops, resulting in pests and diseases having a greater destructive impact as well as a shift in climatically suitable areas for specific crops. • Increased humidity levels resulting in higher rates of microbial growth in fresh	• Increasing temperatures together with increased intensity of drought will potentially increase the occurrence of algal blooms in reservoirs and dams which are damaging to ecosystem functioning and water services. • Drought and decreased rainfall causing wetland habitat loss. • Locally specific changes in humidity levels will have impacts on local vegetation. • Increased threat to watershed and aquifer recharge areas, affecting vegetation. • Reduced soil moisture availability increasing moisture stress leading to dieback and death of plants and the loss or degradation of indigenous communities, including threatened species or ecosystems. • Increased moisture stress leading to decline in crop yield and quality, and reduced fodder quantity and quality for livestock. • Drying up of aquatic systems, perennial systems will become seasonal and seasonal systems will die off	• Increasingly saturated soils leading to more standing water (ponding) which can result in more insect (pest) activity and their potential to carry diseases. • Increased wave energy and run-up (sea level rise and more storms) causing degradation of natural coastal defence structures.	quality (e.g., sandblasting and fruit fall). • Increased windblown materials (e.g., dust, litter) increasing the need for maintenance and city cleaning. • Degradation of natural coastal defence structures and increased damage to hard coastal infrastructure.	

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	produce, reducing their expiry time. • Increased heat stress on crops changes the micro-nutrients of crops products, decreasing the nutrient density and quality of food. • Increased water temperature leading to increased growth of aquatic weeds which increases breeding of disease vectors and reduces water oxygen levels. • Milder winters and reduced frost increase the duration of the growing season, increasing the survival rate of insects and diseases. • Increased sea surface temperatures (SST) causing shifts in the spatial distribution of fish species. • Increased SST and ocean acidification decreases marine phytoplankton growth and synthesis of omega-3 polyunsaturated fatty acids (PUFA's), affecting the oceanic food chain and consequent ecosystems. • Increased heat stress and higher humidity levels potentially resulting in the exceedance of the	and be replaced by terrestrial plants. • Increased spread of drought-adapted alien invasive plant species.			

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	temperature humidity index in livestock, causing reduced immunity, fertility, productivity and even mortality of livestock.				
Culture and Heritage	• Increased temperature having significant impacts on the comfort levels of built heritage resources, resulting in the building no longer being fit-for-purpose. • Increased demand for additional heating and cooling resulting in the installation of heating, ventilation, and air-conditioning systems with potential negative consequences on the heritage value. • Increased heat stress potentially impacting on the materials and structural integrity of heritage resources. • Migration of several plant species due to changing climate patterns, posing a threat to the conservation of biodiversity hotspots, and potentially altering heritage places. • Increase in veld and forest fires raising the threat of fire to all heritage resources, natural and built, as well as posing health risks to	• Decreased rainfall impacting negatively on ground moisture levels and thus the geological conditions of sensitive heritage resources. Drying out clays, for example, will shrink and potentially undermine founding conditions.	• Increased rainfall in areas with clay soils resulting in swelling which poses a threat to the structural integrity of heritage resources. • Increased floods and changes in precipitation resulting in increasing vulnerability of archaeological evidence buried underground due to changing stratigraphic integrity of the soils. • Increased threat to materials and structural integrity of heritage resources exposed to higher humidity/ precipitation levels.		(van Wyk, 2018)

Parameter	Results of Climate Change				Reference
	Increase in temperature and heat stress	Drought and decrease in rainfall	Increase in rainfall and inland flooding	Increased wind speed	
	heritage resource dwellers from exposure to smoke and ash pollution.				

9.14.5 SCOPE 1 GHG EMISSION SOURCES

9.14.5.1 CLEARING AND REHABILITATION – CARBON SEQUESTRATION AND CARBON SINK

Accounting for the uptake of carbon by plants, soils and water is referred to as carbon sequestration and these sources are commonly referred to as carbon sinks. Quantifying the rate of carbon sequestration is however not a trivial task requiring detailed information on the geographical location, climate (specifically temperature and humidity) and species dominance (Ravin & Raine, 2007).

Photosynthesis is the main sequestration process in forests and in soils. Carbon is absorbed as fixed carbon into the roots, trunk, branches, and leaves and during the shedding of leaves, but is emitted – although at a reduced percentage – from foliage and when biomass decays. Several factors also determine the amount of carbon absorbed by trees such as species, size, and age. Mature trees, for example, will absorb more carbon than saplings (Ravin & Raine, 2007).

Aspects required to calculate the carbon stack change in the pool (in tons of carbon per year) include the climate, the type of forest or vegetation removed and the type to be re-introduced, and management measures. Soil type also has different absorption and release ratios that need to be included. "Decomposition of soil organic matter in drained inland grassland" was used to the carbon losses from the cleared areas. It should be noted that carbon losses apply to the replacement of vegetation with built infrastructure, except where temporary clearing activities could have long-term impacts on water resources, including rivers, aquifers, streams, and wetlands, or water infrastructure (for example dams and storm water systems) (Government Gazette No. 44761, Notice 559, 25 June 2021), where in this case, vegetation is likely to recover over the pipeline areas.

The areas to be cleared were accounted for as indicated in Table 70.

Table 70: Tetra4 Cluster 2 land clearance during construction.

Construction Activity	Description of Area	Area (m^2) (unit area)	No of units	Total area (m^2)
Land Clearance	Road construction	5 000	1	5 000
	Pipeline construction (a)	2 500	139	346 530
	Well construction	900	300	270 000
	Booster station construction	3 600	30	108 000
	Compressor station construction	3 600	3	10 800
	Plant construction	93 979	1	93 979
			Area (m^2)	**834 309**
			Area (ha)	**83.43**

9.14.5.2 CONSTRUCTION FUEL COMBUSTION

There will be an initial carbon sink loss due to the vegetation removal for the new and expansion Cluster 2 areas. GHG will also be emitted through operating diesel-powered mobile and stationary equipment, as listed in Table 71.

Table 71: Tetra4 Cluster 2 construction fuel combustion.

Mobile Diesel Equipment	Total kWh	Stationary Equipment	Total kWh
Plant	11 799 841	Natural gas generator	210 287
Pipeline	854 684		
Wells	1 275 986		
Booster Stations	1 275 986		
Compressor Stations	1 275 986		
Drilling	862 682		

9.14.5.3 **OPERATIONS**

The main sources of GHG due to the proposed operations are the mobile (trucking) and stationary equipment (generators) (Table 72), and emissions from the gas processing (fugitives, flaring and raw CO_2 venting) calculated in Gg per $10^6 m^3$ raw gas feed (Table 73) and emissions from transmission and storage (calculated in Gg/year/km and Gg/year/m^3 respectively (Table 74).

Table 72: Tetra4 Cluster 2 operational phase fuel combustion per year.

Road transportation (diesel)	Total GJ	Stationary Equipment	Total kWh
Trucking	7 350	Natural gas generator	36 842 352

Table 73: Tetra4 Cluster 2 gas processing during an operational year.

Gas processed	Volume (10^3 m^3)
Raw gas processed	203 786.67

Table 74: Tetra4 Cluster 2 transmission (pipeline fugitives and venting) and storage during an operational year.

Gas transmission	Length (km)	Storage per year	Volume (m^3/year)	Product (tpa)	Density (kg/m^3)
Pipeline length	120	Product	232 558.14	100 000	430

9.14.5.4 **DECOMMISSIONING**

As operations progress, the previously cleared areas that form part of the project will be rehabilitated resulting in a carbon sink gain. Even assuming rehabilitation uses the same indigenous vegetation, the carbon balance will not be completely restored. There may also be potential soil degradation due to stockpiling. However, there is insufficient data at this point to determine the decommissioning GHG emissions. This is likely to be equivalent or less than the construction phase, with the reestablishment of a carbon sink in the revegetation of the site.

9.14.6 SCOPE 2 GHG EMISSION SOURCES

Scope 2 GHG emissions apply to consumption of purchased electricity, heat, or steam. Tetra 4 Cluster 2 will make use of Eskom electricity supply for some operations as listed in Table 75.

Table 75: Tetra4 Cluster 2 ESKOM electricity supply during construction and operations.

Project phase	Activity	MW	No of hours/ year	Total MWh
Construction	Gas gathering	-	-	-
	Plant	0.16	5 278	844
Operations	Gas gathering	9.72	8 322	80 890
	Plant	23.06	8 322	191 905

9.14.7 SUMMARY OF SCOPE 1 AND SCOPE 2 GHG EMISSIONS

A summary of the calculated GHG emissions for the construction and operational phases is provided in Table 76.

Table 76: Tetra4 Cluster 2 Scope 1 and 2 GHG emission summary.

Emission summary					
Construction	**Activities**	**CO_2 (as tCO_2-e)**	**CH_4 (as tCO_2-e)**	**N_2O (as tCO_2-e)**	**Total CO_2-e (tonnes/year)**
Total Scope 1 Emission	Land clearance	509			509
	Off-road mobile equipment	4 627	6	529	5 162
	Generators	42	0.09	0.02	43
	Well drilling	10 716			10 716
	Well testing	14 517			14 517
	Well servicing	1 534			1 534
Total Scope 1 Emissions	Land clearance, heavy construction, generators, well drilling, well testing and well servicing	32 479			32 479
Total Scope 2 Emissions	Electricity bought from Eskom	861			861
				Total emissions (Construction)	**33 341**
Operations	**Activities**	**CO_2 (as tCO_2-e)**	**CH_4 (as tCO_2-e)**	**N_2O (as tCO_2-e)**	**Total CO_2-e (tonnes/year)**
Scope 1 Emissions	Road transportation	19 858			19 858
	Generators	7 441	15	4	7 460
	Gas production (fugitives)	37	112 490	n/a	112 527
	Gas production (flaring)	326	5	0	331
	Gas processing (fugitives)	71	5 156	n/a	5 227

	Gas processing (flaring)	509	7	2	519
	Gas processing (CO_2 venting)	8 151			8 151
	Gas storage		12		12
	Gas transmission (pipeline fugitives)	2	6 900		6 902
	Gas transmission (pipeline venting)	1	2 760		2 761
Total Scope 1 Emission	Road transportation, gas processing, transmission and storage, generators	50 411			163 748
Total Scope 2 Emission	Electricity bought from ESKOM	278 251			278 251
				Total emissions (Operations)	**441 999**

The total CO_2eq emission rate from the Tetra4 Cluster 2 construction phase is 32 479 tpa (Scope 1) and 861 tpa (Scope 2). For a single operational year, the Scope 1 GHG emissions are 163 748 tpa, with Scope 2 accounting for the largest part at 278 251 tpa.

9.14.8 SCOPE 3 GHG EMISSIONS

Scope 3 GHG emissions are listed in Table 77.

Table 77: Tetra4 Cluster 2 GHG Scope 3 emission summary.

Scope 3 Sector	Activities	Total CO_2-e (tonnes/year)
Total Scope 3 emissions – Transportation	Category 4 – Upstream transportation and distribution	6 498
	Category 6 – Business travel	26
	Category 7 – Employee commuting	2 297
	Category 9 – Downstream transportation and distribution	17 962
Total Scope 3 emissions – Products used	Category 1 – Purchased goods and services	147 442
Total Scope 3 emissions – Use of products	Category 11 – Use of sold products	398 391
Total Scope 3 emissions – Other sources	Category 5 – Generated in operations	14 677
	Total emissions	**587 293**

The main source of scope 3 emissions would be the end use of the LNG. As LNG will be replacing other fuels already in use, there will be a reduction in indirect GHG emissions as shown in Table 78. By using LNG, indirect GHG emissions would be reduced by 85 960 tons per annum (tpa)

Table 78: Tetra4 Cluster 2 GHG scope 3 use of sold products to replace other fuels currently in use.

Scope 3 sector	Activities	Total CO_2-e (tonnes/year)
Total Scope 3 emissions – Use of products currently (diesel)	Category 11 – Use of sold products	289 531
Total Scope 3 emissions – Use of products currently (LPG)	Category 11 – Use of sold products	122 476
Total Scope 3 emissions – Use of products currently (HFO)	Category 11 – Use of sold products	72 345
Total Scope 3 emissions – Use of products currently (Total)	Category 11 – Use of sold products	484 352
Total Scope 3 emissions – Use of products in future	Category 11 – Use of sold products	398 391
	Total emissions reduction	**85 960**

9.14.9 THE PROJECT'S GHG EMISSIONS IMPACT

9.14.9.1 IMPACT ON THE NATIONAL INVENTORY

The operational phase of Tetra4 Cluster 2 will likely result in an increase in Scope 1 & 2 emissions. The annual operational CO_2-e emissions from the Tetra4 Cluster 2 operations would contribute approximately 0.12% to the South African "energy" sector total (374.07 million metric tonnes CO_2-e, excluding FOLU) and represent a contribution of 0.09% to the National GHG inventory total (478.88 million metric tonnes CO_2-e, excluding FOLU), based on the published 2017 National GHG Inventory (DFFE, 2024). The annual CO_2-e emissions from the construction phase would contribute approximately 0.009% to the South African "energy" sector total and represents a contribution of 0.007% to the National GHG inventory total (DFFE, 2021).

9.14.9.2 ALIGNMENT WITH NATIONAL POLICY

Regulations pertaining to GHG reporting using the NAEIS were published in 2017 (Republic of South Africa, 2017) (as amended by GN R994, 11 September 2020) where mandatory reporting guidelines focus on reporting of Scope 1 emissions only. The DFFE is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the IPCC default emission figures may be used to populate the SAAQIS GHG emission factor database. With the operational Scope 1 CO_2-e emissions below 100 000 t/a, Tetra4 does not have to report on SAGERS, calculate its Carbon Tax nor compile a pollution prevention plan (PPP).

Whereas a framework for future power generation in South Africa is set out in the NDC, energy policies for South Africa are provided in the Integrated Resource Plan (IRP) as developed by the Department of Mineral Resources and Energy's (DMRE). These energy policies are based on the demand in electricity and what energy generation types should be procured to meet that demand, along with the generation capacity, timing, and cost. The IRP acts as the government's roadmap for expanding capacity in the electricity sector, setting targets for all technologies, including renewable energy. The 2023 update of the IRP (IRP-2023) includes two key timeframes. The first focuses on the period leading up to 2030, primarily aimed at addressing existing generation capacity constraints and bridging the electricity supply gap. The second horizon spans from 2031 to 2050, concentrating on the country's long-term electricity strategy to inform future policy decisions.

The IRP 2030 projection for electricity demand is 1.3% per annum for the first 10 years, with a 0.3% per annum up to 2050. The production of thermal energy in SA is expected to decrease by 10.5 GW by 2030, with a decrease of 25% in the current energy generation potential due to the shutting down of coal-fired power stations. Although the aim is to eventually replace fossil fuels completely, there is a strong case to use natural gas in the interim to replace coal for baseload capacity.

A concern with natural gas is around the leaking methane emissions, occurring mainly during the extraction, processing, and transportation of natural gas. The estimated Scope 1 and 2 CH_4 emissions from the operational phase at Cluster 2 accounts for 78% of the total CO_2-eq emissions. Even though CH_4 emissions are 28 times more effective than CO_2 at trapping heat in the atmosphere over a 100-year timescale (US EPA, 2024a), studies show gas has a lower life cycle GHG impact than coal with a lifetime of roughly a decade (PACE, 2015). According to the UK Department for Environment Food & Rural Affairs (DEFRA), natural gas releases 46% less CO_2-eq lifecycle emissions compared to coal-fired facilities and 49% less than diesel-fired facilities for the same electricity generation rate. The IPCC reports, based on the median value, indicate natural gas to result in less than 51% direct- and 40% lifecycle CO_2-eq emissions compared to CO_2-eq emissions from coal (Schlömer S., 2014).

The projects' contribution to the national CO_2-eq is only 0.09%, and 0.12% to the national energy sector CO_2-eq.

9.14.9.3 PHYSICAL RISKS OF CLIMATE CHANGE ON THE PROJECT'S CONSTRUCTION AND OPERATIONS

9.14.9.3.1 TEMPERATURE

With the increase in temperature, including heat waves, there is the likelihood of an increase in discomfort, possibility of heat related illness (such as heat exhaustion, heat cramps, and heat stroke). Both these have the potential to negatively affect staff process performance and productivity.

From a process point of view, elevated ambient temperatures (up to 45°C) may slightly reduce the fuel requirements needed to meet the generating capacity required. However, water use as a dust control measure during construction, may increase.

9.14.9.3.2 RAINFALL, WATER STRESS, AND EXTREME EVENTS

Rainfall decreases in autumn, winter and spring could result in constrained water supply outside of summer months. During drought conditions water supply could decline and intended use of reclaimed water and boreholes/wellpoints should be investigated to secure long-term supplies.

The impact of intense rainfall events on the LNG/LHe Plant cannot be ruled out, where the frequency of intense rainfall events could increase from the long-term baseline. These events could affect production capacity during intense rainfall (unless fully protected from rain and wind), flooding affecting site access, safe operation of equipment, delivery of fuel; collection of compressed gas product, as well as physical damage to infrastructure during high wind speed events associated with intense storms.

9.14.9.4 POTENTIAL EFFECT OF CLIMATE CHANGE ON THE COMMUNITY

9.14.9.4.1 TEMPERATURE

With the increase in temperature, including heat waves, there is the likelihood of an increase in discomfort and possibility of heat related illness (such as heat exhaustion, heat cramps, and heat stroke). There is also the possibility of increased evaporation which in conjunction with the decrease in rainfall can result in water shortage. This does not only negatively affect the community's water supply but can reduce the crop yields and affect livestock resulting in compromised food security.

9.14.9.4.2 RAINFALL, WATER STRESS, AND EXTREME EVENTS

As discussed above the decrease in rainfall can result in the following effects:

- Reduced water supply of reduced water quality; and,
- A negative impact on food security.

The impact of intense rainfall events on the local communities cannot be ruled out, where the frequency of these events could increase from the long-term baseline. These events could affect road access within the area due to flooding, and physical damage to public and private infrastructure through flooding and high wind speeds.

9.14.10 PROJECT ADAPTATION AND MITIGATION MEASURES

Climate change management includes both mitigation and adaptation. The main aim of mitigation is to stabilise or reduce GHG concentrations as a result of anthropogenic activities. This is achievable by lessening sources (emissions) and/or enhancing sinks through human intervention. Mitigation measures are typically the focus of the energy, transport, and industry sectors (Thambiran & Naidoo, 2017). Adaptation measures focus on minimising the impact of climate change, especially on vulnerable communities and sectors. Inclusion of the climate change adaptation in business strategic implementation plans is one of the outcomes defined in the Draft National Climate Change Adaptation Strategy (Government Gazette No.42466:644, May 2019).

Additional support infrastructure can reduce the climate change impact on the staff and project, for example improving thermal and electrical efficiency of buildings to reduce electricity consumption, ensuring adequate water supply for staff and reducing on-site water usage as much as possible. A community development program could be initiated to assist communities near the Tetra4 project site that are vulnerable to climate change impacts, such as thermal and electrically efficient buildings (to minimise electricity needs for heating and cooling), energy efficient stoves (to minimise the use of coal and woody biomass), or small-scale renewable energy innovations suitable for use in homes.

Project specific mitigation measures, may include:

- GHG emissions from vehicles and equipment:
    - Maintain vehicles and machinery in accordance with manufacturers standard specifications; and
    - A leak-detection program to be implemented to reduce product loss.
- GHG emissions from flaring, venting and fugitives:
    - Emissions of GHG should be limited as much as possible to reduce the global impact;
    - Flaring and venting of GHG should be minimised; and
    - Prudent operations and reductions in plant upsets would lead to fewer maintenance, start-up, and shutdown events that cause flare and blowdown emissions, with the added benefit of retaining more product.
- GHG from National Grid:
    - The implementation and use of renewable energy such as solar photovoltaic (PV) units to replace/ reduce the reliance on ESKOM electricity would reduce the Tetra4 Cluster 2 GHG emissions significantly since ESKOM's contribution to the operational phase is the main source of GHG emissions; and
    - The use of LNG instead of diesel for generators and other stationary equipment would reduce the Project's GHG footprint further.

9.15 NOISE RECEPTORS

A specialist assessment of the noise environment within the study area has been undertaken by Airshed Planning Professionals and the specialist report is included in Appendix 4. The findings are presented in the subsections below.

9.15.1 NOISE SENSITIVE RECEPTORS

NSRs generally include places of residence and areas where members of the public may be affected by noise generated by proposed activities. Potential noise sensitive receptors within the study area are shown in Figure 195 include individual homesteads and industrial and residential areas (i.e., Virginia).

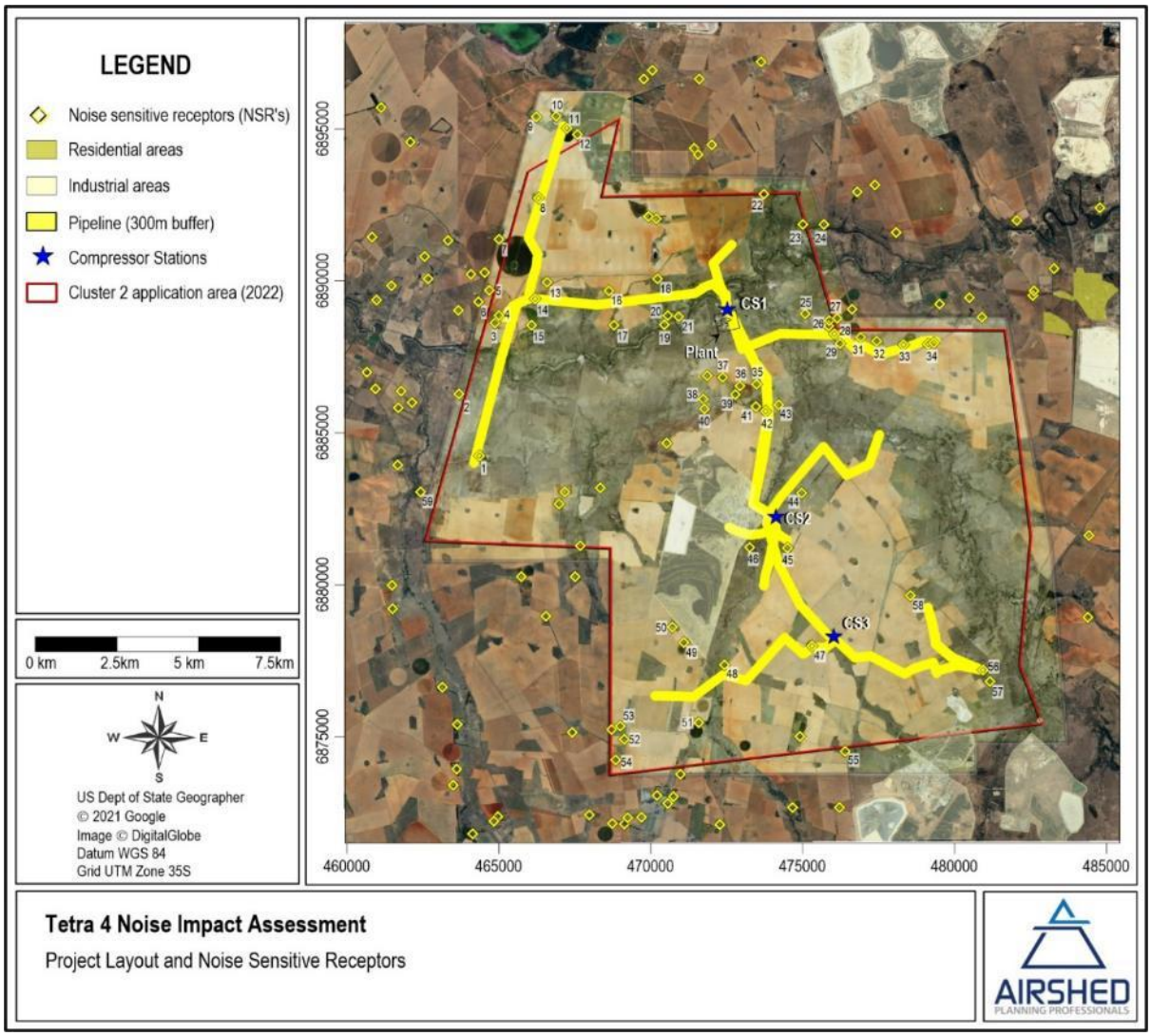


Figure 195: Sensitive noise receptors within the study area.

Sampling points for the noise survey conducted by Airshed in 2022 were selected based on proposed project activities, position of identified sensitive receptors and noise survey locations selected for the baseline campaign conducted in 2016. The baseline 2016 and 2022 noise survey results are included in the specialist report. All the measurements indicated a site with a very complex sound character. Areas away from busy roads and mining activities are very quiet, with measurement locations closer to houses, busy roads and mining activities indicating higher sound levels. Vegetation growth closer to dwellings creates habitat, attracting birds and insects, which in turn make sounds that increases the ambient sound levels. The vegetation also increased wind-induced noises. The larger study area, away from roads, dwellings and mining activities can be rated as Rural as per the SANS 10103:2008 criteria.

9.15.2 NOISE PROPAGATION AND SIMULATION

The noise source inventory, noise propagation modelling and results for the construction and operational phase of the project are discussed in detail in the specialist report while a summary of the findings are presented below for ease of reference.

The simulated noise levels for the construction and operational phase took into consideration the working hours as follows:

- Construction activities will take place during day-time hours with a one-hour lunch break.
- Operational activities were assumed to take place 24 hour per day, 7 days per week.

The exact location of the wells and pipelines will only be determined during the exploration phase as more data becomes available to guide the positioning of further wells and associated pipelines. As such, the simulated noise levels will be used to determine suitable mitigation measures associated with each aspect of the project. A summary of the noise simulations against the IFC day- and night-time guidelines (55dBA and 45dBA respectively) is provided in Table 79. Numerous Isopleths (noise simulation maps) are presented in the noise specialist study for each of the project aspects should the reader require a visual representation of the simulation.

Table 79: Noise simulation (IFC day- and night-time) against construction and operational aspects.

Aspect	Construction noise exceedance distance to receptors for IFC daytime guideline (55dBA)	Operational noise exceedance distance to receptors for IFC daytime and night-time guidelines (55dBA & 45dBA)
Well drilling (construction)	400m from Noise Sensitive Receptors.	N/A
Pipeline construction	90m from Noise Sensitive Receptors.	N/A
Blower Stations	600m from Noise Sensitive Receptors.	IFC day- (55 dBA) and night-time (45 dBA) noise guidelines for residential areas are exceeded up to 50 m and 150 m from the Blower Station sites respectively.
LNG/LHe Plant and Compressor Stations	The IFC day-time noise guidelines for residential areas (55 dBA) are not exceeded at any of the identified NSRs.	The IFC day- (55 dBA) and night-time (45 dBA) noise guidelines for residential areas are not exceeded at any of the identified NSRs.

9.16 VISUAL RECEPTORS

Landscape and visual impacts are being assessed by Environmental Planning and Design and the specialist report is included in Appendix 4. The baseline receiving environment findings are presented in the subsections below.

9.16.1 LANDSCAPE CHARACTER AREAS AND VISUAL ABSORPTION CAPACITY (VAC)

Landscape Character Areas (LCAs) are defined as “single unique areas which are the discrete geographical areas of a particular landscape type”. The overriding character differentiating factors within the subject landscape appear to be landform /drainage and vegetation cover. The landform appears to divide the landscape into Four discrete areas including;

1. Cultivated Rural Landscape Character Area. This area has gently undulating topography and a predominance of cultivated fields that are generally separated by areas of natural grassland. This is a relatively open landscape with little VAC which is only provided by minor ridgelines and alien vegetation;
2. Natural Landscape Character Area. This area is comprised of the shallow valleys surrounding watercourses and is generally covered in Natural Vegetation including grassland and woody alien species that occur in alluvial areas. VAC within these areas is generally moderate due to the fact that much of the woody vegetation extends above eye level;

3. Mining Landscape Character Area. This area includes all mining operations and the extensive stockpiles and infrastructure that associated with them; and

4. The Urban / Residential LCA. This area is comprised entirely of the urban areas of Virginia and Welkom. VAC is generally high within these areas due to the extent of structures and urban vegetation. Also due to distance (minimum 2.7km) surrounding rural vegetation and mining activities are likely to provide an effective screen.

Visual Receptors are defined as "individuals and / or defined groups of people who have the potential to be affected by the proposal". The significance of a change in a view for a visual receptor is likely to relate to use. Uses such as guest houses, recreation and tourism related areas are likely to rely on the maintenance of an outlook for successfully attracting guests and users. Residential areas could depend on outlook for the enjoyment of the area by residents and for maintaining property values. A route that is particularly important for tourism may also be dependent on outlook for the maintenance of a suitable experience for users.

Visual receptors within the affected landscape that due to use could be sensitive to landscape change are indicated below.

- Area Receptors may include;
    - Urban areas within the towns of Virginia and Welkom which are located approximately 2.7km to the east and 7.3km north of the proposed Cluster 2 Boundary Extension respectively; and
    - The H Joel Private Nature Reserve which, at its closest, is located approximately 1.0km to the south of the proposed Cluster 2 Extension area.
- Point Receptors that include;
    - There are a number of Local Farmsteads and Homesteads located both within the surrounding landscape. From the site visit it appears that the farmsteads within the proposed site have a primarily agricultural use.
- Linear Receptors or routes through the area that include;
    - The R30, the R730 and the unsurfaced local roads that that run through the proposed Cluster 2 Extension area. All of these are used mainly by local people with little or no tourism / recreational importance.

The landscape character areas and visual receptors within the study area are presented in Figure 196 and Figure 197.

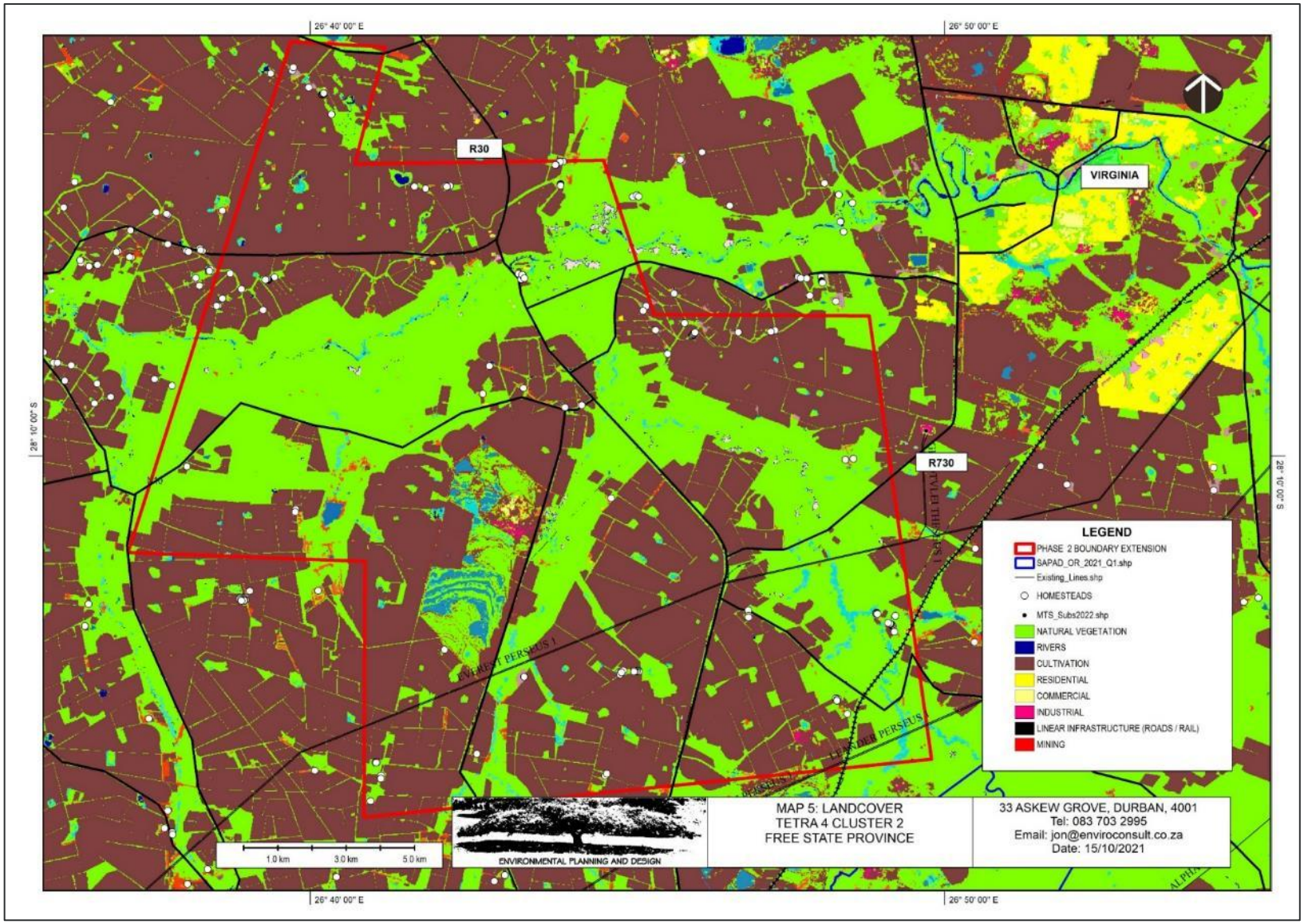


Figure 196: Landscape character areas and visual receptors.

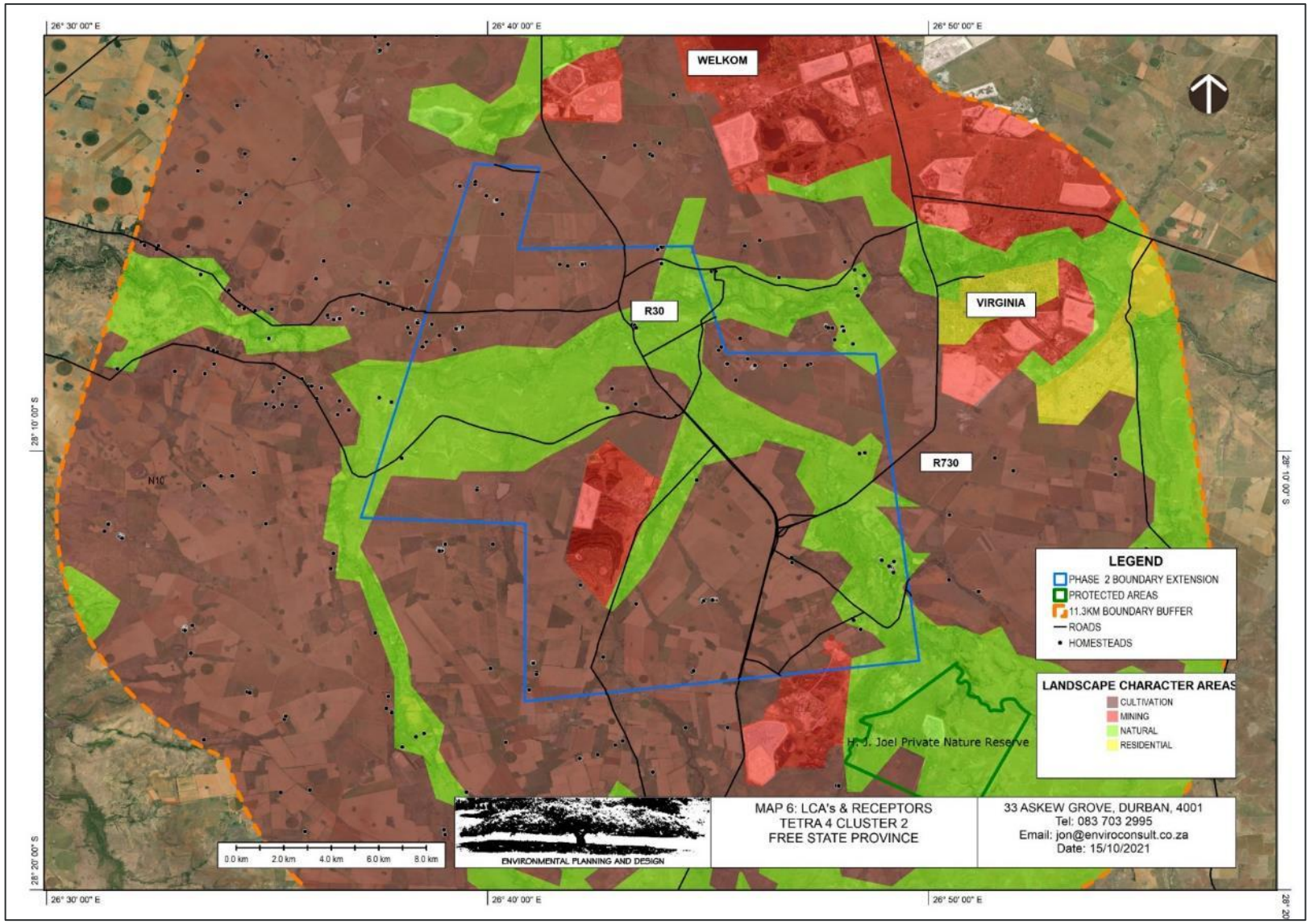


Figure 197: Visual receptors within and near the study area.

9.16.2 VISUAL SENSITIVITY

Site (Landscape) sensitivity (Figure 198) is largely related to the way that the site fits into the surrounding landscape i.e. is it an important component. The sensitivity of potential receptors generally relates to whether views are important to support current or potential usage. However, they also relate to nuisance and whether for instance a proposed use could impose on and make an existing use uncomfortable or even untenable.

The landscape within which the proposed projects is located is not highly sensitive. It has largely been transformed by large scale mining operations and commercial agriculture. The topography and vegetation patterns are also such that there is little VAC, receptors are therefore to a large degree affected by views of mining operations. However, the development proposal is likely to result in a finer grain industrial character which could mean that even though most individual elements are relatively small they will be considerably closer to most potential receptors. The visual sensitivity of the landscape has been categorised into no-go, high, medium and low (non-sensitive) areas as described below.

- No-Go Areas:
    - Since the affected landscape is highly transformed by both agriculture and mining and because protected areas are highly unlikely to be affected, there are no potentially affected areas where development should not happen due to potential landscape or visual impacts.
- Areas with High Sensitivity:
    - There are potentially affected areas that could be sensitive to potential development, these include:
        - All Natural areas that are largely located within the shallow river valleys. These areas have largely survived in a natural state due to their unsuitability for large scale mining and agriculture, they are therefore relatively intact. In addition to the provision of key environmental services such as attenuation of storm run-off, they provide visual buffers between intensive agriculture and mining operations. There are therefore sound reasons to maintain the integrity of these areas. From a landscape and visual perspective however, it is likely that the location of wells, compressor stations and pipelines might occur within these areas with minimal impact. However, this is subject to minimal disturbance and appropriate mitigation to ensure that the natural landscape character remains intact;
        - All areas within close proximity to homesteads. Currently there are views from many homesteads of large-scale mining operations. However, there are very few homesteads that have close range views over industrial operations. It is possible that the development of the various elements associated with the proposed project could be located in close proximity to homesteads and, subject to distance, these could dominate views of residents. Due to the small scale of the majority of proposed elements, the screening ability of natural areas in which many of the proposed elements are located, a 250 m buffer has been indicated around homesteads. It is not proposed that development in these areas is prevented, however, development must be undertaken in a way that views from affected homesteads are not dominated by views of the elements, appropriate mitigation is undertaken, and appropriate consultation is undertaken with residents.
        - All areas within close proximity to roads. Views from the main “R” roads that pass through the affected area are currently largely comprised of large-scale arable agriculture in the foreground and middle distance backed by large scale mining operations. These views are punctuated by natural landscape areas as the motorist crosses the shallow river valleys. Subject to distance, the majority of proposed elements are such that their location within the current large scale open agricultural

landscape is unlikely to be highly obvious. Due to their scale, a well, compressor station or LV overhead power line located 250 m away from a road is unlikely to the highly visible from the road. A pipeline at any distance from the road, as long as appropriate rehabilitation is undertaken, is unlikely to be highly visible.

- Areas with Medium Sensitivity
    - Areas with medium sensitivity to development include all arable agricultural areas outside 250 m from homesteads and roads.
- Non-Sensitive Areas
    - All non-sensitive areas including mining areas outside 250m from homesteads and roads.

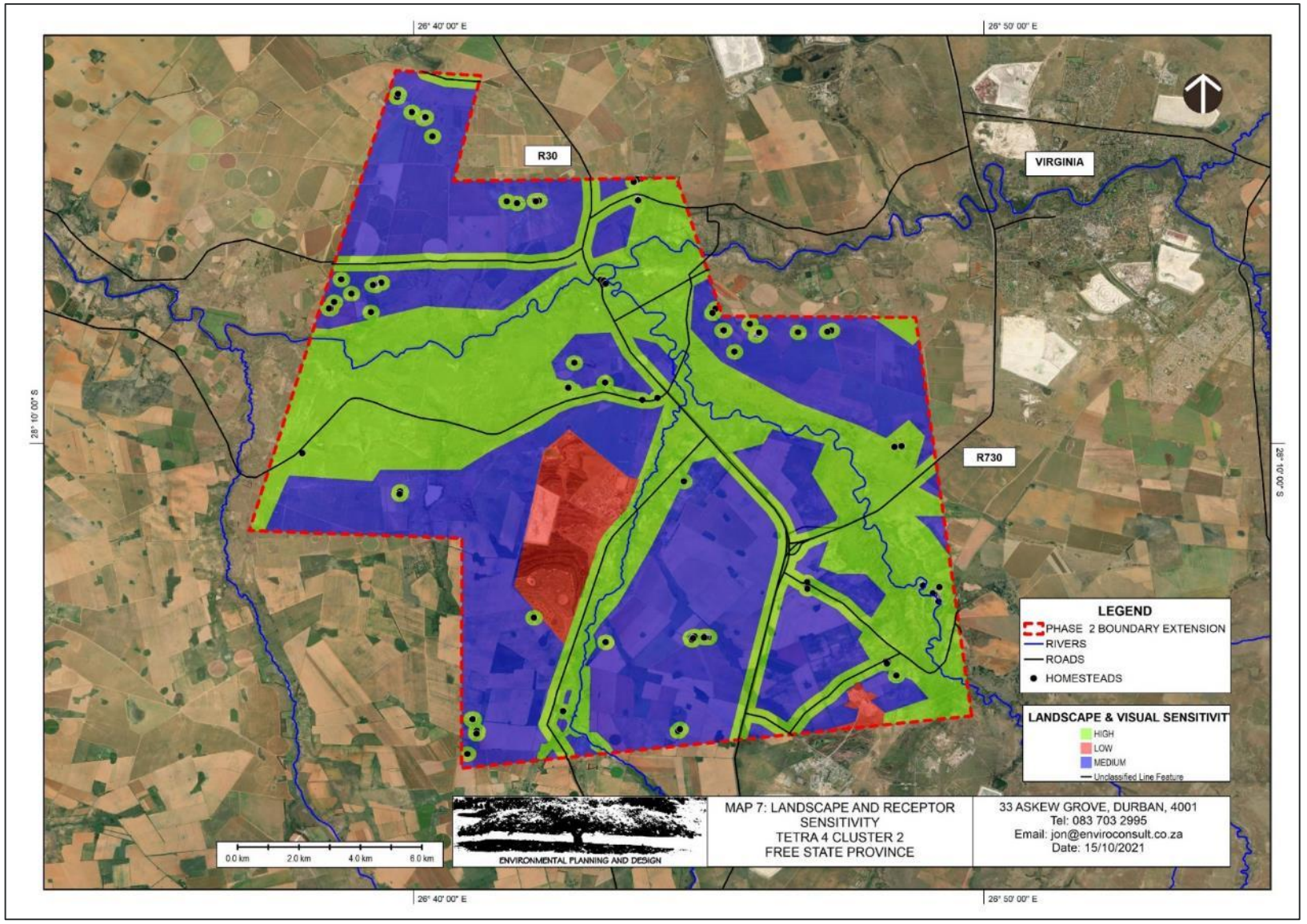


Figure 198: Landscape visual sensitivity rating for the study area.

10 ENVIRONMENTAL IMPACT ASSESSMENT

This section describes the impact assessment methodology, the identified impacts and an assessment of each.

10.1 IMPACT ASSESSMENT METHODOLOGY

The impact significance rating methodology, as provided by EIMS, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S). The impact assessment methodology has been applied to all identified alternatives. Where possible, mitigation measures have been recommended for impacts identified.

10.1.1 DETERMINATION OF ENVIRONMENTAL RISK

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER). The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$\boldsymbol{C = \frac{(E + D + M + R) * N}{4}}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 80 below.

Table 80: Criteria for Determining Impact Consequence.

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years)
	3	Medium term (6-15 years)
	4	Long term (15-65 years, the impact will cease after the operational life span of the project)
	5	Permanent (>65 years, no mitigation measure of natural process will reduce the impact after construction)

Aspect	Score	Definition
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected)
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way, moderate improvement for +ve impacts)
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease, high improvement for +ve impacts)
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease, substantial improvement for +ve impacts)
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost
	4	Impact is reversible only by incurring prohibitively high time and cost
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per Table 81.

Table 81: Probability Scoring.

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25 %),
	2	Low probability (there is a possibility that the impact will occur; >25 % and <50 %),
	3	Medium probability (the impact may occur; >50 % and <75 %),
	4	High probability (it is most likely that the impact will occur- > 75 % probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

ER= C x P

Table 82: Determination of Environmental Risk.

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10

	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 83.

Table 83: Significance Classes.

Environmental Risk Score	
Value	Description
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk/ reward).
≥9 - <17	Medium (i.e. where the impact could have a significant environmental risk/ reward),
≥17	High (i.e. where the impact will have a significant environmental risk/ reward).

The impact ER has been determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

10.1.2 IMPACT PRIORITISATION

Further to the assessment criteria presented in the section above, it is necessary to assess each potentially significant impact in terms of:

1. Cumulative impacts; and
2. The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) has been applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF has been applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 84: Criteria for Determining Prioritisation.

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/ definite that the impact will result in spatial and temporal cumulative change.
	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.

Irreplaceable Loss of Resources (LR)	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 84. The impact priority is therefore determined as follows:

Priority = CI + LR

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (refer to Table 85).

Table 85: Determination of Prioritisation Factor.

Priority	Prioritisation Factor
2	**1**
3	**1.125**
4	**1.25**
5	**1.375**
6	**1.5**

In order to determine the final impact significance, the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

Table 86: Final Environmental Significance Rating.

Environmental Significance Rating	
Value	Description
≤ -17	High negative (i.e. where the impact must have an influence on the decision process to develop in the area).
> -17 ≤ -9	Medium negative (i.e. where the impact could influence the decision to develop in the area).
> -9 < 0	Low negative (i.e. where this impact would not have a direct influence on the decision to develop in the area).
0	No impact
>0 < 9	Low positive (i.e. where this impact would not have a direct influence on the decision to develop in the area).

Environmental Significance Rating	
≥ 9 < 17	Medium positive (i.e. where the impact could influence the decision to develop in the area).
≥ 17	High positive (i.e. where the impact must have an influence on the decision process to develop in the area).

The significance ratings and additional considerations applied to each impact has been used to provide a qualitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants has been applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

10.2 IDENTIFICATION AND ASSESSMENT OF IMPACTS

This Section presents the potential impacts that have been identified during the scoping phase assessment. It should be noted that this report has been made available to I&AP's for review and comment with all comments and responses included in the final Scoping report submitted to the PASA for adjudication. Potential environmental impacts were identified during the scoping process. These impacts were identified by the EAP, the appointed specialists, and updated where relevant based on public input.

Without proper mitigation measures and continual environmental management, most of the identified impacts may potentially become cumulative, affecting areas outside of their originally identified zone of impact. As this Cluster 2 development is an extension to the existing Cluster 1 development within the Production Right and both share the same infrastructure (wells, pipelines, stations, plant, etc), the current approved EMPr mitigation measures have been assessed for their adequacy in mitigating the Cluster 2 development and specifically assessed in terms of the Generic EMPr for Gas Infrastructure as published by the DFFE.

Relevant cumulative impacts have been identified. When considering cumulative impacts, it is important to bear in mind the scale at which different impacts occur. There is potential for a cumulative effect at a broad scale, such as regional deterioration of air quality, as well as finer scale effects occurring in the area surrounding the activity. The main impacts which have a cumulative effect on a regional scale are related to the transportation vectors that they act upon. For example, air movement patterns result in localised air quality impacts having a cumulative effect on air quality in the region. Similarly, water acts as a vector for distribution of impacts such as contamination across a much wider area than the localised extent of the impacts source. At a finer scale, there are also impacts that have the potential to result in a cumulative effect, although due to the smaller scale at which these operate, the significance of the cumulative impact is lower in the broader context.

10.2.1 CONSTRUCTION PHASE IMPACTS

10.2.1.1 **AIR QUALITY IMPACTS**

For air quality impacts during the construction phase, the assumption is that construction activities would be during day-time hours only. Given the nature of construction activities for the roads/pipeline, wells and booster stations (where the location may vary depending on the gas reserves in the area) the air quality impacts (due to dust and vehicle exhaust gas) at the nearest residential receptors to the construction areas may exceed the respective short-term NAAQS's for residential areas. If there are exceedances of the standards, however, it would be of short duration. The negative air quality impacts are therefore considered to be of medium significance without mitigation and low significance with mitigation at the nearest receptors due to construction activities for roads/pipeline sections and construction of wells/booster stations.

Unlike the roads/pipeline, wells or booster stations (where the location may vary depending on the gas reserves in the area) the locations of the three compressor stations and plant have been fixed. The construction period for the plant is also longer (i.e. more than 1 year). The air quality impacts (due to dust and vehicle tailpipe emissions) at the nearest residential receptors to the construction areas may exceed the respective short-term

NAAQS's for residential areas. These exceedances, should they occur, would be of short duration as the construction activities will be intermittent in nature and not part of routine operations. The negative air quality impacts are therefore considered to be of medium significance without mitigation and low significance with mitigation at the nearest receptors.

The following air quality impacts have been identified and assessed by the air quality specialist:

- Increase in air quality impacts due to construction of the road/pipeline
- Increase in air quality impacts due to construction of the wells and booster stations
- Increase in air quality impacts due to construction of the plant and compressor stations

In order to mitigate the above impacts, the following mitigation measures are put forward:

(i) Mitigation measures

- As construction will only take place during day-time hours and will be of limited duration, AQSRs within 150 m of the road/pipeline construction site should be notified of the activities and potential disturbance durations prior to construction taking place.
- As construction will only take place during day-time hours and will be of limited duration, AQSRs within 300 m radius of all well construction sites and 200 m from booster station construction sites should be notified of the activities and potential disturbance durations prior to construction taking place.
- For construction/operation, it is recommended to pave the access road between the plant and the R30 provincial road. This would result in a control efficiency of between 87% and 92% (US EPA, 2006).
- For topsoil management during construction and rehabilitation, the existing EMPr (nr 35) should be amended to include the recommendation that exposed areas must be ensured to remain moist through water spraying during dry, windy periods (CE 50%).
- During all phases, material transfers are to be controlled using water sprays resulting in 50% control efficiency.
- The following good practice should be followed during all phases of the project: To ensure lower exhaust emissions from vehicles and machinery, equipment suppliers or contractors should be required to ensure compliance with appropriate emission standards for production fleets. Also, maintenance and repair of diesel engines should be carried out as prescribed by manufacturer to maximize combustion and reduce gaseous emissions.
- Fuel efficient driving practices on site, during all phases of the Project, may also help lower exhaust emissions from vehicles and machinery, such as stipulating a maximum speed on all unpaved roads. In addition, other fuel-efficient practices that may lower exhaust emissions include limiting idling of machinery, driving in an upper gear rather than a lower gear as much as possible, ensuring tire pressure are always adequate etc.
- Products, liquid fuels, and chemicals should be stored in areas where there are provisions for containment of spills.
- The project proponent has indicated that all infrastructure and facilities will be designed, installed and maintained according to best industry practices to control fugitive and unintended methane emissions as prescribed in (US EPA, 2015). In addition, the following actions are recommended:
    - If applicable, the implementation of a leak detection and repair (LDAR) program, which include identifying equipment, leak definition, monitoring equipment, repairing equipment, and recordkeeping; and
    - Regular check (monthly or quarterly) and reporting of exploration well, booster and compressor facility installations, as well as pipelines portions close to ground surface or those that have potential to be vandalized.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.1.2 CLIMATE CHANGE IMPACTS

The significance of climate change impacts was based on Scope 1, 2 and 3 GHG emissions and assessed according to the NEMA impact assessment methodology. Refer to Section 9.14.9 for a discussion on the impacts as a result of the projects GHG emissions. Since climate change is a global phenomenon, the criterion is not fully applicable to an assessment of the impacts of GHG emissions on climate change. Furthermore, the extent of climate change impact is always national or wider and therefore can result in an overly conservative significance, and since the overall consequence and significance are not influenced by the extent, but rather by the intensity of emissions, "extent" was not included in the significance rating.

The Climate Change Specialist Study was updated to address the Ministers decision and recommendations on the appeal. Despite these changes to the Study, the negative climate change impacts are still considered to be of low significance without mitigation and low significance with mitigation. Therefore, no change in the overall outcome of the Climate Change Impact Assessment scoring or mitigation measures is required in this updated EIA Report.

(i) Mitigation measures

- As construction will be of limited duration develop and implement management programs and procedures to limit GHG emissions as far as possible.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.1.3 NOISE IMPACTS

For noise impacts during the construction phase, the assumption is that construction activities would be during day-time hours only. Given the nature of construction activities for the pipeline, wells and Blower Stations (where the location may vary depending on the gas reserves in the area) the noise levels at the nearest residential receptors to the construction areas may exceed IFC guidelines for residential areas (55 dBA). If there are exceedances of this guideline, it would be of short duration. The negative noise impacts are therefore considered to be of medium significance without mitigation and low significance with mitigation at the nearest receptors due to these activities.

The noise levels at the nearest residential receptors due to the construction activities of the Plant and Compressor Stations are not likely to exceed daytime IFC guidelines for residential areas (55 dBA). The negative noise impacts are therefore considered to be of low significance without and with mitigation at the nearest receptors due to these activities.

(i) Mitigation measures

- As construction will only take place during day-time hours and will be of limited duration, NSRs within 90 m of the pipeline construction site should be notified of the activities and potential disturbance durations prior to construction taking place.

- As construction will only take place during day-time hours and will be of limited duration, NSRs within 400 m radius of all well construction sites and 600 m from Blower Station construction sites should be notified of the activities and potential disturbance durations prior to construction taking place.
- The noise levels due to Blower Station operations is likely to exceed the IFC night-time noise guideline for residential areas up to 150 m from the operations. Care should be taken to site the Blower Stations at least 150 m from all NSRs.
- Although the current EMPr (number 50) specifies complaints need to be registered it is recommended that the complaints register description be expanded (for number 50 and number 78) as follows:
    - A complaints register, including the procedure which governs how complaints are received, managed and responses given, must be implemented, and maintained.
- The existing EMPr specifies that construction activities should where possible be during day-time (number 50). It is recommended that this be expanded as follows (applying to all phases of the project):
    - Unless it is an emergency situation, non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.
- It is recommended that the current EMPr include the following specifications for equipment (number 50 and number 78) be amended as follows:
    - Equipment to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels.
- The existing EMPr specifies enclosures (number 50). The following additional information could be included:
    - It should be noted that the effectiveness of partial enclosures and screens can be reduced if used incorrectly, e.g., noise should be directed into a partial enclosure and not out of it, there should not be any reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.
- The following good practice should be implemented (additional measures to be included in the EMPr (number 50 and number 78)):
    - Machines and mobile equipment used intermittently should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy.
    - Acoustic covers of engines should be kept closed when in use or idling.
- Construction activities that are to take place within the below specified distances from noise sensitive receptors must first be discussed and agreed with the affected party:
    - Wells: 400 m
    - Pipeline: 90 m
    - Blower station: 600 m
    - Plant: 430 m
    - Compressors: 420 m
- In the event that noise related complaints are received, the existing EMPr makes provision for short term ambient noise measurements. The EMPr specifies that the noise levels should be co-ordinated with the 10-m wind speed. It should be noted that it is good practice to undertake noise measurements when wind speeds are less than 5 m/s and it is recommended that this description be amended.

- It is also recommended that the following procedure be adopted and included in the EMPr for all noise surveys (for complaints):
    - Any surveys should be designed and conducted by a trained specialist.
    - Sampling should be carried out using a Type 1 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory.
    - The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.
    - Samples sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples, representative of the day- and night-time acoustic environment should be taken.
    - The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
    - Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
    - A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.1.4 **SOCIAL IMPACTS**

The proposed Cluster 2 project will impact on high quality agricultural soil which is used to grow crops that contribute to food security in South Africa. One of the most significant potential social impacts associated with the proposed project is the potential impacts on livelihoods of the farming community. Farmers may fear that their land rights and property values will be affected. The project will require access to farms, and because of the current socio-political issues in South Africa, this is a sensitive matter. Farmers may also be concerned about the impact of the Cluster 2 project on their existing way of life, and on the infrastructure on their farms. An impact assessment of each of the below impacts has been undertaken and a more detailed description of each impact is provided in the social specialist report in Appendix 4. Furthermore, each of the below impacts is relevant to the construction and operational phases.

- Impact on livelihoods
- Uncertainty in landowners maintaining full control over their properties
- Nuisance factor due to increase in ambient dust and noise levels
- Changes in travel patterns
- Damage to farm roads, existing services, and infrastructure
- Impacts on livelihoods due to behaviour of contractors
- Impacts on safety and security of local residents
- impacts on sense and spirit of place

- Impacts on the social licence to operate
- Increase in social pathologies
- Secondary economic opportunities.

(i) Mitigation measures

- The Tetra4 community liaison officer (CLO) must continue to deal with the affected landowners throughout the life of the project
- In cases where there the farmer does not agree with the compensation offered by Tetra4 related to loss of potential income due to exploration, construction or operational activities, Tetra 4 must appoint an agricultural economist at their cost to determine what the actual losses will be to the farmers due to the drilling and trenching activities on their properties. Farmers must be compensated for the actual losses for the entire period that they cannot use the land due to Tetra's activities. This may be one or two years, depending on when in the season the drilling and trenching take place, and how long the property is affected. The principles explained in the IFC Handbook for Preparing a Resettlement Action Plan must be followed. This includes a land use/land capability inventory; an asset register and physical asset survey; an income stream analysis and entitlement matrix. Compensation must be determined with input from the landowners.
- If any existing livelihood activities will be affected negatively Tetra4 must enter into negotiations with the affected parties as soon as reasonably achievable to ensure the affected parties are compensated fairly or can make additional arrangements. Interference with existing livelihoods should be avoided if possible. If any new activities are planned for a property, Tetra4 must consult with the landowner and obtain his consent to execute the activity on his/her land.
- If any interference takes place and there are actual losses, the landowner should be compensated for their losses. Tetra4 must have a claims procedure that is communicated to all affected landowners. There must be specific timeframes dealing with response times and time it takes to close out complaints. In order to receive compensation, the claim forms must be submitted to the Tetra4 CLO Compensation should follow the IFC principles, which states that market related prices should be paid, and if anything is restored, it must be to the same or better standards than before.
- If areas are fenced, the fences must be checked for snares on a daily basis for the duration of the construction period. All incidences must be reported to the closest police station. Anti-poaching toolbox talks should form part of the induction process of all the fencing teams. Any contractor or employee caught poaching should be removed from site.
- Tetra4 must provide detailed written information to the landowners to assist them with making informed decisions. The information must include:
    - Depth and route of the pipeline
    - Timeframe associated with the drilling and installation process - when will Cluster 2 start and end.
    - A3 or A2 maps of the entire project area for each affected landowner
    - Information about well heads and boreholes:
        - How long does it take to drill a borehole?
        - Can more than one borehole be drilled with the same drill point?
        - What infrastructure are needed around the well heads and sketches of this infrastructure
        - Are all the drill points necessary?

        - What will happen if there is a change in the infrastructure presented to the landowners?
        - Can more than one wellhead be operated from one underground manhole?
        - Will the boreholes be left open for a period of time after the holes were drilled?
        - How are the wellheads connected to each other?
        - What happens if no gas is found at a borehole?
        - Will unproductive boreholes be investigated again later?
    - Positions of blowers, booster stations and compressors, if any. Sketches of all associated infrastructure.
    - Will there be overhead power lines or electric cables? Will cables be buried?
    - What maintenance will be required, and how often will teams need access for maintenance?
    - Where will the condensation wells be?
    - How will condensation water be removed? The contract states it will be no more than once a week, but is it once a week per well, or once a week that the vehicle gets access?
    - Who will be responsible for damage to Tetra4 property?
- Any future expansion plans must be communicated to any landowner that will be influenced by the expansion.
- The relevant specialists will provide scientific mitigation measures for this aspect. Practical, visible solutions such as putting shade nets against fences close to dwellings during the construction phase should be investigated. No drilling or construction must take place on weekends or between sunset and sunrise.
- It may be unavoidable to change travel patterns. It is important to inform the affected stakeholders about the possibility of this impact as soon as possible. It will allow them time to get used to the idea and plan their activities accordingly. It is also important that locally affected parties give input in potential mitigation measures. Before construction and drilling commences Tetra4 must meet individually with each landowner to discuss their movement patterns and needs. Tetra4 must provide all the affected landowners with a construction and drilling schedule to ensure that they know when construction will take place on their properties. It is recommended that construction and drilling be done outside the peak planting and harvesting seasons. Any changes to the construction and drilling schedule must be communicated to the farmers at least a week in advance. As far as possible obstruction of access routes and sensitive areas must be avoided. If it cannot be avoided both parties must agree on alternative routes, and Tetra4 should carry the cost of implementing the alternatives. Industrial vehicles should not travel during peak traffic times. If practical and required by the landowner, access routes to land/infrastructure should be reinstated in the decommissioning phase. This must be done in conjunction with the landowners.
- If private roads are affected by project activities, it is the responsibility of Tetra4 to maintain these roads as long as they use it. Tetra4 should engage with the relevant farmers about road maintenance, as some of them have preferential ways in which the roads must be maintained, for example if roads are only graded and not built up it turns into rivers when there is heavy rain. The road maintenance agreements must be formalised before construction and drilling commences to ensure all parties involved are protected and know their rights and responsibilities. Tetra4 must make sure that all compacting and rehabilitating of trenches are done to the specifications in the Environmental Management Plan. It is recommended that construction and drilling be planned for the dry season. Tetra4 must provide all the affected landowners with a construction and drilling schedule to ensure that they know when construction will take place on their properties. Any changes to the construction and drilling schedule must be communicated to the farmers at least a week in advance.

- Before the project commences Tetra4 should compile an asset and infrastructure baseline of any landowner infrastructure such as fences, pipes, electricity lines, roads and troughs that may be affected by the project. Photographs and GPS co-ordinates of the infrastructure must be included in the baseline. A copy of the baseline affecting their property should be given to each landowner, who should sign off the document to ensure that it is accurate. Tetra4 should keep the master document. If any damage occurs it should be reinstated to its pre-project status. If the infrastructure must move, it must be done at Tetra4's cost. Tetra4 must ensure that the construction team has a copy of the asset and infrastructure baseline to guarantee that no infrastructure will be damaged due to ignorance during the construction phase of the project.
- All contractors should sign a code of conduct as part of their induction process. Induction must explicitly include aspects such as closing gates and littering. Toolbox talks must be designed to include social and environmental aspects. A fining system must be put in place for any transgressions affecting the landowners. It is important to instil respect for the landowners and their livelihoods from the beginning of the project.
- Tetra4 should work with the preferred farmers' security group (Erfenis Veiligheid) and implement the AgriSA farm access protocol for everybody that need to access the properties. Pictures, make and registration numbers of all vehicles used by Tetra4 on site should be provided to the farmer's security group and distributed to all affected landowners to ensure that they will be able to identify these vehicles if they access their properties. For scheduled and maintenance work Tetra4 should give a roster to the farmers stating dates and approximate times that contractors will be on the farms. Farmers emphasised that they need to know of people accessing the farm ahead of time. It is too late to inform them when entering the property. All access arrangements should be made at least 24 hours before access is required. Tetra4 must meet with the landowners before the construction and drilling phase commence and formalise security arrangements. This should be done in writing and include the existing forums that the landowners know and trust.
- All contractors and employees need to wear photo identification cards. Vehicles should be marked as construction vehicles and should have Tetra4's logo clearly exhibited. Entry and exit points of the site should be controlled during the construction and drilling phase. Areas where materials are stockpiled must be fenced. The schedules of the security company should be communicated to the farmers, especially to those farmers that have Tetra4 infrastructure that need to be guarded. It must be considered that guards changing shifts contribute to the impact of strangers accessing properties, and therefore a system that consider the safety of both the Tetra4 infrastructure and the safety of the landowners must be implemented. The necessary sanitation facilities must be made available, and some form of shelter from the elements. The security guards must not be allowed to make fires for cooking or heating purposes.
- A system to arrange access to properties must be devised and formalised. The landowners must agree to the system. Access must be arranged at least 24 hours prior, except in emergencies, when the landowners should also be informed immediately. Landowners have the right to refuse people access to their properties if it was not arranged in advance. If routine access is required, the landowners must be provided with a roster indicating dates and approximate times that access will be required. Tetra4 must compensate the landowners for any damage to property or goods if it was due to behaviour of their contractors. Sub-contractors must be made aware of this and a clause spelling out their liability should be included in their contracts.
- It is difficult to mitigate the impact on sense of place as it is experienced on a personal level. In general, the mitigation measures suggested in the visual, noise, ecological impact assessments and other relevant specialist studies should be adhered to. The relevant specialists will provide scientific mitigation measures for the aspects relevant to their studies. The direction and brightness of lights close to residences must be considered. Pipeline markers on game farms must be camouflaged by either painting it in a colour that blend in with the surrounding areas or putting natural materials such as branches or wooden poles around it. This must be done in consultation with the affected

landowners. Sense of place is a personal experience, but successful rehabilitation will go a long way in recreating a rural sense of place. The public perception would be negative or positive depending on the successful implementation of the rehabilitation.

- Tetra4 has a dedicated person that communicate with the landowners with whom they have a positive relationship. It is important that this relationship is extended to the Cluster 2 landowners. Information sharing, frequent communication and quick responses to issues/complaints/enquiries will assist Tetra4 with maintaining their SLO
- Toolbox talks should include talks about the impact of promiscuous behaviour. Tetra4 should develop an in-house infectious diseases strategy to address health issues within the workforce. A workforce code of conduct should be developed to maximise positive employee behaviour in the local community, and optimise integration.
- Tetra4 should ensure that a good proportion of secondary economic opportunities are given to local contractors. Services and goods must be procured locally as far as reasonably possible. Aspects of this positive impact will occur by default when the construction force lives locally and they utilise local services and support local shops.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources but where this may occur, mitigation measures shall be put forward to reduce this potential as far as possible.

10.2.1.5 **ECONOMIC IMPACTS**

The majority of the economic impacts of this project have been rated as positive with the impacts extending from a local level, through to the region and also to a national level. In addition, the Gas Act makes provision for black economic transformation and the provisions thereof is described in the BBBEE Act. This project will need to comply with these provisions which compliance will have an obvious positive impact on economic transformation. During the construction phase, the positive impacts on the local economy will be the greatest (through employment opportunities as well as material and contractor requirement) while during the operational phase the economic impacts move towards a more regional and national level when gas production and distribution is in full swing. From an economic perspective, the decommissioning phase would represent a negative impact due to the local, regional and national financial and general economic benefits from the project effectively ceasing.

The following economic impacts relating to all phases of the project have been identified:

- Gross Geographical Product (GGP)/ Gross Domestic Product (GDP) Impact
- Employment Impacts
- Forex savings
- Fiscal Income
- Economic development per capita
- Country and Industry Competitiveness
- Black Economic Transformation
- Alternative Land-use
- Need and Desirability
- Impact on individual farmland values

(i) Mitigation measures

- Ensure that as much of the infrastructure as possible is sited away from agricultural lands. Utilize servitudes, farm roads and any other routes to avoid sensitive areas. Ensure that pipelines are buried at sufficient depth (>1 m minimum) to avoid interference with arable agriculture activities.
- Communication to stakeholders about the nature and extent of economic opportunities should be undertaken. No unrealistic expectations should be created and the recruitment policy giving preference to local labour should be communicated from the beginning of the project. The local area of influence should be agreed with stakeholders early on in the process.
- Landowners must be consulted, and all reasonable requests complied with. A written landowner agreement should be negotiated and concluded prior to commencement. Should this not be possible, a record should be kept of reasonable negotiations with the land owners.
- The pipelines will be buried in accordance with the schedule as agreed upon with landowners to minimise disturbance to farming operations.
- If any farm labourers apply for positions at Tetra4 or one of its contractors, Tetra4 or the contractor must ensure that the labourer is aware that the position may only be temporary and what the long-term consequences of taking the position are.
- Preference for employment should be given to the local community. The recruitment policy must be communicated openly and made available to the public if requested.
- Tetra4 should liaise with local training institutions or service providers to determine whether there are any opportunities to offer internships and practical experience for their students. Tetra4 must ensure that skills development requirements form part of their contracts with sub-consultants as prescribed in the SLP. The skills development requirements and bursaries for local learners as discussed in their Social and Labour Plan (SLP) must be implemented.
- Tetra4 must appoint a CLO that deals with the affected landowners throughout the life of the project. If existing activities will be affected negatively Tetra4 must enter into negotiations with the affected parties as soon as reasonably achievable to ensure the affected parties are compensated fairly or can make additional arrangements. Interference with existing livelihoods should be avoided if possible. If any new activities are planned for a property, Tetra4 must consult with the landowner and take reasonable steps to obtain his consent to execute the activity on his/her land. A system to arrange access to properties must be devised and formalised. All reasonable efforts must be taken to obtain agreement on the system with the landowners and it must be formalised. Access must be arranged at least 24 hours prior, except in emergencies, when the landowners should also be informed immediately. If routine access is required, the landowners must be provided with a roster indicating dates and approximate times that access will be required. Tetra4 must compensate the landowners for any damage to property or goods if it was due to behaviour of their contractors. Sub-contractors must be made aware of this and a clause spelling out their liability should be included in their contracts. All contractors should sign a code of conduct as part of their induction process. Induction must explicitly include aspects such as closing gates and littering. Toolbox talks must be designed to include social and environmental aspects. A fining system must be put in place for any transgressions affecting the landowners.
- Contractors should be required to make use of a certain proportion of local labour - it is acknowledged that not all skills will be available locally. Jobs should be advertised in a way that is accessible to all members of society and labour desks (labour registration stations) should be in accessible areas. No unrealistic expectations should be created and the recruitment policy giving preference to local labour should be communicated from the beginning of the project. The local area of influence should be agreed with the stakeholders early on in the process.
- Procurement targets to be in line with the existing Social Labour Plan (SLP).

- Comply with downscaling regulations of the DMRE.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact may result in the irreplaceable loss of resources however the value of these resources would be limited.

10.2.1.6 GROUNDWATER IMPACTS

The Geohydrological Specialist Report was updated to address the Ministers decision and recommendations on the appeal. Despite the additional data included in the updated report, no change in the overall outcome of the Geohydrological Impact Assessment scoring or mitigation measures is required in this updated EIA Report.

The environmental significance rating of the following potential impact is rated as medium negative without the implementation of mitigation measures and low negative with the implementation of mitigation measures.

- Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.

During the construction phase minimal impacts on the groundwater system are expected. The environmental significance rating of the following potential impacts is rated as low negative with and without the implementation of mitigation measures.

- Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area.
- Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.
- Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.

The following mitigation measures should be considered to minimise the potential groundwater impacts during the construction phase.

(i) Mitigation measures

- Develop a stormwater management plan in accordance with GN704 in order to separate dirty/contact water from clean water circuits. All water retention structures, process water dams; storm water dams, retention ponds etc. should be constructed to have adequate freeboard to be able to contain water from 1:50 year rain events.
- All construction should take place during the dry season, as far as possible.
- Location of construction camps must be carefully considered and within the approved area to ensure that the site does not impact on sensitive areas identified during the Environmental Assessment phase or field work.
- Sites must be located, where possible, on previously disturbed areas.
- Every effort must be made to keep the footprint as small as possible.
- Any excess sand, stone and cement must be removed or reused from site on completion of the construction period and disposed at a registered disposal facility. Certificates of safe disposal for general and recycled waste must be maintained and retained on file.
- Construction vehicles and machinery must be serviced and maintained regularly in order to ensure that oil spillages are limited. Spill trays must be provided if refuelling of operational vehicles is done on site.

Further to this spill kits must be readily available in case of accidental spillages with regular spot checks to be conducted.

- During servicing of vehicles or equipment, especially where emergency repairs are effected outside the workshop area, a suitable drip tray must be used to prevent spills onto the soil.
- Leaking equipment must be repaired immediately or be removed from site to facilitate repair.
- Workshop areas must be monitored for oil and fuel spills.
- An appropriate number of spill kits must be available and must be located in all areas where activities are being undertaken.
- All hazardous substances used on-site should have an applicable Material Safety Data Sheet (MSDS) to provide information regarding the hazards, emergency response, protective measures and correct storage methodology.
- Hazardous substance containment facilities to be used during operational phase should comply with the relevant hazardous substance storage legislation in order to ensure spillages are contained.
- All hazardous substances and material used on-site should be stored in a dedicated, closed-off facility with an impervious floor and bunded area to prevent seepage and/or run-off in case of accidental spills.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact may result in irreplaceable loss of resources if not adequately mitigated but the value of the resources will be limited.

10.2.1.7 HYDROLOGICAL IMPACTS

During the construction phase, pipes connecting the new wells to the compressor stations and helium plant will be laid down. Construction work for laying of pipes across rivers or parallel to them may involve the excavation of riverbed material and restoring the river to a near-natural state thereafter. Horizontal Directional Drilling (HDD) will be the method generally used on site to lay pipes so that the impact is minimal/negligible. The floodline delineation was updated to address the Ministers decision and recommendations on the appeal. Despite the revised 1:100-year floodline based on a climate change scenario, the overall floodline delineation with and without consideration of climate change remain largely the same. Therefore, no change in the overall outcome of the Hydrological Impact Assessment scoring or mitigation measures is required in this updated EIA Report.

The potential hydrological impacts that have been identified during the construction phase include the following:

- Exposure of soil, leading to increased runoff, and erosion, and thus increased sedimentation of the watercourses.
- Soil and stormwater contamination by oils and hydrocarbons spills, originating from construction vehicles
- Increase in the number of alien and/or invasive vegetation as a result of disturbances.
- Alterations of the river banks and river bed due to movement near the drainage lines.

Although the above hydrological impacts are predicted to have a minimal/negligible impact significance, the following mitigation measures should be considered:

(i) Mitigation measures

- Ensure total footprint area is kept to a minimum.
- Traffic and movement of machinery should be minimised and restricted to certain paths.
- Progressive rehabilitation of disturbed land should be carried out.
- Construction waste must be collected and stored safely for disposal in accordance with the relevant waste regulations, protocols, and product specifications. Care must be taken not to leave any waste on project area that can lead to future contamination of the project area or the downstream area.
- Monitoring for the project area for alien and invasive vegetation species must be undertaken, specifically for access roads through or along the watercourses. Should alien and invasive plan species be identified, they must be removed and disposed of as per an alien and invasive species control plan and the area must be revegetated with suitable indigenous vegetation.
- The reaches of all watercourses where no construction activities are planned to occur must be considered no-go areas.
- Exploration drilling and subsequent production wells must remain outside the delineated 1:100 year floodlines.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.1.8 IMPACTS ON HERITAGE OR PALAEONTOLOGICAL FEATURES

A total of fourteen (14) burial grounds and graves (TET 1, TET 7-8, TET 11, TET 15, TET 19, TET 22, SSL/BET/72, SITE 2, SITE 19 and T0003, T0009, T0024, T0029) were identified within the proposed development areas. Burial grounds and graves have high heritage significance and are given a IIIA significance rating in accordance with the system described in Section 4 of this document.

Burial grounds and graves are protected under Section 36 of the NHRA 25 of 1999. Thus, the sites are provisionally rated as having a high heritage significance with a heritage rating of IIIA. All graves have high levels of emotional, religious and in some cases historical significance. It is also important to understand that the identified graves could have significant heritage value to the relevant families.

A total of fourteen (14) possible grave sites (TET 4-6, TET 13, TET 14, TET 25a, TET 25b, TET 26, SSL/BET/37-39, SSL/BET/53, SSL/BET/60, SSL/BET/66) were identified within the proposed development area. Burial grounds and graves have high heritage significance and are given a IIIA significance rating.

A total of thirty-one (31) structures (TET 2, TET3, TET 9, TET 27, SSL/BET/25-26, SSL/BET/36, SITE 1A, SITE 1B, SITE 20-21and T0001, T0002, T0004, T0005, T0017, T0018, T0019, T0020, T0021, T0025, T0030, T0031, T0033, T0034, T0036, T0037, T0038, T0039, T0040, T0041) were identified within the proposed development area.

Twenty-one (21) of the heritage sites (TET27, SSL/BET/25, SSL/BET/26, SSL/BET/36, T0001, T0002, T0004, T0005, T0017, T0018, T0019, T0020, T0025, T0030, T0031, T0033, T0034, T0036, T0037, T0038, T0039) are assessed to have a low heritage significance are not included in the impact assessment. The reason for this is that sites of low significance will not require mitigation.

Structures older than 60 years fall under the protection of Section 34(1) of the National Heritage Resources Act 25 of 1999. Additionally, in terms of Section 35(4) of the National Heritage Resources Act (25 of 1999), man-made features and artefacts older than 100 years are defined as being archaeological. In the same section, the Act also states that such archaeological sites and objects may not be disturbed, altered, modified or destroyed without a suitable permit from the South African Heritage Resources Agency (SAHRA).

The pre-mitigation impact significance for burial grounds, graves, heritage sites/structures is rated as MEDIUM, but with the implementation of the required mitigation measures the post-mitigation impact will be LOW. The overall Environmental significance will be Low negative.

No visible evidence of fossiliferous outcrops was found in the development footprint and thus an overall medium palaeontological significance is allocated to the development footprint. It is therefore considered that the proposed development will not lead to detrimental impacts on the palaeontological reserves of the area.

(iv) Mitigation measures

- Implement a chance find procedures in case where possible heritage finds are uncovered.
- Burial Grounds and Graves (TET 1, TET 7-8, TET 11, TET 151, TET 19, TET 22, SSL/BET/72, SITE 2, SITE 19 and T0003, T0009, T0024, T0029):
    - The graves should be demarcated with a 50-meterbuffer and should be avoided and left in situ.
    - A Grave Management Plan should be developed for the graves which also need to be approved by SAHRA BGG.
    - If the site is going to be impacted and the graves need to be removed a grave relocation process as per the Heritage Management Plan for the site is recommended as a mitigation and management measure. This will involve the necessary social consultation and public participation process before grave relocation permits can be applied for with the SAHRA BGG under the NHRA and National Health Act regulations.
- Historic to recent sites with possible grave sites (TET 4-6, TET 13, TET 14, TET 25a, TET 25b, TET 26, SSL/BET/37-39, SSL/BET/53, SSL/BET/60, SSL/BET/66):
    - Apply for the test excavation and/or GPR permit to determine if the site contains graves.
    - If human remains are discovered a grave relocation process is recommended as a mitigation and management measure. This will involve the necessary social consultation and public participation process before grave relocation permits can be applied for with the SAHRA BGG under the NHRA and National Health Act regulations.
    - When graves are discovered/uncovered the site should be demarcated with a 50-meter no-go-buffer-zone and the grave should be avoided.
    - If, during test excavations, it is determined that the site does not contain graves, no further mitigation will be required.
- Structures (TET2, TET3, TET9, SITE 1A, SITE 1B, SITE 20, SITE 21, T0021, T0040, T0041):
    - It is recommended that a no-go-buffer-zone of at least 30m is kept to the closest infrastructure.
    - If development occurs within 30m of the site, the structure will need to be satisfactorily studied and recorded before impact occurs.
    - Recording of the site i.e. (a) map indicating the position and footprint of the structure (b) photographic recording of the structure (c) measured drawings of the floor plans of the structure.
    - Submission of permit application to SAHRA to allow for the disturbance to the site. A Cluster 2 Heritage Report must accompany the permit.
- Structures (TET27, SSL/BET/25, SSL/BET/26, SSL/BET/36, T0017, T0018, T0019, T0020, T0025, T0037, T0038):
    - No mitigation is required. The documentation of the site in the HIA report is sufficient and the site can be destroyed without a permit but with the approval of the HIA report.

- Palaeontology:
    - The ECO for the project must be informed that the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) has a Very High Palaeontological Sensitivity.
    - If Palaeontological Heritage is uncovered during surface clearing and excavations the Chance find Protocol attached should be implemented immediately. Fossil discoveries ought to be protected and the ECO/site manager must report to South African Heritage Resources Agency (SAHRA) (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation (recording and collection) can be carried out.
    - Before any fossil material can be collected from the development site the specialist involved would need to apply for a collection permit from SAHRA. Fossil material must be housed in an official collection (museum or university), while all reports and fieldwork should meet the minimum standards for palaeontological impact studies proposed by SAHRA (2012).

(v) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(vi) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.1.9 TERRESTRIAL BIODIVERSITY IMPACTS

The majority of the biodiversity within the study area has been fragmented and impacted on by existing land uses including agriculture, farmsteads, roads powerlines and other infrastructure as well as mining. Due to the spatial extent of the proposed Cluster 2 infrastructure, a variety of terrestrial biodiversity areas exist. These range from low sensitive (e.g. agricultural areas etc) to highly sensitive areas (e.g. pristine areas, wetlands and watercourses as well as areas where red data species occur). Furthermore the study area contains CBA1 and ESA 1&2 areas. The ecological integrity, importance, and functioning of these terrestrial biodiversity areas provide a variety of ecological services that are considered beneficial, with one key service being the maintenance of biodiversity. The preservation of these systems is the most important aspect to consider for the proposed project. Thus, if these areas are not maintained in a natural or near natural state, destroyed or fragmented further, then meeting targets for biodiversity features will not be achieved.

The following construction phase impacts have been identified and assessed in this report:

- Destruction, further loss and fragmentation of the vegetation community.
- Introduction of alien species, especially plants.
- Erosion due to storm water runoff and wind.
- Displacement of faunal community due to habitat loss, direct mortalities and disturbance (road collisions, noise, light, dust, vibration and poaching).

(i) Mitigation measures

- Any drill sites or infrastructure routes located inside medium, high or very high sensitive sites on the sensitivity /constraint map require a site-specific pre-commencement assessment. The pre-commencement assessment must address the sensitive aspects on site, as identified in the overall sensitivity / constraint map. The pre-commencement assessment must be compiled by the site Environmental Officer (EO) with a suitable environmental qualification and experience. All recommendations of the pre-commencement assessment must be implemented on site. The completeness and adequacy of the pre-commencement assessment in respect of identifying and managing on site sensitivities must be included in the monthly ECO reports and annual independent audit.

- The area delineated as no-go must be avoided. No development may take place within this area.
- Once prospective drilling sites are identified, a suitably trained EO must undertake a site-specific pre-commencement assessment to assess the site for any potential environmental sensitivities prior to commencement. Should environmental sensitivities be identified, the relevant Tetra4 Response or Action Plan Procedures must be adhered to.
- If sensitive species occur within the preferred footprint, the first option should be to relocate the proposed footprint followed by the alternative of preparing a relocation plan (prepared by a suitably qualified specialist).
- Search and rescue of species of concern. Obtain permits for disturbance/destruction of any listed/protected species found on site. Where possible, undertake activities in previously disturbed areas and/or habitats with lower sensitivity. Where possible, locate activities on the boundaries of existing disturbance. Use existing access roads as much as possible.
- Construction activities must take place systemically, especially in relation to the game farm areas. These particularly pertains for Game Farm Areas.
- Where possible, locate infrastructure in previously disturbed places and/or habitats with a lower sensitivity score. Rehabilitate disturbed areas as soon as possible. Control alien plants.
- Where possible, undertake activities in previously disturbed areas and/or habitats with lower sensitivity. Where possible, locate activities on the boundaries of existing disturbance. Use existing access roads as much as possible. Rehabilitate disturbed areas as soon as possible.
- If areas are fenced, the fences must be checked for snares. All incidences must be reported to the closest police station. Anti-poaching toolbox talks should form part of the induction process of all the fencing teams. Any contractor or employee caught poaching should be removed from site.
- The areas to be developed must be specifically demarcated to prevent movement into surrounding environments, especially wetlands and watercourses. Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed further. Clearing of vegetation should be minimized and avoided where possible.
- Restrict the clearing of watercourse vegetation as far as possible. Areas that have been cleared should be re-vegetated with indigenous species or other suitable plant species, such as *Eragrostis tef*, after construction and initial rehabilitation work (reinstatement of the geomorphological template) is completed. Compile and implement an alien plant control program with a particular focus on alien control in watercourses (including wetlands) during the rehabilitation phase of the project. Rehabilitate disturbed areas as soon as possible. Restrict new footprints to disturbed areas as far as possible. Regular monitoring should be undertaken in the watercourses to check any possible invasion by alien vegetation so that they can be weeded out before they grow and spread out.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources over the majority of the application area.

10.2.1.10 **AQUATIC AND WETLAND IMPACTS**

The impacts that have been identified on aquatic and wetland systems during the construction phase include altered surface flow dynamics; erosion; alteration of sub-surface flow dynamics; sedimentation of the water resource; direct and indirect loss of wetland areas; water quality impairment; compaction; decrease in vegetation; change of drainage patterns; altering hydromorphic properties; altered surface flow dynamics;

erosion; alteration of sub-surface flow dynamics; indirect loss of wetland areas; water quality impairment; compaction; decrease in vegetation; change of drainage patterns; and altering hydromorphic properties.

Three levels of risk have been identified and determined for the impact assessment and these include low, medium and high risks. High risks are applicable despite the potential direct risks posed, this is motivated by the direct impacts posed by the project and the nature of the proposed project. Medium risk refers to wetland areas that are either directly affected or on the periphery of the infrastructure and at an indirect risk. Low risks are wetland systems beyond the application area that would be avoided, or wetland areas that could be avoided if feasible. The significance of all post-mitigation risks was determined to be low.

(iv) Mitigation measures

- The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access.
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly.
- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces.
- All chemicals and toxicants to be used for the construction must be stored within the drilling site and in a bunded area.
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site.
- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”.
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the application area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation).
- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems.
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil.
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported.

(v) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(vi) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.1.11 **IMPACTS ON SOIL (PEDOLOGY)**

During the construction phase, foundations will be cleared with topsoil often being stripped and stockpiled. Access roads will be created with trenches being dug for the installation of relevant pipelines. Construction of compressor sites will take place together with the erection of transmission lines where relevant. Contractor and laydown yards will also be cleared with construction material being transported to laydown yards. The construction phase of the compressors will include a short powerline and water connection to the compressors as well as ablution facilities etc. For the wells the construction phase will consist of the clearance of drilling sites.

Based on the impact assessment, the results indicate “Insignificant” to “Very Low” post-mitigation significance ratings for the proposed components. It is therefore clear that the proposed activities are expected to have a minimal impact on land potential resources.

(i) Mitigation measures

- Only predefined access roads are to be used to reduce any unnecessary compaction.
- Prevent any spills from occurring. Machines must be parked within hard park areas and must be checked daily for fluid leaks.
- Invasive plant control must be undertaken quarterly.
- All excess soil (soil that are stripped and stockpiled to make way for foundations) must be stored, continuously rehabilitated to be used for rehabilitation of eroded areas.
- If a spill occurs, it is to be cleaned up immediately and reported to the appropriate authorities.

(ii) Cumulative Impacts

- The cumulative impacts have been scored “Medium”, indicating that the potential incremental, interactive, sequential, and synergistic cumulative impacts. It is probable that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The irreplaceable loss of resources has been scored “Low”, where the impacts are unlikely to result in an irreplaceable loss of resources.

10.2.1.12 **VISUAL IMPACTS**

In general terms the proposed project could industrialise this Landscape Character Area. Large scale mining operations are currently visible from within this landscape. The proposed project will see drilling operations occurring throughout the area during exploration and construction. However when this is complete, there will be up to 300 production wells, booster and compressor stations, LNG/LHe plant and a 4km long 132kV overhead power line within the landscape. These are relatively small infrastructure elements. The large-scale agricultural nature of the landscape will remain very evident. A degree of industrialisation will therefore occur however, the existing landscape character will still dominate.

In terms of cumulative effects, the proposed project will not significantly change the character of views. It will however combine with large scale mining operations including stockpiles and plant during the construction and operational phases to intensify current impacts on landscape character.

After decommissioning, visual impacts will reduce due to the removal of operational plant etc. Due to the fact that the affected landscape is relatively flat and open, no mitigation is feasible.

(i) Mitigation measures

- Rehabilitate disturbed area and reinstate agricultural usage.
- Minimise disturbance of the natural landscape.
- Return disturbed agricultural land to agricultural use.
- Undertake rehabilitation and screen planting where possible.
- Locate wells and compressor stations a minimum 250m from the edge of local roads.
- Ensure that temporary lighting is of sufficient power to ensure safety but not so powerful that it creates glare that could cause danger for drivers or nuisance for neighbours.
- Ensure that temporary lighting minimises light spill outside the area that it is intended to light.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.2 OPERATIONAL PHASE IMPACTS

10.2.2.1 **AIR QUALITY IMPACTS**

For air quality impacts during the operational phase, the assumption is that the operational activities would take place during day- and night-time conditions. Given the location of the plant and the compressor stations and their potential air quality impacts, it is unlikely that the respective NAAQS's and NDCR limits for residential areas will be exceeded at AQSRs due to plant or compressor operations.

The operation of vehicles on unpaved roads, and specifically the plant access road, even under mitigated conditions, could result in single exceedances of the respective NAAQS's and NDCR limits for residential areas at AQSRs. The negative air quality impacts are therefore considered to be of medium significance at the nearest receptors but will reduce to low significance should the roads be paved.

The air quality impacts due to booster station (generator) operations are likely to exceed the long-term NAAQS's for residential areas up to 90 m from the operations. Care should be taken to site the booster stations at least 100 m from all AQSRs. With careful siting, NAAQSs for residential areas should not be exceeded at AQSRs. The negative air quality impacts are therefore considered to be of medium significance (given the possible impact zone of 90 m) but will reduce to low significance at the nearest receptors with mitigation measures in place.

The air quality impacts due to plant (flaring) operations are not likely to exceed the long-term NAAQS's. The negative air quality impacts are therefore considered to be of low significance at the nearest receptors.

(i) Mitigation measures

- Ground level concentrations and dust fallout due to vehicle operations on unpaved roads are likely to exceed the PM_{10} NAAQS limit and NDCR limit for residential areas up to 80 m from the operations. Care should be taken to apply mitigation measures to unpaved roads located near AQSRs.
- Air quality impacts due to booster station operations are likely to exceed the $PM_{2.5}$ and NO_2 NAAQS for residential areas up to 100 m from the operations. Care should be taken to site the booster stations at least 100 m from all AQSRs.
- The existing EMPr (nr 39) states that in controlling vehicle entrained PM during construction, it is recommended that water (at an application rate of 2 litre/m^2-hour), be applied on all unpaved road sections to ensure a minimum of 50% control efficiency (CE), and that binding agents or chemical suppressants (such as "Dust-A-Side" or "Dustex") should be considered for application on all unpaved road sections (emissions reduction efficiency of more than 80%). This should be amended to also be applicable during the operational phase.
- For construction/operation, it is recommended to pave the access road between the plant and the R30 provincial road. This would result in a control efficiency of between 87% and 92% (US EPA, 2006).
- During all phases, material transfers are to be controlled through the use of water sprays resulting in 50% control efficiency.
- The following good practice should be followed during all phases of the project: In order to ensure lower exhaust emissions from vehicles and machinery, equipment suppliers or contractors should be required to ensure compliance with appropriate emission standards for production fleets. Also, maintenance and repair of diesel engines should be carried out as prescribed by manufacturer in order to maximize combustion and reduce gaseous emissions.
- Fuel efficient driving practices on site, during all phases of the Project, may also help lower exhaust emissions from vehicles and machinery, such as stipulating a maximum speed on all unpaved roads. In

addition, other fuel-efficient practices that may lower exhaust emissions include limiting idling of machinery, driving in an upper gear rather than a lower gear as much as possible, ensuring tire pressure are always adequate etc.

- Products, liquid fuels, and chemicals should be stored in areas where there are provisions for containment of spills.
- The project proponent has indicated that all infrastructure and facilities will be designed, installed and maintained according to best industry practices to control fugitive and unintended methane emissions as prescribed in (US EPA, 2015). In addition, the following actions are recommended:
    - If applicable, the implementation of a leak detection and repair (LDAR) program, which include identifying equipment, leak definition, monitoring equipment, repairing equipment, and recordkeeping; and
    - Regular check (monthly or quarterly) and reporting of exploration well, booster and compressor facility installations, as well as pipelines portions close to ground surface or those that have potential to be vandalized.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.2.2 CLIMATE CHANGE IMPACTS

The significance of climate change impacts was based on Scope 1, 2 and 3 GHG emissions and assessed according to the NEMA impact assessment methodology. Refer to Section 9.14.9 for a discussion on the impacts as a result of the projects GHG emissions. Since climate change is a global phenomenon, the criterion is not fully applicable to an assessment of the impacts of GHG emissions on climate change. Furthermore, the extent of climate change impact is always national or wider and therefore can result in an overly conservative significance, and since the overall consequence and significance are not influenced by the extent, but rather by the intensity of emissions, “extent” was not included in the significance rating.

The Climate Change Specialist Study was updated to address the Ministers decision and recommendations on the appeal. Despite these changes to the Study, the negative climate change impacts are still considered to be of medium significance without mitigation and medium significance with mitigation. Therefore, no change in the overall outcome of the Climate Change Impact Assessment scoring or mitigation measures is required in this updated EIA Report.

(iv) Mitigation measures

- Emissions of GHG should be limited as much as possible to reduce the global impact.
- Flaring and venting of GHG should be minimised.
- A leak-detection program to be implemented to reduce product loss.
- Replacing Eskom electricity supply with renewable energy.
- Using LNG instead of diesel in equipment and machinery.

(v) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is likely that the impact will result in spatial and temporal cumulative change.

(vi) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.2.2.1 CLIMATE CHANGE ALTERNATIVE SIGNIFICANCE RATING

Other literature (Murphy & Gillam, 2013) suggests use of thresholds (Table 87) presented as tonnes of CO_2e per year, as basis for specific consideration of the specific elements to be assessed in the EIA, as guidance states that the contribution of an individual project to climate change cannot be measured.

Table 87: GHG and Climate in EIAs - Elements to consider.

GHG emissions (tonnes CO2e/year)	Qualitative rating	Elements of assessment to consider
GHGs < 25 000	Very Low	Quantify GHG
25 000 < GHGs < 100 000	Low	Look at possible mitigation, quantify GHG, place in context
100 000 < GHGs < 1 000 000	Medium	As above and prepare management plan, describe existing climate conditions, consider how changes in climate may affect project and surroundings
GHGs > 1 000 000	High	As above and consider adaptation analyses

Based on the suggested thresholds from Table 87, the construction phase Scope1 and Scope 2 GHG emissions would result in Very Low significance, separately and combined. The operational phase would result in Low significance for Scope 1 emissions, and Medium for Scope 2 emissions, where the combined (Scope 1 and Scope 2) significance would be Medium. The contribution of Scope 3 to GHG emissions would still result in a Medium significance.

10.2.2.3 **NOISE IMPACTS**

For noise impacts during the operational phase, the assumption is that the operational activities would take place during day- and night-time conditions. The noise levels due to Blower Station operations is likely to exceed the IFC night-time noise guideline for residential areas up to 150 m from the operations. Care should be taken to site the Blower Stations at least 150 m from all NSRs. With careful siting, IFC noise guidelines for residential areas should not be exceeded at NSRs. The negative noise impacts are therefore considered to be of low significance at the nearest receptors.

Given the location of the Plant and the Compressor Stations and the potential noise levels due to operations, it is unlikely that IFC noise guidelines for residential areas will be exceeded at NSRs. The negative noise impacts are therefore considered to be of low significance at the nearest receptors.

(i) Mitigation measures

- The noise levels due to Blower Station operations is likely to exceed the IFC night-time noise guideline for residential areas up to 150 m from the operations. Care should be taken to site the Blower Stations at least 150 m from all NSRs.
- Although the current EMPr (number 50) specifies complaints need to be registered it is recommended that the complaints register description be expanded (for number 50 and number 78) as follows:
    - A complaints register, including the procedure which governs how complaints are received, managed and responses given, must be implemented, and maintained.
- The existing EMPr specifies that construction activities should where possible be during day-time (number 50). It is recommended that this be expanded as follows (applying to all phases of the project):
    - Unless it is an emergency situation, non-routine noisy activities such as construction, decommissioning, start-up and maintenance, should be limited to day-time hours.

- It is recommended that the current EMPr include the following specifications for equipment (number 50 and number 78) be amended as follows:
    - Equipment to be employed should be reviewed to ensure the quietest available technology is used. Equipment with lower sound power levels must be selected in such instances and vendors/contractors should be required to guarantee optimised equipment design noise levels.
- The existing EMPr specifies enclosures (number 50). The following additional information could be included:
    - It should be noted that the effectiveness of partial enclosures and screens can be reduced if used incorrectly, e.g., noise should be directed into a partial enclosure and not out of it, there should not be any reflecting surfaces such as parked vehicles opposite the open end of a noise enclosure.
- The following good practice should be implemented (additional measures to be included in the EMPr (number 50 and number 78)):
    - Machines and mobile equipment used intermittently should be shut down between work periods or throttled down to a minimum and not left running unnecessarily. This will reduce noise and conserve energy.
    - Acoustic covers of engines should be kept closed when in use or idling.
- Operational activities that take place within the below specified distances from noise sensitive receptors must first be discussed and agreed with the affected party (prior to construction):
    - Operation (daytime):
        - Blower station: 50 m
        - Plant: 170 m
        - Compressors: 80 m
    - Operation (night-time):
        - Blower station: 150 m
        - Plant: 580 m
        - Compressors: 150 m
- Regular and effective maintenance of equipment are included in the current EMPr (number 50). This should also be included for the operational phase (number 78).
- In the event that noise related complaints are received, the existing EMPr makes provision for short term ambient noise measurements. The EMPr specifies that the noise levels should be co-ordinated with the 10-m wind speed. It should be noted that it is good practice to undertake noise measurements when wind speeds are less than 5 m/s and it is recommended that this description be amended.
- It is also recommended that the following procedure be adopted and included in the EMPr for all noise surveys (for complaints):
    - Any surveys should be designed and conducted by a trained specialist.
    - Sampling should be carried out using a Type 1 SLM that meets all appropriate IEC standards and is subject to annual calibration by an accredited laboratory.
    - The acoustic sensitivity of the SLM should be tested with a portable acoustic calibrator before and after each sampling session.

- Samples sufficient for statistical analysis should be taken with the use of portable SLM's capable of logging data continuously over the time period. Samples, representative of the day- and night-time acoustic environment should be taken.
- The SLM should be located approximately 1.5 m above the ground and no closer than 3 m to any reflecting surface.
- Efforts should be made to ensure that measurements are not affected by the residual noise and extraneous influences, e.g. wind, electrical interference and any other non-acoustic interference, and that the instrument is operated under the conditions specified by the manufacturer. It is good practice to avoid conducting measurements when the wind speed is more than 5 m/s, while it is raining or when the ground is wet.
- A detailed log and record should be kept. Records should include site details, weather conditions during sampling and observations made regarding the acoustic environment of each site.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources

10.2.2.4 **SOCIAL IMPACTS**

The proposed Cluster 2 project will impact on high quality agricultural soil which is used to grow crops that contribute to food security in South Africa. One of the most significant potential social impacts associated with the proposed project is the potential impacts on livelihoods of the farming community. Farmers may fear that their land rights and property values will be affected. The project will require access to farms, and because of the current socio-political issues in South Africa, this is a sensitive matter. Farmers may also be concerned about the impact of the Cluster 2 project on their existing way of life, and on the infrastructure on their farms. An impact assessment of each of the below impacts has been undertaken and a more detailed description of each impact is provided in the social specialist report in Appendix 4. Furthermore, each of the below impacts is relevant to the construction and operational phases.

- Impact on livelihoods
- Impact of servitudes on land values
- Damage to farm roads, existing services, and infrastructure
- Impacts on safety and security of local residents
- impacts on sense and spirit of place
- Impacts on the social licence to operate
- Public perceptions about safety associated with gas production
- Contribution to economy of South Africa
- Secondary economic opportunities
- Potential opportunity for education, skills development, and training.

(i) Mitigation measures

- The Tetra4 community liaison officer (CLO) must continue to deal with the affected landowners throughout the life of the project.

- In cases where there the farmer does not agree with the compensation offered by Tetra4 related to loss of potential income due to exploration, construction or operational activities, Tetra 4 must appoint an agricultural economist at their cost to determine what the actual losses will be to the farmers due to the drilling and trenching activities on their properties. Farmers must be compensated for the actual losses for the entire period that they cannot use the land due to Tetra's activities. This may be one or two years, depending on when in the season the drilling and trenching take place, and how long the property is affected. The principles explained in the IFC Handbook for Preparing a Resettlement Action Plan must be followed. This includes a land use/land capability inventory; an asset register and physical asset survey; an income stream analysis and entitlement matrix. Compensation must be determined with input from the landowners.
- If any existing livelihood activities will be affected negatively Tetra4 must enter into negotiations with the affected parties as soon as reasonably achievable to ensure the affected parties are compensated fairly or can make additional arrangements. Interference with existing livelihoods should be avoided if possible. If any new activities are planned for a property, Tetra4 must consult with the landowner and obtain his consent to execute the activity on his/her land.
- If any interference takes place and there are actual losses, the landowner should be compensated for their losses. Tetra4 must have a claims procedure that is communicated to all affected landowners. There must be specific timeframes dealing with response times and time it takes to close out complaints. In order to receive compensation, the claim forms must be submitted to the Tetra4 CLO Compensation should follow the IFC principles, which states that market related prices should be paid, and if anything is restored, it must be to the same or better standards than before.
- If areas are fenced, the fences must be checked for snares on a daily basis for the duration of the construction period. All incidences must be reported to the closest police station. Anti-poaching toolbox talks should form part of the induction process of all the fencing teams. Any contractor or employee caught poaching should be removed from site.
- Servitudes should only be registered for the life of the operations or as long as the well and pipeline in use are productive. At the end of the life of operations, or when a well or pipeline is no longer productive od used, servitudes must be de-registered at the cost of Tetra4. Servitudes cannot be seen as access routes unless it has been specified as such and agreed on by both parties.
- Temporary access and land arrangements must be made until there are more certainty on exactly where the wells will be. Servitudes should only be registered for productive wells.
- If private roads are affected by project activities, it is the responsibility of Tetra4 to maintain these roads as long as they use it. Tetra4 should engage with the relevant farmers about road maintenance, as some of them have preferential ways in which the roads must be maintained, for example if roads are only graded and not built up it turns into rivers when there is heavy rain. The road maintenance agreements must be formalised before construction and drilling commences to ensure all parties involved are protected and know their rights and responsibilities. Tetra4 must make sure that all compacting and rehabilitating of trenches are done to the specifications in the Environmental Management Plan. It is recommended that construction and drilling be planned for the dry season. Tetra4 must provide all the affected landowners with a construction and drilling schedule to ensure that they know when construction will take place on their properties. Any changes to the construction and drilling schedule must be communicated to the farmers at least a week in advance.
- Before the project commences Tetra4 should compile an asset and infrastructure baseline of any landowner infrastructure such as fences, pipes, electricity lines, roads and troughs that may be affected by the project. Photographs and GPS co-ordinates of the infrastructure must be included in the baseline. A copy of the baseline affecting their property should be given to each landowner, who should sign off the document to ensure that it is accurate. Tetra4 should keep the master document. If any damage occurs it should be reinstated to its pre-project status. If the infrastructure must move, it must be done at Tetra4's cost. Tetra4 must ensure that the construction team has a copy of the asset and

infrastructure baseline to guarantee that no infrastructure will be damaged due to ignorance during the construction phase of the project.

- Tetra4 should work with the preferred farmers' security group (Erfenis Veiligheid) and implement the AgriSA farm access protocol for everybody that need to access the properties. Pictures, make and registration numbers of all vehicles used by Tetra4 on site should be provided to the farmer's security group and distributed to all affected landowners to ensure that they will be able to identify these vehicles if they access their properties. For scheduled and maintenance work Tetra4 should give a roster to the farmers stating dates and approximate times that contractors will be on the farms. Farmers emphasised that they need to know of people accessing the farm ahead of time. It is too late to inform them when entering the property. All access arrangements should be made at least 24 hours before access is required. Tetra4 must meet with the landowners before the construction and drilling phase commence and formalise security arrangements. This should be done in writing and include the existing forums that the landowners know and trust.
- All contractors and employees need to wear photo identification cards. Vehicles should be marked as construction vehicles and should have Tetra4's logo clearly exhibited. Entry and exit points of the site should be controlled during the construction and drilling phase. Areas where materials are stockpiled must be fenced. The schedules of the security company should be communicated to the farmers, especially to those farmers that have Tetra4 infrastructure that need to be guarded. It must be considered that guards changing shifts contribute to the impact of strangers accessing properties, and therefore a system that consider the safety of both the Tetra4 infrastructure and the safety of the landowners must be implemented. The necessary sanitation facilities must be made available, and some form of shelter from the elements. The security guards must not be allowed to make fires for cooking or heating purposes.
- A system to arrange access to properties must be devised and formalised. The landowners must agree to the system. Access must be arranged at least 24 hours prior, except in emergencies, when the landowners should also be informed immediately. Landowners have the right to refuse people access to their properties if it was not arranged in advance. If routine access is required, the landowners must be provided with a roster indicating dates and approximate times that access will be required. Tetra4 must compensate the landowners for any damage to property or goods if it was due to behaviour of their contractors. Sub-contractors must be made aware of this and a clause spelling out their liability should be included in their contracts.
- It is difficult to mitigate the impact on sense of place as it is experienced on a personal level. In general, the mitigation measures suggested in the visual, noise, ecological impact assessments and other relevant specialist studies should be adhered to. The relevant specialists will provide scientific mitigation measures for the aspects relevant to their studies. The direction and brightness of lights close to residences must be considered. Pipeline markers on game farms must be camouflaged by either painting it in a colour that blend in with the surrounding areas, or putting natural materials such as branches or wooden poles around it. This must be done in consultation with the affected landowners. Sense of place is a personal experience, but successful rehabilitation will go a long way in recreating a rural sense of place. The public perception would be negative or positive depending on the successful implementation of the rehabilitation.
- Tetra4 has a dedicated person that communicate with the landowners with whom they have a positive relationship. It is important that this relationship is extended to the Cluster 2 landowners. Information sharing, frequent communication and quick responses to issues/complaints/enquiries will assist Tetra4 with maintaining their SLO.
- Tetra4 should compile a background information document (BID) explaining the process and potential risks in laymen terms. This should be distributed to local stakeholders. Special sessions to inform the farm workers in their native languages must be conducted. They can also consider a media awareness campaign on local radio stations and press statements to local papers.

- Tetra4 must become a member of the local firefighting association. Access routes and procedures in case of any veld fire must be determined and shared with the firefighting association, farm owners and Tetra4 staff.
- Wells and pipelines must be kept away from residences as far as possible.
- Tetra4 should ensure that a good proportion of secondary economic opportunities are given to local contractors. Services and goods must be procured locally as far as reasonably possible. Aspects of this positive impact will occur by default when the construction force lives locally and they utilise local services and support local shops.
- Tetra4 should liaise with local training institutions to determine whether there are any opportunities to offer internships and practical experience for their students. Tetra4 must ensure that skills development requirements form part of their contracts with sub-consultants. The skills development requirements in their Social and Labour Plan (SLP) must be implemented. Tetra4 can liaise with local schools to participate in science classes or bring science pupils to visit the facility once it is operational.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources but where this may occur, mitigation measures shall be put forward to reduce this potential as far as possible.

10.2.2.5 **ECONOMIC IMPACTS**

The majority of the economic impacts of this project have been rated as positive with the impacts extending from a local level, through to the region and also to a national level. In addition, the Gas Act makes provision for black economic transformation and the provisions thereof is described in the BBBEE Act. This project will need to comply with these provisions which compliance will have an obvious positive impact on economic transformation. During the construction phase, the positive impacts on the local economy will be the greatest (through employment opportunities as well as material and contractor requirement) while during the operational phase the economic impacts move towards a more regional and national level when gas production and distribution is in full swing. From an economic perspective, the decommissioning phase would represent a negative impact due to the local, regional and national financial and general economic benefits from the project effectively ceasing.

The following economic impacts relating to all phases of the project have been identified:

- GGP/GDP Impact
- Employment Impacts
- Forex savings
- Fiscal Income
- Economic development per capita
- Country and Industry Competitiveness
- Black Economic Transformation
- Alternative Land-use
- Need and Desirability
- Impact on individual farmland values

(i) Mitigation measures

- Ensure that as much of the infrastructure as possible is sited away from agricultural lands. Utilize servitudes, farm roads and any other routes to avoid sensitive areas. Ensure that pipelines are buried at sufficient depth (>1 m minimum) to avoid interference with arable agriculture activities.
- Communication to stakeholders about the nature and extent of economic opportunities should be undertaken. No unrealistic expectations should be created and the recruitment policy giving preference to local labour should be communicated from the beginning of the project. The local area of influence should be agreed with stakeholders early on in the process.
- Landowners must be consulted, and all reasonable requests complied with. A written landowner agreement should be negotiated and concluded prior to commencement. Should this not be possible, a record should be kept of reasonable negotiations with the land owners.
- The pipelines will be buried in accordance with the schedule as agreed upon with landowners to minimise disturbance to farming operations.
- If any farm labourers apply for positions at Tetra4 or one of its contractors, Tetra4 or the contractor must ensure that the labourer is aware that the position may only be temporary and what the long-term consequences of taking the position are.
- Preference for employment should be given to the local community. The recruitment policy must be communicated openly and made available to the public if requested.
- Tetra4 should liaise with local training institutions or service providers to determine whether there are any opportunities to offer internships and practical experience for their students. Tetra4 must ensure that skills development requirements form part of their contracts with sub-consultants as prescribed in the SLP. The skills development requirements and bursaries for local learners as discussed in their Social and Labour Plan (SLP) must be implemented.
- Tetra4 must appoint a CLO that deals with the affected landowners throughout the life of the project. If existing activities will be affected negatively Tetra4 must enter into negotiations with the affected parties as soon as reasonably achievable to ensure the affected parties are compensated fairly or can make additional arrangements. Interference with existing livelihoods should be avoided if possible. If any new activities are planned for a property, Tetra4 must consult with the landowner and take reasonable steps to obtain his consent to execute the activity on his/her land. A system to arrange access to properties must be devised and formalised. All reasonable efforts must be taken to obtain agreement on the system with the landowners and it must be formalised. Access must be arranged at least 24 hours prior, except in emergencies, when the landowners should also be informed immediately. If routine access is required, the landowners must be provided with a roster indicating dates and approximate times that access will be required. Tetra4 must compensate the landowners for any damage to property or goods if it was due to behaviour of their contractors. Sub-contractors must be made aware of this and a clause spelling out their liability should be included in their contracts. All contractors should sign a code of conduct as part of their induction process. Induction must explicitly include aspects such as closing gates and littering. Toolbox talks must be designed to include social and environmental aspects. A fining system must be put in place for any transgressions affecting the landowners.
- Contractors should be required to make use of a certain proportion of local labour - it is acknowledged that not all skills will be available locally. Jobs should be advertised in a way that is accessible to all members of society and labour desks (labour registration stations) should be in accessible areas. No unrealistic expectations should be created and the recruitment policy giving preference to local labour should be communicated from the beginning of the project. The local area of influence should be agreed with the stakeholders early on in the process.
- Procurement targets to be in line with the existing Social Labour Plan (SLP).
- Comply with downscaling regulations of the DMRE.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative positive economic change.

(iii) Irreplaceable loss of Resources

- The impact may result in the irreplaceable loss of resources however the value of these resources would be limited.

10.2.2.6 GROUNDWATER IMPACTS

The Geohydrological Specialist Report was updated to address the Ministers decision and recommendations on the appeal. Despite the additional data included in the updated report, no change in the overall outcome of the Geohydrological Impact Assessment scoring or mitigation measures is required in this updated EIA Report.

The potential impacts on groundwater resources associated with the operational phase activities include the following:

- Migration of saline groundwater from the deep, fractured aquifer to the overlying, shallow freshwater aquifer(s) during the gas production phase.
- Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, shallow freshwater aquifer(s) during the gas production phase.
- Groundwater pollution as a result of wastewater spills and seepage from the evaporation dams.
- Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.
- Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.
- Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.
- Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.
- Leachate of contaminants used in the drilling mud sump(s) to the intergranular, potable aquifer(s) during the operational phase.

The environmental significance rating of the following potential impacts is rated as high negative without the implementation of mitigation measures and medium negative with the implementation of mitigation measures.

- Migration of saline groundwater from the deep, fractured aquifer to the overlying, shallow freshwater aquifer(s) during the gas production phase.
- Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, shallow freshwater aquifer(s) during the gas production phase.

The environmental significance rating of the following potential impacts is rated as medium negative without the implementation of mitigation measures and low negative with the implementation of mitigation measures.

- Groundwater pollution as a result of wastewater spills and seepage from the evaporation dams.
- Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.
- Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.
- Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.

- Leachate of contaminants used in the drilling mud sump(s) to the intergranular, potable aquifer(s) during the operational phase.

The environmental significance rating of the following potential impact is rated as low negative without the implementation of mitigation measures and low negative with the implementation of mitigation measures.

- Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.

The following mitigation measures should be considered to minimise the potential groundwater impacts during the operational phase.

(i) Mitigation measures

- All exploration wells should be sealed-off with a combination of casing and grouting to ensure isolation of the saline water from the host-aquifer(s).
- Development and implementation of an integrated groundwater monitoring program evaluating hydrochemistry will serve as early warning and detection mechanism to implement mitigation measures.
- Monitoring results should be evaluated and reviewed on a biannual basis by a registered hydrogeologist for interpretation and trend analysis for submission to the Regional Head of Department. Based on the water quality results, the monitoring network should be refined and updated every three to five years based on hydrochemical results obtained to ensure optimisation and adequacy of the proposed localities.
- The calibrated groundwater flow model should be updated on a bi-annual basis as newly gathered monitoring results become available in order to be applied as groundwater management tool for future scenario predictions.
- All exploration wells should be sealed-off with a combination of casing and grouting to ensure isolation of the gas from the host-aquifer(s).
- Develop a stormwater management plan in accordance with GN704 in order to separate dirty/contact water from clean water circuits. All water retention structures, process water dams; storm water dams, retention ponds etc. should be constructed to have adequate freeboard to be able to contain water from 1:50 year rain events.
- An appropriately sized spill kit must kept onsite and available at all times. The spill kit size must be relevant to the scale of the activities involving the use of hazardous substances.
- An appropriate number of spill kits must be available and must be located in all areas where activities are being undertaken.
- The responsible operator must have the required training to make use of the spill kit in emergency situations.
- Plant areas must be fitted with a containment facility for the collection of dirty water. This facility must be impervious to prevent soil and groundwater contamination. Ii.
- The plant area must have a concrete slab that is sloped to facilitate runoff into a collection sump.
- Operational vehicles and machinery must be serviced and maintained regularly in order to ensure that oil spillages are limited. Spill trays must be provided if refuelling of operational vehicles is done on site. Further to this spill kits must be readily available in case of accidental spillages with regular spot checks to be conducted.
- During servicing of vehicles or equipment, especially where emergency repairs are effected outside the workshop area, a suitable drip tray must be used to prevent spills onto the soil.
- Leaking equipment must be repaired immediately or be removed from site to facilitate repair.

- Workshop areas must be monitored for oil and fuel spills, and a suitable oil/water separator should be in place where maintenance work on vehicles and equipment can be performed. .
- An appropriate number of spill kits must be available and must be located in all areas where activities are being undertaken.
- All hazardous substances used on-site should have an applicable Material Safety Data Sheet (MSDS) to provide information regarding the hazards, emergency response, protective measures and correct storage methodology.
- Hazardous substance containment facilities to be used during operational phase should comply with the relevant hazardous substance storage legislation in order to ensure spillages are contained.
- All hazardous substances and material used on-site should be stored in a dedicated, closed-off facility with an impervious floor and bunded area to prevent seepage and/or run-off in case of accidental spills.
- Annual external audits should be conducted to ensure that pipelines and waste facilities are maintained and functioning effective and according to licence conditions.
- The Licensee shall appoint a suitably qualified and responsible person to give effect to all recommendations as stipulated in specialist reports to ensure compliance to licence conditions pertaining to activities in order to ensure that potential impact(s) are minimised, and mitigation measures proposed are functioning effectively.
- A stormwater management plan in accordance with GN704, separating dirty/contact water from clean water circuits, should be in place until all decommissioning and rehabilitation activities have been concluded.
- A rehabilitation plan must be developed based on site-specific issues and requirements including soft and hard engineering interventions and revegetation.
- An ECO must be appointed to oversee the rehabilitation phase and ensure least possible harm to biodiversity and ensure compliance to the rehabilitation plan.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact may result in irreplaceable loss of resources if not adequately mitigated but the value of the resources will be limited.

10.2.2.7 HYDROLOGICAL IMPACTS

The activities expected during the operational phase involve the operation of the well pad, pipelines, compression station and LNG/LHe beneficiation plant, movement of trucks and other vehicles, general and hazardous waste management, gas processing as well as operation of road tankers for gas distribution. The floodline delineation was updated to address the Ministers decision and recommendations on the appeal. Despite the revised 1:100-year floodline based on a climate change scenario, the overall floodline delineation with and without consideration of climate change remain largely the same. Therefore, no change in the overall outcome of the Hydrological Impact Assessment scoring is required in this updated EIA Report.

The potential environmental impacts and mitigation measures during the operational phase are listed below.

- Disturbance to soil and ongoing erosion as a result of periodic maintenance activities.
- Altered water quality as a result of increased availability of pollutants.
- Potential increase in the number of alien and/or invasive vegetation as a result of floods or people who visit the site.

Although the above hydrological impacts are predicted to have a minimal/negligible impact significance, the following mitigation measures should be considered:

(vii) Mitigation measures

- No movement of construction equipment through the watercourses may be permitted during standard operational activities or maintenance activities. Use must be made of the existing and/or approved watercourse crossings only.
- Regular conditional inspections of all stormwater infrastructure are required. Inspection data must be recorded and accumulated for tracking purposes. Regular reporting should be scheduled management task.
- Specific attention must be given to inspection during and after any rain and/or flood event to kerb any damage that may have occurred.
- Oil recovered from construction vehicles and machinery should be collected, stored and disposed of by accredited vendors for recycling.
- Monitoring for the project area for alien and invasive vegetation species must be undertaken, specifically for access roads through or along the watercourses. Should alien and invasive plan species be identified, they must be removed and disposed of as per an alien and invasive species control plan and the area must be revegetated with suitable indigenous vegetation.

(viii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact may result in spatial and temporal cumulative change.

(ix) Irreplaceable loss of Resources

- The impact may result in irreplaceable loss of resources if not adequately mitigated but the value of the resources will be limited.

10.2.2.8 **TERRESTRIAL BIODIVERSITY IMPACTS**

Most of the biodiversity within the study area has been fragmented and impacted on by existing land uses including agriculture, farmsteads, roads powerlines and other infrastructure as well as mining. Due to the spatial extent of the proposed Cluster 2 infrastructure, a variety of terrestrial biodiversity areas exist. These range from low sensitive (e.g. agricultural areas etc) to highly sensitive areas (e.g. pristine areas, wetlands and watercourses as well as areas where red data species occur). Furthermore the study area contains CBA1 and ESA 1&2 areas. The ecological integrity, importance, and functioning of these terrestrial biodiversity areas provide a variety of ecological services that are considered beneficial, with one key service being the maintenance of biodiversity. The preservation of these systems is the most important aspect to consider for the proposed project. Thus, if these areas are not maintained in a natural or near natural state, destroyed or fragmented further, then meeting targets for biodiversity features will not be achieved.

The following operational phase impacts have been identified and assessed in this report:

- Destruction, further loss and fragmentation of the vegetation community.
- Introduction of alien species, especially plants.
- Erosion due to storm water runoff and wind.
- Displacement of faunal community due to habitat loss, direct mortalities and disturbance (road collisions, noise, light, dust, vibration and poaching).

(i) Mitigation measures

- Tetra4 must timeously control alien and invasive species in all areas disturbed by project specific construction.

- Use existing access roads as much as possible. Rehabilitate disturbed areas as soon as possible.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.2.9 AQUATIC AND WETLAND IMPACTS

The impacts that have been identified on aquatic and wetland systems during the operational phase include altered surface flow dynamics; erosion; alteration of sub-surface flow dynamics; sedimentation of the water resource; direct and indirect loss of wetland areas; water quality impairment; compaction; decrease in vegetation; change of drainage patterns; altering hydromorphic properties; altered surface flow dynamics; erosion; alteration of sub-surface flow dynamics; indirect loss of wetland areas; water quality impairment; compaction; decrease in vegetation; change of drainage patterns; and altering hydromorphic properties.

Three levels of risk have been identified and determined for the impact assessment and these include low, medium and high risks. High risks are applicable despite the potential direct risks posed, this is motivated by the direct impacts posed by the project and the nature of the proposed project. Medium risk refers to wetland areas that are either directly affected or on the periphery of the infrastructure and at an indirect risk. Low risks are wetland systems beyond the application area that would be avoided, or wetland areas that could be avoided if feasible. The significance of all post-mitigation risks was determined to be low.

(i) Mitigation measures

- Maintenance and inspection vehicles and machinery must make use of existing and pre-defined access routes.
- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems.
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil.
- All waste generated on-site must be adequately managed. Separation and recycling of different waste materials should be supported.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.2.10 IMPACTS ON SOIL (PEDOLOGY)

The operational phase will include an increase in traffic, ongoing maintenance and anthropogenic activities associated with the extraction of gas. It is worth noting that the bulk of the impacts would have already been associated with the construction phase, with the remainder of the operational activities only being associated with the already developed areas. The operational phase of the compressors and wells includes anthropogenic movement, together with the physical extraction of gas. Besides compaction and erosion caused by increased traffic, few aspects are expected to be associated with this phase. The operational phase of the pipelines will include infrastructure being maintained and monitored regularly, with no other expected impacts potentially threatening the land capability.

Based on the impact assessment, the results indicate “Insignificant” to “Very Low” post-mitigation significance ratings for the proposed components. It is therefore clear that the proposed activities are expected to have a minimal impact on land potential resources.

(i) Mitigation measures

- Only predefined access roads are to be used to reduce any unnecessary compaction.
- If a spill occurs, it is to be cleaned up immediately and reported to the appropriate authorities.

(ii) Cumulative Impacts

- The cumulative impacts have been scored “Medium”, indicating that the potential incremental, interactive, sequential, and synergistic cumulative impacts. It is probable that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The irreplaceable loss of resources has been scored “Low”, where the impacts are unlikely to result in an irreplaceable loss of resources.

10.2.2.11 **VISUAL IMPACTS**

In general terms the proposed project could industrialise this Landscape Character Area. Large scale mining operations are currently visible from within this landscape. The proposed project will see drilling operations occurring throughout the area during exploration and construction. However when this is complete, there will be up to 300 production wells, booster and compressor stations, LNG/LHe plant and a 4km long 132kV overhead power line within the landscape. These are relatively small infrastructure elements. The large-scale agricultural nature of the landscape will remain very evident. A degree of industrialisation will therefore occur however, the existing landscape character will still dominate.

In terms of cumulative effects, the proposed project will not significantly change the character of views. It will however combine with large scale mining operations including stockpiles and plant during the construction and operational phases to intensify current impacts on landscape character.

After decommissioning, visual impacts will reduce due to the removal of operational plant etc. Since the affected landscape is relatively flat and open, no mitigation is feasible.

(i) Mitigation measures

- Locate wells and compressor stations a minimum 250m from homesteads.
- Undertake rehabilitation.
- Re-establish agricultural uses.
- Undertake screen planting between the R30 and the proposed production plant if possible.
- Ensure that temporary lighting is of sufficient power to ensure safety but not so powerful that it creates glare that could cause danger for drivers or nuisance for neighbours.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.3 DECOMMISSIONING REHABILITATION AND CLOSURE PHASE IMPACTS

10.2.3.1 **AIR QUALITY IMPACTS**

The assumption is that decommissioning would be during day-time hours only. Given the nature of decommissioning activities, and the extent of the process, NAAQS limits for residential areas may be exceeded sporadically at AQSRs. Mitigation measures, however, can be implemented to reduce emissions due to fugitive dust. The negative air quality impacts are therefore considered to be of medium significance without mitigation and low significance with mitigation at the nearest receptors.

(i) Mitigation measures

- In controlling vehicle entrained PM, it is recommended that water be applied on all unpaved road sections to ensure a minimum of 50% control efficiency (CE). In addition, binding agents or chemical suppressants (such as “Dust-A-Side” or “Dustex”) should be considered for application on all unpaved road sections.
- For topsoil management during construction and rehabilitation, the existing EMPr (nr 35) should be amended to include the recommendation that exposed areas must be ensured to remain moist through water spraying during dry, windy periods (CE 50%).
- During all phases, material transfers are to be controlled through the use of water sprays resulting in 50% control efficiency.
- The following good practice should be followed during all phases of the project: In order to ensure lower exhaust emissions from vehicles and machinery, equipment suppliers or contractors should be required to ensure compliance with appropriate emission standards for production fleets. Also, maintenance and repair of diesel engines should be carried out as prescribed by manufacturer in order to maximize combustion and reduce gaseous emissions.
- Fuel efficient driving practices on site, during all phases of the Project, may also help lower exhaust emissions from vehicles and machinery, such as stipulating a maximum speed on all unpaved roads. In addition, other fuel-efficient practices that may lower exhaust emissions include limiting idling of machinery, driving in an upper gear rather than a lower gear as much as possible, ensuring tire pressure are always adequate etc.
- Products, liquid fuels, and chemicals should be stored in areas where there are provisions for containment of spills.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.3.2 **CLIMATE CHANGE IMPACTS**

As operations progress, the previously cleared areas that form part of the project will be rehabilitated resulting in a carbon sink gain. Even assuming rehabilitation uses the same indigenous vegetation, the carbon balance will not be completely restored. There may also be potential soil degradation due to stockpiling. However, there is insufficient data at this point to determine the decommissioning GHG emissions and significance thereof during the decommissioning phase. This is likely to be equivalent or less than the construction phase, with the reestablishment of a carbon sink in the revegetation of the site.

10.2.3.3 **NOISE IMPACTS**

The assumption is that decommissioning would be during day-time hours only. Given the nature of decommissioning activities, and the extent of the process, IFC noise guidelines for residential areas may be

exceeded sporadically at NSRs. Attenuation measures, however, can be implemented to reduce noise levels. The negative noise impacts are therefore considered to be of medium significance without mitigation and low significance with mitigation at the nearest receptors.

(i) Mitigation measures

- Regular and effective maintenance of equipment are essential to noise control. Increases in equipment noise are often indicative of eminent mechanical failure. Also, sound reducing equipment/materials can lose effectiveness before failure and can be identified by visual inspection.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.3.4 **ECONOMIC IMPACTS**

Whilst the construction phase and operational phase economic impacts were largely rated as highly positive, the decommissioning phase would represent a negative impact due to the local, regional and national financial and general economic benefits from the project effectively ceasing.

The following economic impacts relating to the decommissioning phase of the project have been identified:

- GGP/GDP Impact
- Employment Impacts
- Forex savings
- Fiscal Income
- Economic development per capita
- Country and Industry Competitiveness
- Black Economic Transformation
- Alternative Land-use
- Need and Desirability
- Impact on individual farmland values

(i) Mitigation measures

- Ensure that as much of the infrastructure as possible is sited away from agricultural lands. Utilize servitudes, farm roads and any other routes to avoid sensitive areas. Ensure that pipelines are buried at sufficient depth (>1 m minimum) to avoid interference with arable agriculture activities.
- Communication to stakeholders about the nature and extent of economic opportunities should be undertaken. No unrealistic expectations should be created and the recruitment policy giving preference to local labour should be communicated from the beginning of the project. The local area of influence should be agreed with stakeholders early on in the process.
- Landowners must be consulted, and all reasonable requests complied with. A written landowner agreement should be negotiated and concluded prior to commencement. Should this not be possible, a record should be kept of reasonable negotiations with the land owners.
- The pipelines will be buried in accordance with the schedule as agreed upon with landowners to minimise disturbance to farming operations.

- If any farm labourers apply for positions at Tetra4 or one of its contractors, Tetra4 or the contractor must ensure that the labourer is aware that the position may only be temporary and what the long-term consequences of taking the position are.
- Preference for employment should be given to the local community. The recruitment policy must be communicated openly and made available to the public if requested.
- Tetra4 should liaise with local training institutions or service providers to determine whether there are any opportunities to offer internships and practical experience for their students. Tetra4 must ensure that skills development requirements form part of their contracts with sub-consultants as prescribed in the SLP. The skills development requirements and bursaries for local learners as discussed in their Social and Labour Plan (SLP) must be implemented.
- Tetra4 must appoint a CLO that deals with the affected landowners throughout the life of the project. If existing activities will be affected negatively Tetra4 must enter into negotiations with the affected parties as soon as reasonably achievable to ensure the affected parties are compensated fairly or can make additional arrangements. Interference with existing livelihoods should be avoided if possible. If any new activities are planned for a property, Tetra4 must consult with the landowner and take reasonable steps to obtain his consent to execute the activity on his/her land. A system to arrange access to properties must be devised and formalised. All reasonable efforts must be taken to obtain agreement on the system with the landowners and it must be formalised. Access must be arranged at least 24 hours prior, except in emergencies, when the landowners should also be informed immediately. If routine access is required, the landowners must be provided with a roster indicating dates and approximate times that access will be required. Tetra4 must compensate the landowners for any damage to property or goods if it was due to behaviour of their contractors. Sub-contractors must be made aware of this and a clause spelling out their liability should be included in their contracts. All contractors should sign a code of conduct as part of their induction process. Induction must explicitly include aspects such as closing gates and littering. Toolbox talks must be designed to include social and environmental aspects. A fining system must be put in place for any transgressions affecting the landowners.
- Contractors should be required to make use of a certain proportion of local labour - it is acknowledged that not all skills will be available locally. Jobs should be advertised in a way that is accessible to all members of society and labour desks (labour registration stations) should be in accessible areas. No unrealistic expectations should be created and the recruitment policy giving preference to local labour should be communicated from the beginning of the project. The local area of influence should be agreed with the stakeholders early on in the process.
- Procurement targets to be in line with the existing Social Labour Plan (SLP).
- Comply with downscaling regulations of the DMRE.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative positive economic change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of recourses.

10.2.3.5 GROUNDWATER IMPACTS

The Geohydrological Specialist Report was updated to address the Ministers decision and recommendations on the appeal. Despite the additional data included in the updated report, no change in the overall outcome of the Geohydrological Impact Assessment scoring or mitigation measures is required in this updated EIA Report.

The potential impacts on groundwater resources associated with the decommissioning phase activities include the following:

- Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.
- Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, potable aquifer(s) borehole closure and decommissioning phase.
- Groundwater pollution as a result of wastewater spills and seepage from the evaporation dams.
- Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.
- De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.

The environmental significance rating of the following potential impacts is rated as medium negative without the implementation of mitigation measures and medium negative with the implementation of mitigation measures.

- Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.
- Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, potable aquifer(s) borehole closure and decommissioning phase.

The environmental significance rating of the following potential impacts is rated as low negative without the implementation of mitigation measures and low negative with the implementation of mitigation measures.

- Groundwater pollution as a result of wastewater spills and seepage from the evaporation dams.
- Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.
- De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.

The following mitigation measures should be considered to minimise the potential groundwater impacts during the construction phase.

(i) Mitigation measures

- "Contractor to prepare a consolidated site-specific closure/sealing plan to be submitted for approval. The plan should include a detailed description of the following aspects:
    - Calliper Logging should be conducted to identify and investigate potential blockages/cavities within well.
    - Cement Bond Logging should be performed to investigate the current integrity of the casing and cementation.
    - Contractor to determine the most suitable and appropriate closure, sealing and rehabilitation strategy with specific focus on the plugging method to ensure no vertical gas and/or fluid movements within the well.
    - Develop cement formulation for cementing the entire well annulus.
    - Develop cement formulation to top-up “no bond” or “poor bond” cemented sections between casing and formation walls – ensure cement seals and does not disperse into porous formations.
    - Cement formulations and volumetric calculations to be approved by well engineer/cement specialist.
    - Contractor must ensure cement mixture seals the entire well length along the well annulus.

- Cement plugs must be stacked along the full length and diameter of the well to surface (open hole section above the packer as well as the upper casing) to ensure efficient redundancy.
- All plugs must be tagged to ensure successful placement.
- Cementation extent: Should be from end of hole (bottom of well) to surface.
- Cementation technique: Squeeze technique - this displacement method minimizes the contamination of the cement by being able to displace fluid within the well, thus allowing for a more stable well plug. Contractor must also make use of wiper plugs for cement displacement.
- Contractor to conduct cement top-ups along the annulus and existing cemented sections showing “no bond” or “poor bond” from logging results.
- A surface / shallow cement plug (+/ 50m below ground Level) must be set, and the well casing must be cut and capped 1 m below ground level to remove the wellhead and all casing above this point.
- Integrity of the plugs must be confirmed by setting weight down on the upper most plug (using the drill string) as well as a differential pressure test for 4 hours at determined pressure with less than 10% bleed over the period. Pressure test data to be captured in 15-minute intervals for the entire 4-hour testing period. "

- Development and implementation of a post-closure groundwater monitoring program evaluating hydrochemistry will serve as early warning and detection mechanism to implement mitigation measures.
- Develop a stormwater management plan in accordance with GN704 in order to separate dirty/contact water from clean water circuits. All water retention structures, process water dams; storm water dams, retention ponds etc. should be constructed to have adequate freeboard to be able to contain water from 1:50 year rain events.
- A rehabilitation plan must be developed based on site-specific issues and performed in accordance to best practise guidelines and guided by the closure and rehabilitation plans.
- An ECO must be appointed to oversee the rehabilitation phase and ensure least possible harm to biodiversity and ensure compliance to the rehabilitation plan.
- Operational vehicles and machinery must be serviced and maintained regularly in order to ensure that oil spillages are limited. Spill trays must be provided if refuelling of operational vehicles is done on site. Further to this spill kits must be readily available in case of accidental spillages with regular spot checks to be conducted.
- During servicing of vehicles or equipment, especially where emergency repairs are effected outside the workshop area, a suitable drip tray must be used to prevent spills onto the soil.
- Leaking equipment must be repaired immediately or be removed from site to facilitate repair.
- Workshop areas must be monitored for oil and fuel spills, and a suitable oil/water separator should be in place where maintenance work on vehicles and equipment can be performed. .
- An appropriate number of spill kits must be available and must be located in all areas where activities are being undertaken.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact may result in irreplaceable loss of resources if not adequately mitigated but the value of the resources will be limited.

10.2.3.6 HYDROLOGICAL IMPACTS

The decommissioning phase involves the removal of all berms, trenches and other storm water infrastructure, stationary infrastructure, certain pipeline surface infrastructure and wastes. As the pipelines that cross the watercourse will not be removed during decommissioning (i.e. no further surface or subsurface disturbance), the hydrological impact on is minimal/negligible. The floodline delineation was updated to address the Ministers decision and recommendations on the appeal. Despite the revised 1:100-year floodline based on a climate change scenario, the overall floodline delineation with and without consideration of climate change remain largely the same. Therefore, no change in the overall outcome of the Hydrological Impact Assessment scoring or mitigation measures is required in this updated EIA Report.

The potential hydrological impacts that have been identified during the decommissioning phase include the following:

- Increased erosion due to construction vehicles movement.
- Stormwater Contamination resulting from spillages of polluted groundwater from wells
- Potential increase in the number of alien and/or invasive vegetation as a result of floods or people who visit the site.

Although the above hydrological impacts are predicted to have a minimal/negligible impact significance, the following mitigation measures should be considered:

(x) Mitigation measures

- Topsoil removed during construction must be stored on site for rehabilitation and re-vegetation. The soil must be stabilised using materials such as netting or geotextiles where necessary.
- The site shall be re-instated to its original condition as far as possible. No foreign material generated / deposited during decommissioning shall remain on site.
- Rehabilitate disturbance areas as soon as decommissioning in an area is completed.
- All wells should be capped to prevent the spilling of contaminated groundwater.
- Monitoring for the project area for alien and invasive vegetation species must be undertaken, specifically for access roads through or along the watercourses. Should alien and invasive plan species be identified, they must be removed and disposed of as per an alien and invasive species control plan and the area must be revegetated with suitable indigenous vegetation.

(xi) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact may result in spatial and temporal cumulative change.

(xii) Irreplaceable loss of Resources

- The impact may result in irreplaceable loss of resources if not adequately mitigated but the value of the resources will be limited.

10.2.3.7 TERRESTRIAL BIODIVERSITY IMPACTS

The majority of the biodiversity within the study area has been fragmented and impacted on by existing land uses including agriculture, farmsteads, roads powerlines and other infrastructure as well as mining. Due to the spatial extent of the proposed Cluster 2 infrastructure, a variety of terrestrial biodiversity areas exist. These range from low sensitive (e.g. agricultural areas etc) to highly sensitive areas (e.g. pristine areas, wetlands and watercourses as well as areas where red data species occur). Furthermore the study area contains CBA1 and ESA 1&2 areas. The ecological integrity, importance, and functioning of these terrestrial biodiversity areas provide a

variety of ecological services that are considered beneficial, with one key service being the maintenance of biodiversity. The preservation of these systems is the most important aspect to consider for the proposed project. Thus, if these areas are not maintained in a natural or near natural state, destroyed or fragmented further, then meeting targets for biodiversity features will not be achieved.

The following decommissioning and rehabilitation phase impacts have been identified and assessed in this report:

- Destruction, further loss and fragmentation of the vegetation community.
- Introduction of alien species, especially plants.
- Erosion due to storm water runoff and wind.
- Displacement of faunal community due to habitat loss, direct mortalities and disturbance (road collisions, noise, light, dust, vibration and poaching).

(i) Mitigation measures

- Use existing access roads as much as possible. Rehabilitate disturbed areas as soon as possible.
- Compile and implement an alien plant control program with a particular focus on alien control in watercourses (including wetlands) during the rehabilitation phase of the project. Rehabilitate disturbed areas as soon as possible. Restrict new footprints to disturbed areas as far as possible. Regular monitoring should be undertaken in the watercourses to check any possible invasion by alien vegetation so that they can be weeded out before they grow and spread out.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.3.8 AQUATIC AND WETLAND IMPACTS

The impacts that have been identified on aquatic and wetland systems during the decommissioning and rehabilitation phase include altered surface flow dynamics; erosion; alteration of sub-surface flow dynamics; sedimentation of the water resource; direct and indirect loss of wetland areas; water quality impairment; compaction; decrease in vegetation; change of drainage patterns; altering hydromorphic properties; altered surface flow dynamics; erosion; alteration of sub-surface flow dynamics; indirect loss of wetland areas; water quality impairment; compaction; decrease in vegetation; change of drainage patterns; and altering hydromorphic properties.

Three levels of risk have been identified and determined for the impact assessment and these include low, medium and high risks. High risks are applicable despite the potential direct risks posed, this is motivated by the direct impacts posed by the project and the nature of the proposed project. Medium risk refers to wetland areas that are either directly affected or on the periphery of the infrastructure and at an indirect risk. Low risks are wetland systems beyond the application area that would be avoided, or wetland areas that could be avoided if feasible. The significance of all post-mitigation risks was determined to be low.

(i) Mitigation measures

- All vehicles and machinery must make use of existing access routes as much as possible.
- Spill kits must be available to ensure that any fuel or oil spills are clean-up and discarded correctly.
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site.

- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good "housekeeping".
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the application area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation).
- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems.
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil.
- All waste generated on-site during decommissioning must be adequately managed. Separation and recycling of different waste materials should be supported as a first priority and only thereafter disposed of at a suitably waste disposal facility.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.3.9 IMPACTS ON SOIL (PEDOLOGY)

The decommissioning/closure phase for the proposed activities will result in similar impacts to the construction phase, in that infrastructure will be removed and the application area disturbed once again. The rehabilitation phase is expected to reduce the overall negative impact significance for selected aspects such as the removal and rehabilitation of roads.

Based on the impact assessment, the results indicate "Insignificant" to "Very Low" post-mitigation significance ratings for the proposed components. It is therefore clear that the proposed activities are expected to have a minimal impact on land potential resources.

(i) Mitigation measures

- Only predefined access roads are to be used to reduce any unnecessary compaction.
- Prevent any spills from occurring. Machines must be parked within hard park areas and must be checked daily for fluid leaks.
- Invasive plant control must be undertaken quarterly.
- Rip compacted soil and return topsoil to ensure that good vegetation cover is achieved.
- Only indigenous species are to be used in rehabilitation and revegetation.

(ii) Cumulative Impacts

- The cumulative impacts have been scored "Medium", indicating that the potential incremental, interactive, sequential, and synergistic cumulative impacts. It is probable that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The irreplaceable loss of resources has been scored "Low", where the impacts are unlikely to result in an irreplaceable loss of resources.

10.2.3.10 **VISUAL IMPACTS**

In general terms the proposed project could industrialise this Landscape Character Area. Large scale mining operations are currently visible from within this landscape. The proposed project will see drilling operations occurring throughout the area during exploration and construction. However when this is complete, there will be up to 300 production wells, booster and compressor stations, LNG/LHe plant and a 4 km long 132 kV overhead power line within the landscape. These are relatively small infrastructure elements. The large-scale agricultural nature of the landscape will remain very evident. A degree of industrialisation will therefore occur however, the existing landscape character will still dominate.

In terms of cumulative effects, the proposed project will not significantly change the character of views. It will however combine with large scale mining operations including stockpiles and plant during the construction and operational phases to intensify current impacts on landscape character.

After decommissioning, visual impacts will reduce due to the removal of operational plant etc. Since the affected landscape is relatively flat and open, no mitigation is feasible.

(i) Mitigation measures

- Rehabilitate disturbed area and reinstate agricultural usage.
- Remove all above ground infrastructure.
- Return land to pre-construction use.
- Minimise disturbance of the natural landscape.
- Ensure that temporary lighting is of sufficient power to ensure safety but not so powerful that it creates glare that could cause danger for drivers or nuisance for neighbours.
- Ensure that temporary lighting minimises light spill outside the area that it is intended to light.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

10.2.4 NO-GO ALTERNATIVE

The no-go alternative option means ‘do nothing’ or the option of not undertaking the proposed Cluster 2 project or any of its activities, consequently leading to the continuation of the current land-use. As such, the ‘do nothing’ alternative or keeping the current status quo of the various current land uses also provides the baseline against which the impacts of all other alternatives were compared.

Should the Cluster 2 project not go ahead, there would be certain impacts identified above which would change from negative to positive (mostly biophysical and cultural impacts) and conversely certain impacts would change from positive to negative (mostly social and economic impacts).

10.3 SUMMARY OF IMPACT ASSESSMENT

A summary of all the identified impacts, their associated phases, as well as their impact calculations and significance are presented in Table 88 below. This impact assessment has been informed by the final specialist studies following due consideration of comments received during the scoping review process.

Table 88: EIA Phase Impact Assessment.

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
1	Air Quality	Air Quality - Increase in air quality impacts due to construction of the road/pipeline	Alternative 1	Construction	-1	3	1	3	2	4	-9	-1	3	1	3	2	3	-6.8	Medium	2	1	-8
2	Air Quality	Air Quality - Increase in air quality impacts due to construction of the wells and booster stations	Alternative 1	Construction	-1	3	1	4	2	4	-10	-1	3	1	3	2	3	-6.8	Medium	2	1	-8
3	Air Quality	Air Quality - Increase in air quality impacts due to construction of the plant and compressor stations	Alternative 1	Construction	-1	3	2	4	2	4	-11	-1	3	2	3	2	3	-7.5	Medium	2	1	-8
4	Air Quality	Air Quality - Increase in air quality impacts due to the operation of vehicles on unpaved roads	Alternative 1	Operation	-1	3	4	3	2	4	-12	-1	2	4	2	2	3	-7.5	Medium	2	1	-8
5	Air Quality	Air Quality - Increase in air quality impacts due to operation of the booster stations	Alternative 1	Operation	-1	3	4	3	2	4	-12	-1	3	4	2	2	3	-8.3	Medium	1	1	-8
6	Air Quality	Air Quality - Increase in air quality impacts due to operation of the plant	Alternative 1	Operation	-1	2	4	2	2	3	-7.5	-1	2	4	2	2	3	-7.5	Medium	1	1	-8
7	Air Quality	Air Quality - Increase in air quality impacts due to decommissioning and closure	Alternative 1	Decommissioning	-1	3	2	4	2	4	-11	-1	3	2	3	2	3	-7.5	Medium	1	1	-8

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
8	Climate Change	Climate Change risk due to Scope 1 & 2 construction	Alternative 1	Construction	-1		1	2	5	3	-8	-1		1	1	5	3	-7	Low	2	2	-9
9	Climate Change	Climate Change risk due to Scope 1 & 2 construction	Alternative 1	Operation	-1		4	3	5	3	-12	-1		4	2	5	3	-11	Medium	3	2	-15
10	Noise	Noise - Increase in noise levels due to construction of the pipeline	Alternative 1	Construction	-1	3	2	4	2	4	-11	-1	3	2	3	2	3	-7.5	Medium	1	1	-8
11	Noise	Noise - Increase in noise levels due to construction of the wells and Blower Stations	Alternative 1	Construction	-1	3	3	4	2	4	-12	-1	3	3	3	2	3	-8.3	Medium	1	1	-8
12	Noise	Noise - Increase in noise levels due to construction of the Plant and Compressor Stations	Alternative 1	Construction	-1	3	3	3	2	3	-8.3	-1	3	3	2	2	3	-7.5	Medium	1	1	-8
13	Noise	Noise - Increase in noise levels due to Blower Station operation	Alternative 1	Operation	-1	3	4	2	3	3	-9	-1	3	4	2	3	2	-6	Medium	1	1	-6
14	Noise	Noise - Increase in noise levels due to Plant and Compressor Station operation	Alternative 1	Operation	-1	3	4	2	3	3	-9	-1	3	4	2	3	2	-6	Medium	1	1	-6
15	Noise	Noise - Increase in noise levels	Alternative 1	Decommissioning	-1	3	2	4	2	4	-11	-1	3	2	3	2	3	-7.5	Medium	1	1	-8
16	Geohydrology	Groundwater deterioration and siltation due to contaminated stormwater run-off	Alternative 1	Construction	-1	2	2	2	2	2	-4	-1	2	2	1	2	1	-1.8	Medium	1	1	-2

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
		from the construction area.																				
17	Geohydrology	Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.	Alternative 1	Construction	-1	3	2	3	3	3	-8.3	-1	2	2	2	3	2	-4.5	Medium	2	2	-6
18	Geohydrology	Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	Alternative 1	Construction	-1	3	5	4	4	3	-12	-1	2	5	4	4	2	-7.5	Medium	2	2	-9
19	Geohydrology	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Alternative 1	Construction	-1	3	2	3	3	3	-8.3	-1	2	2	2	3	2	-4.5	Medium	2	2	-6
20	Geohydrology	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Alternative 1	Operation	-1	3	5	5	5	4	-18	-1	3	5	4	4	3	-12	Medium	2	2	-15
21	Geohydrology	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Alternative 1	Operation	-1	3	5	5	5	4	-18	-1	3	5	4	4	3	-12	Medium	2	2	-15

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
22	Geohydrology	Groundwater pollution as a result of wastewater spills and seepage from the evaporation dams.	Alternative 1	Operation	-1	3	5	4	4	3	-12	-1	2	5	4	4	2	-7.5	Medium	2	2	-9
23	Geohydrology	Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	Alternative 1	Operation	-1	3	5	4	4	3	-12	-1	2	5	4	4	2	-7.5	Medium	2	2	-9
24	Geohydrology	Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	Alternative 1	Operation	-1	3	2	3	3	3	-8.3	-1	2	2	2	3	2	-4.5	Medium	2	2	-6
25	Geohydrology	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Alternative 1	Operation	-1	3	5	4	4	3	-12	-1	2	5	4	4	2	-7.5	Medium	2	2	-9
26	Geohydrology	Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.	Alternative 1	Operation	-1	3	5	4	4	3	-12	-1	2	5	4	4	2	-7.5	Medium	2	2	-9
27	Geohydrology	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable	Alternative 1	Decommissioning	-1	3	3	5	5	4	-16	-1	2	2	4	4	3	-9	Medium	2	2	-11

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
		aquifer(s) during the borehole closure and decommissioning phase.																				
28	Geohydrology	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) borehole closure and decommissioning phase.	Alternative 1	Decommissioning	-1	3	3	5	5	4	-16	-1	2	2	4	4	3	-9	Medium	2	2	-11
29	Geohydrology	Groundwater pollution as a result of wastewater spills and seepage from the evaporation dams.	Alternative 1	Decommissioning	-1	3	3	3	4	2	-6.5	-1	2	2	2	3	1	-2.3	Medium	1	2	-3
30	Geohydrology	Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	Alternative 1	Decommissioning	-1	3	3	3	4	2	-6.5	-1	2	2	2	3	1	-2.3	Medium	1	2	-3
31	Geohydrology	De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.	Alternative 1	Decommissioning	-1	3	3	3	4	2	-6.5	-1	2	2	2	3	1	-2.3	Medium	1	2	-3
32	Hydrology	Hydrology - Loss of watercourse vegetation	Alternative 1	Construction	-1	2	1	1	2	2	-3	-1	2	1	1	2	1	-1.5	Low	2	1	-2
33	Hydrology	Erosion	Alternative 1	Construction	-1	1	2	1	2	4	-6	-1	1	1	2	2	2	-3	Low	2	1	-3

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
34	Hydrology	Stormwater contamination	Alternative 1	Construction	-1	1	2	2	2	4	-7	-1	1	1	2	2	2	-3	Medium	2	1	-3
35	Hydrology	Alien and/or Invasive Vegetation	Alternative 1	Construction	-1	3	4	3	3	2	-6.5	-1	2	2	1	2	1	-1.8	Low	2	1	-2
36	Hydrology	Alterations of the river banks and river bed	Alternative 1	Construction	-1	2	2	2	3	3	-6.8	-1	2	2	1	2	2	-3.5	Medium	2	2	-4
37	Hydrology	Erosion	Alternative 1	Operation	-1	2	4	3	2	2	-5.5	-1	2	4	3	2	1	-2.8	Low	2	2	-3
38	Hydrology	Stormwater contamination	Alternative 1	Operation	-1	3	3	3	3	3	-9	-1	2	2	1	2	2	-3.5	Medium	2	2	-4
39	Hydrology	Alien and/or Invasive Vegetation	Alternative 1	Operation	-1	3	4	3	3	3	-9.8	-1	2	2	1	3	2	-4	Medium	2	2	-5
40	Hydrology	Erosion	Alternative 1	Decommissioning	-1	2	3	3	2	2	-5	-1	2	3	3	2	1	-2.5	Low	2	2	-3
41	Hydrology	Stromwater contamination	Alternative 1	Decommissioning	-1	3	3	3	3	3	-9	-1	2	2	1	2	2	-3.5	Medium	2	2	-4
42	Hydrology	Alien and/or Invasive Vegetation	Alternative 1	Decommissioning	-1	3	4	3	3	2	-6.5	-1	2	2	1	2	1	-1.8	Low	2	1	-2
43	Heritage & Palaeontology	Impact on unidentified heritage resources	Alternative 1	Construction	-1	1	5	1	5	1	-3	-1	1	4	2	4	2	-5.5	Medium	2	3	-8
44	Heritage & Palaeontology	Impact on burial grounds and graves	Alternative 1	Construction	-1	2	4	5	5	4	-16	-1	1	4	2	5	2	-6	Medium	2	3	-8
45	Heritage & Palaeontology	Impact on historic to recent sites with possible graves	Alternative 1	Construction	-1	2	4	4	5	3	-11	-1	1	4	2	5	2	-6	Medium	1	3	-8
46	Heritage & Palaeontology	Impact on structures of medium heritage significance	Alternative 1	Construction	1	1	5	3	5	3	10.5	-1	1	3	3	3	2	-5	Medium	2	2	-6
47	Heritage & Palaeontology	Impact on palaeontology	Alternative 1	Construction	-1	4	5	4	5	4	-18	-1	4	5	2	5	2	-8	Medium	2	3	-11
48	Social	Impact on livelihoods	Alternative 1	Construction	-1	2	2	4	4	5	-15	-1	2	2	2	3	5	-11	High	2	2	-14
49	Social	Impact on livelihoods	Alternative 1	Operation	-1	3	4	5	4	5	-20	-1	3	4	4	4	4	-15	High	2	3	-21
50	Social	Impact of servitudes on land values	Alternative 1	Operation	-1	3	5	5	4	5	-21	-1	3	4	4	4	4	-15	High	3	2	-21

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
51	Social	Uncertainty	Alternative 1	Planning	-1	3	3	4	3	5	-16	-1	3	2	3	3	3	-8.3	High	2	2	-10
52	Social	Nuisance factor due to increase in ambient dust and noise levels	Alternative 1	Construction	-1	2	2	3	3	5	-13	-1	2	2	3	3	4	-10	High	2	1	-11
53	Social	Changes in travel patterns	Alternative 1	Construction	-1	2	2	4	2	5	-13	-1	2	2	3	2	4	-9	High	2	1	-10
54	Social	Damage to farm roads, existing services, and infrastructure	Alternative 1	Construction	-1	2	2	5	3	5	-15	-1	2	2	4	2	4	-10	High	2	1	-11
55	Social	Damage to farm roads, existing services, and infrastructure	Alternative 1	Operation	-1	2	4	5	3	4	-14	-1	2	4	4	3	4	-13	High	3	1	-16
56	Social	Impacts on livelihoods due to behaviour of contractors	Alternative 1	Construction	-1	3	2	4	2	4	-11	-1	2	2	3	2	3	-6.8	High	2	1	-8
57	Social	Impacts on safety and security of local residents	Alternative 1	Construction	-1	3	2	5	3	4	-13	-1	3	2	3	3	4	-11	High	3	3	-17
58	Social	Impacts on safety and security of local residents	Alternative 1	Operation	-1	3	4	5	3	5	-19	-1	3	4	4	3	4	-14	High	2	2	-18
59	Social	impacts on sense and spirit of place	Alternative 1	Construction	-1	2	2	5	3	5	-15	-1	2	2	4	2	4	-10	High	3	2	-14
60	Social	impacts on sense and spirit of place	Alternative 1	Operation	-1	2	5	4	5	5	-20	-1	2	5	4	5	5	-20	High	3	2	-28
61	Social	Impacts on the social licence to operate	Alternative 1	Construction	-1	3	2	4	3	4	-12	1	2	2	4	3	4	11	Medium	2	2	14
62	Social	Impacts on the social licence to operate	Alternative 1	Operation	-1	3	4	5	3	4	-15	1	3	4	4	2	4	13	Medium	2	2	16
63	Social	Increase in social pathologies	Alternative 1	Construction	-1	3	2	3	3	4	-11	-1	3	2	3	2	4	-10	Medium	2	1	-11
64	Social	Public perceptions about safety	Alternative 1	Operation	-1	3	3	4	2	4	-12	-1	3	2	2	2	3	-6.8	Medium	1	1	-7

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
		associated with gas production																				
65	Social	Contribution to economy of South Africa	Alternative 1	Operation	1	5	4	4	5	5	22.5	1	5	4	5	5	5	23.8	High	2	1	27
66	Social	Secondary economic opportunities	Alternative 1	Construction	1	3	2	4	2	4	11	1	4	4	4	2	5	17.5	Medium	2	1	20
67	Social	Secondary economic opportunities	Alternative 1	Operation	1	3	4	4	2	4	13	1	4	4	4	3	5	18.8	Medium	2	1	21
68	Social	Potential opportunity for education, skills development, and training	Alternative 1	Operation	1	3	4	4	2	4	13	1	4	4	4	3	5	18.8	Medium	2	1	21
69	Visual	Impact on Existing Agricultural Landscape Character	Alternative 1	Construction	-1	2	1	3	2	4	-8	-1	2	1	3	2	4	-8	Medium	2	1	-9
70	Visual	Impact on Existing Agricultural Landscape Character	Alternative 1	Operation	-1	1	4	1	2	2	-4	-1	1	4	1	2	2	-4	Medium	2	1	-5
71	Visual	Impact on Existing Agricultural Landscape Character	Alternative 1	Decommissioning	-1	2	4	2	2	4	-10	-1	1	1	1	1	1	-1	Medium	2	1	-1
72	Visual	Impact on Existing Natural Landscape Character	Alternative 1	Construction	-1	2	1	3	2	4	-8	-1	1	1	2	2	2	-3	Medium	2	1	-3
73	Visual	Impact on Existing Natural Landscape Character	Alternative 1	Operation	-1	2	4	2	2	3	-7.5	-1	1	4	1	1	2	-3.5	Medium	2	1	-4
74	Visual	Impact on Existing Natural Landscape Character	Alternative 1	Decommissioning	-1	2	1	2	2	3	-5.3	-1	1	1	1	1	2	-2	Medium	1	1	-2
75	Visual	The visual impact on views from local roads	Alternative 1	Construction	-1	2	1	3	2	4	-8	-1	2	1	2	2	3	-5.3	Medium	2	1	-6
76	Visual	The visual impact on views from local roads	Alternative 1	Operation	-1	2	4	3	2	4	-11	-1	2	4	2	2	3	-7.5	Medium	2	1	-8

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
77	Visual	The visual impact on views from local roads	Alternative 1	Decommissioning	-1	2	3	3	2	4	-10	-1	1	1	1	1	1	-1	Medium	1	1	-1
78	Visual	Change of Natural of Views from Homesteads	Alternative 1	Construction	-1	2	4	4	2	4	-12	-1	2	1	1	2	3	-4.5	Medium	2	1	-5
79	Visual	Change of Natural of Views from Homesteads	Alternative 1	Operation	-1	1	4	2	2	3	-6.75	-1	1	4	1	2	2	-4	Medium	2	1	-5
80	Visual	Change of Natural of Views from Homesteads	Alternative 1	Decommissioning	-1	2	3	3	2	4	-10	-1	1	1	1	1	1	-1	Medium	1	1	-1
81	Visual	The visual impact on views from local homesteads due to Lighting	Alternative 1	Construction	-1	2	1	4	1	4	-8	-1	1	1	1	1	1	-1	Medium	1	1	-1
82	Visual	The visual impact on views from local homesteads due to Lighting	Alternative 1	Operation	-1	2	4	4	1	4	-11	-1	1	4	1	1	1	-1.8	Medium	1	1	-2
83	Visual	The visual impact on views from local homesteads due to Lighting	Alternative 1	Decommissioning	-1	2	1	4	1	4	-8	-1	1	1	1	1	1	-1	Medium	1	1	-1
84	Terrestrial	Temporary disturbance of wildlife due to increased human presence and possible use of machinery and/or vehicles.	Alternative 1	Planning	-1	2	2	2	1	2	-3.5	-1	1	1	1	1	2	-2	High	1	1	-2
85	Terrestrial	Destruction, further loss and fragmentation of the vegetation community	Alternative 1	Construction	-1	2	2	4	3	4	-11	-1	2	2	3	2	4	-9	High	2	2	-11

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
86	Terrestrial	Introduction of alien species, especially plants	Alternative 1	Construction	-1	2	3	3	2	3	-7.5	-1	1	2	2	3	3	-6	High	2	1	-7
87	Terrestrial	Erosion due to storm water runoff and wind	Alternative 1	Construction	-1	2	3	3	2	3	-7.5	-1	2	2	2	3	3	-6.8	Medium	2	1	-8
88	Terrestrial	Displacement of faunal community due to habitat loss, direct mortalities and disturbance (road collisions, noise, light, dust, vibration and poaching).	Alternative 1	Construction	-1	2	3	4	3	3	-9	-1	1	3	3	3	3	-7.5	High	2	1	-8
89	Terrestrial	Environmental pollution due to potential leaks, discharges, pollutant leaching into the surrounding environment	Alternative 1	Operation	-1	3	3	3	3	3	-9	-1	2	3	3	3	2	-5.5	High	1	1	-6
90	Terrestrial	Continued fragmentation, further loss and fragmentation of the vegetation community	Alternative 1	Operation	-1	2	4	3	2	4	-11	-1	2	3	3	3	3	-8.3	High	2	2	-10
91	Terrestrial	Vegetation loss due to erosion and encroachment by alien invasive plant species	Alternative 1	Operation	-1	2	4	3	2	3	-8.3	-1	2	3	2	2	2	-4.5	Medium	2	1	-5
92	Terrestrial	Potential leaks, discharges, pollutant from activities leaching into the surrounding environment	Alternative 1	Operation	-1	3	3	3	3	3	-9	-1	2	3	2	3	3	-7.5	High	1	1	-8

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
93	Terrestrial	Continued displacement and fragmentation of the faunal community (including threatened or protected species) due to ongoing anthropogenic disturbances (noise, dust and vibrations) and habitat degradation/loss (litter, road mortalities and/or poaching).	Alternative 1	Operation	-1	2	4	3	3	4	-12	-1	2	3	3	3	2	-5.5	High	2	1	-6
94	Terrestrial	Continued encroachment of vegetation community by alien invasive plant species as well as erosion due to disturbed soils	Alternative 1	Decommissioning	-1	2	2	3	3	3	-7.5	-1	2	3	2	2	2	-4.5	High	1	1	-5
95	Terrestrial	Continued displacement and fragmentation of the faunal community (including potential threatened or protected species) due to ongoing habitat degradation/loss (infringement, litter, road mortalities and/or poaching).	Alternative 1	Decommissioning	-1	2	2	3	3	3	-7.5	-1	2	3	2	2	2	-4.5	High	1	1	-5

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
96	Pedology	Construction of compressors and wells		Construction	-1	2	2	3	3	3	-7.5	-1	2	2	3	3	3	-7.5	Medium	2	1	-8
97	Pedology	Construction of pipelines and transmission loop		Construction	-1	2	2	2	2	3	-6	-1	2	2	2	2	3	-6	Medium	2	1	-7
98	Pedology	Operation of Compressor and Wells		Operation	-1	2	4	3	2	3	-8.3	-1	2	4	3	2	2	-5.5	Medium	2	1	-6
99	Pedology	Operation of pipelines and transmission loop		Operation	-1	2	4	2	2	3	-7.5	-1	2	4	2	2	2	-5	Medium	2	1	-6
100	Pedology	Decommissioning of Compressors and Wells		Decommissioning	-1	2	2	2	2	3	-6	-1	2	2	2	2	3	-6	Medium	2	1	-7
101	Pedology	Decommissioning of pipelines and transmission loop		Decommissioning	-1	2	2	2	2	2	-4	-1	2	2	2	2	2	-4	Medium	2	1	-5
102	Wetlands	Exploration Wells - Habitat	Alternative 1	Planning	-1	2	2	2	2	2	-4	-1	2	2	3	2	1	-2.3	Medium	2	1	-3
103	Wetlands	Exploration Wells - Water Quality	Alternative 1	Planning	-1	2	2	2	2	2	-4	-1	2	2	3	2	1	-2.3	Medium	1	1	-2
104	Wetlands	Exploration Wells - Flow	Alternative 1	Planning	-1	1	1	2	2	2	-3	-1	1	1	2	2	1	-1.5	Medium	1	1	-2
105	Wetlands	Pipelines and Transmission loop - Habitat	Alternative 1	Construction	-1	3	2	3	2	3	-7.5	-1	2	2	2	2	2	-4	Medium	2	1	-5
106	Wetlands	Pipelines and Transmission loop - Water Quality	Alternative 1	Construction	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
107	Wetlands	Pipelines and Transmission loop - Flow	Alternative 1	Construction	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
108	Wetlands	Compressors Station CS1 - Habitat	Alternative 1	Construction	-1	2	3	3	3	3	-8.3	-1	2	3	2	3	2	-5	Medium	2	1	-6
109	Wetlands	Compressors Station CS1 - Water Quality	Alternative 1	Construction	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
110	Wetlands	Compressors Station CS1 - Flow	Alternative 1	Construction	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
111	Wetlands	Compressors Station CS1 - Habitat	Alternative 2	Construction	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
112	Wetlands	Compressors Station CS1 - Water Quality	Alternative 2	Construction	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
113	Wetlands	Compressors Station CS1 - Flow	Alternative 2	Construction	-1	1	1	2	2	2	-3	-1	1	1	1	2	2	-2.5	Medium	1	1	-3
114	Wetlands	Compressors CS2 - Habitat	Alternative 1	Construction	-1	2	2	2	2	2	-4	-1	2	2	2	2	2	-4	Medium	2	1	-5
115	Wetlands	Compressors CS2 - Water Quality	Alternative 1	Construction	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
116	Wetlands	Compressors CS2 - Flow	Alternative 1	Construction	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
117	Wetlands	Compressors CS3 - Habitat	Alternative 1	Construction	-1	1	2	1	1	3	-3.8	-1	1	1	2	2	2	-3	Medium	2	1	-3
118	Wetlands	Compressors CS3 - Water Quality	Alternative 1	Construction	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
119	Wetlands	Compressors CS3 - Flow	Alternative 1	Construction	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
120	Wetlands	Compressors CS3 - Habitat	Alternative 2	Construction	-1	2	2	2	2	2	-4	-1	2	2	2	2	2	-4	Medium	2	1	-5
121	Wetlands	Compressors CS3 - Water Quality	Alternative 2	Construction	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
122	Wetlands	Compressors CS3 - Flow	Alternative 2	Construction	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
123	Wetlands	Powerlines - Habitat	Alternative 1	Construction	-1	3	3	3	2	2	-5.5	-1	1	1	2	2	2	-3	Medium	1	1	-3
124	Wetlands	Powerlines - Water Quality	Alternative 1	Construction	-1	1	1	1	1	2	-2	-1	1	1	2	1	1	-1.3	Medium	1	1	-1
125	Wetlands	Powerlines - Flow	Alternative 1	Construction	-1	1	1	1	2	2	-2.5	-1	1	1	2	1	1	-1.3	Medium	1	1	-1
126	Wetlands	Access Roads - Habitat	Alternative 1	Construction	-1	2	2	3	2	2	-4.5	-1	1	1	2	2	2	-3	Medium	1	1	-3
127	Wetlands	Access Roads - Water Quality	Alternative 1	Construction	-1	2	3	2	2	3	-6.8	-1	2	2	2	2	2	-4	Medium	1	1	-4
128	Wetlands	Access Roads - Flow	Alternative 1	Construction	-1	2	1	2	2	2	-3.5	-1	1	1	1	1	2	-2	Medium	1	1	-2

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
129	Wetlands	LNG/LHe Plant - Habitat	Alternative 1	Construction	-1	2	2	2	2	2	-4	-1	1	1	2	2	2	-3	Medium	1	1	-3
130	Wetlands	LNG/LHe Plant - Water Quality	Alternative 1	Construction	-1	2	1	2	2	2	-3.5	-1	1	1	1	2	2	-2.5	Medium	1	1	-3
131	Wetlands	LNG/LHe Plant - Flow	Alternative 1	Construction	-1	1	1	2	2	2	-3	-1	1	1	1	2	2	-2.5	Medium	1	1	-3
132	Wetlands	Pipelines and Transmission loop - Habitat	Alternative 1	Operation	-1	2	2	2	2	2	-4	-1	2	1	1	1	2	-2.5	Medium	2	1	-3
133	Wetlands	Pipelines and Transmission loop - Water Quality	Alternative 1	Operation	-1	2	2	2	1	2	-3.5	-1	1	1	1	1	2	-2	Medium	1	1	-2
134	Wetlands	Pipelines and Transmission loop - Flow	Alternative 1	Operation	-1	1	1	2	2	2	-3	-1	1	1	1	1	1	-1	Medium	1	1	-1
135	Wetlands	Compressors Station CS1 - Habitat	Alternative 1	Operation	-1	3	4	3	3	3	-9.8	-1	3	4	3	2	2	-6	Medium	2	1	-7
136	Wetlands	Compressors Station CS1 - Water Quality	Alternative 1	Operation	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
137	Wetlands	Compressors Station CS1 - Flow	Alternative 1	Operation	-1	2	2	2	2	2	-4	-1	2	2	2	2	2	-4	Medium	1	1	-4
138	Wetlands	Compressors Station CS1 - Habitat	Alternative 2	Operation	-1	1	4	2	2	3	-6.8	-1	1	4	1	1	2	-3.5	Medium	2	1	-4
139	Wetlands	Compressors Station CS1 - Water Quality	Alternative 2	Operation	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
140	Wetlands	Compressors Station CS1 - Flow	Alternative 2	Operation	-1	1	1	2	2	2	-3	-1	1	1	1	1	1	-1	Medium	1	1	-1
141	Wetlands	Compressors CS2 - Habitat	Alternative 1	Operation	-1	3	4	2	2	3	-8.3	-1	1	2	2	1	2	-3	Medium	2	1	-3
142	Wetlands	Compressors CS2 - Water Quality	Alternative 1	Operation	-1	1	2	2	1	2	-3	-1	1	1	1	1	2	-2	Medium	1	1	-2
143	Wetlands	Compressors CS2 - Flow	Alternative 1	Operation	-1	1	2	4	2	2	-4.5	-1	1	1	1	1	2	-2	Medium	1	1	-2
144	Wetlands	Compressors CS3 - Habitat	Alternative 1	Operation	-1	3	3	2	2	3	-7.5	-1	2	2	2	2	2	-4	Medium	2	1	-5
145	Wetlands	Compressors CS3 - Water Quality	Alternative 1	Operation	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
146	Wetlands	Compressors CS3 - Flow	Alternative 1	Operation	-1	2	2	2	2	2	-4	-1	2	2	2	2	2	-4	Medium	1	1	-4
147	Wetlands	Compressors CS3 - Habitat	Alternative 2	Operation	-1	3	3	2	2	3	-7.5	-1	2	2	2	2	2	-4	Medium	2	1	-5
148	Wetlands	Compressors CS3 - Water Quality	Alternative 2	Operation	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
149	Wetlands	Compressors CS3 - Flow	Alternative 2	Operation	-1	2	2	2	2	2	-4	-1	2	2	2	2	2	-4	Medium	1	1	-4
150	Wetlands	Powerlines - Habitat	Alternative 1	Operation	-1	2	4	2	2	2	-5	-1	1	4	1	1	2	-3.5	Medium	1	1	-4
151	Wetlands	Powerlines - Water Quality	Alternative 1	Operation	-1	1	1	1	1	1	-1	-1	1	1	1	1	1	-1	Medium	1	1	-1
152	Wetlands	Powerlines - Flow	Alternative 1	Operation	-1	1	1	1	1	1	-1	-1	1	1	2	1	1	-1.3	Medium	1	1	-1
153	Wetlands	Access Roads - Habitat	Alternative 1	Operation	-1	3	4	3	2	3	-9	-1	1	4	2	2	2	-4.5	Medium	1	1	-5
154	Wetlands	Access Roads - Water Quality	Alternative 1	Operation	-1	2	4	2	2	2	-5	-1	2	4	1	1	2	-4	Medium	1	1	-4
155	Wetlands	Access Roads - Flow	Alternative 1	Operation	-1	2	4	2	2	2	-5	-1	1	4	1	1	2	-3.5	Medium	1	1	-4
156	Wetlands	LNG/LHe Plant - Habitat	Alternative 1	Operation	-1	1	4	2	2	2	-4.5	-1	1	4	1	2	2	-4	Medium	1	1	-4
157	Wetlands	LNG/LHe Plant - Water Quality	Alternative 1	Operation	-1	2	1	2	2	2	-3.5	-1	1	4	1	1	2	-3.5	Medium	1	1	-4
158	Wetlands	LNG/LHe Plant - Flow	Alternative 1	Operation	-1	1	1	2	2	2	-3	-1	1	4	1	1	2	-3.5	Medium	1	1	-4
159	Wetlands	Pipelines and Transmission loop - Habitat	Alternative 1	Decommissioning	-1	3	2	3	2	3	-7.5	-1	2	2	2	2	2	-4	Medium	2	1	-5
160	Wetlands	Pipelines and Transmission loop - Water Quality	Alternative 1	Decommissioning	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
161	Wetlands	Pipelines and Transmission loop - Flow	Alternative 1	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
162	Wetlands	Compressors Station CS1 - Habitat	Alternative 1	Decommissioning	-1	3	2	3	3	3	-8.3	-1	2	3	2	3	2	-5	Medium	2	1	-6

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
163	Wetlands	Compressors Station CS1 - Water Quality	Alternative 1	Decommissioning	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
164	Wetlands	Compressors Station CS1 - Flow	Alternative 1	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
165	Wetlands	Compressors Station CS1 - Habitat	Alternative 2	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
166	Wetlands	Compressors Station CS1 - Water Quality	Alternative 2	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
167	Wetlands	Compressors Station CS1 - Flow	Alternative 2	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	1	2	2	-2.5	Medium	1	1	-3
168	Wetlands	Compressors CS2 - Habitat	Alternative 1	Decommissioning	-1	2	2	2	2	2	-4	-1	2	2	2	2	2	-4	Medium	2	1	-5
169	Wetlands	Compressors CS2 - Water Quality	Alternative 1	Decommissioning	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
170	Wetlands	Compressors CS2 - Flow	Alternative 1	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
171	Wetlands	Compressors CS3 - Habitat	Alternative 1	Decommissioning	-1	1	2	1	1	3	-3.8	-1	1	1	2	2	2	-3	Medium	2	1	-3
172	Wetlands	Compressors CS3 - Water Quality	Alternative 1	Decommissioning	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
173	Wetlands	Compressors CS3 - Flow	Alternative 1	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
174	Wetlands	Compressors CS3 - Habitat	Alternative 2	Decommissioning	-1	2	2	2	2	2	-4	-1	2	2	2	2	2	-4	Medium	2	1	-5
175	Wetlands	Compressors CS3 - Water Quality	Alternative 2	Decommissioning	-1	2	2	2	1	2	-3.5	-1	2	2	2	1	2	-3.5	Medium	1	1	-4
176	Wetlands	Compressors CS3 - Flow	Alternative 2	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	2	2	2	-3	Medium	1	1	-3
177	Wetlands	Powerlines - Habitat	Alternative 1	Decommissioning	-1	3	2	3	2	2	-5	-1	1	1	2	2	2	-3	Medium	1	1	-3
178	Wetlands	Powerlines - Water Quality	Alternative 1	Decommissioning	-1	1	1	1	1	2	-2	-1	1	1	2	1	1	-1.3	Medium	1	1	-1
179	Wetlands	Powerlines - Flow	Alternative 1	Decommissioning	-1	1	1	1	2	2	-2.5	-1	1	1	2	1	1	-1.3	Medium	1	1	-1
180	Wetlands	Access Roads - Habitat	Alternative 1	Decommissioning	-1	2	2	3	2	2	-4.5	-1	1	1	2	2	2	-3	Medium	1	1	-3

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
181	Wetlands	Access Roads - Water Quality	Alternative 1	Decommissioning	-1	2	2	2	2	3	-6	-1	2	2	2	2	2	-4	Medium	1	1	-4
182	Wetlands	Access Roads - Flow	Alternative 1	Decommissioning	-1	2	1	2	2	2	-3.5	-1	1	1	1	1	2	-2	Medium	1	1	-2
183	Wetlands	LNG/LHe Plant - Habitat	Alternative 1	Decommissioning	-1	2	2	2	2	2	-4	-1	1	1	2	2	2	-3	Medium	1	1	-3
184	Wetlands	LNG/LHe Plant - Water Quality	Alternative 1	Decommissioning	-1	2	1	2	2	2	-3.5	-1	1	1	1	2	2	-2.5	Medium	1	1	-3
185	Wetlands	LNG/LHe Plant - Flow	Alternative 1	Decommissioning	-1	1	1	2	2	2	-3	-1	1	1	1	2	2	-2.5	Medium	1	1	-3
186	Economic	GGP Impact	Alternative 1	Construction	1	4	2	5	5	4	16	1	4	2	5	5	4	16	High	1	2	18
187	Economic	Employment Impacts	Alternative 1	Construction	1	3	2	3	5	4	13	1	3	2	3	5	4	13	High	1	2	15
188	Economic	Forex savings	Alternative 1	Construction	-1	5	2	1	5	3	-9.8	-1	5	2	1	5	3	-9.8	High	1	2	-11
189	Economic	Fiscal Income	Alternative 1	Construction	1	5	1	1	5	4	12	1	5	1	1	5	4	12	High	1	2	14
190	Economic	Economic development per capita	Alternative 1	Construction	1	4	2	4	5	4	15	1	4	2	4	5	4	15	High	1	2	17
191	Economic	Country and Industry Competitiveness	Alternative 1	Construction	1	5	2	4	5	4	16	1	5	2	4	5	4	16	Medium	1	2	18
192	Economic	Black Economic Transformation	Alternative 1	Construction	1	5	2	4	3	4	14	1	5	2	4	3	4	14	Medium	1	2	16
193	Economic	Alternative Land-use	Alternative 1	Construction	1	2	2	1	2	5	8.75	1	2	2	1	2	5	8.75	High	1	2	10
194	Economic	Need and Desirability	Alternative 1	Construction	1	4	2	5	4	4	15	1	4	2	5	4	4	15	High	1	2	17
195	Economic	Impact on individual farmland values	Alternative 1	Construction	-1	3	2	3	2	3	-7.5	-1	3	2	3	2	3	-7.5	Low	1	2	-8
196	Economic	GGP Impact	Alternative 1	Operation	1	5	4	5	5	5	23.8	1	5	4	5	5	5	23.8	High	3	2	33
197	Economic	Employment Impacts	Alternative 1	Operation	1	4	4	4	5	4	17	1	4	4	4	5	4	17	High	3	2	23
198	Economic	Forex savings	Alternative 1	Operation	1	5	4	4	5	4	18	1	5	4	4	5	4	18	High	3	2	25
199	Economic	Fiscal Income	Alternative 1	Operation	1	5	4	3	5	4	17	1	5	4	3	5	4	17	High	3	2	23
200	Economic	Economic development per capita	Alternative 1	Operation	1	4	4	4	5	4	17	1	4	4	4	5	4	17	High	3	2	23

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
201	Economic	Country and Industry Competitiveness	Alternative 1	Operation	1	5	5	5	5	4	20	1	5	5	5	5	4	20	Medium	3	2	28
202	Economic	Black Economic Transformation	Alternative 1	Operation	1	5	4	4	3	4	16	1	5	4	4	3	4	16	Medium	3	2	22
203	Economic	Alternative Land-use	Alternative 1	Operation	1	2	4	1	2	5	11.3	1	2	4	1	2	5	11.3	High	3	2	15
204	Economic	Need and Desirability	Alternative 1	Operation	1	5	5	5	5	4	20	1	5	5	5	5	4	20	High	3	2	28
205	Economic	Impact on individual farmland values	Alternative 1	Operation	-1	3	4	3	2	3	-9	-1	3	4	3	2	3	-9	Medium	3	2	-12
206	Economic	GGP Impact	Alternative 1	Decommissioning	-1	4	2	4	3	4	-13	-1	4	2	4	3	4	-13	High	1	1	-13
207	Economic	Employment Impacts	Alternative 1	Decommissioning	-1	4	2	4	3	4	-13	-1	4	2	4	3	4	-13	High	1	1	-13
208	Economic	Forex savings	Alternative 1	Decommissioning	-1	4	5	4	5	5	-23	-1	4	5	4	5	5	-23	High	1	1	-23
209	Economic	Fiscal Income	Alternative 1	Decommissioning	-1	4	5	4	5	5	-23	-1	4	5	4	5	5	-23	High	1	1	-23
210	Economic	Economic development per capita	Alternative 1	Decommissioning	-1	4	2	4	3	4	-13	-1	4	2	4	3	4	-13	High	1	1	-13
211	Economic	Country and Industry Competitiveness	Alternative 1	Decommissioning	-1	5	5	3	5	4	-18	-1	5	5	3	5	4	-18	Medium	1	1	-18
212	Economic	Black Economic Transformation	Alternative 1	Decommissioning	-1	3	5	3	5	4	-16	-1	3	5	3	5	4	-16	Medium	1	1	-16
213	Economic	Alternative Land-use	Alternative 1	Decommissioning	-1	2	2	4	4	5	-15	-1	2	2	4	4	5	-15	High	1	1	-15
214	Economic	Need and Desirability	Alternative 1	Decommissioning	-1	4	2	5	4	4	-15	-1	4	2	5	4	4	-15	High	1	1	-15
215	Economic	Impact on individual farmland values	Alternative 1	Decommissioning	1	3	2	3	3	3	8.25	1	3	2	3	3	3	8.25	Medium	1	1	8
216	Economic	GGP Impact	Alternative 1	Rehab and closure	-1	4	5	4	5	5	-23	-1	4	5	4	5	5	-23	High	1	1	-23
217	Economic	Employment Impacts	Alternative 1	Rehab and closure	-1	4	5	4	5	5	-23	-1	4	5	4	5	5	-23	High	1	1	-23
218	Economic	Forex savings	Alternative 1	Rehab and closure	-1	4	5	4	5	5	-23	-1	4	5	4	5	5	-23	High	1	1	-23
219	Economic	Fiscal Income	Alternative 1	Rehab and closure	-1	4	5	4	5	5	-23	-1	4	5	4	5	5	-23	High	1	1	-23
220	Economic	Economic development per capita	Alternative 1	Rehab and closure	-1	4	5	4	5	5	-23	-1	4	5	4	5	5	-23	High	1	1	-23

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
Identifier	Discipline	Impact	Alternative	Phase	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Pre-mitigation ER	Nature	Extent	Duration	Magnitude	Reversibility	Probability	Post-mitigation ER	Confidence	Cumulative Impact	Irreplaceable loss	Final score
221	Economic	Country and Industry Competitiveness	Alternative 1	Rehab and closure	-1	5	5	3	2	4	-15	-1	5	5	3	2	4	-15	Medium	1	1	-15
222	Economic	Black Economic Transformation	Alternative 1	Rehab and closure	-1	3	5	3	5	4	-16	-1	3	5	3	5	4	-16	Medium	1	1	-16
223	Economic	Alternative Land-use	Alternative 1	Rehab and closure	-1	2	5	4	4	5	-19	-1	2	5	4	4	5	-19	High	1	1	-19
224	Economic	Need and Desirability	Alternative 1	Rehab and closure	-1	4	5	5	4	4	-18	-1	4	5	5	4	4	-18	High	1	1	-18
225	Economic	Impact on individual farmland values	Alternative 1	Rehab and closure	1	3	2	3	3	3	8.25	1	3	2	3	3	3	8.25	Medium	1	1	8

11 FINAL SENSITIVITY ANALYSIS

Environmental sensitivity mapping provides a strategic overview of the environmental, cultural and social assets in a region. The sensitivity mapping technique integrates numerous datasets (base maps and shapefiles) into a single consolidated layer making use of Geographic Information System (GIS) software and analysis tools. Environmental sensitivity mapping is a rapid and objective method applied to identify areas which may be particularly sensitive to development based on environmental, cultural and social sensitivity weightings – which is refined by specialists' input within each respective specialist field based on aerial or ground-surveys. Therefore, the sensitivity mapping exercise assists in the identification of sensitive areas within and surrounding the proposed application area. Table 89 provides an overview of the sensitivity ranking system and Figure 199 provides a visual representation of the combined sensitivity mapping approach.

This sensitivity mapping approach allows for the identification of lower risk areas for positioning the project infrastructure whilst protecting identified sensitive environmental areas/ features though more rigorous mitigation (where possible). Areas identified as no-go would be fully excluded from any project related development regardless of the level of mitigation put forward. Furthermore, environmental sensitivity is used to aid in decision-making during consultation processes, forming a strategic part of environmental assessment processes.

The compilation of this map has taken into consideration the individual raking of sensitivity by the following respective specialist disciplines:

- Air quality & Health Risk;
- Geohydrology;
- Heritage (*Note: Heritage sites are not visible on the combined sensitivity map due to the small scale of these sites. Please refer to individual heritage sensitivity maps*);
- Hydrology (1:100-year floodlines);
- Noise;
- Social;
- Soils and Agriculture;
- Terrestrial Biodiversity (including Aquatic and Wetlands); and
- Visual.

The individual sensitivity maps for the above mentioned studies are presented in Figure 200 to Figure 218 and Figure 219 presents the risk based consolidated sensitivity/ composite map which provides an overlay of all sensitivity areas however each specialist discipline sensitivities have various management and mitigation measures. Work within the various sensitivity rankings must be managed according to the EMPr (Appendix 5) as well as the recommendations in the individual specialist reports (Appendix 4).

The application area contains a range of low, medium and high sensitive areas as well as two no-go areas which are as follows:

1. The Beatrix tailings storage facility has been designated as a no-go area due to the limitations of any development on the facility (damage to this facility would be unacceptable).
2. An area assigned a Very High terrestrial theme sensitivity has been delineated on the farm Adamsons Vley 655 (Portion 0) based on the presence of a protected faunal species. Previous attempts to relocate this species have been unsuccessful and in situ conservation remains the preferred outcome. This area should exclude any surface development infrastructure. Consultation and communication with the lead or implementing agent for the sensitive species, Endangered Wildlife Trust (EWT), must be implemented before any construction proximal to the specific area. Monitoring and Management of

the species will be crucial throughout the lifetime of the project and must be discussed and implemented in conjunction with the EWT.

The detailed specialist assessments of the receiving environment within the well and pipeline transects have allowed specific mitigation measures to be put forward for these areas including the high, medium, low and least concern areas and development within the transects must comply with the EMPr. The areas outside of the well and pipeline transects have been assessed and ranked based on previous studies as well as desktop analysis (including lidar imagery where possible) and therefore any activities outside of the ground-truthed transects must follow a risk-based approach to determine what additional measures, if any, must be implemented. For any minor[18] infrastructure required outside of the well and pipeline transects, a risk-based approach will be undertaken based on the following methodology:

- Infrastructure required within low sensitive areas can be undertaken and managed in line with identified mitigation measures in the EMPr.
- Infrastructure located inside medium or highly sensitive sites on the sensitivity maps require a site-specific pre-commencement assessment. The pre-commencement assessment must address the sensitive aspects on site, as identified in the relevant specialist reports. The pre-commencement assessment must be compiled by the site Environmental Officer (EO) with a suitable environmental qualification and experience. All recommendations of the pre-commencement assessment must be clearly recorded and thereafter implemented on site. The completeness and adequacy of the pre-commencement assessment in respect of identifying and managing on site sensitivities must be included in the monthly ECO reports and annual independent audit reports.

Table 89: Sensitivity rating system.

Sensitivity Rating	Description	Management Method
Least Concern	The inherent feature status and sensitivity is already degraded. The proposed development will not affect the current status and/or may result in a positive impact. These features would be the preferred alternative for infrastructure placement.	Comply with EMPr
Low	The proposed development will not have a significant effect on the inherent features status and sensitivity.	Comply with EMPr
Medium	The proposed development will negatively influence the current status of the feature.	Undertake risk-based assessment prior to final infrastructure placement and then comply with EMPr.
High	The proposed development will negatively significantly influence the current status of the feature.	Undertake risk-based assessment prior to final infrastructure placement and then comply with EMPr.
No-Go	No development permitted under any circumstances.	No development permitted under any circumstances.

[18] By “minor” it is important to note that the intention is not to provide for carte-blanch development of areas outside of the transects.

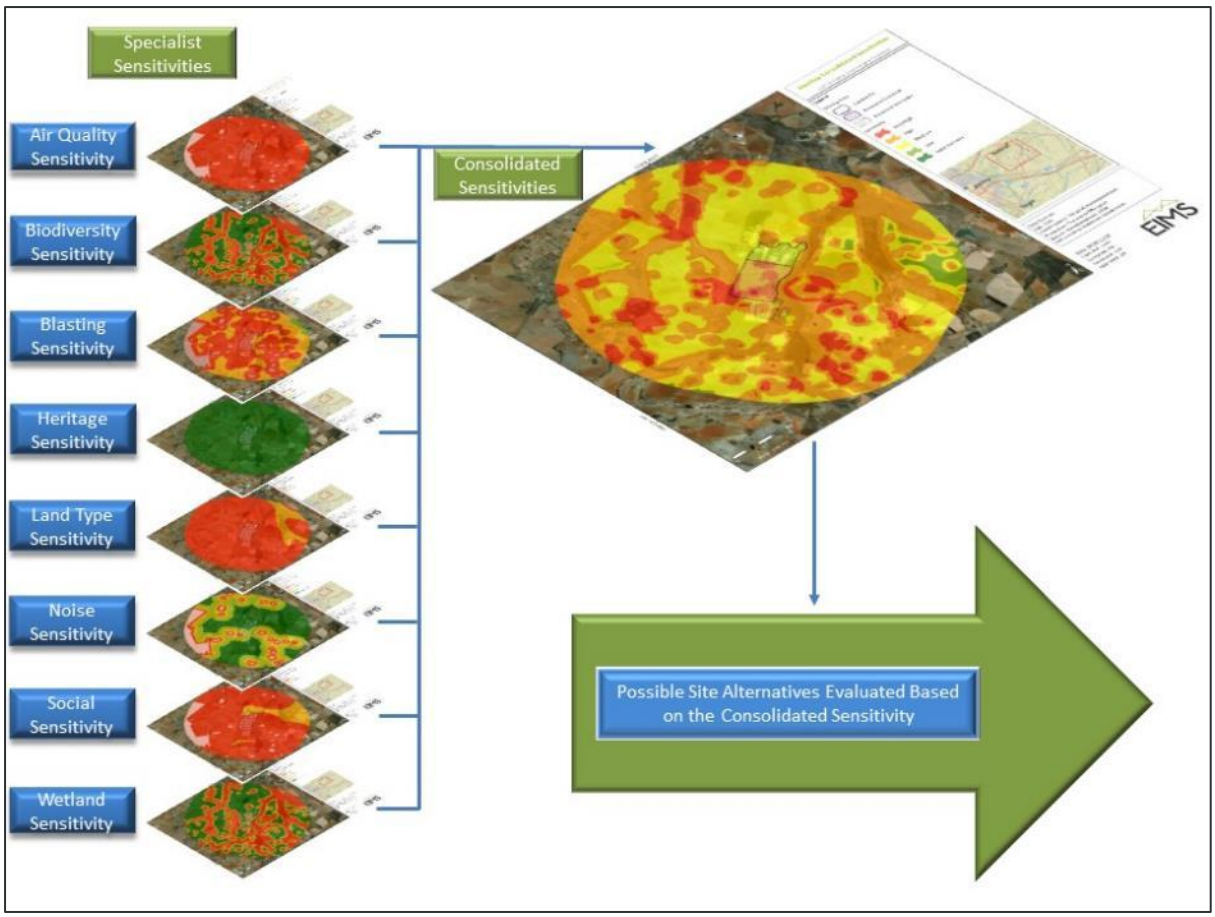


Figure 199: Example of combined sensitivity mapping approach.

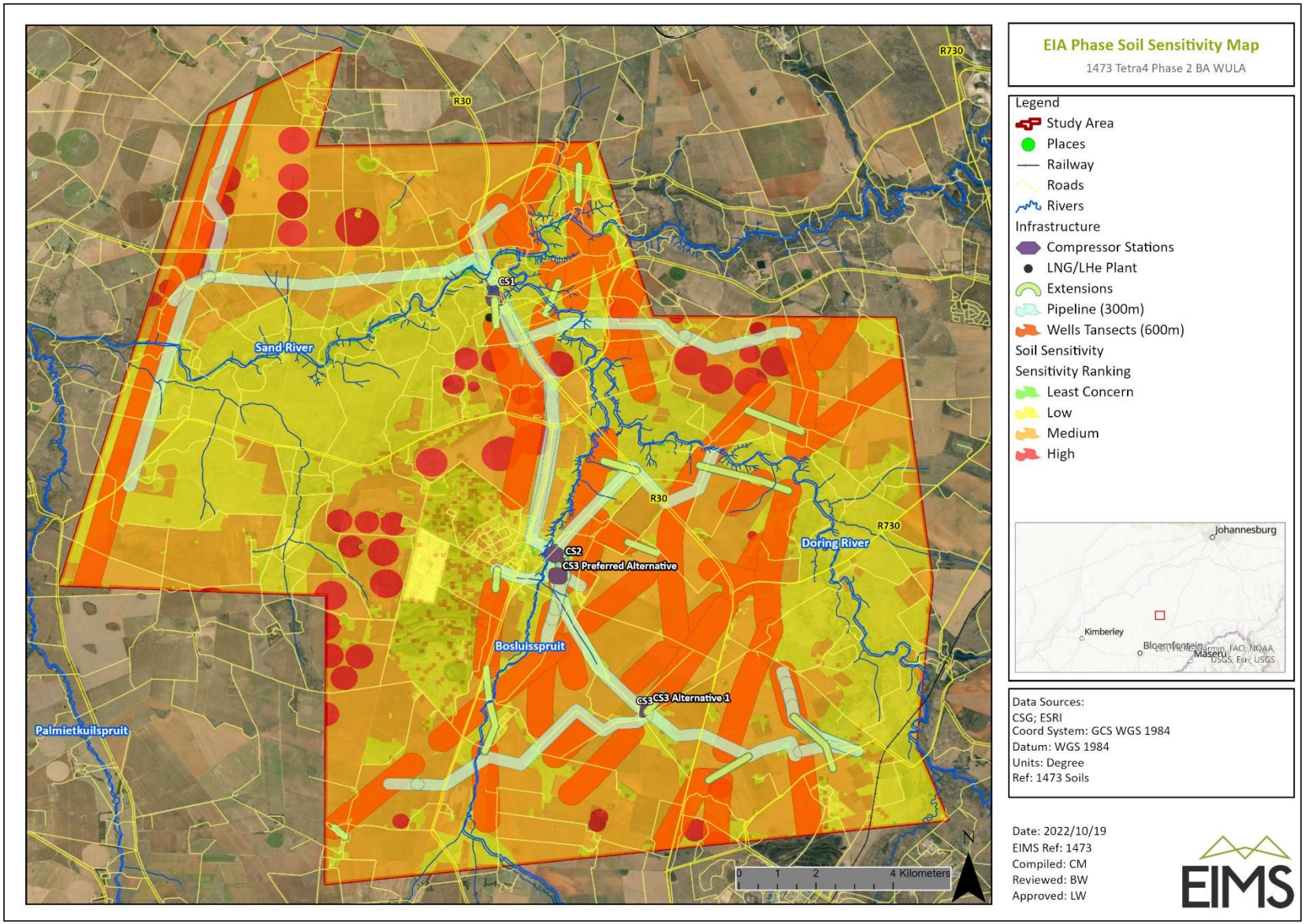


Figure 200: Soils and Agricultural Sensitivity Map.

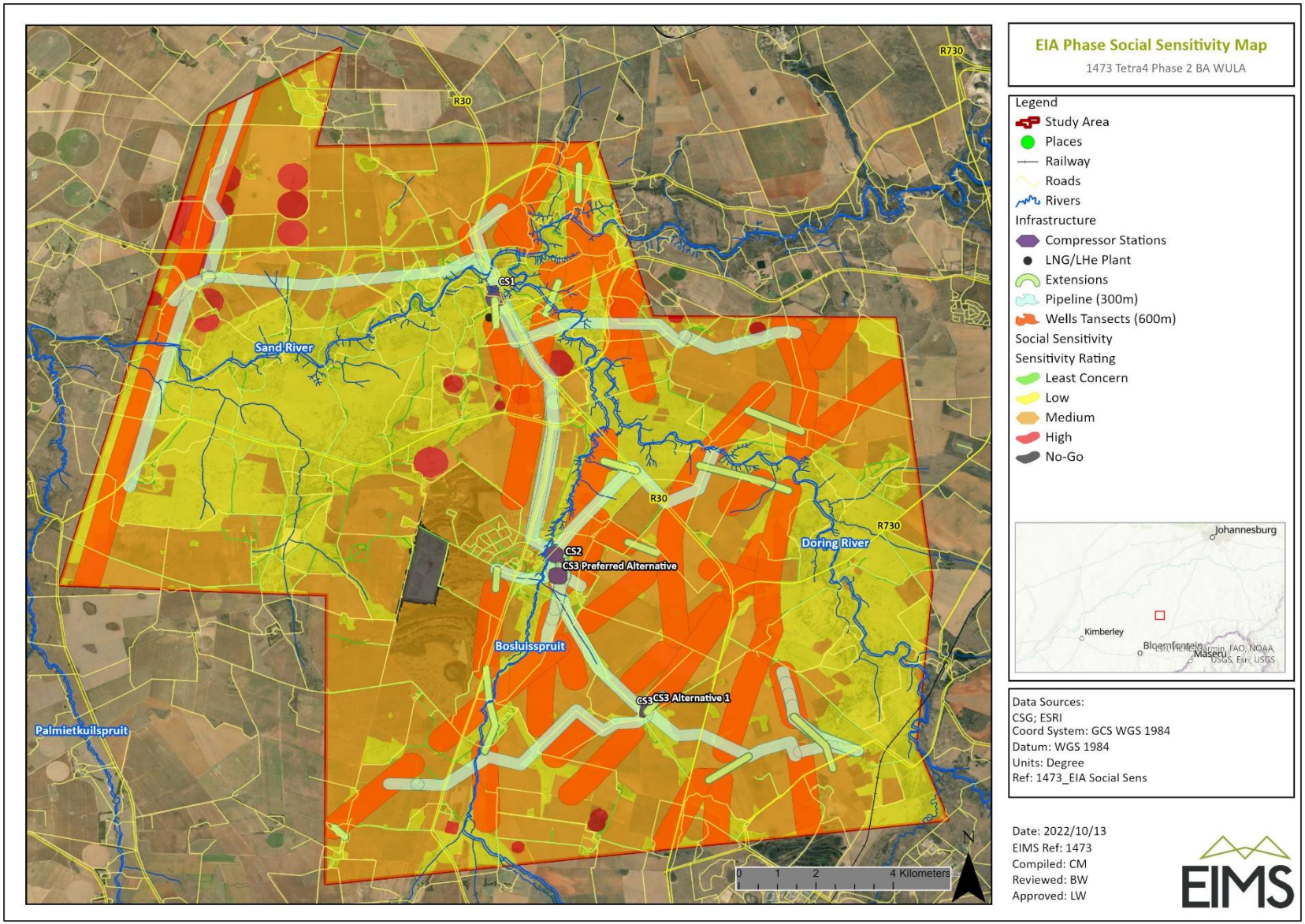


Figure 201: Social Sensitivity Map.

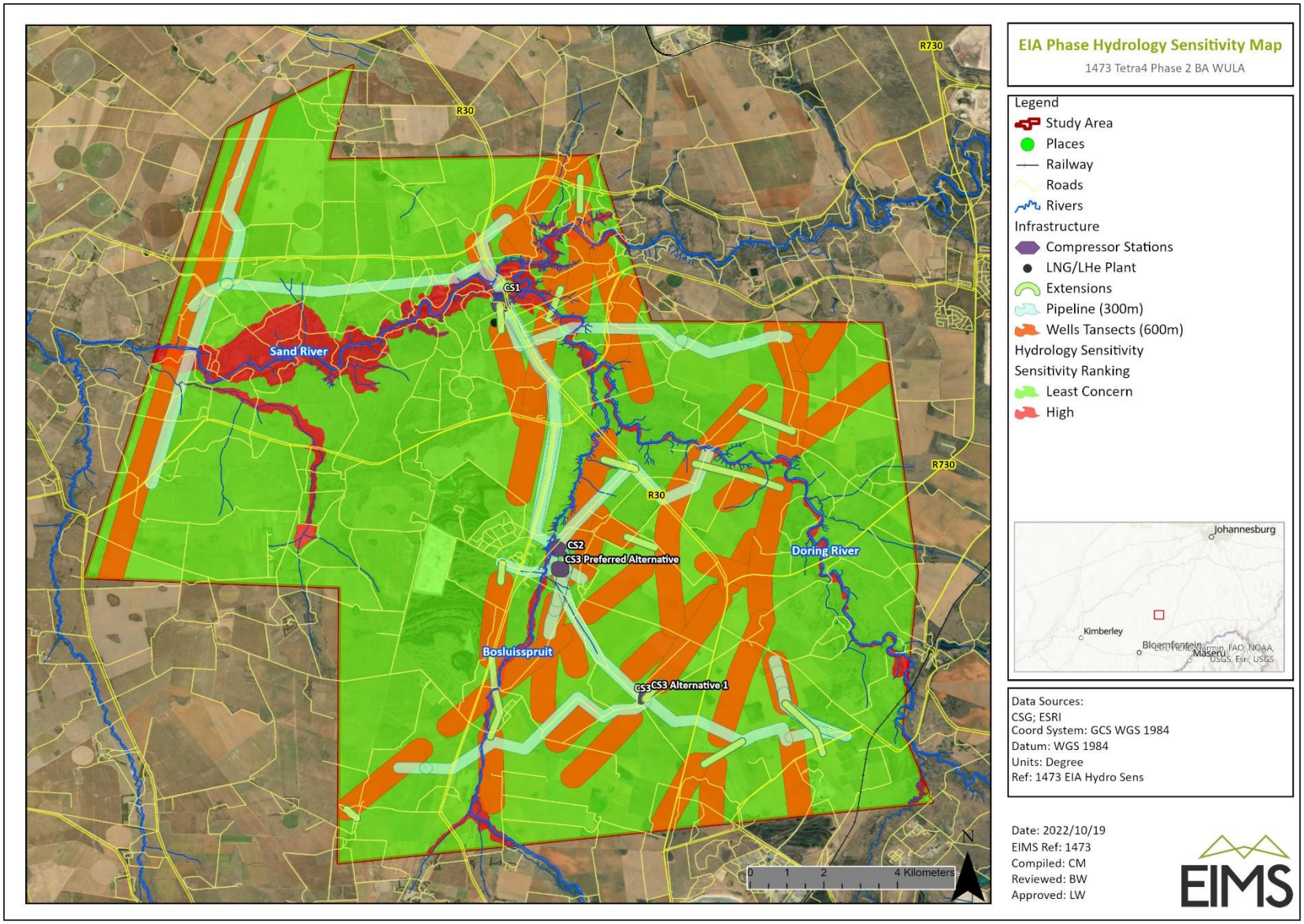


Figure 202: Hydrology sensitivity map (1:100-year floodlines).

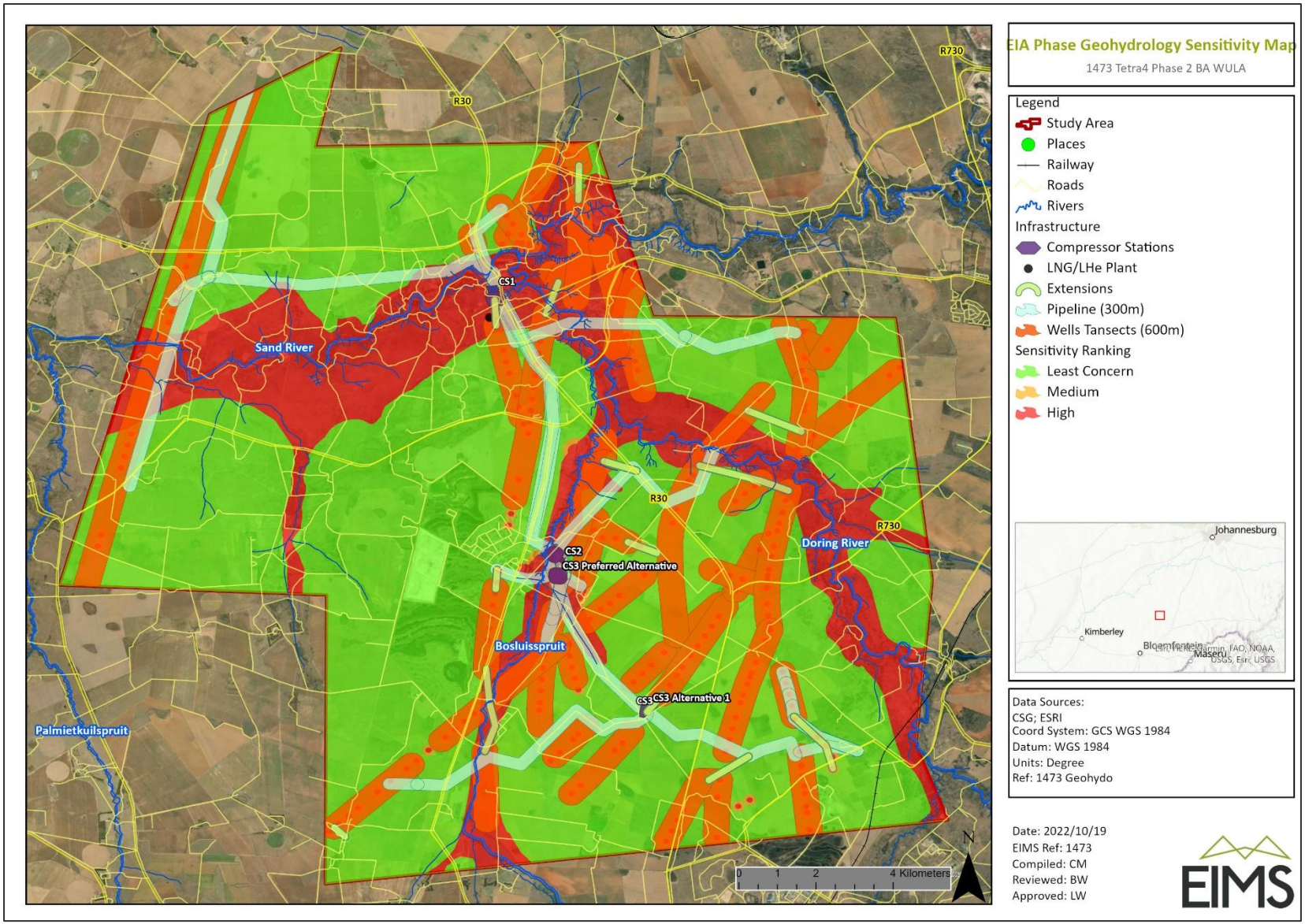


Figure 203: Geohydrology sensitivity map.

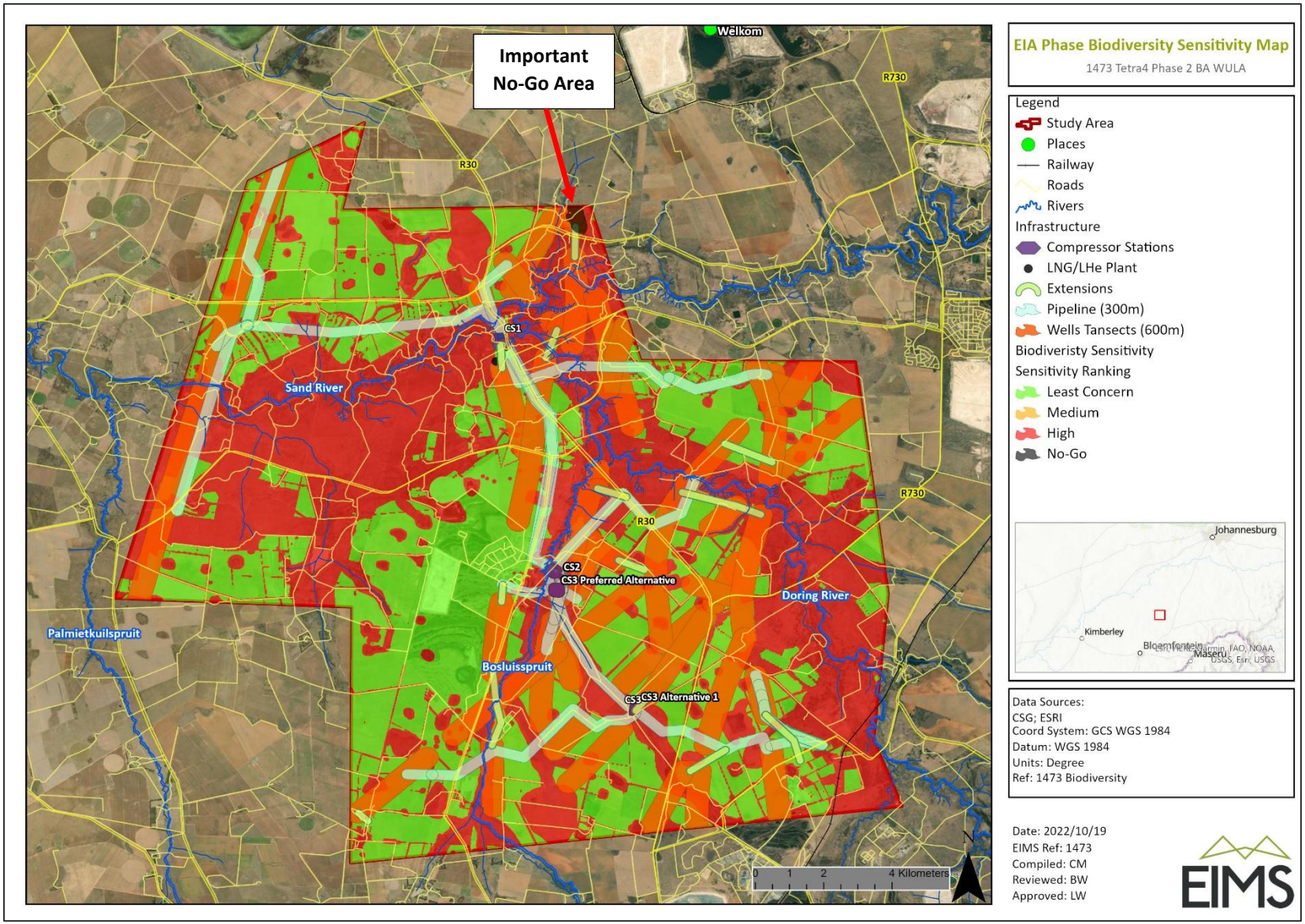


Figure 204: Biodiversity (ecology, aquatic and wetlands) sensitivity map.

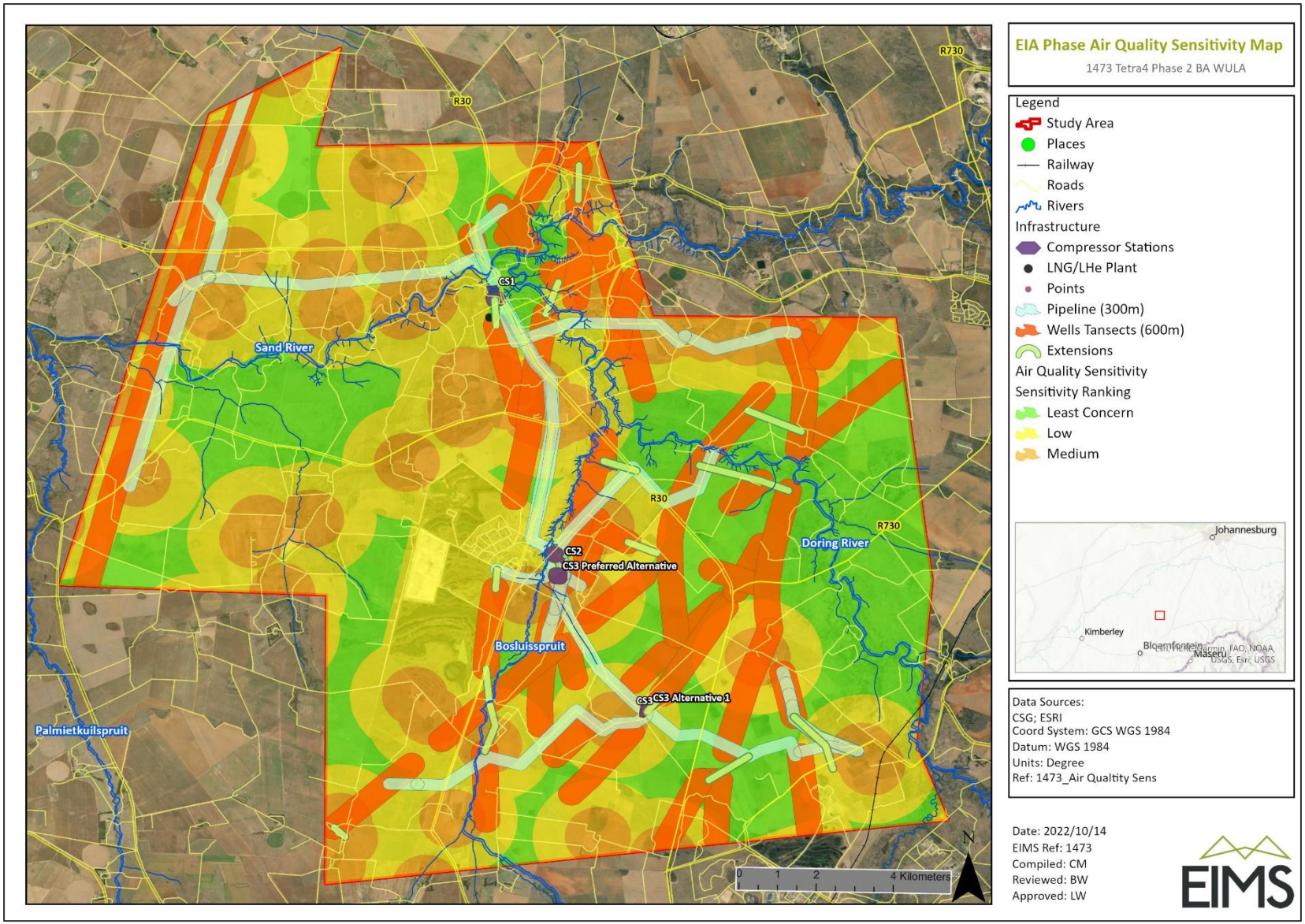


Figure 205: Air quality sensitivity map.

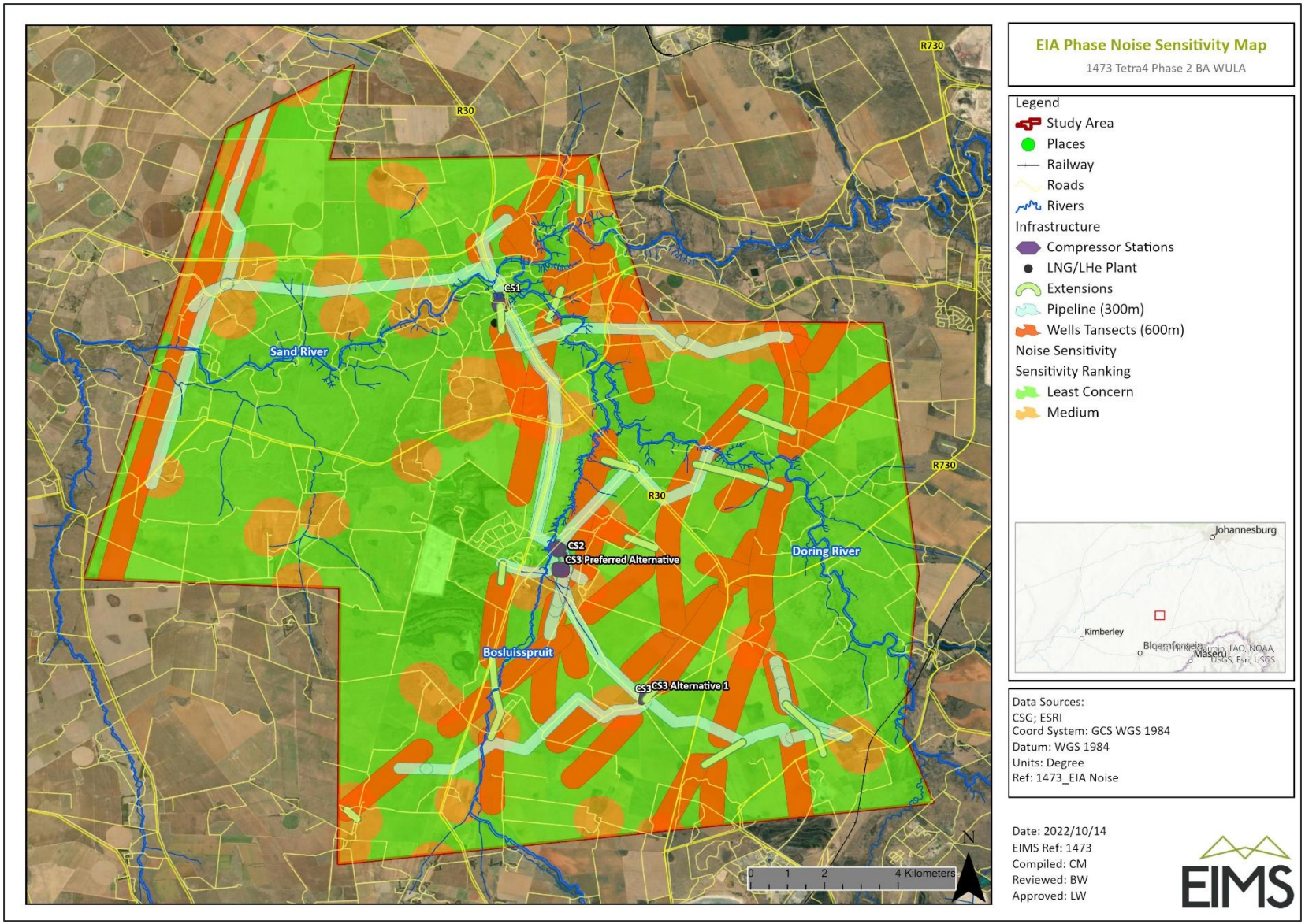


Figure 206: Noise sensitivity map.

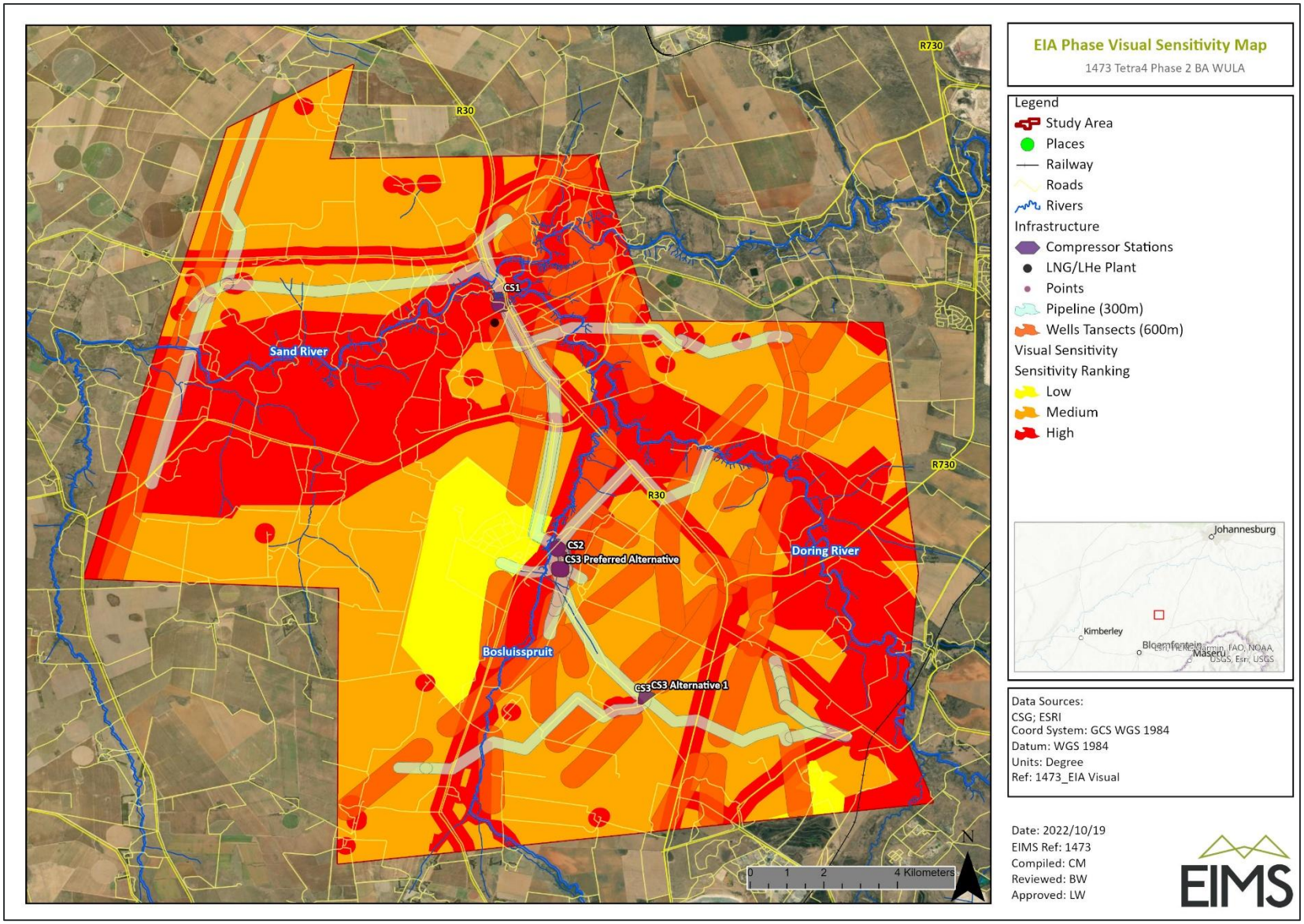


Figure 207: Visual sensitivity map.

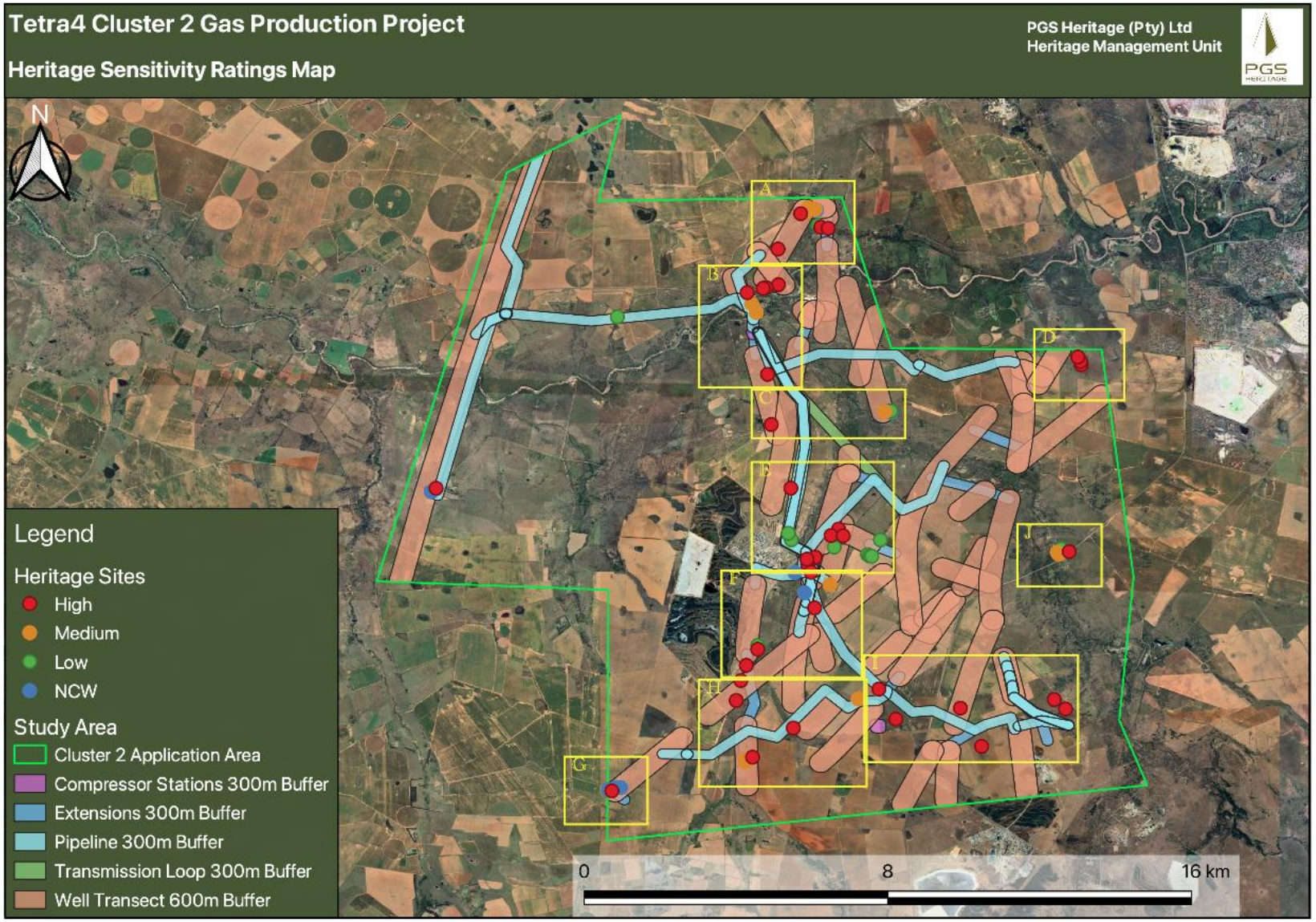


Figure 208: Map showing heritage sensitivity rating of identified heritage resources. See insets below.

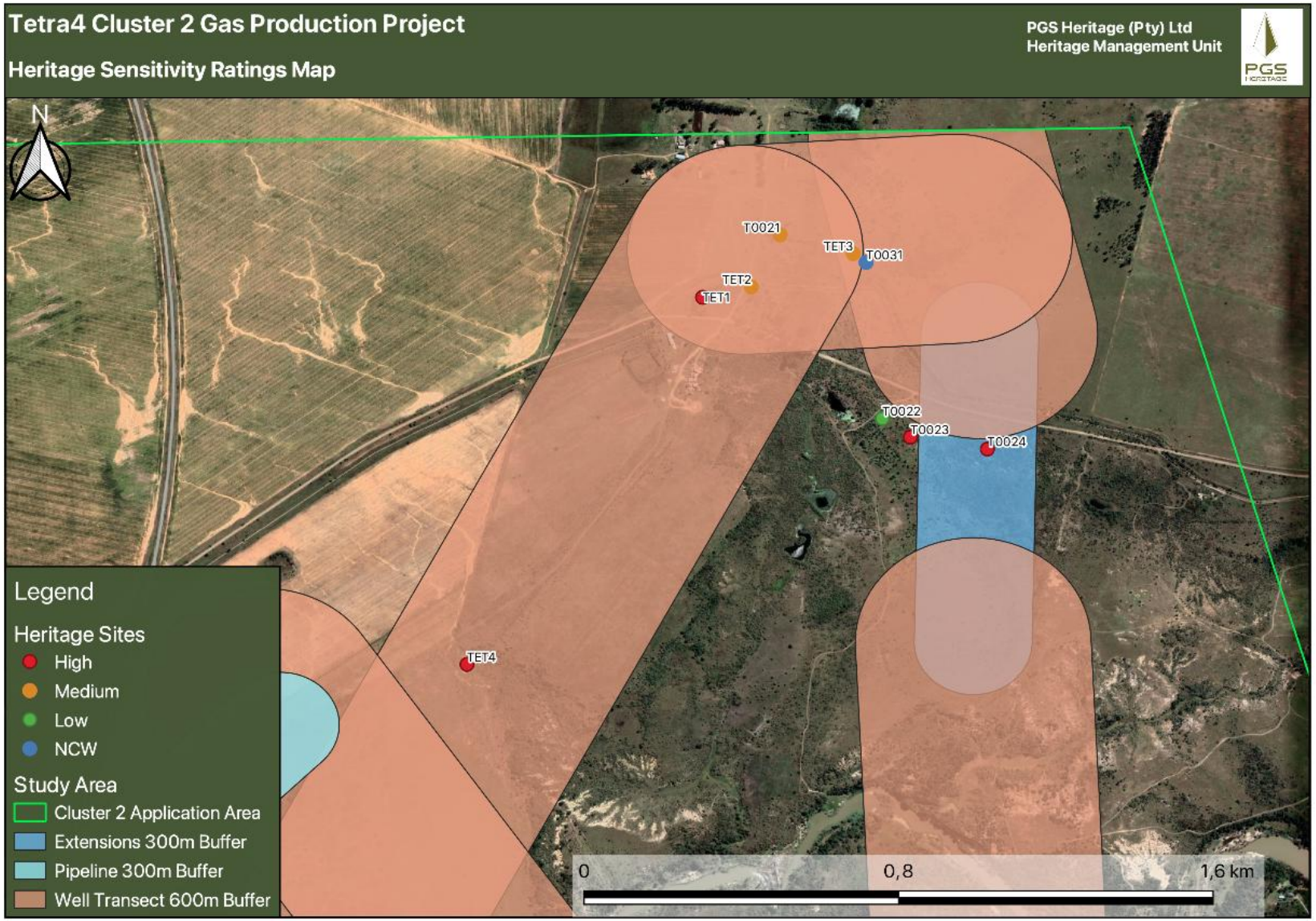


Figure 209: Heritage sensitivity rating of identified heritage resources. Inset A.

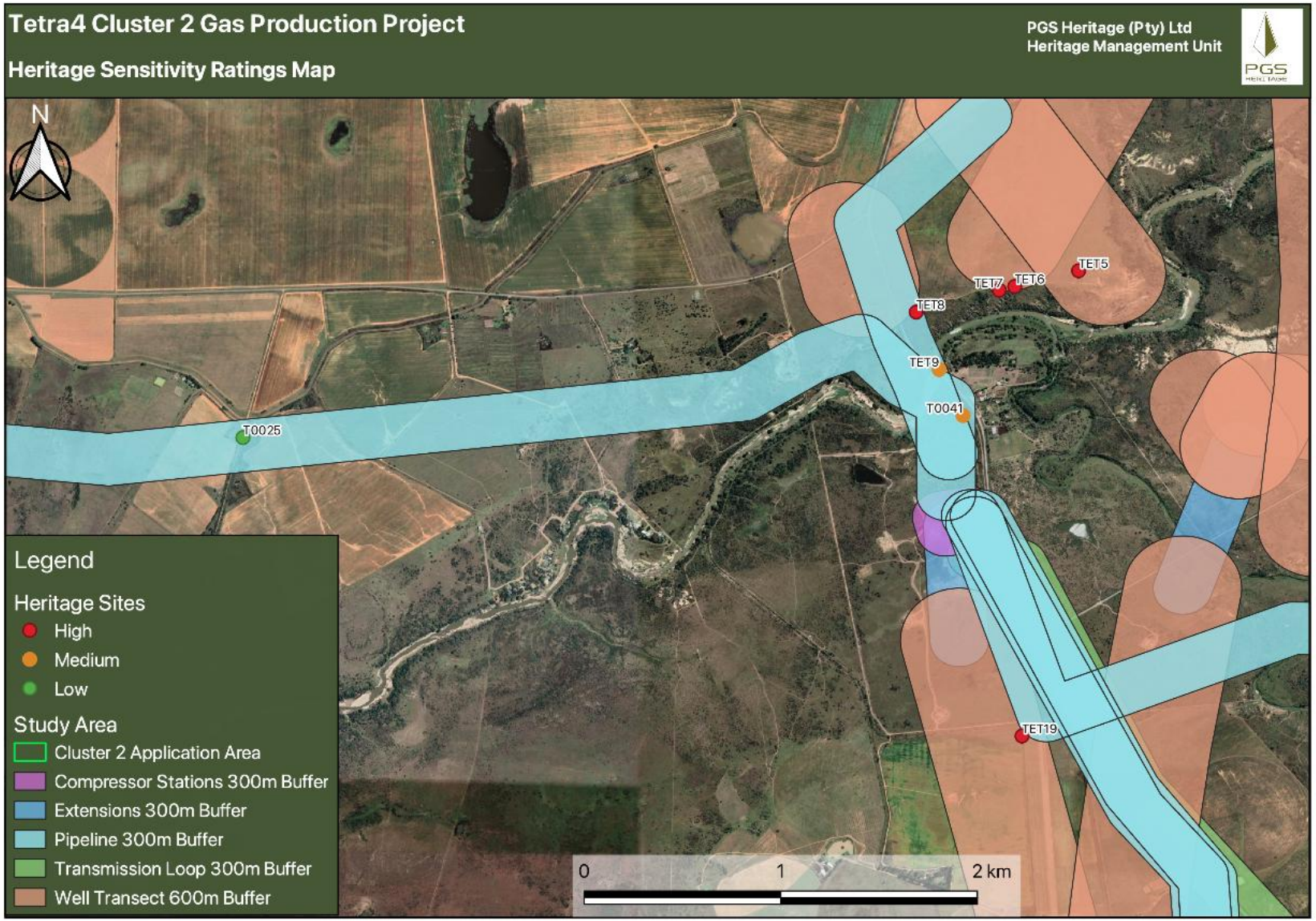


Figure 210: Heritage sensitivity rating of identified heritage resources. Inset B.

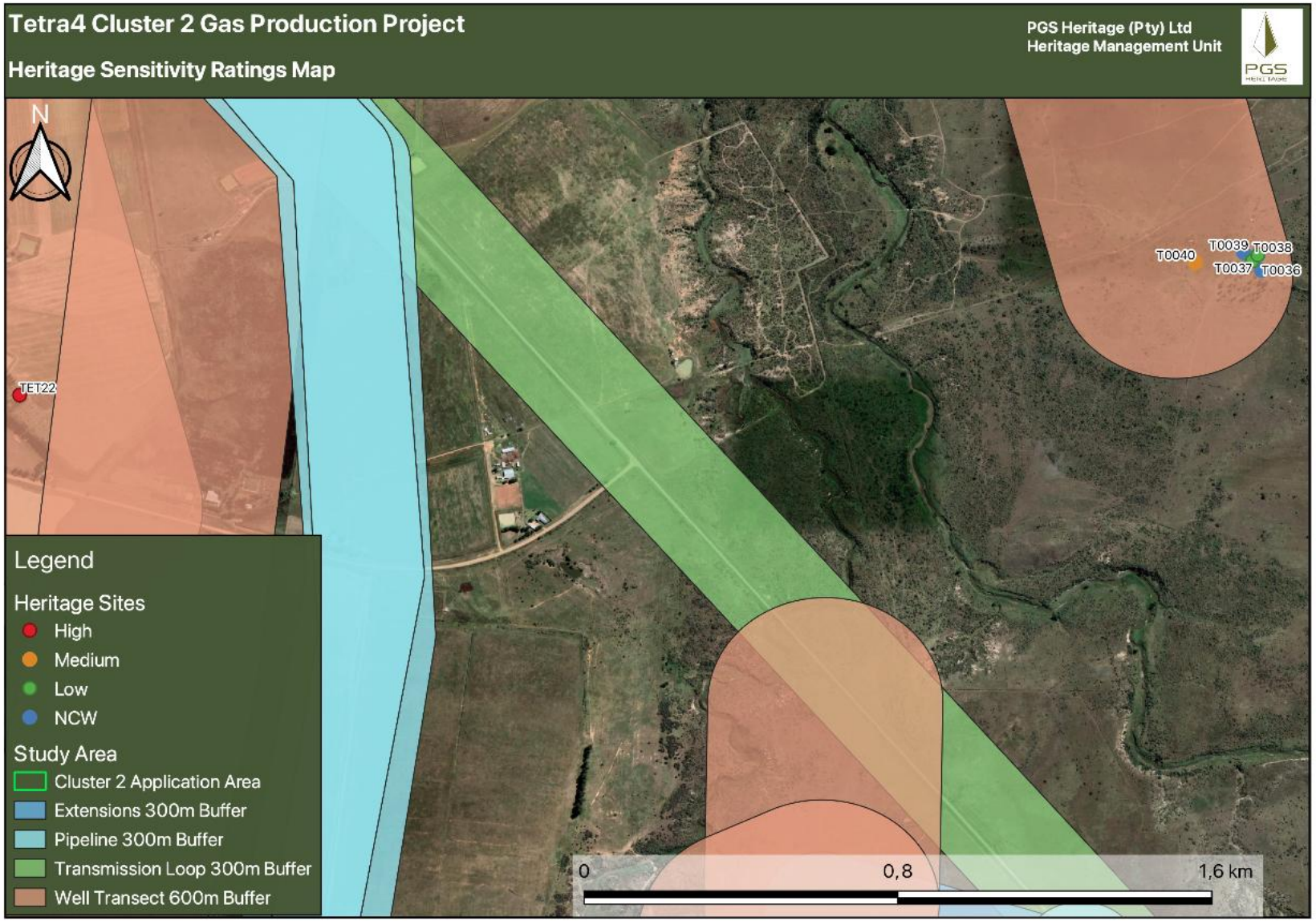


Figure 211: Heritage sensitivity rating of identified heritage resources. Inset C.

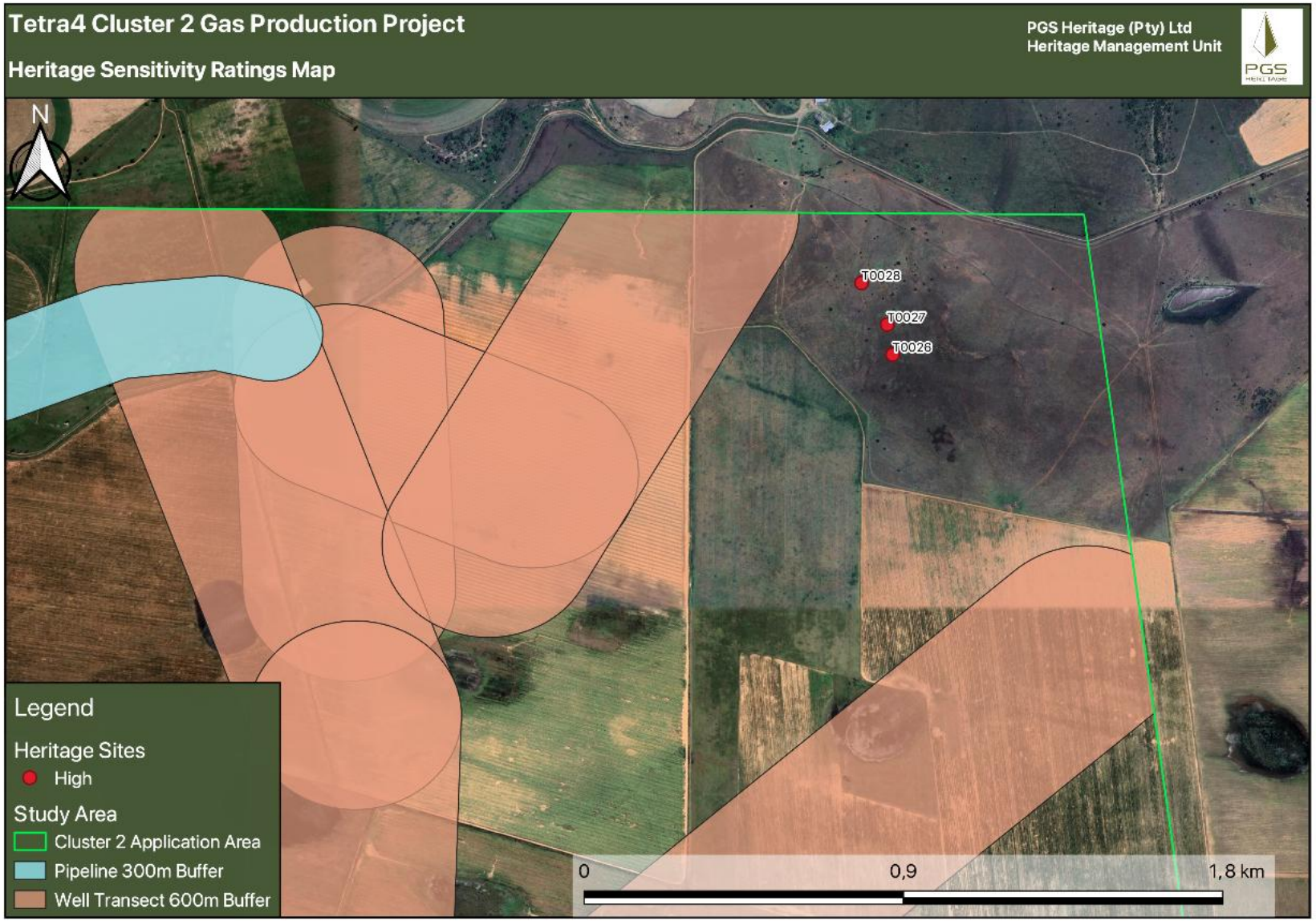


Figure 212: Heritage sensitivity rating of identified heritage resources. Inset D.

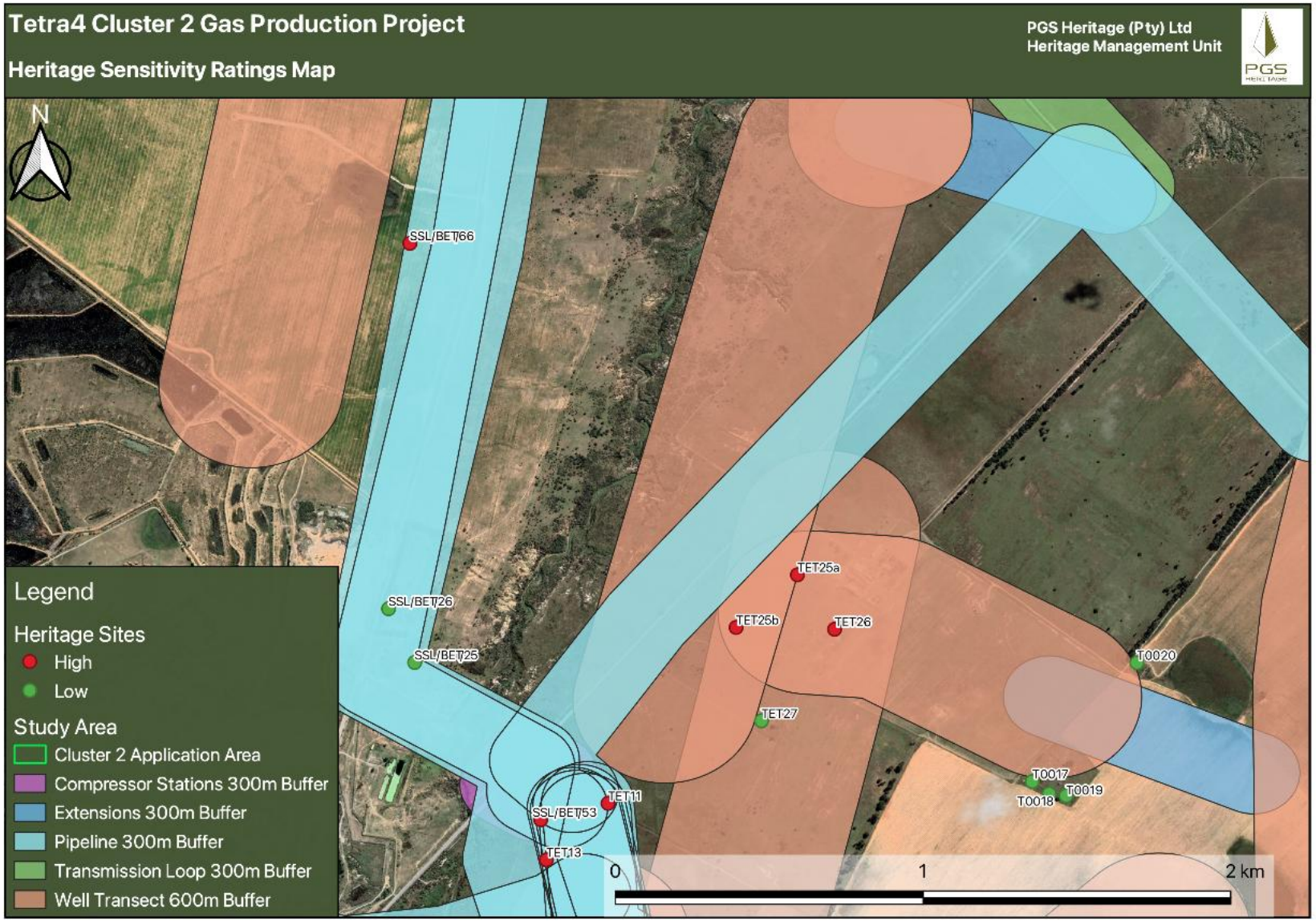


Figure 213: Heritage sensitivity rating of identified heritage resources. Inset E.

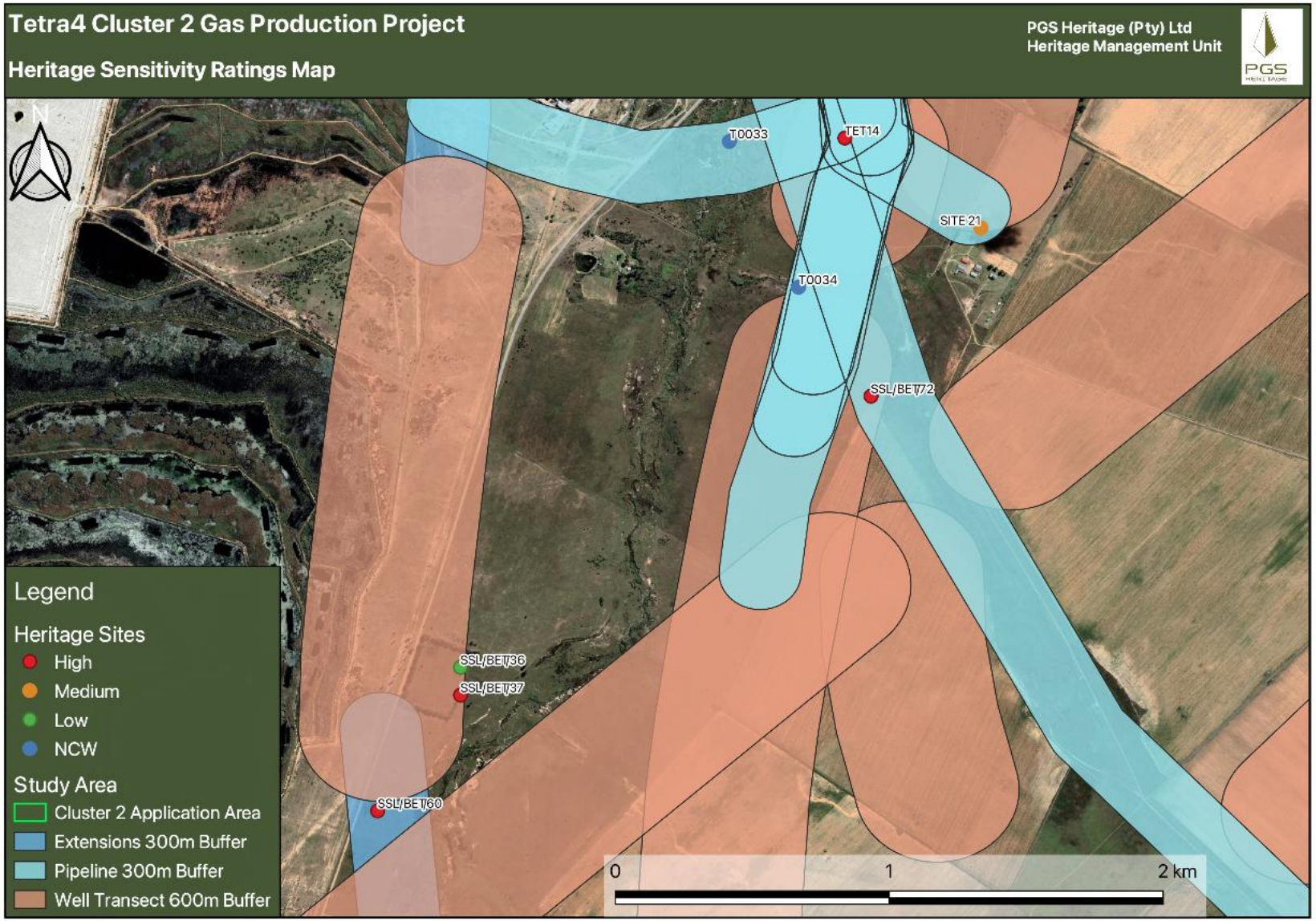


Figure 214: Heritage sensitivity rating of identified heritage resources. Inset F.

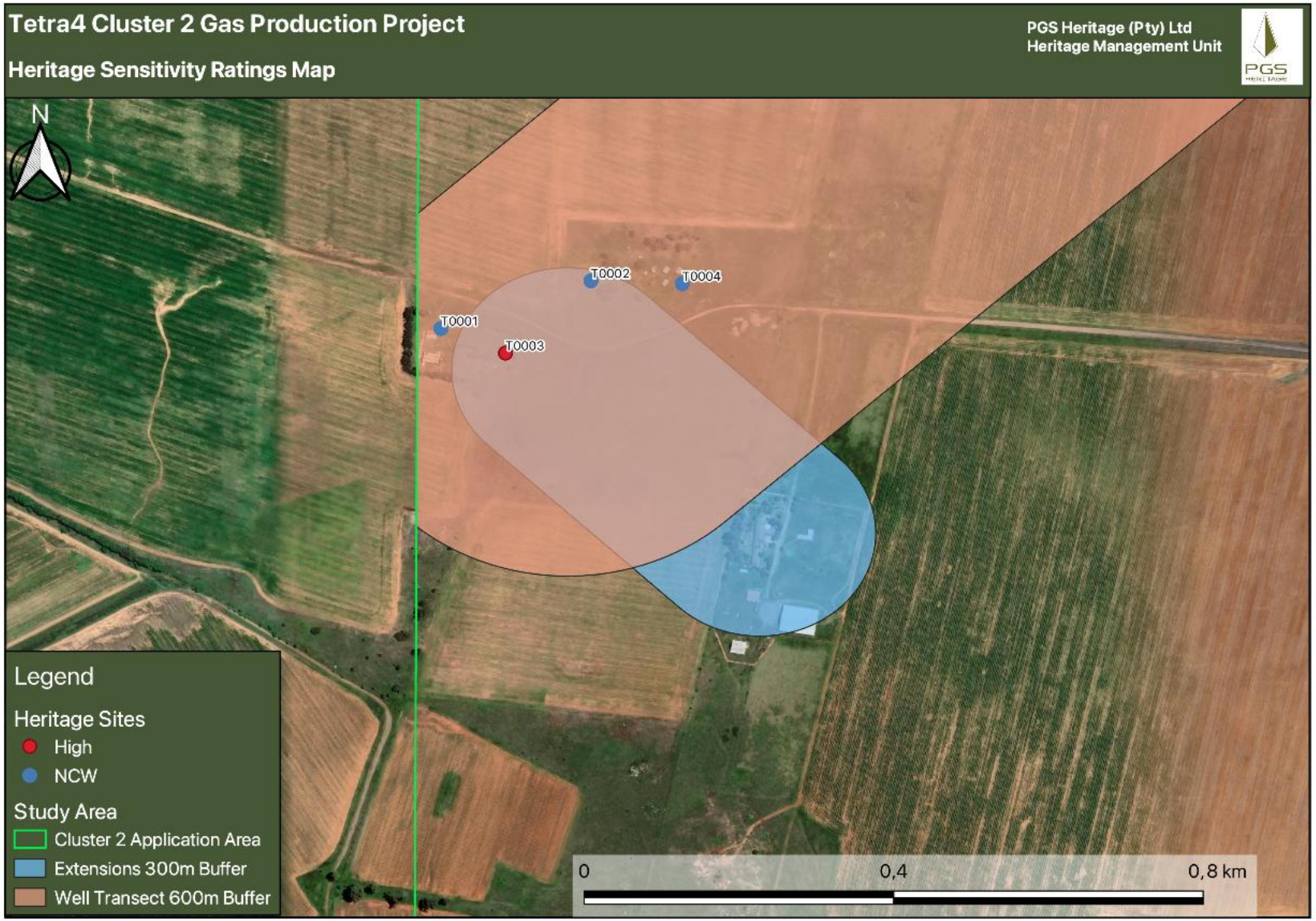


Figure 215: Heritage sensitivity rating of identified heritage resources. Inset G.

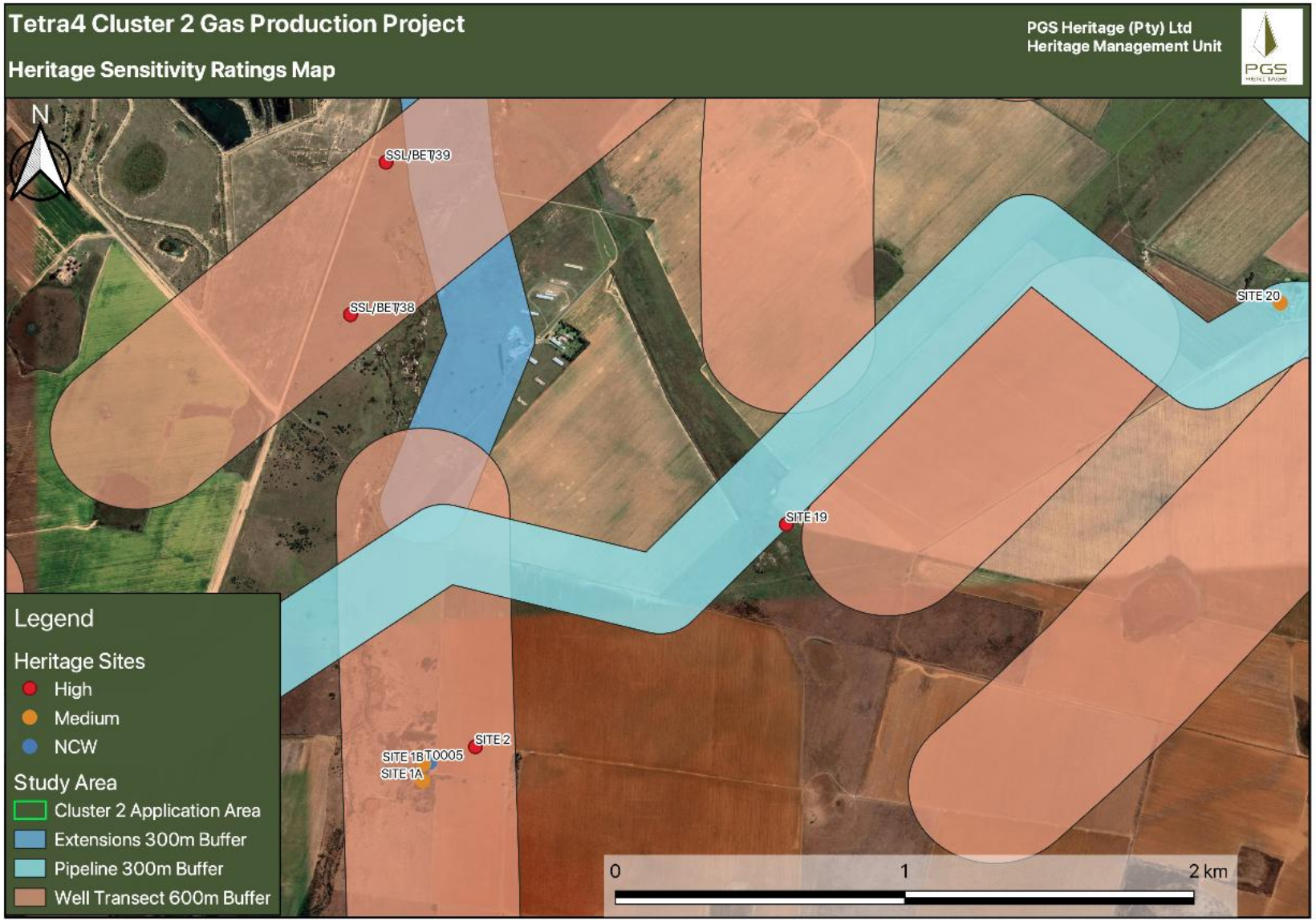


Figure 216: Heritage sensitivity rating of identified heritage resources. Inset H.

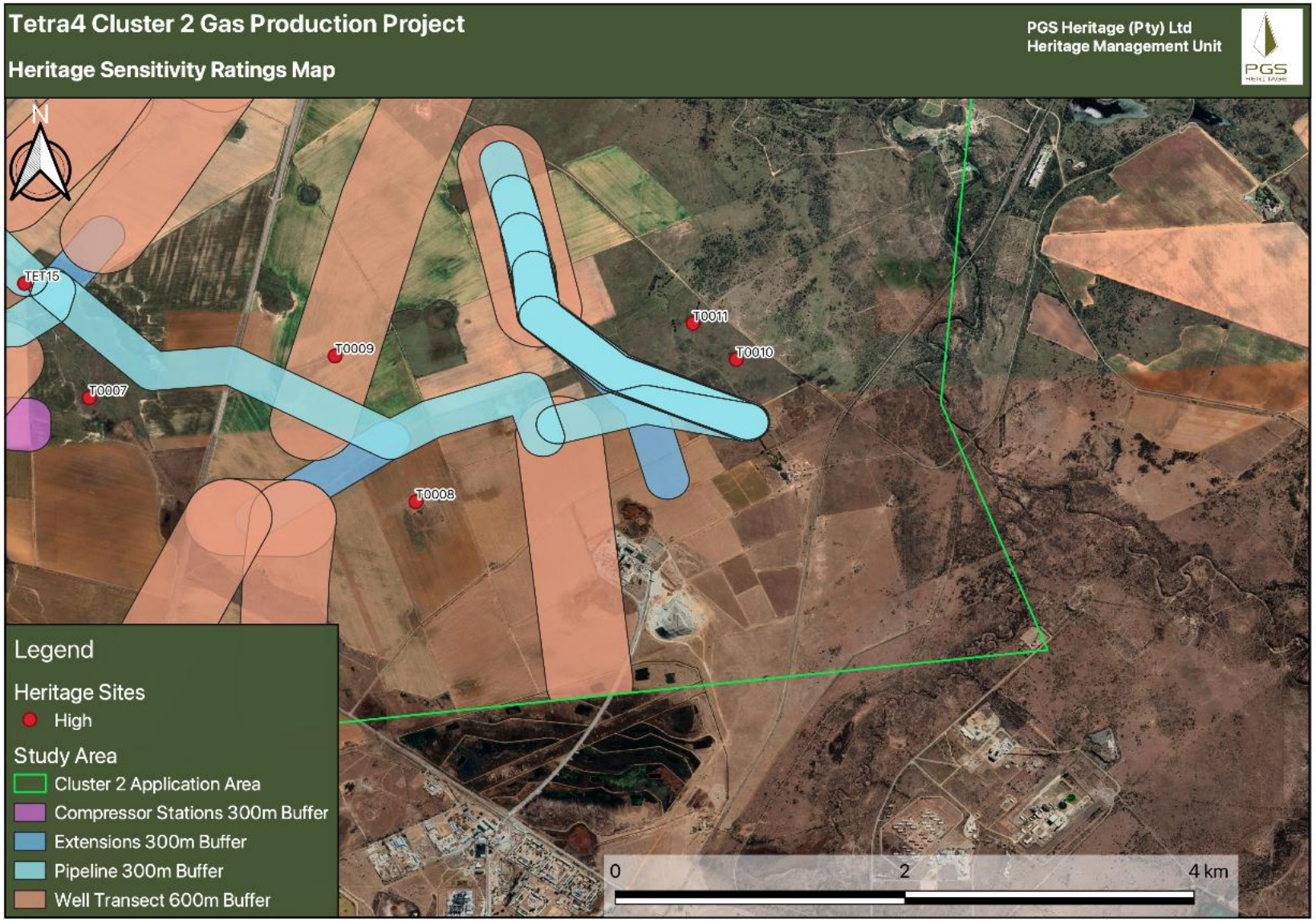


Figure 217: Heritage sensitivity rating of identified heritage resources. Inset I.

Figure 218: Heritage sensitivity rating of identified heritage resources. Inset J.

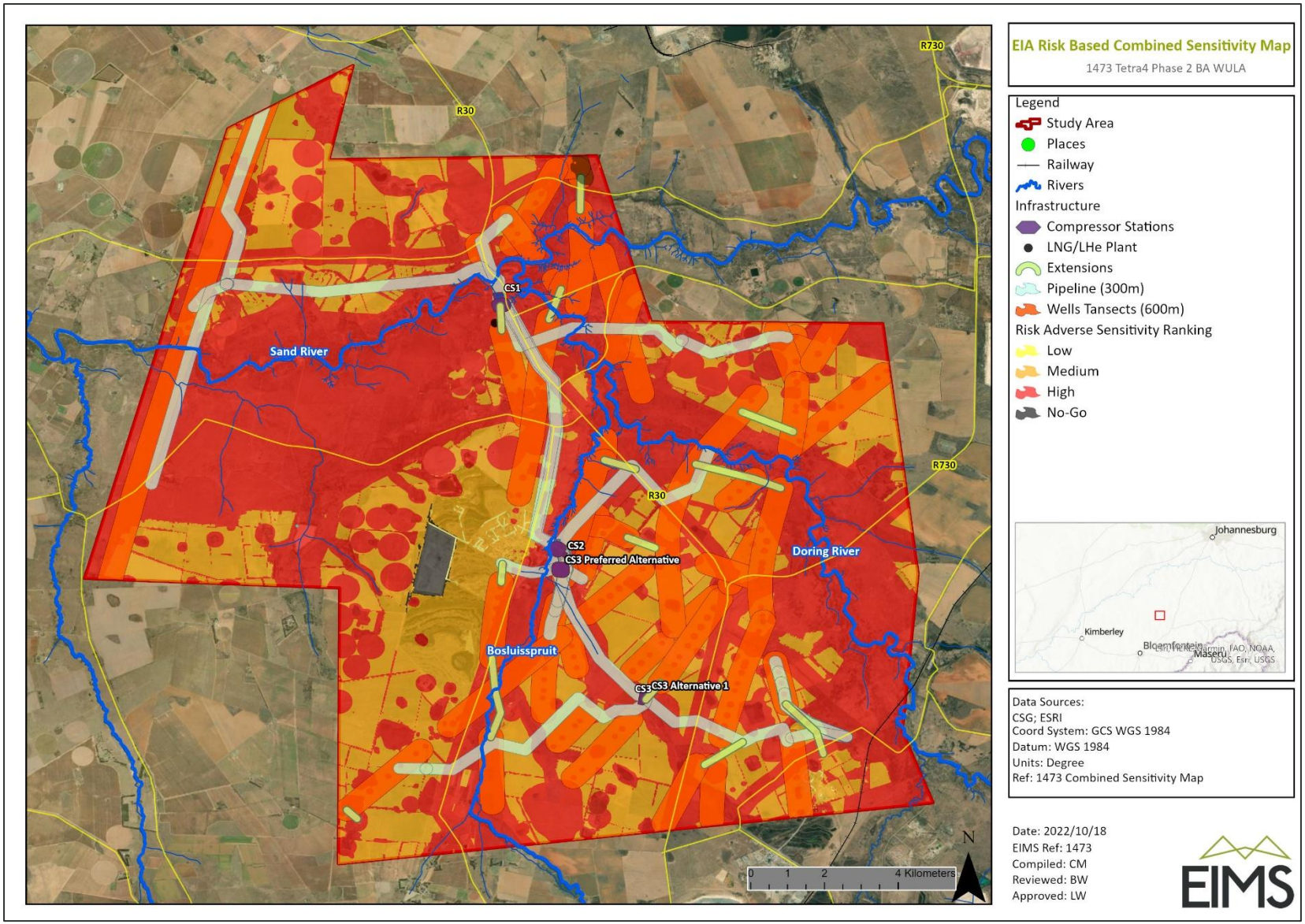


Figure 219: Combined sensitivity map.

12 DECOMMISSIONING REHABILITATION AND CLOSURE

For a detailed description of the financial provision and costing for the proposed Cluster 2 gas production project, please refer to Appendix 6 for a standalone Rehabilitation and Closure Report.

13 CONCLUSION AND RECOMMENDATIONS

The Scoping Phase of the EIA process pre-identified potential issues and impacts associated with the proposed project and following the scoping consultation process, valuable comments were received from various I&APs which the EAP and specialist team considered carefully in the drafting of this EIA phase reports. The EIA Phase addressed those identified potential environmental impacts and benefits (direct, indirect and cumulative impacts) associated with applicable phases of the project and recommendations made of appropriate mitigation measures for potentially significant environmental impacts. The release of a draft EIA Report provides stakeholders with an opportunity to verify that the issues they have raised through the EIA process had been captured and adequately considered.

The EIA Phase aimed to achieve the following:

- Provide an overall assessment of the social, economic and biophysical environments affected by the proposed project.
- Assess potentially significant impacts (direct, indirect and cumulative, where required) associated with the proposed project.
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts; and
- Undertake a fully inclusive public involvement process to ensure that I&APs are afforded the opportunity to participate, and that their issues and concerns are recorded.

13.1 CONCLUSIONS FROM SPECIALIST STUDIES

The conclusions and recommendations of this EIA are the result of the assessment of identified impacts by specialists, and the parallel process of public participation. The public consultation process has been extensive, and every effort has been made to include representatives of all stakeholders in the study area. The main conclusions from each of the specialist studies are presented below.

13.1.1 AIR QUALITY STUDY CONCLUSIONS

A quantitative air quality impact assessment was conducted for the planning and design, construction, operation, decommissioning, rehabilitation and closure phase activities of the Tetra4 Cluster 2 Project. The assessment included an estimation of atmospheric emissions, the simulation of pollutant levels and determination of the significance of impacts. This section summarises the main findings of the impact assessment.

The conclusions and recommendations of the assessment are summarised below:

- The receiving environment:
    - The area is dominated by winds from the north-northeast and northeast, followed by northerly and easterly winds with an average wind speed of 3.7 m/s.
    - Ambient air pollutant levels in the project area are currently affected by the following sources of emission: agricultural activities, gold mining and ore processing, fugitive and process emissions, vehicle tailpipe emissions, household fuel combustion, biomass burning and windblown dust from exposed areas.
    - AQSRs such as residences and farm holdings are located within and beyond the project boundary. Nearby towns include Welkom, Virginia, Bronville, Harmony and Theunissen.

- Impact of the Project:
    - Planning, design and construction phase impacts:
        - Construction activities for the roads/pipeline, wells and booster stations (where the location may vary depending on the gas reserves in the area) vehicle and equipment (vehicle entrainment and vehicle exhaust gas), three compressor stations and the plant might include land clearing, topsoil removal, material loading, bulk services construction, hauling, excavation, back-filling, road construction (where necessary) and traffic, rig-move/drilling, pipeline installation, and wind erosion of exposed areas.
        - Resulting potential air quality health and nuisance impacts at the nearest residential receptors resulted in a medium significance without mitigation and low significance with mitigation. Worst-case simulated construction impacts are not anticipated to occur over long intervals since construction activities will only last a few weeks and peak activities will not be consistent over the specified period.
    - Operational phase impacts:
        - Potential air quality impacts, including health and nuisance impacts, as a result of operational phase activities such as operation of the well pad, roads, pipelines, compression station, booster station and combined LNG/LHe plant, as well as associated emissions from movement of trucks and other vehicles, flaring (if applicable), and gas processing as well as operation of heavy machinery.
        - Vehicles on unpaved roads, and specifically the plant access road, even under mitigated conditions are likely to result in medium significance at the nearest receptors but will reduce to low significance should the road be paved.
        - Air quality impacts due to booster station (generator) operations of medium significance but low significance at the nearest receptors with mitigation measures in place.
        - Plant (flaring) operations are unlikely to result in exceedances of the respective NAAQS's and are therefore considered to be of low significance at the nearest receptors.
    - Decommissioning, rehabilitation and closure phase impacts:
        - Potential air quality impacts, including health impacts as a result of decommissioning, rehabilitation and closure phase activities such as decommissioning/ removal of all berms, trenches and other storm water infrastructure, stationary infrastructure, pipeline infrastructure, and wastes.
        - The environmental risk was assigned a score of low significance due to localised impacts of the various emissions, their temporary nature, and the likelihood that these activities will not occur concurrently at all portions of the site.

In conclusion, it is the specialist opinion that the project may be authorised provided that the recommended air quality management measures are implemented.

13.1.2 CLIMATE CHANGE STUDY CONCLUSIONS

A Climate Change Assessment (CCA) was conducted to determine the potential long term climate change impacts as a result of the Tetra4 Cluster 2 operations. Greenhouse gas (GHG) emissions for the project were calculated based on the Department of Forestry, Fisheries and Environment (DFFE) 2022 Methodological guidelines for quantification of GHG emissions which are based on the Intergovernmental Panel on Climate Change (IPCC) emission factors. This study considered Scope1, Scope 2 and Scope 3 emissions, where Scope 1 are the emissions directly attributable to the project and Scope 2 emissions are the emissions associated with bought-in electricity. Scope 3 emissions consider the "embedded" carbon in bought-in materials and transport

as well as the use of exported materials. Only Scope 1 emissions need to be quantified to be in line with the DFFE guidelines; the addition of Scope 2 would place the assessment in line with the guidelines provided by the International Finance Corporation (IFC).

The conclusions and recommendations of the assessment are summarised below:

- The region around Welkom and Virginia where Tetra4 Cluster 2 project is proposed to be developed is likely to experience increased temperatures and extreme weather-related events in the future. Climate change impacts will disproportionately affect under-developed communities that lack the physical and financial resources to cope with the physical effects of climate change, such as droughts, floods and increases in diseases.

- Scope- 1, 2 and 3 emissions were estimated based on emission factors and expected production rates or raw material use. The main construction activities attributing to GHG emissions are well drilling, well testing and well servicing followed by off-road mobile equipment. During operations, the electricity bought from ESKOM (Scope 2) is the main source, followed by road transportation and gas process venting (Scope 1). The main source of Scope 3 GHG emissions would be the end use of the LNG, but as LNG will be replacing other fuels already in use, there will result in a reduction in indirect GHG emissions.

- Construction- and operational-related GHG emissions from the proposed Tetra4 Cluster 2 project cannot be attributed directly to any particular climate change effects, and, when considered in isolation, will have a Low to Medium impact on the National GHG inventory total. The main GHG impact is associated with downstream use of the LNG, i.e. Scope 3. GHG emissions per unit of gas combusted, however, is less than per unit coal.

- Since climate change is a global challenge, there is a collective responsibility to address climate change and Tetra4 has an individual responsibility to minimise its own negative contribution to the issue. It is recommended that renewable energy (such as photovoltaic solar panels) be considered to replace/ reduce the reliance on ESKOM electricity which is likely to reduce the significance from the Tetra4 Cluster 2 project from Medium to Low, since ESKOM's contribution to the operational phase is the main source of GHG emissions. Also, the use of LNG instead of diesel will reduce the GHG footprint further. Maintenance of vehicles and machinery, the implementation of a leak-detection program, and the minimisation of flaring and venting would reduce the potential for GHG emissions.

- Once operational, it is recommended records be kept of actual fuel usage for transport of materials and products, energy requirements, production rates, flare and venting rates and raw material consumption for GHG reporting purposes and refinement of the emissions inventory.

Based on Tetra4 Cluster 2 Scope 1, 2 and 3 GHG emissions, it is the specialist opinion that the project may be authorised due to its low to medium impact significance.

13.1.3 NOISE STUDY CONCLUSIONS

A summary of simulated noise levels due to project construction and operational activities area as follows:

- Construction activities:
    - Activities were specified to take place during day-time hours only
    - Exceedances of the day-time IFC noise guidelines for residential, educational, and institutional areas (55 dBA) were as follows:
        - Wells: Up to 400 m from activities.
        - Pipeline: Up to 90 m from activities.
        - Blower Stations: Up to 600 m from activities (this is a conservative estimate as topography was not taken into account for these predictions).

        - Plant: Up to 420 m from Plant area.
        - Compressor Stations: Up to 380 m from Compressor Station areas.
- Operational activities:
    - Activities were assumed to take place continuously (24 hours per day)
    - Exceedances of the night-time IFC noise guidelines for residential, educational, and institutional areas (45 dBA) were as follows:
        - Blower Stations: Up to 150 m from activities (this is a conservative estimate as topography was not taken into account for these predictions).
        - Plant: Up to 600 m from Plant area.
        - Compressor Stations: Up to 120 m from Compressor Station areas.

It is recommended that general good practice measures for managing noise as set out in this report, be adopted as part of the facility's Environmental Management Plan. In the event that noise related complaints are received short term (30-min to 24-hours in duration) ambient noise measurements should be conducted as part of investigating the complaints. The results of the measurements should be used to inform any follow up interventions.

The significance of project activities was found to be as follows:

- Construction activities:
    - Wells, Blower Stations and pipeline: Significance rating was medium without mitigation and low with mitigation.
    - Compressor Stations and plant: Significance rating was low without and with mitigation.
- Operational activities:
    - Blower Stations, Compressor Stations and plant: Significance was low without and with mitigation
- Decommissioning activities: Significance rating was medium without mitigation and low with mitigation.

Based on the findings of the assessment and provided the recommended general "good practice" management and mitigation measures are in place, it is the specialist opinion that the project may be authorised.

13.1.4 ECONOMIC STUDY CONCLUSIONS

Matjhabeng has a relatively large economy compared to that of other SA municipalities, but its GGP has been declining for years. Although the local economy still has a measure of critical mass that could provide continued private consumption expenditure which could sustain it for quite some time, it requires new investments to sustain itself.

The Matjhabeng economy is by all accounts finding a new equilibrium – an economy that is adjusting to declines in mining employment and a stagnating population. The increase in government expenditure and perennial agricultural activities are keeping the municipality's decline in check, but if more mines close down its GGP and formal employment is set to decline more. At present it is not sure what the impact of higher commodity prices are on the local economy.

An investment such as that of Renergen will undoubtedly improve the economic prospects for the local economy. Furthermore, both the economic quantitative and qualitative factors ought to be considered as positive for the SA economy in general and therefore the project is supported from an economic perspective.

13.1.5 GEOHYDROLOGY STUDY CONCLUSIONS

The project area's surficial geology comprises mostly aeolian sands, quaternary deposits and isolated outcrops of the Karoo Supergroup i.e., dolerite and sandstone/ shales, while the greater study area is generally also underlain by rocks of the Witwatersrand Supergroup as well as the Ventersdorp Supergroup. Isolated patches within the study area are also covered by alluvial sand deposits which is mainly associated with the Sand and Doringriver floodplains and constrained by drainage patterns and riparian zones. The primary source of gas originates from the Witwatersrand Supergroup as well as the shallower Karoo sediments.

The site is predominantly underlain by an intergranular and fractured aquifer system (d2) with the aquifer media consisting mainly of fractured and weathered compact argillaceous strata. According to Vegter's groundwater regions delineated (2000) the study area can be classified as falling under the North-eastern Pan Belt region.

For the purposes of this investigation, four main hydrostratigraphic units/aquifer systems can be inferred in the saturated zone:

i. **A shallow quaternary and recent types of sediments** (unconfined) are characteristically a primary porosity aquifer associated with alluvium material deposited in flood plains of the main rivers traversing the study area. These aquifers cover a large portion of the study area and are limited to a zone of variable width and depth. The alluvial aquifer is specifically vulnerable to contamination as it there is a direct connectivity with rivers and streams and associated high permeability.

ii. **A shallow, intergranular aquifer** (unconfined to semi-confined) occurring in the transitional soil and weathered bedrock formations of the Karoo Supergroup rocks underlain by more consolidated bedrock. Groundwater flow patterns usually follow the topography, discharging as natural springs at topographic low-lying areas. Usually, this aquifer can be classified as a secondary porosity aquifer and is generally unconfined with phreatic water levels. Due to higher effective porosity (n) this aquifer is most susceptible to impacts from contaminant sources.

iii. **An intermediate, fractured aquifer** (semi-confined to confined) where pores are well-cemented and do not allow any significant flow of water. Groundwater flow is dictated by transmissive secondary porosity structures such as bedding plane fractures, faults, contact zones as well as fracture zones that occur in the relatively competent Karoo Supergroup host rock. Fractured sandstones, mudstones and shales sequences are considered as fractured rock aquifers holding water in storage in both pore spaces and fractures. This aquifer system usually displays semi-confined or confined characteristics with piezometric heads often significantly higher than the water-bearing fracture position. Although generally low yielding, this aquifer is important to local groundwater users as it forms the sole source of water supply in the region (Lea, 2017).

iv. **A deeper, fractured aquifer** (semi-confined to confined) where pores are well-cemented and do not allow any significant flow of water. Groundwater flow is dictated by transmissive secondary porosity structures such as bedding plane fractures, faults and contact zones fracture zones that occur in the relatively competent Ventersdorp and Witwatersrand Supergroups host rock. Volcanic formations of the Ventersdorp lavas can also act as aquicludes, restricting the vertical movement of groundwater. Fractured quartzites of the Witwatersrand Supergroup are considered as fractured rock aquifers holding water in storage in both pore spaces and fractures. Groundwater yields, although more heterogeneous, can be expected to be higher than the weathered zone aquifer. This aquifer system usually displays semi-confined or confined characteristics with piezometric heads often significantly higher than the water-bearing fracture position.

The water in the deep aquifers is naturally saline due to their marine depositional history. It should be noted that the shallow potable Karoo aquifers are separated from deep aquifer systems associated with the Ventersdorp and Witwatersrand Supergroup formations by the 30.0 m thick dolerite sill (which may act as an aquitard) that extends across the study area and by the 65.0 m thick Dwyka Tillite sedimentary deposit acting as an aquiclude. It should furthermore be noted that, under natural conditions, there is very limited hydraulic connectivity between the deep, fractured and shallow, intergranular aquifers.

The hydraulic conductivity of sedimentary formations such as evident on site can range from $10E^{-6}$ – $10E^{-2}$ m/d. Historical aquifer tests results confirm that the permeability of the shales is very low

(9E-4m/d). The hydraulic conductivity of fractured igneous rocks (i.e., dolerite) varies between $10E^{-6}$ – $10E^{-1}$ m/d, while conductivity values for un-fractured igneous rocks (i.e., fresh dolerite sill) ranges between $10E^{-9}$ – $10E^{-6}$ m/d. The hydraulic conductivity of quaternary deposits and alluvial pockets associated with the drainage system i.e., riverbed aquifers can be orders higher and can vary between $10E^{-2}$ – $10E^{1}$ m/d.

An approximation of recharge for the study area is estimated at ~4.0 % of MAP i.e., ~21.69 mm/a.

A total of 78 groundwater receptors i.e., boreholes, artesian wells, wind pumps as well as surface water features were visited as part of the hydrocensus user survey which are largely applied for livestock watering and domestic water supply purposes. Of the boreholes recorded, the majority are in use (>78.0 %) while ~17.0 % are not currently being utilized.

The unsaturated zone within the study area is in the order of 0 (fully saturated to surface) to >26.0 m with a mean thickness of approximately ~9.0 m. It should be noted that due to the argillaceous nature of the host aquifer(s) the shallow water levels observed at some of the borehole localities can be attributed to clay/silt lenses and be indicative of perched aquifer conditions and not necessarily represent the vadose zone.

Artesian conditions were observed at three of the boreholes visited namely HBH31, 21B as well as 8B which can be indicative of semi-confined to confined aquifer conditions present or perched aquifer conditions. The minimum water level was recorded at 0.0mbgl, while the deepest water level was measured at borehole locality Mon-HDR1 (26.71 mbgl).

It is noted that most water levels suggest a decrease in water levels and recovering trend. The latter can be attributed the onset of the wet cycle and above average rainfall events experienced with rainfall recharge replenishing aquifer storage. It can be observed that there is a definite a relatively quick response to rainfall, suggesting that recharge of the shallow, intergranular aquifer takes place without a prolonged lag effect. Statistical analyses of the water level trends furthermore suggest that the local groundwater system is in quasi-steady state conditions.

Analysed data indicate that the surveyed water levels correlate very well to the topographical elevation (R^2 <0.98). Accordingly, it can be assumed that the regional groundwater flow direction is dictated by topography. Bayesian interpolation was used to interpolate the groundwater levels throughout the study area. The inferred groundwater flow direction will be towards the lower laying drainage system(s) traversing the project area from where groundwater will discharge as baseflow. The groundwater flow direction within the southern catchment of the Sandrivier and Doringrivier, also in the vicinity of the proposed plant expansion footprint, will be in a general northern direction, whereas the groundwater flow direction within the northern catchment of the study area will be mostly in a south to southwestern direction.

The average groundwater gradient (i) of the shallow, weathered aquifer in the vicinity of the proposed plant expansion footprint is relatively flat and calculated at a mean of 0.002, with a maximum of 0.003 in a south to north orientation and a minimum of 0.001 in a general southeast to northwest orientation.

The expected seepage rate from contamination originating at the proposed plant expansion footprint as well as associated infrastructure is estimated at an average of approximately 1.26 m/a, with a maximum distance of ~2.20 m/a in a southern to northern direction.

Under natural conditions this area exhibits certain regions where there is pronounced interaction between surface and groundwater and regional drainages can be generally classified as influent or gaining stream systems. The alluvial associated with the floodplains of the Sand - and Doringrivier forms a primary aquifer and is directly connected with surface water resources, especially during high flow conditions.

The hydrochemical results of the hydrocensus boreholes water samples analysed suggest the overall ambient groundwater quality is good with most macro and micro determinants falling within or below the SANS 241:2015 limits. Groundwater can be described as neutral, saline to very saline and hard to very hard. The groundwater quality is impacted by the geological formations, which were deposited in shallow marine environments and are therefore naturally saline.

It is observed that most of the boreholes indicate elevated Nitrate (NO_3) concentrations. The latter may be attributed to the agricultural land-use activities dominating the greater study area with elevated NO3 concentrations potentially derived from leachate of fertilizer to the local aquifer. It is noted that borehole localities with elevated NO_3 concentrations are generally situated within or directly down-gradient of planted crop areas as well as near surface water features.

Surface water quality can be classified as moderate to good with Aluminium (Al) and Iron (Fe) being slightly elevated. It should be noted that there is not a significant change in the downstream water quality compared to the upstream quality with an increase in Aluminium (Al), however all surface water samples analysed suggest elevated heavy metal concentrations i.e., Al and Fe.

Three distinct categories can be observed, Category A: Calcium-Bi-carbonate dominance which suggest a recently recharged and unimpacted groundwater environment (majority of samples), Category B: Calcium-Magnesium-Chloride dominance which indicate a static and disordinate environment as well as Category C: Sodium-Potassium-Bi-carbonate dominance which indicate an area of dynamic groundwater environments.

The surface water samples analysed can be categorized as having Calcium-Magnesium-Chloride dominance which indicate a static and disordinate environment, one would except a more Calcium-Bi-carbonate signature from an unpolluted surface water source, however baseflow discharge present from the saline groundwater resource will have an impact on the salinity of the surface water resources as is evident.

Comparison of different hydrochemical signatures observed suggest on-site boreholes to target a shallow, inter-granular aquifer unit as well as a deeper (possibly intermediate, fractured aquifer unit) being more saline.

The Sodium-Potassium-Chloride dominance of the deep, fractured aquifer groundwater suggest extremely saline conditions as expected.

According to the aquifer classification map of South Africa the project area is underlain by a “Minor aquifer”. It should however be noted that the shallow, intergranular aquifer is important to local groundwater users as it form the sole source of water supply in the region. Furthermore, the primary riparian zone aquifer is classified as a major aquifer system due to its highly permeable nature as well as good water quality.

A GQM Index = 4 was calculated for the local aquifer system and according to this estimate, a “Medium” level groundwater protection is required for this aquifer system. According to the DRASTIC index methodology applied, the existing/proposed activities and associated infrastructure’s risk to groundwater pollution of the shallow, intergranular aquifer is rated as “Moderate”, Di = 109.

A numerical groundwater flow and mass transport migration model was developed and calibrated in steady state based on gathered site characterisation information which was applied as initial hydrogeological conditions for transient simulations.

A scenario was simulated representing point source pollution plume migration of saline groundwater emanating from leaking boreholes targeting the deep, fractured aquifer for the operational phase (20-year period). The TDS pollution plume extend covers a total area of approximately 414.06 ha in the Karoo formations, reaching a maximum distance of ~80.0 m in a radial pattern from the gas production borehole(s), and approximately 251.60 ha in the alluvial deposits, reaching a maximum distance of ~200.0 m in a radial pattern from the gas production borehole(s) after a simulation period of 20-years. The simulation indicates that the following neighbouring boreholes will potentially be intercepted by the simulated pollution plume HBH08, HBH41, HBH42, HBH43, HBH63, HBH72, HBH73 and HBH74.

It can be noted that the pollution plume migration in the denser Karoo formations is sluggish while movement in the unconsolidated alluvial deposits of the riparian zone suggest a larger flux.

It is evident that source term mass load contribution to existing neighbouring borehole situated near the gas production borehole(s) does not exceed ~800.0 mg/l and ranges between 600 mg/l to 700.0 mg/l

A scenario was simulated representing point source pollution plume migration of stray methane (CH_4) gas emanating from leaking boreholes targeting the deep, fractured aquifer for the operational phase (20-year period). The CH_4 pollution plume extend covers a total area of approximately 162.74 ha in the Karoo formations,

reaching a maximum distance of ~50.0 m in a radial pattern from the gas production borehole(s), and approximately 62.83 ha in the alluvial deposits, reaching a maximum distance of ~100.0 m in a radial pattern from the gas production borehole(s) after a simulation period of 20-years. The simulation indicates that the following neighbouring boreholes will potentially be intercepted by the simulated pollution plume HBH08, HBH41, HBH42, HBH43, HBH63, HBH72, HBH73 and Tetra4 monitoring borehole 11A.

It is noted that the source term mass load contribution to existing neighbouring borehole situated near the gas production borehole(s) remains below the EPA safety threshold (2011) of 10.0 mg/l and ranges between 0.01 mg/l to 1.50 mg/l.

A scenario was simulated with a pollution plume migration from the plant footprint areas for the operational phase. The TDS pollution plume extend covers a total area of approximately 48.80 ha reaching a maximum distance of ~110.0 m in a general north-northwest direction towards the lower laying drainage system(s) after a simulation period of 20-years. The simulation indicates that no neighbouring boreholes or local drainages are expected to be impacted on during the operational phase.

It is evident that the TDS mass load contribution to down-gradient receptors increase to a concentration of between 200.0 – 800.0 mg/l, however, remains below the SANS 241:2015 limit of 1200.0 mg/l for the duration of the simulation period.

It can be noted that the mass transport of the pollution plume is mostly limited to the shallow, intergranular aquifer.

A scenario was simulated representing point source pollution plume migration of saline groundwater emanating from leaking boreholes targeting the deep, fractured aquifer for the post-closure phase. The TDS pollution plume extend covers a total area of approximately 643.70 ha in the Karoo formations, reaching a maximum distance of ~100.0 m in a radial pattern from the gas production borehole(s), and approximately 392.70 ha in the alluvial deposits, reaching a maximum distance of ~250.0 m in a radial pattern from the gas production borehole(s) after a simulation period of 50-years. The TDS pollution plume extend covers a total area of approximately 1 456.42 ha in the Karoo formations, reaching a maximum distance of ~150.0m in a radial pattern from the gas production borehole(s), and approximately 769.70 ha in the alluvial deposits, reaching a maximum distance of ~350.0 m in a radial pattern from the gas production borehole(s) after a simulation period of 100-years. The simulation indicates that the following neighbouring boreholes will potentially be intercepted by the simulated pollution plume HBH08, HBH41, HBH42, HBH43, HBH48, HBH50, HBH63, HBH72, HBH73, HBH74 as well as Tetra4 monitoring boreholes Mon 2057 and 11A.

It is noted that source term mass load contribution to existing neighbouring and monitoring boreholes situated near the gas production boreholes ranges between 650.0 mg/l to >1200.0 mg/l. Furthermore, it is observed that the SANS241:2015 limit is exceeded at borehole localities HBH63 and Mon 2057.

A scenario was simulated representing point source pollution plume migration of stray methane (CH_4) gas emanating from leaking boreholes targeting the deep, fractured aquifer for the post-closure phase. The CH_4 pollution plume extend covers a total area of approximately 414.06 ha in the Karoo formations, reaching a maximum distance of ~80.0 m in a radial pattern from the gas production borehole(s), and approximately 141.37 ha in the alluvial deposits, reaching a maximum distance of ~150.0 m in a radial pattern from the gas production borehole(s) after a simulation period of 50-years. The CH_4 pollution plume extend covers a total area of approximately 643.70ha in the Karoo formations, reaching a maximum distance of ~100.0 m in a radial pattern from the gas production borehole(s,) and approximately 392.70 ha in the alluvial deposits, reaching a maximum distance of ~250.0 m in a radial pattern from the gas production borehole(s) after a simulation period of 100-years. The simulation indicates that the following neighbouring boreholes will potentially be intercepted by the simulated pollution plume HBH08, HBH41, HBH42, HBH43, HBH48, HBH49, HBH63, HBH72, HBH73 as well as Tetra4 monitoring boreholes Mon 2057 and 11A.

It is evident that source term mass load contribution to existing neighbouring and monitoring boreholes situated near the gas production boreholes ranges between 0.50 mg/l to ~2.0 mg/l, however, remains below the EPA safety threshold (2011) of 10.0 mg/l.

A scenario was simulated with a pollution plume migration from the plant footprint areas for the post-closure phase. The TDS pollution plume extend covers a total area of approximately 54.8 ha reaching a maximum distance of ~170.0 m in a general north-northwest direction towards the lower laying drainage system(s) after a simulation period of 50-years and covers a total area of approximately 71.20 ha reaching a maximum distance of ~300.0 m in a general north-northwest direction towards the lower laying drainage system(s) after a simulation period of 100-years. It is evident that the pollution plume potentially reaches the local drainages system down-gradient of the plant footprint during the post-closure phase.

It is observed that the TDS mass load contribution to down-gradient receptors increase to a concentration above the SANS 241:2015 limit of 1200.0 mg/l for the post-closure simulation period. It is noted that the TDS mass load contribution increases to a percentage of ~10.0 % to the Sandrivier where the mass load contribution to the Doringrivier increase to a percentage of ~2.0 % for the duration of the post-closure simulation period.

It should be noted that vast areas within the study area have been subjected to historical mining activities and, as such, reflect modified to highly modified present ecological status. A total number of >15 000 historical exploration wells have been drilled throughout the study area, some of which remain uncased and unsealed. The latter may act as preferential pathways and conduits for groundwater flow and contaminant transport mechanisms. As mentioned earlier an impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human and/or other related activities. Accordingly, this already highly modified zones should form part of the impact significance rating and risk approach.

During the construction phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium negative without implementation of remedial measures and low negative with implementation of proposed mitigation measures. The main impacts associated with the construction phase activities include the following:

i. Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area.

ii. Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.

iii. Mobilisation and maintenance of heavy vehicles and machinery on-site may cause hydrocarbon contamination of groundwater resources.

iv. Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.

During the operational phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium to high negative without implementation of remedial measures and low to medium negative with implementation of proposed mitigation measures. The main impacts associated with the operational phase activities include the following:

i. Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.

ii. Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.

iii. Groundwater pollution because of wastewater spills and seepage from the evaporation dams.

iv. Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.

v. Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.

vi. Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.

vii. Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.

viii. Leachate of contaminants used in the drilling mud sump(s) to the intergranular, potable aquifer(s) during the operational phase.

During the decommissioning and post-closure phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium negative without implementation of remedial measures and low to medium negative with implementation of proposed mitigation measures. The main impacts associated with the post-closure and decommissioning phase activities include the following:

i. Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.

ii. Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, potable aquifer(s) borehole closure and decommissioning phase.

iii. Groundwater pollution because of wastewater spills and seepage from the evaporation dams.

iv. Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.

v. De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.

The most significant impact of the project on the regional groundwater regime is deterioration of the potable Karoo aquifer water quality as well as modification of the riparian zone primary porosity aquifer associated with alluvium material deposited in flood plains. Groundwater is the sole water resource to the landowners and rural communities within the study area and can thus be classified as a sole source aquifer. It can be concluded that, should the prescribed mitigation and management measures, as stipulated in the groundwater management plan, be implemented and honoured, the impacts associated with the project phases can be minimised. It is important that an integrated groundwater monitoring program be developed and applied serving as an early warning and detection mechanism to implement mitigation measures. The calibrated groundwater flow model should be applied as groundwater management tool for future scenario predictions.

The following recommendations are proposed following this investigation:

i. Mitigation and management measures as set out in the groundwater management plan should be implemented as far as practically possible. It should be noted that the mitigation and management measures recommended in this report should be incorporated into the existing EMPr groundwater management plan and do not substitute the existing mitigation measures, but rather supplement them.

ii. Any development and/or drilling which takes place within the primary porosity aquifer associated with alluvium material deposited in flood plains must be avoided where possible and restricted if it cannot be avoided.

iii. The identified hydrogeological sensitive areas and buffer zones delineated as part of this assessment must be adhered to during the construction and operational phase activities. It is recommended that a localised hydrocensus user survey be performed within a 500.0m radius of each proposed gas production borehole situated within the riparian zone(s) and 350.0m radius of each proposed gas production borehole situated within the Karoo formations in order to identify the presence of other sensitive groundwater receptors and/or private boreholes. Accordingly, the gas production well design must take the results of the hydrocensus into consideration, specifically with regard to the planning and placement of boreholes as part of future drilling programmes.

iv. Additional monitoring boreholes should be established down-gradient of the existing and proposed plant expansion footprints to evaluate the mass load contribution to sensitive environmental and groundwater receptors. Drilling localities should be determined by means of a geophysical survey to target lineaments and weathered zones acting as preferred groundwater flow pathways and contaminant transport mechanisms.

v. It is recommended that the revised monitoring program as set out in this report should be implemented and adhered to. It is imperative that monitoring be conducted to serve as an early warning and detection system. Monitoring results should be evaluated on a bi-annual basis by a suitably qualified person for interpretation and trend analysis and submitted to the Regional Head: Department of Water and Sanitation.

vi. The numerical groundwater flow modelling assumptions should be verified and confirmed. The calibrated groundwater flow model should be updated on a biennial basis as newly gathered monitoring results become available to be applied as groundwater management tool for future scenario predictions.

vii. All preferred groundwater flow pathways which are in direct connection with surface topography such as decommissioned gas production boreholes as well as historical mining exploration boreholes should be sealed off and rehabilitated according to best practise guidelines.

13.1.6 HYDROLOGY STUDY CONCLUSIONS

Most impacts are considered to be easily detectable and the considered mitigation measures are easily practicable therefore the risks associated with the development are considered to be low.

13.1.7 TERRESTRIAL BIODIVERSITY STUDY CONCLUSIONS

Based on the latest available ecologically relevant spatial datasets, the following information is pertinent to the degraded and water resource habitats in the project area:

- It is recognised as a CBA 1 and ESA 1& 2 as per the Free State Conservation Plan; and
- Categorised as intact constituents of an EN ecosystem or CR river as identified by the National Biodiversity Assessment.

The ecological integrity, importance, and functioning of these terrestrial biodiversity areas provide a variety of ecological services that are considered beneficial, with one key service being the maintenance of biodiversity. The preservation of these systems is the most important aspect to consider for the proposed project. Thus, if these areas are not maintained in a natural or near natural state, destroyed or fragmented, then meeting targets for biodiversity features will not be achieved.

Observation and species records during the field survey denote that certain habitats within the assessment area were utilised by threatened flora and fauna species, comprising of:

- One flora species;
- Four (4) avifaunal species;
- Three (3) mammal species;
- One (1) reptile species; and
- One (1) amphibian species.

The completion of a comprehensive desktop study, in conjunction with the results from the field survey, suggest there is a high confidence in the information provided. The survey ensured that there was a suitable groundtruth coverage of the assessment area and major habitats and ecosystems were assessed to obtain a general species (fauna and flora) overview and the major current impacts were observed.

The developer is urged to provide a layout or design which represents a compromise between the needs of the development and the environmental concerns at the site, especially in regard to the very high/high sensitivity areas. A potential suggested alternative could be to make use of the existing agricultural areas within the surrounds.

The existence and importance of these habitats is regarded as crucial, due to the fauna species recorded as well as the role of this intact unique habitat to biodiversity within a very fragmented and disturbed local landscape, not to mention the sensitivity according to various ecological datasets.

In order to ensure that the ecosystem and biodiversity is adequately protected it is strongly recommended that a follow up survey to more accurately determine the population size and extent of *Smaug giganteus* (Sungazer/Giant Dragon Lizard).

13.1.8 AQUATIC STUDY CONCLUSIONS

The baseline assessment established three main watercourses within the project area, namely the Sand River, Doring River, and Boschluispruit, and a single system outside the project boundary, the Palmietkuilspruit. Additionally, numerous ephemeral systems and wetlands occur throughout the project area. The ecological assessment of the watercourses indicated moderate to large modifications attributed to varying land use, namely agriculture, mining, and urban activities upstream of the project area on the Sand River (Virginia). The land use activities have cumulatively resulted in a moderate deterioration in water quality, flow, and instream habitat, and subsequently to the biotic communities within the systems. Despite modifications, the Sand River met the Resource Quality Objectives for the reach, and all the water resources associated with the project area are considered sensitive. Given the findings of this assessment, no pristine or natural waterbodies were observed or expected in any of the project right areas, with the Doring River being classed as largely modified (class D), the Boschluispruit as largely modified (class D), and the Sand River as moderately modified (class C).

The upper reaches of the Boschluispruit and several tributaries within the project area are characteristic of wetland systems, and riparian zones and buffers were applied according to the wetland report (TBC, 2022). The Sand, Doring and lower reaches of the Boschluispruit presented well defined riparian zones consisting of woody vegetation. The soils along the watercourses are highly susceptible to erosion and considered sensitive to any potential anthropogenic activities along these systems which could potentially compromise the ecological integrity of the watercourses.

The water resources are poorly protected, and the ecosystems are critically endangered. Additionally, no Freshwater Priority Areas are assigned to them. *Labeobarbus kimberleyensis* (Largemouth Yellowfish) is expected within the Sand River and is the only species of conservational concern within the catchment and red listed as Near Threatened due to habitat fragmentation and water quality deterioration. The species was not collected during the survey, however, despite the absence of the species during the survey, the precautionary approach would assume the species to be within the project area and would likely be collected with increased sampling effort. The poorly protected nature of the systems indicates that strict mitigation measures should be adhered to ensure no further deterioration of the watercourses should the project proceed.

The buffers determined for the lower foothill systems was calculated at 50 m, and for the ephemeral systems, drainage lines and wetlands a buffer of 35 m.

The impact assessment considered both direct and indirect impacts, to the water resources. According to the layout provided and the delineated riparian zones and applicable buffers, the compression station, and pipeline crossings intersect with the water resources. Considering the pipelines are linear infrastructure, avoidance of the watercourses is not possible, strict mitigation implementation is required to ensure the minimisation of erosion and additional deterioration of the water resources are negated. The locality of compressor station CS1 falls within the riparian zone and buffer of the Sand River. This poses a moderate risk to the watercourse and alternative sites should be selected as erosion of the banks is likely. The position of compressor stations CS2 and CS3 are located within delineated wetlands and are addressed in the wetland specialist assessment.

Risks associated with the proposed infrastructure range from low to moderate, with the majority of moderate risks being reduced to low with the implementation of adequate mitigation measures, however, activities within the buffers and water resources remain moderate.

It is the specialist's opinion that no fatal flaws have been identified for the proposed activities. The alternative positioning of the compressor stations is preferred due to the avoidance of water resource sensitive areas. The soils within the catchment are prone to erosion and care is required to ensure proposed activities do not exacerbate erosion within the catchment. Monitoring of the aquatic resources is required during construction and operational activities.

A competent Environmental Control Officer (ECO) must oversee the construction activities and associated concurrent rehabilitation measures undertaken, with watercourse areas as a priority. Two follow up ECO assessments/audits must be carried out in the first and sixth months of operation. The ECO must be supplied with a copy of this and the other specialists reports and must be familiar with the mitigation and recommendations prior to construction.

13.1.9 WETLAND STUDY CONCLUSIONS

Natural wetlands classified as being channelled valley bottoms, depressions, hillslope seeps and unchanneled valley bottom as well as artificial systems were identified within the study area. The Present Ecological State (PES) of the wetlands ranges from "Seriously Modified" to 'Moderately Modified". Most modifications to wetlands in the study area is from agricultural activities taking place in the wetland and their respective catchments.

The Ecosystem Services of the wetlands range from "Moderately High" to "Moderately Low" for the study area. The valley bottom scored overall higher ecosystem services scores due to their ability to regulate streamflow, prevent flooding and helps with erosion control. The vegetation cover within the wetlands plays a major role in the ecosystem services scores. All the wetlands delineated within the study area were rate to be "Moderately" sensitive due to the relatively high protection status of the wet veg type and the low protection status of the wetland itself.

The buffer zone calculated for the delineated wetlands is 35 m. This buffer zone will ensure the conservation of the delineated wetlands from the proposed activities.

The impact assessment considered both direct and indirect impacts, to the water resources. It is evident that the pipeline and the transmission loop will encroach into the delineated wetland areas. The buffers around the wells and compressors also encroach into the wetland buffers but impacts can be avoided with the mitigation provided.

All the risks were considered low (post-mitigation). No moderate post-mitigation risks are anticipated to occur for the proposed project. Overall, the impacts associated with this service development are unlikely to negatively impact water resources to any appreciable level provided that the suggested mitigations measures are effectively implemented. Additionally, the project focusses on conveying gas, thus risks associated with leaks are considered low.

It is the specialist's opinion that no fatal flaws have been identified, and that the proposed activities may proceed as have been planned. Given the fact that "Low" post-mitigation significance ratings were determined for various aspects of the proposed project, it's the specialist's opinion that a General Authorisation could be applied for.

13.1.10 SOIL AND AGRICULTURE STUDY CONCLUSIONS

Three main sensitive soil forms were identified within the assessment area, namely the Avalon, Ermelo and Griffin soil forms. The land capability sensitivities (DAFF, 2017) indicate land capabilities with "Low" and "Moderate high" sensitivities, which correlates with the findings from the baseline assessment.

The assessment area is associated with arable soils, due to the type of soils which the DEA Screening Tool (2022) also identified as high to very high sensitivity for field crops farming. However, the available climatic conditions of low annual rainfall and high evapotranspiration potential severely limits crop production significantly resulting in land capabilities with "Low" and "Moderate high" sensitivities. The land capabilities associated with the regulated area are suitable for cropping and grazing, which corresponds with the current land use.

The final results indicate "Insignificant" to "Very Low" post-mitigation significance ratings for the proposed components. It is therefore clear that the proposed activities are expected to have a minimal impact on land potential resources. It is worth noting that some "High" sensitivity crop field areas were identified by means of the DEA Screening tool (2022) which is not expected to be avoided throughout the life of the operation. Therefore, stakeholder engagement must be undertaken to compensate land owners for high crop field land use areas where necessary.

With this being considered, it is recommended that the proposed activities may proceed as have been planned.

13.1.11 VISUAL STUDY CONCLUSIONS

Because the affected landscape areas are neither unique or protected and due to the fact that mitigation measures should generally be effective in minimising landscape impacts and visual impact experienced by potential receptors, there is no reason from a landscape and visual impact perspective that the project should not proceed as long as listed mitigation measures are implemented.

13.2 PREFERRED ALTERNATIVES

The preferred alternatives are discussed in the sections below.

13.2.1 LOCATION ALTERNATIVES

Two location alternatives were assessed for Compressor Station 3 as listed below:

- **CS3_L1** (Doorn River 330 (Portion 2))
- **CS3_L2** (Palmietkuil 328 (Portion 6))

From an air quality and noise perspective, both alternatives are considered equally weighted with low negative final impact significance and therefore either alternative is acceptable. The visual specialist assessment identified the preferred compressor station 3 alternative as being CS3_L2 which is close to Compressor Station 2 and also within 1km of a local road whereas the alternative location is within 400m of a group of eight homesteads and 1.3km of the R30.

From a social perspective, the landowner who owns Portion 2 of the farm Doorn Rivier 330 has specifically raised his concern that the project infrastructure would significantly alter his visual sense of place.

As neither of the two location alternatives were highlighted as no-go or significantly flawed by any of the specialist assessments, the CS3_L2 (Preferred Alternative) on the farm Palmietkuil 328 Portion 6 is considered the preferred alternative.

13.2.2 LAYOUT ALTERNATIVES

Based on the sensitivity planning approach, two areas have been delineated as no-go areas. The first is the Sibanye Beatrix tailings facility however there is no planned project infrastructure in this location and therefore this no-go area is for information purposes. The second location identified as no-go is located in the north of the application area on the farm Adamsons Vley 655 (Portion 0) as this area contains a very highly sensitive area due to the presence of a protected species which cannot be relocated. This area includes proposed project infrastructure (wells and pipelines) however based on this EIA assessment and as per the recommendation of the Terrestrial Ecologist, the surface area within this buffered area must remain undisturbed and must be treated as a no-go area. Consultation and communication with the lead or implementing agent for the sensitive species, Endangered Wildlife Trust (EWT), must be implemented before any construction proximal to the specific area. Monitoring and Management of the species will be crucial throughout the lifetime of the project and must be discussed and implemented in conjunction with the EWT

13.2.3 NO-GO ALTERNATIVE

The no-go alternative has been considered as a baseline against all project impacts. This alternative is not considered reasonable as no fatal flaws in the overall project plan have been identified. Where necessary, certain restrictions on sensitive areas have been put forward as well as identification of no-go areas however the overall project plan remains feasible.

13.3 ENVIRONMENTAL IMPACT STATEMENT

This EIA Report has been updated to include information which addressed the Ministers Appeal decision recommendations. Based on further consideration of this information, the outcome of the impact significance determined through the impact assessment did not change as presented in the previous EIA Report. The additional information reinforced the assumptions and/or assessments that were previously undertaken.

The findings of the specialist studies conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Based on the nature and extent of the proposed project, the limited level of disturbance predicted as a result of the production activities, the findings of the specialist studies, and the understanding of the significance level of potential environmental impacts, it is the opinion of the EIA project team and the EAP that the significance levels of the majority of identified negative impacts can generally be reduced to an acceptable level by implementing the recommended mitigation measures and the project should be authorized on condition that the below recommended conditions are included in the decision and that compliance with the EMPr must be strictly adhered to.

13.4 RECOMMENDATIONS FOR INCLUSION IN INTEGRATED DECISION

In addition to the standard conditions of an integrated Environmental Authorisation, the following specific conditions must be included in the EA to specifically add focus on the pertinent issues raised during this EIA application process. This section was expanded upon to include additional specialist conditions as requested by a landowner during the EIA comment period.

- If any deviations are to be undertaken from the designs and/or footprints of infrastructure or activities to take place outside of the assessed well or pipeline transects (as indicated in the EIA/EMPr), Tetra4 must follow due process in terms of applications for Amendments where such applications are determined to be required. The Competent Authority must be notified of any deviations and the required amendment process confirmed with the Competent Authority prior to implementing any deviations.
- Landowners must be consulted, and all reasonable requests complied with. A written landowner agreement should be negotiated and concluded prior to commencement. Should this not be possible, a record should be kept of reasonable negotiations with the land owners.
- Ensure that as much of the infrastructure as possible is sited away from agricultural lands. Where work in agricultural land is unavoidable this must be compensated accordingly, completed quickly and infrastructure placed underground as far as possible to allow continued land use post construction.
- The identified drill site should, where possible, not infringe on the landowners' surface activities. Where impacts on landowners' surface activities are unavoidable this must be compensated accordingly, completed quickly and infrastructure placed underground as far as possible to allow continued land use post construction.
- The location of the drilling site should be done so as to impact minimally on the daily activities of the landowner. The location of the site should be consulted and agreed with the landowner.
- As far as possible, exploration wells should be constructed (drilled) outside of existing cultivated lands. Where this is not possible, the final production well concrete bunkers must be located outside of cultivated lands and the borehole and connecting pipeline must be at least 1.5 m below surface to prevent interference with crop production activities.
- Tetra4's activities will cause a certain level of economic displacement for some of the affected landowners. In the event that the landowner disagrees with the compensation offered, the actual impact on their livelihoods must be assessed by a suitably experienced third party such as an agricultural economist, town planner, etc. Compensation must be done according to international best practice or market related land value.
- The impacts of servitudes on the land value of the affected properties must be considered and mitigated by means of negotiation. If the negotiation process is unsuccessful, it must be arbitrated by a suitably qualified third party. Once the preferred routing has been identified, Tetra4 must engage with the affected landowners for consensus of the preferred final pipeline routing. The preferred or final routing will be developed through reasonable negotiations with landowners for their respective

property. The agreed upon routing must be attached to Landowner agreements as a sketch plan and indicate the provisional servitude area.

- Temporary access and land arrangements must be made until there are more certainty on exactly where the wells will be. Servitudes should only be registered for productive wells.
- Tetra4 must take reasonable measures to prevent any disruption to the landowners' use of the properties (e.g. farming, crops, pivots, crop-dusting safety limitations, etc.). Landowners/tenants should be compensated for loss of arable land in accordance with the landowner access agreements (contracts).
- Adverse impacts on farming activities during the planting or harvesting season must be minimised as far as possible however should tangible impacts occur during these times, adequate and market related compensation must be agreed upon and provided to the affected party.
- If any damage is done to the property or harvest of the landowner, they must be compensated for their losses.
- If any damage to landowners' property occurs as a result of project activities, Tetra4 must carry the cost of rehabilitation /repair /replacement and compensate the farmer for his losses. If needed an external mediation process should be followed.
- There must be a formal procedure in place on how to report incidents and/or damage to landowner property and a claims procedure to ensure records of all grievances are kept. To receive compensation, the claim forms must be submitted to the Tetra4 CLO or suitable representative. Compensation should follow the IFC principles, which states that market related prices should be paid, and if anything is restored, it must be to the same or better standards than before.
- Tetra4 should engage with the relevant farmers about maintenance of farm roads used by the project, as some of landowners have preferential ways in which the roads must be maintained. The road maintenance agreements must be formalised before construction commences.
- Weed species should be eradicated at all disturbed areas. This must be monitored following rehabilitation until similar natural vegetation cover to surrounding areas has established to ensure that alien invasive plants do not establish themselves.
- Rehabilitate area to its original landform or as agreed to by the landowner, tenants and/or authorities.
- Landowners should be notified prior to accessing their land. The number and identity of workers, the purpose of the visit and specific areas to be visited, should be provided in the notification.
- A procedure to arrange access to properties must be devised and formalised. All reasonable efforts must be taken to obtain agreement on the procedure with the landowners and it must be formalised. Access must be arranged at least 24 hours prior, except in emergencies, when the landowners should also be informed immediately. If routine access is required, the landowners must be provided with a roster indicating dates and approximate times that access will be required.
- Tetra4 must meet with the landowners before the construction phase commences and formalise security arrangements in writing and where appropriate include the existing forums.
- If any new activities are planned for a property, Tetra4 must consult with the landowner and take reasonable steps to obtain his consent to execute the activity on his/her land.
- Light (visual) impact should be kept to a minimum (e.g. use of full cut-off lighting fixtures if necessary).
- Affected landowners must be provided with the construction schedule and when revisions to the schedule are made, these must be communicated to the affected landowners. Furthermore, construction timeframes must be made clear to individual affected landowners prior to construction.

- The impacts of servitudes on the land value of the affected properties must be considered and mitigated by means of negotiation. If the negotiation process is unsuccessful, it must be arbitrated by a suitably qualified third party.
- Farm safety must be a priority and the landowners and Tetra4 must agree on security measures prior to construction on their farms.
- Tetra4 must consult with landowners about any new work or potential changes that may take place on their properties.
- Protocols on farm access, compensation, communication, and road maintenance must be agreed upon and be in place before construction commences. The affected landowners must have input in the development of these protocols.
- A grievance mechanism and claims procedure must be in place and shared with all the stakeholders before the construction commences.
- A special meeting must be conducted with farm workers and other vulnerable parties, in their mother languages, to ensure that they understand the technical and safety aspects of the project.
- Construction activities may only take place during the daytime (sunrise to sunset) and no construction personnel may remain on private land at night (sunset to sunrise) except for security personnel in certain instances but with landowner agreement.
- The separation distances as indicated in the air quality specialist study must be complied with for the respective project phases and project components.
- Tetra4 must develop the following procedures and strict adherence with these procedures must be undertaken at all times by all relevant project personnel:
    - Pipeline Monitoring Maintenance Procedure
    - Access Procedure
    - Access Road Inspection and Maintenance Procedure
- The no-go area identified by the Terrestrial Ecologist on the farm Adamsons Vley 655 (Portion 0) must be excluded from any surface development infrastructure. Consultation and communication with the lead or implementing agent for the sensitive species, Endangered Wildlife Trust (EWT), must be implemented before any construction proximal to the specific area. Monitoring and Management of the species will be crucial throughout the lifetime of the project and must be discussed and implemented in conjunction with the EWT.
- Tetra4 must implement a reasonable fine and/or disciplinary action where landowner access agreements are not followed. Such fine or disciplinary action must be of a suitable value to deter nonadherence with landowner access agreements.
- A landowner contract must be finalized prior to commencement of construction and Tetra4 will engage with each individual affected landowner regarding the detailed planned works on their properties.
- Tetra4 must share the works schedule per property prior to commencement of any activity onsite. This communication will include details of the respective contractors that are appointed, provide the affected landowners with a project schedule for their respective properties and any changes to the schedule must be formally communicated in writing to the affected landowners prior to implementing such changes.
- Once the preferred routing has been identified, Tetra4 must engage with the affected landowners for consensus of the preferred final pipeline routing. The preferred or final routing will be developed through reasonable negotiations with landowners for their respective property. The agreed upon routing must be attached to Landowner agreements as a sketch plan and indicate the provisional servitude area.

- Tetra4 must investigate alternative methods to remove condensation water within the pipe network with the intention to limit or reduce the number of low points drains in the system. This may include nitrogen purging lines to flush out the system.
- The annual NEMA audits undertaken by an independent auditor must specifically record any concerns raised during the audit period in relation to safety and security and negative impacts on livelihoods of affected landowners within the application area. Furthermore, the audit report must include detail on how any such concerns have been dealt with.
- All workers must be educated on the need to ensure safety of surrounding communities and the public in general. Road safety legislation must be complied with at all times with additional consideration of the World Bank Group Environmental Health and Safety Guidelines. A community health and safety plan inclusive of a Traffic Management Plan will be developed based on risks identified in consideration of community health and safety.
- Risks associated with the potential use of security personnel will be assessed prior to operations and a security management plan will be developed if required and in accordance with IFC Performance Standard 4.
- Renewable energy (such as PV Solar) should be considered to replace/ reduce the reliance on Eskom electricity which, if implemented, would likely to reduce the operational phase climate change significance from the project from Medium to Low, since Eskom's contribution to the operational phase is the main source of GHG emissions. Also, the use of LNG instead of diesel for power generation will reduce the GHG footprint further.
- All references to "construction" in the EIA Report and EMPr shall be deemed to include commencement of a listed activity including all exploration related activities. The terms "construction" and "exploration" should be deemed to be synonymous in so far as they relate to temporary disturbance of the receiving environment.
- A township is proclaimed over Portion 3 of the farm Blaauwdrift 188 (Portion 3), and the township proclamation is dated 12 October 1956. No exploration drilling of any Cluster 2 wells on this property may take place until such time as the legal status of the township and rights of the landowner are adequately addressed. Any new pipelines to be laid on this property must be discussed and agreed with the landowner prior to commencement.
- The Holder must, at intervals not exceeding ten (10) years from the date of commencement of construction and throughout the operational lifespan of the project, undertake a Climate Change Review. The Review must:
    - Assess updated climate change projections and actual recorded rainfall trends relevant to the project area, including annual and seasonal rainfall totals, intensity, and variability;
    - Evaluate the adequacy of the project's stormwater management infrastructure, and associated engineering designs in relation to such projections and monitoring data; and
    - Identify and implement, where necessary, design modifications or adaptive measures to ensure that the infrastructure remains resilient and effective under predicted and observed climate conditions.
    - The findings of each Climate Change Review, together with any proposed or implemented design adjustments, must be submitted to the Competent Authority within 90 days of completion of the Review. Compliance with the above requirements, and implementation of any identified measures (where applicable) must be reported on in the annual NEMA Regulation 34 audit.

14 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations relating to this EIA phase assessment should be noted:

14.1 GENERAL

- This study is based on the engineering designs and Reports provided by the applicant, and it is assumed that no significant changes or deviations to the final designs will occur.
- In determining the significance of impacts, with mitigation, it is assumed that mitigation measures proposed in the report are correctly and effectively implemented and managed throughout the life of the project.

14.2 SOILS AND LAND CAPABILITY (AGRICULTURE)

- The assessment is based on auger points taken and observations on site. There may be variations in terms of the delineation of the soil forms across the area;
- Due to the size of the proposed area only the key areas where infrastructure is located were focused on, the remaining areas were predominantly delineated through means of desktop; and
- The GPS used for delineations is accurate to within five meters. Therefore, the delineation plotted digitally may be offset by at least five meters to either side.

14.3 AIR QUALITY AND HEALTH RISK

- Project information required to calculate emissions for proposed operations was provided by Tetra4 and EIMS. Where necessary, assumptions were made based on common industry practice and experience.
- Only routine emissions for the operational phase were estimated and simulated. Atmospheric releases occurring as a result of non-routine conditions were not accounted for limited to emergency flaring at the plant, with other non-routine releases expected to be minimal.
- Emission factors were used to estimate all fugitive and processing emissions resulting from plant, construction activities and transport. These emission factors generally assume average operating conditions.
- The access road from the R30 road to the plant was assumed to be unpaved for the purposes of the assessment. As such, a worst-case scenario was modelled as the access road will be paved in future.
- The compressor stations were assumed to be electrically powered, whereas the booster stations were assumed to use diesel generators.
- Flaring was simulated at the plant only (no flaring of wells was included). Throughput data were provided for two designs (continuous and emergency design) and modelled accordingly.
- Assumptions on flare stack metrics were made based on similar operation elsewhere (Burger and Akinshipe, 2014).
- It was assumed that no smoke/soot will be emitted by the flare.
- The impact assessment was limited to airborne particulates (including TSP, PM10 and PM2.5) and gaseous pollutants from combustion and non-combustion machinery, including CO, NOx, VOCs and SO_2.
- Nitrogen monoxide (NO) emissions are rapidly converted in the atmosphere into nitrogen dioxide (NO_2). NO_2 impacts where calculated by using a NO_2/NOx emission ratio of 0.2 (Howard, 1988).
- Planning and design, decommissioning, closure and rehabilitation phase impacts were not quantified. Impacts associated with these phases are highly variable and generally less significant than construction and operational phase impacts. Mitigation and management measures recommended for the

construction and operational phases are however also applicable to the planning and design, decommissioning, closure and rehabilitation phases.

14.4 CLIMATE CHANGE

- Project information required to calculate GHG emissions for proposed operations were provided by Tetra4 via EIMS. Where necessary, assumptions were made based on common industry practice and experience.
- The compressor stations were assumed to be electrically powered, whereas the booster stations were assumed to use natural gas generators.
- The methodological guidelines for quantification of GHG emissions (DFFE, 2022), published in October 2022, have been used to estimate the Scope 1 GHG emissions. The 100-year GWPs were used.
- GHG emissions from the well drilling[19], well testing[20], and well servicing[21] were based on measurements provided by Tetra4 and not calculated using emission factors. These activities were included under construction operations.
- Scope 3 emissions were estimated using the UK DEFRA (2022) emission factors (https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022).
- The following Scope 3 categories are excluded since these are not regarded applicable to the project:
    - Category 2: Capital Goods.
    - Category 8: Upstream Leased Assets.
    - Category 10: Processing of Sold Products.
    - Category 12: End-of-Life Treatment of Sold Products.
    - Category 13: Downstream Leased Assets.
    - Category 14: Franchises.
    - Category 15: Investments.
- The following assumptions apply to the Scope 3 assessment:
    - Raw materials needed for the wells and plant was assumed to be 100 980 tonne concrete, 26 060 tonne metal and 9 000 tonne HDPE.
    - It was assumed that the raw materials would be transported by truck to site (450 km).
    - Industrial waste to be sent to a landfill was assumed to be 31 428 tpa.
    - Business travel was assumed to be 6 people travelling to USA and Europe per year.
    - It was assumed that contractors and permanent staff (total 1 254 people) would have the following split for employee commuting to work (2.8% diesel car, 4.6% petrol car, 19.6% taxi and 73% bus). It was assumed that the return trip per day was 60 km.
    - It was assumed that 60% of the LNG (~ 90 000 tpa) would be shipped by sea tanker to China as a worst case scenario.

[19] Data obtained from kestrel flow meter while drilling and extrapolated for duration of exploration drilling in gas bearing units.
[20] Data obtained from flow testing and flaring of existing exploration wells.
[21] Data obtained from fugitive monitoring of both existing production and exploration wells.

- It was assumed that the Helium (1 825 tpa) would be transported by truck to Durban (600 km), and then by ship (cargo ship average bulk carrier) to either Europe, Asia or North America (average 14 461 km).
- It was assumed that the LNG (~ 160 000 tpa) would be combusted (end use of product).

14.5 ECONOMIC

- Although Tetra4's Cluster 1 production project is in progress (thus there is direct evidence that the enterprise is operational), the Cluster 2 economic impact is based on an intent, namely Tetra4's intent to generate the output and employment as is discussed in the economic specialist report. The eventuation of these benefits is reliant on an economically viable Tetra4, an assumption that is made in the compilation of the economic specialist report.
- As a sub-section of the economic viability, it is assumed that Tetra4 will be fully funded for its Cluster 2 project.
- Accepting of the above assumption, the next limitation is the ratios and multipliers used in the economic valuation. Although care was taken to use acceptable economic science, there is always a risk that some of the estimates may not eventuate in practice, and hence that the actualised economic and employment benefits may be much less. This is a limitation over which no assessment has control but needs to be mentioned.
- A further important limitation is that multipliers on a national level are different compared to a municipal level. This is due to the "leakages" from a local economy, for example income earned by a mine is often distributed to a region outside the enterprise's' municipality, or procurement if from outside the region, or salaries and wages are not always spent in a local economy. For this reason the direct impact is used as a barometer of impacts on the local economy and when multipliers were included those ratios were stated as relative to the local economy. However, despite this limitation the economy-wide benefits compared to the local base is instructive as it allows a competent authority a better perspective of the total local and national benefits relative to the local base.
- The gas multipliers for a well-established gas driven economy will be different to that of SA and for this reason, where possible, multipliers were adjusted to assume a more mature gas industry in SA.
- The economic impacts are calculated on the supply side of the economy in an optimal year. Thus, GDP is calculated as the sum of salaries and wages, depreciation and gross operating profit for the optimal year.
- For a long-term project such as Tetra4 the net present value of economic benefits could also have been used, but it has been shown that using the optimal year methodology, is equally correct, and easier to understand for the lay reader.
- The investment of the project is used separately as year 1 and 2 increases in GDP.
- As the world had experienced, outlier events such as the impact of Covid-19 are not included in this assessment.

14.6 GEOHYDROLOGY

Data limitations were addressed by following a conservative approach and assumptions include the following:

- The scale of the investigation was set at 1:50 000 resolutions in terms of topographic and spatial data, a lower resolution of 1:250 000 scale for geological data and a 1: 500 000 scale resolution for hydrogeological information.
- The Digital Elevation Model (DEM) data was interpolated with a USGS grid spacing of 25 m intervals.
- Rainfall data and other climatic data was sourced from the WR2012 database.

- Water management and catchment-based information was sourced from the GRDM and Aquiworx databases.
- The concept of representative elementary volumes (REV) has been applied i.e., a scale has been assumed so that heterogeneity within a system becomes negligible and thus can then be treated as a homogeneous system. The accuracy and scale of the assessment will result in deviations at point e.g. individual boreholes.
- The investigation relied on data collected as a snapshot of field surveys and existing monitoring data. Further trends should be verified by continued monitoring as set out in the monitoring program.
- Stratigraphical units, as delineated from surface geology within the model domain, are assumed to occur throughout the entire thickness of the model and were incorporated as such.
- The geological structures (fault zones and dyke contact zones) were modelled as permeable linear zones.
- The model basement i.e., competent Karoo basement or Dwyka tillite/diamictite is assumed to generally be impermeable and serves to isolate the fractured Karoo aquifer from the fractured pre-Karoo aquifer units.
- Model calibration was achieved by assigning a ratio of 1:1 for Hydraulic Conductivity (K) in x and y directions, with a ratio of 1:10 in the z direction i.e., anisotropic aquifer (except for alluvial deposits which were assigned at a 1:1 ratio).
- Perennial rivers within the model domain have been treated as gaining type streams. As such groundwater is lost from the system via baseflow to local drainages.
- Groundwater divides have been assumed to align with surface water divides and it is assumed that groundwater cannot flow across this type of boundaries.
- The numerical groundwater flow model was developed considering site specific information. It should be stated that influences from neighbouring mining developments were not taken into consideration as part of this investigation.
- Prior to development, the system is in equilibrium and therefore in steady state.
- Where data was absent or insufficient, values were assumed based on literature studies and referenced accordingly.

14.7 HERITAGE AND PALAEONTOLOGY

- Not detracting in any way from the comprehensiveness of the fieldwork undertaken, it is important to realise that the heritage resources located during the fieldwork do not necessarily represent all the possible heritage resources present within the area. Various factors account for this, including the subterranean nature of some archaeological sites, as well as the dense vegetation cover and disturbance found in some areas (crops: maize, sunflowers, soya bean; ploughed land).
- There was also restricted access to certain farm properties (BLAAUWDRIFT No.188 (Portion 3), BRUINTJE HOOGTE No.367 (Portion 2, 3), BRYAN No.561 (Portion 10, 21, 28, 29, 30, 31, 38), GLEN ROSS No.734 (Portion 4, 5, 6, 7, 18, 20), JONKERS RUST No.72, KALKOENKRANS No.225 (Portion 3), MOND VAN DOORNRIVIER No.38 (Portion 2), MOOIFONTEIN No.639, PALMIETJUIL No.548 (Portion 1), STILLE WONING no.703, VLAKPAN No.358) due to farm owners not giving permission to access their properties, flooded roads and dangerous game life on the properties.
- As such, should any heritage features and/or objects not included in the present inventory be located or observed, a heritage specialist must immediately be contacted. Such observed or located heritage features and/or objects may not be disturbed or removed in any way until such time that the heritage specialist has been able to make an assessment as to the significance of the site (or material) in question. This applies to graves and cemeteries as well. In the event that any graves or burial places are

located during the development, the procedures and requirements pertaining to graves and burials will apply as set out below.

- The study area boundaries and development footprints depicted in this report were provided by the client. As a result, these were the areas assessed during the fieldwork. Should any additional development footprints located outside of these study area boundaries be required, such additional areas will have to be assessed in the field by an experienced archaeologist/heritage specialist long before construction starts.
- When conducting a PIA several factors can affect the accuracy of the assessment. The focal point of geological maps is the geology of the area, and the sheet explanations were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have not been reviewed by palaeontologists and data is generally based on aerial photographs. Locality and geological information of museums and universities databases have not been kept up to date or data collected in the past have not always been accurately documented.
- Comparable Assemblage Zones in other areas is used to provide information on the existence of fossils in an area which was not yet been documented. When similar Assemblage Zones and geological formations for Desktop studies is used it is generally assumed that exposed fossil heritage is present within the footprint.

14.8 NOISE

- The quantification of sources of noise was limited to the construction and operational phase of the project. Impacts due to closure phase activities are expected to be similar to construction activities and its impacts only assessed qualitatively. Noise impacts will cease post-closure.
- The source power levels were calculated based on information provided by EIMS. The assumption is that this information is correct and reflects the routine construction and operational phase of the project.
- Structural obstacles were not included in the propagation modelling of the project noise sources. This is a conservative approach as the simulated noise impacts would not be attenuated by structural obstacles.
- Process activities were assumed to be 24 hours per day, 7 days per week.
- Although other existing sources of noise within the area were identified during the survey, such sources were not quantified but were taken into account during the baseline sampling.
- The environmental noise assessment focuses on the evaluation of impacts for humans.
- The scope of work did not include a vibration assessment.

14.9 SOCIAL

- Not every individual in the community could be interviewed therefore only key people in the community were approached for discussion. These key people include all the directly affected landowners. Additional information was obtained using existing data.
- The social environment constantly changes and adapts to change, and external factors outside the scope of the project can offset social changes, for example changes in local political leadership, droughts or economic conditions. It is therefore difficult to predict all impacts to a high level of accuracy, although care has been taken to identify and address the most likely impacts in the most appropriate way for the current local context within the limitations. In addition, it is also important to manage social impacts for the life of the project, especially in the light of the changing social environment.

- Social impacts can be felt on an actual or perceptual level, and therefore it is not always straightforward to measure the impacts in a quantitative manner.
- Social impacts commence when the project enters the public domain. Some of these impacts will occur irrespective of whether the project continues or not, and other impacts have already started. These impacts are difficult to mitigate, and some would require immediate action to minimise the risk.
- There are different groups with different interests in the community, and what one group may experience as a positive social impact, another group may experience as a negative impact. This duality will be pointed out in the impact assessment phase of the report.
- Social impacts are not site-specific but take place in the communities surrounding the proposed development.

14.10 TERRESTRIAL BIODIVERSITY

- The assessment area was based on the area provided by the client and any alterations to the area and/or missing GIS information pertaining to the assessment area would have affected the area surveyed;
- Only a single season survey will be conducted for the respective studies, this would constitute a wet season survey with its limitations;
- Access to certain portions within the study area was not possible due to the fact that the land owner did not give the go-ahead;
- Whilst every effort is made to cover as much of the site as possible, representative sampling is completed and by its nature it is possible that some plant and animal species that are present on site were not recorded during the field investigations; and
- The GPS used in the assessment has an accuracy of 5 m and consequently any spatial features may be offset by 5 m.

14.11 AQUATIC AND WETLANDS

- Areas characterised by external wetland indicators have been focussed on for this study. Areas lacking these characteristics, i.e. disturbed areas, developed areas etc. have not been focussed on;
- Due to the size of the proposed area only the key areas where infrastructure is located were focused on, the remaining areas were predominantly delineated through means of desktop; and
- The GPS used for water resource delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side.

14.12 VISUAL

- A site visit was undertaken over a two-day period (21st and 22nd February 2022).
- The timing of photography was planned to ensure that the sun was as far as possible behind the photographer to ensure that as much detail as possible was recorded in the photographs.
- GIS data sets used in the assessment are either available on line to the public or have been sourced from relevant government departments.
- Photographs were taken with a Canon EOS M50 camera fitted with a 22mm lens.
- Visibility of the proposed facilities has been assessed using the Global Mapper Viewshed tool.
- Most data sets have been used for assessment context. These have largely been sourced from government departments. Whilst these have been mainly mapped at national scale, they were found to be largely sufficient to provide context for the assessment. Where additional detail was required,

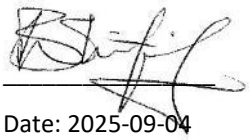
such as the location of local roads and homesteads, this was mapped on site and / or captured from online mapping.

- The visibility assessments were based on terrain data that has been derived from satellite imagery (STRM Worldwide Elevation Data). This data was originally prepared by NASA and is freely available on the CIAT-CCAFS website (http://www.cgiar-csi.org). This data has been ground truthed using a GPS as well as online mapping. This is the key data on which the definition of possible affected landscapes and receptors was based and is considered sufficient for this purpose.
- Calculation of visibility is based purely on the Digital Elevation Model and does not take into account the screening potential of vegetation or other development.
- A stack height of 16 m for the plant flare has been assumed for in this assessment.

15 UNDERTAKING REGARDING CORRECTNESS OF INFORMATION

I **Brian Whitfield** herewith undertake that the information provided in the foregoing report is correct, and that the comments and inputs from stakeholders and Interested and Affected Parties has been correctly recorded in the report.

Signature of the EAP

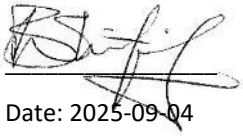


Date: 2025-09-04

16 UNDERTAKING REGARDING LEVEL OF AGREEMENT

I **Brian Whitfield** herewith undertake that the information provided in the foregoing report is correct, and that the level of agreement with Interested and Affected Parties and stakeholders has been correctly recorded and reported herein.

Signature of the EAP



Date: 2025-09-04

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