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SCOPING REPORT

TETRA4 CLUSTER 2 GAS PRODUCTION PROJECT

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1 EXECUTIVE SUMMARY (NON-TECHNICAL)

This non-technical executive summary provides a high-level overview of this environmental Scoping 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 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 is 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 LNG Facility and associated infrastructure was approved which comprises the first gas field for development within the approved Production Right area.

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

- Provisional Atmospheric Emission Licence (PAEL) (reference: LDM/AEL/YMK/014) for the Storage and Handling of Petroleum Products under the National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA); and

- Water Use Licence (WUL) (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).

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 around 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 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 Scoping 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 being undertaken. The relevant WUL and AEL applications will be submitted for the triggers under the NWA and NEMAQA respectively. The culmination of this study and application process will be an amendment to the existing approved Environmental Management Programme (EMPr) to include any additional specific mitigation measures that may be identified for Cluster 2. This will provide for a more streamlined process of managing the environmental impacts relating to both Cluster 1 and Cluster 2 as both developments consist of similar infrastructure components.

1.2 NEED FOR THE PROJECT

Tetra4 has successfully commenced with the Cluster 1 Helium and Methane gas production operations with proven resources of both products. Helium is one of the key 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. 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 South Africa's economy as well as end users of Helium. Liquid Natural Gas (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. As Helium and Methane occur together in the underground reserves, the project will produce both products simultaneously and therefore cannot 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, major 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 (e.g. borehole 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. 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 a main gas underground 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, 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 percussion or diamond drill rig to drill to varying depths (~380 m to ~880 m) along known fault lines in order to strike the gas reserve.

Percussion and diamond drills typically require temporary clearance of an area of 50 m x 50 m 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 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 diamond 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 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 ASME B31.8 (Section 851.7) and will have inspection chambers 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 there will be approximately 14 pig launcher/receiver pairs.

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 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 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.

1.4 SCOPING REPORT AND SPECIALIST STUDIES

This Scoping Report represents the “Scoping Phase: of the environmental authorisation application process and the term “scoping” refers to the process of determining the spatial and temporal boundaries of the proposed project. In broad terms, the objectives of the Scoping Process are to:

- Confirm the process to be followed and opportunities for stakeholder engagement;
- Clarify the project scope to be covered;
- Identify and confirm alternatives as well as preferred alternatives where relevant;
- Describe the need and motivation of the project; and
- Identify the key impacts to be addressed in the impact assessment phase and the approach to be followed in addressing these issues (Plan of Study for EIA phase).

A public consultation process is undertaken during this scoping phase which includes:

- The competent authority involved in the decision-making for this application as well as other government departments or organs of state that may have an interest in or be affected by this project;
- The affected landowners as well as public and NGOs to ensure that local, regional and national issues are well understood.

Any comments or issues raised as part of the legislated Scoping Report 30-day comment period will be captured in an Issues and Responses Report as an appendix to the Final Scoping Report, which will be submitted to the Petroleum Agency SA (PASA) for decision-making (i.e. approval or rejection).

Several specialist studies have been commissioned to investigate key issues and impacts that require further investigation and preliminary baseline information and findings from these studies are included in this report while the final specialist studies will be included in the EIAR. A list of the preliminary specialist studies that will be undertaken is included below and any additional studies that may be identified during the consultation process will be considered and included in the EIA phase:

- Agriculture and Hydropedology
- Air Quality & Health Risk
- Climate Change and GHG
- Economic
- Financial Provision
- Geohydrology
- Heritage and Palaeontology
- Hydrology
- Noise
- Social
- Terrestrial Biodiversity
- Visual
- Wetland and Aquatic

1.5 IMPACTS IDENTIFIED AND PRELIMINARY ASSESSMENT

A list of biophysical and socio-economic impacts that have been identified during this scoping phase as well as the preliminary pre-mitigation environmental risk, post mitigation environmental risk and final significance when applying a priority factor is presented below and these will be interrogated further in the EIA phase.

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	-20	-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	-10	-9	-10
	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	-11	-6.8	-8
	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).

Notification regarding the availability of this 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 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; and/or
- Email notifications with a letter attachment containing the information described above.

The scoping report will be available for public review from 29 July 2022 to 30 August 2022 for a period of at least 30 days.

2 INTRODUCTION

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 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:

- Provisional Atmospheric Emission Licence (PAEL) dated 4 August 2017 (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. A final atmospheric emission licence will be issued after operation of the plant which is currently under construction; 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, Tetra4 wishes 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 Scoping 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 being undertaken. The relevant WUL and AEL applications will be submitted for the triggers under the NWA and NEMAQA respectively. The culmination of this study and application process will be an amendment to the existing approved Environmental Management Programme (EMPr) to include and additional specific mitigation measures that may be identified for Cluster 2. This will provide for a more streamlined process of managing the environmental impacts relating to both Cluster 1 and Cluster 2 as both developments consist of similar infrastructure components.

2.1 REPORT STRUCTURE

This report has been compiled in accordance with the 2014 NEMA EIA Regulations, as amended. A summary of the report structure, and the specific sections that correspond to the applicable regulations, is provided in Table 1 below.

Table 1: Report structure

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 2(1)(a):	Details of – i. The Environmental Assessment Practitioner (EAP) who prepared the report; and ii. The expertise of the EAP, including a curriculum vitae;	Section 2.2 Appendix 2
Appendix 2(1)(b):	The location of the activity. 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 Table 4
Appendix 2(1)(c):	A plan which locates the proposed activity or activities applied for 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;	Figure 1 Figure 2 Figure 3 Figure 4 Figure 5 Figure 6
Appendix 2(1)(d):	A description of the scope of the proposed activity, including – i. All listed and specified activities triggered; ii. A description of the activities to be undertaken, including associated structures and infrastructure;	Table 6 Section 4

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 2(1)(e):	A description of the policy and legislative context within which the development is proposed including an identification of all legislation, policies, plans, guidelines, spatial tools, municipal development planning frameworks and instruments that are applicable to this activity and are to be considered in the assessment process;	Section 6
Appendix 2(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 location;	Section 6.15.2 Section 8
Appendix 2(1)(g):	A full description of the process followed to reach the proposed preferred activity, site and location within the site, including –	
	i. Details of all alternatives considered;	Section 8
	ii. Details of the public participation process undertaken in terms of regulation 41 of the Regulations, including copies of the supporting documents and inputs;	Section 9
	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;	Section 9.3
	iv. The environmental attributes associated with the alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects;	Section 10
	v. The impacts and risks identified for each alternative, 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;	Section 10.16.2
	vi. The methodology used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks associated with the alternatives;	Section 11.1
	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;	Section 11.2
	viii. The possible mitigation measures that could be applied and level of residual risk;	Section 11.3
	ix. The outcome of the site selection matrix;	
	x. If no alternatives, including alternative locations for the activity were investigated, the motivation for not considering such; and	
	xi. A concluding statement indicating the preferred alternatives, including preferred location of the activity;	Section 8

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 2(1)(h):	A plan of study for undertaking the environmental impact assessment process to be undertaken, including – i. A description of the alternatives to be considered and assessed within the preferred site, including the option of not proceeding with the activity; ii. A description of the aspects to be assessed as part of the environmental impact assessment process; iii. Aspects to be assessed by specialists; iv. A description of the proposed method of assessing the environmental aspects, including a description of the proposed method assessing the environmental aspects to be assessed by specialists; v. A description of the proposed method of assessing duration and significance; vi. An indication of the stages at which the competent authority will be consulted; vii. Particulars of the public participation process that will be conducted during the environmental impact assessment process; and viii. A description of the tasks that will be undertaken as part of the environmental impact assessment process; ix. Identify suitable measures to avoid, reverse, mitigate or manage identified impacts and to determine the extent of the residual risks that need to be managed and monitored;	Section 13
Appendix 2(2)(i)	An undertaking under oath or affirmation by the EAP in relation to – i. The correctness of the information provided in the report; ii. The inclusion of comments and inputs from stakeholders and interested and affected parties; and iii. 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
Appendix 2(2)(j):	An undertaking under oath or affirmation by the EAP in relation to the level of agreement between the EAP and interested and affected parties on the plan of study for undertaking the environmental impact assessment;	Section 16
Appendix 2(2)(k):	Where applicable, any specific information required by the competent authority; and	No additional requirements have been received from the Competent Authority to date.
Appendix 2(2)(l):	Any other matter required in terms of section 24(4)(a) and (b) of the Act.	No additional required matters

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
		were identified in terms of these sections of the Act.

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 2: 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 senior project manager at EIMS and has over 18 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 and 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, a number of specialist studies have been pre-emptively commissioned to investigate key impacts that require further investigation. A list of the preliminary specialist studies is included in Table 3. Any additional studies that may be identified during the course of the scoping and consultation process will be considered and included in the EIA phase.

Table 3: List of specialist studies to inform this EIA application.

Specialist Discipline	Company/Organisation
Agriculture and Hydropedology	The Biodiversity Company
Air Quality & Health Risk & GHG	Airshed Planning Professionals
Economic	Strategy4Good
Financial Provision	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 preliminary environmental impacts that may occur as a result of the proposed project. These preliminary impacts were assessed according to pre-defined impact rating methodology detailed in Section 11.1. Preliminary mitigation / management measures to minimise potential negative impacts or enhance potential benefits are put forward in this Scoping Report and will be finalised during the EIA phase based on public input and specialist final considerations of all available information. The specialist reports that informed this scoping level report will be made available in the EIA phase.

3 DESCRIPTION OF THE PROPERTY

Details of the application area, the location as well as the properties are included in Table 4 below.

Table 4: Locality details.

Farm Names	The application area covers a number of farm portions and whilst not all portions of parent farms are 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
Application Area (Ha)	The Cluster 2 application area covers a total of ~27 500 hectares.
Magisterial District	The proposed project falls within the Masilonyana and Matjhabeng Local Municipalities, in the Lejweleputswa District Municipality, Free State Province.
Distance and direction from nearest towns	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.
Farm Name, Number and Portion as well as 21-digit Surveyor General Code	

Farm Name, Number and Portion	21 Digit Surveyor General Code
Adamsons Vley 655 (Portion 0)	F03500000000065500000
Adamsons Vley 655 (Portion 1)	F03500000000065500001
Adamsons Vley 655 (Portion 2)	F03500000000065500002
Annex 3 No 478 (Portion 0)	F03300000000047800000
Annex Glen Ross 562 (Portion 0)	F03300000000056200000
Annex Glen Ross 562 (Portion 1)	F03300000000056200001
Annex Glen Ross 562 (Portion 10)	F03300000000056200010
Annex Glen Ross 562 (Portion 2)	F03300000000056200002
Annex Glen Ross 562 (Portion 3)	F03300000000056200003
Annex Glen Ross 562 (Portion 4)	F03300000000056200004
Annex Glen Ross 562 (Portion 5)	F03300000000056200005
Annex Glen Ross 562 (Portion 6)	F03300000000056200006
Annex Glen Ross 562 (Portion 7)	F03300000000056200007
Annex Glen Ross 562 (Portion 8)	F03300000000056200008
Annex Glen Ross 562 (Portion 9)	F03300000000056200009
Annex Grusde 474 (Portion 0)	F03300000000047400000
Annex Mooivlakte 208 (Portion 0)	F03300000000020800000
Annex Welgelegen No 76 (Portion 0)	F03300000000007600000
Bethel No 96 (Portion 0)	F03300000000009600000
Blaauwdrift 188 (Portion 2)	F03300000000018800002
Blaauwdrift 188 (Portion 3)	F03300000000018800003
Bloemhoek 509 (Portion 0)	F03300000000050900000
Bloemhoek 509 (Portion 1)	F03300000000050900001
Bloemhoek 509 (Portion 2)	F03300000000050900002

Bloemhoek 509 (Portion 5)	F03300000000050900005
Bloemhoek 509 (Portion 7)	F03300000000050900007
Bloemhoek 509 (Portion 8)	F03300000000050900008
Boschkop No 227 (Portion 4)	F03300000000022700004
Boschkop No 227 (Portion 5)	F03300000000022700005
Boschluis Spruit 278 (Portion 0)	F03300000000027800000
Boschluis Spruit 278 (Portion 1)	F03300000000027800001
Boschluis Spruit 278 (Portion 2)	F03300000000027800002
Braklaagte 41 (Portion 0)	F03300000000004100000
Braklaagte 41 (Portion 1)	F03300000000004100001
Brakspruit 121 (Portion 0)	F03300000000012100000
Bruintjes Hoogte 367 (Portion 0)	F03300000000036700000
Bruintjes Hoogte 367 (Portion 2)	F03300000000036700002
Bruintjes Hoogte 367 (Portion 3)	F03300000000036700003
Bruintjes Hoogte 367 (Portion 4)	F03300000000036700004
Bryan 561 (Portion 0)	F03300000000056100000
Bryan 561 (Portion 1)	F03300000000056100001
Bryan 561 (Portion 10)	F03300000000056100010
Bryan 561 (Portion 11)	F03300000000056100011
Bryan 561 (Portion 18)	F03300000000056100018
Bryan 561 (Portion 19)	F03300000000056100019
Bryan 561 (Portion 21)	F03300000000056100021
Bryan 561 (Portion 22)	F03300000000056100022
Bryan 561 (Portion 23)	F03300000000056100023
Bryan 561 (Portion 26)	F03300000000056100026
Bryan 561 (Portion 27)	F03300000000056100027
Bryan 561 (Portion 28)	F03300000000056100028
Bryan 561 (Portion 29)	F03300000000056100029
Bryan 561 (Portion 32)	F03300000000056100032
Bryan 561 (Portion 33)	F03300000000056100033
Bryan 561 (Portion 34)	F03300000000056100034
Bryan 561 (Portion 35)	F03300000000056100035
Bryan 561 (Portion 36)	F03300000000056100036
Bryan 561 (Portion 37)	F03300000000056100037
Bryan 561 (Portion 38)	F03300000000056100038
Bryan 561 (Portion 39)	F03300000000056100039
Bryan 561 (Portion 40)	F03300000000056100040
Bryan 561 (Portion 41)	F03300000000056100041
Bryan 561 (Portion 46)	F03300000000056100046
Bryan 561 (Portion 6)	F03300000000056100006
Cabriere 215 (Portion 0)	F03300000000021500000
Carlo 596 (Portion 0)	F03300000000059600000
Clewer No 104 (Portion 1)	F03300000000010400001
Commericia No 430 (Portion 0)	F03300000000043000000
Damplaats 341 (Portion 0)	F03300000000034100000
Dankbaarheid 16 (Portion 0)	F03300000000001600000

		Dayton No 560 (Portion 0)	F03300000000056000000	
		De Klerks Kraal 231 (Portion 0)	F03300000000023100000	
		De Klerks Kraal 231 (Portion 1)	F03300000000023100001	
		De Klerks Kraal 231 (Portion 4)	F03300000000023100004	
		De Klerks Kraal 231 (Portion 5)	F03300000000023100005	
		De Klerks Kraal 231 (Portion 6)	F03300000000023100006	
		De Klerks Kraal 231 (Portion 7)	F03300000000023100007	
		De Klerks Kraal 231 (Portion 8)	F03300000000023100008	
		Die Mond 479 (Portion 0)	F03300000000047900000	
		Die Mond 479 (Portion 1)	F03300000000047900001	
		Digito 642 (Portion 0)	F03300000000064200000	
		Doorn River 330 (Portion 0)	F03300000000033000000	
		Doorn River 330 (Portion 1)	F03300000000033000001	
		Doorn River 330 (Portion 10)	F03300000000033000010	
		Doorn River 330 (Portion 11)	F03300000000033000011	
		Doorn River 330 (Portion 12)	F03300000000033000012	
		Doorn River 330 (Portion 13)	F03300000000033000013	
		Doorn River 330 (Portion 14)	F03300000000033000014	
		Doorn River 330 (Portion 15)	F03300000000033000015	
		Doorn River 330 (Portion 16)	F03300000000033000016	
		Doorn River 330 (Portion 17)	F03300000000033000017	
		Doorn River 330 (Portion 18)	F03300000000033000018	
		Doorn River 330 (Portion 19)	F03300000000033000019	
		Doorn River 330 (Portion 2)	F03300000000033000002	
		Doorn River 330 (Portion 20)	F03300000000033000020	
		Doorn River 330 (Portion 21)	F03300000000033000021	
		Doorn River 330 (Portion 3)	F03300000000033000003	
		Doorn River 330 (Portion 5)	F03300000000033000005	
		Doorn River 330 (Portion 6)	F03300000000033000006	
		Doorn River 330 (Portion 8)	F03300000000033000008	
		Doorndeel 236 (Portion 0)	F03300000000023600000	
		Doorndeel 236 (Portion 1)	F03300000000023600001	
		Driekoppies No 422 (Portion 0)	F03300000000042200000	
		Du Preez Leger No324 (Portion 0)	F03500000000032400000	
		Enkeldoorn 360 (Portion 0)	F03300000000036000000	
		Excelsior No 147 (Portion 0)	F03300000000014700000	
		Excelsior No 147 (Portion 1)	F03300000000014700001	
		Fairview No 532 (Portion 0)	F03300000000053200000	
		Farm Annex 2 30 (Portion 0)	F03300000000003000000	
		Farm Blijdschap 17 (Portion 0)	F03300000000001700000	
		Farm Byran No 49 (Portion 1)	F03300000000004900001	
		Farm Byran No 49 (Portion 4)	F03300000000004900004	
		Farm Lekkerlewe 13 (Portion 0)	F03500000000001300000	
		Farm Lekkerlewe 14 (Portion 1)	F03900000000001300001	
		Farm Shalom 24 (Portion 0)	F03300000000002400000	
		Farm Welgelegen Station No 64 (Portion 0)	F03300000000006400000	

		Frisgewaag 550 (Portion 0)	F03300000000055000000	
		Frisgewaag 550 (Portion 1)	F03300000000055000001	
		Frisgewaag 550 (Portion 2)	F03300000000055000002	
		Glen Ross 734 (Portion 0)	F03500000000073400000	
		Glen Ross 734 (Portion 1)	F03500000000073400001	
		Glen Ross 734 (Portion 10)	F03500000000073400010	
		Glen Ross 734 (Portion 11)	F03500000000073400011	
		Glen Ross 734 (Portion 12)	F03500000000073400012	
		Glen Ross 734 (Portion 13)	F03500000000073400013	
		Glen Ross 734 (Portion 14)	F03500000000073400014	
		Glen Ross 734 (Portion 15)	F03500000000073400015	
		Glen Ross 734 (Portion 16)	F03500000000073400016	
		Glen Ross 734 (Portion 17)	F03500000000073400017	
		Glen Ross 734 (Portion 18)	F03500000000073400018	
		Glen Ross 734 (Portion 19)	F03500000000073400019	
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The farms and portions included within the application area are depicted in Figure 1 to Figure 4 overleaf.

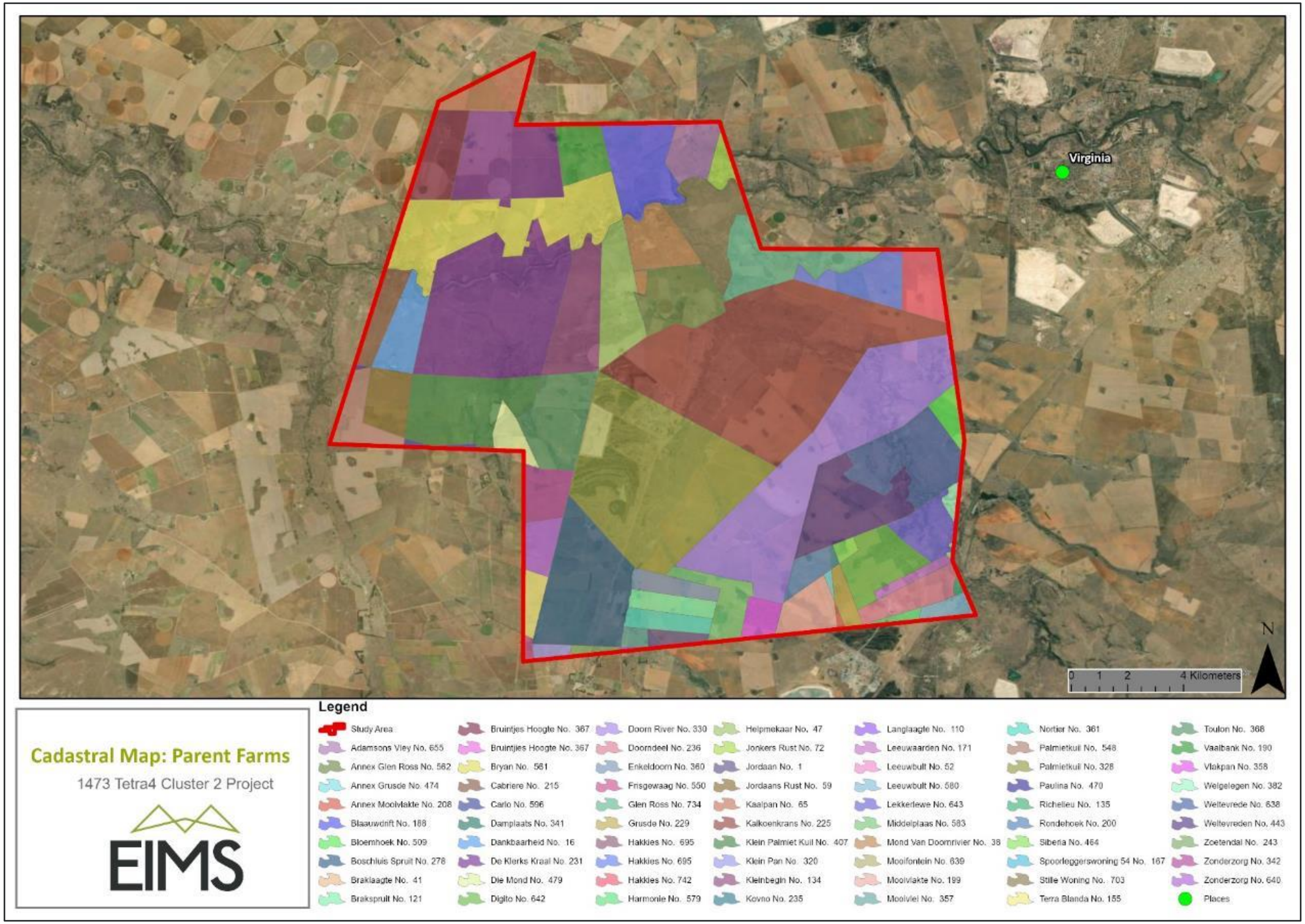


Figure 1: Parent farms included in the application area.

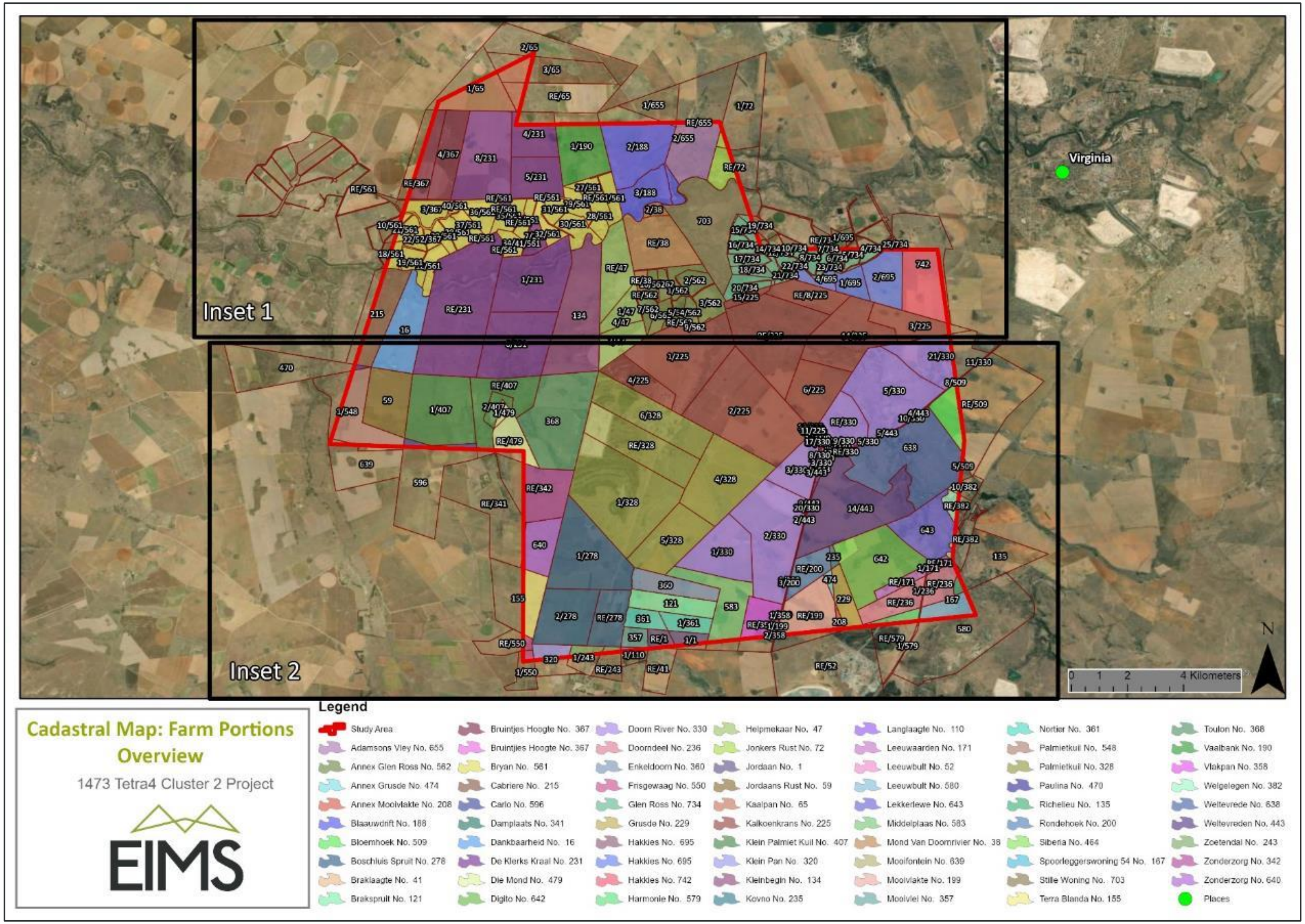


Figure 2: Overview of parent farms and portions included in the application area.

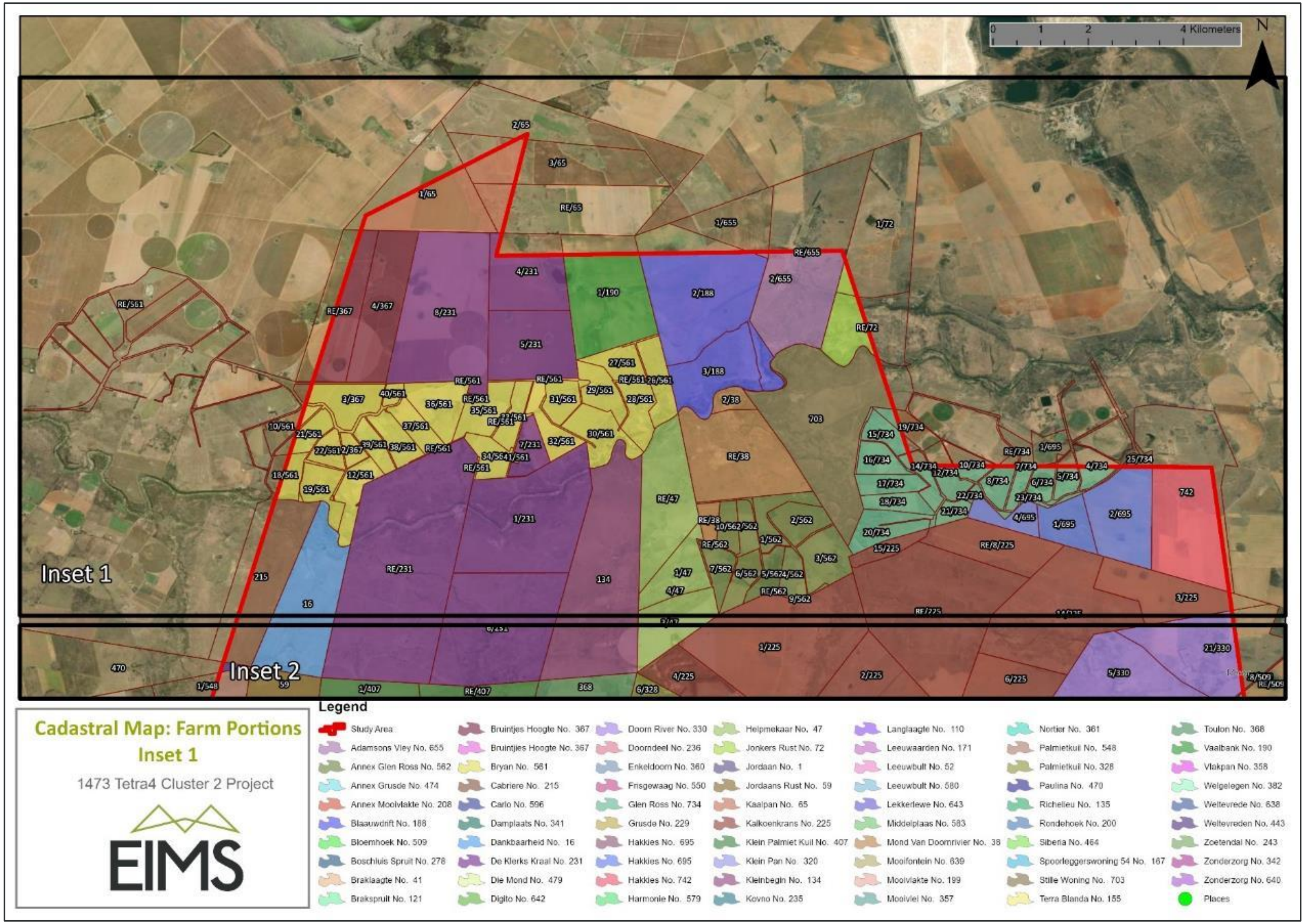


Figure 3: Inset 1 map of parent farms and portions included in the application area.

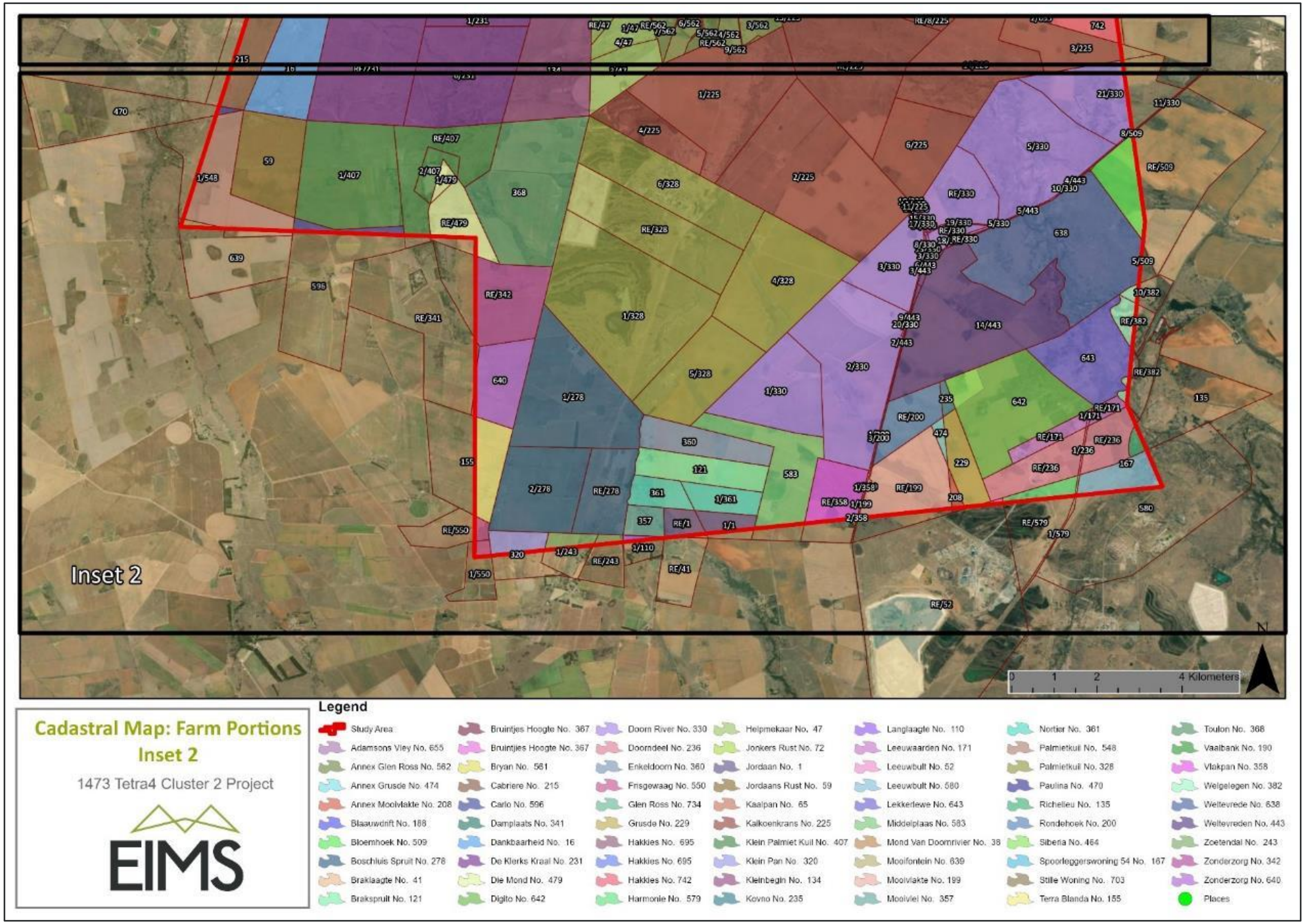


Figure 4: Inset 2 map of parent farms and portions included in the application area.

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. The aim of the description is to describe the activities that are planned, and where relevant, highlight any additional EA approval requirements. The project description is also aimed at facilitating the readers understanding of the project related activities, their extent (spatial and temporal) and resultant impacts, where relevant.

4.1.1 PROPOSED CLUSTER 2 PROJECT

Tetra4 wishes to expand the natural gas 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 Production Right area (blue outline) while the accompanying EMPr to the Production Right was prepared based on a detailed assessment of the reduced area (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.

The Cluster 2 study area and transects within which infrastructure will be positioned are presented in Figure 6.

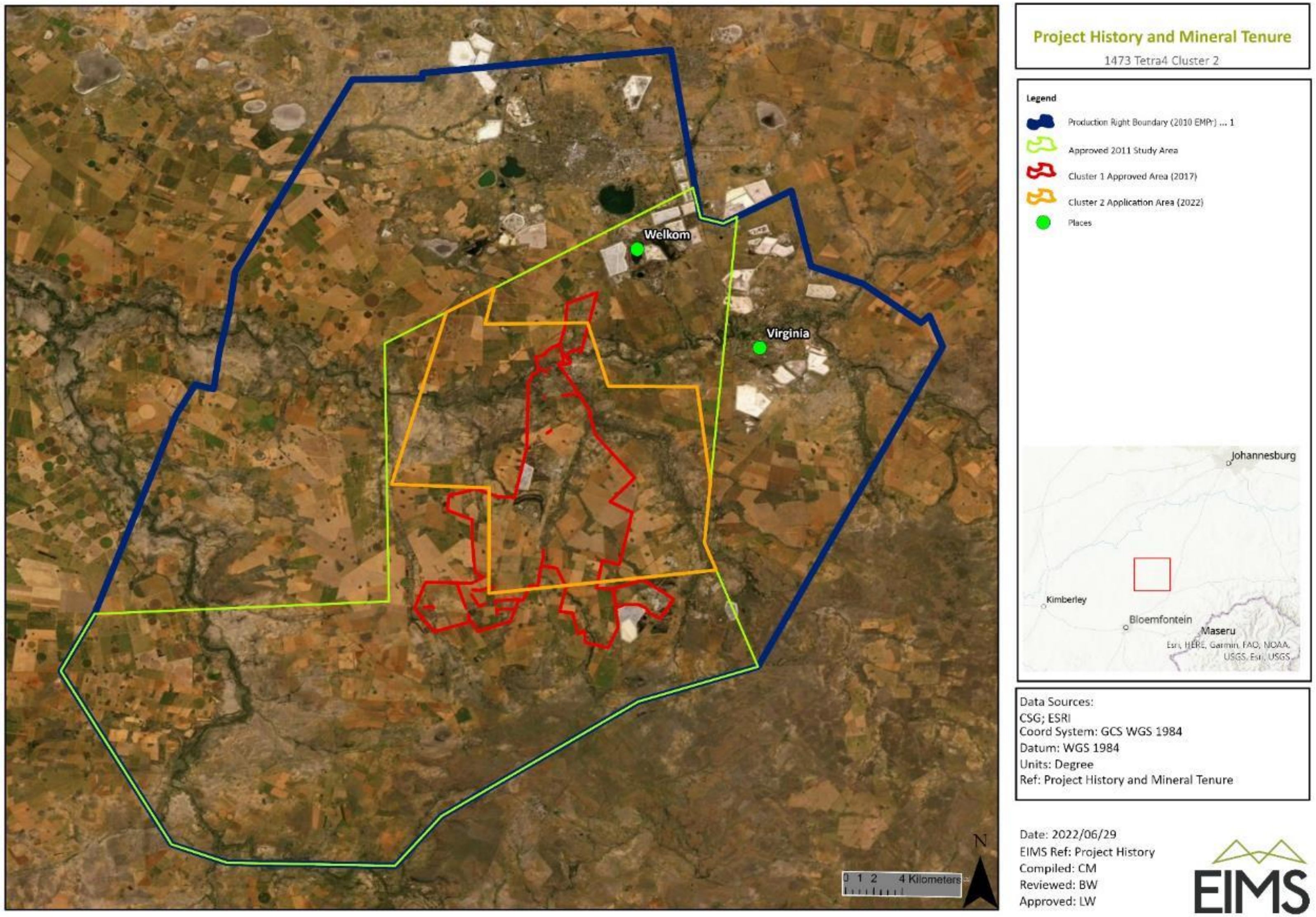


Figure 5: Project history and mineral tenure.

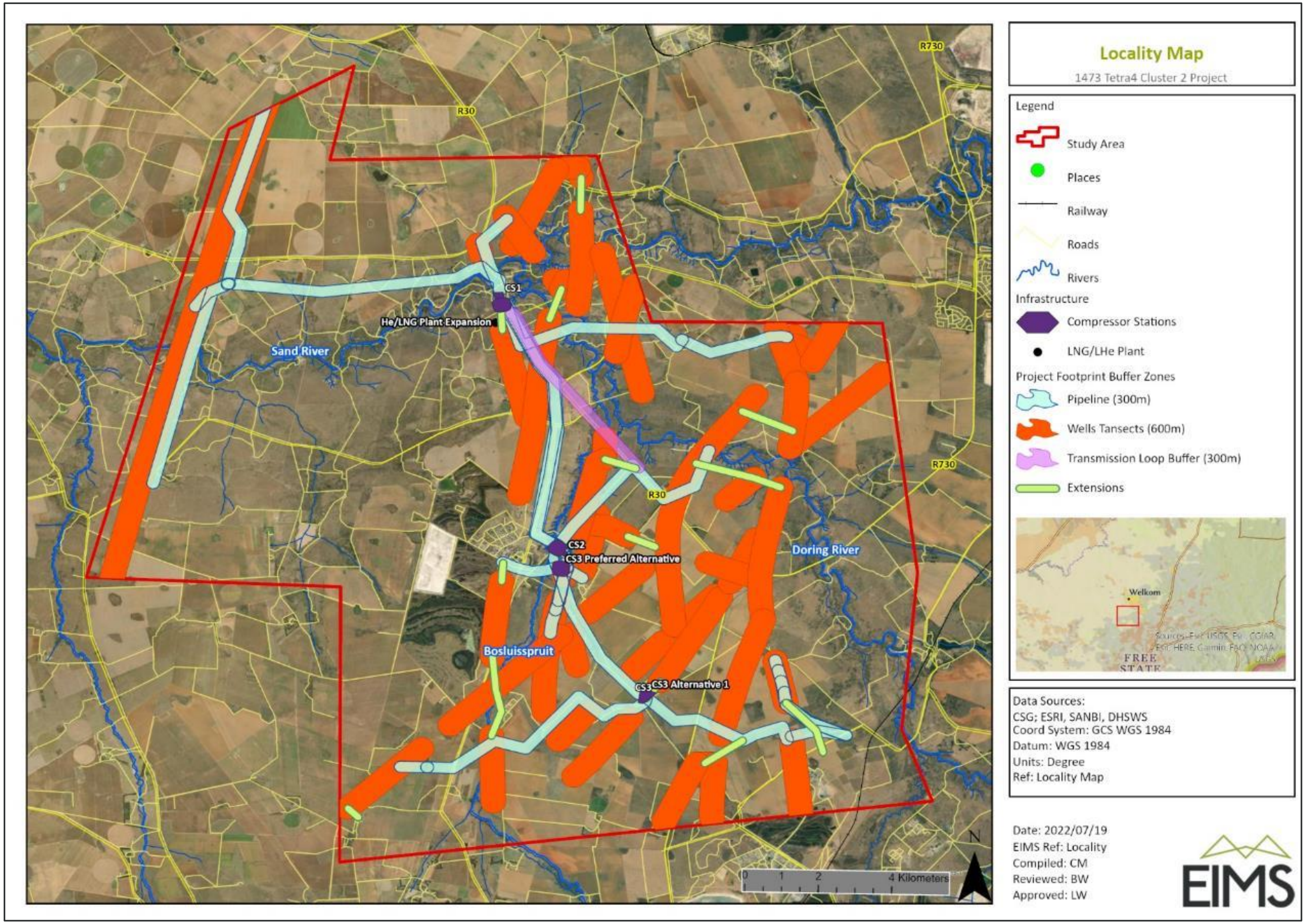


Figure 6: Cluster 2 study area and proposed infrastructure footprint buffer zones.

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 from the mantle, and biogenic hydrocarbons 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) which will be located at strategic points along the gas pipeline routes as shown in Figure 6. A gas pre-treatment will remove condensate 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 which is minimal 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 removal 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 for 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 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 well underway and the LNG/LHe processing facility is currently in the construction phase. Once Cluster 1 is complete, Tetra4 will begin 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 existing gas sources, gas gathering and the production capacities. The project consists of two components namely, gas gathering and the LNG/LHe processing plant. The targeted total feed gas flow from Cluster 2 production wells is estimated at ~44 million-standard cubic feet per day (MMSCFD) by 2026.

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 gas wells will feed into a common booster station. From the booster stations the gas will be fed into a dual gathering 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 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.

The gas gathering network will comprise primarily of High-Density Polyethylene (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. To ensure 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.

4.1.3.1 EXPLORATION 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 fault lines). Exploration drilling entails the use of a truck, trailer or skid mounted percussion or diamond drill rig to drill to varying depths (~380 m to ~880 m) along known fault lines in order 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.

Percussion and diamond drills typically require temporary clearance 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 from both the surrounding geology and 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 per day is required for drilling purposes and will be sourced from the municipality.

In the event that an exploration borehole proves unsuccessful it will be 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 (refer to Appendix 5) and the area rehabilitated to pre-drilling conditions. In the event that 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 and the equipment to be used during drilling activities includes a truck/trailer or skid mounted diamond drill rig, excavator, dozer, grader water cart, light motor vehicle for transport of personnel and chemical toilets.

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. The casing and grouting ensure that the gas is isolated from surrounding

[2] To contextualize this volume of gas, if ALL of this 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.

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. The flange and well head will be located within the concrete well chamber.

Due to low gas pressures in the wells, groups of ~10 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 high-density polyethylene (HDPE) depending on site conditions and installed at a minimum depth of 1.5 m below surface level. 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 7) and adhere to ASME B31.8 (Section 851.7) and will have inspection chambers at strategic locations for testing and pipeline maintenance.

Figure 7: 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. 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 13 shows the typical designs of a precast 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 14) and a total of 28 booster stations are expected to be constructed.

Inline pigging stations (Figure 8) 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 9) 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.

Figure 8: View of an existing pigging station constructed as part of Cluster 1.

Figure 9: 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 10 and Figure 15).

Figure 10: 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 will 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 5 below and an overview provided in Figure 11.

Table 5: Approximate LNG/LHe Plant and laydown area.

Aspect	Total Ha	Total Ha
LNG/LHe Plant Cluster 2 (Permanent)	~9.6	~25.4
Laydown areas for drilling contractors, gas gathering contractors, plant contractors, parking, offices, etc. (Temporary)	~15.8	

Figure 11: 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.

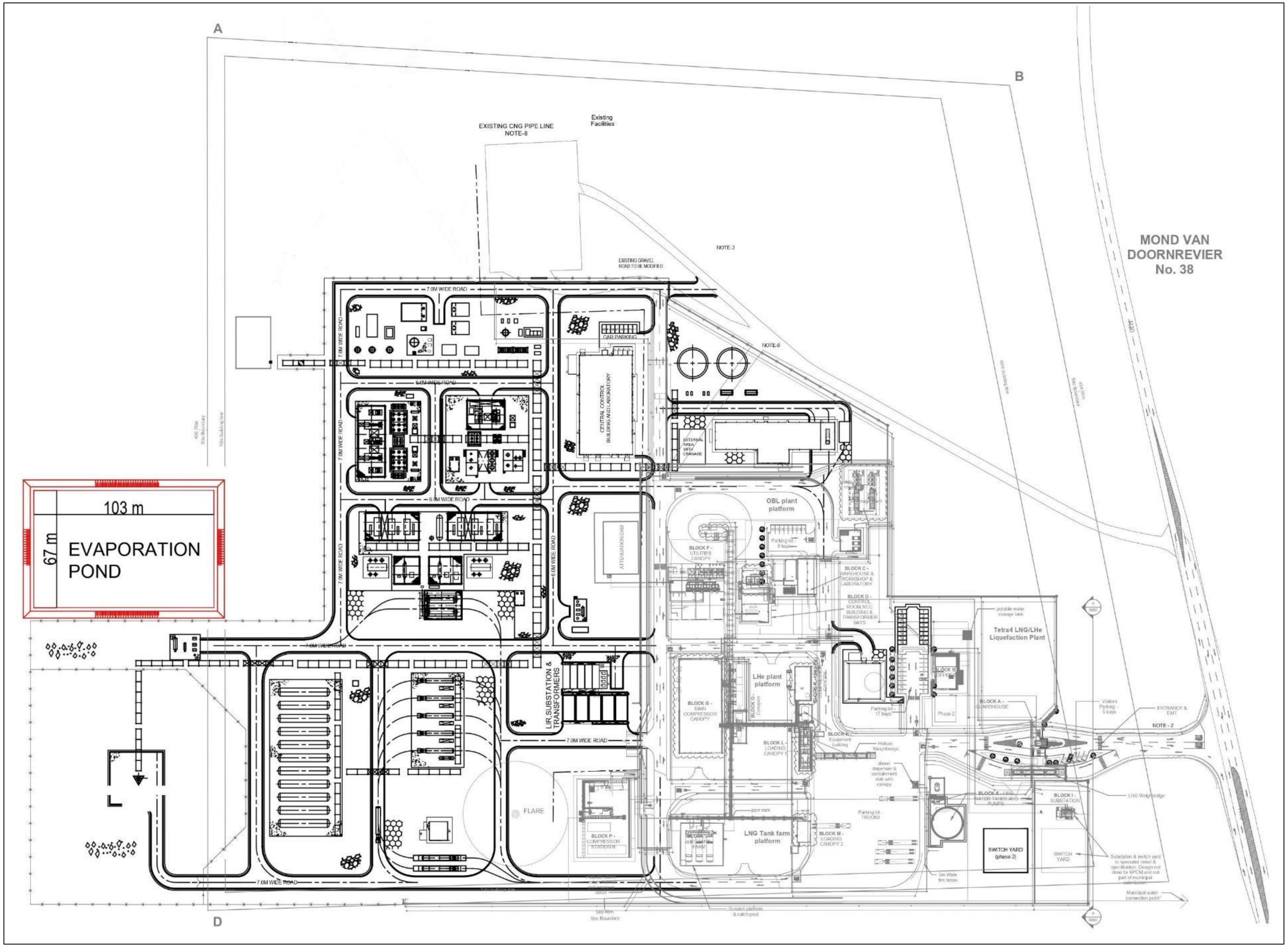


Figure 12: Preliminary layout of the Cluster 2 Plant extension to Cluster 1 Plant

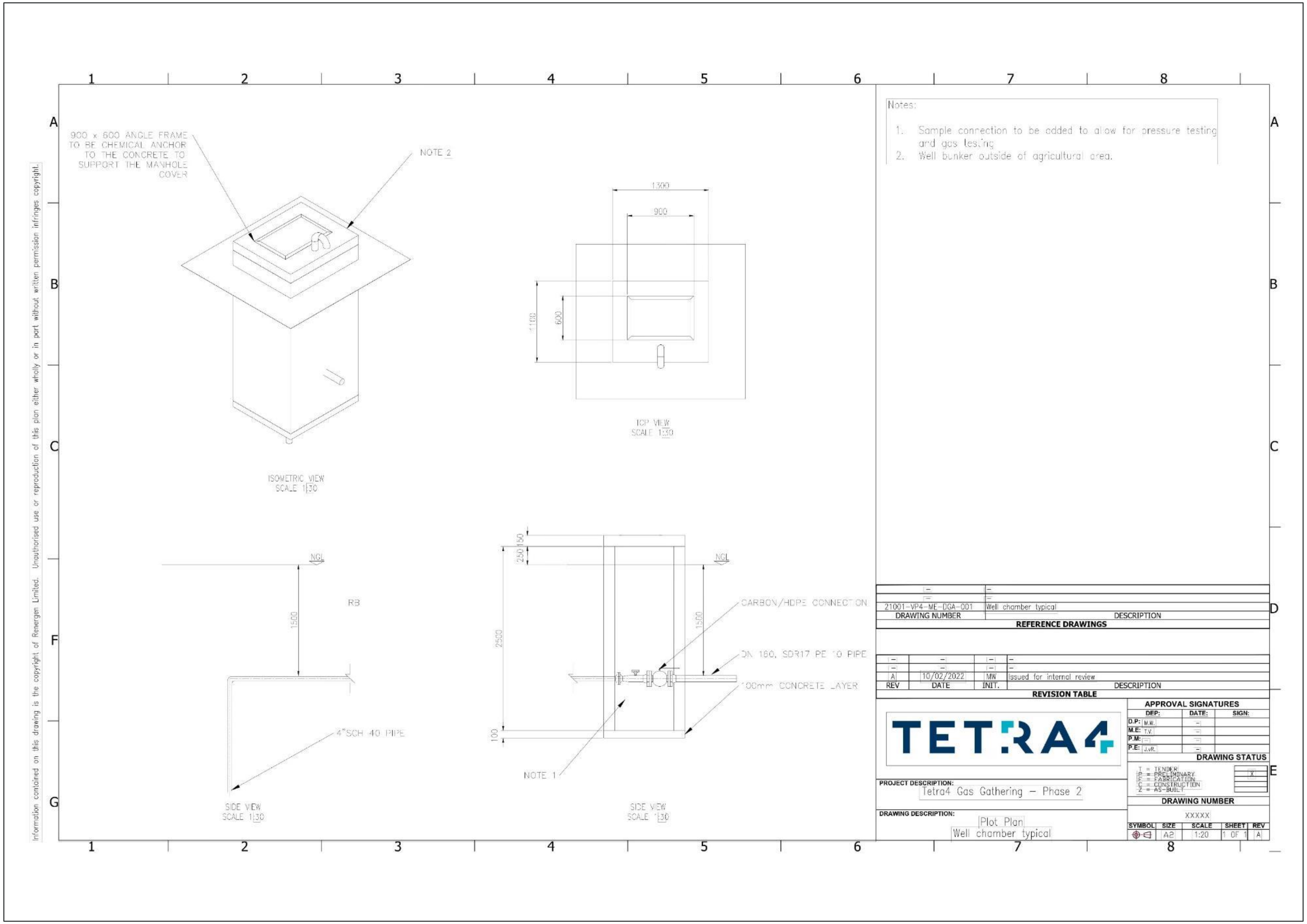


Figure 13: Typical subterranean precast well chamber layout

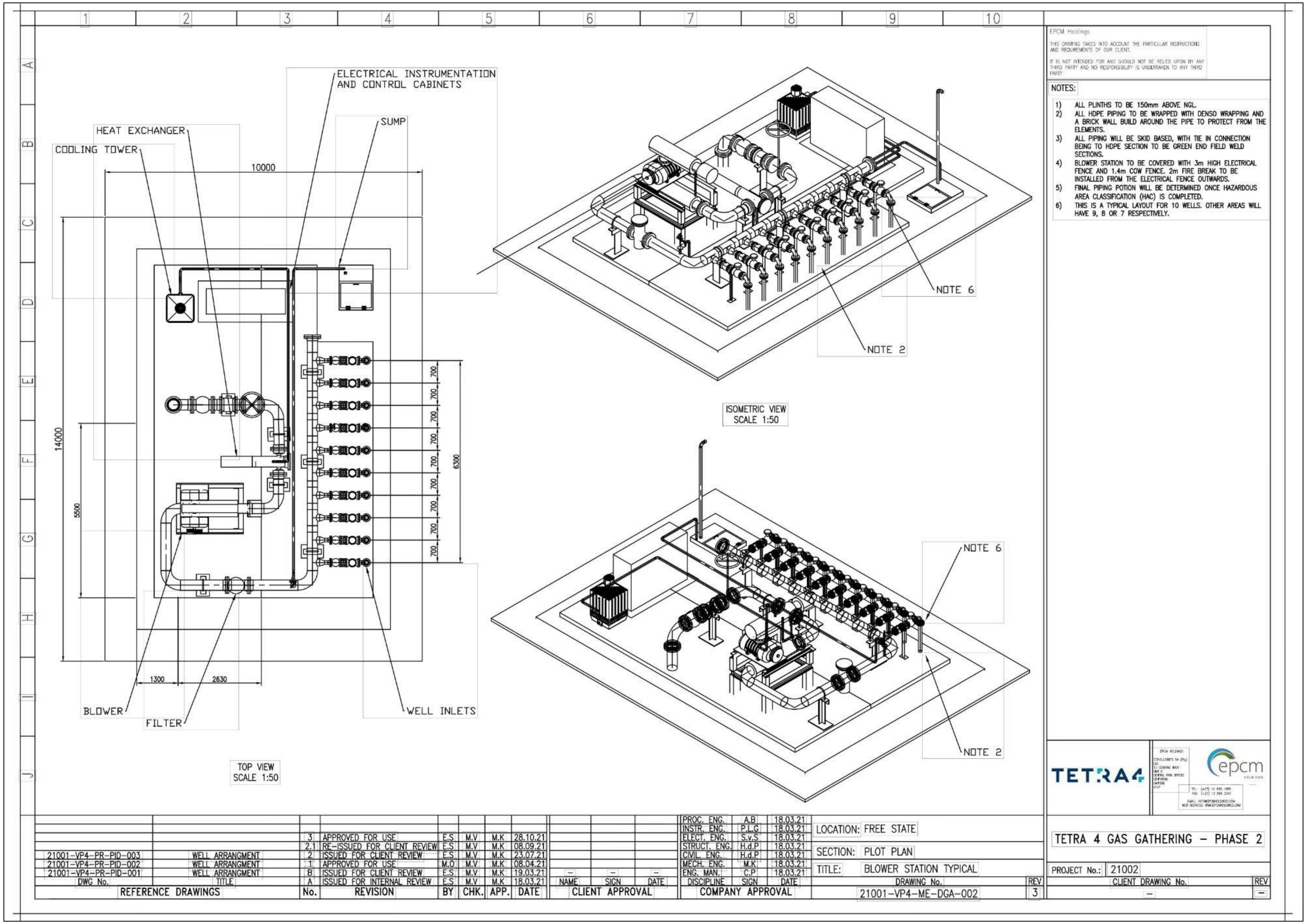


Figure 14: Typical booster station layout

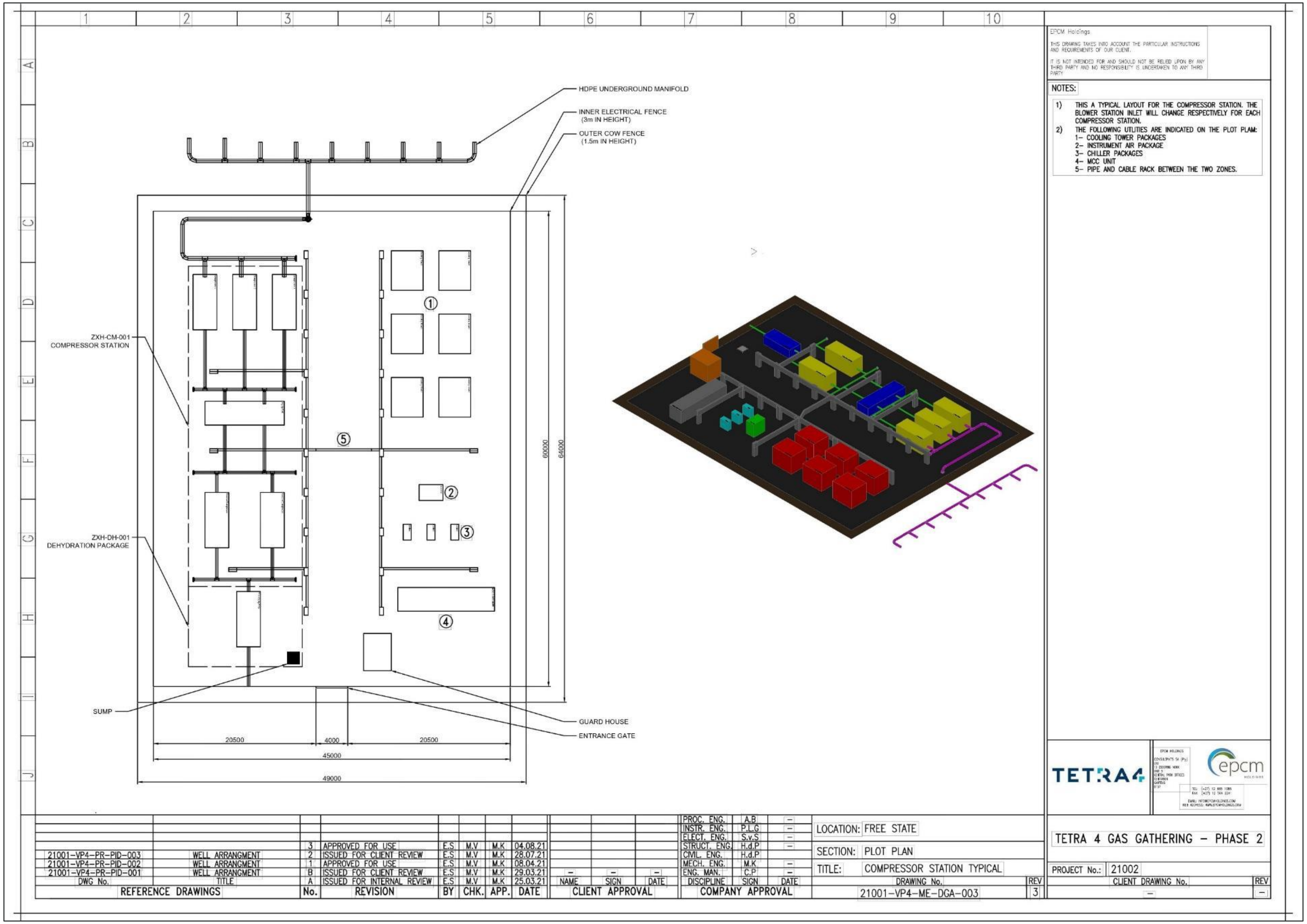


Figure 15: Typical compressor station layout

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 (limited to gas producing wells, 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 sites will be required to sign in at the security check point located at the entrance gates. All employees will be required to retain proof of identification whilst on site.

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 construction.

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 16). 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.

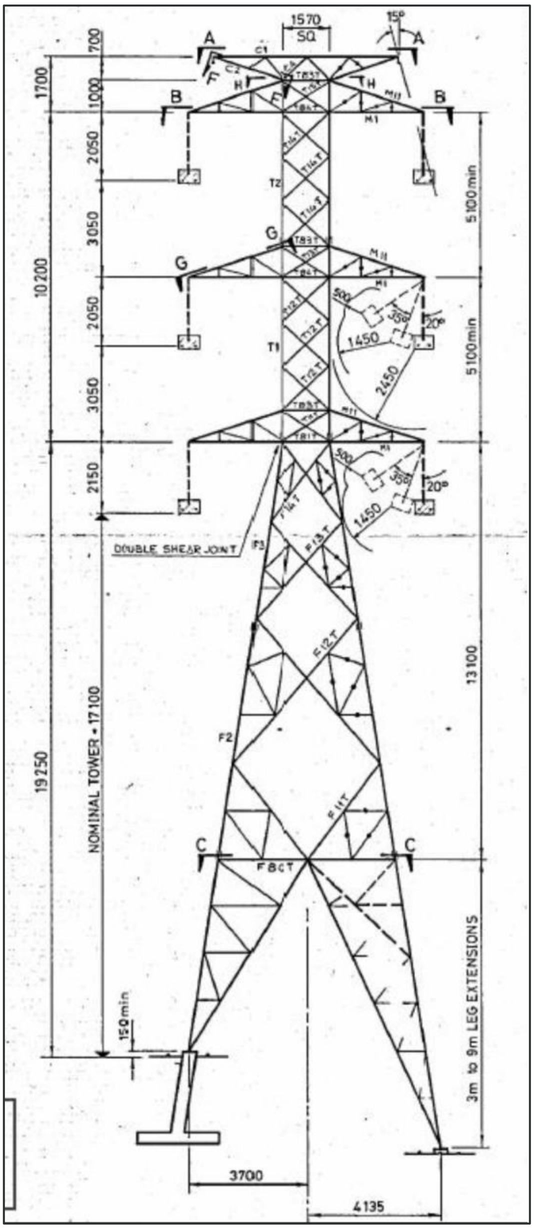


Figure 16: Typical transmission tower outline drawing.

The compressor stations will require a medium voltage substation connection from existing Municipal/Eskom lines (6.6 kV / 3.3 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 requirements for exploration and limited amounts for production activities, 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 which is piped into the Cluster 1 plant service water tank.

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 19 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 will be developed which will ensure separation of clean and dirty water. Clean water will be diverted back into the environment in a controlled manner, while dirty water will be collected and stored within an 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, condensate, formation water, etc) will be stored in an evaporation pond (Figure 12) before being treated. 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 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 17.

The main RO-WTW will have a 5 m^3 feed tank which will be supplied with effluent from the 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 18.

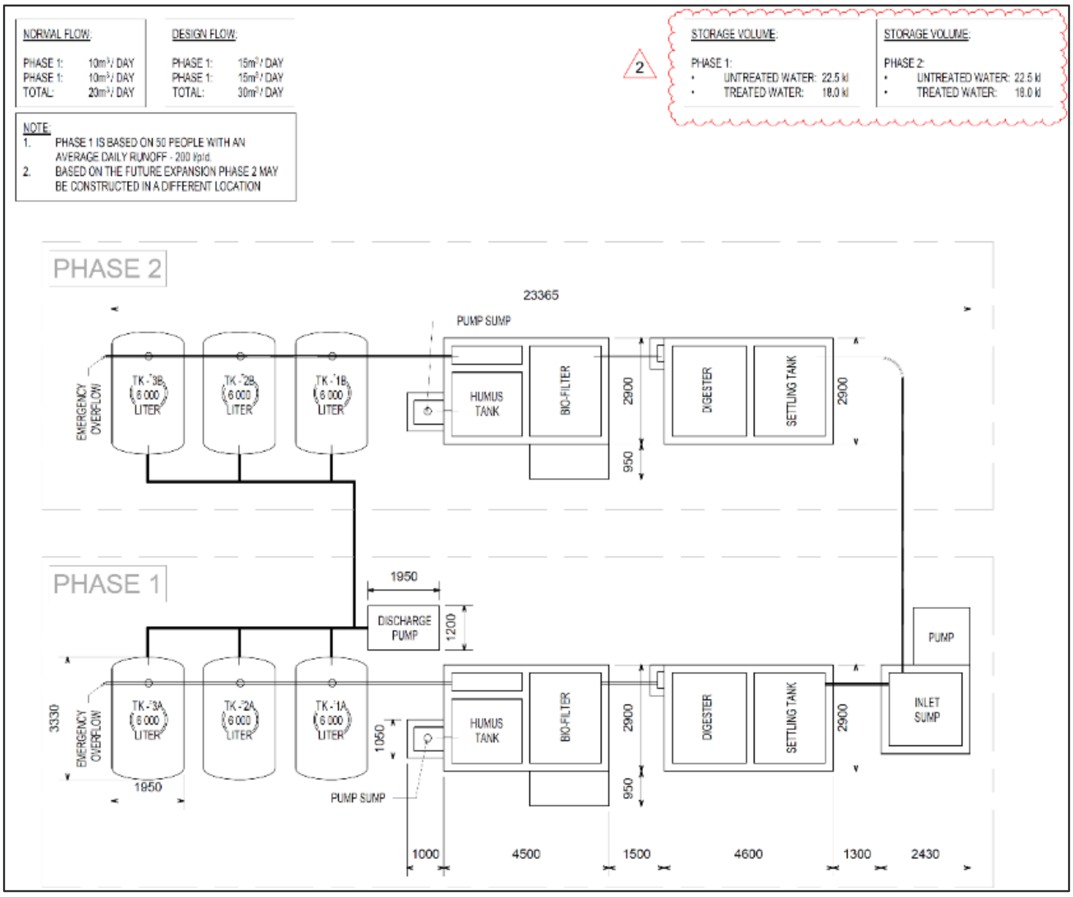
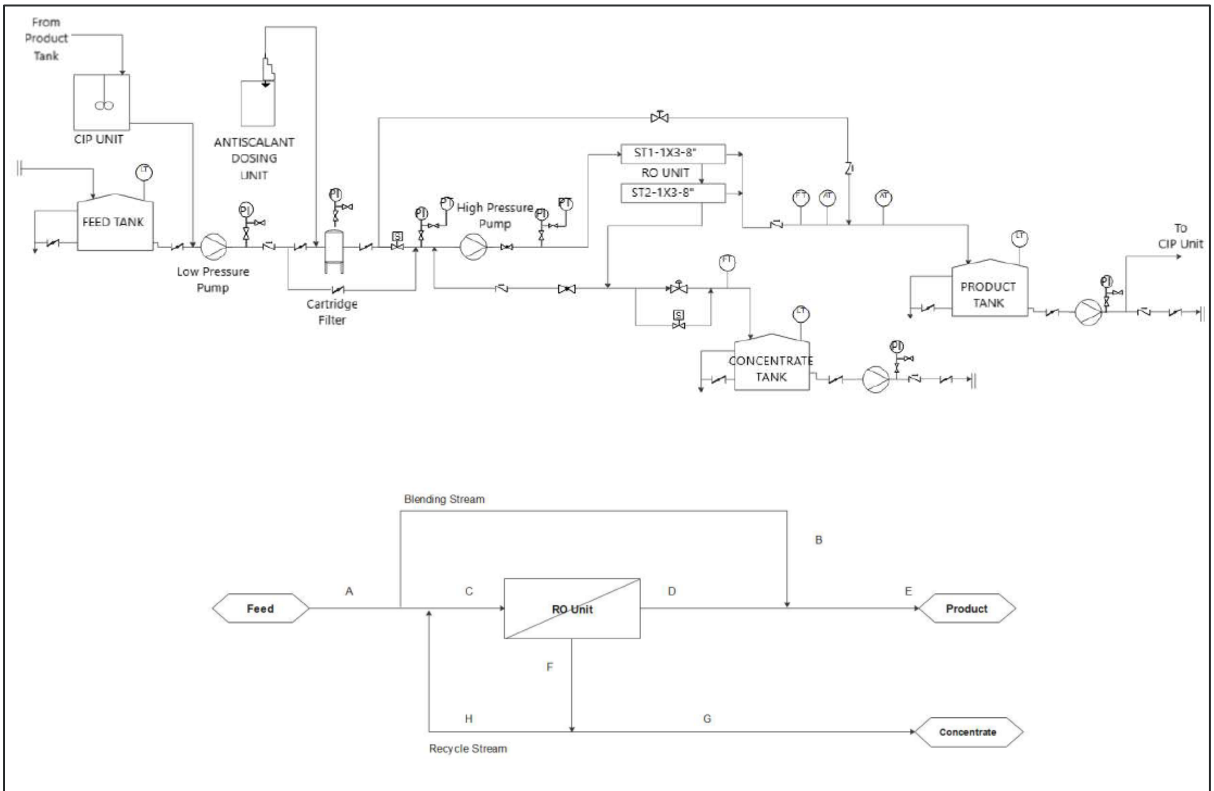
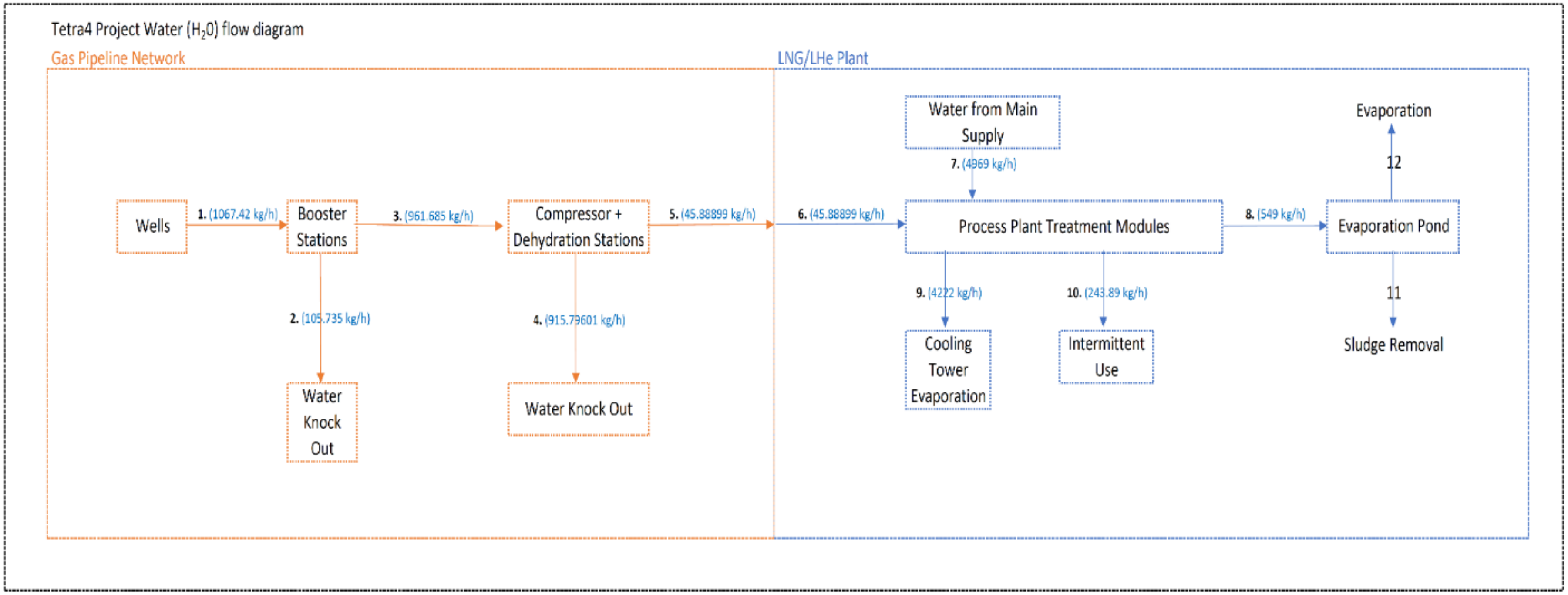


Figure 17: Typical schematic of the proposed sewage water treatment works.



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 18: 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 19: 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 which will not be stored more than 90 days on site. 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. Exploration drilling is approved in the Production Right and therefore does not fall within the scope of this application.

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).

5 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 6 below.

Table 6: 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.

Activity No	Activity Description	Applicability
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 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.	This project comprises extensive linear activities such as pipelines (with associated low point drains, 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 the vast majority of these roads will not be wider than 2m and many will only be 2-spoor tracks. This activity will be investigated further during the EIA process and if no access roads wider than 8m are identified, this activity will be removed during the EIA phase.
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.

Activity No	Activity Description	Applicability
		Pipelines and access roads are linear activities and therefore excluded from this listed activity and the calculation of vegetation clearance.
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	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
	from the edge of a watercourse; excluding- (aa) the expansion of infrastructure or structures within existing ports or harbours 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.

Activity No	Activity Description	Applicability
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; 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.	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 own not trigger a listed activity but when combined, exceed the threshold for clearance of vegetation.
NEMA LISTING NOTICE 2 ACTIVITIES		

Activity No	Activity Description	Applicability
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, 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.	The LNG/LHe Plant will be constructed for Cluster 2 which serves the purpose of beneficiation/refining 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;	Approximately 480 km of roads may be required to service the various exploration and production wells, pipelines, compressor stations, etc which may occur within the identified CBA areas within the application area. In certain areas the width of the access roads by exceed 4m however the majority thereof would be ~2 m wide or consist of 2-spoor type roads. The applicability of this activity will be assessed in more detail during the EIA phase.

Activity No	Activity Description	Applicability
	(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 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.

Activity No	Activity Description	Applicability
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. 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	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.
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;	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
	(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 (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	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
	infrastructure will be expanded by 30 cubic metres or more but no more than 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 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;	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
	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 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

Activity No	Activity Description	Applicability
		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 monthly average, excluding the treatment of effluent, wastewater, sewage or organic waste using composting or 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". 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.

Activity No	Activity Description	Applicability
		Note: This NEMWA trigger does not require a waste management licence but rather requires registration and compliance with the Norms and Standards.
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.	The evaporation pond has already been registered by the DWS under the General Authorisation Regulation for this activity.
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.

6 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.

6.1 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.

6.2 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 Regulation 21 and Appendix 2 of the EIA Regulations (2014, as amended) in order to satisfy the criteria for a Scoping Report.

6.3 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 20 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 5 (Table 6).

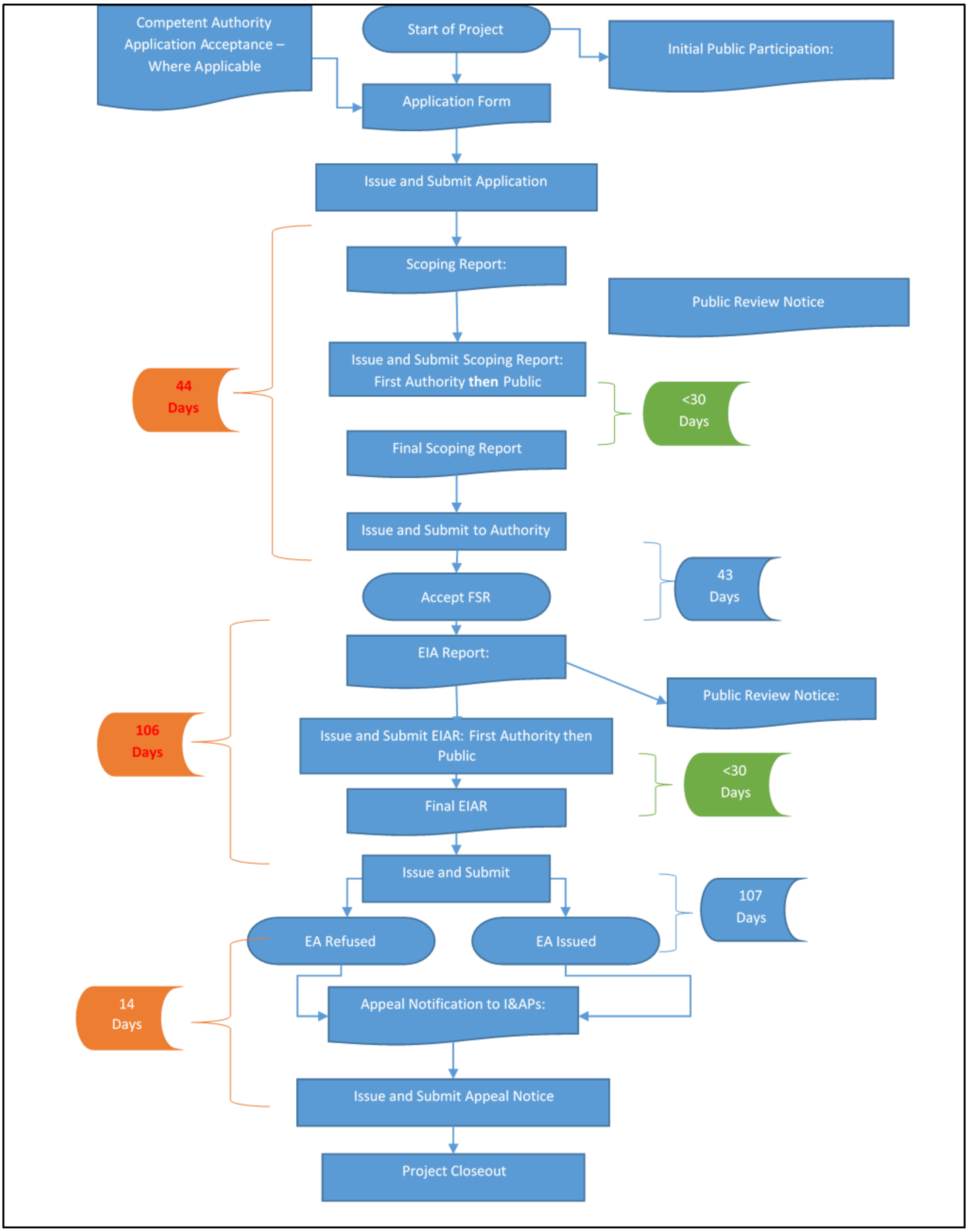


Figure 20: EIA process diagram.

6.4 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 21.

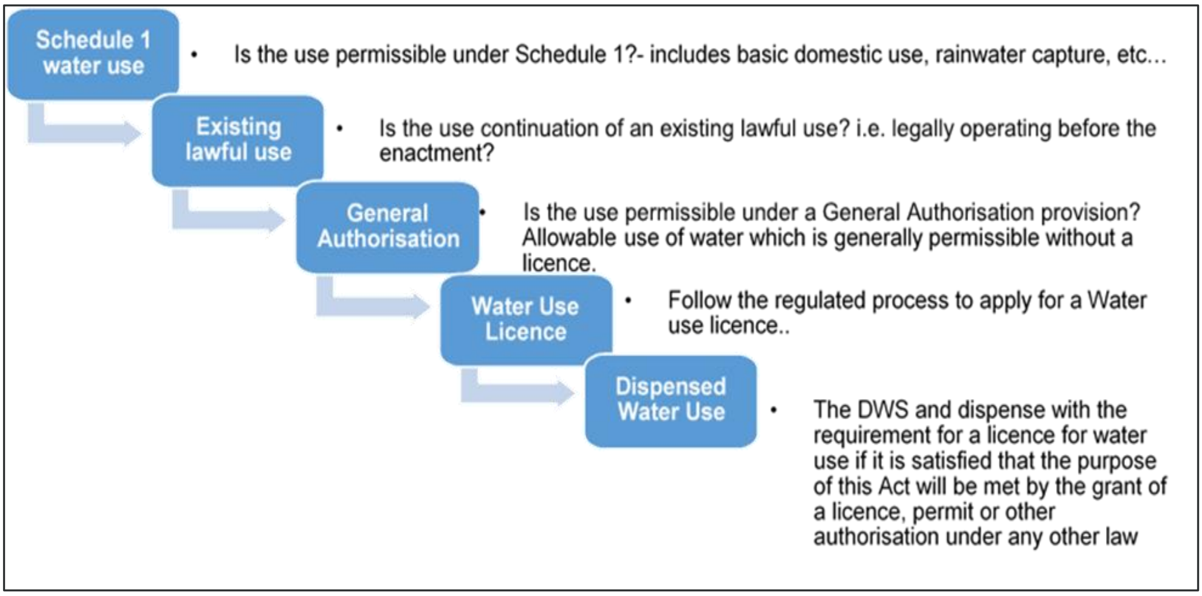


Figure 21: Authorisation processes for new water uses

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 will be utilised to delineate the watercourses as well as the 1 in 100-year floodlines and based on this input, the relevant water uses will be identified and applied for. The required water use licencing process will run concurrently with the EIA process.

6.4.1 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).

6.5 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 5 (Table 6).

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.

6.6 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 is being undertaken and an amendment to the Cluster 1 AEL will be undertaken to include the Cluster 2 relevant aspects.

6.6.1 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.

6.7 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.

6.8 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.

6.8.1.1 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 will assess whether any of these threatened or protected ecosystems occur within the study area and provided recommendations on how the development should or should not proceed based on the findings of the assessment in the EIA phase. Permits for protected species under the NEMBA may also be required.

6.8.1.2 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.

6.8.1.3 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.

The provisions of this Act will be considered and where relevant incorporated into the proposed mitigation measures and requirements of the EIA Phase.

6.9 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. Preliminary impacts on the agriculture and soil, biodiversity and water resources have been identified with regards to this project, and mitigation and management measures recommended. These will be updated during the EIA phase of this project as and where necessary.

6.10 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.

6.11 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.

6.11.1 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.

6.11.2 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. Where necessary this will be expanded on in the EIA Phase.

6.12 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.

6.13 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.

6.14 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*."

6.15 OTHER APPLICABLE ACTS AND LOCAL OR INTERNATIONAL GUIDELINES

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 that have relevance to this project and application, and these are described below.

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

6.15.1.1 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.

6.15.1.2 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.

6.15.1.3 **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 7, 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 7: 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

6.15.2 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).

6.15.2.1 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.

6.15.2.2 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).

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

6.15.2.3.1 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 8.

Table 8: 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

6.15.2.3.2 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.

6.15.2.3.3 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.

6.15.2.3.4 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.

7 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 9 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 9: 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,

Helium Properties and Uses	LNG Properties and Uses
	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 variants found in weather balloons may have other elements that are unhealthy to breathe.	Most natural gas comes from three types of wells namely natural gas and condensate wells, oil wells, and coal bed methane wells.
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.	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

Helium Properties and Uses	LNG Properties and Uses
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.	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 combination gets to the lungs much quicker. Helium in different forms and combinations are used in medical instrumentations and nuclear medicine.	Besides use in road vehicles, it is also used in aerial vehicles. Compressed natural gas has been used in 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 Properties and Uses	LNG Properties and Uses
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 determine their actions 100% accurately. This is due to the nature of quantum mechanics.	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.

7.1 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.

7.2 ECONOMIC FACTORS IN FAVOUR OF THE PROJECT

7.2.1 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 10 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 10: 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 10 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.

7.2.2 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 9. A summary of the commercial uses of Helium is shown in Figure 22.

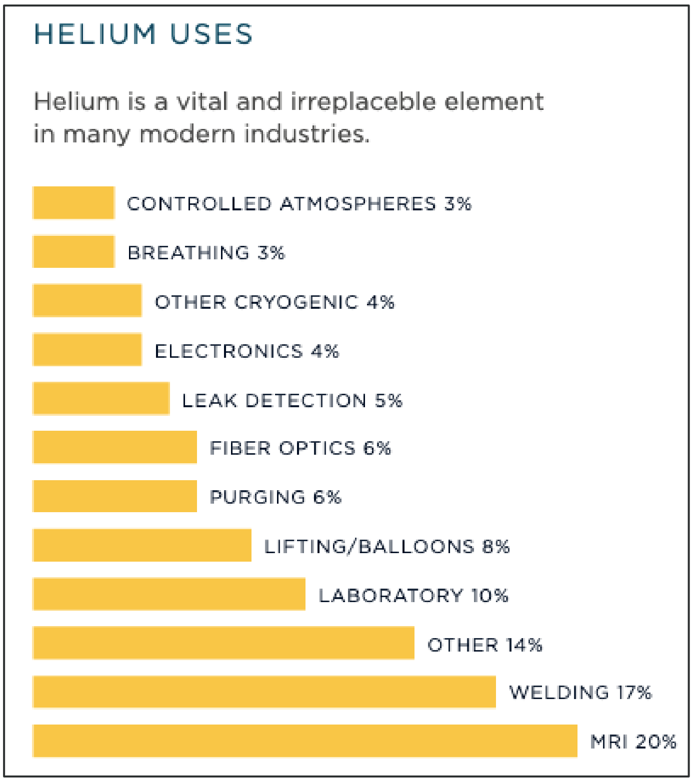


Figure 22: Uses of Helium.

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.

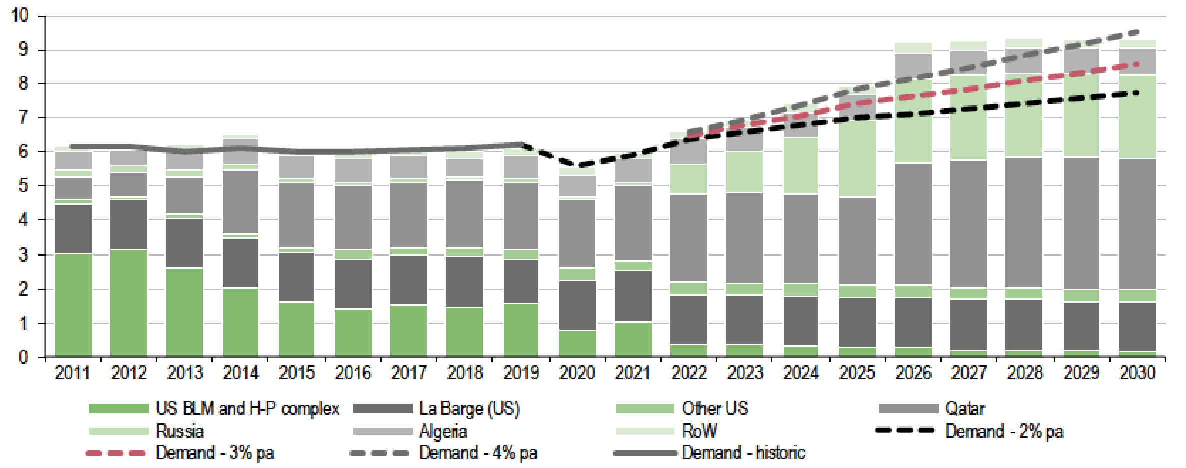
The global supply and demand for Helium is shown in Figure 23 was sourced from the Edison Research Group as published on Renergen's website. It shows a possible slight oversupply of helium in next few years, but thereafter demand is likely to outstrip supply (all things being equal).

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.

Exhibit 1: Estimated global supply/demand forecast (bcf)



Source: Edison Investment Research based on various sources

Figure 23: Global demand and supply of Helium in Billion Cubic Feet.

7.2.3 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.

7.2.4 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 24 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.

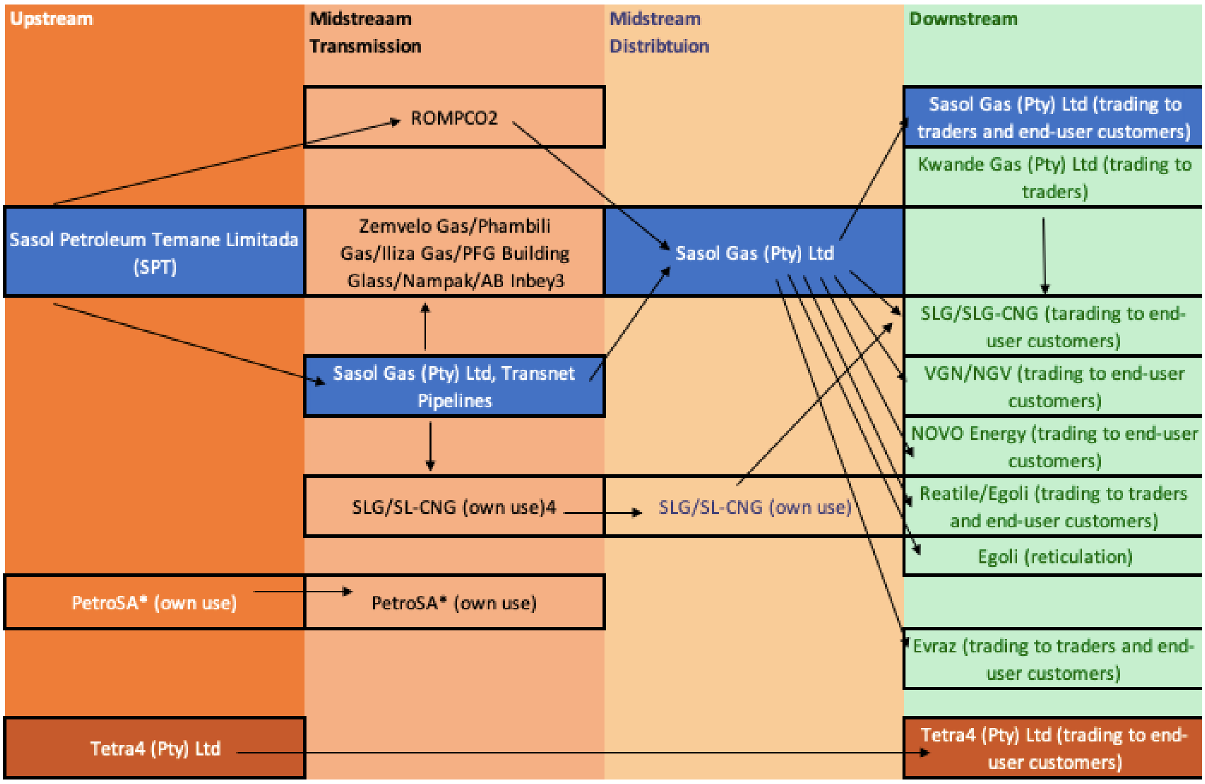


Figure 24: South Africa natural gas sector overview.

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.

7.3 ARGUMENTS NEUTRAL OR AGAINST THE PROJECT.

7.3.1 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.

7.3.2 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.

7.4 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 11 present the needs and desirability analysis undertaken for the project.

Table 11: 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?	The level of risk is considered low at this stage and will be further interrogated during the EIA phase (where applicable).
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, it is fortunate that a strategic assessment of transects (300m to 600m wide) is able to be undertaken as part of this EIA process in order to identify areas of high sensitivity and even no-go areas. 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.)?	A low impact on third party wellbeing, livelihoods and ecosystem services is foreseen at this stage of this application 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 prior to the final placement of infrastructure.
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	As part of the scoping phase, suitable alternatives are being considered and will be finalised in the EIA phase once due consideration of alternatives has been

Ref No.	Question	Answer
	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?	completed. Therefore at this stage of the application process, this aspect is yet to be concluded.
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 11 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 10.4. 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 11 in this report.
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?	At this stage of the application process, there has not been specific feedback from the relevant communities on how this development will impact on their physical, psychological, developmental, cultural and/or social needs. While the baseline receiving environment is presented in Section 10, this aspect will be updated during the EIA phase once more consultation has been undertaken.
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:**	

Ref No.	Question	Answer
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),	
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

Ref No.	Question	Answer
		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?	This assessment has identified the potential socio-economic risks which will be further refined once more public input is received. None of the limits of knowledge are considered significant in terms of the identification and mitigation of impacts on the socio-economic environment.
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 11 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	

Ref No.	Question	Answer
	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 11 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 11 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.	Notwithstanding the detailed description of the stakeholder consultation process included in Section 9 of this report, the consultation process has been undertaken in 3 languages (English, Afrikaans and Sesotho). Furthermore, public and focus group meetings will be undertaken during the Scoping and EIA phase consultation during which any additional consultation requirements of the I&APs will be identified and addressed where necessary.
2.13.2	Provide all people with an opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation,	
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)?	

Ref No.	Question	Answer
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 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.
2.16.2	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.	
2.16.5	The opportunity costs in terms of job creation.	
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 will be 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 majority of the proposed mitigation measures for this application are in alignment with the existing Cluster 1 EMPr mitigation measures and therefore these measures have been tested in the real world as Cluster 1 is nearing completion of construction. Refer to the impact assessment and mitigation measures in Section 11 of this report. During the EIA phase, the updated Cluster 1

Ref No.	Question	Answer
		EMPr will be shared which will provide additional evidence as to how this aspect has been addressed.
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 8 wherein a description of the process followed to reach the proposed preferred site.
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 11 of this Report.

8 PROJECT ALTERNATIVES

The identification of alternatives is a key aspect of the success of the scoping process. All reasonable and feasible alternatives must be identified and screened to determine the most suitable alternatives to consider and assess in the EIA phase. There are however some significant 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 discussed 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.

8.1 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). The Cluster 2 project will be an extension to the Cluster 1 project and similarly have a minimal impact in terms of sterilisation of existing land uses.

On the other hand, 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. Therefore, the proposed gas production activity in conjunction with current agricultural and mining land uses will be taken forward to the EIA phase for further assessment. No additional activity alternatives are identified.

8.2 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 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 drilling activities planned within the Production Right area. Cluster 1 which is well underway and nearing full production involves exploration drilling activities, establishment of production wells, connection of production wells with pipelines and construction and operation of compressor stations and the first gas beneficiation plant. The Cluster 1 exploration program has provided sufficient data to unequivocally confirm the viability of gas production in the area. While 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.

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 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 alternative however site-specific alternatives for various infrastructure can be considered and is discussed in more detail in the subsections below.

8.2.1 WELL SITES

The proposed Cluster 2 project involves 300 new production wells located along various 600 m wide transects within 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 %. 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 still remain within the 600 m well transects as assessed in this application process and will be guided by the sensitivities identified from the specialist assessments to position the well sites in such a manner to avoid sensitivities as far as possible. The sensitivity mapping undertaken during this scoping phase will be updated during the EIA phase once public input has been received and further considered as well as final specialist sensitivity mapping is completed.

Based on the above, no location alternatives for well sites are being assessed other than the positioning of well sites within the 600 m transects. The sensitivity mapping based on input from all specialist disciplines will further guide the development of buffer-zones within the transects in which highly sensitive or no-go areas should be avoided.

8.2.2 PIPELINE ROUTES

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 this area, the pipelines will be constructed, again using the sensitivity mapping approach as described above. Therefore no location alternatives are to be assessed other than the sensitivity planning approach.

8.2.3 COMPRESSOR STATIONS

Three compressor stations are required within the Cluster 2 gas pipeline network and must be located within the 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 put forward. 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 confirmed.

These location alternatives for CS3 shall be 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.

Both these CS3 location alternatives will be assessed in more detail from a biophysical and socio-economic perspective in the EIA phase.

8.2.4 LNG/LHE PLANT

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

1. The approved Cluster 1 plant is currently being constructed in this location with access roads and other infrastructure that will be shared by the Cluster 2 plant. Therefore the Cluster 2 plant is located directly adjacent to an existing Tetra4 plant which will prevent unnecessary 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 are to be considered further.

8.3 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, in order 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 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 8.2 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 where 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. As there will be approximately 300 production wells in the Cluster 2 development, the well designs have been altered to a concrete bunker type design. This will result in a far lower visual impact as well as a smaller constructed footprint per well. As this is regarded as an improvement in the design, no further design alternatives will be assessed for the production wells.

8.4 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.

8.5 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. depths, 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.

8.6 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 for the reasons stated in Table 63 below.

Table 12: Advantages and disadvantages of the no-go alternative.

Advantages	Disadvantages
No additional disturbance of land and this specific development related negative impacts.	• A Production Right has already been granted and the Cluster 1 development has provided proof of viability of the gas field however this first phase development will only produce very limited gas resources. Without expanding on this first phase, the project will have limited long-term benefits to the local and regional economy. • If the proposed Cluster 2 does not proceed, then large quantities of imported Helium and LNG will have to continue being procured at a considerable cost to the South African economy. • Positive impacts associated with the proposed Cluster 2 project will not occur such as some employment creation (mostly during construction), as well as technology advancement that will result from this pioneering local gas production project. Refer to Section 6.15.2 for more details with regards to the Need and Desirability of the proposed project, as well as Section 10.16.2 for impacts identified and proposed mitigation measures particularly those related to socio-economic factors.

8.7 SENSITIVITY PLANNING APPROACH

As described in Section 8.2 above, the sensitivity planning approach will guide the final location of the proposed wells, pipelines and related infrastructure. Based on input from the various specialists as well as feedback from the public, the final sensitivity map will be presented in the EIA phase which will delineate no-go areas as well as high, medium and low sensitive areas. The EMPr will additionally provide mitigation measures in the form of limitations on where infrastructure can be placed.

8.8 ALTERNATIVE ASSESSMENT SUMMARY

Table 13 describes the advantages and disadvantages of the alternatives identified above. The alternatives will be compared to each other as well as with the No-Go alternative. Table 13 further details which alternatives are to be taken forward for further investigation in the EIA phase.

Table 13: Alternative assessment summary.

Alternative Category	Alternative	Alternative Description Summary	Advantages	Disadvantages/ Risks	Carried into EIA
Location Alternatives	CS3_L1	Compressor Station 3 alternative located on the farm Doorn River 330 (Portion 2).	Well positioned within the southern gas pipeline network to balance the system without expensive reinforced pipeline network.	High risk that no electricity supply / connection is available in this location which would prevent operation of the compressor station and negatively affect the entire southern gas production network.	**Yes**
	CS3_L2	Compressor Station 3 located adjacent to the existing Cluster 1 Compressor Station A on farm Palmietkuil 328 (Portion 6).	Electricity supply is confirmed as the existing Cluster 1 CSA is already connected to the Eskom grid.	Would require a more costly pipeline design in the southern gas pipeline network.	**Yes**
Layout Alternatives	Based on a sensitivity mapping of the well transects and pipeline transects, any unacceptably high-risk areas will be delineated as no-go areas.				**Yes**
Process Alternatives	No specific feasible process alternatives were identified.				**No**
Technology Alternatives	No specific feasible technology alternatives were identified.				**No**
No-Go Alternative	No-Go	The proposed Cluster 2 project will not take place at all.	No environmental impacts as a result of the Cluster 2 project.	No benefits with respect to job creation and also no direct and indirect socio-economic benefits created for the local and regional economies.	**Yes**

9 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.

9.1 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 will be 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
- Frackfree SA
- Groundwork South Africa
- 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 an attempt to solicit input from any I&AP's who's contact details were not available at the start of this application.

9.2 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:

9.2.1 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.

9.2.2 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.

9.2.3 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.

9.2.4 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).

9.2.5 AVAILABILITY OF SCOPING REPORT

Notification regarding the availability of this 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 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 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 can be obtained.

The scoping report will be available for public review from 29 July 2022 to 30 August 2022 during which comments will be received on the report.

9.3 PUBLIC PARTICIPATION PROGRESS

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

To date the general comments that have been received are summarised below:

- Concerns of water availability to farmers and air quality impacts of the proposed project;
- Groundwater contamination concerns;
- I&AP requests to be deregistered;
- I&AP requests to be registered;
- Eskom requested a google earth file (.kmz) to assess the impact on their infrastructure;

- Notification of ongoing PV Authorization project (Oryx Solar) from another EAP within the application area who shared a notification document and emails, locality map and BID documents;
- Clarification request of farms that could be affected by the proposed development;
- Companies that wish to provide services and/or resources to the proposed development; and
- Transnet commented that the proposed development does not affect their pipeline servitudes in the region.

10 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.

10.1 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 25 depicts a topographical cross-section (south-western aspect) of the greater study area.

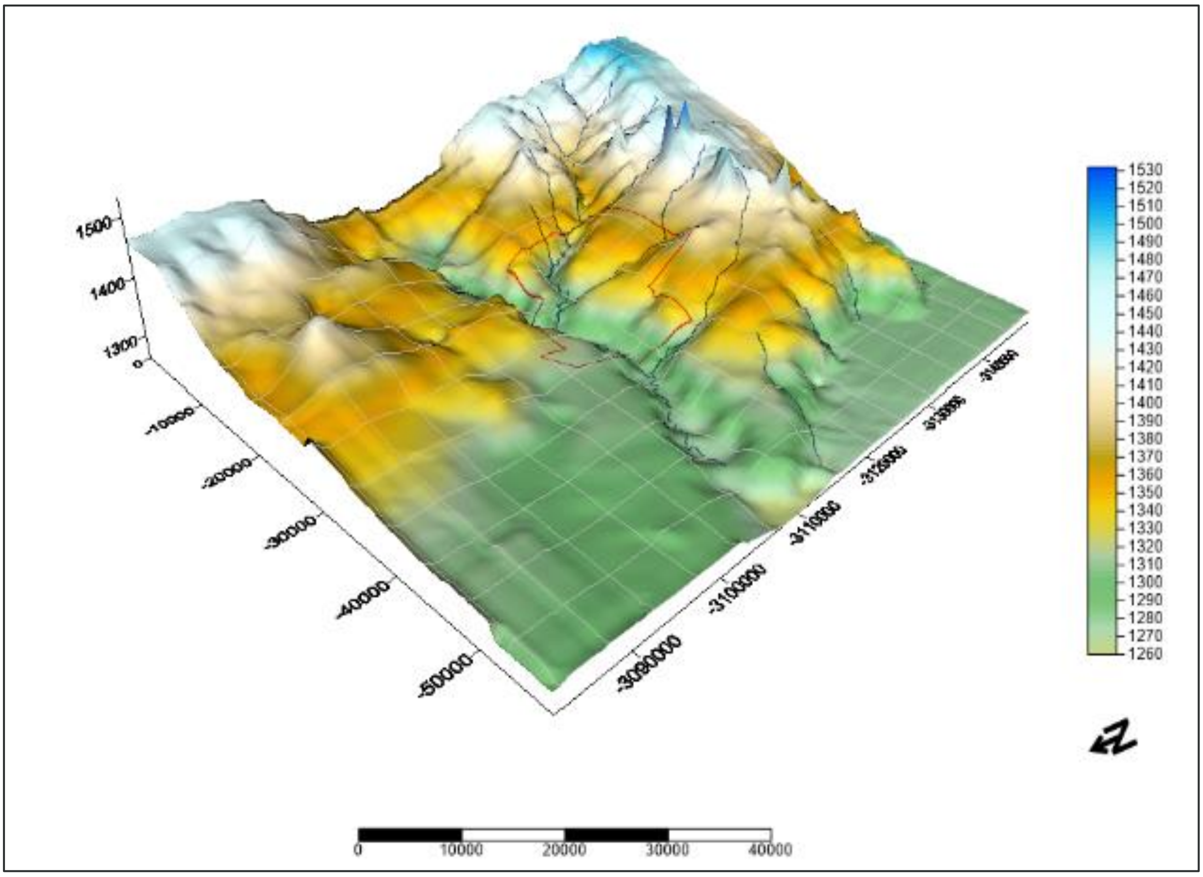


Figure 25: Topographical cross-sections of the greater application area.

10.2 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 26.

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.

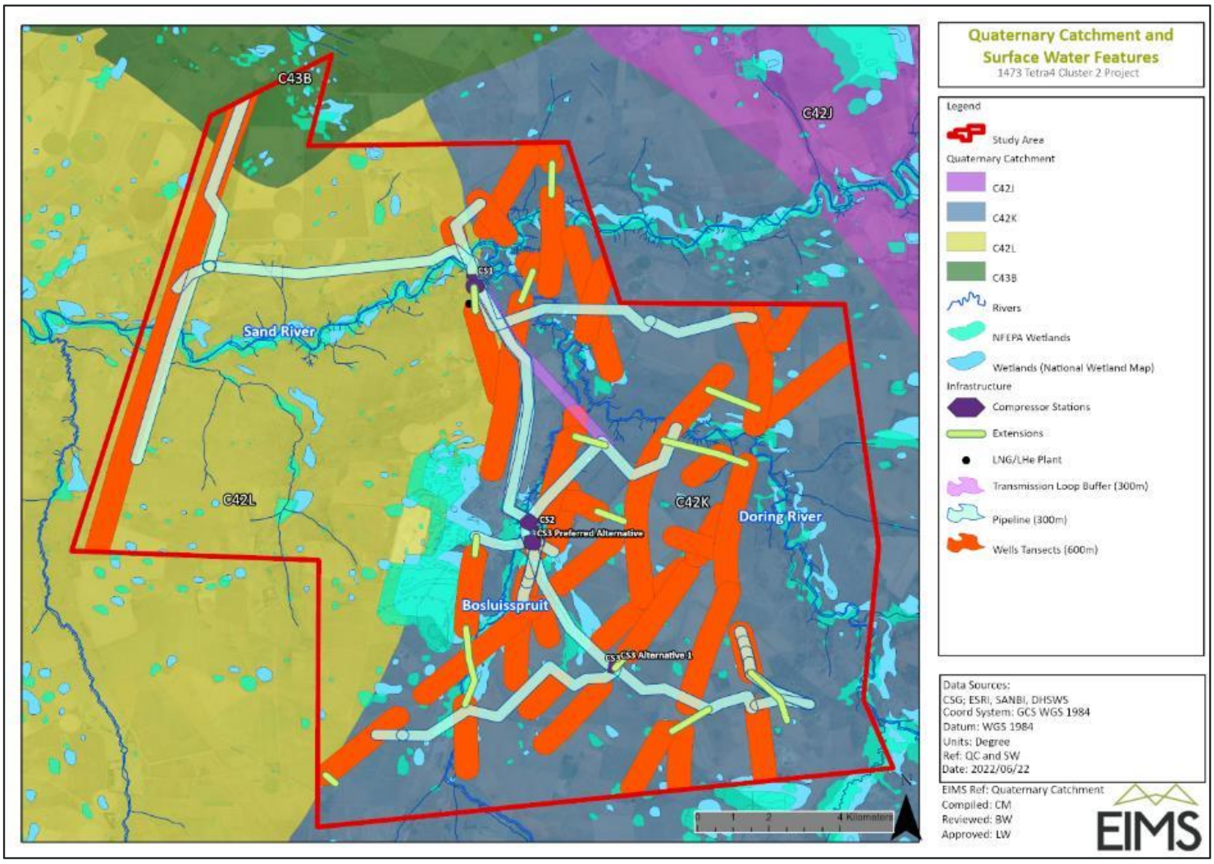


Figure 26: Study area in relation to quaternary catchments and drainage areas.

10.3 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.

10.4 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 will include 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.

10.4.1 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 27 shows the location of the proposed Cluster 2 project as well as some social and physical infrastructure in the area and Figure 28 shows a broad overview of the land cover in the study area.

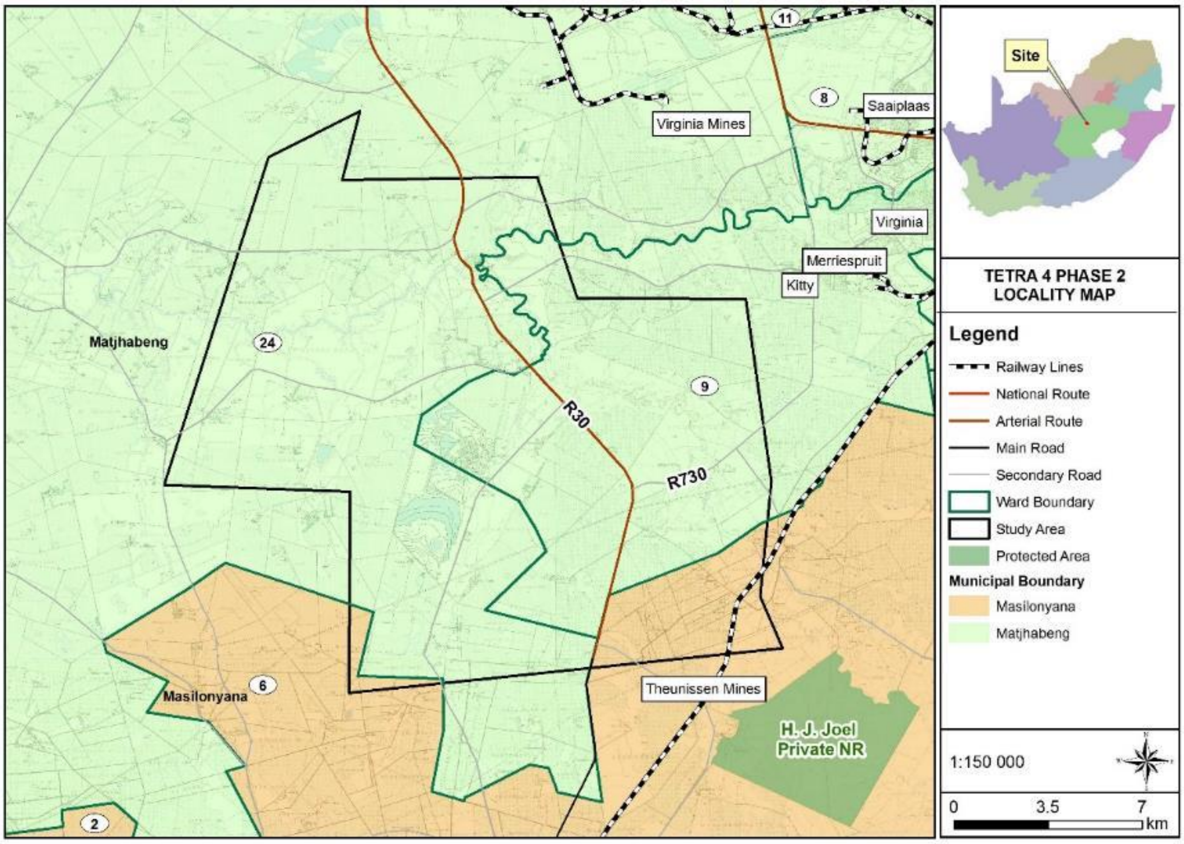


Figure 27: Location of the proposed Cluster 2 Project in relation to Municipal Wards.

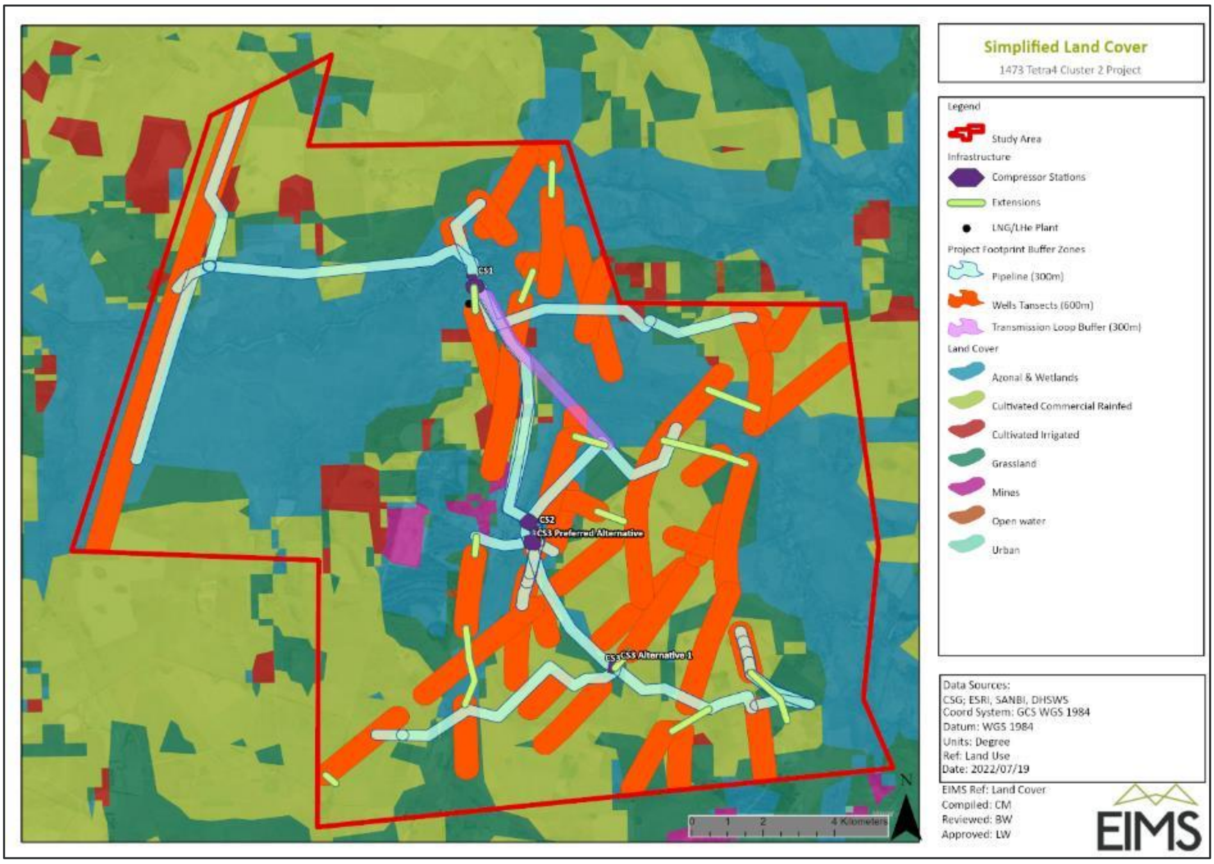


Figure 28: Broad overview of land cover in the study area.

10.4.2 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.

10.4.3 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).

10.4.4 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.

10.4.5 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.

10.4.6 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 14), 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 14: 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 15). 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 15: 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 16), 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 16: 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 17), 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 17: 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

10.4.7 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 29), 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.

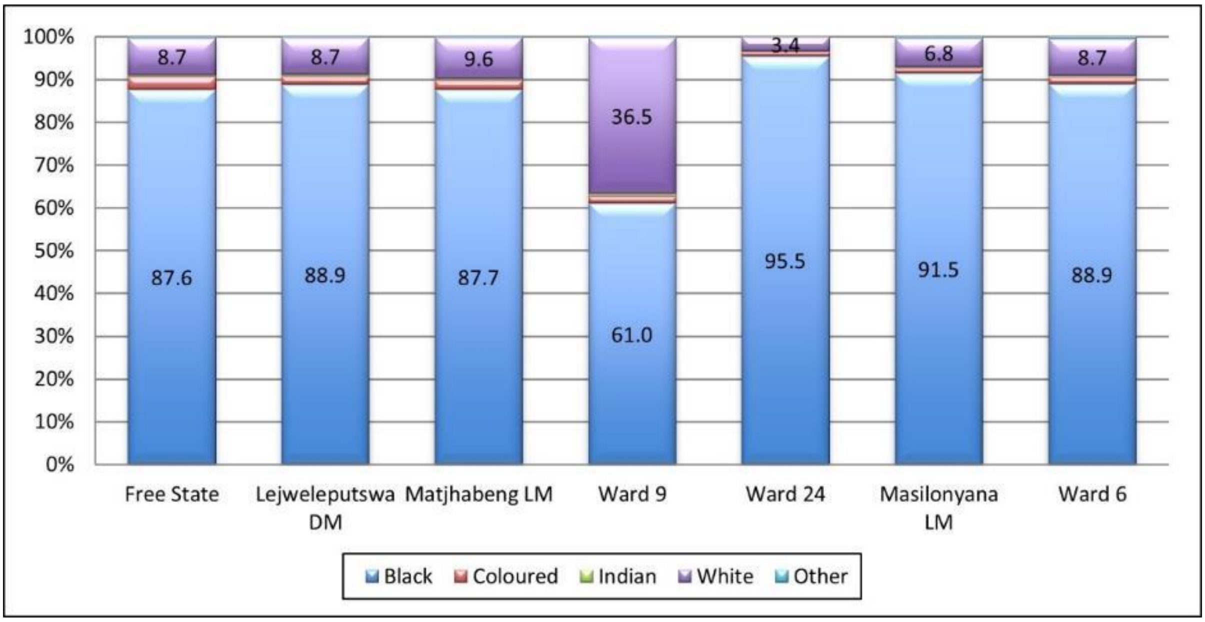


Figure 29: Population distribution (shown in percentage, source: Census 2011).

The average age on local level is higher than on district and provincial level (Table 18). The highest average age is in Ward 9 of the Matjhabeng LM.

Table 18: 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 30).

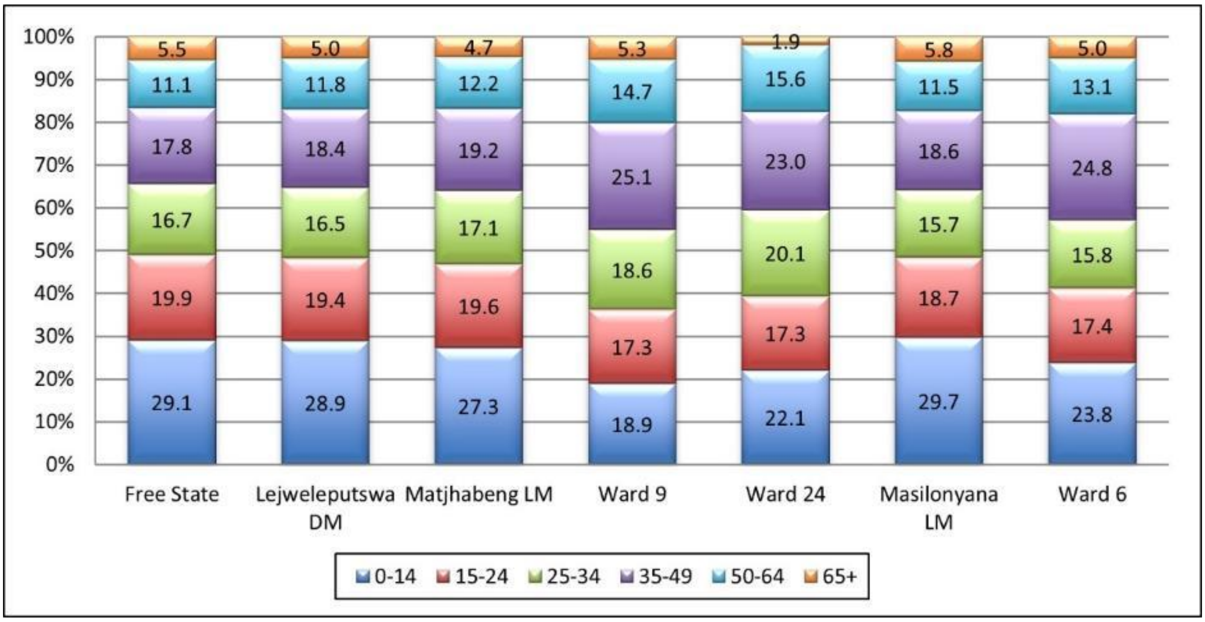


Figure 30: Age distribution (shown in percentage, source: Census 2011).

10.4.8 GENDER

The gender distribution on provincial, district and local level is balanced (Figure 31), 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.

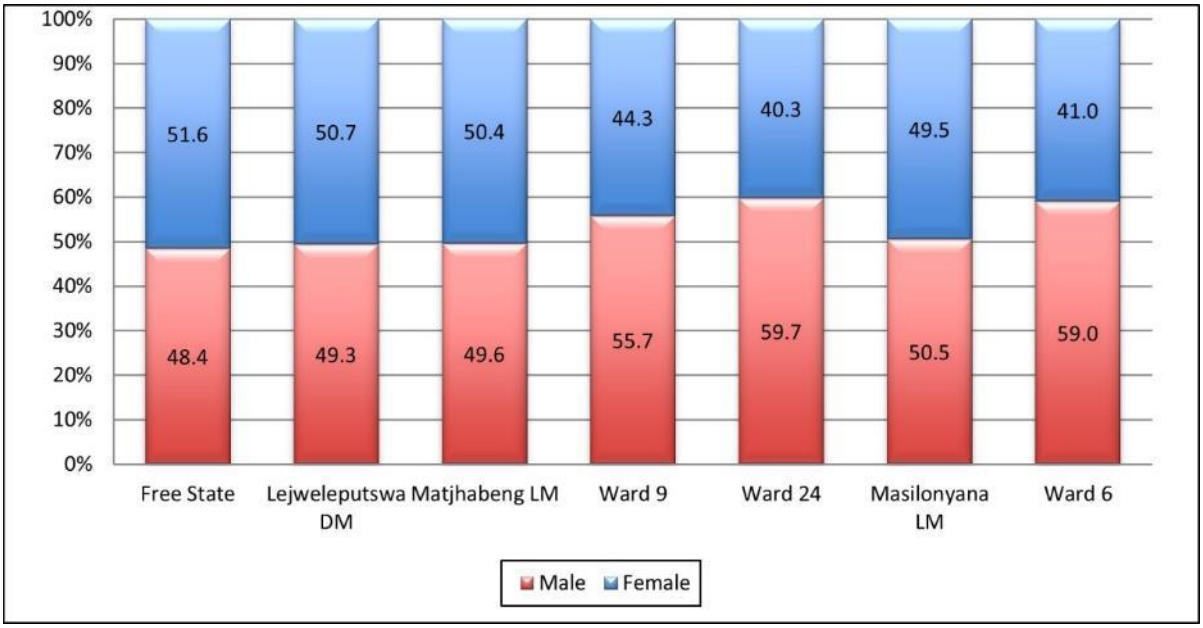


Figure 31: Gender distribution (shown in percentage, source: Census 2011).

10.4.9 LANGUAGE

Almost two thirds of people in the region have Sesotho as home language (Figure 32), 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.

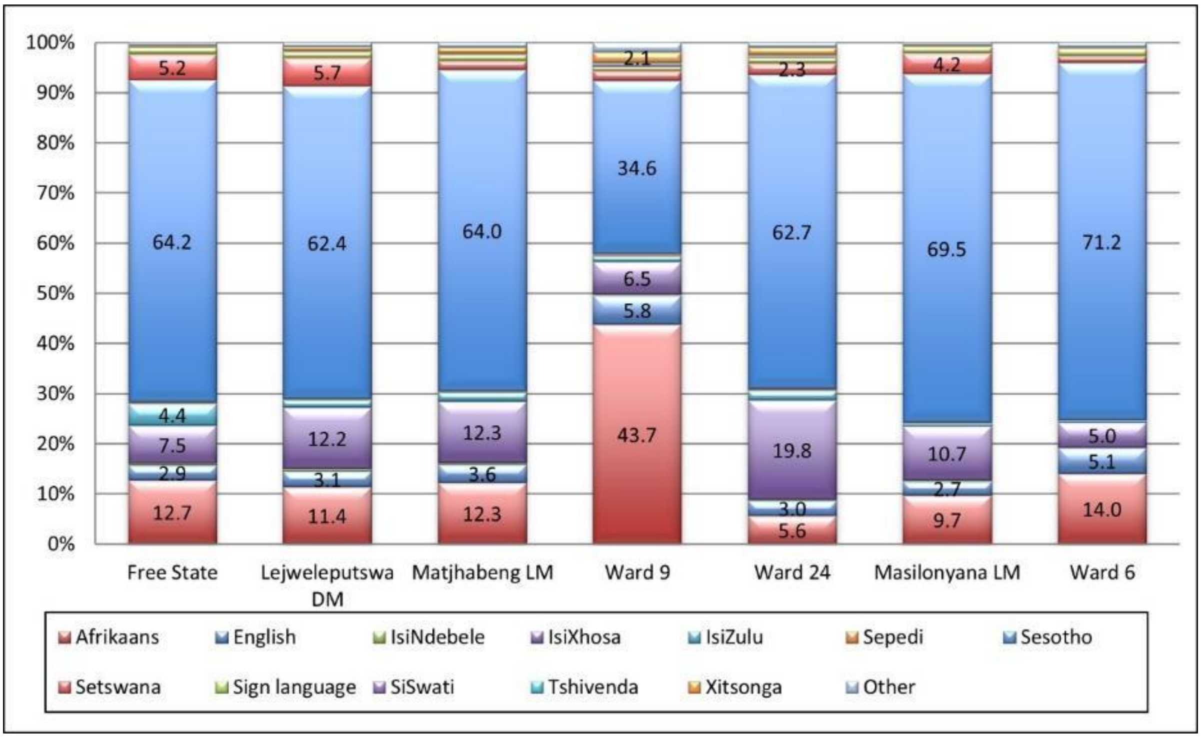


Figure 32: Language distribution (shown in percentage, source: Census 2011).

10.4.10 EDUCATION

Figure 33 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.

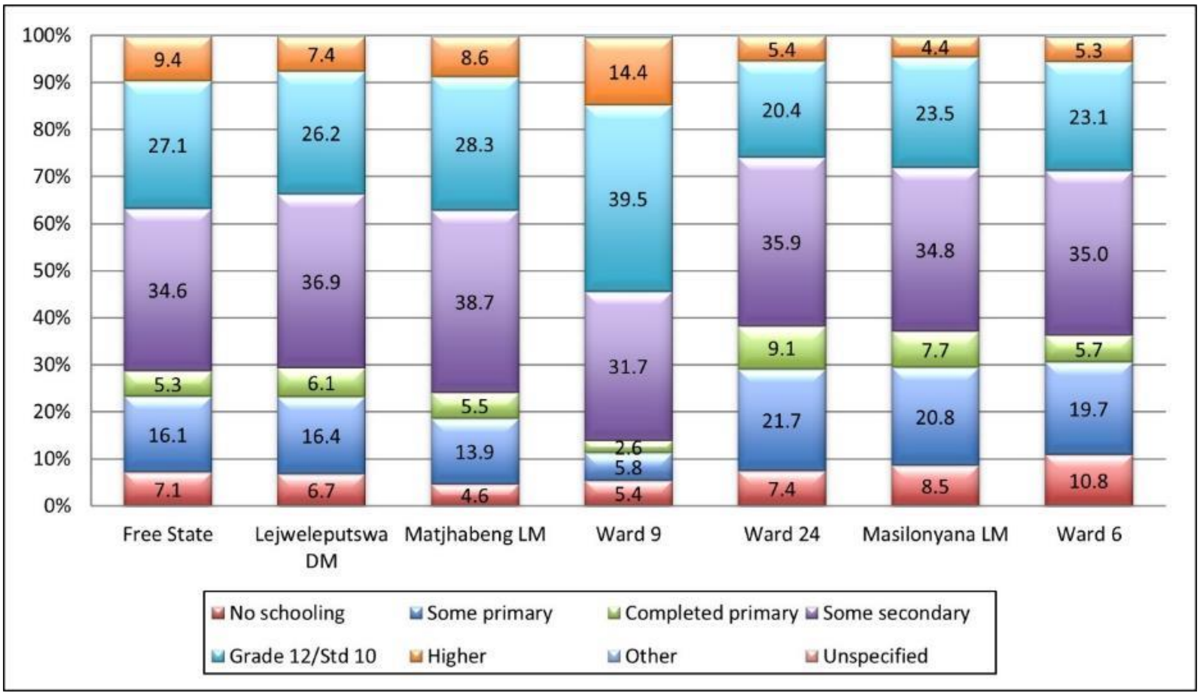


Figure 33: Education profiles (those aged 20 years or older, shown in percentage, source: Census 2011).

10.4.11 EMPLOYMENT

Ward 6 has the lowest proportion of people of economically active age (aged between 15 years and 65 years) that are employed (Figure 34), 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.

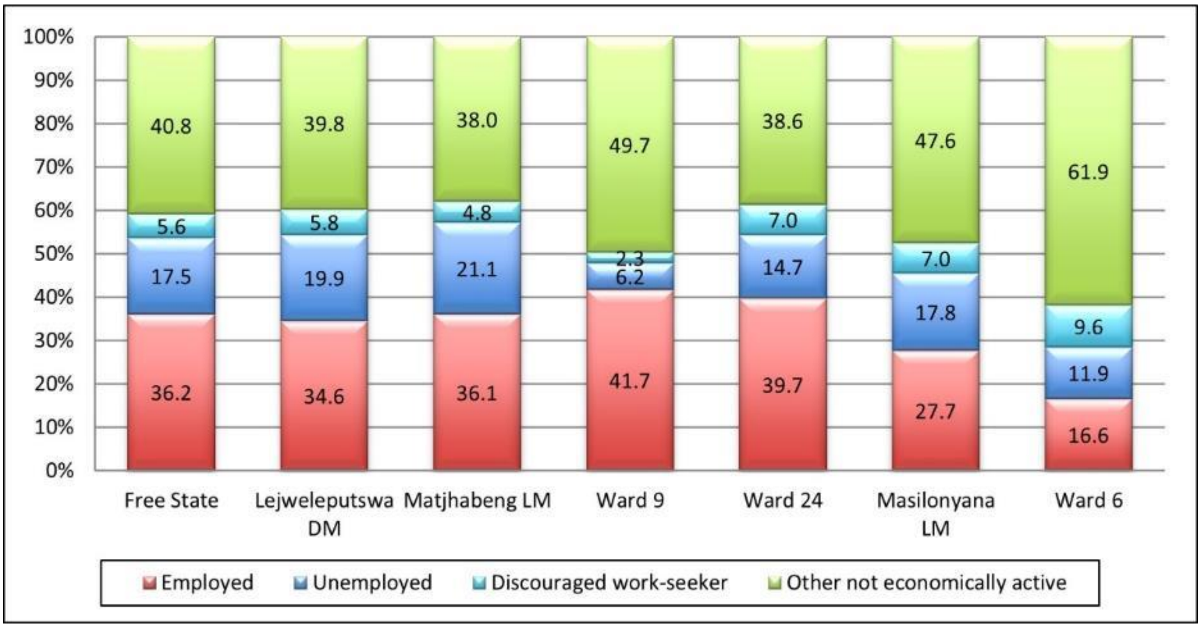


Figure 34: Labour status (those aged between 15 - 65 years, shown in percentage, source: Census 2011).

Most of the employed people in the areas under investigation work in the formal sector (Figure 35). 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.

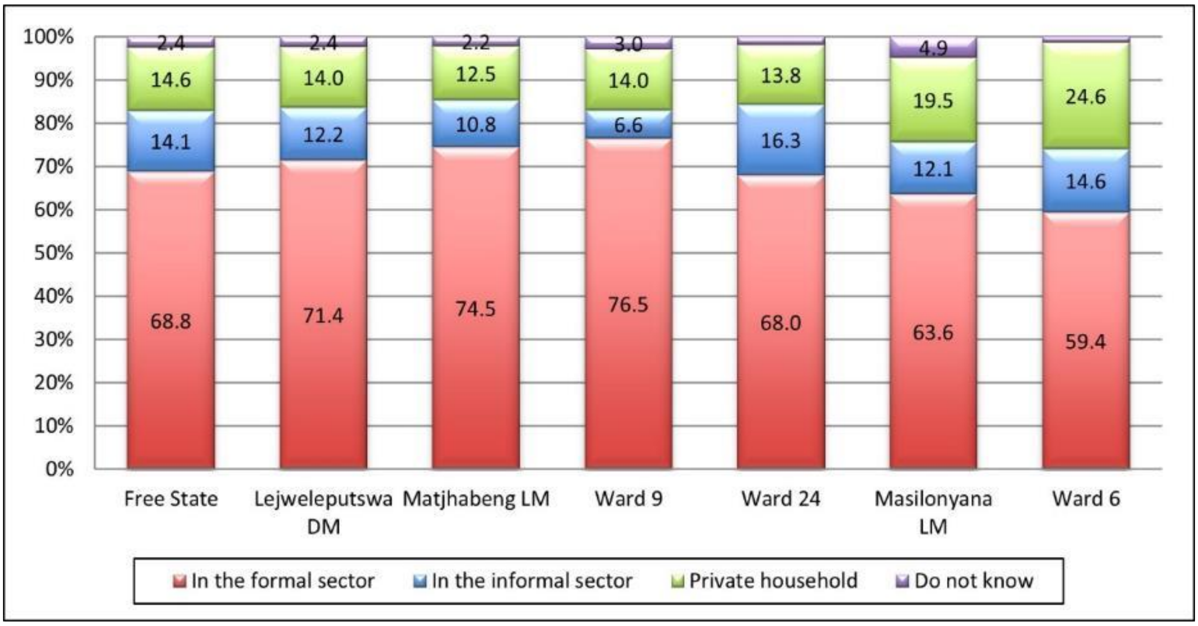


Figure 35: Employment sector (those aged between 15 - 65 years, shown in percentage, source: Census 2011).

10.4.12 HOUSEHOLD INCOME

Ward 24 has the highest proportion of households that have no annual household income (Figure 36), while Ward 9 has the highest average household income.

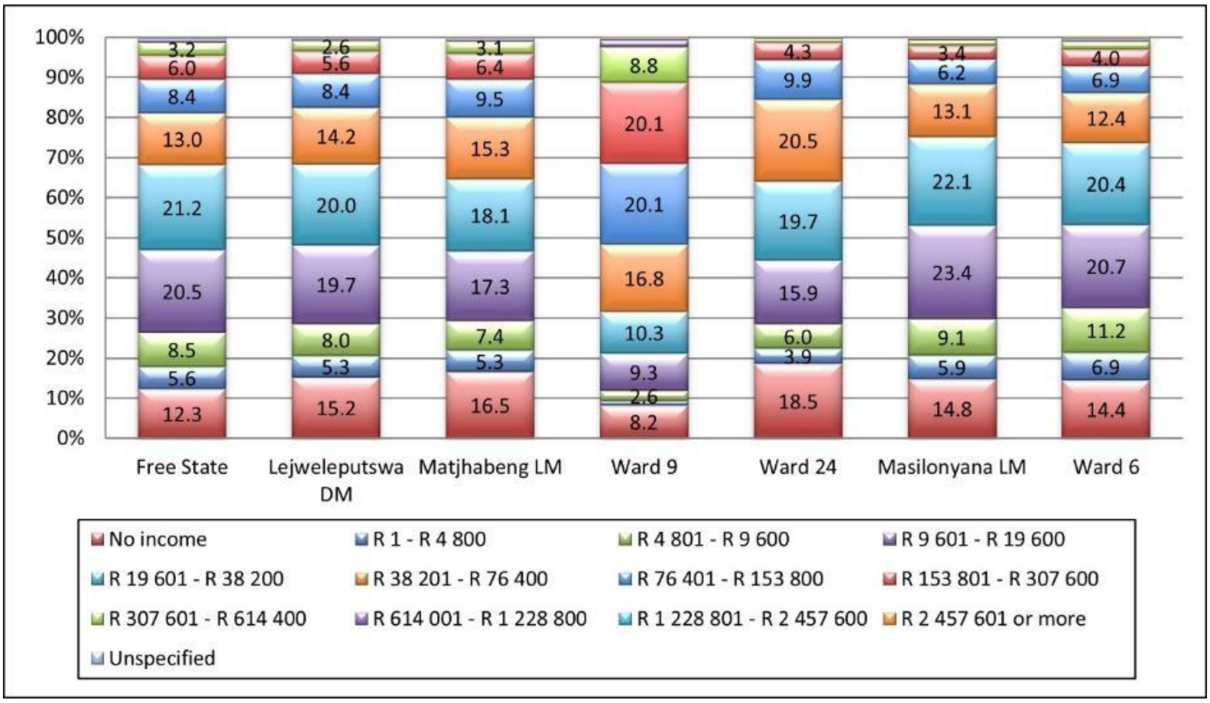


Figure 36: Annual household income (shown in percentage, source: Census 2011).

10.4.13 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 19: 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 37), 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.

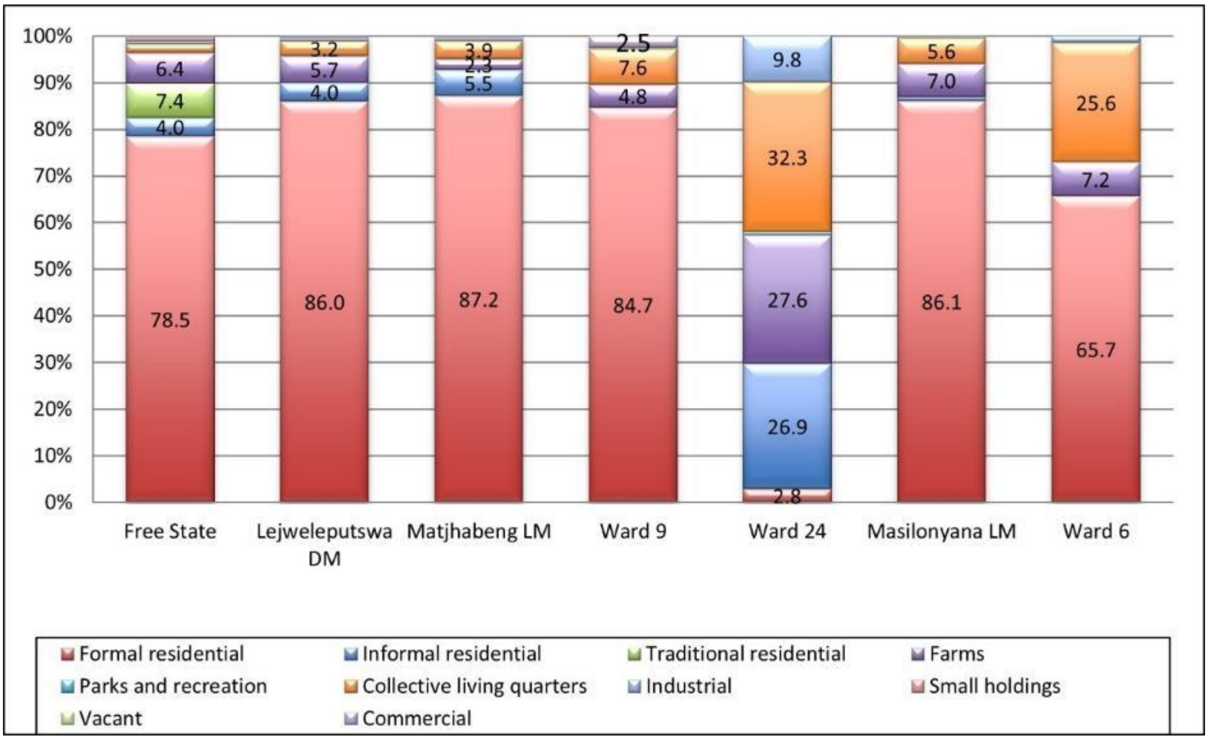


Figure 37: Enumeration area types (persons, shown in percentage, source: Census 2011).

Most of the dwellings in the area are houses or brick/concrete block structures that are on a separate yard, stand or farm (Figure 38), 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.

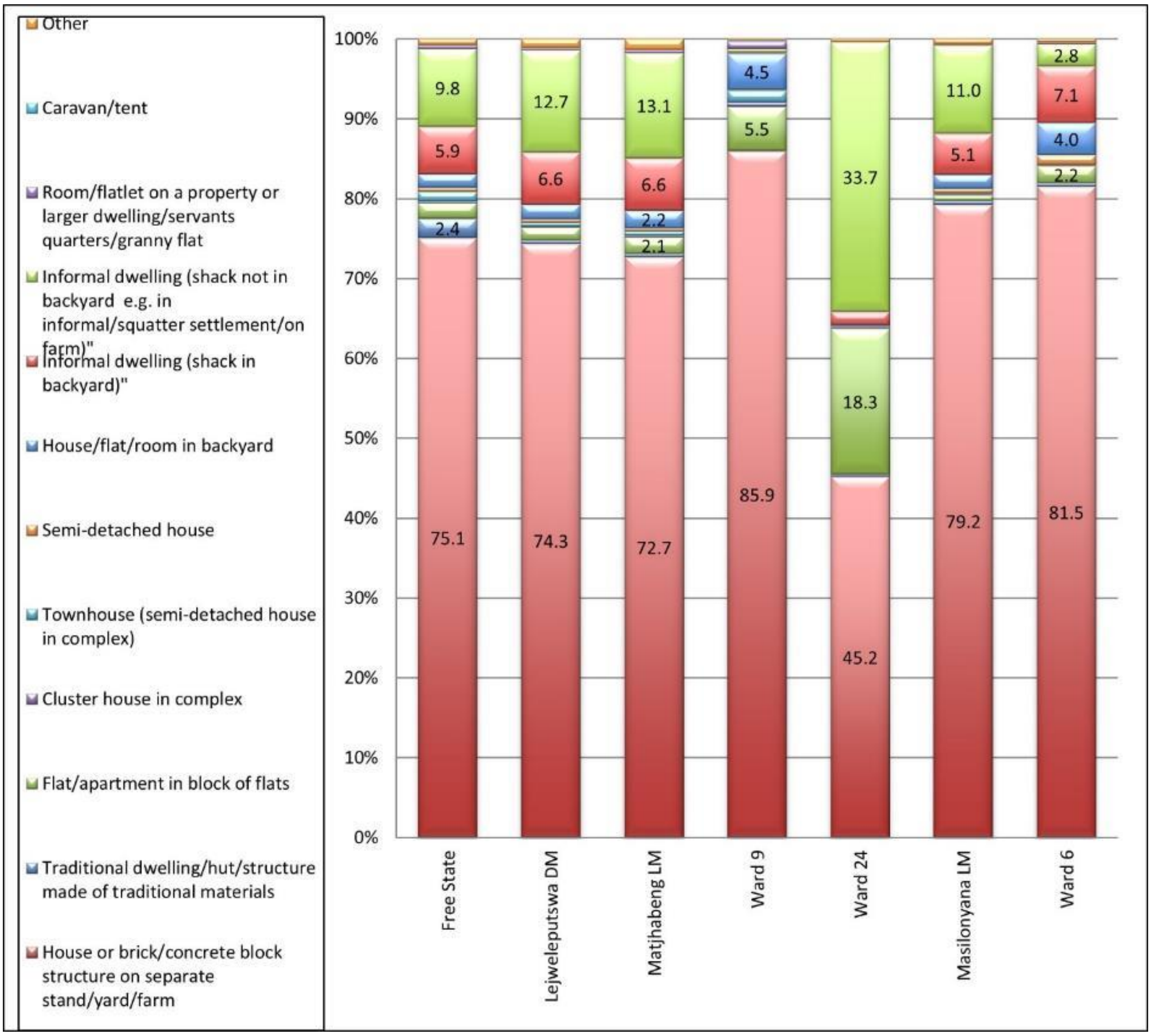


Figure 38: Dwelling types (shown in percentage, source: Census 2011).

Ward 24 has the largest proportion of households that are renting their dwellings (Figure 39), 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.

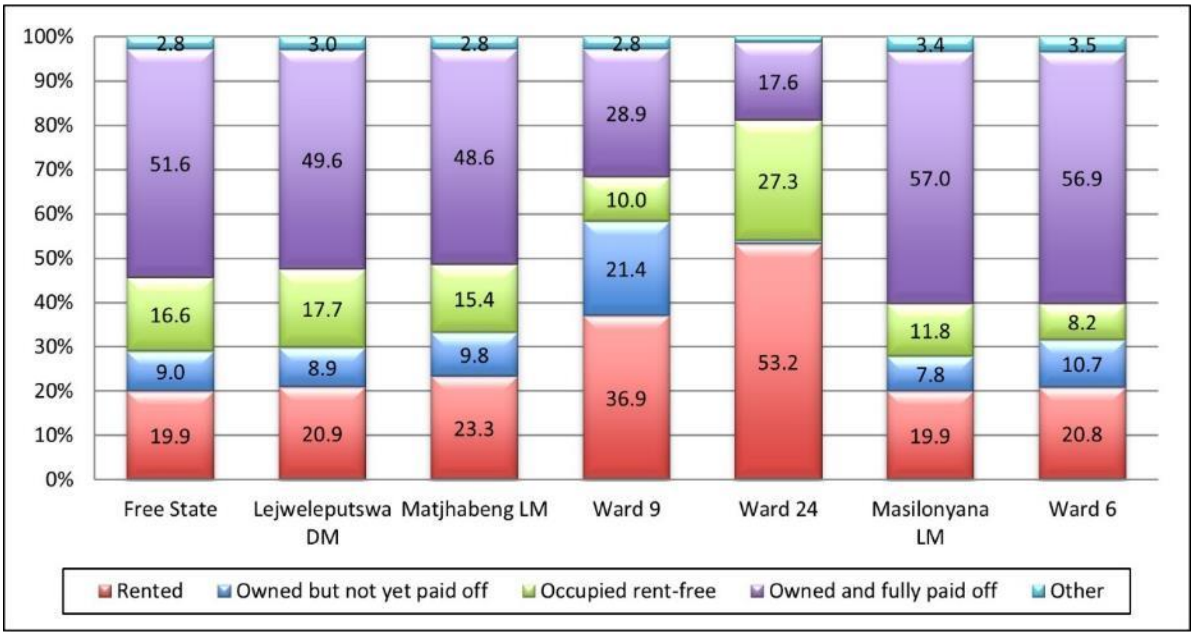


Figure 39: Tenure status (shown in percentage, source: Census 2011).

10.4.14 HOUSEHOLD SIZE

Household sizes on a ward level in the Matjhabeng LM tend to be smaller than on local, district or provincial level (Figure 40), 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.

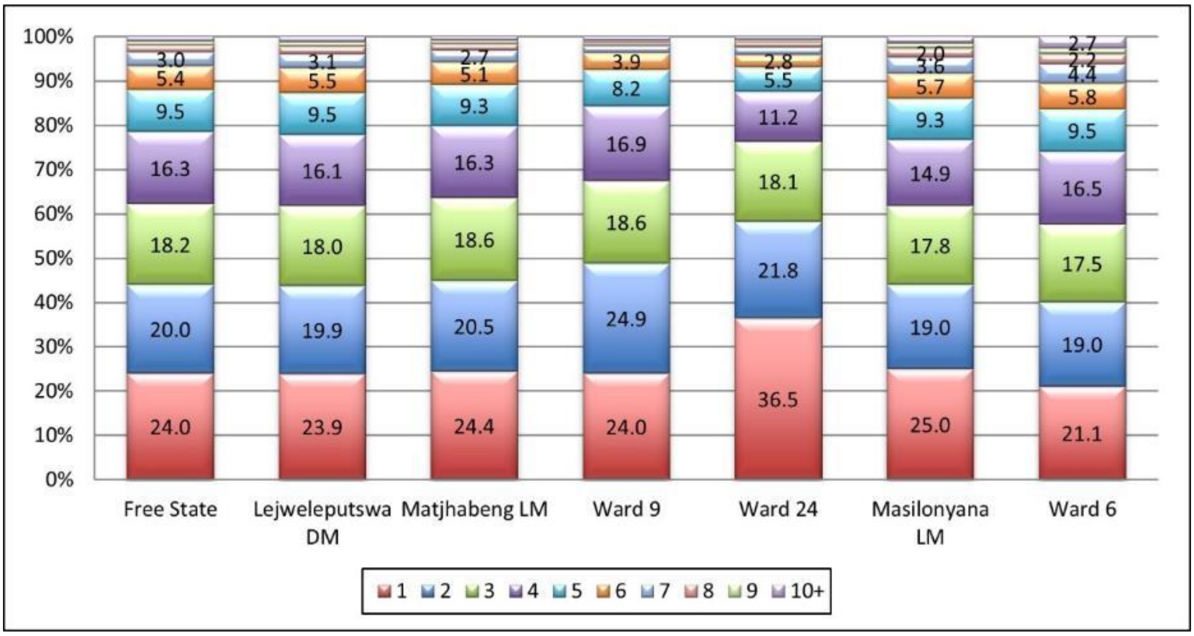


Figure 40: Household size (shown in percentage, source: Census 2011).

10.4.15 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 41).

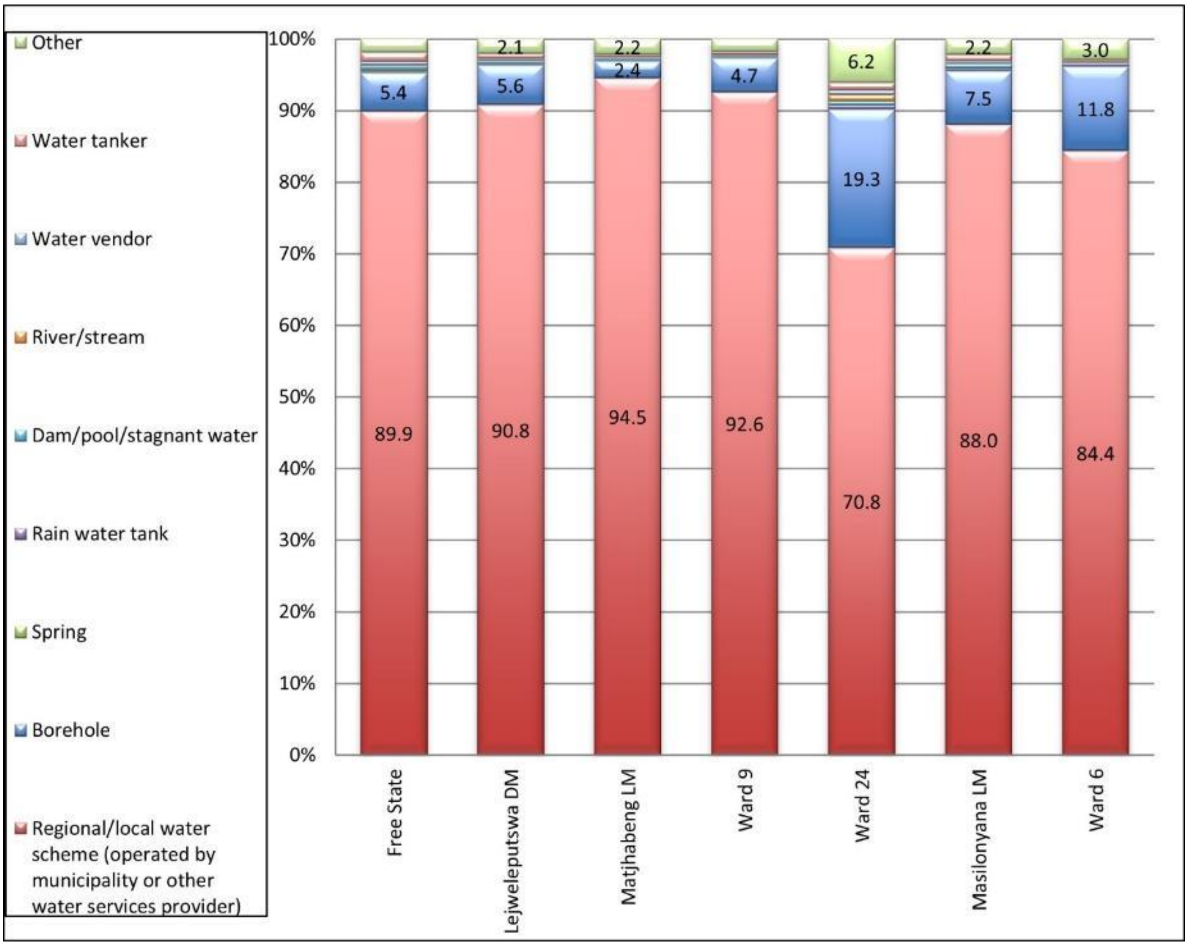


Figure 41: Water source (shown in percentage, source: Census 2011).

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 42). In Ward 6 more than 90 % of households have access to water insider their dwelling or stand, compared to almost 80 % in Ward 24.

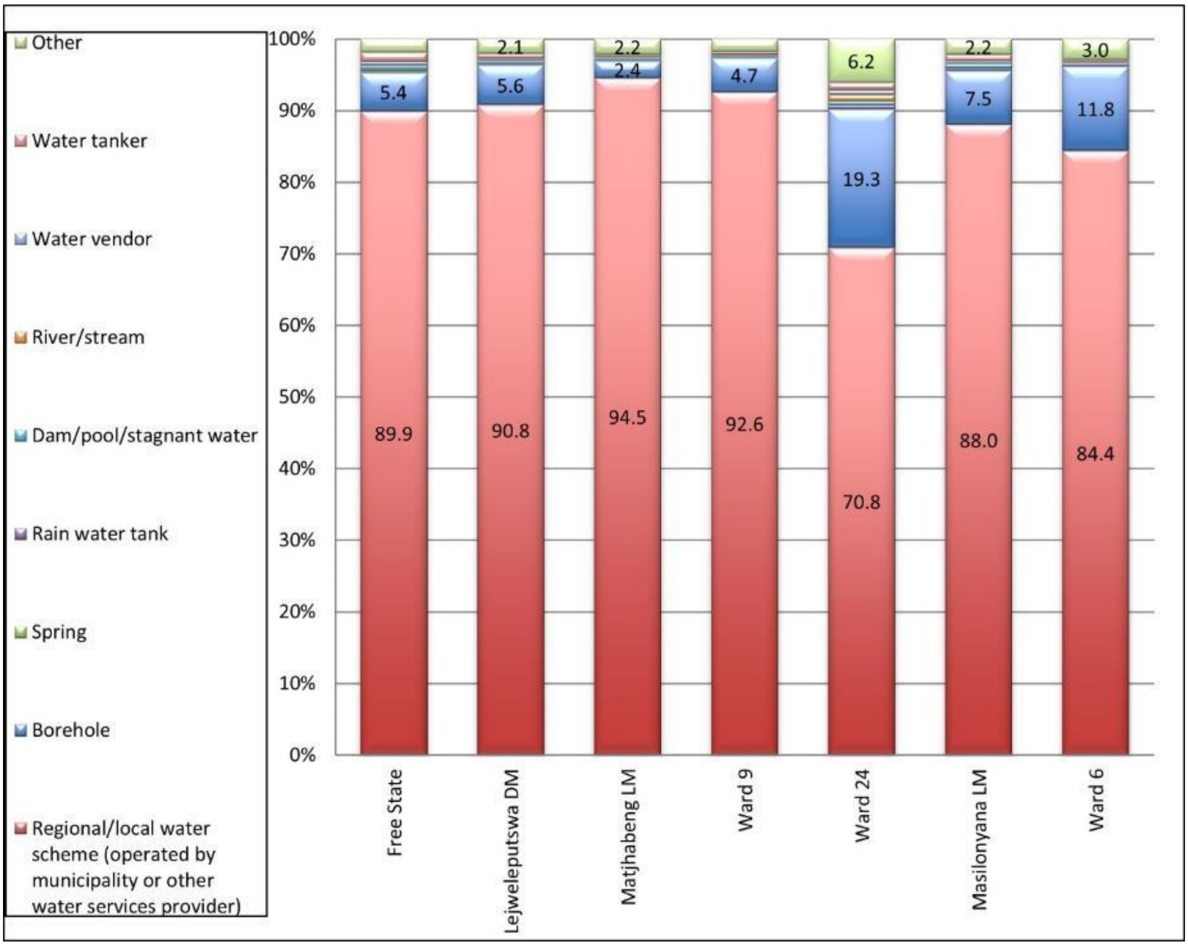


Figure 42: Piped water (shown in percentage, source: Census 2011).

The highest incidence of households that do not have access to any sanitation services is in Ward 24 (Figure 43), with approximately a third of the households in the ward having access to pit toilets without ventilation.

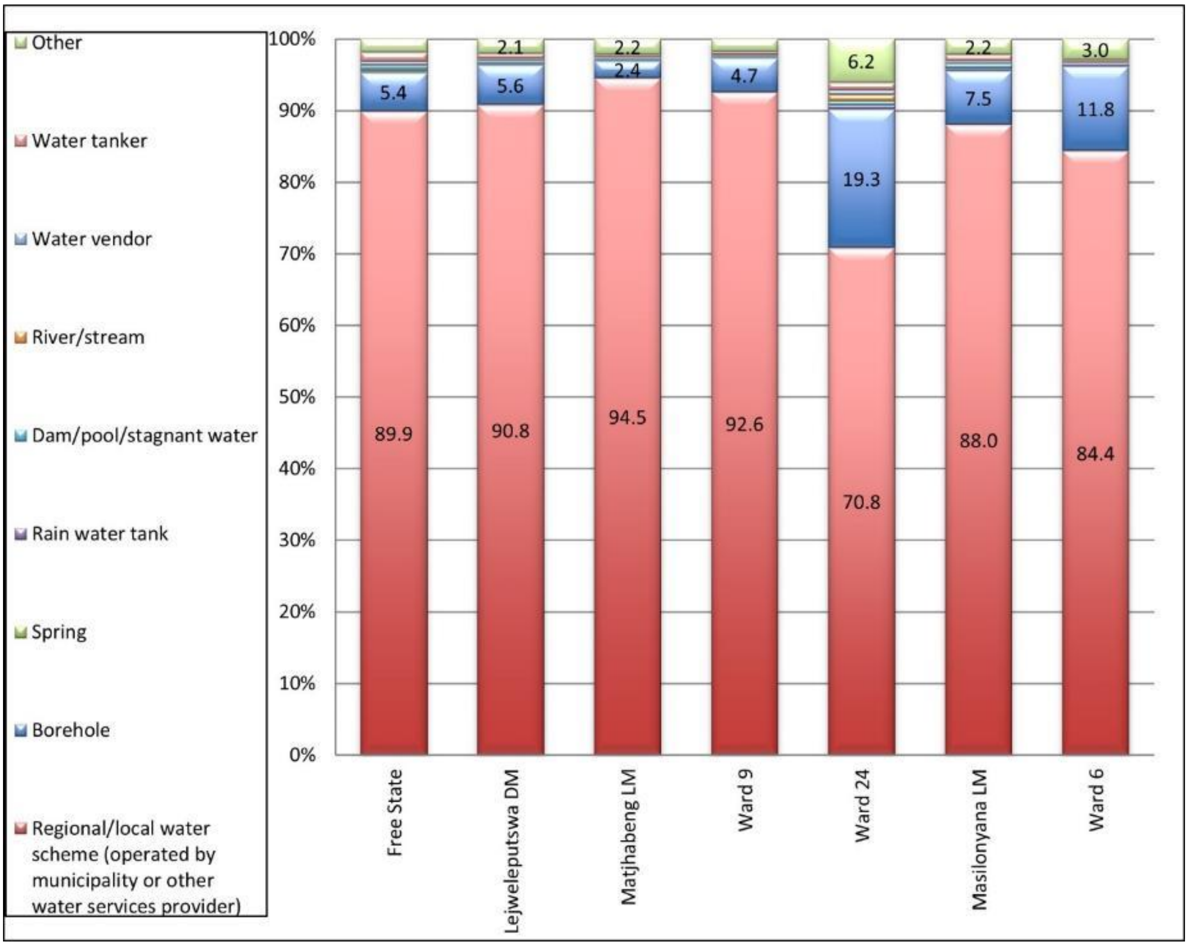


Figure 43: Sanitation (shown in percentage, source: Census 2011).

10.4.16 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 44), with candles the second most used source.

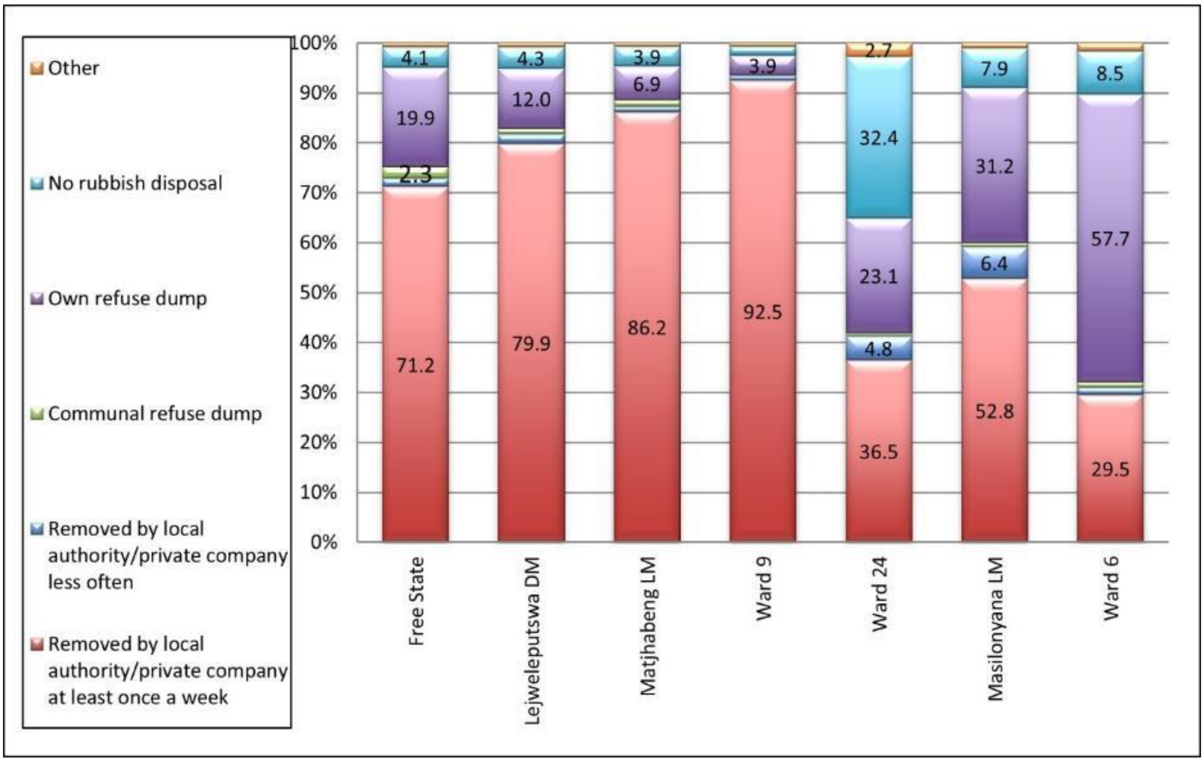


Figure 44: Energy source for lighting (shown in percentage, source: Census 2011).

10.4.17 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 45), with almost a third of households in Ward 24 having no rubbish disposal.

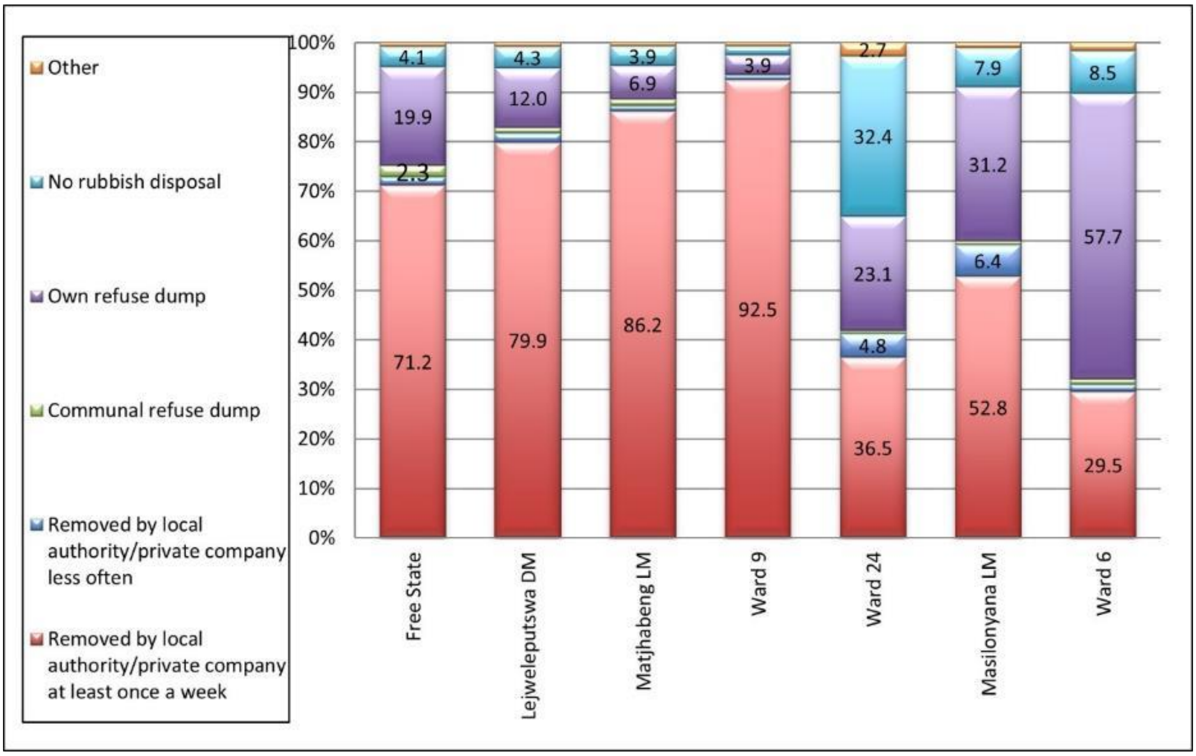


Figure 45: Refuse removal (shown in percentage, source: Census 2011).

10.5 ECONOMIC ENVIRONMENT

An economic impact assessment is being undertaken by Strategy4Good and the final report will be included in the EIA phase. 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.

10.5.1 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.

10.5.2 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 46 to Figure 49 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 49 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.

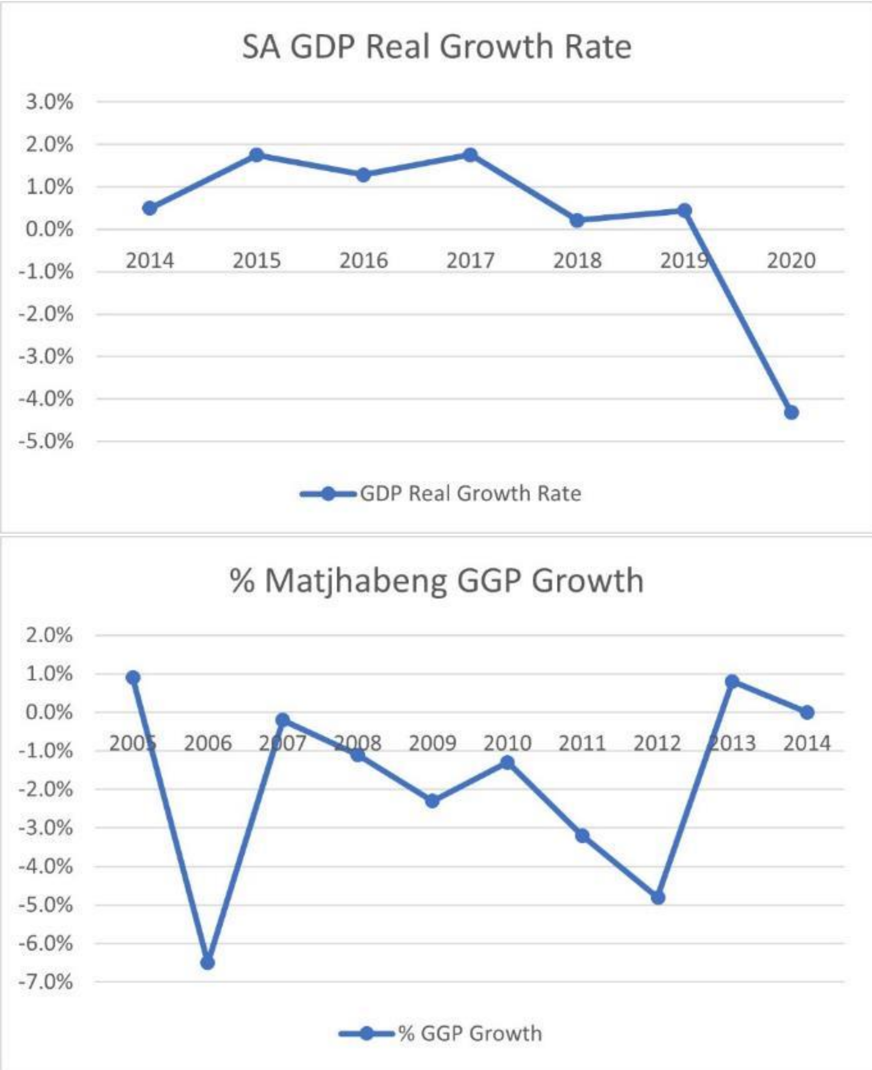


Figure 46: Key economic graphs.

Figure 47: Structure of Matjhabeng economy by economic output 2014 – sector specific.

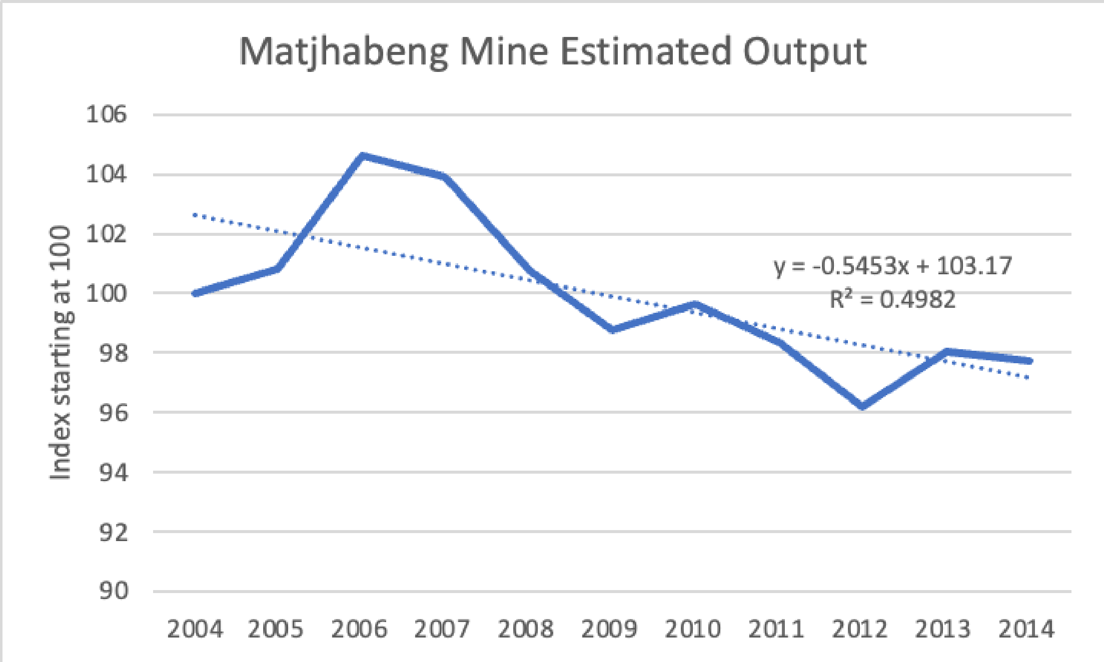


Figure 48: Structure of Matjhabeng economy by economic output 2014 – overall output.

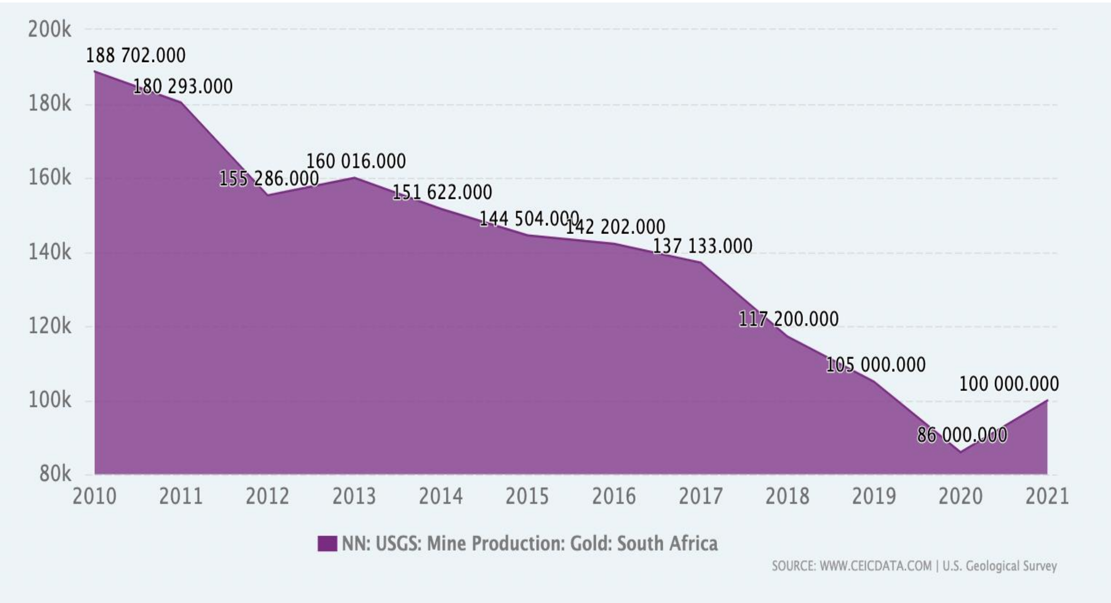


Figure 49: South African gold production.

10.5.2.1 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.

10.5.2.2 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.

10.6 CULTURAL AND HERITAGE RESOURCES

A Specialist Heritage and Palaeontology Impact Assessment study is being undertaken to inform this application and the final report will be included in the EIA phase. 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);

- o 11 structures (TET 2-3, TET 9, TET 27, SSL/BET/25-26, SSL/BET/36, SITE 1A, SITE 1B, SITE 20-21); and
- o 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:
  - o 6 sites containing burial grounds and graves (T0003, T0009, T0010, T0013, T0024, T0029);
  - o 8 sites historic to recent sites with possible graves (T0007, T0008, T0011, T0015, T0023, T0026, T0027, T0028); and
  - o 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 will be included in the final specialist report in the EIA phase. The location of the identified heritage sites are superimposed on the project infrastructure areas in Figure 50 with the relevant insets included in Figure 51 to Figure 60.

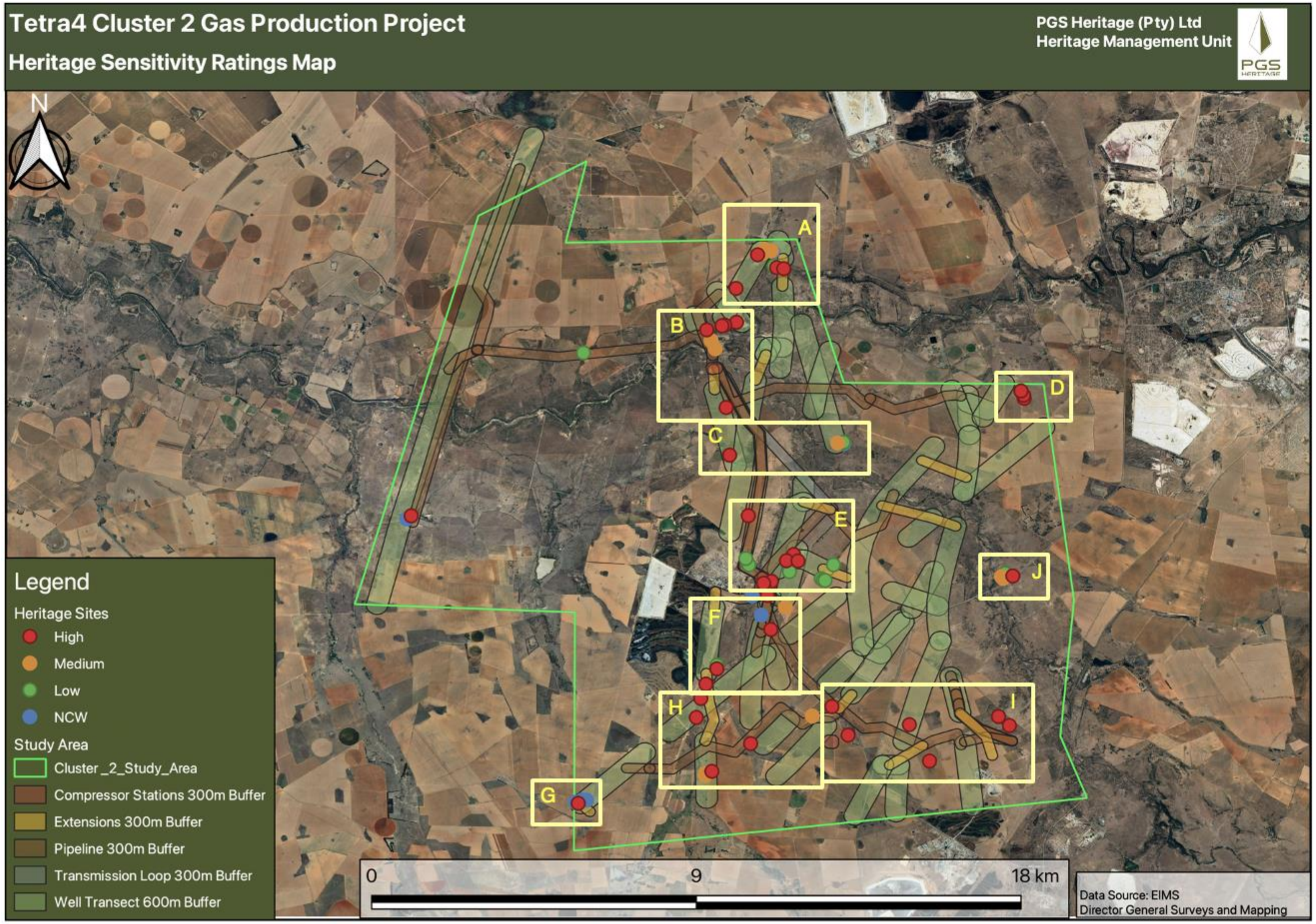


Figure 50: Map showing heritage sensitivity rating of identified heritage resources.

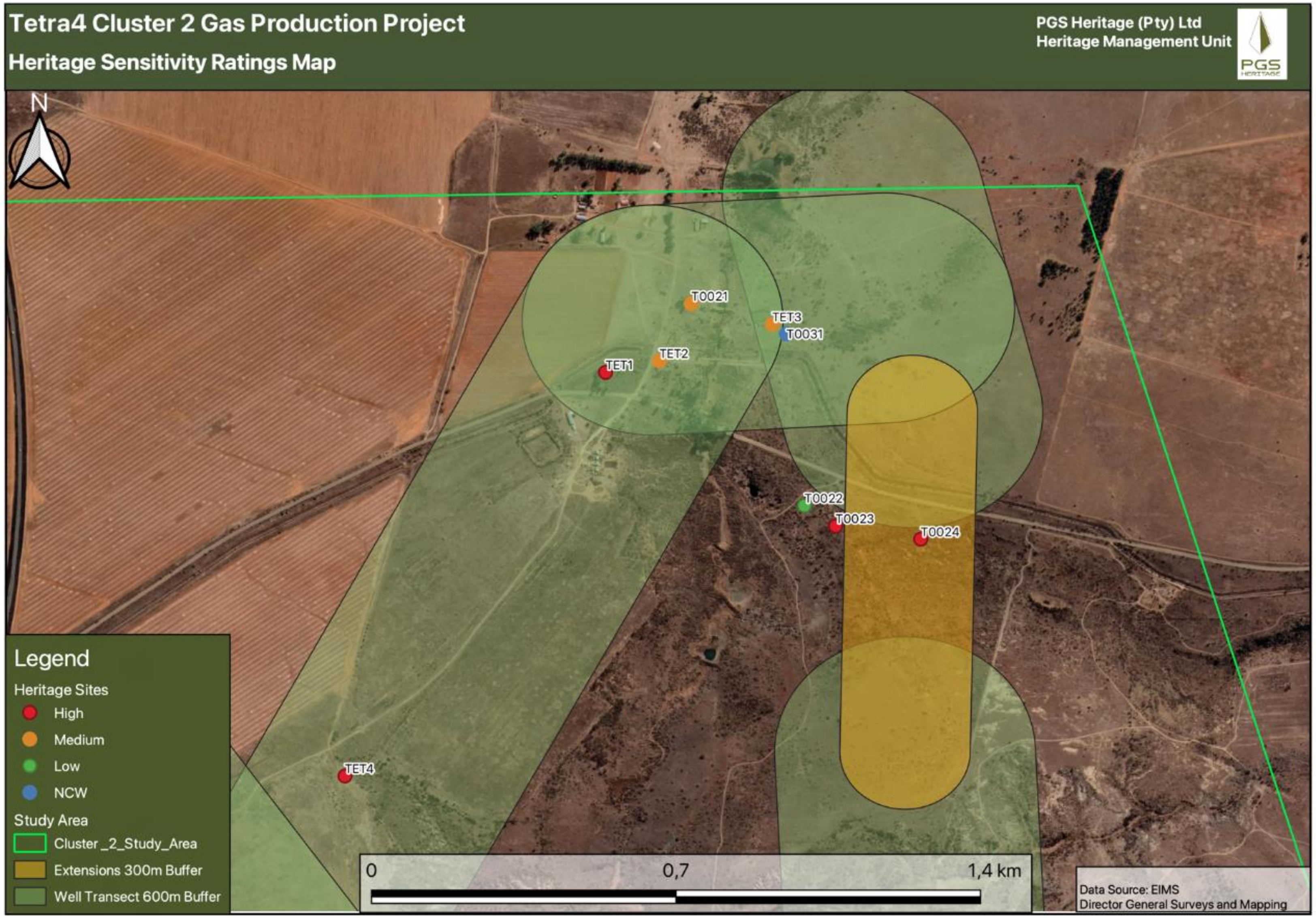


Figure 51: Heritage sensitivity rating of identified heritage resources - Inset A.

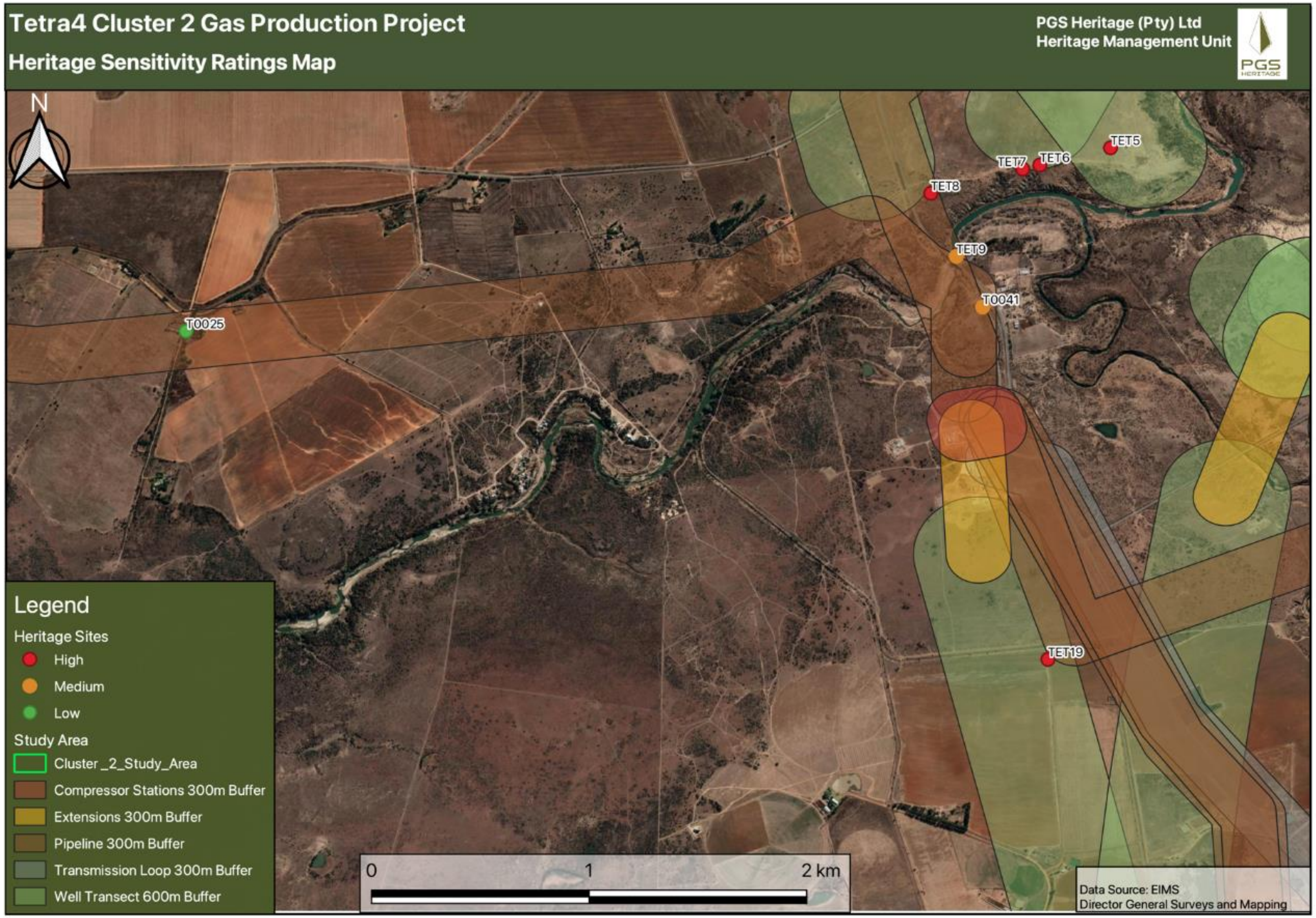


Figure 52: Heritage sensitivity rating of identified heritage resources - Inset B.

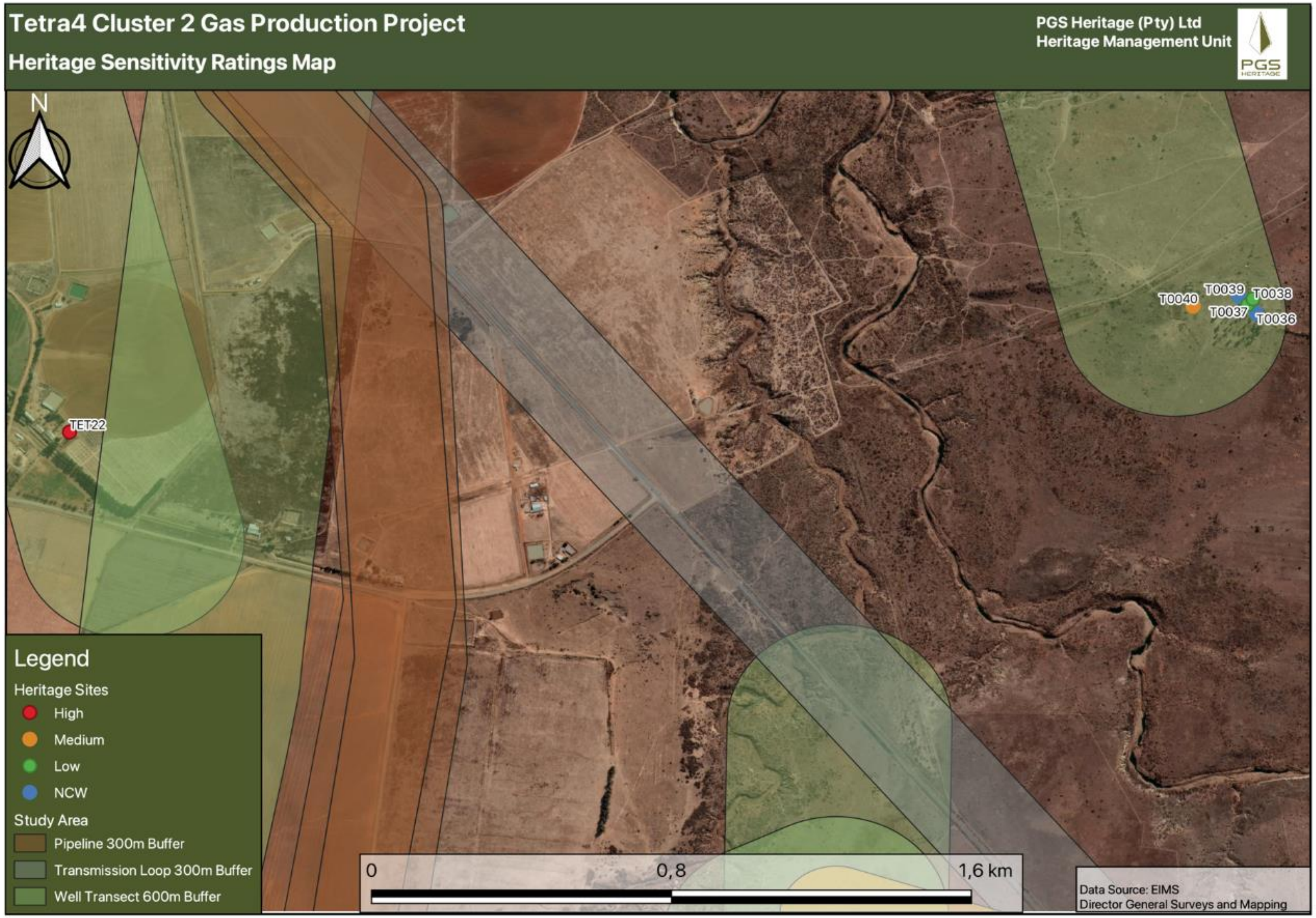


Figure 53: Heritage sensitivity rating of identified heritage resources - Inset C.

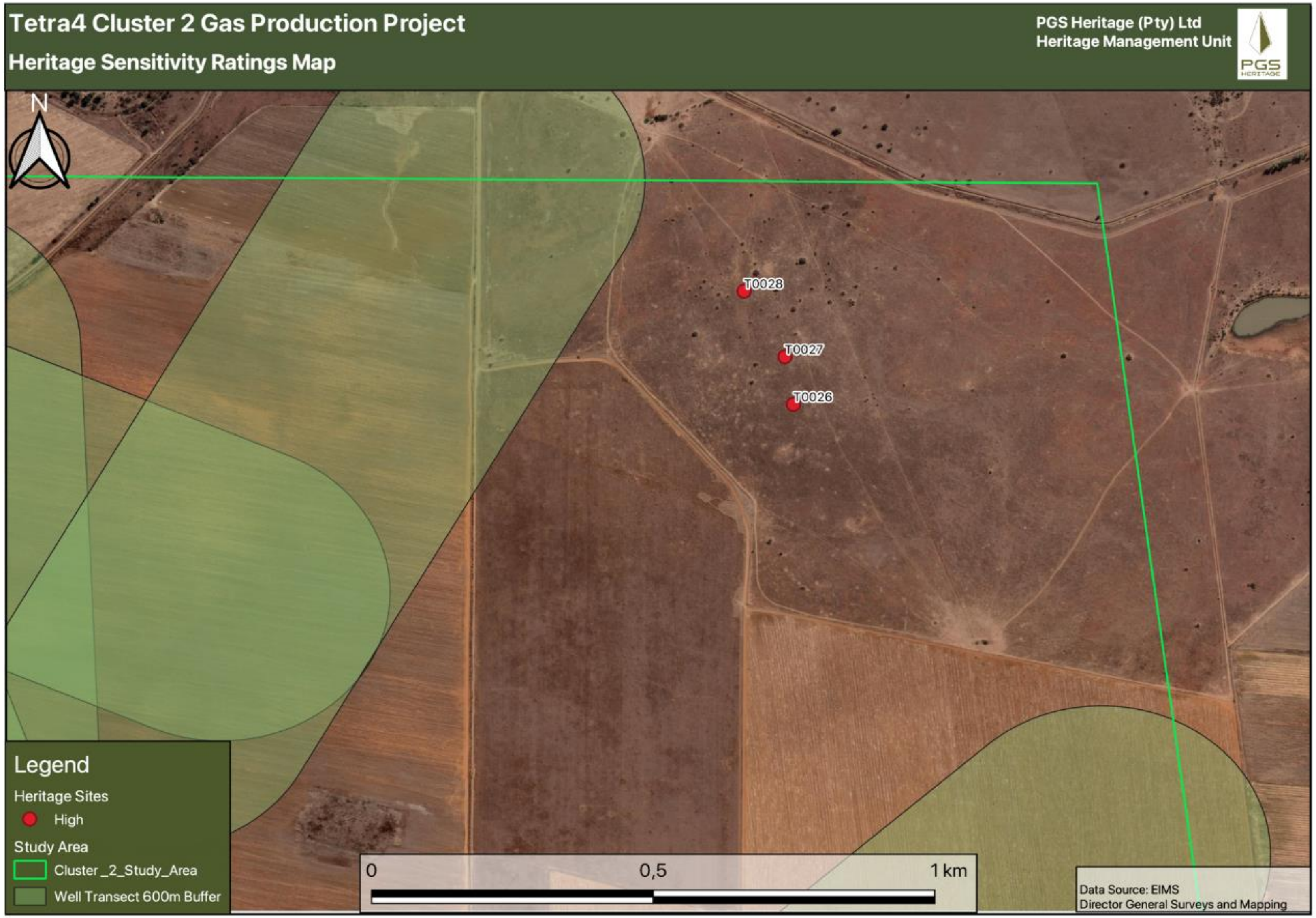


Figure 54: Heritage sensitivity rating of identified heritage resources - Inset D.

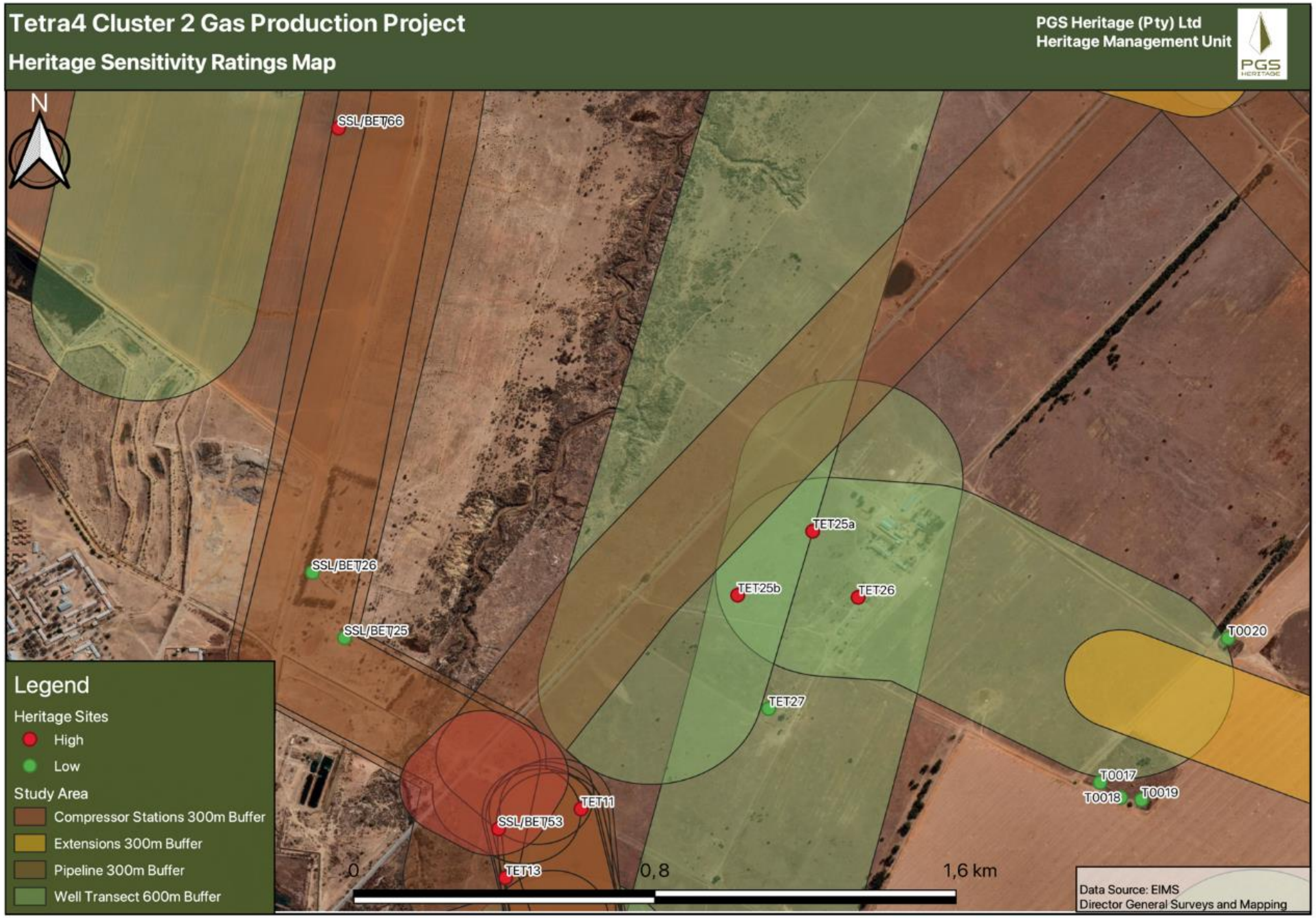


Figure 55: Heritage sensitivity rating of identified heritage resources - Inset E.

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

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

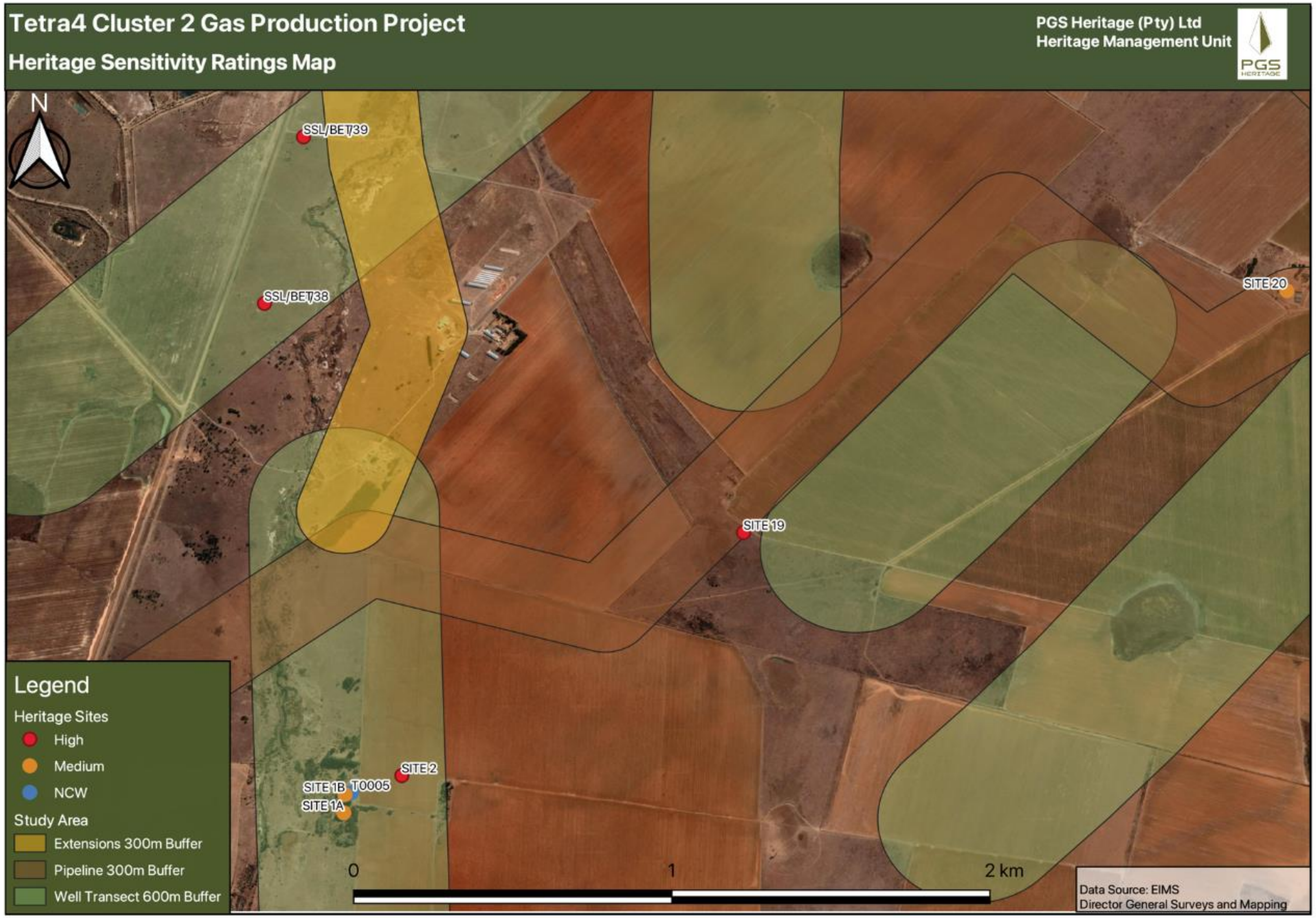


Figure 58: Heritage sensitivity rating of identified heritage resources - Inset H.

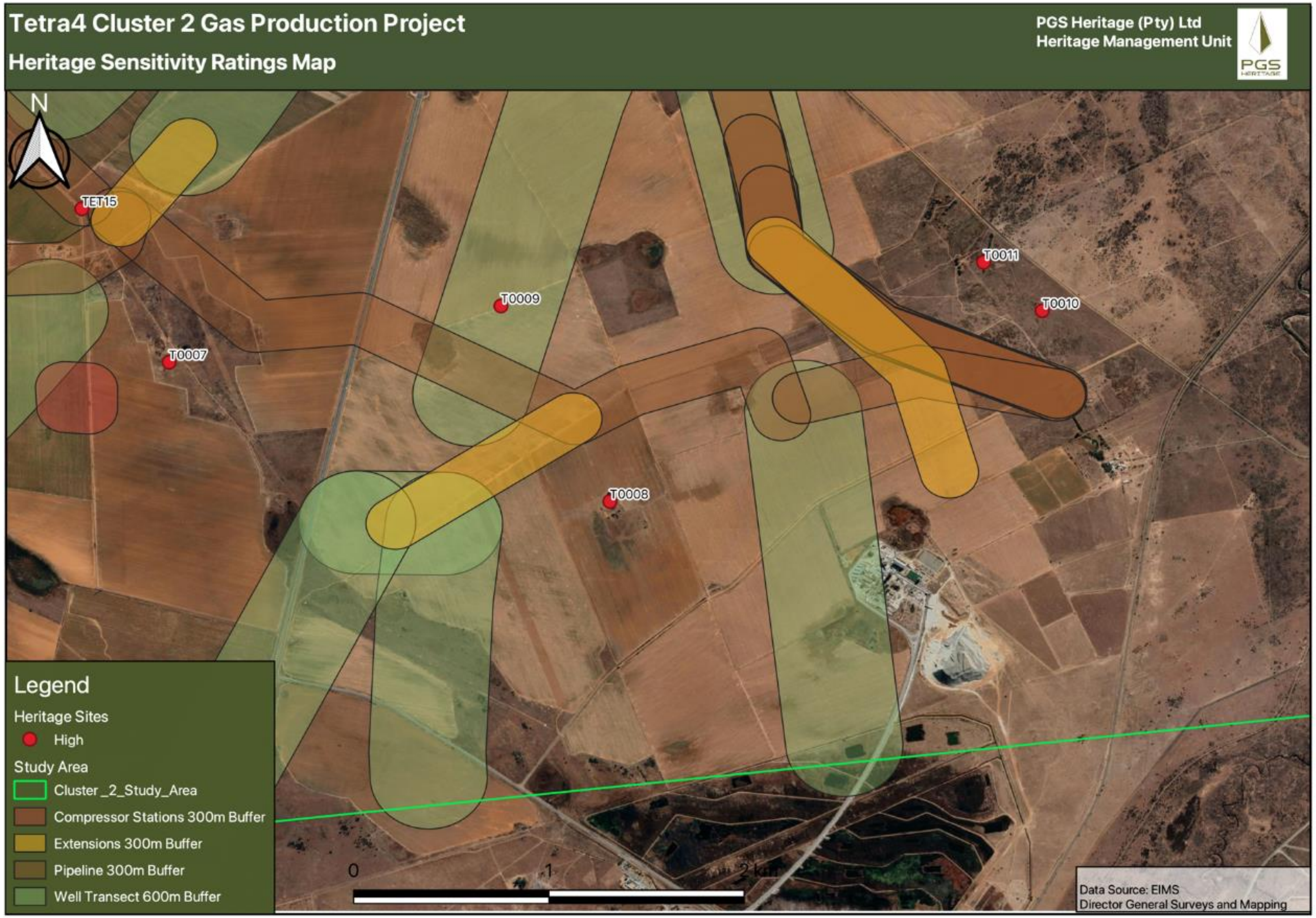


Figure 59: Heritage sensitivity rating of identified heritage resources - Inset I.

Figure 60: 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.

10.7 GEOLOGY

The below sections present the geological setting of the study area.

10.7.1 REGIONAL GEOLOGY

Although the application 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. It can be inferred from exploration borehole geological logs that the estimated depth of the unconsolidated material within the application area is approximately 11 m.

The Witwatersrand Supergroup is a sedimentary deposition across the stable granite-gniess 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 mbgl.

The Ventersdorp Supergroup uncomfortably overlies the Witwatersrand Supergroup. This Group is very thick, more than 4500 m. The lower Kliprivierberg Group is mafic lava and tuff while the upper Platberg Group is conglomerates and breccia on top of Klipriverberg, with intermediate and felsic lava higher, with quartzite, shale and siltstone layers in between. The Ventersdorp Supergroup depth within the study area was inferred from exploration borehole geological logs and is estimated at an average depth of >1120 mbgl.

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. 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 mbgl. Gas will be extracted from deep-seated fracture zones associated with the Ventersdorp lavas and Witwatersrand quartzites.

10.7.2 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. 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.

10.7.3 STRUCTURAL GEOLOGY

Large dolerite intrusions in the form of dykes and sills are observed throughout the study area. The Karoo sediments in this portion of the water management area (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 to 182 Ma. 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. Exploration data evaluated suggest dykes are relatively thin, usually not wider than 5 m while sills may be as thick as 100 m. 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.

10.8 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 61 and Table 20 respectively. Similarly, those for the Bd20 land type is depicted in Figure 62 and Table 21; Dc8 land type in Figure 63 and Table 22; Dc9 land type in Figure 64 and Table 23 and Dc12 in Figure 65 and Table 24 respectively.

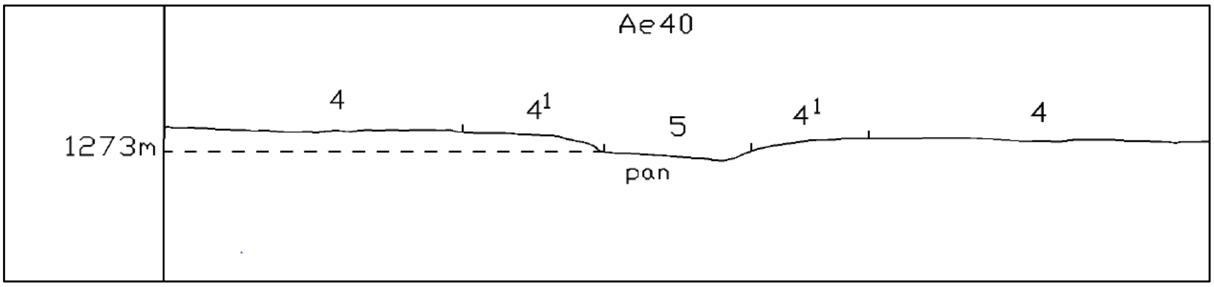


Figure 61: Illustration of land type Ae40 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 20: 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 %				

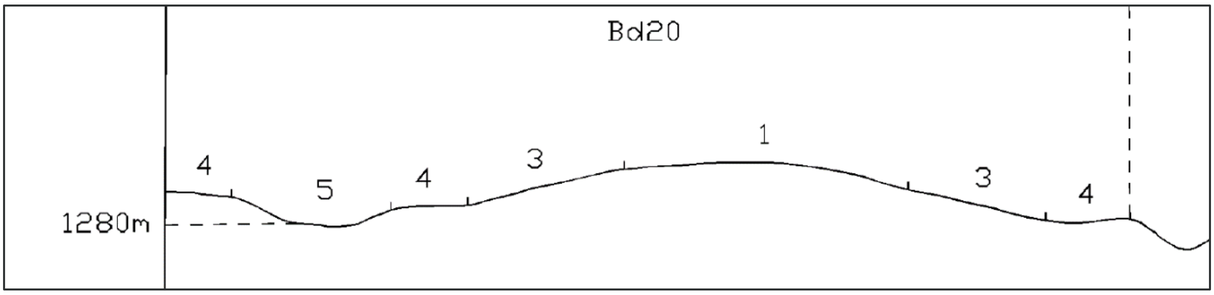


Figure 62: Illustration of land type Bd 20 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 21: 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 %		

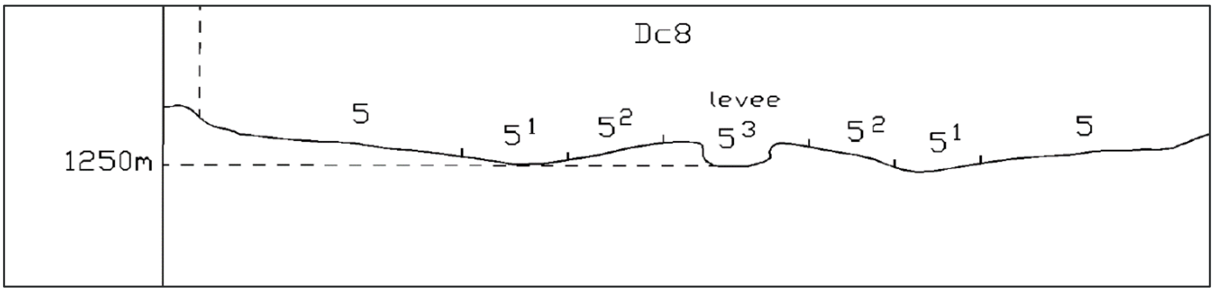


Figure 63: Illustration of land type Dc 8 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 22: 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 %						

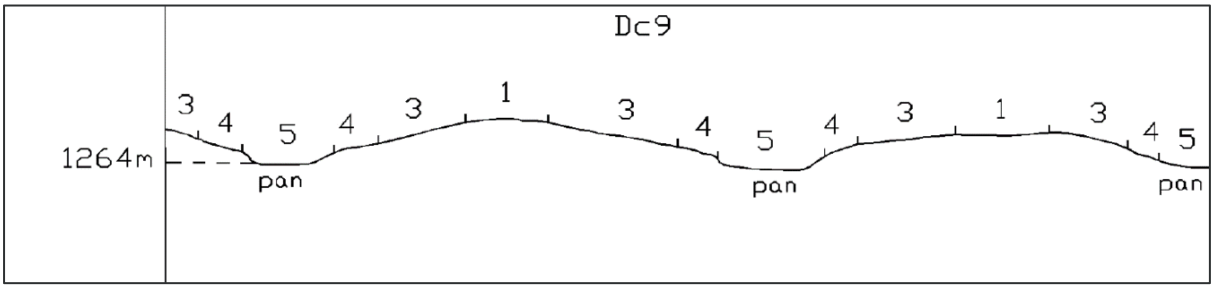


Figure 64: Illustration of land type Dc 9 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 23: 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 %		

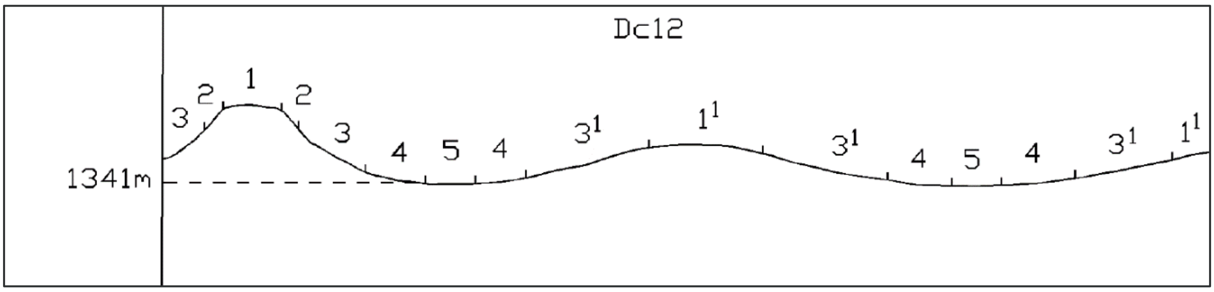


Figure 65: Illustration of land type Dc 12 terrain unit (Land Type Survey Staff, 1972 - 2006).

Table 24: 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 66. 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 67.

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 69).

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.

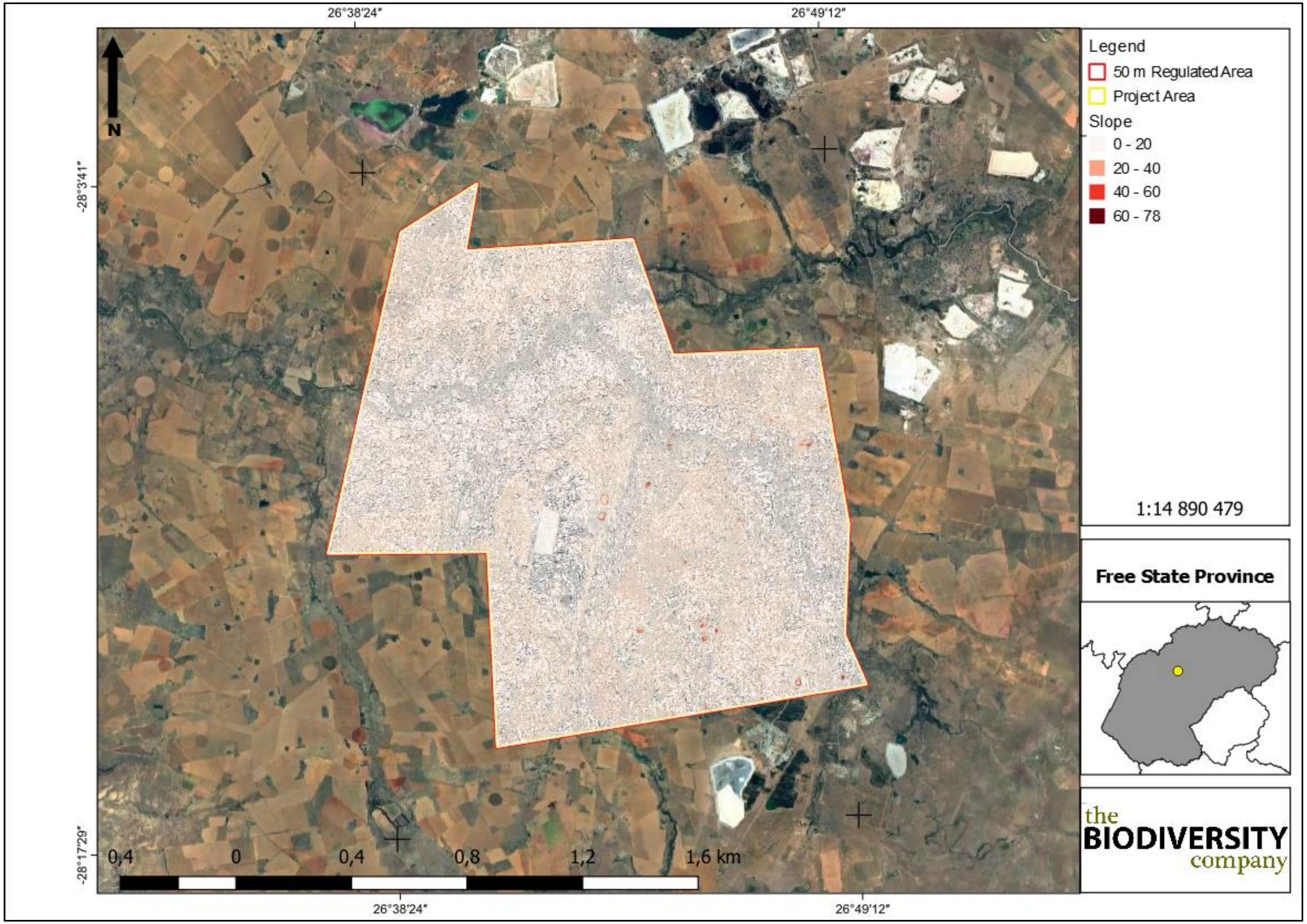


Figure 66: Slope percentage map for the assessment area.

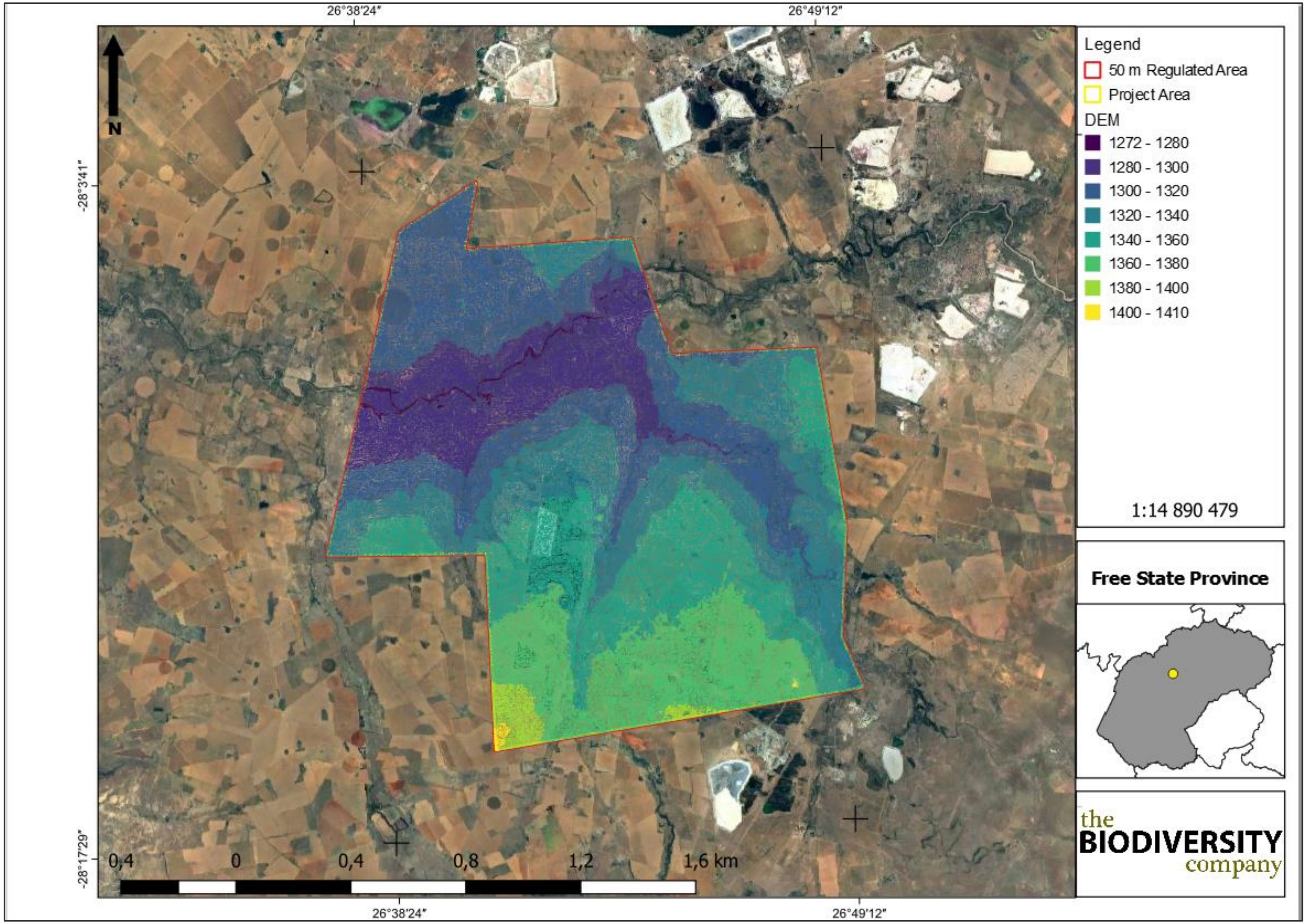


Figure 67: Elevation map for the assessment area.

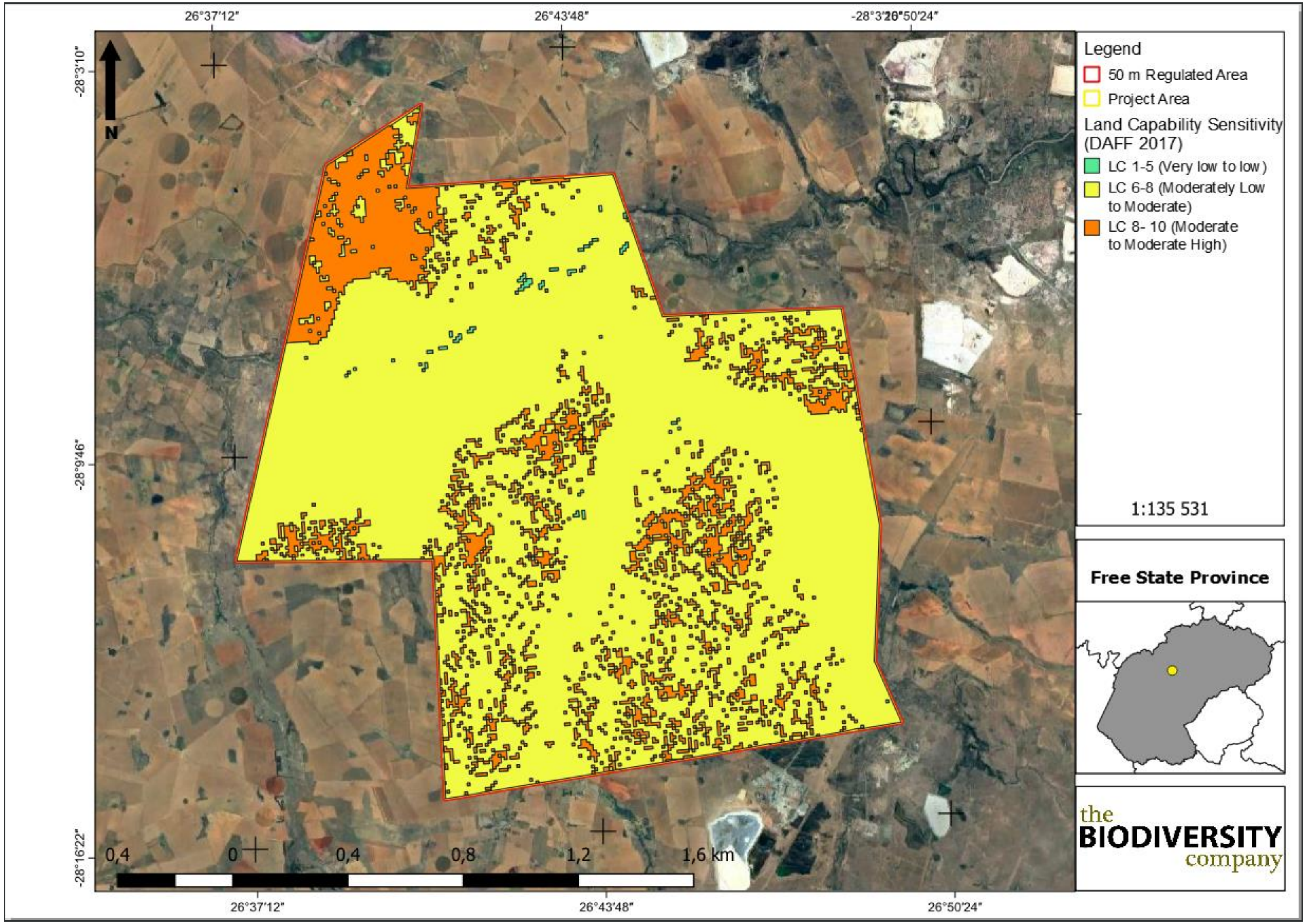


Figure 68: Land Capability Sensitivity (DAFF, 2017).

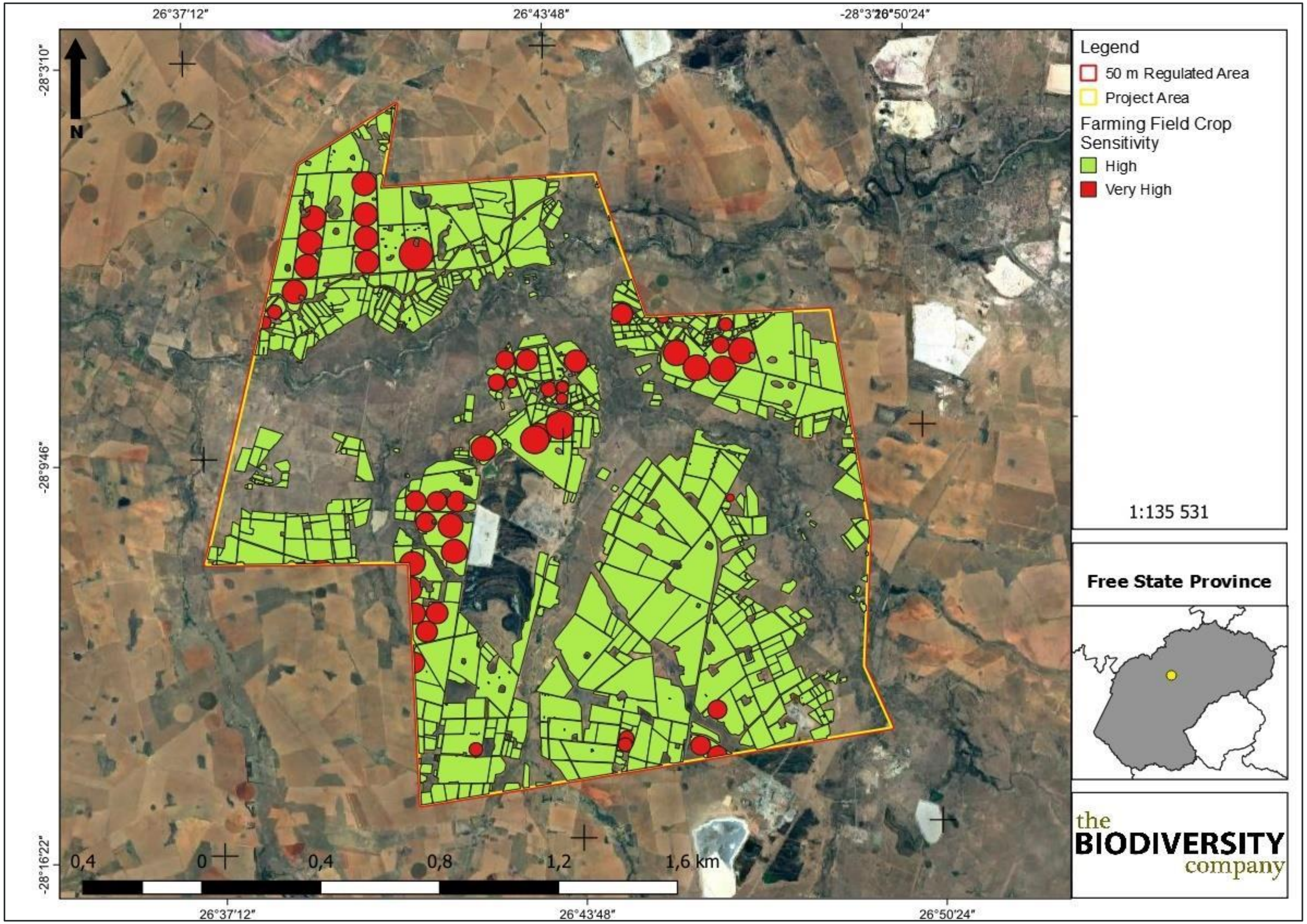


Figure 69: Farming Field crop Sensitivity (DEA, 2022).

10.9 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 70.

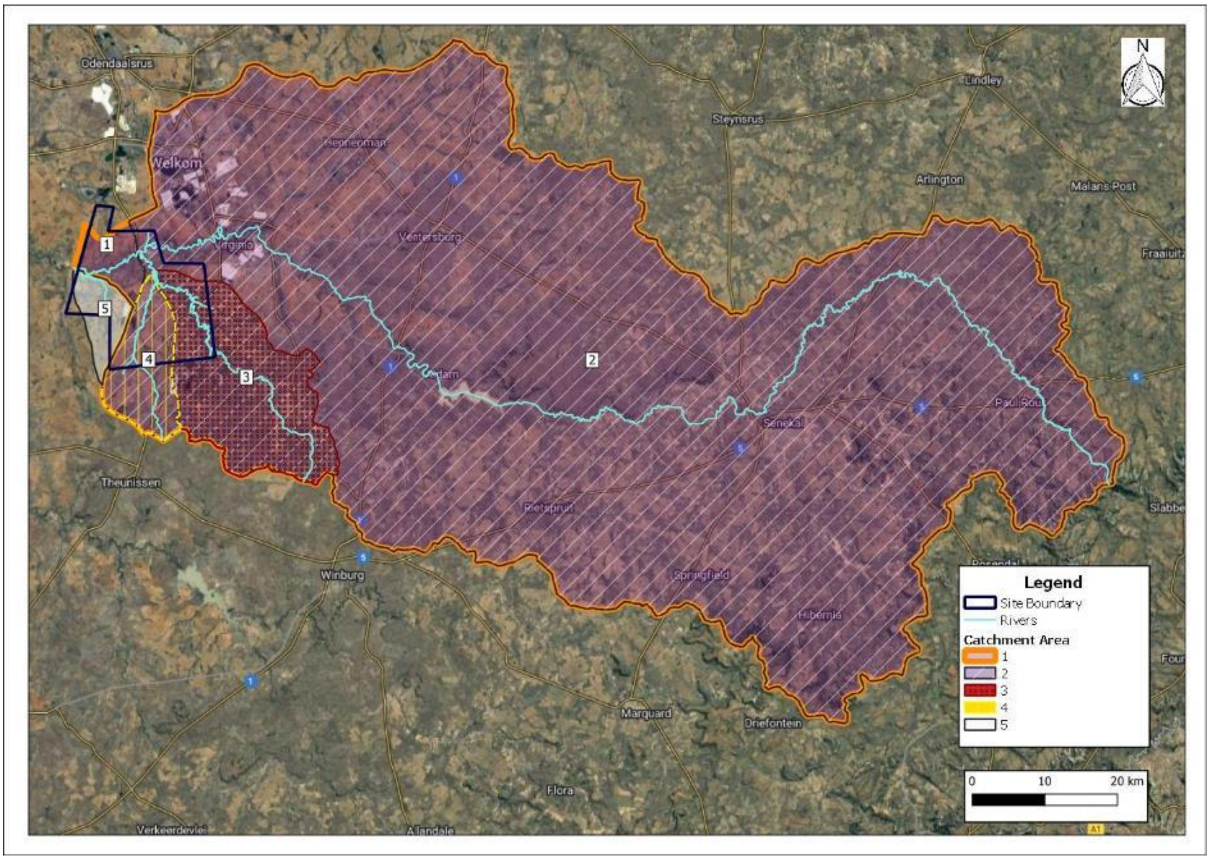


Figure 70: Catchment areas.

The physical properties of the various catchment areas shown in Figure 70 are summarized in Table 25.

Table 25: 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	239	58	29	20
Average Stream Slope	m/m	0.0013	0.0013	0.0032	0.0055	0.0079

Floodline modelling was undertaken to determine the 1:100-year floodlines for the major rivers within the application area. The hydrological analysis and floodline modelling detail will be included in the EIA phase. The 1:100-year floodlines are indicated in Figure 71.

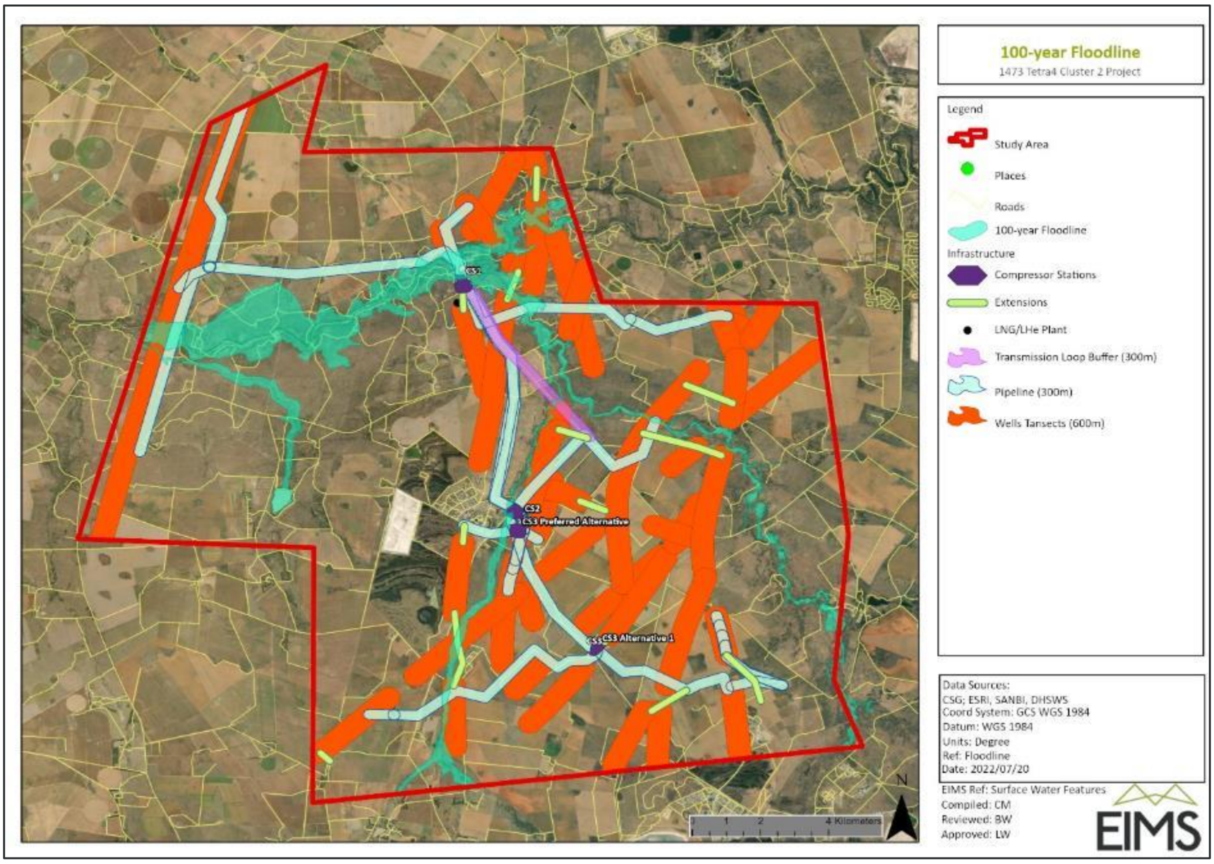


Figure 71: 1:100-year floodlines.

10.10 GROUNDWATER (GEOHYDROLOGY)

The groundwater (geohydrology) study is being undertaken by Gradient Groundwater Consulting and the final report will be included in the EIA phase. The baseline geohydrological features are presented in the subsections below.

10.10.1 HYDROCENSUS

A hydrocensus user survey within the greater study area was conducted during February and March 2022 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 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. Relevant hydrocensus information is summarised in the specialist report while a spatial distribution map is shown in Figure 72.

Of the boreholes recorded, the majority are in use (>78 %) while ~17 % are not currently being utilized. Approximately 4 % 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 (~45 %) while domestic and household purposes which is combined with either irrigation or livestock purposes account for >18 %. A small number of boreholes are also being applied for either monitoring or industrial purposes (~5 %) while ~17 % of boreholes do not have an application and are not currently being utilized. According to the Middle Vaal ISP (DWAF, 2004), most boreholes are being applied for irrigation and small-town water supply.

The majority of boreholes visited are equipped with submersible pumps and accounts to 57 %, while 15 % of boreholes were fitted either with a wind pump, mono pump (4 %), handpump (1 %) or solar pump (1 %). An average of 18 % of boreholes are not equipped.

10.10.2 GROUNDWATER FLOW

The following sub-sections outline the groundwater flow dynamics of the study area.

10.10.2.1 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 any potential surface contamination to the underlying aquifer(s). The unsaturated zone within the study area is in the order of 0m (fully saturated to surface) to >26 m with a mean thickness of approximately ~9 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.

10.10.2.2 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 in the specialist report. 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 mbgl, while the deepest water level was measured at borehole locality Mon-HDR1 (26.71 mbgl). The average water level is calculated at 8.91 mbgl which is much shallower than the regional average water level of ~23 mbgl (Aquiworx, 2014).

Time-series water levels within the existing Tetra 4 monitoring boreholes was assessed 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 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 and 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 %, which accounts to less than 0.5 m, 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.

10.10.2.3 GROUNDWATER FLOW DIRECTION AND HYDRAULIC GRADIENTS

Analysed data indicate that the surveyed water levels correlate very well to the topographical elevation. 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 application area from where groundwater will discharge as baseflow. The groundwater flow direction within the southern catchment of the Sandrivier and Doornrivier, 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 73.

Figure 72: Spatial distribution of hydrocensus user survey geosites.

Figure 73: Regional groundwater flow direction and depth to groundwater.

10.10.3 GROUNDWATER QUALITY

The hydrochemical results of the hydrocensus boreholes water samples analysed suggest the overall ambient groundwater quality is good with the majority of 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 (Lea, 2017). It is noted that the TDS concentration increase 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. 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.

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 included 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 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.

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. The majority of samples analysed suggest elevated Calcium/Magnesium-Chloride concentrations with isolated boreholes (BH04 and BH05) indicating elevated concentrations of Manganese (Mn).

10.10.4 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, shallow freshwater aquifer(s) during the gas exploration and production phase.
ii. Migration of stray gas from the deep, fractured aquifer to the overlying, shallow freshwater aquifer(s) during the gas exploration and production phase.
iii. Migration of contaminants from the plant expansion waste storage facilities and evaporation pond 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. Gas exploration and production wells (if not suitably mitigated) will form preferential flow paths and serve as a direct connection between the deeper, fractured aquifer and shallow, freshwater 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.

10.10.5 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 is included in the groundwater specialist report. 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 74.

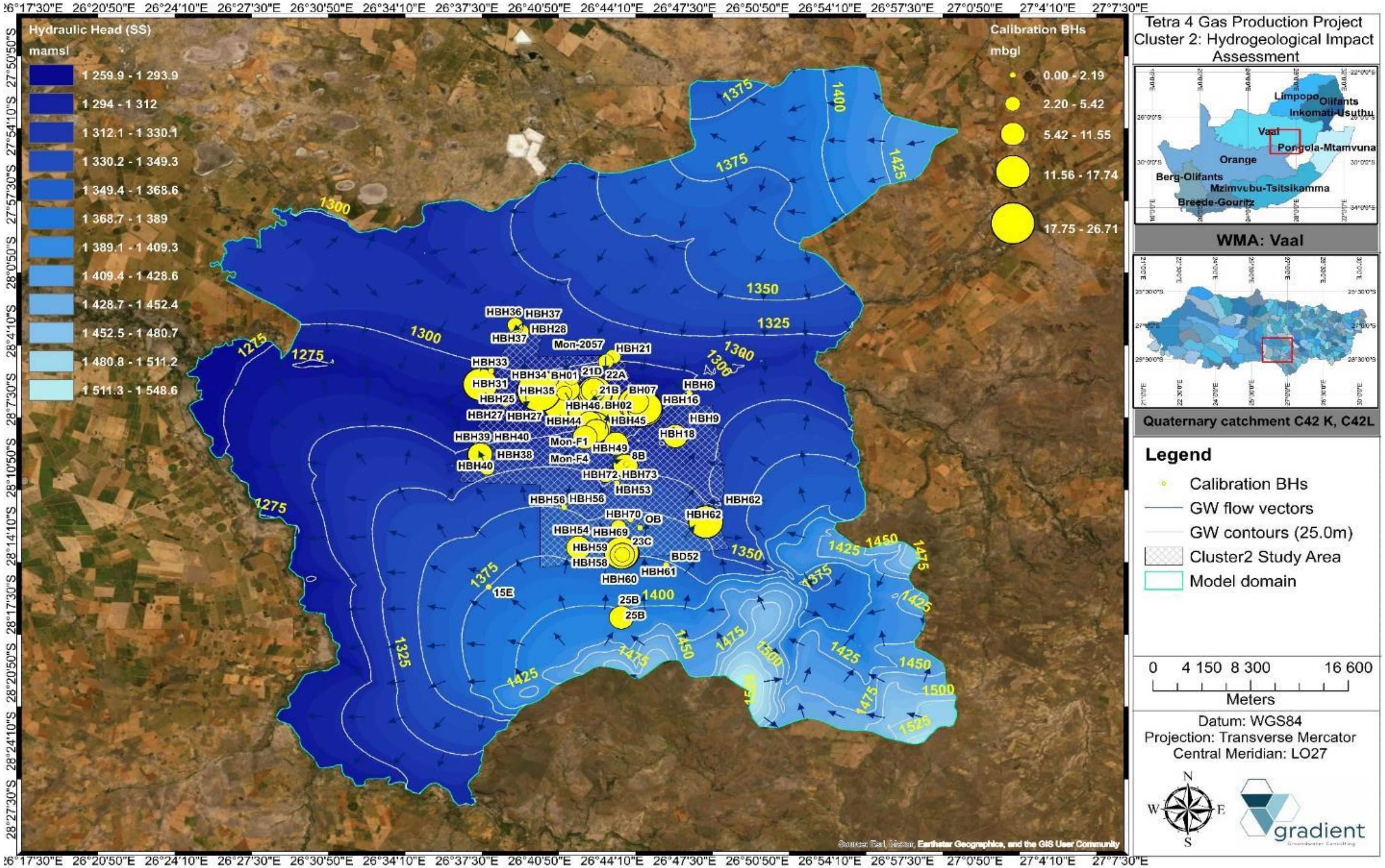


Figure 74: Steady state hydraulic heads and groundwater flow direction.

10.11 TERRESTRIAL BIODIVERSITY

Terrestrial Biodiversity is being assessed by The Biodiversity Company (TBC) and the specialist report will be included in the EIA phase. The baseline terrestrial biodiversity (flora and fauna) findings are presented in the subsections below.

10.11.1 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 26.

Table 26: 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

10.11.2 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 75).

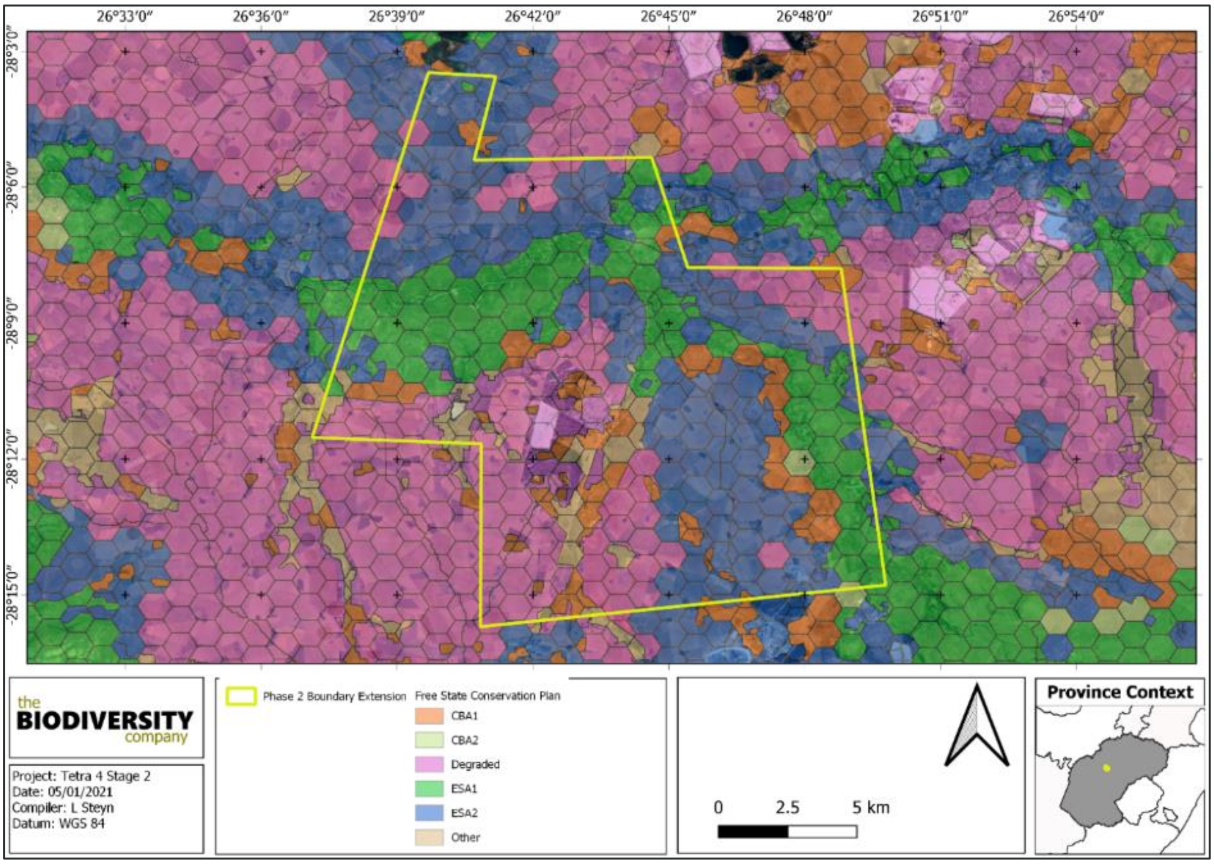


Figure 75: Application area superimposed on the Free State BSP.

10.11.3 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.

10.11.3.1 **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 76). According to the spatial dataset the proposed development overlaps with LC and EN ecosystems.

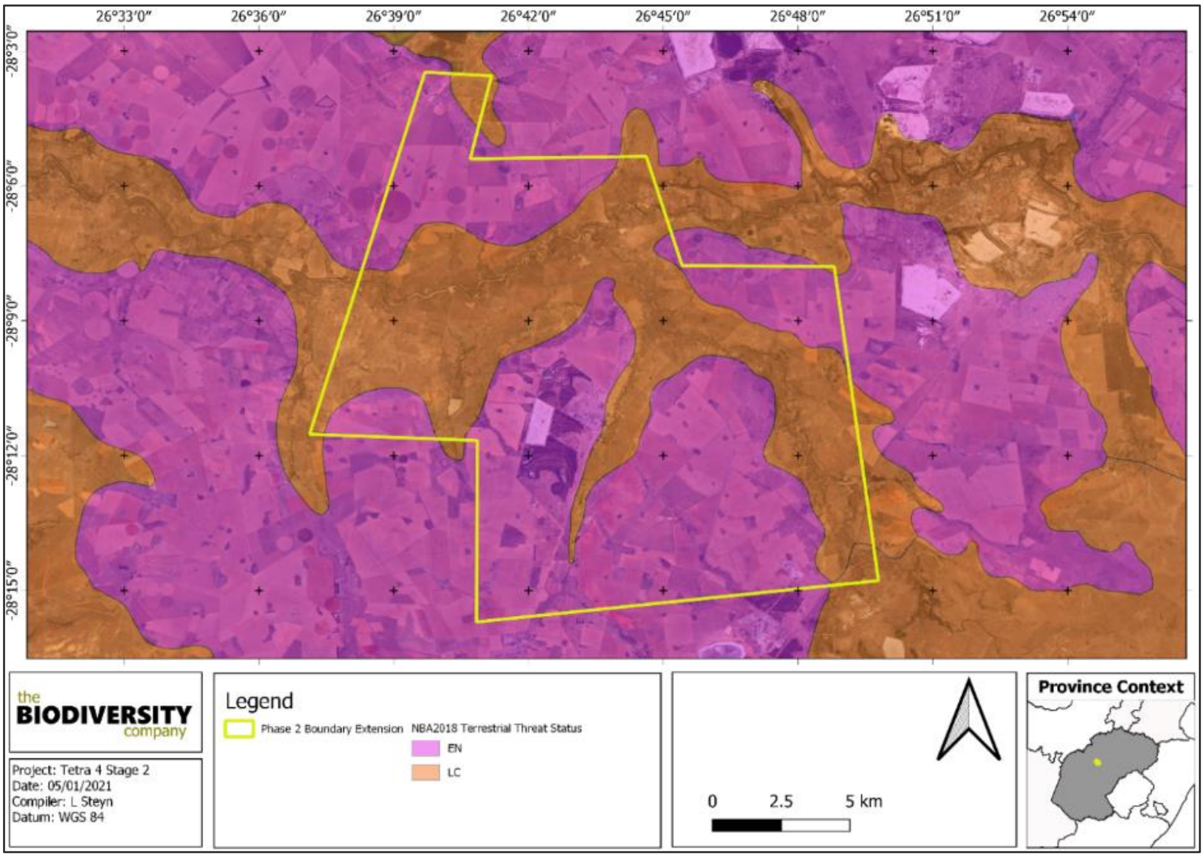


Figure 76: The application area showing the regional ecosystem threat status of the associated terrestrial ecosystems (NBA, 2018).

10.11.3.2 **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 77). The application area overlaps with Not Protected (NP) and Poorly Protected (PP) ecosystems.

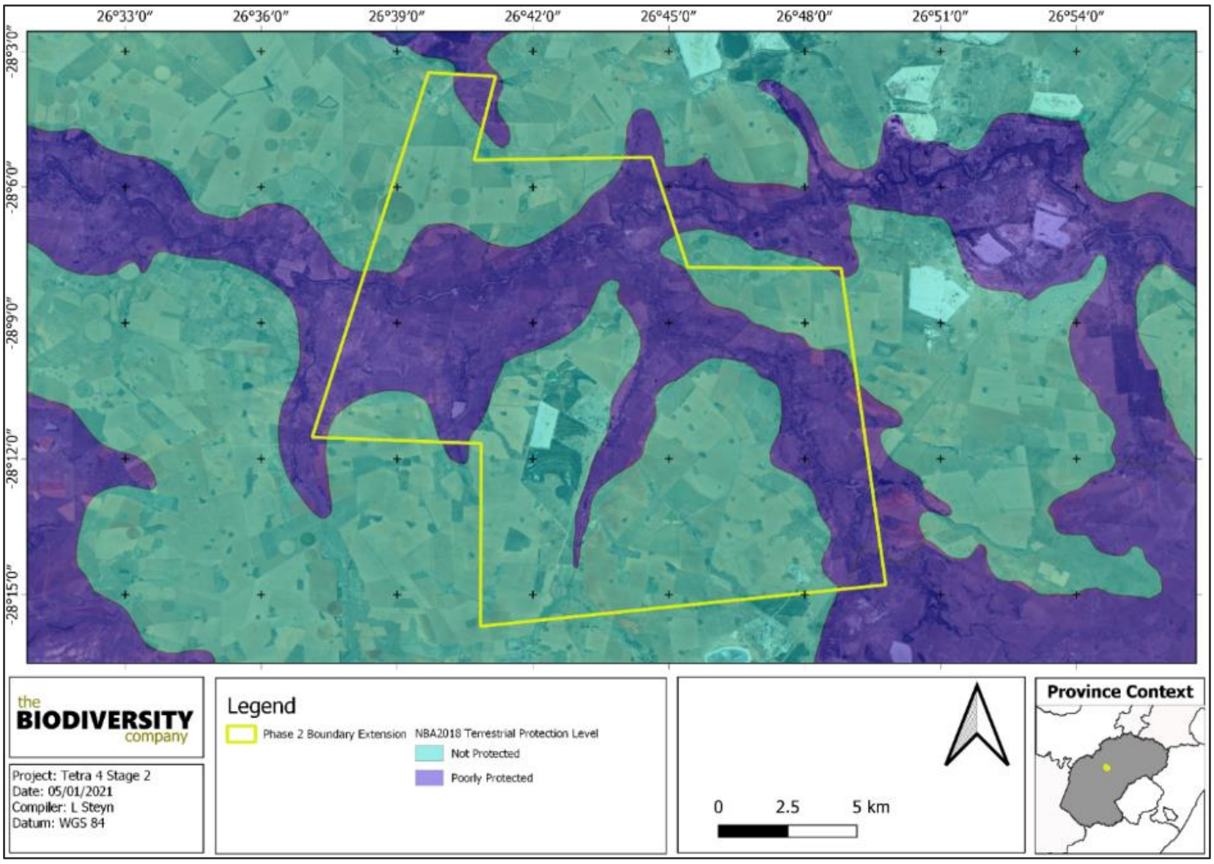


Figure 77: The application area showing the regional level of protection of terrestrial ecosystems (NBA, 2018).

10.11.4 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 78). The south-eastern corner of the application area overlaps with a NPAES priority focus area (Figure 79).

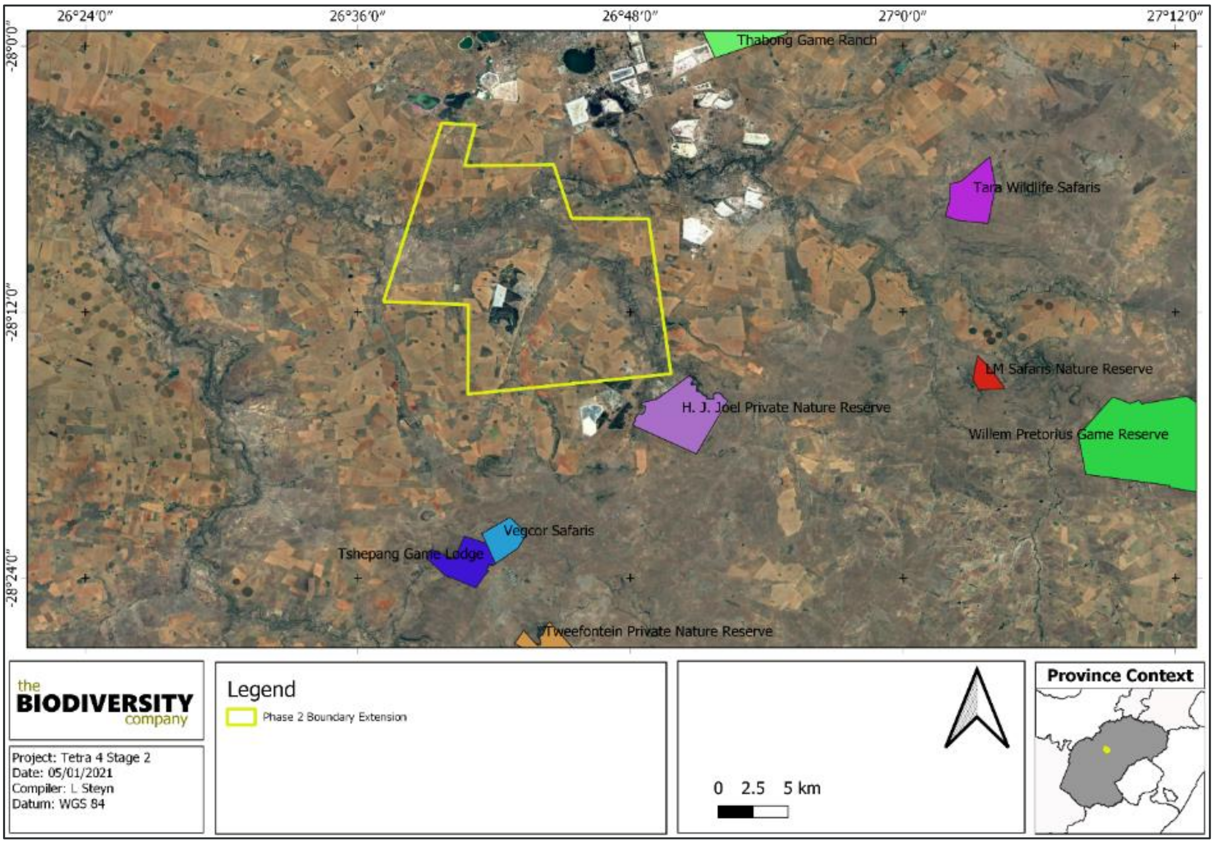


Figure 78: Map illustrating the location of protected areas proximal to the assessment area.

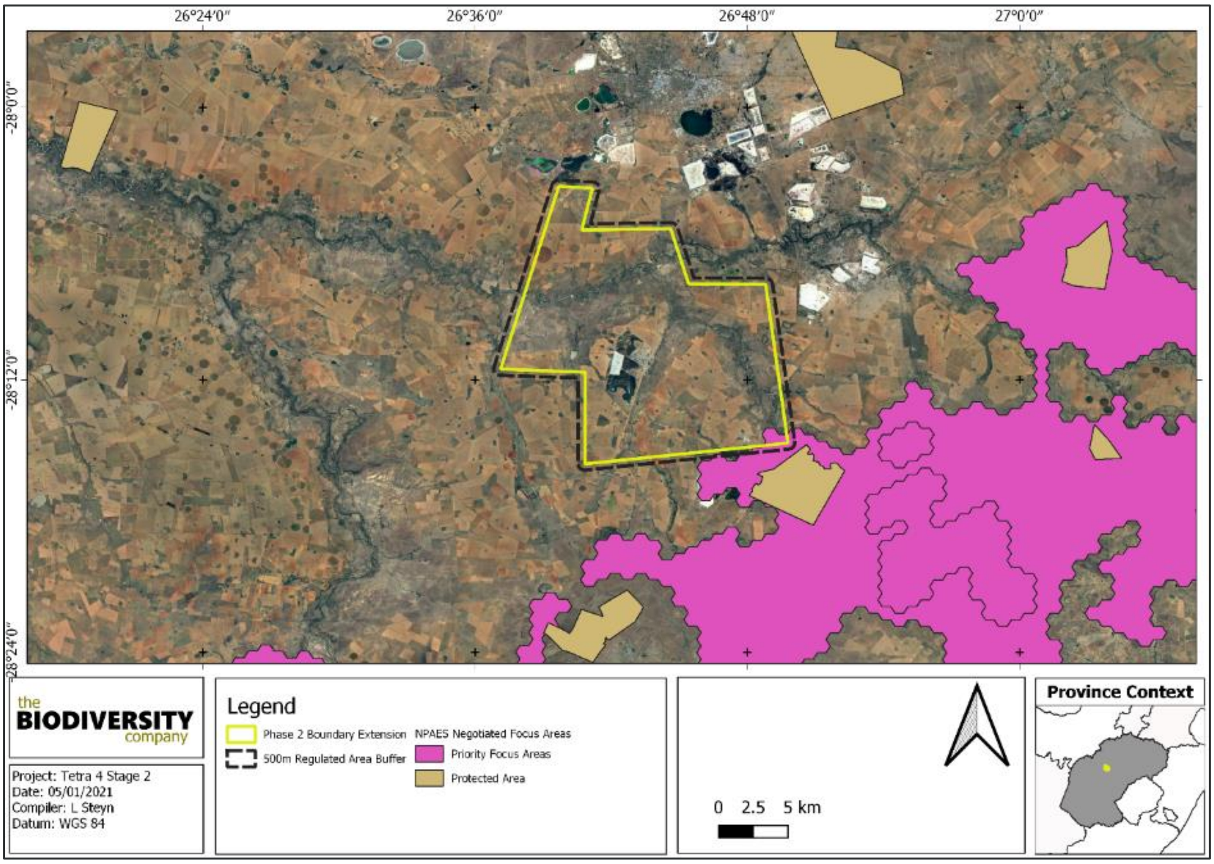


Figure 79: Map illustrating the location of NPAES proximal to the assessment area.

10.11.5 IMPORTANT BIRD AND BIODIVERSITY AREAS (IBAS)

The proposed development does not overlap any IBA (Figure 80). The closest IBA, the Willem Pretorius Nature Reserve, is located approximately 29.5 km to the east.

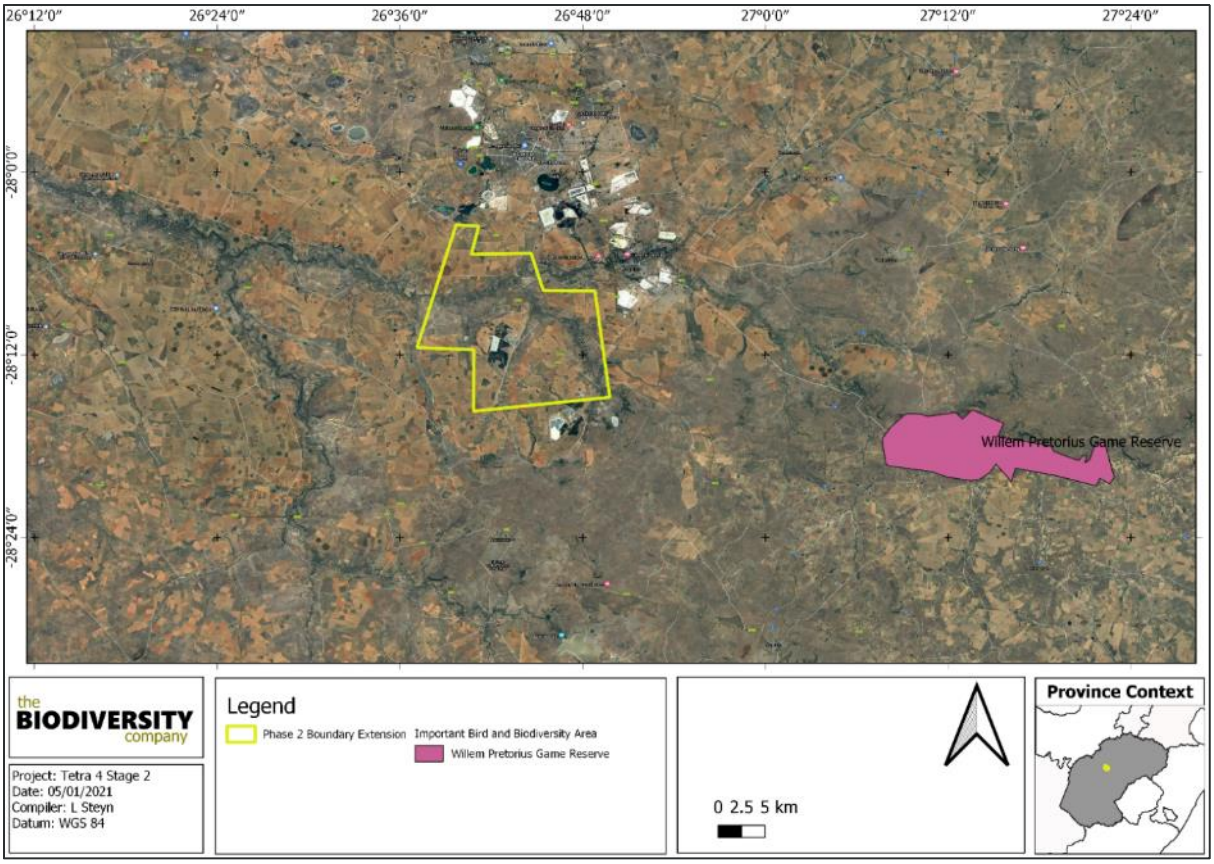


Figure 80: Location of Important Bird and Biodiversity Areas (IBAs) in relation to the assessment area.

10.11.6 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 81). 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.

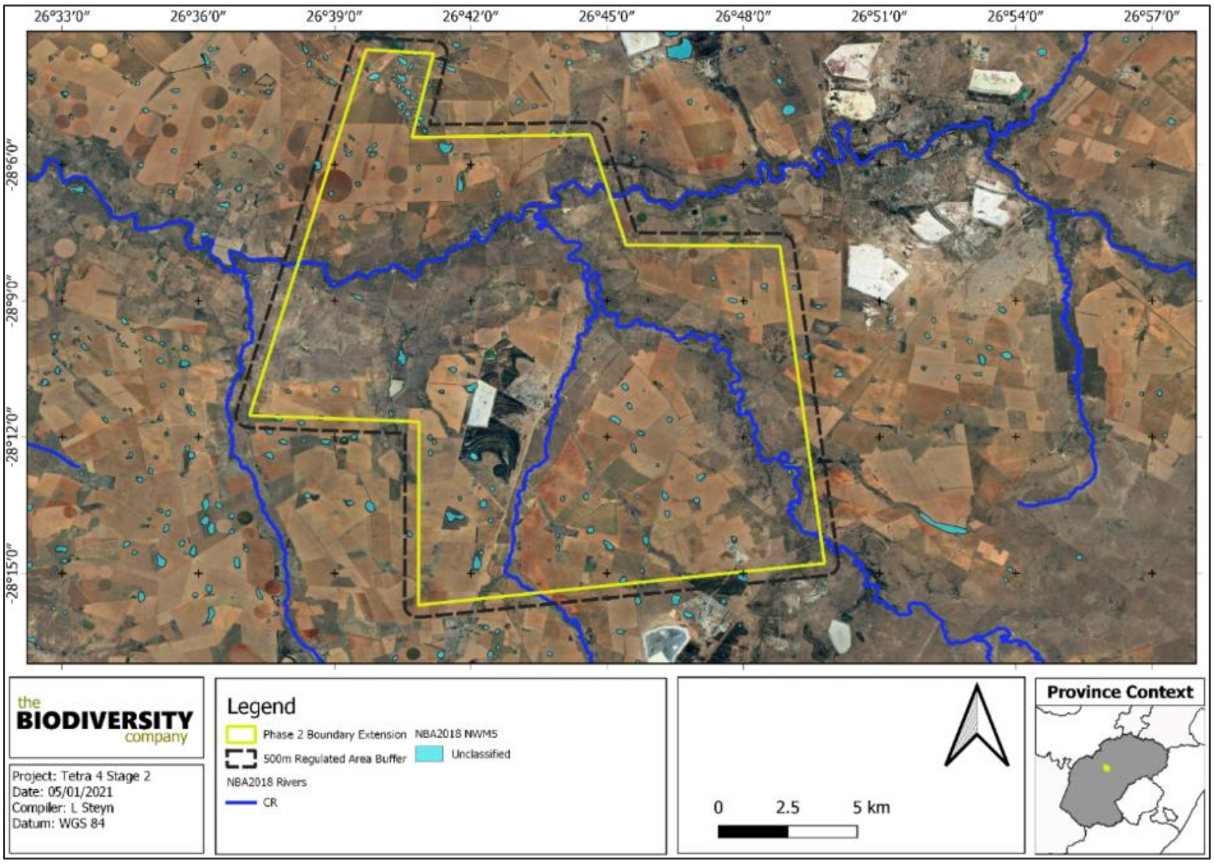


Figure 81: Hydrological context of the assessment area based on the NBA spatial dataset (2018).

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 82 shows the assessment area overlaps with a true FEPA wetland and an unclassified river.

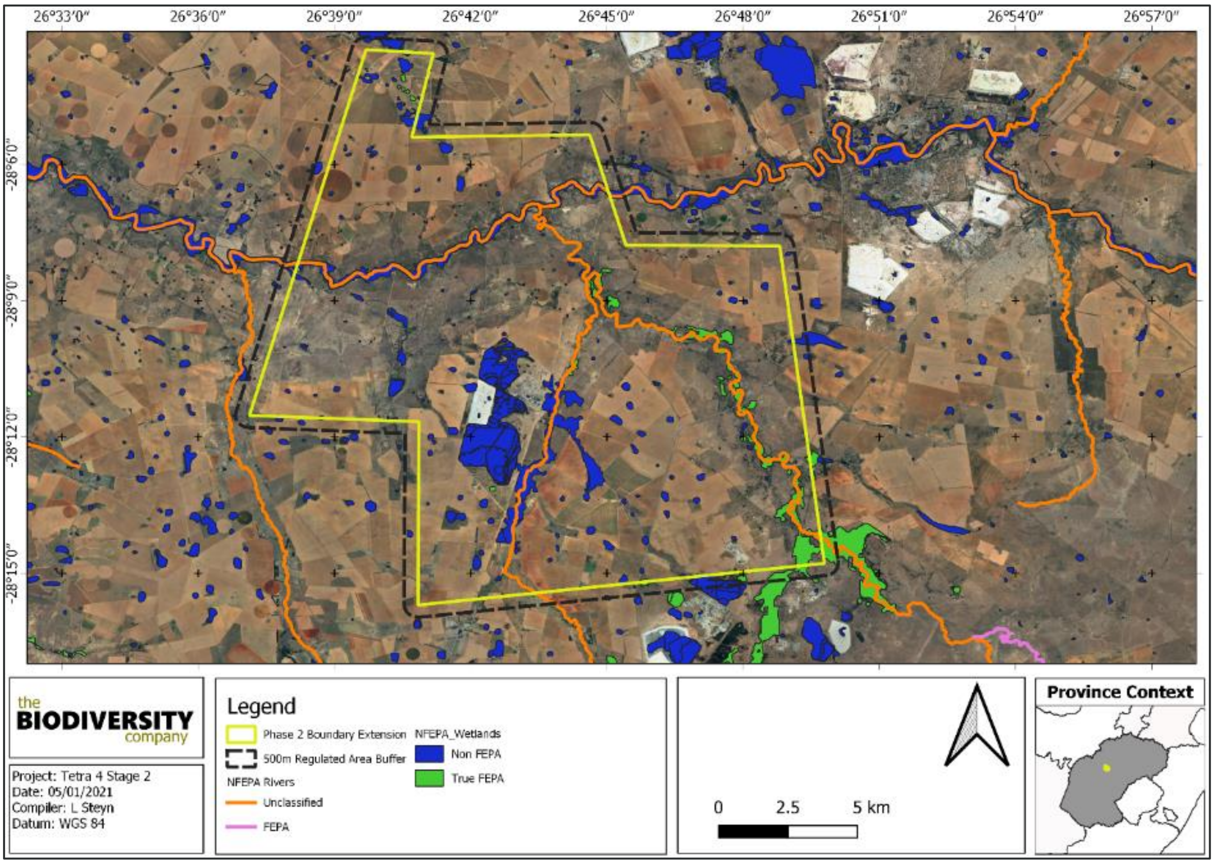


Figure 82: Hydrological context of the assessment area based on the NFEPA spatial dataset (2011).

10.11.7 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 83.

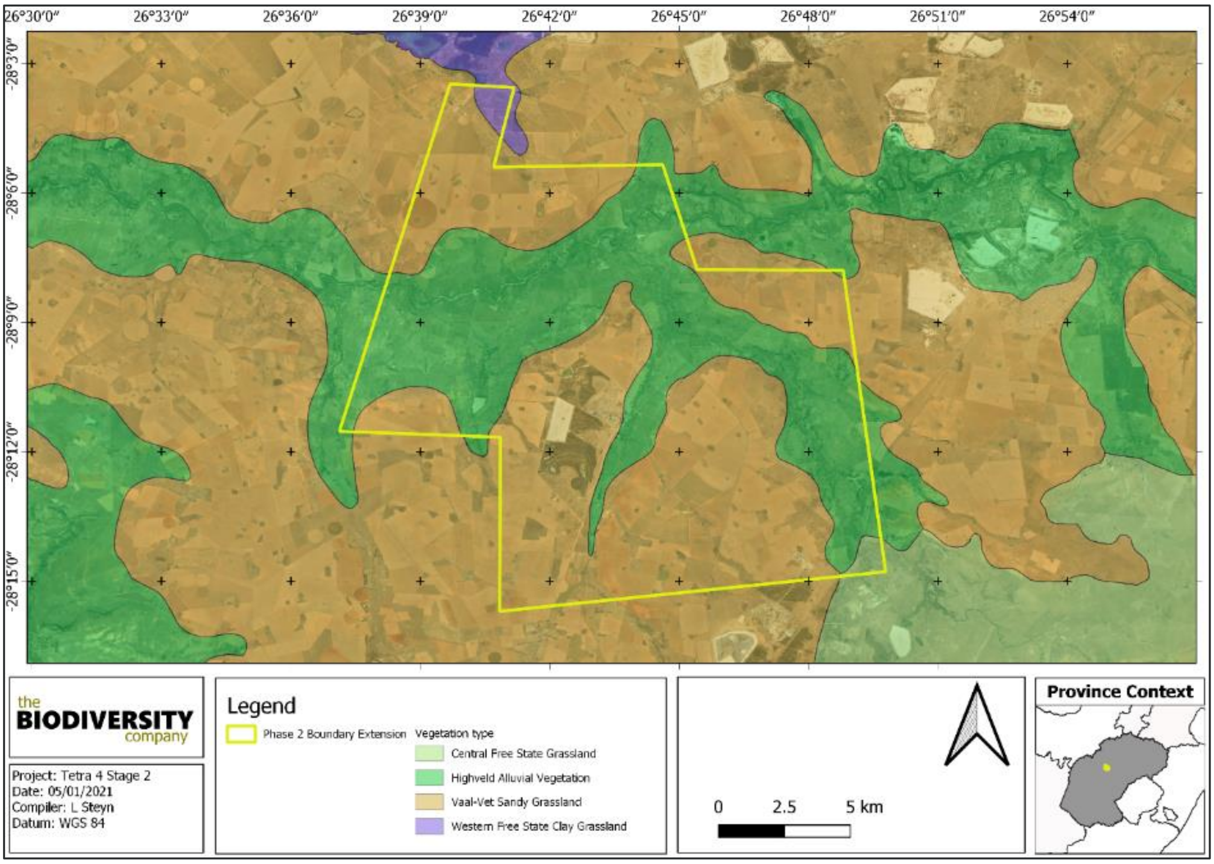


Figure 83: The application area showing the vegetation type based on the Vegetation Map of South Africa, Lesotho & Swaziland (BGIS, 2018).

10.11.8 FLORA ASSESSMENT

This section is divided into three sections:

3. Indigenous Flora;
4. Invasive Alien Plants (IAPs); and
5. Protected Plant Species.

10.11.8.1 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 27). 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 27: 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	

10.11.8.2 **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.

10.11.8.3 **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).

10.11.9 FAUNA ASSESSMENT

Avifauna, Mammal and Herpetofauna observations and recordings fall under this section.

10.11.9.1 **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 28). Four (4) (red text) species are rated as Species of Conservation Concern (SCC), whereas 75 were listed as protected provincially.

Table 28: 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

10.11.9.2 MAMMALS

Twenty-two (22) mammal species were observed during the survey of the application area (Table 29) 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 29: 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	-

10.11.9.3 HERPETOFAUNA

10.11.9.3.1 REPTILES

Eleven (11) species of reptiles were recorded in the application area during survey period. (Table 30). 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 (km^2) 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 30: 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	-

10.11.9.3.2 AMPHIBIANS

Four (4) amphibian species were recorded in the application area (Table 31). One species recorded is a SCCs (shown in red text).

Table 31: 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	-

10.11.10 HABITAT ASSESSMENT AND SITE ECOLOGICAL IMPORTANCE

10.11.10.1 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 84 and Figure 85. 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.

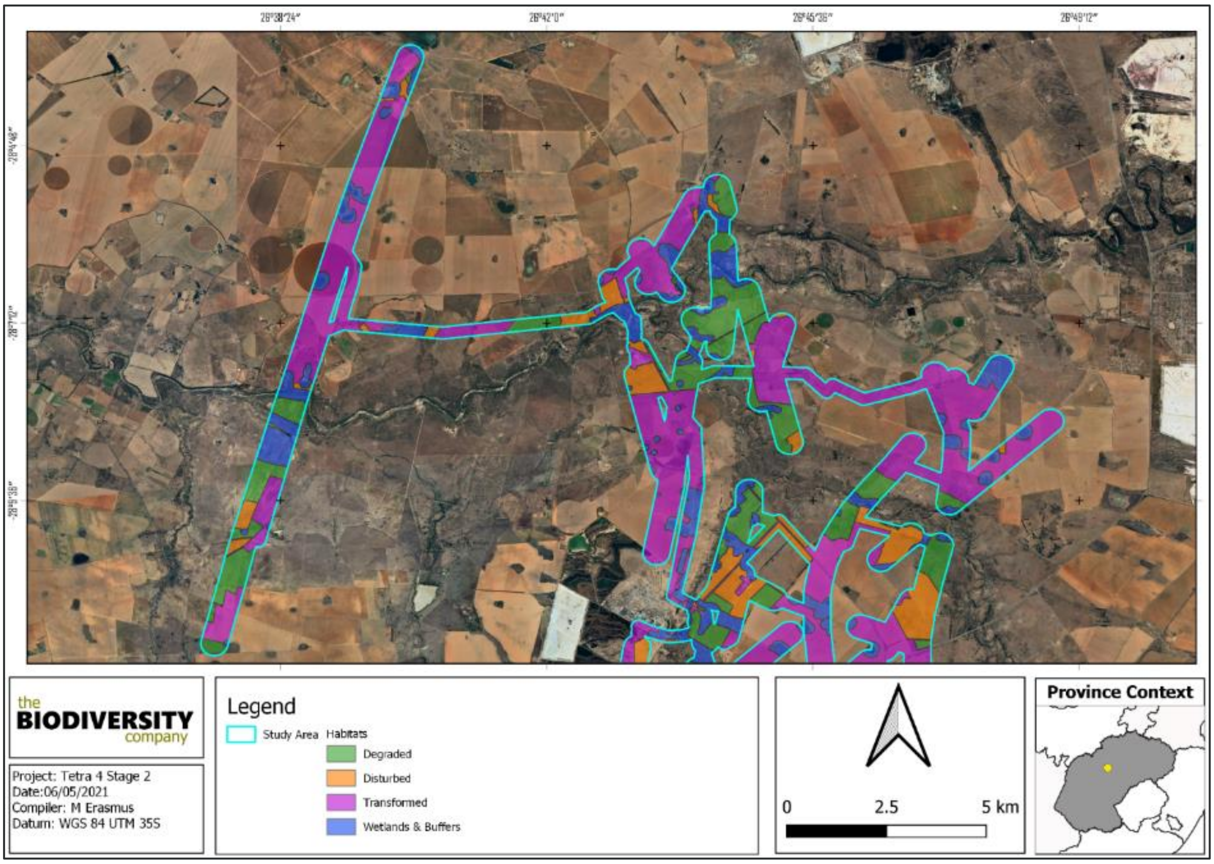


Figure 84: Habitats identified within the application area (northern section).

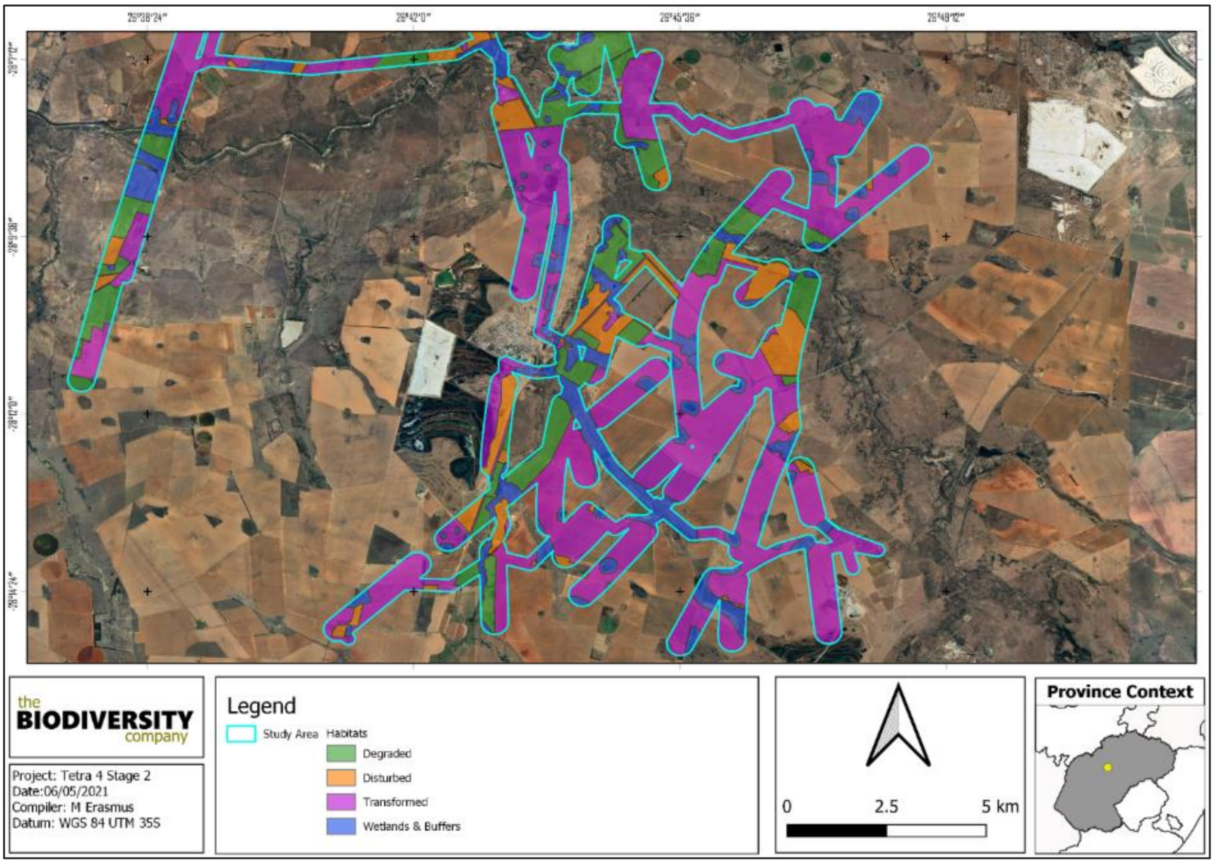


Figure 85: Habitats identified within the application area (southern section).

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.

10.11.10.2SITE ECOLOGICAL IMPORTANCE

The biodiversity theme sensitivity as indicated in the screening report (Appendix 4) 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 86 and Figure 87. All habitats within the assessment area of the proposed project were allocated a sensitivity category (Table 32). 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 33:

- 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 32: 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 33: 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.

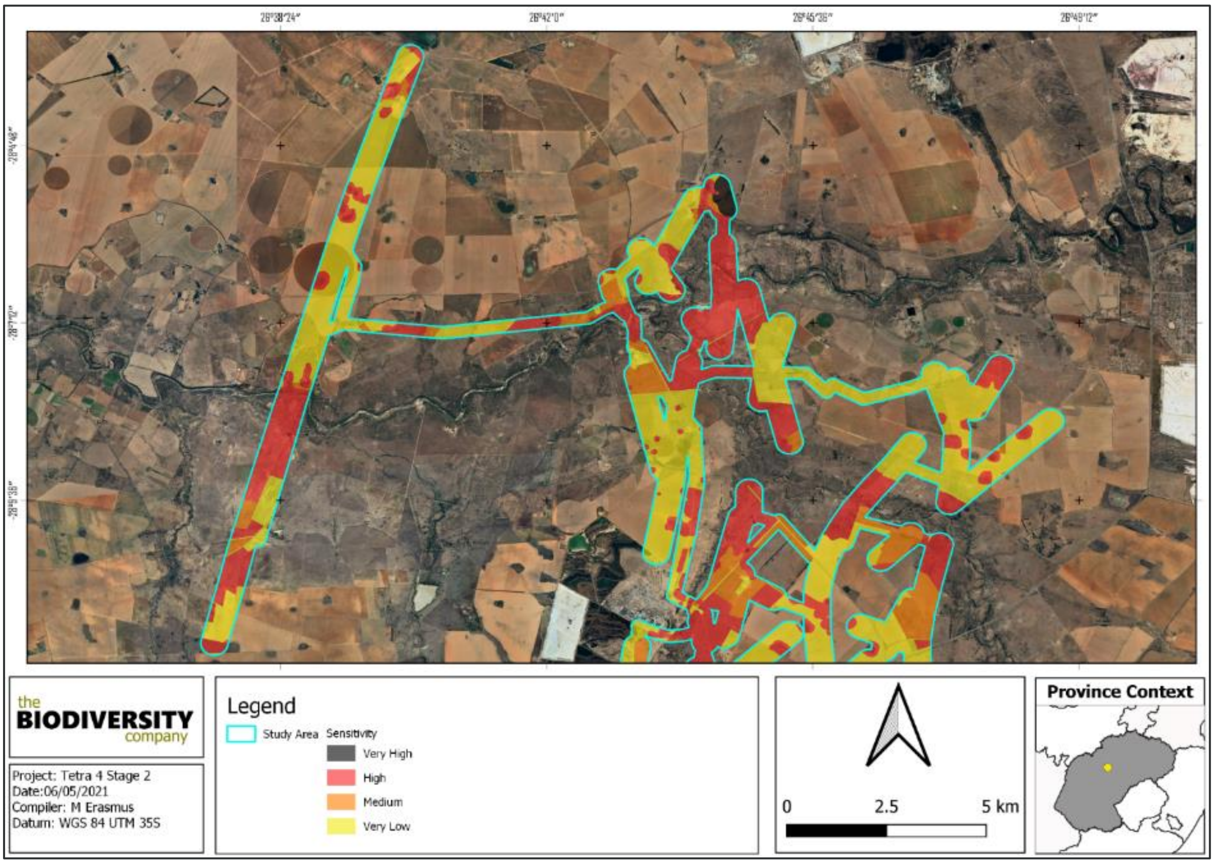


Figure 86: The study area superimposed over the sensitivities in the northern section of the study area.

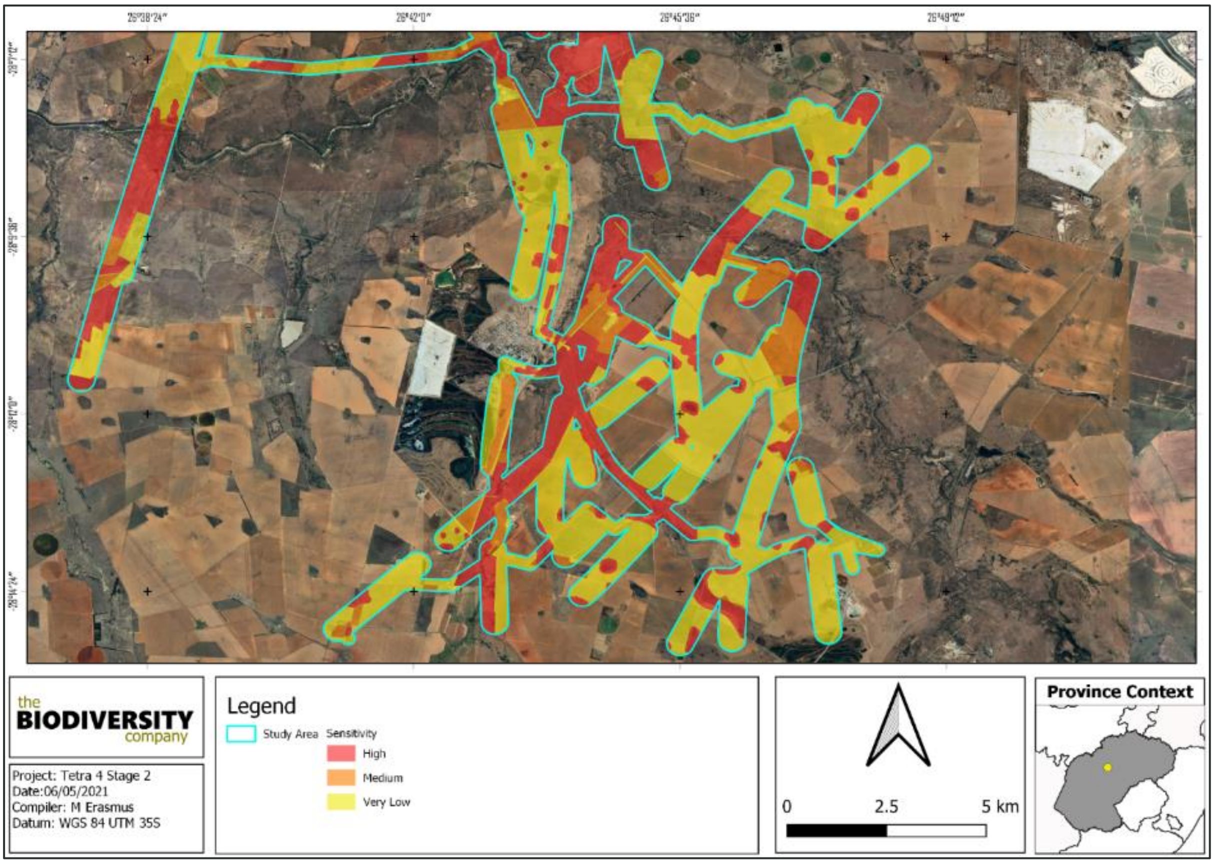


Figure 87: The study area superimposed over the sensitivities in the southern section of the study area.

10.12 AQUATIC AND WETLANDS

The aquatic and wetland environment are being assessed by The Biodiversity Company (TBC) and the specialist report will be included in the EIA phase. The baseline aquatic and wetland findings are presented in the subsections below.

10.12.1 WETLAND DELINEATION AND DESCRIPTION

During the site visit four different wetland types were delineated in accordance with the DWAF (2005) guidelines (Figure 88). 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.

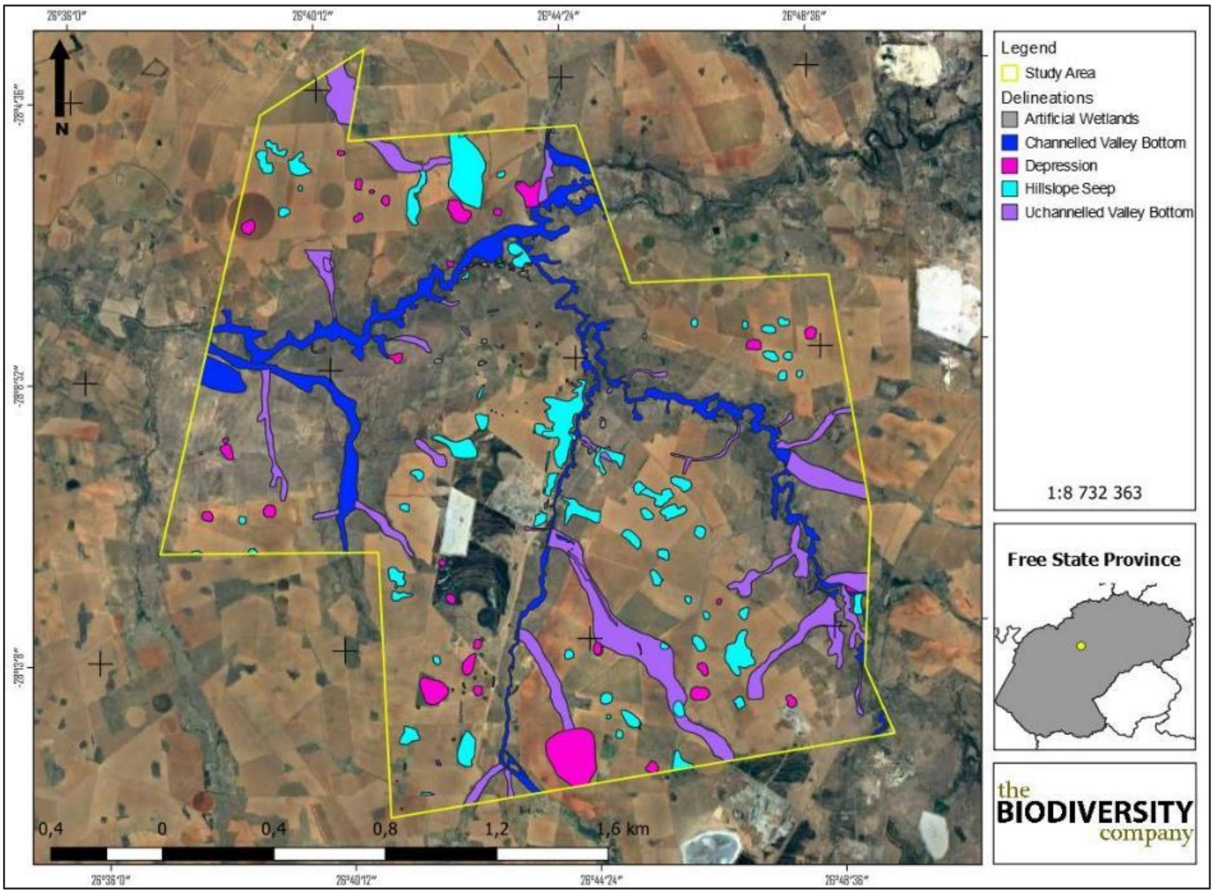


Figure 88: Delineation of wetlands within the study area.

10.12.2 ECOLOGICAL FUNCTIONAL ASSESSMENT

The average ecosystem services scores for the assessed wetlands are presented in Figure 89. 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.

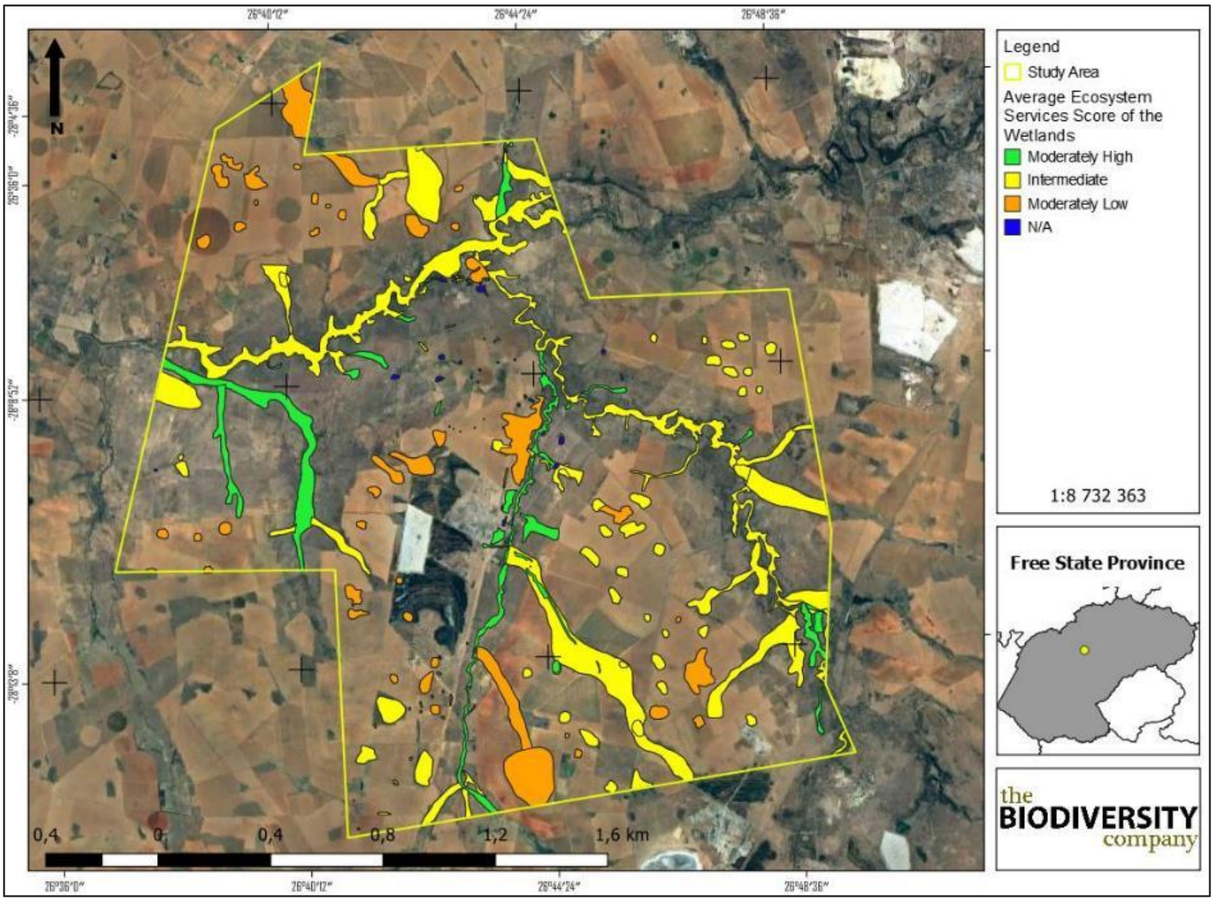


Figure 89: Average ecosystem service scores for the delineated wetland systems.

10.12.3 THE ECOLOGICAL HEALTH ASSESSMENT

The Present Ecological State (PES) for the assessed wetlands is presented in Figure 90. 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.

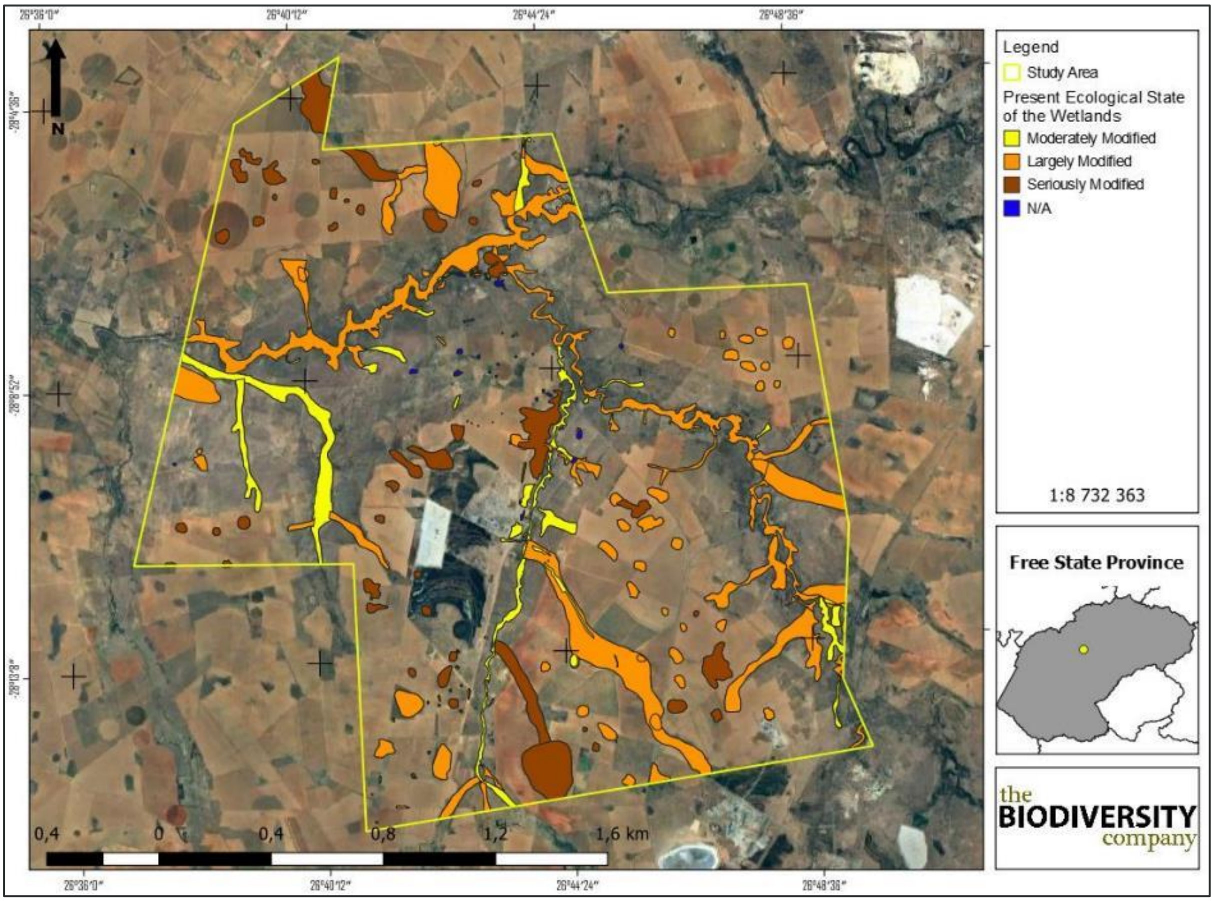


Figure 90: Overall present ecological state of delineated wetlands.

10.12.4 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 91).

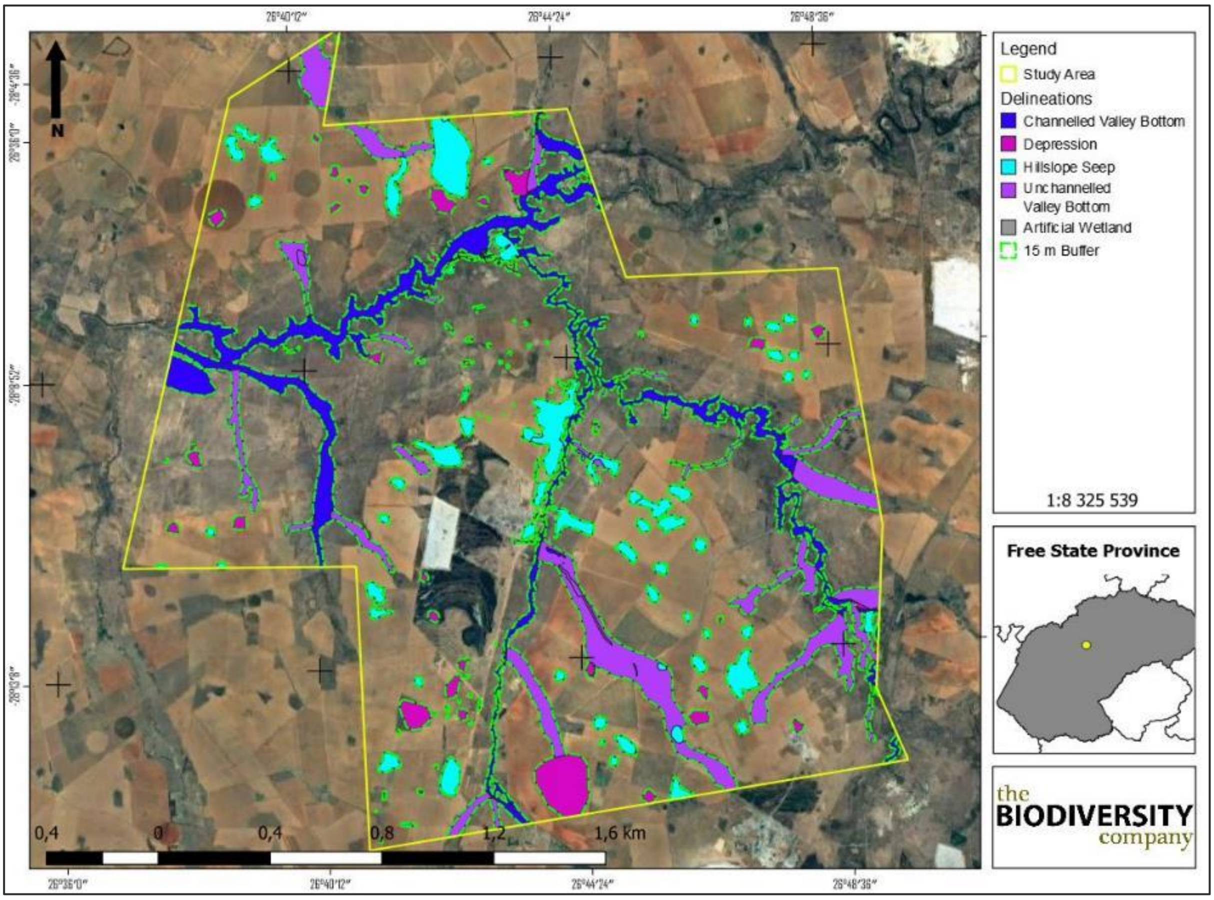


Figure 91: Extent of recommended buffer zones.

10.13 AIR QUALITY AND HEALTH

An air quality study is being undertaken by Airshed Planning Professionals and the specialist report will be included in the EIA phase. The baseline air quality findings are presented in the subsections below.

10.13.1 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 92, while the seasonal variations are shown in Figure 93.

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 92).

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 93).

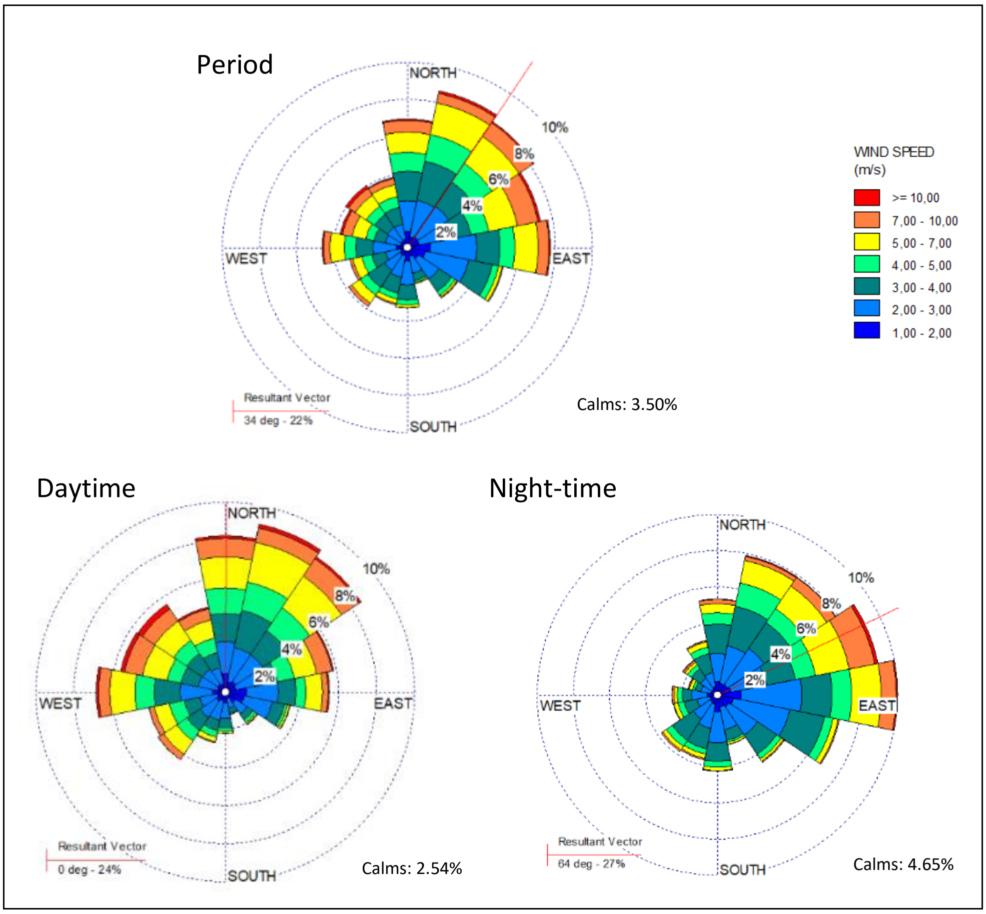
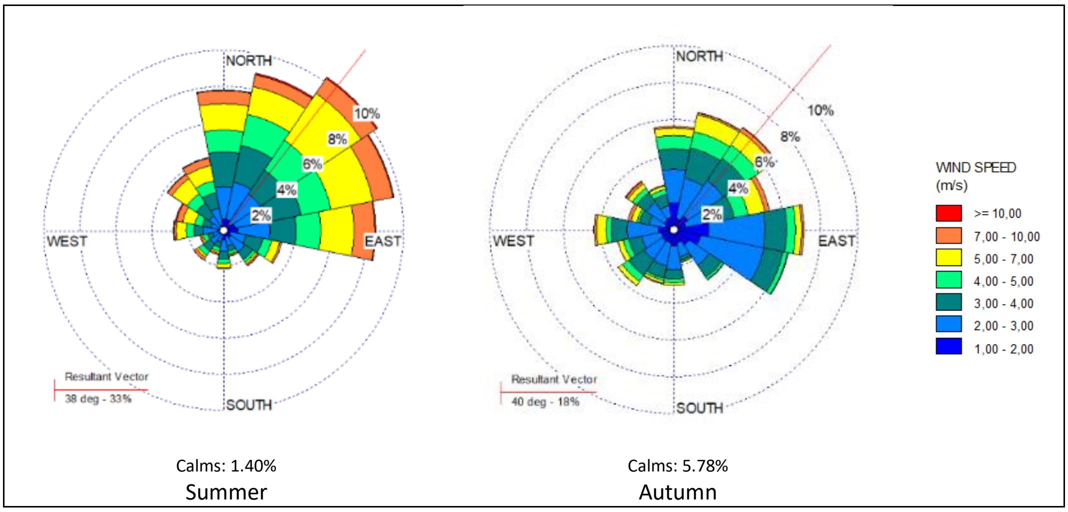


Figure 92: Period, day- and night-time wind roses (SAWS Welkom Data, 2019 to 2021).



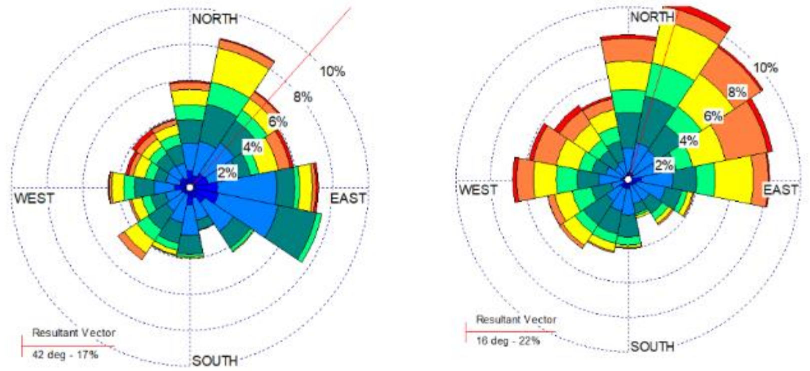


Figure 93: Seasonal wind roses (SAWS Welkom Data, 2019 to 2021).

10.13.2 AMBIENT AIR QUALITY WITHIN THE REGION

10.13.2.1 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.

10.13.2.1.1 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 (CH4), 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.

10.13.2.1.2 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.

10.13.2.1.3 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.

10.13.2.1.4 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.

10.13.2.1.5 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.

10.13.2.1.6 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.

10.13.2.1.7 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.

10.13.2.1.8 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.

10.13.2.2 **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 94, with the coordinates, elevation and site classification detailed in Table 34.

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 34: 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

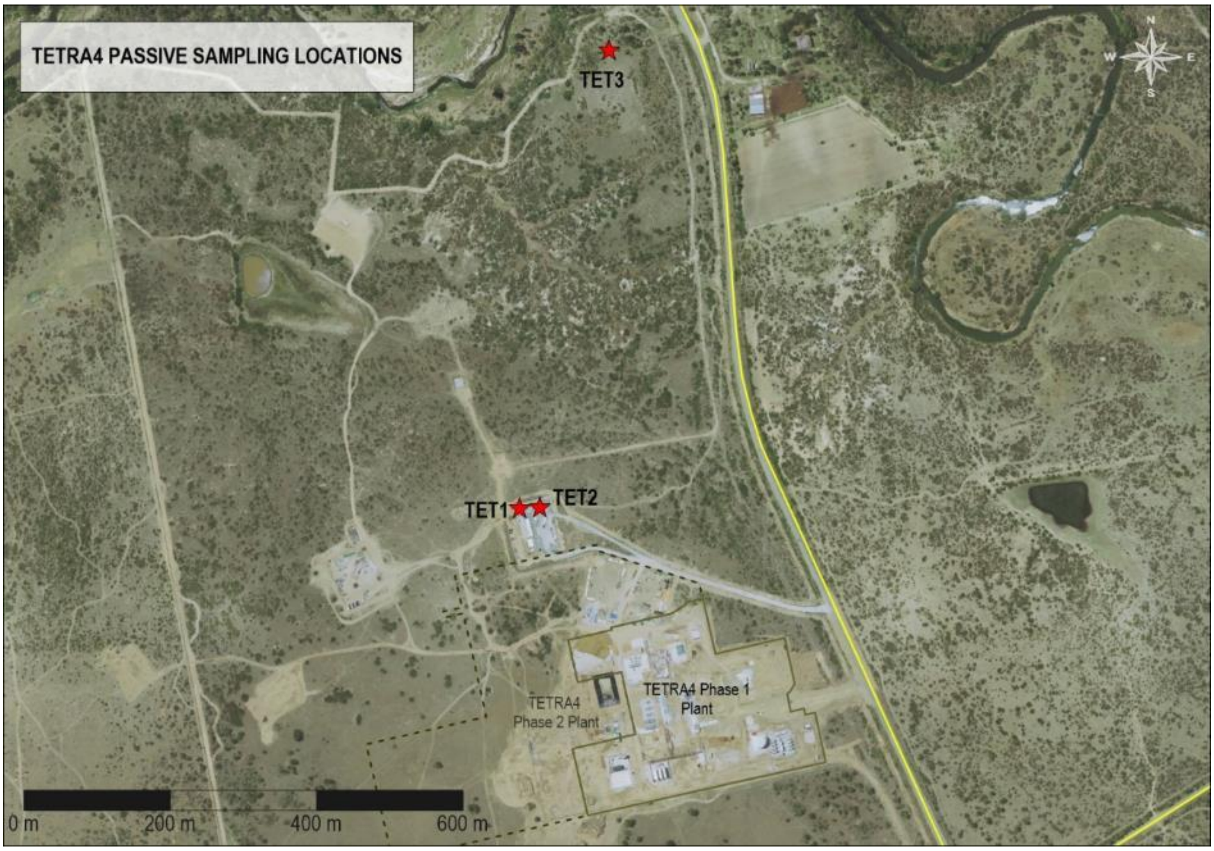


Figure 94: Tetra4 passive sampling locations.

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.

10.14 CLIMATE CHANGE

10.14.1 PHYSICAL RISKS OF CLIMATE CHANGE ON THE REGION

In 2017 the South African Weather Service (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 as a result of the model's physics and accuracy of input data; for this reason, an ensemble of models' projections is used to determine the potential change in near-surface temperatures and rainfall depicted in the CCRA. The projections are for 30-year periods described as the near future (2036 to 2065) and the far future (2066 to 2095). Projected changes are defined relative to a historical 30-year period (1976 to 2005). 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°.

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 CO2 concentration of 560 ppm and RCP8.5 on 950 ppm by 2100. RCP4.5 is based on the expectation that current interventions will reduce GHG emissions and that it will be sustained (after 2100 the concentration is expected to stabilise or even decrease). RCP8.5 is based on no interventions implemented to reduce GHG emissions (then after 2100 the concentration is expected to continue to increase).

10.14.1.1 **RCP4.5 TRAJECTORY**

Based on the median, for the region in which the proposed facility and communities are situated, the annual average near surface temperatures (2 m above ground) are expected to increase by between 1.5°C and 2.0°C for the near future and between 2.0°C and 2.5°C for the far future. The seasonal average temperatures are expected to increase for all seasons, in the same order as the annual average increases, with slightly larger temperature increases in autumn (March to May) and larger increases in spring (September to November). The total annual rainfall is expected to increase by between 5 mm and 10 mm for the near future and decrease by up to 20 mm in the far future. Seasonal rainfall is expected to increase in summer (December to February) up to 30mm in the near- and far future, while other seasons are likely to show decreases between 5 and 10 mm.

10.14.1.2 **RCP8.5 TRAJECTORY**

Based on the median, the region in which the proposed facility and communities are situated, the annual average near surface temperatures (2 m above ground) are expected to increase by between 2.0°C and 2.5°C for the near future and between 5.0°C and 5.5°C for the far future. The seasonal average temperatures are expected to increase for all seasons in similar ranges to the annual average temperature, with higher increases in spring, summer, and autumn. The total annual rainfall change is likely to increase by between 20 and 30 mm, while it is more uncertain for the far future with potential decrease up to 5 mm. Seasonal rainfall changes could see an increase of 5 mm in spring and summer in the near future with decreased up to 10 mm in autumn and winter. In the far future, the seasonal the rainfall changes are similar to the near future, except in summer where increased rainfall could be up to 50 mm.

10.14.2 WATER STRESS AND EXTREME EVENTS

South Africa is known to be a water stressed country (Kusangaya, Shekede, & Mbengo, 2017), but Welkom/Virginia falls within a low water- stress and depletion zone. It falls in a Low-Medium interannual variability but with a Medium-High seasonal variability, leading to a Medium-High drought risk. Climate change, through elevated temperatures, is likely to increase evaporation rates and decrease water volumes available for dryland and irrigated agriculture (Davis-Reddy & Vincent, 2017). Commercial agriculture (crop and livestock farming) is the predominant agricultural land-use in the vicinity of Welkom and Virginia.

Extreme weather events affecting southern Africa, including heat waves, flooding due to intensified rainfall due to large storms and drought, have been shown to increase in number since 1980 (Davis-Reddy & Vincent, 2017). Projections indicate (Davis-Reddy & Vincent, 2017):

- With high confidence, that heat wave and warm spell duration are likely to increase while cold extremes are likely to decrease, where up to 80 days above 35°C are projected by the end of the century under the RCP4.5 scenario;
- With medium confidence, that droughts are likely to intensify due to reduced rainfall and/or an increase in evapotranspiration; and
- With low confidence, that heavy rainfall events (more than 20 mm per 24 hours) will increase.

10.14.3 SCOPE 1 GHG EMISSION SOURCES

10.14.3.1 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 35.

Table 35: 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**

10.14.3.2 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 36.

Table 36: 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		

10.14.3.3 OPERATIONS

The main sources of GHG due to the proposed operations are the mobile (trucking) and stationary equipment (generators) (Table 37), and emissions from the gas processing and flaring (Table 38).

Table 37: 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 38: Tetra4 Cluster 2 gas processing during an operational year.

Gas processed	Volume (10^6 m^3)	Marketable gas product	Volume (10^6 m^3)	Product (tpd)	Density (kg/m3)
Gas processed [(a)]	436	Product (LNG & LHe)	215	470.26	0.8
Flaring (warm flare, intermittent) [(b)]	2.41				
Flaring (cold flare, intermittent) [(c)]	0.69				
Flaring (continuous design) [(d)]	0.20				

Notes: (a) Total production per day = 42.32 MMSCFD
(b) Flaring (warm flare, emergency) = 37048 kg/hr (assumed 1 hour of flaring once a week)
(c) Flaring (cold flare, emergency) = 10539 kg/hr (assumed 1 hour of flaring once a week)
(d) Flaring (continuous design) = 18 kg/hr (assumed 24-hours a day)

The South African CO_2eq emission factors (kg/tonne of fuel consumed) were used (DEA, 2017), with different emission factors for the fuel, and mobile and stationary sources.

10.14.3.4 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.

10.14.4 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 39.

Table 39: 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

10.14.5 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 40.

Table 40: Tetra4 Cluster 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, heavy construction, generators	5 100	6	554	5 660
Total Scope 2 Emission	Electricity bought from ESKOM	861			861
				Total emissions	**6 521**
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)**
Total Scope 1 Emission	Gas processing, transmission and storage, generators	8 405	30 496	13	38 914
Total Scope 2 Emission	Electricity bought from ESKOM	278 251			278 251
				Total emissions	**317 165**

10.14.6 THE PROJECT'S GHG EMISSIONS IMPACT

10.14.6.1 **IMPACT ON THE NATIONAL INVENTORY**

The operational phase of Tetra4 Cluster2 will likely result in an increase in Scope 1 & 2 emissions. The annual operational CO_2-e emissions from the Tetra4 Cluster2 operations would contribute approximately 0.062% to the South African "energy" sector total and represent a contribution of 0.077% to the National GHG inventory total, based on the published 2017 National GHG Inventory (DFFE, 2021). The annual CO_2-e emissions from the construction phase would contribute approximately 0.002% to the South African "energy" sector total and represent a contribution of 0.001% to the National GHG inventory total (DFFE, 2021).

10.14.6.2 **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).

10.14.6.3 **PHYSICAL RISKS OF CLIMATE CHANGE ON THE PROJECT'S CONSTRUCTION AND OPERATIONS**

10.14.6.3.1 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.

10.14.6.3.2 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.

10.14.6.4 **POTENTIAL EFFECT OF CLIMATE CHANGE ON THE COMMUNITY**

10.14.6.4.1 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.

10.14.6.4.2 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 event 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.

10.15 NOISE RECEPTORS

A specialist assessment of the noise environment within the study area is being undertaken by Airshed Planning Professionals and the specialist report will be included in the EIA phase. The baseline findings are presented in the subsections below.

10.15.1 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 95 include individual homesteads and industrial and residential areas (i.e., Virginia).

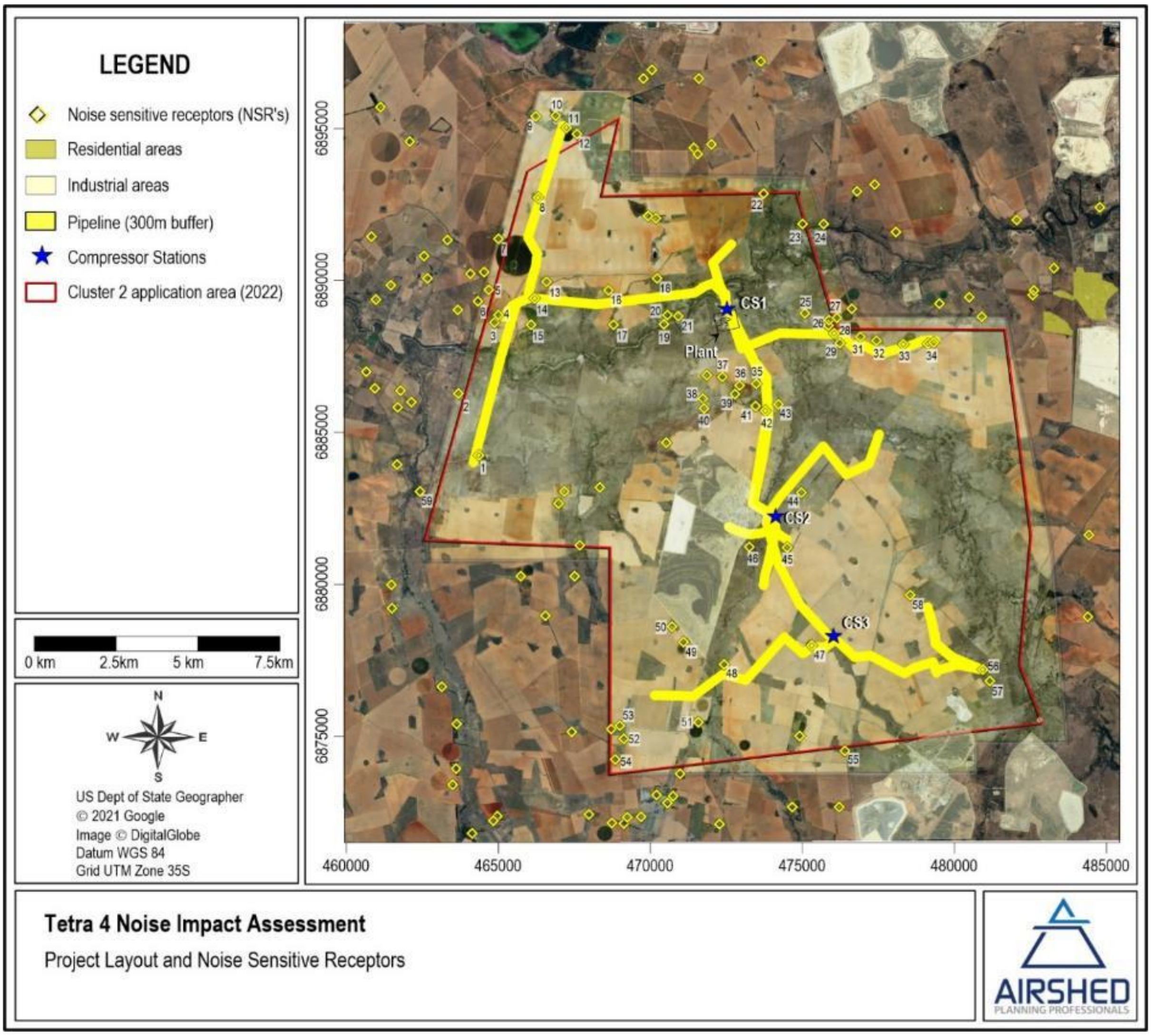


Figure 95: Sensitive noise receptors within the study area.

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.

10.15.2 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 41. 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 41: 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.

10.16 VISUAL RECEPTORS

Landscape and visual impacts are being assessed by Environmental Planning and Design and the specialist report will be included in the EIA phase. The baseline findings are presented in the subsections below.

10.16.1 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 96 and Figure 97.

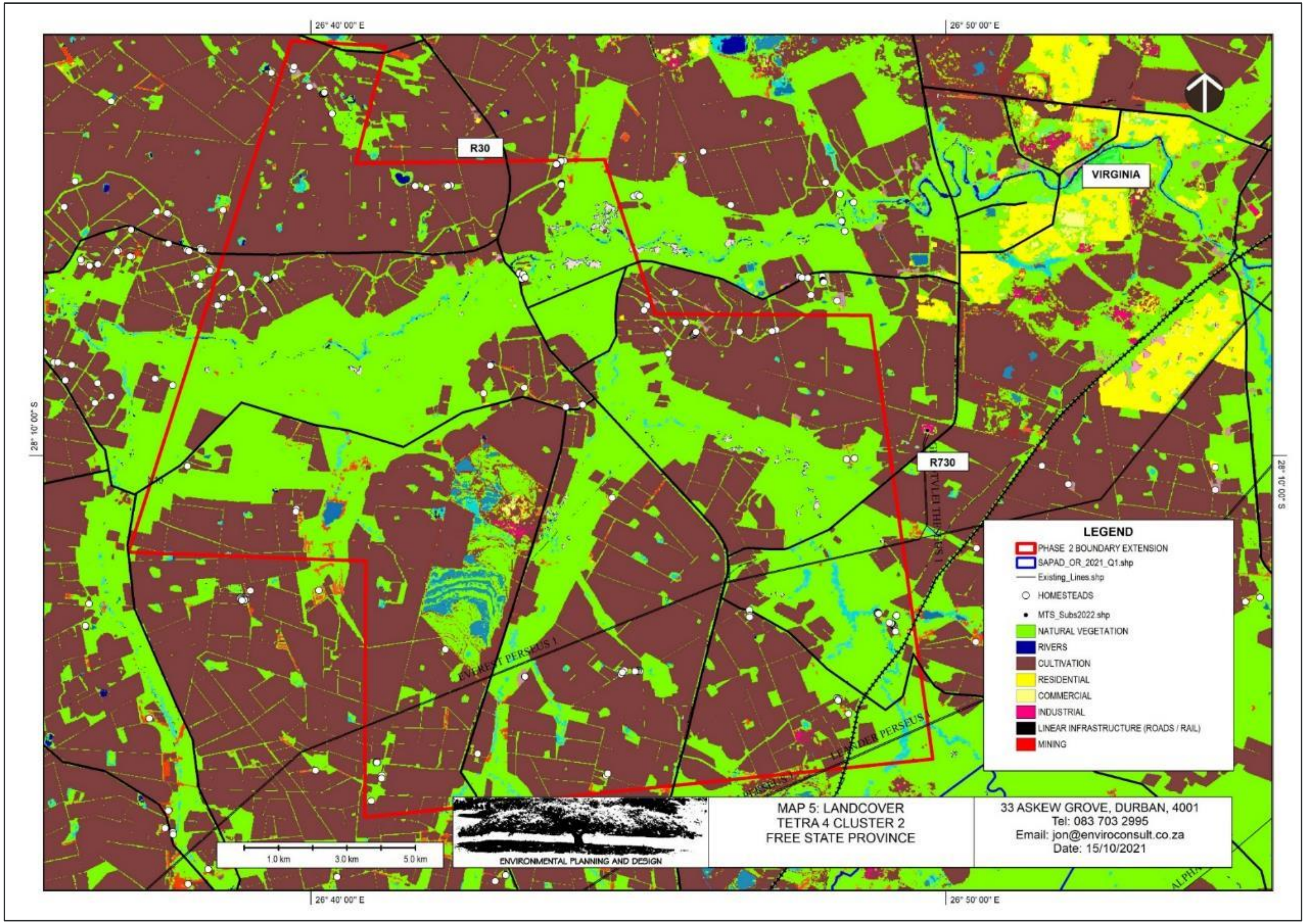


Figure 96: Landscape character areas and visual receptors.

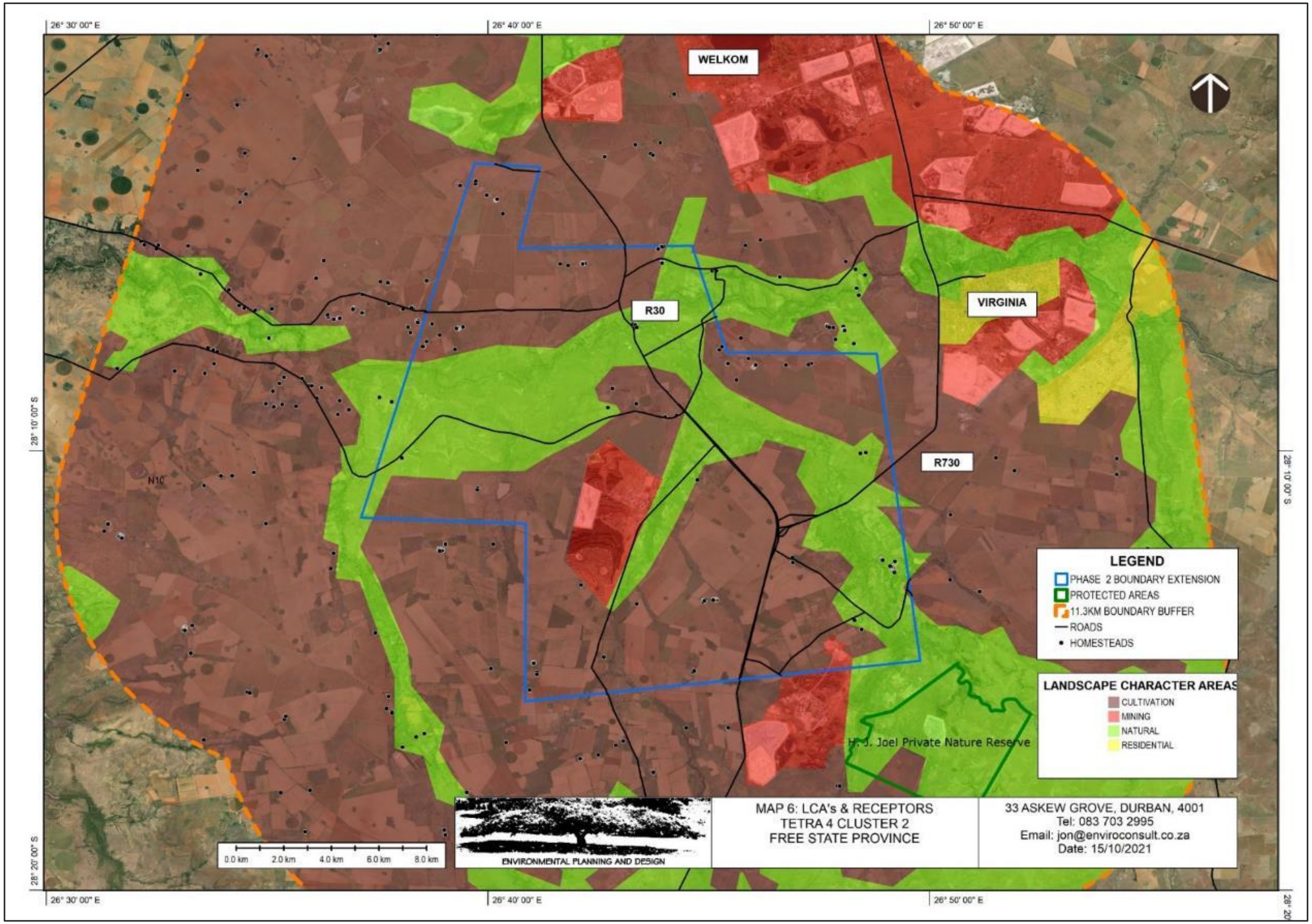


Figure 97: Visual receptors within and near the study area.

10.16.2 VISUAL SENSITIVITY

Site (Landscape) sensitivity (Figure 98) 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.

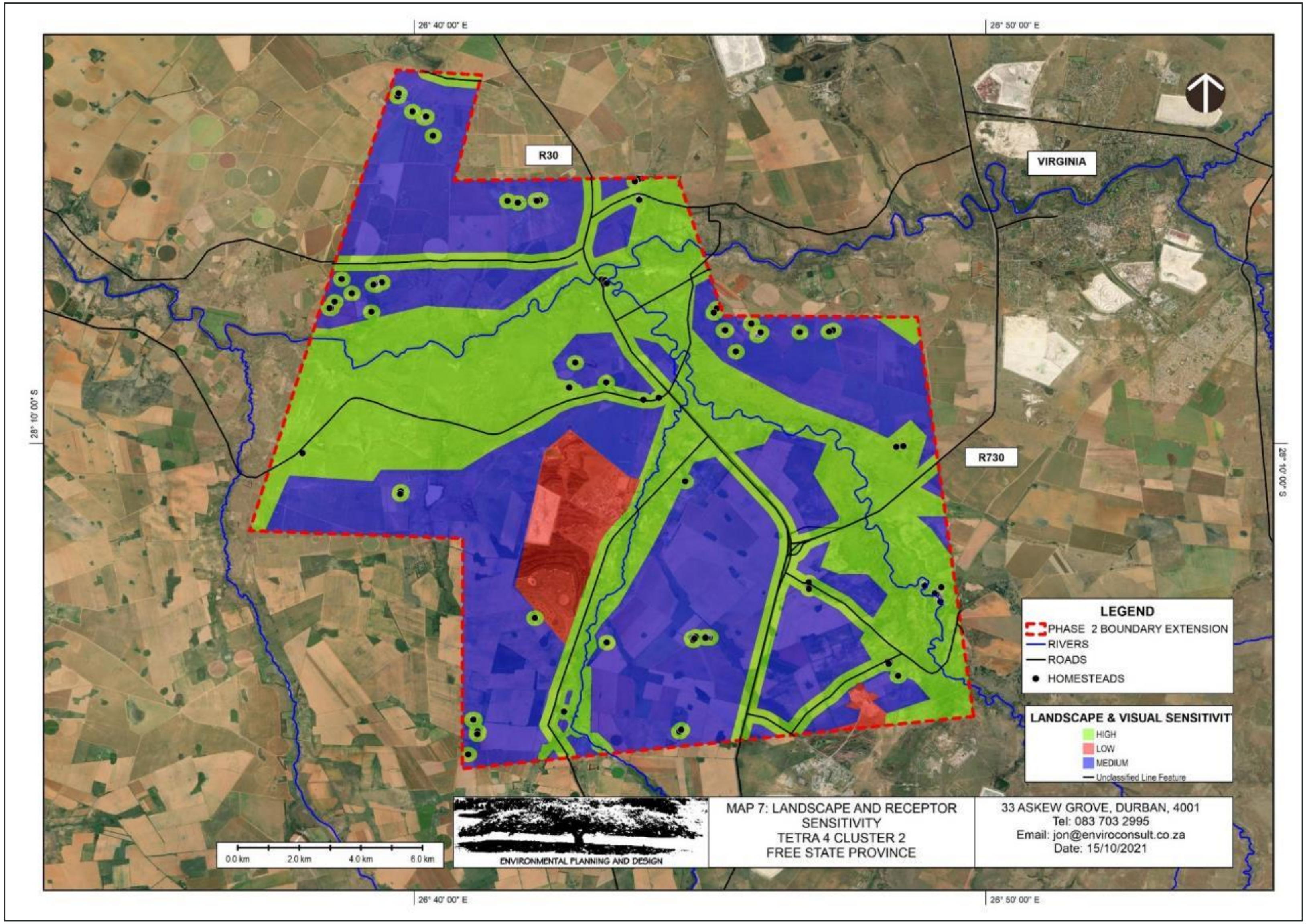


Figure 98: Landscape visual sensitivity rating for the study area.

11 ENVIRONMENTAL IMPACT ASSESSMENT

This section describes the impact assessment methodology, the impacts identified as well as the preliminary impact assessment during this scoping phase. Further impacts may be identified once public consultation on this report has been concluded and an updated impact assessment will be presented in the EIA phase.

11.1 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 will be applied to all identified alternatives. Where possible, mitigation measures will be recommended for impacts identified.

11.1.1 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:

$$\boldsymbol{C} = \frac{(\boldsymbol{E} + \boldsymbol{D} + \boldsymbol{M} + \boldsymbol{R}) * \boldsymbol{N}}{\boldsymbol{4}}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 42 below.

Table 42: 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)

Aspect	Score	Definition
	5	Permanent (>65 years, no mitigation measure of natural process will reduce the impact after construction)
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 43.

Table 43: 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 44: Determination of Environmental Risk.

Conseq	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 45.

Table 45: 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 will be 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.

11.1.2 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) will be 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 will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 46: 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 46. 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 47).

Table 47: 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 48: 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 will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

11.2 IDENTIFICATION AND PRELIMINARY 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 will be made available to I&AP's for review and comment with all comments and our responses included in the final Scoping report submitted to the PASA for adjudication. The results of the public consultation will be used to update the identified potential impacts which will be further refined during the course of the EIA assessment and consultation process. Potential environmental impacts were identified during the scoping process. These impacts were identified by the EAP, the appointed specialists, and will be updated once public input is received.

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 and both share the same infrastructure (wells, pipelines, stations, plant, etc), the current approved EMPr mitigation measures will be assessed for their adequacy in mitigating the Cluster 2 development. Any additional specific mitigation measures or required amendments to the current mitigation measures will be put forward in the EIA phase.**

Relevant preliminary cumulative impacts have been identified and will be updated during the detailed EIA level investigation. 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.

11.2.1 CONSTRUCTION PHASE IMPACTS

11.2.1.1 **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.

(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.

(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.

11.2.1.2 **CLIMATE CHANGE IMPACTS**

The significance of climate change impacts was based on Scope 1 and Scope 2 GHG emissions and assessed according to the NEMA impact assessment methodology. 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.

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 negative climate change impacts are considered to be of low significance without mitigation and low significance with mitigation.

(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.

Scope 1, 2 and 3 Climate Change Impact Assessment will be undertaken and presented in the EIA phase to address the Cluster 2 cumulative impacts of GHG contributions to climate change.

11.2.1.3 **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.

(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.

11.2.1.4 **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. Further assessments of the social impacts will be undertaken and presented in the EIA phase. A preliminary impact assessment of each of the below construction phase impacts has been undertaken and will be refined in the EIA phase.

- Impact on livelihoods
- 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
- Tetra4 must appoint an agricultural economist 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 activities will be affected negatively Tetra4 must enter 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. 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 daily 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.
- 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. 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 consider working with the preferred farmers' security group 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.
- 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 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 but where this may occur, mitigation measures shall be put forward to reduce this potential as far as possible.

11.2.1.5 **ECONOMIC IMPACTS**

The majority of the economic impacts of this project have been rated as positive at this preliminary impact assessment stage 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.

The following preliminary economic impacts during the construction phase have been identified at this stage:

- 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

- Close cooperation with the local, district and provincial economic development government spheres is strongly advised. The economic impact at optimal processing is likely to result in considerable infrastructure development needs. Thus, impacts on roads, servitudes and traffic patterns need to be addressed.
- An in-migration of jobseekers will be expected and Tetra4 needs to work closely with Government to ensure no further informal settlements proliferate.
- Much of the gas technology and equipment will likely be imported during the investment phases of the project. Tetra4 is encouraged to build local capacity if and where possible as this decreases imports, increase foreign reserves and employment.
- Provide local employment as far as possible.
- Tetra4 needs to negotiate with each individual farmer where there is clear evidence of land value losses (which losses could be a result of either productivity losses or general land value losses).

(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.

11.2.1.6 GROUNDWATER IMPACTS

The potential impacts on groundwater resources associated with the construction phase activities include the following:

- Erosion of site and siltation of surface water features due to vegetation clearance and stockpiling of unconsolidated and loose material.
- Surface and 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 and surface water quality.
- Mobilisation and maintenance of vehicle and machinery on-site may cause hydrocarbon contamination of surface water and groundwater resources.
- Poor storage and management of hazardous chemical substances on-site may cause surface water and groundwater pollution.

During the construction phase minimal impacts on the groundwater system are expected. The environmental significance rating of groundwater quantity impacts on down-gradient receptors are rated as moderately negative without implementation of remedial measures and low negative with implementation of proposed mitigation measures. Groundwater quality impacts from exploration footprints and related waste facilities are rated as moderately negative without implementation of remedial measures and low negative with implementation of mitigation measures.

(i) Mitigation measures

- A hydrocensus must be undertaken within a 500m radius around each future gas production target to confirm the presence of private boreholes that have not already been identified as part of the hydrocensus. All private boreholes inside this zone must be visited and inspected. The information gathered, must be used to plan for and implement groundwater management measures. A photo must be taken of each private borehole within the 500 m radius for future record.

- All on site vehicle and equipment maintenance must be undertaken within an area of secondary containment, such as a bund or over a drip tray, to prevent accidental soil contamination. Oil and diesel stored on site must be placed within a suitably sized bund. The dispensing of hydrocarbons must be undertaken with due care to prevent or contain spills.
- All waste generated must be contained and stored in suitably sealed, bunded and protected areas to avoid spills and leaks. Waste must be collected and disposed of offsite in a responsible manner so as to prevent groundwater contamination off site.
- The current groundwater monitoring programme must be extended to include the hydrocensus boreholes that may be affected during the Cluster 2 gas production operation and must include any third-party boreholes within 500m from exploration drill sites. Should the results of the monitoring programme indicate a negative impact on private groundwater users as a result of Tetra4's activities, alternative arrangements must be negotiated with the affected parties.
- Exploration and production wells must be sealed and cased to prevent interplay between deeper saline aquifers and shallower freshwater aquifers as well as to prevent interplay between gas resources and freshwater aquifers. This will require a minimum of ~300m deep casing from surface.

(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.

11.2.1.7 **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.

(i) 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).

(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.

11.2.1.8 **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 preliminary 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

- 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.

- 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 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.
- 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.

11.2.1.9 **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. These impacts will be assessed and discussed in more detail in the EIA phase.

Three levels of risk have been identified and determined for the preliminary 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.

11.2.1.10 **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 preliminary 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.

11.2.1.11 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 determining prioritisation, public response, cumulative effects and the possible irreplaceable loss of resources have to be considered. As consultation has not been undertaken it is impossible to confirm public response, however, given the extent of mining in the vicinity and the fact that landscape is not protected and not of high quality, it seems unlikely that the issue will be raised as a significant concern.

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.
- Remove all above ground construction phase infrastructure.
- Return land to pre-construction use.
- Minimise disturbance of the natural landscape.
- Undertake rehabilitation and screen planting where possible.
- Locate wells and compressor stations a minimum 250m from the edge of local roads.

(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.

11.2.2 OPERATIONAL PHASE IMPACTS

11.2.2.1 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 PM10 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 PM2.5 and NO2 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.

(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.

In addition to the air quality and health impacts presented above, a Scope 1, 2 and 3 Climate Change Impact Assessment will be undertaken and presented in the EIA phase to address the Cluster 2 cumulative impacts of GHG contributions to climate change.

11.2.2.2 CLIMATE CHANGE IMPACTS

The significance of climate change impacts was based on Scope 1 and Scope 2 GHG emissions and assessed according to the NEMA impact assessment methodology. 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.

Vehicle and trucks, natural gas generators, and the processing and flaring of gas, could result in medium significance on climate change and could reduce, although still medium significance with mitigation and adaptation measures in place.

The major GHG impact is likely to be associated with the downstream use of the LNG i.e. Scope 3 which will be quantified and presented in the EIAR. Gas, however, is considered a 'transition' fuel on the decarbonising roadmap and GHG emissions per unit of gas combusted is less than per unit coal. Also, the 'extractive' GHG cost (Scope 1 & 2 for Construction and Operations) is offset by the benefit of helium (a rare resource) and LNG co-extraction.

(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.

Scope 1, 2 and 3 Climate Change Impact Assessment will be undertaken and presented in the EIA phase to address the Cluster 2 cumulative impacts of GHG contributions to climate change.

11.2.2.2.1 ALTERNATIVE SIGNIFICANCE RATING

Other literature (Murphy & Gillam, 2013) suggests use of thresholds (Table 49) 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 49: 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 49, 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.

11.2.2.3 **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.

(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

11.2.2.4 **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. Further assessments of the social impacts will be undertaken and presented in the EIA phase. A preliminary impact assessment of each of the below operational phase impacts has been undertaken and will be refined in the EIA phase.

- 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
- Tetra4 must appoint an agricultural economist 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 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. 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.
- 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. 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. 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 consider working with the preferred farmers' security group 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.
- 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 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 but where this may occur, mitigation measures shall be put forward to reduce this potential as far as possible.

11.2.2.5 **ECONOMIC IMPACTS**

The majority of the economic impacts of this project have been rated as positive at this preliminary impact assessment stage 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.

The following preliminary economic impacts during the construction phase have been identified at this stage:

- 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

- Close cooperation with the local, district and provincial economic development government spheres is strongly advised. The economic impact at optimal processing is likely to result in considerable infrastructure development needs. Thus, impacts on roads, servitudes and traffic patterns need to be addressed.
- An in-migration of jobseekers will be expected and Tetra4 needs to work closely with Government to ensure no further informal settlements proliferate.
- Much of the gas technology and equipment will likely be imported during the investment phases of the project. Tetra4 is encouraged to build local capacity if and where possible as this decreases imports, increase foreign reserves and employment.
- Provide local employment as far as possible.

- Tetra4 needs to negotiate with each individual farmer where there is clear evidence of land value losses (which losses could be a result of either productivity losses or general land value losses).

(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.

11.2.2.6 **GROUNDWATER IMPACTS**

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 gas from the deep, fractured aquifer to the overlying, shallow freshwater aquifer(s) during the gas production phase.
- Surface and groundwater pollution as a result of wastewater spills and seepage from the evaporation dam.
- Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater and surface water quality.
- Mobilisation and maintenance of vehicle and machinery on-site may cause hydrocarbon contamination of surface water and groundwater resources.
- Poor storage and management of hazardous chemical substances on-site may cause surface water and groundwater pollution.
- Leakage of harmful substances from tanks, pipelines or other equipment.
- Surface and groundwater deterioration and siltation due to contaminated stormwater run-off from the plant footprint area.

During the operational phase the environmental significance rating of groundwater quantity impacts on down-gradient receptors are rated as moderate to high negative without implementation of remedial measure and moderate to low negative with implementation of proposed mitigation measures. Groundwater quality impacts from production wells are rated as moderately negative without implementation of remedial measures and medium to low negative with implementation of mitigation measures.

(i) Mitigation measures

- All on site vehicle and equipment maintenance must be undertaken within an area of secondary containment, such as a bund or over a drip tray, to prevent accidental soil contamination. Oil and diesel stored on site must be placed within a suitably sized bund. The dispensing of hydrocarbons must be undertaken with due care to prevent or contain spills.
- All waste generated must be contained and stored in suitably sealed, bunded and protected areas to avoid spills and leaks. Waste must be collected and disposed of offsite in a responsible manner so as to prevent groundwater contamination off site.
- The groundwater monitoring programme must continue throughout the operational phase. Should the results of the monitoring programme indicate a negative impact on private groundwater users as a result of Tetra4's activities, alternative arrangements must be negotiated with the affected parties.

(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.

11.2.2.7 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 preliminary 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

- Control alien plants.
- 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.

11.2.2.8 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. These impacts will be assessed and discussed in more detail in the EIA phase.

Three levels of risk have been identified and determined for the preliminary 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.

11.2.2.9 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 preliminary 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.

11.2.2.10 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 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 determining prioritisation, public response, cumulative effects and the possible irreplaceable loss of resources must be considered. As consultation has not been undertaken it is impossible to confirm public response, however, given the extent of mining in the vicinity and the fact that landscape is not protected and not of high quality, it seems unlikely that the issue will be raised as a significant concern.

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

- Undertake screen planting between the R30 and the proposed production plant if 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.

11.2.3 DECOMMISSIONING REHABILITATION AND CLOSURE PHASE IMPACTS

11.2.3.1 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.

(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.

In addition to the air quality and health impacts presented above, a Scope 1, 2 and 3 Climate Change Impact Assessment will be undertaken and presented in the EIA phase to address the Cluster 2 cumulative impacts of GHG contributions to climate change.

11.2.3.2 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. 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.

11.2.3.3 **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.

11.2.3.4 **ECONOMIC IMPACTS**

Most of the economic impacts of this project have been rated as positive at this preliminary impact assessment stage 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.

The following preliminary economic impacts during the construction phase have been identified at this stage:

- 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

- Downscaling needs to be meticulously planned and the downscaling section of the SLP needs to be thoroughly considered.

- Tetra4 is encouraged to provide wealth planning education to its direct employees, direct suppliers' employees and contractors as inadequate pension provisions could result in the reduction in the quality of life and economic standards in affected areas.

(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.

11.2.3.5 **GROUNDWATER IMPACTS**

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, shallow freshwater aquifer(s) during the borehole closure and decommissioning phase.
- Migration of stray gas from the deep, fractured aquifer to the overlying, shallow freshwater aquifer(s) borehole closure and decommissioning phase.
- Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater and surface water quality.
- Mobilisation and maintenance of vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of surface water and groundwater resources.

During the post-closure phase, the groundwater quality impacts from production wells are rated as moderate to high negative without implementation of remedial measure and moderate to low negative with implementation of mitigation measures.

(i) Mitigation measures

- Well abandonment and plugging to comply with international best practice requirements.
- Tetra4 will implement well specific plugging requirements protect the shallow potable Karoo aquifers at closure. Well design will be done by a qualified reservoir engineer who will take corrosion, pressures, temperatures, exposure times, production life and well rehabilitation into consideration. The cement seals will be pumped as a water cement slurry down the casing to the bottom of the well, leaving a sheath of cement to set and harden.
- Upon completion of the rehabilitation of the well, a surface casing vent flow test should be considered to determine whether gas or liquid or a combination thereof is escaping from the casing. If gas is detected during this test, additional seals should be designed and implemented.
- A groundwater and gas monitoring programme will be implemented near each decommissioned well to serve as an early detection mechanism.

(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.

11.2.3.6 **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 preliminary 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.

11.2.3.7 **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. These impacts will be assessed and discussed in more detail in the EIA phase.

Three levels of risk have been identified and determined for the preliminary 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.

11.2.3.8 **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 preliminary 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.

11.2.3.9 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 determining prioritisation, public response, cumulative effects and the possible irreplaceable loss of resources must be considered. As consultation has not been undertaken it is impossible to confirm public response, however, given the extent of mining in the vicinity and the fact that landscape is not protected and not of high quality, it seems unlikely that the issue will be raised as a significant concern.

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.

(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.

11.2.4 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).

11.3 SUMMARY OF PRELIMINARY IMPACT ASSESSMENT

A summary of all the identified preliminary impacts, their associated phases, as well as their impact calculations and significance are presented in Table 50 below. This preliminary impact assessment is subject to change once additional information from specialists, or I&APs becomes available. The updated or final impact assessment will be presented in the EIA phase.

Table 50: Preliminary Scoping 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

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
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
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

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
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 from the construction area.	Alternative 1	Construction	-1	2	2	2	2	2	-4	-1	2	2	1	2	1	-1.8	Medium	1	1	-2
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	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
		overlying, potable aquifer(s) during the gas production phase.																				
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
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	Alternative 1	Operation	-1	3	5	4	4	3	-12	-1	2	5	4	4	2	-7.5	Medium	2	2	-9

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
		substances on-site may cause groundwater pollution.																				
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 aquifer(s) during the 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
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

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
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
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

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
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 & Palaeo	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 & Palaeo	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 & Palaeo	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 & Palaeo	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 & Palaeo	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
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

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
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 associated with gas production	Alternative 1	Operation	-1	3	3	4	2	4	-12	-1	3	2	2	2	3	-6.8	Medium	1	1	-7
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

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
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	2	4	2	2	4	-10	-1	2	4	1	2	4	-9	Medium	2	1	-10
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	2	4	3	2	4	-11	-1	2	4	1	2	3	-6.8	Medium	2	1	-8
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	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
		activities leaching into the surrounding environment																				
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)	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
		due to ongoing habitat degradation/loss (infringement, litter, road mortalities and/or poaching).																				
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

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
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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
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

IMPACT DESCRIPTION					Pre-Mitigation							Post Mitigation								Priority Factor Criteria		
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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
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

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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
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

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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
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

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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
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

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
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
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

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
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

12 SENSITIVITY MAPPING

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 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.

This sensitivity mapping approach allows for the identification of lower risk areas for positioning the project infrastructure whilst protecting identified sensitive environmental areas/ features. Furthermore, environmental sensitivity is used to aid in decision-making during consultation processes, forming a strategic part of environmental assessment processes. Refer to Figure 99 for the preliminary scoping combined sensitivity/ composite map. The compilation of this map has taken into consideration the various baseline specialist studies undertaken for the application area. Most of the application area consists of low to medium sensitive areas while the Beatrix tailings storage facility has been designated as a no-go area due to the limitations of any development on that land. This sensitivity map will be updated during the course of the EIA phase once the specialist studies have been completed. Any relevant feedback from the public participation process will also be considered in the EIA phase update. Additionally, during the EIA phase, a detailed assessment will be undertaken for a risk-based approach for future requirements where pipelines may need to connect wells to the main gas transmission grid and these pipelines fall outside of the 300 m transects assessed in detail in this study. This risk-based approach will be defined in more detail in the EIA phase however the basis for this approach would be:

- 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 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.

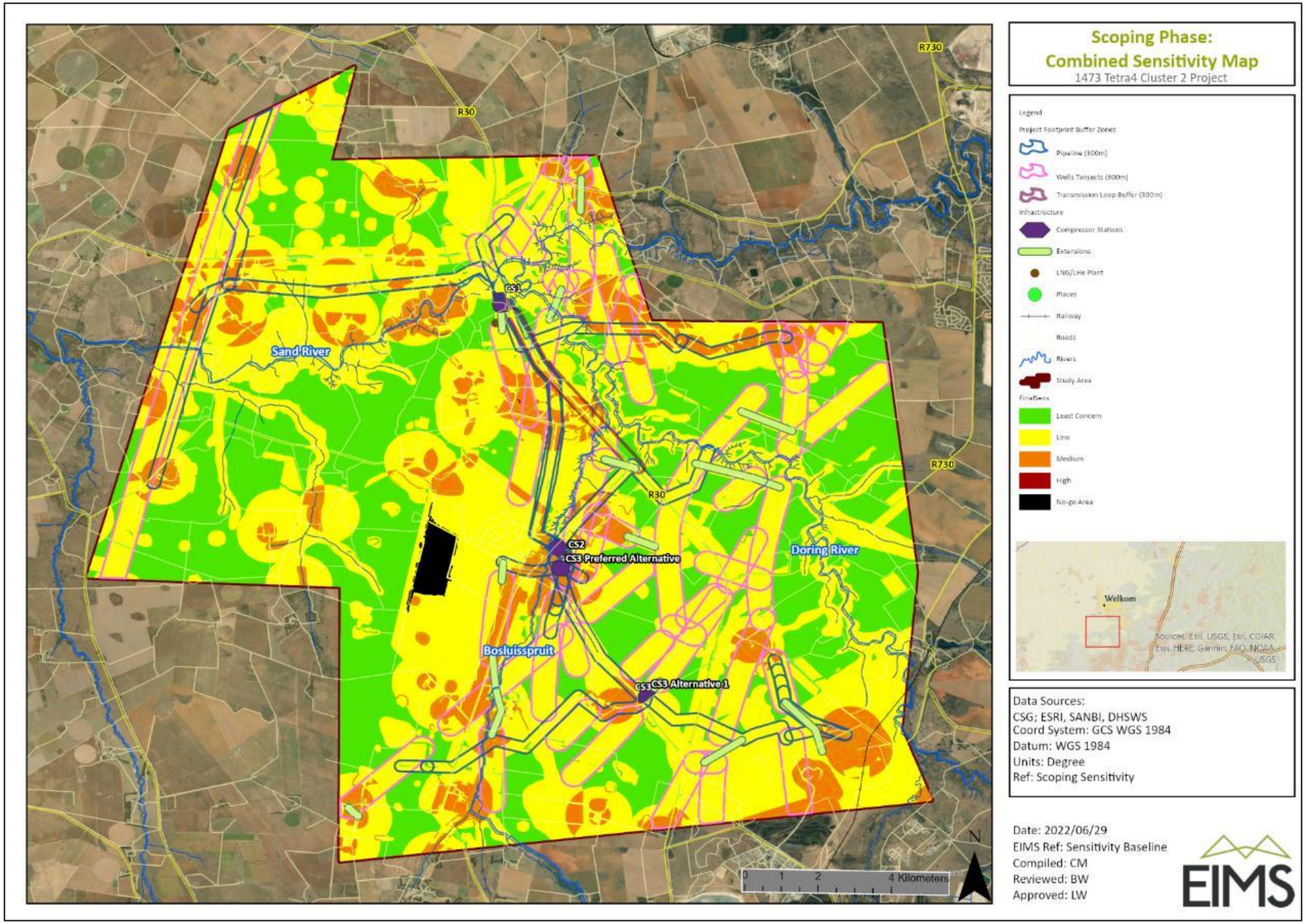


Figure 99: Scoping level sensitivity map.

13 PLAN OF STUDY FOR ENVIRONMENTAL IMPACT ASSESSMENT

The section below outlines the proposed plan of study which will be conducted for the various environmental aspects during the EIA Phase. It is also important to note that the plan of study will also be guided by comment obtained from I&AP's and other stakeholders during the PPP.

13.1 DESCRIPTION OF ALTERNATIVES TO BE CONSIDERED IN EIA PHASE

The alternatives that have been considered are discussed in Section 8 of this Scoping Report with a summary of the alternative assessment presented in Section 8.8. The feasible development alternatives to be further assessed in the EIA phase are presented below.

13.1.1 LOCATION ALTERNATIVES

Two location alternatives have been identified for Compressor Station 3 as follows:

1. **CS3_L1** (on farm Doorn River 330 Portion 2) is positioned within the southern gas pipeline network to balance the system without expensive reinforced pipeline network however poses a high risk of no electricity supply.
2. **CS3_L2** (on farm Palmietkuil 328 Portion 6) has confirmed electricity supply as the existing Cluster 1 CSA is already connected to the Eskom grid in this location however this CS3 location require a more costly pipeline design in the southern gas pipeline network.

Both of the above CS3 locations will be assessed as separate alternatives in the EIA phase.

13.1.2 LAYOUT ALTERNATIVES

A final sensitivity mapping exercise will be undertaken of the well and pipeline transects during the EIA phase and any unacceptably high-risk areas will be delineated as no-go areas.

13.2 DESCRIPTION OF THE ASPECTS TO BE ASSESSED AS PART OF THE EIA PROCESS

The following aspects will be assessed further during the EIA phase investigation to be undertaken:

- Air Quality and Health Impacts;
- Climate Change and GHG;
- Closure and Rehabilitation (including updated financial provisions);
- Cultural and Heritage Resources;
- Economic Impacts;
- Groundwater Quality;
- Noise Impacts;
- Seismicity (high level specialist opinion);
- Social Impacts;
- Soil Impacts;
- Surface Water Quality;
- Terrestrial and Aquatic Ecology; and
- Visual Impacts.

13.3 ASPECTS TO BE ASSESSED BY SPECIALISTS

Table 51 below details the various aspects of the project to be addressed in the EIA phase through detailed specialist studies.

Table 51: Details of specialists input during the EIA phase.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
Air Quality, Health Risk Climate Change (Scope 1, 2 and 3) and AEL amendment	Airshed Planning Professionals	Dr Hanlie Liebenberg-Enslin	**Air Quality and Health Impact Assessment:** • The compilation of an emissions inventory including the identification and quantification of all emissions associated with the construction and operational phases of the project. • Atmospheric dispersion simulations of all gaseous pollutants, PM10, PM2.5 and dust fallout for the operations reflecting highest hourly, highest daily and annual average concentrations and total daily dust deposition due to routine and upset emissions from the operations. The US EPA approved AERMOD model will be used. • Compliance and impact assessment by comparing ambient pollutant concentration levels to the relevant air quality requirements. • The identification of air quality management and mitigation measures based on the findings of the compliance and impact assessment. **Green House Gas (GHG) emissions and Climate Change Assessment** • Identification of the Transitional and Physical Risks associated with the project (as per the Task Force on Climate-related Financial Disclosures). • GHG emissions during the construction and operation of the project covering scope 1, scope 2 and scope 3 emissions. • Compared GHG emissions to the global and national emission inventories; and to international benchmarks for the project. • The robustness of the project in terms of forecasted climate change impacts to the area over the lifetime of the project. • The vulnerability of communities in the immediate vicinity of the project to climate change. • Comparative assessment of displacement of other fossil fuels with LNG. • Proposed management and mitigation strategies. **Variation of the provision AEL:**

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			• The following tasks are included in the AEL scope of work: • Section 1 – Reason for Application • Section 4 – Nature of the Process • Section 5 – Raw Materials and Products (including emissions data) • Submit the AEL application online at the South African Atmospheric Emissions Licence Portal (SAAELIP).
Noise	Airshed Planning Professionals	Renee von Gruenewaldt	• Noise emissions from the project's operations will be estimated. The propagation of noise from the proposed project operations will be calculated according to SANS 10357:2004, 'The calculation of sound propagation by the Concawe method'. The Concawe method makes use of the International Organisation for Standardization's (ISO) air absorption parameters and equations for noise attenuation as well as the factors for barriers and ground effects. In addition to the ISO method, the Concawe method facilitates the calculation of sound propagation under a variety of meteorological conditions. Data representative of conditions in the study area and obtained from the air quality study will be applied in the calculations. • Noise impacts will be calculated both in terms of total ambient noise levels as a result of the project as well as the effective change in ambient noise levels. Impacts will be calculated and assessed according to local and international guidelines (i.e. International Finance Corporation (IFC)). • The findings of the noise assessment will inform recommendations of noise management measures, including mitigation and monitoring.
Groundwater	Gradient Groundwater Consulting	Ferdinand Mostert	The planned scope of work (SoW) will be based on a phased approach and is set out below: I. Baseline characterisation and screening phase to identify potential impacts: The client will provide preliminary (but not definitive) well locations and pipeline routes. At screening level, a detailed baseline map of the study area as well as a sensitivity map will be compiled. A list of impacts per phase and per activity will be identified in this phase. II. A detailed assessment phase confirming associated impacts: The proposed activities and associated impacts will be assessed per zone/area and relevant management and

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			mitigation measures presented. A specialist impact assessment report will be prepared in compliance with the legislative requirements. The specialist will review the existing EMPR held by the client and provide additional (if necessary) management and mitigation actions specific to the extension areas. **Phase A: Desk study and gap analysis** Phase A will entail the following activities: • Information gathering and data acquisition. • Desk study and review of historical groundwater baseline information, existing specialist reports as well as DWS supported groundwater databases i.e. national groundwater archive (NGA). • Fatal flaw and gap analysis. **Phase B: Hydrogeological baseline assessment - hydrocensus user survey, hydrochemical analysis and aquifer classification** Phase B will entail the following activities: • Hydrocensus user survey to evaluate and verify existing surface and groundwater uses, local and neighbouring borehole locations and depths, spring localities and seepage zones, regional water levels, abstraction volumes, groundwater application as well as environmental receptors in the vicinity of the proposed gas exploration area. • Sampling of existing boreholes and surface water bodies according to best practise guidelines and analyses of fifty (50) water samples to determine the macro and micro inorganic chemistry and hydraulic connections based on hydrochemistry (analyses at SANAS accredited laboratory). • Assess the structural geology and geometry of the aquifer systems with respect to hydraulic interactions and compartmentalisation. • Data interpretation aiding in aquifer classification, delineation and vulnerability ratings. Development of a scientifically defendable hydrogeological baseline. • Compilation of geological, hydrogeological and hydrochemical thematic maps summarising the aquifer system(s), indicating aquifer delineation, groundwater

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			piezometric map, depth to groundwater, groundwater flow directions as well as regional geology. **Phase C: Development of a numerical groundwater flow and mass transport model** Phase C will entail the following activities: • Development of a conceptual hydrogeological model in conjunction with interpreted geology data and gathered site characterisation information. • Development of a regional numerical groundwater flow model by applying the Finite Element Flow (FEFLOW) modelling software. Model domain to include proposed infrastructure and gas exploration footprint as well as associated activities. • Calibration of groundwater flow model using site specific data including hydrocensus geosites information. • Development of a numerical mass transport model utilizing the calibrated groundwater flow model as basis. • The calibrated model will be used to simulate management scenario's as follows: ○ Steady state groundwater flow directions, hydraulic gradient and flow velocities. ○ Seepage potential from waste facilities and mass transport plume migration with time. ○ Hydrochemical migration of deeper, saline water towards the shallow aquifer and plume propagation with time. ○ Migration of dissolved gas within the aquifer units and plume migration with time. ○ Post-closure scenarios. ○ Water management alternatives and best practice mitigation measures. **Phase D: Hydrogeological impact assessment and reporting** Phase D will entail the following activities:

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			• Compilation of a detailed hydrogeological specialist investigation report with conclusions and recommendations on the following aspects: ○ Fatal flaw and gap analyses. ○ Site baseline characterisation. ○ Field work summary and interpretation. ○ Aquifer classification and vulnerability. ○ Numerical groundwater flow and mass transport model development, calibration and simulations. ○ Formulation of an impact assessment and risk matrix of proposed activities. ○ Recommendation on best practise mitigation and management measures to be implemented. • Development of an integrated surface water and groundwater monitoring program for implementation.
Terrestrial Biodiversity	The Biodiversity Company	Andrew Husted	**Fauna (mammals, herpetofauna and avifauna)** The surveys will include the following: • A survey of the application areas (if permitted); • Compilation of an expected species list; • Compilation of an identified species list; • Identify any Red Data or listed species present or potentially occurring in the area; • A proximity assessment to any protected or ecologically important areas; and • A habitat assessment and delineation. The field survey for fauna will be undertaken concurrently with vegetation surveys. All animals observed in the area will be noted. Ecological indicators, such as calls, tracks and dung will be noted and regarded as indicative of the presence of that particular animal.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			A detailed fauna lists will be compiled and discussed in relation to the floristic survey findings. The probability of occurrence for species not observed during field surveys will be considered if applicable regarding available habitats. Protected and endemic species will be the focus of discussion. Faunal composition of disturbed sites will be compared to the composition of undisturbed areas. The current status of the faunal environment will be determined and an evaluation of the extent of site-related effects in terms of certain ecological indicators, as well as identification of specific important ecological attributes such as rare and endangered species, protected species, sensitive species and endemic species will be made. The faunal environment and habitat will be characterised in relation to biota and the extent of site related effects. Presence of red data and protected species will be indicated on a map. Sampling techniques will be passive (sightings, calls and tracking) as well as active (trapping, cameras and searching). Fauna will be assessed during the day and at night, the fauna which will be assessed for this study include the following: • Mammals; • Avifauna; and • Reptiles & amphibians. **Plants & vegetation** The surveys will include the following: • A survey for Red and Orange Data plant species; • Vegetation units will be identified, classified and delineated; • Habitat types will be classified and delineated; • The survey will be conducted in consultation with local authorities who have information to be considered; and • The survey area will include the application area.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			The floristic survey should be conducted during the growing season (the rainy season when most plants are in flower or seeding), over the application areas. This period is between October and April. These will give an indication of the actual species present on site and will be discussed in context of plant communities (should the area support distinct communities) within the ecosystem of the area. Protected, endemic, exotic, alien invasive and culturally significant species will also be discussed as separate issues and related back to relevant legal requirements. Furthermore the identification of red data and protected species as listed according to the IUCN List, NEMBA and other Provincial and National legislation will be completed. Depending on the vegetation and terrain, the timed meander sampling could be used during vegetation assessments, however should dominant vegetation types require other methods be used, then these shall be motivated. **Habitat features** The surveys will include the following: • The identification of these features and delineation thereof; and • The location of any unique or protected habitat features. All sensitive areas, as described by the provincial and national legislation, will be identified. The locality and extent, as well as species composition of sensitive areas such as the wetlands or pans, streams, rivers and rocky outcrops will be conducted to identify and map all such sensitive areas present. Sensitive areas will be identified and delineated.
Aquatic and Wetlands	The Biodiversity Company	Andrew Husted	**Wetlands** • A desktop assessment of all available datasets. • The wetland areas are delineated in accordance with the DWAF (2005) guidelines, whereby the outer edges of the wetland areas were identified.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			• The Present Ecological State (PES) or health for the wetland as a whole was calculated, whereby the hydrology, geomorphology and vegetation scores are aggregated to obtain an overall PES health score (Macfarlane et al., 2020). • The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze et al., 2020). • The Ecological Importance and Sensitivity (EIS) tool was derived to assess the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Rountree et al., 2013). **Aquatic Ecology** The overall Present Ecological Status of the associated aquatic ecosystems will be determined using the River Eco-status Monitoring Programme (REMP) Ecological Classification manual (Kleynhans and Louw, 2007). The PES will be calculated based on the results of the various abovementioned biological indexes. The methods that will be utilised are summarised in the table below.

Aspect	Analyses
Water Quality	*In situ* (DWAF, 1996)
Habitat	Intermediate Habitat Integrity Assessment (Kleynhans, 1998) Integrated Habitat Assessment System (McMillan, 1998) Biotope assessment (Tate and Husted, 2015)
Biotic indices	SASS5 (Dickens and Graham, 2002); The Average Score Per Taxon (ASPT); Macroinvertebrate Response Assessment Index (MIRAI); (Thirion,2007) Fish Response Assessment Index (Kleynhans, 2007)

Buffer Zones

The "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries" (Macfarlane, et al., 2014) will be used to determine the appropriate buffer zone for the proposed activity.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
Agricultural Potential & Hydropedology Impact Assessment	The Biodiversity Company	Andrew Husted	**Agricultural Potential Assessment** Owing to the large surface area to be assessed, an approach combining predictive soil mapping, supported by ground truthing has been proposed. Predictive soil mapping (PSM) can be defined as the development of a numerical or statistical model of the relationship among environmental variables and soil properties, which is then applied to a geographic data base to create a predictive map. The use of the Land Type Survey (Land Type Survey Staff 1972-2006), Geographic Information Systems (GIS) and Digital Elevation Models (DEM) in collaboration with ground truthed baseline information have helped refine the ability of predictive mapping, which has paved the way for Digital Soil Mapping (DSM) (van Zijl & Botha, 2016). Tough terrain and large application areas often render soil sampling impractical, which emphasises the need for DSM. Van Zijl (2018) mentions that sparse observation densities are often used in such cases, ranging from 74-216 ha.obs-1. The main advantage of DSM lies within the importance of the soil-environmental correlation, which can be used to map out the distribution of soils with relatively few sampling sites. According to van Zijl (2018), two main methodologies may be used for DSM, including the expert knowledge approach as well as the land type disaggregation approach. The latter will form part of the methodology used for the basic assessment required for this particular study. The land type disaggregation approach includes the use of land type information to digitally map out the soil units as per the dominant soil forms associated with the terrain units. All land type inventories illustrate dominant soil forms associated with a specific terrain unit. As per example, the Aa 1 land type will have a 22% chance of a terrain unit "1" (characterised by a slope percentage between 2-8) to be associated with a Kranskop soil form, and a 15% chance of being characterised by an Inanda soil form. The terrain 1 units, which will be digitized by means of DEM modelling, will therefore be mapped out as a Kranskop soil form. Given the fact that the difference in the possibility of these two soil forms occurring on the same terrain unit is small, expert knowledge will be used to verify the soil unit which includes soil surveying. As with all DSM projects, an element of accuracy will be assessed as part of the assessment. Scattered soil surveying will determine the accuracy of the digital soil mapping exercise. The land type disaggregation approach is commonly used for Environmental Impact Assessments (EIAs) and has been well-documented in the past to be practical and time efficient. In addition to soil

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			information derived from the Land Type Database (Land Type Survey Staff 1972-2006), the soil-environmental relationships observed during the site assessment will be used to improve the accuracy of the study, ultimately upholding the principle of (Botha, 2016), that in-field observations is an important addition to land type information. To summarise, as part of this assessment, the expected distribution of soils will be integrated with soil-environmental associations as well as topography to digitally map out the soil distribution. The site assessment will then focus on ground-truthing these soil distributions and acquiring additional information to improve the specialist's knowledge of the soil-environmental correlation. The accuracy of the DSM exercise will then be calculated to determine the accuracy of soil maps. Expert knowledge from in-field soil-environmental correlations will then be used to improve the accuracy as much as possible. In the event that a low accuracy is calculated for a specific uniform area, additional sampling sits will be investigated to ensure an accurate soil map. Land capability and agricultural potential is determined by a combination of soil, terrain and climate features. Land capability is defined by the most intensive long term sustainable use of land under rain-fed conditions. At the same time an indication is given about the permanent limitations associated with the different land use classes. Land capability is divided into eight classes, and these may be divided into three capability groups. The land classes and groups are arranged in order of decreasing capability and ranges of use. The risk of use increases from class I to class VIII (Smith, 2006). The land potential classes are determined by combining the land capability results and the climate capability of a region. Land use will be identified using aerial imagery and then ground-truthed while out in the field. The land use categories are split into: • Cultivated; • Grazing; • Natural; • Mines; • Urban Built-Up; and • Waterbodies.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			Hydropedology The hydropedological will take cognisance of the “Guidelines for hydropedological Assessments and Minimum Requirements” as set forth by DWS in 2021. According to these guidelines a hydropedology study is required for the following: • A hydropedological study is required whenever a geohydrological and/or hydrological study is required as hydropedology focus on the vadose zone between these focus areas. This is essential for a holistic understanding of the flow drivers in ecosystems and landscapes in order to propose sound mitigation for the impacts of the development. The hydropedological assessment includes parts of the hydrological cycle hidden between the land surface hydrology and groundwater hydrology. Developments have different intensities (minor, moderate or severe) and spatial extent (local, hillslope or catchment) and the investigations vary accordingly. Based on the project info, a level 2 hydropedology assessment has been proposed due to the “moderate” intensity associated with proposed development.
Visual	Enviroconsult	Jon Marshall	The visual impact assessment will be undertaken in accordance with: • The Government of the Western Cape Guideline for Involving Visual and Aesthetic Specialists in EIA Processes, which is the only relevant local guideline, setting various levels of assessment subject to the nature of the proposed development and surrounding landscape; and • The Landscape Institute and Institute of Environmental Management and Assessment (UK) Guidelines for Landscape and Visual Impact Assessment (LVIA) which provides detail of international best practice (technical methodology). In terms of availability of information, current project planning provides a high-level approximation of the location of the various project components but none of these can be confirmed at this stage. The final position of the production wells will be dependent on ongoing exploration activities. Exploration activities to define the specific target areas will continue over the next few years and will overlap with the rollout of the production phases. It is therefore not possible to define accurate site locations for the drill sites and the associated pipelines to inform the Impact Assessment.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			However, detailed information and location for the expanded LNG and Helium Processing Plant will be provided. In order to address the lack of final information, your suggested approach is to undertake: • A comprehensive investigation into the study area to define the baseline receiving environmental conditions. This will be based primarily on high resolution aerial imagery and supplemented with spot field verification; and • The baseline characterisation will be categorised into areas or zones per specialist discipline and then the impact of the proposed activities (production wells and pipelines) assessed for each zone. Specific mitigation applicable to the activity and zone can then be defined, thereby permitting expansion of the production activities on condition that zone specific management and mitigation is implemented. Based on this approach the following deliverables / input: • A baseline characterisation and screening phase: The client will provide preliminary (but not definitive) well locations and pipeline routes. You will provide detailed mapping of the study area. We will then provide their own baseline and sensitivity map based on this detailed information. A list of impacts per phase and per activity will be identified in this phase. • A detailed assessment phase: The proposed activities and associated impacts will be assessed per zone/area and relevant management and mitigation measures presented. A specialist impact assessment report will be prepared in compliance with the legislative requirements. We will review the existing EMPR held by the client and provide additional (if necessary) management and mitigation actions specific to the extension areas.
Heritage and Palaeontology	PGS Heritage	Wouter Fourie	The proposed development triggers the need for a Heritage Impact Assessment as required under S.38 of the NHRA. SAHR will be the commenting authority under S38.8 of the NHRA. A Notice of Intent to Develop (NID) will be submitted to SAHRA to inform them of the proposed developments and the proposed way forward. As soon as this process has been agreed upon with SAHRA the following steps will be taken. • High-level (primarily desktop combined with some focused site verification) sensitivity mapping of study area.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			○ This sensitivity mapping will determine high, medium and low risk areas for FUTURE exploration drilling with the intention that if future drilling is planned in low-risk areas, then these would be able to take place without further studies or approvals (besides compliance with the EMPR). ○ Future drilling in medium/ high areas would be subject to certain additional studies and possibly further approvals at a later date. This will be discussed with SAHRA, and the process streamlined within the ambit of the HIA process as per the NHRA. ○ The assessment will be done through recent and historic aerial and topographical map assessments to identify possible places where heritage resources might be located. • Site-specific Phase 1 Heritage Assessment ○ A desktop study, which is aimed at compiling as much information as possible, regarding the known heritage resources within and surrounding the proposed development areas. The desktop study will cover the following: a. Archival Research: Archival documents and maps housed at the National Archives will be accessed and studied to provide historical background to the study area as well as the identification of heritage resources located there. b. Outcome: Identification of Heritage sensitive areas on outcome of Heritage work c. Fieldwork: The fieldwork component consists of a selective site visit to some of the identified sensitive areas and is aimed at identifying heritage resources and compiling a general heritage character for the area. The locations of all heritage resources that are recorded during the survey will be documented using a hand-held GPS. • Reporting for HIAs/PIAs • Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2017, as amended;

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			• Adherence to all best practice guidelines, relevant legislation and authority requirements; • Identification sensitive areas to be avoided; • Assessment of the impact and significance of the proposed development during the Pre-construction, Construction, Operation, Decommissioning Phases (according to the impact rating methodology).
Updated Decommissioning, Rehabilitation and Closure Plan including Financial Provision update	MineLock Environmental Engineers & Environmental Impact Management Services	Johann Le Roux (MineLock) Liam Whitlow (EIMS)	An update to the existing Final Rehabilitation Decommissioning and Closure Plan (FRDCP) will be undertaken to incorporate the Cluster 2 project activities as well as the required adjustment of the current financial provision amount. This will involve inter alia an update to the following components of the existing FRDCP Report: • Project Context • Environmental and Social Context • Environmental Risk Assessment • Environmental Indicators and Monitoring • Final Post Closure Land Use • Final Rehabilitation, Decommissioning and Closure Schedule • Closure Cost and Financial Provision • Monitoring, Auditing and Reporting • Annual Rehabilitation Plan • Environmental Risk Assessment (Latent and Residual Impacts)
Hydrology	SMEC South Africa	Viren Gajathar	**Baseline Characterisation and Screening Phase:** The Hydrology Impact Assessment Study will be executed using the following methodology: • Description of the receiving environment

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			○ The hydrological receiving environment will be described based on publicly available data including for instance the quaternary catchment within which the site falls, etc. ○ Using information provided by the Client, downstream water uses will be defined. • Description of the proposed activities and potential impacts ○ At this stage these will be qualitatively described in terms of the receiving environment. A quantitative assessment of flood impacts will then follow as per the next bullet. • Quantitative Flood Impact Assessment - delineation of 1:100 and 1:50 year floodlines will be undertaken using Geo-HECRAS river modelling software for the watercourses marked in magenta in Figure 3. This will be performed as follows: ○ Hydrological assessment: a. Assess catchment size (desktop assessment) and determine run-off factors and catchment characteristics. b. Source historical daily rainfall records for the area. c. Time of concentration will be calculated for each catchment along its longest watercourse, using methods and formulae appropriate to the hydrological method selected. d. 1:100-year flood peaks will be calculated using the most appropriate hydrological methods for each catchment. ○ Hydraulic Modelling: a. A 1D river hydraulic model will be compiled for each of the identified watercourses (those highlighted in magenta in Figure 3 above). b. Appropriate boundary conditions will be selected based on the likely hydraulic regime. c. The model geometry will be based on topographic survey data to be provided by the Client.

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			d. Roughness factors will be determined through an assessment of site and aerial photos. o Delineate the floodlines on a map, with respect to any known locations of pipe routes, well locations and plant areas. • Floodline and sensitivity maps for well locations and pipe routes. **Detailed Assessment Phase:** • Determine flood impacts on pipe routes and flood per zone. • Recommendations on required hydrological management and mitigation measures will be provided. The effectiveness of the mitigation measures proposed will be quantified, and a quantitative comparison made between the significance of impacts with and without the proposed mitigation measures. The provisions of GN704 will be considered in the assessment of impacts and mitigation measures. • Prepare a Hydrological Impact Assessment Study Report • Review the existing EMPr for adequacy of mitigation measures.
Social	Equispectives Research and Consulting Services	Ilse Aucamp	**Baseline characterisation and screening phase** • Baseline description of the social environment (variables used typically include population, • household sizes, sex, age, home language, employment, household income, access to services (energy, water, sanitation, refuse removal); • Identify site sensitivities; • Identify preliminary impacts; and • GIS mapping. **Detailed assessment** • Stakeholder engagement and fieldwork; • Identification and assessment of social impacts;

Aspect	Company Responsible	Consultant	Scope of Work / Terms of Reference
			• Suggest mitigation measures; • Social management plan; and • Integration meeting.
Economic	Strategy4Good	Gerrie Muller	Economic impact assessment of the Cluster 2 development on the Matjhabeng economy. The aspects to be analysed and discussed are: • The economic impacts as it relates to macro-economic variables and industry competitive factors; • An alternative land-use analysis; and • Discussing certain aspects of the current guideline on need and desirability in terms of the Environmental Impact Assessment (EIA) regulations, 2010. Methodology: • Review the project description and other relevant documentation and use this as input to evaluating the various economic impacts. • Research the Integrated Development Plan of the Matjhabeng municipality to understand the local economic development challenges and opportunities. • Use the best historical local economic data available. • Use standard econometric methods to project economic variables and calculate the economic impact assessments. • Use a historic national set of multipliers to calculate the indirect impacts of the investment. • Local vs national aspects – Most of the impacts assessed will be undertaken on a local level, but some impacts are more related on a national level, and these will be highlighted as such. The determinant of this division is the directness of receptors, for example household income and employment is felt more acutely at a local level, whereas foreign exchange earnings can only be conducted on a national level. • The impacts will be assessed over the life cycle of the project, thus construction, operational, decommissioning and closure.

13.4 PROPOSED METHOD OF ASSESSING ENVIRONMENTAL ASPECTS

The same method of assessing impact significance as was used during the Scoping phase will be applied during the EIA phase. This methodology is described in detail in Section 11.1 of this report.

13.5 PROPOSED METHOD FOR ASSESSING DURATION AND SIGNIFICANCE

The significance of environmental impacts will be rated before and after the implementation of mitigation measures. These mitigation measures may be existing measures or additional measures that may arise from the impact assessment and specialist input. The impact rating system considers the confidence level that can be placed on the successful implementation of the mitigation. The proposed method for the assessment of environmental issues is set out in the Section 11.1. This assessment methodology enables the assessment of environmental issues including: the severity of impacts (including the nature of impacts and the degree to which impacts may cause irreplaceable loss of resources), the extent of the impacts, the duration and reversibility of impacts, the probability of the impact occurring, and the degree to which the impacts can be mitigated.

The specialist studies will recommend practicable mitigation measures or management actions that effectively minimise or eliminate negative impacts, enhance beneficial impacts, and assist project design. If appropriate, the studies will differentiate between essential mitigation measures, which must be implemented and optional mitigation measures, which are recommended.

13.6 STAGES AT WHICH COMPETENT AUTHORITIES WILL BE CONSULTED

Competent authorities have been and will be consulted during the initial notification period, the scoping phase as well as during the EIA phase.

13.7 PROPOSED METHOD OF EIA PHASE PUBLIC PARTICIPATION

The proposed public participation process to be followed for the EIA phase is provided below.

- The commenting periods that will be provided to the I&AP's (and the competent authorities) will be 30 days as per the relevant legislative requirements.
- The dates of the review and commenting period for the draft EIA/EMPr will be determined at a later date and communicated to all registered I&APs through faxes, emails, SMS's and/or registered letters.
- The location at which the hard copy of the EIA report will be made available is at the same public venues in the application area that the Scoping Report was made available (refer to Section 9.2.5), will be sent electronically to stakeholders who request a copy, and placed on the EIMS website (www.eims.co.za).
- The public participation will be undertaken in compliance with Chapter 6 of NEMA GNR 982.
- Public meetings and focus group meetings will be held during the review period for the EIA report.
- All comments and issues raised during the various comment periods will be incorporated into the EIA Report that will be submitted to the Competent Authority for review and decision making.

13.8 DESCRIPTION OF TASKS THAT WILL BE UNDERTAKEN DURING THE EIA PROCESS

The plan of study detailed in the above sections and is summarised below. The following tasks will be undertaken as part of the EIA phase of the project:

- EIA-phase specialist studies.
- Public consultation:
  - Notification of the availability of the EIAR for review and comment to all registered I&AP's;
  - Public and focus group meetings.

- Authority consultation:
    - Consultation with Competent Authorities as well as commenting authorities; and
    - Correspondence or meetings with certain authorities to provide authorities with project related information and obtain their feedback.
- Document compilation:
    - The EIA and EMPr will be compiled in line with the requirements of Appendix 3 and 4 of the NEMA EIA Regulations. The Cluster 1 EMPr will form the basis of the Cluster 2 EMPr and where necessary, amendments made to incorporate the Cluster 2 project description and any additional or amended mitigation measures that may apply.
    - The EIA and EMPr will be made available for public comment for a minimum period of 30 days.
    - The EIA and EMPr will be finalised and submitted to the PASA for adjudication and decision making.

13.9 MEASURES TO AVOID, REVERSE, MITIGATE, OR MANAGE IMPACTS

This Cluster 2 application forms an extension and expansion to the current approved Cluster 1 project and therefore it is **proposed that the existing approved Cluster 1 EMPr will be updated to incorporate the Cluster 2 project description as well as any additional mitigation measures that may be identified by the EAP or specialists**. All comments received from I&APs during the Scoping Report review will be taken into consideration and where applicable inform the relevant EMPr update.

14 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations relating to this scoping 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 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.

14.5 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.

14.6 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.

14.7 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.

14.8 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.

14.9 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.

14.10 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.

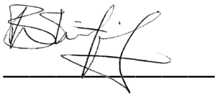
14.11 VISUAL

- 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.
- Gas is likely to be flared continuously to maintain a pilot flare. During normal conditions the height of the flare could be up to 16 m although the air quality specialist indicates that this might be reduced through design. During occasional abnormal circumstances the flare could be significantly larger. A stack height of 16 m 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

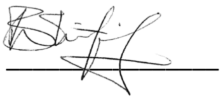


Date: 27 July 2022

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: 27 July 2022

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Appendix 1: Copy of Application Form

Appendix 2: EAP Curriculum Vitae

Appendix 3: Public Participation

Appendix 4: DEA Screening Tool Report and SSVR

Appendix 5: Tetra4 Well Closure and Rehabilitation Guideline