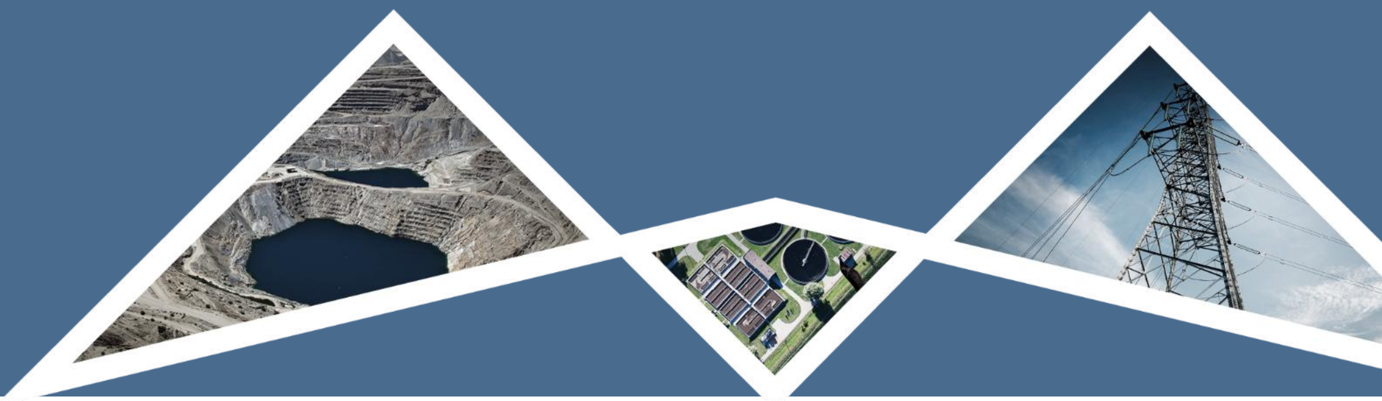
EIMS | ENVIRONMENTAL IMPACT MANAGEMENT SERVICES

T 011 789 7170 E info@eims.co.za W www.eims.co.za

ENVIRONMENTAL SCOPING REPORT

THUNGELA LEPHALALE COAL BED METHANE PROJECT

PASA REF NO: 12/4/17 PR



DOCUMENT DETAILS

EIMS REFERENCE:	1590
DOCUMENT TITLE:	Environmental Scoping Report

DOCUMENT CONTROL

	NAME	SIGNATURE	DATE
COMPILED:	Brian Whitfield / Lucien James	BW	2026/05/25
CHECKED:	Liam Whitlow		2026/05/25
AUTHORIZED:	Liam Whitlow		2026/05/25

REVISION AND AMENDMENTS

REVISION DATE:	REV #	DESCRIPTION
2026/05/25	ORIGINAL DOCUMENT	Scoping Report

Table of Contents

1 Executive Summary 1
1.1 Project Overview 1
1.1.1 Exploration and the Original "5-Spot" 1
1.1.2 Initial Proof of Concept (PoC) 2
1.1.3 Phase 1 (This Application) 2
1.2 Need for the Project 3
1.3 Specialist Studies 3
1.4 Impacts Identified and summary of Impact Assessment 4
1.5 Public Participation 1
2 Introduction 3
2.1 Report Structure 4
2.2 Details of the EAP 7
2.3 Specialists 8
3 Location and Property Description 8
4 Description of the Proposed Activity 13
4.1 Project Description 13
4.1.1 Project Overview 13
4.1.2 Project Timeline 15
4.1.3 Gas Resource 15
4.1.4 Wells 17
4.1.5 Gas and Water Reticulation 31
4.1.6 Processing Plant 32
4.1.7 Water Treatment and Disposal 38
4.1.8 Waste Management 41
4.1.9 Associated Activities and Infrastructure 42
4.1.10 Resource use and requirements 45
4.1.11 Human resources and labour 46
4.2 Abnormal or unwanted events or conditions 46
5 Listed and Specified Activities Triggered 48
6 Policy and Legislative Context 63
6.1 Constitution of the Republic of South Africa 63
6.2 The Mineral and Petroleum Resources Development Act (MPRDA) 63
6.3 The National Environmental Management Act (NEMA) 64
6.4 The National Water Act (NWA) 66
6.5 The National Environmental Management Waste Act (NEMWA) 70
6.6 The National Environmental Management Air Quality Act (NEMAQA) 72
6.7 The National Heritage Resources Act (NHRA) 73

6.8 National Environmental Management Biodiversity Act (NEMBA) 73
6.9 Environment Conservation Act (ECA) 75
6.10 The Spatial Planning and Land Use Management Act (SPLUMA) 75
6.11 Occupational Health and Safety Act 76
6.12 Basic Conditions of Employment Act 76
6.13 Labour Relations Act 76
6.14 Employment Equity Act 77
6.15 Promotion of Equality and Prevention of Unfair Discrimination 77
6.16 Firearms Control Act 77
6.17 National Energy Act 77
6.18 Gas Act 79
6.19 Gas Master Plan and Integrated Resource Plan 79
6.20 GHG and Climate Change 79
6.20.1 International Agreements 80
6.20.2 South African National Climate Change Response Policy 2011 81
6.20.3 Nationally Determined Contribution 82
6.20.4 Greenhouse Gas Emissions Reporting 82
6.20.5 GHG Inventories 83
6.21 District and Local Municipal Integrated Development Plans 84
7 Need and Desirability of the Proposed Activity 85
7.1 International Perspectives 85
7.1.1 Climate Change and the Global Energy Transition 85
7.1.2 Role of Gas in Supporting Energy Security and Renewables 86
7.1.3 Sustainable Development Considerations 86
7.1.4 IPCC Assessment Report 86
7.2 National Policy and Legislative Perspectives 87
7.2.1 National Development Plan 87
7.2.2 Integrated Resource Plan 87
7.2.3 Gas Master Plan 87
7.2.4 White Paper on Energy Policy 87
7.2.5 National Climate Change Response White Paper 88
7.2.6 Just Energy Transition 88
7.2.7 Low Emissions Development Strategy 2050 89
7.2.8 Legislative and Regulatory Framework 90
7.2.9 Energy Security and Economic Development 90
7.3 Regional and Local Perspective 90
7.3.1 Regional Economic Context: The Waterberg Energy Hub 90
7.3.2 Just Transition and Socio-Economic Benefits 90

7.3.3 Alignment with Provincial and Municipal Planning 91
7.3.4 Environmental Sensitivities 91
7.4 Need and Desirability Statement 91
7.5 Need and Desirability DFFE Guideline Analysis 91
8 Project Alternatives 102
8.1 Activity Alternatives 102
8.2 Location Alternatives 102
8.2.1 Well Sites 103
8.2.2 Pipeline and Well Access Road Routes 103
8.2.3 Powerlines 103
8.2.4 LNG Plant 103
8.3 Design and Layout Alternatives 105
8.4 Process Alternatives 105
8.4.1 Process Water Disposal Alternatives 106
8.4.2 Access Route to LNG Plant Alternatives 106
8.5 Technology Alternatives 106
8.6 No Go Alternative 107
8.7 Sensitivity Planning Approach 107
8.8 Alternative Assessment 107
9 Stakeholder Engagement 115
9.1 Methodology 116
9.2 Stakeholder Identification 116
9.2.1 Extent of Project and Zone of influence 116
9.2.2 Landowner Identification 119
9.2.3 Interested Stakeholder Identification 119
9.2.4 Local Communities of Interest 122
9.3 Initial Call to Register 122
9.3.1 Site Notice Placement 123
9.3.2 Advertisements: Newspaper and Gazette Notice 123
9.3.3 Notification Letters, Emails, Faxes, and SMs 123
9.3.4 Radio Broadcast 124
9.4 Engagement Activities 124
9.4.1 Focus Group Discussions 124
9.4.2 Public Meetings 124
9.4.3 Placement of Reports at Local Venues 125
9.5 Summary of Engagment Activities 125
9.6 Summary of Preliminary I&AP Feedback 126
10 Environmental Attributes and Baseline Environment 127

10.1 Topography 127
10.2 Drainage and Catchment 129
10.3 Climate 129
10.3.1 Prevailing and Historic Climate 129
10.3.2 Physical Risks of Climate Change 131
10.4 Land Use and Land Cover 173
10.5 Seismicity 175
10.5.1 The Eenzaamheid Fault 178
10.5.2 The Zoetfontein Fault Zone 178
10.5.3 The Daarby Fault 178
10.5.4 The Bulklip Fault 178
10.6 Geology 178
10.6.1 Regional Geology 178
10.6.2 Local Geology 178
10.6.3 Structural Geology 179
10.7 Soils and Land Capability 181
10.8 Hydrology and Floodlines 183
10.9 Groundwater (Geohydrology) 185
10.9.1 Hydrocensus 185
10.9.2 Geosite type 190
10.9.3 Groundwater Status 191
10.9.4 Groundwater Application 191
10.9.5 Borehole Equipment 191
10.9.6 Groundwater Flow Evaluation 191
10.9.7 Groundwater Quality 199
10.10 Terrestrial Biodiversity 202
10.10.1 Ecologically Important Landscape Features 202
10.10.2 Flora Assessment 209
10.10.3 Fauna Assessment 210
10.11 Air Quality 213
10.11.1 Local Wind Field 214
10.11.2 Ambient Temperature 215
10.11.3 Rainfall 216
10.11.4 Ambient Air Quality within the Region 217
10.12 Noise Receptors 217
10.12.1 Potential Sensitivity Receptors 217
10.12.2 Baseline Noise Survey 218
10.12.3 Measured Noise Levels 218

10.13 Visual Receptors 221
10.13.1 Landscape Character 221
10.13.2 Landscape Character Areas and Visual Absorption Capacity 221
10.13.3 Visual Sensitivity 222
10.14 Social 225
10.14.1 Limpopo Province 227
10.14.2 Waterberg District Municipality 227
10.14.3 Lephalale Local Municipality 227
10.14.4 Description of the Population 227
10.14.5 Population and Household Sizes 228
10.14.6 Population Composition, Age, Gender and Home Language 231
10.14.7 Gender 233
10.14.8 Language 234
10.14.9 Education 235
10.14.10 Employment 236
10.14.11 Household Income 237
10.14.12 Housing 238
10.14.13 Household Size 241
10.14.14 Access to Water and Sanitation 241
10.14.15 Energy 244
10.14.16 Refuse Removal 245
10.15 Traffic and Existing Road Networks 246
10.15.1 R510 (Lephalale to Grobler's Bridge) 246
10.15.2 R510 (Stockpoort to grobler's Bridge) 246
10.15.3 Deelkraal Road (D41) 246
10.16 Cultural and Heritage Resources 246
10.16.1 Historical Structures 246
10.16.2 Kraals 247
10.16.3 Boreholes 247
10.16.4 Excavation Pit 247
10.16.5 Archaeological Site 247
10.17 Palaeontology 251
10.18 Economic Environment 253
11 Environmental Impact Assessment 254
11.1 Impact Assessment Methodology 254
11.1.1 Determination of Significance 254
11.1.2 Impact Prioritisation 257
11.2 Identification and Preliminary Assessment of Potential Impacts 259

11.2.1 Construction Phase Impacts 267
11.2.2 Operational Phase Impacts 277
11.2.3 Decommissioning Rehabilitation and Closure Phase Impacts 284
11.2.4 No-Go Alternative Impacts 290
11.3 Summary of Preliminary Impact Assessment 290
12 Sensitivity Mapping 301
13 Plan of Study for Environmental Impact Assessment 303
13.1 Description of Alternatives to be Considered in EIA Phase 303
13.2 Description of the Aspects to be Assessed as part of the EIA process 303
13.3 Aspects to be Assessed by Specialists 304
13.4 Proposed Method of Assessing Environmental Aspects 322
13.5 Proposed Method for Assessing Duration and Significance 322
13.6 Stages at Which Competent Authorities will be Consulted 322
13.7 Proposed Method of EIA Phase Public Participation 322
13.8 Description of Tasks that will be Undertaken During the EIA Process 323
13.9 Measures to Avoid, Reverse, Mitigate, or Manage Impacts 323
14 Assumptions and Limitations 324
14.1 General 324
14.2 Economic Analysis 324
14.3 Geohydrological Investigation 324
14.4 Hydrological modelling 324
14.5 Heritage and Palaeontology 325
14.6 Social Assessment 326
14.7 Terrestrial Freshwater Soils hydropedology and Land Use Assessment 326
14.8 Visual Assessment 326
15 Undertaking Regarding Correctness of Information 327
16 Undertaking Regarding Level of Agreement 327
17 References 328

List of Figures

Figure 1: Topographical location and extent of the overall Production Right area (black outline) and the EIA application area (green outline). 10
Figure 2: Google Earth image showing location and extent of the overall Production Right area (black outline) and the EIA application area (green outline). 11
Figure 3: Topographical map showing properties under this EIA application. 12
Figure 4: Deep Waterberg basic stratigraphic column. 16
Figure 5: List of surface infrastructure and example pictures. 17

Figure 6: Proposed infrastructure layout including LNG Plant location, indicative production wells, Deelkraal Road upgrade and discharge pipeline alternative routes. ... 18
Figure 7: Aerial view of typical well construction. ... 19
Figure 8: View of typical production well above ground infrastructure. ... 20
Figure 9: High level estimated duration (in days) for a well completion. ... 20
Figure 10: Typical wellbore profile schematic showing casing strings which are well integrity barriers. ... 22
Figure 11: Hydraulic stimulation schematic. ... 24
Figure 12: Primary materials required for hydraulically stimulation per well. ... 25
Figure 13: Silica sand utilised as a proppant during hydraulic stimulation. ... 26
Figure 14: Proposed combination hydraulic stimulation rig. ... 27
Figure 15: Typical well site layout during stimulation. ... 28
Figure 16: View of one of the existing well sites. ... 30
Figure 17: CBM production. ... 31
Figure 18: Reference images for an existing LNG Plant. ... 37
Figure 19: Description of the conceptual RO treatment process being considered and an illustration of the process in action. ... 39
Figure 20: Initial 5-spot project water production. ... 40
Figure 21: View of the site access road off the R510 (left) and existing local in-field site access to well sites (right). ... 43
Figure 22: EIA process diagram. ... 65
Figure 23: Authorisation processes for new water uses. ... 67
Figure 24: Alternative locations for the LNG Plant. ... 104
Figure 25: Discharge pipeline alternative routes. ... 105
Figure 26 Project zone of influence, relevant boundaries, affected properties, and affected communities. ... 118
Figure 27: Regional topography and conceptual slice ... 128
Figure 28: Bar chart indicating yearly rainfall distribution for rainfall zone A4E (WR2012) ... 130
Figure 29: Bar chart indicating monthly rainfall distribution for rainfall zone A4E (WR2012) ... 130
Figure 30: Baseline (1961 to 1990) annual average temperature for the project area (CSIR, 2019). ... 132
Figure 31: Baseline (1961 to 1990) number of very hot days (>35°C) annually for the project area (CSIR, 2019). ... 133
Figure 32: Baseline (1961 to 1990) annual average rainfall for the project area (CSIR, 2019). ... 134
Figure 33: Baseline (1961 to 1990) annual average number of extreme rainfall days (>20 mm in <24 hours) for the project area (CSIR, 2019). ... 135
Figure 34: Annual average temperature (top panel) and temperature anomaly (lower panel) between 1979 and 2023 (Meteoblue, 2023). ... 136
Figure 35: Annual average rainfall (top panel) and rainfall anomaly (lower panel) between 1979 and 2021 (Meteoblue, 2023). ... 136
Figure 36: Projected change in annual average temperature for the near future (2021 – 2050) for the RCP4.5 trajectory. ... 138

Figure 37: Projected change in very hot days for the near future (2021 – 2050) for the RCP4.5 trajectory...... 139
Figure 38: Projected change in annual average rainfall for the near future (2021 – 2050) for the RCP4.5 trajectory. 140
Figure 39: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP4.5 trajectory. 141
Figure 40: Projected change in annual average temperature for the near future (2021 – 2050) for the RCP8.5 trajectory. 143
Figure 41: Projected change in very hot days for the near future (2021 – 2050) for the RCP8.5 trajectory...... 144
Figure 42: Projected change in annual average rainfall for the near future (2021 – 2050) for the RCP8.5 trajectory. 145
Figure 43: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP8.5 trajectory. 146
Figure 44: Risk of increased wildfires for Lephalale Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project). 148
Figure 45: Risk of increased drought tendencies for Lephalale Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project). 148
Figure 46: Risk of increased heat extremes for Lephalale Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project). 149
Figure 47: Risk of increased flooding for Lephalale Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project). 150
Figure 48: Current water stress for the project area (Hofste, et al., 2019) (blue dot indicates project location). 150
Figure 49: Projected (2050) water stress for the project area (Hofste, et al., 2019) (blue dot indicates project location). 150
Figure 50: Current water availability for the Lephalale Municipality. 151
Figure 51: Estimated current and future (2050) water supply vulnerability based on medium population growth for the Lephalale Municipal. 152
Figure 52: Quaternary catchment areas for the study area. 153
Figure 53: Current annual and monthly surface water runoff, precipitation and evaporation for the Lephalale Municipality which falls under the Limpopo Primary Catchment. 154
Figure 54: Projected monthly change to future (2050) evaporation, precipitation, and estimated runoff values. 155
Figure 55: Groundwater potential and dependency for the Lephalale Municipality (dark blue marker indicates approximate location of the project). 156
Figure 56: Groundwater potential and depletion for 2050 for the Lephalale Municipality (dark blue marker indicates approximate location of the project). 157
Figure 57: The contribution that the different economic sectors make to the total GVA of the Lephalale Municipality. 158
Figure 58: Landcover within and surrounding the application area. 174
Figure 59: Geological setting of the study area 176
Figure 60: Structural Geology of the study area. 177
Figure 61: Regional geology. 180

Figure 62: Stratigraphy of the study area. 181
Figure 63: Land types associated with the project area. 182
Figure 64: Illustration of the land type terrain units (Land Type Survey Staff, 1972 – 2006). 182
Figure 65: Hydrological setting of the site 184
Figure 66: Hydrocensus user survey: Borehole water level status. 192
Figure 67: Hydrocensus user survey: Groundwater status. 192
Figure 68: Hydrocensus user survey: Groundwater application. 193
Figure 69: Hydrocensus user survey: Equipment type. 193
Figure 70: Spatial distribution of hydrocensus user survey geosites. 194
Figure 71: Topographical elevation vs. groundwater elevation correlation graph for both aquifer units. 197
Figure 72: Regional groundwater flow direction and depth to groundwater. 198
Figure 73: Hydrochemistry: Composite bar-chart indicating groundwater major anion cation composition. 199
Figure 74: Map illustrating the vegetation types, ecosystem threat status and protection level associated with the project area. 203
Figure 75: Map illustrating the project area in relation to the Limpopo Conservation Plan. 205
Figure 76: Map illustrating the project area in relation to the Waterberg District Bioregional Plan. 206
Figure 77: The project area in relation to the National Protected Area Expansion Strategy. 207
Figure 78: Map illustrating the ecosystem threat status of rivers and wetland ecosystems in the project area. 208
Figure 79: The project area in relation to the NFEPA & NWM5 datasets. 209
Figure 80: Period average, daytime and night-time wind roses (measured data; January 2020 to August 2023; DFFE Lephalale monitoring station). 214
Figure 81: Seasonal wind roses (measured data; January 2020 to August 2023; DFFE Lephalale monitoring station). 215
Figure 82: Diurnal temperature profile (DFFE Lephalale monitoring station for the period January 2020 to August 2023). 216
Figure 83: Monthly rainfall (DFFE Lephalale monitoring station for the period January 2020 to August 2023). 217
Figure 84: Project layout and potential sensitive receptors within the study area. 218
Figure 85: Location of the noise survey sites. 219
Figure 86: Day-time broadband survey results. 220
Figure 87: Night-time broadband survey results. 220
Figure 88: Map of Visual Sensitivity across the site. 224
Figure 89: Location of the proposed LCBM Project (including Production Right Area). 226
Figure 90: Population distribution (shown in percentage, source: (*Census*, 2011)) 231
Figure 91: Age distribution (shown in percentage, source: Census 2011) 233
Figure 92: Gender distribution (shown in percentage, source: Census 2011) 234
Figure 93: Language distribution (shown in percentage, source: Census 2011) 235

Figure 94: Education profiles (those aged 20 years or older, shown in percentage, source: Census 2011) 235
Figure 95: Labour status (those aged between 15 - 65 years, shown in percentage, source: Census 2011) 236
Figure 96: Employment sector (those aged between 15 - 65 years, shown in percentage, source: Census 2011) 237
Figure 97: Annual household income (shown in percentage, source: Census 2011) 238
Figure 98: Enumeration area types (persons, shown in percentage, source: Census 2011) 239
Figure 99: Dwelling types (shown in percentage, source: Census 2011)........ 240
Figure 100: Tenure status (shown in percentage, source: Census 2011). 240
Figure 101: Household size (shown in percentage, source: Census 2011) 241
Figure 102: Water source (shown in percentage, source: Census 2011) 242
Figure 103: Piped water (shown in percentage, source: Census 2011)........ 243
Figure 104: Sanitation (shown in percentage, source: Census 2011) 244
Figure 105: Energy source for lighting (shown in percentage, source: Census 2011) 245
Figure 106: Refuse removal (shown in percentage, source: Census 2011) 245
Figure 107: Photographs of finds at heritage sites. (A) View of the borehole at TL001, (B) View of the kraal and foundation remains at TL003, (C) View of structural remains at TL008, (D) Single MSA tool find at TL010, (E) Ceramic pot shards located at TL012........ 248
Figure 108: Identified heritage resources within the LCBM area. 249
Figure 109: Extent of Grade IIIA and Grade IIIC heritage sites and buffers 250
Figure 110: Extract of the 1:250 000 Ellisras 2326 (1993) Geological Map (Council for Geosciences, Pretoria) indicates that the Thungela LCBM is underlain by the Clarens (TR c) and Lisbon (TRl) Formations of the Karoo Supergroup. 252
Figure 111: Palaeontological Sensitivity according to the SAHRIS PalaeoMap indicates a Very High (red), and High (orange) Palaeontological Sensitivity. 252
Figure 112: Scoping level sensitivity map. 302

List of Tables

Table 1: Environmental significance ratings of activities pre and post application of mitigations. 1
Table 2: Report structure. 4
Table 3: EAP Details. 7
Table 4: List of specialist studies to inform this EIA application. 8
Table 5: Locality details 9
Table 6: Conceptual casing progression. 23
Table 7: Select differences between CBM and shale gas hydraulic stimulation. 28
Table 8: Gas Processing Facility Components. 34
Table 9: Historical produced coal seam water qualities (average from 5-spot 2004 to 2007). 40
Table 10: Estimated traffic to be generated. 43
Table 11: Estimated wastewater. 44

Table 12: Estimated project human resource requirements. 46
Table 13: Abnormal events and conceptual controls. 46
Table 14: Applicable Listed Activities. 49
Table 15: Likely NWA Section 21 water uses triggered by this project. 68
Table 16: Needs and desirability analysis for the LCBM Project. 92
Table 17: Alternative assessment matrix. 108
Table 18: Environmental aspects and their high-level zone of influence considered when defining the larger zone of influence of the project. 117
Table 19: List of pre-identified national organs of state 119
Table 20: List of pre-identified provincial organs of state 120
Table 21: List of pre-identified local government offices 120
Table 22: List of pre-identified corporations and parastatals 121
Table 23: List of pre-identified NGOs 121
Table 24 Summary of newspaper advertisements placed. 123
Table 25 Planned public meeting venues and target groups. 125
Table 26 Preliminary schedule of placement of relevant material at key locations. 125
Table 27 Summary of scheduled engagement opportunities. 125
Table 28: Forecasted economic gains or losses for the RCP4.5 and RCP8.5 scenarios. 158
Table 29: Economic contribution of main commodities for Lephalale Municipality. 159
Table 30: Projected economic contribution of main commodities for Lephalale Municipality. 159
Table 31: Soils expected at the terrain units within the land type (Land Type Survey Staff, 1972 - 2006). 183
Table 32: Hydrocensus user survey: relevant geosite information 186
Table 33: Hydrocensus user survey: relevant geosite information - Includes other indices. 187
Table 34: Regional water level summary. 195
Table 35: Hydrochemistry: Groundwater quality evaluation of hydrocensus samples analysed. 200
Table 36: Hydrochemistry: Monitoring borehole water quality evaluation. 201
Table 37: Summary of relevance of the proposed project to ecologically important landscape features. 202
Table 38: Threatened mammal species that are expected to occur within the project area. 211
Table 39: Threatened avifauna species that are expected to occur within the project area. 212
Table 40: Monthly average temperature summary (DFFE Lephalale monitoring station for the period January 2020 to August 2023). 215
Table 41: Population density and growth estimates (sources: *Census*, 2011, Statistics South Africa, 2016) 228
Table 42: Household sizes and growth estimates (sources: Census 2011, Statistics South Africa, 2016) 229
Table 43: Dependency ratios (source: *Census 2011)* 229
Table 44: Poverty and SAMPI scores (sources: Census 2011 and Community Survey 2016). 231
Table 45: Average age (source: *Census*, 2011) 231
Table 46: Geotypes (source: *Census*, 2011, households) 238

Table 47: Criteria for Determining Impact Consequence. 254
Table 48: Probability/ Likelihood Scoring. 256
Table 49: Determination of Significance. 256
Table 50: Significance Scores. 256
Table 51: Criteria for Determining Prioritisation. 257
Table 52: Determination of Prioritisation Factor. 257
Table 53: Final Environmental Significance Rating. 258
Table 54: Summary impact matrix. 260
Table 55: Preliminary Scoping Phase Impact Assessment. 291
Table 56: Alternatives to be assessed in the EIA Phase. 303
Table 57: Details of specialists input during the EIA phase. 305

Appendices

Appendix 1: Curriculum Vitae of the EAP
Appendix 2: Production Right Property List
Appendix 3: Initial Public Participation
Appendix 4: Hydraulic Stimulation Fluid Additive MSDS's
Appendix 5: DFFE Screening Tool Report and Site Sensitivity and Verification Report
Appendix 6: Waste Classification and MSDS for Combined Drill Waste
Appendix 7: DFFE IQ Clarification Listing Notice 2 - Activity 20 and 20A
Appendix 8: Integrated EA Application Form

Abbreviations

AEL	Air Emissions Licence
AQSR	Air Quality Sensitivity Receptors
BOG	Boil-off Gas
CBM	Coal bed methane
CCRA	Climate Change Reference Atlas
CE	Control Efficiency
CH_4	Methane
cm	centimetres
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
DAFF	Department of Agriculture, Forestry and Fisheries
DDM	District Development Model
DEM	Digital Elevation Model
DMRE	Department of Mineral Resources and Energy
DWAF	Department of Water Affairs and Forestry (Currently referred to as DWS)
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECA	Environment Conservation Act
ECO	Environmental Control Officer
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EIMS	Environmental Impact Management Services
EMPr	Environmental Management Programme
EO	Environmental Officer
ER	Exploration Right
Er	Environmental Risk
ERA5	5th generation ECMWF (European Centre for Medium-Range Weather Forecasts) atmospheric reanalysis
FEPA	Freshwater Ecosystem Priority Area
GCM	Global Climate Change Model
GDP	Gross Domestic Product
GGP	Gross Geographic Product
GHG	Greenhouse gas

GIS	Geographic Information System
ha	hectares
I&AP	Interested and Affected Party
IDP	Integrated Development Plan
IEM	Integrated Environmental Management
IFC	International Finance Corporation
IRP	Integrated Resource Plan
ISO	International Organisation for Standardisation
LCA	Landscape Character Area
LCBM	Lephalale Coal Bed Methane
LNG	Liquified Natural Gas
m	Meters
m^2	Meters squared
m^3	Cubic meters
MAP	Mean Annual Precipitation
MEC	Member of Executive Council
MHI	Major Hazard Installation
mm	millimetres
MPRDA	Mineral and Petroleum Resources Development Act
MSDS	Material Safety Datasheet
MW	Megawatts
NAAQS	National Ambient Air Quality Standards
NCW	Not Conservation Worthy
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management: Air Quality Act
NEMBA	National Environment Management: Biodiversity Act
NEMWA	National Environmental Management: Waste Act
NFEPA	National Freshwater Ecosystem Priority Area
NGO	Non-Governmental Organisation
NHRA	National Heritage Resources Act
NPAES	National Protected Area Expansion Strategy
NSR	Noise Sensitivity Receptors
NWA	National Water Act
OHSA	Occupational Health and Safety Act
PASA	Petroleum Agency of South Africa
PPP	Public Participation Process

PR	Production Right
RO	Reverse Osmosis
SAHRA	South African Heritage Resources Agency
SANBI	South African National Biodiversity Institute
SANS	South African National Standards
SCC	Species of Conservation Concern
SIA	Social Impact Assessment
SPLUMA	Spatial Planning and Land Use Management Act
Tcf	Trillion cubic feet
TDS	Total Dissolved Solids
VAC	Visual Absorption Capacity
WMA	Water Management Areas
WML	Waste Management Licence
WUL	Water Use Licence

1 EXECUTIVE SUMMARY

This executive summary provides a high-level overview of this 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

Thungela Operations Proprietary Limited, a member of the Thungela Resources Limited Group (hereafter referred to as the Applicant or Thungela) has submitted a Production Right (PR) application to the Petroleum Agency SA (PASA) for coal bed methane (CBM) in the Lephalale Local Municipality, Limpopo Province, South Africa. Historic exploration activities which were undertaken in accordance with an Exploration Right (ER) have indicated a potentially viable and extractable CBM resource. The Applicant has applied to the PASA for a PR to extract and produce (utilize/beneficiate) the CBM resource.

What is CBM: CBM is a form of natural gas which can be recovered from coal deposits or coal seams. The gas is formed during the natural conversion of plant material into coal, known as coalification. When coalification occurs, the coal becomes saturated with water and methane gas is trapped within it

---

Thungela aims to extract the CBM resource from the PR area in a phased manner. At present a total of 3 production phases are expected to reach the conceptual full field production which spans a total surface area of 134 302.6699 hectares (ha). The first production phase comprises of 333 production wells which will be connected via a buried gas gathering network of pipelines to a centralised gas processing facility. This phase will include 19 existing exploration phase wells as well as new wells to be constructed across the 20 properties of the EA area, all totalling approximately 333 wells and situated within an area of approximately 20 443 ha.

The PR and EA application area falls within the Lephalale Local Municipality (LM) and Waterberg District Municipality (DM), Limpopo Province. The EA application area is situated ~14km to the northwest of Lephalale town, 5km north of Marapong, and ~11km northwest of Onverwacht. The 20 farm portions forming the initial phase 1 of the production activities are: Withoutpan 404 (Portion 0); Paddakraal 405 (Portion 0); Ganzepan 446 (Portion 0); Vooruit 449 (Portion 0); Schrikvoorby 445 (Portion 0); Schrikvoorby 445 (Portion 1); Gelykebult 450 (Portion 0); Welgevonden 444 (Portion 0); Eendragtpan 451 (Portion 0); Grootpan 452 (Portion 0); Elandsvley 453 (Portion 0); Nooitgedacht 403 (Portion 0); Bulklip 701 (Portion 0); Bulklip 701 (Portion 1); Leeuwfontein 400 (Portion 0); Oliphantspad 255 (Portion 0); Klimopfontien 223 (Portion 0); Kurzabonakop 399 (Portion 0); Kerryfontein 402 (Portion 0); Waterval 169 (Portion 0). Two (2) of these farm portions are privately owned, three (3) are owned by Exxaro and the remaining fifteen (15) are owned by Thungela.

To optimally produce CBM, hydraulic stimulation or hydraulic fracturing of the target coal seams is being proposed. Following stimulation, the coal seam is dewatered to reduce the hydrostatic pressure of the water within the coal seam which allows the gas to be released to the wellbore. The gas processing includes a compression and liquefaction facility to produce the final product, Liquified Natural Gas (LNG), which will be distributed off site via road transport. The production is planned to span a period of 30 years commencing from the date that all relevant approvals and licences have been obtained.

1.1.1 EXPLORATION AND THE ORIGINAL "5-SPOT"

Exploration activities conducted under Thungela's Exploration Right established the earliest basis for proving the technical and commercial viability of CBM extraction within the Production Right (PR) area. As part of these activities, Thungela constructed the original 5-Spot on the farm Bulklip 701 in the early 2000s. This consisted of a cluster of five vertically drilled CBM wells that were hydraulically stimulated and connected to a small gas and water gathering network, a water treatment unit, and a small gas processing facility. The 5-Spot was used as a prefeasibility test site and generated valuable geological, operational and production data that informed the design of subsequent project phases.

1.1.2 INITIAL PROOF OF CONCEPT (POC)

Building on the results from the original 5-Spot, Thungela later developed a second 5-Spot on the farm Nooitgedacht 403 as part of the exploration programme. These wells were stimulated much later together with nine additional wells creating a functional 14-well wellfield. These wells were hydraulically stimulated and connected to a centralised gas and water processing facility. The 14-well cluster were connected to the original 5 spot wells, and together the 19 wells became the company's effective Proof of Concept (PoC), successfully demonstrating sustained CBM production capability, stable gas quality, and commercial-scale LNG production under the existing environmental authorisation previously referred to as the "37-Spot EA".

The Proof of Concept confirmed the viability of expanding CBM operations in the Lephalale region and now forms an integral part of Phase 1 of the wider production roll-out. For the purposes of this EIA, Phase 1 comprises approximately 333 wells in total, and this number includes:

- The 19 wells constructed during exploration,
- Approximately 314 additional new wells that will form part of the Phase 1 production sequence.

These existing wells and their associated infrastructure will be incorporated into the Phase 1 operational footprint and will tie into the broader gas and water gathering networks, processing facilities, and long-term production systems proposed for the full Phase 1 development.

This consolidation of the earlier exploration and PoC infrastructure into Phase 1 ensures continuity between historic data-generating activities, the proven operational model, and the larger-scale production configuration assessed as part of this application.

1.1.3 PHASE 1 (THIS APPLICATION)

This phase will cover the 20 properties described above and engage the installation of new wells and associated CBM production infrastructure. As a point of departure Thungela has identified a uniform well grid pattern covering the EA application area at a well density of 1 well per 40 acres/ 16 hectares or 400m apart from each other in a North-South, East-West direction.

The location of the individual well sites will be defined firstly by the location of the target resource (i.e. depth and presence of coal seams) and secondly considering any physical or environmental constraints that may occur at a site-specific location. Examples of constrains that will, where practically possible, be avoided when siting well sites may include, but not limited to:

- Sensitive biophysical and environmental features, such as wetlands, watercourses, springs, sensitive habitats or species of conservation concern, etc.
- Sensitive social and cultural features: existing land uses which may not be compatible with the well infrastructure (e.g. homesteads), graves sites or cemeteries, archaeological or paleontological sites, etc.
- Geological or physical features, such as fault lines, areas of geologic instability, steep slopes, or rocky outcrops.

Individual wells will be connected to the gas gathering network through an underground gas pipeline network and the dewatering pipelines will be located along the same routes as the gas pipeline network. The pipeline networks will transport gas to the LNG plant for processing of the gas and water to the water treatment plant for treatment of the water. Various options will be considered during this EIA process for the use or disposal of the treated water to identify the optimal use of this resource.

Thungela has applied to the relevant designated authority, namely the PASA, for an EA for the overall Production Right and first phase of the production (i.e. ~333 wells and associated infrastructure). The infrastructure comprising the remaining phases within the production right are not included in this EIA and will need to be assessed and applied for separately as and when the need for these expansions and future phases arises.

EIMS has been appointed by Thungela to fulfil the role of the Independent EAP in undertaking an EIA process to support applications for the required environmental regulatory approvals. These approvals include, but are not limited to:

- EA in terms of the NEMA;
- Environmental Management Programme (EMPr) in terms of the MPRDA;
- WUL in terms of the NWA;
- WML in terms of the NEMWA; and
- AEL in terms of the NEMAQA (if applicable).

1.2 NEED FOR THE PROJECT

South Africa's integrated resource planning framework holds significant relevance in justifying the development of natural gas resources within the country. Firstly, the framework underscores the importance of energy diversification, and natural gas, being a cleaner and more environmentally friendly energy source compared to coal, aligns perfectly with this goal. By integrating natural gas into the energy sector, South Africa can effectively reduce carbon emissions and cultivate a more sustainable energy portfolio. Secondly, the economic growth prospects associated with natural gas development are substantial, attracting investment across the entire value chain, from exploration and extraction to infrastructure development. Furthermore, the widespread utilisation of natural gas across industries, power generation, and transportation has the potential to foster job creation and stimulate economic activity. Thirdly, recognising the imperative of energy security, the framework acknowledges that natural gas can serve as a dependable and versatile energy source, capable of acting as a backup during peak demand periods and complementing intermittent renewable energy sources.

Additionally, the integrated resource planning framework places a strong emphasis on environmental sustainability, with natural gas seen as a transitional energy source that can help diminish South Africa's reliance on coal, a major contributor to air pollution and greenhouse gas emissions. Consequently, transitioning to natural gas can facilitate cleaner energy production, aligning with global sustainability goals.

In conclusion, South Africa's integrated resource planning framework aligns with energy diversification, economic growth, energy security, environmental sustainability, rural development, foreign investment attraction, and export potential which underscores its role in economically justifying the development of natural gas resources in South Africa.

1.3 SPECIALIST STUDIES

As part of this EIA a number of specialist studies have been commissioned to investigate key impacts that require further investigation. 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. A list of the preliminary specialist studies is as follows:

- Air Quality and Climate Change
- Economic
- Geohydrology

- Heritage and Palaeontology
- Hydrology
- Noise
- Social
- Ecology
- Visual
- Aquatic and Wetland
- Soil, Agriculture and Hydropedology
- Major Hazardous Installation - Qualitative Risk Assessment
- Seismicity or Seismic Risks
- Traffic

1.4 IMPACTS IDENTIFIED AND SUMMARY OF IMPACT ASSESSMENT

Based on the type and extent of the proposed project infrastructure as well as the receiving environment, preliminary impacts have been identified and assessed during this scoping phase assessment. The results of the public consultation will be used to update the identified potential impacts (e.g. include additional impacts) which will be further refined during the EIA assessment and consultation process. Potential environmental impacts were identified during the scoping process, and these impacts were identified by the EAP in conjunction with the appointed specialists.

Impacts have been identified for the various phases of the project namely, planning, construction, operation, decommissioning, rehabilitation and closure. The broad approach to the significance rating methodology is to determine the environmental risk by considering the consequence of each impact (comprising nature, extent, duration, magnitude, and reversibility) and relate this to the probability/ likelihood of the impact occurring. Impacts may be positive in nature or negative in nature. This methodology of impact assessment 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 which is applied to the post mitigation environmental risk to determine the overall significance of the impact. The overall significance is categorised as either low, medium or high and would apply to both the positive and negative impacts identified.

Based on the project activities, the scoping phase list of pre-identified potential impacts for specific environmental themes and project phases are listed below.

Project Activity	Phase	Potential Impact	Environmental Theme
Preliminary site investigations and layout planning. **Traffic movements.**	Planning	Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety associated with gas production	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Effect on Energy Security	Economic
		Local Economic Growth and Rural Development	

Project Activity	Phase	Potential Impact	Environmental Theme
		Job Creation and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	
Access road construction. **Construction camp and laydown establishment.** **Well site clearance, establishment, drilling, stimulation.** **Water abstraction, treatment and disposal.** **Gas and water pipeline construction.** **Electricity distribution infrastructure construction.** **LNG Plant and booster / compressor station construction.** **Traffic movements.** **Waste storage and disposal.**	Construction	Destruction, further loss and fragmentation of the vegetation community	Terrestrial Biodiversity
		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).	
		Loss of watercourse habitat	Aquatic/Wetland
		Decrease in surface water quality	
		Disruption of watercourse hydrology	
		Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety associated with gas production	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Disturbance of: Historical Structures - Historical structure foundations	Heritage
		Disturbance of: Historical Structures - Kraals	
		Disturbance of: Historical Structures - Boreholes	
		Disturbance of: Historical Structures - Excavated pit	
		Disturbance of: Archaeological Sites - Single find spot	
		Disturbance of: Archaeological Sites - Iron Age Site	
		Erosion of soils	Hydrology (surface water)
		Pollutants entering the surface water environment	
		Increase in runoff	
		Increased flood potential	
		Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area.	Geohydrology (groundwater)
		Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.	
		Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	
		Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	
		Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.	
		Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	
		Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	
		Effect on Energy Security	Economic
		Local Economic Growth and Rural Development	
		Job Creation and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	
		Impact on palaeontological resources	Palaeontology

Project Activity	Phase	Potential Impact	Environmental Theme
		Decrease in ambient air quality	Air Quality
		Increase in noise levels	Noise
		Further general degradation of the local landscape	Visual
		Degradation of views from the R33 and R572 in proximity to the proposed site	
		Further degradation of the local landscape as viewed from adjacent local roads	
		Further degradation of the local landscape as viewed from homesteads	
		Degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves	
		Lighting impacts on sensitive receptors	
		Induced or triggered seismic activity	Seismicity
		Deterioration of existing road surfaces/ pavements	Traffic
		Traffic congestion	
		Safety of road users	
Maintenance and monitoring of wells and pipelines. **Water abstraction, treatment and disposal.** **Traffic movements.** **LNG Plant operations.** **Waste storage and disposal.**	Operation	Continued encroachment of an indigenous vegetation community by alien invasive plant species as well as erosion due to disturbed soils	Terrestrial Biodiversity
		Continued displacement and fragmentation of the faunal community (including threatened species) due to ongoing anthropogenic disturbances (noise, dust and vibrations) and habitat degradation/loss (litter, road mortalities and/or poaching).	
		Loss of watercourse habitat	Aquatic/Wetland
		Decrease in surface water quality	
		Disruption of watercourse hydrology	
		Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety associated with gas production	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Erosion of soils	Hydrology (surface water)
		Pollutants entering the surface water environment	
		Increase in runoff	
		Increased flood potential	
		Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.	Geohydrology (groundwater)
		Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	
		Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	
		Groundwater pollution as a result of wastewater spills and seepage from wastewater storage facilities.	
		Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	
		Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	
		Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	
		Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.	

Project Activity	Phase	Potential Impact	Environmental Theme
		Effect on Energy Security	Economic
		Local Economic Growth and Rural Development	
		Job Creation and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	
		Decrease in ambient air quality	Air Quality
		Increase in noise levels	Noise
		Further general degradation of the local landscape	Visual
		Degradation of views from the R33 and R572 in proximity to the proposed site	
		Further degradation of the local landscape as viewed from adjacent local roads	
		Further degradation of the local landscape as viewed from homesteads	
		Degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves	
		Lighting impacts on sensitive receptors	
		Induced or triggered seismic activity	Seismicity
		Deterioration of existing road surfaces/ pavements	Traffic
		Traffic congestion	
		Safety of road users	
Removal of project infrastructure. **Well sealing and concrete batching.** **Traffic movements.** **Waste disposal.**	Decommissioning	Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety during decommissioning activities	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Erosion of soils	Hydrology (surface water)
		Pollutants entering the surface water environment	
		Increase in runoff	
		Increased flood potential	
		Dewatering effects lessening, post-operational re-watering and flooding of underground coal seams which may result in a rebound of the local hydraulic head and regional water levels.	Geohydrology (groundwater)
		Poor quality leachate emanating from sulphide bearing minerals associated with dewatered coal seams and faces which will have a negative impact on groundwater water quality.	
		Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.	
		Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) if the wells not adequately sealed.	
		Groundwater pollution as a result of wastewater spills and seepage from wastewater storage facilities.	
		Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	
		De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.	
		Effect on Energy Security	Economic
		Local Economic Growth and Rural Development	
		Retrenchments of labour and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	
		Decrease in ambient air quality	Air Quality

Project Activity	Phase	Potential Impact	Environmental Theme
		Increase in noise levels	Noise
		Induced or triggered seismic activity	Seismicity
		Deterioration of existing road surfaces/ pavements	Traffic
		Traffic congestion	
		Safety of road users	
Soil reinstatement. **Ripping of compacted soils.** **Seeding and vegetation establishment.** **Traffic movements.**	Rehab and closure	Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety during decommissioning activities	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Erosion of soils	Hydrology (surface water)
		Pollutants entering the surface water environment	
		Increase in runoff	
		Increased flood potential	
		Effect on Energy Security	Economic
		Local Economic Growth and Rural Development	
		Retrenchments of labour and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	

Following on from the above biophysical and socio-economic impacts that have been identified and assessed during this Scoping phase, the pre-mitigation environmental risk, post mitigation environmental risk, and final significance **when applying a priority factor**[1] to each impact is presented below with a colour scale representing the Environmental Significance Rating ranging from high negative to high positive as follows.

Environmental Significance Rating (ER)	
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).
≥ 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).

[1] Refer to Section 11.1.2 of this report which clarifies how the priority factor is calculated and applied to the final significance. Note that the final significance including the priority factor can in some instances result in a higher final significance than the pre-mitigation scenario.

Table 1: Environmental significance ratings of activities pre and post application of mitigations.

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
Terrestrial Biodiversity	Destruction, further loss and fragmentation of the vegetation community	Construction	-14	-6	-7.5
	Introduction of alien species, especially plants	Construction	-15	-4	-5
	Erosion due to storm water runoff and wind	Construction	-15	-7.5	-9.375
	Displacement of faunal community due to habitat loss, direct mortalities and disturbance (road collisions, noise, light, dust, vibration and poaching).	Construction	-16	-6.75	-8.4375
	Continued encroachment of an indigenous vegetation community by alien invasive plant species as well as erosion due to disturbed soils	Operation	-15	-6.75	-8.4375
	Continued displacement and fragmentation of the faunal community (including threatened species) due to ongoing anthropogenic disturbances (noise, dust and vibrations) and habitat degradation/loss (litter, road mortalities and/or poaching).	Operation	-15	-6.75	-8.4375
Aquatic/Wetland	Habitat	Construction	-6.5	-5	-5
	Water Quality	Construction	-7	-5.5	-5.5
	Flow	Construction	-5.5	-2.25	-2.25
	Habitat	Operation	-6.5	-4.5	-4.5
	Water Quality	Operation	-7	-2.5	-2.5
	Flow	Operation	-5.5	-2.25	-2.25
Soils	Loss of land capability, soil compaction, soil erosion, land degradation	Planning	-1.25	-1	-1
	Loss of land capability, soil compaction, soil erosion, land degradation	Construction	-9	-6.75	-9.28125
	Loss of land capability, soil compaction, soil erosion, land degradation	Operation	-5	-4	-5
	Loss of land capability, soil compaction, soil erosion, land degradation	Decommissioning	-6.75	-4	-5

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
	Loss of land capability, soil compaction, soil erosion, land degradation	Rehab and closure	-4	-1.75	-1.96875
Social	Damage to farm roads, existing services, and infrastructure	Planning	-5	-5	-5
	Impacts on safety and security of local residents	Planning	-5	-5	-5
	Public perceptions about safety associated with gas production	Planning	-5	-5	-5
	Nuisance factor due to an increase in ambient dust and noise levels	Planning	-5	-5	-5
	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Planning	-5	-5	-5
	Impacts on the livelihoods of landowners	Planning	-5	-5	-5
	Impacts on the social license to operate	Planning	-5	-5	-5
	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Planning	-5	-5	-5
	Contribution to the economy of South Africa	Planning	5	5	5
	Damage to farm roads, existing services, and infrastructure	Construction	-9	-9	-11.25
	Impacts on safety and security of local residents	Construction	-9	-9	-11.25
	Public perceptions about safety associated with gas production	Construction	-11	-9	-11.25
	Nuisance factor due to an increase in ambient dust and noise levels	Construction	-9	-9	-11.25
	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Construction	-9	-9	-11.25
	Impacts on the livelihoods of landowners	Construction	-9	-9	-11.25
	Impacts on the social license to operate	Construction	-9	-9	-11.25
	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Construction	-11	-11	-13.75
	Contribution to the economy of South Africa	Construction	16.25	16.25	20.3125
	Damage to farm roads, existing services, and infrastructure	Operation	-14	-13	-17.875
	Impacts on safety and security of local residents	Operation	-14	-13	-17.875
	Public perceptions about safety associated with gas production	Operation	-14	-12	-16.5
	Nuisance factor due to an increase in ambient dust and noise levels	Operation	-13	-13	-16.25

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Operation	-13	-13	-16.25
	Impacts on the livelihoods of landowners	Operation	-13	-13	-16.25
	Impacts on the social license to operate	Operation	-13	-12	-15
	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Operation	-15	-15	-18.75
	Contribution to the economy of South Africa	Operation	21.25	20	30
	Damage to farm roads, existing services, and infrastructure	Decommissioning	17.5	17.5	26.25
	Impacts on safety and security of local residents	Decommissioning	17.5	17.5	26.25
	Public perceptions about safety associated with gas production	Decommissioning	17.5	17.5	26.25
	Nuisance factor due to an increase in ambient dust and noise levels	Decommissioning	17.5	17.5	26.25
	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Decommissioning	17.5	17.5	26.25
	Impacts on the livelihoods of landowners	Decommissioning	13.75	17.5	26.25
	Impacts on the social license to operate	Decommissioning	17.5	17.5	26.25
	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Decommissioning	17.5	17.5	26.25
	Contribution to the economy of South Africa	Decommissioning	20	18.75	28.125
	Damage to farm roads, existing services, and infrastructure	Rehab and closure	21.25	20	30
	Impacts on safety and security of local residents	Rehab and closure	21.25	20	30
	Public perceptions about safety associated with gas production	Rehab and closure	21.25	20	30
	Nuisance factor due to an increase in ambient dust and noise levels	Rehab and closure	21.25	20	30
	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Rehab and closure	21.25	20	30
	Impacts on the livelihoods of landowners	Rehab and closure	17.5	20	30
	Impacts on the social license to operate	Rehab and closure	21.25	20	30

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Rehab and closure	21.25	20	30
	Contribution to the economy of South Africa	Rehab and closure	22.5	21.25	31.875
	Historical Structures - Historical structure foundations	Construction	-19	3.5	4.375
Heritage	Historical Structures - Kraals	Construction	-6	3.5	3.5
	Historical Structures - Boreholes	Construction	-15	3.5	3.9375
	Historical Structures - Excavated pit	Construction	-3	3	3
	Archaeological Sites - Single find spot	Construction	-6.5	3.25	4.0625
	Archaeological Sites - Iron Age Site	Construction	-12.75	4	5
	Erosion of Soils	Construction	-8.25	-4	-5
Hydrology (surface water)	Erosion of Soils	Operation	-8.25	-5	-6.25
	Erosion of Soils	Decommissioning	-7.5	-4	-5
	Erosion of Soils	Rehab and closure	-4.5	-4	-5
	Pollutants entering the surface water environment	Construction	-12	-5.5	-6.875
	Pollutants entering the surface water environment	Operation	-12	-5.5	-6.875
	Pollutants entering the surface water environment	Decommissioning	-12	-5.5	-6.875
	Pollutants entering the surface water environment	Rehab and closure	-7.5	-4	-5
	Increase in runoff	Construction	-10	-10	-11.25
	Increase in runoff	Operation	-10	-10	-11.25
	Increase in runoff	Decommissioning	-10	-10	-11.25

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
	Increase in runoff	Rehab and closure	-6.75	-6.75	-7.59375
	Flood potential	Construction	-9	-4.5	-4.5
	Flood potential	Operation	-9	-4.5	-4.5
	Flood potential	Decommissioning	-9	-4.5	-4.5
	Flood potential	Rehab and closure	-6.75	-4.5	-4.5
	Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area.	Construction	-8	-1.75	-1.75
Geohydrology (groundwater)	Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.	Construction	-11	-4.5	-5.625
	Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	Construction	-11	-4.5	-5.625
	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Construction	-4	-1.75	-1.75
	Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.	Operation	-17.5	-3.25	-4.875
	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Construction	-14	-3.25	-4.875

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Construction	-14	-3.25	-4.875
	Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.	Operation	-21.25	-4	-6
	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Operation	-17	-4	-6
	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Operation	-17	-4	-6
	Groundwater pollution as a result of wastewater spills and seepage from wastewater storage facilities.	Operation	-12	-3.75	-4.6875
	Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	Operation	-12	-3.75	-4.6875
	Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	Operation	-12	-3.75	-4.6875
	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Operation	-12	-3.75	-4.6875
	Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.	Operation	-12	-3.75	-4.6875
	Dewatering effects lessening, post-operational re-watering and flooding of underground coal seams which may result in a rebound of the local hydraulic head and regional water levels.	Decommissioning	16	-6	-7.5

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
	Poor quality leachate emanating from sulphide bearing minerals associated with dewatered coal seams and faces which will have a negative impact on groundwater water quality.	Decommissioning	-23.75	-6	-7.5
	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.	Decommissioning	-16	-6	-7.5
	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) if the wells not adequately sealed.	Decommissioning	-16	-6	-7.5
	Groundwater pollution as a result of wastewater spills and seepage from wastewater storage facilities.	Decommissioning	-6.5	-2.25	-2.53125
	Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	Decommissioning	-6.5	-2.25	-2.53125
	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	-2.25	-2.53125
	Energy Security	Planning	6.25	6.25	8.59375
Economic	Local economic growth and rural development as a result of this project	Planning	6.25	6.25	8.59375
	Job creation and Household Income as a result of additional employment opportunities	Planning	6.25	6.25	8.59375
	Foreign investment attraction and forex savings	Planning	6.25	6.25	8.59375
	Population Growth due to influx of workers and pressure on local infrastructure	Planning	6.25	6.25	8.59375
	Tourism and alternative land-use	Planning	-6.25	-6.25	-7.8125
	Energy Security	Construction	14	14	19.25
	Local Economic Growth and Rural Development	Construction	13	13	17.875
	Job Creation and Household Income	Construction	13	13	17.875
	Foreign Investment Attraction and Forex Savings	Construction	12	12	16.5
	Population Growth and Pressure on Local Infrastructure	Construction	-10	-10	-13.75
	Tourism and alternative land-use	Construction	-12	-6.25	-8.59375

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
	Energy Security	Operation	14	14	19.25
	Local Economic Growth and Rural Development	Operation	13	13	17.875
	Job Creation and Household Income	Operation	13	13	17.875
	Foreign Investment Attraction and Forex Savings	Operation	12	12	16.5
	Population Growth and Pressure on Local Infrastructure	Operation	-10	-10	-13.75
	Tourism and alternative land-use	Operation	-12	-12	-16.5
	Energy Security	Decommissioning	-14	-13	-17.875
	Local Economic Growth and Rural Development	Decommissioning	-13	-13	-17.875
	Job Creation and Household Income	Decommissioning	-13	-12	-16.5
	Foreign Investment Attraction and Forex Savings	Decommissioning	-12	-10	-13.75
	Population Growth and Pressure on Local Infrastructure	Decommissioning	10	13	17.875
	Tourism and alternative land-use	Decommissioning	12	12	15
	Energy Security	Rehab and closure	-14	-13	-17.875
	Local Economic Growth and Rural Development	Rehab and closure	-13	-12	-16.5
	Job Creation and Household Income	Rehab and closure	-13	-10	-13.75
	Foreign Investment Attraction and Forex Savings	Rehab and closure	-12	-13	-17.875
	Population Growth and Pressure on Local Infrastructure	Rehab and closure	10	13	17.875
	Tourism and alternative land-use	Rehab and closure	12	12	15
	Impact on palaeontological resources	Construction	-10.5	11.25	12.65625
Palaeontology	Ambient air quality	Construction	-10	-7.5	-7.5
	Ambient air quality	Operation	-12	-8.25	-8.25
Air Quality	Ambient air quality	Decommissioning	-10	-7.5	-7.5
	Increase in noise levels	Construction	-10	-7.5	-7.5
	Increase in noise levels	Operation	-9.75	-9	-9
Noise	Increase in noise levels	Decommissioning	-10	-7.5	-7.5
	Further general degradation of the local landscape	Construction	-6	-4	-4
	Further general degradation of the local landscape	Operation	-6.75	-4.5	-4.5
Visual	Degradation of views from the R33 and R572 in proximity to the proposed site	Construction	-6	-4	-4
	Degradation of views from the R33 and R572 in proximity to the proposed site	Operation	-6.75	-4.5	-4.5

Environmental Theme / Specialist Discipline	Impact	Phase	Pre-mitigation Significance	Post-mitigation Significance	Final Significance Including Priority Factor
	Further degradation of the local landscape as viewed from adjacent local roads	Construction	-6	-4	-4
	Further degradation of the local landscape as viewed from adjacent local roads	Operation	-6.75	-4.5	-4.5
	Further degradation of the local landscape as viewed from homesteads	Construction	-6	-4	-4
	Further degradation of the local landscape as viewed from homesteads	Operation	-6.75	-4.5	-4.5
	Degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves	Construction	-6	-4	-4
	Degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves	Operation	-6.75	-4.5	-4.5
	Lighting impacts on sensitive receptors	Construction	-6	-4	-4
	Lighting impacts on sensitive receptors	Operation	-6.75	-4.5	-4.5
	Induced or triggered seismic activity	Construction	-4	-3.75	-5.15625
Seismicity	Induced or triggered seismic activity	Operation	-4.5	-3.75	-3.75
	Induced or triggered seismic activity	Decommissioning	-4	-3	-3
	Deterioration of existing road surfaces/ pavements	Construction	-11	-5.5	-6.1875
Traffic	Deterioration of existing road surfaces/ pavements	Operation	-13	-6.5	-7.3125
	Deterioration of existing road surfaces/ pavements	Decommissioning	-5	-2.5	-2.5
	Traffic congestion	Construction	-11	-5.5	-6.1875
	Traffic congestion	Operation	-13	-6.5	-7.3125
	Traffic congestion	Decommissioning	-10	-2.5	-2.5
	Safety of road users	Construction	-13	-6.5	-7.3125
	Safety of road users	Operation	-15	-7.5	-8.4375
	Safety of road users	Decommissioning	-12	-3	-3

1.5 PUBLIC PARTICIPATION

The public participation process (PPP) 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). An integrated PPP process is being conducted which encompasses the EA application, WUL application as well as the AEL application. 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 and ultimately to inform this EIA process and authority decision making.

While there was an initial notification undertaken in November 2023, the project was put on hold and recommenced in 2026 and subsequently a second notification and call to register commenced on 20 March 2026. The initial notification was undertaken in English, Afrikaans, Sepedi and Setswana and was given in the following manner:

- Registered letters, faxes, emails and SMS's: Notification were distributed to all pre-identified and previously registered 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 Mogol Pos and Lekae Newspapers with circulation in the vicinity of the application area. The initial newspaper advertisements were published in English, Afrikaans, Sepedi and Setswana.
- Sixty-two (62) A1 Correx site notices (in English, Afrikaans, Sepedi and Setswana) were placed at 36 strategic locations within and surrounding the Production Right application area between the 16th and 20th of March 2026.
- In addition to the above methods of notification, a radio advertisement was broadcast between 18 to 20 March 2026 on Waterberg Stereo radio station.

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;
- SMS notifications where cell phone numbers were available for registered I&AP's; and/or
- Email notifications with a letter attachment containing the information described above.

A high-level summary of the comments raised to date since the initial Call to Register notifications were published/distributed are presented below:

- Request to be registered as an I&AP of the project.
- Request for information relating to the background of the project.
- Request for details (and associated stakeholder engagement forms) on how to register as an I&AP.
- Request for information on affected properties, both in PR area and EIA area.
- Query on how the project will affect other economic activities in the area.

During this scoping phase, the statutory 30-day public participation process is intended to provide opportunity for engagement with landowners, the public, and key stakeholders to obtain any comments, concerns or other relevant information that would be material to the ongoing environmental impact assessment. The methods of engagement are discussed above, and further engagement will be undertaken during the EIA phase following completion of the scoping phase. All comments, concerns and information shared during these consultation processes will be considered by the EAP as well as the specialists to inform the outcome of the various studies.

2 INTRODUCTION

Thungela Operations Proprietary Limited, a member of the Thungela Resources Limited Group (hereafter referred to as the Applicant or Thungela) has submitted a Production Right (PR) application to the Petroleum Agency SA (PASA) for coal bed methane (CBM) in the Lephalale Local Municipality, Limpopo Province, South Africa. Exploration activities which were undertaken in accordance with an Exploration Right (ER) have indicated a potentially viable and extractable CBM resource. The Applicant has applied to the PASA for a PR to extract and produce (utilize) the CBM resource.

The Applicant aims to extract the CBM resource from the PR area in a phased manner. At present a total of 3 production phases are expected to reach the conceptual full field production which spans a total surface area of 134 302.6699 hectares (ha). The first production phase comprises of approximately 333 production wells which will be connected via a buried gas gathering network of pipelines to a centralised gas processing facility. This EA application only covers the first production phase (phase 1) infrastructure along with the overall application for Production Right over the entire PR area and additional environmental permitting and licencing will be required at a later stage for the remaining phases of the wellfield development should these be pursued in future. This phase will include 19 existing wells that were developed during exploration activities.

To optimally produce CBM, hydraulic stimulation or hydraulic fracturing of the target coal seams is being proposed. Following stimulation, the coal seam is dewatered to reduce the hydrostatic pressure of the water within the coal seam which allows the gas to be released to the wellbore. The gas processing includes a compression and liquefaction facility to produce the final product, Liquid Natural Gas (LNG), which will be distributed off site via road transport. The production for phase 1 and 2 is planned to span a period of 30 years commencing from the date that all relevant approvals and licences have been obtained.

The proposed development infrastructure triggers various listed activities in terms of the National Environmental Management Act (Act 107 of 1998 – 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 Water Use Licence (WUL) and Air Emissions Licence (AEL) applications will be submitted for the triggers under the National Water Act (Act 36 of 1998 – NWA) and National Environmental Management Air Quality Act (Act No. 39 of 2004 as amended – NEMAQA) respectively.

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 2 below.

Table 2: 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(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 5
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 3
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 14 Section 4
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

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
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 7
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; ii. Details of the public participation process undertaken in terms of regulation 41 of the Regulations, including copies of the supporting documents and inputs; iii. A summary of the issues raised by interested and affected parties, and an indication of the manner in which the issues were incorporated, or the reasons for not including them; iv. The environmental attributes associated with the alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; 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 of resources; and c. Can be avoided, managed or mitigated; vi. The methodology used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks associated with the alternatives; vii. Positive and negative impacts that the proposed activity and alternatives will have on the environment and on the community that may be affected focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; viii. The possible mitigation measures that could be applied and level of residual risk; ix. 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 Section 9 Section 9.6 Section 0 Section 11 Section 11.1 Section 11.2 Section 13.1
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;	Section 13

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	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;	
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 requirements have been received from the Competent Authority to date.

2.2 DETAILS OF THE EAP

Environmental Impact Management Services (Pty) Ltd (EIMS) has been appointed by Thungela to assist in preparing and submitting the relevant environmental applications, associated reports and documentation, and to undertake a Public Participation Process (PPP) in support of the proposed Thungela Lephalale CBM Project. EIMS is a private and independent environmental management-consulting firm that was founded in 1993. EIMS has in excess of 30 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 EIAs;
- Complies 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 EAP who compiled this Report are as follows:

Table 3: EAP Details.

Name	**Brian Whitfield (Registered EAP) and Lucien James (Candidate EAP)**
Tel No:	+27 11 789 7170
Fax No:	+27 86 571 9047
E-mail:	LCBM@eims.co.za
Professional Registrations:	Brian Whitfield: 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). Lucien James: Candidate EAP with the Environmental Assessment Practitioners Association of South Africa – EAPASA (2023/6772).

Brian Whitfield is a senior project manager at EIMS and has over 20 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, International Finance Corporation (IFC) Performance Standards and World Bank Environmental Health and Safety 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.

Dr Lucien James is an Environmental Consultant and Archaeologist with experience in different fields across the Arts, Social Science, Natural Science, and academia in general. He has been employed by EIMS as an environmental consultant since March 2023 working on several projects under various roles. He is registered with EAPASA as a Candidate EAP. Lucien has obtained a BSc (Hons) in Geography, Archaeology and Environmental Studies (Archaeology-focused) and is accredited as a Professional Archaeologist with the Association of Southern African Professional Archaeologists (ASAPA). He holds a MSc in Geography having done research on phytoremediation and the mining industry. In 2024, he completed his Ph.D. through research with a focus on collaborative River Basin Management in South Africa. He has worked as a Teaching Assistant (TA) and researcher since 2018 and engages in academic work through publications and conferences. The Curricula Vitae of the EAPs included in Appendix 1.

2.3 SPECIALISTS

As part of this EIA several specialist studies have been commissioned to investigate key impacts that require further investigation. A list of the preliminary specialist studies is included in Table 4. Any additional studies that may be identified during the scoping and consultation process will be considered and included in the EIA phase.

Table 4: List of specialist studies to inform this EIA application.

Specialist Discipline	Company/Organisation
Air Quality and Climate Change	Airshed Planning Professionals
Economic	Strategy4Good
Geohydrology	Gradient Groundwater Consulting
Heritage and Palaeontology	PGS Heritage
Hydrology	Hydrologic Consulting
Noise	Airshed Planning Professionals
Social	Equispectives Research and Consulting Services
Ecology	The Biodiversity Company
Visual	Environmental Planning and Design
Aquatic and wetland	The Biodiversity Company
Hydropedology	The Biodiversity Company
Major Hazardous Installation - Qualitative Risk Assessment	Riscom
Seismicity	Council for Geosciences
Traffic	LD&S Consulting

3 LOCATION AND PROPERTY DESCRIPTION

The Production Right (PR) application area encompasses 224 farm portions and a total area of 134 302.6699 ha. The first phase (the EA application area) will comprise a smaller area within the broader PR area and will be the subject of this EIA and application for EA. The EA application area encompasses 20 farms and covers an area of approximately 20 443 ha. Refer to Table 5 for locality details as well as a full list of the affected properties and their respective 21-digit Surveyor General codes for the Phase 1 area. Figure 1 provides a spatial representation of the PR and EIA application project extent. A satellite image of the EA application area in relation to the PR area is provided as Figure 2. A site plan demarcating the separate properties included within the application area are depicted in Figure 3.

A description of the application area and location as well as the properties are included in Table 5 below.

Table 5: Locality details

EA Application Area (ha)	The EA application area encompasses 20 farms and covers an area of ~20 443 ha.	
Magisterial District	The proposed project falls within the Lephalale Local Municipality, in the Waterberg District Municipality, Limpopo Province.	
Distance and direction from nearest towns	The EA Application area is situated ~14km to the northwest of Lephalale town, 5km north of Marapong, and ~11km northwest of Onverwacht.	
Farm Name, Number and Portion as well as 21-digit Surveyor General Code	**Farm Name, Number and Portion**	**21 Digit Surveyor General Code**
	Withoutpan 404	T0LQ00000000040400000
	Paddakraal 405	T0LQ00000000040500000
	Ganzepan 446	T0LQ00000000044600000
	Vooruit 449	T0LQ00000000044900000
	Schrikvoorby 445 (Remaining Extent)	T0LQ00000000044500000
	Schrikvoorby 445 (Portion 1)	T0LQ00000000044500001
	Gelykebult 450	T0LQ00000000045000000
	Welgevonden 444	T0LQ00000000044400000
	Eendragtpan 451	T0LQ00000000045100000
	Grootpan 452	T0LQ00000000045200000
	Elandsvley 453	T0LQ00000000045300000
	Nooitgedacht 403	T0LQ00000000040300000
	Bulklip 701 (Remaining Extent)	T0LQ00000000070100000
	Bulklip 701 (Portion 1)	T0LQ00000000070100001
	Leeuwfontein 400	T0LQ00000000040000000
	Oliphantspad 255	T0LQ00000000025500000
	Klimopfontein 223 (Remaining Extent)	T0LQ00000000022300000
	Kurzabonakop 399	T0LQ00000000039900000
	Kerryfontein 402	T0LQ00000000040200000
	Waterval 169 (Remaining Extent)	T0LQ00000000016900000

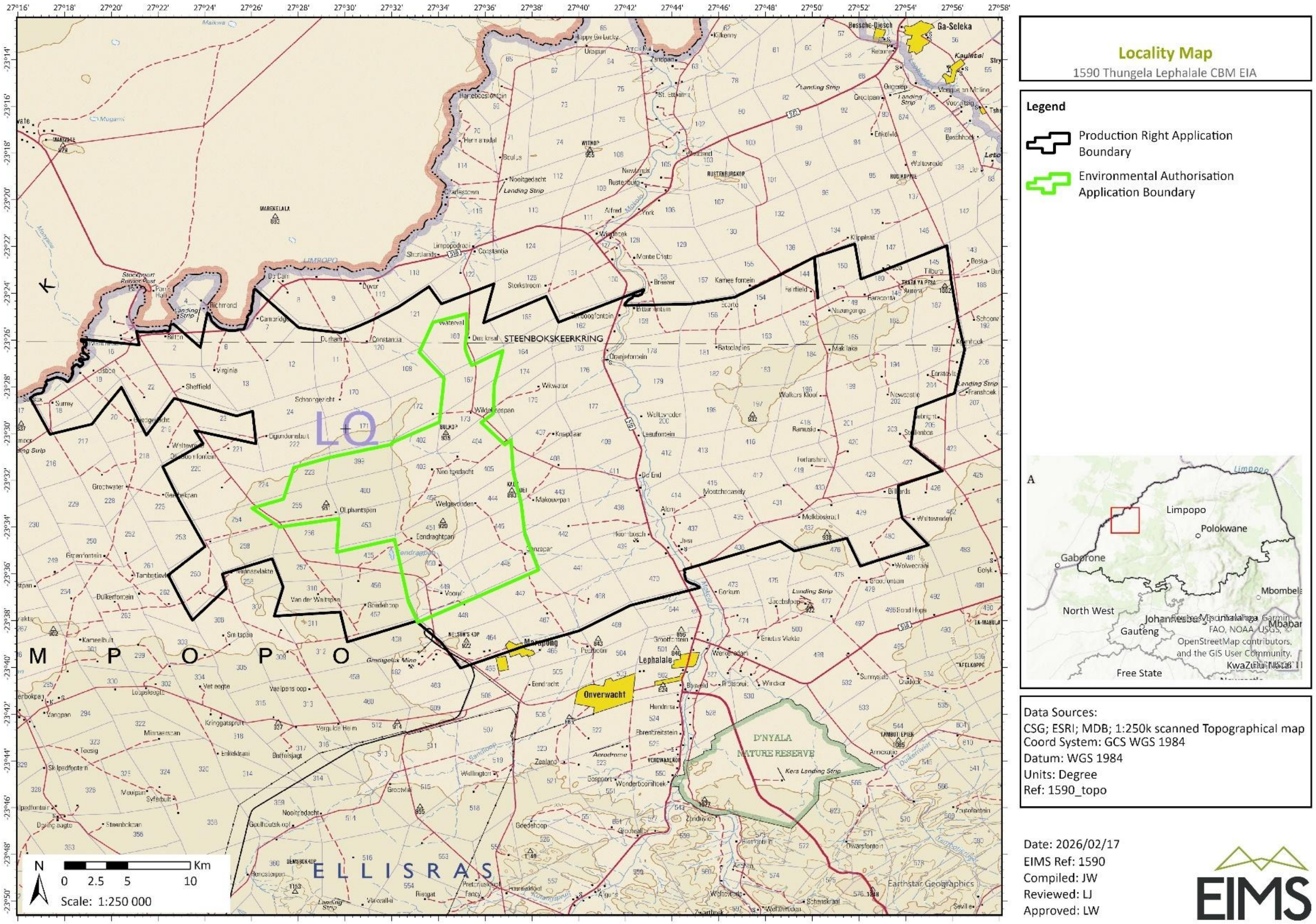


Figure 1: Topographical location and extent of the overall Production Right area (black outline) and the EIA application area (green outline).

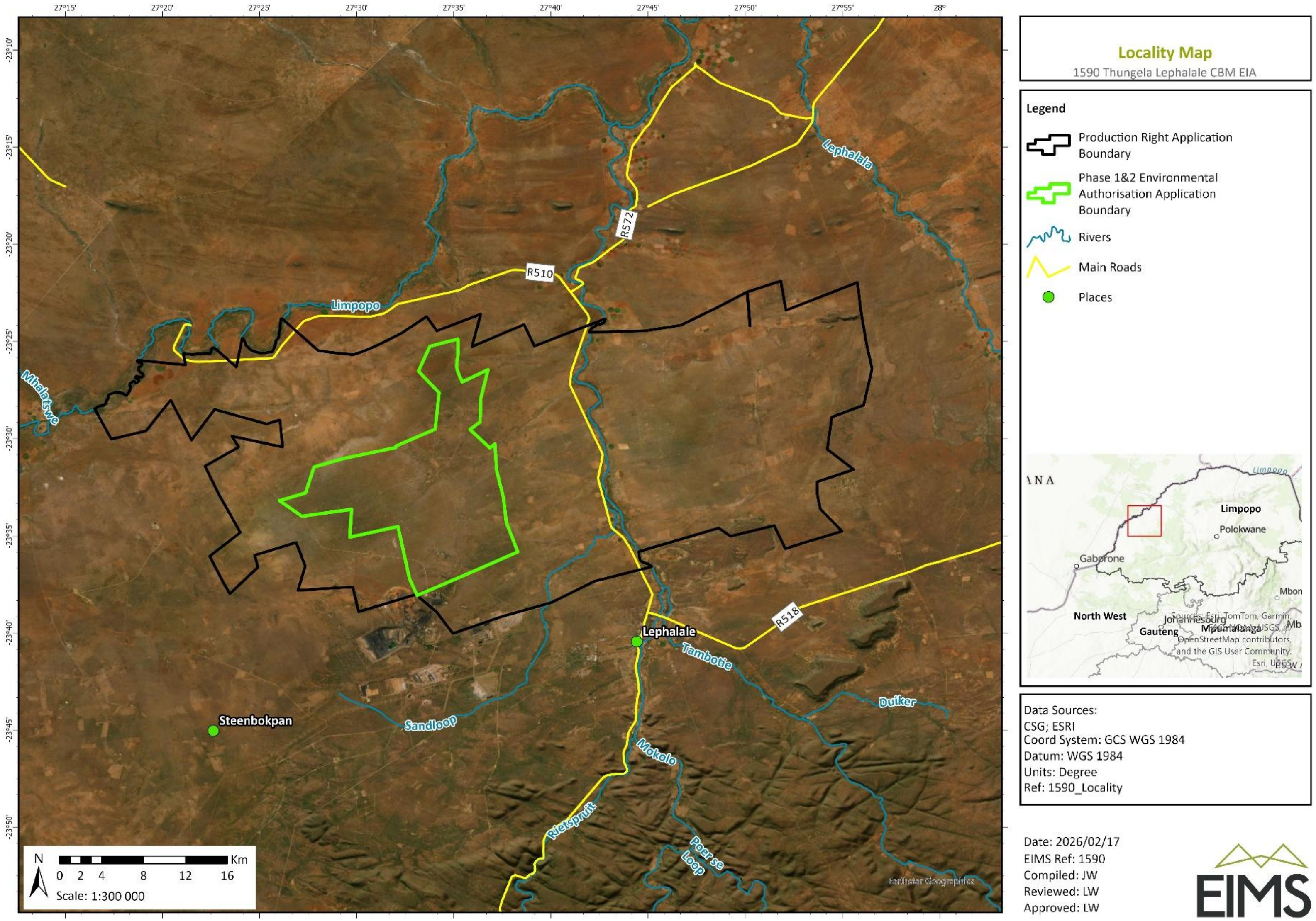


Figure 2: Google Earth image showing location and extent of the overall Production Right area (black outline) and the EIA application area (green outline).

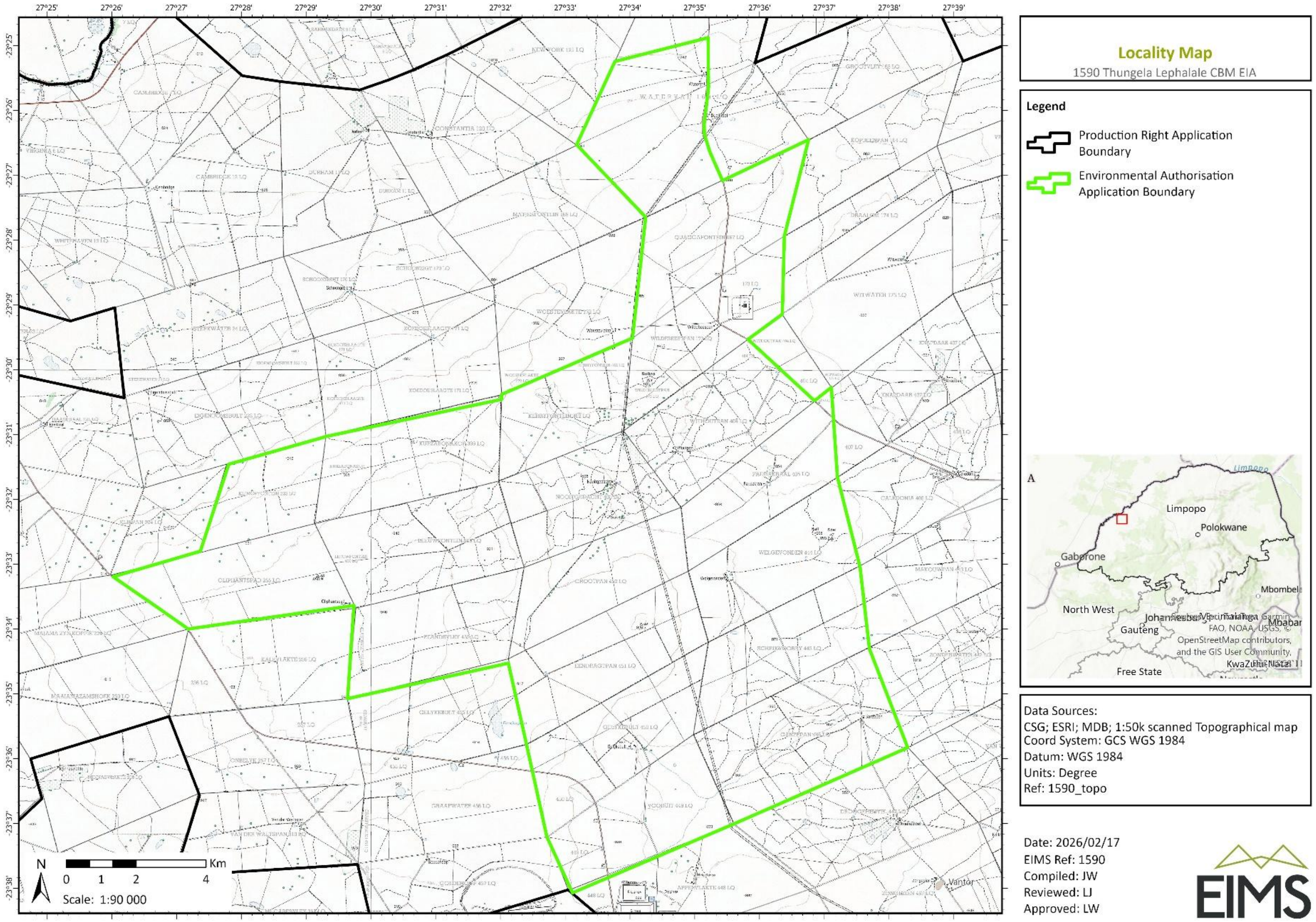


Figure 3: Topographical map showing properties under this EIA application.

4 DESCRIPTION OF THE PROPOSED ACTIVITY

This section describes the proposed Thungela Lephalale CBM (LCBM) Project with its associated infrastructure. At the end of this section, the applicable listed activities[2] relating to the project are presented.

4.1 PROJECT DESCRIPTION

This section provides a detailed description of the project, associated structures and infrastructure, and activities. A description of the extent (spatial and temporal) is also provided.

4.1.1 PROJECT OVERVIEW

Thungela has submitted a Production Right (PR) application to the Petroleum Agency SA (PASA) for coal bed methane (CBM) in the Lephalale Local Municipality, Limpopo Province, South Africa. Exploration activities which were undertaken in accordance with an Exploration Right (ER) have indicated a potentially viable and extractable CBM resource. The Applicant consequently has applied to the PASA for a PR to extract and produce (utilize) the CBM resource.

***What is CBM:** CBM is a form of natural gas which can be recovered from coal deposits or coal seams. The gas is formed during the natural conversion of plant material into coal, known as coalification. When coalification occurs, the coal becomes saturated with water and methane gas is trapped within it*

Thungela aims to extract the CBM resource from the PR area in a phased manner. At present a total of 3 production phases are expected to reach the conceptual full field production which spans a total surface area of 134 302.6699 hectares (ha). The first production phase comprises of approximately 333 production wells which will be connected via a buried gas gathering network of pipelines to a centralised gas processing facility. This phase will include 19 existing wells as well as new wells to be constructed across the 20 properties of the EA area, all totalling to approximately 333 wells and covers an area of approximately 20 443 ha.

The PR and EA application area falls within the Lephalale Local Municipality (LM) and Waterberg District Municipality (DM), Limpopo Province. The EA application area is situated ~14km to the northwest of Lephalale town, 5km north of Marapong, and ~11km northwest of Onverwacht. The 20 farms and/or farm portions under this application are presented in Table 5. Two (2) of these farm portions are privately owned, three (3) are owned by Exxaro and the remaining fifteen (15) are owned by Thungela.

To optimally produce CBM, hydraulic stimulation or hydraulic fracturing of the target coal seams is being proposed. Following stimulation, the coal seam is dewatered to reduce the hydrostatic pressure of the water within the coal seam which allows the gas to be released to the wellbore. The gas processing includes a compression and liquefaction facility to produce the final product, Liquified Natural Gas (LNG), which will be distributed off site via road transport. The production is planned to span a period of 30 years commencing from the date that all relevant approvals and licences have been obtained.

4.1.1.1 **EXPLORATION AND THE ORIGINAL “5-SPOT”**

Exploration activities conducted under Thungela’s Exploration Right established the earliest basis for proving the technical and commercial viability of coal bed methane (CBM) extraction within the Production Right (PR) area. As part of these activities, Thungela constructed the original “5-Spot” on the farm Bulklip 701. This consisted of a cluster of five vertically drilled CBM wells that were hydraulically stimulated and connected to a small gas and water gathering network, a water treatment unit, and a small gas processing facility. The 5-Spot was used as a

[2] "activity" means an activity identified in any notice published by the Minister or MEC in terms of the NEMA, NEMWA, NWA and/or NEMAQA as a listed activity or specified activity that may not commence without the requisite authorisation granted by the Minister or MEC.

prefeasibility test site and generated valuable geological, operational and production data that informed the design of subsequent project phases.

4.1.1.2 INITIAL PROOF OF CONCEPT (POC)

Building on the results from the original 5-Spot, Thungela later developed a second 5-Spot on the farm Nooitgedacht 403 as part of the exploration programme. These wells were stimulated much later together with nine additional wells creating a functional 14-well wellfield. These wells were hydraulically stimulated and connected to a centralised gas and water processing facility. The 14-well cluster were connected to the original 5 spot wells, and together the 19 wells became the company's effective Proof of Concept (PoC), successfully demonstrating sustained CBM production capability, stable gas quality, and commercial-scale LNG production under the existing environmental authorisation (which included bulk sampling approval) previously referred to as the "37-Spot EA".

The PoC confirmed the viability of expanding CBM operations in the Lephalale region and now forms an integral part of Phase 1 of the wider production roll-out. For the purposes of this EIA, Phase 1 comprises approximately 333 wells in total, and this number includes:

- The 19 wells constructed during exploration, and
- Approximately 314 additional new wells that will form part of the Phase 1 production sequence.

These existing wells and their associated infrastructure will be incorporated into the Phase 1 operational footprint and will tie into the broader gas and water gathering networks, processing facilities, and long-term production systems proposed for the full Phase 1 development.

This consolidation of the earlier exploration and PoC infrastructure into Phase 1 ensures continuity between historic data-generating activities, the proven operational model, and the larger-scale production configuration assessed as part of this application.

4.1.1.3 PHASE 1 (THIS APPLICATION)

This phase will cover the 20 properties described above and engage the installation of new wells and associated CBM production infrastructure. As a point of departure Thungela has identified a uniform well grid pattern covering the EA application area at a well density of 1 well per 40 acres/ 16 hectares or ~400m apart from each other in a North-South, East-West direction.

The location of the individual well sites will be defined firstly by the location of the target resource (i.e. depth and presence of coal seams) and secondly considering any physical or environmental constraints that may occur at a site-specific location. Examples of constrains that will, where practically possible, be avoided when siting well sites may include, but not limited to:

- Sensitive biophysical and environmental features, such as wetlands, watercourses, springs, sensitive habitats or species of conservation concern, etc
- Sensitive social and cultural features: existing land uses which may not be compatible with the well infrastructure (e.g. homesteads), graves sites or cemeteries, archaeological or paleontological sites, etc.
- Geological or physical features, such as fault lines, areas of geologic instability, steep slopes, or rocky outcrops.

Individual wells will be connected to the gas gathering network through an underground gas pipeline network and the dewatering pipelines will be located along the same routes as the gas pipeline network. The pipeline networks will transport gas to the LNG plant for processing of the gas and transport water to the water treatment plant for the treatment of the water to relevant discharge standards. Various options will be considered during this EIA process for the use or disposal of the treated water to identify the optimal use of this resource.

Thungela has applied to the relevant designated authority, namely the PASA, for an EA for the first phase of the production (i.e. ~333 wells). The remaining phases and associated areas within the production right are not included in this EIA and will need to be assessed separately as and when the need for these expansions and future phases arises.

EIMS has been appointed by Thungela to fulfil the role of the Independent EAP in undertaking an EIA process to support applications for the required environmental regulatory approvals. These approvals include, but are not limited to:

- EA in terms of the NEMA;
- Environmental Management Programme (EMPr) in terms of the MPRDA;
- WUL in terms of the NWA;
- WML in terms of the NEMWA; and
- AEL in terms of the NEMAQA (if required).

4.1.2 PROJECT TIMELINE

The Production Project will span a period of ~30 years. The high-level project timelines are as follows:

- Year 0 to 3.5: Develop the Phase 1 wellfield (construction phase). This includes the well development and the installation of the associated water and gas gathering reticulation. The phase 1 gas processing facilities and water treatment facilities will be constructed.
- Year 3.5 to year 30[3]: Wellfield and plants will be operational.

4.1.3 GAS RESOURCE

Thungela has identified the opportunity to extract and produce CBM from the coal deposits in the Waterberg Coalfield. The Waterberg coalfield is an extensive deposit of coal resources located in the Lephalale basin. The coal resources fall within the Karoo Supergroup deposited during the late Permian through Triassic periods (260-190 million years ago). The production zone for the CBM lies within the Beaufort #1 seam of the Ecca Group (refer to Figure 4).

[3] The MPRDA makes provision for extension of the production right validity beyond 30-years (subject to application review and approval by the Competent Authority).

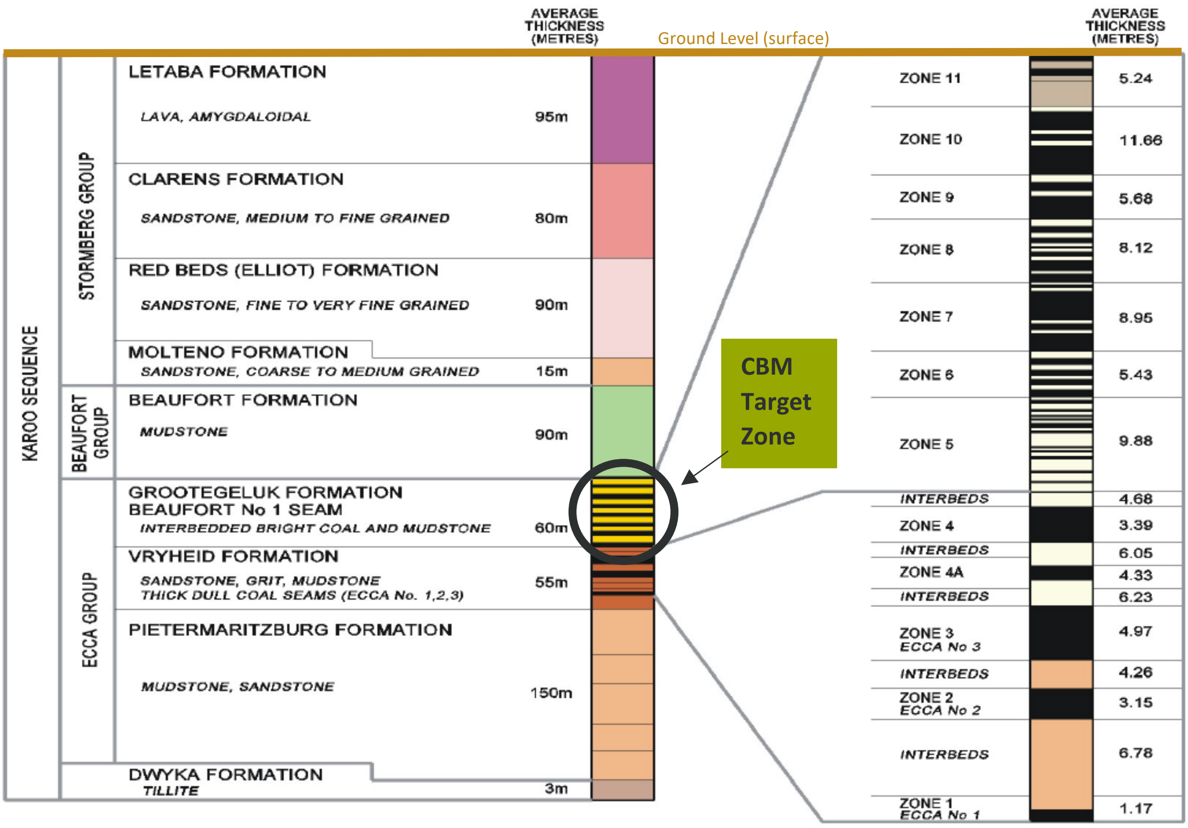


Figure 4: Deep Waterberg basic stratigraphic column.

As Thungela plans to develop the PR area in distinct phases, this would allow amongst others, for the development of the full field production accommodating changes in market demand for natural gas and LNG and avoid/ minimise the potential risk of a stranded asset. A calibrated geological and reservoir model was utilized to identify production parcels within the PR boundary. A total of 25 production parcels were identified and modelled for gas and water production at three depths within the targeted Beaufort No.1 coal seam.

The predicted gas and water production from each parcel was used to identify 3 separate phases over which the full field could be developed. The infrastructure needed to support the development of Phase 1 is listed and illustrated in Figure 5. A description of the infrastructure and associated activities is provided in the subsequent sections.

Figure 5: List of surface infrastructure and example pictures.

4.1.4 WELLS

The collection of production wells required to extract the gas from the resources is referred to as the wellfield. The proposed wellfield for Phase 1 (the extent of this EA application area) comprises of 333 wells, which includes 14 existing production wells as well as the original 5 exploration wells, part of the original "5-spot".

The location of the individual well sites will be defined firstly by the location of the target resource (i.e. depth and presence of coal seams) and secondly considering any physical or environmental constraints that may occur at a site-specific location. Examples of constraints that will, where practically possible, be avoided when siting well sites may include, but not limited to:

- Sensitive biophysical and environmental features, such as wetlands, watercourses, springs, sensitive habitats or species of conservation concern, etc
- Sensitive social and cultural features: existing land uses which may not be compatible with the well infrastructure (e.g. homesteads), graves sites or cemeteries, archaeological or paleontological sites, etc.
- Geological or physical features, such as fault lines, areas of geologic instability, steep slopes, or rocky outcrops.

The specific environmental, social, cultural, and geological constraint areas will be identified through the course of this EIA process. The aim being to optimally locate the proposed well sites such that impacts are avoided, or where not avoidable the significance of the impact is reduced.

Well development comprises the initial well drilling (including casing and cementing) and then the hydraulic stimulation of the well followed by coal seam dewatering to promote gas flows.

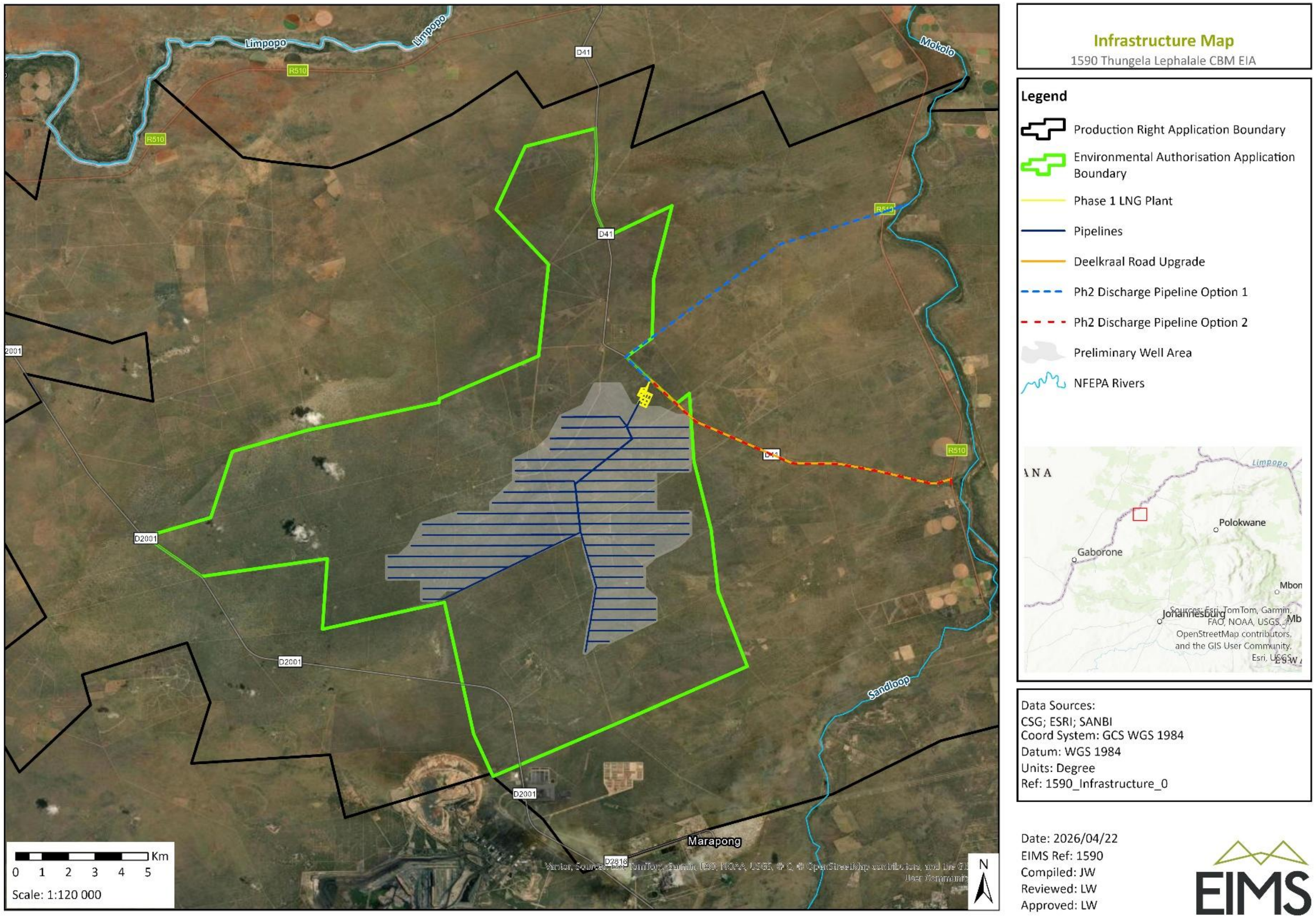


Figure 6: Proposed infrastructure layout including LNG Plant location, indicative production wells, Deelkraal Road upgrade and discharge pipeline alternative routes.

4.1.4.1 **WELL DRILLING**

Following receipt of all relevant approvals, once the specific well location has been identified and relevant landowners' agreements have been finalised (if required), the site clearance and well drilling will commence. Each drill site will be cleared of grass and shrubs over an area of ~40m x 40m (1600m^2). Pitless[4] drilling methods will be investigated and implemented if required or alternatively temporary sumps will be constructed to contain the drilling fluids and separate out drill cuttings for drill water reuse. Sumps for the drill mud will be excavated (8m x 8m x 1.5m (d)). Single vertical well configuration is proposed for the LCBM project. A typical well drill site layout is presented in Figure 7, and will cover a footprint of disturbance of ~0.16ha. The well development site will need to be large enough to accommodate the drill rig and associated equipment (including drill strings, casing, etc), the drill water management facilities (mud settling ponds, water storage tanks) and the hydraulic stimulation equipment (described in Section 4.1.4.4). The temporary well development site will be demarcated.

The well is drilled using a combination of air and water rotary drilling or conventional reverse circulation percussion drilling. Figure 8 provides an image of a typical production well above ground infrastructure. Figure 9 provides an indication of the likely duration for individual well completion activities. Depending on the conditions experienced at specific sites, the geological profile, and the number of other wells being drilled these durations can vary.

Figure 7: Aerial view of typical well construction.

[4] Pitless drilling, or closed-loop systems, is a modern, eco-friendly method in gas drilling that eliminates traditional, large earthen waste pits. Instead, it uses specialized surface equipment—like centrifuges and steel tanks—to continuously treat and reuse drilling fluids on-site.

Figure 8: View of typical production well above ground infrastructure.

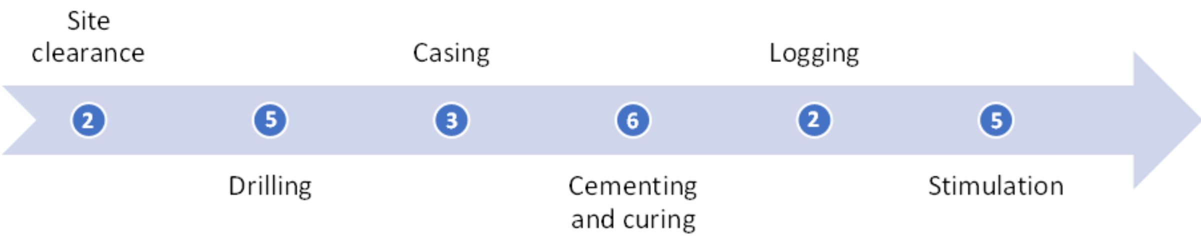


Figure 9: High level estimated duration (in days) for a well completion.

Air and water rotary drilling is typically used in low pressure formations when drilling through zones which may potentially be susceptible to loss of circulation, or through freshwater aquifer zones if water is present. Drilling fluids (often referred to as drilling mud) fulfil the following purposes:

- To circulate the rock chips and cuttings as the drill bit advances through the rock and transport these to the surface to clear the wellbore;
- To lubricate and cool the drill bit;
- To stabilise the wellbore and prevent unnecessary collapse or cave-ins; and
- To control and maintain downhole fluid pressures.

The following order of priority for the sourcing of water for drill muds will be applied for the project wherever reasonably possible:

1. Reuse of produced water from earlier wells, which will be treated to meet the drilling standards for reuse and environmental discharge requirements as applicable.
2. Natural groundwater resources (boreholes)- subject to relevant licencing.

Preference will always be given to water conservation options and reuse of water, as opposed to abstracting water from the local natural water resources. The water required for the drilling will be hauled (via water tanker) or piped to the well site. The water will be stored on site at the well site in lined ponds or above ground water tanks until it is used. It is expected that a 15m^3 water storage tank (similar to a large Jo-Jo tank) will be required at each well site.

Closed loop drilling will be implemented and allows for the re-use / recirculation of the drilling fluids. The drilling duration per well will take ~15 days with overlapping activities on different wells. The volume of water used to drill each well will be approximately 80m^3 with 7 stimulation zones and an additional ~ 60m^3 for notching. In summary, the drill water will be used for the following activities:

- preparing the drilling mud (used to clean the well bore of rock);
- cleaning and flushing of equipment and wellbore;
- notching of the casing; and
- well stimulation.

The wastewater generated during the drilling operations will be ~5-10 m^3 which will be collected in lined sumps and allowed to evaporate. The sumps will be designed to maintain a freeboard of at least ~61cm. After a well is completed the residual fluids and mud will be collected and stored in above ground receptacles (e.g. waste skips for solids and liquids moved to water treatment plant), prior to disposal at an appropriately licenced waste disposal facility.

Vehicle access to each well site will be required. Access will be established prior to well development and will comprise a 2-spoor track wide enough to accommodate the drill rig and will, where possible and reasonable, align with the future gas and water pipeline networks. Where necessary, environmentally sensitive areas and features (e.g. protected trees, water resources, heritage features, etc) and surface infrastructure (e.g. residences, kraals, reservoirs, etc) will be avoided.

The power requirements for the well development phase will be provided through a combination of the following:

- Diesel combustion engines (drill rig, mobile generators); and
- Local low voltage electrical reticulation systems if available within proximity to a specific well site.

All wells will be drilled, cased and cemented in accordance with applicable international standards and best practice guidelines (e.g. API, ASTM, etc), to ensure vertical isolation of the gas and/or saline water (produced or formation water) from both the surrounding geology and freshwater aquifers.

4.1.4.2 **WELL DESIGN**

This section provides a brief description of the proposed design concepts for the drilling, casing and cementation.

The depth of the production wells is dependent on the depth of the targeted coal seam and is expected to be between 218m to 312m, with an average depth of 264m. Figure 10 provides a schematic of the structure of a typical CBM well for this project. The drilling operations will be undertaken by an experienced drilling contractor under the supervision of the Thungela representatives.

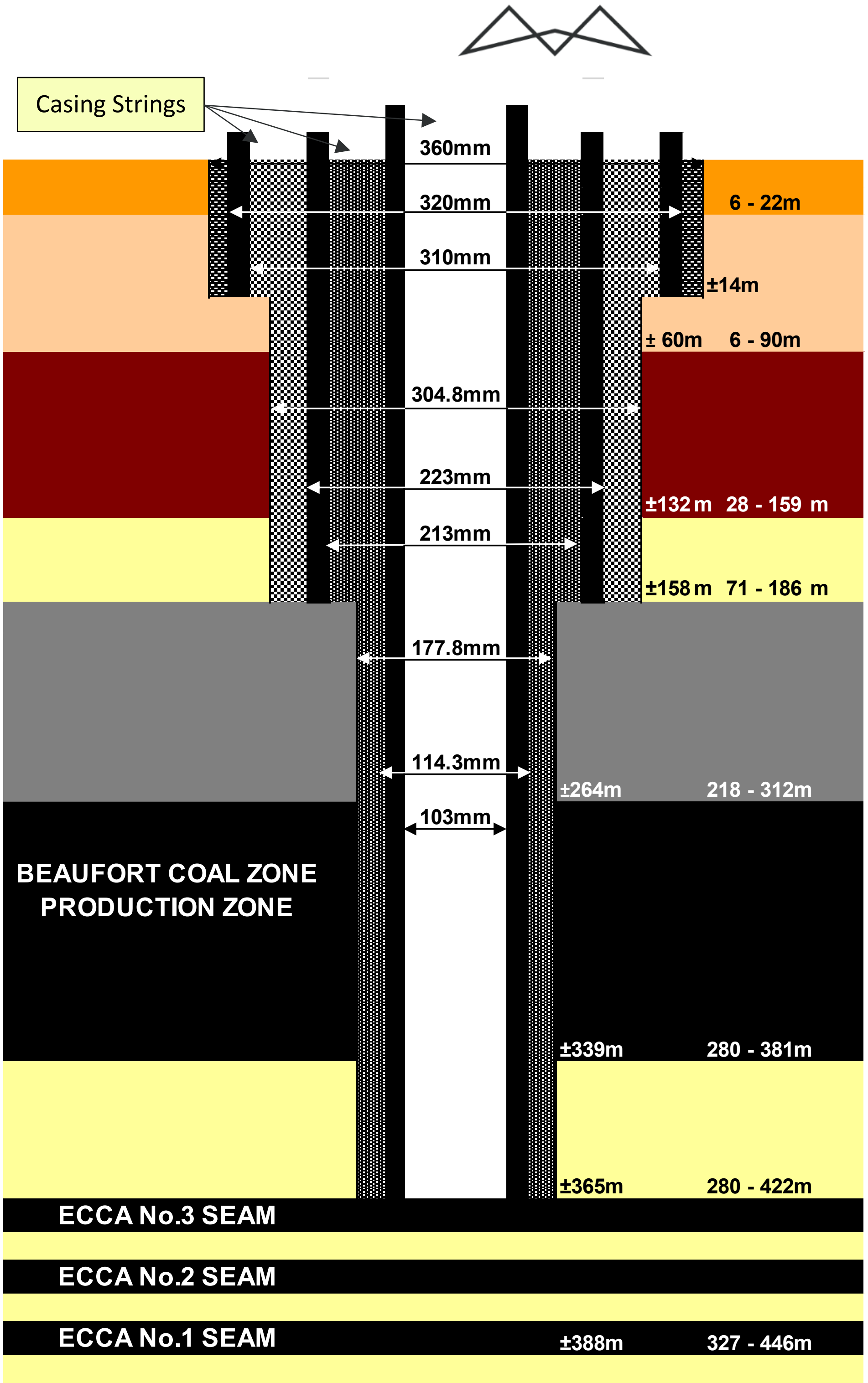


Figure 10: Typical wellbore profile schematic showing casing strings which are well integrity barriers.

A wellbore casing is a series of steel pipes installed in the drilled hole and cemented in place to provide structural support, isolate geological formations, and create a controlled conduit for gas to flow safely to the surface. Multiple casing strings (e.g., conductor, surface, and production casing) are typically used. In the context of well integrity, the casing forms a critical part of an integrity barrier—a system of physical elements designed to prevent the uncontrolled migration of fluids (gas or liquids) from the wellbore into surrounding formations or to the surface. When combined with properly placed cement in the annulus (the space between the casing and the borehole wall), the casing acts as a primary or secondary barrier, ensuring containment of reservoir fluids, protection of groundwater resources, and safe operation throughout the life of the well. The conceptual wellbore and casing progression are described in Table 6.

Table 6: Conceptual casing progression.

Casing	Purpose[5]	Specifications[6]
Conductor casing	Component that provides structural support for the well, and often used for hole stability for initial drilling operations.	0-10m (range 6-22m) deep: 381mm (15-in) diameter (Ø) percussion drilled hole containing a 327mm Ø conductor casing cemented to surface
Surface casing	Casing that is run inside the conductor casing to protect shallow potable aquifer zones and/or weaker formations.	10m- ~160m deep (range 71-186m): 292.1cm Ø percussion hole drilled containing 219.1mm Ø casing cemented to surface
Production casing	The casing which is installed from the wellhead to the top of, or through, the completion interval and is cemented in place to seal off producing/injection zones and water bearing formations. The tubing string, if used, is suspended in the production casing.	~160m- 370m deep (range 280-422): 200mm Ø percussion hole drilled containing a 139.7mm Ø casing cemented to surface.

It should be noted that the actual lengths and diameters of the conductor, surface, and production casing will depend on the specific geological and hydrogeological character of the specific wellbore site. Also, considering that well stimulation is being proposed the casing strength must be designed to accommodate the high pressures and prevent damage to the casing string and cementation.

4.1.4.3 **WELL CEMENTATION**

Once the wellbore casing is installed the cementation process commences. The cementing involves mixing a predefined cement slurry and pumping it into a wellbore to perform functions such as supporting casing, isolating formations behind casing, and protecting freshwater aquifers. The cement also permanently seals and secures the casing string to the wellbore and involves the placing of the cement slurry into the space between the wellbore (i.e. the rock surface) and the casing, known as the annulus. Specialized high pressure cementing equipment is required to complete the cementing operations.

The physical properties of the cement mixture are adapted to the specific target geological formation to ensure a functional seal between the casing and the wellbore, without degrading the formation.

Prior to the pumping of the cement the following is undertaken:

- Casing string must be centred within the wellbore using centralisers. These centralisers allow for a uniform cement sheath around the casing string as well as ensuring that the cement scours the entire annulus and displaces all the drilling fluids. This centralising is critical to ensuring effective cement coverage and bond.
- A float shoe is placed at the base of the casing to ensure one direction flow of cement from the casing into the annulus.
- Annulus must be cleared of any debris. This cleaning and conditioning of the annulus is typically achieved by pumping a defined viscous fluid (e.g. bentonite), known as a slug, into the annulus that is then displaced by the cement as it is pumped. This ensures better cement coverage.

The cementation involves the pumping of cement down the casing and U-tubes through the annulus to arrive at surface. Once the full length of the annulus is cemented a wiper plug is inserted into the casing to remove residual cement within the casing.

A cement bond log will be run on the production string to ensure an effective cement job before commencing with the final casing perforation and well stimulation.

[5] Source: International Association of Drilling Contractors (2023)
[6] These specifications are provided as guidance only. The specific technical requirements will be defined and adapted during the Production phase.

4.1.4.4 WELL STIMULATION

Once the well is cased and effectively cemented, the casing is perforated at intervals within the coal bed (218-381m deep) to allow for the stimulation of the target seam. The casing is perforated at the target coal seam by using a technique known as notching. Notching of the casing is achieved by running a jetting tool on tubing to the desired depth. Water is then pumped down the tubing with a mix of low concentration abrasive (e.g. sand which is sourced from commercial sources) to create a high-pressure jet against the casing. The tool has three cutting holes. Once the casing and cement has been penetrated, the coal seam will then be hydraulically stimulated to initiate gas flow. There will likely be four different depth entry points for each stage within the well aligned to the coal seams where the casing is perforated. Hydraulic stimulation takes place in seven stages in the well. Refer to Figure 11 for underground schematic of a perforated well during stimulation.

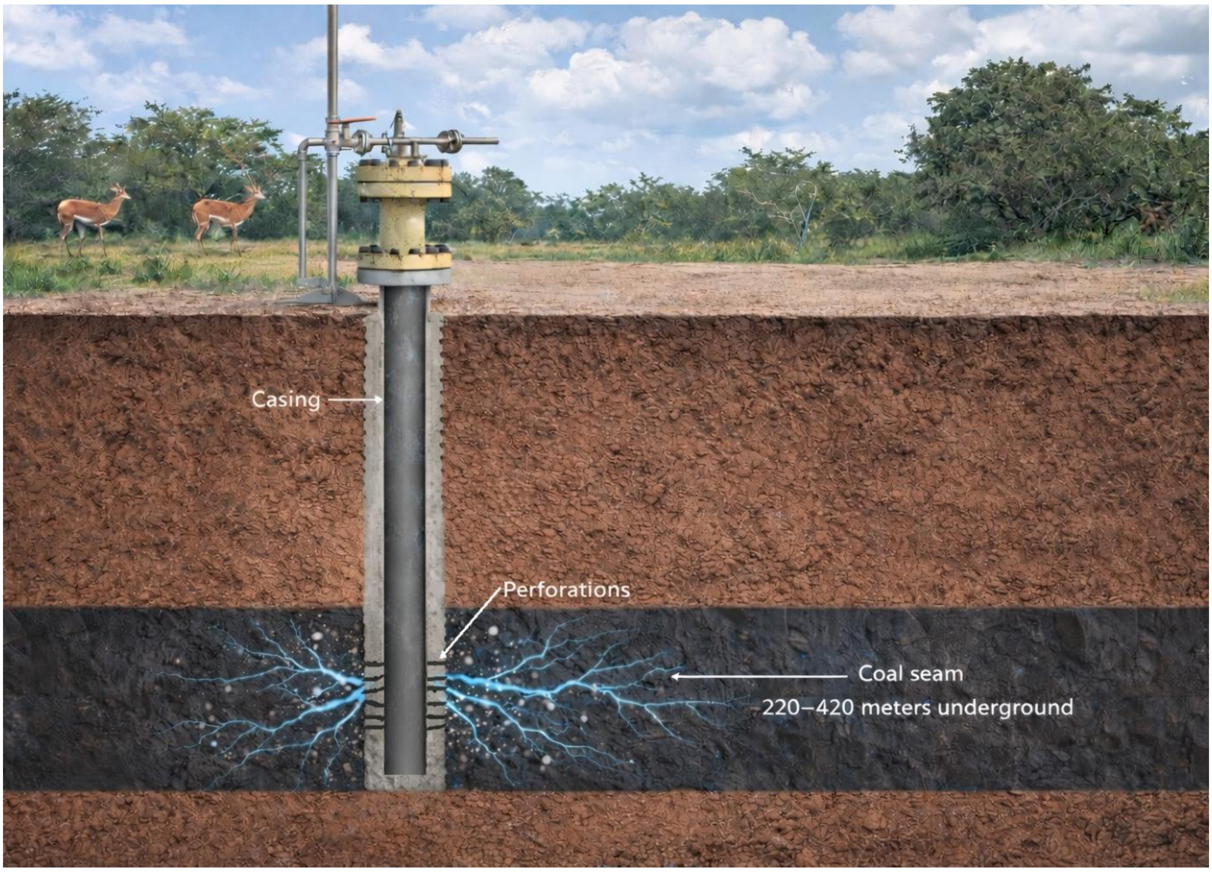


Figure 11: Hydraulic stimulation schematic.

In terms of the Department of Water and Sanitation (2021), hydraulic stimulation is defined as “the process of injecting fluids into a target formation at pressures exceeding the parting pressure of the rock to induce fractures through which hydrocarbons can flow.” While this definition is broadly applicable to shale gas operations, it does not fully describe stimulation of coal beds for coal-bed methane (CBM). Unlike shale formations, coal seams already contain a natural network of *cleats* (bedding-parallel fractures) through which gas is stored and can flow.

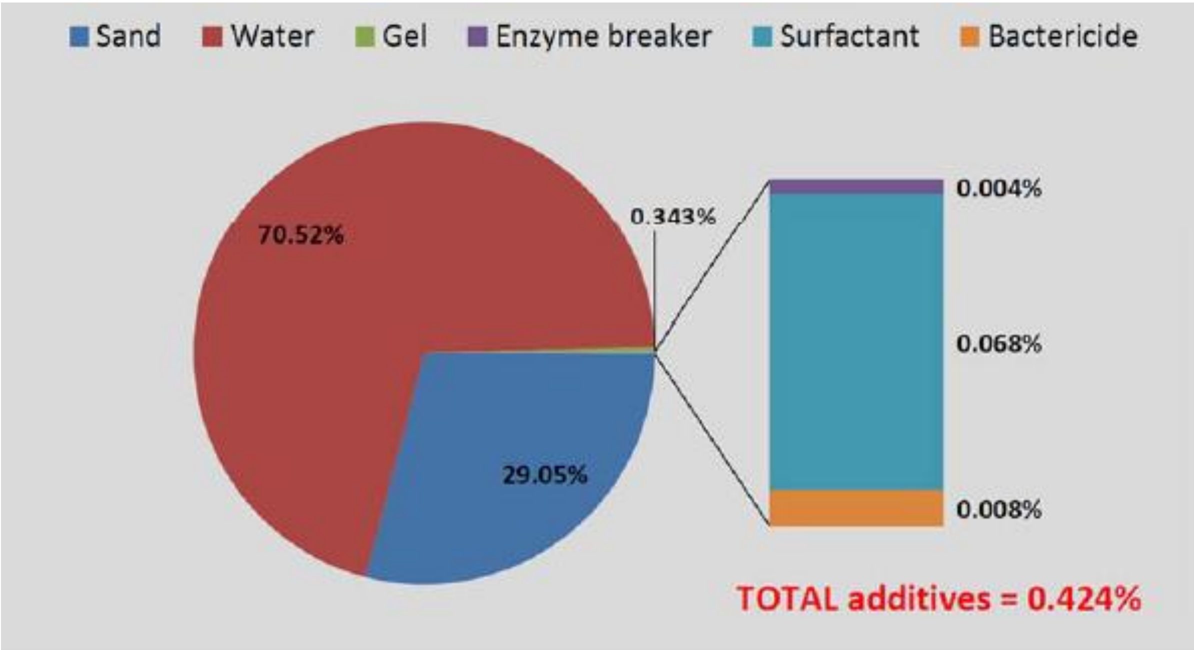
For CBM, hydraulic stimulation does not aim to create large new fractures or propagate long, high-pressure stimulation fractures. Instead, the purpose of the stimulation is to:

- enhance connectivity within the existing cleat system,
- clean and widen natural micro-fractures, and
- improve the permeability of the coal to initiate efficient gas release and subsequent flow

The pressures used during CBM stimulation are significantly lower than those applied in shale gas fracking, and the resulting fracture lengths are typically shorter. The process is therefore better described as hydraulic stimulation, rather than “fracturing” in the shale-gas sense.

Thungela has successfully undertaken hydraulic stimulation as part of the exploration phase at the 5-Spot (effectively a cluster of 5 exploration wells connected to a small gas processing plant) during 2004. In addition, the PoC developed under the “37-Spot” EA included a total of 19 wells which were hydraulically stimulated and dewatered to produce methane which was processed at the established LNG plant for internal use only. A seismic monitoring network was installed prior to the 19 wells being hydraulically stimulated and the data will be shared with the Council for Geoscience (CGS) as part of the EIA phase seismic reporting. These projects have provided valuable insight to the Thungela technical team to guide and optimise the hydraulic stimulation being proposed for the production phase.

Thungela has estimated the material requirements for each CBM well by utilising existing information including historic well test data; historic hydraulic stimulation activities; the available geological data; and industry experience. The estimated material requirement for the hydraulic stimulation of a single CBM well for this project is presented in Figure 12.



Per Well Basis		
Number of fracs per well	7	
Total sand/avg well	65.00	tonnes
Total frac water/avg well	157.86	m3
Total fracgel/avg well	768.85	kg
Total enzyme breaker/avg well	7.85	ℓ
Total surfactant/ avg well	157.85	ℓ
Total bactericide/avg well	18.92	kg

Figure 12: Primary materials required for hydraulically stimulation per well.

The greatest portion of the hydraulic stimulation fluid is water and silica sand. The silica sand functions as a proppant to keep the fractures in the coal open. The sand consists of silica and must be of a specific and consistent particle size. The sand is supplied by road transport directly from a third-party supplier. Figure 13 provides an example of the sand utilised and the classification and MSDS of the silica sand is contained in Appendix 6 which indicates no concerning inherent hazards to the environment.

Figure 13: Silica sand utilised as a proppant during hydraulic stimulation.

The remainder of the hydraulic stimulation fluid (~0.4%) is comprised of additional additives, including:

- An enzyme breaker which aims to convert the stimulation fluid into a lower viscosity fluid which allows for easier extraction of the fluid. According to the MSDS for the enzyme breaker (AF Drillsafe), this product is non-toxic and biodegradable.
- A surfactant which aims to enhance the gas productivity and reduce energy consumption by optimising viscosity of stimulation fluids, reducing surface/interfacial tension between the geological formations and the stimulation fluid, assisting fluid recovery after stimulation, altering the wettability of rock and reducing flow friction of the stimulation fluid. In summary, the surfactant enhances dewatering and drill cuttings transport. According to the MSDS for the surfactant (Hydrofoam), this product is non-toxic and biodegradable.
- A biocide which aims to prevent bacteria, which may cause bio-clogging, inhibit gas extraction, produce toxic hydrogen sulfide (H_2S), and induce corrosion leading to downhole equipment failure. According to the MSDS for one of the biocide (AF Biocide), this product is non-toxic and biodegradable.

The Material Safety Datasheet's (MSDS) of the proposed additives and hydraulic stimulation fluids are attached in Appendix 4.

The complexity of hydraulic stimulation treatments in coal seams can result in short, branching radial fractures that extend only a limited distance from the well. These fractures primarily enhance the permeability of the existing cleat network rather than forming long, planar fractures typical of shale formations.

Thungela plans to utilise a combination blender and pump rig for the project. Figure 14 provides a photo of the combination rig utilised by the project in earlier phases. The combo rig provides a blender tub into which the gelled water and additives is mixed with the sand provided by the hopper and augers at the back. The mixed fluid then gets displaced by the rig mounted triplex pump into the formation via high pressure treatment surface pipes connected to the wellbore.

Figure 14: Proposed combination hydraulic stimulation rig.

Input water required for hydraulic stimulation can be sourced from numerous sources, depending on the availability at the specific time of the stimulation. The following order of priority for the sourcing of water will be applied for the LCBM project wherever reasonably possible:

1. Treated produced water from existing wells.
2. Untreated produced water from existing wells.
3. Natural groundwater resources- subject to relevant licensing.

The water required for the hydraulic stimulation will be hauled (via a water tanker) or piped to the well site. The water will be stored on-site at the well site in above-ground water tanks or flexible water bladders or lined ponds prior and post usage. It is expected that a water storage capacity of 140m^3 will be required at each well site. Figure 15 presents a high-level schematic layout of the typical well site during the stimulation process.

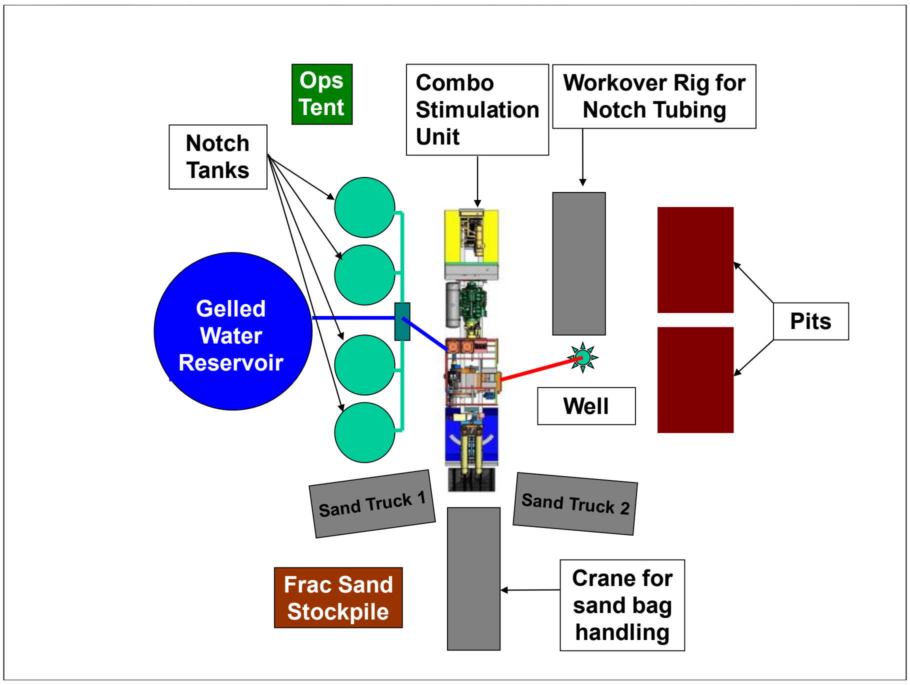


Figure 15: Typical well site layout during stimulation.

Following each series of hydraulic stimulation treatments the wellbore must be dewatered to allow for the gas to flow. Flowback refers to this water that flows back to the surface after the completion of the stimulation treatment. It consists of the fluid used to fracture the formation, including additives. In contrast, produced water is naturally occurring water found in the coal formations that flows to the surface throughout the entire life of the well. At some point, the water that is recovered from the CBM well makes a transition from flowback water to produced water. This transition point can be difficult to discern but is typically identified by the chemical composition of the return water.

The notching and stimulation process is expected to take ~5 days to complete the 7 stage stimulations per well. Following stimulation, the temporary infrastructure is decommissioned and removed from site and the wells fitted with pumps to dewater the targeted producing coal seams. The site is then rehabilitated.

It is important to distinguish between the nature and extent of hydraulic stimulation for a CBM well and a typical shale gas well. Hydraulic stimulation has been proposed for the extraction of natural gas from tight shales in the Karoo region of South Africa. This shale gas hydraulic stimulation has gathered significant public concern and response. Whilst there are likely to be environmental impacts associated with the proposed CBM stimulation (to be assessed in this EIA), there are important distinctions between this and shale gas hydraulic stimulation which should be considered to make an informed decision. Table 7 presents some of the key distinctions between the proposed hydraulic stimulation for the LCBM project and a typical hydraulic stimulation operation in shale gas resources.

Table 7: Select differences between CBM and shale gas hydraulic stimulation.

Parameter	Shale gas fracking	LCBM hydraulic stimulation
Typical well type:	Deep horizontal (2000-3000m deep).	Shallow vertical well (150m to 450m to top of coal)
Length of lateral wellbore:	7 hydraulic stimulation treatments over a total of 1050m.	None- all wells are vertical only.
# of stimulation treatments per well:	~7 hydraulic stimulation treatments over a horizontal distance of 1050 (at intervals of 100-150m).	~7 hydraulic stimulation treatments over vertical distance of 50-70m.
Vertical length of resultant fractures:	~100m	~4m to 30m

Parameter	Shale gas fracking	LCBM hydraulic stimulation
Surface radius of stimulation impact from well:	50m to 100m	21 to 37m
Stimulation site infrastructure and extent:	Larger surface operations. ~5-20 pump trucks.	As per description above- 1 x combination stimulation rig.
~Raw water volume required:	~21 000m^3 per well.	158-160m^3 per well.
~Water flow back volume (flowback as well as produced water)	30% within first 2-8 weeks. Limited additional produced water as the shales are not typically saturated. Shale gas production typically doesn't involve dewatering the reservoir.	70-80% over life of well. Significantly larger volumes of produced water due to the need to dewater the reservoir.
Stimulation / Fracturing pressures	~400-1000 bar	~160 bar

Based on Table 7, the proposed hydraulic stimulation for CBM will differ significantly from the typical hydraulic stimulation treatments for shale gas in the following key aspects:

- Only vertical wells are used.
- Stimulation pressures are significantly lower.
- Shorter resultant fractures.
- Smaller well development footprint.
- Lower volumes of water required.
- Larger volumes of produced water over a longer duration.
- Shallower target zone.

4.1.4.5 **WELL OPERATIONS DURING PRODUCTION PHASE**

After the drilling and stimulation is completed the footprint of disturbance at each well site can be significantly reduced to ~25-30m^2 for the duration of the production phase. Figure 16 provides a representative view a well site. The production phase well comprises of the following key infrastructure at each well:

1. The cased and cemented wellbore or well;
2. The wellhead;
3. The water pump, used to dewater/ drawdown the water within the wellbore or well;
4. The water separator used for separating the entrained gas from the water;
5. Control, metering and telemetry skid;
6. Buried water and gas pipelines; and
7. Trenched (underground) electrical and optical fibre cables depending on the site-specific requirements.

Depending on the location of the well site and the relevant landowner's requirements there may be a need to provide security fencing at the site.

Figure 16: View of one of the existing well sites.

A water pump is used to dewater the wellbore and thereby reduce the pressure at the target seam allowing the coal to desorb and release the gas (refer to Figure 17). The specific type of water pump will be defined based on the nature of the specific wellbore and the specific phase of production; however, the use of Electrical Submersible Progressive Cavity Pumps (ESPCP) has been provisionally proposed. The pump is powered by a down-hole electric motor and is suspended by 1-inch flexible hose. The pump system will also include a down-hole transducer, strapped power cable to the water flexible hose, as well as a pump control unit (including pump protection and data interface).

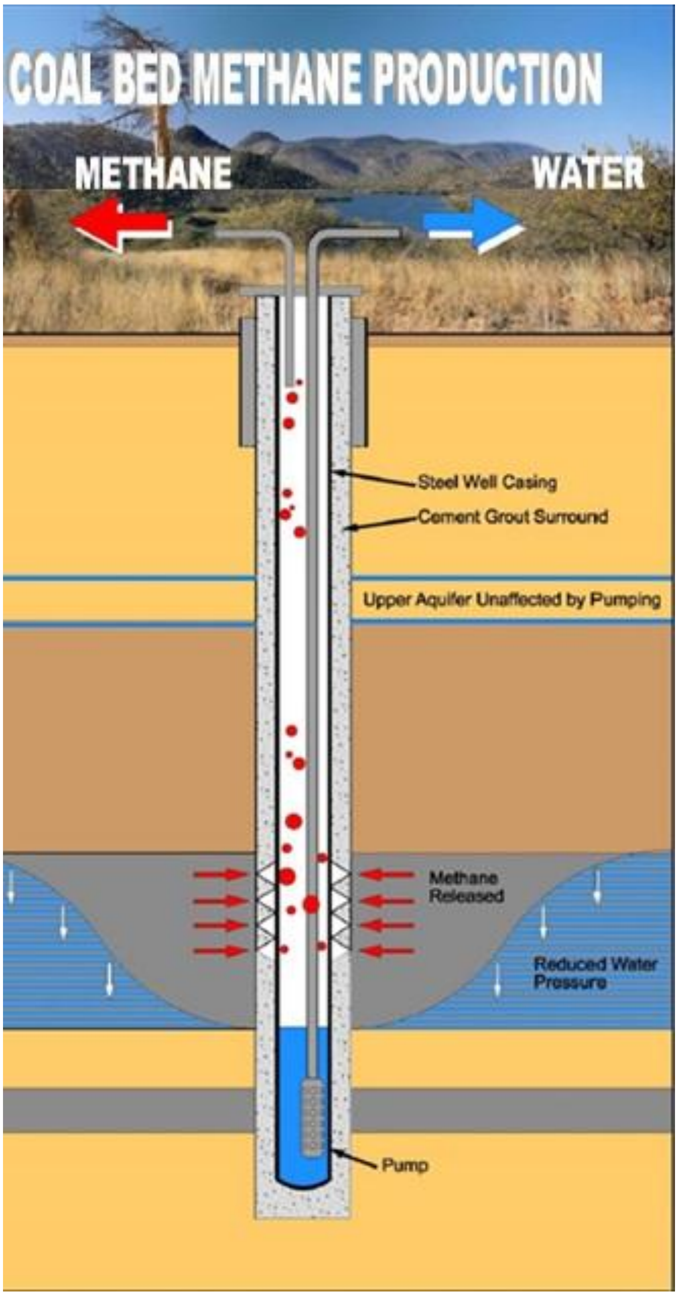


Figure 17: CBM production.

The water is transported from the pump to the surface via flexible hose within the production casing. The gas is then free to move from the coal into the production casing and flow to the surface. Separators located at the end of a line of wells are connected to the gas flows from the wells as well as the water flows to remove any water from the gas stream and any gas from the water stream respectively. Meters will be installed at the well sites to measure the respective volumes.

The produced water is pumped to the surface and connected to a network of trenched water pipelines which transport the water to the centralised water treatment plant. The gas from the well is put through a separator to get rid of the moisture and then transported via a gas-gathering network to a centralised gas processing facility.

4.1.5 GAS AND WATER RETICULATION

The production wells generate both a gas and a water stream. These outputs from each well site are connected to a network of water pipelines and gas pipelines and associated infrastructure.

Both the gas and the water pipeline networks will, as far as reasonably possible, be trenched at a safe depth below the surface level (600mm-900mm) and will comprise plastic low-pressure HDPE pipes (~15cm Ø). Trenching for the pipelines will be done either manually (using local un-skilled labour) or mechanically (with small trenching machines). HDPE piping is particularly effective for water handling as it does not corrode and is not affected by H_2S or CO_2. The plastic low-pressure gas pipes will flow to a central compressor station where the gas is pumped into an intermediate-pressure steel pipeline, before being pumped to the central gas processing facility. The water is similarly transported via plastic HDPE pipelines to a centralised processing/ treatment facility. The shortest possible route between the well and the processing facilities will be followed for the gas and water pipelines. Where necessary environmentally sensitive areas and features (e.g. protected trees, water resources, heritage features, etc) and surface infrastructure (e.g. residences, kraals, reservoirs, etc) will be avoided. The final pipeline routes will be determined prior to construction and will be subject to the defined environmental obligations in the EMPr.

The gas-gathering pipeline network will contain several components. The first component will be a series of relatively small diameter pipelines designed to move the gas from the wellhead to the trunk lines and are referred to as 'flowlines'. The second component will be the relatively larger diameter pipelines that move gas from the gas field to the processing facility, referred to as 'trunk lines'. As the field grows there may be a need to install intermediate diameter pipelines between the trunk lines and the flowlines and these are typically referred to as the 'gathering lines'.

Additional infrastructure that will be installed is as follows:

- Ultra-sonic metering: the gas and water gathering networks will have metering facilities to monitor flow balances as well as provide leak detection. Meters will be provided at the wells and at the plant.
- Booster compressors are used to boost the in-pipe pressure of the gas network to efficiently transport the gas to the plant.
- Water accumulation tanks and transfer pump stations may, depending on the flows, or topography, be required as new wells are connected to the network to facilitate the efficient movement of water from the wellhead to the water treatment facility.
- Low point drains along the gas pipelines may be required to allow for the collection of water which may potentially be released by the gas.

Shutdown of well pumps would be done from the control room as these pumps feature telemetry capability and as the pumps stop, the water in the wells start to rise to static water level over and above the perforations which stops gas flow from the wells. Manual shut-in valves would form part of the pipeline designs either at individual wells or trunklines or both.

4.1.6 PROCESSING PLANT

The gas processing facility consists of an integrated modular system. The components listed below, that is, booster compression, dehydration, gas conditioning, liquefaction, and LNG storage, are all housed within the gas plant footprint and operate collectively as a single processing system. The network of gas pipelines will transport the gas from the well heads to the gas processing plant.

The gas within the gathering system will require both dehydration and compression. The purpose of the dehydration is to remove any water vapour from the gas. Water vapor causes the formation of hydrates, over saturation of natural gas, and corrosion of equipment. Hydrates are solid, ice-like crystallized compounds formed of hydrocarbons and water. Dehydration will take place partially at the well by means of separators and the residual moisture will be dehydrated at the gas processing plant.

The purpose of the infield compressors is to ensure that there is pressure in the gas flow to allow for efficient processing at the processing plant. The number of booster compressors infield would be determined by the gas pipeline design.

It is Thungela's intention to process the collected natural gas into LNG. "LNG is natural gas (primarily methane) that has been liquefied for ease of storing and transporting. LNG is 600 times smaller than natural gas when the latter is in its gaseous form, and it can be easily shipped. LNG is produced by cooling natural gas below its boiling point, −162 °C, and is stored in double-walled cryogenic containers at or slightly above atmospheric pressure. It can be converted back to its gaseous form by simply raising the temperature" (Britannica, 2023).

Table 8 provides a breakdown of the anticipated gas processing components for Phase 1, i.e., the wellfield of ~333 wells. Figure 18 provides a visual reference of the current LNG facility which is part of the "37-spot" PoC and will be included as part of the infrastructure of Phase 1. The specifications provided are based on current production estimates and due to the modular nature of the components can be scaled according to the specific production circumstances. The Phase 1 Plant layout will be provided in the EIA phase once the Engineering design team have completed the designs and layout. These layouts will be further refined and adjusted and presented in the EIA Phase.

Table 8: Gas Processing Facility Components.

Processing Component	Description	Requirements for Phase 1	Example reference images.
Booster compression	Use of a reciprocating compressor to achieve the required gas pressure for the remainder of the process.	1-2 Boosters to boost pressure from 3 barg up to 25 barg.	
Gas Conditioning:	Pre-treatment is designed to remove any non-desirable components such as nitrogen, water, mercaptans, and mercury, and to reduce CO_2. The treatment facilities to be used prior to liquefaction include: • Amine Plants: The amine plant aims to treat the raw gas flows to remove CO_2 and other impurities. • ZPTS Modules: to remove remnant CO_2 and moisture.	• 5 Amine Plants to reduce CO_2 levels. • 5 ZPTS Modules to remove remnant CO_2 • and moisture.	

Processing Component	Description	Requirements for Phase 1	Example reference images.
Liquefaction unit:	It is proposed that the liquefaction technology to be used will be a modular nano-scale liquefaction plant based on a combination of Joule Thomson with a single refrigerant (propane) closed loop that allows for rapid startup and LNG production. The plant requires electricity, compressed air, and a network connection.	16 Cryoboxes (includes existing PoC cryobox) 750 – Liquefaction units; ~290 tons of LNG production per day.	
LNG Storage:	Produced LNG will be stored in ISO containers. The containers are modular and stackable to accommodate any project-specific requirements.	32 isotanks (includes existing PoC isotanks), 41,3 m3 capacity each, storage for ~2 days.	
Transfer (loading/ offloading):	A dedicated LNG transfer bay will be constructed. The transfer bay will include necessary hoses (LNG/ vapour) connections and a break away system to minimise any spills or damage	8 Loading Bays (includes PoC Loading bay).	

Figure 18: Reference images for an existing LNG Plant.

As mentioned above, LNG is a liquid form of natural gas that requires the cooling of the gas to below its boiling point (-162°C), i.e. as a cryogenic liquid. LNG is therefore susceptible to evaporation when at temperatures above its boiling point, and this results small amounts of the liquid form of the gas reverting to its gaseous form. This unwanted gaseous form is often referred to as Boil-Off-Gas (BOG). A BOGs recovery system will be installed to ensure that any boil-off gas is collected and recirculated to the compressors. No venting of BOG is planned.

Flaring will form part of the abnormal or unwanted operating conditions at the LNG facility. It is important to first acknowledge the vast research that has been done on the impacts of flaring and venting (Johnson and Coderre, 2011; Soltanieh *et al.*, 2016; Rodrigues, 2022). Substantial research has considered the impact of flaring as a contributor to GHG emissions, and for this reason, the implications of this activity has been considered. For example, flaring has been branded as a form of resource waste, resulting in billions of rands in losses (Soltanieh *et al.*, 2016). A justification for the use of flaring is therefore necessary. Firstly, as some suggest, the flaring of natural gas takes place at much lower volumes as compared with the oil industry. Secondly, flaring as part of this project is understood as part of maintenance processes for safety purposes, being implemented in certain areas only. Flaring is therefore argued as a foreseeable, yet not pre-defined activity in terms of quantities and timeframes. Thungela plans to flare during commissioning of the LNG plant until the minimum required amount of gas needed to be fed to the plant has been reached. The gas processing facility will have a flare stack for emergency conditions.

The proposed LNG Plant comprises the largest physical infrastructure aspect of this project which is to be located near the existing Deelkraal road for ease of access and therefore 3 alternative locations for this plant will be considered. The key technical aspects that have informed the selection of the proposed LNG Plant alternatives are the following:

- Distance of the plant to the Deelkraal Road;
- Pre-existing access route off Deelkraal Road which will facilitate construction access and can be upgraded accordingly; and
- Setback distance of ~400m from Deelkraal Road to provide vegetative cover/screening to reduce visual impact.

The three alternatives to be considered in the EIA phase are located on the following properties:

1. LNG Plant location Option 1 – PADDAKRAAL 405 Portion 0
2. LNG Plant location Option 2 – WITHOUTPAN 404 Portion 0
3. LNG Plant location Option 3 – BULKLIP 701 Portion 1

The alternative LNG Plant locations to be assessed are shown in Figure 24 which is contained in Section 8.2.4. It is anticipated that the footprint of the gas processing facility will be ~2.4ha (170m x 140m) and will include the LNG gas processing plant, the water treatment plant and pollution control dams.

4.1.7 WATER TREATMENT AND DISPOSAL

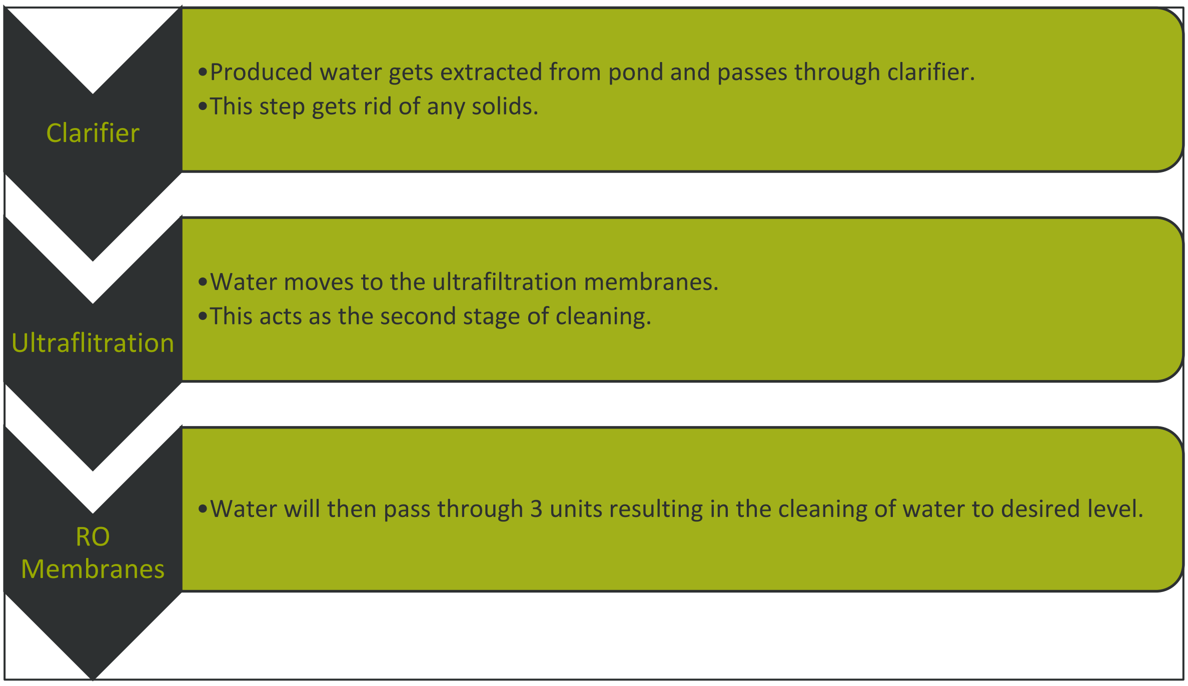
The network of water pipelines will transport the produced water from the wellheads to the water treatment plant. The water will either be pumped to a water transfer station or accumulated in a holding tank before being pumped to the water treatment plant.

The method of water treatment, utilisation and final disposal depends largely on the volumes, produced water quality, and other environmental considerations. The potential water treatment, use and/or disposal options considered are listed below and discussed in more detail in the alternative analysis section of the Scoping Report:

1. Direct offtake of the water by a third-party water user. This could be direct use of the water by an industrial user with either no, or minimal treatment.
2. Treatment of the water to a quality suitable for irrigation (e.g. lucerne or food crops), game or livestock watering use.
3. Treatment of the water to a quality suitable for reuse and/or discharge to the Mogol River.
4. Enhanced water evaporation (e.g. evaporation cannons).
5. Disposal of water to local wastewater impoundments for evaporation.

Produced water will be collected and treated by a modular Reverse Osmosis (RO) plant. The treated water can be used for wildlife / game on the Thungela owned properties (or adjacent landowner properties if agreed to) which would reduce the consumption of local groundwater. The brine will be stored in lined evaporation ponds for collection by third party for reuse (e.g. as a source of salts) or alternatively the brine will be disposed of offsite at a suitable registered waste disposal site. The EIA process will consider alternative options and will make a recommendation of the most appropriate option for implementation. Water recovery from a RO plant is estimated to be ~80%.

The water treatment process involves the use of membranes to separate out cleaned water from a concentrated brine stream. Figure 19 provides a high-level overview of the RO treatment process involving three main steps. The water treatment plant will be scaled depending on the treatment requirements and peak water production from the wells.



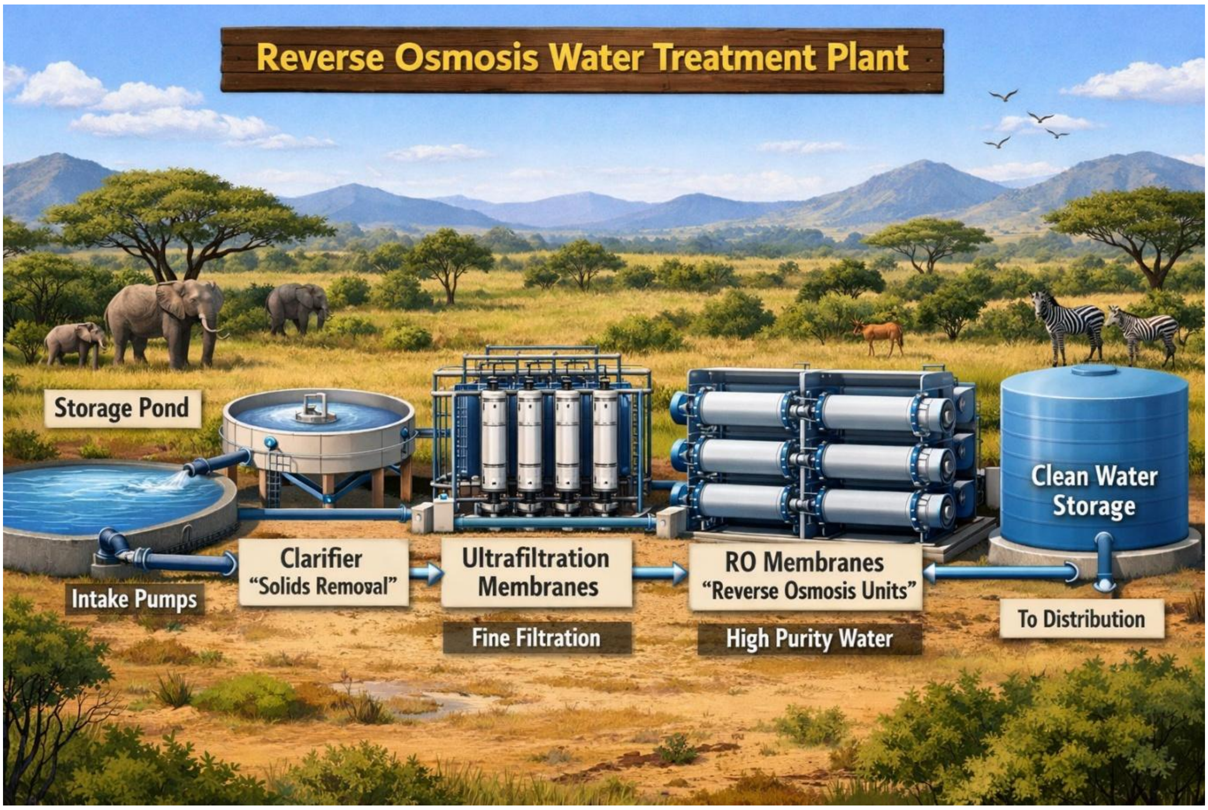


Figure 19: Description of the conceptual RO treatment process being considered and an illustration of the process in action.

CBM wells typically produce 12 – 60m^3/day of formation water during the early stages of production, which may range from 6 months to several years depending on the permeability, gas saturation, pump rates, and well spacing. As new wells are connected the water volumes are expected to increase initially and then decrease over time as the wells are dewatered. Thungela has utilised computer models calibrated with the historical data from the initial 5-spot project which shows the trend in produced water volumes over time (Figure 20). This model predicts a high volume of produced water during the first 10 months of production before tapering down to a consistent rate of less than half the initial rate.

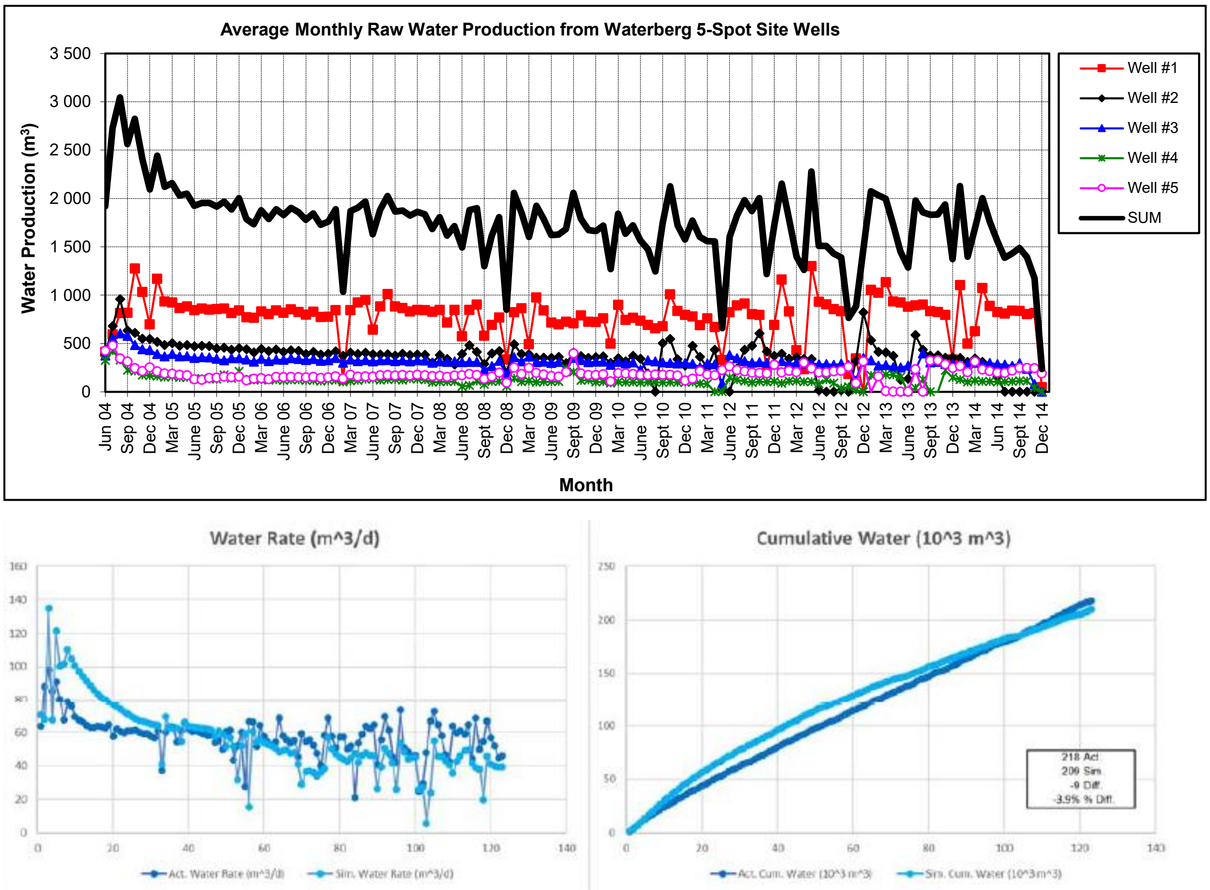


Figure 20: Initial 5-spot project water production.

The water treatment facility will need to cater for the effective treatment of the initial flowback water as well as the longer-term produced water. The expected water chemistries for produced coal seam water can be predicted from available data gathered from water monitoring done since 2004 for the initial exploration phases. This information is presented in Table 9.

Table 9: Historical produced coal seam water qualities (average from 5-spot 2004 to 2007).

Description	Symbol	mg/l	Standard Deviation
CATIONS			
Calcium	Ca^{2+}	22.08	2.74
Potassium	K^{+}	13.78	0.70
Magnesium	Mg^{2+}	12.47	0.74
Sodium	Na^{+}	2090.7	174.9
Aluminium	Al^{3+}	0.084	0.032
Barium	Ba^{2+}	1.31	0.29
Total Iron	$Fe^{2+} + Fe^{3+}$	0.84	0.13
Manganese	Mn^{2+}	0.04	0.01
Lead	Pb^{2+}	0.09	0.02
Strontium	Sr^{2+}	0.34	0.07
ANIONS			
Bicarbonate (as HCO_3)	HCO_3^{-}	5408.7	517.3
Carbonate	CO_3^{2-}	8.52	0.66
Fluoride	F^{-}	3.84	0.58

Description	Symbol	mg/l	Standard Deviation
Chloride	Cl^-	357.1	7.6
Nitrate	NO_3^--N	0.17	0.10
Sulphate	SO_4^{2-}	5.78	0.81
Phosphate	PO_4^{3-} - P	0.44	0.11
Silica	SiO_3^{2-}-Si	10.19	1.49
OTHER			
Conductivity @ 25 ºC, mS/cm	Cond.	7777	615
Chemical Oxygen Demand	C.O.D	16.9	2.5
pH	pH	7.56	0.11
Suspended Solids	S.S.	22.8	3.8
Total Alkalinity (CaCO3)	Alk Total	4998.3	431.2
Total Dissolved Solids	TDS @ 180 ºC	5286.2	501.9
Total Hardness (CaCO3)	TH	108.8	7.1
Turbidity (NTU)	Turb.	5.2	2.0

Based on historical sampling the LCBM produced water is drawn from a depth of ~250m and is dominated by sodium bicarbonate and has an elevated electrical conductivity (EC). The available water quality results were compared to the South African National Standards (SANS) drinking water standards, and it was determined that the water is poor and exceeds the maximum limit allowable for potable use. The produced water is high in sodium (Na) concentrations, TDS, and fluoride (F). This contrasts with the quality of the local shallow groundwater resources which have acceptable potable water quality.

The first phase (this EA application) water treatment facility will be located adjacent to the LNG Plant of which there are 3 alternative locations under assessment as presented in Section 8.2.4.

4.1.8 WASTE MANAGEMENT

The design philosophies for waste management are based on applicable legislation, in particular NEMWA, Department of Water and Sanitation (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. The anticipated waste (general and hazardous) generated during construction and operations will be addressed as detailed below.

4.1.8.1 GENERAL WASTE

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

- Domestic solid waste (e.g. food packaging, food waste, printing paper, and non-hazardous cleaning waste);
- Scrap metal; and
- Construction waste (e.g. cleared vegetation waste, broken concrete pieces, rock fragments, soil from sump excavation).

The Project will utilise a temporary general waste storage facility within the boundary of the respective processing plant footprint. All waste will be collected by an approved, licenced waste contractor for removal and final disposal at a registered general waste disposal facility. As a point of reference, Thungela aims to practice the recycling of paper, scrap metal, and plastic waste. This will be addressed through consultation with local recyclers. No new landfills will be directly established by the project within the project boundaries.

4.1.8.2 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 waste (drill cuttings). This waste will be temporarily stored in lined sumps adjacent to the drill rig during drilling activities and once drilling is completed, the waste will be removed from site and adequately disposed of at an appropriately licenced waste disposal facility. A sample of the drill waste has been classified according to the Globally Harmonized System (GHS[7]) and this waste stream has been classified as hazardous. The intrinsic hazards posed by this waste relate predominantly to Skin Irritation (Category 3). As per the 'Waste Classification and Management Regulations, 2013 (GN R 634)[8], a safety data sheet (SDS) is required for this waste stream (refer to Appendix 6). Disposal requirements for the specified waste type are Class A, B or C landfills. No further restrictions were identified concerning disposal to landfill.

Other trace metals may be absorbed by membranes, filters and or guard beds equipped at the plant as part of the various components. These membranes, filters, and 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.

4.1.9 ASSOCIATED ACTIVITIES AND INFRASTRUCTURE

4.1.9.1 ADMINISTRATION

Current buildings would be utilised as far as possible for offices and accommodations during construction and operation. During the operation phase new access and security offices would be built at the gas processing and loading area. A control room hosting the various process controls would also be newly constructed at the centralised collection and processing facilities.

Potable water for onsite domestic use would be provided by reverse osmosis (RO) treatment of the main plant product water.

Accommodation of construction and operational personnel will be at the existing facilities on the Thungela properties, or where such capacity is insufficient at available local accommodation suppliers and at the closest towns. With reference to Section 4.1.11 , it is not anticipated that there will be significant numbers of temporary or permanent workers.

4.1.9.2 ELECTRICITY

Electricity is required for well pumps, metering units, booster compressors, gas processing equipment and the water treatment plant, and therefore forms part of the associated activities under this application.

Electricity for the first phase will be supplied primarily through a gas-to-power generator system located at the LNG plant. In this regard, power will be generated as LNG is produced. The installed capacity will be approximately 20 MW to a maximum of 25 MW. A modular approach may be implemented (e.g., two ~10 MW generators). External, third party supplied Solar PV electricity may supplement the plant subject availability, while Eskom will serve as a backup supply source. Final powerline configuration will be confirmed during detailed engineering.

[7] Globally Harmonised System of Classification and Labelling of Chemicals (GHS), 2023. United Nations, New York and Geneva, (10th revised Edition).
[8] National Environmental Management: Waste Act, 2008. (Act No. 59 of 2008). Department of Forestry, Fisheries and Environment. Waste Classification and Management Regulations. GN R 634, GG. 36784, 23 August 2013.

4.1.9.3 **ROADS, TRAFFIC AND TRANSPORT**

The project area is currently accessible via the regional R510 surfaced dual carriage way public road from Lephalale. The construction and operation phase of the project is likely to generate additional traffic volumes to the site with high level estimates provided in Table 10. Depending on the final traffic volumes there may be a requirement to upgrade the main access roads (Figure 21) to accommodate the additional construction and operational phase traffic to the plant area.

Figure 21: View of the site access road off the R510 (left) and existing local in-field site access to well sites (right).

Well access will form part of a consolidated linear service corridor that may include the buried gas and water pipelines and, where required, electrical and communication infrastructure.

Initial vegetation clearing for the corridor may resemble a formal road; however, once construction is complete, natural regrowth will reduce the corridor to a narrower track suitable for light-duty vehicles required for operations and maintenance. Access routes will be micro-sited following sensitivity mapping to avoid protected trees, wetlands, heritage features, and other sensitive environmental receptors. This approach reduces landscape fragmentation by clustering access and pipeline routes within a single managed corridor.

Once the well is developed and the production phase begins the vehicular traffic to each of the well sites will reduce dramatically allowing the natural revegetation of the cleared area. Access to the well site during production will be required for maintenance and monitoring purposes.

Where existing or new access roads traverse drainage lines or streams, where a risk of bank instability occurs, culverts or other suitable engineered solutions will be installed.

Table 10: Estimated traffic to be generated.

Traffic type	Approximate number of trips to the site[9] per week	
	Construction Phase	Operational Phase
Personnel Transport (light passenger vehicles)	40	20
Personnel Transport (bus/ taxi)	4	2
Materials and plant delivery	Sand = ~6 x 30-ton trucks /week for a period of ~32 months Cement =3 x 30t trucks / month Casing = 1 x 30t truck / month of 32 months Plant Construction Deliveries HDPE Pipes Trucks once off	Equipment replacement, maintenance of RO and LNG Plant = ~2-6 trucks or vehicles / month

[9] Trips to site refers to vehicle traffic on public roads to and from the project site boundary and not the internal traffic between well sites on privately owned properties.

Traffic type	Approximate number of trips to the site[9] per week	
	Construction Phase	Operational Phase
	WTP Phase 1 = TBA Gas plant Phase 1 = TBA	
Fuel delivery	2	1
Waste collection	2	1
Sewage collection	2	1
LNG trucks	7	182

4.1.9.4 WATER

Water will be required for the following:

- General project construction activities (e.g. cement mixing, cleaning, etc).
- Consumption by onsite personnel during construction and operation phase.
- General domestic use.
- Waterborne sewage.
- Dust suppression.
- Well drilling and cementing.
- Hydraulic stimulation.

The following order of priority for the sourcing of water will be applied for the project wherever reasonably possible:

1. Treated produced water from earlier wells to meet reuse or discharge requirements.
2. Natural groundwater resources- subject to relevant licencing or registration under General Authorisation.

Details of water volumes required for drilling, stimulation, etc can be found in the relevant sections above.

4.1.9.5 SEWAGE AND WASTEWATER

The following primary wastewater streams are anticipated during the project:

- On-site sewage and domestic wastewater (e.g. toilets, kitchens, ablutions, etc).
- Flowback and produced water from hydraulic stimulation.
- Gas gathering network knock-out or condensate water.
- Gas processing plant water extracted through the gas dehydration processes, which will be thermally evaporated.
- Treated effluents (e.g. RO Brine) from the water treatment plant, which will be evaporated to allow for concentration of the brine prior to disposal.

Table 11 provides a breakdown of the primary wastewater and effluent streams and the estimated volumes and management, treatment and disposal options. At all times the hierarchy of waste management will be applied wherever reasonably possible.

Table 11: Estimated wastewater.

Wastewater generated	Estimated Volume (m3)		Management option
	Construction Phase	Operational Phase	
Domestic effluents and sewage	18-28m^3 day	1.5-4m^3 day	Septic tank system collected by third party contractor for offsite disposal/treatment.

Wastewater generated	Estimated Volume (m3)		Management option
	Construction Phase	Operational Phase	
Drilling muds	$15m^3$ x 314holes	-	Collection, drying through evaporation and disposal of remaining sludge to licenced offsite disposal facility.
Hydraulic stimulation	158 -$160m^3$ / well	-	Water will return to the wellbore as flowback and will be collected and treated at the treatment plant.
Flowback and produced water.	-	4770 m^3 /day ~28 $478m^3$ /well over 30 years. = $949m^3$/well/year = $2.6m^3$/well/day = average of $861m^3$/day total for 324 wells.	Construction phase: Settling in drill sump and evaporate. Operations: collection and transfer to treatment plant.
Gas gathering network	Insignificant volumes of water are expected. These will be collected and added to the produced water system for treatment.		
Gas processing			
Treated effluents (e.g. RO Brines)		20% of Produced water.	Crystalise concentrated brine and discard solids at approved disposal site.

4.1.9.6 STORMWATER MANAGEMENT

A Storm Water Management Plan (SWMP) for the central gas and water processing plant 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 to prevent scouring, sedimentation or erosion from forming, while dirty water will be collected and stored within an evaporation pond system for treatment and reuse.

4.1.9.7 SECURITY

Thungela will enlist security personnel during the construction and operational phase to control access and patrol the site. A private security company will also be on call should the need arise.

4.1.10 RESOURCE USE AND REQUIREMENTS

Apart from typical small quantity resources required for the construction and operational phases, the following primary resources will be required for the project:

- Bulk materials (e.g. quarries/borrow pits): The access road will require upgrading; therefore, bulk road building materials will be required. These will be sourced from a local licenced supplier.
- Batching plant: The cement required for the well bores will be batched (mixed) at each well. Any bulk batching (should this be required) will take place off site at a suitably authorised location.
- Sand for hydraulic stimulation: the sand required as a proppant during the hydraulic stimulation will be obtained in bulk from a third-party provider. It is estimated that each well site will require ~65 tons of sand (i.e. 2 truckloads). Thungela aims to achieve the drilling of 10 wells per month, which would equate to a total sand volume of ~650 tons per month. The sand will be delivered to the drill sites and stockpiled at site as required.

4.1.11 HUMAN RESOURCES AND LABOUR

Table 12 provides an estimation of the project labour requirements. All human resources and labour will be engaged in accordance with Thungela Policies and commitments in the Social and Labour Plan (SLP).

Table 12: Estimated project human resource requirements.

Labour group	Estimated # range	Estimated % split	
		Skilled	Unskilled
Construction phase	~600-800	5%	95%
Operation phase	60-80	95%	5%

4.2 ABNORMAL OR UNWANTED EVENTS OR CONDITIONS

When undertaking an EIA, it is important to consider the potential abnormal operating conditions or unwanted events. These are especially significant in instances where these conditions or events may result in an unacceptable environmental impact. A predictive risk identification and assessment process should be followed by Thungela and updated on a regular basis. Many of these risks can be adequately mitigated through pre-emptive contingency planning and if necessary, embedded into relevant project design. Table 13 provides a high-level identification and description of potential abnormal operating conditions and the embedded designs / controls that have been considered and incorporated by Thungela.

Table 13: Abnormal events and conceptual controls.

Abnormal condition/ event	Description	Embedded design or preventative control
Downhole loss of fluids or cement.	Depending on the permeability of the geology through which the drill is moving there may be a potential to lose drilling fluids into the geological formation. Further there is a potential that the cement or grouting being used in the annulus may enter the surrounding geology or resource. This may compromise the functionality of the cementation job or even impact on the gas permeability of the coal resource (e.g. invasion of the cement into the natural coal fractures).	• Readily available fluid loss control additive for the drilling process • Cement design provides for lightweight slurry. This reduces the hydrostatic weight of the cement slurry. Readily available fluid loss additives would be available to add to the bentonite mix to seal off any voids encountered in susceptible formations.
Wellbore casing bursts due to excessive pressures (e.g. during hydraulic stimulation).	The wellbore is exposed to additional pressures during the hydraulic stimulation process. This has the potential to damage or rupture the casing string and result in a loss of gas or fluids, as well as risk of pollution.	• Ensure correct specification casing used based on well engineer's requirements. Casing pressure rating would exceed maximum specified pressure rating for the stimulation rig. • Undertake casing and cementation job testing prior to stimulation (e.g. bond log tests, compression strength test on cement samples, etc).

Abnormal condition/ event	Description	Embedded design or preventative control
Rupture of gas or water gathering network pipes.	The gas and water gathering system will include HDPE piping which is susceptible to damage in abnormal instances. This could be due to excavations, burrowing animals, tree roots, etc.	• Ensure adequate bedding and padding in the respective trenches. • Real time monitoring of volumetric balances at well head and gas plant to detect leaks, coupled with remote controlled shut-off valves.
Excess water content in gas.	Excessive water content in the raw gas may result in damage to equipment and blockage for gathering lines.	• Installation and operation of gas/water separator at each well site and the installation of strainers post the wellhead and pre-separator skid to catch any coal fines or sand returns from the formation. • Real time monitoring of volumetric balances to detect leaks, coupled with remote controlled shut-off valves.
Medium to long term climate change vulnerability	The prevailing climatic conditions are predicted to change over time as per the climate change predictions (refer to Section 10.3.2.3 for a description of the likely changes predicted). Changes in temperature and rainfall may affect the optimal functioning of certain infrastructure and equipment.	Equipment design would provide for equipment to be operational under elevated temperatures and rainfall. Excess rainfall events would be catered for in the stormwater designs.
Uncontrolled releases of LNG from storage vessels.	Storage vessels could be damaged through pressures exceeding design, accidental physical damage (e.g. vehicle accident). This could result in a gradual or sudden release of LNG.	ISO container design is of such a nature that any boil-off gas gets returned to the gas plant for reprocessing, resulting in no excessive pressure build up. The ISO container consists of a double wall to prevent accidental damage and to keep the gas cold for longer.
Flaring of gas at the LNG Plant	Unexpected breakdowns within the plant or emergencies which require evacuation of methane from the plant to ensure safety.	Gas will be diverted to the emergency flare to ensure that methane emissions are curtailed while only CO_2 is released.
Sabotage, Community unrest, and terrorist attacks.	Production operations or equipment could be damaged resulting in uncontrolled release of gas and/or produced water.	Install and maintain well pump shutoff valves. Gas in the pipe network on its way to the gas plant would either vent to atmosphere or be flared at the gas plant until depleted should any of the aforementioned happens.

LNG facilities, and methane gas in general, poses an environmental and safety risk if not managed correctly. To supplement the abnormal operating conditions listed above, a specialist qualitative risk assessment will be undertaken during the EIA to identify potential hazards and incidents that may occur and to ascertain whether the project falls within the definition of a Major Hazardous Installation (MHI). In addition, the EIA process will identify and assess other potential environmental impacts and make recommendations for relevant alternatives, management and mitigation measures.

5 LISTED AND SPECIFIED ACTIVITIES TRIGGERED

The intention of the amendments to the mining-related NEMA EIA Regulations Listing Notice 2 activities including Activities 20 and 20A, published under Government Notice No. 517 in Government Gazette No. 38282 on the 11 June 2021, was to ensure that all the associated activities (i.e. any activity contained in the relevant NEMA Listing Notices) required to exercise the permission, right, permit, or consent required in terms of the MPRDA, are included in the listing of the production right or permission and do not require additional individual applications for such associated activities. This will also ensure that the Minister responsible for mineral resources is the competent authority for the activities associated with mining. As per the DFFE clarification received by EIMS (Appendix 7), in practical terms, ONLY ONE activity (such as Activity 20A of LN2) should be indicated in the application form and all associated activities (i.e. activities required for the proposed development must be covered under that one application). The project description and environmental impact assessment therefore deals with the entire scope of the proposed LCBM Project and all the possible impacts that may transpire from such development/ operation. All relevant aspects of the proposed development have been duly considered and assessed, so as to be appropriately authorised. The EMPr will contain all identified impacts and provide the mitigation actions that will achieve the desired impact management outcomes.

Whilst only the applicable NEMA listed activities will be applied for in the application form (i.e. LN2 Activity 20 and 20A), the associated activities applicable to this development have been identified and the NEMA, NEMWA, NWA and NEMAQA listed activities triggered by the LCBM Project are presented in Table 14 below.

Table 14: Applicable Listed Activities.

Act and Activity #	Activity Description	Applicability
NEMA LISTING NOTICE 1 ACTIVITIES		
NEMA GNR 983 Activity 9	The development of infrastructure exceeding 1 000 metres in length for the bulk transportation of water or storm water- (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for bulk transportation of water or storm water or storm water drainage inside a road reserve or railway line reserve; or (b) where such development will occur within an urban area.	This project will include pipelines for treated water. The length, diameter and throughput capacity of the water pipelines will be confirmed once engineering designs are available.
NEMA GNR 983 Activity 10	The development and related operation of infrastructure exceeding 1 000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes- (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; excluding where- (a) such infrastructure is for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve or railway line reserve; or (b) where such development will occur within an urban area.	This project will include pipelines for process water (produced water). The length, diameter and throughput capacity of the water pipelines will be confirmed once engineering designs are available.
NEMA GNR 983 Activity 11	The development of facilities or infrastructure for the transmission and distribution of electricity- (i) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts; or (ii) inside urban areas or industrial complexes with a capacity of 275 kilovolts or more;	Additional powerlines will be developed around the existing Eskom 22kV powerlines. The Phase 1 plant will be fed from a 132kV powerline. The final proposed powerlines and voltages will be identified once the engineering designs are available.

Act and Activity #	Activity Description	Applicability
	excluding the development of bypass infrastructure for the transmission and distribution of electricity where such bypass infrastructure is- (a) temporarily required to allow for maintenance of existing infrastructure; (b) 2 kilometres or shorter in length; (c) within an existing transmission line servitude; and (d) will be removed within 18 months of the commencement of development.	
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	Non-perennial drainage lines and dams/pans occur within the application area which would constitute “watercourses” and various infrastructure may be constructed within a watercourse or within 32m of a watercourse (such as pipelines and access roads).

Act and Activity #	Activity Description	Applicability
	removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared.	
NEMA GNR 983 Activity 13	The development of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, with a combined capacity of 50 000 cubic metres or more, unless such storage falls within the ambit of activity 16 in Listing Notice 2 of 2014.	Engineering designs will confirm final dirty water containment facilities dimensions and thereafter the applicability of this listed activity can be confirmed.
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 project includes a reverse osmosis water treatment plant with a capacity greater than $100m^3$ per day.
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.	Non-perennial drainage lines and dams/pans occur within the application area which would constitute "watercourses" and various infrastructure may be constructed within a watercourse or within 32m of a watercourse (such as pipelines and access roads).
NEMA GNR 983 Activity 21F	Any activity including the operation of that activity required for the reclamation of a residue stockpile or a residue deposit as well as any other applicable activity as contained in this Listing Notice or in Listing Notice 3 of 2014, required for the reclamation of a residue stockpile or a residue deposit.	Drill cuttings are to be disposed of and not "reclaimed" but could be construed as being "reclaimed" once storage thereof is done. Additionally, topsoil will be stripped and stored and later "reclaimed" for rehabilitation.

Act and Activity #	Activity Description	Applicability
NEMA GNR 983 Activity 25	The development and related operation of facilities or infrastructure for the treatment of effluent, wastewater or sewage with a daily throughput capacity of more than 2 000 cubic metres but less than 15 000 cubic metres.	A water treatment plant will be constructed to treat produced water. The throughput capacity of the plant will be confirmed by the engineering team and thereafter the applicability of this listed activity will be finalised.
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 ha; 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 Plant would constitute industrial land use, and the footprint of the plant would be greater than 1 hectare. The land is currently used for game farming.
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.	Thungela intends to make use of existing infrastructure which was established as part of their PoC and Exploration activities. This includes the incorporation of the existing LNG plant, and CBM wells (Original 5-spot, and the additional 14 wells of the PoC) into the first phase of production.

Act and Activity #	Activity Description	Applicability
NEMA GNR 983 **Activity 46**	The expansion and related operation of infrastructure for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes where the existing infrastructure- (i) has an internal diameter of 0,36 metres or more; or (ii) has a peak throughput of 120 litres per second or more; and (a) where the facility or infrastructure is expanded by more than 1 000 metres in length; or (b) where the throughput capacity of the facility or infrastructure will be increased by 10% or more; excluding where such expansion- (aa) relates to the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes within a road reserve or railway line reserve; or (bb) will occur within an urban area.	Expansions of existing infrastructure (existing CBM wellfield and LNG Plant) and the incorporation thereof into the first phase of production which will include additional infrastructure resulting in the development of the wellfield of ~333 wells, two plants as well as RO plant.
NEMA GNR 983 **Activity 48**	The expansion of- (i) infrastructure or structures where the physical footprint is expanded by 100 square metres or more; or (ii) dams or weirs, where the dam or weir, including infrastructure and water surface area, is expanded by 100 square metres or more; where such expansion occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding- (aa) the expansion of infrastructure or structures within existing ports or harbours 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;	The current LNG plant and associated existing infrastructure will be expanded to accommodate the increased capacity of gas and water from CBM wells.

Act and Activity #	Activity Description	Applicability
	(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 50	The expansion of facilities or infrastructure for the off-stream storage of water, including dams and reservoirs, where the combined capacity will be increased by 50 000 cubic metres or more.	The existing water storage facilities may require expansion to accommodate the extra water generated. Once the engineering designs are completed, the applicability of this listed activity can be confirmed.
NEMA GNR 983 Activity 53	The expansion and related operation of facilities for the desalination of water where the design capacity will be expanded to produce an additional 100 cubic metres or more of treated water per day.	Once the engineering designs are available, the required expansions to the existing 5-spot reverse osmosis plant will be confirmed and thereafter the applicability of 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.	The upgrading of the Deelkraal road. The road will be tarred to accommodate increased traffic loads. The final road upgrade specifications will be confirmed during the course of this EIA.
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 continuation of production activities such as gas processing and LNG production. Increased production capacities to accommodate the new well infrastructure proposed. Integration of PoC infrastructure into the larger Phase 1 production infrastructure and modular expansion potential of gas production infrastructure.
NEMA GNR 983 Activity 66A	The expansion and related operation of hydraulic fracturing, as well as any other applicable activity as contained in this Listing Notice or in Listing Notice 3 of 2014, required for hydraulic fracturing expansion and related operation.	The original POC gas wells were previously stimulated, and the additional wells will result in an expansion.
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	The sequential construction of wells and pipelines will eventually trigger certain listed activity thresholds while in the early stages may not trigger the thresholds. The overall

Act and Activity #	Activity Description	Applicability
	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.	intention of this project is to undertake a phased construction of infrastructure.
NEMA LISTING NOTICE 2 ACTIVITIES		

Act and Activity #	Activity Description	Applicability
NEMA GNR 984 Activity 2	The development and related operation of facilities or infrastructure for the generation of electricity from a non-renewable resource where the electricity output is 20 megawatts or more.	As part of this LCBM Project, a gas to power generator of ~20 - 25MW will be installed as a primary power supply. The gas generator will utilise methane from the LNG plant and this source of methane would be considered a non-renewable resource.
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 gas storage volumes will be ~750m^3 which is above the 500m^3 threshold in this listed activity. LNG is listed as a dangerous good and therefore this activity is applicable. Furthermore, the explosive magazine may be constructed for the storage of the explosive charges for the well bore perforation gun and the explosives would likely trigger the definition of dangerous good. The total volume of storage of explosive charges as well as their chemical makeup to define them as a dangerous good will be identified during the course of this EIA process.
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 volume of LNG produced per day for this LCBM Project will exceed 50m^3 per day.
NEMA GNR 984 Activity 6	The development of facilities or infrastructure for any process or activity which requires a permit or licence or an amended permit or licence in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent, excluding- (i) activities which are identified and included in Listing Notice 1 of 2014; (ii) 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	Additional legislative triggers for this LCBM Project include a WUL under the NWA and possibly an AEL under the NEMAQA (to be confirmed during EIA phase).

Act and Activity #	Activity Description	Applicability
	(Act No. 59 of 2008) in which case the National Environmental Management: Waste Act, 2008 applies; (iii) the development of facilities or infrastructure for the treatment of effluent, polluted water, wastewater or sewage where such facilities have a daily throughput capacity of 2 000 cubic metres or less; or (iv) where the development is directly related to aquaculture facilities or infrastructure where the wastewater discharge capacity will not exceed 50 cubic metres per day.	
NEMA GNR 984 Activity 15	The clearance of an area of 20 ha 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 combined clearance of all the well pads for this LCBM project would be in the order of ~50 ha. The Phase 2 LNG plant would an additional ~5ha. The study area contains almost exclusively indigenous vegetation and therefore this project will result in the clearance of more than 20ha of indigenous vegetation and this activity is applicable.
NEMA GNR 984 Activity 16	The development of a dam where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of 10 ha or more.	This activity is unlikely to be triggered based on the available information however on completion of the engineering designs, the applicability of this activity can be confirmed.
NEMA GNR 984 Activity 20	Any activity including the operation of that activity which requires a production right in terms of section 83 of the Mineral and Petroleum Resources Development Act, as well as any other applicable activity as contained in this Listing Notice, in Listing Notice 1 of 2014 or Listing Notice 3 of 2014, required to exercise the production right.	This is one of the two primary activities applicable to this LCBM Project as a Production Right application is required.
NEMA GNR 984 Activity 20A	Hydraulic fracturing including the operation as well as any other applicable activity as contained in this Listing Notice, in Listing Notice 1 of 2014 or Listing Notice 3 of 2014, required for hydraulic fracturing and related operation.	This is one of the two primary activities applicable to this LCBM Project as the CBM extraction requires hydraulic stimulation.
NEMA LISTING NOTICE 3 ACTIVITIES		
GNR 985 Activity 2	The development of reservoirs, excluding dams, with a capacity of more than 250 cubic metres.	The applicability of this activity will be confirmed on completion of the engineering designs and specifically the location of the proposed water storage dams.

Act and Activity #	Activity Description	Applicability
GNR 985 Activity 3	The development of masts or towers of any material or type used for telecommunication broadcasting or radio transmission purposes where the mast or tower- (a) is to be placed on a site not previously used for this purpose; and (b) will exceed 15 metres in height- but excluding attachments to existing buildings and masts on rooftops.	Due to the intermittent cellular coverage over the entire application area, it is likely that broadcast masts will be required to boost the signal strength. The applicability of this activity will be confirmed on completion of the engineering designs.
GNR 985 Activity 4	The development of a road wider than 4 metres with a reserve less than 13,5 metres.	The Traffic engineering study will identify the required road network upgrades and therefore the applicability of this activity will be confirmed in the EIA phase.
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.	Storage of diesel as well as storage of LNG will constitute the storage of a dangerous good and capacities will exceed 30 cubic meters.
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.	The application area contains sensitive environmental features which shall be assessed in detail by the Terrestrial specialist. This activity will therefore be confirmed during the EIA phase.
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	Non-perennial drainage lines and dams/pans occur within the application area which would constitute "watercourses" and various infrastructure may be constructed within a watercourse or within 32m of a watercourse (such as pipelines and access roads). The Wetland and Aquatic specialist study will inform the applicability of this activity in the EIA phase.

Act and Activity #	Activity Description	Applicability
	within existing ports or harbours that will not increase the development footprint of the port or harbour.	
GNR 985 Activity 15	The transformation of land bigger than 1000 square metres in size, to residential, retail, commercial, industrial or institutional use, where, such land was zoned open space, conservation or had an equivalent zoning, on or after 02 August 2010.	Three alternative locations of the Phase 2 LNG Plant will be assessed during the EIA phase and thereafter the applicability of this activity will be confirmed.
GNR 985 Activity 16	The expansion of reservoirs, excluding dams, where the capacity will be increased by more than 250 cubic metres.	Whilst it is highly unlikely that 5-spot dam will be physically expanded (broken and made bigger) the engineering designs will inform the applicability of this listed activity in the EIA phase.
NEMWA LISTED ACTIVITIES		
NEMWA Category A1	The storage of general waste in lagoons.	Settling dams at the well pads and evaporation dams could be considered lagoons and would contain a mixture of general and hazardous waste. Legal opinion or DFFE IQ clarification to be obtained to confirm applicability of this activity.
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.	The separation of drill mud from the drilling water may constitute “treatment” as per the definition of such. Legal opinion or DFFE IQ clarification to be obtained to confirm applicability of this activity.
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.	The separation (“treatment”) of the hazardous portion of the drill mud during drilling (assuming it is >500kg but below 1 ton per day). Legal opinion or DFFE IQ clarification to be obtained to confirm applicability of this activity.
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).	This activity could be applicable as Category A1 above requires construction of such facility. In the event that the legal opinion or DFFE IQ clarification confirms the Category A1 activity as not being triggered, then this activity would similarly not be triggered.

Act and Activity #	Activity Description	Applicability
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.	Owing to the nature of CMB production activities and the ongoing construction of wells to be included into the overall wellfield, this may be considered as "expansion" activities. Legal opinion or DFFE IQ clarification to be obtained to confirm applicability of this activity.
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 construction of each well, the drill waste settling dams (lagoons) will be removed and rehabilitated which would constitute "decommissioning". In the longer term, on completion of the production activities, the LNG and water treatment plant with associated evaporation dams would be decommissioned as part of the closure and rehabilitation phase. In the event that the legal opinion or DFFE IQ clarification confirms the Category A1 activity as not being triggered, then this activity would similarly not be triggered.
NEMWA Category B1	The storage of hazardous waste in lagoons excluding storage of effluent, wastewater or sewage.	A certain fraction of the drill cuttings which consist of rock strata constitute hazardous waste and together with the drill water, this will be stored in constructed settling ponds (lagoons) at the drill sites. Legal opinion or DFFE IQ clarification to be obtained to confirm applicability of this activity.
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).	This activity could be applicable as Category B1 above requires construction of such facility. In the event that the legal opinion or DFFE IQ clarification confirms the Category A1 activity as not being triggered, then this activity would similarly not be triggered.
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).	The MPRDA definition of residue stockpiles and residue deposits is very broad and could apply to drill cuttings as well as any other product derived from or incidental to the production operation and which is stockpiled, stored or accumulated for potential re-use, or which is disposed of. Legal opinion or DFFE IQ clarification to be obtained to confirm applicability of this activity.

Act and Activity #	Activity Description	Applicability
NEMWA Category C1	The storage of general waste at a facility that has the capacity to store in excess of 100m3 of general waste at any one time, excluding the storage of waste in lagoons or temporary storage of such waste.	During the construction phase, the central contractors waste storage area may store more than $100m^3$ of general waste at any one time.
NEMWA Category C2	The storage of hazardous waste at a facility that has the capacity to store in excess of 80m3 of hazardous waste at any one time, excluding the storage of hazardous waste in lagoons or temporary storage of such waste.	During the construction phase, the central contractors waste storage area may store more than $80m^3$ of hazardous waste at any one time.
NWA SECTION 21 ACTIVITIES		
NWA Section 21a	Taking water from a water resource;	Abstraction of potable water from boreholes for domestic use.
NWA Section 21c	Impeding or diverting the flow of water in a watercourse;	Aquatic and hydrology delineations show infrastructure within regulated area of a watercourse.
NWA Section 21e	Engaging in a controlled activity identified as such in section 37 (1) or declared under section 38 (1);	Hydraulic stimulation is a controlled activity in terms Section 37(1) of the National Water Act as per the notice published by the Minister of Water and Sanitation dated 16 October 2015. In addition to the above controlled activity, treated water disposal options to be assessed include irrigation (game watering, crop production, etc).
NWA Section 21f	Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;	The discharge of treated coal seam water into the Mogol River.
NWA Section 21g	Disposing of waste in a manner which may detrimentally impact on a water resource;	Various water uses such as: • Septic tanks for storage of sewage (for offsite disposal by waste contractor); • Brine storage pond (waste product from the water treatment works); • Evaporation dams to store produced water prior to treatment. • Drill mud stored in lined sumps at the drill sites.
NWA Section 21i	Altering the bed, banks, course or characteristics of a watercourse;	Aquatic and hydrology delineations show infrastructure within regulated area of a watercourse.

Act and Activity #	Activity Description	Applicability
NWA Section 21j	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	Coal seam dewatering.
NEMAQA SCHEDULED ACTIVITIES		
NEMAQA Sub-category 1.4	**Gas Combustion Installations** Description: Gas combustion (including gas turbines burning natural gas) used primarily for steam raising or electricity generation. Application: All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.	One or multiple gas-to-power generators to a maximum generation capacity of 25MW will be installed.

6 POLICY AND LEGISLATIVE CONTEXT

This section provides a description of the policy and legislative context within which the development is proposed. 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 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 rights 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.

The Upstream Petroleum Resources Development Act (Act 23 of 2024 - UPRDA) has been promulgated but is not yet in force at the time of writing. Once effective, the Act will establish a dedicated legislative framework for the regulation of upstream petroleum activities in South Africa, separating these from the mining regime currently governed under the Mineral and Petroleum Resources Development Act (MPRDA). The UPRDA is expected to introduce revised processes and institutional arrangements for the granting, administration and regulation of petroleum rights, which may influence future licensing and project authorisation requirements applicable to the proposed development.

In support of the EA 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/DMRE 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 Scoping Report.

6.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA)

The main aim of the 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, EIAs 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 Member of Executive Council (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 EIAs 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 22 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.

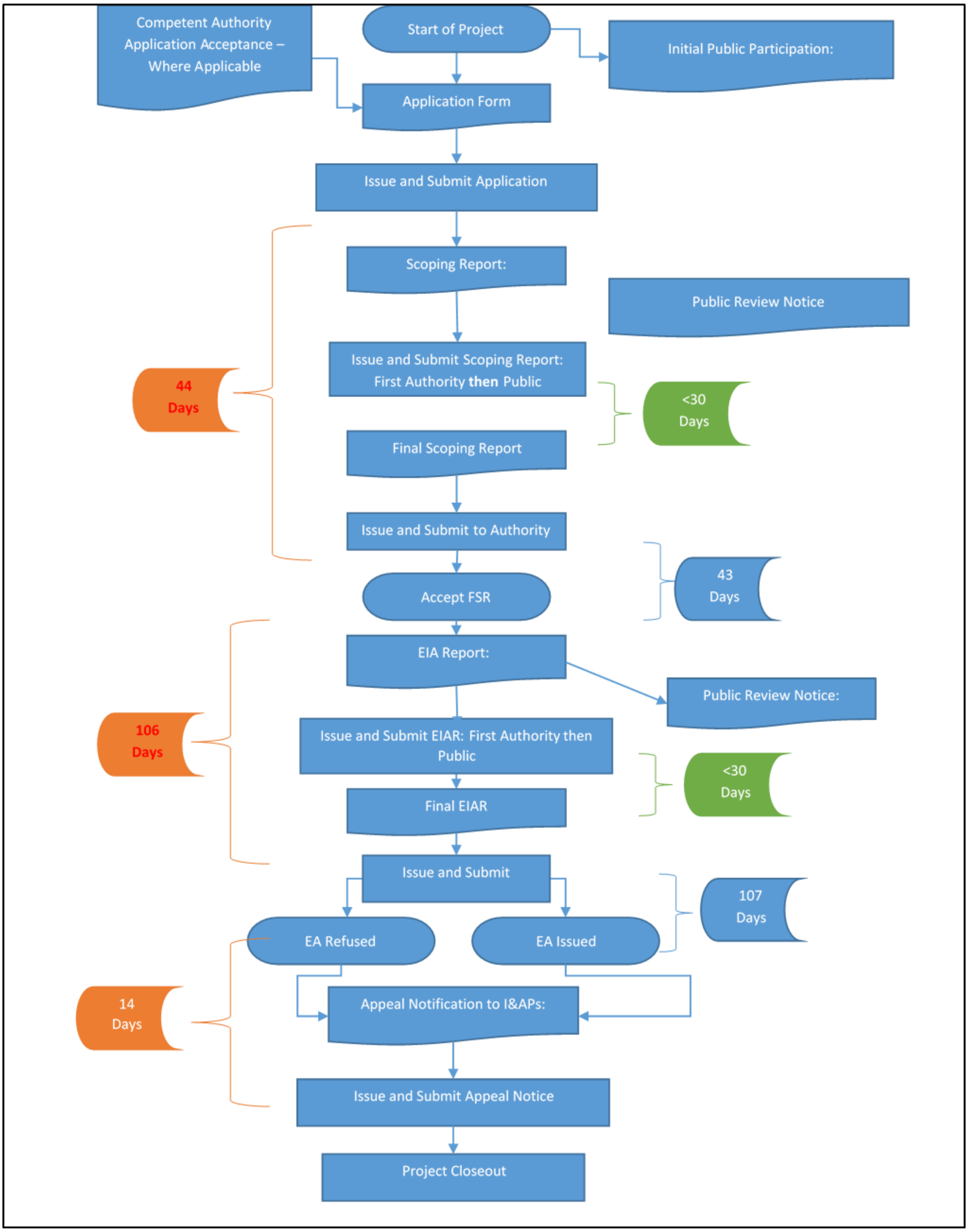


Figure 22: EIA process diagram.

The DFFE have published a number of guidelines and protocols which have been considered in the compilation of this report and include but not limited to:

- Public Participation Guideline in terms of NEMA EIA Regulations (2017).
- Need and desirability Guideline in terms of NEMA (2012).
- National guideline on minimum information requirements for preparing Environmental Impact Assessments for mining act activities that require environmental authorisation (2018).

- 2004 Information Series covering various aspects of the EIA process.
- Procedures for assessment and minimum criteria for specialist studies.

The impacts of climate change as a result of, as well as potentially affecting the project is addressed by the environmental management tools of integrated environmental management (IEM) and EIA, as prescribed by the NEMA 107 of 1998. Given that the purpose of EIA is to give effect to the general objectives of IEM (section 24(1), NEMA), including sustainable development, there is a logical and necessary interrelationship between climate change and EIA.

NEMA sets out the general objectives of IEM in South Africa, including to (section 23(2)), of which the following two are of relevance for this report:

- Identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities. This is to be done with a view to minimising negative impacts, maximising benefits and promoting compliance with the principles of environmental management set out in section 2 (of NEMA).
- Ensure that the effects of activities on the environment receive adequate consideration before actions are taken in connection with them.

A Screening Tool Report was generated from the DFFE Screening tool as per the requirements of Regulation 16 (1)(b)(v) of the EIA Regulations 2014, as amended, and was included in the Application for EA. The screening Tool provided a list of specialist studies for consideration and inclusion in the Scoping and EIA process.

In this regard, as Site Sensitivity Verification Report (SSVR) has been compiled to consider the recommendations of the DFFE Screening Tool Report and to provide a rationale for the selection of specialist studies included in line with the recommendations of the Plan of Study for EIA included in the Scoping Report. Please refer to Appendix 5 for the SSVR.

On 11 July 2022 the Minister of Forestry, Fisheries and the Environment published draft Regulations Pertaining to the Exploration and Production of Onshore Oil and Gas requiring Hydraulic Fracturing under the National Environmental Management Act 107 of 1998. The Minister also published on 8 July 2022 her intention to prescribe Minimum Requirements for the Submission of Applications for an Authorisation, Right, Permit or Licence for the Onshore Exploration of Oil and Gas Intending to Utilise Hydraulic Fracturing.

Whilst the above-mentioned draft regulations have not yet been adopted/promulgated for implementation, in the absence of other hydraulic fracturing regulations, these regulations are being considered, where applicable to this project, to inform this EIA process.

6.4 THE NATIONAL WATER ACT (NWA)

The purpose of the NWA is to ensure that the nation’s water resources are protected, used, developed, conserved, managed and controlled in ways which consider amongst other factors:

a) meeting the basic human needs of present and future generations;

b) promoting equitable access to water;

c) redressing the results of past racial and gender discrimination;

d) promoting the efficient, sustainable and beneficial use of water in the public interest;

e) facilitating social and economic development;

f) providing for growing demand for water use;

g) protecting aquatic and associated ecosystems and their biological diversity;

h) reducing and preventing pollution and degradation of water resources;

i) meeting international obligations;

j) promoting dam safety;

k) managing floods and droughts,

and for achieving this purpose, to establish suitable institutions and to ensure that they have appropriate community, racial and gender representation.

The 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.

The above water use processes are described in Figure 23.

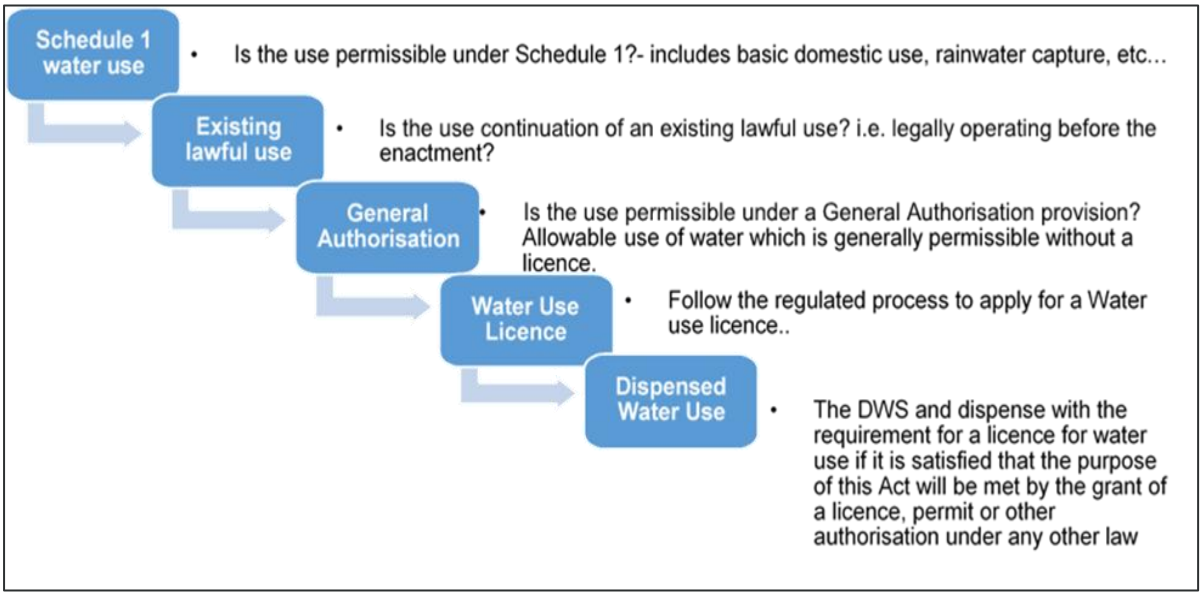


Figure 23: Authorisation processes for new water uses.

The NWA defines 11 water uses in Section 21 of the Act. A water use may only be undertaken if authorised by the DWS. 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.

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 obtained 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 water uses applicable to this project are presented in Table 15 below and shall be discussed and agreed upon with the DWS during the WULA process.

Table 15: Likely NWA Section 21 water uses triggered by this project.

Section 21 water use	Description	Applicability
a	Taking water from a water resource.	Abstraction of water from boreholes for use.
c & i	Impeding or diverting the flow of water in a watercourse and/or altering the bed, banks, course or characteristics of a watercourse.	Aquatic and hydrology delineations show infrastructure within regulated area of a watercourse. Linear infrastructure (gas and water pipelines from wells to plant and access roads) within the regulated area which may impact on defined water resources in certain areas.
e	Engaging in a controlled activity identified as such in section 37 (1) or declared under section 38 (1);	Hydraulic stimulation is a controlled activity in terms Section 37(1) of the National Water Act as per the notice published by the Minister of Water and Sanitation dated 16 October 2015. This Section 21 (e) water use is also triggered through the reinjection of coal seam water into a deeper coal seam aquifer.

Section 21 water use	Description	Applicability
f	Discharging waste or water containing waste into a water resource.	The potential discharge of treated water into the Mogol River.
g	Disposing of waste in a manner which may detrimentally impact on a water resource.	• Septic tanks for storage of sewage (for offsite disposal by waste contractor); • Brine Storage Pond; • PCDs / evaporation dams to store produced water.
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.	Dewatering of groundwater from the wells in order to release the hydrostatic pressure of the gas within the coal seam.

The required water use licencing application will run concurrently with this EIA process and in consultation with the DWS, additional water uses may be identified.

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 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.

This project falls within the Limpopo WMA which is the most northern WMA in South Africa. The Limpopo WMA North forms part of the internationally shared Limpopo Basin. The Limpopo River forms the entire length of the international border between the WMA and Botswana and Zimbabwe before flowing into Mozambique. The main rivers form the six major catchment areas in the Limpopo WMA North which include the Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele. These rivers, together with other smaller tributaries, all flow northwards into the Limpopo River.

According to the Limpopo WMA North Reconciliation Strategy, irrigation developments occur at various locations in the Limpopo WMA North, such as the Waterberg area, the Sand River catchment and along the Limpopo River, with much of the water being supplied from farm dams and groundwater. Small areas of commercial forest are found in the high rainfall parts of the Soutpansberg near Louis Trichardt. Most of the WMA remains under natural vegetation, with livestock and game farming as main activities. Severe overgrazing is prevalent in many areas. Mining is a strategic water user with a variety of minerals found mainly in the eastern and southern part of the WMA. Recent developments include large expansions in mining activities with respect to the platinum group metals, mainly in the vicinity of Mokopane and extending both east and westward along the Bushveld Igneous Complex. Extensive future coal mining development is anticipated between the Louis Trichardt and Musina.

On 7 May 2021 the Minister of Water and Sanitation published draft Regulations Pertaining to the Use of Water for Exploration and Production of Onshore Naturally Occurring Hydrocarbons that Require Stimulation, Including Hydraulic Fracturing and Underground Gasification, to Extract, and any Activity Incidental Thereto that May Impact Detrimentally on the Water Resource (GN 406 of 2021). The purpose of these draft regulations is to protect the water resource so as to avoid and minimise detrimental and cumulative impacts on the water resource by the controlled activity. Under these draft regulations, the following prohibited areas are listed with the Responsible Authority able to further amend the various distances provided:

a) within five kilometres from the edge of an existing or proposed municipal wellfield, including its aquifer; water supply borehole and/or groundwater supply infrastructure;

b) within five kilometres from any town without a wellfield as future water source areas;

c) within five kilometres of any government waterworks including dams with a safety risk;

d) within five kilometres from the edge of any identified strategic water source area; and

e) within five kilometres from the edge of a thermal or cold spring including seismically active springs.

Whilst the above-mentioned draft hydraulic fracturing regulations have not yet been adopted/promulgated for implementation, in the absence of other hydraulic fracturing regulations, these regulations are being considered, where applicable to this project, to inform this EIA process.

6.5 THE NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT (NEMWA)

On 2 June 2014, the NEMWA came into force. Waste is accordingly no longer governed by the MPRDA but is subject to all the provisions of the NEMWA.

The objectives of this Act are:

a) to protect health, well-being and the environment by providing reasonable measures for-

    i. minimising the consumption of natural resources;

    ii. avoiding and minimising the generation of waste;

    iii. reducing, re-using, recycling and recovering waste;

    iv. treating and safely disposing of waste as a last resort;

    v. preventing pollution and ecological degradation;

    vi. securing ecologically sustainable development while promoting justifiable economic and social development;

    vii. promoting and ensuring the effective delivery of waste services;

    viii. remediating land where contamination presents, or may present, a significant risk of harm to health or the environment; and

    ix. achieving integrated waste management reporting and planning;

b) to ensure that people are aware of the impact of waste on their health, well-being and the environment;

c) to provide for compliance with the measures set out in paragraph (a); and

d) generally, to give effect to section 24 of the Constitution in order to secure an environment that is not harmful to health and well-being.

Section 16 of the NEMWA states:

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.*"

The NEMWA provides for specific waste management measures to be implemented, as well as providing for the licensing and control of waste management activities. This 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 Waste Classification and Management Regulations (GNR 634) are published under the NEMWA. 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.

6.6 THE NATIONAL ENVIRONMENTAL MANAGEMENT AIR QUALITY ACT (NEMAQA)

The 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 of 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.

As part of this LCBM application, an Air Quality and GHG study is being undertaken to inform the required compliance with the NEMAQA and associated regulations.

The National Dust Control Regulations, 2026 (GNR 7335 of 31 March 2026), promulgated under the National Environmental Management: Air Quality Act, 2004, establish a comprehensive regulatory framework for the prevention, control and monitoring of dust emissions from listed and non-listed activities. The regulations set permissible dustfall limits for different land-use areas, require operators to implement reasonable measures to prevent dust generation and migration beyond site boundaries, and prescribe mandatory monitoring and reporting obligations to demonstrate compliance. Where dustfall standards are exceeded, regulated entities must develop and implement Dust Management Plans detailing mitigation measures and ongoing control strategies. These 2026 updated regulations strengthen earlier provisions contained in the 2013 regulations by enhancing compliance, enforcement mechanisms and reporting requirements, and by expanding the scope of regulated activities, thereby aligning dust management practices with improved environmental protection and public health objectives. Dust that may be created from the 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) gives effect to the NHRA and 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 considered in the EIA Regulations under the NEMA relates to the Specialist Report requirements (Appendix 6 of EIA Regulations 2014, as amended) which apply to Heritage Impact Assessments.

The MPRDA also gives effect to the NHRA as this Act 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 MPRDA 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.

The National List of Ecosystems that are Threatened and Need of Protection (GN 1002 of 2011) are promulgated under the NEMBA, and these Regulations provide 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 avoidance mechanisms can be applied. Permits for protected species under the NEMBA may also be required should avoidance not be possible in certain areas and the requirement for pre-construction surveys and permit applications will be included in the EMPr.

Further regulations published under the NEMBA are the threatened or protected Species Regulations (GN R 152 OF 2007) which aims 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.

The relevant specialists that will undertake their respective studies for this application will assess the presence or likely presence of Threatened or Protected Species (TOPS) and apply the mitigation hierarchy to identify suitable mechanisms to avoid adverse impacts on TOPS.

The Alien and Invasive Species Lists are promulgated under the NEMBA with the aim of protecting 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.

Thungela will be required to continually monitor their development footprint areas for the presence of alien and invasive species and implement suitable control measures to prevent further establishment or spread of these species.

In giving effect to the above, the Alien and Invasive Species Regulations (GNR 1020 of 2020) provide for amongst others, the prevention of the spread or allowing the spread of, any specimen of a listed invasive species.

6.9 ENVIRONMENT CONSERVATION ACT (ECA)

The ECA (Act 73 of 1989) 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 in Limpopo while these regulations have been repealed in Gauteng by Gen N 5479 / PG 75 / 19990820; in the Free State by Gen N 24 / PG 35 / 19980424 and in the Western Cape by RN 627 / PG 5309 / 19981120. These Regulations serve to control noise and general prohibitions relating to noise impact and nuisance.

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.

There are a few SANS relevant to noise from mines, industry and roads. They are:

- 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 will be undertaken for this project and the findings utilised in the impact assessment and associated management measures in the EMPr.

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

The Spatial Planning and Land Use Management Act (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.

Thungela will need to undertake the relevant rezoning or land use change applications for the relevant areas in accordance with the relevant municipal bylaws.

6.11 OCCUPATIONAL HEALTH AND SAFETY ACT

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

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

A "major hazard installation" means an installation-

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

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

MHI qualitative risk assessment shall be undertaken to confirm whether the project is defined as an MHI, and to inform the necessary risk mitigation.

6.12 BASIC CONDITIONS OF EMPLOYMENT ACT

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

6.13 LABOUR RELATIONS ACT

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

6.14 EMPLOYMENT EQUITY ACT

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

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

6.15 PROMOTION OF EQUALITY AND PREVENTION OF UNFAIR DISCRIMINATION

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

6.16 FIREARMS CONTROL ACT

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

6.17 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 in 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.

This project aims to produce LNG which 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.

6.18 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. This LCBM project may indirectly contribute towards the development of the piped gas industry in South Africa. Section 15(1) of the Gas Act states that no person may without a licence issued by the Gas Regulator:

a) construct gas transmission, storage, distribution, liquefaction and re-gasification facilities or convert infrastructure into such facilities;

b) operate gas transmission, storage, distribution, liquefaction or re- gasification facilities; or

c) trade in gas.

While the Gas Act of 2001 is still in effect, there is a draft updated Gas Act that may be promulgated in due course and therefore Thungela will need to comply with the relevant Gas Act (if applicable) at the time of commencement of the activities.

6.19 GAS MASTER PLAN AND INTEGRATED RESOURCE PLAN

The South African Gas Master Plan (GMP 2024), published by the Department of Mineral Resources and Energy in April 2024 for public comment, is a strategic policy framework intended to guide the development of the country's gas sector and ensure long-term security of supply. The Plan seeks to diversify gas supply sources through a combination of domestic production, regional imports and liquefied natural gas (LNG), while outlining the role of natural gas within the national energy mix and broader energy transition. It provides policy direction across the full gas value chain, including demand projections, supply options, infrastructure requirements (such as pipelines, import terminals and gas-to-power facilities), and distribution networks, based on least-cost modelling and multiple demand scenarios. The GMP further aims to catalyse investment, support industrial growth, and enable a transition away from a coal-dominated energy system, while recognising gas as a flexible and relatively lower-emission energy source for power generation and thermal applications. As of 2025, the Plan has undergone stakeholder consultation and technical modelling and is progressing through internal government review processes toward Cabinet approval.

The Integrated Resource Plan 2025 (IRP 2025), finalised and published on 28 October 2025 by the Department of Electricity and Energy, reinforces the role of natural gas as a key component of South Africa's future energy mix. The Plan provides for a material allocation of gas-fired power generation capacity, primarily to deliver flexible, dispatchable energy that complements the increasing penetration of variable renewable energy sources such as wind and solar. In this context, gas—particularly in the form of locally produced or imported liquefied natural gas (LNG)—is positioned as a strategic enabler of grid stability and energy security, capable of meeting peak demand and addressing supply intermittency. The IRP 2025 further signals government's commitment to advancing enabling infrastructure, including LNG import terminals and associated gas-to-power projects, thereby supporting both electricity generation and broader industrial energy requirements as part of a pragmatic, lower-emission energy transition pathway.

6.20 GHG AND CLIMATE CHANGE

GHGs 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 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).

6.20.1 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 will end in 2020 (UNFCCC, 2017) but due to lack of ratification has not come into force.

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 central aim of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2.0°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 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.

In 2018, Parties contemplated progress towards the goal set in the Paris Agreement and to inform the preparation of NDCs. There will also be a global stocktake every five years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties.

As of October 2022, 194 Parties of the 197 Parties to the UNFCCC Convention, including South Africa, had ratified the Paris Agreement. South Africa submitted its NDC to the UNFCCC on 25 September 2016 and an updated NDC in September 2021.

6.20.2 SOUTH AFRICAN NATIONAL CLIMATE CHANGE RESPONSE POLICY 2011

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. South Africa later also ratified the Paris Agreement (as signed on 22 April 2016) which although not bound to commit to a cap or reduce GHG emissions, pledged to reduce emissions by 34% below Business-As-Usual (BAU) emissions by 2020 and 42% below BAU by 2025. The proposed 2030 target range represents a 28% reduction in GHG emissions commitment from the original 2015 NDC targets. However, these original goals were ambitious, and South Africa subsequently shifted from BAU-based targets for 2020 and 2025 in terms of the Cancun Agreement under the UNFCCC, to absolute GHG emissions targets under the Paris Agreement. This update demonstrates reducing the upper range of South Africa's targets by a more realistic 17% for 2025 and 28% for 2030, respectively.

The National Climate Change Response White Paper, passed by Cabinet in October 2011, 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 sulphur dioxide concentrations to levels in compliance with the National Ambient Air Quality Standards (NAAQS) by 2020. To achieve these objectives, the Department of Forestry, Fisheries and Environment (DFFE) established a national GHG emissions inventory that reports through the South African Atmospheric Quality Information System (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 NDC 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 co-ordinating 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, its establishment only carries legal force after the Bill becomes an Act.
- Establish a National Adaptation Strategy to 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 that 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 be linked to the Carbon Tax Act, which will replace the current National Pollution Prevention Plan mechanism which is enforced under the National Environmental Management: Air Quality Act (NEM:AQA).

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 proposed project activities, if not before.

6.20.3 NATIONALLY DETERMINED CONTRIBUTION

The first South African Nationally Determined Contribution (NDC) was submitted in 2016 in fulfilment of decisions adopted under the United Nations Framework Convention on Climate Change. This was followed by an updated NDC submitted on 27 September 2021 ahead of the 26th Conference of the Parties. In October 2025, South Africa submitted its second updated NDC, which further refines the country's commitments on mitigation, adaptation, and the associated finance and investment requirements, in line with the long-term temperature goals of the Paris Agreement.

The 2025 NDC retains a strong focus on adaptation through the continued implementation of the National Climate Change Adaptation Strategy, with emphasis on strengthening institutional capacity, improving climate risk information and planning tools, and enhancing resilience across priority sectors including water, agriculture, health, biodiversity, human settlements, and infrastructure. It also reinforces the need for scaled-up financial support, including access to international climate finance, to enable effective adaptation responses.

From a mitigation perspective, the 2025 NDC introduces more ambitious greenhouse gas (GHG) emission targets, narrowing the emissions range compared to the 2021 update. South Africa has committed to limiting its annual GHG emissions to a range of approximately 350–420 Mt CO_2-e by 2030, representing a strengthening of its previous target range of 398–440 Mt CO_2-e. The NDC continues to support a just energy transition, including the accelerated deployment of renewable energy, improvements in energy efficiency, electrification of transport, and the potential role of emerging technologies such as green hydrogen and carbon capture, utilisation and storage (CCUS).

Overall, the updated NDC signals South Africa's increased ambition while recognising national development priorities and the need for international support to achieve a balanced transition that is both climate-resilient and socio-economically sustainable.

6.20.4 GREENHOUSE GAS EMISSIONS REPORTING

Regulations pertaining to GHG reporting using the National Atmospheric Emission Inventory System (NAEIS) were published on 3 April 2017 (Government Notice (GN) 257 in Government Gazette 40762 and amendment – GNR 994 in Government Gazette 43712). The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only. The three broad scopes for estimating GHG are:

- Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.

The South African Greenhouse Gas Emission Reporting System (SAGERS) web-based monitoring and reporting system is 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).

The DFFE is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the IPCC's 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. Methodological guidelines for GHG emission estimation, which include country specific emission factors for fuels used in stationary and mobile combustion, have been issued (DFFE, 2022b)

Also, the Carbon Tax Act (Act 15 of 2019) includes details on the imposition of a tax on the CO2-e of GHG emissions. Certain production processes indicated in Annexure A of the Declaration of Greenhouse Gases as

Priority Pollutants (GN 710 in GG 40966, 21 July 2017) with GHG more than 0.1 Mt/year, measured as carbon dioxide equivalent (CO2-e), are required to submit a pollution prevention plan to the Minister for approval. The proposed project will be required to report CO2-e emissions but may not be required to prepare a pollution prevention plan, unless directed by the minister.

6.20.5 GHG INVENTORIES

6.20.5.1 NATIONAL GHG EMISSION INVENTORY

South Africa is a GHG 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 (DFFE, 2022a). 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 2020 National GHG Inventory was prepared using the 2006 IPCC Guidelines (IPCC, 2006). According to the draft 8th National GHG Inventory Report to the UNFCCC (DFFE, 2021), the total GHG emissions in 2020 were estimated at approximately 478.634 million metric tonnes CO2-e (excluding Forestry and Other Land Use (FOLU)). This was a 1% increase from the 2000 total GHG emissions (excluding FOLU). FOLU is estimated to be a net carbon sink which reduces the 2020 GHG emissions to 445.566 million metric tonnes CO2-e. The assessment (excluding FOLU) showed the main sector contributing to GHG emissions in 2020 to be the energy industry, contributing 79.4 % to the total GHG emissions (excluding FOLU), this increased by 2.4% from 2000.

6.20.5.2 GHG EMISSION INVENTORY FOR THE SECTOR

The proposed project would be categorised in the energy category for both the global GHG inventory and for the national GHG inventory. According to the World Resources Institute – CAIT Climate Data Explorer the 2020 global GHG emissions from the energy category were approximately 937 000 Gt CO_2-e; 74% of the total GHG emissions (including Land-Use Change and Forestry (LUCF)). The South African energy sector contributed 11.9 Gt CO_2-e, ~1.3% of the global emissions from the energy sector in 2020.

6.20.5.3 DRAFT NATIONAL GUIDELINE FOR CONSIDERATION OF CLIMATE CHANGE IN DEVELOPMENT APPLICATIONS, 2025

The draft National Environmental Management Act (NEMA): National Guideline for Consideration of Climate Change Implications in Applications for Environmental Authorisations, Atmospheric Emission Licences and Waste Management Licences (published for public comment in 2025) introduces a formalised approach to integrating climate change considerations into South Africa’s environmental authorisation and permitting framework. The guideline is issued under the National Environmental Management Act, 1998 (Act No. 107 of 1998) and is intended to provide competent authorities, applicants, and environmental assessment practitioners with a consistent methodology for assessing both greenhouse gas (GHG) emissions and climate change resilience within development applications.

The guideline applies across Environmental Authorisations (EAs), Atmospheric Emission Licences (AELs), and Waste Management Licences (WMLs), thereby ensuring that climate change is addressed in a coordinated manner across key environmental regulatory instruments. It requires proponents to identify, quantify where appropriate, and evaluate the significance of project-related GHG emissions, including direct and indirect emissions, while also considering feasible mitigation measures in line with the mitigation hierarchy. In addition, it introduces the requirement to assess climate change vulnerability and adaptation needs of proposed developments, including exposure to climate-related hazards such as extreme temperatures, flooding, drought, and other physical climate risks over the project lifecycle.

A key feature of the guideline is its emphasis on decision-making alignment with national climate policy commitments, including South Africa’s Nationally Determined Contribution (NDC), long-term low-emissions development strategy, and the principles of a just transition. It further encourages consideration of reasonable alternatives, including low-carbon design options and technologies, and requires that climate-related impacts and risks be explicitly documented in environmental assessment reports and decision-making records.

Overall, the draft guideline represents a significant strengthening of South Africa's environmental regulatory framework by embedding climate change considerations as a mandatory component of environmental decision-making across authorisation, emissions licensing, and waste management processes.

6.21 DISTRICT AND LOCAL MUNICIPAL INTEGRATED DEVELOPMENT PLANS

For the purpose of this project, Integrated Development Plan (IDP) documents of two municipalities need to be considered: the Waterberg District Municipality and the Lephalale Local Municipality.

The Waterberg District Municipality IDP (2023/24) indicated the following municipal priorities:

- Municipal health and environmental management;
- Air quality;
- Firefighting services;
- Disaster management;
- Abattoirs;
- Local economic development and tourism;
- Community participation and good governance;
- Financial viability;
- Municipal roads and storm water;
- Municipal support and institutional development;
- Sports, arts and culture;
- Water and sanitation;
- Electricity; and
- Transport.

The Waterberg District Municipality was one of three municipalities selected to pilot the District Development Model (DDM). Government is using DDM as a practical model to improve cooperative governance and promote integrated planning, budgeting, and implementation on the basis of stakeholder and community involvement and thereby build a capable and ethical developmental state with strong local government that can respond to current and future needs and effectively implement national priorities.

The Waterberg One Plan has been developed on the following vision: "A tourism and energy hub that enables a participative, investment friendly and diversified economy" with six DDM themes which are Demographics & People Development, Economic Positioning, Spatial Restructuring/Environmental, Infrastructure Engineering, Service Provisioning, and Governance (Waterberg DM IDP 2024/25).

Lephalale Local Municipality identified the following pillars of their performance framework (IDP 2023-27):

- Putting people first;
- Delivering basic services;
- Good Governance;
- Sound financial management; and
- Building capacity.

Under the Lephalale IDP, the district development model aims to amongst others, restructure the Waterberg economy from a focus on primary activities such as mining and agriculture to secondary and tertiary activities which include manufacturing and downstream beneficiation opportunities. The IDP states that the municipal area's contribution of mining to Gross Domestic Product (GDP) is significant at 59.21% and the expansion of mining to exploit the coalfields and power supply industries in Lephalale Local Municipality is seen as a priority to facilitate and allow economic growth of the Region and the Province as a whole. This indicates that the intention is to grow the economy with additional services in addition to the current mining activities. The Thungela LCBM would contribute to this downstream development in the medium to long term.

7 NEED AND DESIRABILITY OF THE PROPOSED ACTIVITY

In South Africa, an Environmental Impact Assessment ("EIA") is required for various types of activities and projects to ensure that their potential environmental and social impacts are properly assessed and mitigated. The legal and other triggers for an EIA in South Africa are primarily outlined in the NEMA and associated regulations. This section has been compiled in consultation with the economic specialist.

NEMA includes a list of activities that are classified as "listed activities" and if a project meets the criteria outlined in this list, it triggers the need for an EIA. In this regard the Thungela's long term intent of developing a gas field over an area encompassing 224 farm portions and a total area of 134 302.6699 hectares (ha) certainly puts it in that list - even though the Phase 1 will comprise a smaller area within the broader PR area.

As the result of the need for an EIA, a need and desirability assessment is also required. This is a critical assessment that ensures development projects are conducted in an environmentally responsible and sustainable manner. Specific factors that require consideration are listed in the Guideline on Need and Desirability published by DFFE and updated in 2017.

Generally, a need and desirability analysis establishes a well-defined framework for decision-making, facilitating the evaluation of whether a proposed project should proceed while considering its socio-economic and environmental desirability. Additionally, the need and desirability analysis encompass public engagement, delineating the involvement of stakeholders, including affected communities and environmental organisations, ensuring their perspectives are considered throughout the EIA process. Moreover, this assessment fosters transparency and accountability by elucidating the project's objectives, rationale, and potential impacts, thereby enabling both the public and authorities to hold project proponents accountable. Furthermore, it ensures alignment with South Africa's rigorous environmental laws and policies, verifying that projects conform to these frameworks and promoting compliance. The need and desirability analysis also initiates risk assessments and encourages the exploration of alternative project designs or locations, emphasising environmental and sustainability goals. Finally, it prompts the consideration of cumulative impacts, which is vital for assessing the long-term sustainability of development in each region.

The need and desirability analysis should provide a thorough and evidence-based assessment of why the proposed project is economically necessary and desirable. It should consider economic benefits, costs, alternatives, and long-term sustainability to inform decision-making within the framework of South African EIA requirements.

This section sets out the need and desirability of the proposed LCBM gas production project, with reference to international trends, national policy and legislative frameworks, and the regional and local development context.

7.1 INTERNATIONAL PERSPECTIVES

7.1.1 CLIMATE CHANGE AND THE GLOBAL ENERGY TRANSITION

Globally, there is an increasing shift towards low-carbon energy systems in response to climate change and international agreements such as the Paris Agreement. These commitments seek to limit global warming and reduce greenhouse gas emissions through the gradual reduction of reliance on carbon-intensive fuels such as coal. Within this transition, natural gas has emerged as an important intermediary energy source. While it remains a fossil fuel, it has a lower carbon intensity than coal when used for energy generation and produces fewer air pollutants such as sulphur dioxide and particulate matter. Importantly, CBM development enables the capture and beneficial use of methane gas that would otherwise be released into the atmosphere, thereby reducing fugitive emissions of a potent greenhouse gas.

The utilisation of CBM as an energy resource therefore contributes to global objectives of reducing emissions while maintaining energy availability, particularly in economies that are still transitioning from coal-based systems.

7.1.2 ROLE OF GAS IN SUPPORTING ENERGY SECURITY AND RENEWABLES

International energy systems increasingly rely on natural gas to support energy security and system flexibility. As renewable energy technologies such as wind and solar are expanded, their inherent intermittency requires complementary energy sources that are capable of providing reliable, dispatchable power. Gas-fired generation plays a critical role in stabilising electricity systems by balancing fluctuations in renewable supply. In this regard, gas is not positioned as a replacement for renewable energy, but rather as an enabling technology that supports higher levels of renewable penetration. The development of indigenous gas resources, such as CBM, is therefore consistent with global energy trends that emphasise diversification, resilience, and system reliability.

7.1.3 SUSTAINABLE DEVELOPMENT CONSIDERATIONS

From a sustainable development perspective, CBM projects can contribute positively where they are implemented responsibly and in accordance with environmental best practice. This includes minimising impacts on water resources, managing land disturbance, and protecting biodiversity. In addition, such projects can contribute to socio-economic development through job creation, infrastructure investment, and local economic stimulation. When appropriately managed, CBM development supports the broader objectives of sustainable resource use, energy access, and economic growth.

7.1.4 IPCC ASSESSMENT REPORT

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6, 2021–2023) provides the most comprehensive global scientific assessment of climate change, concluding with high confidence that human activities—primarily the combustion of fossil fuels—are the dominant cause of observed global warming, which has reached approximately 1.1 °C above pre-industrial levels. The report emphasises that limiting warming to 1.5 °C or well below 2 °C requires rapid, deep and sustained reductions in greenhouse gas emissions across all sectors, including a substantial decline in fossil fuel use over the coming decades. Within this pathway, the role of natural gas is nuanced. The IPCC does not explicitly promote gas expansion as a long-term solution; rather, it recognises that in many mitigation scenarios, gas consumption declines more gradually than coal, reflecting its relatively lower carbon intensity and potential as a transitional energy source in certain contexts. However, the report also highlights that continued reliance on fossil fuels, including gas, without significant abatement measures (such as carbon capture and storage), is incompatible with achieving net-zero emissions targets.

A critical aspect of the IPCC's assessment is the prominence of methane, the primary component of natural gas and CBM, as a potent greenhouse gas with a significantly higher short-term warming potential than carbon dioxide. The AR6 emphasises that substantial reductions in methane emissions are essential to meet the goals of the Paris Agreement, noting that failure to reduce methane would significantly constrain the remaining global carbon budget. This has direct implications for gas production activities, including CBM, where fugitive emissions during extraction and processing must be strictly managed. At the same time, the controlled capture and utilisation of methane—such as in CBM projects—can contribute positively by preventing uncontrolled emissions from coal seams, thereby aligning with mitigation objectives.

Overall, the IPCC AR6 positions gas within a transitional and conditional role in the global energy system. While gas may support energy security and facilitate the integration of renewable energy in the short to medium term, its long-term role is expected to diminish as energy systems decarbonise. The report underscores that any continued use of gas must be accompanied by aggressive emissions reductions, methane management, and a clear trajectory toward low- and zero-carbon energy systems. In this context, CBM development can be considered consistent with IPCC findings where it contributes to emission reduction (through methane capture), supports a phased transition from coal, and does not lock in long-term fossil fuel dependency.

7.2 NATIONAL POLICY AND LEGISLATIVE PERSPECTIVES

7.2.1 NATIONAL DEVELOPMENT PLAN

The National Development Plan (NDP) 2030 sets out South Africa's long-term vision for economic development and identifies energy security as a critical enabler of growth. The NDP emphasises the need for a diversified energy mix that reduces reliance on coal while ensuring reliable and affordable energy supply.

Within this framework, natural gas is identified as a key component of the future energy mix. The NDP recognises the role of gas in supporting industrial development, enabling cleaner energy production, and providing flexible generation capacity. The development of CBM resources in the Lephalale area directly supports these objectives by contributing to domestic gas supply, reducing dependence on imports in this volatile global energy market, and supporting regional economic development.

7.2.2 INTEGRATED RESOURCE PLAN

The Integrated Resource Plan ("IRP") 2025, published by the Department of Electricity and Energy on 28 October 2025, is the current national policy framework guiding long-term electricity generation planning in South Africa. The IRP 2025 sets out the country's projected electricity supply pathway to 2050 and seeks to balance energy security, affordability, economic growth, infrastructure constraints and environmental considerations within a diversified energy mix. The plan recognises the continued role of dispatchable generation technologies alongside increasing renewable energy penetration and battery storage deployment.

Within the IRP 2025 framework, gas is identified as an important component of South Africa's future electricity system, particularly in relation to flexible generation capacity, grid balancing and dispatchable support for variable renewable energy sources such as wind and solar photovoltaic generation. The IRP 2025 includes significant gas-to-power ("GtP") allocations and policy adjustments intended to increase the utilisation of gas-fired generation facilities relative to earlier planning assumptions. In terms of the IRP 2025, gas is projected to contribute approximately 11% of South Africa's electricity generation by 2039, with the plan further increasing the assumed operational load factor of certain gas-fired plants to improve system adequacy and reliability.

The IRP 2025 further acknowledges that the future role of gas in South Africa is dependent on the development of supporting infrastructure, including transmission networks, pipelines, storage facilities, liquefied natural gas ("LNG") import capability and domestic gas supply opportunities. In this regard, indigenous gas resources, including coal bed methane ("CBM"), are increasingly relevant within broader national discussions concerning energy diversification, energy security and industrial development. Although the IRP 2025 does not prescribe or endorse specific projects, it provides a policy context recognising the potential strategic role of gas in facilitating a more flexible and diversified electricity supply system during South Africa's energy transition. At the same time, the IRP 2025 reflects the country's stated objective of progressively transitioning toward a lower-carbon electricity sector over the longer term.

7.2.3 GAS MASTER PLAN

The Gas Master Plan provides a strategic framework for the development of a gas-based economy in South Africa. Its objectives include diversifying energy sources, promoting the use of gas in power generation and industry, and developing the necessary infrastructure to support gas supply and distribution.

A key focus of Gas Master Plan is the development of indigenous gas resources to reduce reliance on imported gas and enhance energy security. The proposed LCBM project aligns strongly with this objective by unlocking local gas resources within the Waterberg region and contributing to the establishment of a domestic gas market.

7.2.4 WHITE PAPER ON ENERGY POLICY

The White Paper on Energy Policy outlines the government's commitment to ensuring access to affordable energy services, promoting economic development, and managing environmental impacts. It emphasises the importance of diversifying energy sources and promoting environmentally sustainable energy development.

CBM development is consistent with these objectives, as it introduces an alternative energy carrier into the national energy mix and provides a comparatively cleaner fossil fuel option relative to coal with many other downstream uses such as the gas powered transportation sector and a host of other chemical applications.

7.2.5 NATIONAL CLIMATE CHANGE RESPONSE WHITE PAPER

The Department of Environmental Affairs National Climate Change Response White Paper ("NCCRWP"), published in 2011, establishes South Africa's overarching national policy framework for responding to climate change through both mitigation and adaptation measures. The White Paper recognises climate change as a significant environmental, social and economic challenge requiring a transition toward a lower-carbon and climate-resilient economy and society. At the same time, the policy acknowledges South Africa's developmental priorities, including poverty alleviation, economic growth, industrial development and energy security, and emphasises that climate responses must be aligned with principles of sustainable development and a "just transition".

The NCCRWP adopts a balanced approach which seeks to reduce greenhouse gas emissions while recognising the country's historical dependence on coal-based energy generation and energy-intensive industries. The policy framework therefore supports a gradual transition toward a more diversified energy mix, including the increased deployment of renewable energy, improved energy efficiency measures and the development of lower-carbon technologies. Within this context, natural gas is not positioned as a primary long-term energy solution within the White Paper; however, the policy does acknowledge the potential role of lower-carbon fossil fuel alternatives and cleaner energy technologies in supporting the transition to a less carbon-intensive economy.

Although coal bed methane ("CBM") and large-scale gas-to-power development were not a major focus of the 2011 policy framework at the time of publication, subsequent national energy planning instruments, including later Integrated Resource Plans ("IRPs"), have increasingly recognised gas as a flexible and dispatchable energy source capable of complementing renewable energy generation and supporting electricity supply stability. Accordingly, indigenous gas resources may be viewed within the broader climate policy context as potentially contributing toward reduced carbon intensity relative to conventional coal combustion, while simultaneously supporting energy security and economic development objectives. However, the NCCRWP also emphasises that all energy developments should contribute toward South Africa's long-term emissions reduction trajectory and be assessed in terms of their environmental sustainability, climate impacts and alignment with national mitigation objectives.

The White Paper further promotes the principles of sustainable development, pollution prevention, environmental protection and integrated planning, all of which remain relevant considerations in the environmental assessment of proposed energy developments. In this regard, projects involving the exploration and production of gas resources remain subject to environmental authorisation processes and the balancing of socio-economic benefits with potential environmental and climate-related impacts.

7.2.6 JUST ENERGY TRANSITION

South Africa's Just Energy Transition ("JET") framework constitutes a key national policy approach intended to support the country's transition toward a lower-carbon economy while simultaneously addressing socio-economic development priorities, energy security and employment considerations. The Just Energy Transition Investment Plan ("JET-IP"), together with associated policy instruments and international partnership commitments, recognises that South Africa's energy transition must occur in a manner that is socially inclusive and economically sustainable, particularly in regions historically dependent on coal mining and coal-based energy generation.

The JET framework acknowledges that South Africa continues to face significant developmental challenges, including high unemployment, poverty, inequality and electricity supply constraints. Accordingly, the transition pathway proposed within the JET framework does not envisage an immediate cessation of fossil fuel utilisation, but rather a phased and managed transition balancing environmental objectives with economic stability and energy reliability. The JET-IP identifies electricity, new energy vehicles and green hydrogen as priority sectors for transition-related investment, while also recognising the importance of maintaining secure and reliable energy supply during the transition period.

Within this broader transition context, gas is increasingly referenced in South African policy and energy planning discussions as a potential "transition fuel" capable of supporting system flexibility and dispatchable electricity generation while renewable energy infrastructure and storage capacity continue to expand. National planning frameworks, including the Integrated Resource Plan ("IRP") 2025, recognise the potential role of gas-fired generation in complementing variable renewable energy sources and supporting grid stability. Consequently, indigenous gas resources, including coal bed methane ("CBM"), are increasingly relevant within discussions concerning energy diversification, industrial development and reduced reliance on imported energy products. At the same time, policy discussions relating to the Just Energy Transition also emphasise the need to progressively reduce greenhouse gas emissions over the longer term and to ensure that future energy developments align with evolving climate commitments and sustainability objectives.

The JET framework further places emphasis on regional economic resilience and the creation of alternative economic opportunities in areas historically associated with mining and energy production. In this regard, energy-related developments that contribute toward infrastructure investment, employment creation, skills development and local economic activity may be considered relevant within the broader objectives of ensuring a managed and socially responsive energy transition. However, all such developments remain subject to applicable environmental authorisations, regulatory requirements and the balancing of socio-economic and environmental considerations within South Africa's evolving energy policy landscape.

7.2.7 LOW EMISSIONS DEVELOPMENT STRATEGY 2050

South Africa's Low Emission Development Strategy 2050 ("SA LEDS 2050") constitutes the country's long-term strategic framework for transitioning toward a low-carbon and climate-resilient economy in alignment with the objectives of the United Nations Framework Convention on Climate Change Paris Agreement. The strategy, formally submitted to the UNFCCC in 2020, builds upon earlier climate policy instruments, including the National Climate Change Response White Paper ("NCCRWP"), and sets out a long-term vision for reducing greenhouse gas ("GHG") emissions while simultaneously supporting socio-economic development, poverty alleviation, industrial growth and employment creation. The SA LEDS 2050 emphasises that South Africa's transition pathway must occur within the context of sustainable development and a "just transition" responsive to the country's developmental challenges and economic realities.

The SA LEDS 2050 recognises that South Africa's economy has historically been highly dependent on fossil fuels, particularly coal, and that a progressive transition toward a lower-emissions economy will require significant transformation across the energy, transport, industrial and land-use sectors. The strategy supports the long-term reduction of carbon intensity through measures including renewable energy deployment, improved energy efficiency, electrification, technological innovation and climate-resilient infrastructure development. At the same time, the strategy acknowledges the importance of maintaining economic competitiveness, energy security and social stability during the transition process.

Although the SA LEDS 2050 does not position fossil gas as a definitive long-term end-state energy solution, the strategy recognises that transitional and lower-carbon technologies may play a role in enabling South Africa's gradual decarbonisation pathway. Within the broader national energy planning context, gas has increasingly been identified in subsequent planning instruments, including later Integrated Resource Plans ("IRPs"), as a flexible and dispatchable energy source capable of supporting renewable energy integration, grid stability and energy supply reliability during the transition toward a lower-carbon electricity sector. In this regard, indigenous gas resources, including coal bed methane ("CBM"), may contribute toward diversification of domestic energy supply and a reduction in carbon intensity relative to conventional coal combustion, particularly where such resources support displacement of higher-emitting energy sources and reduce reliance on imported fuels. However, the SA LEDS 2050 simultaneously emphasises the importance of progressively reducing overall greenhouse gas emissions over time and aligning future development pathways with South Africa's long-term climate mitigation objectives and peak-plateau-decline emissions trajectory.

The SA LEDS 2050 further highlights the importance of technological innovation, infrastructure development and investment mobilisation in achieving the country's long-term climate and development objectives. Accordingly, energy-related developments that contribute toward energy security, economic activity, infrastructure investment and employment creation may be considered relevant within the broader context of

South Africa's transition planning, subject to compliance with applicable environmental legislation, climate policy objectives and environmental authorisation requirements.

7.2.8 LEGISLATIVE AND REGULATORY FRAMEWORK

The proposed activity is governed by a comprehensive legislative framework that ensures environmental protection and responsible resource development. Key legislation includes:

- The National Environmental Management Act (NEMA), which requires environmental impact assessment and promotes sustainable development;
- The Mineral and Petroleum Resources Development Act (MPRDA), which regulates the exploration and production of petroleum resources, including CBM;
- The National Water Act, which governs water use and is particularly relevant to groundwater management in CBM extraction;
- The National Environmental Management: Air Quality Act, which regulates emissions; and
- The National Environmental Management: Biodiversity Act, which provides for the protection of ecosystems and species.

Compliance with these legislative requirements ensures that the proposed development is undertaken in an environmentally responsible manner.

7.2.9 ENERGY SECURITY AND ECONOMIC DEVELOPMENT

South Africa continues to face challenges related to energy security, including supply constraints and infrastructure limitations. The development of domestic gas resources provides an opportunity to diversify energy supply, reduce reliance on coal and imported fuels, and support industrial growth. The proposed LCBM project is therefore considered necessary in the context of national priorities to enhance energy security, promote economic development, and support the transition to a more sustainable energy system.

7.3 REGIONAL AND LOCAL PERSPECTIVE

7.3.1 REGIONAL ECONOMIC CONTEXT: THE WATERBERG ENERGY HUB

The proposed project is located within the Waterberg region of Limpopo Province, a strategically important area for energy generation and resource-based development. The region currently hosts extensive coal mining operations and major power generation facilities, making it a key contributor to South Africa's energy supply. However, the region's heavy reliance on coal presents long-term sustainability challenges in the context of a transitioning energy economy. The development of CBM resources provides an opportunity to diversify the regional economy while building on existing infrastructure and expertise. In doing so, it supports the evolution of the Waterberg into a multi-energy hub that includes both traditional and emerging energy sources.

7.3.2 JUST TRANSITION AND SOCIO-ECONOMIC BENEFITS

Given the dependence of the Waterberg region on coal-related activities, the introduction of CBM development represents an important step in supporting a just transition. By leveraging existing skills in resource extraction and energy production, the project enables a gradual shift toward a more diversified energy economy.

While it is acknowledged that the scale of this current Phase 1 of the LCBM Project is relatively small in the broader national context, the proposed development is expected to contribute to local socio-economic development through employment creation, skills development, and increased economic activity. Secondary benefits may include the growth of supporting industries and increased municipal revenues. These outcomes align with the broader objectives of inclusive economic development and social sustainability.

7.3.3 ALIGNMENT WITH PROVINCIAL AND MUNICIPAL PLANNING

The proposed LCBM project is consistent with key planning frameworks at provincial and local levels, including the Limpopo Provincial Spatial Development Framework, the Waterberg District Municipality Integrated Development Plan, and the Lephalale Local Municipality Spatial Development Framework.

These frameworks identify the Waterberg as a priority area for energy and industrial development, while emphasising the need for economic diversification, infrastructure development, and environmental sustainability. The proposed project aligns with these objectives, provided that environmental impacts are appropriately managed and that development is integrated with existing land uses and infrastructure.

7.3.4 ENVIRONMENTAL SENSITIVITIES

The Waterberg region is characterised by important environmental sensitivities, including limited water resources, sensitive ecosystems, and the potential for cumulative impacts associated with multiple large-scale developments. The desirability of the proposed project is therefore contingent on the effective management of these environmental constraints. This includes careful site selection, responsible water use, protection of biodiversity, and implementation of robust mitigation measures. These considerations are addressed in detail in subsequent sections of this EIA.

7.4 NEED AND DESIRABILITY STATEMENT

Based on the above International, National and Regional policy and legislative analysis, the proposed Thungela LCBM project is considered both necessary and desirable. The project aligns with international trends toward lower-carbon energy systems and supports South Africa’s transition to a more diversified and resilient energy mix. At a national level, it is consistent with key policy frameworks, including the NDP, IRP, and Gas Master Plan, and contributes to objectives related to energy security, economic development, and emissions reduction. At a regional and local level, it supports the transformation of the Waterberg Region into a diversified energy hub, while contributing to a just transition for affected communities. While environmental sensitivities are present, these can be effectively managed through appropriate mitigation measures and adherence to legislative requirements. The project’s location, strategic relevance, and potential socio-economic benefits further reinforce its desirability. Overall, the proposed development represents a balanced and appropriate response to the need for sustainable energy development in South Africa, supporting both current and future energy requirements while advancing broader environmental and socio-economic objectives.

7.5 NEED AND DESIRABILITY DFFE GUIDELINE ANALYSIS

The needs and desirability analysis component of the Guideline on Need and Desirability published by DFFE in 2014 and updated in 2017 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 16 present the needs and desirability analysis undertaken for the project by answering the questions as presented in Section 4 of the DFFE Need and Desirability Guideline. This analysis will be revisited and revised during the EIA phase once further detail is available (i.e. from specialist assessments, and development plans).

Table 16: Needs and desirability analysis for the LCBM 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 will inform this application and environmental impact assessment and include amongst others: • Air Quality and GHG Assessment • Geohydrological Assessment • Hydrological Assessment • Terrestrial Biodiversity Assessment • Aquatic and Wetland Assessment • Social Impact Assessment The above studies will assist 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 are identified, relevant mitigation measures shall be 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 and the wells being located ~400m apart. Whilst the majority of the development area constitutes natural areas, the specialist assessments will guide the final placement of infrastructure so as to avoid or minimise the impact on sensitive biodiversity. A preliminary impact assessment is included in this Scoping Report and will be refined during the EIA phase through specialist inputs. Various measures will be put forward to mitigate the impacts on biological diversity. The mitigation measures will be developed in consultation with the relevant specialists as mentioned above. Existing and future declared alien and invasive species will be controlled which will enhance the opportunities for indigenous and beneficial species in the environment. Options for rehabilitation of degraded areas are being investigated.
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 types of general and hazardous waste, the majority of which will be generated during the construction phase (refer to Section 4.1.8). 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

Ref No.	Question	Answer
		adequately stored prior to disposal at a suitably licenced hazardous waste disposal facility. In addition to the waste streams mentioned above, this project will abstract large quantities of coal seam water to reduce the hydrostatic pressure on the coal seam and thereby release the methane. This produced water (saline water) will be treated to acceptable limits and options for reuse of this water are being explored (e.g. game watering, crop production, etc). The final option/s for the treated water will be presented in the EIA phase.
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 altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	A specialist heritage and palaeontological study have 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. In addition to the above, a chance find procedure will be developed 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 non-renewable gas resource will be depleted. 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. Gas to power can complement the transition to renewable power while reducing the reliance on coal to power in the short to medium term. 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?	The impact of this project on the terrestrial ecosystem will be limited to the footprint of the infrastructure. Whilst this project covers a large area (~20 443 ha), the physical footprint of disturbance will be minimal and therefore the impact on the interconnectivity and functioning of the terrestrial ecosystem will also be minimal. Measures that will be investigated to enhance positive impacts on the ecosystem where feasible and include rehabilitation of existing disturbed areas as well as post operational phase rehabilitation to restore the ecosystem to the predevelopment condition.
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 rely on the extraction and production of a non-renewable resource. The proposed project will provide an opportunity for South Africa to move away from dirtier energy (coal) while transitioning to a more

Ref No.	Question	Answer
		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 production of this gas resource would constitute a better use thereof as it is currently not being produced in this area for any commercial beneficial use. The existing coal mining operations in the area are not collecting this methane resource but are indirectly releasing the intercepted methane into the atmosphere without being flared to lower this 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. An assessment of the impact of this LCBM Project will be undertaken and the assessment will be compared to the No-Go alternative which is described in Section 8.
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 promote 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 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?	During this scoping phase assessment, the baseline sensitivities have been identified which will assist in adjusting the preliminary layout of the proposed well field and associated infrastructure to minimise impacts on identified sensitivities. This will be further refined in the EIA phase where detailed specialists will undertake more detailed site assessments to further identify site specific sensitivities which will then be mitigated through the first tier of the mitigation hierarchy (i.e. avoidance) and where this is not possible, identify suitable mitigation to minimise the impacts.
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	The following specialists have been appointed to inform this EIA process: • Air Quality Impact Assessment

Ref No.	Question	Answer
	taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	• Climate Change Impact Assessment • Surface Water Impact Assessment • Groundwater Impact Assessment • Terrestrial Ecology Impact Assessment • Soils and Land Capability Impact Assessment • Noise Impact Assessment • Visual Impact Assessment • Social Impact Assessment • Economic Impact Assessment • Heritage and Palaeontological Impact Assessment • Major Hazardous Installation Risk Assessment. This team of specialists will assist in identifying relevant avoidance mechanisms for negative impacts as a first priority and where not possible, suitable mitigation measures will be put forward to minimize the impacts. The specialists will similarly identify measures to enhance positive impacts where possible or at least prevent a reduction of positive impacts as far as possible.
1.9.2	Positive impacts: e.g. improved access to resources, improved amenity, improved air or water quality, etc. What measures were taken to enhance positive impacts?	
1.10	Describe the linkages and dependencies between human wellbeing, livelihoods and ecosystem services applicable to the area in question and how the development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, loss of heritage site, opportunity costs, etc.)?	The predominant land use in the application area consists of game farming due to the "bushveld" nature of the terrestrial ecology. The projects ecological impacts are anticipated to be limited in spatial extent however the construction phase will likely result in a greater disruption to ongoing land use as opposed to the operational phase. The relevant specialists will assess these impacts on livelihoods, loss of heritage site, opportunity costs, etc to avoid or minimise these impacts as far as possible.
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?	The overall impact on the ecological integrity objectives or targets or considerations of the area will be assessed by the terrestrial specialist and reported on in the EIA phase.
1.12	Considering the need to secure ecological integrity and a healthy biophysical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being proposed), resulted in the selection of the "best practicable environmental option" in terms of ecological considerations?	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 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 for the preliminary impact assessment. This assessment will be refined in the EIA phase.

Ref No.	Question	Answer
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 Waterberg District Municipality as well as the Lephalale Local Municipality are included in Section 6.21. The Waterberg District Municipality IDP acknowledges that "large coal reserves occur in most of the western parts of the province and are associated with significant quantities of natural gas or coal bed methane". This project will assist the district to realise the potential of this valuable CBM resource. The Lephalale Local Municipal IDP acknowledges that the mineral and petroleum resources should contribute to economic growth and job creation which this project will contribute to this realisation.
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 011 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?	As part of the Production Right, a Social and Labour Plan must be developed and implemented which will result in economic benefits to the local communities.
2.3	How will this development address the specific physical, psychological, developmental, cultural and social needs and interests of the relevant communities?	The baseline receiving environment is presented in Section 0. The impact of this project on the physical, psychological, developmental, cultural and social needs and interests of the relevant communities will be updated during the EIA phase once more consultation with the relevant communities 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?	An environmental impact assessment is being undertaken to identify the positive and negative impacts to ultimately determine the short- and long-term impacts from a social and economic perspective. Once the EIA phase assessment has been concluded, this question can be answered in more detail.
2.5	**In terms of location, describe how the placement of the proposed development will:**	
2.5.1	Result in the creation of residential and employment opportunities in close proximity to or integrated with each other.	It is unlikely that this project will result in the creation of residential opportunities however the project is likely to result in limited employment opportunities which will indirectly result in residential opportunities. This project is not anticipated to reduce the need for transport of people and goods. In fact, this project will require the transport of LNG offsite and therefore may have an impact on traffic and traffic infrastructure which will be considered and assessed in the EIA phase. This project
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),	

Ref No.	Question	Answer
		is not anticipated to have any impacts on improving public transport however should this be identified at a later date, this will be communicated in the EIA phase.
2.5.4	Compliment other uses in the area,	This project is anticipated to complement the existing mining industry in the local municipality and thereby complement the revenue generated through the mineral and petroleum industry.
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 town of Lephalale has experienced a boom in development in recent times due to the construction of Medupi Power Station. This project will likely provide additional revenue and opportunities to the town which would indirectly benefit the bulk infrastructure planning.
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 town of Lephalale.
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 cover a small footprint. This will allow for existing land uses (game farming) to continue while this gas development project is ongoing and once the decommission phase approaches, the intention would be to revert the land use to its current form (i.e. game farming).
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.),	This CBM project aims to maximise the use of a resource (methane) that would otherwise be lost should coal mining take place. Once the CBM project is completed, the coal reserves would still remain in place.
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 game farming 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	A Heritage Impact Assessment will be undertaken to determine the impact of this project on existing cultural and heritage sites, and the results of this assessment will be presented in the EIA phase.

Ref No.	Question	Answer
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?	It is not anticipated that this project will have an impact the existing settlements in the area. This aspect will however be investigated by the Social and Economic specialists and will be elaborated on in the EIA phase.
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 14of 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. This will however be elaborated upon in the EIA phase once the Social and Economic specialist studies have been concluded along with public feedback on this application.
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?	Where uncertainties exist, the approach was taken to assume the worst-case scenario for impact planning purposes.
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?	The preliminary positive and negative socio-economic impacts have been identified and will be assessed in more detail during the EIA phase.
2.7.2	Positive impacts. What measures were taken to enhance positive impacts?	
2.8	Considering the linkages and dependencies between human wellbeing, livelihoods and ecosystem services, describe the linkages and dependencies applicable to the area in question and how the development's socioeconomic impacts will result in ecological impacts (e.g. over utilisation of natural resources, etc.)?	
2.9	What measures were taken to pursue the selection of the "best practicable environmental option" in terms of socio-economic considerations?	
2.10	What measures were taken to pursue environmental justice so that adverse environmental impacts shall not be distributed in such a manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons (who are the beneficiaries and is the development located appropriately)? Considering the need for social equity and justice, do the alternatives identified, allow the "best practicable environmental option" to be selected, or is there a need for other alternatives to be considered?	

Ref No.	Question	Answer
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 and an assessment of this impact as well as mitigation measures will be put forward to prevent undue negative impacts in this regard.
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?	This application will include an assessment of the projects impacts on the environmental health and safety through various specialist studies. The results of this assessment will be presented in the EIA phase.
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 4 languages (English, Afrikaans, Sepedi and Setswana). In addition to the standard requirements for public notification as defined in the EIA Regulations, radio advertisements have been utilised to increase coverage of the notification process. 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)?	
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	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

Ref No.	Question	Answer
	work, and what measures have been taken to ensure that the right of workers to refuse such work will be respected and protected?	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 project is not anticipated to generate significant numbers of temporary or permanent jobs. An estimate of ~600-800 temporary jobs and ~60-80 permanent jobs are anticipated at this stage. Where possible, existing local labour will be utilised. Should transport of labour to and from site be required, considerations will be made on how to make provision for transport challenges based on the capacity of stakeholders involved.
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 is considered where relevant. Should any conflicts of interest between organs or state be identified, these will be resolved through appropriate channels.
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 impacted by this project have been identified and where relevant, specialist input will be 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 similarly, mitigation measures will be put forward to reduce negative impacts.
2.19	Are the mitigation measures proposed realistic and what long-term environmental legacy and managed burden will be left?	At this scoping phase, only preliminary mitigation is put forward. On completion of the specialist assessments and public consultation process in the EIA phase, the mitigation measures will be adjusted where necessary to ensure that they are realistic and implementable to achieve the intended outcomes.
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?	As part of this EIA application process, the required financial provisioning for the rehabilitation, decommissioning and closure costs will be determined, and it will be incumbent upon Thungela to provide the Competent Authority with the financial guarantee. This fund will ensure that there are sufficient financial resources to address any costs required for remedying environmental degradation.

Ref No.	Question	Answer
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 identified alternatives is provided as well as the preliminary process followed to identify which alternatives to assess further in the EIA phase.
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 further 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; 2006). Incremental alternatives typically arise during the EIA or design 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

These are sometimes referred to as project alternatives, although the term activity can be used in a broad sense to embrace policies, plans and programmes as well as projects. Consideration of such alternatives requires a change in the nature of the proposed activity. The overall objective of this project is to produce LNG sourced from the existing coal seam. The method of such production has been selected based on existing proven industry methodologies and therefore alternative methods for production such as underground coal gasification are not being considered. Furthermore, the coal resources are relatively deep which would create restrictions on the ability to mine the coal resource through conventional underground mining methods. Lastly the applicant is a mining company and would therefore not reasonably undertake divergent activities. No activity alternatives are therefore to be considered further.

8.2 LOCATION ALTERNATIVES

Location alternatives can apply to the entire project (e.g. the strategic decision to locate the proposed development in the Waterberg District within the Limpopo Province (where Thungela holds an existing exploration right), as well as the spatial alternatives for specific individual components of the proposed developments (e.g. the location of wells, pipelines, booster and compressor stations and the LNG plant including any associated infrastructure within the study area).

Thungela holds an Exploration Right for CBM in the application area and surroundings and has undertaken long term feasibility of this project through the initial 5-spot bulk sampling project to confirm a viable gas resource. The location of the activity regionally is dependent on the location of the coal resource, and this limits an assessment of alternative locations for undertaking coal bed methane. Therefore, no location alternatives for the entire project are relevant. There are however site-specific alternatives for various infrastructure that can be considered to avoid sensitive receptors, and these alternatives are discussed in more detail in the subsections below. Location alternatives will be considered in this assessment in order to ensure that the project infrastructure is located in the least impactful manner as far as possible.

8.2.1 WELL SITES

The proposed wellfield for the first production phase comprises of ~333 wells. The preliminary location of the proposed new wells was based on a uniform well grid pattern across the EA application area at a well density of 1 well per 16 ha. The adjustment of the proposed well positions 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 initial scoping level public input has been received and further considered as well as final specialist sensitivity mapping is completed (post scoping phase). Thereafter the proposed location of certain well sites will be adjusted to areas with lower sensitivities and shall be presented in the EIA Report.

8.2.2 PIPELINE AND WELL ACCESS ROAD ROUTES

Further to the above well site location alternative description, the gas and produced water pipeline routes are largely dependent on the location of the final well locations to connect these wells to the main gas trunklines leading to the LNG Plant. Pipelines will run along the outer edge of the vehicular access roads and both the gas, and the water pipeline networks will, as far as reasonably possible, be trenched at a safe depth below the surface level (900mm). The pipeline and access road routes will be constructed 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 POWERLINES

Several alternatives for providing electrical power to the wellfield, gas and water gathering networks, and processing facilities were considered. Electricity is required for well pumps, metering units, booster compressors, gas processing equipment and the water treatment plant.

Electricity for the first phase will be supplied primarily through a gas-to-power generator system located at the LNG plant. As alternatives to this principal energy source, Eskom will serve as a backup supply source together with the potential of drawing power from third party PV and Solar facilities where available. Final powerline configuration will be confirmed during detailed engineering.

8.2.4 LNG PLANT

The PoC LNG plant which will form part of the Phase 1 infrastructure is pre-existing. The proposed Phase 1 LNG Plant comprises the largest physical infrastructure aspect of this project which is to be located near the existing Deelkraal road for ease of access and therefore alternative locations for this plant will be considered. The key aspects that have informed the selection of the proposed LNG Plant alternatives are the following:

- Distance of the plant to the Deelkraal Road;
- Pre-existing access route off Deelkraal Road which will facilitate construction access and can be upgraded accordingly; and
- Setback distance of ~400m from Deelkraal Road to provide vegetative cover/screening to reduce visual impact.

The three alternatives to be considered in the EIA phase are located on the following properties:

4. LNG Plant location Option 1 – PADDAKRAAL 405 Portion 0
5. LNG Plant location Option 2 – WITHOUTPAN 404 Portion 0
6. LNG Plant location Option 3 – BULKLIP 701 Portion 1

The alternative LNG Plant locations to be assessed are shown in Figure 24 and Table 17 contains a discussion of the advantages and disadvantages of the above alternatives which shall be assessed further in the EIA phase.

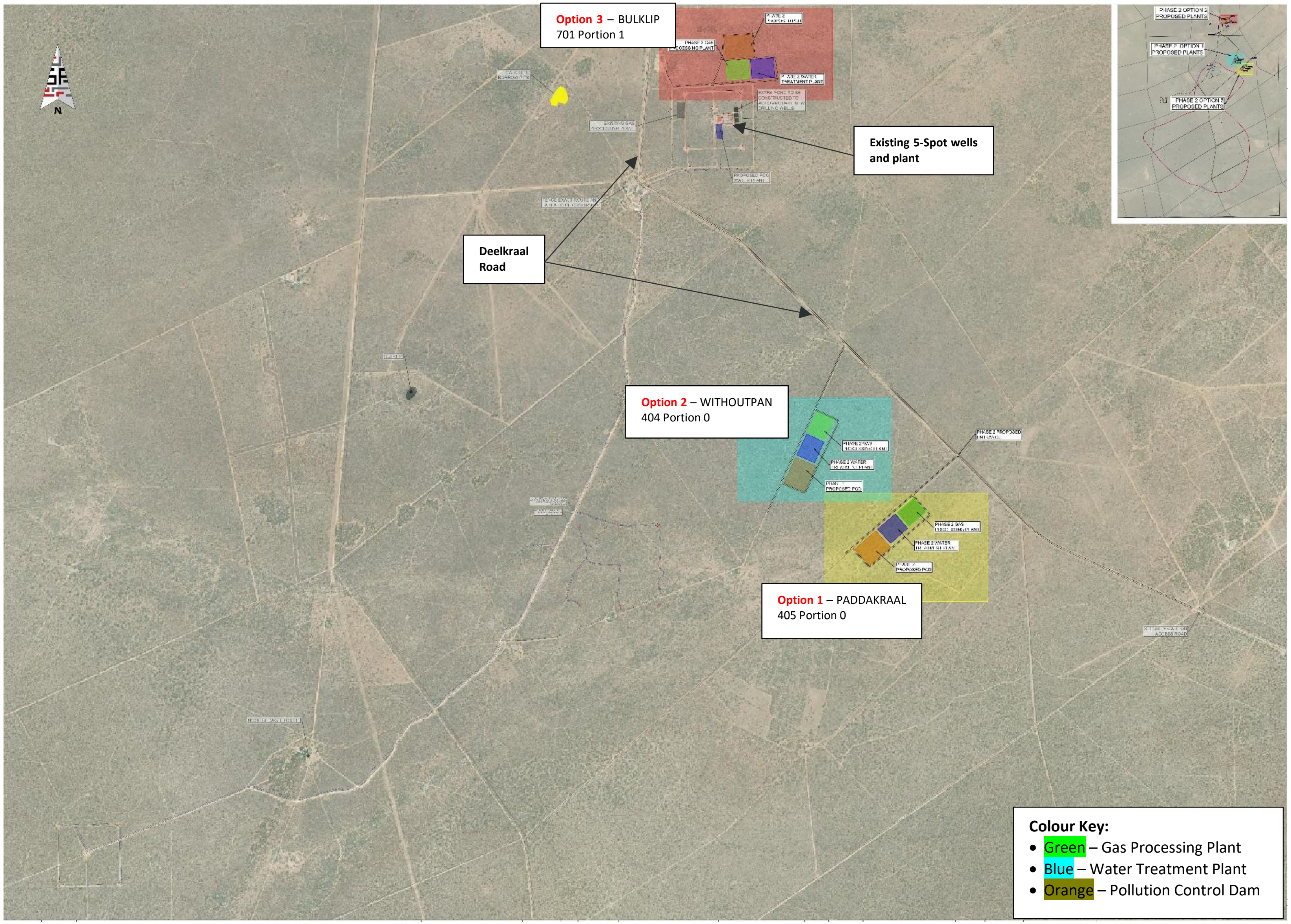


Figure 24: Alternative locations for the LNG Plant.

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 sensitivity planning approach as described above for the wells and pipelines 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 project activities avoid areas of high environmental sensitivity and minimise infringement on existing infrastructure where possible.

Electricity supply to the wells will require an internal powerline network. The following 2 powerline design/layout alternatives will be assessed as and where relevant to the project infrastructure requirements:

- Overhead powerlines on gum poles with a span of ~25-50m); and/or
- Trenched and buried power cables adjacent to access roads.

Produced coal seam water will be treated to suitable water quality standards and thereafter reused if possible (game watering, crop production, etc) and/or discharged into the Mogol River. Two pipeline alternative routes have been identified for the discharge pipeline as shown in Figure 25 below. Alternative 1 (red route) follows the southern side of the Deelkraal Road while Alternative 2 (green route) traverses the farms Bulklip 701 LQ, Draai-om 174 LQ and the remaining extent of the farm Vryplaats 163 LQ (Portion 1).

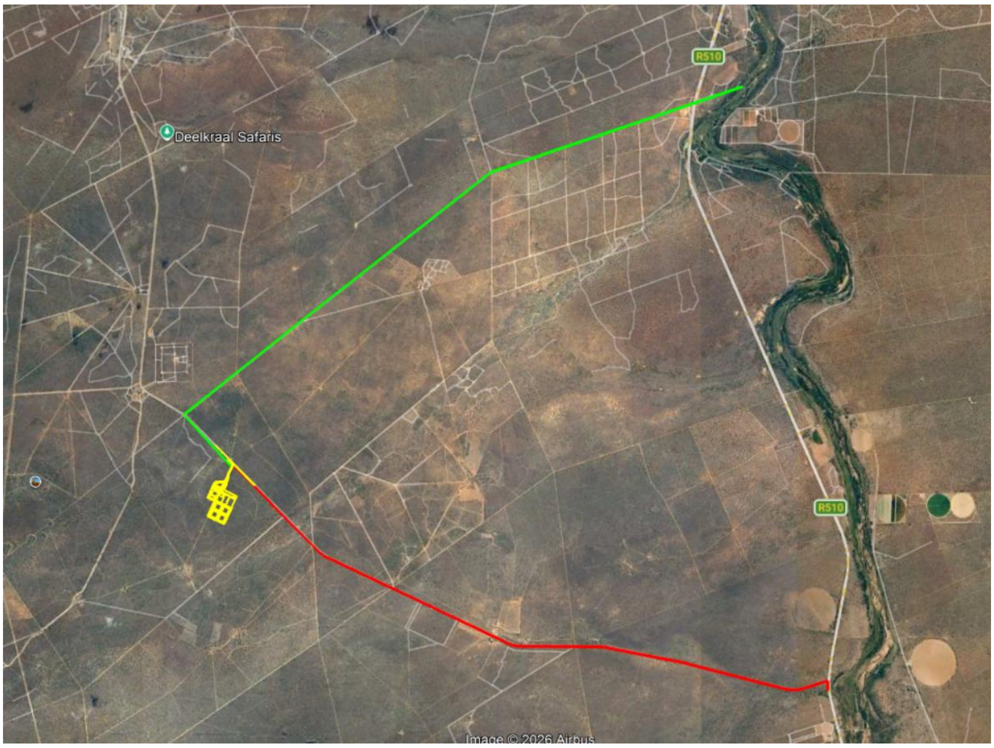


Figure 25: Discharge pipeline alternative routes.

Table 17 contains a discussion of the advantages and disadvantages of the above alternatives which shall be assessed further in the EIA phase.

8.4 PROCESS ALTERNATIVES

Process alternatives imply the investigation of alternative processes or technologies that can be used to achieve the same goal for a particular activity to achieve the desired outcome. This includes using environmentally friendly designs or materials, transport routing and reusing scarce resources like water and non-renewable energy sources. 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 as well as the proposed design of the LNG facility which is scalable in terms of production volumes.

The below subsections describe the two process alternatives to be investigated and deal with process water and access routes from the R510 to site.

8.4.1 PROCESS WATER DISPOSAL ALTERNATIVES

CBM extraction requires the dewatering of the coal seam which results in large volumes of process water being produced. This process water contains high concentrations of salts as listed in Table 9 (Section 4.1.7) which necessitates a water treatment works to ensure a suitable water quality for a particular disposal option. A number of water treatment and disposal options have been considered namely:

1. Direct offtake of the water by a third-party industrial water user. This could be direct use of the water by an industrial user with either no, or minimal treatment.
2. Treatment of the water to a quality suitable for irrigation or livestock watering use.
3. Cultivate lucerne for supply to local farmers.
4. Treatment of the coal seam water to a quality suitable for direct discharge to the Mogol River, used for dust suppression, game watering and/or crop production, etc.
5. Water evaporation cannons post water treatment.
6. Disposal of water to local wastewater impoundments for evaporation.

Table 17 contains a discussion of the advantages and disadvantages of the above alternatives and where the disadvantages are considered unacceptable from an environmental perspective, those alternatives have been scoped out and will not be assessed further in the EIA phase.

The ideal option for disposal of this excess water (or at least some portion thereof) would be an income generating option which would firstly provide financial benefits (offsetting the treatment costs) and secondly provide financial resources to undertake additional beneficial environmental activities such as rehabilitation of existing disturbed areas and/or possibly donating a portion of the treated water to surrounding landowners within proximity to the pipeline infrastructure for use on their farms.

A number of the above water disposal alternatives will be assessed further in the EIA phase while some have been scoped out at this scoping level (refer to Table 17).

8.4.2 ACCESS ROUTE TO LNG PLANT ALTERNATIVES

Traffic access to the 5-Spot Plant and Phase 2 LNG Plant will be from the existing R510 provincial road and via the existing Deelkraal road. Two options are to be considered for site access along Deelkraal Road as follows:

2. Option 1: Access from the R510 via Deelkraal Road from the EAST; or
3. Option 2: Access from the R510 via Deelkraal Road from the NORTH.

Both route options along Deelkraal Road are located nearby to existing third-party sensitive receptors (i.e. residential homesteads and lodges) and both route options are almost equidistant from the existing 5-Spot to the R510. An assessment of which route alternative would be least impactful will be undertaken and mitigation measures will be identified to reduce the impact on the sensitive receptors (e.g. dust impact, nuisance impact, visual impact, etc).

8.5 TECHNOLOGY ALTERNATIVES

The selection of the technology to be adopted for the construction and operation of the gas production infrastructure has considered the requirements for gas wells (i.e. depths, casing, stimulation method, maximising gas collection, etc.); pipeline function and efficiency; as well as LNG processing, storage and distribution. Whilst other methods of well stimulation exist such as cavitation, this will not be considered in this assessment as internationally there is significant concerns about using cavitation as a technology and is therefore not deemed suitable for further interrogation in this EIA process. No further technology alternatives have been identified at this stage, and this alternative will be revisited as and when additional technology alternatives are identified during the course of this EIA process.

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 LCBM development would continue (i.e. current land use only). It is important to note that the No Go alternative is the baseline against which all other alternatives and the development proposal are assessed.

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 (i.e. the change caused by the project from baseline current conditions). Considering that the area already includes exploration activities (including the 5-Spot) the holder would be required to apply for and undertake closure and rehabilitation. This would most likely revert the area back to a land-use in line with the predominant surrounding land-uses (i.e. livestock, game farming and /or ecotourism). It is however noted that if implemented and managed correctly, there is a possibility that the preexisting surface land uses and the LCBM production activities can occur in parallel over the same area.

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 developed in the EIA phase will additionally provide mitigation measures in the form of limitations on where infrastructure can be placed.

8.8 ALTERNATIVE ASSESSMENT

Table 17 describes the advantages and disadvantages of the alternatives identified above. The alternatives have each been assigned a unique identifier for future reference in the EIA phase assessment. The table also identifies which specific alternatives are to be carried to EIA phase.

Table 17: Alternative assessment matrix.

Alternative Category	Alternative	Alternative Description Summary	Advantages	Disadvantages/ Risks	Carried into EIA
Location Alternative	LA_1	Well site locations: Well site positions to be guided by sensitivity planning approach	• The sensitivity planning approach allows for adjustments to be made to the spatial siting of the wells to minimise impacts on features with a higher sensitivity.	• No disadvantages identified when applying the sensitivity planning approach.	**Yes**
	LA_2	Pipelines and access roads routing: Pipeline and access road routing to be guided by sensitivity planning approach	• The sensitivity planning approach allows for adjustments to be made to the routing of the pipelines and access roads to minimise impacts on features with a higher sensitivity.	• No disadvantages identified when applying the sensitivity planning approach.	**Yes**
	LA_3	Powerline routing: Powerline routing to be guided by sensitivity planning approach	• The sensitivity planning approach allows for adjustments to be made to the routing of the powerlines to minimise impacts on features with a higher sensitivity.	• No disadvantages identified when applying the sensitivity planning approach.	**Yes**
	LA_4.1	Phase 2 LNG Plant location Option 1 – PADDAKRAAL 405 Portion 0	• Nearby access to Deelkraal Road.	• Privately owned land. • Site consists of existing natural bushveld.	**Yes**
	LA_4.2	Phase 2 LNG Plant location Option 2 – WITHOUTPAN 404 Portion 0	• Thungela owned land. • Existing access road available off Deelkraal Road.	• Site consists of existing natural bushveld.	**Yes**
	LA_4.3	Phase 2 LNG Plant location Option 3 – BULKLIP 701 Portion 1	• Adjacent to existing 5-Spot infrastructure which would present lower visual impact in the broader study area. • Thungela owned land.	• Closer proximity to third party dwellings.	**Yes**

Alternative Category	Alternative	Alternative Description Summary	Advantages	Disadvantages/ Risks	Carried into EIA
Design Alternative	DA_1.1	Above ground powerlines on gum-poles	• Lower installation costs.	• Could pose an overhead hazard to movement of taller wildlife and/or vehicles. • Increases visual impact from surrounding sensitive receptors. • Require ongoing management of vegetation below powerlines (especially tree canopy) to prevent arcing and possible fires.	**Yes**
	DA_1.2	Below ground powerlines trenched to 900mm deep and backfilled	• Removes hazards to taller wildlife and/or vehicle movements below overhead powerlines. • Removes visual impact for sensitive visual receptors.	• Higher installation costs.	**Yes**
Layout Alternatives	Based on a sensitivity mapping any unacceptably high-risk areas will be delineated as no-go areas.				**Yes**
	LayA_1.1	<u>Treated water discharge pipeline to Mogol River Alternative 1</u> – routed along Deelkraal Road	• Follows existing Deelkraal Road with limited impact on natural vegetation • Allows for potential water offtake by adjacent properties (third party reuse of treated water)	• No significant disadvantages as the Deelkraal Road will be upgraded and pipeline can be installed during road construction activities.	**Yes**
	LayA_1.2	<u>Treated water discharge pipeline to Mogol River Alternative 2</u> - routed across the farms Bulklip 701 LQ, Draai-om 174 LQ and the remaining extent of the farm Vryplaats 163 LQ (Portion 1)	• Directly affected landowners could potentially have access to water offtake through agreement	• Traverses privately owned properties and natural vegetation • Potentially limits the number of third-party water use as pipeline would be within privately owned properties.	**Yes**

Alternative Category	Alternative	Alternative Description Summary	Advantages	Disadvantages/ Risks	Carried into EIA
Process Alternatives	PA_1.1	Process water disposal Option 1: Direct offtake of the water by a third-party industrial water user. This could be direct use of the water by an industrial user with either no, or minimal treatment.	• Minimal to no treatment of the process water is required depending on the off takers intended use of the water. • Low to no financial costs for treatment of water.	• Would require off taker to agree to use of water at the volumes available over the project lifetime.	**Yes**
	PA_1.2	Process water disposal Option 2: Treatment of the water to a quality suitable for irrigation or livestock watering use.	• Beneficial use of water resource in a water scarce area. In times of drought, this may represent a lifesaving source of water for many game species.	• Financial costs of treating to irrigation or livestock water quality is high. • Off takers of this water may become dependent on this water source which will cease to be produced towards the end of the operational phase. • Volume of treated water may exceed the demand for irrigation or livestock watering in the application area and surroundings.	**Yes**
	PA_1.3	Process water disposal Option 3: Cultivate lucerne or other suitable crops.	• Beneficial use of the water to create an additional revenue generating activity which could offset the costs of treatment. • Revenue generated could be used for rehabilitation of existing disturbed areas within the application area. Additionally, revenue can be used to finance a long-term eco-tourism development as a post-production land use.	• Required land area to be impacted by the lucerne farming would add a greater overall footprint of disturbance within the application area unless existing disturbed areas can be identified. • Financial costs of treating to irrigation water quality is high but can be offset through revenue generated by sale of lucerne.	**Yes**

Alternative Category	Alternative	Alternative Description Summary	Advantages	Disadvantages/ Risks	Carried into EIA
	PA_1.4	Process water disposal Option 4: Treatment of the water to a quality suitable for direct discharge to the local surface or groundwater resources or use for dust suppression.	• Beneficial recharge of surface or groundwater resources would create additional water availability in the medium to long term. • Shallow groundwater recharge would result in water storage (without evaporation) and subsequent availability of water over a medium to long term. • Discharge to the Mogol river may provide an added benefit if mini hydro power is included. This additional electricity generation may offset some of the electricity demands from the LCBM Project.	• Volume of water is too great for purely dust suppression use. Additional options of discharge to surface or groundwater resources would need to be undertaken in conjunction with dust suppression. • Discharge to surface water resources may alter the hydraulic and aquatic environment within the surface water resource into which discharge takes place. • Long term discharge into surface water resource may result in dependency by third parties on this water source which would over time reduce in volume and ultimately cease in towards the end of the gas production operational phase.	**Yes**
	PA_1.5	Process water disposal Option 5: Water evaporation cannons post water treatment.	• Large volumes of water can be disposed to atmosphere with minimal to no impact on the surrounding water users.	• Evaporation is not an environmentally sound option for disposal of water in a water scarce environment. • Excess salts around the evaporation cannon infrastructure may cause unintended contamination	**No**

Alternative Category	Alternative	Alternative Description Summary	Advantages	Disadvantages/ Risks	Carried into EIA
				of the surrounding environment. • The number of evaporation cannons to achieve full disposal of produced water volumes may require significant spatial distribution of the cannons. • Altered micro biomes may form around the evaporation cannons which would not be sustainable in the long terms once the evaporation activities cease. • No financial cost benefit would be derived from the evaporation project.	
	PA_1.6	<u>Process water disposal Option 6:</u> Disposal of water to local wastewater impoundments for evaporation.	• Large volumes of water can be disposed to atmosphere with minimal to no impact on the surrounding water users.	• Construction of large evaporation dams to cater for the significant volumes of water to be disposed of would require significant clearance of vegetation as well as represent a significant capital cost. • The time required for passive evaporation may not be possible for the large volumes of water produced daily with resultant overflow of the evaporation dams. • Remaining brine / salt beds would require eventual	**No**

Alternative Category	Alternative	Alternative Description Summary	Advantages	Disadvantages/ Risks	Carried into EIA
				disposal at a suitably licenced disposal facility. • No financial cost benefit would be derived from the evaporation project.	
	PA_2.1	Access from the R510 via Deelkraal Road from the EAST	• Fewer existing third-party homesteads adjacent to Deelkraal Road.	• Route runs directly past third-party homestead.	**Yes**
	PA_2.2	Access from the R510 via Deelkraal Road from the NORTH	• Slightly shorter distance from 5-Spot to R510.	• Greater number of existing third-party homesteads adjacent to Deelkraal Road.	**Yes**
Technology Alternatives	No specific feasible technology alternatives were identified.				**No**
No-Go Alternative	No-Go	The proposed project will not take place at all under the No-Go alternative.	• No environmental impacts as a result of the project.	• Thungela holds an Exploration Right over this land and as a result of the exploration activities including 5-spot wells, a proven resource exists. Should the no-go option be followed, the exploration activities conducted to date and the proven gas resource would not result in any benefits. • South Africa would remain dependent on imports of natural gas and would not realise the benefits of this project from an energy independence point of view. • Positive impacts associated with the proposed LCBM project will not occur such as	**Yes**

Alternative Category	Alternative	Alternative Description Summary	Advantages	Disadvantages/ Risks	Carried into EIA
				some employment creation (mostly during construction), as well as technology advancement and energy security benefits that will result from this local gas production project. Refer to Section 6 for more details with regards to the Need and Desirability of the proposed project, as well as Section 10 for impacts identified and proposed mitigation measures particularly those related to socio-economic factors.	

9 STAKEHOLDER ENGAGEMENT

The PPP is a requirement of several pieces of South African legislation and aims to ensure that all relevant 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.

This Section captures the Stakeholder Engagement Plan (SEP) for the proposed EIA process. The SEP highlights key steps in the stakeholder engagement process including stakeholder identification, subsequent notification, and engagement activities planned to inform and involve stakeholders and communities in the overall project.

This SEP has been prepared to highlight key areas in public participation which have been identified as necessary for meaningful engagement with communities, stakeholders, and other individuals and entities who may be directly and indirectly or have an interest in the project while not being affected. Furthermore, the SEP will set out the process for undertaking engagement and consultation with stakeholders. Stakeholder engagement is a key step in the overall EIA process and is essential to ensuring the wellbeing and integrity of social networks and relationships as the project is implemented.

Defending the need for an SEP, this specific area has been exposed to stakeholder engagement processes in the past, given that the area includes several developments and land uses. For example, the area hosts two major power stations, that is, Medupi and Matimba. In addition, the area also hosts game hunting activity as well as major Exxaro coal mining operations. In this regard, the area represents a potential space characterised by stakeholder fatigue. Therefore, a plan of action is necessary to address potential shortcomings and risks involved with engaging stakeholders in the project.

The SEP is designed following international best practice guidelines. Stakeholder engagement has been described as a process through which the public and interested organisations and individuals are given opportunities to engage with policy, planning and practice[10]. Furthermore, it is important to identify who

[10] Leyden, K.M., Slevin, A., Grey, T., Hynes, M., Frisbaek, F. and Silke, R., 2017. Public and stakeholder engagement and the built environment: a review. Current environmental health reports, 4, pp.267-277.

interested stakeholders would be in different context or in relation to different projects[11]. Therefore, these two points, in reference to a definition of stakeholder engagement, form the fundamental design elements of this SEP. The SEP will involve continuous implementation and reflection as various steps of the project are undertaken throughout the EIA process. The SEP has the objective to provide an update to the local communities regarding the progress of the project as well as to seek valuable insights into issues affecting the local communities. Essentially, through the plan set out below, an avenue of communication will be established between Thungela, EIMS, stakeholders, and communities.

In summary, the SEP has the fundamental role of:

- The creation of a stakeholder database and profile;
- To define the proposed mechanisms of engagement with the affected communities with due consideration of the project and social context in the project area; and
- Creating a platform for stakeholders to engage with the project through different activities such as physical and virtual meetings.

9.1 METHODOLOGY

A systematic approach involving key methods has been developed to address this SEP. As part of this methodology, key steps include:

1. The identification of key stakeholders through desktop research and ground-truthing.
2. Initial engagement activities with pre-identified stakeholders.
3. Engagement plan for activities through which stakeholders will engage with information on the project as it develops.

The approach adopted by this SEP is informed by the guidelines of the National Environmental Management Act 107 of 1998 on Public Participation. Furthermore, this approach has been critically assessed drawing from experience from several[12,13,14] case studies across South Africa.

9.2 STAKEHOLDER IDENTIFICATION

As a first step, the SEP involves the identification of key stakeholders and communities who will be engaged with as pre-identified I&APs. Throughout the process, however, other I&APs will be identified and engaged with through the methods described below.

9.2.1 EXTENT OF PROJECT AND ZONE OF INFLUENCE

A key aspect to consider when identifying stakeholders to engage as part of this SEP, is the zone of influence or the geographical extent of the project's potential impacts. Through prior investigation, and consultation with different specialists, several environmental aspects were highlighted as key areas to consider when evaluating the project's cumulative impact.

As captured in Table 18, air quality, noise, groundwater, visual impact, terrestrial biodiversity and surface water were all considered as the immediate environmental aspects to be directly affected by project activities. The maximum zone of influence spans 15kms (highlighted in Table 18), relating to potential visual impacts. The

[11] Silvius, G. and Schipper, R., 2019. Planning project stakeholder engagement from a sustainable development perspective. Administrative Sciences, 9(2), p.46.

[12] Maphanga, T., Shale, K., Gqomfa, B. and Zungu, V.M., 2022. The state of public participation in the EIA process and its role in South Africa: a case of Xolobeni. South African Geographical Journal, pp.1-29.

[13] Boshoff, D.S., 2019. Of smoke and mirrors:(Mis) Communicating EIA results of solar energy projects in South Africa. Journal of Environmental Assessment Policy and Management, 21(03), p.1950014.

[14] Hasan, M.A., Nahiduzzaman, K.M. and Aldosary, A.S., 2018. Public participation in EIA: A comparative study of the projects run by government and non-governmental organizations. Environmental Impact Assessment Review, 72, pp.12-24.

maximum zone of influence of each environmental aspect was subsequently mapped out (Figure 26) to allow for a better understanding of which stakeholders would be interested and affected by the project's activities. Included on the map is (1) the extent of the PR area, (2) the EIA area and all directly affected properties, (3) the adjacent properties to the EIA area, (4) Local municipality boundaries, (5) different ward boundaries, (6) surrounding settlements, (7) maximum zone of influence across all environmental aspects considered.

Additionally, considerations have been made related to the social zone of influence. It is expected that this zone of influence is defined by surrounding communities. As such, the closest communities to the EIA area are Marapong, and Lephalale. However, it must be noted that surrounding communities including, but not limited to, Seleka, Shongowane, Beauty, Monyeki, and Abbottspoort, while further away, may be impacted by social implications of the project. Therefore, the potential social impacts have been considered, forming a separate zone of influence, defined by the various communities that could be affected through aspects such as potential environmental impacts, as well as social impacts such as employment.

Figure 26 is therefore a visual representation of the potential extent to which the project's impacts may span, as well as facilitates the identification of key landowners and communities. At the same time, different levels of governance and relevant local, national, and potentially international authorities can also be identified.

Table 18: Environmental aspects and their high-level zone of influence considered when defining the larger zone of influence of the project.

Environmental Aspect	Potential Maximum Zone of Influence
Air quality	5km
Noise	3km
Groundwater	5km
Visual	15km
Terrestrial Biodiversity	1km
Surface Water	Onsite wetlands and watercourses and the Mogol River
Social	Includes surrounding communities, particularly, Lephalale and Marapong. Furthest reaches being Seleka, Beauty, Abbottspoort, Monyeki, and Shongwane.

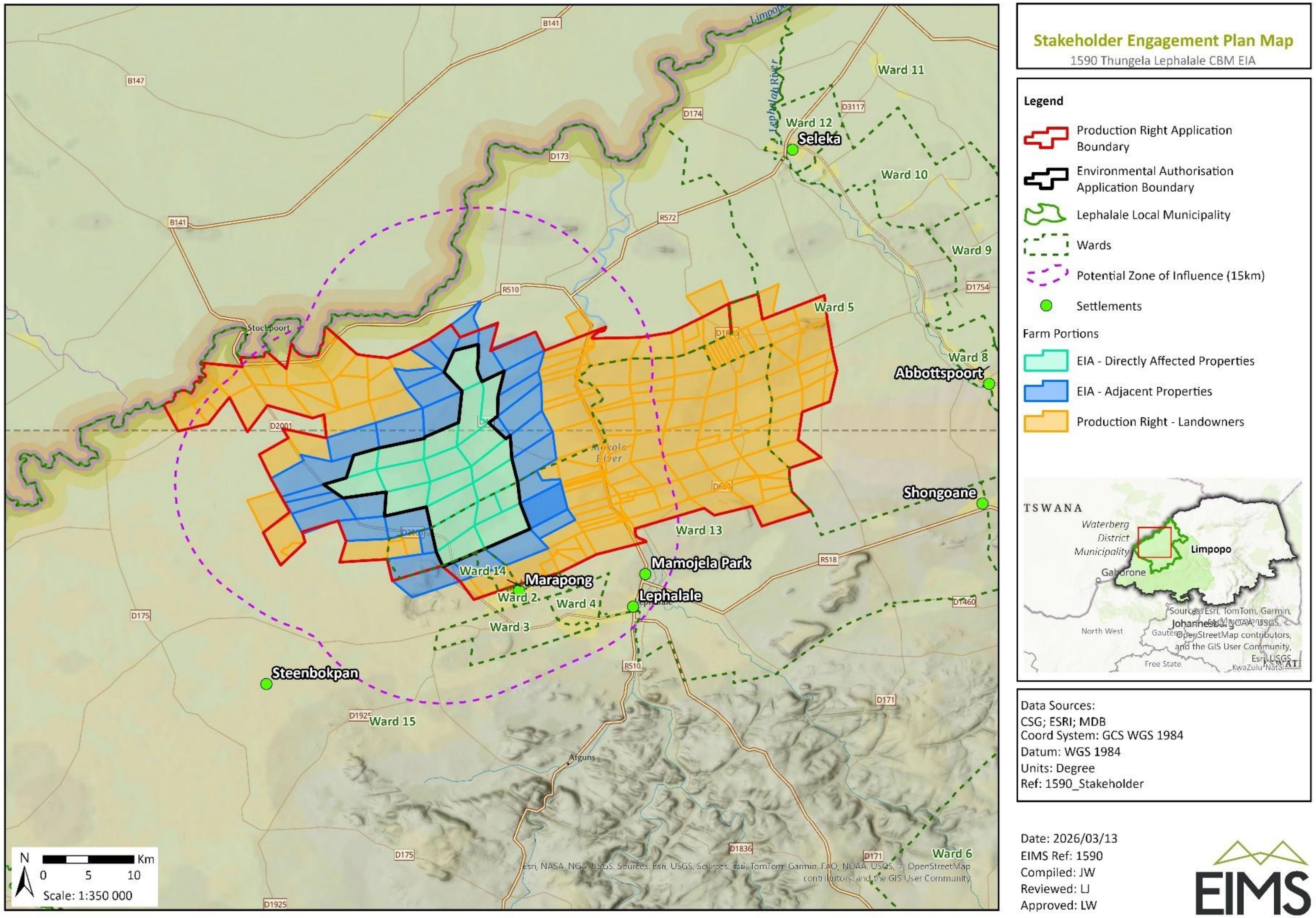


Figure 26 Project zone of influence, relevant boundaries, affected properties, and affected communities.

9.2.2 LANDOWNER IDENTIFICATION

Through a better understanding of the zone of influence and the overall extent of potential impacts, affected properties can be identified. The owners of these properties will be a key focus group to be engaged. Landowners of directly affected and adjacent properties will be identified through various platforms including online deed searches and investigation. The information gathered through these methods will subsequently be verified through ground-truthing activities. Ground-truthing will involve site visits and in-person or virtual consultation with identified landowners.

Engagement with landowners will facilitate the identification of other stakeholders including landowners who may not be affected, yet have an interest in the project, or fall within the pre-established potential zone of influence. The information gathered through this step will be collected and stored for further communication of engagement activities planned as part of this SEP.

The information collected will be used to engage further with landowners, particularly those within the EIA area, adjacent, and those who fall within the PR area. Landowners will be engaged through the initial call to register, subsequent public meetings, and focus group workshops. While direct contact and engagement is planned for this specific group of landowners, all other interested landowners outside of this targeted group will be informed about the project through the various engagement activities planned as part of the call to register, including advertisements and site notice placement.

9.2.3 INTERESTED STAKEHOLDER IDENTIFICATION

In addition to landowners, other stakeholders who fall within the zone of influence will be engaged. These stakeholders include individuals and entities who may have an interest in the project, whether being directly, indirectly, or not affected. These stakeholders include, but are not limited to, (1) organs of State, (2) authorities and local government, (3) corporations and parastatals, (4) community forums and (5) non-governmental organisations (NGOs). This section is dedicated to detailing the prior considerations made through this SEP with regard to the pre-identified key stakeholders.

9.2.3.1 NATIONAL AND INTERNATIONAL ORGANS OF STATE

As a first point of consideration, all national, and where relevant, international authorities who may be affected by the project will be engaged. Relevant organs of state have been as listed as part of Table 19. These include national and international departments and ministries concerned with both, environmental and social spheres of governance. As part of this SEP, different individuals including heads of departments will be identified through a snowball sampling strategy by first going through general communication avenues. All individuals identified through the sampling procedure will be included in the database to be formulated.

Table 19: List of pre-identified national organs of state

Stakeholder group	Pre-identified entities	Role of stakeholder
National Organs of State	• Department of Forestry, Fisheries and the Environment • Department of Water and Sanitation • Department of Mineral Resources and Energy • Petroleum Agency SA • Department of Transport • Department of Agriculture, Land Reform, and Rural Development • Department of Health • Department of International Relations and cooperation • Department of Social Development • Department of Tourism • Department of Employment and Labour • South African Heritage Resources Agency	Spheres of government and statutory bodies exercising a public power.

Stakeholder group	Pre-identified entities	Role of stakeholder
	• South African Civil Aviation authority • Presidential Climate Commission	
International Organs of State (Botswana)	• Ministry of Environment, Natural Resources Conservation and Tourism • Ministry of Infrastructure and Housing development • Ministry of Mineral Resources, Green Technology and Energy Security • Ministry of Land Management, Water and Sanitation Services • Ministry of Investment, Trade and Industry	Spheres of government and statutory bodies to provide comment on this application.

9.2.3.2 REGIONAL GOVERNMENT

Table 20 includes a list of all regional organs of state who bee identified as stakeholders of this project considering its potential zone of influence. These include various provincial departments of different spheres of government, much like the national and international departments. In a similar way, focus was placed on both environmental and social aspects of governance. As part of this SEP, different individuals including heads of departments will be identified through a snowball sampling strategy by first going through general communication avenues. All individuals identified through the sampling procedure will be included in the database to be formulated.

Table 20: List of pre-identified provincial organs of state

Stakeholder group	Pre-identified entities	Role of stakeholder
Regional Government	• Limpopo Provincial Department of Agriculture and Rural Development • Limpopo Provincial Department of Social Development • Limpopo Provincial Department of Governance, Human Settlement and Traditional Affairs • Limpopo Provincial Department of Public Works, Roads and Infrastructure • Limpopo Provincial Department of Transport and Community Safety • Limpopo Economic Development, Environment and Tourism • Limpopo Council of Cooperative Governance, Human Settlements and Traditional Affairs (COGTA) • Mokolo Irrigation Board	Govern provincial spheres of government. This includes spaces such as environmental and social security.

9.2.3.3 LOCAL GOVERNMENT

In addition to organs of state, local government authorities have also been identified as stakeholders of interest. Included as part of this group are the various authorities at district, municipal, and ward level. At the time of writing this report, the project and associated zone of influence is anticipated to affect one district, and one local municipality of this district. However, more districts and local municipalities may be considered during the stakeholder identification process. Table 21 includes a list of the pre-identified local government offices.

Table 21: List of pre-identified local government offices

Stakeholder group	Pre-identified entities	Role of stakeholder
Local Government	• Waterberg District Municipality • Lephalale Local Municipality and associated departments: o Planning and Economic Development Services	Government and local authorities at different levels. Represent

Stakeholder group	Pre-identified entities	Role of stakeholder
	○ Municipal Infrastructure Services ○ Social Services • Potentially affected and interested ward councillors – wards affected include: ○ Ward 1 ○ Ward 2 ○ Ward 3 ○ Ward 4 ○ Ward 5 ○ Ward 12 ○ Ward 13 ○ Ward 15	governance of the affected area at a smaller scale

9.2.3.4 CORPORATIONS AND PARASTATALS

Alongside national, regional, and local government, different corporations and parastatals play an important role in the wellbeing of the country. Some of these entities have been pre-identified and will be engaged with through the engagement activities of this SEP. Table 22 includes a list of pre-identified corporations and parastatals who were considered prior to the implementation of the SEP. Where applicable, more entities may be identified.

Table 22: List of pre-identified corporations and parastatals

Stakeholder group	Pre-identified entities	Role of stakeholder
Corporations and parastatals	• Eskom SOC • Transnet • South African National Roads Agency SOC • South African National Biodiversity Institute • Council of Geosciences • Civil Aviation Authority • National Energy Regulator of South Africa (NERSA)	Governance at a corporation level. This group plays a role in the wellbeing of the country alongside government.

9.2.3.5 NGOS AND INTEREST GROUPS

Finally, governance includes entities who work independently towards the wellbeing of the country. Therefore, these entities must be considered and engaged through the SEP. As part of this group, many of these entities are national entities who consider the wellbeing of stakeholders, communities, and the environment. Table 23 lists all of the pre-identified relevant non-governmental organisations.

Table 23: List of pre-identified NGOs

Stakeholder group	Pre-identified entities	Role of stakeholder
NGOs	• Endangered Wildfire Trust • Greenpeace Africa • GroundWork • Centre of Environmental Rights • The Green Connection • The Wildlife and Environment Society of South Africa • World Wildlife Fund for Nature • Earthlife Africa • Natural Justice • Frackfree SA • Justshare	An entity that works independently from government.

Stakeholder group	Pre-identified entities	Role of stakeholder
	• Lephalale Farmers' associations • Transvaal Landbou Unie • AGRI SA - Lephalale • Traditional Leaders of the area	

9.2.4 LOCAL COMMUNITIES OF INTEREST

Following desktop research and ground-truthing, several communities have been identified as potentially interested and affected. These communities represent populations on different ends of an economic scale or spectrum. Some of these communities represent whole settlements which fall within the zone of influence. At the same time, several of these communities fall outside the zone of influence, while in proximity of the PR area. Figure 26 presents a map showing the location of the identified towns and settlements with respect to the application area and the perceived zone of influence.

Lephalale is a central community which will be considered through this SEP, falling within the zone of influence, and in proximity of the PR area. This area (wards 4 and 13) is characterised by a community with a higher average annual income per household than surrounding communities such as Marapong, Seleka, Beauty, Abbottspoort, and Shongwane. Languages spoken in this area contrasts with surroundings, with Afrikaans being the majority spoken language in the area, followed by Sepedi, and English. Majority of the population is between the ages 18 – 64 (76%), with a smaller percentage of the population being under the age of 18. The area also includes most of its population being employed in the formal sector. An unnamed settlement located approximately 3kms North of Lephalale, along the R510, is also present which contrasts with the Lephalale area further south. This area will be further investigated and subsequently engaged when implementing engagement activities.

The second community, Marapong, falls within the zone of influence in the same way as Lephalale. Previous research demonstrates that the community of Marapong has been recently subjected to potential risks associated with previous development activities[15]. While this community is further from the Lephalale area, Marapong has a history with development and its impacts[16], making it a vital community to engage when considering future developments in the area. Contrasting with Lephalale, Marapong (wards 1 and 2) has a much lower annual average income per household. Two main languages are observed in the area, that is, Sepedi, and Setswana. The population of Marapong contrasts with Lephalale in that the community is largely represented by a younger population, including a larger percentage of individuals under the age of 18. Further, very small percentages of the population are represented by individuals over the age of 50 (5%).

9.3 INITIAL CALL TO REGISTER

As a primary means of commencing the engagement process, and the implementation of planned engagement activities, an initial call to register has been initiated. This call to register will follow the guidelines as per Chapter 6 of the EIA Regulations (GRN982 of 2014, as amended) and allow for interested and affected stakeholders or parties to register throughout the EIA application process. As such, the call to register incudes elements which are described below.

The call to register was targeted at all stakeholders, both pre-identified as well as those identified during the initial engagements with landowners and the applicant. These stakeholders include surrounding communities as highlighted in previous sections, who were specifically considered when initiating the call to register. A database of pre-identified stakeholders and interested and affected parties is included as Appendix 3.

[15] Cornelius, L.A.J., 2018. Stakeholder participation in surface water and groundwater quality management in the Waterberg area: Limpopo Province, South Africa (Doctoral dissertation, University of the Witwatersrand, Faculty of Science, School of Animal, Plant and Environmental Sciences).

[16] Itzkin, A., 2015. Health in the Waterberg, Up in Smoke? (Doctoral dissertation, University of the Witwatersrand, Faculty of Science, School of Animal, Plant and Environmental Sciences).

9.3.1 SITE NOTICE PLACEMENT

A total of sixty-two (62) A1 Correx site notices were placed at different locations along, within and surrounding the perimeter of the proposed Production Right area. A3 posters were placed at key public spaces. Site notices and posters were drafted in 4 languages, including English, Afrikaans, Sepedi and Setswana. Site notices included the following information:

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

9.3.2 ADVERTISEMENTS: NEWSPAPER AND GAZETTE NOTICE

Six individual advertisements describing the proposed project and EA process were placed in local newspapers with circulation in the vicinity of the study area. Table 24 provides a breakdown of the different advertisements placed in newspapers and relevant languages published. As part of these advertisements, a national gazette notice was placed as an official channel suggested by the guidelines as per Chapter 6 of the EIA Regulations. Advertisements were placed in English, Afrikaans, Sepedi and Setswana, corresponding with the languages that site notices were drafted in. In addition to newspaper advertisements, notices were placed in the national gazette. In this regard, two notices in different languages were placed. Advertisements and gazette notices included the following information:

- Project name;
- Applicant name;
- Project location;
- Nature of the activity;
- Legislative requirements; and
- Relevant EIMS contact person for the project.

Table 24 Summary of newspaper advertisements placed.

No. of adverts	Newspaper	Language(s)	Area of distribution
3	Mogol Pos	English, Afrikaans, Sepedi	Lephalale, Marapong, Vaalwater
3	Lekae Newspaper	English, Sepedi, Setswana	Marapong, Shongwane, Mokopane, Seleka
2	National Gazette	English, Afrikaans	National coverage

9.3.3 NOTIFICATION LETTERS, EMAILS, FAXES, AND SMS

Notification letters have been distributed to stakeholders through either registered mail, faxes, and/or emails.

The notification documents included the following information:

- List of anticipated activities to be authorised;
- Sufficient detail of the proposed development to enable I&APs to assess/surmise what impact the development will have on them or on the use of their land;

- The purpose of the proposed project;
- Details of the application processes associated with proposed activities;
- Details of the affected properties (including a locality map);
- Details of the South African environmental legislation that must be adhered to;
- Contact details of the EAP.

Additionally, SMSs were sent out to all mobile numbers of identified stakeholders informing them about the call to register.

9.3.4 RADIO BROADCAST

In addition to the above methods of notification, a radio advertisement was broadcast from 18 to 20 March 2026 (Wednesday to Friday) on Waterberg Stereo radio station. The advert aired on 2 slots per day (10:30am, 14:45pm). Radio adverts were broadcast in both English and Afrikaans and the content of the advertisement provided similar information to the written notifications above namely:

- Sufficient detail of the proposed development to enable I&APs to assess/surmise what impact the development will have on them or on the use of their land;
- The purpose of the proposed project;
- Details of the application processes being followed;
- Contact details of the EAP for further information and registration.

9.4 ENGAGEMENT ACTIVITIES

Following the initial engagement activities and initial call to register, several engagement platforms and opportunities will be made available to communities and stakeholders for further engagement during the EIA application process. These include focus group discussions, public meetings and site visits.

9.4.1 FOCUS GROUP DISCUSSIONS

Focus group discussions allow for people of similar backgrounds to interact with a topic or problem, answering common questions within their group. Focus group discussions should include no more than 10 people per focus group and be brief. At the same time, focus group discussions should not exceed one hour in duration. Where needed, different focus group discussions will take place during Scoping and EIA phases of the project, should certain groups, such as landowners, request them. The aim of these focus group discussions will be to address the concerns of specific groups as well as allow these groups to independently consult with aspects of the project.

Focus group discussions will be considered as separate avenues through which the public will be engaged. The implementation of this engagement activity will depend on the needs of stakeholders.

9.4.2 PUBLIC MEETINGS

In addition to focus group discussions, public meetings will be scheduled to include all who are interested in a general discussion of the project. These meetings will be held in key locations to allow those interested to access a platform to engage with aspects of the project. Table 25 provides a potential schedule of public meetings to be held during this stage of the SEP. Public meetings will be aimed to disseminate information about the project, but also to provide stakeholders with an opportunity to share their concerns and comment on the proposed activities. For this reason, key groups will be targeted, specifically those who would need a platform in addition to communication channels to be established such as email, telephone, and fax.

Table 25 Planned public meeting venues and target groups.

Public Meeting Location	Potential venue	Groups of interest
Lephalale	Lephalale municipality/Mogol Club	Members of Lephalale community
Marapong	To be confirmed	Community of Marapong
Thungela Offices	LCBM Nooitgedacht Conference Room	Affected landowners and adjacent landowners

Public meetings will be facilitated by an independent individual. This individual will be selected based on their ability to share information in the relevant local languages. This will allow for smoother liaison between the stakeholders and attendees of meetings. At the same time, the facilitator will also allow for meeting to remain structured and maintained within timeframes.

9.4.3 PLACEMENT OF REPORTS AT LOCAL VENUES

At the various stages of the project, the relevant outputs or reports of the EIA process will be made available for public review. Table 26 provides a breakdown of the locations where documents will be physically placed and projected dates when the relevant material will be placed at these locations. The three main outputs to be made available for public review include the Background Information Document (BID), Scoping Report (DSR), and the EIA Report which includes the EMPr. In addition to these locations, the relevant material will also be made available on EIMS's website (including a data free portal on request).

Table 26 Preliminary schedule of placement of relevant material at key locations.

Material to be placed	Venue(s)	Projected dates
Background information Document	• Lephalale Public Library • Marapong Public Library • Die Wind Pomp Lodge Electronic copy on EIMS Website	16 March 2026
Scoping Report		May 2026
Environmental Impact Report (including EMPr)		Date to be confirmed following Scoping Report acceptance

9.5 SUMMARY OF ENGAGMENT ACTIVITIES

Table 27 provides a summary of the various engagement activities planned. Included in the table are projected planned dates for these activities.

Table 27 Summary of scheduled engagement opportunities.

Action	Description	Publication/Place	Date
Initial Engagement with Landowners	Initial meetings with affected landowners	Venues that suit the individual landowners	3-5 March 2026
Initial Call to Register	Notification of landowners, occupiers, and other key I&APs.	Affected landowners and key I&APs were notified via email, fax, and/or post.	16-27 March 2026
	Placement of site notices.	Sixty (60) A1 Correx site notices (in English, Afrikaans, Sepedi, and Setswana) to be placed at different locations along, within and	

Action	Description	Publication/Place	Date
		surrounding the perimeter of the proposed project area.	
	Newspaper advertisement	Six (6) adverts to be placed in two (2) newspapers and Government Gazette.	
	Radio advertisement	Waterberg Stereo and broadcast in English and Afrikaans.	18-20 March 2026. The advert aired on two slots, at 10:30 and 14:45.
DSR Review	Placement of DSR for Public Review	DSR to be placed at various libraries and locations and on EIMS website	28 May 2026
	Public meetings and/or focus group discussion	At three locations, Lephalale municipality or Mogol Club, community of Marapong, and LCBM Nooitgedacht Conference Room	11-13 June 2026
EIR and EMPr Review	Placement of EIR and EMPr for Public Review	EIR and EMPr to be placed at various libraries and on EIMS Website	Date to be confirmed following Scoping Report submission and acceptance.
	Public meetings	At three locations, Lephalale municipality or Mogol Club, community of Marapong, and LCBM Nooitgedacht Conference Room	Date to be confirmed following Scoping Report submission and acceptance.

9.6 SUMMARY OF PRELIMINARY I&AP FEEDBACK

The following list is a high-level summary of the comments raised to date since the initial Call to Register notifications were published/distributed:

- Request to be registered as an I&AP of the project.
- Request for information relating to the background of the project.
- Request for details (and associated stakeholder engagement forms) on how to register as an I&AP.
- Request for information on affected properties, both in PR area and EIA area.
- Query on how the project will affect other economic activities in the area.
- Confirmation of existing mineral tenure within the PR area.

10 ENVIRONMENTAL ATTRIBUTES AND BASELINE ENVIRONMENT

A baseline assessment of the receiving environment within 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, which are presented below for the study area.

10.1 TOPOGRAPHY

The topography of the greater study area is mostly flat and can be characterised as low-laying Limpopo plains. Due to the relative resistance to erosion, the Waterberg Supergroup sandstones make out the Waterberg Mountain range, a prominent high-standing topographic feature which forms an escarpment along the south-western border with altitudes greater than 1800.0mamsl. The landscape gradually flattens out towards the lower laying Limpopo River drainage system in the north with altitudes below 800.0mamsl.

The relief of the Limpopo plains varies between 0.0 – 130.0m while the relief towards the more mountainous southwestern escarpment ranges from 130 – 900m. The lowest topographical elevation on-site is recorded as 845.0mamsl which is situated towards the far north-eastern perimeter of the EA application boundary and form part of the Mogol River drainage system to the east. The highest topographical point recorded on site is approximately 945.0mamsl and form part of the quaternary catchment boundary and groundwater and surface water divide to the far western section of the study area.

On-site gradients are variable, but generally gentle with the average slope calculated at 0.60%, and an elevation loss of 100.0 m over a lateral distance of 15.0km in a west-east orientation whereas an average slope of ~0.05% and elevation loss of 10.0m over a lateral distance of 17.0km is calculated in a south- north orientation. Figure 27 shows the regional topographical contours and setting. Localised topographical features within the application area include Bulklip, Koeiklip and Kalfklip rock outcrops.

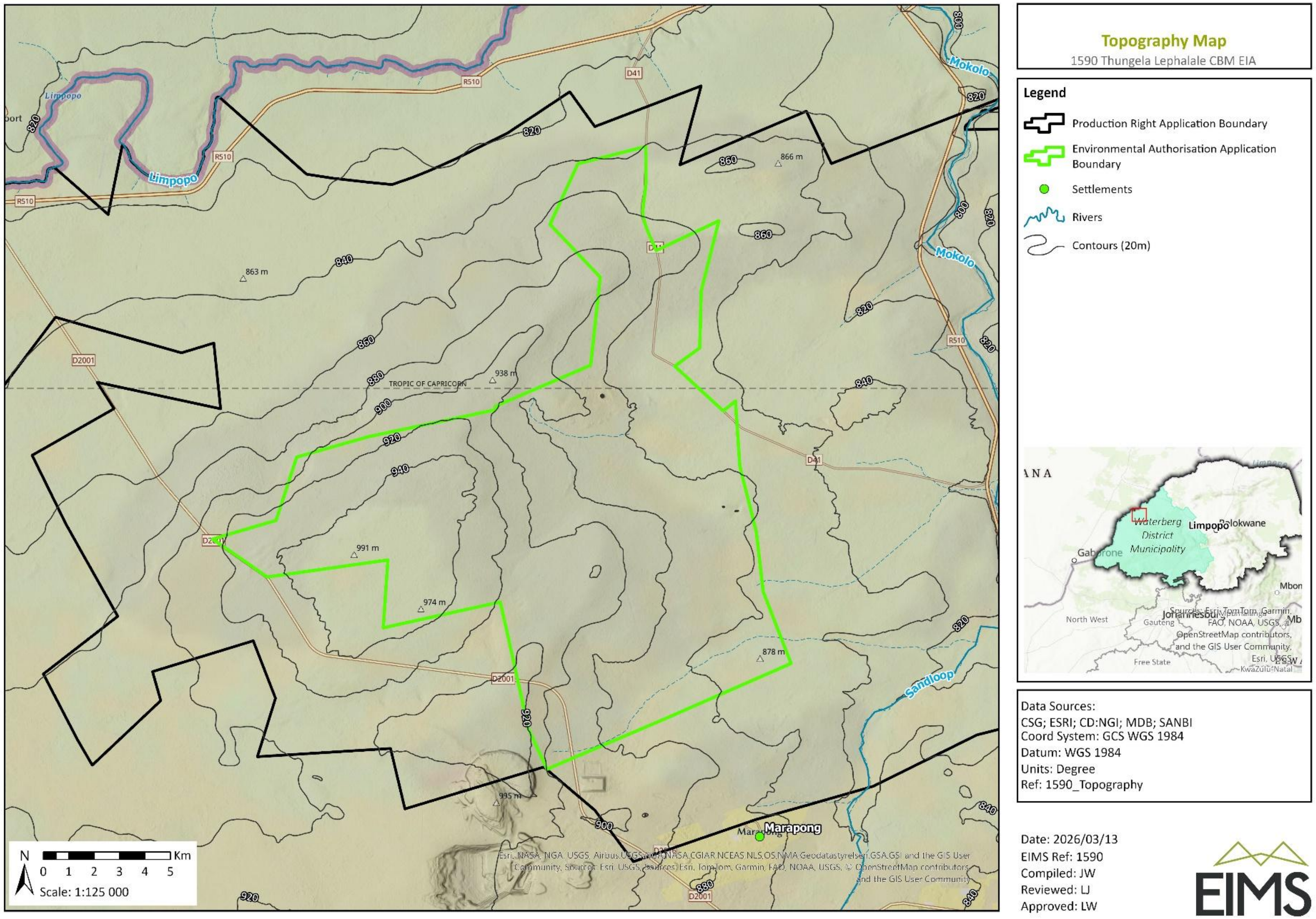


Figure 27: Regional topography and conceptual slice

10.2 DRAINAGE AND CATCHMENT

The study area is situated in the Limpopo primary catchment of the Limpopo, Rietspruit and Mokolo drainage systems (A). The resource management falls under the Limpopo WMA (WMA1) which spans an area of approximately 109 5812km. The Limpopo WMA is the northern most WMA in the country and contains a large part of the South African portion of the Limpopo Basin, which is also shared with Botswana, Zimbabwe and Mozambique. The water management area borders on Botswana and Zimbabwe, with the Limpopo River forming the entire length of the international boundary before flowing into Mozambique. All rivers in the Limpopo WMA drain in a northerly direction and flow into the Limpopo River (Limpopo ISP).

The proposed development is situated within quaternary catchment A42J (1810.8km^2) and falls within hydrological zone U with an estimated mean annual runoff (MAR) being 4.10mm (WR, 2012; Aquiworx, 2016). The catchment boundaries are depicted in Figure 65. The hydrology of the region is characterised by predominately non-perennial watercourses. The main rivers draining the greater study area in a general northern direction is the Mokolo River (also called the Mogol river) which has its source from the Sand River further to the south. The Rietspruit joins the Mokolo River approximately 20.0km south of the study area as well as the Tambotie River approximately 13.0km towards the southeast. The Mokolo/Mogol River traverses the proposed production right area in a northern direction from where it forms a confluence with the Limpopo River approximately 25.0km northeast flowing eastwards towards the Indian Ocean. Locally the study area is situated on the quaternary catchment divide towards the western perimeter and surface runoff will be in a general northern to northeasterly direction towards the lower laying drainage system.

10.3 CLIMATE

This section describes the prevailing and historic climate data as well as the vulnerability of the area due to climate change with the projected future climate.

10.3.1 PREVAILING AND HISTORIC CLIMATE

The study area's weather pattern reflects a typical summer rainfall region, with > 87% of precipitation occurring as high-intensity thunderstorms from October to March. Patched rainfall and evaporation data were sourced from the WR2012 database (Rainfall zone A4E) and span a period of some 90 years (1920 – 2009).

The calculated Mean Annual Precipitation (MAP) for this rainfall zone is 424.90mm/a, with the 5th percentile of the data set (roughly equivalent to a 1:20 year drought period) calculated at 265.40mm/a and the 95th percentile (representing a 1:20 flood period) 625.80mm/a. The highest MAP for the 90 years of rainfall data was recorded as of 768.30mm (1999) while the lowest MAP of 223.20mm was recorded during 1965. All catchment areas are categorised under evaporation zone 1D which have a mean annual evaporation (s-pan) of approximately 1950mm/a, almost five times the annual precipitation. Figure 28 depicts a bar chart of the yearly rainfall distributions with Figure 29 indicating monthly patterns.

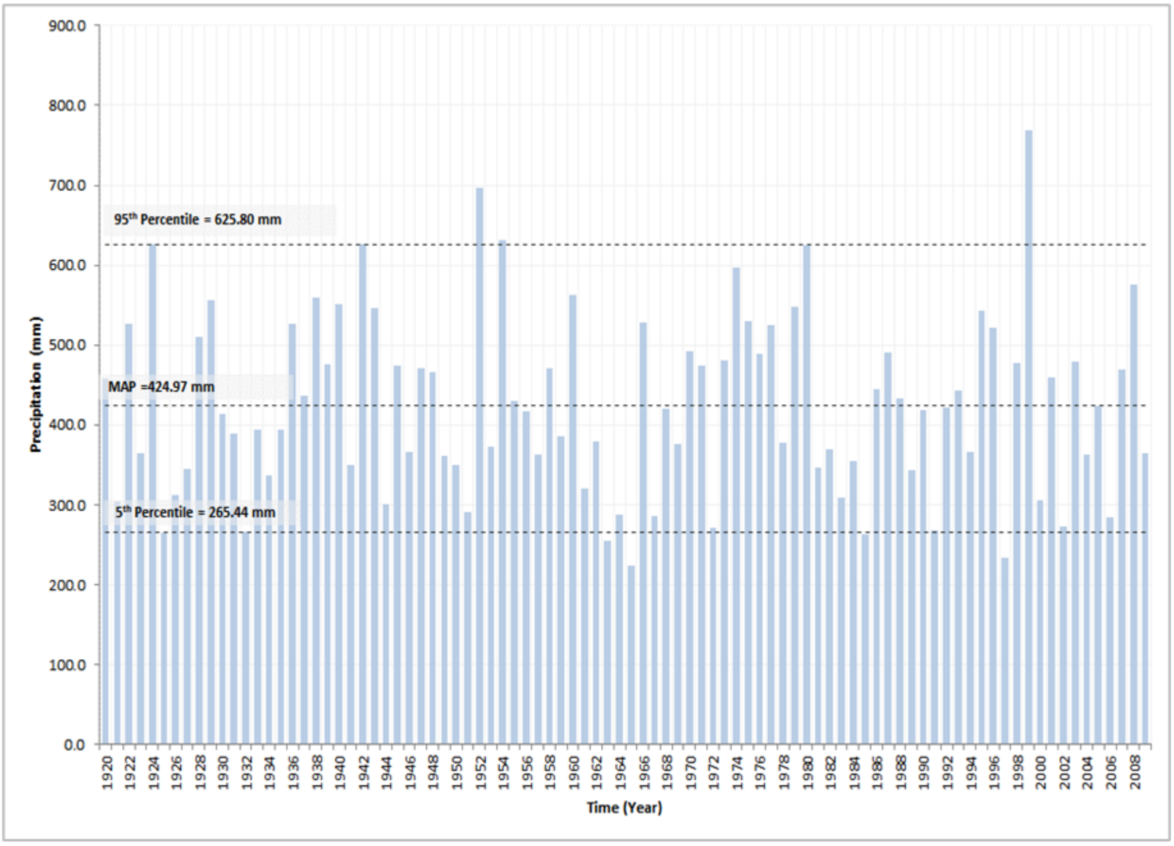


Figure 28: Bar chart indicating yearly rainfall distribution for rainfall zone A4E (WR2012)

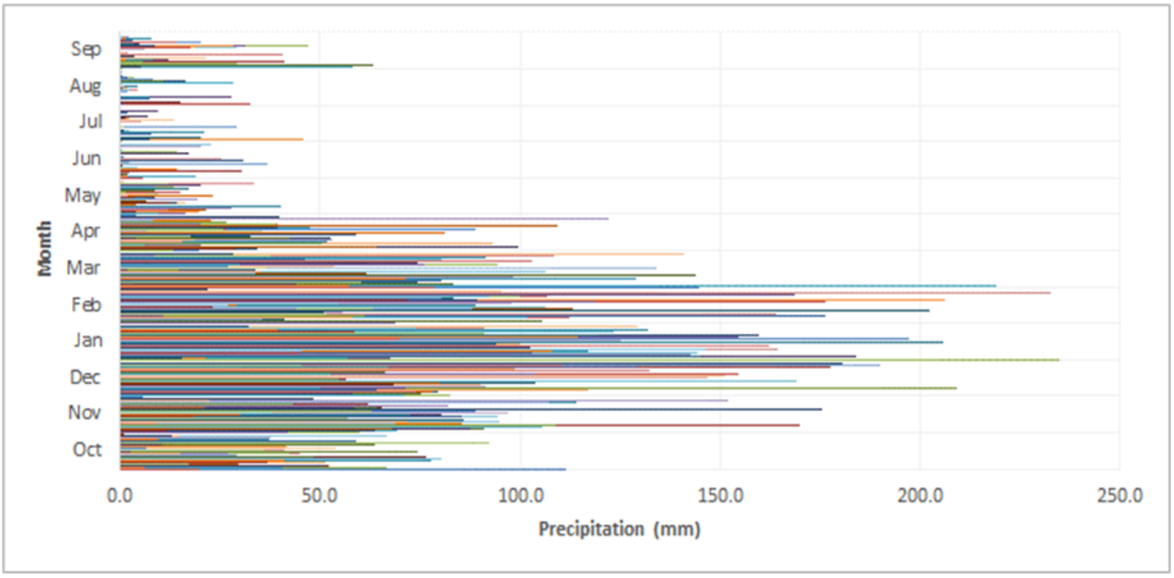


Figure 29: Bar chart indicating monthly rainfall distribution for rainfall zone A4E (WR2012)

10.3.2 PHYSICAL RISKS OF CLIMATE CHANGE

10.3.2.1 VULNERABILITY

The Green Book (CSIR, 2019); was developed to be an online platform providing quantitative scientific evidence on the likely impacts that climate change and urbanisation will have on South Africa's cities and towns. A profile for each local municipality, including individual settlements and neighbourhoods, was built in terms the rates of socio-economic, economic, physical and environmental risks associated with urbanisation, population growth and climate change (Le Roux *et al.*, 2019). The risk profile was accessed for the Lephalale Municipality. The Lephalale Municipality socio-economic vulnerability score (out of 10) is 4.6 for 1996, reducing to 3.0 for 2011. The lower score in 2011 compared to 1996 indicates improvement of socio-economic factors. The Lephalale Municipality for socio-economic vulnerability ranks 2nd out of 26 in the province and 46th out of 213 in the country. The Lephalale Municipality economic vulnerability score (out of 10) is 7.1 for 1996, increasing to 9.2 for 2011. The economic vulnerability ranks 19th out of 26 in the province and 206th out of 213 in the country. The physical vulnerabilities rank 19th out of 26 in the province and 184th out of 213 in the country. The environmental vulnerability ranks 3rd out of 26 in the province and 74th out of 213 in the country.

10.3.2.2 BASELINE CLIMATE

Climate change metrics focus on temperature; the number of very hot days (where temperatures exceed 35°C); rainfall; and extreme rainfall events (more than 20 mm in 24 hours). The baseline (1961 to 1990) annual averages for these metrics were accessed for the area near the project site from the South Africa 'Green Book' (CSIR, 2019). The metrics include three percentiles (10th, 50th, and 90th) as an indication of the variability within the measured data set.

Baseline annual average temperature was in the range 21.76°C (10th percentile) and 22.16°C (90th percentile) (Figure 30) with the number of very hot days varying between 50.30 (10th percentile) and 61.42 (90th percentile) days per year (Figure 31). High inter-annual rainfall variability is noticed (Figure 32) as the range between the 10th and 90th percentiles was 448.28 mm and 526.13 mm. Extreme rainfall days varied between 2.52 (10th percentile) and 3.32 (90th percentile) days per year (Figure 33).

Recent change in climatic conditions near the project site were accessed from MeteoBlue a weather forecasting platform developed at the University of Basel, Switzerland and based on models of National Oceanic and Atmospheric Administration (NOAA) or National Centres for Environmental Prediction (NCEP). The data sets also include historical climate data tracking changes in climate by referencing ERA5, the fifth generation ECMWF (European Centre for Medium-Range Weather Forecasts) atmospheric reanalysis of the global climate, for the period between 1979 to 2021, with a spatial resolution of 30 km. Based on a point selected over the project site, no significant trend in the annual average temperatures have been observed with temperatures measuring 21.1°C in 1979 to 22.1°C in 2021 (Figure 34). The lower part the graph shows the so-called warming stripes. Each coloured stripe represents the average temperature for a year - blue for colder and red for warmer years. Similarly, the change in rainfall over the same period (1979 – 2021) displays no significant trend (Figure 35), where the difference from long-term average for each year in the data set is visualised by the stripes in the lower panel of Figure 35 (brown stripes indicate lower than average rainfall and green stripes above average rainfall).

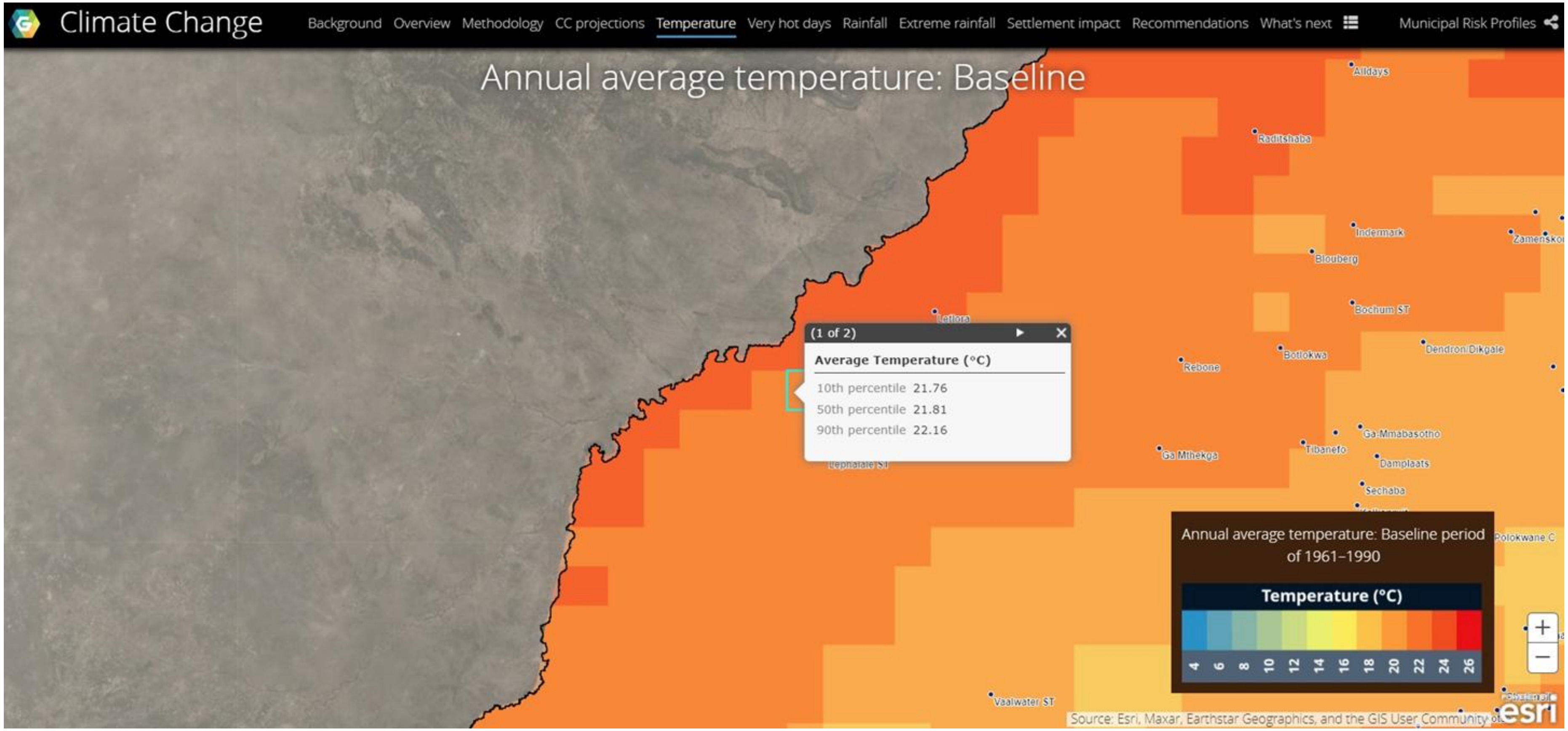


Figure 30: Baseline (1961 to 1990) annual average temperature for the project area (CSIR, 2019).

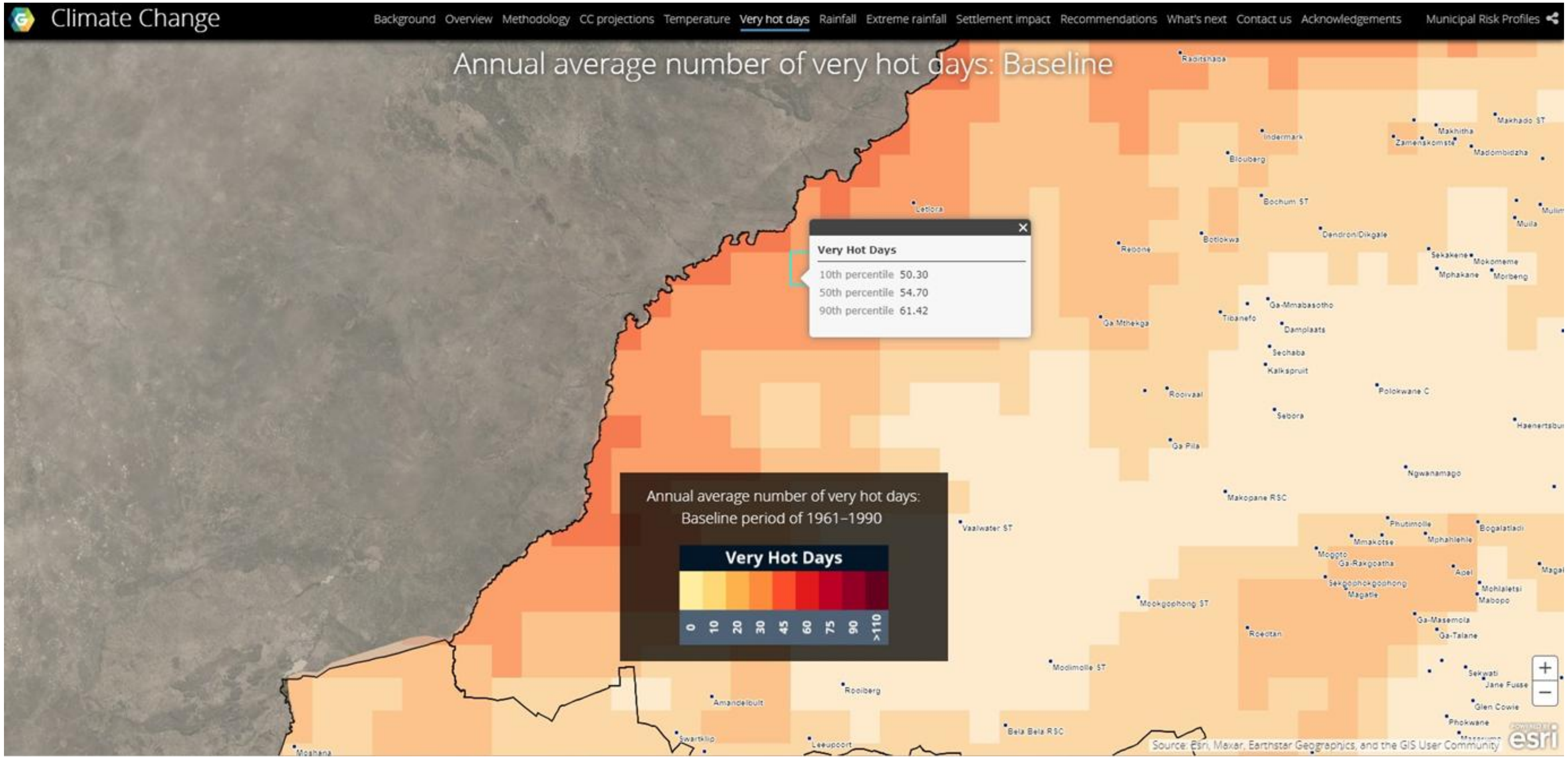


Figure 31: Baseline (1961 to 1990) number of very hot days (>35°C) annually for the project area (CSIR, 2019).

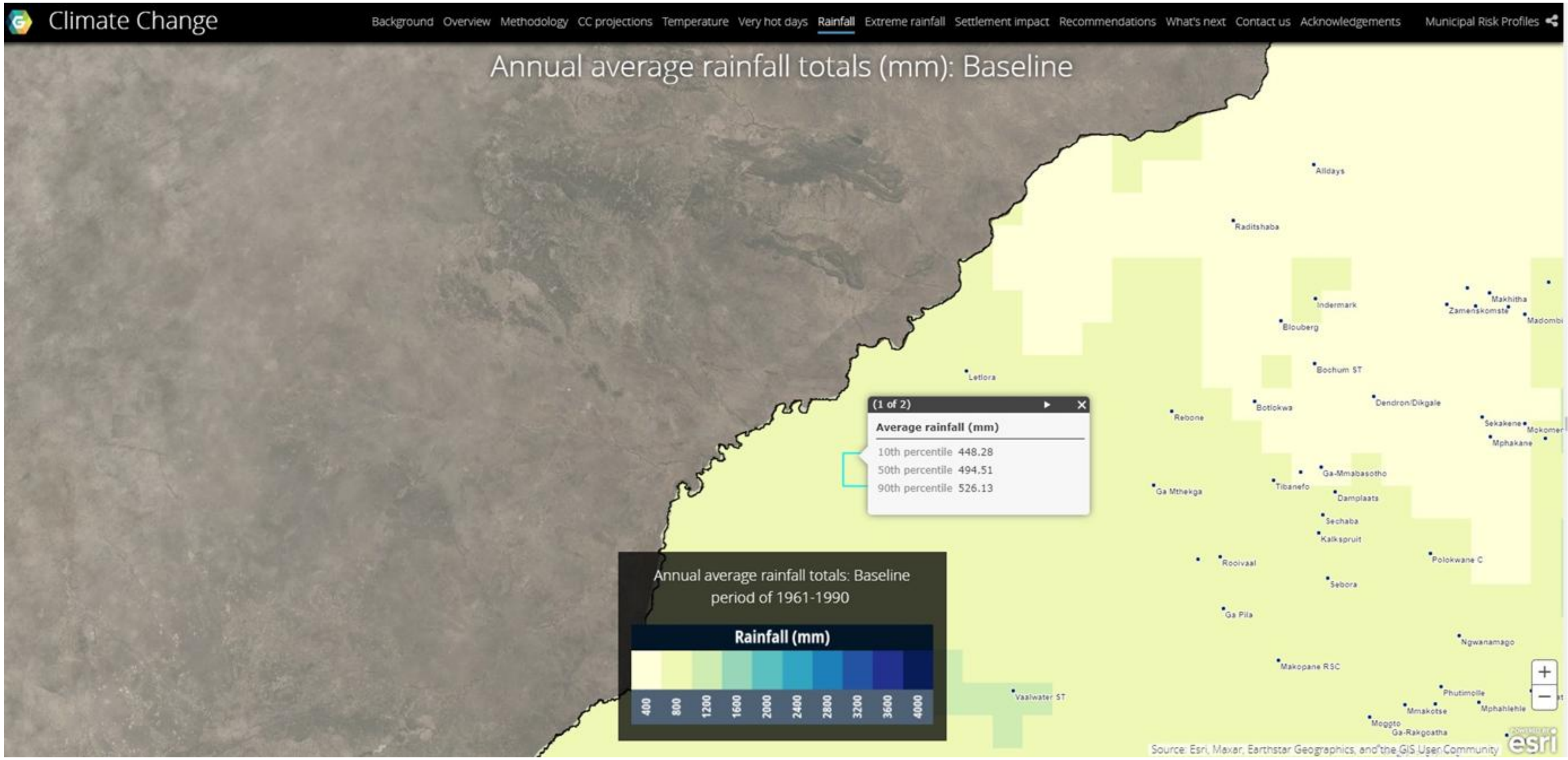


Figure 32: Baseline (1961 to 1990) annual average rainfall for the project area (CSIR, 2019).

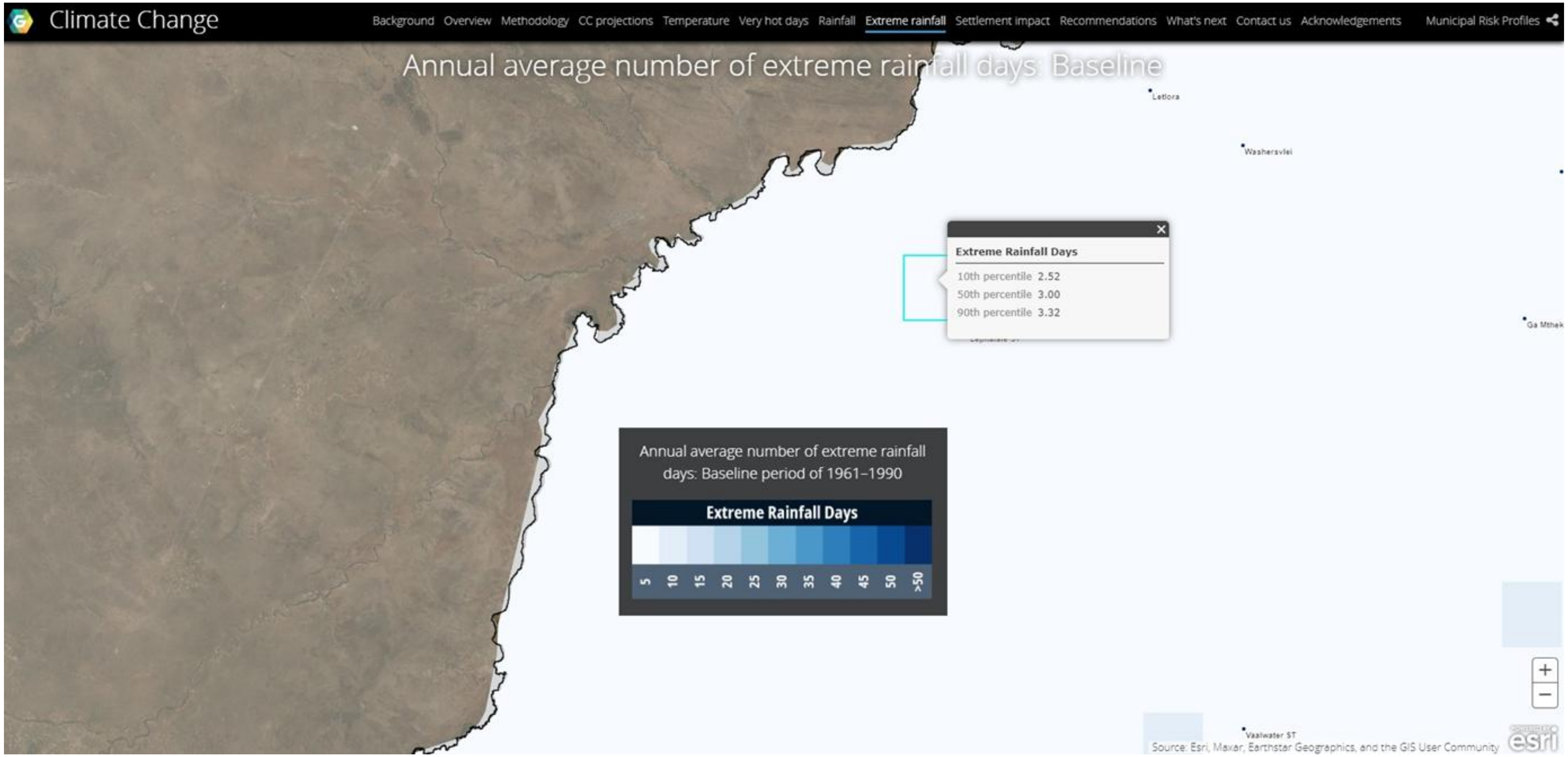


Figure 33: Baseline (1961 to 1990) annual average number of extreme rainfall days (>20 mm in <24 hours) for the project area (CSIR, 2019).

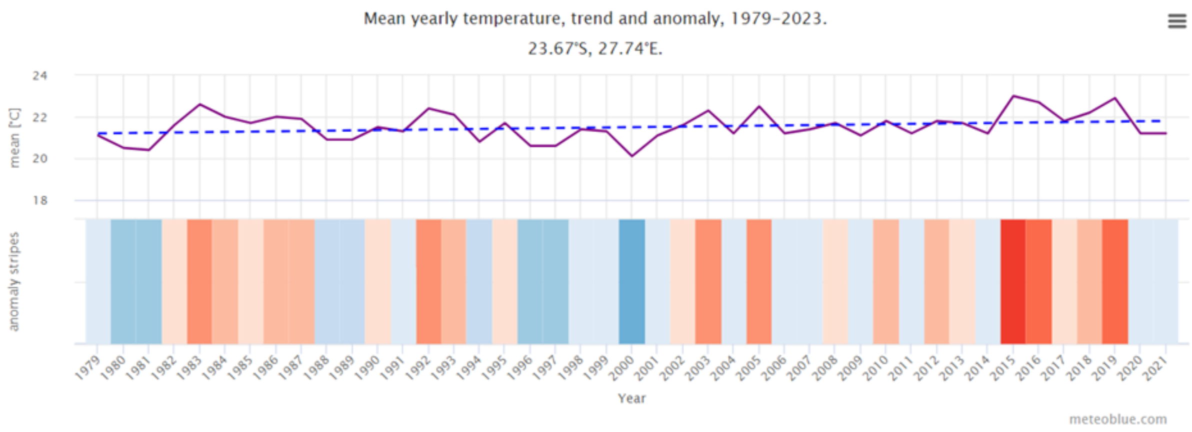


Figure 34: Annual average temperature (top panel) and temperature anomaly (lower panel) between 1979 and 2023 (Meteoblue, 2023).

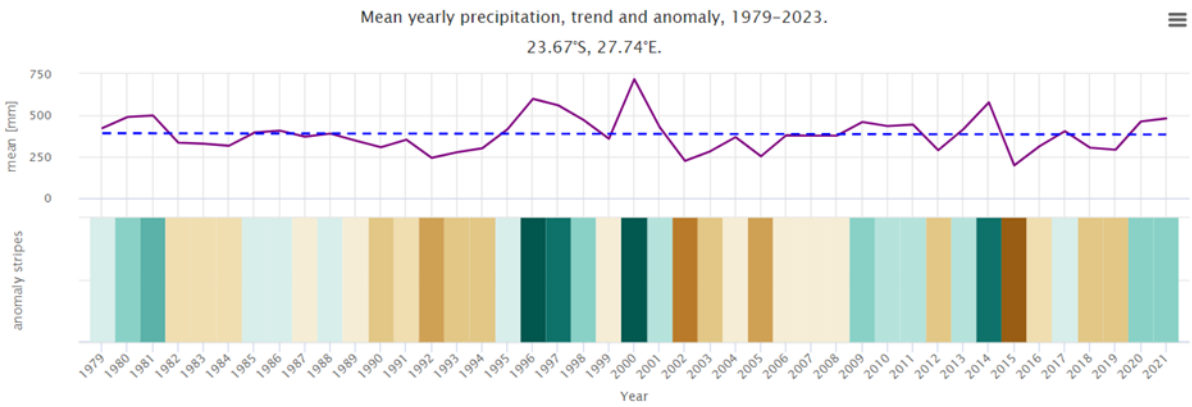


Figure 35: Annual average rainfall (top panel) and rainfall anomaly (lower panel) between 1979 and 2021 (Meteoblue, 2023).

10.3.2.3 **PROJECTED FUTURE CLIMATE**

In 2017 the South African Weather Services (SAWS) published an updated Climate Change Reference Atlas (CCRA) based on Global Climate Change Models (GCMs) projections (SAWS, 2017). It must be noted that as with all atmospheric models there is the possibility of inaccuracies in the results 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°. Findings from downscaled climatic simulations using six global climate models, at an 8 km x 8 km resolution over South Africa, for the time slab 2021 to 2050 were included in the Green Book (Engelbrecht, 2019).

In both the CCRA and the Green Book, two trajectories are included based on the four Representative Concentration Pathways (RCPs) discussed in the IPCC's fifth assessment report (AR5) (IPCC, 2013). RCPs are defined by their influence on atmospheric radiative forcing in the year 2100. RCP4.5 represents an addition to the radiation budget of 4.5 W/m^2 as a result of an increase in GHGs. The two RCPs selected were RCP4.5 representing the medium-to-low pathway and RCP8.5 representing the high pathway. RCP4.5 is based on a CO_2 concentration of 560 ppm and RCP8.5 on 950 ppm by 2100. RCP4.5 is based on if current interventions to reduce GHG emissions being sustained (after 2100 the concentration is expected to stabilise or even decrease). RCP8.5

is based on if no interventions to reduce GHG emissions being implemented (after 2100 the concentration is expected to continue to increase).

10.3.2.3.1 RCP4.5 TRAJECTORY

Based on the median, for the region in which the proposed project is situated, the annual average near surface temperatures (2 m above ground) are expected to increase by ~2.5°C for the near future and ~3.0°C for the far future (SAWS, 2017). The Green Book projected temperature changes in the near future (2021 to 2050) indicate a 50th percentile increase of 2.6°C and a 90th percentile increase of 2.7°C (Figure 36, Engelbrecht, et al., 2019). The number of very hot days are expected to increase to between 55 and 65 days per year (Figure 37). Between 2021 and 2050 the annual rainfall near the project site was projected to decrease by 64 mm per year between 2021 and 2050 (50th percentile) (Figure 38, Engelbrecht, et al., 2019), with extreme rainfall days unlikely to see a substantial change in the near future (Figure 39, Engelbrecht, et al., 2019). Seasonal rainfall is expected to decrease for all seasons except summer for near and far future (SAWS, 2017).

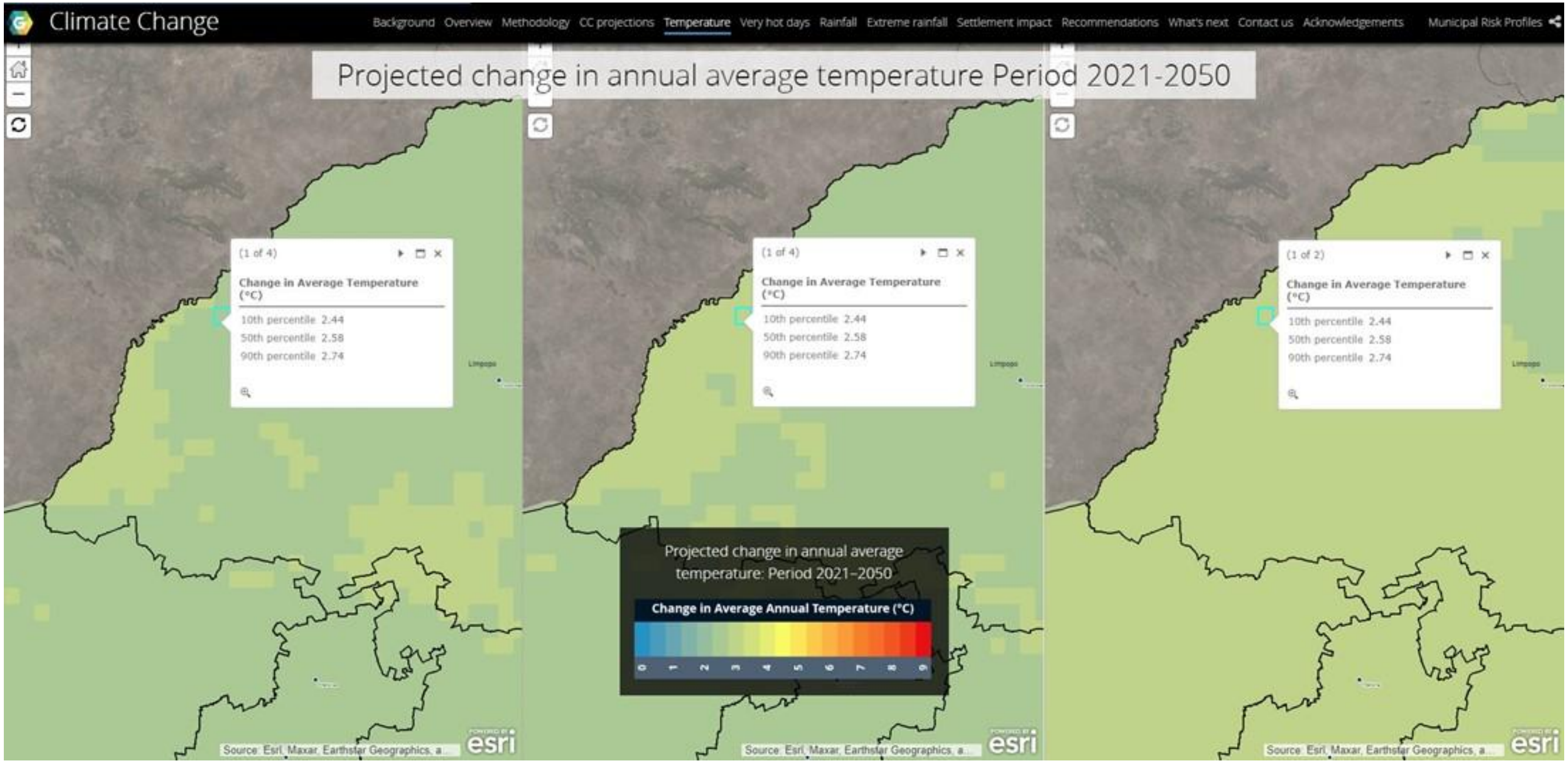


Figure 36: Projected change in annual average temperature for the near future (2021 – 2050) for the RCP4.5 trajectory.

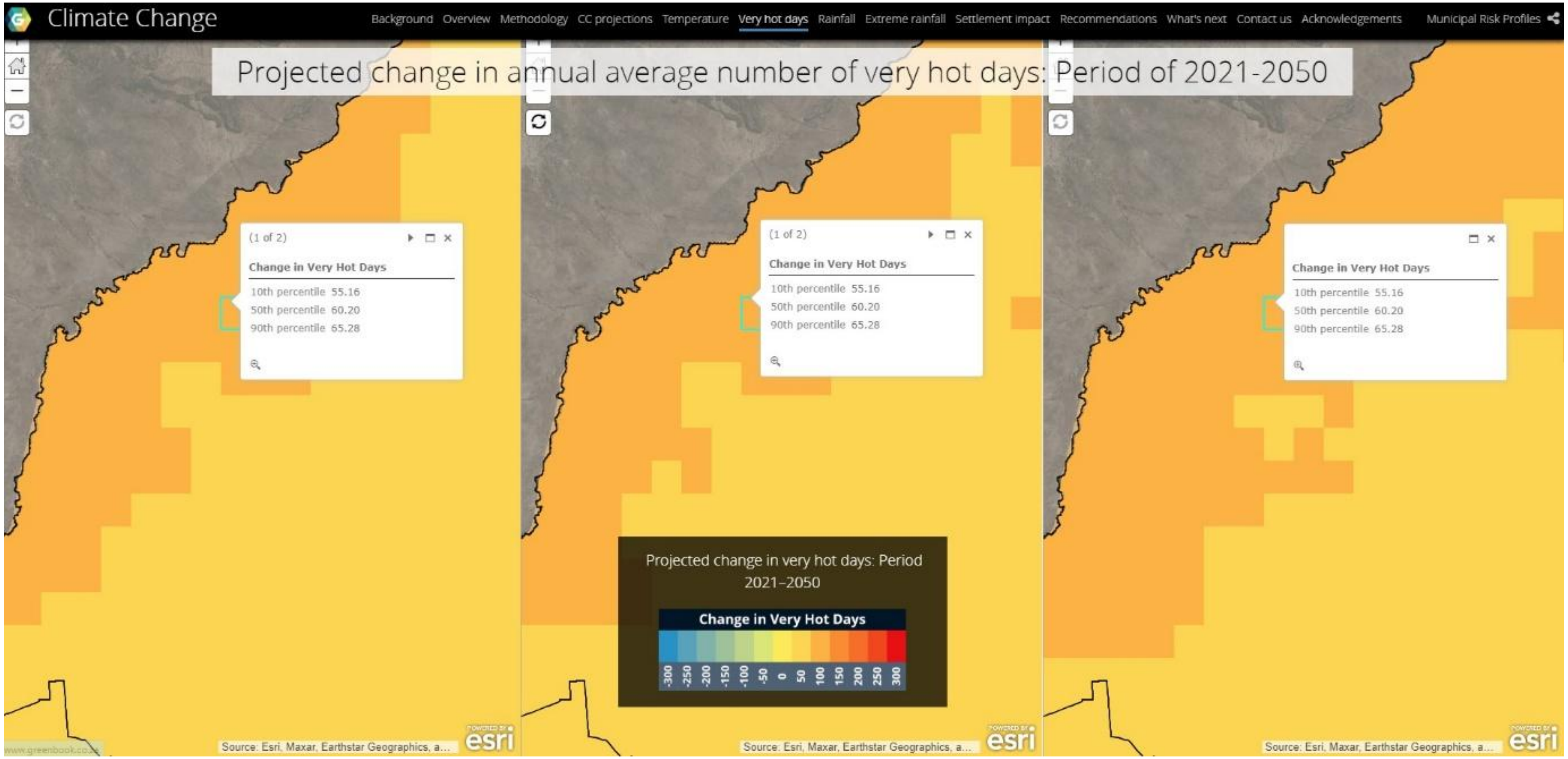


Figure 37: Projected change in very hot days for the near future (2021 – 2050) for the RCP4.5 trajectory.

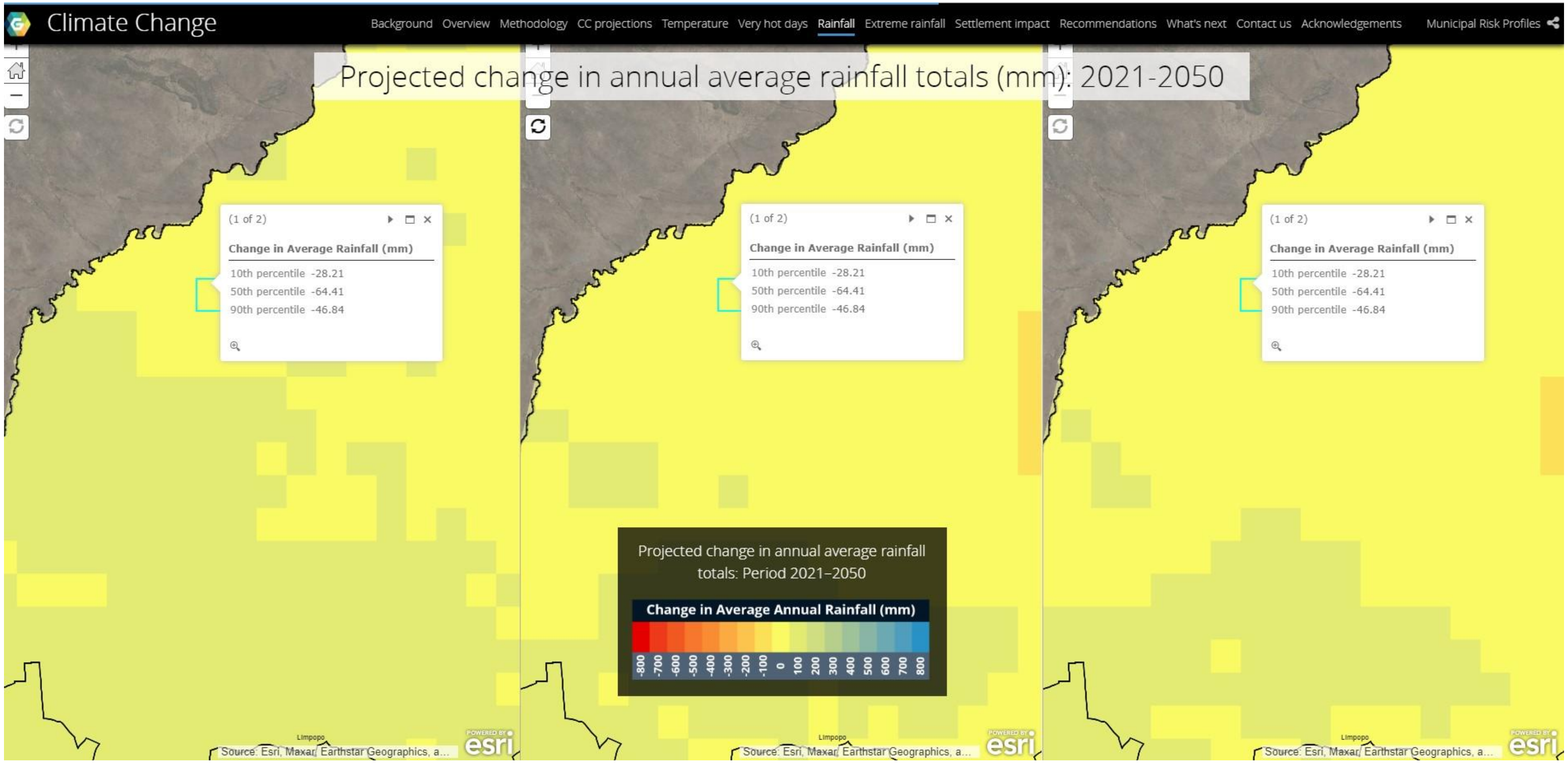


Figure 38: Projected change in annual average rainfall for the near future (2021 – 2050) for the RCP4.5 trajectory.

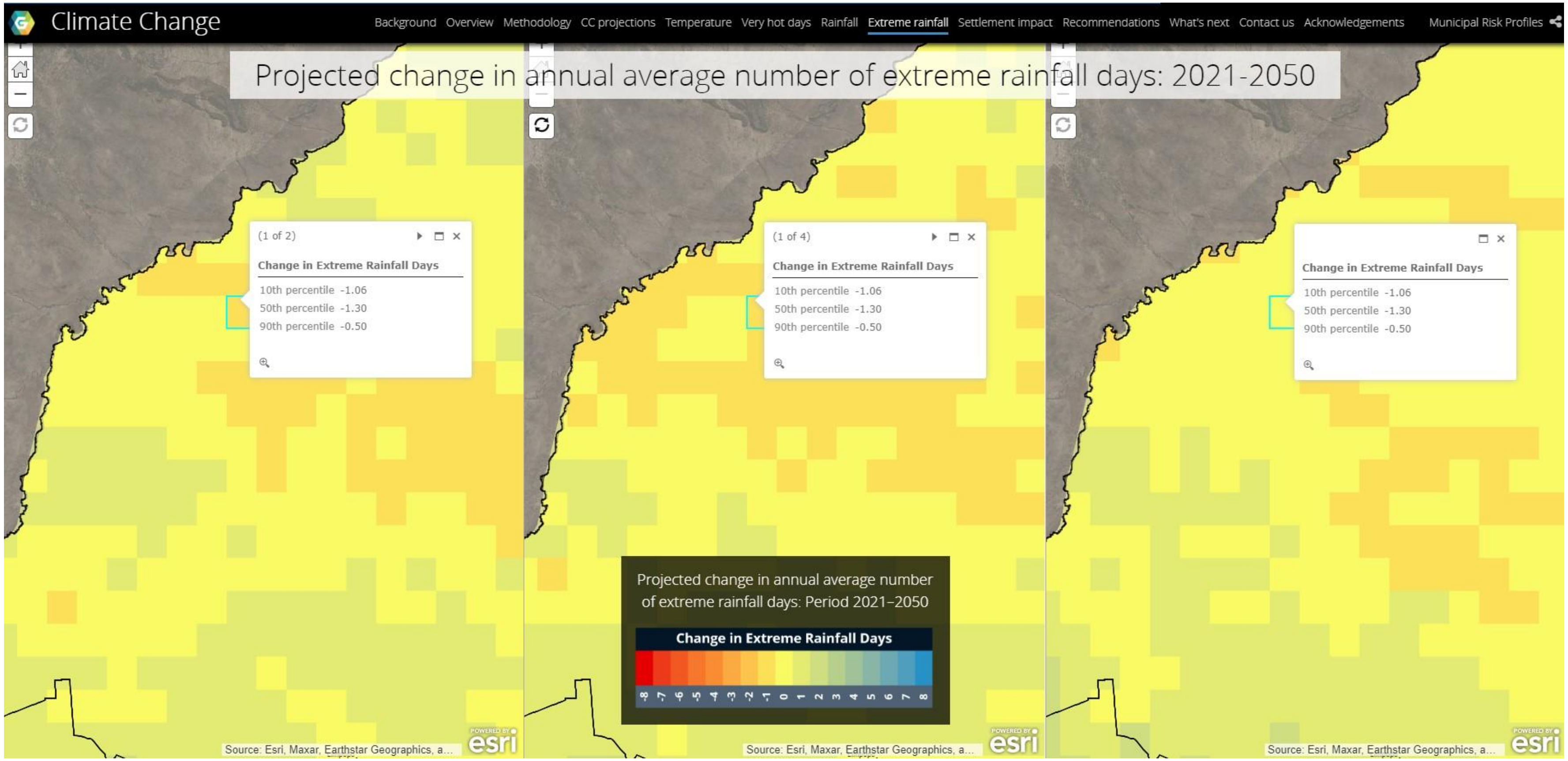


Figure 39: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP4.5 trajectory.

10.3.2.3.2 RCP8.5 TRAJECTORY

Based on the median, the region in which the project and receptors are situated, the annual average near surface temperatures (2 m above ground) are expected to increase by 3.0°C and 4.5°C for the near and far future respectively (SAWS, 2017). The Green Book projected temperature changes in the near future (2021 to 2050) indicate a 50th percentile increase of 3.1°C and a 90th percentile increase of 2.8°C (Figure 40, Engelbrecht, et al., 2019). The number of very hot days are expected to increase to 71 days per year (50th percentile) (Figure 41). Between 2021 and 2050 the annual rainfall near the project site was projected to decrease by 31 mm per year between 2021 and 2050 (50th percentile) (Figure 42, Engelbrecht, et al., 2019), with extreme rainfall days unlikely to see a substantial change in the near future (Figure 43, Engelbrecht, et al., 2019). Seasonal rainfall is expected to decrease for all seasons except summer for near and far future (SAWS, 2017).

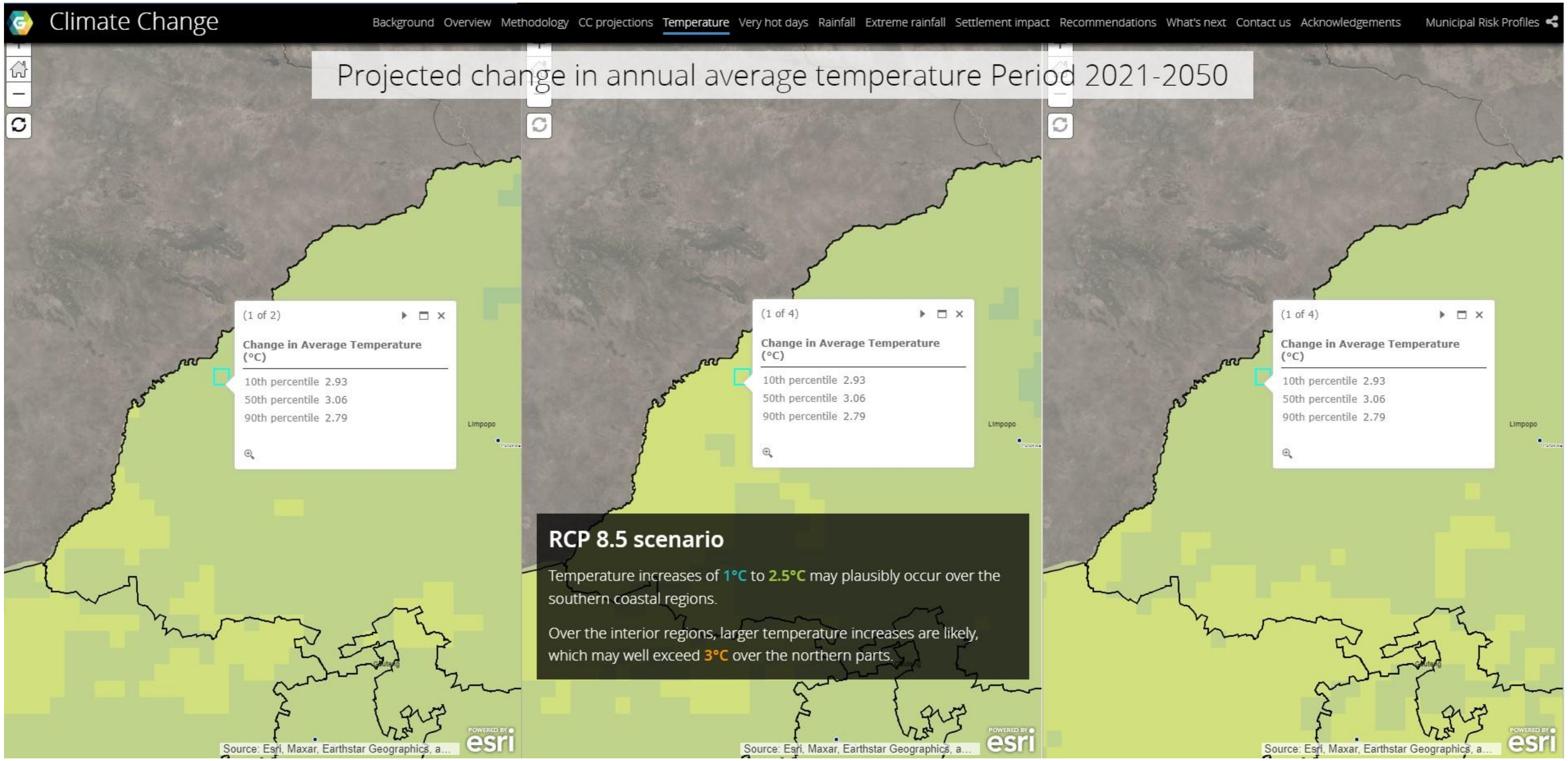


Figure 40: Projected change in annual average temperature for the near future (2021 – 2050) for the RCP8.5 trajectory.

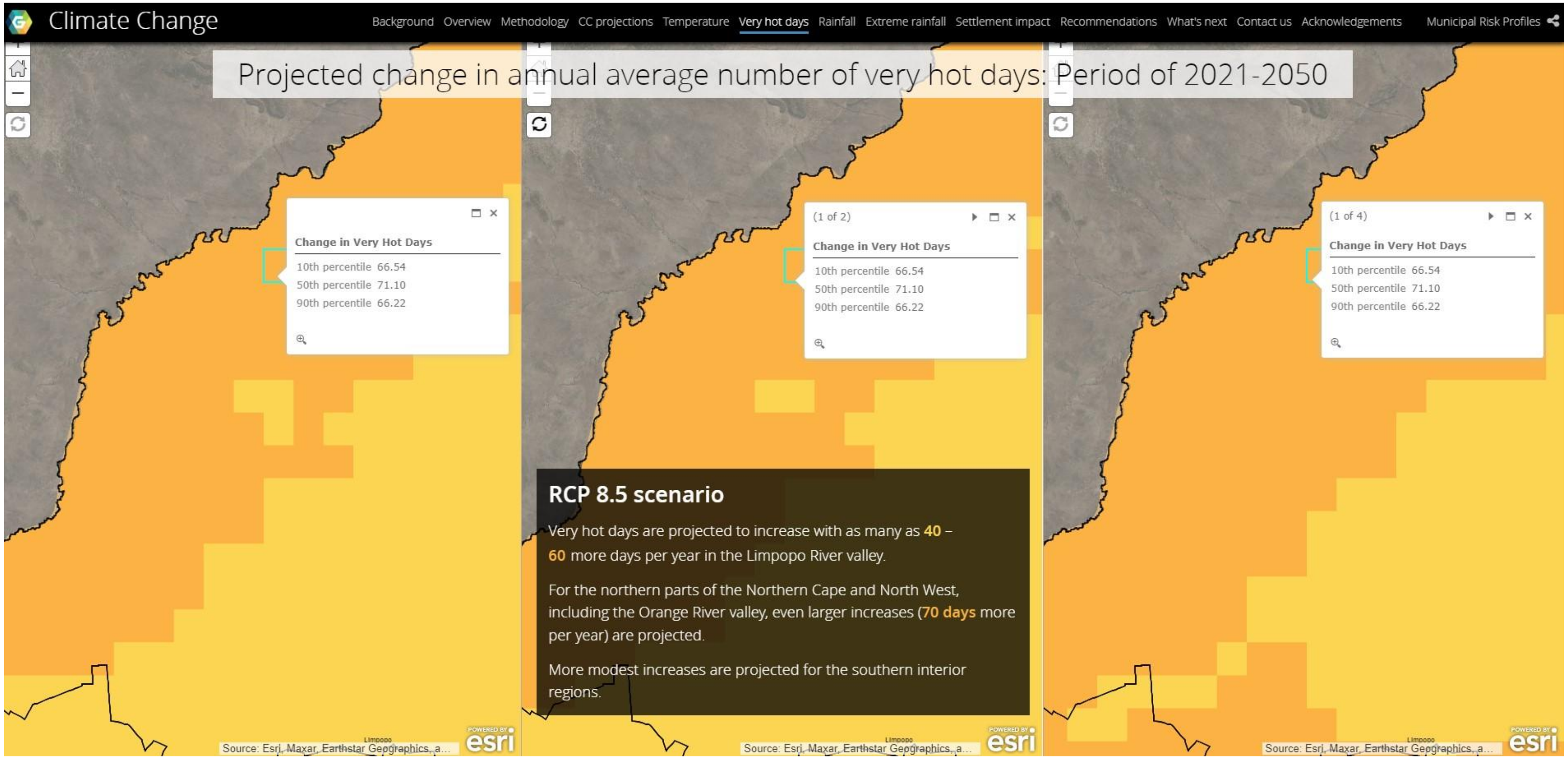


Figure 41: Projected change in very hot days for the near future (2021 – 2050) for the RCP8.5 trajectory.

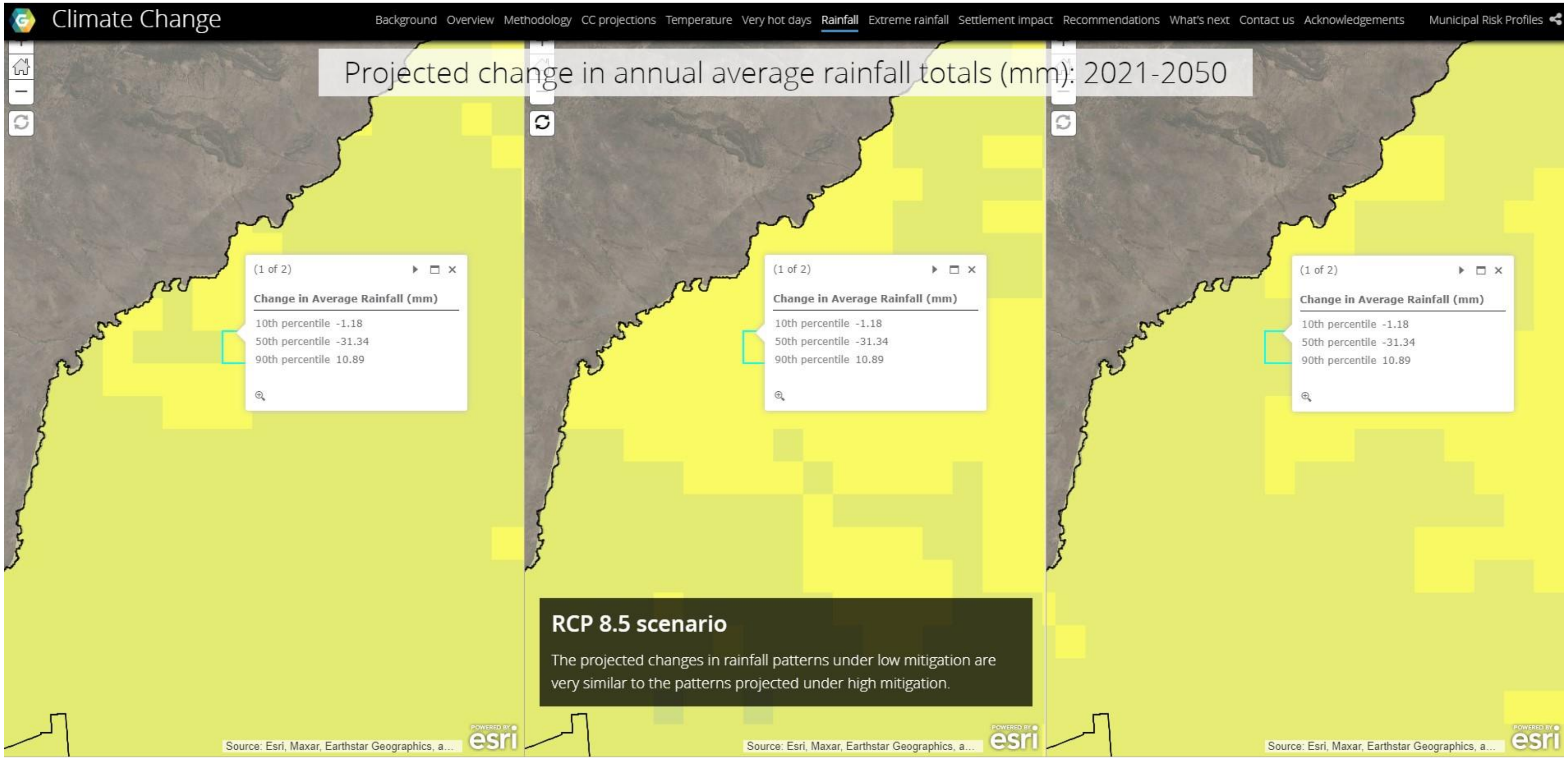


Figure 42: Projected change in annual average rainfall for the near future (2021 – 2050) for the RCP8.5 trajectory.

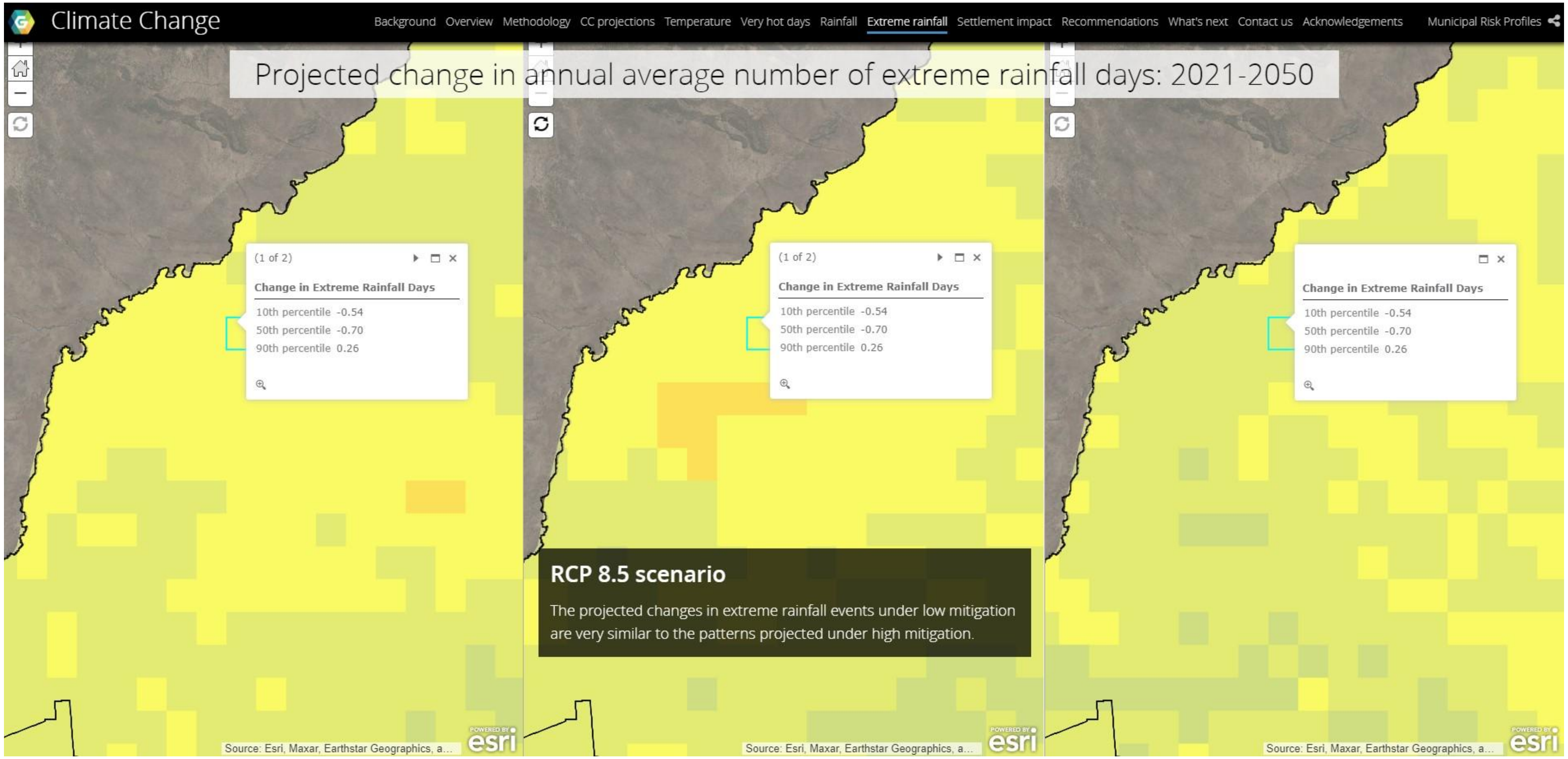


Figure 43: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP8.5 trajectory.

10.3.2.3.3 IPCC'S SIXTH ASSESSMENT REPORT: TEMPERATURE AND RAINFALL PROJECTIONS

The most recent IPCC data are from the Coupled Model Intercomparison Project (CMIP) which were derived from the sixth phase of the CMIPs (CMIP6) and supports the IPCC's Sixth Assessment Report (AR6) which was released on 9 August 2021 (Working Group I), 28 February 2022 (Working Group II) and 4 April 2022 (Working Group III). Projection data is presented at a 1.0º x 1.0º (100 km x 100 km) resolution. The scenarios are the result of complex calculations that depend on how quickly humans curb greenhouse gas emissions, whilst also capturing socioeconomic changes in areas such as population, urban density, education, land use and wealth. For example, a rise in population is assumed to lead to higher demand for fossil fuels and water. Education can affect the rate of technology developments. Emissions increase when land is converted from forest to agricultural land. Each scenario is labelled to identify both the emissions level and the so-called Shared Socioeconomic Pathway, or SSP, used in those calculations. This first scenario is the only one that meets the Paris Agreement's goal of keeping global warming to around 1.5°C above preindustrial temperatures, with warming hitting 1.5°C but then dipping back down and stabilizing around 1.4°C by the end of the century. Projected changes are defined relative to a historical 20-year period (1995 to 2014).

The AR6 projections for the study area for the scenario RCP2.6 indicate an increase in annual average temperatures of 1.5°C for the period 2041 to 2060 and 1.7°C for the period 2081 to 2100. The projections for the RCP4.5 indicate an increase in annual average temperatures of 1.9°C for the period 2041 to 2060, to 3°C for the period 2081 to 2100 (IPPC, 2022). Although the CCRA and AR6 projections are based on different baselines, with the former earlier by a decade, and the definitions of the scenarios not exactly the same, the temperature projections are similar.

The AR6 projections for rainfall in the study area for RCP2.6 indicate a decrease in annual rainfall of 4.7% for the period 2041 to 2060, to 5% for the period 2081 to 2100. The projections for RCP4.5 indicate decrease of rainfall of 4.9% for the period 2041 to 2060, to 5% for the period 2081 to 2100 (IPPC, 2022).

10.3.2.3.4 CLIMATE CHANGE HAZARDS AND RISKS

The Green Book risk profile includes an assessment of projected risk to the Lephalale Municipality in 2050, mostly based on the low mitigation RCP8.5 climate simulations, and highlights the following:

- Isolated pockets of high and low increased risk of wildfires within the municipality with no indicated increase in risk of wildfires over the project area (Figure 44);
- Isolated pockets of very low and low risk of increased drought frequency within the municipality with no indicated increase in risk of drought over the project area and the Standardized Precipitation Index (SPI)[17] of -0.6 (Figure 45);
- Isolated pockets of extreme and high increased heat extremes within the municipality with no indicated risk within the project area (Figure 46); and,
- Isolated pockets of very low and low risk of increased urban flooding within the municipality with no indicated risk within the project area (Figure 47). Very slight decrease in rainfall days is expected for the project area (0.9) (Figure 47).

In addition to the hazards identified in the Green Book, Hofste, et al., (2019) currently rate the project area at near normal risk of water stress (Figure 48) with a similar projection for the future (2050 based on a conservative low mitigation trajectory) but may affect areas to the west of the project site that are predicted to have a doubled increase in water stress (Figure 49).

[17] The Standardized Precipitation Index (SPI) is a widely used index to characterize meteorological drought on a range of timescales. SPI index.

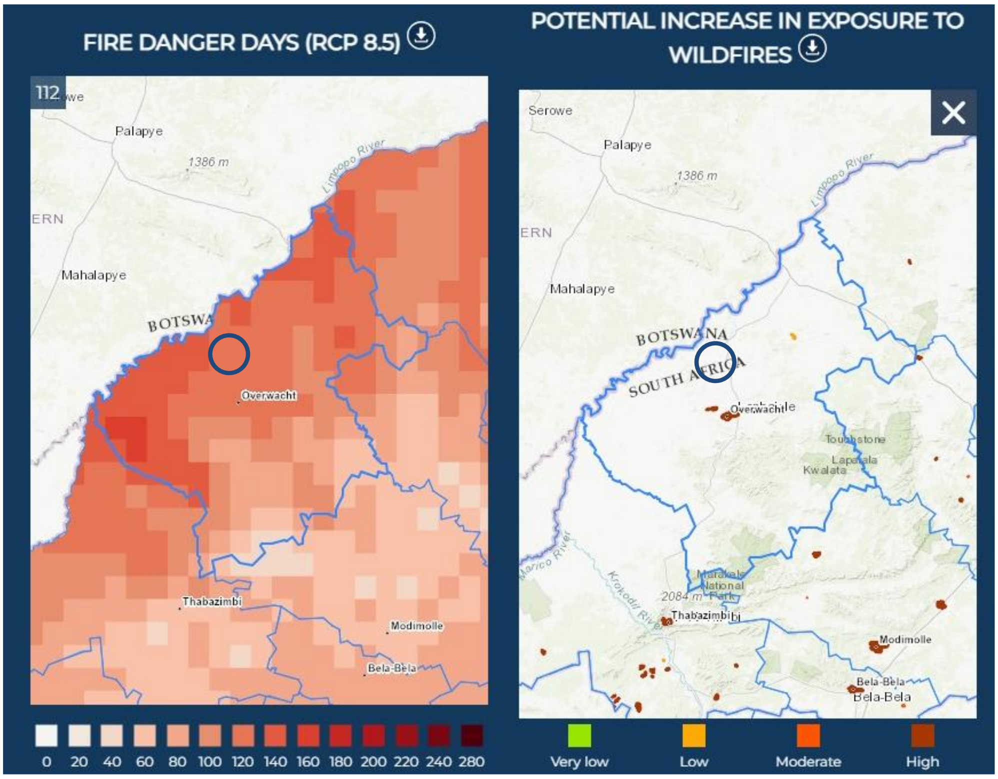


Figure 44: Risk of increased wildfires for Lephalale Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project).

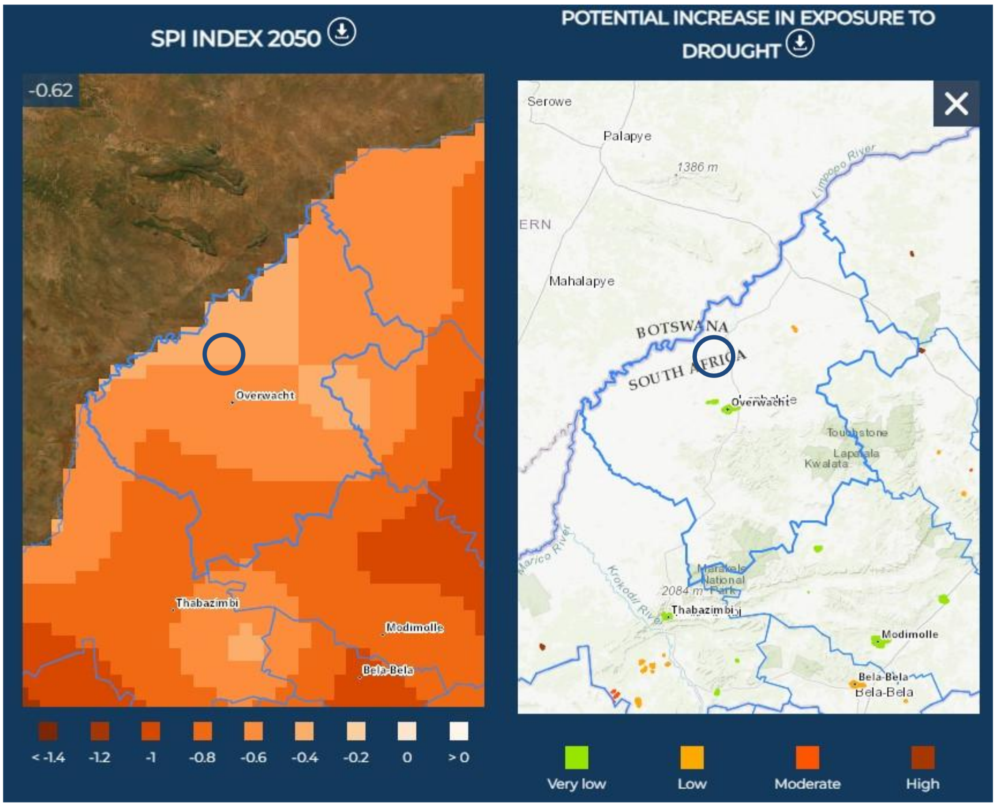


Figure 45: Risk of increased drought tendencies for Lephalale Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project).

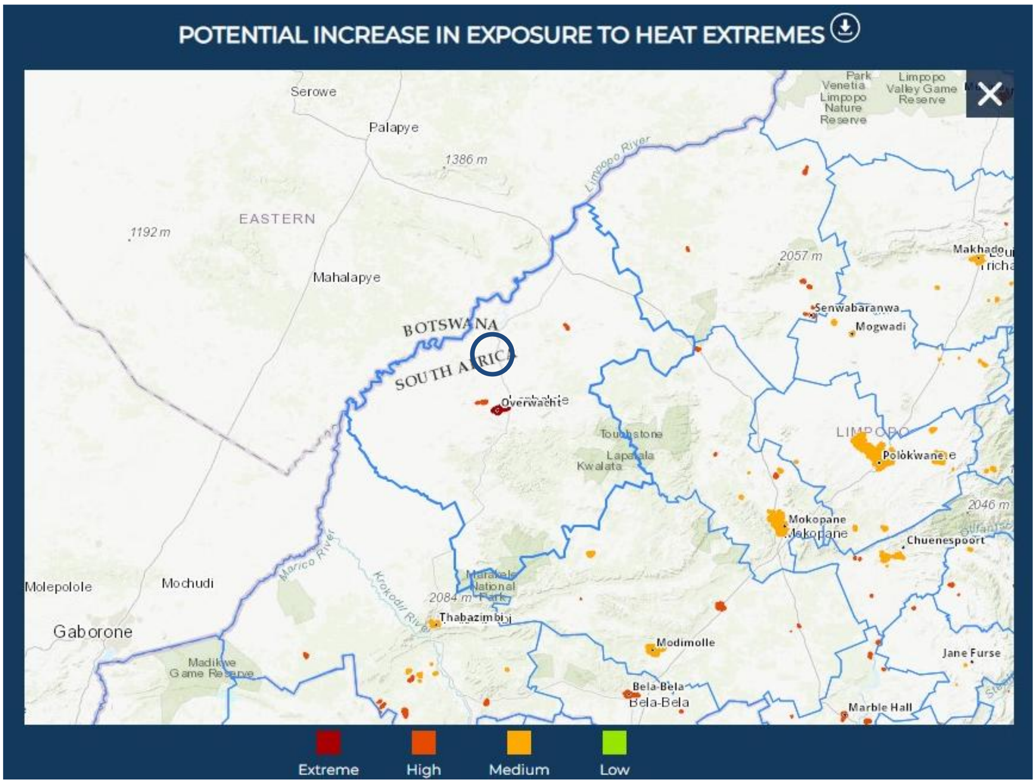


Figure 46: Risk of increased heat extremes for Lephalale Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project).

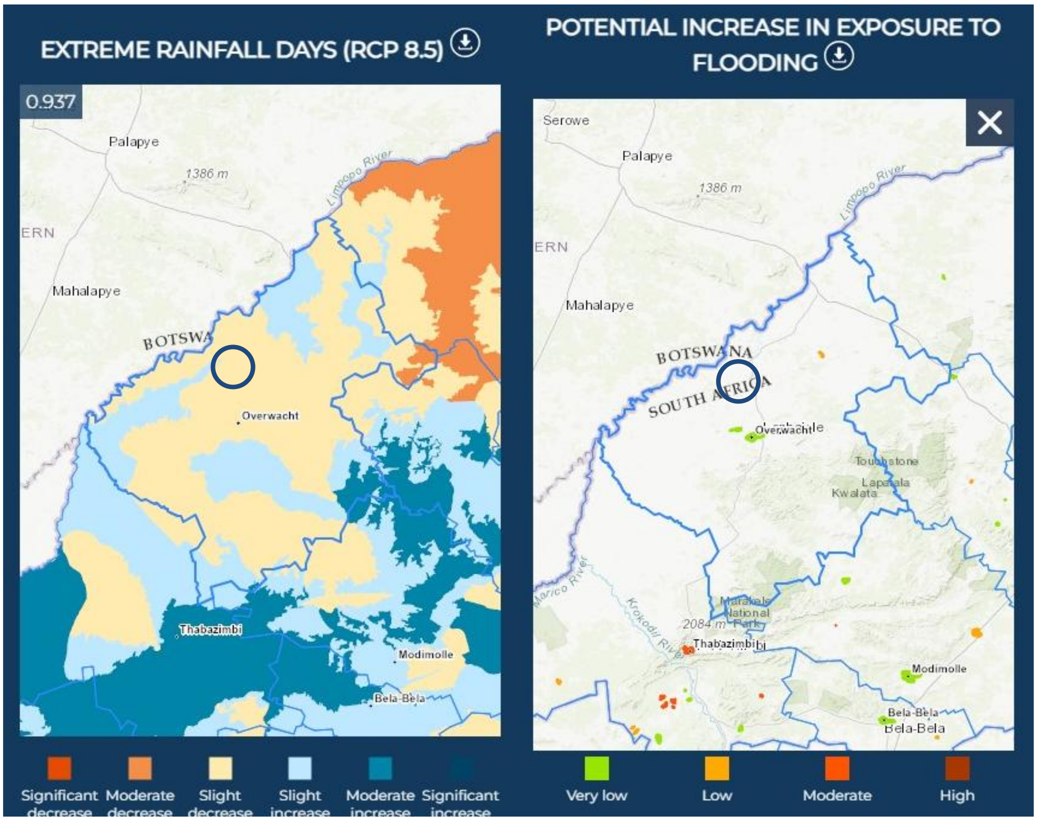


Figure 47: Risk of increased flooding for Lephalale Municipality in 2050 based on RCP8.5 trajectory (dark blue marker indicates approximate location of the project).

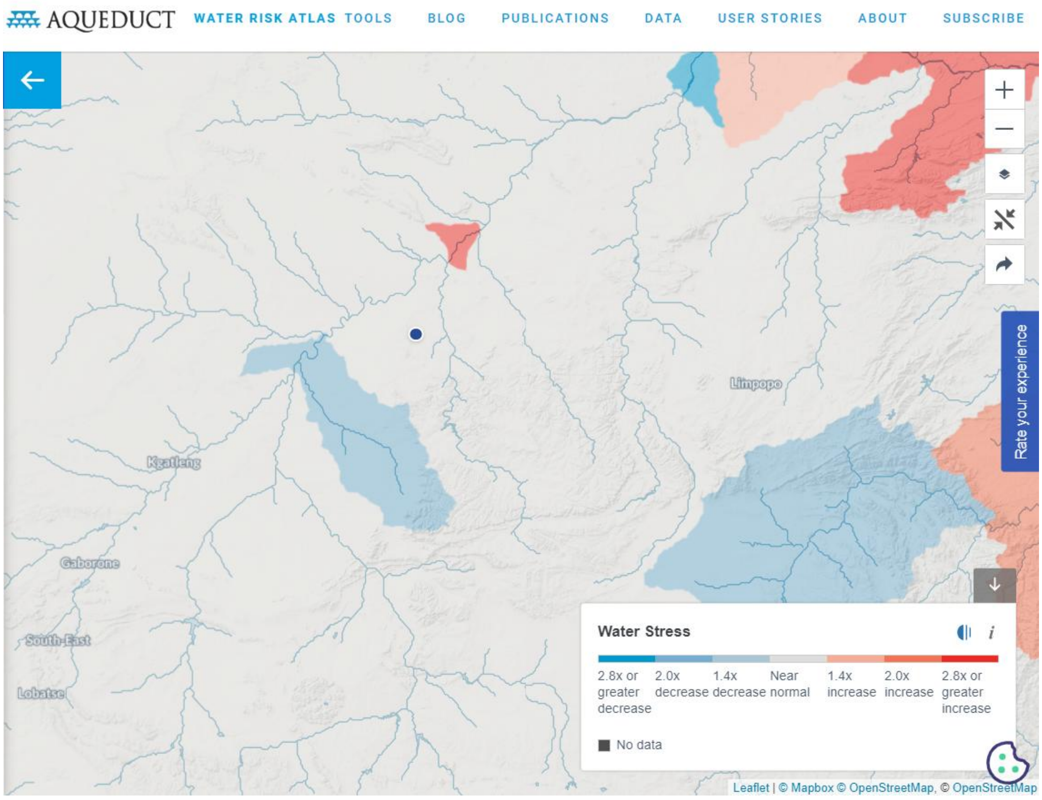


Figure 48: Current water stress for the project area (Hofste, et al., 2019) (blue dot indicates project location).

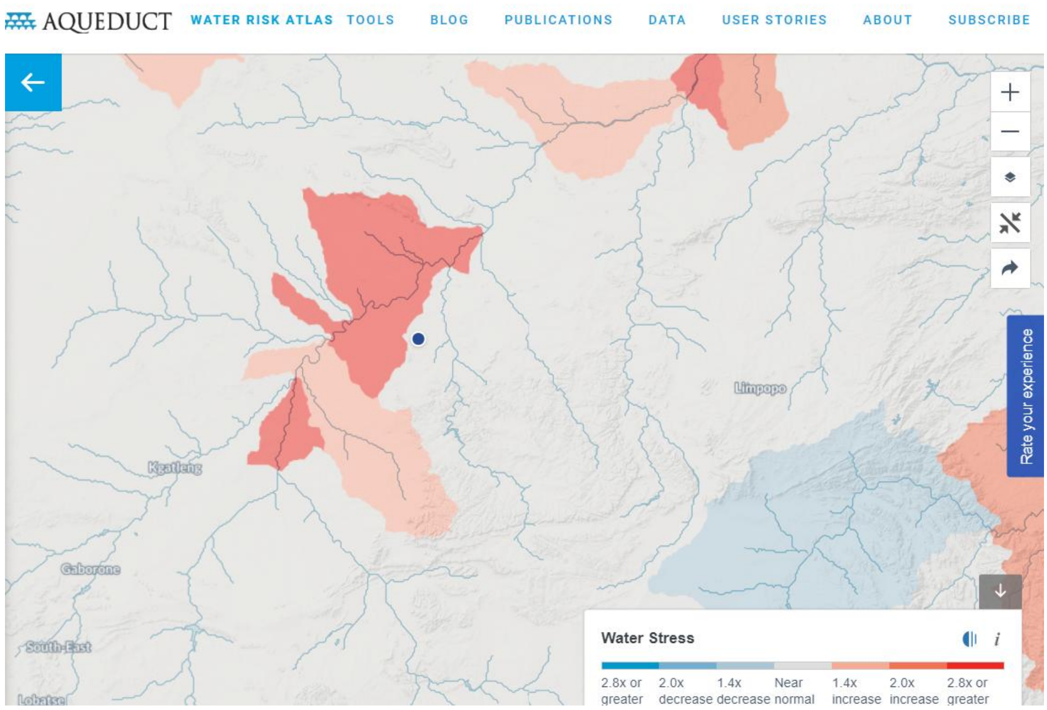


Figure 49: Projected (2050) water stress for the project area (Hofste, et al., 2019) (blue dot indicates project location).

10.3.2.3.5 VEGETATION DISTURBANCE

The vegetation type that will be disturbed over the lifetime of the proposed project – are the Limpopo Sweet Bushveld (South African National Biodiversity Institute, 2021). This information will be used in the quantification of permanent GHG sink losses due to project infrastructure for the CCA.

10.3.2.3.6 IMPACT OF CLIMATE CHANGE

To understand the impact that climate change might have on the major resources of the Lephalale Municipality it is first necessary to provide an overview of the current situation, which has been provided for water, economy, and agriculture.

Water Supply

Current Resources

Figure 50 provides the current water supply vulnerability (i.e., demand versus supply) for the Lephalale Municipality (0.45) based on the data compiled for the Department of Water and Sanitation (DWS) All Town's Study (Cole, 2017). The current water demand for the municipality is 93.3 l/d (litres per day) with supply of 209.3 l/d, with approximately 80% sourced from ground water.

SURFACE WATER USAGE	
Demand Per Capita (l/p/d)	93.3
Supply Per Capita (l/p/d)	209.3
Current Vulnerability	0.45

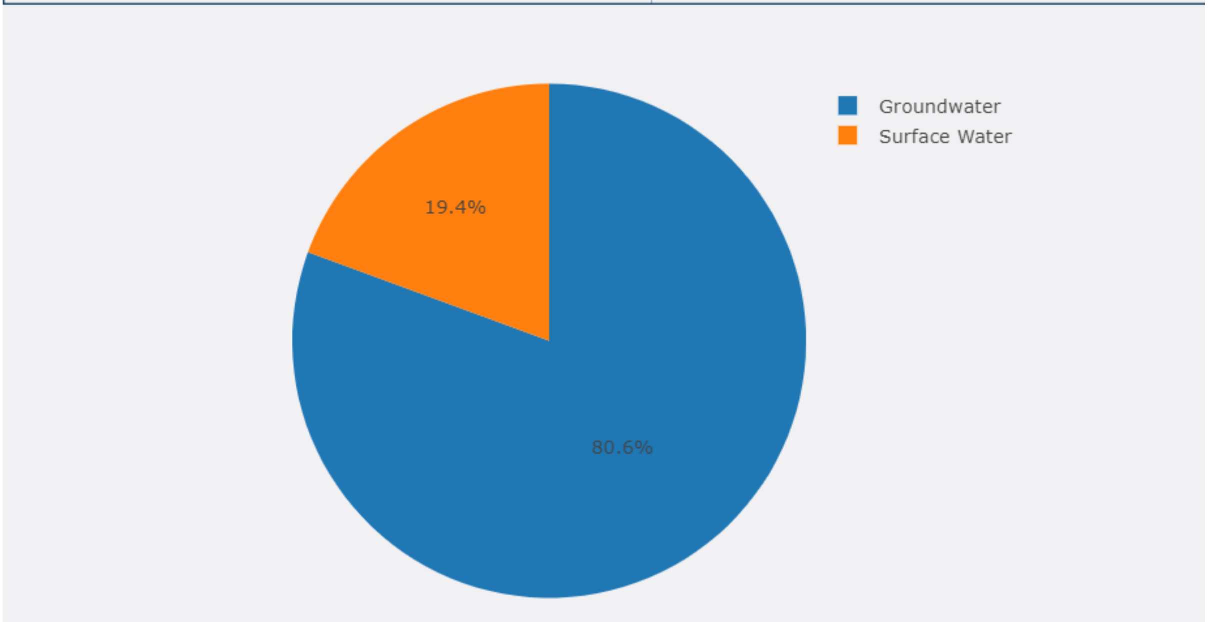
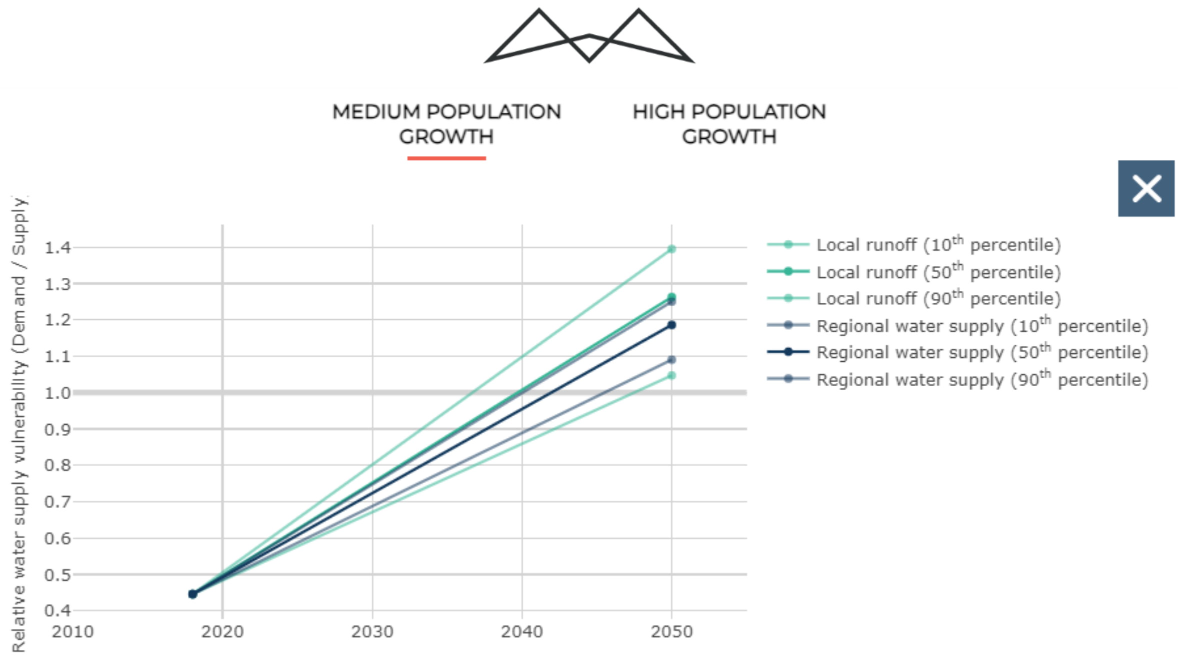


Figure 50: Current water availability for the Lephalale Municipality.

Impact on Resources

Figure 51 shows the estimated current and future water supply vulnerability (i.e., the ratio of demand to supply) based on 1) a local water supply perspective incorporating changes to population growth coupled with exposure to climate risk (based on impacts on local runoff), and 2) a regional water supply perspective (based on impacts of regional water supply assuming supply is part of the integrated regional and national bulk water supply network). The mean annual precipitation for the municipality is predicted to decrease by 14% for 2050 with a regional urban water supply increase of 0.06%.



VULNERABILITY CONTRIBUTION FACTORS		PERCENTAGE CHANGE
Mean annual precipitation	⌄	-14.27%
Mean annual evaporation	⌃	12.4%
Mean annual runoff	⌄	-27.57%
Regional urban water supply	⌃	0.06%
Population growth	⌃	109.51%

Figure 51: Estimated current and future (2050) water supply vulnerability based on medium population growth for the Lephalale Municipal.

<u>Surface Water</u>

Current Situation

The Lephalale Municipality is within the Limpopo Primary Catchment (Figure 52).

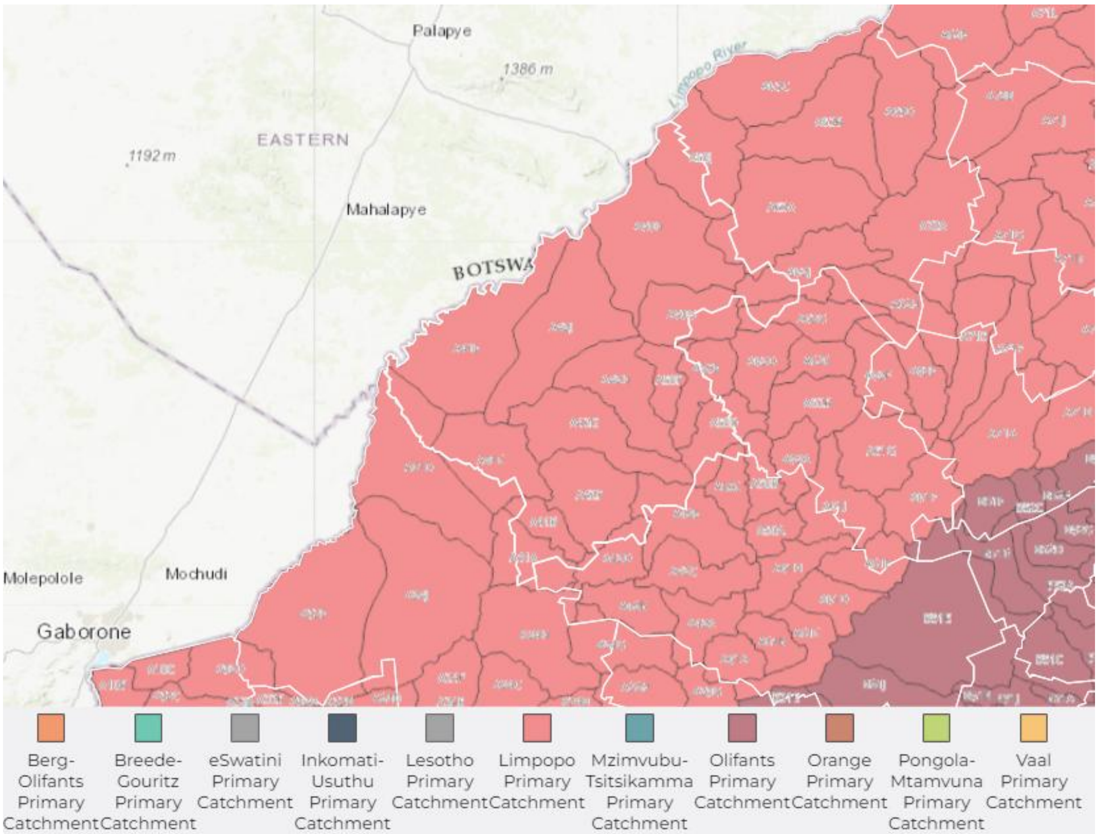


Figure 52: Quaternary catchment areas for the study area.

Figure 53 depicts the current annual and monthly surface water runoff, precipitation and evaporation for the Limpopo Primary Catchment associated with the Lephalale Municipality. Precipitation and evaporation for the municipality is currently 518 mm/yr and 1 861 mm/yr respectively.

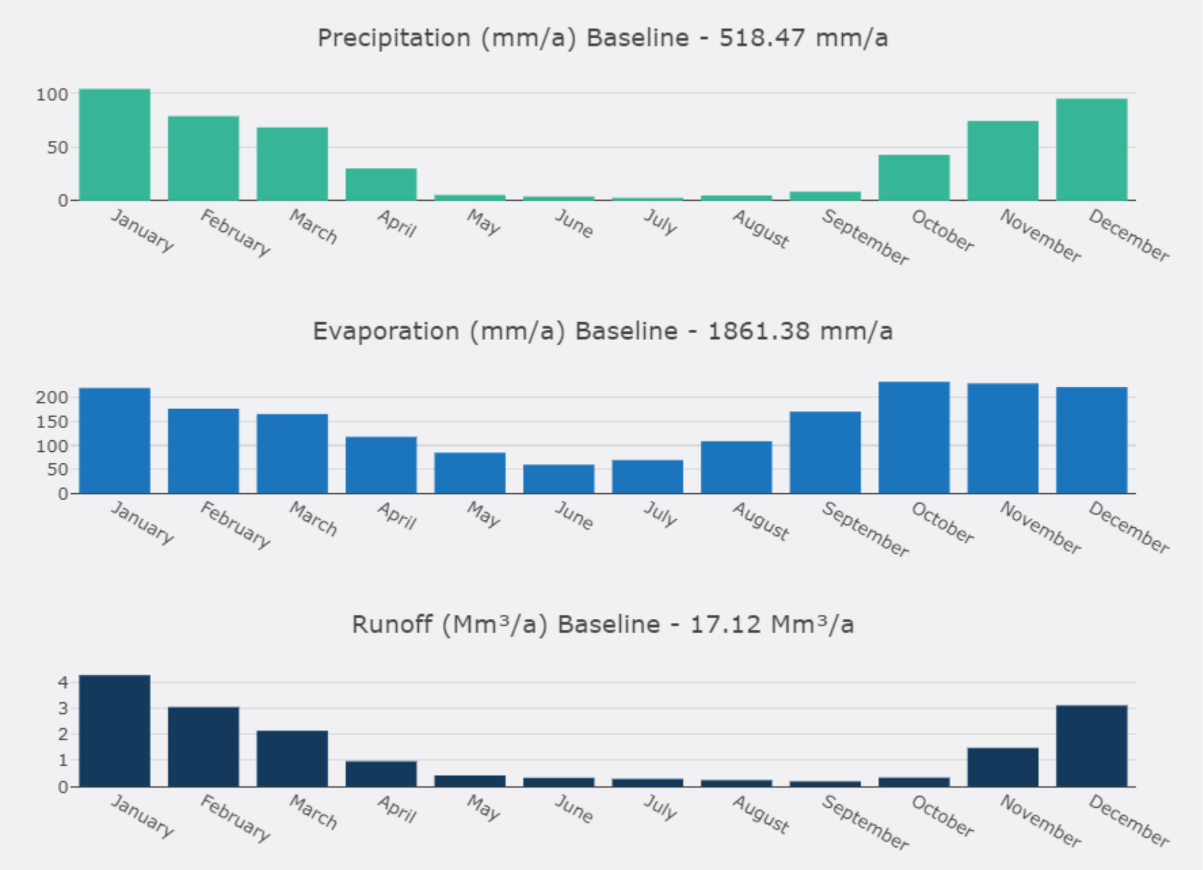


Figure 53: Current annual and monthly surface water runoff, precipitation and evaporation for the Lephalale Municipality which falls under the Limpopo Primary Catchment.

Projected Impact

Figure 54 provides the projected monthly change for future (2050) evaporation, precipitation, and estimated runoff values.

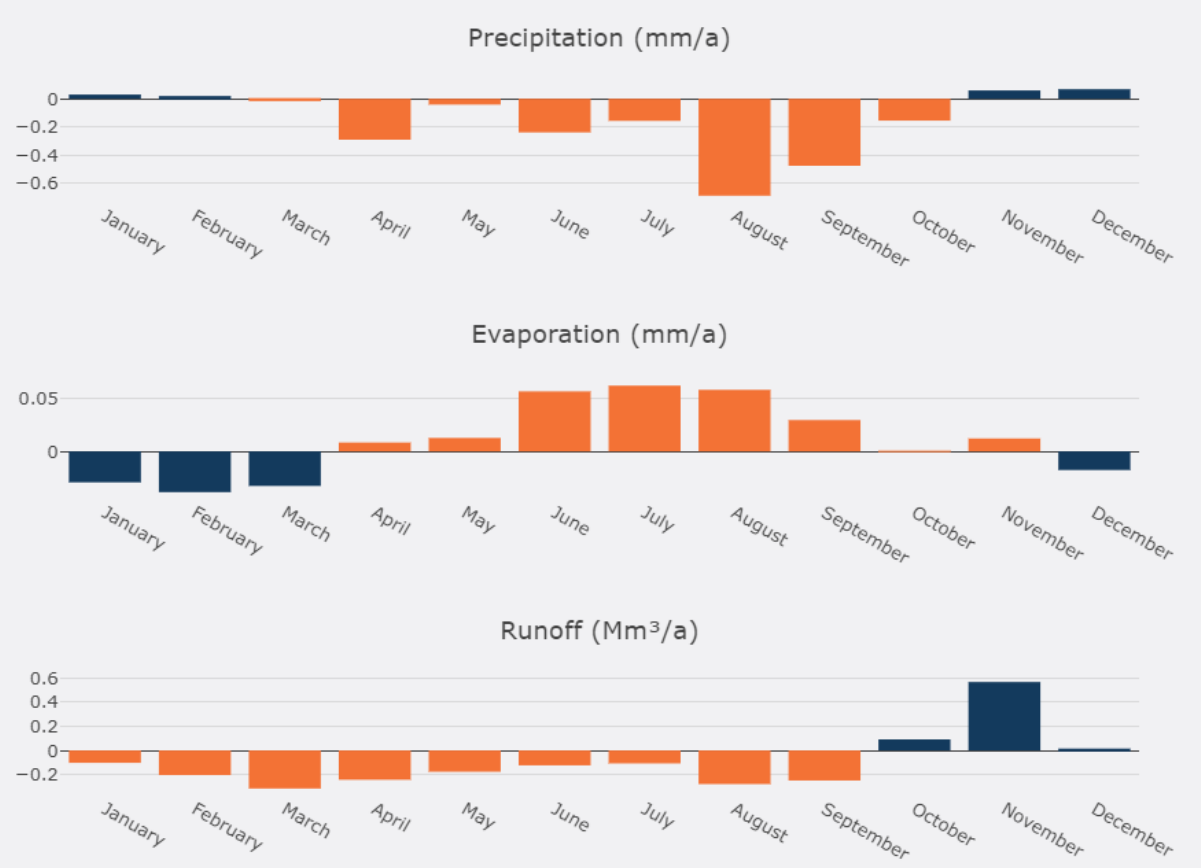


Figure 54: Projected monthly change to future (2050) evaporation, precipitation, and estimated runoff values.

<u>Ground Water</u>

Current Situation

The groundwater recharge potential map (Figure 55) indicates the occurrence and distribution of groundwater resources across the country, showing distinctive recharge potential zones. The groundwater dependency map indicates where settlements get their main water supply from, be it groundwater, surface water or a combination of both sources. Settlements that rely on groundwater, either entirely or partially, are deemed groundwater dependent. The residential settlements of Onverwacht and Lephalale, to the south of the project site, are groundwater dependent. This needs to be noted by the project, as careful consideration needs to be given to the prevention and, where necessary, mitigation of groundwater contamination.

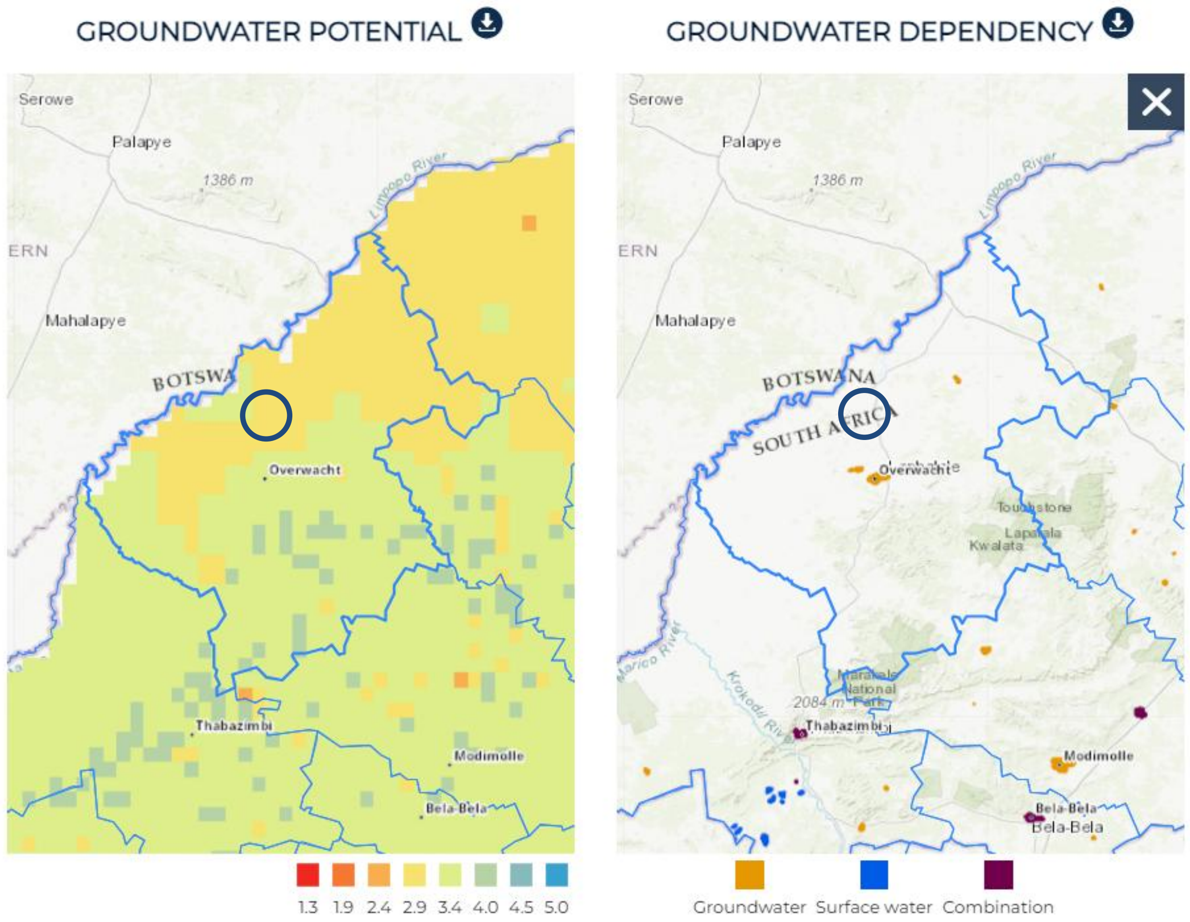


Figure 55: Groundwater potential and dependency for the Lephalale Municipality (dark blue marker indicates approximate location of the project).

Projected Impact

A groundwater depletion risk map was created to determine which of South Africa's groundwater dependent settlements may be most at risk to groundwater depletion based on decreasing groundwater aquifer recharge potential and significant increases in population growth pressure by 2050.The groundwater depletion risk map (Figure 56) is based on the settlement aquifer recharge potential of the 50th percentile RCP8.5 scenario, and the medium population growth scenario. Based on this information, the groundwater depletion risk of moderate is provided for the residential settlements of Onverwacht and Lephalale, located to the south of the project site.

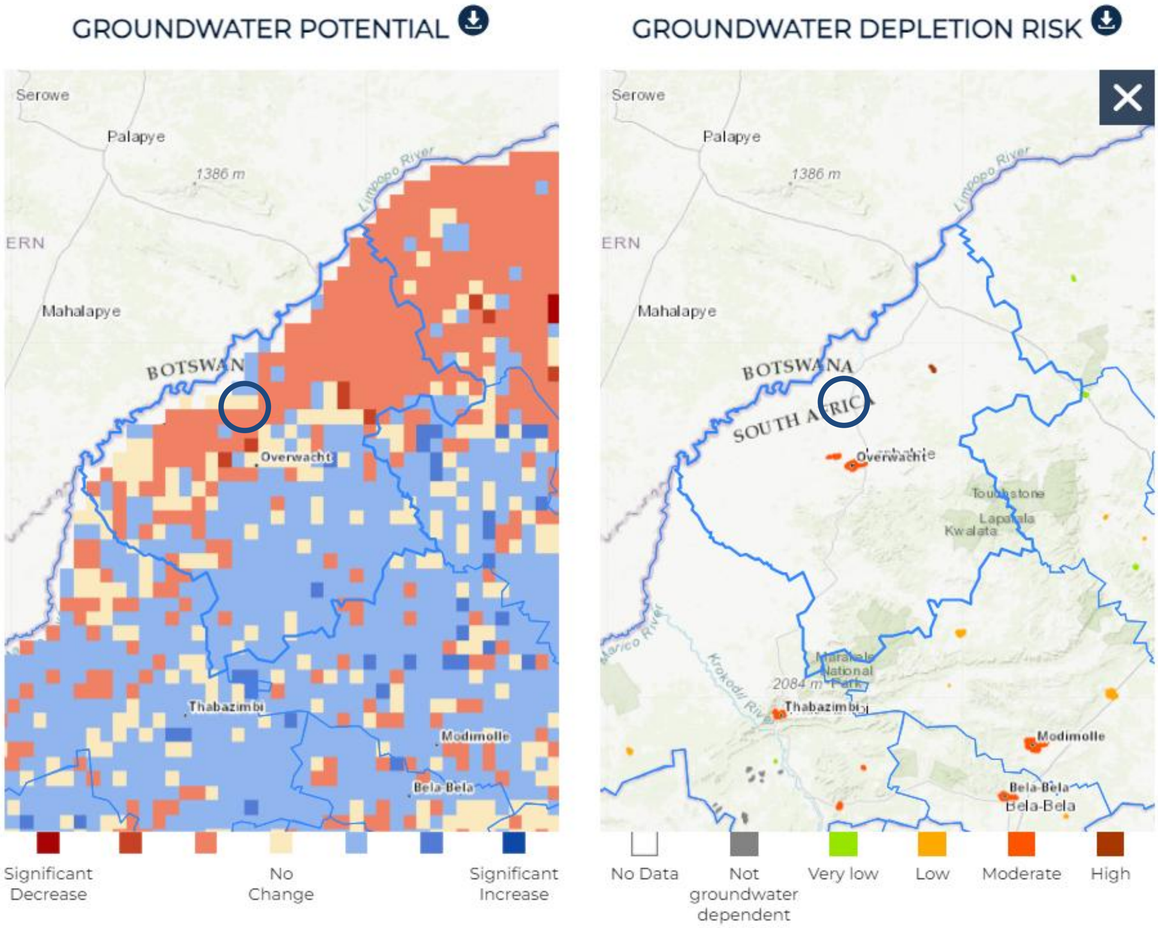


Figure 56: Groundwater potential and depletion for 2050 for the Lephalale Municipality (dark blue marker indicates approximate location of the project).

Economy

Figure 57 shows the contribution that the different economic sectors make to the total Gross Value Added (GVA) of the Lephalale Municipality as well as its national GVA rank (total GVA contribution to the national GVA). Mining and quarrying activities make up the highest economic sector to the total GVA at 44.7%. The Lephalale Municipality ranks 50th in the national GVA rank.

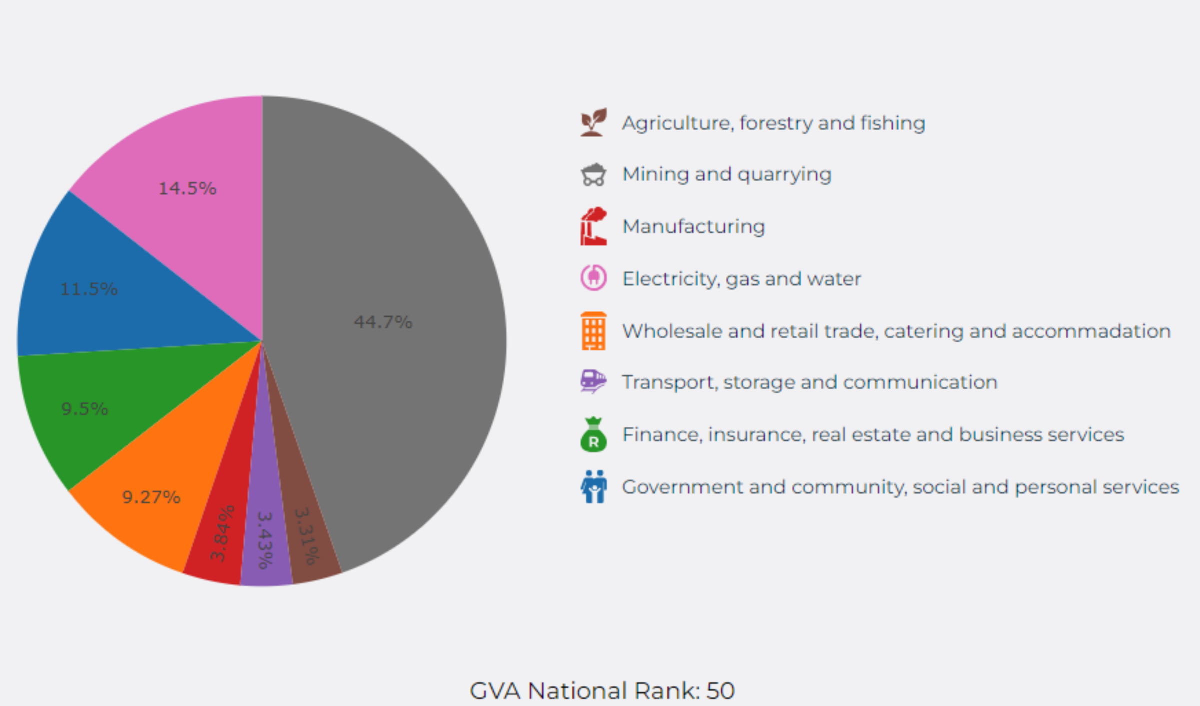


Figure 57: The contribution that the different economic sectors make to the total GVA of the Lephalale Municipality.

Table 28 summarises the forecasted economic gains or losses for the Lephalale Municipality, under both the RCP4.5 and RCP8.5 scenarios, for each of the contributing economic sectors.

Table 28: Forecasted economic gains or losses for the RCP4.5 and RCP8.5 scenarios.

RCP 4.5 Impacts		RCP 8.5 Impacts	
Average	-3.65%	Average	-6.61%
Agriculture Sector	-5.82%	Agriculture Sector	-10.54%
Forestry Sector	-7.45%	Forestry Sector	-13.48%
Fishing Sector	-8.88%	Fishing Sector	-16.08%
Mining Sector	-0.79%	Mining Sector	-1.44%
Manufacturing Sector	-0.73%	Manufacturing Sector	-1.32%
Electricity & Gas Sector	-5.88%	Electricity & Gas Sector	-10.65%
Water Sector	1.28%	Water Sector	2.32%
Service Sector	-0.93%	Service Sector	-1.69%

3.5.5 Agriculture, Forestry and Fisheries

The main agricultural commodities for the Lephalale Municipality are beef cattle and tobacco (Table 29). Agriculture, Forestry and Fishing (AFF) sector contributes 3.31% to Lephalale Municipality GVA production and 19.77% to Lephalale total employment. The total AFF GVA production of Lephalale Municipality contributes 0.4% of the national AFF GVA (Table 29).

Table 29: Economic contribution of main commodities for Lephalale Municipality.

MAIN COMMODITIES		
BEEF CATTLE	TOBACCO	
AFF contributes 3.31% to Lephalale GVA production	AFF contributes 19.77% to Lephalale total employment	The total AFF GVA production of Lephalale Municipality contributes 0.4% to the national AFF GVA, ranking them as the 81st biggest contributor

The main agricultural commodities for 2050 for the municipality are beef cattle and tobacco (under an RCP8.5 low-mitigation scenario) (Table 30). The climate for the municipality is expected to be hotter and wetter but drier towards the end of the century. The hot moist conditions will result in increased spread of disease and parasites, and the heat stress will result in reduced growth and reproduction performance. Production will remain viable as long as the heat stress is managed.

Table 30: Projected economic contribution of main commodities for Lephalale Municipality.

MAIN COMMODITIES	
BEEF CATTLE	TOBACCO
CLIMATE IMPACT	
Change in climate expected: Hotter and wetter but drier towards end of century	
Increased water availability. Hot and moist conditions cause increased spread of disease and parasites. Reduced growth & reproduction performance due to heat stress.	Production remains viable as long as heat stress is managed.

Transport and Mobility

The climate change risk on transport and mobility, as summarised in the Green Book (Mokonyama & Van Wyk, 2018) is provided in this section.

Within settlements, transport networks comprise of nodes (e.g., buildings and public transport stops and stations) and various connector links (e.g., walkways, roads, bridges, railways, tunnels, and waterways). Apart from being a large asset base in themselves, these networks are indispensable conduits for the movement of people and goods for social, economic, political, health and recreational purposes. Within the context of climate change, therefore, climate resilient transport networks are necessary to ensure unimpeded functioning of society.

Vulnerability of transport networks to climate change depends on infrastructure age, its materials, construction practices, design features, and maintenance history (Colin, Palhol, & Leuxe, 2016) (Rattanachot, Wang, & Chong, 2015). Societal level of risk to infrastructure failure is dependent on individual functions of different parts of the transport network. Therefore, spatial differentiation should be an integral component of adaptation strategies.

Disruption to transport networks due to climatic extreme events may lead to social exclusion, trade interruption, and consequently social disorder. It is imperative, therefore, that the design and in-situ upgrading of transport networks and their operations be responsive to threats posed by climate change, especially in high-risk areas. It is equally important to ensure transport networks do not add to landscape vulnerability – for example increasing erosion of steep slopes, landslides or increasing vulnerability of natural habitats to fragmentation and overharvesting.

Increased temperatures and heat stress may result in:

- Increased rate of infrastructure deterioration leading to pavement failure including cracking, rutting, potholes, flushing, and stripping.
- Increased stress on bridges, particularly expansion joints, through thermal expansion and increased movement.
- Corrosion of steel reinforcing in concrete structures due to increase in surface salt levels in some locations.
- Increased infrastructure maintenance cost for road repair and reconstruction work, causing traffic delays and emergency service response delays.
- Increased frequency and intensity of wildfires leading to more road closures.
- Increased vehicle accidents, due to low pavement adhesion, leading to higher rates of transport-related fatalities.

Drought and decrease in rainfall may result in:

- Reduced water resources available for construction and maintenance.
- Reduced production of some agricultural produce leading to changes in freight flows in the network.

Increase in rainfall, inland flooding and sea level rise may result in:

- Increased rate of infrastructure deterioration, especially in areas with poor infrastructure maintenance history.
- Temporary and permanent flooding of road, rail, port and airport infrastructure.
- Structural integrity of roads, bridges and tunnels could be compromised by higher soil moisture levels.
- Potential destruction of bridges and culverts.
- Erosion of embankments and road bases leading to undermining of roads or railways.
- Increased risk of landslides, slope failures, road washouts and closures.
- Undermining of bridge structures (scouring).
- Closure of roadways and tunnels leading to traffic delays.
- Transportation system disruptions, impacts to traffic signalling and low water crossings.
- Increased weather-related accidents.

Increased wind speed may result in:

- Increased drag on vehicles resulting in increased fuel consumption.
- Increased safety risk for pedestrians and cyclists due to flying objects or being uncontrollably dragged by winds, additionally leading to reduced trip making by pedestrians and cyclists.

Solid Waste

The climate change risk on solid waste, as summarised in the Green Book (Oelofse, 2018) is provided in this section.

Human settlements generate massive amounts of solid waste that needs to be managed effectively so as not to cause air, water and soil pollution (Koop & van Leeuwen, 2017). As cities grow and need more land, suitable collection and disposal sites can be difficult to acquire and develop. The majority of households in South Africa (64% in 2015) receive a waste removal service at least once a week, but there are still households that rely on their own or communal rubbish dump sites (StatsSA, 2015). Illegal dumping and littering are problems in most municipalities resulting in solid waste often accumulating in waterways and areas otherwise intended for water run-off and flood control (Zimmerman & Faris, 2010). These conditions make municipalities vulnerable to flooding, contamination of water resources, adverse health effects and rehabilitation costs that may overwhelm the resilience of cities (Koop and Van Leeuwen 2017).

The vulnerability of the solid waste sector to climate change relates to the logistical complexity of solid waste removal and disposal systems (Zimmerman and Faris 2010). In small, rural settlements, the waste management system typically only includes waste collection and disposal at landfill, but in cities where recycling initiatives and alternative waste treatment technologies are being implemented, there are many variable and interrelated components relating to the collection, sorting and recycling of waste. Related municipal assets can be directly damaged through droughts, floods and severe storms (Koop and Leeuwen 2017).

The waste sector is in a unique situation being both vulnerable to climate change, but also having the potential to move to becoming a major emissions saver through the prevention and recovery of waste (i.e., as secondary resources for materials and energy) which in turn avoids emissions in other sectors of the economy (UNEP, 2010) (Koop & van Leeuwen, 2017). The adaptation strategies for waste management should therefore include building resilience for service delivery in a changing climate but also focussing on waste prevention and recovery of secondary resources to maximise the emission saving potential of integrated waste management.

Increased temperatures and heat stress may result in:

- Increased risk of combustion at open waste disposal sites and illegal dumps and increase in explosion risk associated with methane gas.
- Increased rate of decay of putrescible waste resulting in increased odour, breeding of flies, and attracting of vermin.
- Increased health and safety concern regarding heat stroke to staff collecting waste.
- Increased risk of landfill site instability and failure due to changes in consumption patterns with increased waste creation (i.e., glass, plastic and paper cups).

Increase in rainfall, inland flooding and sea level rise may result in:

- Increased risk of flooding due to pressure on stormwater and leachate management systems at landfills.
- Increased demand for capacity to cope with large volumes of waste generated by flood events.
- Increase in soil saturation causing decreased stability of slopes and landfills linings (if clay or soil based) at waste management facilities.
- Inundation of waste releasing contaminants to waterways, pathways and low elevation zones.

- Potential loss of value and degradation of paper and cardboard for recycling due to increased moisture content.
- Increased flooding causing the risk of localised disruption of waste collection rounds.
- Flooding in areas with untreated, dumped waste causing the risk of groundwater contamination.
- Increased flooding causing the risk of litter entering the storm water systems.

Increased wind speed may result in:

- Possible increase in nuisance due to waste dispersed by high winds leading to increased health effects associated with particulate matter (air pollution).

Stormwater

The stormwater risk, as summarised in the Green Book (Dunker & Van Wyk, 2018) is provided in this section.

A stormwater drainage system collects, conveys, and discharges stormwater with the aim to reduce the risk of flooding in settlements and control water quality (traditional pollutants that are commonly associated with municipal and industrial discharges, e.g., nutrients, sediment, and metals). Conventionally rainwater falling onto a hard surface will be collected and drained through surface channels to a collection point or culvert where it will enter into a storm water pipe. The pipe will use gravity to discharge the water into a watercourse or a dam. Where a gravity-fed system cannot be used the water will be collected into a storage dam and pumped to the discharge location.

There are two types of storm water systems namely, major storm water systems that cater for severe, infrequent storm events, and minor storm water systems that cater for frequent storms of a minor nature. Under the climate change scenario of increased precipitation intensity, both the major and minor systems may need to be recalculated as the volume of water to be conveyed and discharged may exceed the original design parameters. This will result in flooding in parts or the whole settlement.

Sustainable Urban Drainage Systems (SUDS) seeks to minimize the volume of storm water entering the drainage system. It does this in three ways: first, collect and store as much rainwater at source as possible; second, filtrate as much surface water into the ground as possible as close to the source as possible; third, collect storm water at grade in various storage systems (weirs, wetlands, attenuation ponds, etc.).

In South Africa, the management of stormwater is typically separated from that of water and sanitation and rather assigned to the roads department. Stormwater is therefore approached as a hazard to be disposed of as quickly as possible in order to protect road structures, as opposed to being treated as a potential resource. Stormwater management is planned based on local weather and climate. However, climate changes, such as the amount, timing, and intensity of rain events, in combination with land development, can significantly affect the amount of stormwater runoff that needs to be managed.

An increase in stormwater runoff can exacerbate existing, or introduce new, pollution problems. More frequent and intense downpours, projected for all regions of the country, can overwhelm the design capacity of municipal stormwater management systems. Overwhelmed stormwater management systems can lead to backups that cause localised flooding or lead to greater runoff of contaminants such as trash, nutrients, sediment, or bacteria into local waterways.

More frequent and intense downpours can also challenge cities with combined stormwater and wastewater drainage systems. These systems can be overwhelmed by large amounts of rainfall or snowmelt and lead to more combined sewer overflows (CSOs) into waterways. An increase in CSOs can reduce water quality and make meeting water quality standards more difficult. Increased sediment, nutrients and other pollutants into waterways can diminish water quality, threaten drinking water sources, and complicate water treatment processes. Drought conditions and lower streamflow can exacerbate these problems by concentrating pollutants and limiting dilution (EPA, 2016).

In a human settlement planning context, in some regions of the country, the combination of climate and land use change may make existing stormwater related flooding worse, while other areas may be minimally affected. These changing conditions have implications for stormwater management as local decision makers look to improve existing infrastructure and build new stormwater systems.

Increased temperatures and heat stress may result in:

- Potential risk of undermining the temperature regime of temperature-sensitive stormwater ponds and receiving waters, resulting in a decrease in water quality.
- Increased corrosion in stormwater drains due to a combination of higher temperatures, increased strengths, longer retention times, and stranding of solids.

Drought and decrease in rainfall may result in:

- Increased shrinking soils increasing the potential for cracking, increased infiltration and exfiltration of water mains and sewers, which in turn exacerbates treatment and groundwater or storm water contamination.

Increase in rainfall, inland flooding and sea level rise may result in:

- Increased risk of flooding due to pressure on stormwater systems.
- Increased risk of litter entering the stormwater systems.
- Increased risk of damage and failure of stormwater systems due to overloading during floods and intense rainfall events.
- Failure of stormwater treatment devices during high flow events leading to by-pass and / or flushing of contaminated water.
- High wet-weather hydraulic loads and bottlenecks in stormwater and networks due to inflow and sewer infiltration, leading to local inundation and overflows of untreated wastewater.
- Increased rainfall causes soil erosion thus damaging underground stormwater systems.
- Increased surface and stream erosion causing deposition of sediments in receiving environments.
- Stream morphology for undeveloped, developing and fully developed urban areas, may change, hence affecting existing outfall structures and potential stormwater pond locations.

Increased wind speed may result in:

- Increased wind speed and intensity causing changes in rainfall over complex topography including increasing upwind of hills and ranges.

Sanitation

The climate change risk on sanitation, as summarised in the Green Book (Duncker, 2018) is provided in this section.

Sanitation and wastewater management poses a number of operational challenges to governments and settlements. In South Africa, the water sector, which includes sanitation, is highly complex. Accordingly, managing water resources involves contributions from various stakeholders at different points in the value chain. The sanitation value chain comprises eight broadly defined stages, as follows: collection/containment; storage; transport; treatment; distribution; wastewater treatment; and discharge.

The National Water Resource Strategy (NWRS2) states that conventional waterborne sanitation, which uses potable standard water to wash away human faeces, in the process combining good quality water with potentially valuable resources (faeces and urine) to create polluted water that needs to be treated, is not an efficient system in a context where fresh water is scarce and precious and where fertiliser inputs for agriculture productivity are limiting (Department of Water Affairs, 2013). With increasing population growth, urbanisation, and industrialisation, it remains a major challenge for municipalities in both developed and developing countries to collect, treat, and dispose of increasing quantities of wastewater in sustainable ways.

The challenge of sanitation is also critical due to its potential impact on health. People in settlements that are in direct contact with water bodies can fall victim to untreated sewage, as waterborne diseases transmitted through human excreta are a leading cause of illness and death, especially in the developing world. Not only does the poor quality of existing sanitation cause significant health problems for billions of people across the world, inadequate, poorly thought-through sanitation systems are contaminating the environment. Re-use of water is becoming more acceptable and feasible because of increasing water shortages, improved purification technology and decreasing treatment costs. A water reuse strategy that is forward thinking over ten to twenty years needs to take these possible changes into account. The direct re-use of treated wastewater can pose a risk to public health and safety and thus must be managed carefully and be subject to water quality management and control. Advanced treatment technologies, sufficient operating capacity and proper monitoring of all processes, and quality of potable water produced is essential.

There are a number of ways in which climate change and its impacts can affect sanitation systems and services provision within cities. It is important to understand these vulnerabilities to be able to better respond through adaptation.

Increased temperatures and heat stress may result in:

- Increased heat waves, accompanied by dry weather, can exacerbate already stressed water supply systems leading to competition between sectors for water services, affecting sanitation.

Drought and decrease in rainfall may result in:

- Decrease in water supply for sanitation through decrease in available water to flush sewage systems adequately.
- Declining annual rainfall threatening the viability of water-borne sanitation systems, and the capacity of surface water to dilute, attenuate and remove pollution.
- Sewers are structurally vulnerable to drying, hence shrinking soils increase the potential for cracking, increased infiltration, and exfiltration, which in turn exacerbates treatment and groundwater or storm water contamination.
- Increased corrosion in sewers due to a combination of higher temperatures, increased strengths, longer retention times, and stranding of solids.

Increase in rainfall and inland flooding may result in:

- Increased wet-weather hydraulic loads and bottleneck in stormwater and sanitary sewer networks due to inflow and sewer infiltration, causing local inundation and overflows of untreated wastewater.
- Increased rainfall and heavy rainfall events increasing the washing of faecal matter into water sources due to flooding of wastewater treatment works.
- Increased risk of flooding resulting in both infrastructure damage and contamination of surface and groundwater supplies.
- Increased groundwater levels due to flooding, putting risk on sewage treatment plants (which are often positioned on low-lying ground as sewerage systems rely on gravity).
- Increased vulnerability of sewerage pipe systems due to their size and complexity, and their exposure to multiple flood damage threats from source, through treatment, to delivery.
- Increased vulnerability of pit toilets (widely used in rural areas) due to flooding, causing serious environmental contamination.

- Increase in groundwater recharge and groundwater levels causing flooding of subsurface infrastructure such as pit toilets or septic tanks.

Information and Communication Technology

The climate change risk on Information and Communication Technology (ICT), as summarised in the Green Book (Naidoo, 2018) is provided in this section.

The effective operation of the nation's infrastructure in the energy, water, transport, and ICT sectors is necessary in maintaining the country's economy. According to South Africa's National Development Plan, the country needs to invest in a strong network of economic infrastructure to support the country's medium- and long-term objectives. Economic infrastructure includes rail, ports, roads, electricity, water, and telecommunications infrastructure (DBSA, 2012); the latter is to be considered below.

ICT, or telecommunications, plays a critical role in society and is central to the operations of every industry and sector, and society relies on it for social and leisure purposes as well as work. Climate change impacts on ICT infrastructure in settlements include the impacts of increased warming and precipitation, extreme weather events, strong winds, and sea-level rise and storm surges. The ICT industry experiences weather-related impacts which are expected to worsen due to ongoing climate variability and climate change.

The adaptive capacity of all infrastructure sectors is directly related to the present condition of the infrastructure, life expectancy, service level expectancy, maintenance regime, levels of investment and lead time for planning, design and construction of adaptation options (such as protection, reinforcing and elevation adjustments) (Thom, et al., 2010). Existing infrastructure may be old and was not designed with future climate in mind, so this makes it potentially more vulnerable to climate change.

Compared to 'heavy' infrastructure sectors like energy, water or transportation, the ICT sector has smaller infrastructure and shorter lifetimes, reliance on a combined network instead of individual structures, redundancy of service and infrastructure and service providers, and fast-paced technological change and innovation. While technologies in the ICT sector in the future may converge towards wireless technologies and reduce dependence on current infrastructure, this will not negate the need for infrastructure altogether, for example, there will still be a requirement for equipment such as mobile or fixed wireless towers to operate this technology (Garnaut Climate Change Review, 2008).

Increased temperatures and heat stress may result in:

- Increased weathering and deterioration of infrastructure resulting in increased maintenance and repair costs.
- Heat stress causing structural damage to infrastructure.
- Increased energy demands during heatwaves resulting in power outages which can impact on delivery of telecommunications services.
- Increases in temperature and higher frequency, duration, and intensity of heat waves increasing the risk of overheating in data centres, exchanges, and base stations, which can result in increased failure rates of equipment.
- Increased mean temperature increasing operating temperature of network equipment which may cause malfunctions if it surpasses design limits.

Drought and decrease in rainfall may result in:

- Decreased precipitation leading to land subsidence and heave, reducing the stability of telecommunications infrastructure above and below ground (foundations and tower structures).

Increase in rainfall, inland flooding and sea level rise may result in:

- Increased risk of flooding of low-lying infrastructure, access holes and underground facilities.

- Increases in storm frequency or intensity increasing the risk of damage to aboveground transmission infrastructure and impacting on telecommunications service delivery.
- Increases in storm frequency leading to more lightning strikes, consequently damaging transmitters, and overhead cables, causing power outages.
- Increased cost of insurance for infrastructure in areas with repeated incidents of flooding, as well as withdrawal of risk coverage in vulnerable areas by private insurers.
- Road closures due to flooding thus inhibiting service and/or restoration efforts.
- Rising sea levels and corresponding increases in storm surges, increasing the risk of saline corrosion of coastal telecommunications infrastructure, and leading to erosion or inundation of coastal and underground infrastructure.

Increased wind speed may result in:

- Increased risk of storm surges impacting on coastal infrastructure.
- Increased storm intensity and frequency impacting on electricity and telecommunications infrastructure.

Human Health

The climate change risk on health, as summarised in the Green Book (Garland, 2018) is provided in this section.

Healthy people are an essential component of a city's growth (WHO, 2016). Throughout history, most of the world's cities have been planned largely without consideration of human health (WHO 2016). Cities, including rural areas around the urban, are thus faced with a variety of challenges, which may include rapid unplanned urbanization, climate related pressures such as floods, heat waves and earthquakes, as well as unequal economic growth between different communities. This affects the health and development status within cities (WHO, 2016).

Climate-health linkages are complex and multi-faceted, and this relationship between health and climate in South Africa is not well quantified (Myers, Young, Galloway, Manyike, & Tucker, 2011), however it can confidently be stated that climate change will amplify some of the existing health threats that are already faced by communities. Certain people and communities are especially vulnerable, including children, the elderly, the sick and the poor.

Climate change will amplify some of the existing health threats that are already faced by communities. Certain people and communities are especially vulnerable, including children, the elderly, the sick and the poor. Public health actions, especially preparedness and prevention, can do much to protect people from some of the impacts of climate change. Early action provides the largest health benefits. As the number and severity of threats increase, our ability to adapt to future changes may be limited.

Natural disasters (e.g., floods, drought, fires) can have immediate and long-term impacts on health. Poor emergency service delivery immediately after disaster can impact health, as well as damage to services such as water reticulation can have longer-lasting impacts on public health. Natural disasters can also create a conducive environment for the occurrence of mental health problems.

Health is also affected by multiple variables outside health infrastructure including variation in supply and demand of human settlement goods and services such as energy, water, sanitation, solid waste, and food. These factors include linkages to health issues because of air and water pollution as well as food security and malnutrition.

Increased temperatures and heat stress may result in:

- More exposure to high temperatures causing increased health risks including heat strokes.
- Heat waves increase threat of cardiovascular, kidney, and respiratory disorders.

- Increase in fire danger days causing increased loss of life and damage to health infrastructure.
- Wildfire smoke significantly reducing air quality, both locally and in areas downwind of fires. Smoke exposure increases respiratory and cardiovascular hospitalizations; emergency department visits; medication dispensations for asthma, bronchitis, chest pain, chronic obstructive pulmonary disease, and respiratory infections; and medical visits for lung illnesses.
- Increased emissions in biogenic volatile organic compounds from vegetation causing increases in air pollution.
- Increase in evaporative emissions from cars contributing to exposure to, and health impacts from, air pollution.
- Increase in distribution of vector-borne diseases in warmer areas.
- Increased water temperatures leading to an increase in algal blooms which can likely lead to increases in food- and waterborne exposures.
- Increased temperatures combined with fewer clouds (e.g., from increased subsidence that is projected for parts of South Africa) causing increased exposure to Information and Communication Technology which will have negative impacts on health.
- Increased temperatures increasing the reaction between certain pollutants and sunlight and heat, resulting in more severe hazardous smog events.

Drought and decrease in rainfall may result in:

- Decreased soil moisture potentially creating more wind-blown dust which has negative impacts on air quality.
- Increase in water-borne diseases and diarrhoeal diseases due to inadequate water availability.
- Decreased precipitation causing changes in salinity of water, resulting in an increase in algal blooms which can likely lead to increases in food- and waterborne exposures.
- Increase in stagnant air, decreasing air quality.

Increase in rainfall, inland flooding and sea level rise may result in:

- Wetter climate combined with increased temperatures may have negative health impacts as many diarrhoeal diseases vary seasonally, typically peaking during the rainy season.
- Extreme rainfall and higher temperatures increasing the prevalence of fungi and mould indoors, with increased associated health concerns.
- Increased flooding increasing the risk of drinking and wastewater treatment facilities being flooded, meaning that diarrhoeal diseases can be transmitted as wastewater systems overflow or drinking water treatment systems are breached.
- Increase in natural disasters (e.g., floods) creating a conducive environment for the occurrence of mental health problems.

Increased wind speed may result in:

- Increase in wind-blown dust combined with low humidity causing increased cases of meningitis (Davis, 2014).

<u>Gender Inclusivity</u>

The climate change risk on gender inclusivity, as summarised in the Green Book (Nortje, 2018) is provided in this section.

There is general consensus that the degree to which people are affected by the consequences of climate change is in large part a function of their social status, gender, poverty, power and access to and control over resources (Sellers, 2016) (UNDP, 2013). When analysing the relationship between gender and climate change, there are a number of themed focus areas, namely; agriculture, nutrition and health, vulnerability to natural disasters, climate adaptation and economic empowerment.

According to Alber (2011) vulnerability to climate change depends on three factors, these are: exposure to hazards, sensitivity to effects of hazards, and adaptive capacity to the changing climate systems and their effects. This adaptive capacity is dependent on access to and control over resources, including reliable income and financial resources, natural resources, infrastructure and services such as energy, water services and sanitation, as well as on the available information, knowledge and skills on climate risks and the existing relations within the community and social support (Alber, 2011). Cities and towns are often the places where these resources are concentrated, providing access for persons and households, and historically, cities were seen as places of refuge that are safe from disasters and that can protect one from being exposed to environmental change (Wamsler, Brink, & Rivera, 2013). This is however changing rapidly, and cities are becoming "hotspots of disasters and risk" (Pelling, 2003). Wamsler et al. (2013) further notes that urbanisation is in fact at the heart of the environmental changes facing humanity. When climate change impacts these resources, household and individual adaptive capacity is negatively affected.

Scott (2014) argues that recognising the differences between men and women and how they use space as well as how they may be vulnerable in urban areas is crucial for designing and implementing policies and strategies that reduce climate change risks. This is supported by the UNDP that argues that there is a discrepancy between the way in which men and women are exposed to, are sensitive to and adapt their own vulnerability to climate change risks (see UNDP 2013).

There is also an environmental justice aspect to climate change. What this means is that one has to acknowledge and incorporate the environmental issues related to climate change with social injustice issues such as racism, classism, and economic inequity (Dankelman, 2002). Kratzer and le Masson (2016) argues that one should include here discriminatory social and cultural norms, practices, and stereotypes such as patriarchy that promotes unequal distribution of power and welfare as well as restrictions on the mobility and autonomy of women. Nyukuri (2016) echoes this sentiment by arguing that gender inequality which is driven by socially constructed attitudes towards men and women's different roles in society is a key underlying driver of vulnerability to climate change.

Alber (2011) notes that in general the number of women living in poverty are higher than men, and when looking at poor populations, women tend to be the poorest of the poor. Research shows that women in developing countries are particularly vulnerable to climate change and its impacts, and more often than not have severely diminished adaptive capacity (Kratzer and le Masson 2016; Nyukuri 2016; Sellers 2016; UNDP 2013). Additionally, cultural, and social practices, beliefs and norms may limit and even prevent women from acquiring the necessary skills and information to escape or avoid hazards. This could include dress codes, beliefs with regards to behaviour, as well as rules relating to gendered access to knowledge (UNDP 2013). Traditional gender roles, such as a woman's role in the family (usually food and water collectors, and finders of fuel for cooking and heating homes) can also lead to an additional work burden, especially when climate-related shortages of energy, water and food occur (Alber 2011).

Severe climate change impacts will impede the ability of poor, rural women to secure livelihoods, thus causing these poor, rural women to more regularly seek other livelihood opportunities, specifically in urban areas. Within this trend of urbanisation, these rural women need particular attention within policies and planning as often their agricultural, traditional knowledge is no longer valued or valid in the urban context (Practical Action Consulting, 2015). There is a clear need for changes in how women are brought into development and resilience planning processes. Denton (2002) argues that for many years women have been excluded from the climate change decision making process and their marginalisation from environmental policies have been ignored.

Gender mainstreaming is defined as "the public policy concept of assessing the different implications for women and men of any planned policy action, including legislation and programmes, in all areas and levels. Mainstreaming essentially offers a pluralistic approach that values the diversity among both women and men"

(Booth & Bennett, 2002). Mainlay and Tan (2012) note that gender mainstreaming is not an end in itself, but a means to achieve more equitable, sustainable and effective programmes and policies. They further note that an analysis using a gendered approach recognises that men and women play different roles in society as well as take on different responsibilities; they have access to different kinds of information as well as resources (Mainlay & Tan, 2012).

Energy

The climate change risk on energy, as summarised in the Green Book (Thambiran & van Wyk, 2018) is provided in this section.

In South Africa, the country's energy mix is primarily dominated by the use of fossil fuels to derive grid supplied electricity and imported crude oil and petroleum products. Regarding access to energy within our human settlements, grid-supplied electricity is transmitted from power stations to sub-stations to settlements typically through overhead powerlines. A further comment on the current state of energy services is that much of the grid technologies that are used are considered to be based on the use of old technologies (Aivalioti, 2015) (Gellings & Yeager, 2004). Electricity supply is not equally distributed within the country with many people within informal settlements still not connected to the electricity grid. Many thus rely on the combustion of fuels within or near their homes to meet their cooking, heating, and lighting needs.

Electricity infrastructure is exposed to weather and climate and is vulnerable to the effects of climate change. Variations in temperature (hotter and colder days) will increase the demand for energy for both cooling and heating within homes and buildings, as will urban growth. Thus, both the electricity supply and demand needs of a settlement are likely to be impacted by climate change.

Furthermore, energy plays a key role in economic development through its role as a production input, and as a direct component in human well-being (Winkler, 2007). A reliable and secure supply of energy to a settlement is key to promoting socio-economic upliftment and an improved quality of life for all the citizens.

Future planning for energy production and distribution in cities therefore needs to take cognizance of potential climate change impacts in order to ensure a sustainable energy supply and energy security. Interventions that are taken in this sector will not only help to build the resiliency of the sector but also has the potential of co-benefits, that is, to contribute toward the reduction of greenhouse emissions thus providing opportunities to achieve low carbon, resilient cities.

Increased temperatures and heat stress may result in:

- Increased heat causing expansion of overhead cables, and cable sag. Sagging below a certain level result in a reduction in the amount of electricity transmitted.
- Increased heat stress on electricity transmission networks (overhead cables).
- Increase in heat island effect increasing energy demand for cooling, leading to grid stress.
- Increased threat of wildfires causing widespread damage to infrastructure and causing disruptions to service provision.

Increase in rainfall, inland flooding and sea level rise may result in:

- Increase in flooding causing damage to electricity transmission and distribution infrastructure, poles, lines and sub-stations.
- Increase in frequency and cost of maintenance of concrete structures due to frequent and intense rainfall, flooding, or sea level rise.
- Increased repair events increasing stress put on service crews and resulting in delays to power restoration.

Increased wind speed may result in:

- Winds causing damage to energy supply infrastructure as winds cause overhead lines to sag, reducing electricity transmission.
- Extreme winds causing poles and trees to fall, causing further damage to energy supply infrastructure such as overhead lines.

Ecosystem Services

The climate change risk on ecosystem services, as summarised in the Green Book (Pieterse & Crankshaw, 2018) is provided in this section.

Urban areas are dependent on natural ecosystems in and around towns to provide communities with services such as safe and plentiful drinking water, increased food security, better health, decreased exposure to natural disasters and extreme weather (wildfires, floods, storm surges, prolonged drought, and heat stress) and increased recreational opportunities. These services are generated in a diverse set of habitats found in green and blue spaces, collectively termed ecological infrastructure. Well managed ecological infrastructure can play an important role in both mitigation and adaptation to climate change (Geneletti & Zardo, 2016). They buffer human settlements and infrastructure against extreme events, playing a crucial and cost-effective role in disaster risk reduction.

For these ecosystems to continue to provide these services they need to be in a healthy condition. Unfortunately, many ecosystems have been degraded as a consequence of misuse and overuse of soil, water, plant and animal species. At the same time global climate change is aggravating the vulnerabilities of these ecosystems and therefore diminishing the benefits that ecological infrastructure can provide.

It is therefore critical to rehabilitate and maintain ecological infrastructure in the urban environment to help residents adapt to risks posed by future climate change. Formally this is termed Ecosystem-based Adaptation (EbA) and can be defined as the use of green infrastructure and restoring of ecological processes and functions to be more resilient to global climate change. Ecosystem based adaptation can bring multiple monetary and nonmonetary benefits to society and human well-being, contributing to maintenance of biodiversity, and development of more resilient urban areas. Some examples of ecological infrastructure, their benefits for urban areas and associated vulnerabilities to climate change include coastal ecosystems, riparian zones and wetlands; catchments and rivers; and urban forests and natural vegetation. Functional ecosystems provide multiple benefits to society; in fact, the entire economy relies to some extent on services generated by ecological infrastructure. One example is water which is a vital element in mining, agriculture, processing, and manufacturing as well as domestic use. Without good quality and quantity of water sustainable economic growth is not possible. Protecting and improving biodiversity will help to maintain the ability of natural ecosystems to continue to deliver critical ecosystem services and absorb/recover from natural disasters.

Increased temperatures and heat stress may result in:

- Increased risks of water shortages increasing demand for irrigation of gardens and agriculture.
- Increased evapotranspiration rates with rising temperatures, reducing the water available in reservoirs and water available for reliant ecosystems.
- Increase in temperature leading to water loss via evapotranspiration resulting in decreased water quality and loss of wetlands.
- Loss or degradation of indigenous species, including threatened species or ecosystems.
- Increased threat from invasive species as competition for water increases.
- Dieback or death of susceptible plants (e.g., street trees) and animals (e.g., fish).
- Reduced availability of water and increased evapotranspiration resulting in reductions in harvested area (cropping area), yield (ton/ha) and quality.

- Warmer winters resulting in reduced period of dormancy (rest period) in deciduous fruit crops, decreasing the production and quality of associated food products.
- Warmer climate resulting in shifts in the growing season and life cycles of various plants, including crops, resulting in pests and diseases having a greater destructive impact as well as a shift in climatically suitable areas for specific crops.
- Increased humidity levels resulting in higher rates of microbial growth in fresh produce, reducing their expiry time.
- Increased heat stress on crops changes the micro-nutrients of crops products, decreasing the nutrient density and quality of food.
- Increased water temperature leading to increased growth of aquatic weeds which increases breeding of disease vectors and reduces water oxygen levels.
- Milder winters and reduced frost increase the duration of the growing season, increasing the survival rate of insects and diseases.
- Increased sea surface temperatures (SST) causing shifts in the spatial distribution of fish species.
- Increased SST and ocean acidification decreases marine phytoplankton growth and synthesis of omega-3 polyunsaturated fatty acids (PUFA's), affecting the oceanic food chain and consequent ecosystems.
- Increased heat stress and higher humidity levels potentially resulting in the exceedance of the temperature humidity index in livestock, causing reduced immunity, fertility, productivity and even mortality of livestock.

Drought and decrease in rainfall may result in:

- Decreased amounts of rainfall reaching ecosystems as settlements use rainwater harvesting techniques for increased household use.
- Increased reliance on irrigation and greater demand for water to maintain public open space and gardens.
- Reduced planting and pollination leading to greater risk of erosion and soil loss.
- Increasing temperatures together with increased intensity of drought will potentially increase the occurrence of algal blooms in reservoirs and dams which are damaging to ecosystem functioning and water services.
- Drought and decreased rainfall causing wetland habitat loss.
- Locally specific changes in humidity levels will have impacts on local vegetation.
- Increased threat to watershed and aquifer recharge areas, affecting vegetation.
- Reduced soil moisture availability increasing moisture stress leading to dieback and death of plants and the loss or degradation of indigenous communities, including threatened species or ecosystems.
- Increased moisture stress leading to decline in crop yield and quality, and reduced fodder quantity and quality for livestock.
- Drying up of aquatic systems, perennial systems will become seasonal and seasonal systems will die off and be replaced by terrestrial plants.
- Increased spread of drought-adapted alien invasive plant species.

Increase in rainfall, inland flooding and sea level rise may result in:

- Rainfall in shorter and more violent spells making recharging groundwater difficult.
- Increase in intensity of rainfall and flooding leading to increased surface runoff, resulting in increased soil erosion, soil loss and degradation.
- Increased rainfall and floods resulting in waterlogged soils which increase the likelihood of crop failure.
- Increasingly saturated soils leading to more standing water (ponding) which can result in more insect (pest) activity and their potential to carry diseases.
- Increased wave energy and run-up (sea level rise and more storms) causing degradation of natural coastal defence structures.

Increased wind speed may result in:

- Evapotranspiration rates increase with wind speed, reducing the water available in reservoirs and water available for reliant ecosystems.
- Increased rate of fire spread and spotting (the ignition of fires ahead of the main fire front) of fires.
- Potential damage to or uprooting of vegetation including trees, which can also damage infrastructure.
- Potential wind damage to crops, reducing yield and quality (e.g., sandblasting and fruit fall).
- Increased windblown materials (e.g., dust, litter) increasing the need for maintenance and city cleaning.
- Degradation of natural coastal defence structures and increased damage to hard coastal infrastructure.

Culture and Heritage

The climate change risk on culture and heritage, as summarised in the Green Book (van Wyk, 2018) is provided in this section.

Culture refers to the dynamic totality of distinctive spiritual, material, intellectual, emotional and aesthetic features that characterise a society or social group, including its arts, but also intangible aspects such as values, worldviews, ideas and beliefs, and the expression of these in individual and social behaviour, relationships, organisational and societal forms, and in economic, political, educational and judicial systems (Department of Arts and Culture, 2016). The variance between these groups, known as cultural diversity, is illustrated by the many ways in which the cultures of groups and societies find expression.

Within an urban context, culture may manifest itself spatially through heritage sites and resources. These areas are vulnerable to the effects of climate change and require particular management and sensitivity within planning. This heritage may include wildlife and scenic parks, sites of scientific or historic importance, national monuments, historic buildings, works of art, literature and music, oral traditions, and museum collections together with their documentation (International Museums Council) (Revised White Paper).

Due to the sensitive nature of culture and heritage, the physical and cultural value associated with these sites and resources is vulnerable to any aesthetic and functional changes caused by climate change. Potential physical impacts may have indirect social consequences.

Increased temperatures and heat stress may result in:

- Increased temperature having significant impacts on the comfort levels of built heritage resources, resulting in the building no longer being fit-for-purpose.
- Increased demand for additional heating and cooling resulting in the installation of heating, ventilation, and air-conditioning systems with potential negative consequences on the heritage value.
- Increased heat stress potentially impacting on the materials and structural integrity of heritage resources.

- Migration of several plant species due to changing climate patterns, posing a threat to the conservation of biodiversity hotspots, and potentially altering heritage places.
- Increase in veld and forest fires raising the threat of fire to all heritage resources, natural and built, as well as posing health risks to heritage resource dwellers from exposure to smoke and ash pollution.

Drought and decrease in rainfall may result in:

- Decreased rainfall impacting negatively on ground moisture levels and thus the geological conditions of sensitive heritage resources. Drying out clays, for example, will shrink and potentially undermine founding conditions.

Increase in rainfall and inland flooding may result in:

- Increased rainfall in areas with clay soils resulting in swelling which poses a threat to the structural integrity of heritage resources.
- Increased floods and changes in precipitation resulting in increasing vulnerability of archaeological evidence buried underground due to changing stratigraphic integrity of the soils.
- Increased threat to materials and structural integrity of heritage resources exposed to higher humidity/ precipitation levels.

10.4 LAND USE AND LAND COVER

The land use within and adjacent to the application area is dominated by game farming activities with the Thungela exploration phase as well as the PoC gas well and plant infrastructure situated within the application area. The landcover dataset (Figure 58) identifies most of the application area and surrounding areas comprising open woodlands with scattered natural grasslands. To a limited extent, certain areas within the application area are historically disturbed because of fallow land or old fields as well as gravel roads. Existing Exxaro coal mining activities (Grootegeluk Coal Mine) are located directly south-west of the application area with Medupi and Matimba Power Stations to the south.

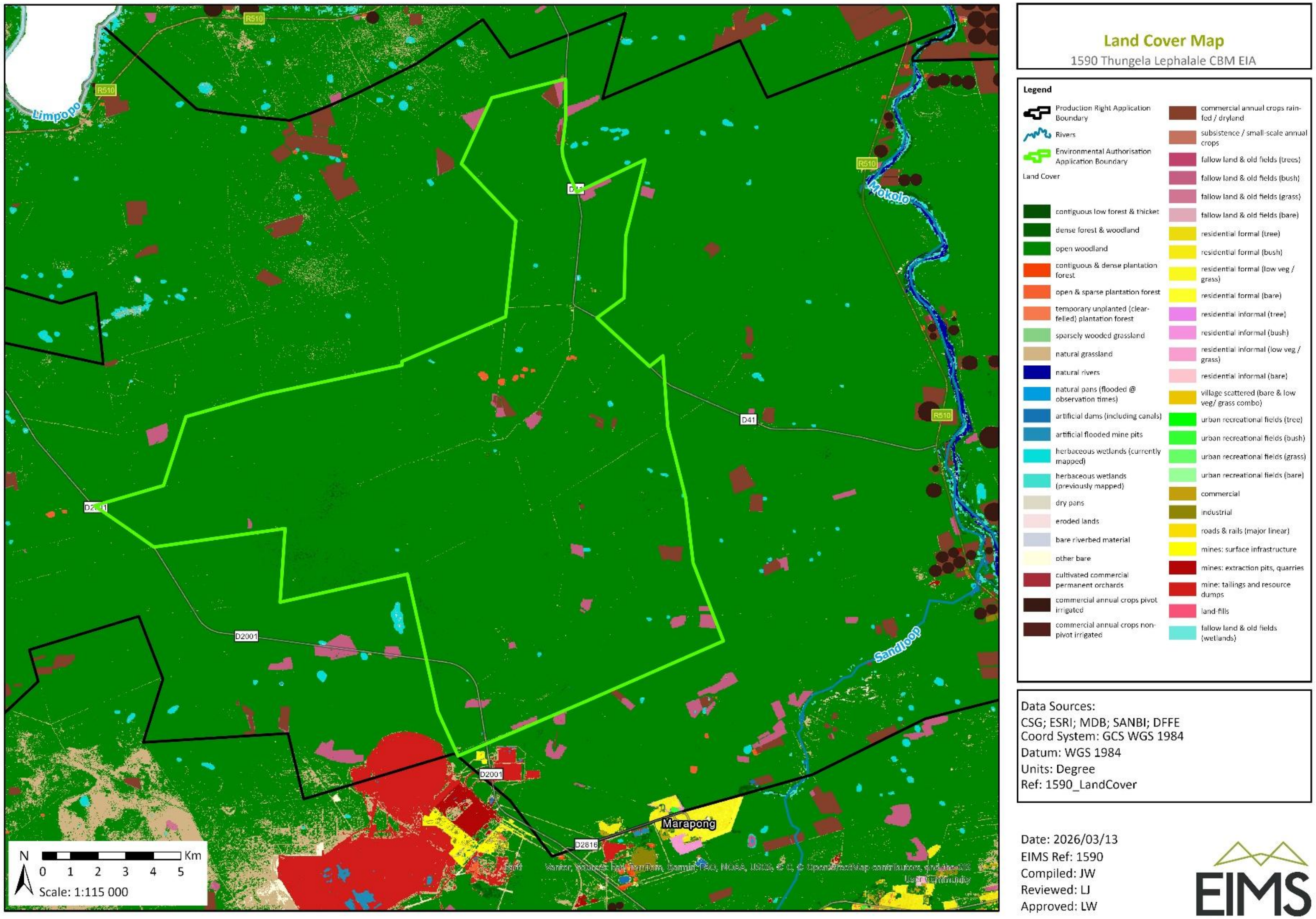


Figure 58: Landcover within and surrounding the application area.

10.5 SEISMICITY

The project area is in the western part of Limpopo Province close to Lephalale town. It is near a coal mine that is west of Lephalale town and is also located close to the active Zoetfontein fault. Though there are no records of large earthquakes in this area, the presence of faults in and around the project area poses a seismic risk in the area especially when hydraulic fracturing is conducted there. The largest earthquake to occur near this place is the 2017 Botswana earthquake of magnitude Mw= 6.5, which was located about 270 km from the project area. Though some shaking from this event might have been felt in the study area, the shaking would not have been severe enough to cause any damage (Midzi et al., 2018).

The project area is situated in the Ellisras basin which is a fault-bounded basin, with the Zoetfontein fault in the north, and the Eenzaamheid fault in the south (Figure 59). The basin is known to have structural lineaments that were cyclically re-activated over time, such as the Melinda fault (Jansen, 1982) and Zoetfontein fault (Brandl, 1996).

Fourie et al. (2014) summarised the geology of the Ellisras (now known as Lephalale) area which is provided by Brandl (1996) in his explanation of Sheet 2326 Ellisras (1:250 000-scale geological map), compiled in 1993. The Ellisras Basin is situated in the north-western part of South Africa in Limpopo Province and continues across the border into Botswana. It is approximately 35 km (north-south) by 80 km (east-west) in size and is fault-bounded against the Limpopo Mobile Belt to the north, and the Waterberg Basin to the south. To the east, the Karoo rocks are unconformably developed on Limpopo Belt and Bushveld Complex rocks. These rocks form the basement to the Ellisras Basin and were the main source of the sediments that were transported into it.

The northern limit of the Ellisras Basin is defined by the Zoetfontein Fault Zone, to the north of which the Limpopo Belt is developed. This belt comprises highly deformed and metamorphosed meta-sedimentary and meta-igneous rocks that were involved in at least two major tectono-thermal events ~2.69 Ga to ~2.56 Ga and ~2.0 Ga ago (Kramers et al., 2006). The rocks to the north of the Malala Drift Suite of the Beit Bridge Complex comprise mainly quartzo-feldspathic gneisses. To the north-east of the basin, mafic rocks of the Messina Suite are developed (Brandl, 1996). These rocks are in fault-contact with the Villa Nora lobe of the Bushveld Complex (~2.06 Ga in age) and consist of both layered basic rocks and intrusive granites (Figure 59).

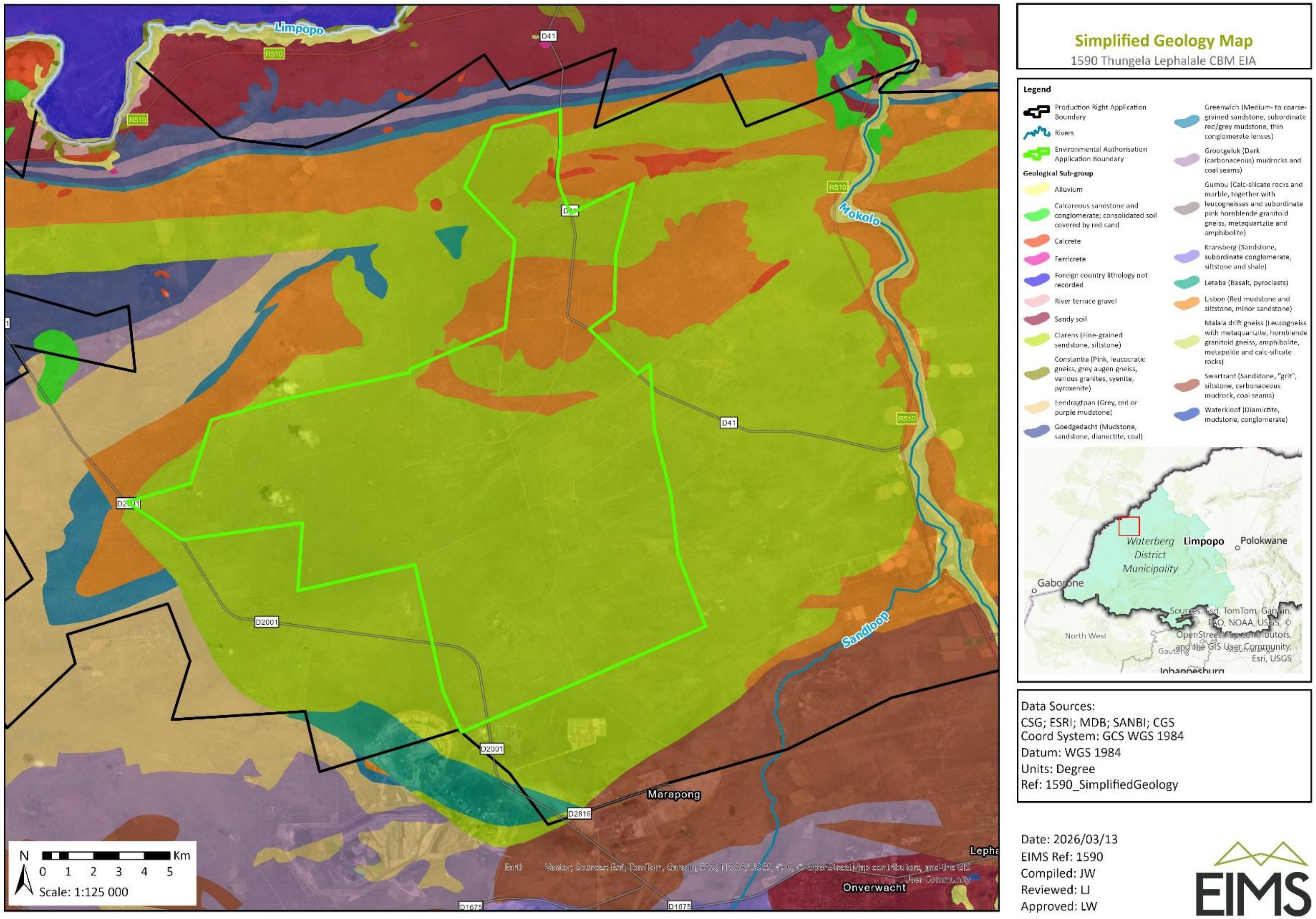


Figure 59: Geological setting of the study area

To the south, the Ellisras Basin is bounded by the Eenzaamheid Fault Zone (Figure 60), which also serves as the northern boundary of the Waterberg Group outcrops. The Waterberg Group consists mainly of clastic sedimentary rocks that were deposited in a fault-bounded basin between ~1.95 and ~1.7 Ga ago (Barker et al., 2006). The rocks immediately to the south of the Ellisras Basin belong to the Mogalakwena Formation of the Waterberg Group and consist of coarse-grained sandstones and conglomerates that dip gently to the north.

Movement along the Limpopo Mobile belt, as tectonic re-activation due to continuous tension in the Karoo era in the Soutpansberg and Limpopo fault zones occurred, controlled the formation of the Karoo sediments and finally acted as conduits for the extrusion of basalts which terminated the Karoo era (Barker, 1983). Studies have indicated that east-northeast - trending fractures have been rejuvenated in post-Karoo times (Barker, 1983).

The project area has an extended structural history that starts in the Mid-Proterozoic (~2 000Ma) with the cratonisation of Africa, followed by early rifting and the onset of deposition of the Waterberg Group at about 1920Ma. The rocks of the Waterberg Group within eastern Botswana have been laid down under lacustrine or very shallow marine conditions. Crocket and Jones, (1975) suggest that the sedimentation of the Waterberg took place in “a series of rectilinear basins whose margins were defined by a number of sets of persistent major faults.”

Arnott and Williams (2007) found that the coalfields of the Ellisras, developed within the greater intracratonic Soutpansberg trough, which was re-activated during late Permian to early Triassic times. This viewpoint correlates with the work of Siepker (1986) who discusses continuous tectonic activity occurring within the mentioned timeframe.

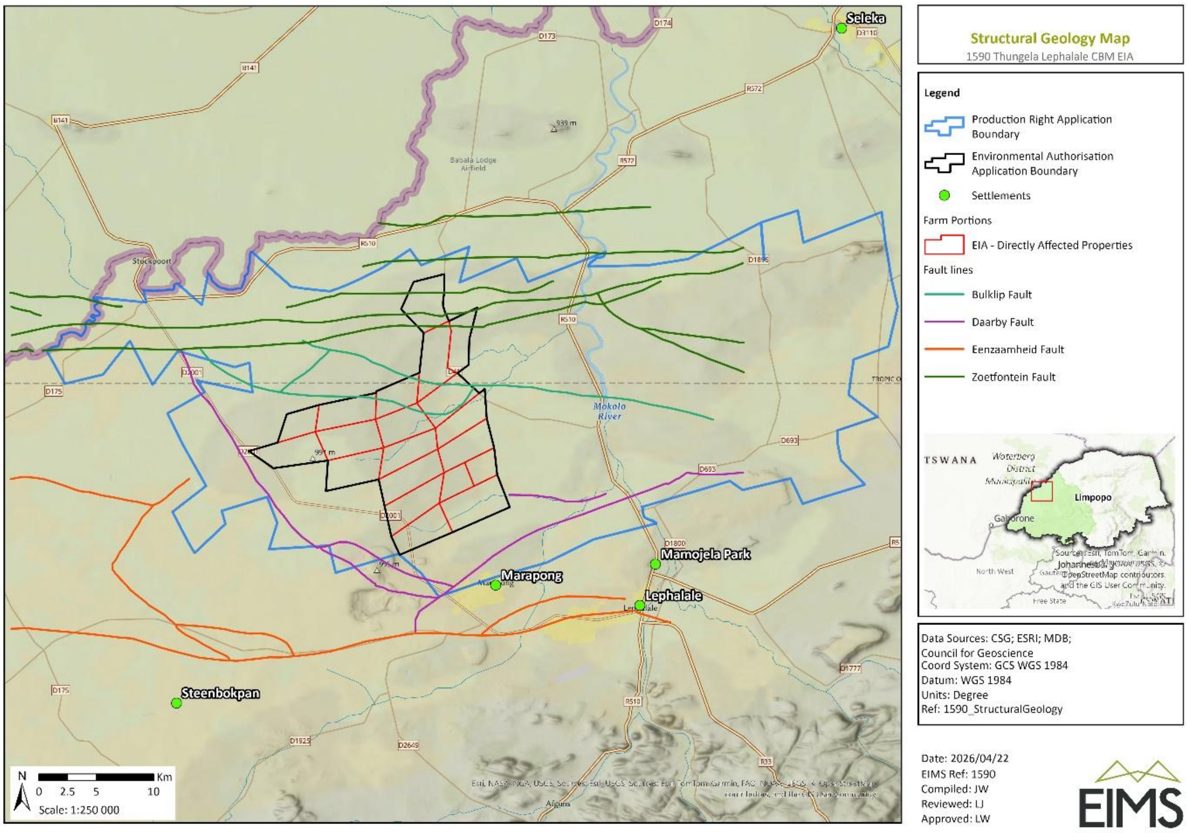


Figure 60: Structural Geology of the study area.

Major faults in and around the project area are described below. Fault scarps along the faults in and around the project area are clear in the elevation models prepared by Andersen et al. (2014).

10.5.1 THE EENZAAMHEID FAULT

The Eenzaamheid Fault bounds the northern margin of the Waterberg Group rocks (Fourie et al., 2014) and is also the southern boundary of the Ellisras Basin in which the project area is located. It has a downthrow to the north and a vertical displacement of up to 250 m in certain areas (Brandl 1996). The angle of the Eenzaamheid fault is near vertical (Golder, 2018). The location of earthquakes along the western segment of this fault suggests that the fault is active.

10.5.2 THE ZOETFONTEIN FAULT ZONE

The Zoetfontein Fault Zone forms the northern boundary of the Ellisras basin against Archaean Limpopo Belt rocks. It is block-faulted and steeply dipping (Fourie et al., 2014). The fault was tectonically active before and during the Karoo deposition (Bester and Vermeulen, 2010). This structure generally trends in an ENE-WSW direction. The Zoetfontein fault extends north-eastward to join other fault segments, the Tshipise, Melinda and Bosbokpoort faults. Geological investigations (Holland, 2011) and paleoseismic investigations (Eskom, 1998) have shown normal faulting along most of the structures, with displacement of Aeolian sands and fault scarps ranging from 2 to 10 m in height. The Zoetfontein fault has a history of repeated reactivation since the late Archean continuing to the present (Hutchins and Reeves 1980, Smith 1984). A seismic survey interpretation of the Karoo Supergroup reflects reactivation of the Zoetfontein Fault during Karoo sedimentation and its development as a growth fault (Modie, 2007). Smith (1984) also reported on the existence of down-throw of Karoo rocks on the northern side of the Zoetfontein Fault of up to 300 m long with several hundred metres throw on other post-Karoo NNW-SSE oriented faults intersecting the Zoetfontein fault.

10.5.3 THE DAARBY FAULT

The Daarby Fault is a major NE-SW, then NW-SE trending fault, assumed to be part of one set of events, as both legs exhibit the same throw and throw direction. It has also been observed to have a down throw of 360 m to the north and the fault dips at an angle of between 50° and 60° to the north (Bester and Vermeulen, 2010). Field measurements indicate that the fault has undergone left lateral dip-slip motion (Andersen and Luyt, 2014). As with the Eenzaamheid Fault, a few epicentres are located along the eastern segment of the fault, which could also be an indication that the fault is active.

10.5.4 THE BULKLIP FAULT

The Bulklip fault is oriented in a WNW-ESE direction and passes through the project area. It downthrows to the south and dips more than 75° (Andersen and Luyt, 2014). Elevation models reported by Andersen et al. (2014) indicate that there is a fault scarp on most segments of the fault. Despite not having evidence about the activity of the fault, its location in the project area poses a risk as injection of fluids directly into the fault could result in the triggering of earthquakes along the fault.

10.6 GEOLOGY

10.6.1 REGIONAL GEOLOGY

The study area is situated in the Waterberg Coal basin with the regional geology consisting of various groups within the Karoo Supergroup. The Karoo Sequence is best developed in the Main Karoo Basin, which covers more than half of South Africa. The Stormberg Group of the greater Karoo Supergroup represents the final phase of preserved sedimentation of the Karoo Basin. The Malaladrift Group of the Beit Bridge Complex is situated towards the north of the EA Application area whereas the Kransberg Subgroup of the Waterberg Group is located on the southern perimeter. The geological setting of the greater study area is depicted in Figure 61.

10.6.2 LOCAL GEOLOGY

According to the 1:250 000 geological map (2326: Ellisras), superficial formations within the study area comprises the Clarens Formation of the Stormberg Group. The early to middle Jurassic Clarens Formation represents the final phase of the Karoo sedimentation and consists mainly of wind-blown, fine-grained sandstone and siltstone. Channel-filled wadi sandstones and horizontally laminated sheet-flood sandstone are also present. Minor interbedded sandstone, siltstone and mudstone represent localised playa lake deposits. Underlaying the Clarens Formation is the Lisbon Formation comprises a succession of dominantly red, massive mudstone and siltstone as well as minor medium to coarse grained sandstone.

Following this is the late Triassic to early Jurassic Elliot Formation comprises an alternating sequence of mudrock and subordinate fine- to medium-grained sandstone. Beneath the Elliot formation is the late Triassic Molteno Formation comprises alternating medium- to coarse-grained, sandstones and grey mudrocks, with sporadic coal seams. The Beaufort Group underlies the Molteno Formation consisting of alternating mudstone layers.

Underneath the Stormberg Group lies the Eendragtpan and Swartrant Formations. The Eendragtpan Formation is composed entirely of variegated mudstones and is attained in the central part of the basin whereas the Swartrant Formation consists of alternating sandstone and siltstone layers. Underneath the Beaufort Group lies the sedimentary Ecca Group of the Karoo Supergroup, which consists of a sequence of units, mostly of nonmarine origin, deposited between the Late Carboniferous and Early Jurassic (Schlüter, 2008). The latter hosts the Grootegeluk and Vryheid formations consisting of various coal seams being targeted for gas production. The Permian Ecca Group follows conformably after the Dwyka Group in certain sections and underlies the Beaufort Group in all known outcrops and exposures. Refer to Figure 62 for a stratigraphical column of the formations underlaying the study area.

10.6.3 STRUCTURAL GEOLOGY

Structural activity may have an impact on the local hydrogeological regime as it can serve as potential preferred pathways for groundwater flow and contaminant transport due to increased transmissivity. The sedimentation of the Waterberg took place in “a series of rectilinear basins whose margins were defined by a number of sets of persistent major faults. Initial deposition of the Karoo Supergroup sediments took place between these two faults as the result of north-south extension and subsidence (Crockett, 1975). The Waterberg Coalfield trends east–west and is heavily faulted. On a regional scale two very prominent fault zones are evident traversing the greater study i.e., Daarby Fault situated to the south and west of the EA Application area (striking in a general southwest-northeast orientation as well as north-south orientation) and the Zoetfontein Fault situated to the northwest of the EA Application area (striking in a general west-east orientation. The Eenzaamheid fault forms the southern boundary, with rocks belonging to the Waterberg Group occurring south of this fault, while the northern boundary is delineated by the Zoetfontein fault with Archaean granites outcropping north of this fault. The Karoo sequence in the area has been faulted by 2 major faults with displacements greater than 250 m, namely the Daarby Fault in the north and the Eenzaamheid Fault in the south. Associated minor faulting within this graben is also apparent and recognizable lineaments have been interpreted over the regional area as well. The Zoetfontein fault was tectonically active before and during Karoo deposition, while the Eenzaamheid and Daarby faults – as most of the other faulting in the Waterberg Coalfield – are younger than the Karoo sequence. The original sedimentary basin in which the coal was formed extended further south than the present southern boundary (Eenzaamheid fault). The Daarby fault has a down throw of 360 m to the north and the fault dips at an angle of between 50 and 60 degrees to the north, bringing up-thrown Beaufort and Ecca Groups to the south into contact with the down-thrown Letaba, Clarens, Elliott and Molteno formations on the north. The Eenzaamheid fault, situated south of the Daarby fault, has a throw of 250 m to the north bringing the up-thrown Waterberg Group on the southern side of the fault into contact with the down-thrown Beaufort and Ecca groups on the northern side of the fault. The dip angle of the Eenzaamheid fault is near vertical (Snyman, 1998).

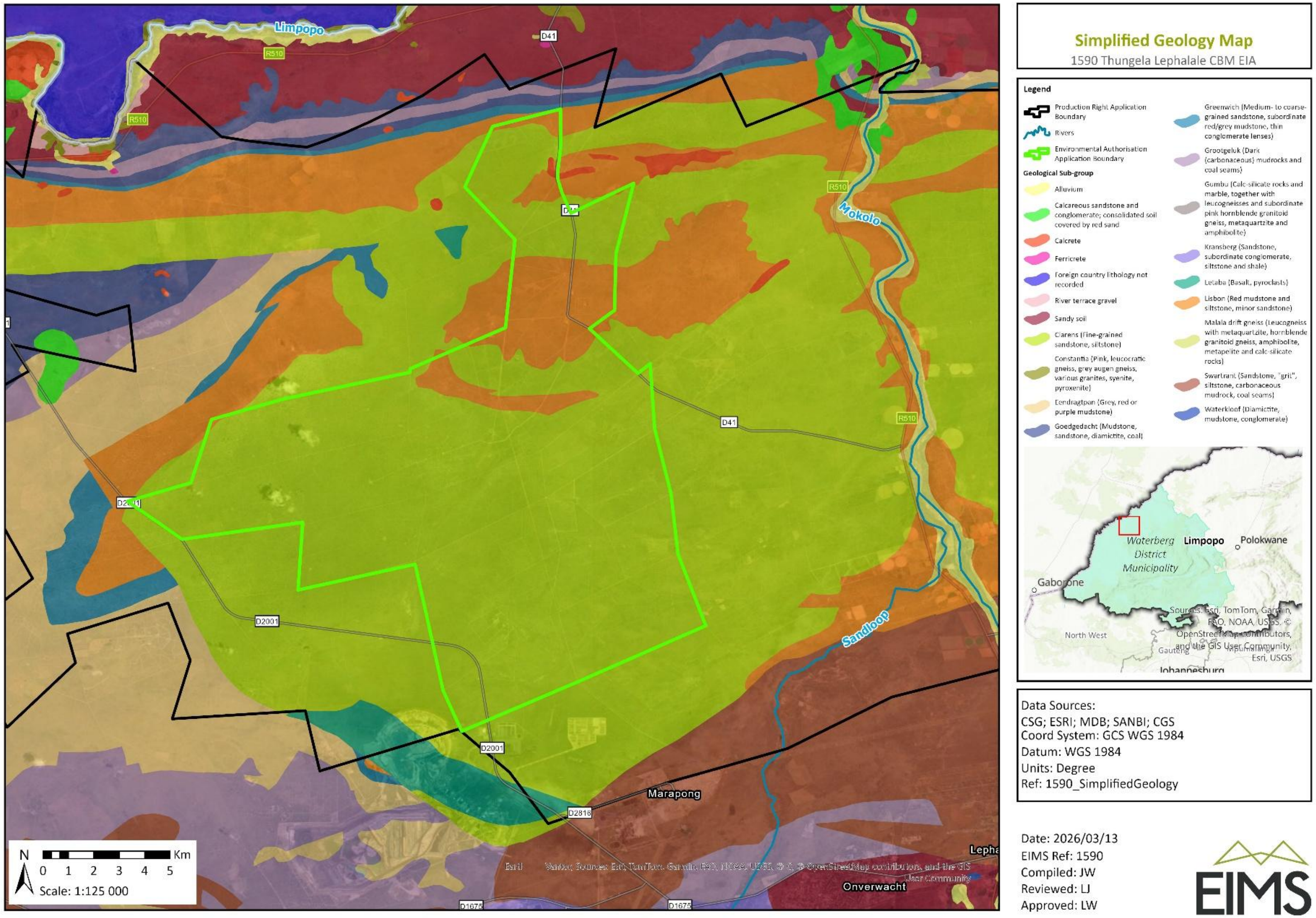


Figure 61: Regional geology.

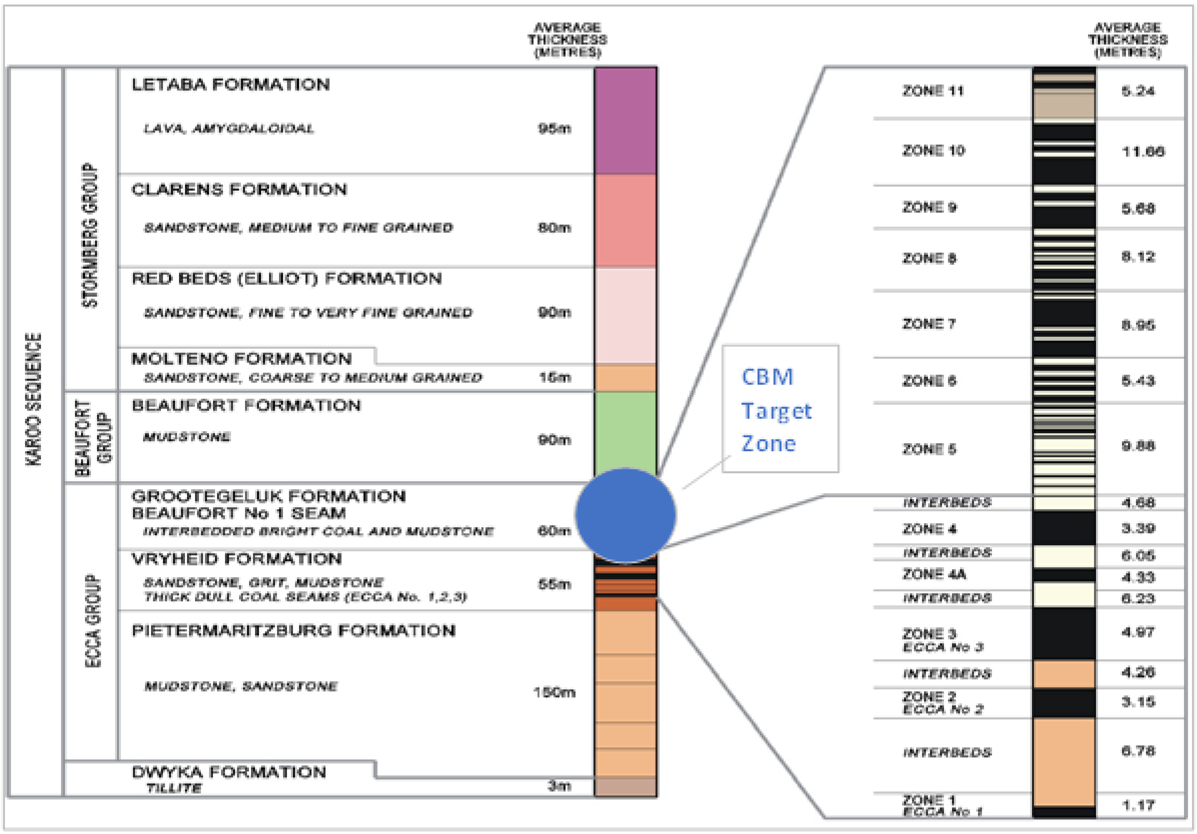


Figure 62: Stratigraphy of the study area.

10.7 SOILS AND LAND CAPABILITY

As part of the desktop assessment, soil information was obtained using published South African Land Type Data. Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 – 2006). The land type data is presented at a scale of 1:250 000 and comprises of the division of land into land types. According to the land type database (Land Type Survey Staff, 1972 – 2006) the development falls within the Ah 85 land type (Figure 63).

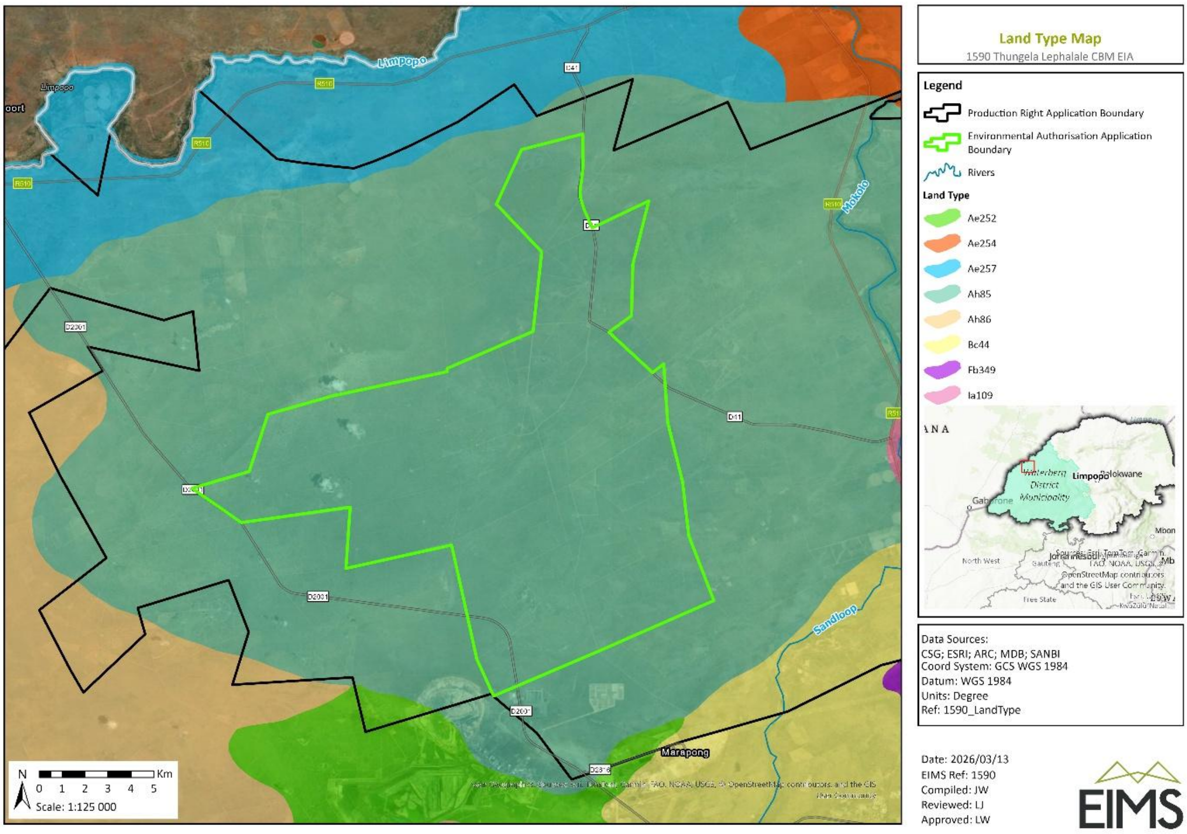


Figure 63: Land types associated with the project area.

According to the land type database (Land Type Survey Staff, 1972 - 2006), the project area is characterised by the Ah 85 land type. The land terrain units for the featured Ah 85 land type are illustrated in Figure 64 with the expected soils listed in Table 31.

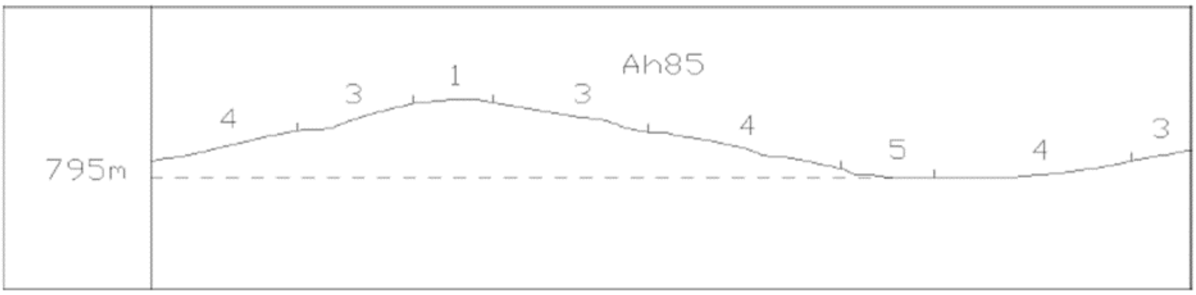


Figure 64: Illustration of the land type terrain units (Land Type Survey Staff, 1972 – 2006).

Table 31: Soils expected at the terrain units within the land type (Land Type Survey Staff, 1972 - 2006).

Ah 85 Terrain Units							
1 (5%)		3 (30%)		4 (60%)		5 (5%)	
Hutton	29%	Hutton	48%	Hutton	46%	Avalon	7%
Clovelly	20%	Clovelly	27%	Clovelly	33%	Oakleaf	46%
Hutton	28%	Hutton	12%	Hutton	8%	Longlands	32%
Clovelly	20%	Fernwood	3%	Fernwood	5%	Stream beds	15%
Mispah	3%	Avalon	3%	Avalon	4%		
		Clovelly	4%	Clovelly	2%		
		Mispah	3%	Hutton	2%		

Fifteen land capabilities have been digitised by (DAFF, 2017) across South Africa, of which eight potential land capability classes are located within the proposed project areas, including;

- Land Capability 1 to 5 (Very Low to Low Sensitivity); and
- Land Capability 6 to 8 (Low/Moderate to Moderate).

The sensitivities as per the Department of Agriculture, Forestry and Fisheries (DAFF, 2017) national raster file indicated that the land capabilities range from low-moderate to moderate across the project area. The extent of the area is dominated by the low-moderate classification.

10.8 HYDROLOGY AND FLOODLINES

Figure 65 presents the local hydrological setting of the Site. The Site is positioned within quaternary catchment A42J. This quaternary catchment falls into the greater Limpopo River catchment. The primary river of quaternary catchment A42J is the Mokolo/Mogol River, which is positioned to the east of the Site and drains the containing catchment depicted in Figure 65.

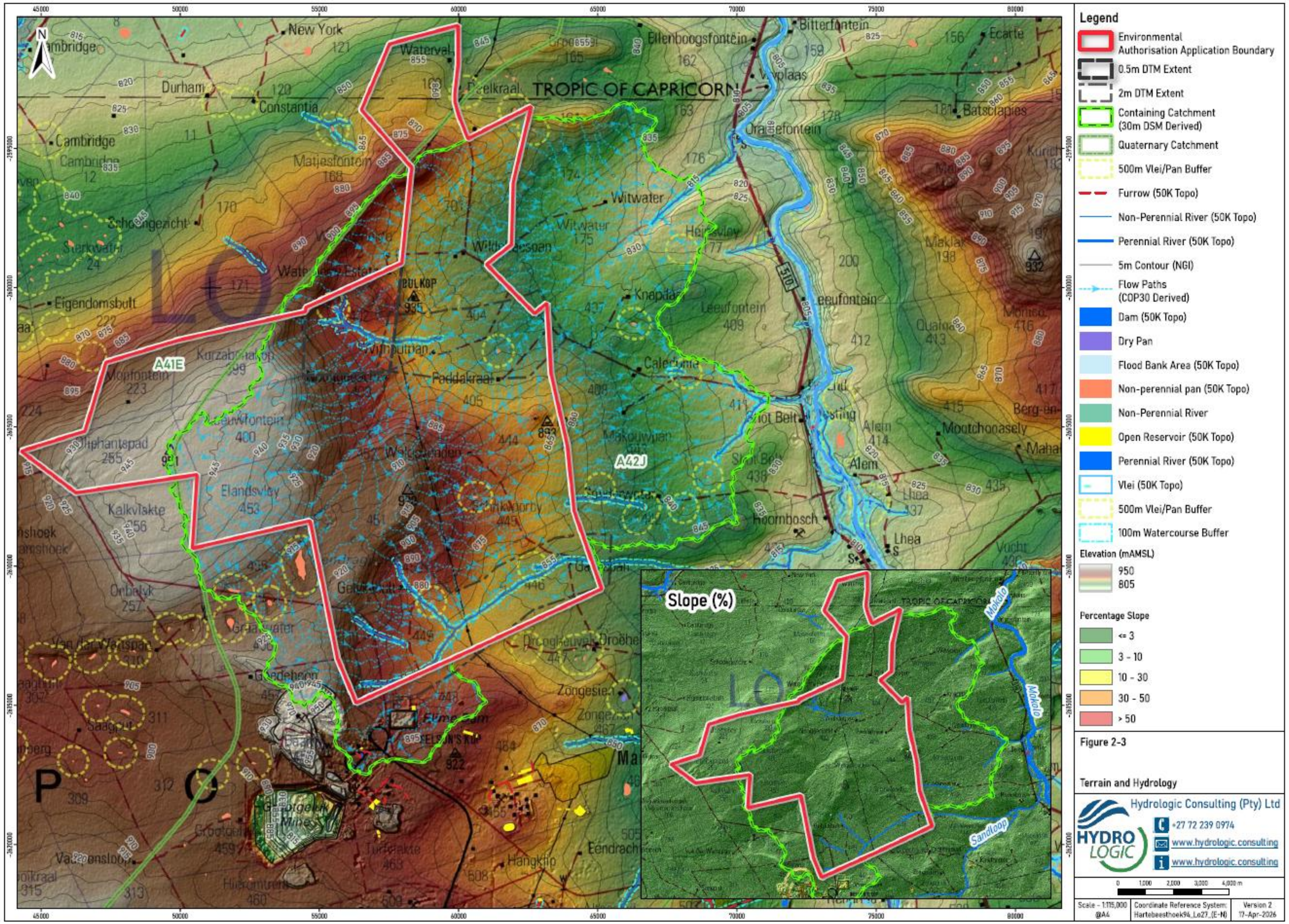


Figure 65: Hydrological setting of the site

This containing catchment approximates 299.4km^2. There are two non-perennial river branches defined by the 1:50,000 topographical map that are relevant to this study as they either intersect or are close enough to the area of the Site considered for development to warrant consideration. Besides the two non-perennial rivers, hydrological features are limited to non-perennial river headwater which (just) intersects the Site's eastern boundary and several small non-perennial pans.

Overall, the Site is characterized by limited hydrological features including a low drainage density. Of interest is the discontinuity of the few non-perennial rivers, likely an indication of the slope, land-cover and soils on site which tend to limit the development of clearly defined river channels.

10.9 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.

10.9.1 HYDROCENSUS

A hydrocensus user survey within the greater study area was conducted during August 2023 where relevant hydrogeological baseline information was gathered. The aim of the hydrocensus survey is to determine the ambient and background groundwater conditions including groundwater application and to identify potential sensitive environmental receptors i.e., groundwater and surface water users including wetlands or spring localities in close vicinity to the proposed development footprint. A total of 47 geosites were visited as part of the hydrocensus user survey. Relevant information is summarised in Table 32 and Table 33 while a spatial distribution map of geosites is shown in Figure 70.

Table 32: Hydrocensus user survey: relevant geosite information

Site ID	Latitude	Longitude	Site status	Site Type	Site purpose
CBM BH 01	-23.59595	27.59946	In Use	Borehole	Domestic
CBM BH 02	-23.58507	27.60082	In Use	Borehole	Livestock watering
CBM BH 03	-23.58809	27.62579	In Use	Borehole	Domestic
CBM BH 04	-23.59005	27.62632	In Use	Borehole	Livestock watering
CBM BH 05	-23.58946	27.62605	In Use	Borehole	Livestock watering
CBM BH 06	-23.53927	27.64536	In Use	Borehole	Domestic
CBM BH 07	-23.54026	27.64641	In Use	Borehole	Domestic
CBM BH 08	-23.5408	27.64602	In Use	Borehole	Domestic
CBM BH 09	-23.54395	27.63843	In Use	Borehole	Domestic
CBM BH 10	-23.55114	27.63363	In Use	Borehole	Livestock watering
CBM BH 11	-23.55047	27.63277	In Use	Borehole	Livestock watering
CBM BH 12	-23.56904	27.60966	In Use	Borehole	Livestock watering
CBM BH 13	-23.53054	27.66438	In Use	Borehole	Livestock watering
CBM BH 14	-23.5413	27.59661	Not in use	Borehole	Not in use
CBM BH 15	-23.51493	27.63578	In use	Borehole	Livestock watering
CBM BH 16	-23.53078	27.54246	In use	Borehole	Not in use
CBM BH 17	-23.5289	27.56325	In use	Borehole	Domestic
WN 07	-23.4835	27.59822	In Use	Borehole	Dewatering
WN 15	-23.48354	27.59744	In Use	Borehole	Monitoring
WN 09	-23.48288	27.59679	In Use	Borehole	Monitoring
WN 10	-23.480403	27.59655	In Use	Borehole	Monitoring
WN 14	-23.48292	27.59478	In Use	Borehole	Monitoring
WN 13	-23.48958	27.58995	In Use	Borehole	Monitoring
WN 04	-23.48958	27.58995	In Use	Borehole	Monitoring
WP 04	-23.5213	27.57844	In Use	Borehole	Monitoring
WP	-23.52159	27.57904	Not in use	Borehole	Not in use

Site ID	Latitude	Longitude	Site status	Site Type	Site purpose
WP 03	-23.50284	27.60392	Not in use	Borehole	Not in use
PL 01	-23.528891	27.60262	In Use	Borehole	Domestic
KD 04	-23.52385	27.62191	In Use	Borehole	Livestock watering
KD 02	-23.50232	27.6467	In Use	Borehole	Domestic
CA 01	-23.5262	27.65025	In Use	Borehole	Domestic
WNC	-23.52795	27.61997	In Use	Borehole	Monitoring
WNM	-23.52792	27.6199	In Use	Borehole	Monitoring
SYM	-23.59354	27.58307	In Use	Borehole	Monitoring
SYC	-23.59354	27.58307	In Use	Borehole	Monitoring
EYM	-23.58421	27.49433	In Use	Borehole	Monitoring
EYC	-23.58421	27.49433	In Use	Borehole	Monitoring
ODM	-23.55312	27.43514	In Use	Borehole	Monitoring
ODC	-23.55306	27.43512	In Use	Borehole	Monitoring
KF 01	-23.49755	27.56031	In Use	Borehole	Monitoring
WN 01	-23.49991	27.58195	In Use	Borehole	Monitoring
WP 02	-23.49184	27.60599	In Use	Borehole	Monitoring
WN 06 N	-23.47692	27.596	In Use	Borehole	Monitoring
WN 06 S	-23.47707	27.56	In Use	Borehole	Monitoring
WN 02	-23.48799	27.58896	In Use	Borehole	Domestic
WN 03	-23.48873	27.58957	In use	Borehole	Livestock watering
WN 05	-23.48351	27.59204	In use	Borehole	Dewatering

Table 33: Hydrocensus user survey: relevant geosite information - Includes other indices.

Site ID	Water level status	Measured Water Level (mbch)	Collar heigh t (m)	Calculate d Water Level (mbgl)	Equipment type	Field notes
CBM BH 01	Static	19.31	0.24	19.07	Electrical submersible	Back-up Borehole

Site ID	Water level status	Measured Water Level (mbch)	Collar height (m)	Calculated Water Level (mbgl)	Equipment type	Field notes
CBM BH 02	Obstructed	NAWL			Windpump	Broken Windpump
CBM BH 03	Static	19.65	0.39	19.26	Mono pump	Back-up Borehole
CBM BH 04	Dynamic	22.51	0.35	22.16	Solar	Solar Pump. Pump during sunny days only.
CBM BH 05	Dynamic	21.76	0.29	21.47	Solar	Solar Pump. Pump during sunny days only.
CBM BH 06	Static	21.36	0.25	21.11	Electrical submersible	Pump 1x per day for +- 5hours
CBM BH 07	Static	21.42	0.4	21.02	Electrical submersible	Pump 1 to 2x per week for 4hours.
CBM BH 08	Obstructed	NAWL			Solar	Solar Pump. Pump during sunny days only.
CBM BH 09	Static	21.99	0.1	21.89	Not equipped	
CBM BH 10	Static	25.71	0.35	25.36	Electrical submersible	Pump 1x per week for 4hours.
CBM BH 11	Static	25.07	0.18	24.89	Solar	Solar Pump. Pump during sunny days only.
CBM BH 12	Static	25.18	0.25	24.93	Not equipped	Solar pump which was stolen.
CBM BH 13	Dynamic	22.99	0.4	22.59	Electrical submersible	Pump 1x per week for 4hours. Use generator
CBM BH 14	Static	26.48	0	26.48	Not equipped	
CBM BH 15	Static	35.31	0.6	34.71	Electrical submersible	Pump 1x per week for 2hours
CBM BH 16	Static	33.49	0.55	32.94	Not equipped	
CBM BH 17	Static	23.35	0.57	22.78	Electrical submersible	
WN 07	Static	33.4	0.29	33.11	Electrical submersible	Dewatering Borehole

Site ID	Water level status	Measured Water Level (mbch)	Collar height (m)	Calculated Water Level (mbgl)	Equipment type	Field notes
WN 15	Dry	Dry			Not equipped	
WN 09	Static	7.4	0.37	7.03	Not equipped	
WN 10	Static	7.65	0.32	7.33	Not equipped	
WN 14	Dry	Dry			Not equipped	
WN 13	Dry	Dry			Not equipped	
WN 04	Dry	Dry			Not equipped	
WP 04	Static	28.46	0.44	28.02	Not equipped	
WP	Static	22.71	0	22.71	Not equipped	
WP 03	Static	17.5	0.25	17.25	Not equipped	
PL 01	Dynamic	23.34	0.3	23.04	Electrical submersible	Pump 1x per day for 5-6 hours
KD 04 (PL04)	Obstructed	NAWL			Mono pump	Pump 1x per month.
KD 02 (PL02)	Static	20.09	0.56	19.53	Electrical submersible	Pump 1x per day for 30min. Farmer complaining about salty taste in water as well as scaling.
CA 01	Static	27.78	0.27	27.51	Electrical submersible	
WNC	Static	25.13	0.35	24.78	Not equipped	
WNM	Static	22.25	0.4	21.85	Not equipped	
SYM	Static	26.69	0.3	26.39	Not equipped	

Site ID	Water level status	Measured Water Level (mbch)	Collar height (m)	Calculated Water Level (mbgl)	Equipment type	Field notes
SYC	Dry	Collapsed			Not equipped	
EYM	Static	50.53	0.53	50	Not equipped	
EYC	Dry	Collapsed			Not equipped	
ODM	Static	80.5	0.28	80.22	Not equipped	
ODC	Static	32.51	0.4	32.11	Not equipped	
KF 01	Static	35.15	0.21	34.94	Not equipped	
WN 01	Static	4.5	0.41	4.09	Not equipped	
WP 02	Static	30.45	0.33	30.12	Not equipped	
WN 06 N	Static	19.15	0.3	18.85	Not equipped	
WN 06 S	Dry	Dry			Not equipped	
WN 02	Static	47.79	0.47	47.32	Electrical submersible	
WN 03	Dynamic	70.23	0.08	70.15	Electrical submersible	
WN 05	Obstructed	NAWL			Electrical submersible	
NAWL: No Access to the Water Level						

10.9.2 GEOSITE TYPE

A total of 47 geosites or potential receptors were visited and recorded all of which consisted of boreholes. Approximately two thirds of these boreholes (66.0%) are representative of static water level conditions, while 11.0% of water levels were recorded as dynamic i.e., either pumping or still in the recovering phase. Water levels could not be measured at the remaining boreholes because the boreholes were either dry or there was no access to the water levels (Refer to Figure 66).

10.9.3 GROUNDWATER STATUS

Of the boreholes recorded, the vast majority are in use (>93.0%) while three (3) boreholes are not currently utilised (Refer to Figure 67).

10.9.4 GROUNDWATER APPLICATION

Geosites recorded are being applied for monitoring purposes (42.0%), domestic and garden water supply (23.0%) as well as livestock watering purposes (~21.0%). Two boreholes were recorded as historically utilized for dewatering purposes (no longer in use) while the remaining 8.0% are not currently being used for any specific purpose (Figure 68). According to the Limpopo ISP (2004), groundwater is the main source of water supply to these rural communities although surface water is also used conjunctively where this is available. Most of the Limpopo WMA is too dry for dryland agriculture and there are limited surface water resources to support irrigation. Land use is therefore dominated by stock farming (mostly cattle) while there is an increasing tendency to replace this with game farming.

10.9.5 BOREHOLE EQUIPMENT

The majority of boreholes visited are not equipped (55.0%) while boreholes equipped with electrical submersible pumps accounts to 30.0%. The remaining boreholes are either fitted with solar pumps (9.0%), mono pumps (4.0%) or windpumps (2.0%) as indicated in Figure 69.

10.9.6 GROUNDWATER FLOW EVALUATION

In order to assess potential impacts of the proposed development on the groundwater regime, it is necessary to develop a baseline/background to be applied as benchmark. The following section serves to characterise ambient groundwater flow conditions and develop a relevant baseline for future reference.

10.9.6.1 **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 4.0m to ~35.0m with a mean thickness of approximately ~23.0m. It should be noted that water levels deeper than 40.0mbgl are potentially targeting the deeper aquifer units.

10.9.6.2 **DEPTH TO GROUNDWATER**

A distribution of borehole water levels recorded as part of the hydrocensus user survey conducted, were considered and used to interpolate local groundwater elevation and hydraulic head contours as summarised in Table 34 and depicted in Figure 71. The minimum on-site water level was recorded at borehole WN01 4.09mbgl, while the deepest water level was measured at borehole ODM (80.22mbgl). The average water level is calculated at 27.42mbgl with the 5th Percentile value of the data range calculated at 7.26mbgl, 95th Percentile 55.04mbgl and the standard deviation of 14.70m. The Coefficient of Variation (CV) calculated for the water level database is relatively low (~30.0%), indicating that the regional groundwater system remains relatively constant, and it can be assumed that currently the system is in a quasi-steady state condition. The regional average water level is recorded as ~26.20mbgl (Aquiworx, 2016) while the median depth to the water table/ piezometric head according to the Limpopo WMA is approximately 28.0mbgl (Limpopo ISP, 2004). It can thus be concluded that the study area is characterised by a deeper piezometric head distribution.

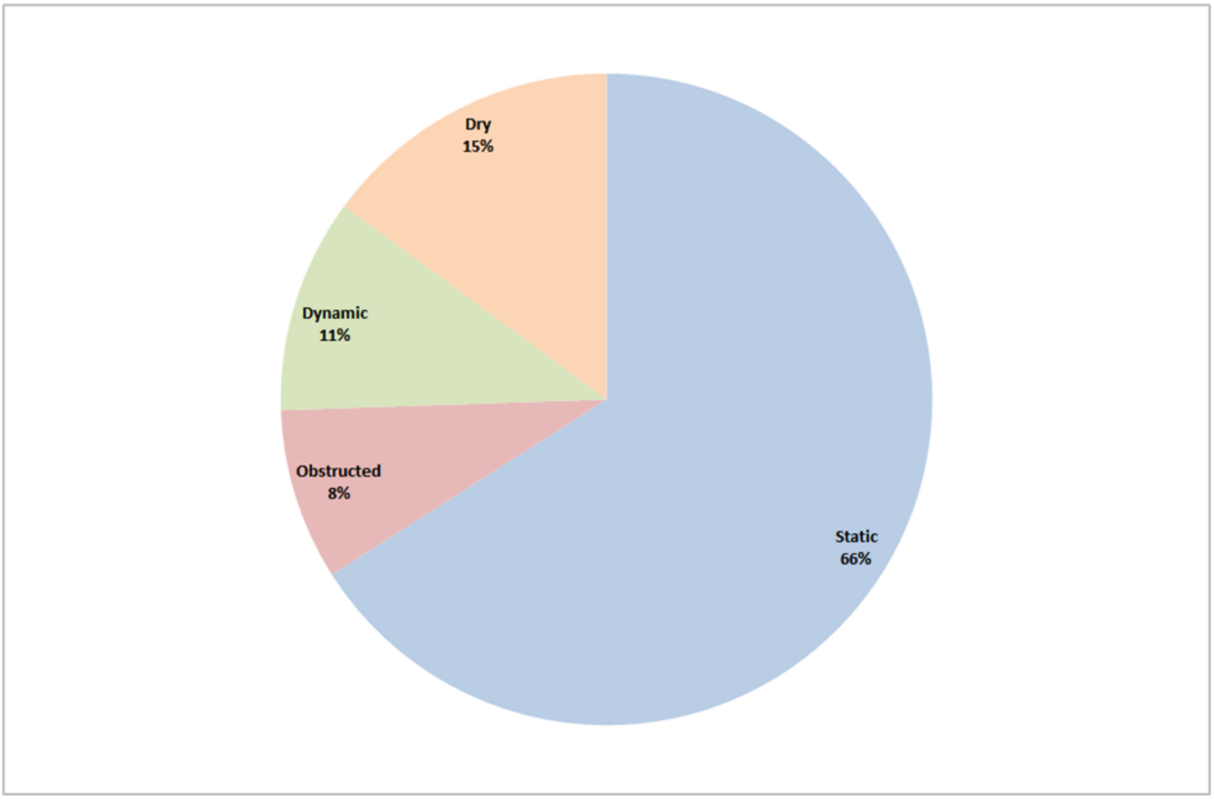


Figure 66: Hydrocensus user survey: Borehole water level status.

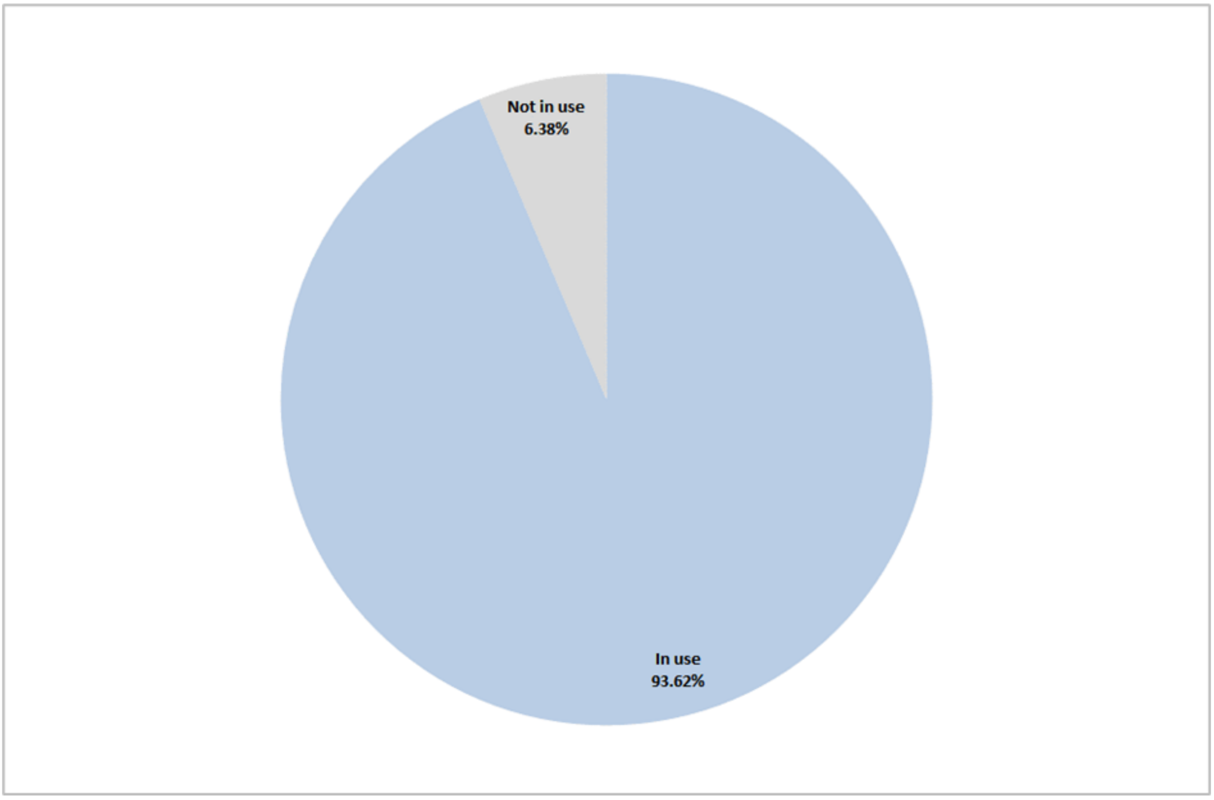


Figure 67: Hydrocensus user survey: Groundwater status.

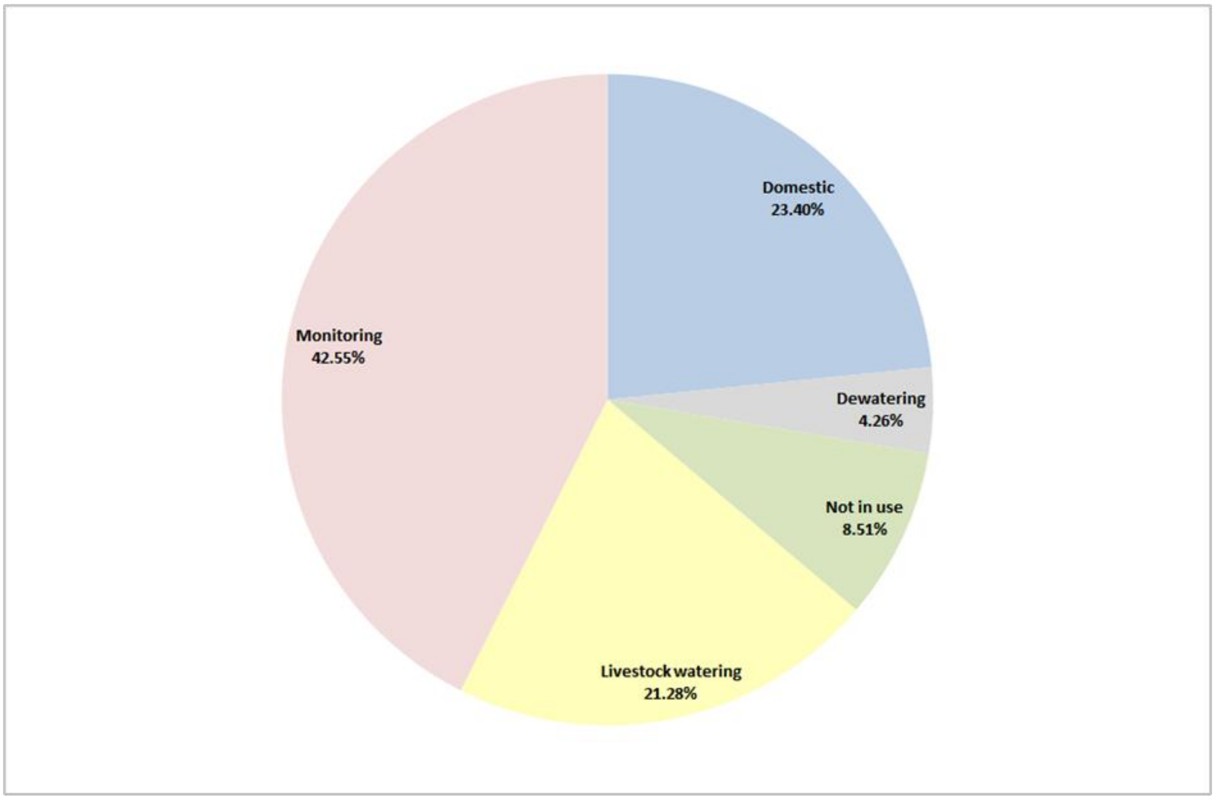


Figure 68: Hydrocensus user survey: Groundwater application.

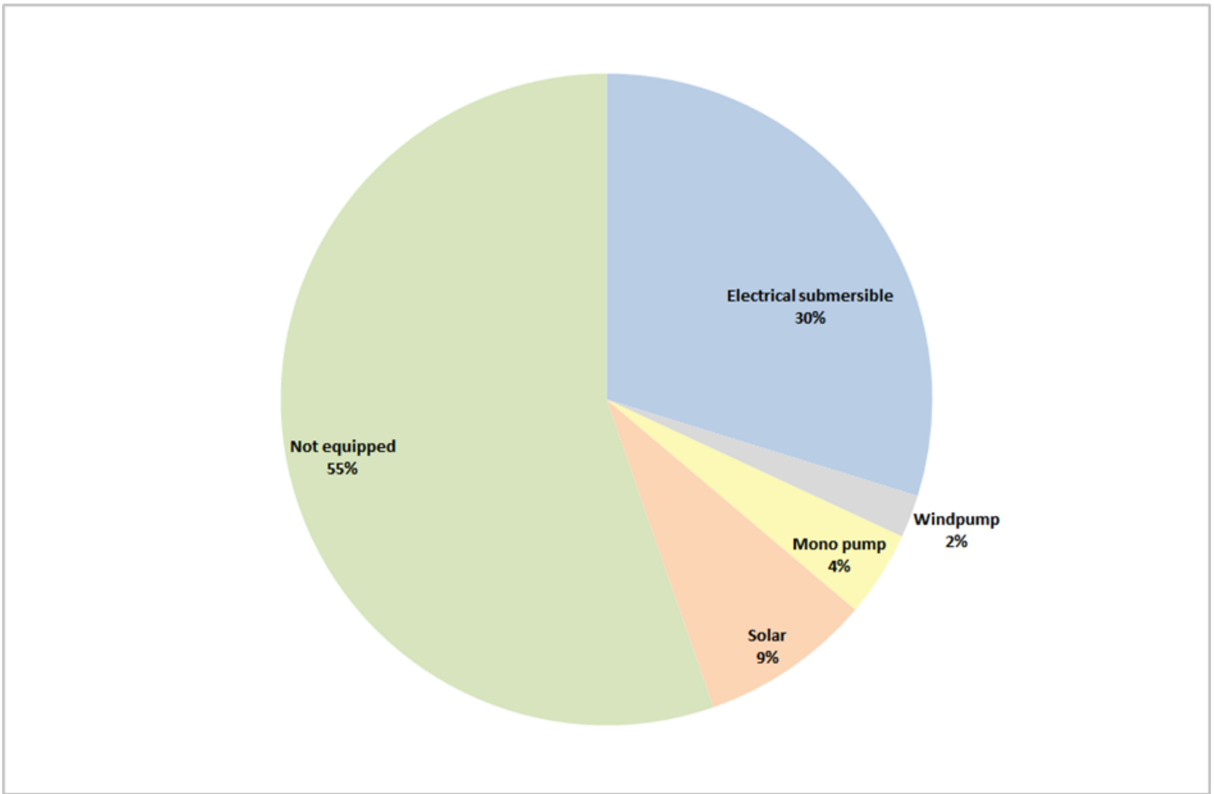


Figure 69: Hydrocensus user survey: Equipment type.

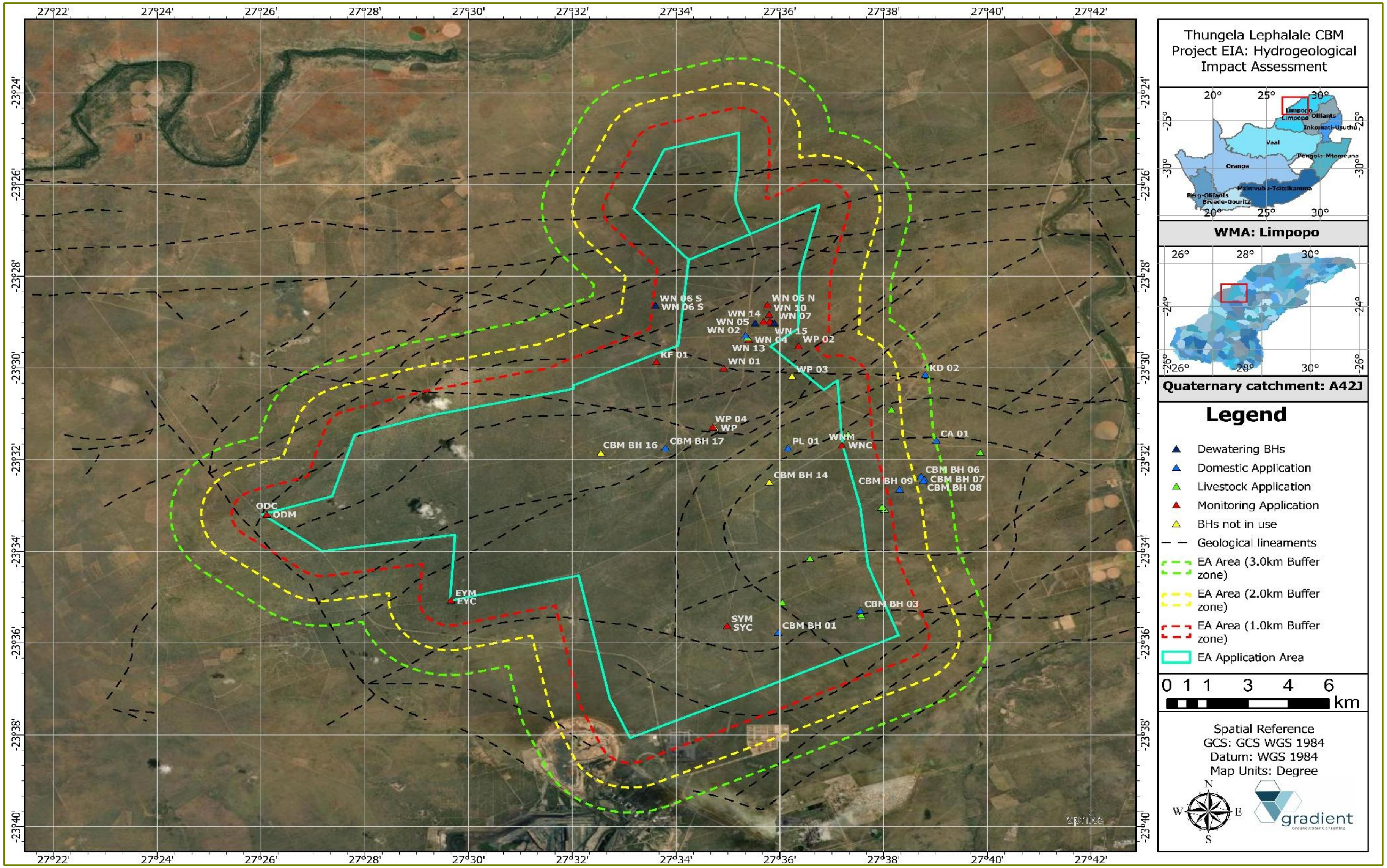


Figure 70: Spatial distribution of hydrocensus user survey geosites.

10.9.6.3 GROUNDWATER FLOW DIRECTION AND HYDRAULIC GRADIENT

Bayesian interpolation was used to interpolate the groundwater levels throughout the study area. Analysed data indicate that the surveyed water levels, representative of the deeper, fractured aquifer as well as the shallow, intergranular aquifer correlate moderately to the corresponding topographical elevation and suggest a dynamic groundwater system especially in isolated zones. The correlation between topography and groundwater head elevation is calculated at 78.0% with an R2 >0.57 as depicted in Figure 71. It should be stated that the correlation of the topographical elevation to the hydraulic head elevation is generally very good when the dynamic water levels as well as deeper aquifer representative water levels are not taken into consideration (correlation>90.0% and R2= 0.85). Accordingly, it can be assumed that, under natural conditions, the regional groundwater flow direction will be dictated by topography.

The inferred regional groundwater flow direction of the shallow, intergranular aquifer will thus be towards the lower laying drainage system of the Mokolo and Limpopo Rivers and will flow in a general north to northeastern direction as depicted in Figure 72. Localised deviation in groundwater flow direction can be observed and is attributed to groundwater abstraction causing negative hydraulic gradients towards respective boreholes, altering flow directions.

Table 34: Regional water level summary.

Site ID	Topographical Elevation (mamsl)	Water level (mbgl)	Groundwater Elevation (mamsl)
CBM BH 01	864.07	19.07	845.00
CBM BH 03	866.65	19.26	847.39
CBM BH 04	851.12	22.16	828.96
CBM BH 05	852.34	21.47	830.87
CBM BH 06	852.18	21.11	831.07
CBM BH 07	845.23	21.02	824.21
CBM BH 09	844.86	21.89	822.97
CBM BH 10	854.09	25.36	828.73
CBM BH 11	855.01	24.89	830.12
CBM BH 12	869.40	24.93	844.47
CBM BH 13	834.07	22.59	811.48
CBM BH 14	873.82	26.48	847.34
CBM BH 15	839.08	34.71	804.37
CBM BH 16	902.45	32.94	869.51
CBM BH 17	877.88	22.78	855.10
WN 07	848.06	33.11	814.95
WN 09	848.63	7.03	841.60

Site ID	Topographical Elevation (mamsl)	Water level (mbgl)	Groundwater Elevation (mamsl)
WN 10	848.51	7.33	841.18
WP 04	863.55	28.02	835.53
WP	863.45	22.71	840.74
WP 03	852.00	17.25	834.75
PL 01	857.42	23.04	834.38
KD 02	836.47	19.53	816.94
CA 01	838.81	27.51	811.30
WNC	859.26	24.78	834.48
WNM	859.26	21.85	837.41
SYM	882.82	26.39	856.43
EYM	941.40	50.00	891.40
ODM	913.74	80.22	833.52
ODC	913.74	32.11	881.63
KF 01	875.67	34.94	840.73
WN 01	857.34	4.09	853.25
WP 02	846.67	30.12	816.55
WN 06 N	850.35	18.85	831.50
WN 02	852.00	47.32	804.68
WN 03	851.59	70.15	781.44
Average	861.71	27.42	834.37
Minimum	834.07	4.09	781.44
Maximum	941.40	80.22	891.40
5th Percentile	838.23	7.26	804.60
95th Percentile	913.74	55.04	872.54
Standard deviation	23.08	14.70	20.89
Correlation	0.78		

Site ID	Topographical Elevation (mamsl)	Water level (mbgl)	Groundwater Elevation (mamsl)
****Cells highlighted in red suggest a dynamic water level**			

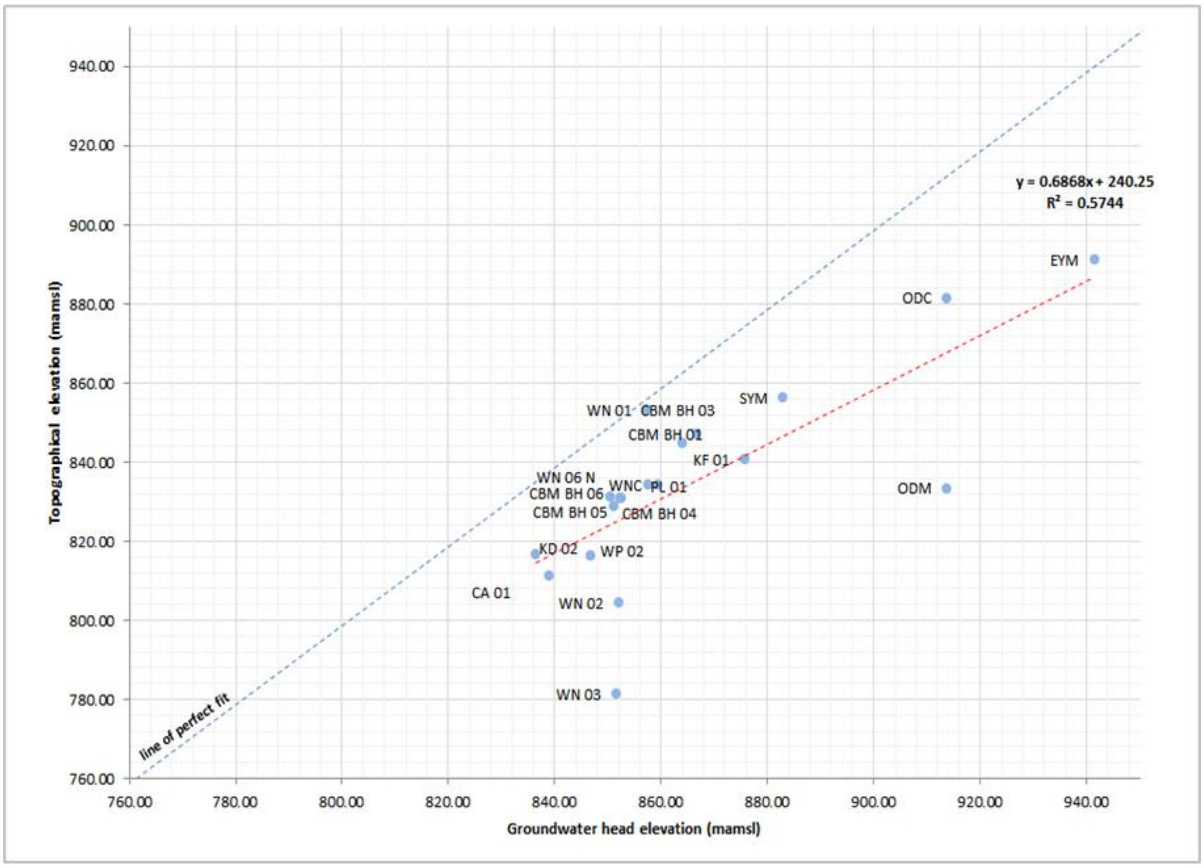


Figure 71: Topographical elevation vs. groundwater elevation correlation graph for both aquifer units.

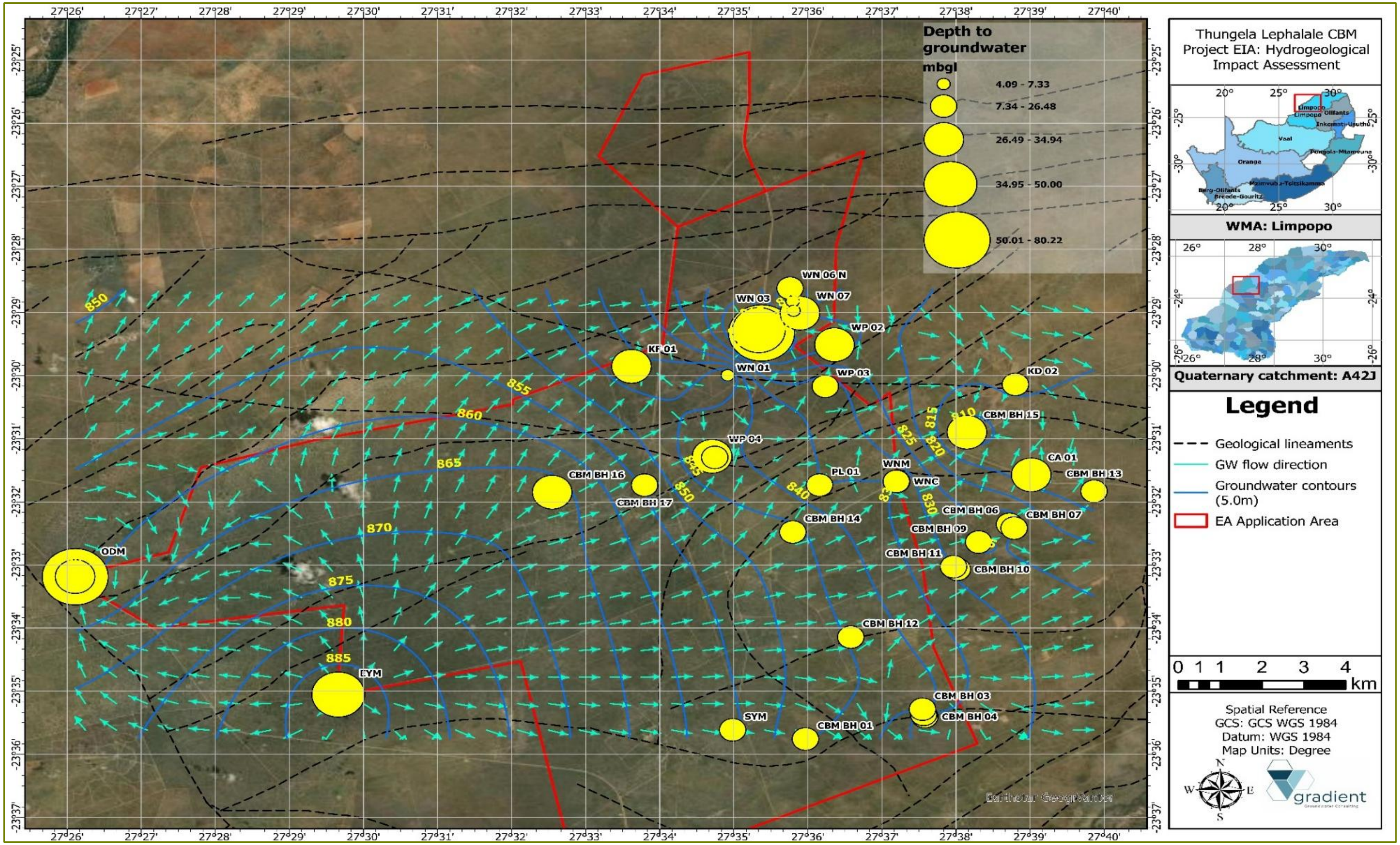


Figure 72: Regional groundwater flow direction and depth to groundwater.

10.9.7 GROUNDWATER QUALITY

The hydrochemical results of the hydrocensus boreholes water samples analysed in 2023 suggest the overall ambient groundwater quality is good with most macro and micro determinants falling within or below the SANS 241:2015 limits. Isolated boreholes indicate elevated concentrations of Nitrate and Sodium. Groundwater can be described as neutral, non-saline and moderately soft.

In contrast, water quality analysed from the deeper aquifer is moderate to poor with various macro and micro determinants including TDS, Chloride (Cl), Sodium (Na), Nitrate (NO_3) exceeding the SANS 241:2015 limits. Isolated boreholes also indicate elevated concentrations of Barium (Ba), Aluminium (Al), Fluoride (F), Lead (Pb) as well as Strontium (Sr) which makes it generally unfit for human consumption in the long-term. Groundwater can be described as neutral, saline to very saline and slightly hard to very hard. As there currently exist no external activities and/or developments in the direct vicinity of the surveyed boreholes which may contribute to these dissolved determinants observed, it can be assumed that the water qualities noted can be considered as baseline and background qualities, thus the water quality is naturally poor. It should be noted that the groundwater quality is impacted by the geological formations as underlying geology was deposited under extreme arid conditions which may contribute to high salt loads observed. The low recharge observed throughout the greater study area further contributes to the high salinity observed. It should be noted that the water quality abstracted from the alluvial, riverbed aquifer is generally good due to the higher recharge rate. The Limpopo Internal Strategic Perspective (ISP - 2004) also confirms that the groundwater quality in much of the Mokolo Key Area is generally poor.

Table 35 and Table 36 summarises water quality analysis for the hydrocensus geosites and monitoring borehole water samples analysed. Figure 73 depicts a bar-chart of the major anion and cation composition. Below is a short summary of water quality per sampling locality for privately owned and neighbouring boreholes surveyed.

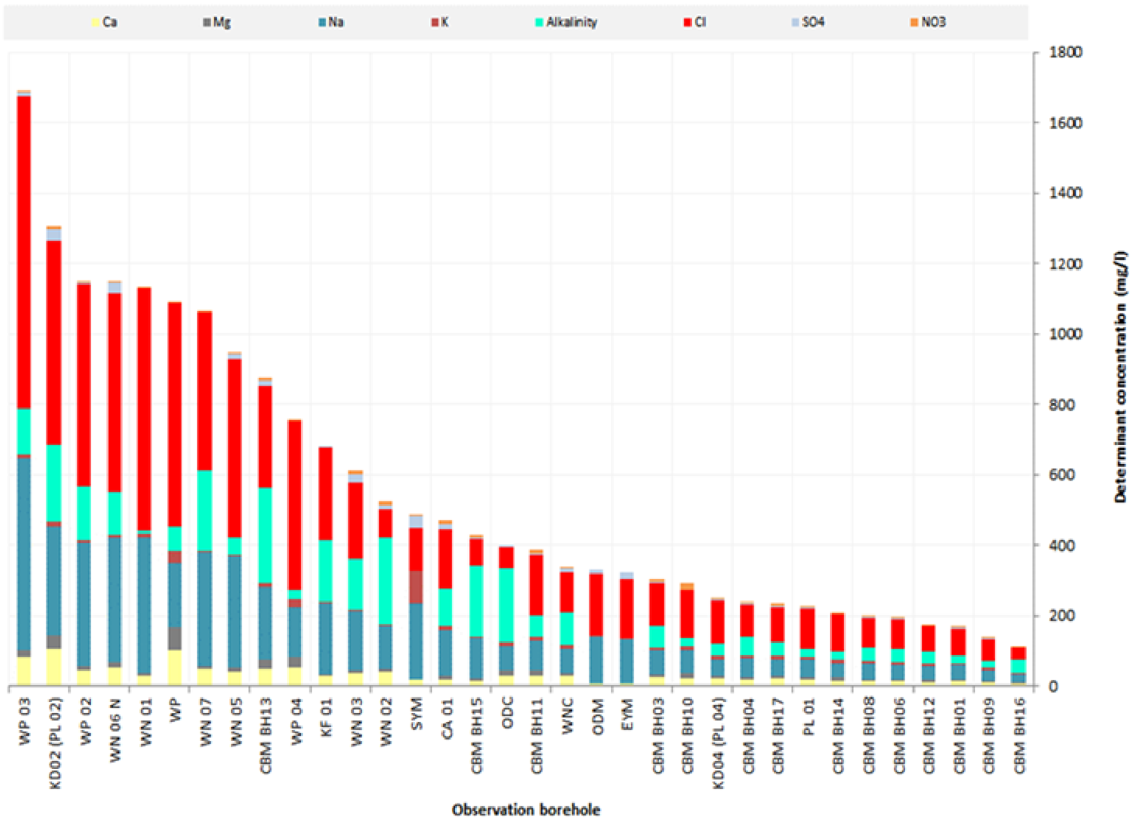


Figure 73: Hydrochemistry: Composite bar-chart indicating groundwater major anion cation composition.

Table 35: Hydrochemistry: Groundwater quality evaluation of hydrocensus samples analysed.

Determinant	Unit	Risk	SANS 241:2015 limits	CBM BH01	CBM BH03	CBM BH04	CBM BH06	CBM BH08	CBM BH09	CBM BH10	CBM BH11	CBM BH12	CBM BH13	CBM BH14	CBM BH15	CBM BH16	CBM BH17	KD02 (PL 02)	KD04 (PL 04)
Physical determinands																			
Colour	-	-	-	Clear	Clear	Clear	Clear	Greenish	Clear	Clear	Brownish	Clear	Clear	Brownish	Clear	Greyish	Clear	Clear	Clear
Temperature	°C	-	-	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
General parameters																			
pH	-	Operational	≥5.0 ≤ 9.5	6.37	6.74	6.98	6.82	6.96	6.59	6.51	6.84	6.91	7.73	7.86	7.58	7.87	7.29	6.96	6.87
EC	mS/m	Aesthetic	≤170.0	33.80	54.40	43.10	35.80	36.00	26.70	60.50	71.80	31.50	141.00	40.40	64.20	17.80	44.30	216.00	46.10
TDS		Aesthetic	≤ 1 200.0	180.40	295.85	230.93	188.37	186.93	154.16	340.43	405.69	173.00	800.02	217.23	372.82	101.73	235.19	1256.15	252.50
Total Alkalinity	CaCO3/l	-	-	21.20	63.40	55.80	38.20	39.20	16.80	23.00	62.20	35.00	273.00	20.40	199.00	34.40	37.00	217.00	35.80
Total Hardness	mg/l	-	-	54.30	99.98	81.40	59.83	58.15	42.75	113.76	138.81	51.76	236.36	75.86	69.07	27.41	88.21	426.93	84.38
DOC	mg/l		10.0	2.04	2.56	2.74	2.12	4.80	2.08	1.92	6.94	2.22	6.78	1.71	5.68	1.91	2.28	7.88	2.74
Anions																			
Cl	mg/l	Aesthetic	≤300.0	76.00	120.00	91.10	83.60	85.60	60.90	138.00	170.00	72.60	288.00	106.00	75.50	36.80	98.70	582.00	122.00
SO_4	mg/l	Acute health	≤500.0	3.64	5.91	2.43	1.82	1.39	5.61	0.67	2.61	<0.5	14.70	3.21	6.76	<0.5	7.13	31.90	5.09
F	mg/l	Acute health	≤1.50	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	0.24	<0.09	0.23	<0.09	<0.09	<0.09	0.64
NO_3< N	mg/l	Acute health	≤12.0	5.14	5.08	3.94	2.31	1.33	5.29	16.80	12.60	3.64	9.26	4.02	5.78	1.06	4.53	10.30	2.16
Cations and metals																			
Na	mg/l	Aesthetic	≤200.0	40.30	66.40	50.90	41.80	42.80	32.10	66.90	81.70	39.10	203.00	41.20	113.00	22.80	45.60	306.00	48.20
K	mg/l	Aesthetic	≤50.0	5.93	8.37	7.27	7.11	7.83	6.81	9.77	12.60	6.25	11.60	10.90	7.27	7.27	11.00	14.50	8.50
Ca	mg/l	Aesthetic	≤150.0	13.40	24.90	20.10	14.10	14.20	10.64	22.80	29.70	12.60	49.80	16.00	13.00	6.54	22.10	106.00	20.40
Mg	mg/l	Operational	70.0	5.06	9.18	7.58	5.98	5.51	3.93	13.80	15.70	4.93	27.20	8.72	8.89	2.69	8.02	39.40	8.12
Al	mg/l	Operational	0.3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.79	<0.01	<0.01	<0.01	<0.01	<0.01
Fe	mg/l	Acute health	2.0	<0.01	0.07	0.08	0.08	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.16	<0.01	0.02	<0.01	<0.01	0.04
Mn	mg/l	Operational	0.4	0.01	<0.01	<0.01	0.04	0.01	0.08	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
B	mg/l	Chronic health	2.4	0.11	0.34	0.24	0.21	0.16	0.15	0.44	0.42	0.20	0.49	0.40	0.20	0.10	0.19	0.46	0.47
As	mg/l	Acute health	0.01	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009
Ba	mg/l	Acute health	0.70	0.11	0.34	0.24	0.21	0.16	0.15	0.44	0.42	0.20	0.49	0.40	0.20	0.10	0.19	0.46	0.47
Co	mg/l	Acute health	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CN	mg/l	Acute health	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	mg/l	Chronic health	0.070	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pb	mg/l	Chronic health	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sr	mg/l	Chronic health	4.0 (EPA limit)	0.13	0.33	0.28	0.16	0.15	0.10	0.24	0.29	0.12	0.46	0.18	0.10	0.06	0.24	0.69	0.21
Zn	mg/l	Aesthetic	5.0	0.01	0.03	<0.01	0.37	0.06	0.14	0.05	<0.01	0.02	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	8.42

Note: "- " indicate that no limits have been provided by the SANS 2015:241 guidelines.
"<" below detection limit
Shaded cells exceed SANS 241:2015 drinking water guidelines.

Table 36: Hydrochemistry: Monitoring borehole water quality evaluation.

Determinant	Unit	Risk	SANS 241:2015 limits	WN 01	WN 02	WN 03	WN 05	WN 06 N	WN 07	WN 09	WN 10	WNC	WP	WP 02	WP 03	WP 04	PL 01	PL 02	PL 04	CA 01	SYM	EYM	ODM	ODC	KF 01
Physical determinands																									
Colour	-	-	-	Brownish	Brownish	Brownish	Brownish	Clear	Clear	Clear	Brownish	Clear	Clear	Rusty	Clear	Brownish	Rusty	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Temperature	°C	-	-	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
General parameters																									
pH	-	Operational	≥5.0 ≤ 9.5	8.47	8.18	7.97	7.82	7.63	7.52	6.58	6.79	8.28	7.39	7.39	7.61	6.50	6.72	6.96	6.87	7.13	11.60	10.50	10.60	7.64	7.79
EC	mS/m	Aesthetic	≤170.0	226.00	81.80	106.00	172.00	204.00	185.00	1656.00	874.00	54.80	205.00	209.00	303.00	146.00	43.80	216.00	46.10	82.80	251.00	70.10	80.60	56.10	113.00
TDS		Aesthetic	≤ 1 200.0	1140.93	469.84	591.59	928.74	1099.90	977.51	12145.14	5535.99	314.65	1070.55	1088.90	1641.00	776.57	236.68	1256.15	252.50	476.31	777.17	356.84	376.25	315.91	613.62
Total Alkalinity	CaCO3/l	-	-	7.20	249.00	147.00	52.00	124.00	226.00	1532.00	2203.00	94.00	65.40	154.00	129.00	29.40	22.00	217.00	35.80	105.00	0.00	0.00	0.00	210.00	175.00
Total Hardness	mg/l	-	-	109.94	135.17	128.93	142.13	191.84	161.79	5169.55	1526.62	101.68	516.21	160.19	283.10	251.10	74.65	426.93	84.38	92.14	44.36	20.19	15.48	133.18	98.78
DOC	mg/l		10	1.78	5.90	3.92	2.22	3.66	5.42	40.60	52.40	2.82	3.28	4.18	3.74	1.35	1.71	7.88	2.74	4.86	8.86	4.16	3.00	7.60	7.00
Anions																									
Cl	mg/l	Aesthetic	≤300.0	689.00	79.90	216.00	503.00	562.00	452.00	5488.00	1663.00	115.00	637.00	573.00	887.00	479.00	115.00	582.00	122.00	169.00	125.00	168.00	174.00	63.20	264.00
SO_4	mg/l	Acute health	≤500.0	<0.5	8.98	21.50	16.40	29.50	<0.5	1142.00	479.00	8.74	1.92	4.84	13.56	<0.5	3.39	31.90	5.09	14.10	33.20	17.70	12.60	2.92	3.06
F	mg/l	Acute health	≤1.50	0.15	0.14	0.20	0.14	0.34	0.79	<0.09	<0.09	0.14	<0.09	1.24	1.47	<0.09	0.12	<0.09	0.64	0.13	0.54	1.13	0.76	0.10	2.21
NO_3< N	mg/l	Acute health	≤12.0	0.62	12.70	11.00	0.97	0.80	0.60	7.76	9.09	4.11	1.41	0.49	0.47	0.46	4.57	10.30	2.16	13.00	3.27	<0.35	<0.35	<0.35	<0.35
Cations and metals																									
Na	mg/l	Aesthetic	≤200.0	383.00	121.00	165.00	316.00	354.00	322.00	2705.00	1510.00	70.30	184.00	351.00	546.00	144.00	51.70	306.00	48.20	128.00	219.00	125.00	136.00	67.80	199.00
K	mg/l	Aesthetic	≤50.0	11.10	3.91	3.37	4.71	6.12	4.68	49.20	33.50	9.61	35.90	5.52	10.80	20.00	7.30	14.50	8.50	13.80	88.80	4.36	3.31	10.70	3.59
Ca	mg/l	Aesthetic	≤150.0	31.10	41.50	39.30	41.60	54.40	48.30	1376.00	270.00	28.60	103.00	47.00	82.70	52.90	16.80	106.00	20.40	19.50	17.60	7.92	5.92	31.40	29.30
Mg	mg/l	Operational	70.0	7.84	7.66	7.48	9.29	13.60	10.00	421.00	207.00	7.35	62.90	10.40	18.60	28.90	7.94	39.40	8.12	10.55	0.10	0.10	0.17	13.30	6.22
Al	mg/l	Operational	0.3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.30	<0.01	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.77	0.19	0.05	<0.01	<0.01
Fe	mg/l	Acute health	2.0	<0.01	0.07	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	31.20	<0.01	<0.01	0.04	<0.01	0.23	<0.01	0.02	0.01	<0.01
Mn	mg/l	Operational	0.4	<0.01	<0.01	<0.01	0.17	0.34	0.06	0.23	0.04	<0.01	0.27	0.02	<0.01	0.81	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
B	mg/l	Chronic health	2.4	0.27	0.17	0.11	0.21	0.29	0.25	0.40	0.30	0.16	1.59	0.27	0.25	1.20	0.18	0.46	0.47	0.23	0.02	0.06	0.09	0.99	0.12
As	mg/l	Acute health	0.01	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009
Ba	mg/l	Acute health	0.70	0.27	0.17	0.11	0.21	0.29	0.25	0.40	0.30	0.16	1.59	0.27	0.25	1.20	0.18	0.46	0.47	0.23	0.02	0.06	0.09	0.99	0.12
Co	mg/l	Acute health	0.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CN	mg/l	Acute health	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ni	mg/l	Chronic health	0.070	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.16	0.37	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pb	mg/l	Chronic health	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sr	mg/l	Chronic health	4.0 (EPA limit)	0.60	0.61	0.52	1.62	1.86	1.86	17.10	12.90	0.16	2.02	1.31	1.55	0.75	0.17	0.69	0.21	0.15	0.06	0.15	0.14	0.44	0.47
Zn	mg/l	Aesthetic	5.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.41	0.21	<0.01	0.02	<0.01	<0.01	0.08	<0.01	<0.01	8.42	0.12	0.06	<0.01	<0.01	0.02	0.01

Note: "- " indicate that no limits have been provided by the SANS 2015:241 guidelines.
"<" below detection limit
Shaded cells exceed SANS 241:2015 drinking water guidelines.

10.10 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.

10.10.1 ECOLOGICALLY IMPORTANT LANDSCAPE FEATURES

The following features describe the general area and habitat based on spatial data that was available from various sources such as the provincial environmental authority and SANBI. The Geographic Information System (GIS) analysis pertaining to the relevance of the proposed project to ecologically important landscape features is summarised in Table 37.

Table 37: Summary of relevance of the proposed project to ecologically important landscape features.

Desktop Information Considered	Relevant/Irrelevant	Section
Ecosystem Threat Status	Relevant – Overlaps with a 'Least Concern' Ecosystem.	10.10.1.1
Ecosystem Protection Level	Relevant – Overlaps with a 'Poorly Protected' Ecosystem.	10.10.1.2
Provincial Conservation Plan	Relevant – The project area overlaps with Other Natural areas.	10.10.1.3
Protected Areas	Relevant – The project area is adjacent to the Gideon Troskie Private Nature Reserve and the Olifantspad private Nature Reserve.	10.10.1.4
National Protected Areas Expansion Strategy (NPAES)	Irrelevant – The project area does not overlap with any NPAES areas.	Not applicable. No overlaps with any NPAESs.
Important Bird and Biodiversity Areas	Not Applicable – The nearest IBA is the 'Waterberg System' IBA situated just over 12 km east of the project area.	N/A
South African Inventory of Inland Aquatic Ecosystems	Relevant – The 500m Regulated area overlaps with a Least Concerned (LC) wetland.	10.10.1.5
National Freshwater Priority Area	Relevant – The 500m Regulated area overlaps with unclassified and true Freshwater Ecosystem Priority Area (FEPA) wetlands.	10.10.1.610.10.1.6
Strategic Water Source Areas (SWSA)	Irrelevant – The project area does not overlap with any SWSAs.	Not applicable. No overlaps with any SWSAs.

10.10.1.1 **ECOSYSTEM THREAT STATUS**

The Ecosystem Threat Status is an indicator of an ecosystem's wellbeing, based on the level of change in structure, function or composition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Least Concern (LC), based on the proportion of the original extent of each ecosystem type that remains in good ecological condition. According to the spatial dataset the proposed project overlaps with a LC ecosystem (Figure 74).

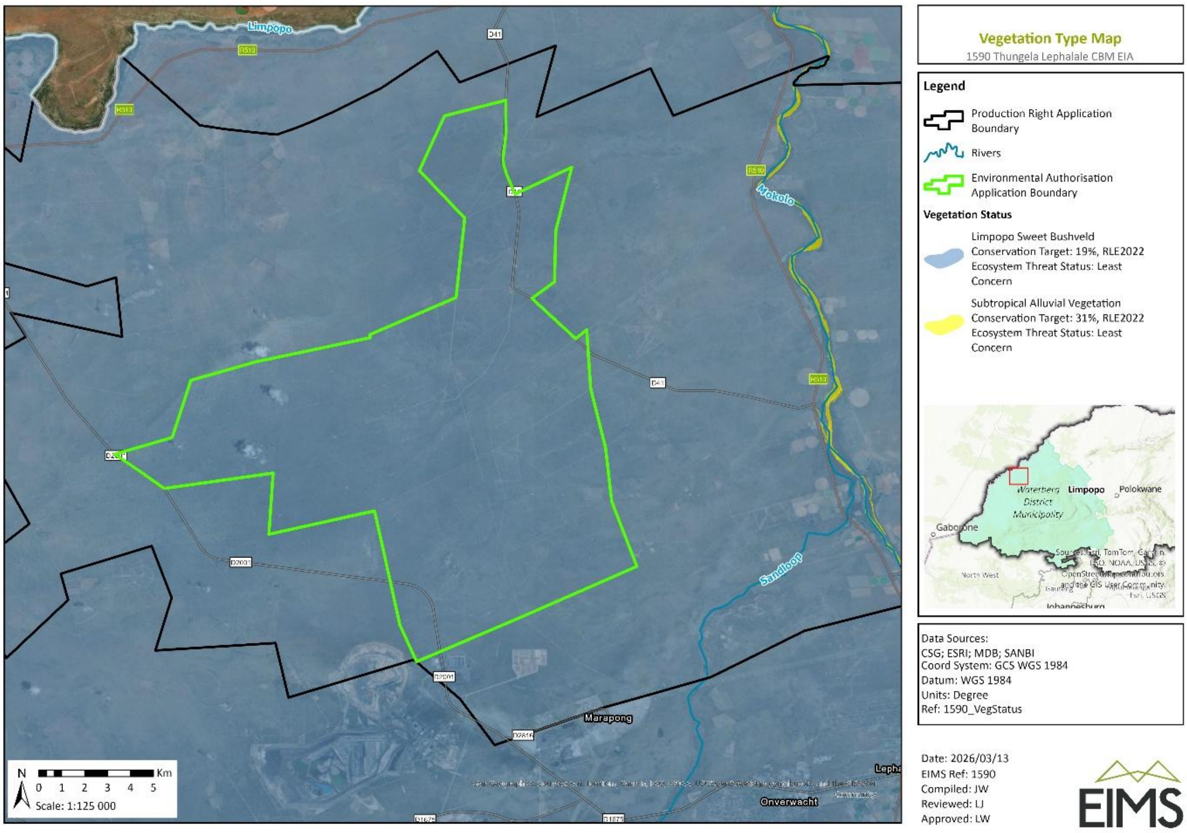


Figure 74: Map illustrating the vegetation types, ecosystem threat status and protection level associated with the project area.

10.10.1.2 ECOSYSTEM PROTECTION LEVEL

This is an indicator of the extent to which ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Well Protected (WP), Moderately Protected (MP), Poorly Protected (PP), or Not Protected (NP), based on the proportion of the biodiversity target for each ecosystem type that is included within one or more protected areas. NP, PP or MP ecosystem types are collectively referred to as under-protected ecosystems. The proposed project overlaps with a PP ecosystem namely the Limpopo Sweet Bushveld vegetation unit (Figure 74).

10.10.1.3 CRITICAL BIODIVERSITY AREAS AND ECOLOGICAL SUPPORT AREAS

The Limpopo Conservation Plan, Version 2 (LCPv2), was completed in 2013 for the Limpopo Department of Economic Development, Environment & Tourism (LEDET) (Desmet *et al.*, 2013). The purpose of the LCPv2 was to develop the spatial component of a bioregional plan (i.e. map of Critical Biodiversity Areas and associated land-use guidelines). The previous Limpopo Conservation Plan (LCPv1) was completely revised and updated (Desmet *et al.*, 2013). A Limpopo Conservation Plan map was produced, and sites were assigned to the following CBA categories based on their biodiversity characteristics, spatial configuration and requirement for meeting targets for both biodiversity pattern and ecological processes:

- Critical Biodiversity Area 1 (CBA1);
- Critical Biodiversity Area 2 (CBA2);
- Ecological Support Area 1 (ESA1);
- Ecological Support Area 2 (ESA2);
- Other Natural Area (ONA);

- Protected Area (PA); and
- No Natural Remaining (NNR).

Figure 75 shows the project area superimposed on the Limpopo Conservation Plan CBA map. Based on this, the project area overlaps with:

- Other Natural Areas (ONA) which are natural and intact but not required to meet targets or identified as CBA or ESA.

Additionally, the Waterberg District Bioregional Plan (Desmet *et al.*, 2013) which indicates the location of the Waterberg Biosphere Reserve in relation to the project area, as well as the CBA categories occurring within the district can be seen in Figure 76.

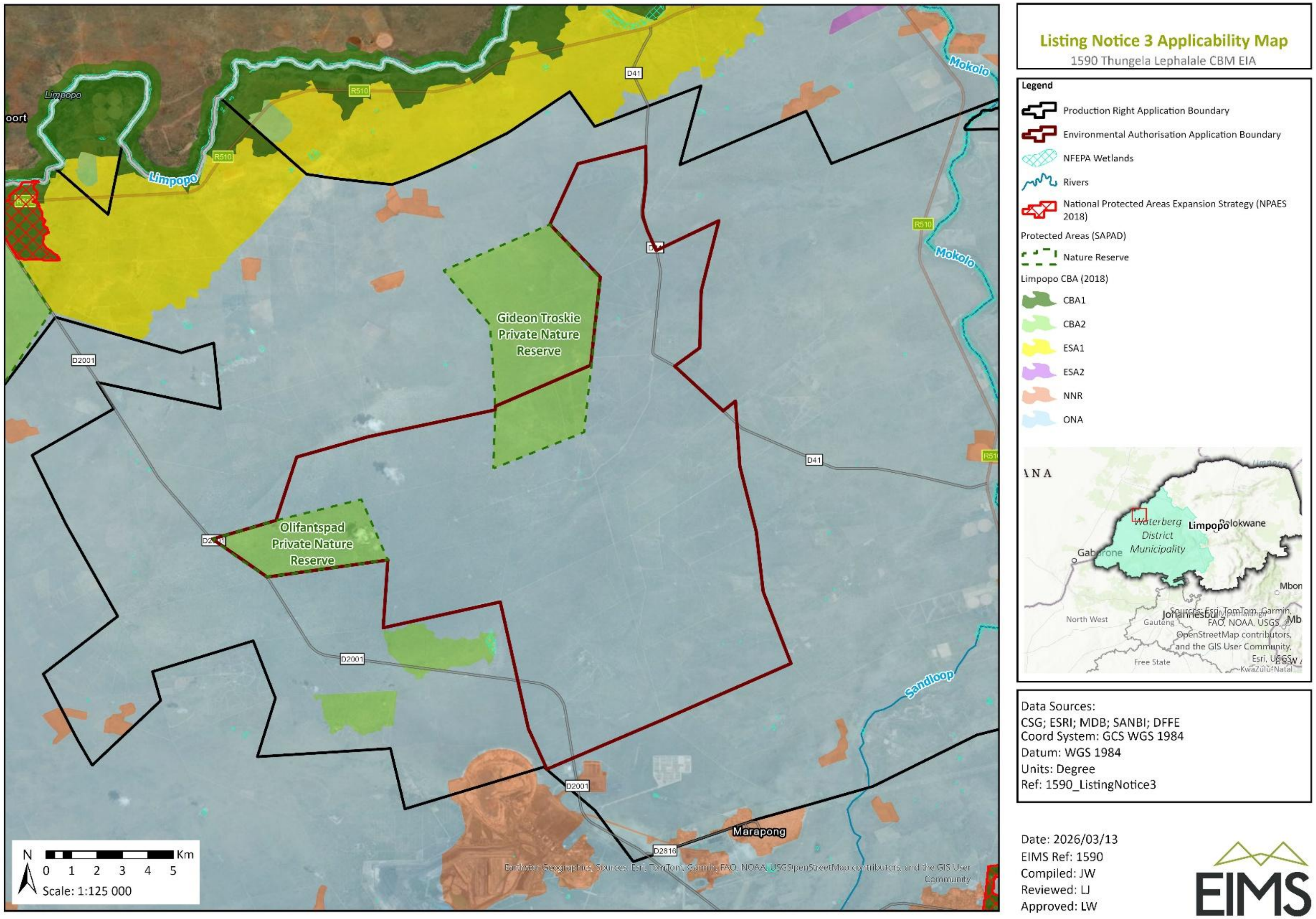


Figure 75: Map illustrating the project area in relation to the Limpopo Conservation Plan.

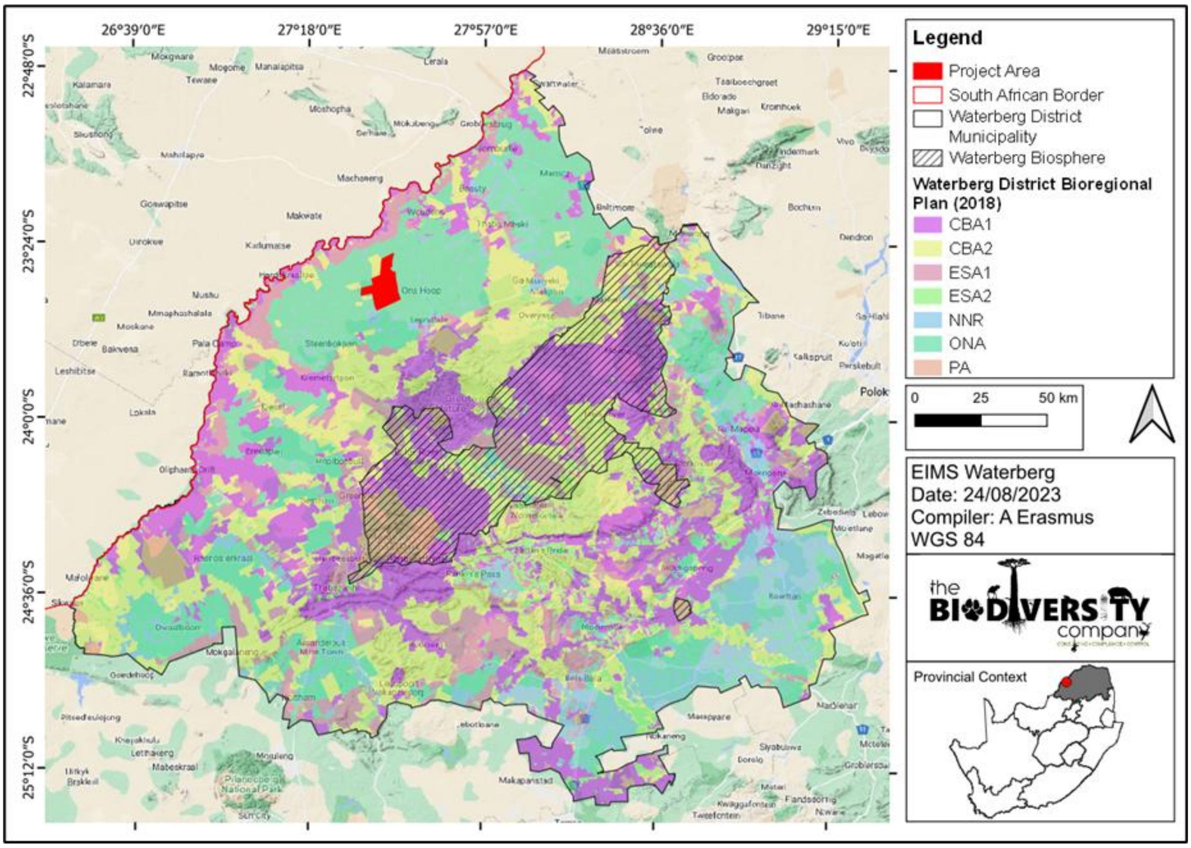


Figure 76: Map illustrating the project area in relation to the Waterberg District Bioregional Plan.

10.10.1.4 NATIONAL PROTECTED AREAS EXPANSION STRATEGY

The NPAES (2018) areas were identified through a systematic biodiversity planning process. They present the best opportunities for meeting the ecosystem-specific protected area targets set in the NPAES and were designed with a strong emphasis on climate change resilience and requirements for protecting freshwater ecosystems. These areas should not be seen as future boundaries of protected areas, as in many cases only a portion of a particular focus area would be required to meet the protected area targets set in the NPAES. They are also not a replacement for fine scale planning which may identify a range of different priority sites based on local requirements, constraints and opportunities (NPAES, 2018). According to available geospatial datasets, the two Protected Areas are located within the Production Right application area, namely the Gideon Troskie Private Nature Reserve and the Olifantspad Private Nature Reserve (Figure 77). Further consultation with the landowner of Gideon Troskie Private Nature Reserve has confirmed that this Protected Area is managed as a commercial game farm and not as a protected area. Similarly, Olifantspad Private Nature Reserve is owned by Thungela and is managed similarly to the other properties owned by Thungela (i.e. game farming).

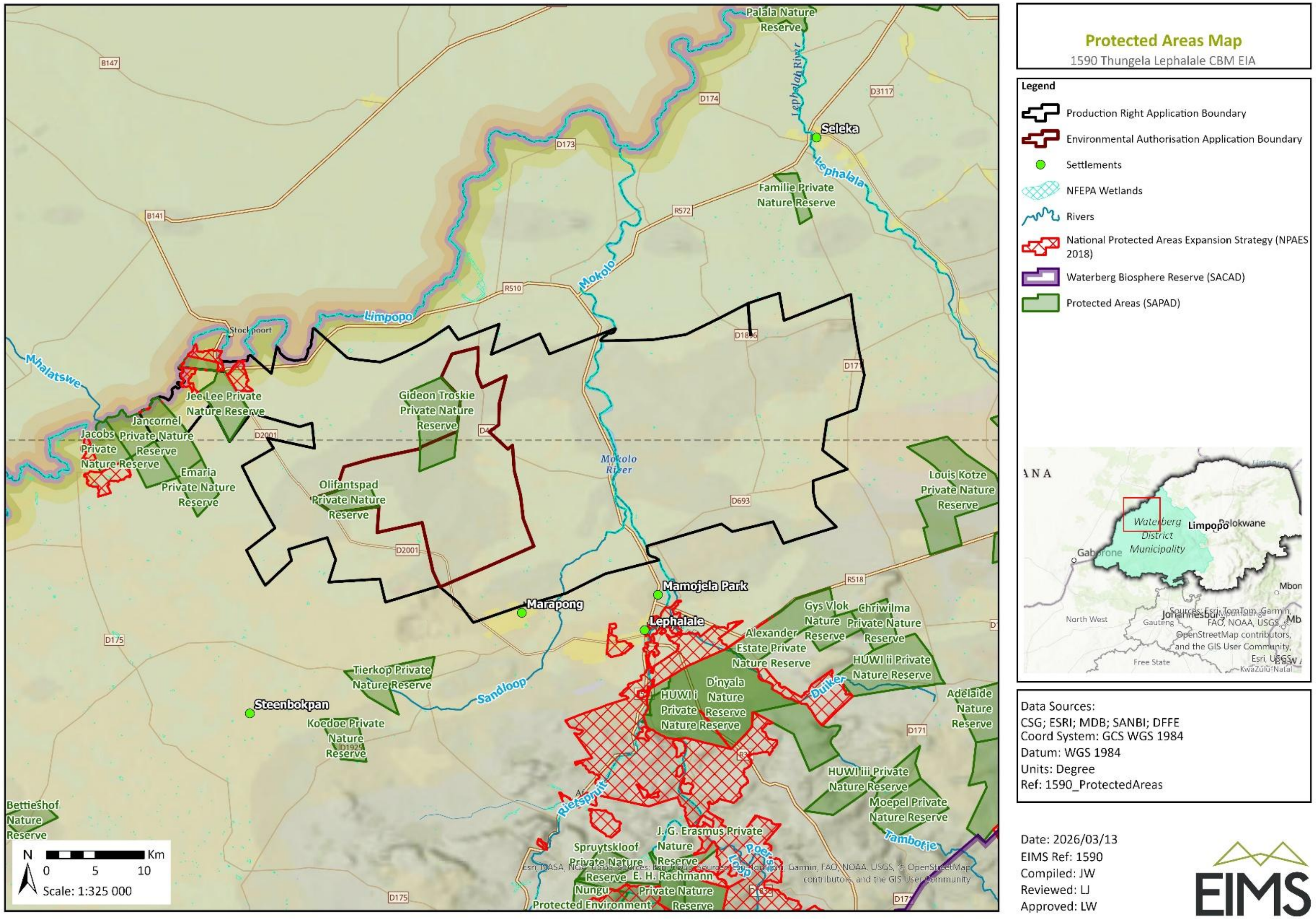


Figure 77: The project area in relation to the National Protected Area Expansion Strategy.

10.10.1.5 **HYDROLOGICAL SETTING**

The South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was released with the NBA 2018. Ecosystem threat status (ETS) of river and wetland ecosystem types are based on the extent to which each river ecosystem type had been altered from its natural condition. Ecosystem types are categorised as CR, EN, VU or LT, with CR, EN and VU ecosystem types collectively referred to as 'threatened' (Skowno *et al.*, 2019; Van Deventer *et al.*, 2019). The project area overlaps with LC SAIIAE wetlands (Figure 78).

10.10.1.6 **NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREA STATUS**

In an attempt to better conserve aquatic ecosystems, South Africa has categorised its river systems according to set ecological criteria (i.e., ecosystem representation, water yield, connectivity, unique features, and threatened taxa) to identify FEPAs (Driver *et al.*, 2011). The FEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the NEMBA biodiversity goals (Nel *et al.*, 2011). The project area overlaps with unclassified FEPA and true FEPA wetlands (Figure 79).

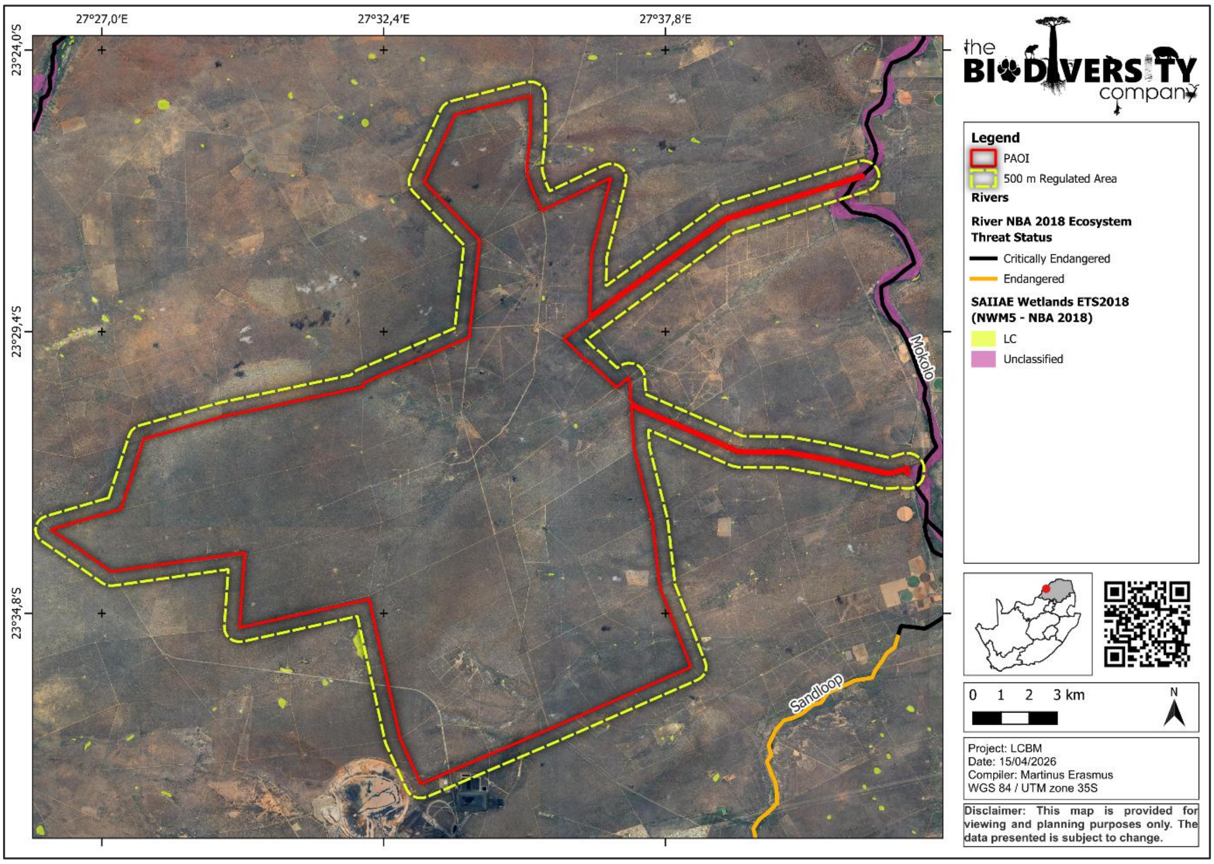


Figure 78: Map illustrating the ecosystem threat status of rivers and wetland ecosystems in the project area.

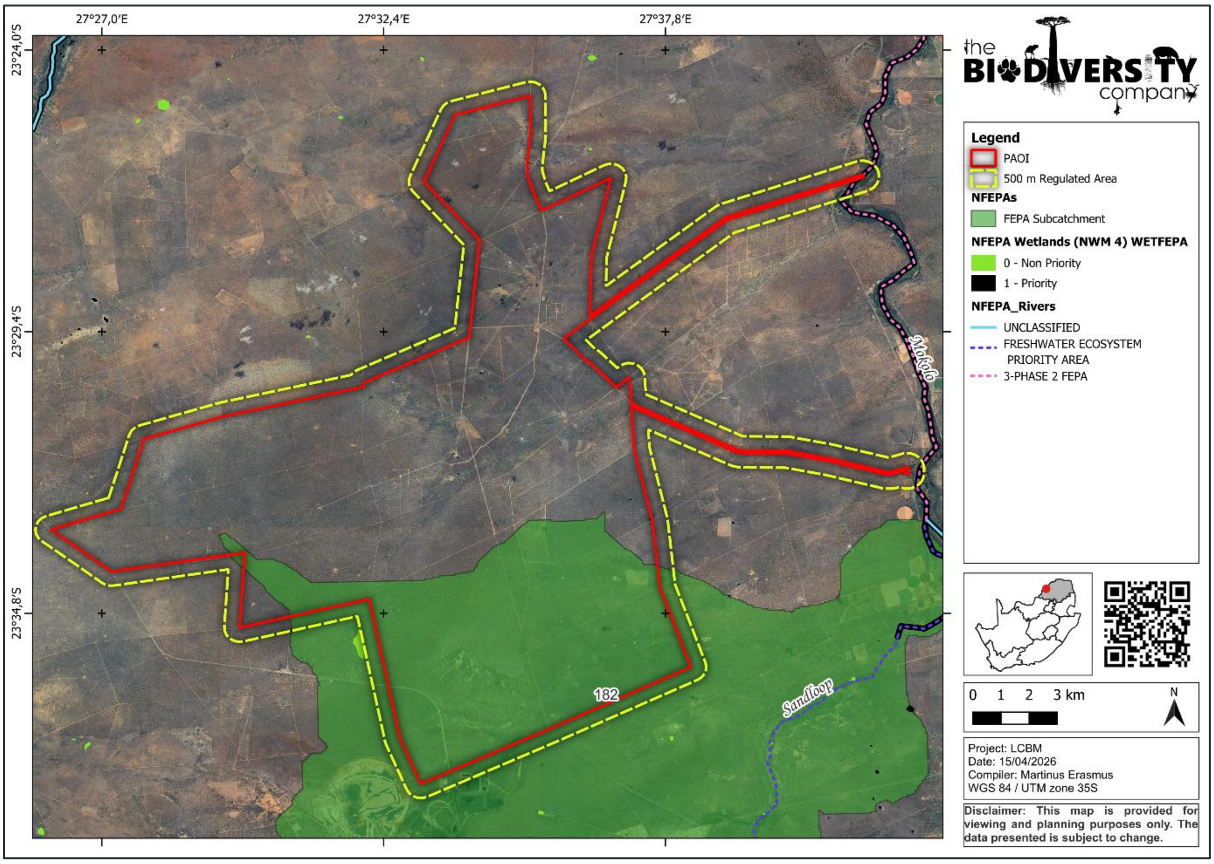


Figure 79: The project area in relation to the NFEPA & NWM5 datasets.

10.10.2 FLORA ASSESSMENT

This section is divided into a description of the vegetation type expected to occur under natural conditions and the expected flora species.

10.10.2.1 VEGETATION TYPE

The project area is situated within the savanna biome. The savanna vegetation of South Africa represents the southernmost extension of the most widespread biome in Africa (Mucina & Rutherford, 2006). Major macroclimatic traits that characterise the Savanna biome include:

- Seasonal precipitation; and
- (Sub) tropical thermal regime with no or usually low incidence of frost (Mucina & Rutherford, 2006).

Most savanna vegetation communities are characterised by an herbaceous layer dominated by grasses and a discontinuous to sometimes very open tree layer (Mucina & Rutherford, 2006). The savanna biome is the largest biome in South Africa, extending throughout the east and north-eastern areas of the country. Savannas are characterised by a dominant grass-layers, over-topped by a discontinuous, but distinct woody plant layer. At a structural level, Africa's savannas can be broadly categorised as either fine-leaved (microphyllous) savannas or broad-leaved savannas. Fine-leaved savannas typically occur on nutrient rich soils and are dominated by microphyllous woody plants of the Mimosaceae family (common genera include *Acacia* and *Albizia*) and a generally dense herbaceous layer (Scholes & Walker, 1993).

On a fine-scale vegetation type, the project area overlaps with the Limpopo Sweet Bushveld vegetation type (Figure 74). The Limpopo Sweet Bushveld is categorised as Near-Endemic to the Waterberg District.

The Limpopo Sweet Bushveld is found from the lower reaches of the Crocodile and Marico Rivers around Makoppa and Derdepoort, down to the Limpopo River Valley including Lephalale and to the Usutu border post and Taaiboschgroet area in the north. The landscape features plains which are sometimes irregular or undulating and transversed by tributaries of the Limpopo River. The vegetation type features short open woodland with impenetrable thickets of *Vachellia erubescens*, *V. mellifera* and *Dichrostachys cinerea* in disturbed areas (Mucina & Rutherford, 2006).

Important plant taxa are those species that have a high abundance, a frequent occurrence or are prominent in the landscape within a particular vegetation type (Mucina & Rutherford, 2006). The following species are important in the Limpopo Sweet Bushveld. (d = dominant)

- Graminoids: *Digitaria eriantha subsp. eriantha, Enneapogon cenchroides (d), Eragrostis lehmanniana (d), Panicum coloratum (d), Schmidtia pappophoroides (d), Aristida congesta, Cymbopogon nardus, Eragrostis pallens, E. rigidior, E. trichophora, Ischaemum afrum, Panicum maximum, Setaria verticillate, Stipagrostis uniplumis, Urochloa mosambicensis* (Mucina & Rutherford, 2006).
- Herbs: *Acanthosicyos naudinianus, Commelina benghalensis, Harpagophytum procumbens subsp, transvaalense, Hemizygia elliotii, Hermbstaedtia odorata, Indigofera daleoides* (Mucina & Rutherford, 2006).
- Succulent Herbs: *Kleinia fulgens, Plectranthus neochilus* (Mucina & Rutherford, 2006).
- Low Shrubs: *Acacia tenuispina (d), Commiphora africana, Felicia muricata, Gossypium herbaceum subsp. africanum, Leucosphaera bainesii* (Mucina & Rutherford, 2006).
- Tall Shrubs: *Catophractes alexandri (d), Dichrostachys cinerea (d), Phaeoptilum spinosum (d), Rhigozum obovatum (d), Cadaba aphylla, Combretum hereroense, Commiphora pyracanthoides, Ehretia rigida subsp. rigida, Euclea undulata, Grewia flava, Gymnosporia senegalensis* (Mucina & Rutherford, 2006).
- Small Trees: *Senegalia erubescens (d), Vachellia fleckii (d), V. nilotica (d), V. Senegal var. rostrata (d), Albizia anthelmintica (d), Boscia albitrunca (d), Combretum apiculatum (d), Terminalia sericea*.
- Tall Trees: *Vachellia robusta (d), Senegalia burkei*.

According to Mucina and Rutherford (2006), the Limpopo Sweet Bushveld vegetation type is classified as Least Threatened. The national target for conservation protection for this vegetation type is 19%, but less than 1% is statutorily conserved and limited to conserved in the southeastern limits of the unit, such as in the D'Nyala Nature Reserve. Very little conserved in other reserves. About 5% of the unit is transformed, mainly due to cultivation.

10.10.2.2 EXPECTED FLORA SPECIES

The Plants of Southern Africa (POSA) database indicates that 609 species of indigenous plants are expected to occur within the project area (the full list of species and the Species of Conservation Concern (SCC) will be provided in the EIA Phase report).

The project screening tool indicates that one (1) sensitive species may occur in the region (*Corchorus psammophilus* known commonly as Sand Jute or Sandy Gusha) which is vulnerable and has a high likelihood of occurrence within the application area and this triggers a medium plant species theme sensitivity for the project area.

10.10.3 FAUNA ASSESSMENT

This section of the report details the lists of expected SCC fauna species that may occur within the Project Area, where the fauna species considered include avifauna, mammals, reptiles, and amphibians.

10.10.3.1 AMPHIBIANS

Based on the FrogMap, 25 amphibian species are expected to occur within the project area (the full list will be provided in the EIA Phase assessment). One (1) amphibian SCC is expected to occur within the project area (*Pyxicephalus adspersus* – Giant Bull Frog) and it has a moderate likelihood of occurrence. The Giant Bull Frog is listed as near threatened on a regional scale. It is a species of drier savannahs. It is fossorial for most of the year, remaining buried underground in cocoons. They emerge at the start of the rains, and breed in shallow, temporary waters in pools, pans and ditches (IUCN, 2017). Due to the presence of suitable habitat, the likelihood of occurrence is listed as moderate.

10.10.3.2 **REPTILES**

Based on the ReptileMAP database, 76 reptile species are expected to occur within the area (the full list will be provided in the EIA Phase assessment). One (1) species is regarded as an SCC (*Crocodylus niloticus* – Nile Crocodile). It has been assigned a low likelihood of occurrence in the project area as there are no suitable permanent water resources for this species within the study area.

10.10.3.3 **MAMMALS**

The MammalMap lists 83 non-volant mammal species that could be expected to occur within the area (the full list will be provided in the EIA Phase assessment). The large mammal species usually confined to protected areas and game reserves have been excluded. Seven (7) of these expected species are regarded as SCCs (Table 38). Five (5) of these species have been assigned a moderate likelihood of occurrence in the application area, while four (4) have been assigned a low likelihood.

The screening tool indicates two (2) sensitive mammal species likely to occur in the Project area, triggering a medium animal species theme sensitivity. This species is included in the table below and indicated by an asterisk (*).

Table 38: Threatened mammal species that are expected to occur within the project area.

Species	Common Name	Conservation Status		Likelihood of Occurrence
		Regional	Global	
Dasymys robertsii*	Robert's Marsh Rat*	VU	Unlisted	Moderate
Hippopotamus amphibius	Common Hippopotamus	LC	VU	Low
Leptailurus serval	Serval	NT	LC	Moderate
Lycaon pictus*	African Wild Dog*	EN	EN	Low
Miniopterus schreibersii	Schreiber's Long - fingered Bat	Unlisted	VU	Low
Panthera pardus	Leopard	VU	VU	Moderate
Parahyaena brunnea	Brown Hyena	NT	NT	Moderate
Redunca fulvorufula	Mountain Reedbuck	EN	EN	Low
Smutsia temminckii	Ground Pangolin	VU	VU	Moderate

Dasymys robertsii (Robert's Marsh Rat) is listed as NT on a regional scale and LC on a global scale. African Marsh Rats are dependent on intact rivers and wetland ecosystems, as they have not been found in artificial or degraded wetlands and are thus patchily distributed within the assessment region. The likelihood of occurrence has been rated as moderate due to the availability of small wetlands (game waterholes) within the project area.

Leptailurus serval (Serval) occurs widely through sub-Saharan Africa and is commonly recorded from most major national parks and reserves (IUCN, 2017). The Serval's status outside reserves is not certain, but they are inconspicuous and may be common in suitable habitat as they are tolerant of farming practices provided there is cover and food available. In sub-Saharan Africa, they are found in habitat with well-watered savanna long-grass environments and are particularly associated with reedbeds and other riparian vegetation types. The likelihood of occurrence has been assigned as moderate due to the habitat type.

Panthera pardus (Leopard) has a wide distributional range across Africa and Asia, but populations have become reduced and isolated, and they are now extirpated from large portions of their historic range (IUCN, 2017). Impacts that have contributed to the decline in populations of this species include continued persecution by farmers, habitat fragmentation, increased illegal wildlife trade, excessive harvesting for ceremonial use of skins, prey base declines and poorly managed trophy hunting (IUCN, 2017). Although known to occur and persist outside of formally protected areas, the densities in these areas are considered to be low. The likelihood of occurrence is rated as moderate due to the habitat type and proximity to protected areas.

Parahyaena brunnea (Brown Hyaena) is endemic to southern Africa. This species occurs in dry areas, generally with annual rainfall less than 100 mm, particularly along the coast, semi-desert, open scrub and open woodland savanna. Given its known ability to persist outside of formally protected areas the likelihood of occurrence of this species in the project area is moderate to good. The presence of moderate to large herbivores on adjacent farms increases the likelihood of occurrence of this species to moderate.

Smutsia temminckii (Temminck's Ground Pangolin) is a predominantly solitary, terrestrial species that inhabits mainly savanna woodland in low-lying regions with moderate to dense scrub where average annual rainfall is between 250 mm and 1,400 mm (IUCN, 2017). The species is eaten as bushmeat to various extents across its range (e.g. South Africa, Zimbabwe, Namibia, Mozambique, Tanzania). Of greater threat is overexploitation for body parts and scales which have superstitious value and are used for medicinal purposes (IUCN, 2017). The likelihood of occurrence in the project area is rated as moderate due to appropriate habitat.

10.10.3.4 **AVIFAUNA**

The South African Bird Potential Atlas (SABAP2) Data lists 234 avifauna species that could be expected to occur within the area (the full list will be provided in the EIA Phase assessment). Six (6) of these expected species are regarded as SCC (Table 39).

The screening tool indicates four (4) sensitive species likely to occur in the Project area, triggering a high animal species theme sensitivity. These species are included in the table below and indicated by an asterisk (*). Three (3) of these SCCs species have been assigned a low likelihood of occurrence due to a lack of suitable habitat and food sources in the project area and six (6) have a moderate likelihood of occurrence.

Table 39: Threatened avifauna species that are expected to occur within the project area.

Species	Common Name	Conservation Status		Likelihood of Occurrence
		Regional	Global	
Aquilla rapax*	Tawny Eagle*	EN	VU	Moderate
Aquilla verreauxii	Verreaux's Eagle	VU	LC	Low
Ardeotis kori	Kori Bustard	NT	NT	Moderate
Ciconia nigra	Black Stork	VU	LC	Low
Coracias garrulus	European Roller	NT	LC	Moderate
Gyps africanus*	White-backed Vulture*	CR	CR	Moderate

Species	Common Name	Conservation Status		Likelihood of Occurrence
		Regional	Global	
Gyps coprotheres	Cape Vulture	EN	EN	Low
Polemaetus bellicosus*	Martial Eagle*	EN	EN	Moderate
Terathopius ecaudatus *	Bateleur*	EN	EN	Moderate

Aquilla rapax (Tawny Eagle) is listed as EN on a regional scale and as VU on a global scale. The regional population of this species appears to have decreased at a rate greater than 50% over three generations. The species occupies dry open habitats from sea level to 3000m and will occupy both woodland and wooded savannah. The likelihood of occurrence is moderate due to the availability of suitable habitat.

Ardeotis kori (Kori Bustard) is listed as NT both on a regional and global scale. It occurs in flat, arid, mostly open country such as grassland, karoo, bushveld, thornveld, scrubland and savanna but also including modified habitats such as wheat fields and firebreaks. Collisions with high voltage power lines are a major threat to this species in the Karoo of South Africa (IUCN, 2007). The likelihood of occurrence is rated as moderate due to appropriate habitat.

Coracias garrulous (European Roller) is a winter migrant from most of South-central Europe and Asia occurring throughout sub-Saharan Africa (IUCN, 2017). The European Roller has a preference for bushy plains and dry savannah areas (IUCN, 2017). There is a moderate chance of this species occurring in the project area due the appropriate habitat and prey species.

Gyps africanus (White-backed Vulture) has a large range and only occurs throughout sub-Saharan Africa. Primarily a lowland species of open wooded savanna, particularly areas of Acacia (Vachellia). It requires tall trees for nesting. According to the IUCN (2017) this species faces similar threats to other African vultures, being susceptible to habitat conversion to agro-pastoral systems, loss of wild ungulates leading to a reduced availability of carrion, hunting for trade, persecution and poisoning. The likelihood of suitably large trees for nesting for this species is low at the project site, but due to the relatively pristine nature of the project area and the abundance of game on the property and surrounding properties, the likelihood of occurrence for the species is moderate.

Polemaetus bellicosus (Martial eagle) is listed as EN on a regional scale and VU on a global scale. This species has an extensive range across much of sub-Saharan Africa, but populations are declining due to deliberate and incidental poisoning, habitat loss, reduction in available prey, pollution and collisions with power lines (IUCN, 2017). It inhabits open woodland, wooded savanna, bushy grassland, thornbush and, in southern Africa, more open country and even sub-desert (IUCN, 2017). Due to the appropriate habitat, and proximity to protected areas, the likelihood of occurrence is rated as moderate.

Terathopius ecaudatus (Bateleur) is listed as EN both regionally and globally and has undergone very rapid declines in population due to poisoning, pesticides and disturbance of nests (BirdLife International 2023c). This species occurs throughout southern Africa as well as is south-west Arabia and habitat includes grasslands, savanna and thorny shrubland. It is usually resident but may be nomadic. Food includes mammals and birds, as well as reptiles, carrion, insects and even bird eggs and crabs. Nesting occurs in large trees in December – August in southern Africa (BirdLife International 2023c). The likelihood of occurrence is rated as moderate due to the proximity to protected areas and the availability of suitable habitat.

10.11 AIR QUALITY

Measured data for the period January 2020 to August 2023 from the Lephalale Ambient Monitoring Station, managed by the DFFE and downloaded from the South African Air Quality Information System (SAAQIS) site, was used to describe the regions ambient and meteorological conditions. The station is located ~12.5 km south of the project. Meteorological and ambient data measured at Eskom monitoring stations in the area have been requested and will be incorporated into the impact assessment.

10.11.1 LOCAL WIND FIELD

The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Tiwary and Colls, 2010).

Period and diurnal wind roses drawn from the Lephalale monitoring station data are shown in Figure 80. During the period January 2020 to August 2023, the wind field was dominated by winds from the east-northeast. Calm conditions occurred 37% of the time, with the average wind speed of 1.4 m/s. Wind speeds decreased during night-time conditions with an increase in calms to 53%.

Seasonal wind roses for the site (Figure 81) reflect the predominant period wind flow pattern with higher wind speeds observed during spring.

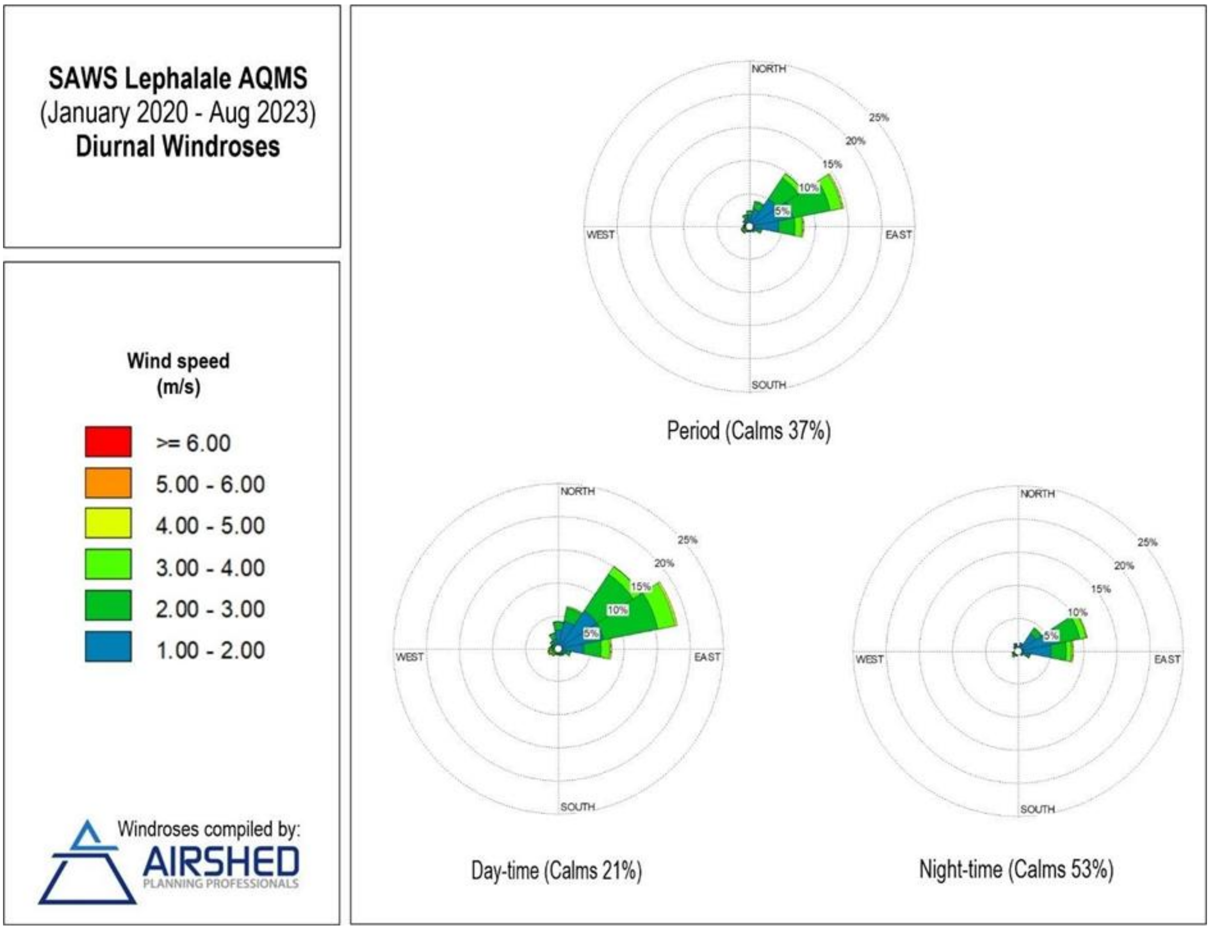


Figure 80: Period average, daytime and night-time wind roses (measured data; January 2020 to August 2023; DFFE Lephalale monitoring station).

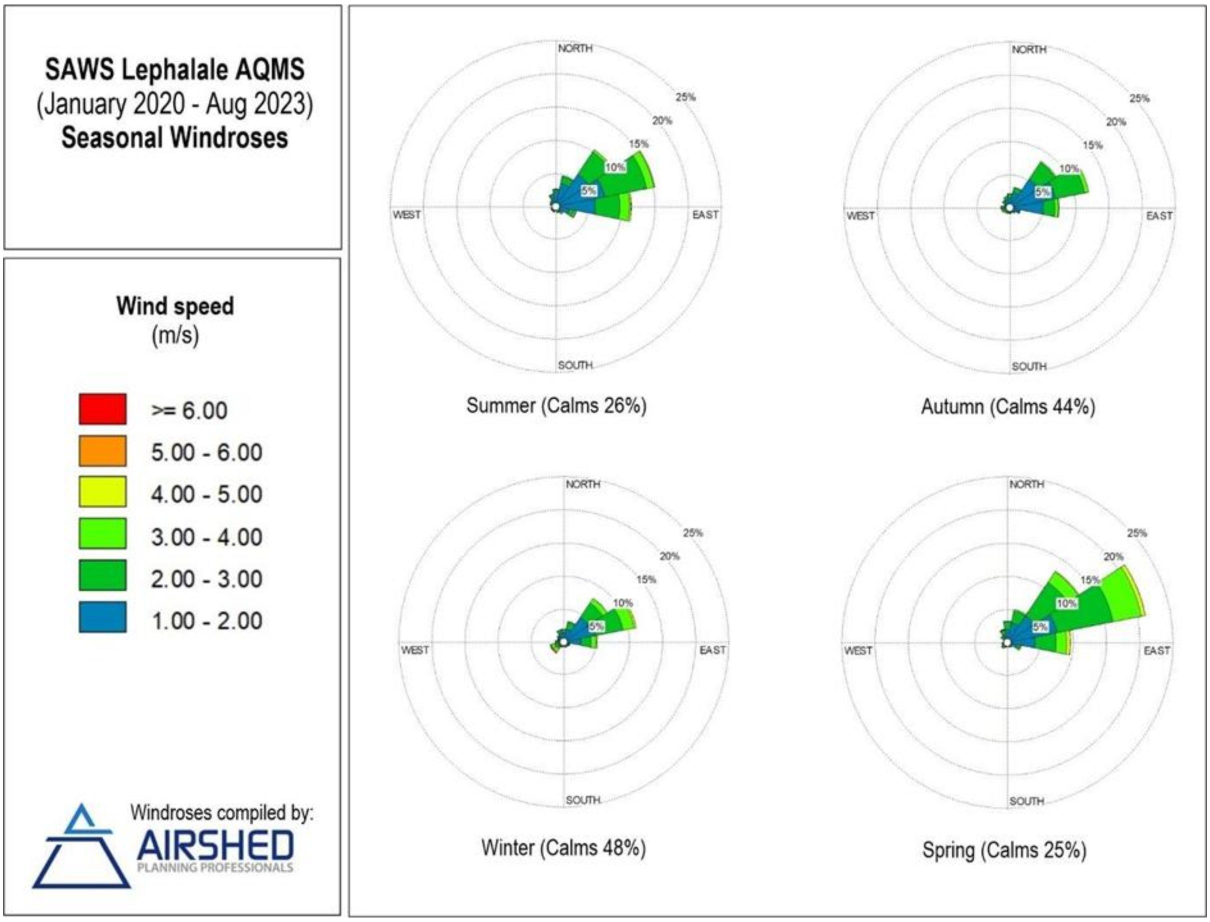


Figure 81: Seasonal wind roses (measured data; January 2020 to August 2023; DFFE Lephalale monitoring station).

10.11.2 AMBIENT TEMPERATURE

Air temperature is important, both for determining the: (i) effect of plume buoyancy (the larger the temperature difference between the emission plume and the ambient air, the higher the plume can rise), and (ii) development of the mixing and inversion layers.

Monthly mean, maximum and minimum temperatures are given in Table 40. Diurnal temperature variability is presented in Figure 3-4. Average monthly temperatures ranged between 14.5°C and 26.2°C. During the day, temperatures increase to reach maximum at about 15:00 in the late afternoon. Ambient air temperature decreases to reach a minimum at between 06:00 and 07:00, i.e., just before sunrise.

Table 40: Monthly average temperature summary (DFFE Lephalale monitoring station for the period January 2020 to August 2023).

	Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	15.3	15.1	12.7	8.8	2.2	1.1	0.4	3.7	5.9	11.4	15.2	14.7
Average	26.2	25.4	24.4	21.7	17.9	15.0	14.5	18.2	22.5	24.9	25.3	25.2
Maximum	38.0	37.8	37.8	36.2	33.2	32.8	30.8	36.1	37.3	40.4	40.5	37.7

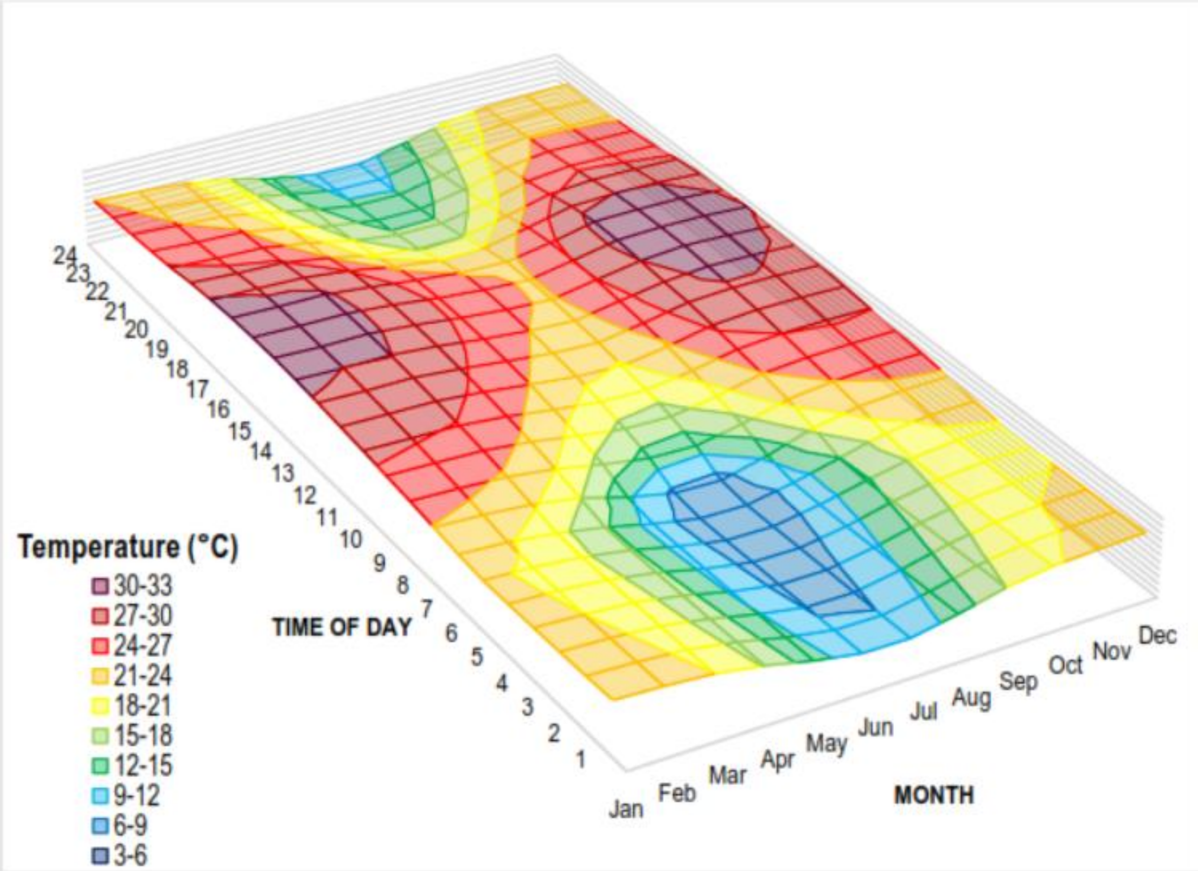
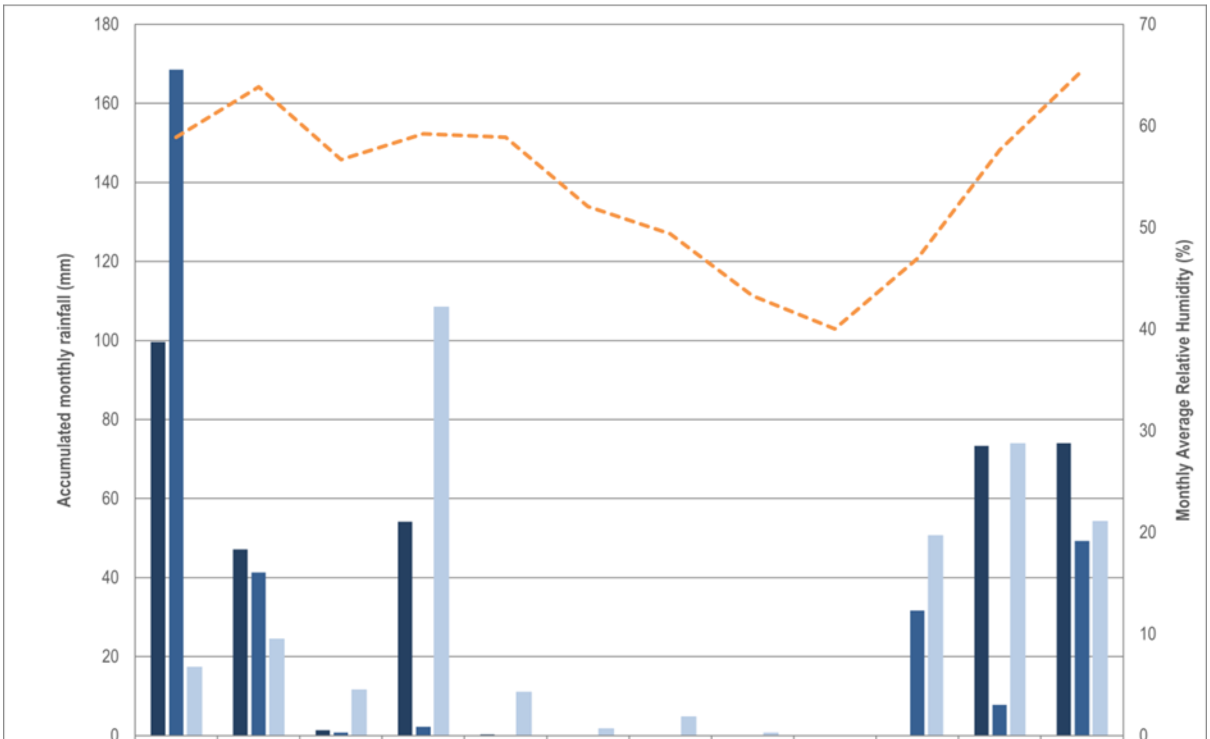


Figure 82: Diurnal temperature profile (DFFE Lephalale monitoring station for the period January 2020 to August 2023).

10.11.3 RAINFALL

Precipitation is important to air pollution studies since it represents an effective mechanism of removing pollutants from the environment. On its way to the surface rainwater combines with lots of pollutants in atmosphere; this process may alter the composition of rain by making it acidic, but this also means that the pollutants are removed from the atmosphere which may reduce the impacts on human health. The measured rainfall for the DFFE Lephalale monitoring station for the period January 2020 to August 2023 is provided in Figure 83.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	99.6	47.1	1.4	54.2	0.3	0	0	0	0	0	73.3	74
2021	168.5	41.3	0.8	2.3	0.1	0	0	0	0	31.7	7.8	49.3
2022	17.3	24.4	11.6	108.4	11	1.7	4.7	0.7	0	50.6	73.9	54.2
RH (%)	59	64	57	59	59	52	49	43	40	47	58	65

Figure 83: Monthly rainfall (DFFE Lephalale monitoring station for the period January 2020 to August 2023).

10.11.4 AMBIENT AIR QUALITY WITHIN THE REGION

The data recorded for the DFFE Lephalale monitoring station for the period January 2020 to August 2023 includes hourly SO_2, NO_2, O_3, CO, PM10 and PM2.5. Data availability for the pollutants measured was between 82% and 55% for SO_2, between 91% and 64% for NO_2, between 94% and 61% for O_3, and between 95% and 65% for CO. The data availability for particulate matter was below 80% for the assessment period.

Exceedances of the 8-hourly NAAQS for O_3 were recorded for the period 2022. Measured SO_2, NO_2, CO, PM10 and PM2.5 concentrations were in compliance with the NAAQS for the sampling period. The existing air pollution sources in the region include 2 coal fired power stations (Medupi and Matimba), the Exxaro Grootegeluk Coal Mine and to a lesser extent the town of Lephalale and surrounding developments (including gravel roads).

10.12 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.

10.12.1 POTENTIAL SENSITIVITY RECEPTORS

Potential sensitive receptors within the project area (indicated in Figure 84), include individual households. The closest residential area is Marapong ~4 km to the southeast, Onwerwacht ~10 km to the southeast and Lephalale ~12.5 km to the southeast.

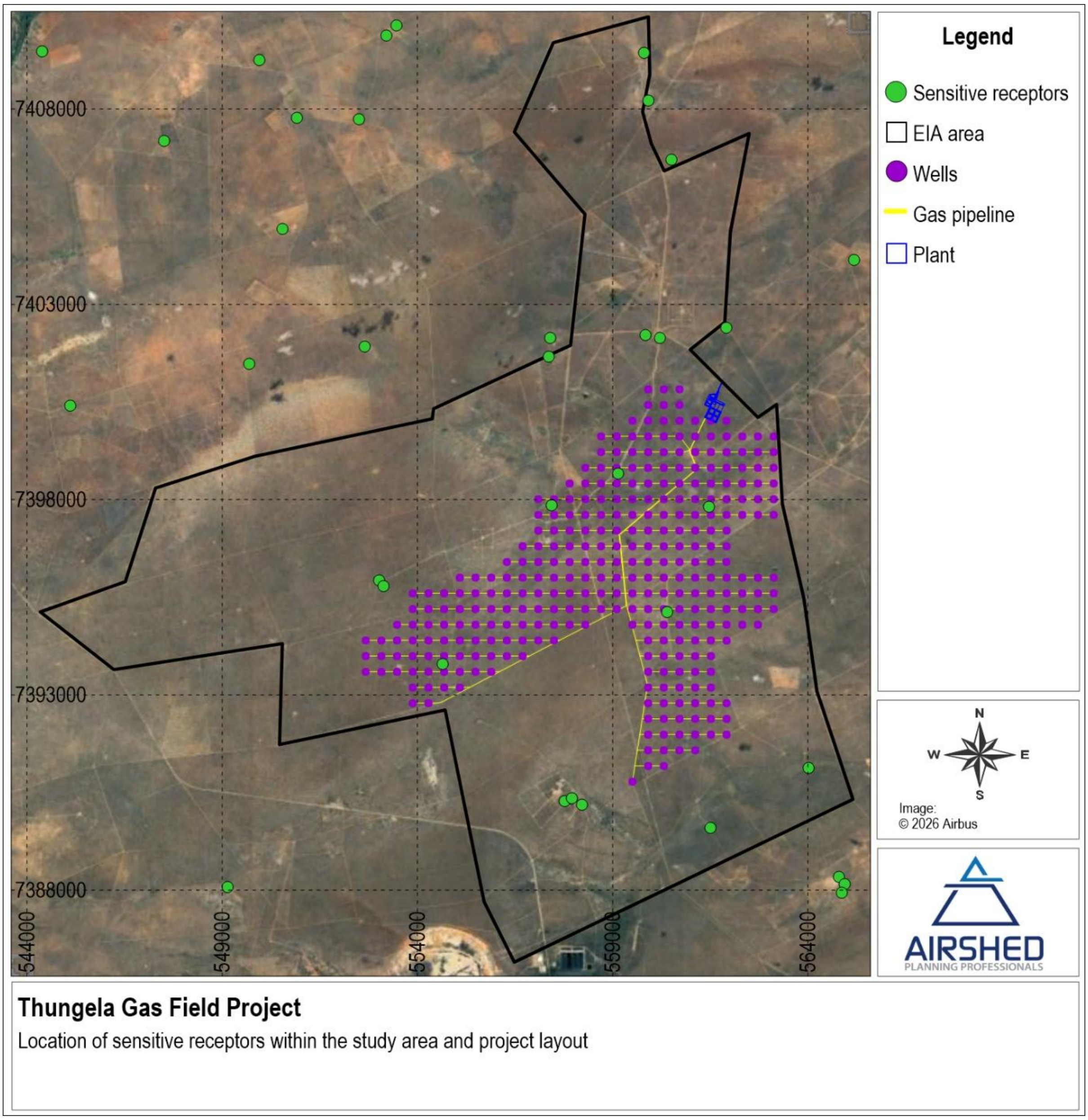


Figure 84: Project layout and potential sensitive receptors within the study area.

10.12.2 BASELINE NOISE SURVEY

Survey sites were selected after careful consideration of future activities, accessibility, potential noise sensitive receptors, and safety restrictions. A total of 5 survey sites (Site 2, Site 3, Site 4, Site 5, and Site 6) was selected for the survey conducted in July 2023. Site 1 could not be surveyed during July due to access restrictions. A second survey was then conducted in September to take noise measurements at Site 1. The locations of the survey sites are shown in Figure 85.

10.12.3 MEASURED NOISE LEVELS

The first noise survey campaign was undertaken on the 12th to the 14th of July 2023. The second noise survey was undertaken on the 13th and 14th of September 2023. The survey results are visually presented in Figure 86 (day-time results) and Figure 87 (night-time results).

The acoustic climate in the area is mainly influenced by birds, insects, domestic animals and livestock. Day-time noise survey results indicate that the acoustic climate in the study area is lower than for typical rural environments. The night-time noise survey levels measured in the study area indicate levels typical of rural to suburban environments. All sampled baseline levels are below the IFC noise guidelines and the SANS thresholds for residential areas.

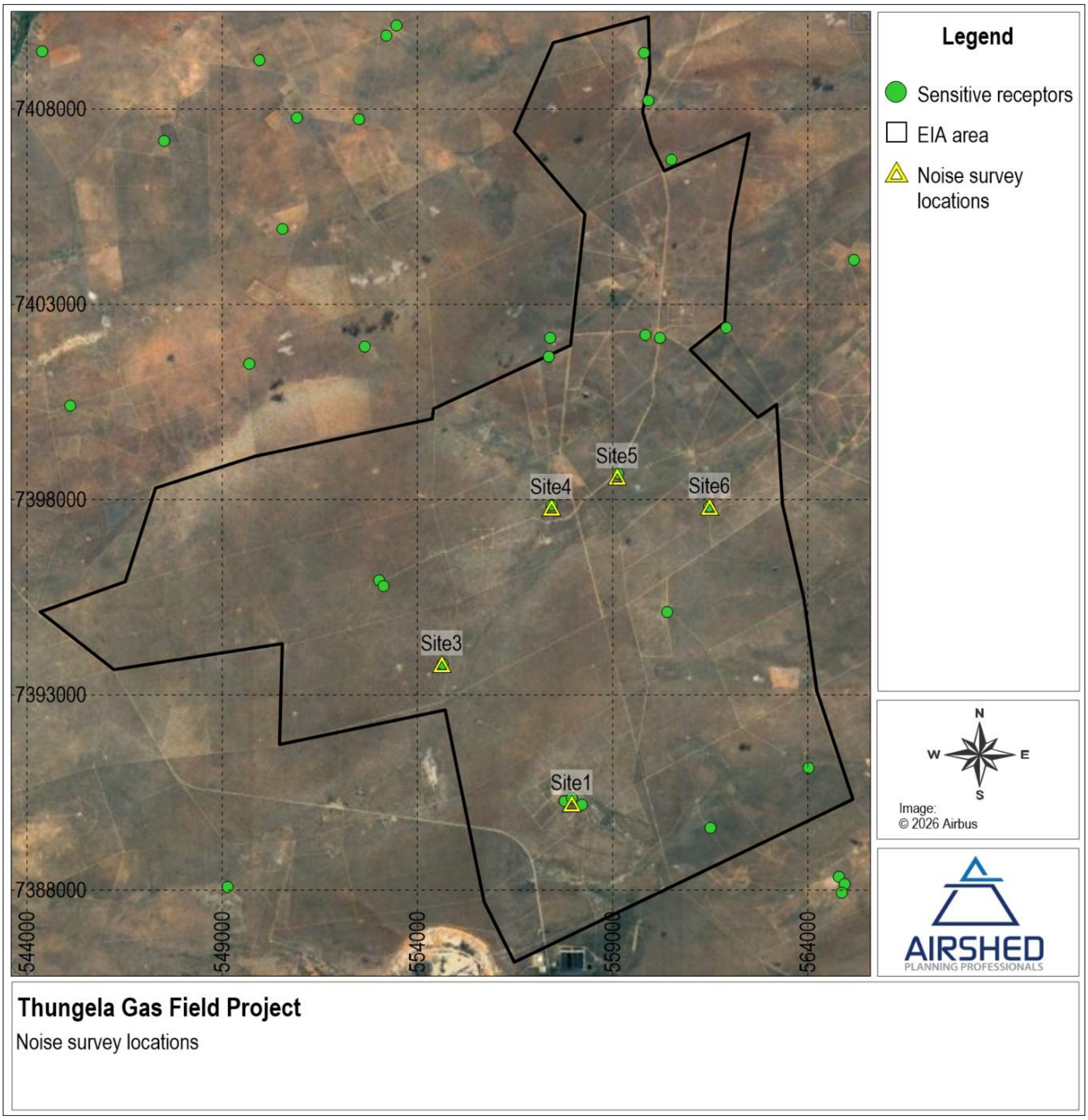


Figure 85: Location of the noise survey sites.

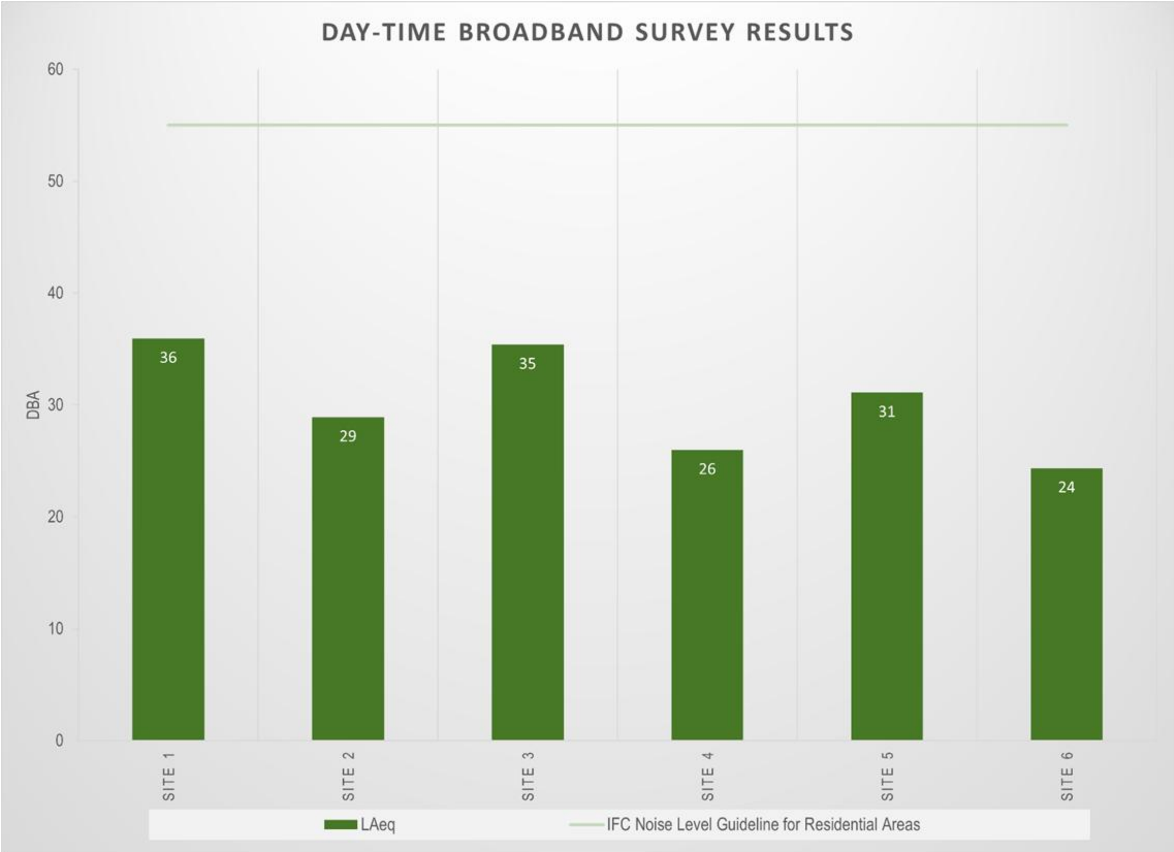


Figure 86: Day-time broadband survey results.

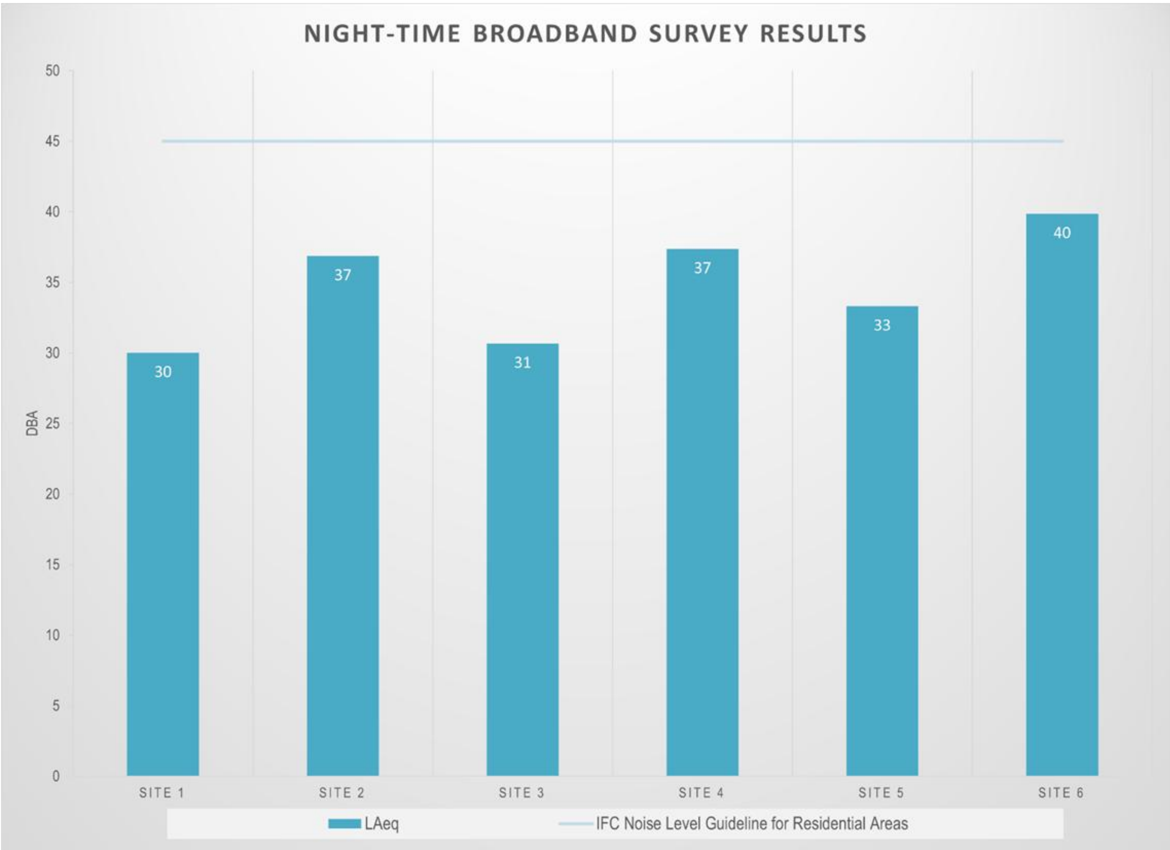


Figure 87: Night-time broadband survey results.

10.13 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.

10.13.1 LANDSCAPE CHARACTER

Landscape character is defined as “a distinct, recognisable and consistent pattern of elements in the landscape that makes one landscape different from another”. Landscape character was defined from a site visit supplemented by available online mapping and aerial photography. Key character components identified were subject to verification through the EIA site visit.

The region has a strong industrial and mining character, interspersed with agricultural activities (maize crop production) and human settlements. The region north of the proposed site appears relatively natural whilst to the south there are major industrial elements including; Exxaro’s Grootegeluk Coal Mine, Eskom’s Matimba Power Station and Eskom’s new Medupi Power Station. These existing large scale industrial elements all lie within 12km of the proposed power station site. The region to the north of the proposed site appears to have an agricultural character with large scale grazing units interspersed with isolated farmsteads.

Landscape Character is a composite of a number of influencing factors including;

- Landform and drainage
- Nature and density of development
- Vegetation patterns

10.13.2 LANDSCAPE CHARACTER AREAS AND VISUAL ABSORPTION CAPACITY

Landscape Character Areas (LCAs) are defined as “single unique areas which are the discrete geographical areas of a particular landscape type”.

Visual Absorption Capacity (VAC) is defined as the landscape's ability to absorb physical changes without transformation in its visual character and quality. Where elements that contrast with existing landscape character are proposed, VAC is dependent on elements such as landform, vegetation and other development to provide screening of a new element. The scale and texture of a landscape is also critical in providing VAC, for example; a new large scale industrial development located within a rural small scale field pattern is likely to be all the more obvious due to its scale.

The affected landscape can be broadly divided into the following LCAs that are largely defined by development.

- The Lowland Landscape Character Area is comprised of the lower slopes of the Limpopo Valley that are largely covered with semi-natural bushveld. The LCA is largely used for grazing. There also appears to be a large eco-tourism secondary bias to the land use.

  The bushveld and in particular the taller shrubs and trees that extend above head height are likely to provide significant VAC in this LCA screening outside elements from the area. It is only likely that elements outside this LCA will be obvious when the viewer is located in an elevated area above the natural vegetation or when a road alignment or clearing channels external views into the area.

- The Industrial Landscape Character Area is largely contained within the minor valley in which the development is proposed. Within this area two existing power stations and the existing Grootegeluk mine dominate the landscape. Between these facilities there are numerous large scale infrastructure elements, small urban areas as well as semi natural bushveld. Due to landform, this is a relatively enclosed character area although due to the scale of industrial elements, this zone does visually influence surrounding areas.

- The Riverine Landscape Character Area is comprised of the narrow corridor either side of the major water courses in the area. It is generally depressed below the level of the surrounding valley floor and is lined with mature vegetation that is mainly comprised of woody tree and shrub species. Whilst in areas there are irrigated arable schemes that open views across the landscape, this zone is generally inward looking with few external views.

- The Upland Landscape Character Area is comprised of the upper valley slopes, major ridgeline of the Limpopo Valley and the associated rugged terrain to the south of the proposed development area. This zone provides a high backdrop to the Industrial LCA. The rugged nature of the zone is likely to result in general screening of the development to the south. It is also likely to result in a limited number of narrow vistas into the zone along valley lines.

Visual Receptors are defined as "individuals and / or defined groups of people who have the potential to be affected by the project".

It is also possible that an area might be sensitive due to an existing use. The nature of an outlook is generally more critical to areas that are associated with recreation, tourism and in areas where outlook is critical to land values.

Visual receptors within the affected landscape that due to use could be sensitive to landscape change are indicated below.

- Area Receptors may include:
    - The urban areas of Lephalale, Marapong and Onverwacht. Areas associated with this use as are likely to be the most sensitive to possible changes in outlook associated with the proposed development. However, due to the already highly industrialised landscape backdrop and the minimal visual impact, it is unlikely that residents would object unless the proposed development is likely to significantly increase existing impacts.
    - There are a number of protected areas in the vicinity of the proposed development area. These include; the Gideon Troskie Private Nature Reserve and the Olifantspad Private Nature Reserve that adjoin the proposed development area to the west.
- Linear Receptors which include:
    - Routes through the area. Because there is such a focus on eco-tourism activities, it is likely that both major and minor routes are likely to be important. It could be argued that minor unsurfaced roads are more important than major surfaced roads as they are likely to provide access to the eco-tourism attractions. Major routes include; the R572 which provides access to the N11 to the northeast, the R510 which provides access to Lephalale and the Stockpoort Border Crossing to the northwest of the study area and the R518 to the east of the study area. It will be necessary to identify and assess impacts on these and on minor unsurfaced roads in the area.
- Point receptors:
    - In excess of 300-point receptors have been identified these in the surrounding area that include; individual farmsteads, bush camps, small groups of dwellings, and the Stockpoort Border Crossing.

10.13.3 VISUAL SENSITIVITY

The review of the proposed project indicates that the following issues need to be considered during site planning and assessment.

- No-Go Development Areas:
    - The directly affected landscape is neither protected nor is it rare, so from a landscape perspective there are no no-go areas.

Sensitivity to development relates to guiding development away from areas of the site that would make it most obvious to surrounding sensitive receptors.

- High Sensitivity Areas include:
    - A buffer of 400m has been allowed adjacent to the boundary of the nature reserves to the west (Gideon Troskie and Olifantspad Private Nature Reserves);
    - A buffer of 400m has been allowed around homesteads within the proposed development area; and
    - A buffer has been allowed adjacent to local roads running through the proposed development area.

High sensitivity indicates that as far as possible, from a landscape and visual perspective, the various project elements should be located outside this area. As long as existing vegetation remains undisturbed, the proposed project will be screened from receptors.

- Medium Sensitivity Areas include:
    - There are no medium sensitivity areas.
- Low Sensitivity Areas include:
    - All other areas of the proposed development area.

It should be noted that from a landscape and visual perspective, low sensitivity indicates that the proposed elements should as far as possible be located in this area. However, it is still critical to minimise clearance of vegetation. Visual sensitivity across the site is captured in Figure 88 which highlight Low Sensitivity (in Green) and High Sensitivity (in Red).

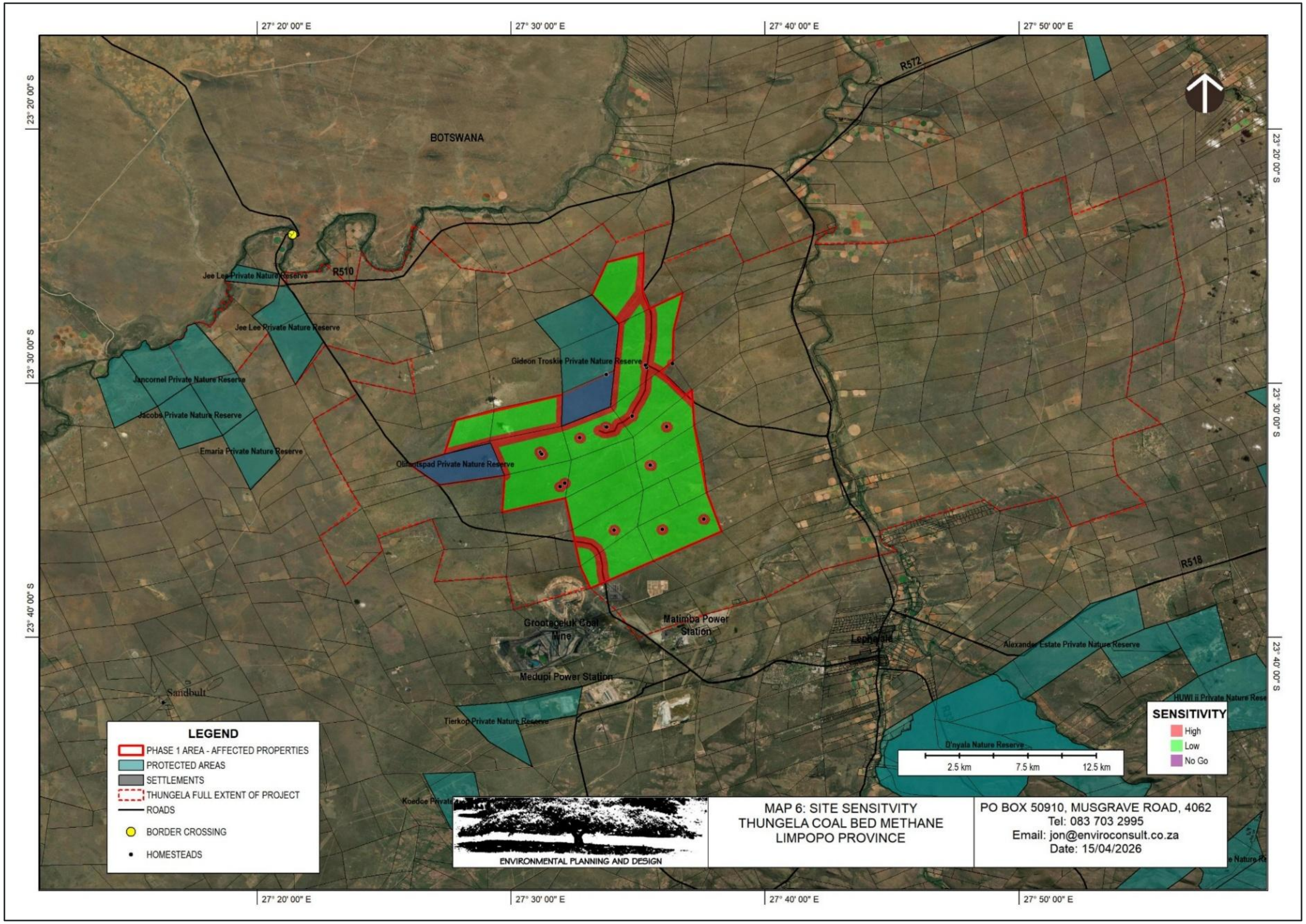


Figure 88: Map of Visual Sensitivity across the site.

10.14 SOCIAL

According to the 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 and 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 *et al.*, 1996). The environment influences and constrains the behaviour of people, but behaviour also leads to changes in the environment. The impact 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.

The proposed site for the project is located in Wards 3 and 5 of the Lephalale Local Municipality that forms part of the Waterberg District Municipality in the Limpopo Province. The baseline description of the environment will include these areas. The wards in close proximity of the site as well as the Production Right area are included for context. Figure 89 shows the location of the proposed project within the context of the Production Right that is the focus of this study, as well as social and physical infrastructure in the area.

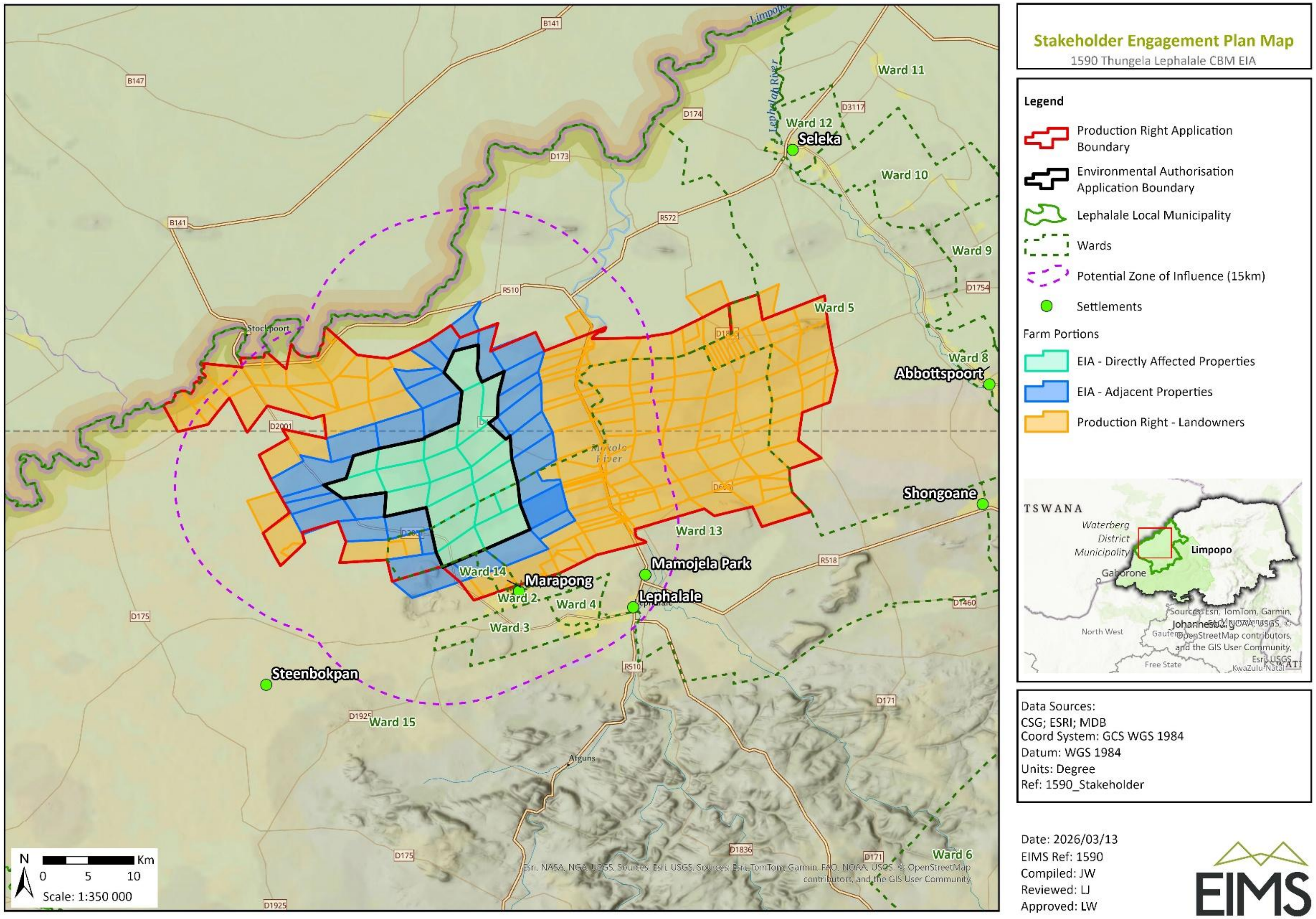


Figure 89: Location of the proposed LCBM Project (including Production Right Area).

10.14.1 LIMPOPO PROVINCE

The Limpopo Province is South Africa's most northern province and covers an area of 125 754 km^2 ((www.municipalities.co.za, 2023). It shares an international border with Mozambique, Zimbabwe and Botswana. It also borders the Gauteng, Mpumalanga and North West Provinces. The capital of the province is Polokwane. Other major cities and towns include Bela-Bela, Lephalale, Makhado, Musina, Thabazimbi and Tzaneen.

Mining is the main driver of the economy and mineral deposits include platinum-group metals, iron ore, chromium, high and middle-grade coking coal, diamonds, antimony, phosphate, and copper. Mineral reserves include gold, emeralds, scheelite, magnetite, vermiculite, silicon and mica.

The province is the largest producer of various crops. Crops grown in Limpopo include sunflowers, cotton, maize, peanuts, bananas, litchis, pineapples, mangoes, pawpaws, a variety of nuts, as well as tea and coffee. The Bushveld is known for cattle, where controlled hunting is often combined with ranching.

Limpopo is divided into five districts, namely Capricorn, Mopani, Sekhukune, Vhembe and Waterberg.

10.14.2 WATERBERG DISTRICT MUNICIPALITY

The Waterberg District Municipality is located in the southwestern part of the Limpopo Province (www.municipalities.co.za, 2023), and covers an area of 44 913 km^2. It shares a border with the North West and Gauteng Provinces. It is the biggest district in the province and shares five border control points with Botswana. Main towns in the area are Amandelbult Mine Town, Bela-Bela, Lephalale, Modimolle, Mokopane, Mookgophong, Pienaarsrivier, Thabazimbi and Vaalwater. The main economic sectors are mining, agriculture and tourism. The district consists of five local municipalities, namely Bela-Bela, Lephalale, Modimolle-Mookgophong, Mogalakwena and Thabazimbi.

10.14.3 LEPHALALE LOCAL MUNICIPALITY

The Lephalale Local Municipality is the largest municipality in the district and covers an area of 13 794 km^2 (www.municipalities.co.za, 2023). The town of Lephalale is a recognised gateway to Botswana and other Southern African countries. Mining, electricity and agriculture are the greatest contributors to the area's GDP (Integrated Development Plan 2023-2027). Agriculture is the sector that employs the largest part of the workforce, followed by community services. Tourism forms an important part of the economy of the area and is a potential future growth area. Hunting and ecotourism are the main tourism activities. Tourism attractions in the area include the Marakele National Park, D'Nyala Nature Reserve, and the Mokolo Dam and Nature Reserve. The Waterberg coal fields that are located in Lephalale contains more than 40% of the total coal reserves of South Africa.

10.14.4 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 Lephalale Local Municipality in the Waterberg District Municipality in the Limpopo 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 and the application area overlaps with Ward 3, 5, 13 and 15. 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.

Although a Census was conducted in 2022, StatsSA could, upon query, not indicate when the results would be released. It is acknowledged that the Census 2011 data is very outdated and as such should be interpreted with care. Where possible, data will be supplemented by data from Community Survey 2016, which is a bit more recent.

The following points regarding Census 2011 must be kept in mind (www.statssa.gov.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.

10.14.5 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 41), much higher 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 greatest increase in population in the Lephalale area.

Table 41: Population density and growth estimates (sources: *Census*, 2011, Statistics South Africa, 2016)

Area	Size in km^2	Population 2011	Population 2016	Population density 2011	Population density 2016	Growth in population (%)
Limpopo Province	125,654	5,4040,868	5,799,090	42.98	46.22	7.29
Waterberg DM	44,914	679,336	745,758	15.13	16.60	9.78
Lephalale LM	13,794	115,767	136,626	8.39	9.90	18.02

The number of households in the study area has increased on all levels (Table 42). The proportionate increase in households was greater than the increase in population on all levels and exceeded the growth in households of 12.3% on a national level. In the Lephalale Local Municipality the proportion of households increased with more than 40%, indicating pressure on existing infrastructure. The average household size has shown a decrease on all levels, which means there are more households, but with less members.

Table 42: Household sizes and growth estimates (sources: Census 2011, Statistics South Africa, 2016)

Area	Households 2011	Households 2016	Average household size 2011	Average household size 2016	Growth in households (%)
Limpopo Province	1,418,102	1,601,083	3.81	3.62	12.90
Waterberg DM	179,866	211,471	3.78	3.53	17.57
Lephalale LM	29,880	42,073	3.87	3.25	40.81

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 Lephalale Local Municipality is much lower than on district or provincial level (Table 43). 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 dependency ratios vary on ward level. Wards 1 – 5 and 14 are located close to the town of Lephalale, and the ratios in these wards are lower than in the other wards, that mainly consist of rural settlements.

Table 43: Dependency ratios (source: *Census 2011)*

Area	Total dependency	Youth dependency	Aged dependency	Employed dependency
Limpopo Province	67,26	56,79	10,47	83,61
Waterberg DM	55,50	46,45	9,05	75,30
Lephalale LM	44,19	38,39	5,81	69,83
Ward 1	33,13	32,03	1,10	60,11
Ward 2	11,15	10,28	0,87	74,97
Ward 3	27,77	22,85	4,92	49,07
Ward 4	26,18	22,32	3,86	49,83
Ward 5	33,38	28,18	5,20	49,62
Ward 6	68,78	60,71	8,07	81,45
Ward 7	74,29	61,98	12,32	86,68
Ward 8	76,22	63,75	12,48	87,33
Ward 9	75,12	67,45	7,67	84,32
Ward 10	88,11	77,70	10,42	85,47

Area	Total dependency	Youth dependency	Aged dependency	Employed dependency
Ward 11	53,60	46,06	7,54	69,55
Ward 12	76,32	63,38	12,95	87,59
Ward 13	14,57	12,24	2,33	53,29

Poverty is a complex issue that manifests itself in economic, social and political ways and 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 44), 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 in the Waterberg District Municipality and Lephalale Local Municipality area has increased significantly, suggesting a great increase in poverty in the area.

Table 44: 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
Limpopo Province	10,1	41,6	0,042	11,5	42,3	0,049
Waterberg DM	6,5	41,6	0,027	9	42,7	0,038
Lephalale LM	5,4	41,9	0,023	9	44,4	0,040

10.14.6 POPULATION COMPOSITION, AGE, GENDER AND HOME LANGUAGE

In most of the wards, the majority of the population belongs to the Black population group (Figure 90), except in Wards 3, 4, 5 and 13 where a large proportion of the people belong to the White population group. In Ward 4 more than 40% of the population belong to the White population group.

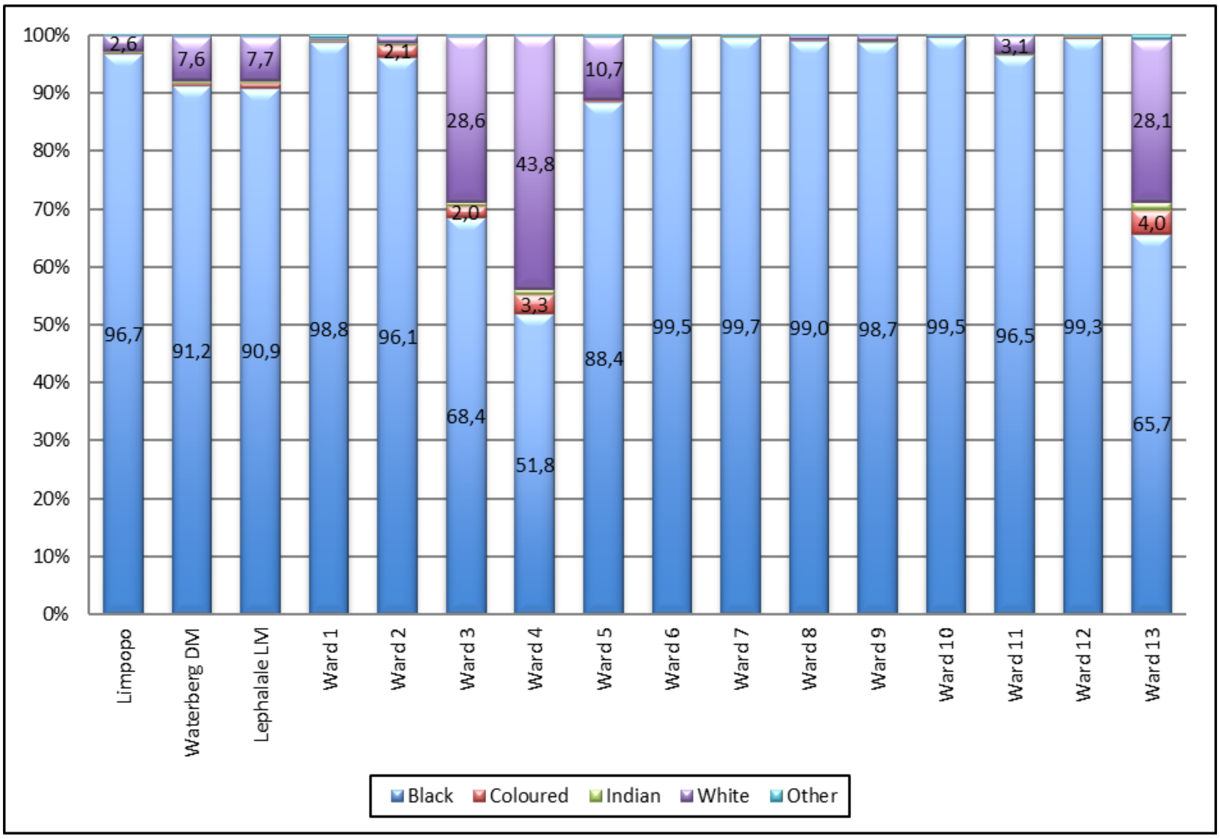


Figure 90: Population distribution (shown in percentage, source: (*Census*, 2011))

The average age is very similar on local, district and provincial level (Table 45) but varies on a ward level. In the wards close to the town of Lephalale (Wards 1-5 and 13) the average age is much higher, but in the other wards the average age is even lower than the provincial average age.

Table 45: Average age (source: *Census*, 2011)

Area	Average Age (in years)
Limpopo Province	26,47

Area	Average Age (in years)
Waterberg DM	27,79
Lephalale LM	27,45
Ward 1	25,48
Ward 2	31,15
Ward 3	30,66
Ward 4	30,63
Ward 5	29,65
Ward 6	25,07
Ward 7	25,80
Ward 8	25,74
Ward 9	23,97
Ward 10	23,84
Ward 11	26,40
Ward 12	26,41
Ward 13	32,15

The age distribution of the areas under investigation shows that almost a third or more of the population in Wards 6 -12 were aged 14 years or younger in 2011 (Figure 91). A large part of this group will now be young adults, looking for employment. In Wards 1-5 and 13 more than 40% of the population were aged between 35 – 64 years.

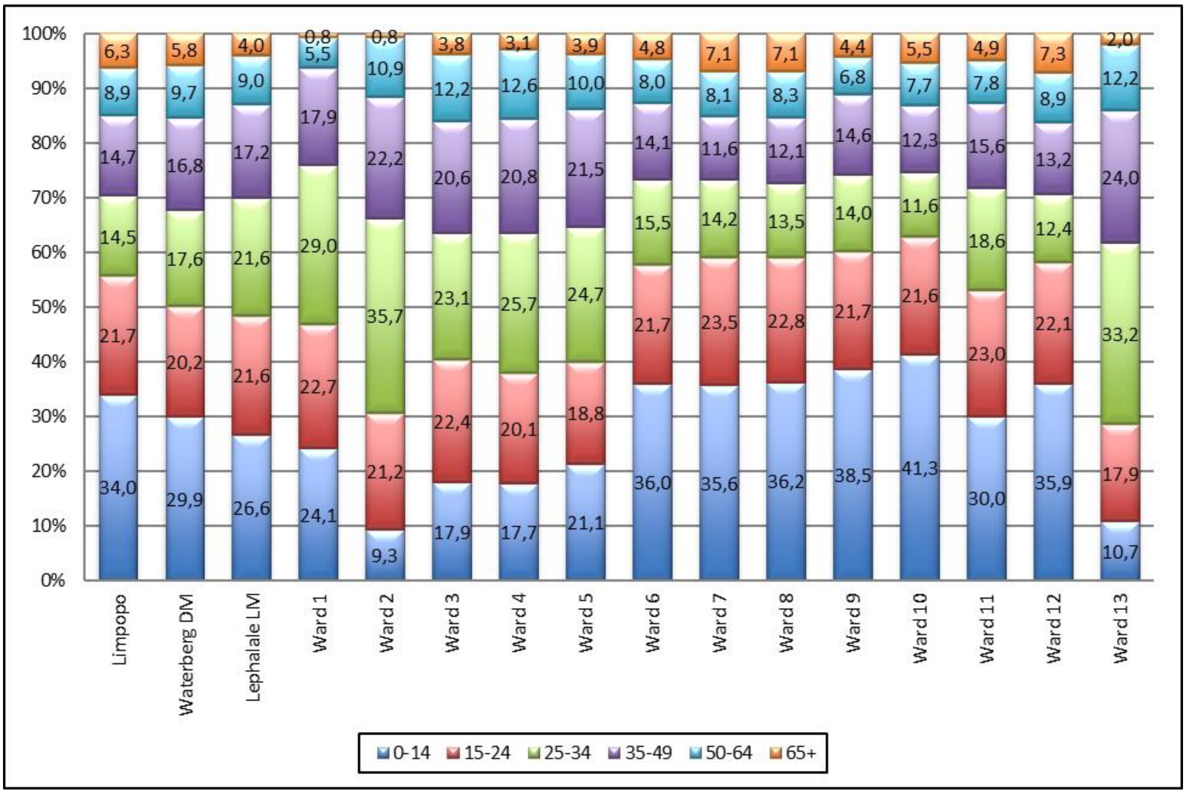


Figure 91: Age distribution (shown in percentage, source: Census 2011)

10.14.7 GENDER

The gender distribution on provincial, district and local level is not balanced (Figure 92), on provincial level there is a bias towards females, while there is a bias towards males on municipal level. In Wards 1-5 and 13 there is a strong bias towards males, while in Wards 6-11 there is a bias towards females. A higher incidence of males is usually found in mining and construction areas.

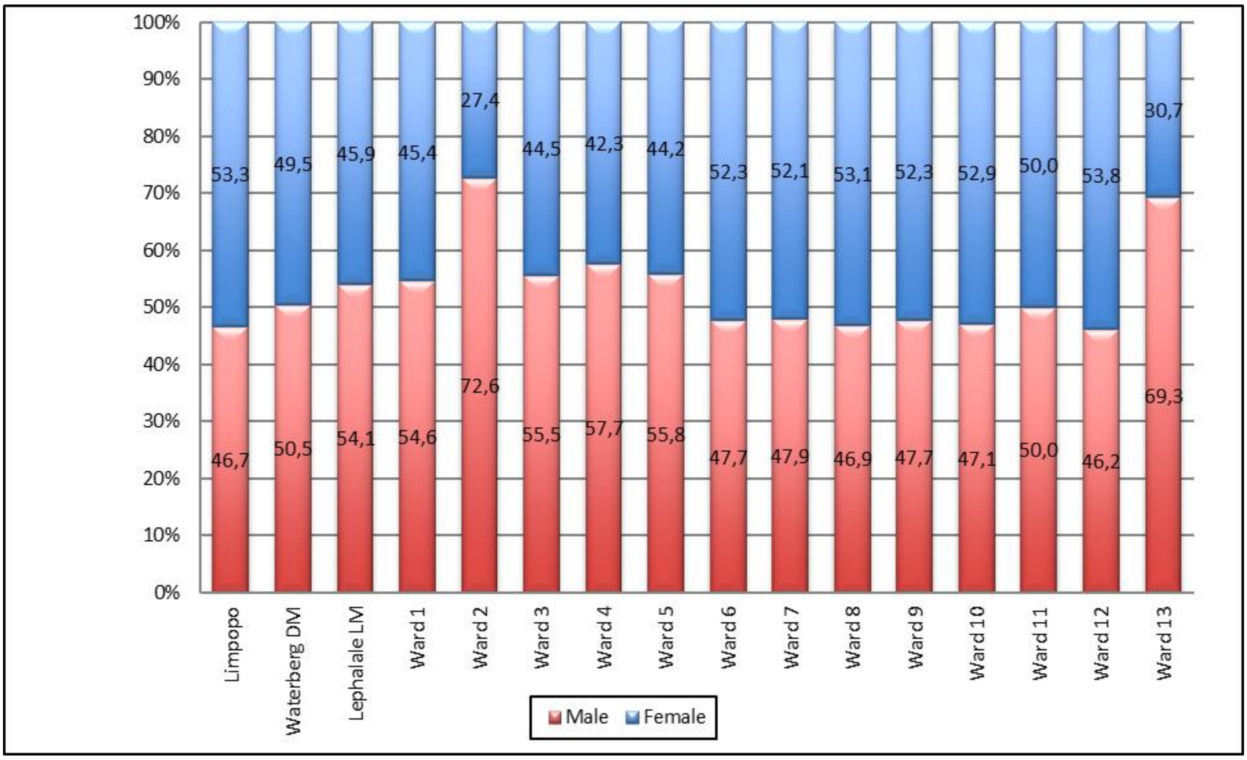


Figure 92: Gender distribution (shown in percentage, source: Census 2011)

10.14.8 LANGUAGE

On a ward level the language composition differs, with the dominant home languages in the municipality being Sepedi and Setswana (Figure 93). In Ward 3, 4 and 13 more than 30% of people have Afrikaans as home language. Home language should be taken into consideration when communicating with the local communities and based on the profile of the area communication should take place in Sepedi, Setswana, Afrikaans and English.

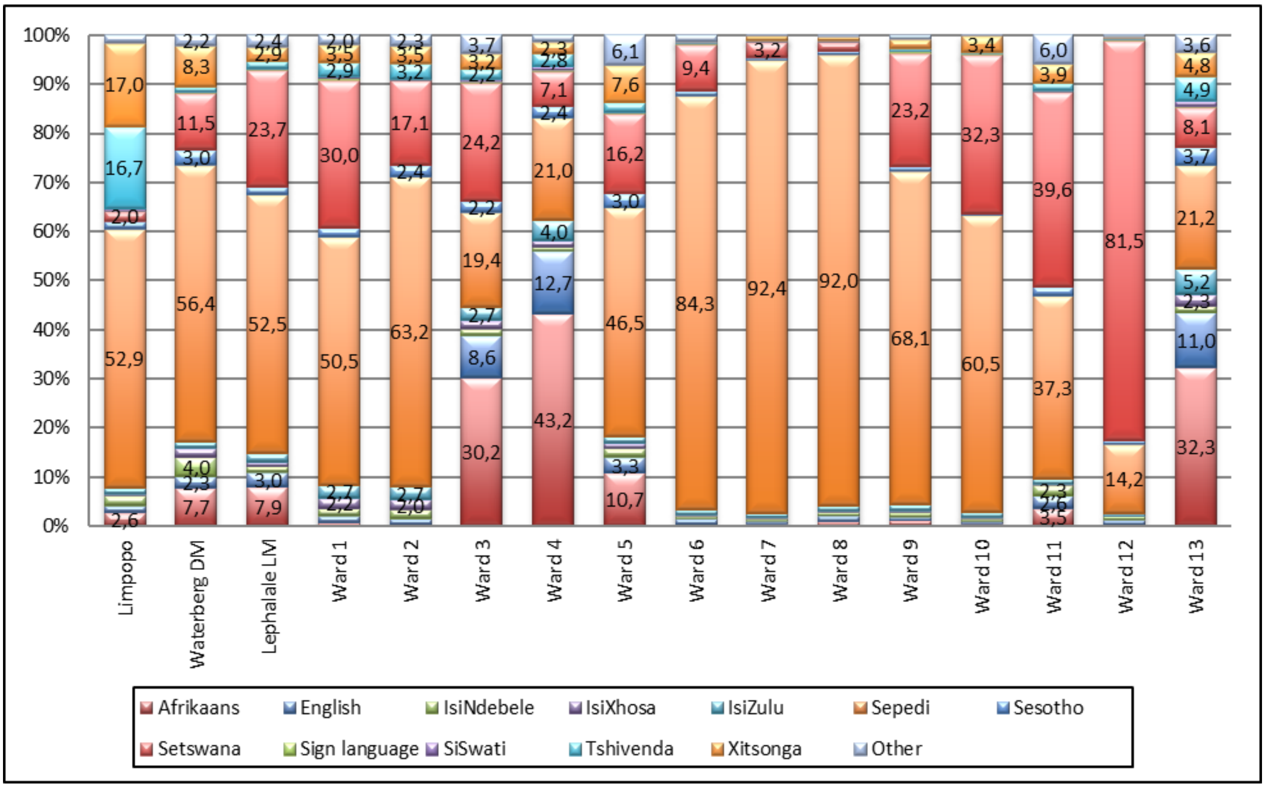


Figure 93: Language distribution (shown in percentage, source: Census 2011)

10.14.9 EDUCATION

Figure 94 shows the education profiles for the areas under investigation for those aged 20 years or older. Ward 4 has the highest proportion of people who have completed Grade 12 or higher. In Wards 6 – 11 more than 70% of those aged 20 years or older have not completed secondary school in 2011.

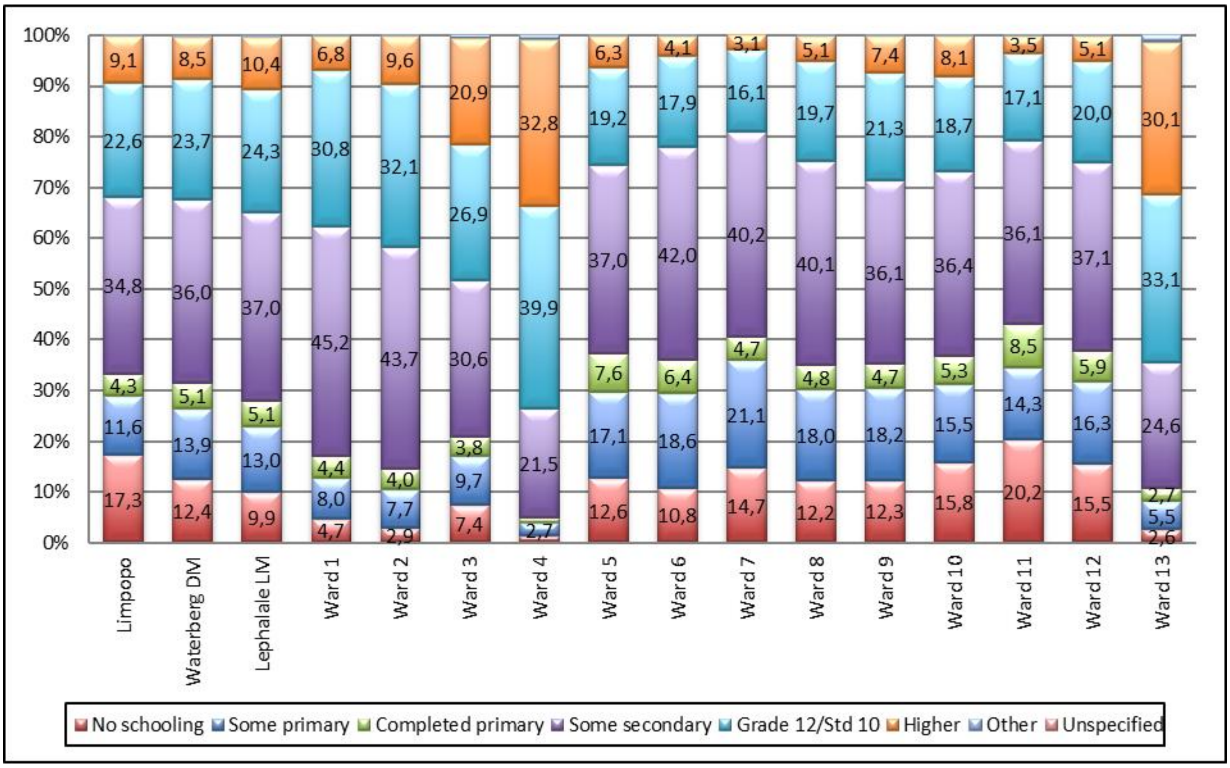


Figure 94: Education profiles (those aged 20 years or older, shown in percentage, source: Census 2011)

10.14.10 EMPLOYMENT

Wards 1, 3, 4, 5 and 13 have the highest proportion of people of economically active age (aged between 15 years and 65 years) that are employed (Figure 95). The majority of the employed people in the areas under investigation work in the formal sector (Figure 96), except in Ward 11 where the majority of people were employed at private households in 2011.

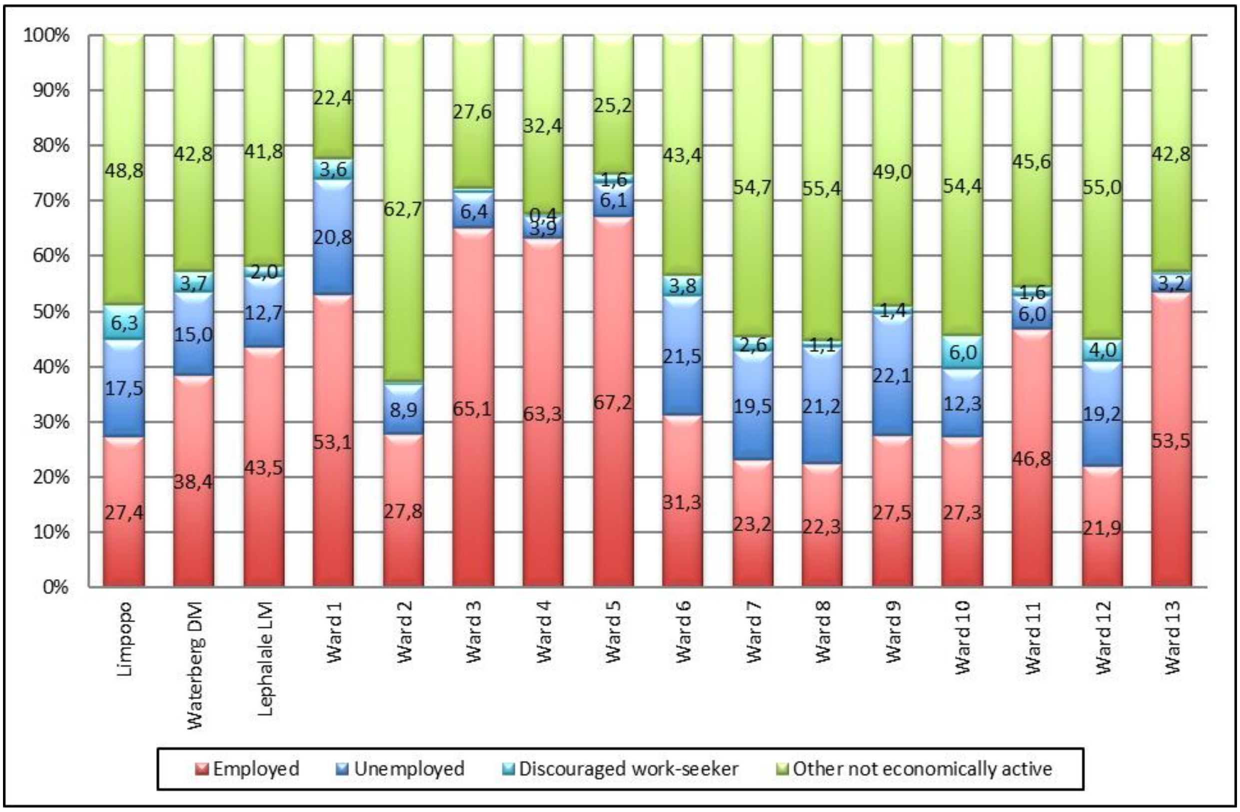


Figure 95: Labour status (those aged between 15 - 65 years, shown in percentage, source: Census 2011)

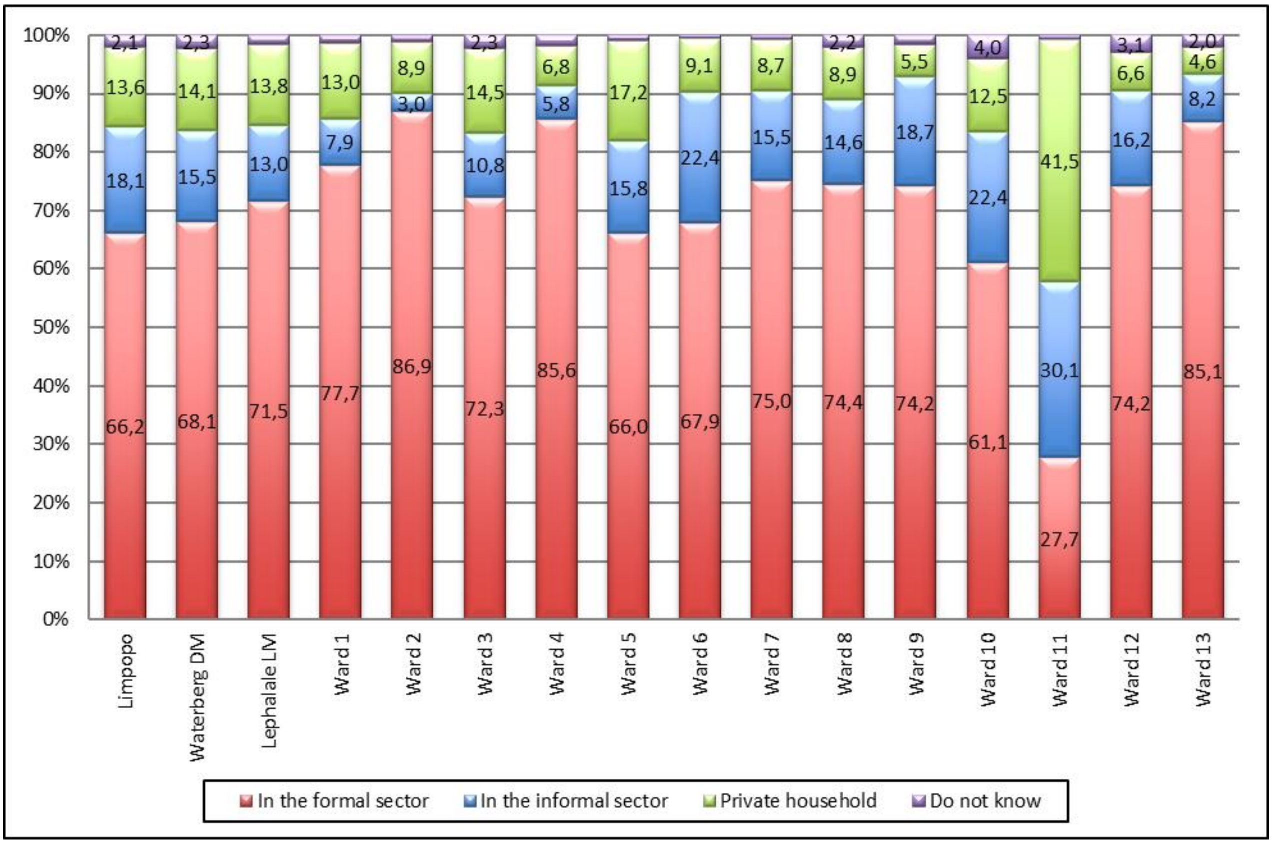


Figure 96: Employment sector (those aged between 15 - 65 years, shown in percentage, source: Census 2011)

10.14.11 HOUSEHOLD INCOME

Wards 4 and 13 had the highest proportion of households with an average income of higher than R19 601 in 2011 (Figure 97). In 2011 households with three members with a household income of R19 600 or less would be below the lower bound poverty line (LBPL). Individuals at the LBPL do not have enough resources to consume or purchase both adequate food and non-food items and are forced to sacrifice food to obtain essential non-food items.

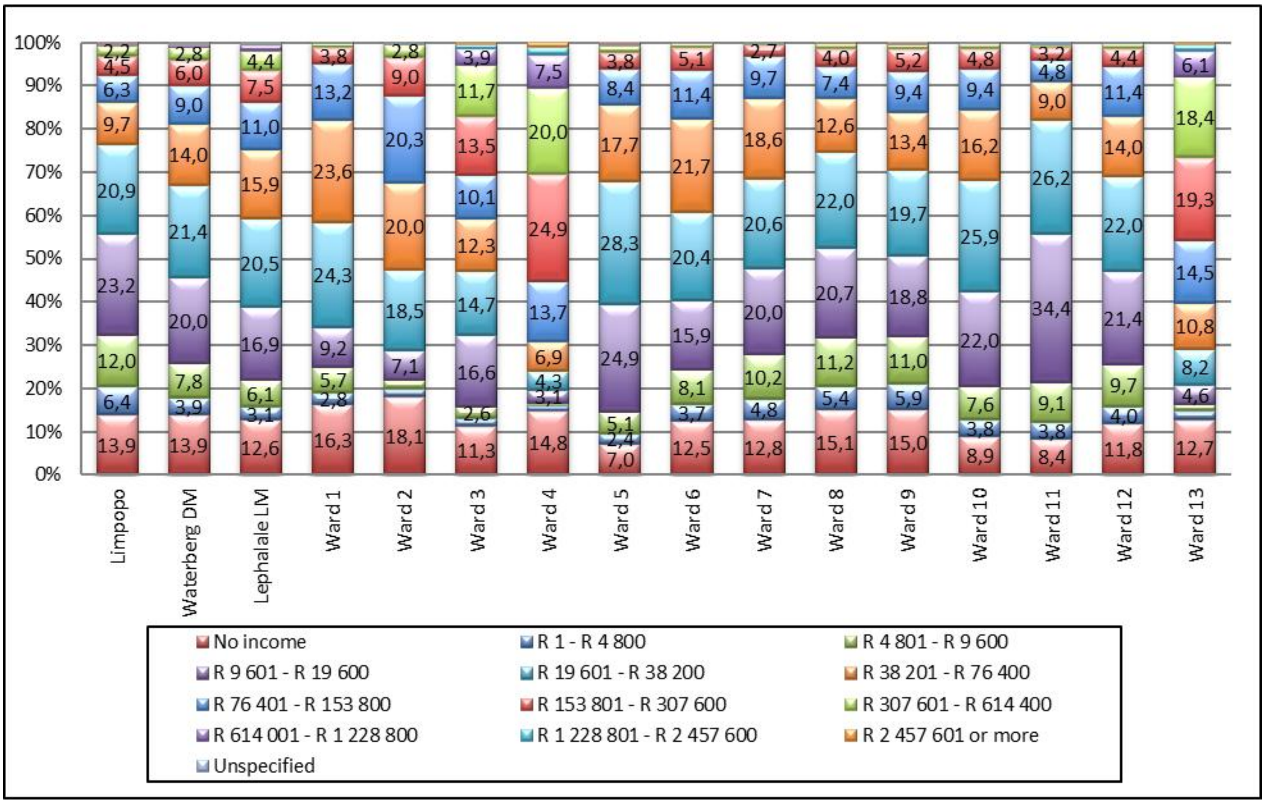


Figure 97: Annual household income (shown in percentage, source: Census 2011)

10.14.12 HOUSING

On a ward level a high incidence of households in Wards 3, 5 and 11 live on areas classified as farmland, while most of the households in the area around the town of Lephalale live in areas classified as urban. In Wards 6-12 a high incidence of households lives in areas classified as tribal or traditional. Most households in Wards 1-4 and 13 live in formal residential areas (Figure 98), while the majority of households in Ward 5 lived in areas classified as farm.

Table 46: Geotypes (source: *Census*, 2011, households)

Area	Urban	Tribal/Traditional	Farm
Limpopo Province	20.1	73.4	6.6
Waterberg DM	50.6	35.7	13.7
Lephalale LM	43.1	37.0	19.9
Ward 1	100.0	0.0	0.0
Ward 2	100.0	0.0	0.0
Ward 3	59.1	0.0	40.9
Ward 4	100.0	0.0	0.0
Ward 5	0.0	12.2	87,8
Ward 6	0.0	100.0	0,0

Area	Urban	Tribal/Traditional	Farm
Ward 7	0.0	100.0	0.0
Ward 8	0.0	97.7	2.3
Ward 9	40.0	60.0	0.0
Ward 10	0.0	98.9	1.1
Ward 11	0.0	53.8	46.2
Ward 12	0.0	100.0	0.0
Ward 13	100.0	0.0	0.0

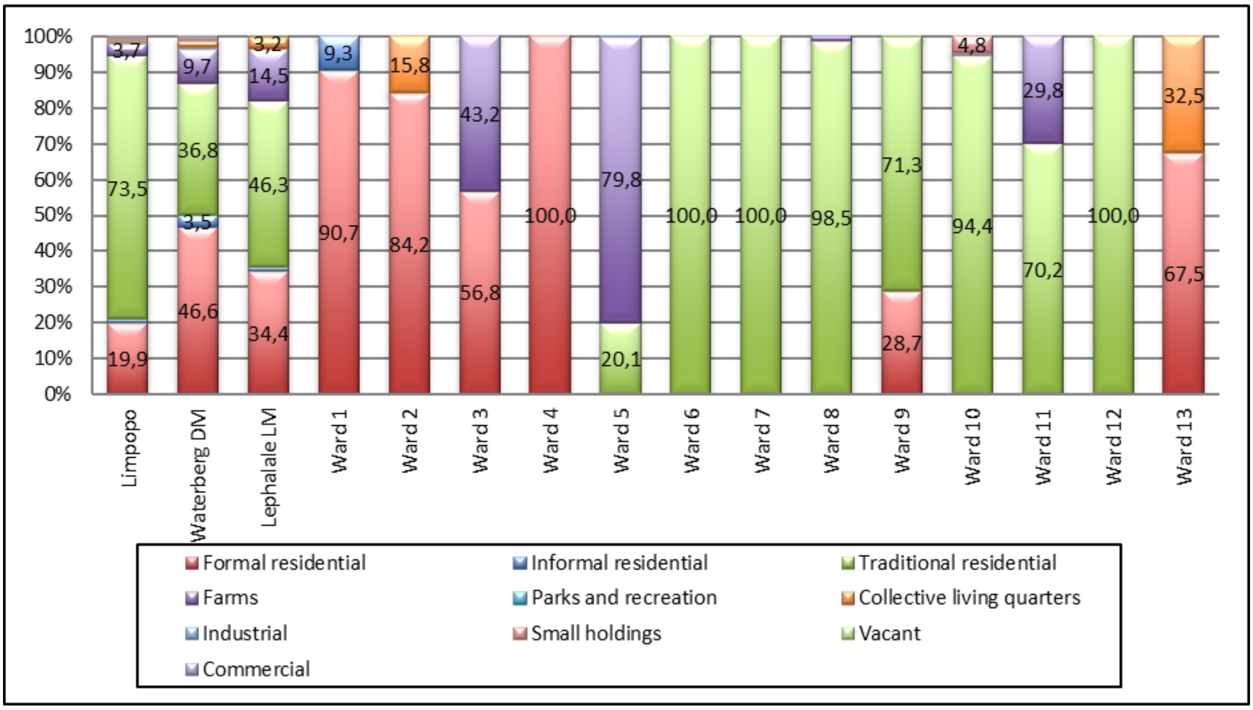


Figure 98: Enumeration area types (persons, shown in percentage, source: Census 2011)

Most of the dwellings in the area are houses or brick/concrete block structures that are on a separate yard, stand or farm (Figure 99). Although there are informal dwellings in Ward 35, it is a lower proportion than on local, district or provincial level.

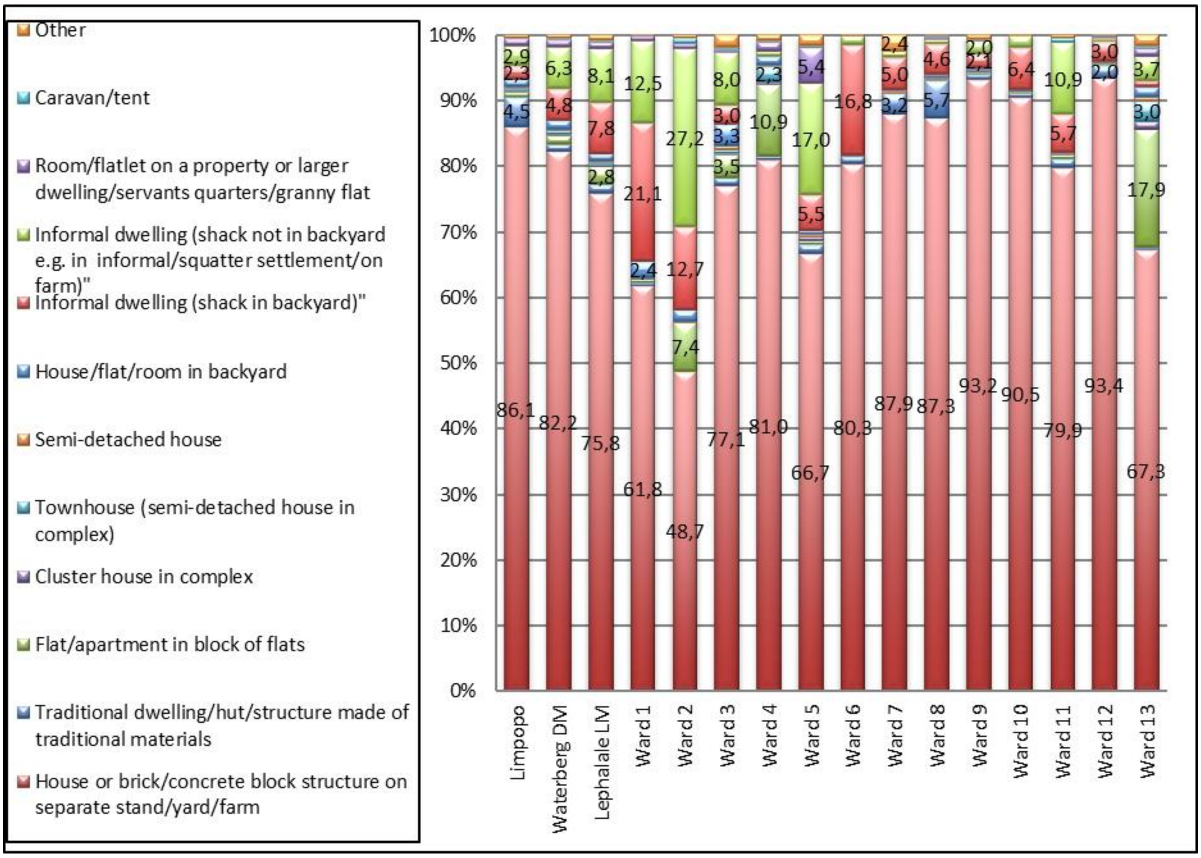


Figure 99: Dwelling types (shown in percentage, source: Census 2011)

A large proportion of households in the area in and around the town of Lephalale are renting their dwellings (Figure 100).

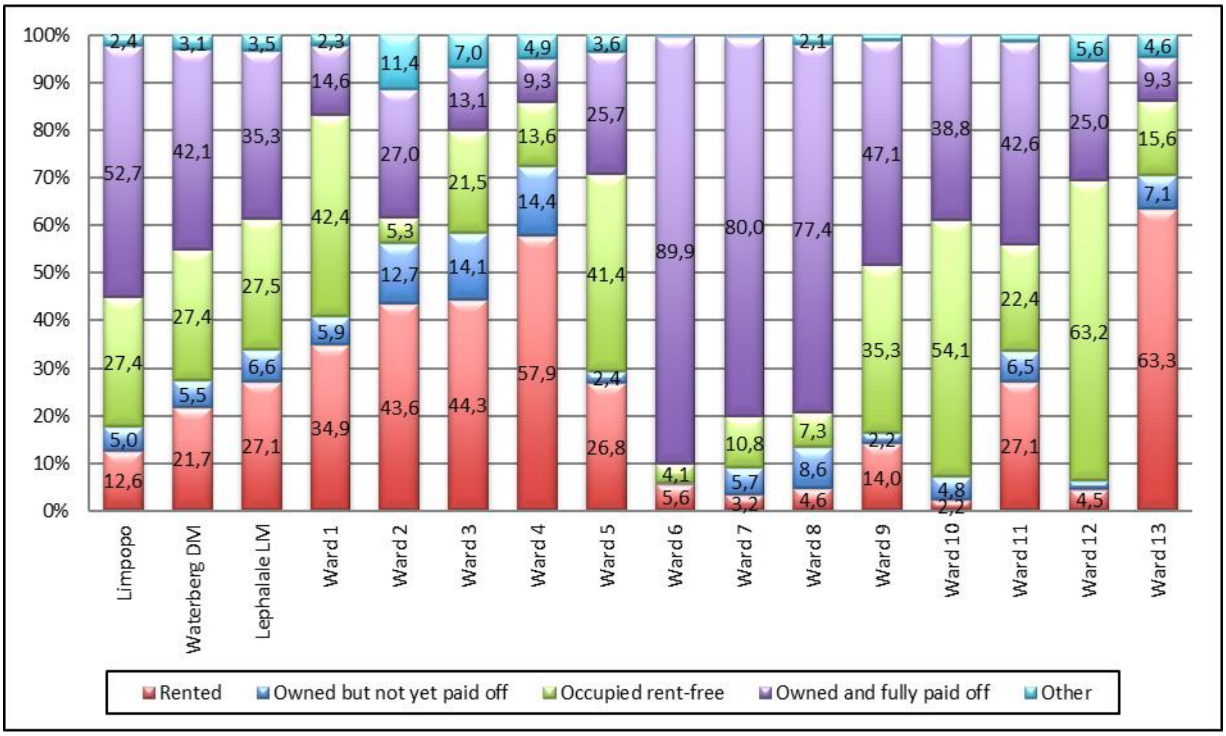


Figure 100: Tenure status (shown in percentage, source: Census 2011).

10.14.13 HOUSEHOLD SIZE

Household sizes on a ward level in the Lephalale LM vary (Figure 101), with most households in Wards 1-5 and 13 consisting of one to two people. This is very typical in mining in construction areas where there are contractors, construction and migrant workers.

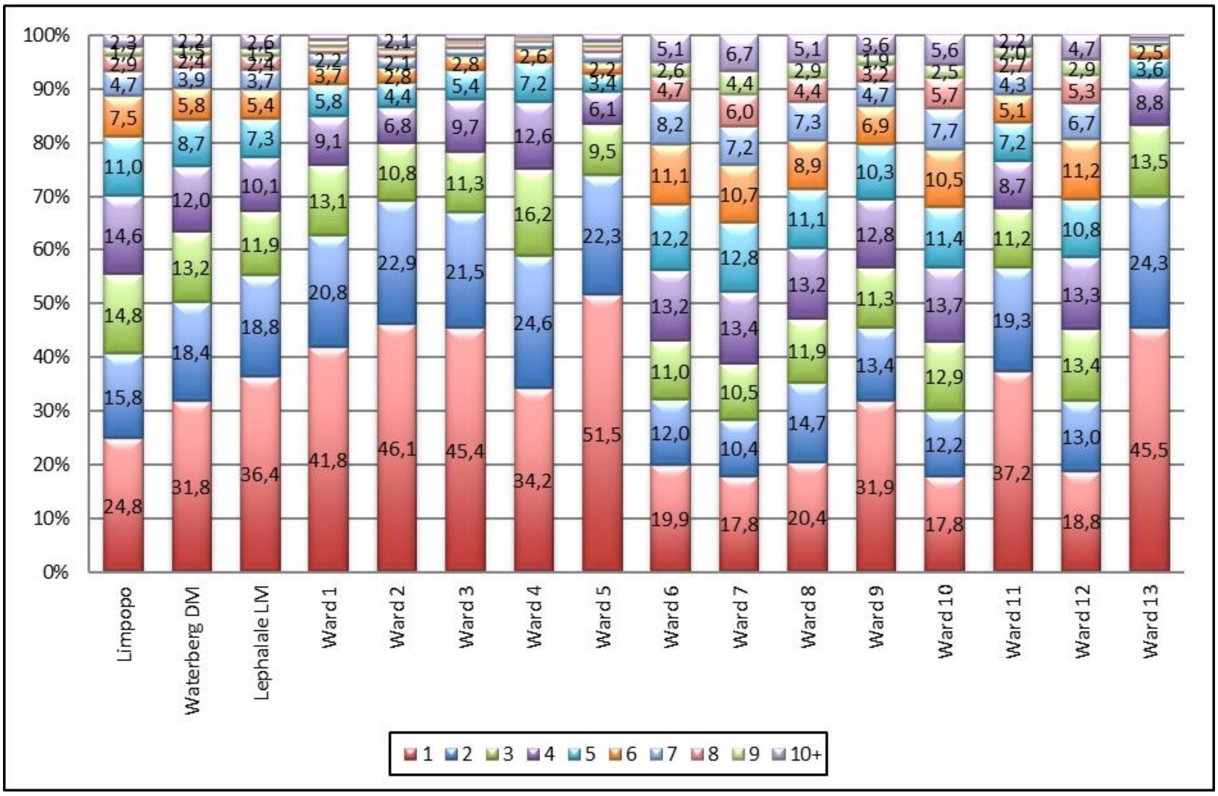


Figure 101: Household size (shown in percentage, source: Census 2011)

10.14.14 ACCESS TO WATER AND SANITATION

Ward 5 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 (Figure 102). Most households in this ward live on farms.

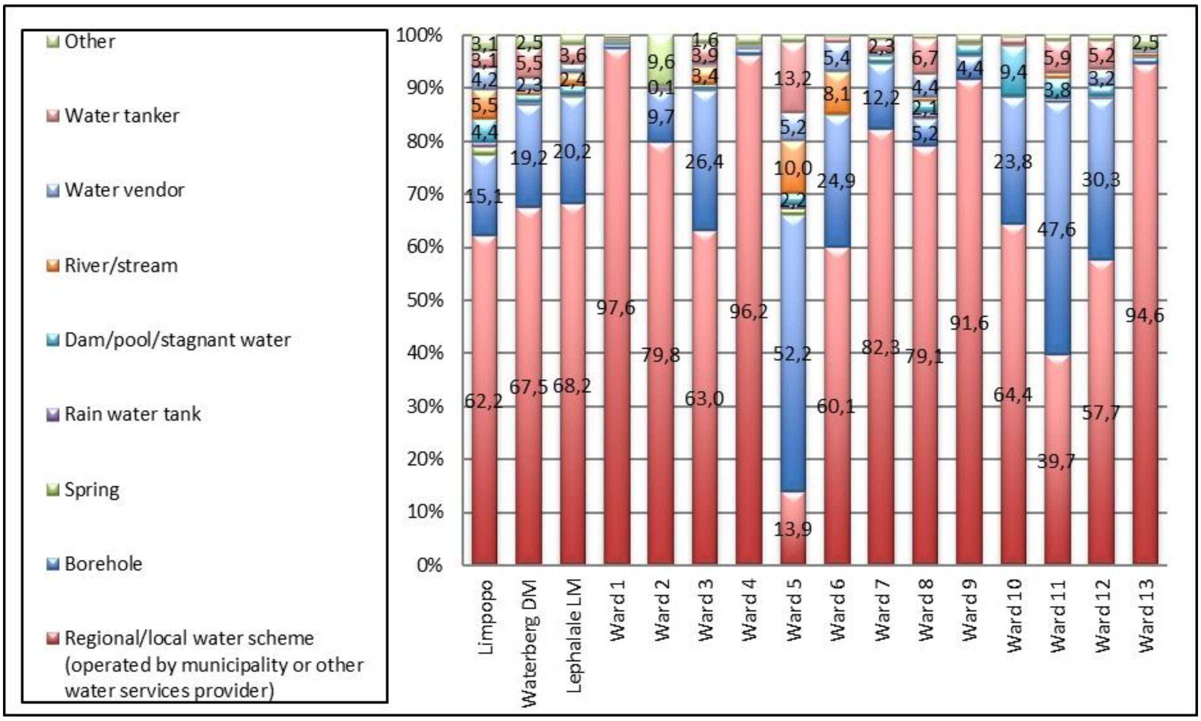


Figure 102: Water source (shown in percentage, source: Census 2011)

Access to piped water, electricity and sanitation relate to the domain of Living Environment Deprivation as identified by Noble *et al.* (2006). Wards 4 and 13 have the highest proportion of households with access to piped water inside the dwelling (Figure 103).

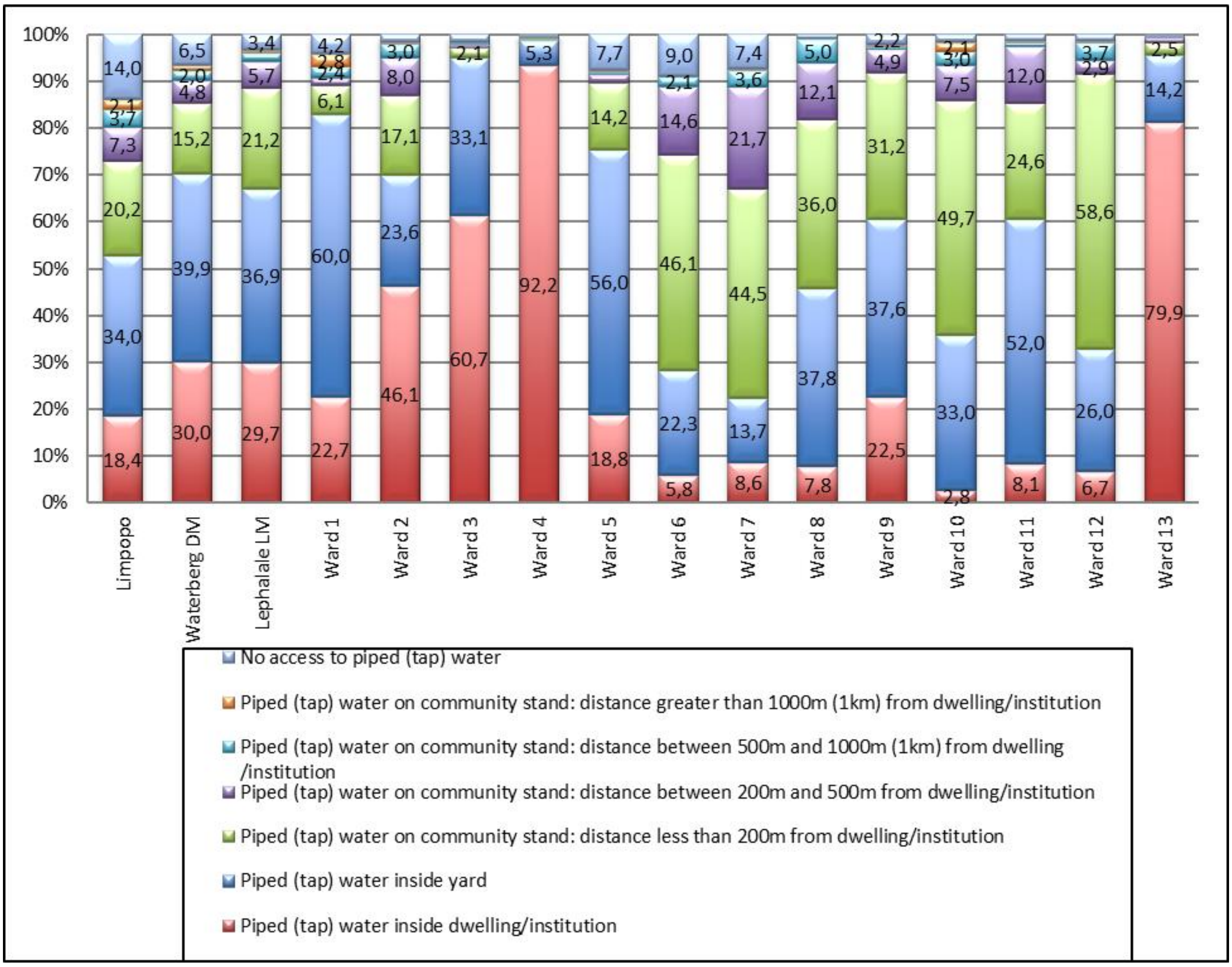


Figure 103: Piped water (shown in percentage, source: Census 2011)

The majority of households in Wards 1-4 and 13 (Figure 104) have access to flush toilets that are connected to a sewerage system. In the other wards most households have access to pit toilets with or without ventilation.

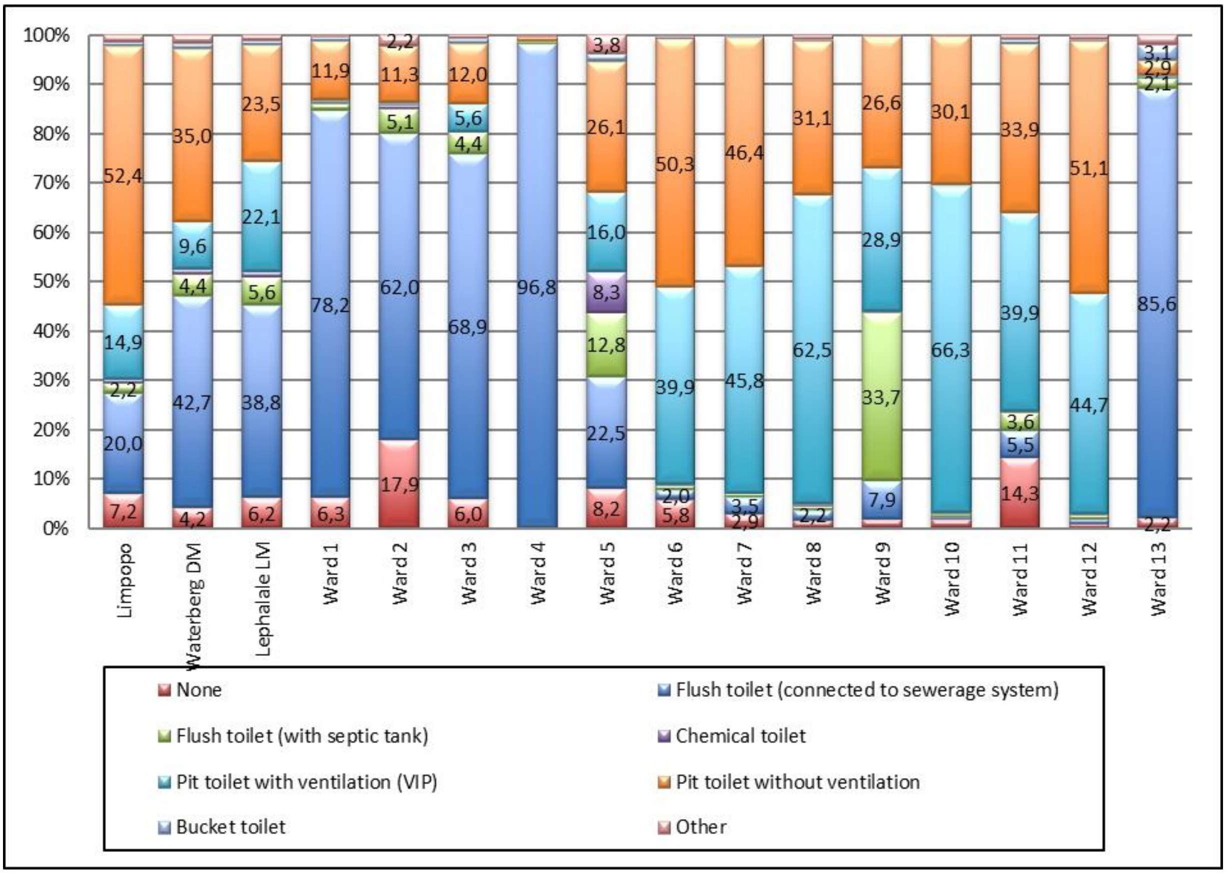


Figure 104: Sanitation (shown in percentage, source: Census 2011)

10.14.15 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. On a ward level more than 80% of households have access to electricity as energy source for lighting (Figure 105), except in Wards 2 and 5 where the incidence is just over 60%.

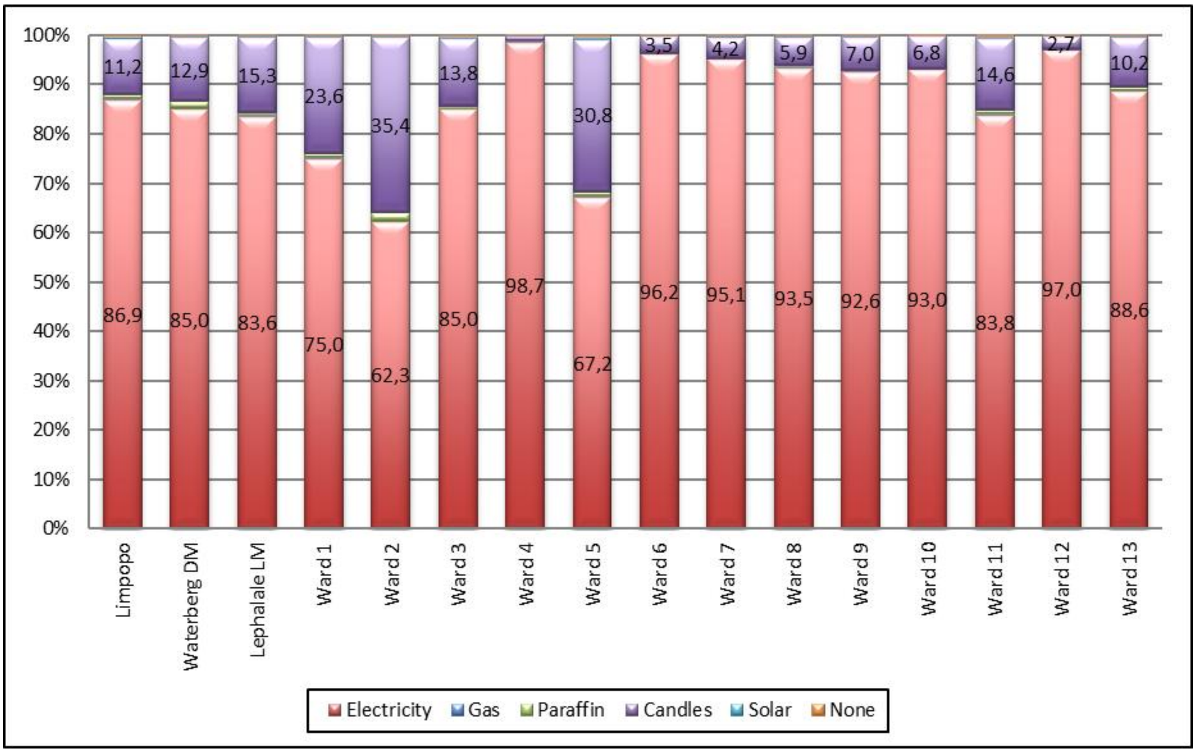


Figure 105: Energy source for lighting (shown in percentage, source: Census 2011)

10.14.16 REFUSE REMOVAL

Most households on a ward level that are close to the town of have their refuse removed at least once a week by a local authority or private company (Figure 106). In the wards further away from town that consists mostly of farms or rural settlements, most households have indicated that they have their own refuse dumps.

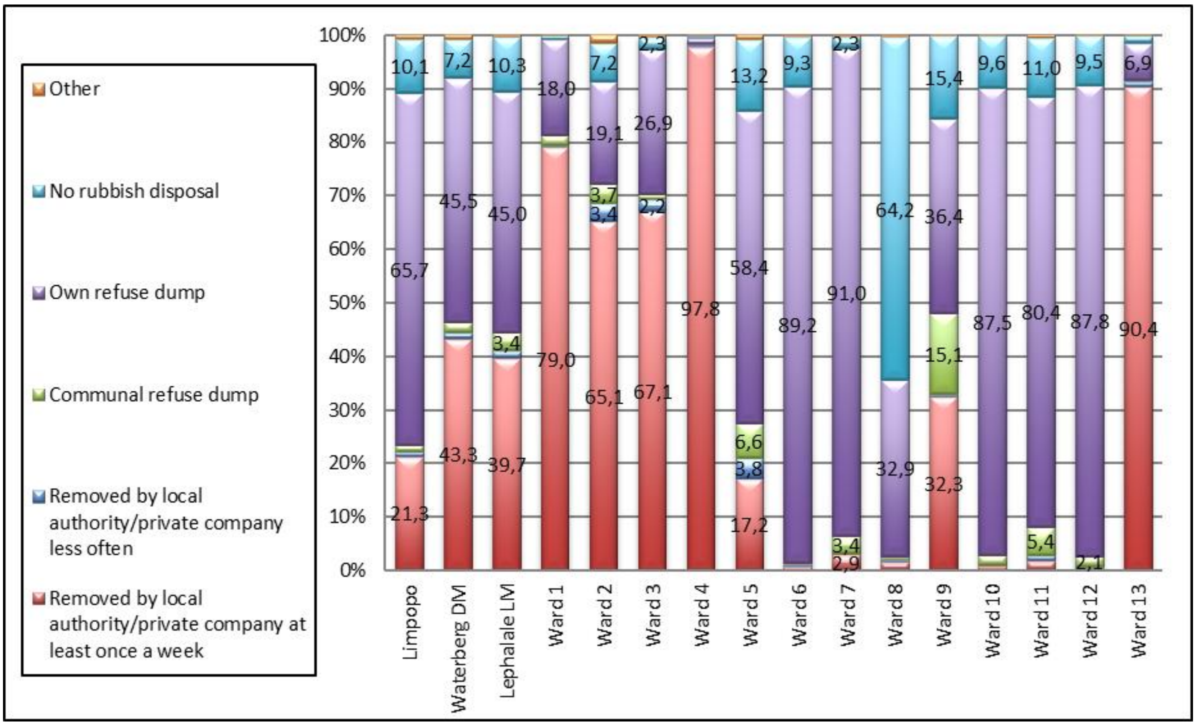


Figure 106: Refuse removal (shown in percentage, source: Census 2011)

10.15 TRAFFIC AND EXISTING ROAD NETWORKS

The affected existing road networks is illustrated in Figure 6 and a brief description of the relevant roads is presented below.

10.15.1 R510 (LEPHALALE TO GROBLER'S BRIDGE)

This road north from Lephalale up to Grobler's Bridge intersection can be classified as a Class 2 primary distributor (major arterial road). It is a national road that strategically Limpopo River connects Limpopo to the neighbouring country Botswana via Tomburke (N11).

10.15.2 R510 (STOCKPOORT TO GROBLER'S BRIDGE)

This road heading west from the Grobler's Bridge intersection towards the Stockpoort Border Post be classified as a Class 2 primary distributor. It is a national road that strategically connects Limpopo to the neighbouring country Botswana via Stockpoort Border Post.

10.15.3 DEELKRAAL ROAD (D41)

This road linking two parts of the R 510 can be classified as a class 4 link catering for the surrounding rural area. It forms a T-junction with the R510 east of the site 18km north of Lephalale and a T-junction with the R510 north of the site 10 km east of the Stockpoort Border Post. The road is a gravel and a single carriageway that will need to be upgraded to cater for future traffic demand including LNG tanker trucks.

10.16 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. An initial assessment was undertaken in 2024 on certain properties, and this assessment is referred to as the "previous assessment". A follow-up assessment will be undertaken in due course to inform the EIA phase, and this assessment will over all affected properties. 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:

- Twelve heritage features and resources were identified. These consist of:
    - 2 boreholes, which were placed in the 1900s during farm divisions (TL001 and TL005)
    - 5 Kraal areas with remaining water reservoirs, troughs and water features (TL002, TL004, TL006, TL007 and TL011)
    - 2 kraal areas with associated structures as mentioned above also including residential areas (TL003 and TL008)
    - 1 excavated pit (TL009)
    - 1 Middle Stone Age (MSA) single find spot (TL010)
    - 1 Early Farming Community (EFC) site (TL013)

10.16.1 HISTORICAL STRUCTURES

Two foundation remains of structures were in the kraal areas. The possibility of stillborn burials must be considered. All burial grounds and graves should be retained and avoided with a buffer zone of 30m as per SAHRA guidelines. Depending on the extent of further impacts, further stakeholder engagement and test excavations could be required to determine the presence of human remains, adhering to the requirements of s36 of the NHRA and its regulations as well as the National Health Act and its regulations. These have a heritage rating of IIIA.

- TL003
- TL008

10.16.2 KRAALS

Several Kraal areas were located which consisted of water troughs and reservoirs. Only five were recorded. These have no heritage value and have a heritage rating of Not Conservation Worthy (NCW).

- TL002
- TL004
- TL006
- TL007
- TL011

10.16.3 BOREHOLES

Two historical boreholes were located. These are represented on the historical maps and were places during the farm division the farm divisions in the early 1900's. Due to their link with the historical development of the area they have a low heritage significance and are rated as IIIC (such a resource is of contributing significance).

- TL001
- TL005

10.16.4 EXCAVATION PIT

One excavated pit was located alongside a collapsed wall. The purpose of this site is unknown. The site has no heritage significance and therefore rated as NCW.

- TL009

10.16.5 ARCHAEOLOGICAL SITE

One Middle Stone Age find spot was located which consisted of a single core with a low heritage significance and is rated as NCW, and one Early Farming Community (EFC) archaeological site was located on the hill slopes of Bulkop. There is evidence of terracing and agricultural activity. Ceramic pot shards are scattered around the slopes and base of the koppie. The site has a heritage rating of IIIC (such a resource is of contributing significance).

- TL010
- TL012

A set of photographs of each of the heritage site and associated finds captured in Figure 107. More information will be included in the final specialist report in the EIA phase. The location of the identified heritage sites are mapped out in Figure 108 with heritage sites extent and buffers included in Figure 109.

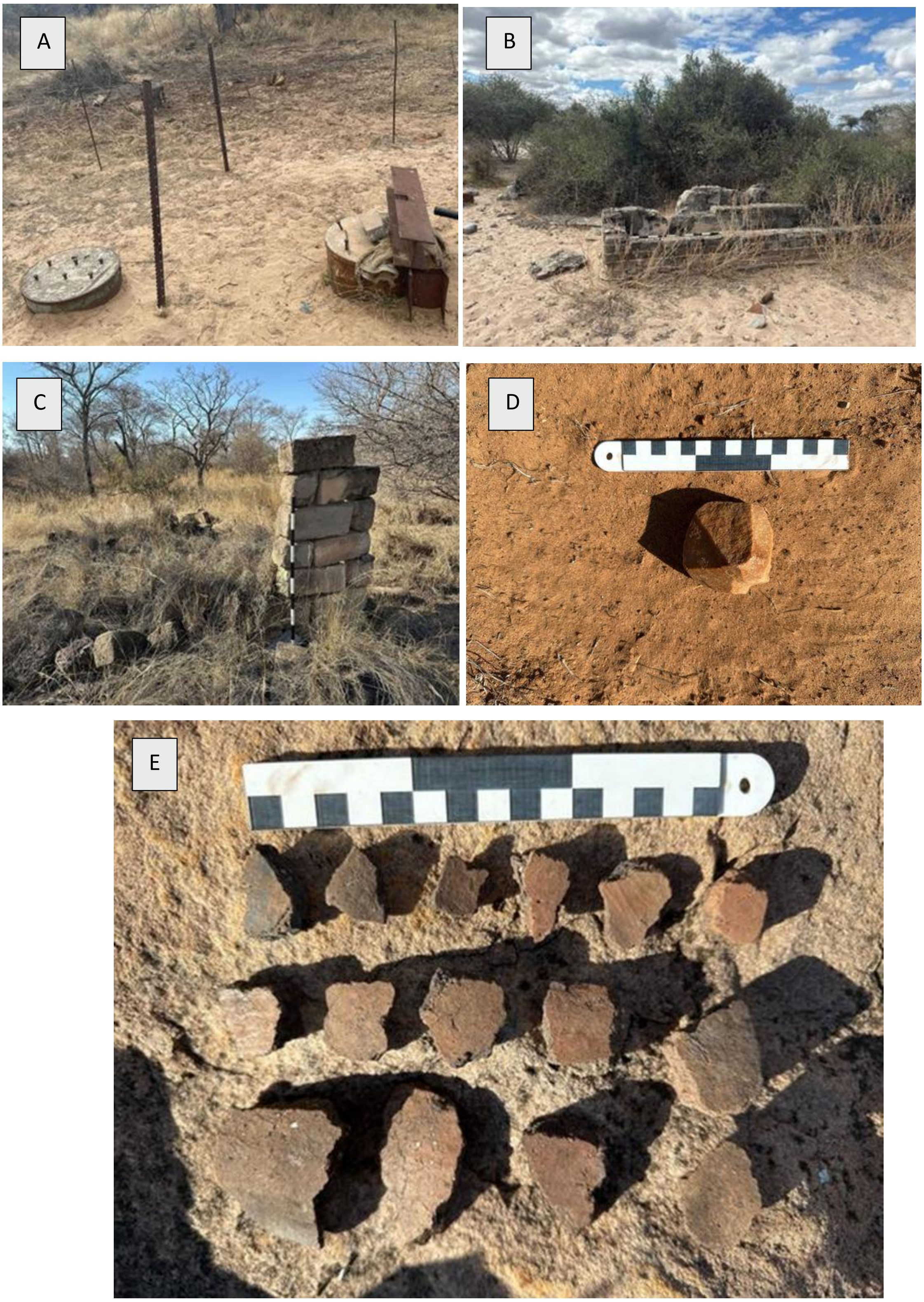


Figure 107: Photographs of finds at heritage sites. (A) View of the borehole at TL001, (B) View of the kraal and foundation remains at TL003, (C) View of structural remains at TL008, (D) Single MSA tool find at TL010, (E) Ceramic pot shards located at TL012

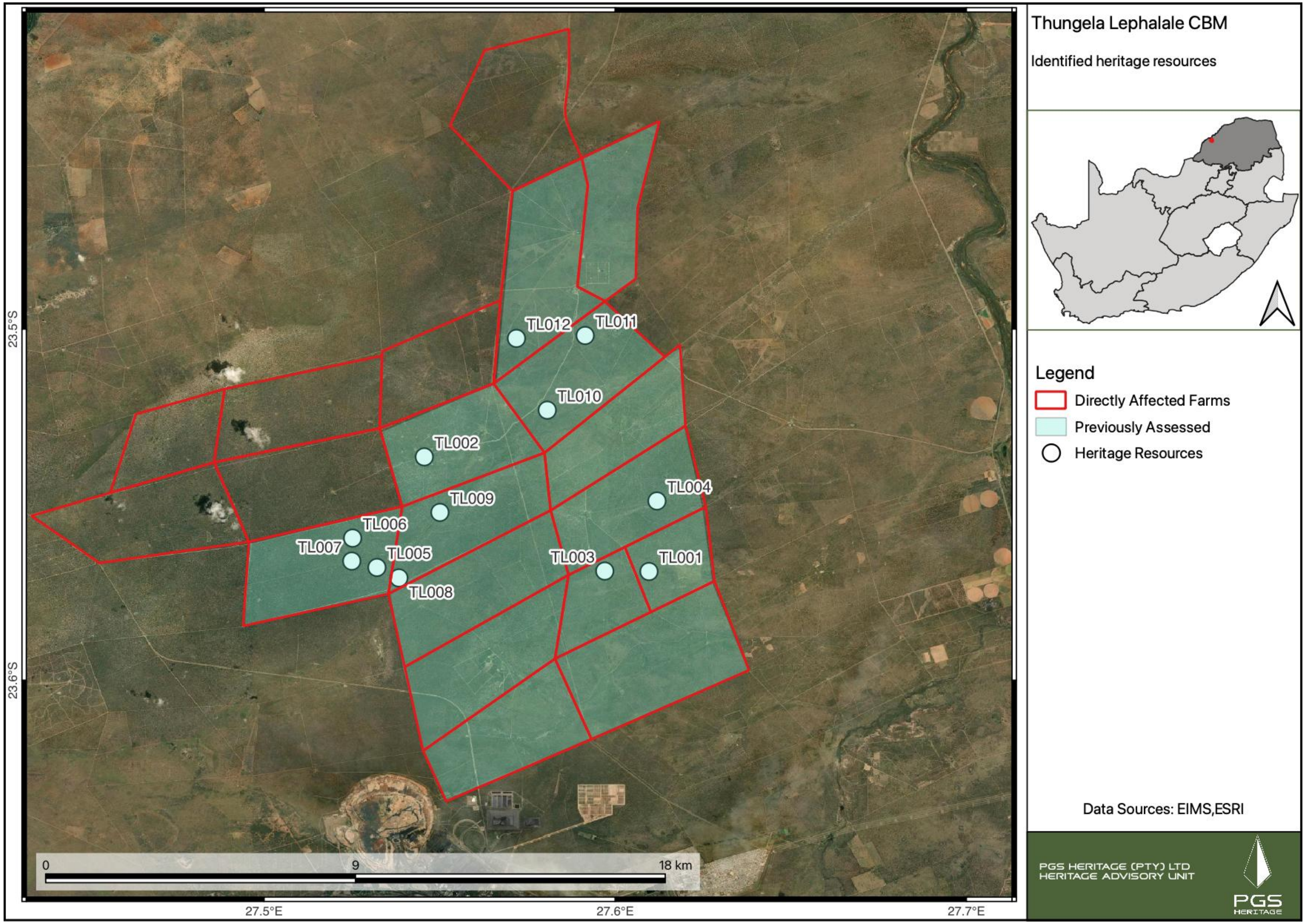


Figure 108: Identified heritage resources within the LCBM area.

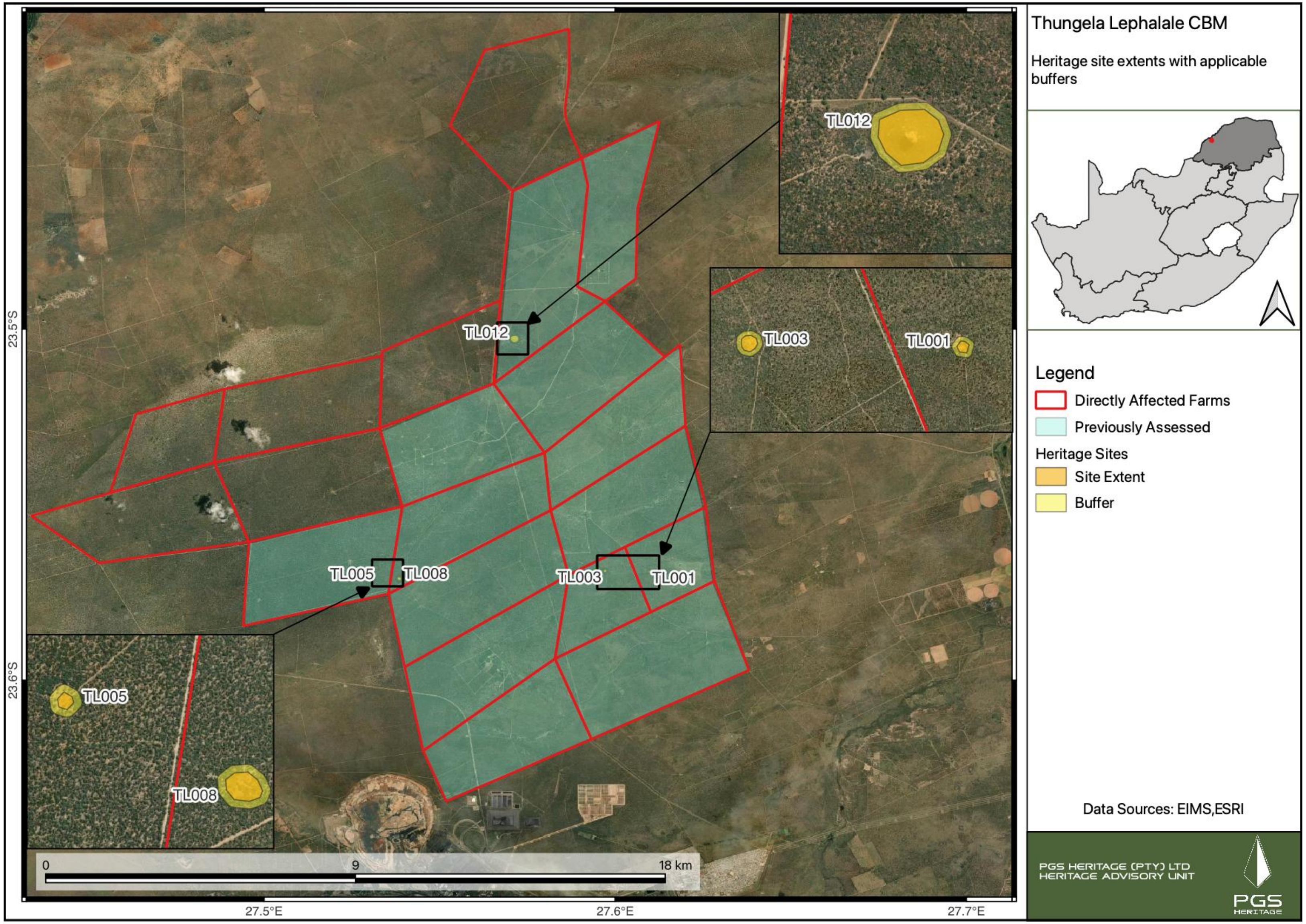


Figure 109: Extent of Grade IIIA and Grade IIIC heritage sites and buffers

10.17 PALAEONTOLOGY

The study area is underlain by Late Triassic to Early Jurassic formations of the Karoo Supergroup, specifically fine-grained cream-coloured sandstones of the Clarens Formation (TRc) and red mudstones and siltstones of the Elliot Formation (TRJ) (locally referred to as the Lisbon Formation in the northern Karoo Basin, including the Lephalale area) (Figure 110). These formations represent the uppermost stratigraphic units of the Main Karoo Basin succession in the Lephalale region and record the transition from terrestrial fluvial-lacustrine environments (Elliot/Lisbon Formation) to extensive aeolian desert conditions (Clarens Formation) that characterized southern Gondwana during the Late Triassic to Early Jurassic period (Bordy & Catuneanu, 2002; Eriksson et al., 2006).

The Clarens Formation is composed of silty sandstone strata and medium-grained, white, cream, or pink, immature sandstone that is weakly sorted (Beukes, 1970; Eriksson, 1981, 1986; Visser, 1984; Bordy & Head, 2018). The formation is characterized by large-scale cross-bedding, desiccation cracks, thick to extremely thick bedding, and less common clay-pellet conglomerates (Bordy & Head, 2018). Carbonate concretions are also found in the lower part of the formation where mudstones are more common (Bordy & Head, 2018). Prior to 1980, this unit was informally known as the "Cave Sandstone" due to the frequent occurrence of small caves, massive overhangs above the weaker red beds of the underlying Elliot Formation, and other unusual erosional landforms (Grab, 2015; Bordy & Head, 2018). The formation reaches a maximum thickness of approximately 320 meters near the southeastern corner of the basin and represents deposition in a vast aeolian erg (sand sea) environment during the Early Jurassic (~190-180 Ma) (Bordy & Head, 2018).

All Upper Triassic to Lower Jurassic continental red beds of South Africa are included within the Elliot Formation (locally referred to as the Lisbon Formation in the northern Karoo Basin). This red-bed succession consists of mudstone, immature fine- to medium-grained sandstones, and siltstone characterized by strong red-purple-maroon diagenetic coloration, predominantly affecting the argillaceous lithologies, and lacking widespread marker beds (Bordy et al., 2004b). In the Elliot type area in the southern basin, the formation reaches a maximum thickness of 460 to 480 meters, thinning northwards toward KwaZulu-Natal and the Free State Drakensberg where thickness varies between 28 and 150 meters (Bordy & Eriksson, 2015).

The formation was deposited in a fluvio-lacustrine environment comprising two distinct sandstone facies associations in the lower and upper parts of the formation, reflecting different fluvial depositional styles (Bordy et al., 2004b). The lower part of the formation consists of multi-story, asymmetrical channel-fill sandstones deposited by perennial, moderately meandering fluvial systems (Botha, 1968; Visser & Botha, 1980; Smith et al., 1993; Bordy et al., 2004b). In more distal Drakensberg regions, the lower part diminishes in thickness and is dominated by seasonal to ephemeral anastomosing rivers (rivers with multiple interconnected channels separated by vegetated islands) with loessic floodplain fines and semi-arid sheetflood deposits (Eriksson, 1984, 1985). The upper part of the formation generally comprises tabular, multi-story sheet sandstones and associated facies formed by loessic, aeolian ephemeral, fluvial, and playa lake processes (Visser & Botha, 1980; Eriksson, 1984, 1985; Smith et al., 1993; Bordy et al., 2004b). These differences in fluvial style were generated by changes in tectonic setting (including tectonic pulses and associated subsidence) as well as evolving climatic conditions during the Late Triassic to Early Jurassic transition (Bordy et al., 2004a).

The PalaeoMap of the South African Heritage Resources Information System (SAHRIS) indicates that the palaeontological sensitivity of the Clarens Formation is High (orange), while that of the Elliot/Lisbon Formation is Very High (red) (Figure 111) (Almond et al., 2013; SAHRIS website). This classification reflects the well-documented fossil record of both formations throughout the Main Karoo Basin. The DFFE Web-based Screening Tool confirms that the palaeontological sensitivity of the study area is predominantly Very High (dark red), with portions also crossing areas of High sensitivity (orange). These sensitivity ratings are based on extensive palaeontological research demonstrating that both formations contain scientifically significant fossil assemblages of national and international importance.

The Elliot Formation (Lisbon Formation) is palaeontologically extremely important as it preserves one of the world's richest early dinosaur faunas, including prosauropods (the richest known sauropodomorph assemblages globally; McPhee, 2017), ornithischians, rare amphibians, turtles, crocodilians and crocodylomorphs, fish, cynodont therapsids, and early mammals representing the mammalian transition (Bordy et al., 2015; Viglietti et al., 2020a, b). Additional fossils include crustaceans, insects, petrified wood, and abundant tetrapod trackways (ichnofossils) (Bordy et al., 2015).

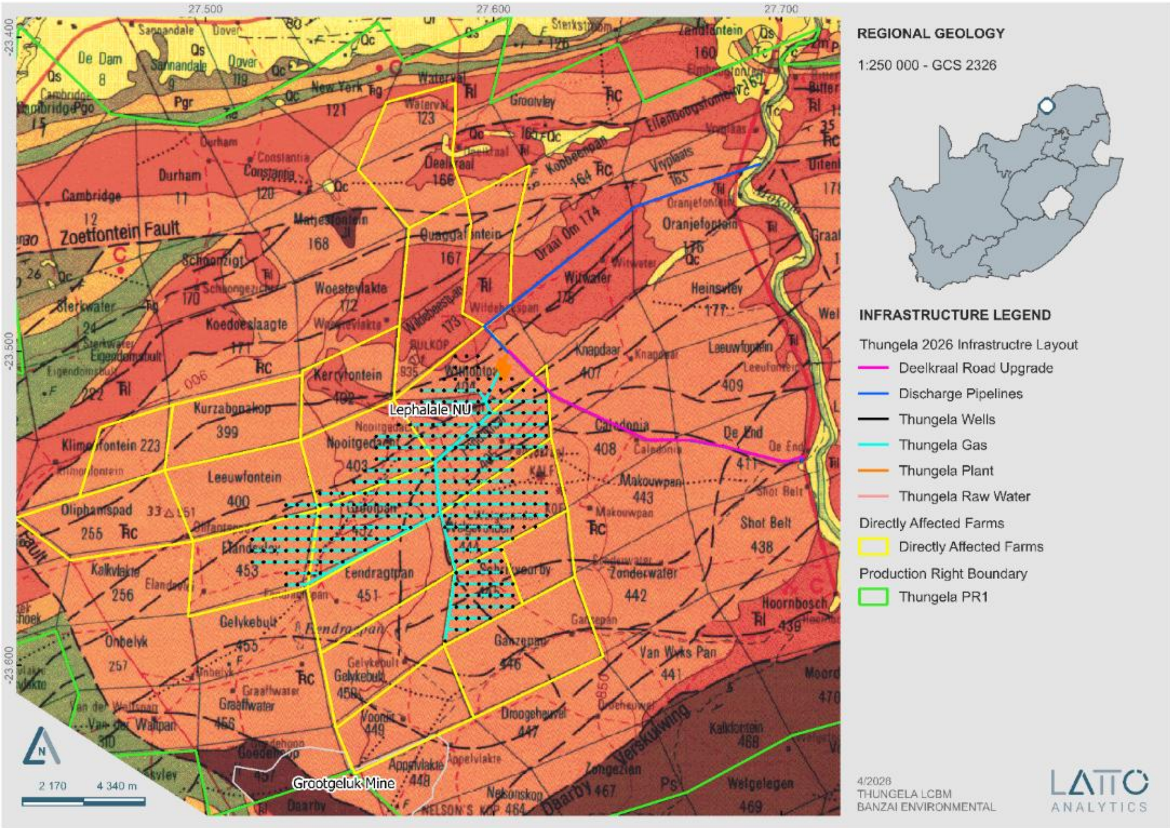


Figure 110: Extract of the 1:250 000 Ellisras 2326 (1993) Geological Map (Council for Geosciences, Pretoria) indicates that the Thungela LCBM is underlain by the Clarens (TR c) and Lisbon (TRl) Formations of the Karoo Supergroup.

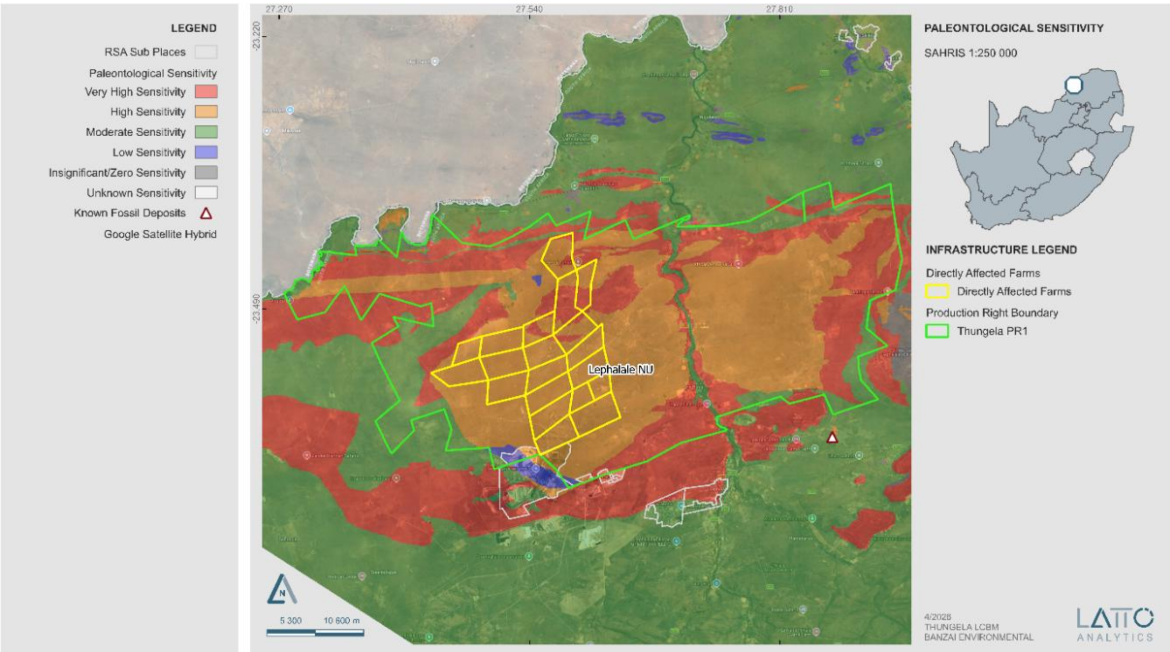


Figure 111: Palaeontological Sensitivity according to the SAHRIS PalaeoMap indicates a Very High (red), and High (orange) Palaeontological Sensitivity.

10.18 ECONOMIC ENVIRONMENT

The sub-sections below provide an overview of the economic baseline applicable to this project.

The following provides an overview and comparison of employment and unemployment rates in key areas within the Waterberg District Municipality. This includes Thabazimbi, Lephalale and Modimolle-Mookgophong, as well as Bela-Bela.

Thabazimbi has a relatively high employment rate of 51%, indicating that a significant portion of its population is engaged in some form of employment. Lephalale and Modimolle-Mookgophong also have relatively high employment rates at 44% and 47%, respectively. Bela-Bela, with a 47% employment rate, has a similar performance to Modimolle-Mookgophong.

In summary, the evaluation of employment performance suggests that Thabazimbi has a relatively strong employment situation with low unemployment. Lephalale, Modimolle-Mookgophong, and Bela-Bela also perform reasonably well in terms of employment and unemployment rates. However, Mogalakwena faces higher unemployment and has a larger proportion of individuals who are not economically active, indicating potential areas for improvement in creating job opportunities and economic activity.

The Waterberg District Municipality has seen an increase in its South African Multidimensional Poverty Index head count poverty rate, rising from 6.5% in 2011 to 9% presently. The Multidimensional Poverty Index (MPI) is a measure that goes beyond traditional income-based poverty assessments. It considers multiple dimensions of poverty, such as education, health, and living standards.

In other words, the MPI provides a more comprehensive view of poverty by considering not only people's income but also their access to basic services like healthcare and education, as well as their overall living conditions. An increase in the MPI head count poverty rate suggests that a larger proportion of the population is experiencing deprivation in multiple dimensions of well-being, which can include factors like lack of access to clean water, sanitation, housing, and education.

Furthermore, there are more concerning statistics: in the past 12 months, 16.6% of households ran out of money to purchase food, and 12.1% of households had to skip a meal. Notably, the majority of the population in this district is African (comprising 91%), with 61% of them living in poverty. Consequently, there are 284,472 social grant beneficiaries, including 202,175 recipients of the Child Support Grant and 55,240 individuals receiving the old age grant.

Lephalale’s Gross Geographic Product (GGP) is estimated to be approximately R70 billion to R75 billion in nominal terms, according to recent municipal and provincial regional indicators. The local economy is dominated by the mining and energy sectors, which account for roughly 59% and 11% of the total GGP.

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 SIGNIFICANCE

The final significance (FS) of an impact or risk is determined by applying a prioritisation factor (PF) to the post-mitigation environmental significance. The significance is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

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

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 47 below.

Table 47: 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. Highly localised, limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property or site boundary, or the area within a few hundred meters of the site)
	3	Local (i.e. beyond the site boundary within the Local administrative boundary (e.g. Local Municipality) or within consistent local geographical features, or the area within 5 km of the site)
	4	Regional (i.e. Far beyond the site boundary, beyond the Local administrative boundaries within the Regional administrative boundaries (e.g. District Municipality), or extends into different distinct geographical features, or extends between 5 and 50 km from the site).
	5	Provincial / National / International (i.e. extends into numerous distinct geographical features, or extends beyond 50 km from the site).
Duration	1	Immediate (<1 year, quickly reversible)

Aspect	Score	Definition
	2	Short term (1-5 years, less than project lifespan)
	3	Medium term (6-15 years)
	4	Long term (15-65 years, the impact will cease after the operational life span of the project)
	5	Permanent (>65 years, no mitigation measure of natural process will reduce the impact after construction/ operation/ decommissioning).
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, or affected environmental components are already degraded)
	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; or where change affects area of potential conservation or other value, or use of resources).
	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; or where change affects high conservation value areas or species of conservation concern)
	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; or disturbance to pristine areas of critical conservation value or critically endangered species)
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 very high time and cost.
	5	Irreversible Impact.

Once the C has been determined, the significance is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per Table 48.

It is noted that both environmental risks as well as environmental impacts should be identified and assessed. Environmental Risk can be regarded as the potential for something harmful to happen to the environment, and in many instances is not regarded as something that is expected to occur during normal operations or events (e.g. unplanned fuel or oil spills at a construction site). Probability and likelihood are key determinants or variables of environmental risk. Environmental Impact can be regarded as the actual effect or change that happens to the environment because of an activity and is typically an effect that is expected from normal operations or events (e.g. vegetation clearance from site development results in loss of species of concern). Typically the probability of an unmitigated environmental impact is regarded as highly likely or certain (management and mitigation measures would ideally aim to reduce this likelihood where possible). In summary, environmental risk is about what could happen, while environmental impact is about what does happen.

Table 48: Probability/ Likelihood Scoring.

Probability	1	Improbable (Rare, the event may occur only in exceptional circumstances, the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <5% chance).
	2	Low probability (Unlikely, impact could occur but not realistically expected; >5% and <20% chance).
	3	Medium probability (Possible, the impact may occur; >20% and <50% chance).
	4	High probability (Likely, it is most probable that the impact will occur- > 50 and <90% chance).
	5	Definite (Almost certain, the impact is expected to, or will, occur, >90% chance).

The result is a qualitative representation of relative significance associated with the impact. Significance is therefore calculated as follows:

S = C x P

Table 49: Determination of Significance.

Consequence	5- Very High[18]	5	10	15	20	25
	4- High	4	8	12	16	20
	3- Medium	3	6	9	12	15
	2- Low	2	4	6	8	10
	Very low	1	2	3	4	5
		Improbable (1)	Low (2)	Medium/ Possible (3)	High/ Probable (4)	Highly likely/ Definite (5)
	Probability					

The outcome of the significance assessment will result in a range of scores, ranging from 1 through to 25. These significance scores are then grouped into respective classes as described in Table 50.

Table 50: Significance Scores.

S Score	Description
≤4.25	Low (i.e. where this impact is unlikely to be a significant environmental risk/ reward).
>4,25, ≤8.5	Low-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>8.5, ≤13.75	High-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>13.75	High (i.e. where the impact will have a significant environmental risk/ reward).

[18] In the event that an impact or risk has very high or catastrophic consequences, but the likelihood/ probability is low, then the resultant significance would be Low-medium. This does in certain instances detract from the relative important of this impact or risk and must consequently be flagged for further specific consideration, management, mitigation, or contingency planning.

The impact significance will be determined for each impact without relevant management and mitigation measures (pre-mitigation significance), as well as post implementation of relevant management and mitigation measures (post-mitigation significance). 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 consider 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 impacts' post-mitigation significance (post-mitigation). This prioritisation factor does not aim to detract from the significance 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 post-mitigation significance based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 51: 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.
Irreplaceable Loss of Resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	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 51. The impact priority is therefore determined as follows:

Priority = CI + LR

he result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (Refer to Table 52).

Table 52: Determination of Prioritisation Factor.

Priority	Prioritisation Factor
2	**1**
3	**1.125**

Priority	Prioritisation Factor
4	**1.25**
5	**1.375**
6	**1.5**

In order to determine the final impact significance (FS), the PF is multiplied by the post-mitigation significance 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 higher significance).

Table 53: Final Environmental Significance Rating.

Significance Rating	Description
<-25	**Very High (Impacts in this class are extremely significant and pose a very high environmental risk. In certain instances these may represent a fatal flaw. They are likely to have a major influence on the decision and may be difficult or impossible to mitigate. Offset's may be necessary.**
<-13.75 to -25	High negative (These impacts are significant and must be carefully considered in the decision-making process. They have a high environmental risk or impact and require extensive mitigation measures).
-8.5 to -13.75	Medium-High negative (i.e. Impacts in this class are more substantial and could have a significant environmental risk. They may influence the decision to develop in the area and require more robust mitigation measures).
<-4.25 to <-8.5	Medium- Low negative (i.e. These impacts are slightly more significant than low impacts but still do not pose a major environmental risk. They might require some mitigation measures but are generally manageable).
-1 to -4.25	Low negative (i.e. Impacts in this class are minor and unlikely to have a significant environmental risk. They do not influence the decision to develop in the area and are typically easily mitigated.
0	No impact
1 to 4.25	Low positive
>4.25 to <8.5	Medium-Low positive
8.5 to 13.75	Medium-High positive
>13.75	High positive

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 POTENTIAL 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&APs 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 EIA assessment and consultation process. Potential environmental impacts were identified during the scoping process, and these impacts were identified by the EAP in conjunction with the appointed specialists. Based on the project activities, the scoping phase list of identified impacts for specific environmental themes and project phases are listed in Table 54 and the impacts and preliminary assessment of each is presented in the subsections below.

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.

Impacts have been identified for the various phases of the project namely, Planning, Construction, Operation, Decommissioning, Rehab and closure.

Table 54: Summary impact matrix.

Project Activity	Phase	Potential Impact	Specialist Discipline
Preliminary site investigations and layout planning. **Traffic movements.**	Planning	Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	
		Impacts on safety and security of local residents	
		Public perceptions about safety associated with gas production	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Effects on Energy Security	Economic
		Local Economic Growth and Rural Development	
		Job Creation and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	
Access road construction. **Construction camp and laydown establishment.** **Well site clearance, establishment, drilling, stimulation.** **Coal seam water**	Construction	Destruction, further loss and fragmentation of the vegetation community	Terrestrial Biodiversity
		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).	
		Loss of watercourse habitat	Aquatic/Wetland
		Decrease in surface water quality	
		Disruption of watercourse hydrology	
		Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety associated with gas production	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	

Project Activity	Phase	Potential Impact	Specialist Discipline
abstraction, treatment and disposal. **Gas and water pipeline construction.** **Electricity distribution infrastructure construction.** **LNG Plant and booster / compressor station construction.** **Traffic movements.** **Waste storage and disposal.**		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Disturbance of: Historical Structures - Historical structure foundations	Heritage
		Disturbance of: Historical Structures - Kraals	
		Disturbance of: Historical Structures - Boreholes	
		Disturbance of: Historical Structures - Excavated pit	
		Disturbance of: Archaeological Sites - Single find spot	
		Disturbance of: Archaeological Sites - Iron Age Site	
		Erosion of soils	Hydrology (surface water)
		Pollutants entering the surface water environment	
		Increase in runoff	
		Increased flood potential	
		Groundwater quality deterioration and siltation due to infiltration of contaminated stormwater run-off from the construction area.	Geohydrology (groundwater)
		Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.	
		Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	
		Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	
		Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.	
		Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	
		Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	
		Effects on Energy Security	Economic
		Local Economic Growth and Rural Development	

Project Activity	Phase	Potential Impact	Specialist Discipline
		Job Creation and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	
		Impact on palaeontological resources	Palaeontology
		Decrease in ambient air quality due to dust, particulates and stray gases	Air Quality
		Increase in noise levels	Noise
		Fugitive methane releases which contribute to climate change (e.g. during well drilling)	Climate Change
		Further general degradation of the local landscape	Visual
		Degradation of views from the R33 and R572 in proximity to the proposed site	
		Further degradation of the local landscape as viewed from adjacent local roads	
		Further degradation of the local landscape as viewed from homesteads	
		Degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves	
		Lighting impacts on sensitive receptors	
		Induced or triggered seismic activity	Seismicity
		Deterioration of existing road surfaces/ pavements	Traffic
		Traffic congestion	
		Safety of road users	
Maintenance and monitoring of wells and pipelines. **Water abstraction, treatment and disposal.** **Traffic movements.** **LNG Plant operations.**	Operation	Continued encroachment of an indigenous vegetation community by alien invasive plant species as well as erosion due to disturbed soils	Terrestrial Biodiversity
		Continued displacement and fragmentation of the faunal community (including threatened species) due to ongoing anthropogenic disturbances (noise, dust and vibrations) and habitat degradation/loss (litter, road mortalities and/or poaching).	
		Loss of watercourse habitat	Aquatic/Wetland
		Decrease in surface water quality	
		Disruption of watercourse hydrology	
		Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety associated with gas production	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	

Project Activity	Phase	Potential Impact	Specialist Discipline
Waste storage and disposal.		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Erosion of soils	Hydrology (surface water)
		Pollutants from produced water management and storage entering the surface water environment	
		Increase in runoff	
		Increased flood potential	
		Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.	Geohydrology (groundwater)
		Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	
		Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	
		Groundwater quality deterioration as a result of wastewater spills and seepage from wastewater storage facilities.	
		Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	
		Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	
		Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	
		Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.	
		Effects on Energy Security	Economic
		Local Economic Growth and Rural Development	
		Job Creation and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	
		Decrease in ambient air quality	Air Quality

Project Activity	Phase	Potential Impact	Specialist Discipline
		Increase in noise levels	Noise
		Fugitive methane releases which contribute to climate change (e.g. leaking well, pipeline, etc)	Climate Change
		Further general degradation of the local landscape	Visual
		Degradation of views from the R33 and R572 in proximity to the proposed site	
		Further degradation of the local landscape as viewed from adjacent local roads	
		Further degradation of the local landscape as viewed from homesteads	
		Degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves	
		Lighting impacts on sensitive receptors	
		Induced or triggered seismic activity	Seismicity
		Deterioration of existing road surfaces/ pavements	Traffic
		Traffic congestion	
		Safety of road users	
Removal of project infrastructure. **Well sealing and concrete batching.** **Traffic movements.** **Waste disposal.**	Decommissioning	Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety associated with gas production	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Erosion of soils	Hydrology (surface water)
		Pollutants entering the surface water environment	
		Increase in runoff	
		Increased flood potential	
		Dewatering effects lessening, post-operational re-watering and flooding of underground coal seams which may result in a rebound of the local hydraulic head and regional water levels.	Geohydrology (groundwater)
		Poor quality leachate emanating from sulphide bearing minerals associated with dewatered coal seams and faces which will have a negative impact on groundwater water quality.	
		Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.	

Project Activity	Phase	Potential Impact	Specialist Discipline
		Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) if the wells not adequately sealed.	
		Groundwater pollution as a result of wastewater spills and seepage from wastewater storage facilities.	
		Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	
		De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.	
		Effects on Energy Security	Economic
		Local Economic Growth and Rural Development	
		Job Creation and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	
		Decrease in ambient air quality	Air Quality
		Increase in noise levels	Noise
		Induced or triggered seismic activity	Seismicity
		Deterioration of existing road surfaces/ pavements	Traffic
		Traffic congestion	
		Safety of road users	
Soil reinstatement. **Ripping of compacted soils.** **Seeding and vegetation establishment.** **Traffic movements.**	Rehab and closure	Loss of land capability, soil compaction, soil erosion, land degradation	Soils
		Damage to farm roads, existing services, and infrastructure	Social
		Impacts on safety and security of local residents	
		Public perceptions about safety associated with gas production	
		Nuisance factor due to an increase in ambient dust and noise levels	
		Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	
		Impacts on the livelihoods of landowners	
		Impacts on the social license to operate	
		Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	
		Contribution to the economy of South Africa	
		Erosion of soils	Hydrology (surface water)
		Pollutants entering the surface water environment	
		Increase in runoff	

Project Activity	Phase	Potential Impact	Specialist Discipline
		Increased flood potential	
		Effects on Energy Security	Economic
		Local Economic Growth and Rural Development	
		Job Creation and Household Income	
		Foreign Investment Attraction and Forex Savings	
		Population Growth and Pressure on Local Infrastructure	
		Impact on tourism and alternative land-use	

11.2.1 CONSTRUCTION PHASE IMPACTS

11.2.1.1 SOCIAL IMPACTS

Sources of social impacts are often not as clear-cut as those in the biophysical environment. Social impacts are not site-specific but occur in the communities surrounding the proposed site (where the people are located). The following is a list of some of the possible impacts that may occur as a result of the project.

- Expectations regarding creation of opportunities (Jobs etc.);
- Damage to farm roads, existing services, and infrastructure;
- Impacts on safety and security of local residents;
- Public perceptions about safety associated with gas production;
- Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective;
- Impacts on livelihoods of landowners;
- Impacts on social license to operate;
- Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc; and
- Contribution to economy of South Africa.

It must be stated that the above list is not exhaustive and may be expanded on in the EIA phase once initial consultation with stakeholders has taken place. Mitigation measures are context specific, and the mitigation measures below should be viewed as preliminary guidelines and may change once consultation with stakeholders has taken place. Due to the complex nature of social impacts, the preliminary significance of the various social impacts' ranges from low to high (negative and positive) before and after mitigation at this scoping level assessment.

(i) Mitigation measures

- Thungela must maintain a communication strategy that will communicate in an open and honest way what kind of employment opportunities will be created, who will qualify and how the recruitment process will work.
- Thungela should maintain the private roads that they use.
- Compile an asset and infrastructure baseline of infrastructure and assets that may be impacted on by the project.
- Work with existing security groups and implement the AgriSA farm access protocol for everybody that needs to access properties.
- Prepare and share information explaining the process and potential risks in laymen's terms.
- Heavy vehicles should travel during off peak times as far as possible and should be clearly marked.
- There should be a code of conduct for contractors to avoid their activities impacting on the landowners.
- Develop mitigation in consultation with the landowners.
- Build and maintain good relationships with the landowners and other relevant stakeholders such as community members.
- Develop and implement an Influx Management Strategy as per IFC Guidelines on Influx Management.

(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 at this scoping level assessment.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

11.2.1.2 ECONOMIC IMPACTS

An economic impact assessment differs from a typical biophysical impact assessment primarily because, during the planning, construction, and operation phases, the economic impacts tend to be predominantly positive.

Many 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).

The rise in population as a result of influx of workers and the resulting strain on infrastructure receive a negative rating during the construction phase. This is primarily due to the increase in social pathologies and the already deteriorated state of local infrastructure in the economy.

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

- Energy Security
- Local Economic Growth and Rural Development
- Job Creation and Household Income
- Foreign Investment Attraction and Forex Savings
- Population Growth and Pressure on Local Infrastructure
- Tourism and alternative land-use

(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.
- Provide local employment as far as possible.
- Negotiations with private landowners where there is clear evidence of 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 is unlikely to result in irreplaceable loss of resources.

11.2.1.3 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/compressor stations the air quality impacts (due to dust and vehicle exhaust gas) at the nearest sensitive receptors to the construction areas may exceed the respective short-term NAAQSs 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.

(i) Mitigation measures

- As construction will only take place during day-time hours and will be of limited duration, Air Quality Sensitivity Receptors (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.
- Where appropriate, dust suppression must be undertaken to minimise dust generation.

(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 **CLIMATE CHANGE IMPACTS**

The impact significance will be based on the quantified GHG emissions from the project including but not limited to venting and flaring of GHGs. As the quantification of GHG for the project will only be undertaken during the impact assessment phase when the engineering designs will be available, the significance rating can only be provided once the impact assessment has been undertaken. No fatal flaws, however, are expected due to the climate impacts.

11.2.1.5 **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 infrastructure, the noise levels at the nearest residential receptors to the construction areas may exceed IFC guidelines for residential areas (55 dBA) unless the setback distance of the infrastructure is adjusted. 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.

(i) Mitigation measures

- As construction will only take place during day-time hours and will be of limited duration, Noise Sensitive Receptors (NSRs) within 90 m of the pipeline construction site 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.

11.2.1.6 **GROUNDWATER IMPACTS**

The main construction activities encompass clearance of vegetation at explorational drilling sites, pipeline and road construction, drilling and stimulation of wells and construction of the LNG Plant. Due to the surficial nature of the associated activities, minimal impacts on the groundwater system are expected. During the construction phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium negative without implementation of remedial measures and low negative with implementation of proposed mitigation measures. The main impacts associated with the construction phase activities include the following:

- Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area.
- Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.
- Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.
- Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.
- Mobilisation and maintenance of heavy vehicles and machinery on-site may cause hydrocarbon contamination of groundwater resources.
- Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.

(i) Mitigation measures

- A stormwater management plan must be developed to prevent contaminated stormwater from impacting negatively on the receiving environment.
- 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.
- Encasing of the wells in cement during the drilling process to prevent groundwater migration (upward and downward). API rated casing will be used to protect upper aquifers from methane gas contamination.
- A groundwater management plan will be developed and implemented as part of all the phases of the development. The groundwater management plan will specifically address production well designs to ensure isolation of the gas from the host-aquifer(s). Well design will be undertaken according to designs developed by a qualified well engineer. 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.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that certain impacts may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- Certain impacts may result in irreplaceable loss of resources if not adequately mitigated but the spatial scale/extent of the resources will be limited.

11.2.1.7 **HERITAGE IMPACTS**

Impacts on heritage resources are likely limited to the construction phase where clearing and excavation activities are undertaken. Thereafter, no impacts on heritage resources are likely during the operational and decommissioning phase. The potential impacts associated with the construction phase activities include the following:

- Historical Structures – Destruction or damage of foundations;

- Historical Structures – Destruction or damage of Kraals;
- Historical Structures – Destruction or damage of Boreholes;
- Historical Structures – Impact on excavated pit;
- Archaeological Sites – Single MSA tool find spot; and
- Archaeological Sites – Iron Age Site.

The pre-mitigation impact on the residential structural remains, is calculated as high negative and only focused during the construction phase. Implementation of the recommended mitigation measures will reduce the impact to low positive.

The pre-mitigation impact on the historic boreholes and EFC site is calculated as medium negative and only focused during the construction phase. Implementation of the recommended mitigation measures will reduce the impact to low positive.

The pre-mitigation impact on the kraals, excavated pit and single MSA tool find spot is calculated as low negative and only focused during the construction phase. Implementation of the recommended mitigation measures will reduce the impact to low positive.

The middle Stone Age find spot is calculated as having a LOW significance before and after implementation of mitigation measures.

The EFC archaeological site is calculated as having a MEDIUM significance before the implementation of mitigation measures and LOW after Implementation.

(i) Mitigation measures

- Implement a chance to find procedures in case where possible heritage finds are uncovered.
- The possibility of still born burials must be considered when working near any historical residential structures. All burial grounds and graves should be retained and avoided with a buffer zone of 30m as per SAHRA guidelines that includes a thorough stakeholder engagement component and test excavations, adhering to the requirements of Section 36 of the NHRA and its regulations as well as the National Health Act and its regulations.
- The identified historical boreholes have been constructed in the early 1900's and should be avoided with a 30m buffer. If they cannot be avoided, they should be documented.
- The Early Farming Community (EFC) site should be avoided with a 30m buffer around Bulklip koppie. If they cannot be avoided, they should be documented by a qualified archaeologist with the relevant permits in place by SAHRA.

(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.

(iv) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

11.2.1.8 **TERRESTRIAL BIODIVERSITY IMPACTS**

The following potential impacts on the biodiversity were considered for the construction phase of the project. This phase refers to the period during construction when the proposed infrastructure is constructed. This phase usually has the largest direct impact on biodiversity. The following potential impacts to terrestrial biodiversity were considered:

- 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, pollution, noise, light, dust, vibration and poaching); and

(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, locate activities on the boundaries of existing disturbance. Use existing access roads as much as possible.
- Rehabilitate disturbed areas as soon as possible and control alien and invader species.
- Check for snares on a regular 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. Any contractor or employee caught poaching should be removed from site.

(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 however some loss of habitat for indigenous species may occur and this should be temporary and short lived.

11.2.1.9 AQUATIC AND WETLAND IMPACTS

A key consideration for the impact assessment is the presence of the identified water resources in relation to the project area. The available data suggests that a LC SAIIAE wetland and unclassified FEPA wetlands are present within the project area and its 500 m Zone of Regulation (ZoR). However, this must be confirmed during the EIA field survey, and the aquatic and wetland systems are currently dry with minimal evidence for their extensive presence across the study area.

Anthropogenic activities could result in the encroachment into water resources and result in the loss or degradation of these systems (if present), most of which will provide some degree of ecological services. These disturbances could also result in the infestation and establishment of alien vegetation, which could affect the functioning of the systems. Leaks and/or spillages could result in contamination of the receiving water resources. Contaminated water resources are likely to influence the associated biota. An increase in stormwater runoff could result in physical changes to the receiving systems caused by erosion, run-off and sedimentation, and the functional changes could result in changes to the vegetative structure of the systems.

The following activities may have a negative effect on water resources and most impacts involve the water resources and the habitats connected to these:

- The drilling of new gas wells ~324 wells spread over a total study area of approximately ~14 229 ha; and
- The installation of gas and water gathering pipelines connecting the wells to gas processing plants, raw water dams and water treatment plant.

Preliminary impacts on watercourses identified during the construction phase include:

- Disturbance of destruction of habitat;

- Decrease in water quality; and
- Disturbance of flow of the watercourse.

(i) 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.
- 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 by planting suitable vegetation (e.g. 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.

(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.

11.2.1.10 **SOIL AND LAND CAPABILITY**

Various soil forms are expected throughout the project area, of which some are commonly associated with moderate land capabilities. Even though the soil depth, texture and permeability of these soils ensure higher land capability, the climatic capability of an area often reduces the land potential. Areas characterised by “moderate” land potential are expected for selected areas however much of the current land use is natural bushveld farms. The proposed development can result in the loss of land capability. The disturbances could also further result in the infestation and establishment of alien vegetation, which in turn can have a detrimental impact on soil resources. The development of the area could result in compaction and/or erosion. Furthermore, these activities could also cause leaks and/or spillages resulting in contamination of soil resources, which could affect the salinity or pH of the soil, which can render the fertility of the soil unable to provide nutrition to plants.

The construction phase has the potential to result in the greatest impact on soils compared to the other phases of the project. The preliminary impact assessment has resulted in a post mitigation significance of medium and this will be verified and updated if necessary, during the EIA phase once a comprehensive site assessment has been completed.

Preliminary impacts on soils and land capability identified during the construction phase include:

- Loss of land capability;
- Soil compaction;
- Soil erosion; and
- Land degradation.

(i) Mitigation measures

- Only predefined access roads should be used to reduce any unnecessary compaction.
- Prevent any spills from occurring.
- Alien and invasive species must be controlled.
- All excess soil (soil that are stripped and stockpiled to make way for foundations) must be stored and used in rehabilitation. Where necessary, active reseeding of stockpiles should be undertaken (e.g. hydroseeding) in order to ensure good vegetation coverage to prevent dust generation and degradation of the topsoil viability.
- If a spill occurs, it is to be cleaned up immediately and reported to the appropriate authorities.

(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.

11.2.1.11 **VISUAL IMPACTS**

The project will increase the proportion of industry in the area and reduce the area of natural vegetation. However, due to its location and screening provided trees and shrubs, with mitigation (preservation of existing vegetation) the proposed project is unlikely to be highly obvious to surrounding areas. Should vegetation not be preserved, a significant change in landscape character is likely to be obvious. Without an indication of the possible location and layout of the project, it is not possible to be confident regarding possible significance of impacts.

The landscape in the vicinity of the proposed site is relatively natural. The project is likely to result in loss of natural areas.

The proposed project may result in degradation of views from the R33 and R572 in proximity to the proposed site. These roads are a minimum of 8km from the proposed development area. Given the screening effect of existing vegetation, it is highly unlikely that the proposed project will be visible from these roads.

The proposed project may result in further degradation of the local landscape as viewed from adjacent local roads. Two local roads run through the proposed development area. Vegetation beside these roads' limits visibility from the road edge. If roadside vegetation is retained and development is kept away from the road edge, then the project is likely to be largely screened. With this mitigation, the significance of the likely impact is anticipated to be low.

From travelling along local roads, homesteads are generally not visible due to the dense vegetation except for a few homesteads located directly adjacent to the local roads. Reference to on-line mapping also indicates that while there are generally cleared areas around local homesteads this is generally limited. It is therefore anticipated that if existing vegetation is maintained, development is unlikely to be visually obvious from homesteads.

The proposed project has the potential to result in degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves. From travelling along local roads, views into the nature reserves are generally not possible due to the density of existing vegetation. It is therefore anticipated that as long as existing screening vegetation is maintained, development is unlikely to be visually obvious from within the reserves.

Lighting is likely to be required for security, maintenance and the safety / convenience of workers. It is likely that lighting of wells will be minimal and only likely during possible nighttime maintenance and it is possible that the production plant will be lit at night for security reasons. Furthermore, during commissioning activities for the wells and LNG Plants, flaring of gas may be required which would pose an additional lighting source to nearby sensitive receptors. It is possible to mitigate lighting impacts to a large degree through design, the use of motion sensors for security lighting and ensuring that lighting is only used in areas where workers are located / working. Locating the production plant away from possible sensitive receptors should also be considered. If suitable mitigation measures are used, it is unlikely that lighting impacts will be significant.

(i) Mitigation measures

- Maintaining a 400m buffer of natural vegetation between sensitive receptors such as homesteads, protected areas and public roads.
- Setting back taller elements within the proposed development from the homesteads. A minimum distance of 400m is recommended.
- Locate the Phase 2 plant away from sensitive visual receptors.
- Identify alternative options to venting or flaring of gas during commissioning activities.
- Lighting design and use should take into consideration the use of motion sensors and ensuring that lighting is only used in areas where workers are located / working.

(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.

11.2.1.12 **SEISMIC IMPACTS**

Following a literature review of the potential impacts of hydraulic stimulation and/or dewatering of the coal seam water, the risk of seismic induced or triggered hazardous were identified as a potential risk to be assessed. This risk depends significantly on the historic seismicity of the area as well as the magnitude and extent of the stimulation and/or dewatering in the receiving environment.

CBM extraction involves drilling into coal seams to release natural gas trapped within them. While this process is generally considered less risky in terms of inducing or triggering seismic activity compared to hydraulic stimulation for shale gas, it still has the potential to pose certain seismic hazards. The extraction of CBM can potentially trigger seismic events due to the depressurization of the coal seams. When gas and water is extracted, it reduces the pressure within the coal reservoirs, leading to stress changes in the surrounding rock layers. This alteration in stress distribution can sometimes induce faults to slip, causing small to moderate seismic tremors.

Moreover, the injection of fluids during the extraction process can also contribute to seismic activity. The high-pressure injection of these fluids into the coal seams can increase pore pressure, affecting the stability of faults nearby. If these faults are already under stress, the additional pressure from fluid injection can potentially trigger seismic events. While most induced seismic events related to CBM extraction are small and rarely cause significant damage, they can still present risks, especially in regions prone to seismic activity or where faults are already stressed. Understanding and monitoring these risks are crucial for safe and responsible CBM extraction practices and therefore this impact will be assessed by a suitably qualified specialist and the results presented in the EIA phase. The content of the seismic impact assessment report should comply with the minimum information requirements for such assessments as prescribed in the "*Draft Minimum Information Requirements* *for the submission of applications for an authorisation, right, permit or licence for the onshore exploration of oil and gas intending to utilise hydraulic fracturing*" (DFFE, 2022).

This preliminary impact assessment has been undertaken by the EAP which carries a low level of confidence due to the EAPs lack of expertise in this field and the inherent uncertainty in predicting seismic events. It is however considered a construction phase risk as this is when the dewatering and hydraulic stimulation takes place. During the EIA Phase assessment, a seismic specialist will be consulted to provide input into this risk.

(i) Mitigation measures

- Seismic monitoring stations should be installed and monitored to identify any changes in the seismicity within and surrounding the application area.
- Seismic monitoring stations should be installed at least 1 year prior to commencement of construction to determine a baseline condition.
- Should an increase in seismic events be noted, the construction of wells should cease until such time as additional studies are concluded by a suitably qualified specialist who should advise on when/if commencement of activities can continue.

(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 may result in the irreplaceable loss of resources of high value (services and/or functions).

11.2.1.13 **TRAFFIC IMPACTS**

The LCBM Project may result in an increase in traffic in the area during the construction phase. Heavy vehicle construction trips are expected to cause additional wear and tear on the surrounding road network. The Deelkraal gravel access road to the site may deteriorate during the construction phase which would require maintenance and/or repair. Furthermore, the intersections where access from Deelkraal Road onto the R510 Road may require upgrading to ensure safety to all road users.

The following impacts were assessed for the construction phase of the project:

- Deterioration of existing road surfaces/ pavements
- Traffic congestion
- Safety of road users

This preliminary impact assessment has been undertaken by the EAP which carries a low level of confidence due to the EAPs lack of expertise in this field. During the EIA Phase assessment, a Traffic Engineer will be consulted to provide input into this risk and an updated impact assessment presented with detailed mitigation measures (including any road upgrade designs where relevant).

(iv) Mitigation measures

- Document the access road conditions prior to construction using photographs and video for record purposes.
- Monitor the conditions of the site access roads and undertake road maintenance and repair as and where necessary.
- Apply dust suppression to the Deelkraal gravel access road near sensitive receptors as and where necessary to ensure safe road driving conditions.
- Upgrade the intersections along Deelkraal road with the R510 as well as to the Phase 1 and Phase 2 LNG Plants (where deemed necessary by a Traffic Engineer).

(v) 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.

(vi) 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 SOCIAL IMPACTS

Sources of social impacts are often not as clear-cut as those in the biophysical environment. Social impacts are not site-specific but occur in the communities surrounding the proposed site (where the people are located). The following is a list of some of the possible impacts that may occur as a result of the project.

- Expectations regarding creation of opportunities (Jobs etc.);
- Damage to farm roads, existing services, and infrastructure;
- Impacts on safety and security of local residents;
- Public perceptions about safety associated with gas production;
- Nuisance factor due to increase in ambient dust and noise levels;
- Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective;
- Impacts on livelihoods of landowners;
- Impacts on social license to operate;
- Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc; and
- Contribution to economy of South Africa.

It must be stated that the above list is not exhaustive and may be expanded on in the EIA phase once initial consultation with stakeholders has taken place. Mitigation measures are context specific, and the mitigation measures below should be viewed as preliminary guidelines and may change once consultation with stakeholders has taken place. Due to the complex nature of social impacts, the preliminary significance of the various social impacts ranges from low to high (negative and positive) before and after mitigation at this scoping level assessment.

(i) Mitigation measures

- Thungela must maintain a communication strategy that will communicate in an open and honest way what kind of employment opportunities will be created, who will qualify and how the recruitment process will work.
- Thungela should maintain the private roads that they use.
- Compile an asset and infrastructure baseline of infrastructure and assets that may be impacted on by the project.
- Work with existing security groups and implement the AgriSA farm access protocol for everybody that needs to access properties.
- Prepare and share information explaining the process and potential risks in laymen’s terms.
- There should be a code of conduct for contractors to avoid their activities of impacting on the landowners.
- Develop mitigation in consultation with the landowners.

- Build and maintain good relationships with the landowners and other relevant stakeholders such as community members.
- Develop and implement an Influx Management Strategy as per IFC Guidelines on Influx Management.

(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 at this scoping level assessment.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

11.2.2.2 **ECONOMIC IMPACTS**

Many 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 operational phase the economic impacts move towards a more regional and national level when gas production and distribution is in full swing. The rise in population and the resulting strain on infrastructure receive a negative rating during the operational phase. This is primarily due to the increase in social pathologies and the already deteriorated state of local infrastructure in the economy.

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

- Energy Security
- Local Economic Growth and Rural Development
- Job Creation and Household Income
- Foreign Investment Attraction and Forex Savings
- Population Growth and Pressure on Local Infrastructure
- Tourism and alternative land-use

(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.
- Provide local employment as far as possible.
- Negotiations with private landowners where there is clear evidence of 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.

11.2.2.3 **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 final location of the infrastructure would have been planned and constructed with AQSRs in mind, it is unlikely that the respective NAAQS's and NDCR limits for residential areas will be exceeded at AQSRs. The operation of vehicles on unpaved roads even under mitigated conditions could result in single exceedances of the respective NAAQS's and NDCR limits for residential areas at AQSRs.

The main pollutant of concern from the proposed plant are SO_2, NO_2, CO, VOC and PM, with PM_{10} and $PM_{2.5}$ the fractions associated with health impacts. Air Quality Sensitive Receptors have been considered, and the following sensitivity buffer zones have been identified:

- Medium sensitivity: 100 m (residential);
- Low sensitivity: 200 m (residential);
- Least concern: other.

(i) Mitigation measures

- Speed limits on unpaved access roads around AQSRs should be minimised to reduce the amount of dust generated in those locations.
- Undertake dust suppression around AQSRs where required.
- Planning to avoid exposure to AQSRs 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.

11.2.2.4 **CLIMATE CHANGE IMPACTS**

The impact significance will be based on the quantified GHG emissions from the project from likely sources such as fugitive gas, gas turbine emissions, project vehicular emissions, flaring, etc. As the quantification of GHG for the project will only be undertaken during the impact assessment phase when the engineering designs will be available, the significance rating can only be provided once the impact assessment has been undertaken. No fatal flaws, however, are expected due to the climate impacts.

11.2.2.5 **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. Sources of noise would include the gas turbine, LNG Plant, compressor stations (at Plant and infield), vehicular traffic, etc. Care should be taken to site the noise generating infrastructure such as the LNG Plant at least 150 m from any NSRs. With careful siting, IFC noise guidelines for residential areas should not be exceeded at NSRs. At this scoping stage and considering that the preliminary infrastructure layout has not been adjusted in consideration of noise sensitive receptors, negative noise impacts are considered to be of medium significance without mitigation and medium significance with mitigation at the nearest receptors. This assessment may be adjusted in the EIA phase once the final infrastructure locations have been identified and assessed.

(i) Mitigation measures

- Care should be taken to site any noise generating infrastructure such as the LNG Plant at least 150 m from any 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.

11.2.2.6 **GROUNDWATER IMPACTS**

The main operational activities include abstraction of water from production boreholes as well as gas production. Other related activities include wastewater management as well as associated supporting infrastructure. Due to the spatial extent and duration of the proposed project certain impacts on the groundwater system are expected. During the operational phase the environmental significance rating of groundwater quantity as well as quality as well as quality impacts on down-gradient receptors are rated as medium to high negative without implementation of remedial measures and low to medium negative with implementation of proposed mitigation measures. The main impacts associated with operational phase activities include the following:

- Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities should there be faults or fractures to allow for natural movements of water. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.
- Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.
- Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.
- Groundwater pollution as a result of wastewater spills and seepage from wastewater storage facilities.
- Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.
- Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.
- Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.
- Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.

(i) Mitigation measures

- Chemicals used to hydraulically stimulate the targeted coal seam must be environmentally friendly to prevent negative long-term impacts on the aquifer system.
- A numerical groundwater flow and pollution plume migration model will be developed for the EIA Phase, and the model will be calibrated by applying representative on-site data. The calibrated groundwater flow model will be utilised to perform management and mitigation scenarios in order to quantify and qualify potential impacts and evaluate remedial alternatives available.
- An integrated groundwater monitoring network and program will be developed for implementation prior to commencement of the proposed activities in order to formulate a baseline to be applied as a benchmark for future reference. It is imperative that monitoring be conducted to serve as an early warning and detection system.
- A groundwater management plan will be developed and implemented as part of all the phases of the development. The groundwater management plan will specifically address production well designs to ensure isolation of the gas from the host-aquifer(s). Well design will be undertaken according to designs developed by a qualified well engineer.
- 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 Thungela activities, alternative arrangements must be negotiated with the affected parties.
- A leak detection and repair program must be developed and implemented to ensure that any leaks in the wells or pipelines are identified timeously.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that certain impacts may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- Certain impacts may result in irreplaceable loss of resources if not adequately mitigated but the spatial scale/extent of the resources will be limited.

11.2.2.7 TERRESTRIAL BIODIVERSITY IMPACTS

The operational phase will result in lower impacts on terrestrial biodiversity as the operation and maintenance of the gas production project will likely require very minimal interference with the surrounding fauna and flora.

The following preliminary operational phase impacts have been identified and assessed in this report:

- Potential encroachment of an indigenous vegetation community by alien invasive plant species as well as erosion due to disturbed soils;
- Potential minor displacement and fragmentation of the faunal community (including threatened species) due to ongoing anthropogenic disturbances (noise, dust and vibrations) and habitat degradation/loss (litter, road mortalities and/or poaching).

(i) Mitigation measures

- Implement alien and invasive species management.
- Monitor for soil erosion and where identified, address the erosion as soon as possible.
- Use existing access roads and prevent speeding to prevent collisions with wildlife.
- Prevent poaching of wildlife by staff.

(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

A key consideration for the impact assessment is the presence of the identified water resources in relation to the project area. The available data suggests that a LC SAIIAE wetland and unclassified FEPA wetlands are present within the project area and its 500 m Zone of Regulation (ZoR). However, this must be confirmed during the EIA field survey, and the aquatic and wetland systems are currently dry with minimal evidence for their extensive presence across the study area.

Anthropogenic activities could result in the encroachment into water resources and result in the loss or degradation of these systems (if present), most of which will provide some degree of ecological services. These disturbances could also result in the infestation and establishment of alien vegetation, which could affect the functioning of the systems. Leaks and/or spillages could result in contamination of the receiving water resources. Contaminated water resources are likely to influence the associated biota. An increase in stormwater runoff could result in physical changes to the receiving systems caused by erosion, run-off and sedimentation, and the functional changes could result in changes to the vegetative structure of the systems.

The significance of all pre- and post-mitigation impacts during the operational phase are considered low in this preliminary assessment. Preliminary impacts on watercourses (where applicable) identified during the operational phase include:

- Disturbance of destruction of habitat;
- Decrease in water quality; and
- Disturbance of flow of the watercourse.

(i) Mitigation measures

- Maintenance and inspection of 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 erosion 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 **SOIL AND LAND CAPABILITY**

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 includes anthropogenic movement, together with the physical extraction of gas. Besides compaction and erosion caused by ongoing traffic, few aspects are expected to be associated with this phase.

Based on the preliminary impact assessment, the results indicate “Insignificant” to “Very Low” post-mitigation significance.

(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

- 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 project is unlikely to result in irreplaceable loss of resources over the majority of the application area however some loss of soil or land capability may occur, and this should be temporary and short lived.

11.2.2.10 VISUAL IMPACTS

The project will increase the proportion of industry in the area and reduce the area of natural vegetation. However, due to its location and screening provided trees and shrubs, with mitigation (preservation of existing vegetation) the proposed project is unlikely to be highly obvious to surrounding areas. Should vegetation not be preserved, a significant change in landscape character is likely to be obvious. Without an indication of the possible location and layout of the project, it is not possible to be confident regarding possible significance of impacts.

The landscape in the vicinity of the proposed site is relatively natural. The project is likely to result in loss of natural areas.

The proposed project may result in degradation of views from the R33 and R572 in proximity to the proposed site. These roads are a minimum of 8km from the proposed development area. Given the screening effect of existing vegetation, it is highly unlikely that the proposed project will be visible from these roads.

The proposed project may result in further degradation of the local landscape as viewed from adjacent local roads. Two local roads run through the proposed development area. Vegetation beside these roads' limits visibility from the road edge. If roadside vegetation is retained and development is kept away from the road edge, then the project is likely to be largely screened. With this mitigation, the significance of the likely impact is anticipated to be low.

From travelling along local roads, homesteads are generally not visible. Reference to on-line mapping also indicates that while there are generally cleared areas around local homesteads this is generally limited. It is therefore anticipated that if existing vegetation is maintained, development is unlikely to be visually obvious from homesteads.

The proposed project has the potential to result in degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves. From travelling along local roads, views into the nature reserves are generally not possible due to the density of existing vegetation. It is therefore anticipated that as long as existing screening vegetation is maintained, development is unlikely to be visually obvious from within the reserves.

Lighting is likely to be required for security, maintenance and the safety / convenience of workers. It is likely that lighting of wells will be minimal and only likely during possible nighttime maintenance. It is possible that the production plant will be lit at night for security reasons. It is possible to mitigate lighting impacts to a large degree through design, the use of motion sensors for security lighting and ensuring that lighting is only used in areas where workers are located / working. Locating the production plant away from possible sensitive receptors should also be considered. If suitable mitigation measures are used, it is unlikely that lighting impacts will be significant.

(i) Mitigation measures

- Maintaining a 400m buffer of natural vegetation between sensitive receptors such as homesteads, protected areas and public roads.
- Setting back taller elements within the proposed development from the homesteads. A minimum distance of 400m is recommended.
- Locate the LNG plant away from sensitive visual receptors.
- Lighting design and use should take into consideration the use of motion sensors and ensuring that lighting is only used in areas where workers are located / working.

(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.

11.2.2.11 TRAFFIC IMPACTS

The LCBM Project will result in an increase in traffic in the area during the operational phase. Heavy vehicle construction trips are expected to cause additional wear and tear on the surrounding road network. The Deelkraal gravel access road to the site may deteriorate during the construction phase and will require ongoing maintenance. Furthermore, the access from Deelkraal Road onto the R510 Road may require upgrading to ensure safety to all road users.

During operation heavy vehicle trips specifically from the LNG transport trucks are expected to cause additional wear and tear on the surrounding road network. It is anticipated that there will be a maximum of 25 tanker trips per day entering and leaving the site.

The following impacts were assessed for the operational phase of the project:

- Deterioration of existing road surfaces/ pavements
- Traffic congestion
- Safety of road users

This preliminary impact assessment has been undertaken by the EAP which carries a low level of confidence due to the EAPs lack of expertise in this field. During the EIA Phase assessment, a Traffic Engineer will be consulted to provide input into this risk and an updated impact assessment presented with detailed mitigation measures (including any road upgrade designs where relevant).

(i) Mitigation measures

- Monitor the site access road conditions to identify any required maintenance and repair.
- Apply dust suppression to the Deelkraal gravel access road near sensitive receptors to ensure safe road driving conditions. Alternatively upgrade the Deelkraal Road access route section to a paved/surfaced road.

(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.

11.2.3 DECOMMISSIONING REHABILITATION AND CLOSURE PHASE IMPACTS

11.2.3.1 SOCIAL IMPACTS

Sources of social impacts are often not as clear-cut as those in the biophysical environment. Social impacts are not site-specific but occur in the communities surrounding the proposed site (where the people are located). The following is a list of some of the possible impacts that may occur as a result of the project.

- Expectations regarding creation of opportunities (Jobs etc.);
- Damage to farm roads, existing services, and infrastructure;
- Impacts on safety and security of local residents;
- Public perceptions about safety associated with gas production;

- Nuisance factor due to increase in ambient dust and noise levels;
- Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective;
- Impacts on livelihoods of landowners;
- Impacts on social license to operate;
- Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc; and
- Contribution to economy of South Africa.

It must be stated that the above list is not exhaustive and may be expanded on in the EIA phase once initial consultation with stakeholders has taken place. Mitigation measures are context specific, and the mitigation measures below should be viewed as preliminary guidelines and may change once consultation with stakeholders has taken place. Due to the complex nature of social impacts, the preliminary significance of the various social impacts ranges from low to high (negative and positive) before and after mitigation at this scoping level assessment.

(i) Mitigation measures

- Thungela must maintain a communication strategy that will communicate in an open and honest way what kind of employment opportunities will be created, who will qualify and how the recruitment process will work.
- Thungela should maintain the private roads that they use.
- Compile an asset and infrastructure baseline of infrastructure and assets that may be impacted on by the project.
- Work with existing security groups and implement the AgriSA farm access protocol for everybody that needs to access properties.
- Prepare and share information explaining the process and potential risks in laymen's terms.
- During construction – relevant specialists' mitigation measures should be adhered to.
- Heavy vehicles should travel during off peak times as far as possible and should be clearly marked. Relevant mitigation proposed in the biophysical studies should be adhered to.
- There should be a code of conduct for contractors to avoid their activities of impacting on the landowners.
- Develop mitigation in consultation with the landowners.
- Build and maintain good relationships with the landowners and other relevant stakeholders such as community members.
- Develop mitigation in consultation with the landowners.
- Develop and implement an Influx Management Strategy as per IFC Guidelines on Influx Management.

(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 at this scoping level assessment.

(iii) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

11.2.3.2 ECONOMIC IMPACTS

During decommissioning and rehabilitation, economic benefits reverse, and the ultimate closure impact can range from notably negative to slightly less traumatic, depending on how these economic benefits are managed. During and after the decommissioning phase, the economic reversal is categorised as significantly negative.

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

- Energy Security
- Local Economic Growth and Rural Development
- Job Creation and Household Income
- Foreign Investment Attraction and Forex Savings
- Population Growth and Pressure on Local Infrastructure
- Tourism and alternative land-use

(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.
- Provide local employment as far as possible.
- Negotiations with private landowners where there is clear evidence of 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.

11.2.3.3 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 near AQSRs to ensure a minimum of 50% control efficiency (CE). In addition, binding agents or chemical suppressants (such as “Dust-A-Side” or “Dustex”) could 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.

11.2.3.4 **CLIMATE CHANGE IMPACTS**

The impact significance will be based on the quantified GHG emissions from the project. As the quantification of GHG for the project will only be undertaken during the impact assessment phase when the engineering designs will be available, the significance rating can only be provided once the impact assessment has been undertaken. No fatal flaws, however, are expected due to the climate impacts.

11.2.3.5 **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.

11.2.3.6 **GROUNDWATER IMPACTS**

During the decommissioning and post-closure phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium to high negative without implementation of remedial measures and low to medium negative as well as low positive with implementation of proposed mitigation measures. The main impacts associated with the post-closure and decommissioning phase activities include the following:

- Dewatering effects lessening, post-operational re-watering and flooding of underground coal seams which may result in a rebound of the local hydraulic head and regional water levels.
- Poor quality leachate emanating from sulphide bearing minerals associated with dewatered coal seams and faces which will have a negative impact on groundwater water quality.
- Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.
- Migration of stray methane (CH_4) gas from the deep, fractured aquifer to the overlying, potable aquifer(s) if the wells not adequately sealed.
- Groundwater pollution as a result of wastewater spills and seepage from the produced water storage dams.
- Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.
- De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.

(i) Mitigation measures

- Well abandonment and plugging to comply with international best practice requirements.

- Implement well specific plugging requirements to protect the shallow potable 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.
- A groundwater monitoring programme will be implemented to serve as an early detection mechanism for any adverse impacts on the shallower aquifers as a result of the project.
- Remove all surface infrastructure including but not limited to water storage dams and LNG plant.

(ii) Cumulative Impacts

- Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that certain impacts may result in spatial and temporal cumulative change.

(iii) Irreplaceable loss of Resources

- Certain impacts may result in irreplaceable loss of resources if not adequately mitigated but the spatial scale/extent of the resources will be limited.

11.2.3.7 **AQUATIC AND WETLAND IMPACTS**

Decommissioning activities will involve the removal of infrastructure including well pads, pipelines (unless left in place), and associated facilities, followed by site rehabilitation. While the removal of infrastructure presents an opportunity for ecological recovery, disturbances during this process may result in temporary impacts on aquatic and wetland systems. These may include soil disturbance, increased erosion risk, sedimentation, and the potential mobilisation of contaminants. In addition, removal activities may expose soils, altering runoff patterns and potentially affecting downstream water resources.

Anthropogenic disturbances during decommissioning could result in the temporary degradation of water resources through increased turbidity, sediment loads, and accidental spills or leaks from remaining equipment. There is also a risk of alien vegetation establishment in disturbed areas if rehabilitation is not effectively implemented. Conversely, successful rehabilitation is expected to improve ecosystem functioning over time and restore ecological services where feasible.

The following activities may have a negative effect on water resources during the decommissioning phase:

- Removal of well infrastructure;
- Decommissioning and removal of gas and water pipelines (if applicable); and
- Rehabilitation of disturbed areas, including recontouring and revegetation.

Preliminary impacts on watercourses identified during the decommissioning phase include:

- Temporary disturbance of habitat during removal activities;
- Short-term decreases in water quality due to sedimentation and potential contaminant mobilisation; and
- Localised disturbance to flow patterns due to soil exposure and reworking.

(i) Mitigation Measures

- Infrastructure removal should be carefully planned to minimise disturbance within and adjacent to water resources, with no-go buffers implemented where feasible.
- Existing access routes must be used wherever possible to limit additional disturbance.
- Erosion and sediment control measures (e.g., silt fences, berms) should be implemented during removal and rehabilitation activities.

- All machinery and equipment must be regularly inspected for leaks, and any maintenance should occur off-site.
- Spill kits must be available on-site, and all personnel must be trained in spill response procedures.
- Hazardous substances and residual materials must be safely removed and disposed of at licensed facilities.
- Disturbed areas must be rehabilitated promptly using appropriate indigenous vegetation to stabilise soils and promote recovery of ecological function.
- Rehabilitation should aim to restore natural drainage patterns and hydrological connectivity where possible.
- Alien invasive species must be actively controlled during and after rehabilitation.
- All personnel should undergo environmental awareness training, including the protection of water resources and proper waste management.
- Adequate sanitation facilities must be provided and maintained throughout decommissioning activities.

(ii) Cumulative Impacts

Considering the removal of infrastructure and the implementation of rehabilitation measures, cumulative impacts on aquatic and wetland systems are expected to be low and largely positive in the long term. While there may be short-term, localised cumulative effects due to simultaneous decommissioning activities, these are unlikely to result in significant spatial or temporal cumulative change if appropriate mitigation measures are applied.

(iii) Irreplaceable Loss of Resources

The decommissioning phase is unlikely to result in the irreplaceable loss of aquatic or wetland resources. On the contrary, the removal of infrastructure and implementation of rehabilitation measures is expected to reduce long-term pressures on these systems and facilitate partial to full ecological recovery, depending on site-specific conditions and rehabilitation success.

11.2.3.8 **VISUAL IMPACTS**

During the decommissioning phase there will be an increase in site activity to remove surface infrastructure however and then the areas rehabilitated to a pre-defined natural state which will lower the visual impacts on sensitive receptors post decommissioning phase.

(i) Mitigation measures

- Remove surface infrastructure and reinstate vegetation.

(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.

11.2.3.9 **TRAFFIC IMPACTS**

The LCBM Project will likely result in ongoing heavy vehicle traffic during the decommissioning phase as infrastructure is demolished and removed from site. Heavy vehicle trips may result in ongoing wear and tear on the surrounding road network.

The following impacts were assessed for the decommissioning phase of the project:

- Deterioration of existing road surfaces/ pavements

- Traffic congestion
- Safety of road users

This preliminary impact assessment has been undertaken by the EAP which carries a low level of confidence due to the EAPs lack of expertise in this field. During the EIA Phase assessment, a Traffic Engineer will be consulted to provide input into this risk and an updated impact assessment presented with detailed mitigation measures (including any road upgrade designs where relevant).

(iv) Mitigation measures

- Continue to monitor the road conditions to identify any required maintenance and repair.

(v) 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.

(vi) Irreplaceable loss of Resources

- The impact is unlikely to result in irreplaceable loss of resources.

11.2.4 NO-GO ALTERNATIVE IMPACTS

The no-go alternative option means 'do nothing' or the option of not undertaking the proposed 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 project not go ahead, there would be certain impacts identified above which would change from negative to positive (mostly biophysical 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 and potential impacts, their associated phases, as well as their impact calculations and significance are presented in Table 55 below. This preliminary impact assessment is subject to change once additional information from specialists and/or I&APs becomes available. The updated and final impact assessment will be presented in the EIA phase for further I&AP consultation.

Table 55: Preliminary Scoping Phase Impact Assessment.

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
1	Terrestrial Biodiversity	Destruction, further loss and fragmentation of the vegetation community	Construction	-1	3	3	4	4	-3,5	4	-14	High -	-1	2	2	2	2	-2	3	-6	Medium to low -	High	2	2	1,25	-7,50	Medium to low -
2	Terrestrial Biodiversity	Introduction of alien species, especially plants	Construction	-1	3	4	4	4	-3,75	4	-15	High -	-1	2	2	2	2	-2	2	-4	Low -	High	2	2	1,25	-5,00	Medium to low -
3	Terrestrial Biodiversity	Erosion due to storm water runoff and wind	Construction	-1	3	4	4	4	-3,75	4	-15	High -	-1	2	3	2	3	-2,5	3	-7,5	Medium to low -	High	2	2	1,25	-9,38	Medium to high -
4	Terrestrial Biodiversity	Displacement of faunal community due to habitat loss, direct mortalities and disturbance (road collisions, noise, light, dust, vibration and poaching).	Construction	-1	4	4	4	4	-4	4	-16	High -	-1	2	3	2	2	-2,25	3	-6,75	Medium to low -	High	2	2	1,25	-8,44	Medium to low -
5	Terrestrial Biodiversity	Continued encroachment of an indigenous vegetation community by alien invasive plant species as well as erosion due to disturbed soils	Operation	-1	3	4	4	4	-3,75	4	-15	High -	-1	2	2	2	3	-2,25	3	-6,75	Medium to low -	Medium	2	2	1,25	-8,44	Medium to low -
6	Terrestrial Biodiversity	Continued displacement and fragmentation of the faunal community (including threatened species) due to ongoing anthropogenic disturbances (noise, dust and vibrations) and habitat degradation/loss (litter, road mortalities and/or poaching).	Operation	-1	4	4	3	4	-3,75	4	-15	High -	-1	2	2	2	3	-2,25	3	-6,75	Medium to low -	Medium	2	2	1,25	-8,44	Medium to low -
7	Aquatic/Wetland	Habitat	Construction	-1	2	3	4	4	-3,25	2	-6,5	Medium to low -	-1	2	3	3	2	-2,5	2	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
8	Aquatic/Wetland	Water Quality	Construction	-1	3	3	4	4	-3,5	2	-7	Medium to low -	-1	3	3	3	2	-2,75	2	-5,5	Medium to low -	Low	1	1	1,00	-5,50	Medium to low -
9	Aquatic/Wetland	Flow	Construction	-1	2	3	4	2	-2,75	2	-5,5	Medium to low -	-1	2	3	2	2	-2,25	1	-2,25	Low -	Low	1	1	1,00	-2,25	Low -
10	Aquatic/Wetland	Habitat	Operation	-1	2	3	4	4	-3,25	2	-6,5	Medium to low -	-1	2	3	2	2	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
11	Aquatic/Wetland	Water Quality	Operation	-1	3	3	4	4	-3,5	2	-7	Medium to low -	-1	3	3	2	2	-2,5	1	-2,5	Low -	Low	1	1	1,00	-2,50	Low -
12	Aquatic/Wetland	Flow	Operation	-1	2	3	4	2	-2,75	2	-5,5	Medium to low -	-1	2	3	2	2	-2,25	1	-2,25	Low -	Low	1	1	1,00	-2,25	Low -
13	Soils	Loss of land capability, soil compaction, soil erosion, land degradation	Planning	-1	1	1	1	2	-1,25	1	-1,25	Low -	-1	1	1	1	1	-1	1	-1	Low -	Low	1	1	1,00	-1,00	Low -
14	Soils	Loss of land capability, soil compaction, soil erosion, land degradation	Construction	-1	3	3	3	3	-3	3	-9	Medium to high -	-1	2	2	2	3	-2,25	3	-6,75	Medium to low -	Medium	3	3	1,50	-10,13	Medium to high -
15	Soils	Loss of land capability, soil compaction, soil erosion, land degradation	Operation	-1	2	3	2	3	-2,5	2	-5	Medium to low -	-1	2	2	2	2	-2	2	-4	Low -	Low	2	2	1,25	-5,00	Medium to low -
16	Soils	Loss of land capability, soil compaction, soil erosion, land degradation	Decommissioning	-1	2	2	2	3	-2,25	3	-6,75	Medium to low -	-1	2	2	1	3	-2	2	-4	Low -	Low	2	2	1,25	-5,00	Medium to low -
17	Soils	Loss of land capability, soil compaction, soil erosion, land degradation	Rehab and closure	-1	2	2	2	2	-2	2	-4	Low -	-1	2	2	1	2	-1,75	1	-1,75	Low -	Low	1	2	1,13	-1,97	Low -

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
18	Social	Impact of servitudes on land values	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
19	Social	Damage to farm roads, existing services, and infrastructure	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
20	Social	Impacts on safety and security of local residents	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
21	Social	Public perceptions about safety associated with gas production	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
22	Social	Nuisance factor due to an increase in ambient dust and noise levels	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
23	Social	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
24	Social	Impacts on the livelihoods of landowners	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
25	Social	Impacts on the social license to operate	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
26	Social	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Planning	-1	1	1	1	1	-1	5	-5	Medium to low -	-1	1	1	1	1	-1	5	-5	Medium to low -	Low	1	1	1,00	-5,00	Medium to low -
27	Social	Contribution to the economy of South Africa	Planning	1	1	1	1	1	1	5	5	Low to medium +	1	1	1	1	1	1	5	5	Low to medium +	Low	1	1	1,00	5,00	Medium to low +
28	Social	Impact of servitudes on land values	Construction	-1	2	2	2	3	-2,25	4	-9	Medium to high -	-1	2	2	2	3	-2,25	4	-9	Medium to high -	Low	2	2	1,25	-11,25	Medium to high -
29	Social	Damage to farm roads, existing services, and infrastructure	Construction	-1	2	2	2	3	-2,25	4	-9	Medium to high -	-1	2	2	2	3	-2,25	4	-9	Medium to high -	Low	2	2	1,25	-11,25	Medium to high -
30	Social	Impacts on safety and security of local residents	Construction	-1	2	2	2	3	-2,25	4	-9	Medium to high -	-1	2	2	2	3	-2,25	4	-9	Medium to high -	Low	2	2	1,25	-11,25	Medium to high -
31	Social	Public perceptions about safety associated with gas production	Construction	-1	2	2	4	3	-2,75	4	-11	Medium to high -	-1	2	2	2	3	-2,25	4	-9	Medium to high -	Low	2	2	1,25	-11,25	Medium to high -
32	Social	Nuisance factor due to an increase in ambient dust and noise levels	Construction	-1	2	2	2	3	-2,25	4	-9	Medium to high -	-1	2	2	2	3	-2,25	4	-9	Medium to high -	Low	2	2	1,25	-11,25	Medium to high -
33	Social	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Construction	-1	2	2	2	3	-2,25	4	-9	Medium to high -	-1	2	2	2	3	-2,25	4	-9	Medium to high -	Low	2	2	1,25	-11,25	Medium to high -
34	Social	Impacts on the livelihoods of landowners	Construction	-1	2	2	2	3	-2,25	4	-9	Medium to high -	-1	2	2	2	3	-2,25	4	-9	Medium to high -	Low	2	2	1,25	-11,25	Medium to high -
35	Social	Impacts on the social license to operate	Construction	-1	2	2	2	3	-2,25	4	-9	Medium to high -	-1	2	2	2	3	-2,25	4	-9	Medium to high -	Low	2	2	1,25	-11,25	Medium to high -
36	Social	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Construction	-1	2	2	4	3	-2,75	4	-11	Medium to high -	-1	2	2	4	3	-2,75	4	-11	Medium to high -	Low	2	2	1,25	-13,75	Medium to high -
37	Social	Contribution to the economy of South Africa	Construction	1	4	2	4	3	3,25	5	16,25	High +	1	4	2	4	3	3,25	5	16,25	High +	Low	2	2	1,25	20,31	High +
38	Social	Impact of servitudes on land values	Operation	-1	3	1	3	4	-2,75	5	-13,75	Medium to high -	-1	3	1	3	4	-2,75	5	-13,75	Medium to high -	Low	2	3	1,38	-18,91	High -

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
39	Social	Damage to farm roads, existing services, and infrastructure	Operation	-1	3	4	3	4	-3,5	4	-14	High -	-1	3	4	3	3	-3,25	4	-13	Medium to high -	Low	3	2	1,38	-17,88	High -
40	Social	Impacts on safety and security of local residents	Operation	-1	3	4	3	4	-3,5	4	-14	High -	-1	3	4	3	3	-3,25	4	-13	Medium to high -	Low	3	2	1,38	-17,88	High -
41	Social	Public perceptions about safety associated with gas production	Operation	-1	3	4	4	3	-3,5	4	-14	High -	-1	3	3	3	3	-3	4	-12	Medium to high -	Low	2	3	1,38	-16,50	High -
42	Social	Nuisance factor due to an increase in ambient dust and noise levels	Operation	-1	3	4	3	3	-3,25	4	-13	Medium to high -	-1	3	4	3	3	-3,25	4	-13	Medium to high -	Low	2	2	1,25	-16,25	High -
43	Social	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Operation	-1	3	4	3	3	-3,25	4	-13	Medium to high -	-1	3	4	3	3	-3,25	4	-13	Medium to high -	Low	2	2	1,25	-16,25	High -
44	Social	Impacts on the livelihoods of landowners	Operation	-1	3	4	2	4	-3,25	4	-13	Medium to high -	-1	3	4	2	4	-3,25	4	-13	Medium to high -	Low	2	2	1,25	-16,25	High -
45	Social	Impacts on the social license to operate	Operation	-1	3	4	3	3	-3,25	4	-13	Medium to high -	-1	3	4	2	3	-3	4	-12	Medium to high -	Low	2	2	1,25	-15,00	High -
46	Social	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Operation	-1	3	4	4	4	-3,75	4	-15	High -	-1	3	4	4	4	-3,75	4	-15	High -	Low	2	2	1,25	-18,75	High -
47	Social	Contribution to the economy of South Africa	Operation	1	4	4	5	4	4,25	5	21,25	High +	1	4	4	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
48	Social	Impact of servitudes on land values	Decommissioning	1	3	2	5	4	3,5	5	17,5	High +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
49	Social	Damage to farm roads, existing services, and infrastructure	Decommissioning	1	3	2	5	4	3,5	5	17,5	High +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
50	Social	Impacts on safety and security of local residents	Decommissioning	1	3	2	5	4	3,5	5	17,5	High +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
51	Social	Public perceptions about safety associated with gas production	Decommissioning	1	3	2	5	4	3,5	5	17,5	High +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
52	Social	Nuisance factor due to an increase in ambient dust and noise levels	Decommissioning	1	3	2	5	4	3,5	5	17,5	High +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
53	Social	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Decommissioning	1	3	2	5	4	3,5	5	17,5	High +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
54	Social	Impacts on the livelihoods of landowners	Decommissioning	1	3	2	2	4	2,75	5	13,75	Medium to high +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
55	Social	Impacts on the social license to operate	Decommissioning	1	3	2	5	4	3,5	5	17,5	High +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
56	Social	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Decommissioning	1	3	2	5	4	3,5	5	17,5	High +	1	3	2	5	4	3,5	5	17,5	High +	Low	3	3	1,50	26,25	Very high +
57	Social	Contribution to the economy of South Africa	Decommissioning	1	4	3	5	4	4	5	20	High +	1	4	3	4	4	3,75	5	18,75	High +	Low	3	3	1,50	28,13	Very high +
58	Social	Impact of servitudes on land values	Rehab and closure	1	3	5	5	4	4,25	5	21,25	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
59	Social	Damage to farm roads, existing services, and infrastructure	Rehab and closure	1	3	5	5	4	4,25	5	21,25	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
60	Social	Impacts on safety and security of local residents	Rehab and closure	1	3	5	5	4	4,25	5	21,25	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
61	Social	Public perceptions about safety associated with gas production	Rehab and closure	1	3	5	5	4	4,25	5	21,25	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
62	Social	Nuisance factor due to an increase in ambient dust and noise levels	Rehab and closure	1	3	5	5	4	4,25	5	21,25	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
63	Social	Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective	Rehab and closure	1	3	5	5	4	4,25	5	21,25	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
64	Social	Impacts on the livelihoods of landowners	Rehab and closure	1	3	5	2	4	3,5	5	17,5	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
65	Social	Impacts on the social license to operate	Rehab and closure	1	3	5	5	4	4,25	5	21,25	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
66	Social	Influx of people – also possible social disintegration and cultural differentiation, increase in HIV/AIDS etc.	Rehab and closure	1	3	5	5	4	4,25	5	21,25	High +	1	3	5	4	4	4	5	20	High +	Low	3	3	1,50	30,00	Very high +
67	Social	Contribution to the economy of South Africa	Rehab and closure	1	4	5	5	4	4,5	5	22,5	High +	1	4	5	4	4	4,25	5	21,25	High +	Low	3	3	1,50	31,88	Very high +
68	Heritage	Historical Structures - Historical structure foundations	Construction	-1	5	5	4	5	**-4,75**	4	-19	High -	1	2	5	2	5	3,5	1	3,5	Low +	High	1	3	1,25	4,38	Medium to low +
69	Heritage	Historical Structures - Kraals	Construction	-1	1	5	1	5	-3	2	-6	Medium to low -	1	2	5	2	5	3,5	1	3,5	Low +	High	1	1	1,00	3,50	Low +
70	Heritage	Historical Structures - Boreholes	Construction	-1	2	5	3	5	-3,75	4	-15	High -	1	2	5	2	5	3,5	1	3,5	Low +	High	1	2	1,13	3,94	Low +
71	Heritage	Historical Structures - Excavated pit	Construction	-1	1	5	1	5	-3	1	-3	Low -	1	1	5	1	5	3	1	3	Low +	High	1	1	1,00	3,00	Low +
72	Heritage	Archaeological Sites - Single find spot	Construction	-1	2	5	1	5	-3,25	2	-6,5	Medium to low -	1	2	5	1	5	3,25	1	3,25	Low +	High	1	3	1,25	4,06	Low +
73	Heritage	Archaeological Sites - Iron Age Site	Construction	-1	4	5	3	5	**-4,25**	3	-12,75	Medium to high -	1	4	5	2	5	4	1	4	Low +	High	2	2	1,25	5,00	Medium to low +
74	Hydrology (surface water)	Erosion of Soils	Construction	-1	2	4	3	2	-2,75	3	-8,25	Medium to low -	-1	2	2	2	2	-2	2	-4	Low -	Low	2	2	1,25	-5,00	Medium to low -
75	Hydrology (surface water)	Erosion of Soils	Operation	-1	2	4	3	2	-2,75	3	-8,25	Medium to low -	-1	2	4	2	2	-2,5	2	-5	Medium to low -	Low	2	2	1,25	-6,25	Medium to low -
76	Hydrology (surface water)	Erosion of Soils	Decommissioning	-1	2	4	2	2	-2,5	3	-7,5	Medium to low -	-1	2	2	2	2	-2	2	-4	Low -	Low	2	2	1,25	-5,00	Medium to low -
77	Hydrology (surface water)	Erosion of Soils	Rehab and closure	-1	2	3	2	2	-2,25	2	-4,5	Medium to low -	-1	2	2	2	2	-2	2	-4	Low -	Low	2	2	1,25	-5,00	Medium to low -
78	Hydrology (surface water)	Pollutants entering the surface water environment	Construction	-1	4	4	4	4	**-4**	3	-12	Medium to high -	-1	2	4	2	3	-2,75	2	-5,5	Medium to low -	Low	2	2	1,25	-6,88	Medium to low -
79	Hydrology (surface water)	Pollutants entering the surface water environment	Operation	-1	4	4	4	4	**-4**	3	-12	Medium to high -	-1	2	4	2	3	-2,75	2	-5,5	Medium to low -	Low	2	2	1,25	-6,88	Medium to low -
80	Hydrology (surface water)	Pollutants entering the surface water environment	Decommissioning	-1	4	4	4	4	**-4**	3	-12	Medium to high -	-1	2	4	2	3	-2,75	2	-5,5	Medium to low -	Low	2	2	1,25	-6,88	Medium to low -
81	Hydrology (surface water)	Pollutants entering the surface water environment	Rehab and closure	-1	2	2	3	3	-2,5	3	-7,5	Medium to low -	-1	2	1	2	3	-2	2	-4	Low -	Low	2	2	1,25	-5,00	Medium to low -
82	Hydrology (surface water)	Increase in runoff	Construction	-1	3	4	1	2	-2,5	4	-10	Medium to high -	-1	3	4	1	2	-2,5	4	-10	Medium to high -	Low	2	1	1,13	-11,25	Medium to high -
83	Hydrology (surface water)	Increase in runoff	Operation	-1	3	4	1	2	-2,5	4	-10	Medium to high -	-1	3	4	1	2	-2,5	4	-10	Medium to high -	Low	2	1	1,13	-11,25	Medium to high -
84	Hydrology (surface water)	Increase in runoff	Decommissioning	-1	3	4	1	2	-2,5	4	-10	Medium to high -	-1	3	4	1	2	-2,5	4	-10	Medium to high -	Low	2	1	1,13	-11,25	Medium to high -
85	Hydrology (surface water)	Increase in runoff	Rehab and closure	-1	2	4	1	2	-2,25	3	-6,75	Medium to low -	-1	2	4	1	2	-2,25	3	-6,75	Medium to low -	Low	2	1	1,13	-7,59	Medium to low -
86	Hydrology (surface water)	Flood potential	Construction	-1	2	1	5	4	-3	3	-9	Medium to high -	-1	2	1	3	3	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
87	Hydrology (surface water)	Flood potential	Operation	-1	2	1	5	4	-3	3	-9	Medium to high -	-1	2	1	3	3	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
88	Hydrology (surface water)	Flood potential	Decommissioning	-1	2	1	5	4	-3	3	-9	Medium to high -	-1	2	1	3	3	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
89	Hydrology (surface water)	Flood potential	Rehab and closure	-1	2	1	3	3	-2,25	3	-6,75	Medium to low -	-1	2	1	3	3	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
90	Geohydrology (groundwater)	Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area.	Construction	-1	2	2	2	2	-2	4	-8	Medium to low -	-1	2	2	1	2	-1,75	1	-1,75	Low -	Medium	1	1	1,00	-1,75	Low -
91	Geohydrology (groundwater)	Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.	Construction	-1	3	2	3	3	-2,75	4	-11	Medium to high -	-1	2	2	2	3	-2,25	2	-4,5	Medium to low -	Medium	2	2	1,25	-5,63	Medium to low -
92	Geohydrology (groundwater)	Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	Construction	-1	3	2	3	3	-2,75	4	-11	Medium to high -	-1	2	2	2	3	-2,25	2	-4,5	Medium to low -	Medium	2	2	1,25	-5,63	Medium to low -
93	Geohydrology (groundwater)	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Construction	-1	2	2	2	2	-2	2	-4	Low -	-1	2	2	1	2	-1,75	1	-1,75	Low -	Medium	1	1	1,00	-1,75	Low -
94	Geohydrology (groundwater)	Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.	Construction	-1	3	2	4	5	-3,5	5	-17,5	High -	-1	3	2	4	4	-3,25	1	-3,25	Low -	Medium	3	3	1,50	-4,88	Medium to low -
95	Geohydrology (groundwater)	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Construction	-1	3	2	4	5	-3,5	4	-14	High -	-1	3	2	4	4	-3,25	1	-3,25	Low -	Medium	3	3	1,50	-4,88	Medium to low -
96	Geohydrology (groundwater)	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Construction	-1	3	2	4	5	-3,5	4	-14	High -	-1	3	2	4	4	-3,25	1	-3,25	Low -	Medium	3	3	1,50	-4,88	Medium to low -

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
97	Geohydrology (groundwater)	Dewatering of the targeted coal-seam aquifer can potentially have a negative impact on groundwater and surface water quantities. Lowering of regional groundwater levels due to a depletion in aquifer storage may cause the formation of a cone of depression i.e., groundwater zone of influence and consequently lowering of the regional phreatic/ piezometric levels.	Operation	-1	3	5	4	5	-4,25	5	-21,25	High -	-1	3	5	4	4	-4	1	-4	Low -	Medium	3	3	1,50	-6,00	Medium to low -
98	Geohydrology (groundwater)	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Operation	-1	3	5	4	5	-4,25	4	-17	High -	-1	3	5	4	4	-4	1	-4	Low -	Medium	3	3	1,50	-6,00	Medium to low -
99	Geohydrology (groundwater)	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.	Operation	-1	3	5	4	5	-4,25	4	-17	High -	-1	3	5	4	4	-4	1	-4	Low -	Medium	3	3	1,50	-6,00	Medium to low -
100	Geohydrology (groundwater)	Groundwater pollution as a result of wastewater spills and seepage from wastewater storage facilities.	Operation	-1	3	5	4	4	-4	3	-12	Medium to high -	-1	2	5	4	4	-3,75	1	-3,75	Low -	Medium	2	2	1,25	-4,69	Medium to low -
101	Geohydrology (groundwater)	Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	Operation	-1	3	5	4	4	-4	3	-12	Medium to high -	-1	2	5	4	4	-3,75	1	-3,75	Low -	Medium	2	2	1,25	-4,69	Medium to low -
102	Geohydrology (groundwater)	Mobilisation and maintenance of heavy vehicle and machinery on-site may cause hydrocarbon contamination of groundwater resources.	Operation	-1	3	5	4	4	-4	3	-12	Medium to high -	-1	2	5	4	4	-3,75	1	-3,75	Low -	Medium	2	2	1,25	-4,69	Medium to low -
103	Geohydrology (groundwater)	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Operation	-1	3	5	4	4	-4	3	-12	Medium to high -	-1	2	5	4	4	-3,75	1	-3,75	Low -	Medium	2	2	1,25	-4,69	Medium to low -
104	Geohydrology (groundwater)	Leakage of harmful substances from tanks, pipelines or other equipment may cause groundwater pollution.	Operation	-1	3	5	4	4	-4	3	-12	Medium to high -	-1	2	5	4	4	-3,75	1	-3,75	Low -	Medium	2	2	1,25	-4,69	Medium to low -
105	Geohydrology (groundwater)	Dewatering effects lessening, post-operational re-watering and flooding of	Decommissioning	1	3	3	5	5	4	4	16	High +	-1	2	2	4	4	-3	2	-6	Medium to low -	Medium	2	2	1,25	-7,50	Medium to low -

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
		underground coal seams which may result in a rebound of the local hydraulic head and regional water levels.																									
106	Geohydrology (groundwater)	Poor quality leachate emanating from sulphide bearing minerals associated with dewatered coal seams and faces which will have a negative impact on groundwater water quality.	Decommissioning	-1	4	5	5	5	**-4,75**	5	-23,75	High -	-1	2	2	4	4	-3	2	-6	Medium to low -	Medium	2	2	1,25	-7,50	Medium to low -
107	Geohydrology (groundwater)	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.	Decommissioning	-1	3	3	5	5	**-4**	4	-16	High -	-1	2	2	4	4	-3	2	-6	Medium to low -	Medium	2	2	1,25	-7,50	Medium to low -
108	Geohydrology (groundwater)	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) if the wells not adequately sealed.	Decommissioning	-1	3	3	5	5	**-4**	4	-16	High -	-1	2	2	4	4	-3	2	-6	Medium to low -	Medium	2	2	1,25	-7,50	Medium to low -
109	Geohydrology (groundwater)	Groundwater pollution as a result of wastewater spills and seepage from wastewater storage facilities.	Decommissioning	-1	3	3	3	4	-3,25	2	-6,5	Medium to low -	-1	2	2	2	3	-2,25	1	-2,25	Low -	Medium	1	2	1,13	-2,53	Low -
110	Geohydrology (groundwater)	Poor quality leachate may emanate from the plant footprint area which may have a negative impact on groundwater quality.	Decommissioning	-1	3	3	3	4	-3,25	2	-6,5	Medium to low -	-1	2	2	2	3	-2,25	1	-2,25	Low -	Medium	1	2	1,13	-2,53	Low -
111	Geohydrology (groundwater)	De-mobilisation of heavy vehicle and machinery as part of the decommissioning phase on-site may cause hydrocarbon contamination of groundwater resources.	Decommissioning	-1	3	3	3	4	-3,25	2	-6,5	Medium to low -	-1	2	2	2	3	-2,25	1	-2,25	Low -	Medium	1	2	1,13	-2,53	Low -
112	Economic	Energy Security	Planning	1	1	2	1	1	1,25	5	6,25	Low to medium +	1	1	2	1	1	1,25	5	6,25	Low to medium +	Low	3	2	1,38	8,59	Medium to high +
113	Economic	Local Economic Growth and Rural Development	Planning	1	1	2	1	1	1,25	5	6,25	Low to medium +	1	1	2	1	1	1,25	5	6,25	Low to medium +	High	3	2	1,38	8,59	Medium to high +
114	Economic	Job Creation and Household Income	Planning	1	1	2	1	1	1,25	5	6,25	Low to medium +	1	1	2	1	1	1,25	5	6,25	Low to medium +	High	3	2	1,38	8,59	Medium to high +
115	Economic	Foreign Investment Attraction and Forex Savings	Planning	1	1	2	1	1	1,25	5	6,25	Low to medium +	1	1	2	1	1	1,25	5	6,25	Low to medium +	High	3	2	1,38	8,59	Medium to high +
116	Economic	Population Growth and Pressure on Local Infrastructure	Planning	1	1	2	1	1	1,25	5	6,25	Low to medium +	1	1	2	1	1	1,25	5	6,25	Low to medium +	Medium	3	2	1,38	8,59	Medium to high +
117	Economic	Tourism and alternative land-use	Planning	-1	1	2	1	1	-1,25	5	-6,25	Medium to low -	-1	1	2	1	1	-1,25	5	-6,25	Medium to low -	Low	3	1	1,25	-7,81	Medium to low -
118	Economic	Energy Security	Construction	1	5	4	3	2	3,5	4	14	High +	1	5	4	3	2	3,5	4	14	High +	Low	3	2	1,38	19,25	High +

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
119	Economic	Local Economic Growth and Rural Development	Construction	1	3	4	4	2	3,25	4	13	Medium to high +	1	3	4	4	2	3,25	4	13	Medium to high +	High	3	2	1,38	17,88	High +
120	Economic	Job Creation and Household Income	Construction	1	3	4	4	2	3,25	4	13	Medium to high +	1	3	4	4	2	3,25	4	13	Medium to high +	High	3	2	1,38	17,88	High +
121	Economic	Foreign Investment Attraction and Forex Savings	Construction	1	5	2	4	1	3	4	12	Medium to high +	1	5	2	4	1	3	4	12	Medium to high +	High	3	2	1,38	16,50	High +
122	Economic	Population Growth and Pressure on Local Infrastructure	Construction	-1	1	2	4	3	-2,5	4	-10	Medium to high -	-1	1	2	4	3	-2,5	4	-10	Medium to high -	Medium	3	2	1,38	-13,75	Medium to high -
123	Economic	Tourism and alternative land-use	Construction	-1	4	5	3	4	-4	3	-12	Medium to high -	-1	1	2	1	1	-1,25	5	-6,25	Medium to low -	Low	3	2	1,38	-8,59	Medium to high -
124	Economic	Energy Security	Operation	1	5	4	3	2	3,5	4	14	High +	1	5	4	3	2	3,5	4	14	High +	Low	3	2	1,38	19,25	High +
125	Economic	Local Economic Growth and Rural Development	Operation	1	3	4	4	2	3,25	4	13	Medium to high +	1	3	4	4	2	3,25	4	13	Medium to high +	High	3	2	1,38	17,88	High +
126	Economic	Job Creation and Household Income	Operation	1	3	4	4	2	3,25	4	13	Medium to high +	1	3	4	4	2	3,25	4	13	Medium to high +	High	3	2	1,38	17,88	High +
127	Economic	Foreign Investment Attraction and Forex Savings	Operation	1	5	2	4	1	3	4	12	Medium to high +	1	5	2	4	1	3	4	12	Medium to high +	High	3	2	1,38	16,50	High +
128	Economic	Population Growth and Pressure on Local Infrastructure	Operation	-1	1	2	4	3	-2,5	4	-10	Medium to high -	-1	1	2	4	3	-2,5	4	-10	Medium to high -	Medium	3	2	1,38	-13,75	Medium to high -
129	Economic	Tourism and alternative land-use	Operation	-1	4	5	3	4	-4	3	-12	Medium to high -	-1	4	5	3	4	-4	3	-12	Medium to high -	Low	3	2	1,38	-16,50	High -
130	Economic	Energy Security	Decommissioning	-1	5	4	3	2	-3,5	4	-14	High -	-1	3	4	4	2	-3,25	4	-13	Medium to high -	Low	3	2	1,38	-17,88	High -
131	Economic	Local Economic Growth and Rural Development	Decommissioning	-1	3	4	4	2	-3,25	4	-13	Medium to high -	-1	3	4	4	2	-3,25	4	-13	Medium to high -	High	3	2	1,38	-17,88	High -
132	Economic	Job Creation and Household Income	Decommissioning	-1	3	4	4	2	-3,25	4	-13	Medium to high -	-1	5	2	4	1	-3	4	-12	Medium to high -	High	3	2	1,38	-16,50	High -
133	Economic	Foreign Investment Attraction and Forex Savings	Decommissioning	-1	5	2	4	1	-3	4	-12	Medium to high -	-1	1	2	4	3	-2,5	4	-10	Medium to high -	High	3	2	1,38	-13,75	Medium to high -
134	Economic	Population Growth and Pressure on Local Infrastructure	Decommissioning	1	1	2	4	3	2,5	4	10	Medium to high +	1	3	4	4	2	3,25	4	13	Medium to high +	Medium	3	2	1,38	17,88	High +
135	Economic	Tourism and alternative land-use	Decommissioning	1	4	5	3	4	4	3	12	Medium to high +	1	4	5	3	4	4	3	12	Medium to high +	Low	3	1	1,25	15,00	High +
136	Economic	Energy Security	Rehab and closure	-1	5	4	3	2	-3,5	4	-14	High -	-1	3	4	4	2	-3,25	4	-13	Medium to high -	Low	3	2	1,38	-17,88	High -
137	Economic	Local Economic Growth and Rural Development	Rehab and closure	-1	3	4	4	2	-3,25	4	-13	Medium to high -	-1	5	2	4	1	-3	4	-12	Medium to high -	High	3	2	1,38	-16,50	High -
138	Economic	Job Creation and Household Income	Rehab and closure	-1	3	4	4	2	-3,25	4	-13	Medium to high -	-1	1	2	4	3	-2,5	4	-10	Medium to high -	High	3	2	1,38	-13,75	Medium to high -
139	Economic	Foreign Investment Attraction and Forex Savings	Rehab and closure	-1	5	2	4	1	-3	4	-12	Medium to high -	-1	3	4	4	2	-3,25	4	-13	Medium to high -	High	3	2	1,38	-17,88	High -
140	Economic	Population Growth and Pressure on Local Infrastructure	Rehab and closure	1	1	2	4	3	2,5	4	10	Medium to high +	1	3	4	4	2	3,25	4	13	Medium to high +	Medium	3	2	1,38	17,88	High +
141	Economic	Tourism and alternative land-use	Rehab and closure	1	4	5	3	4	4	3	12	Medium to high +	1	4	5	3	4	4	3	12	Medium to high +	Low	3	1	1,25	15,00	High +
142	Palaeontology	Impact on palaeontological resources	Construction	-1	1	5	3	5	-3,5	3	-10,5	Medium to high -	1	1	5	4	5	3,75	3	11,25	Medium to high +	Low	2	1	1,13	12,66	Medium to high +
143	Air Quality	Ambient air quality	Construction	-1	3	2	3	2	-2,5	4	-10	Medium to high -	-1	3	2	3	2	-2,5	3	-7,5	Medium to low -	Medium	1	1	1,00	-7,50	Medium to low -
144	Air Quality	Ambient air quality	Operation	-1	3	4	3	2	-3	4	-12	Medium to high -	-1	2	4	3	2	-2,75	3	-8,25	Medium to low -	Medium	1	1	1,00	-8,25	Medium to low -
145	Air Quality	Ambient air quality	Decommissioning	-1	3	2	3	2	-2,5	4	-10	Medium to high -	-1	3	2	3	2	-2,5	3	-7,5	Medium to low -	Medium	1	1	1,00	-7,50	Medium to low -
146	Noise	Increase in noise levels	Construction	-1	3	2	3	2	-2,5	4	-10	Medium to high -	-1	3	2	3	2	-2,5	3	-7,5	Medium to low -	Medium	1	1	1,00	-7,50	Medium to low -
147	Noise	Increase in noise levels	Operation	-1	3	4	3	3	-3,25	3	-9,75	Medium to high -	-1	3	4	2	3	-3	3	-9	Medium to high -	Medium	1	1	1,00	-9,00	Medium to high -

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
148	Noise	Increase in noise levels	Decommissioning	-1	3	2	3	2	-2,5	4	-10	Medium to high -	-1	3	2	3	2	-2,5	3	-7,5	Medium to low -	Medium	1	1	1,00	-7,50	Medium to low -
149	Visual	Further general degradation of the local landscape	Construction	-1	3	2	2	1	-2	3	-6	Medium to low -	-1	3	2	2	1	-2	2	-4	Low -	Low	1	1	1,00	-4,00	Low -
150	Visual	Further general degradation of the local landscape	Operation	-1	3	4	1	1	-2,25	3	-6,75	Medium to low -	-1	3	4	1	1	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
151	Visual	Degradation of views from the R33 and R572 in proximity to the proposed site	Construction	-1	3	2	2	1	-2	3	-6	Medium to low -	-1	3	2	2	1	-2	2	-4	Low -	Low	1	1	1,00	-4,00	Low -
152	Visual	Degradation of views from the R33 and R572 in proximity to the proposed site	Operation	-1	3	4	1	1	-2,25	3	-6,75	Medium to low -	-1	3	4	1	1	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
153	Visual	Further degradation of the local landscape as viewed from adjacent local roads	Construction	-1	3	2	2	1	-2	3	-6	Medium to low -	-1	3	2	2	1	-2	2	-4	Low -	Low	1	1	1,00	-4,00	Low -
154	Visual	Further degradation of the local landscape as viewed from adjacent local roads	Operation	-1	3	4	1	1	-2,25	3	-6,75	Medium to low -	-1	3	4	1	1	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
155	Visual	Further degradation of the local landscape as viewed from homesteads	Construction	-1	3	2	2	1	-2	3	-6	Medium to low -	-1	3	2	2	1	-2	2	-4	Low -	Low	1	1	1,00	-4,00	Low -
156	Visual	Further degradation of the local landscape as viewed from homesteads	Operation	-1	3	4	1	1	-2,25	3	-6,75	Medium to low -	-1	3	4	1	1	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
157	Visual	Degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves	Construction	-1	3	2	2	1	-2	3	-6	Medium to low -	-1	3	2	2	1	-2	2	-4	Low -	Low	1	1	1,00	-4,00	Low -
158	Visual	Degradation of views from the Olifantspad and Gideon Troskie Private Nature Reserves	Operation	-1	3	4	1	1	-2,25	3	-6,75	Medium to low -	-1	3	4	1	1	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
159	Visual	Lighting impacts on sensitive receptors	Construction	-1	3	2	2	1	-2	3	-6	Medium to low -	-1	3	2	2	1	-2	2	-4	Low -	Low	1	1	1,00	-4,00	Low -
160	Visual	Lighting impacts on sensitive receptors	Operation	-1	3	4	1	1	-2,25	3	-6,75	Medium to low -	-1	3	4	1	1	-2,25	2	-4,5	Medium to low -	Low	1	1	1,00	-4,50	Medium to low -
161	Seismicity	Induced or triggered seismic activity	Construction	-1	4	2	5	5	-4	1	-4	Low -	-1	4	2	4	5	-3,75	1	-3,75	Low -	Low	2	3	1,38	-5,16	Medium to low -
162	Seismicity	Induced or triggered seismic activity	Operation	-1	4	4	5	5	-4,5	1	-4,5	Medium to low -	-1	4	4	2	5	-3,75	1	-3,75	Low -	Low	1	1	1,00	-3,75	Low -
163	Seismicity	Induced or triggered seismic activity	Decommissioning	-1	4	2	5	5	-4	1	-4	Low -	-1	4	2	1	5	-3	1	-3	Low -	Low	1	1	1,00	-3,00	Low -
164	Traffic	Deterioration of existing road surfaces/ pavements	Construction	-1	3	2	3	3	-2,75	4	-11	Medium to high -	-1	3	2	3	3	-2,75	2	-5,5	Medium to low -	Low	2	1	1,13	-6,19	Medium to low -
165	Traffic	Deterioration of existing road surfaces/ pavements	Operation	-1	3	4	3	3	-3,25	4	-13	Medium to high -	-1	3	4	3	3	-3,25	2	-6,5	Medium to low -	Low	2	1	1,13	-7,31	Medium to low -
166	Traffic	Deterioration of existing road surfaces/ pavements	Decommissioning	-1	3	2	2	3	-2,5	2	-5	Medium to low -	-1	3	2	2	3	-2,5	1	-2,5	Low -	Low	1	1	1,00	-2,50	Low -
167	Traffic	Traffic congestion	Construction	-1	3	2	3	3	-2,75	4	-11	Medium to high -	-1	3	2	3	3	-2,75	2	-5,5	Medium to low -	Low	2	1	1,13	-6,19	Medium to low -
168	Traffic	Traffic congestion	Operation	-1	3	4	3	3	-3,25	4	-13	Medium to high -	-1	3	4	3	3	-3,25	2	-6,5	Medium to low -	Low	2	1	1,13	-7,31	Medium to low -
169	Traffic	Traffic congestion	Decommissioning	-1	3	2	2	3	-2,5	4	-10	Medium to high -	-1	3	2	2	3	-2,5	1	-2,5	Low -	Low	1	1	1,00	-2,50	Low -
170	Traffic	Safety of road users	Construction	-1	3	2	3	5	-3,25	4	-13	Medium to high -	-1	3	2	3	5	-3,25	2	-6,5	Medium to low -	Low	2	1	1,13	-7,31	Medium to low -

IMPACT DESCRIPTION				PRE-MITIGATION									POST-MITIGATION										PRIORITY FACTOR			FINAL SIGNIFICANCE	
Identifier	Discipline	Impact	Phase	Pre-Nature	Pre-Extent	Pre-Duration	Pre-Magnitude	Pre-Reversibility	Consequence	Pre-Probability	Pre-Mitigation Significance Score	Pre-Mitigation Significance	Post-Nature	Post-Extent	Post-Duration	Post-Magnitude	Post-Reversibility	Consequence2	Post-Probability	Post-mitigation Significance Score	Post-Mitigation Significance	Confidence	Cumulative Impact	Irreplaceable loss	Priority Factor	Final score	Final Significance
171	Traffic	Safety of road users	Operation	-1	3	4	3	5	-3,75	4	-15	High -	-1	3	4	3	5	-3,75	2	-7,5	Medium to low -	Low	2	1	1,13	-8,44	Medium to low -
172	Traffic	Safety of road users	Decommissioning	-1	3	2	2	5	-3	4	-12	Medium to high -	-1	3	2	2	5	-3	1	-3	Low -	Low	1	1	1,00	-3,00	Low -

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 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 the proposed application area in order to identify avoidance areas and/or additional mitigation required in certain areas.

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 112 for the preliminary scoping combined sensitivity map. The compilation of this map has taken into consideration the various desktop baseline assessments undertaken per specialist discipline for the application area. Most of the application area consists of medium to highly sensitive areas which are predominantly based on the terrestrial biodiversity status (i.e. natural bushveld). This sensitivity map will be updated during the EIA phase once the detailed specialist studies for each environmental theme 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 wells and pipelines may need site specific adjustments due to unforeseen reasons. 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 highly sensitive sites on the sensitivity /constraint map (and where the position of the infrastructure was not assessed in this application) would 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 and specific environmental themes. The pre-commencement assessment must be compiled by the site Environmental Officer (EO) with a suitable environmental qualification and experience and must be supplemented by relevant specialist input where the EO does not possess the requisite experience in that discipline. 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.

A sensitivity planning approach will be applied to the location alternatives for well sites, pipelines, access roads, powerlines and the LNG Plant as described in Section 8.2 of this report. During the EIA phase, specialists will undertake detailed site assessments of the preliminary infrastructure locations and corridors and indicate where infrastructure or corridors should be adjusted/relocated to avoid or minimise impacts on sensitive features. The results of this assessment will be presented in the subsequent EIA phase.

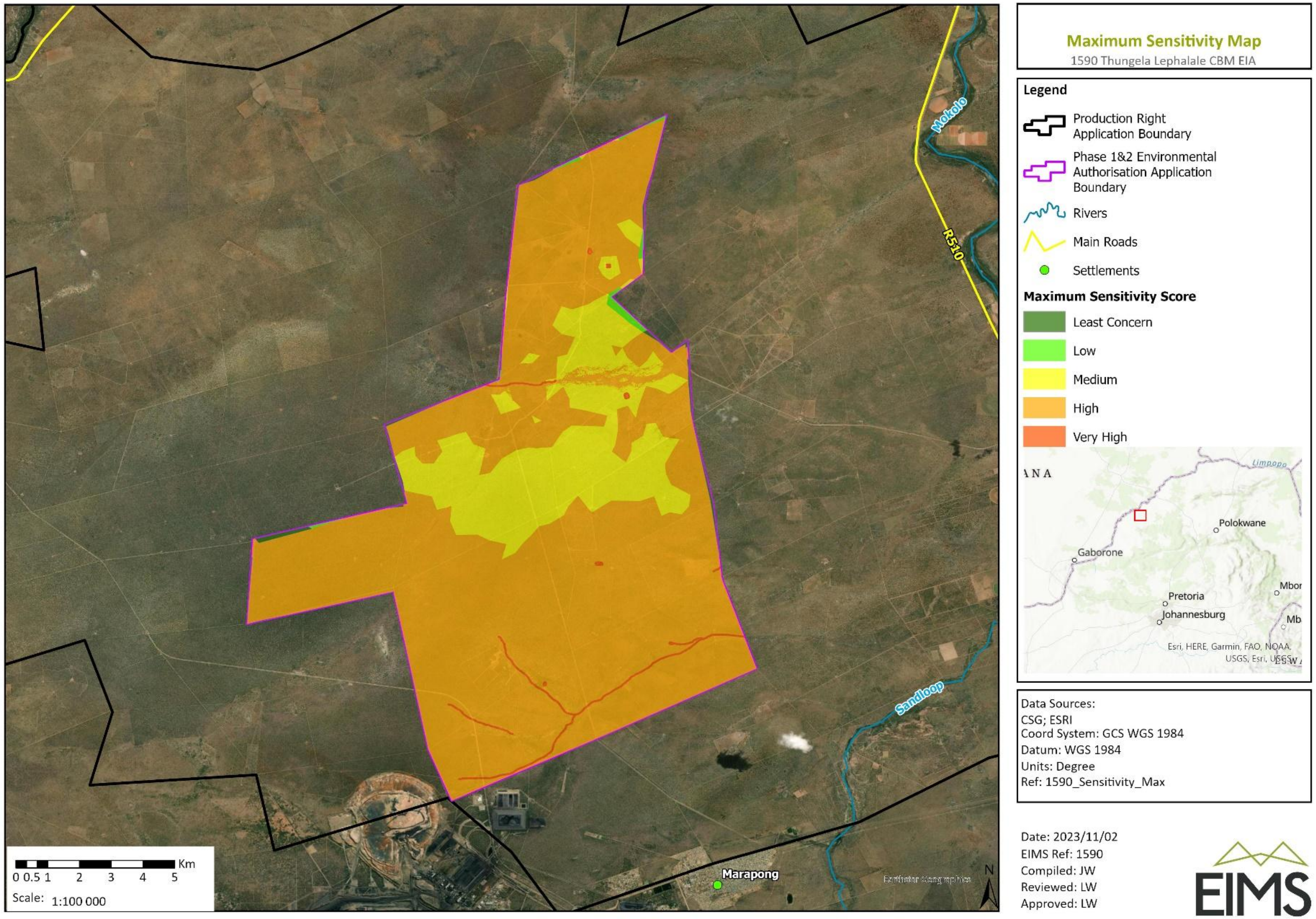


Figure 112: Scoping level sensitivity map.

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 and is presented in this Scoping Report for review and comment by I&APs before being finalised and submitted to the Competent Authority for approval of the proposed way forward. It is also important to note that the plan of study will also be guided by comments 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 identified and considered are discussed in Section 8 of this Scoping Report with a summary of the alternative assessment presented in Section 8.8 (Table 17). The feasible development alternatives to be further comparatively assessed in the EIA phase are presented in Table 56.

Table 56: Alternatives to be assessed in the EIA Phase.

Alternative Category	Alternative	Alternative Description Summary
Location Alternative	LA_1	Well site locations: Well site positions to be guided by sensitivity planning approach
	LA_2	Pipelines and access roads routing: Pipeline and access road routing to be guided by sensitivity planning approach
	LA_3	Powerline routing: Powerline routing to be guided by sensitivity planning approach
	LA_4.1	LNG Plant location Option 1 – PADDAKRAAL 405 Portion 0
	LA_4.2	LNG Plant location Option 2 – WITHOUTPAN 404 Portion 0
	LA_4.3	LNG Plant location Option 3 – BULKLIP 701 Portion 1
Design Alternative	DA_1.1	Above ground powerlines on gum-poles
	DA_1.2	Below ground powerlines trenched to 900mm deep and backfilled
Layout Alternatives	Sensitivity Based Approach	Based on a sensitivity mapping any unacceptably high-risk areas will be delineated as no-go areas.
	LayA_1.1	Treated water discharge pipeline to Mogol River Alternative 1 – routed along Deelkraal Road
	LayA_1.2	Treated water discharge pipeline to Mogol River Alternative 2 - routed across the farms Bulklip 701 LQ, Draai-om 174 LQ and the remaining extent of the farm Vryplaats 163 LQ (Portion 1)
Process Alternatives	PA_1.1	Process water disposal Option 1: Direct offtake of the water by a third-party industrial water user. This could be direct use of the water by an industrial user with either no, or minimal treatment.
	PA_1.2	Process water disposal Option 2: Treatment of the water to a quality suitable for irrigation or livestock watering use.
	PA_1.3	Process water disposal Option 3: Cultivate lucerne for supply to local farmers.
	PA_1.4	Process water disposal Option 4: Treatment of the water to a quality suitable for direct discharge to the local surface or groundwater resources or use for dust suppression.
	PA_2.1	Access from the R510 via Deelkraal Road from the EAST
	PA_2.2	Access from the R510 via Deelkraal Road from the NORTH
No-Go Alternative	No-Go	The proposed project will not take place at all under the No-Go alternative.

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;
- Cultural and Heritage Resources;
- Economic Impacts;
- Groundwater Quality;
- Hydrology;
- Noise Impacts;
- Palaeontology Impacts;
- Seismicity Risks;
- Social Impacts;
- Soil, Agriculture and Hydropedology Impacts;
- Aquatic and Wetlands;
- Terrestrial Biodiversity;
- Traffic Analysis; and
- Visual Impacts.

13.3 ASPECTS TO BE ASSESSED BY SPECIALISTS

The Minister of Environment, Forestry and Fisheries, in terms of sections 24(5)(a), (h) and 44 of the NEMA, prescribe general requirements for undertaking site sensitivity verification and for protocols for the assessment and minimum report content requirements of environmental impacts for environmental themes for activities requiring environmental authorisation. When the requirements of a protocol apply, the requirements of Appendix 6 of the EIA Regulations are replaced by these requirements. Each protocol applies exclusively to the environmental theme identified within its scope. Multiple themes may apply to a single application for environmental authorisation, and assessments for these themes must be undertaken in accordance with the relevant protocol, or where no specific protocol has been prescribed, in accordance with the requirements of the EIA Regulations.

Table 57 below details the proposed scope of work (plan of study) for each of the specialist studies to inform the EIA phase and the specialist studies will comply with the above-mentioned protocols and/or Appendix 6 of the NEMA EIA Regulations as applicable.

Table 57: Details of specialists input during the EIA phase.

Aspect	Company Responsible	Scope of Work / Terms of Reference
Climate Change Assessment	Airshed Planning Professionals	During its construction, operation and closure phases the project will emit GHGs, the quantities of which will be estimated to inform the assessment of the contribution to climate change. The impact assessment will include the following information: • An estimation of the CO_2-equivalent emissions from the project, associated fuel use, vegetation clearing activities, and electricity use, fugitive emissions; • Estimate the impact of the project on national greenhouse gas emissions and considering the national GHG emissions inventory and carbon budget where applicable; • Evaluation of the potential impact of global climate change on the project by identifying potential physical risks to the project, employees, and communities; • Provide the potential risk of climate change on the project and the risk of the project on climate change; • Determination of environmental risk according to stipulated Impact Assessment methodology; and • Recommendation of mitigation and management measures, where applicable. The climate change impact assessment report will consider: • Scope 1 emissions, which are the emissions directly attributable to the proposed project; • Scope 2 emissions, which are the emissions associated with bought-in electricity over the lifetime of the project; and • Scope 3 emissions (as far as is reasonable and practically possible), which consider the “embedded” carbon in bought-in materials and downstream emissions from the off-takers (e.g. liquid fuel replacement, gas to power, export, etc).
Air Quality Impact Assessment	Airshed Planning Professionals	The impact assessment phase of study will include the following: • Incorporation of Eskom operated ambient monitored data in the region (based on available data); • The compilation of an emissions inventory, comprising the identification and quantification of potential sources of emissions associated with the construction and operational phases of the project;

Aspect	Company Responsible	Scope of Work / Terms of Reference
		• 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; • Evaluation of potential for human health and nuisance dust fall impacts; • Determination of environmental risk according to stipulated impact assessment methodology; • The identification of air quality management and mitigation measures based on the findings of the compliance and impact assessment; and • Preparation of an Air Quality Impact Assessment Report.
Noise Impact Assessment	Airshed Planning Professionals	The following will be included in the environmental noise impact assessment study: • Baseline data has been obtained (refer to Section 10.12.2). • Preliminary noise sensitive receptors have been identified (refer to Section 10.12.1). • Noise emissions from the project's operations (including road traffic) 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. IFC). • The findings of the noise assessment will inform recommendations of noise management measures, including mitigation and monitoring. • Determination of environmental noise risk according to the EIMS stipulated Impact Assessment methodology. • Preparation of a Noise Impact Assessment Report

Aspect	Company Responsible	Scope of Work / Terms of Reference
Geohydrology (Groundwater)	Gradient Groundwater Consulting	The proposed activities and associated impacts will be assessed, and relevant management and mitigation measures presented. A specialist impact assessment report will be prepared in compliance with the legislative requirements. **Development of a numerical groundwater flow and mass transport model** • 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 and historical groundwater monitoring data. • 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. **Hydrogeological impact assessment and reporting** • 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.

Aspect	Company Responsible	Scope of Work / Terms of Reference
		○ Numerical groundwater flow and mass transport model development, calibration and simulations. ○ Formulation of an impact assessment and risk matrix of proposed activities and alternatives. ○ Recommendation on best practise mitigation and management measures to be implemented. • Update to the existing integrated surface water and groundwater monitoring program for implementation for the broader project.
Terrestrial Biodiversity	The Biodiversity Company	**Flora Survey:** The fieldwork and sample sites will be placed within targeted areas (i.e., target sites) perceived as ecologically sensitive based on the preliminary interpretation of satellite imagery (Google Corporation) and GIS analysis (which will included the latest applicable biodiversity datasets) available prior to the fieldwork. The focus of the fieldwork will therefore be to maximise coverage and navigate to each target site in the field, to perform a rapid vegetation and ecological assessment at each sample site. Emphasis will be placed on sensitive habitats, especially those overlapping with the proposed project area. Homogenous vegetation units will be subjectively identified using satellite imagery and existing land cover maps. The floristic diversity and search for flora SCC will be conducted through timed meanders within representative habitat units delineated during the fieldwork. Emphasis will be placed mostly on sensitive habitats overlapping with the proposed project areas. The timed random meander method is highly efficient for conducting floristic analysis, specifically in detecting flora SCC and maximising floristic coverage. In addition, the method is time and cost effective and highly suited for compiling flora species lists and therefore gives a rapid indication of flora diversity. The timed meander search will be performed based on the original technique described by Goff et al. (1982). Suitable habitat for SCC will be identified according to Raimondo et al. (2009) and targeted as part of the timed meanders. At each sample site notes will be made regarding current impacts (e.g., livestock grazing, erosion etc.), subjective recording of dominant vegetation species, and any sensitive features (e.g., wetlands, outcrops etc.). In addition, opportunistic observations will be made while navigating through the project area. **Fauna Survey:** The faunal assessment pertains to herpetofauna (amphibians and reptiles), avifauna and mammals. The faunal field survey will be comprised of the following techniques: • A survey of the proposed infrastructure areas including identified alternative location areas; • A proximity assessment to any protected or ecologically important areas;

Aspect	Company Responsible	Scope of Work / Terms of Reference
		• A habitat assessment and delineation; • Identify any Red Data or listed species present or potentially occurring in the area; • Compilation of an expected species list; • Compilation of an identified species list; • Visual and auditory searches - This typically comprises of meandering and using binoculars to view species from a distance without them being disturbed; and listening to species calls; • Active hand-searches - Used for species that shelter in or under particular micro-habitats (typically rocks, exfoliating rock outcrops, fallen trees, leaf litter, bark etc.); • Sherman traps to identify elusive small mammal species; • Camera traps for larger and nocturnal fauna; • Point counts for the avifauna; and • Utilisation of local knowledge. Preparation of a Terrestrial Biodiversity Impact Assessment Report
Freshwater Assessment (Aquatic and wetlands)	The Biodiversity Company	**Aquatic and Wetland Identification and Mapping:** The National Wetland Classification Systems (NWCS) developed by the SANBI will be utilised as part of this assessment. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels. In addition, the method will also include the assessment of structural features at the lower levels of classification (Ollis et al., 2013). The wetland areas will be delineated in accordance with the DWAF (2005) guidelines. The outer edges of the wetland areas will be identified by considering the following specific indicators: • Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur; • Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation; • Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile due to prolonged and frequent saturation; and

Aspect	Company Responsible	Scope of Work / Terms of Reference
		• Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils. Vegetation will be used as the primary wetland indicator. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators will be used in a confirmatory role. **Functional Assessment:** Wetland Functionality refers to the ability of wetlands to provide healthy conditions for the wide variety of organisms found in wetlands and humans. EcoServices serve as the main factor contributing to wetland functionality. The assessment of the ecosystem services supplied by the identified wetlands will be conducted per the guidelines as described in WET-EcoServices (Kotze et al. 2008). **Present Ecological Status:** The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. **Importance and Sensitivity:** The importance and sensitivity of water resources is determined to establish resources that provide higher than average ecosystem services, biodiversity support functions or are particularly sensitive to impacts. **Determining Buffer Requirements:** 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 against the identified water resources. **Risk Assessment:** The risk assessment will be completed in accordance with the requirements of the DWS General Authorisation (GA) in terms of Section 39 of the NWA for water uses as defined in Section 21(c) or Section 21(i) (GN 509 of 2016). Whilst it is anticipated that a full Water Use Licence application process will be followed, it is anticipated that the DWS will require this risk assessment to inform their decision making. Preparation of an Aquatic and Wetland Impact Assessment Report

Aspect	Company Responsible	Scope of Work / Terms of Reference
Agricultural Potential & Hydropedology Impact Assessment	The Biodiversity Company	**Agricultural Potential and Land Use 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 project 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. 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 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 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 are 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

Aspect	Company Responsible	Scope of Work / Terms of Reference
		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. The output of this study will be an Agriculture, Soils and Land Capability Impact Assessment Report (inclusive of hydropedology) and a Topsoil Management Plan for inclusion in the EMPr. **Hydropedology** The hydropedological assessment will take cognisance of the "Guidelines for hydropedological Assessments and Minimum Requirements" as set forth by DWS in 2021. 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.

Aspect	Company Responsible	Scope of Work / Terms of Reference
Visual	Enviroconsult	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). **Identification of issues raised in scoping phase and site visit:** Likely issues have been identified from a baseline and desktop assessment. These issues will be verified from a site visit as well as responses from stakeholders to the scoping documentation. It is possible that additional impacts might be identified form the site visit and from comments by stakeholders. **Visual impact assessment:** The receiving environment will be verified from a site visit. Zones of theoretical visibility will be identified, and visual receptors established from GIS analysis and verified from a site visit. Existing medium to large scale industrial developments in the surrounding areas should help to provide a useful guide as to likely visibility of the proposed development within the receiving environment. Viewpoints will be identified from a site visit to represent views of visual receptors. Given that the existing landscape character is a relatively cohesive rural landscape, it will be assumed that affected receptors are likely to prefer views of a natural or rural landscape rather than an industrial landscape. Criteria that will guide the assessment will include: • The extent of likely industrialisation as seen by each receptor; and • The sensitivity of each receptor to change. Impacts will be assessed using a numerical assessment system that has been adopted by EIMS. **Inclusion of Potential Lighting Impacts at night:** Potential lighting impacts will be assessed through comparison of the likely change in nighttime lighting patterns due to the proposed development. **Description of Alternatives, Mitigation Measures and Monitoring Programme:** This will be compiled from experience of similar projects and through discussion with the applicant.

Aspect	Company Responsible	Scope of Work / Terms of Reference
		Preparation of a Visual Impact Assessment Report
Heritage and Palaeontology	PGS Heritage	The proposed development triggers the need for a Heritage Impact Assessment as required under S.38 of the NHRA. SAHRA will be the commenting authority under S38.8 of the NHRA. A full Heritage Impact Assessment study and report will be prepared according to the following: • Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2017, as amended; • 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 where relevant (according to the impact rating methodology required by EIMS).
Decommissioning, Rehabilitation and Closure Plan including Financial Provision Cost Calculation	MineLock Environmental Engineers & Environmental Impact Management Services	Final Rehabilitation Decommissioning and Closure Plan (FRDCP) will be prepared in accordance with the NEMA Financial Provisioning Regulations, 2015. The quantum of liability will be calculated using the current value of money based on contractor rates.

Hydrology	Hydrologic	**Baseline Characterisation and Screening Phase:**
		The Hydrology Impact Assessment Study will be executed using the following methodology:
		• Description of the receiving environment
		• Description of the proposed activities and potential impacts
		• 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 and based on the LiDAR survey to be undertaken across the application area. This will include the following:
		  ○ Hydrological assessment;
		  ○ Hydraulic Modelling;

Aspect	Company Responsible	Scope of Work / Terms of Reference
		○ Delineate the floodlines on a map overlayed with the proposed project infrastructure. • Floodline and sensitivity maps will be prepared. **Detailed Assessment Phase:** • Determine flood impacts on project infrastructure. • 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 • Provide relevant mitigation measures (where necessary) for inclusion in the EMPr.
Social Impact Assessment	Equispectives Research and Consulting Services	The World Bank Social Standards, Equator Principles, International Principles for Social Impact Assessment and the SIA Guidance document published by the IAIA will be applied in the study. It must be noted that international standards and principles will be adapted to ensure that it can be applied in the local social context. The methodology proposed focuses on involving the affected public in the research and planning where it is realistically possible and executable. Different methodologies will be utilised to ensure the affected communities are consulted in the way that is most appropriate to the community. The following activities will form part of the process forward: • Fieldwork will be conducted to obtain additional information and communicate with key stakeholders. Key stakeholders are likely to include: ○ Authorities: local municipalities that fall in the project area. ○ Affected parties: communities and individuals that will be affected directly or indirectly by the project. ○ Interested parties: local business in the area, community-based organisations and non-governmental organisations within the affected communities, trade unions, and political groups. • Methodologies will include in-depth interviews, participatory rural appraisal, in-the-moment discussion groups, focus groups and immersions. Field notes will be kept of all interviews and focus groups. • An interview schedule might be utilised instead of formal questionnaires. An interview schedule consists of a list of topics to be covered, but it is not as structured as an interview. It provides respondents with more freedom to elaborate on their views. • The final report will focus on current conditions, providing baseline data. Each category will discuss the current state of affairs but also investigate the possible impacts that might occur in future. The impacts identified in the scoping report

Aspect	Company Responsible	Scope of Work / Terms of Reference
		will be revisited and rated accordingly. New impacts that have not been identified will be added to the report. Recommendations for mitigation will be made at the end of the report. • The SIA process will have a participatory focus. This implies that the SIA process will focus strongly on including the local communities and key stakeholders. • The public consultation process undertaken by EIMS during the scoping phase will feed into the SIA. • Impacts will be rated according to the EIMS impact assessment methodology. Information obtained through the public processes will inform the writing of the final SIA and associated documents.
Economic Impact Assessment	Strategy4Good	The methodology to be followed for the economic impact assessment will be as follows: • 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 local and district municipalities 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 and the impact assessment methodology will align with the EIMS methodology.
Palaeontological Impact Assessment	Banzai Environmental	Site visit and compilation of Palaeontological Impact Assessment in accordance with the SAHRA Requirements.
Quantitative Risk Assessment (MHI Study)	RISCOM	The methodology will be based on SANS 1461 with regards to the scenario selection, calculation methodology and criteria. As SANS 1461 is for MHI risk assessment, some elements of the standard may not be compliant, at this stage of the report. RISCOM will conduct a quantitative risk assessment (QRA) according to the background described in this section.

Aspect	Company Responsible	Scope of Work / Terms of Reference
		1. The determination of whether there any factors that will prevent the project from proceeding to the next phase of construction or alternatively whether the project could continue under certain conditions or with mitigation; 2. The determination of whether there are any special requirements that the local authorities should be aware of when evaluating the proposal. The scope of the risk assessment will include: • Review of revised designs of proposed processing units, inventories, routing and transport conditions for all alternatives; • Development of accidental spill and fire scenarios for the facility; • Using generic failure rate data (for tanks, pumps, valves, flanges, pipework, gantry, couplings and so forth), determination of the probability of each accident scenario; • For each incident developed in Step 3, determination of consequences (such as thermal radiation, domino effects, toxic-cloud formation and so forth); • For scenarios with off-site consequences (greater than 1% fatality off-site), calculation of maximum individual risk (MIR), taking into account all generic failure rates, initiating events (such as ignition), meteorological conditions and lethality. • Assessing the risk assessment to the criteria of SANS 1641; and commenting on suitability of the project; • Suggest mitigation, if possible, for successful implementation. This information will then be used to identify any shortcomings and to rank the risks for possible risk reduction programmes. The risk assessment will exclude natural events such as earthquakes and floods.
Seismic Risk and Hazard Assessment	Council for Geoscience (CGS)	The aim of the proposed work is to carry out a study of seismicity in and around the study area including an assessment of how hydraulic fracturing could impact the seismicity of the area. In addition, the CGS proposes to carry out a probabilistic seismic hazard assessment for the study area using state-of-the-art analysis techniques, which incorporate all available information into a framework allowing the rational consideration of uncertainties. This assessment will provide information on the possible impact of seismicity on infrastructure at the well field as well as in the surrounding community. **Seismic Hazard Assessment** Following international best practice, the assessment of the seismic hazard will be implemented in a probabilistic manner, using a logic-tree framework that allows the inclusion of uncertainties related to the characterisation of the seismic sources and resulting

Aspect	Company Responsible	Scope of Work / Terms of Reference
		ground motions. All steps of the process will be documented. The steps that will be carried out in the study are outlined in the tasks below. The following tasks are proposed: **Task 1: Literature Review of effects of hydraulic Fracturing of CBM** Conduct literature review on the effects of hydraulic fracturing of CBM. A major concern by the public with unconventional gas development (both shale gas and CBM) relates to hydraulic fracturing and the associated risk of adverse subsurface impacts, including groundwater contamination, induced seismicity, and unsustainable. However, in this study the CGS will concentrate on induced seismicity groundwater use and will be able to consider the existing seismic data obtained by Thungela during the exploration phase hydraulic stimulation activities. **Task 2: Review of the geological setting** The geological setting of the study region will be reviewed on the basis of available information / literature and any work that might have been undertaken previously in the area. Essential features of the geological history of the region will be summarised, and major tectonic structures described with the help of maps and figures. Particular emphasis will be placed on a description of structures known to be associated with seismic activity, by including detailed conclusions from available neotectonic and palaeoseismic investigations. It is hoped that any site-specific geotechnical and / or geological investigations undertaken by the Client in the study area will be available for use in this task. **Task 3: Review of Seismicity and Development of an Earthquake catalogue** Available information regarding the occurrence of historical and instrumentally recorded earthquakes falling in and around the study area will be reviewed. In view of the length of the recurrence intervals of larger earthquakes in regions of low natural seismic activity, which are typically of the order of several hundred years, the investigation will consider seismicity that covers the whole period for which earthquake information is available. The review will be limited to events within the study region (approximately 100 km extent area). Each earthquake will be characterised in terms of its date of occurrence, estimated location and size (magnitude). This task will build on previous work undertaken in the compilation of regional earthquake catalogues. Particular emphasis will be placed on the assessment of the uncertainties associated with the various source parameters, as well as on the completeness of the information, since these will play an important role in the definition of the seismic source model used in the seismic hazard calculation. A summary will also be provided on the possible impact of hydraulic fracturing on seismicity as observed in other places where this process has been carried out. **Task 4: Identification of active faults**

Aspect	Company Responsible	Scope of Work / Terms of Reference
		The purpose of this task is to identify tectonic structures that can pose a fault rupture hazard in the study area, as well as active faults located in and around the area to require explicit modelling as linear features within the seismic hazard assessment. This task will combine available geological and seismicity information in the area and vicinity (8 and 40 km extent areas) but will depend on the availability of relevant information. The knowledge on active faults could be enhanced by the local, intense monitoring of microseismicity in the area using a dense local network of seismic stations. It is recommended that the client considers carrying out such a study. **Task 5.1: Seismic source model** This task entails the construction of a seismic source model on the basis of the earthquake catalogue as well as geological information regarding the tectonic structures of the area defined in Tasks 2 to 4. All structures within the vicinity (40 km extent area) of the well field deemed capable of generating earthquakes of moment magnitude (Mw) 5.0 or above will be characterised explicitly as linear faults (depends on availability of relevant information). Additionally, the model will also include a number of area source zones representing regions of spatially uniform seismicity. The use of such area source zones to capture diffuse seismicity, which cannot be correlated with particular geologic structures is commonplace in seismic hazard analyses, particularly in regions of low natural seismicity, where the scarcity of available data accentuates the diffuse nature of seismicity. Each seismic source will be characterised in terms of its spatial extent and predominant patterns in the style-of-faulting. The characterisation of the sources in terms of earthquake recurrence parameters will be addressed as part of Task 5.2. **Task 5.2: Seismic source model - Characterisation of sources** Following the definition of the seismic sources in Task 5.1, the maximum possible earthquake magnitude (Mmax) and earthquake recurrence parameters (which characterise the overall level of seismic activity, as well as the relative frequency of occurrence of earthquakes of different sizes) will be determined for each identified seismic source. This determination will mainly be based on the earthquake catalogue developed in Task 3. An accurate determination of the recurrence parameters requires the adjustment of the catalogue to common parameter definitions, the assessment of completeness intervals and declustering to remove the influence of fore- and aftershocks. **Task 6: Selection of suitable ground-motion prediction equations** In addition to a seismic source model describing the distribution of earthquakes in space and time, seismic hazard calculations require a ground-motion model, which describes the level of ground motion expected at the site for a given earthquake scenario (i.e., an earthquake of a given size occurring at a given distance from the site).

Aspect	Company Responsible	Scope of Work / Terms of Reference
		This task entails the selection of a set of ground-motion prediction equations (GMPE) applicable to the current project. In the absence of equations derived using local and / or regional data, equations from other regions will be discussed in terms of their suitability. Only equations providing coefficients for 5% damped response spectral ordinates for response periods up to at least 2 seconds will be considered. In order to enable the calculation of meaningful hazard estimates, the selected equations will be adjusted to common parameter definitions where necessary and possible. **Task 7: Sensitivity Analysis and Set-up of logic tree** In order to comply with international best practice, the probabilistic seismic hazard assessment will include consideration of uncertainties associated with the inputs. Hazard result sensitivity studies will be performed throughout so that areas of uncertainty that contribute disproportionately to the hazard results can, as far as is practicably possible, be identified proactively and addressed timeously. These uncertainties will be implemented in the hazard calculation using a logic-tree framework, and thoroughly documented. The logic tree will summarise alternative models required to capture the uncertainties associated with the characterisation of the seismic sources and expected ground motions. Each alternative will be assigned a weight reflecting the relative level of confidence in the model. Sensitivity studies will include tests to see how fracking induced seismicity could influence seismic hazard in the study area. **Task 8: Ground-shaking hazard calculations** Using the hazard models derived in Tasks 2 to 7 as input, seismic hazard calculations will be carried out. Hazard will be estimated for the proposed well field location as well as for surrounding communities. The hazard calculations be carried out for the following level of probability: • Operating Basis Earthquake (OBE), the maximum earthquake for which no damage is sustained. It is defined as ground motion with 10% probability of exceedance within a lifetime of 50 years (475-year return period). • In addition, calculations can also be carried out for other return periods if requested by the client. • The outcome of the seismic hazard calculations, for the sites considered, includes the following elements: • A set of seismic hazard curves characterising the annual frequency of exceedance of the ground-motion parameters considered; • Site-specific uniform hazard spectra (UHS), representing the envelope of the spectral ordinates at different structural periods (up to at least 2 seconds), for fixed probabilities (i.e., at least 475 years return period). The hazard calculations will be carried out for ground-motion corresponding to bedrock conditions as defined by the National Earthquake Hazards Reduction Program (NEHRP) class B/C with VS30 = 760 m/s.

Aspect	Company Responsible	Scope of Work / Terms of Reference
		Task 9: Earthquake Hazard Management and Mitigation Earthquake hazard management is to evaluate the hazard created when earthquakes occur and use strategies to minimise the damage caused by earthquakes. It is easy to assume that the earthquake itself is a hazard, but what the earthquake can cause is also a hazard. Secondary effects of earthquakes are also hazards. This can include ground shaking, landslides, fires, flooding, surface rupture and liquefaction. The key to mitigating seismic risk therefore lies in control of vulnerability in the built environment; by designing and building structures and facilities or retrofitting existing structures to ensure they have sufficient resistance to withstand the effects of earthquakes. Depending on the results of the seismic hazard study, recommendations will be provided on how the hazards can be managed and / mitigated. **Task 10: Report** A technical report summarising the findings of the probabilistic site-specific seismic hazard analysis will be prepared, which includes: • Overview of regional geological setting; • Description of regional and local seismicity; • Summary of active faults (if any identified) to be considered in seismic hazard analysis; • Description of seismic source model used in the hazard calculations; • Description of ground-motion model used in the hazard calculations; • Description of the set-up of the logic tree and assignment of logic-tree weights; • Presentation and discussion of seismic hazard curves and Uniform Hazard Spectra for a minimum of 475-year return period obtained for the well field location and nearby communities.

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. Commenting authorities will be similarly engaged throughout the application process.

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 NEMA, NEMWA and NEMAQA minimum requirements. The water use licence technical report will be made available for a further 30 days (i.e. 60 days in total) as per the requirements of the NWA.
- 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 (i.e. Lephalale Public Library, Marapong Public Library and Die Wind Pomp Lodge). In addition, the EIA Report and associated appendices will be shared electronically to stakeholders who request a copy, and these documents will be placed on the EIMS website (www.eims.co.za). I&AP's who notify EIMS of their limitations with the costs of data will be provided with a link to a data free online portal.
- 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, and the intention is to hold these meetings at the same venues as per the Scoping Phase meetings (i.e. Lephalale municipality/Mogol Club, Marapong settlement and the Thungela LCBM Nooitgedacht Conference Room) as appropriate. A facilitator will be present during the public meetings and the languages that will be catered for include English, Afrikaans, Sepedi and Setswana.
- 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 Environmental Impact Assessment Report (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 where necessary to provide authorities with project related information and obtain their feedback.
- Document compilation:
  - The EIA Report and EMPr will be compiled in line with the requirements of Appendix 3 and 4 of the NEMA EIA Regulations.
  - The EIA Report and EMPr (including other appendices) will be made available for public comment for a minimum period of 30 days.
  - The EIA Report 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

The mitigation hierarchy approach will be applied to all potential impacts, and the alternative assessment will guide the final proposed development to be put forward in the EIA Report. All comments received from I&APs during the Scoping Report review will be taken into consideration and where applicable inform the development of the EMPr.

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 conceptual project layout and reports provided by the applicant and is subject to adjustment if the more detailed site infrastructure designs are made available prior to the EIA phase.
- 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. It is expected that additional mitigation measures will be put forward during the EIA phase following completion of the specialist assessments.
- Additional impacts may be identified in the EIA Phase following Scoping public consultation and completion of specialist studies and the level of significance presented in this report is subject to change.

14.2 ECONOMIC ANALYSIS

- While a feasibility assessment has confirmed the technical potential to produce natural gas for sale, a detailed, bankable feasibility study specifically focused on the diesel substitution market (e.g., mining and transport sectors) has not yet been completed. The current assessment is therefore based on reasonable assumptions regarding market uptake and potential demand for LNG as an alternative fuel. It is recognised that a more detailed, market-specific feasibility study incorporating customer requirements (where possible) as well as technical, financial, and operational considerations would further refine the understanding of market dynamics and support future project optimisation and decision-making.

14.3 GEOHYDROLOGICAL INVESTIGATION

- 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 25.0m 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 hydrocensus data gathered. Further trends should be verified by continued monitoring as set out in the monitoring program.
- Where data was absent or insufficient, values were assumed based on literature studies and referenced accordingly.

14.4 HYDROLOGICAL MODELLING

Various assumptions were required in the development of the hydraulic model with resultant limitations in the accuracy of the modelled flooding. They included the following:

- PCSWMM parameterisation – Design hydrographs estimated using PCSWMM are accurate given the potential for large deviations in their estimation to significantly influence resulting flooding.

- Land-cover – the land-cover per the 2020 DEA and aerial imagery is assumed to apply to the Site (i.e. the Site has been evaluated in the condition outlined by these datasets). Changes in the land-cover or terrain will alter the flood model results.
- Rainfall depth – DRESSA rainfall depths are assumed accurate, with normal DRESSA values applied to this study. DRESSA also includes upper values representative of upper confidence limits.
- Climate change – Climate change was not considered in the hydrological assessment. A risk analysis using the expected life of a structure or process will indicate the relevance of considering climate change (i.e. as the expected life increases the influence of climate change increases). Climate change is expected to exacerbate any flooding due to a likely increase in rainfall intensities.
- Accuracy of terrain datasets – the 2m DSM was assumed accurate. The flood model accuracy cannot improve on the accuracy of parent data (i.e. the 2m DSM) which has an accuracy of 0.5m vertical and 1m horizontal. Additional LiDAR data with greater accuracy will improve the flood modelling.
- Mesh detail – the default mesh utilised a 10m mesh size. While one of HEC-RAS's major strengths is the use of a sub-grid, the obstructing or routing influence of linear features that are smaller than the mesh resolution will not be well defined.
- Roughness values – The selected Manning's 'n' values were representative of the areas they covered, including being representative regardless of the depth of flooding.
- Model calibration – no calibration of the model was undertaken as there is no observed data for calibration purposes.
- Software Performance - The software and methods utilised are assumed accurate with regards to their utilisation of input data and the processes they simulate.

14.5 HERITAGE AND PALAEONTOLOGY

- Not detracting in any way from the comprehensiveness of the fieldwork undertaken to date, it is necessary to realise that the heritage resources located during the fieldwork only represent some of the possible heritage resources present within the area. Various factors account for this, including the subterranean nature of some archaeological sites and existing vegetation cover. It should be noted most of the study area was accessible for the fieldwork survey.
- Fieldwork was also focussed on area that was not previously ploughed or disturbed by farming activity, thus focussing on areas with the highest potential to yield heritage resources.
- Therefore, should any heritage features and/or objects be located or observed outside the identified heritage sensitive areas during the construction activities, a heritage specialist must be contacted immediately. 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. If 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 focal point of geological maps is the geology of the area, and the sheet explanations of the Geological Maps were not meant to focus on palaeontological heritage. Many inaccessible regions of South Africa have never been reviewed by palaeontologists and data is generally based on aerial photographs alone. 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 also used to provide information on the existence of fossils in an area which has not documented in the past. When using similar Assemblage Zones and geological formations for Desktop studies it is generally assumed that exposed fossil heritage is present within the footprint. A field-assessment will thus improve the accuracy of the desktop assessment.

14.6 SOCIAL ASSESSMENT

- The social setting provided in this report provides a baseline description of the social environment and the identification of preliminary impacts (scoping level) in preparation for the EIA phase.
- A more in-depth assessment of social impacts and possible mitigation measures will be possible once further stakeholder consultation has taken place.
- A number of potential impacts has been identified and at this stage, none of these possible impacts is seen as a fatal flaw in the possible successful execution of the proposed project, but this can only be confirmed once fieldwork has been done and the potential impacts have been finalised and assessed. Most of the potential impacts can be mitigated. The importance of addressing the potential impacts as early in the project cycle as possible must be underlined, since failure to do so may result in the development of risks and an exponential increase in project cost.

14.7 TERRESTRIAL FRESHWATER SOILS HYDROPEDOLOGY AND LAND USE ASSESSMENT

- The assessment area was based on the area provided by the client and any alterations to the footprint and/or missing GIS information pertaining to the assessment area would have affected the area surveyed.
- The scoping assessment has been completed at a desktop level only. All datasets and species lists have been considered for the local area and surrounds.
- The species likelihood of occurrence is based on desktop information for this assessment.

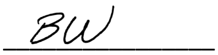
14.8 VISUAL ASSESSMENT

- A site visit was undertaken for another project in the area during 2016 which was used to inform this assessment. A second site visit will be undertaken specifically for this project to inform the EIA phase visual impact assessment.
- The GIS data sets used in undertaking and presenting of the visual assessment are based on available GIS data.

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

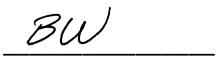


Date: 2026/05/25

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: 2026/05/25

17 REFERENCES

Aquiworx (2016) “Aquiworx Software.” Centre for Water Sciences and Management at the North-West University.

Barnett, E. and Casper, M. (2001) “A definition of" social environment".,” *American Journal of Public Health*, 91(3), p. 465.

Bell, P.A. *et al.* (1996) *Environmental psychology, 4th ed.* Orlando, FL, US: Harcourt (Environmental psychology, 4th ed.), pp. xvii, 645.

Belucio, M. *et al.* (2022) “The Impact of Natural Gas, Oil, and Renewables Consumption on Carbon Dioxide Emissions: European Evidence,” *Energies*, 15(14). Available at: https://doi.org/10.3390/en15145263.

Britannica, T. (2023) “Liquified Natural Gas,” *Encyclopaedia Britannica*. Editors if Encyclopaedia. Available at: https://www.britannica.com/science/liquefied-natural-gas.

Census (2011). Available at: www.statssa.co.za.

Crockett, R.& J., MT** (1975) “Some aspects of the geology of the Waterberg System in eastern Botswana,” *South African Journal of Geology*, 78(1), pp. 1–10.

CSIR (2019) *Green Book: Adapting South African settlements to climate change*. Available at: www.greenbook.co.za.

DEAT (2006) Guideline 5: Assessment of Alternatives and Impacts in support of the Environmental Impact Assessment Regulations, 2006. Integrated Environmental Management Guideline Series, Department of Environmental Affairs and Tourism (DEAT), Pretoria.

Desmet, P. *et al.* (2013) “Limpopo Conservation Plan vol 2: Technical Report,” *Contract Number EDET/2216/2012. Report for Limpopo Department of Economic Development, Environment & Tourism (LEDET) by ECOSOL GIS* [Preprint].

Driver, A. *et al.* (2011) “Implementation manual for freshwater ecosystem priority areas,” *Draft Report for the Water Research Commission* [Preprint].

Engelbrecht, F. (2019) *Technical Report: Green Book – Detailed Projections of Future.* Report reference number: CSIR/BE/SPS/ER/2019/0005/C. Pretoria.

Fabra, N. *et al.* (2024) “Do renewable energy investments create local jobs?,” *Journal of Public Economics*, 239, p. 105212. Available at: https://doi.org/10.1016/j.jpubeco.2024.105212.

Hanna, R., Heptonstall, P. and Gross, R. (2024) “Job creation in a low carbon transition to renewables and energy efficiency: a review of international evidence,” *Sustainability Science*, 19(1), pp. 125–150. Available at: https://doi.org/10.1007/s11625-023-01440-y.

International Association of Drilling Contractors (2023) “Oil and Gas Drilling Glossary.” Available at: https://iadclexicon.org/glossary/ (Accessed: July 19, 2023).

Johnson, M.R. and Coderre, A.R. (2011) “An analysis of flaring and venting activity in the Alberta upstream oil and gas industry,” *Journal of the Air & Waste Management Association*, 61(2), pp. 190–200.

Land Type Survey Staff (1972) *Land Types of South Africa: Digital Map (1:250 000 Scale) and Soil Inventory Databases*. Pretoria: ARC-Institute for Soil, Climate, and Water.

Le Roux, A. *et al.* (2019) *Green Book Risk Profile Tool*. Pretoria: CSIR. Available at: http://www.riskprofiles.greenbook.co.za/.

Lephalale Local Municipality (2023) “Integrated Development Plan 2023-2027.” Available at: www.lephalale.gov.za (Accessed: October 10, 2023).

Meteoblue, A. (2023) “Climate Change Posmasburg,” *meteoblue - weather close to you*. Available at: https://www.meteoblue.com/en/climate-change/-25.969N28.181E1585_Africa%2FJohannesburg.

Nel, J. *et al.* (2011) “Technical report for the national freshwater ecosystem priority areas project,” *Water Research Commission Report*, 1081(2), pp. 1–11.

Noble, M., Wright, G. and Cluver, L. (2006) “Developing a child-focused and multidimensional model of child poverty for South Africa,” *Journal of Children and Poverty*, 12(1), pp. 39–53. Available at: https://doi.org/10.1080/10796120500502136.

Rodrigues, A.C.C. (2022) “Decreasing natural gas flaring in Brazilian oil and gas industry,” *Resources Policy*, 77, p. 102776. Available at: https://doi.org/10.1016/j.resourpol.2022.102776.

SAWS (2017) *A Climate Change Reference Atlas 2017 - based on CMIP5 – CORDEX downscaling*. Pretoria, South Africa: South African Weather Service and the Water Research Commission. Available at: https://www.weathersa.co.za/home/climatechangeatlas.

Schlüter, T. (2008) *Geological atlas of Africa*. Springer.

Skowno, A. *et al.* (2019) “South African national biodiversity assessment 2018 technical report volume 1: Terrestrial realm,” *South African National Biodiversity Institute, Pretoria. http://hdl. handle. net/20.500*, 12143, p. 6370.

Snyman, C.P. (1998) “Coal in the mineral resources of South Africa,” *Handbook, council for geoscience*, 16, pp. 136–205.

Soltanieh, M. *et al.* (2016) “A review of global gas flaring and venting and impact on the environment: Case study of Iran,” *International Journal of Greenhouse Gas Control*, 49, pp. 488–509. Available at: https://doi.org/10.1016/j.ijggc.2016.02.010.

Statistics South Africa (2014) “The South African MPI: Creating a multidimensional poverty index using census data.”

Statistics South Africa (2016) “Community Survey 2016 Provinces at glance,” *Statistics South Africa*. Pretoria.

Tiwary, A. and Colls, J. (2010) “Mitigating secondary aerosol generation potentials from biofuel use in the energy sector,” *Science of the total environment*, 408(3), pp. 607–616.

Van Deventer, H. *et al.* (2019) “South African National Biodiversity Assessment 2018: Technical Report. Volume 2: Inland Aquatic (Freshwater) Realm.”

WR (2012) “Rainfall and meteorological data.”

www.municipalities.co.za (2023) “Municipalities.” Available at: http://www.municipalities.co.za (Accessed: September 21, 2023).