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VULCAN ENERGY

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Phase One Lionheart Project

Environmental and Social Impact Assessment (ESIA)

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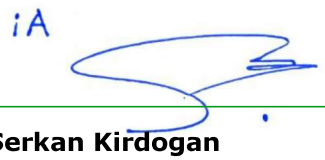
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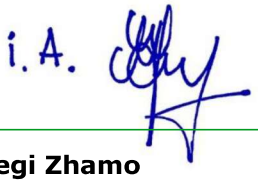
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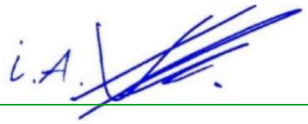
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Every effort has been made to ensure the quality of the translation is technically correct. However, where discrepancies between the various translated texts occur, the English version is to be relied upon as the original and formal version.

CONTENTS

1.	INTRODUCTION	1
1.1	PURPOSE OF THIS REPORT	2
1.2	STRUCTURE OF THIS REPORT	3
2.	PROJECT DESCRIPTION	5
2.1	KEY PROJECT COMPONENTS	7
2.1.1	Well Sites	7
2.1.2	Interconnecting Pipeline & Power (ICPP)	18
2.1.3	Geothermal Lithium Production Plant	21
2.1.4	Insheim Geothermal Plant	23
2.1.5	Landau Well Site (Former Geox Geothermal Power Plant)	25
2.1.6	Central Lithium Plant in Frankfurt industrial park HÖCHST	25
2.2	HAZARDOUS MATERIALS	28
2.2.1	Naturally Occurring Radioactive Material (NORM)	28
2.2.2	Others	30
2.2.3	Transportation of Hazardous Materials	32
2.3	ANCILLARY SERVICES	33
2.3.1	Workers' Camps	33
2.3.2	Access Roads	35
2.3.3	Electrical Infrastructure	35
2.4	PROJECT ALTERNATIVES	35
3.	PROJECT PHASES	38
3.1	PROJECT SCHEDULE	41
3.2	DECOMMISSIONING	42
4.	LEGAL AND REGULATORY FRAMEWORK	43
4.1	INTRODUCTION	43
4.2	NATIONAL CONTEXT	44
4.2.1	German EIA and Permitting Overview	44
4.2.2	Federal Nature Conservation Act	46
4.2.3	National Energy and Climate Change Strategies	47
4.3	VULCAN'S APPLICABLE GERMAN REGULATIONS AND PERMITTING STRATEGY	48
4.3.1	Environmental Impact Assessment	50
4.3.2	Permitting	52
4.4	APPLICABLE INTERNATIONAL REGULATIONS	56
4.4.1	The Aarhus Convention	56
4.4.2	European Union Directives	57
4.4.3	Espoo Convention on Transboundary EIAs	57
4.5	INTERNATIONAL APPLICABLE STANDARDS	58
5.	ESIA PROCESS AND METHODOLOGY	60
5.1	SCOPING	61
5.2	IMPACT ASSESSMENT METHODOLOGY	61
5.3	ASSUMPTIONS AND LIMITATIONS	63

5.4 APPROACH AND METHODS 64

5.4.1 Step 1: Defining the Area of Influence 64
5.4.2 Step 2: Identification of environmental receptors and values 66
5.4.3 Step 3: Identification of Impacts 66
5.4.4 Step 4: Assessment of impact significance 67
5.4.5 Step 5: Impact mitigation and management measures 74
5.4.6 Step 6: Assess Residual Impacts 76
5.4.7 Addressing Uncertainities 76

5.5 STAKEHOLDER ENGAGEMENT 77

5.5.1 Disclosure and Stakeholder Engagement to Date 78
5.5.2 Public Perceptions of the Project 85
5.5.3 Future Stakeholder Engagement 85
5.5.4 Stakeholder Engagement at Frankfurt Höchst Industrial Park 86

6. ENVIRONMENTAL AND SOCIAL BASELINE 88

6.1 PHYSICAL ENVIRONMENT 88

6.2 CLIMATE 88

6.3 CLIMATE CHANGE 90

6.4 GREENHOUSE GAS EMISSIONS 93

6.4.1 Overview of Greenhouse Gas Emissions in Germany 93
6.4.2 Greenhouse Gas Emissions on Project level 93

6.5 GEOLOGY, GEOMORPHOLOGY, SOILS AND GEOHAZARDS 94

6.5.1 Methodology and information Sources 94
6.5.2 Geology and Geomorphology 94
6.5.3 Soils 96
6.5.4 Geohazards 98

6.6 HYDROLOGY – SURFACE AND GROUNDWATER 98

6.6.1 Methodology and Information Sources 98
6.6.2 Area of influence 99
6.6.3 Surface Water 100
6.6.4 Groundwater and Hydrogeology 104
6.6.5 Groundwater Quality 109

6.7 AIR QUALITY 112

6.7.1 Methodology and Information Sources 112
6.7.2 Air Quality Standards 112
6.7.3 Air Quality Features of the Project Area 114

6.8 NOISE 117

6.8.1 Methodology and Information Sources 117
6.8.2 Noise Standards 117
6.8.3 Noise Features of the Project Area 118

6.9 BIOLOGICAL BASELINE 126

6.9.1 General 126
6.9.2 Protected Areas and Internationally Recognised Areas 126
6.9.3 Natural and Modified Habitats 129
6.9.4 Conservation Important Species: Flora and Fauna 131
6.9.5 Critical Habitat 133
6.9.6 Ecosystem Services 134

6.10 SOCIAL BASELINE 134

6.10.1 Overview 134
6.10.2 Methodology 134
6.10.3 Social Area of Influence 135
6.10.4 Nearby Settlements to the CLP 137

6.11 GOVERNANCE AND ADMINISTRATION 137

6.12 DEMOGRAPHICS 139

6.12.1 Population Overview 139
6.12.2 Age 142
6.12.3 Household and Family Composition 142
6.12.4 Nationalities 142
6.12.5 Religion 143
6.12.6 Languages 144
6.12.7 Migration 144

6.13 EDUCATION 146

6.13.1 Educational Attainment 146
6.13.2 Educational Facilities in the AoI 148

6.14 ECONOMY, EMPLOYMENT, AND INCOME 151

6.14.1 Employment and income within the Project AoI 151
6.14.2 Labour and Working Conditions Within the Project AoI 152
6.14.3 Economy and Livelihoods 153
6.14.4 Poverty 155

6.15 LAND USE AND OWNERSHIP 156

6.15.1 Land Ownership 156
6.15.2 Land Use 162

6.16 INFRASTRUCTURE AND PUBLIC SERVICES 166

6.16.1 Transport Infrastructure 166
6.16.2 Public Services 168
6.16.3 Public and Recreational Infrastructure 169

6.17 COMMUNITY HEALTH 171

6.17.1 Healthcare and Healthcare Facilities 171
6.17.2 Health Conditions 173

6.18 CULTURAL HERITAGE 175

6.18.1 Cultural Heritage within the AoI 175

6.19 PRESENCE OF VULNERABLE GROUPS 176

6.19.1 Vulnerable Groups within and near the AoI 178

6.20 HUMAN RIGHTS 180

6.20.1 Human Rights Risk Screening 184

7. IMPACT ASSESSMENT 202

7.1 PHYSICAL IMPACT ASSESSMENT 202

7.1.1 Impacts related to Climate Change 202
7.1.2 Impacts related to Greenhouse Gas Emissions 221
7.1.3 Impacts related to Geology, Soils and Seismicity 258
7.1.4 Impacts related to Noise 269
7.1.5 Impacts related to Air 283
7.1.6 Hydrology 289
7.1.7 Impacts on Surface Water 289
7.1.8 Impacts on Groundwater 295
7.1.9 Impacts from Waste and Wastewater 300

7.2 BIOLOGICAL IMPACT ASSESSMENT 305

7.2.1 Introduction 305
7.2.2 Approach & Methods 305
7.2.3 Project AoI 305
7.2.4 Key Receptors and Biodiversity Values 308
7.2.5 Identification of Biodiversity Impacts 310
7.2.6 Scoped Out Impacts 311

7.3 IMPACTS RELATED TO LOSS OF FAUNA 313

7.4 IMPACTS RELATED TO DISTURBANCE TO FAUNA AND FLORA CAUSED BY NOISE, VIBRATION, LIGHT AND DUST 317

7.5 IMPACTS RELATED TO CREATION OF BARRIERS TO FAUNAL SPECIES MOVEMENT 322

7.6 IMPACTS RELATED TO AQUATIC ECOSYSTEMS 324

7.7 IMPACTS RELATED TO INTRODUCTION/SPREAD OF INVASIVE ALIEN PLANTS 328

7.8 IMPACTS TO PROTECTED AREAS 330

7.9 SOCIAL IMPACT ASSESSMENT 334

7.9.1 Introduction 334
7.9.2 Approach and Methods 335
7.9.3 Scoped Out Impacts 335

7.10 VALUE CREATION 336

7.10.1 Energy Provision 336
7.10.2 Employment and Training 338

7.11 IMPACTS RELATED TO LAND USE AND VISUAL IMPACTS 340

7.12 IMPACTS RELATED TO TRAFFIC AND LAND ACCESS 343

7.13 IMPACTS RELATED TO COMMUNITY HEALTH AND SAFETY 346

7.13.1 Air Quality 347
7.13.2 Noise 347
7.13.3 Security 348

7.14 IMPACTS RELATED TO OCCUPATIONAL HEALTH AND SAFETY 350

7.15 IMPACTS RELATED TO CULTURAL HERITAGE AND ARCHEOLOGICAL SURROUNDINGS 355

7.15.1 Chance Find Procedure 357

8. CUMULATIVE IMPACT ASSESSMENT 359

8.1 INTRODUCTION AND APPROACH 359

8.2 OBJECTIVES 359

8.2.1 Assessment Methodology 360
8.2.2 Information Sources 361

8.3 STEP 1: DEFINING SPATIAL AND TEMPORAL BOUNDARIES 361

8.3.1 Spatial Boundaries 361
8.3.2 Temporal Boundaries 362

8.4 STEP 2: IDENTIFICATION OF VECS AND SCREENING OF OTHER PROJECTS IN THE REGION 362

8.4.1 Identifying the VECs 362
8.4.2 Approach to Identifying Other Relevant Projects in the Region 364
8.4.3 Results of Screening 365

9. TRANSBOUNDARY IMPACTS 367

10. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) 369

10.1 INTRODUCTION 369

10.2 SCOPE 369

10.2.1 Vulcan's Corporate Policies 370
10.2.2 Vulcan's Environmental and Social Management System 373
10.2.3 Supporting Environmental and Social Management Plans 374
10.2.4 EPC CONtractor(s) 374

10.3 MANAGING CHANGES TO PROJECT ACTIVITIES 375
10.4 IMPLEMENTATION 376
10.4.1 Responsibilities and Resources 376
10.4.2 Training and Awareness 379
10.4.3 Documentation 379
10.4.4 Checking and Corrective Action 379
10.5 ENVIRONMENTAL AND SOCIAL PROJECT COMMITMENTS 380
11. SUMMARY OF THE IMPACT ASSESSMENT 397

LIST OF TABLES

TABLE 1-1 REPORT STRUCTURE 3
TABLE 1-2 PROJECT PARTIES 4
TABLE 2-1 HAZARDOUS MATERIALS IN THE LEP 30
TABLE 2-2 HAZARDOUS MATERIALS IN THE ORC 31
TABLE 2-3 HAZARDOUS MATERIALS AT CLP 32
TABLE 3-1 PROJECT PHASES 38
TABLE 3-2 PROJECT SCHEDULE 41
TABLE 4-1 PERMITS PERTINENT TO THE PHASE ONE LIONHEART PROJECT 53
TABLE 5-1 IMPACT CATEGORIES AND DEFINITIONS (ADAPTED FROM HARDNER ET AL., 2015) 67
TABLE 5-2 IMPACT SIGNIFICANCE CATEGORIES 68
TABLE 5-3 QUALITATIVE RATINGS OF MAGNITUDE OF EFFECT 70
TABLE 5-4 QUALITATIVE RATINGS OF RECEPTOR IMPORTANCE & SENSITIVITY 71
TABLE 5-5 MATRIX USED TO RATE IMPACT SIGNIFICANCE 74
TABLE 5-6 PRELIMINARY KEY STAKEHOLDER MAPPING AND ENGAGEMENT APPROACHES 78
TABLE 5-7 OVERVIEW OF STAKEHOLDER ENGAGEMENT TO-DATE 82
TABLE 6-1 CLIMATE HAZARDS IN RHINELAND PALATINATE 92
TABLE 6-2 CLIMATE HAZARDS IN SOUTH HESSE 92
TABLE 6-3 SOIL TYPES AT THE DIFFERENT PROJECT COMPONENTS 97
TABLE 6-4 GROUNDWATER QUALITY IN THE PROJECT AREA 109
TABLE 6-5 WHO RECOMMENDED AIR QUALITY GUIDELINE LEVELS AND INTERIM TARGETS 113
TABLE 6-6 NATIONAL AIR QUALITY STANDARDS IN GERMANY 114
TABLE 6-7 BASELINE VALUES FOR NO_2, PM_{10}, $PM_{2.5}$ AND O_3 115
TABLE 6-8 GERMAN AND INTERNATIONAL NOISE LEVEL GUIDELINES 118
TABLE 6-9 NEAREST NOISE RECEPTORS AT THE WELL SITES 40 MORGEN, TRAPPELBERG AND SCHLEIDBERG 124
TABLE 6-10 NOISE MEASUREMENTS WITH EXCEEDANCE OF THE ORIENTATION VALUE 125
TABLE 6-11 INDIRECT SOCIAL AREA OF INFLUENCE 136

TABLE 6-12 PROXIMITY OF NEAREST BUILDINGS TO PROJECT SITES 136
TABLE 6-13 SETTLEMENT PROXIMITY TO THE CLP 137
TABLE 6-14 KEY HUMAN DEVELOPMENT INDICATORS FOR GERMANY 140
TABLE 6-15 POPULATION COMPOSITION WITHIN THE AOI 141
TABLE 6-16 INDIRECT AOI POPULATION CHANGES 2021 141
TABLE 6-17 PROTECTION STATUS FOR GERMAN POPULATION COMPARED TO POPULATION WITHIN INDIRECT AOI IN 2022 146
TABLE 6-18 GENERAL EDUCATIONAL ATTAINMENT IN RHINELAND-PALATINATE IN 2019 BY GENDER 147
TABLE 6-19 DROPOUTS VS GRADUATES WITHIN INDIRECT AOI IN 2021 148
TABLE 6-20 EMPLOYEES PER SECTOR LANDAU IN THE PALATINATE IN 2021 152
TABLE 6-21 EMPLOYEES PER SECTOR IN SÜDLICHE WEINSTRAßE IN 2021 152
TABLE 6-22 OVERVIEW OF ECONOMIC SECTORS AND EMPLOYMENT IN RHINELAND-PALATINATE IN MAY 2023 154
TABLE 6-23 LAND OWNERSHIP DIRECT AOI 158
TABLE 6-24 FARM AREA AND UTILISED AGRICULTURAL AREA/TYPE IN RHINELAND-PALATINATE IN 2022 162
TABLE 6-25 LAND USE BREAKDOWN IN LANDAU IN THE PALATINATE AN SÜDLICHE WEINSTRAßE AS OF 31.12.2021 164
TABLE 6-26 HEALTHCARE FACILITIES IN RHINELAND-PALATINATE IN 2017 172
TABLE 6-27 RHINELAND-PALATINATE POPULATION HEALTH STATUS OVERVIEW IN 2017 174
TABLE 6-28 CARE IN SÜDLICHE WEINSTRAßE AND LANDAU IN THE PALATINATE IN DECEMBER 2021 175
TABLE 6-29 RECIPIENTS OF SOCIAL SECURITY IN RHINELAND-PALATINATE COMPARED TO LANDAU IN THE PALATINATE AND SÜDLICHE WEINSTRAßE, DECEMBER 2021 179
TABLE 6-30 GERMAN HUMAN RIGHTS LEGISLATION 181
TABLE 6-31 HUMAN RIGHTS RISK SCREENING 185
TABLE 7-1 REPRESENTATIVE CONCENTRATION PATHWAYS 203
TABLE 7-2 RISK MATERIALITY CATEGORIES AND ASSOCIATED DEFINITIONS 204
TABLE 7-3 MAGNITUDE AND SIGNIFICANCE OF PROJECTED PRECIPITATION PERCENTAGE CHANGE IMPACT ASSESSMENT 205
TABLE 7-4 MAGNITUDE AND SIGNIFICANCE OF CONSECUTIVE DRY DAYS IMPACT ASSESSMENT 205
TABLE 7-5 SIGNIFICANCE OF EFFECT OF WATER SCARCITY PARAMETERS DURING CONSTRUCTION 206
TABLE 7-6 SIGNIFICANCE OF EFFECT OF WATER SCARCITY PARAMETERS DURING OPERATION 207
TABLE 7-7 SIGNIFICANCE OF EFFECT OF WATER SCARCITY PARAMETERS DURING DECOMMISSIONING 208
TABLE 7-8 POTENTIAL RISK AREAS AND MATERIALITY – ASSOCIATED WITH WATER SCARCITY 209
TABLE 7-9 MAGNITUDE AND SIGNIFICANCE OF EXTREME HEAT IMPACT ASSESSMENT 210
TABLE 7-10 PROJECTED NUMBER OF HOT DAYS (>30°C TMAX) DURING CONSTRUCTION 210

TABLE 7-11 PROJECTED NUMBER OF HOT DAYS (>30°C TMAX) DURING OPERATIONS 211
TABLE 7-12 PROJECTED NUMBER OF HOT DAYS (>30°C TMAX) DURING DECOMMISSIONING 212
TABLE 7-13 POTENTIAL RISK AREAS AND MATERIALITY – ASSOCIATED WITH EXTREME HEAT 213
TABLE 7-14 MAGNITUDE AND SIGNIFICANCE OF URBAN FLOODS IMPACT ASSESSMENT 215
TABLE 7-15 PROJECTED LARGEST 1-DAY PRECIPITATION IN RHINELAND-PALATINATE AND HESSE 216
TABLE 7-16 PROJECTED LARGEST 1-DAY PRECIPITATION IN RHINELAND PALATINATE AND HESSE 217
TABLE 7-17 PROJECTED LARGEST 1-DAY PRECIPITATION IN RHINELAND-PALATINATE AND HESSE 217
TABLE 7-18 POTENTIAL RISK AREAS AND MATERIALITY – ASSOCIATED WITH URBAN FLOODS 218
TABLE 7-19 EMISSIONS FROM MOBILE COMBUSTION DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 224
TABLE 7-20 EMISSIONS FROM STATIONARY COMBUSTION DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 224
TABLE 7-21 EMISSIONS FROM ELECTRICITY CONSUMPTION DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 226
TABLE 7-22 EMISSIONS FROM PROCURED HEATING DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 226
TABLE 7-23 EMISSIONS FROM CAPITAL GOODS (PRO-RATA) DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 227
TABLE 7-24 EMISSIONS FROM FUEL AND ENERGY-RELATED ACTIVITIES DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 227
TABLE 7-25 EMISSIONS FROM UPSTREAM TRANSPORTATION AND DISTRIBUTION DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 227
TABLE 7-26 EMISSIONS FROM PURCHASED GOODS AND SERVICES DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 228
TABLE 7-27 EMISSIONS FROM PURCHASED GENERATED WASTE DURING CONSTRUCTION AND RAMP-UP (BASE-CASE) 228
TABLE 7-28 TOTAL EXPECTED CONSTRUCTION AND RAMP-UP GHG EMISSIONS (BASE-CASE) 229
TABLE 7-29 EMISSIONS FROM MOBILE COMBUSTION DURING OPERATION (BASE-CASE) 232
TABLE 7-30 EMISSIONS FROM STATIONARY COMBUSTION DURING OPERATION (BASE-CASE) 232
TABLE 7-31 EMISSIONS FROM ELECTRICITY CONSUMPTION DURING OPERATION (BASE-CASE) 233
TABLE 7-32 EMISSIONS FROM PROCURED HEATING DURING OPERATION (BASE-CASE) 233
TABLE 7-33 EMISSIONS FROM PURCHASED GOODS AND SERVICES DURING OPERATION (BASE-CASE) 234
TABLE 7-34 EMISSIONS FROM FUEL AND ENERGY-RELATED ACTIVITIES DURING OPERATION (BASE-CASE) 234
TABLE 7-35 EMISSIONS FROM GENERATED WASTE DURING OPERATION (BASE-CASE) 234
TABLE 7-36 TOTAL EXPECTED OPERATION GHG EMISSIONS (BASE-CASE) 235
TABLE 7-37 NET AVOIDED EMISSIONS DURING OPERATIONS (BASE-CASE) 238

TABLE 7-38 EMISSIONS FROM MOBILE COMBUSTION DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 242
TABLE 7-39 EMISSIONS FROM STATIONARY COMBUSTION DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 242
TABLE 7-40 EMISSIONS FROM ELECTRICITY CONSUMPTION DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 243
TABLE 7-41 EMISSIONS FROM PROCURED HEATING DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 243
TABLE 7-42 EMISSIONS FROM CAPITAL GOODS (PRO-RATA) DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 244
TABLE 7-43 EMISSIONS FROM FUEL AND ENERGY-RELATED ACTIVITIES DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 244
TABLE 7-44 EMISSIONS FROM UPSTREAM TRANSPORTATION AND DISTRIBUTION DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 244
TABLE 7-45 EMISSIONS FROM PURCHASED GOODS AND SERVICES DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 245
TABLE 7-46 EMISSIONS FROM PURCHASED GENERATED WASTE DURING CONSTRUCTION AND RAMP-UP (LOW-CASE) 245
TABLE 7-47 TOTAL EXPECTED CONSTRUCTION AND RAMP-UP GHG EMISSIONS (LOW-CASE) 246
TABLE 7-48 EMISSIONS FROM STATIONARY COMBUSTION DURING OPERATION (LOW-CASE) 249
TABLE 7-49 EMISSIONS FROM ELECTRICITY CONSUMPTION DURING OPERATION (LOW-CASE) 249
TABLE 7-50 EMISSIONS FROM PROCURED HEATING DURING OPERATION (LOW-CASE) 250
TABLE 7-51 EMISSIONS FROM PURCHASED GOODS AND SERVICES DURING OPERATION (LOW-CASE) 250
TABLE 7-52 EMISSIONS FROM FUEL AND ENERGY-RELATED ACTIVITIES DURING OPERATION (BASE-CASE) 251
TABLE 7-53 EMISSIONS FROM GENERATED WASTE DURING OPERATION (LOW-CASE) 251
TABLE 7-54 TOTAL EXPECTED OPERATION GHG EMISSIONS (LOW-CASE) 252
TABLE 7-55 NET AVOIDED EMISSIONS DURING OPERATIONS (LOW-CASE) 255
TABLE 7-56 COMPARISON OF SCOPE 1, 2 AND 3 EMISSIONS FOR THE BASE-CASE AND LOW-CASE SCENARIO DURING CONSTRUCTION AND RAMP-UP 257
TABLE 7-57 COMPARISON OF SCOPE 1, 2 AND 3 EMISSIONS FOR THE BASE-CASE AND LOW-CASE SCENARIO DURING OPERATION 257
TABLE 7-58 MAGNITUDE OF IMPACT ON GEOLOGY, SOILS AND SEISMICITY 258
TABLE 7-59 GEOLOGY, SOILS AND SEISMICITY RECEPTOR SENSITIVITY 259
TABLE 7-60 IMPACTS RELATED TO GEOLOGY AND SOILS 260
TABLE 7-61 IMPACTS RELATED TO GEOHAZARDS 263
TABLE 7-62 RATING OF MAGNITUDE AND SIGNIFICANCE OF CONSTRUCTION NOISE EFFECTS 270
TABLE 7-63 NOISE RECEPTOR SESITIVITY 270
TABLE 7-64 IMPACTS RELATED TO NOISE 271
TABLE 7-65 EXPECTED EQUIPMENT FOR EARTHWORKS DURING CONSTRUCTION 271
TABLE 7-66 CONSTRUCTION NOISE ASSESSMENT CRITERIA 272

TABLE 7-67 CONSTRUCTION NOISE IMPACT ASSESSMENT FOR RECEPTORS WITHIN THE AOI	273
TABLE 7-68 PROJECTED NIGHT-TIME NOISE LEVELS DURING DRILLING AT 40 MORGEN	275
TABLE 7-69 PROJECTED NIGHT-TIME NOISE LEVELS DURING DRILLING AT TRAPPELBERG	275
TABLE 7-70 PROJECTED NIGHT-TIME NOISE LEVELS DURING DRILLING AT SCHLEIDBERG	276
TABLE 7-71 PROJECTED NOISE LEVELS DURING OPERATION AT 40 MORGEN	278
TABLE 7-72 PROJECTED NOISE LEVELS DURING OPERATION AT TRAPPELBERG	279
TABLE 7-73 EUROPEAN AND GERMAN AIR QUALITY STANDARDS	284
TABLE 7-74 DUST DEPOSITION GUIDELINES	285
TABLE 7-75 MAGNITUDE OF IMPACT ON AIR QUALITY	286
TABLE 7-76 RECEPTOR SENSITIVITY AIR QUALITY	286
TABLE 7-77 IMPACT MAGNITUDE ON SURFACE WATER	290
TABLE 7-78 SURFACE WATER RECEPTOR SENSITIVITY	291
TABLE 7-79 MAGNITUDE OF IMPACT ON GROUNDWATER	296
TABLE 7-80 GROUNDWATER RESOURCE SENSITIVITY	296
TABLE 7-81 DEFINING THE AOI FOR CONSTRUCTION AND OPERATIONAL/MAINTENANCE COMPONENTS OF THE PROJECT	306
TABLE 7-82 SUMMARY OF KEY ECOLOGICAL RECEPTORS AND BIODIVERSITY VALUES FOR THE PROJECT AREA	308
TABLE 7-83 SCREENING OF IMPACTS OUT OF SCOPE	336
TABLE 7-84 ENERGY PROVISION AND RELEVANCE TO THE PROJECT	337
TABLE 7-85 CHANCE FIND PROCEDURE	358
TABLE 8-1 SCREENING OF VECS	363
TABLE 10-1 VULCAN'S PRIMARY POLICIES RELATED TO STAKEHOLDER ENGAGEMENT	370
TABLE 10-2 VULCAN’S HSE ROLES AND RESPONSIBILITIES	377
TABLE 10-3 ESMP (PRE-CONSTRUCTION PHASE)	381
TABLE 10-4 ESMP (CONSTRUCTION PHASE)	382
TABLE 10-5 ESMP (OPERATION PHASE)	395
TABLE 11-1 SUMMARY OF PROJECT IMPACTS	397

LIST OF FIGURES

FIGURE 1-1 PHASE ONE PROJECT LOCATION 2
FIGURE 2-1 PROJECT AREA AND PHASE ONE LAYOUT 5
FIGURE 2-2 CENTRAL LITHIUM PLANT (CLP) AT THE INDUSTRIAL PARK HÖCHST 6
FIGURE 2-3 WELL STRUCTURE 9
FIGURE 2-4 STANDARDISED NORTH ALIGNED LAYOUT OF A WELL SITE 10
FIGURE 2-5 SCHLEIDBERG WELL SITE 12
FIGURE 2-6 AERIAL VIEW SHOWING PAVED ACCESS ROAD TO THE CONSTRUCTED SCHLEIDBERG WELL SITE 13
FIGURE 2-7 SITE PLAN FOR THE SCHLEIDBERG WELL SITE 14
FIGURE 2-8 PAVED PATH WITHIN THE TRAPPELBERG WELL SITE 15
FIGURE 2-9 AERIAL OVERVIEW OF THE 40 MORGEN WELL SITE 16
FIGURE 2-10 40 MORGEN WELL SITE DURING SITE VISIT (AUGUST 2023) 16
FIGURE 2-11 SPREISSGRABEN WELL AREA 17
FIGURE 2-12 RIGHT OF WAY OF THE PIPELINE 19
FIGURE 2-13 AERIAL OVERVIEW OF THE LAND PLOT FOR THE GEOTHERMAL AND LITHIUM PRODUCTION PLANT (GLEP) 23
FIGURE 2-14 LAYOUT OVERVIEW OF THE GEOTHERMAL AND LITHIUM PRODUCTION PLANT 23
FIGURE 2-15 OVERVIEW OF THE INSHEIM GEOTHERMAL PLANT 24
FIGURE 2-16 LAYOUT PLAN OF THE CENTRAL LITHIUM PLANT 27
FIGURE 2-17 CREW CAMPS' LAYOUT 34
FIGURE 4-1 VULCAN'S PERMITTING FLOW DIAGRAM 49
FIGURE 4-2 SELECTION PROCESS FOR ENVIRONMENTAL ASSESSMENT 51
FIGURE 5-1 ERM'S ESIA APPROACH 60
FIGURE 5-2 ERM IMPACT ASSESSMENT METHODOLOGY 62
FIGURE 5-3 PROJECT AREA OF INFLUENCE (NOISE & DUST) 65
FIGURE 5-4 FRANKFURT HÖCHST AREA OF INFLUENCE (NOISE & DUST) 66
FIGURE 5-5 MITIGATION HIERARCHY 76
FIGURE 5-6 OPEN DOOR EVENT INSHEIM ON 17.05.2025 80
FIGURE 5-7 PUBLIC EVENT AT INSHEIM 03.10.2022 81
FIGURE 5-8 VULCAN INFORMATION CENTRE LANDAU 83
FIGURE 5-9 ERM AND VULCAN REPRESENTATIVES DISCUSSING WITH LOCAL FARMER 84
FIGURE 6-1 CLIMATE DIAGRAM HERXHEIMWEYER (1991-2020) 89
FIGURE 6-2 CLIMATE DIAGRAM FRANKFURT/MAIN-WESTEND (1991-2020) 90
FIGURE 6-3 DEVELOPMENT OF TEMPERATURE IN RHINELAND-PALATINATE FROM 1881 TO 2022 91
FIGURE 6-4 PROJECTIONS OF THE DEVELOPMENT OF THE MEAN TEMPERATURE IN RHINELAND-PALATINATE UNTIL 2100 91

FIGURE 6-5 EMISSION TRENDS IN CO_2 EQUIVALENTS IN GERMANY 93
FIGURE 6-6 GEOLOGICAL FEATURES IN THE PROJECT AREA 95
FIGURE 6-7 SOIL MAP OF THE PROJECT AREA 96
FIGURE 6-8 AOI FOR SURFACE AND SHALLOW GROUNDWATER 100
FIGURE 6-9 STREAMS IN THE LANDAU AOI 102
FIGURE 6-10 ASSESSMENT OF THE FLOOD RISK AT THE CLP IN HÖCHST 104
FIGURE 6-11 GEOLOGICAL CROSS-SECTION ILLUSTRATING THE HYDROGEOLOGY OF THE QUATERNARY SEDIMENTS IN THE UPPER RHINE GRABEN 105
FIGURE 6-12 PROPOSED WELL CONSTRUCTION AND GENERALISED LITHOSTRATIGRAPHY FOR THE UPPER RHINE GRABEN. 108
FIGURE 6-13 MAJOR ANIONS AND CATIONS CONCENTRACTION FOR THE GROUNDWATER IN THE SHALLOW QUATERNARY AQUIFER 111
FIGURE 6-14 MAJOR ANIONS AND CATIONS CONCENTRATION FOR THE DEEP BRINE AND STAGNANT BRINES WITHIN THE TERTIARY SEDIMENTS 112
FIGURE 6-15 DAYTIME TRAFFIC NOISE EMISSIONS IN THE LANDAU AREA 120
FIGURE 6-16 NIGHTTIME TRAFFIC NOISE EMISSIONS IN THE LANDAU AREA 121
FIGURE 6-17 DAYTIME INDUSTRIAL NOISE AT THE CLP IN HÖCHST 122
FIGURE 6-18 NIGHTTIME INDUSTRIAL NOISE AT THE CLP IN HÖCHST 123
FIGURE 6-19 PROTECTED AREAS NETWORK (NATURA 2000 SITES) IN RELATION TO THE LANDAU PROJECT LAYOUT AND AOI 128
FIGURE 6-20 PROTECTED AREAS (NATURA 2000) RELATIVE TO THE CLP 129
FIGURE 6-21 GERMANY'S ADMINISTRATIVE AND TERRITORIAL STRUCTURE 138
FIGURE 6-22 EDUCATIONAL FACILITIES IN THE NORTHERN REGION OF THE AOI 149
FIGURE 6-23 EDUCATIONAL FACILITIES IN THE SOUTH-WESTERN REGION OF THE AOI 150
FIGURE 6-24 EDUCATIONAL FACILITIES IN THE SOUTH-EASTERN REGION OF THE AOI 150
FIGURE 6-25 LAND PURCHASE PROCESS RHINELAND-PALATINATE 156
FIGURE 6-26 OVERVIEW OF LAND OWNERSHIP (LANDAU) 161
FIGURE 6-27 LAND USE WITHIN THE AOI 165
FIGURE 6-28 TRANSPORT INFRASTRUCTURE WITHIN THE AOI 167
FIGURE 6-29 ACCESS ROAD: D12 GLEP SITE 168
FIGURE 6-30 LEISURE AND RECREATIONAL AREAS (NORTHERN REGION OF AOI) 170
FIGURE 6-31 LEISURE AND RECREATIONAL AREAS (SOUTH-WEST REGION OF AOI) 170
FIGURE 6-32 LEISURE AND RECREATIONAL AREAS (SOUTH-EAST REGION OF AOI) 171
FIGURE 6-33 HEALTHCARE FACILITIES WITHIN THE AOI 173
FIGURE 6-34 PHOTOS TAKEN DURING ARCHAEOLOGICAL INVESTIGATIONS 176
FIGURE 7-1 ORGANISATIONAL BOUNDARIES FOR EMISSIONS DURING CONSTRUCTION AND RAMP-UP – BASE-CASE 223
FIGURE 7-2 ORGANISATIONAL BOUNDARIES FOR EMISSIONS DURING OPERATION – BASE-CASE 231

FIGURE 7-3 ANNUAL SCOPE 1, 2 AND 3 EMISSIONS FOR CONSTRUCTION, RAMP-UP AND OPERATION (BASE-CASE) 236
FIGURE 7-4 TOTAL AVOIDED EMISSIONS IN COMPARISON TO TOTAL PHASE 1 EMISSIONS (BASE-CASE)T 239
FIGURE 7-5 ORGANISATIONAL BOUNDARIES FOR EMISSIONS DURING CONSTRUCTION AND RAMP-UP – LOW-CASE 241
FIGURE 7-6 ORGANISATIONAL BOUNDARIES FOR EMISSIONS DURING OPERATION – LOW-CASE248
FIGURE 7-7 ANNUAL SCOPE 1, 2 AND 3 EMISSIONS FOR CONSTRUCTION, RAMP-UP AND OPERATION (LOW-CASE) 253
FIGURE 7-8 TOTAL AVOIDED EMISSIONS IN COMPARISON TO TOTAL PHASE 1 EMISSIONS (LOW-CASE) 256
FIGURE 7-9 SEISMICITY RISK MITIGATION OF VULCAN 268
FIGURE 7-10 UPDATED LAYOUT OF THE HASENBERG WELL SITE SHOWING DISTANCE TO CLOSEST RECEPTOR 274
FIGURE 7-11 45 DB AND 60 DB ISOPHONES AROUND THE CENTRE OF THE BOREHOLE 277
FIGURE 8-1 CUMULATIVE IMPACT ASSESSMENT PROCESS 361
FIGURE 8-2 VEC CONCEPT 363
FIGURE 8-3 SPATIAL DEVELOPMENT POTENTIAL FOR COMMERIAL BUILDING AREAS – EXTERIOR TO THE CORE OF THE CITY OF LANDAU 366
FIGURE 9-1 UPPER RHINE VALLEY (URV) 367
FIGURE 10-1 VULCAN'S ORGANISATIONAL CHART 376
FIGURE 10-2 VULCAN'S ORGANISATIONAL CHART (PROJECT EXECUTION) 377

ACRONYMS AND ABREVIATIONS

Acronyms	Description
ABC	Anti-Bribery and Anti-Corruption
ADR	International Carriage of Dangerous Goods by Road
AF	Associated Facilities
AGG	General Equal Treatment Act
AoI	Area of Influence
ArbZG	Working Time Act
ASX	Australian Stock Exchange
AQG	Air Quality Guideline
AQIA	Air Quality Impact Assessment
AQS	Air Quality Standards
AufenthG	Act on the Residence, Economic Activity and Integration of Foreigners in the Federal Territory
AZE	Alliance for Zero Extinction
BAG	Bundesamt für Güterverkehr
BBergG	Federal Mining Act (Bundesberggesetz)
BetrVG	German Works Constitution Act
BfN	Federal Agency for Nature Conservation
BFM	Baugrundinstitut Franke-Meißner und Partner GmbH
BImSchV	German Federal Emission Control Act
BNatSchG	Federal Nature Conservation Act or Law
BNetzA	The (German) Federal Network Agency
BUrlG	Federal Vacation Act
BVEG	German Federal Association for Natural Gas, Petroleum, and Geoenergy
CCP	Communication Campaign Plan
CCRA	Climate Change Risk Assessment
Cfb	Temperate Oceanic Climate
CESMP	Construction Environmental and Social Management Plan
CFP	Chance Find Procedure
CGM	Community Grievance Mechanism
CH	Cultural Heritage
CHA	Critical Habitat Assessment
CIA	Cumulative Impact Assessment
CLO	Community Liaison Officer

Acronyms	Description
CLP	Central Lithium Plant
CMIP6	Coupled Model Inter-comparison Project
CoC	Code of Conduct
CR	Critically Endangered (as per the IUCN RDL of Threatened Species)
CSO	Civil Society Organisations
CSR	Corporate Social Responsibility
DCMP	Design Change Management Procedure
DD	Data Deficient (as per the IUCN RDL of Threatened Species)
dGH	Degree of General Hardness
DLS	Direct Lithium Sorption
EBRD	European Bank for Reconstruction and Development
EN	Endangered (as per the IUCN RDL of Threatened Species)
E&S	Environmental and Social
EC	European Commission
ECAs	Export Credit Agencies
EEG (2023)	Germany's Renewable Energy Act
EGEC	European Geothermal Energy Council
EHS	Environmental Health and Safety
ESG	Environmental, Social and Governance
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EP4	Equator Principles 4th Edition
EPRP	Emergency Preparedness and Response Plan
ERT	Emergency Response Team
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESPs	Electrical Submersible Pumps
EU	European Union
EU-SILC	European Union Statistics on Income and Living Conditions
FDP	Field Development Plan
Fe	Iron
FüPoG	Law for the Equal Participation of Women and Men in Executive Positions
GCMs	Global Circulation Models

Acronyms	Description
GHG	Greenhouse Gas
GIP	Good International Practice
GG	German Basic Law
GGVSEB	Gefahrgutverordnung Straße, Eisenbahn und Binnenschifffahrt
GLEP	Geothermal Lithium Production Plant
GM	Grievance Mechanism
GTA	Company for Technical Acoustics (Gesellschaft für Technische Akustik mbH)
HAZMAT	Hazardous Material
HCl	Hydrochloric Acid
HDD	Horizontal Directional Drilling
HGVs	Heavy Goods Vehicles
HLNUG	Hessian State Office for the Nature Protection, Environment and Geology
H&S	Health and Safety
HSEQ	Health, Safety, Environment and Quality
IA	Impact Assessment
IAP	Invasive Alien Plants
IBA	International Bird and Biodiversity Areas
IBAT	Integrated Biodiversity Assessment Tool
IBCs	Intermediate Bulk Containers
ICPP	Interconnecting Pipeline and Power
IFC	International Finance Corporation
IFC PS	International Finance Corporation Performance Standards
ILO	International Labour Organisation
IPCC	Intergovernmental Panel on Climate Change
JArbSchGS	German Child Labour Protection Law
JSchG	German Youth Protection Act
KBA	Key Biodiversity Areas
KorrBekG	German Anti-Corruption Act
KSG	Climate Change Act
LAWA	Water Working Group of the Federal States (Länder-Arbeitsgemeinschaft Wasser)
LBauO	Building and Zoning Code (Landesbauordnung)
LC	Least Concern (as per the IUCN RDL of Threatened Species)
LCA	Life Cycle Assessment

Acronyms	Description
LEP	Lithium Extraction Plant
LHM	Lithium Hydroxide Monohydrate
LiOH	Lithium Hydroxide
LkSG	German Supply Chain Due Diligence Law
LSPs	Line Shaft Pumps
MiLoG	Minimum Wage Act
Mn	Manganese
MOP	Method of Procedure
MuSchG	Maternity Protection Act
NaOH	Sodium Hydroxide
NIA	Noise Impact Assessment
NORM	Naturally Occurring Radioactive Materials
NT	Threatened (as per the IUCN RDL of Threatened Species)
OHS	Occupational Health and Safety
ORC	Organic Rankine Cycle
PAs	Protected Areas
PAPs	Project Affected Persons
PDCA	Plan-Do-Check-Act
PPE	Personal Protective Equipment
RCIA	Rapid Cumulative Impact Assessment
RID	International Carriage of Dangerous Goods by Rail
RLI	Rule of Law Index
RO	Reversed Osmosis
RoW	Right of Way
sAP	Species Conservation Evaluation
SEA	Strategic Environmental Assessment
SEP	Stakeholder Engagement Plan
SIA	Social Impact Assessments
SOP	Standard Operating Procedures
SSP	Shared Socioeconomic Pathways
StGB	German Criminal Code
SWR	Southwest Broadcasting (Südwestrundfunk)
TrinkwV	German Drinking Water Regulations
ToR	Terms of References

Acronyms	Description
UN	United Nations
UNECE	United Nations Economic Commission for Europe
URV	Upper Rhine Valley
UVPG	German Environmental Impact Assessment Act
VEC	Valued Environmental and Social Component
VU	Vulnerable (as per the IUCN RDL of Threatened Species)
WB-Climate Portal	Climate Change Knowledge Portal
WFD	European Water Framework Directive
WHG	Water Resources Act
WHO	World Health Organisation

1. INTRODUCTION

Vulcan Energy Resources Limited (hereinafter called the 'Vulcan" or "the Company") owns the largest combined geothermal energy and lithium resource in Europe (Upper Rhine Valley, Germany, and France).

Vulcan produces both renewable energy and lithium from the same sub-surface brine source. By enhancing existing technology for efficient lithium production from geothermal brine, Vulcan has established itself as a company with two clear operational divisions, poised to be an enabler of Europe's energy and mobility transition by supplying lithium chemicals, renewable energy and transformational technology from Europe, for Europe. Vulcan additionally aims to create significant added value to the area with the provision of renewable electricity and heat to local communities. The Project would ultimately supply approximately up to 596 GWh of heat per year and up to 31 GWh of electricity. Considering average per capita heat consumption in Germany[1], the Project's heat supply is equivalent to the demand of ca. 100,000 people. Beneficiaries will mostly be within the nearby municipalities and districts.

Whilst Vulcan owns a large geothermal energy source and the largest lithium resource in Europe, Vulcan follows a phased approach to implement the Phase One Lionheart Project (hereinafter called the Project): Lithium production and renewable geothermal energy production will take place in the Upper Rhine Valley Brine Field in Rhineland-Palatinate, whereas lithium conversion will take place at the Frankfurt Höchst Industrial Park (Figure 1-1).

This ESIA Report focuses on the Project, its key components, design standards, construction operation and decommissioning activities which may influence various environmental and social (E&S) aspects.

[1] Average per capita heat consumption in Germany of 6,200 kWh (https://www.destatis.de/)

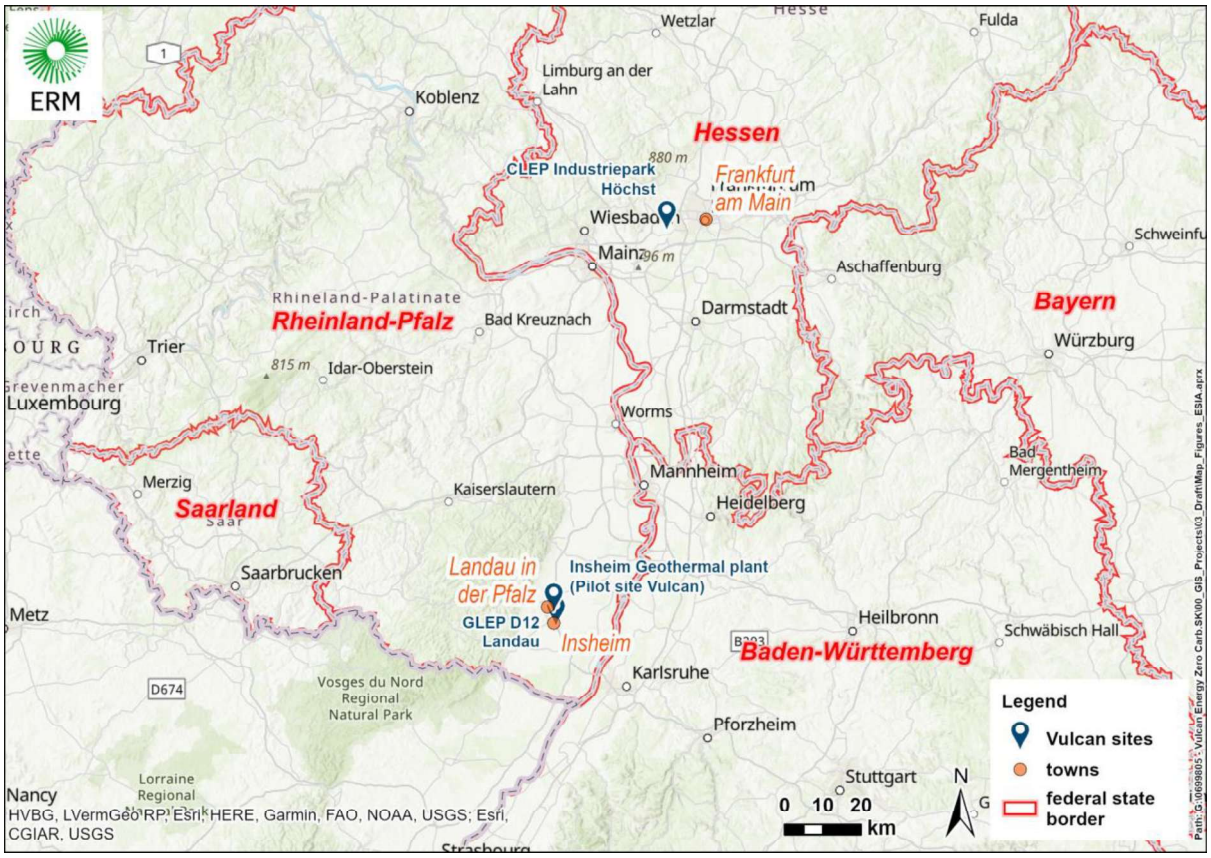


FIGURE 1-1 PHASE ONE PROJECT LOCATION

1.1 PURPOSE OF THIS REPORT

Vulcan is seeking financing for the investment costs of the Project by debt and equity under a Project Finance structure involving international banks as well as Export Credit Agencies (ECAs) (together hereinafter called the lenders). In accordance with international lenders' requirements, an Environmental and Social Impact Assessment (ESIA) is required to identify the potential Environmental and Social (E&S) impacts of the Project and define how the potential impacts will be mitigated, managed, and monitored throughout the design, construction, and operation phases. A more detailed presentation of the ESIA methodology is described in Section 5 of this Report.

In line with lenders requirements, the ESIA disclosure will take place with the following objectives:

- Communicate the purpose, scale, and nature of Project activities.
- Provide a platform to exchange information about the risks and potential impacts of the Project with stakeholders, as well as proposed mitigation.
- Be accessible and culturally appropriate; and
- Meet the specific needs of affected groups, and/or make additional provisions for vulnerable groups/persons as needed.

The ESIA will be made available to all stakeholders in a multitude of formats/channels, such as via online postings (Vulcan website - https://v-er.eu/contact/) and in hard copies (Vulcan offices, Project sites).

Stakeholders will have access to the following documents:

- Environmental and Social Impact Assessment (ESIA) Report.
- The Non-Technical Summary (NTS).
- Stakeholder Engagement Plan (SEP).

This process allows stakeholders to provide their feedback and questions to Vulcan, promoting open dialogue and community engagement. The stakeholders' feedback will be reviewed and responded by the Vulcan team and these changes will be reflected in revisions to the Project as appropriate, and the revised final ESIA Report.

1.2 STRUCTURE OF THIS REPORT

The structure of the remainder of this report is as follows:

TABLE 1-1 REPORT STRUCTURE

Section	Contents
Section 1 – Introduction	Presents a brief background to the Project, the ESIA process and the purpose and structure of the ESIA Report (this Report).
Section 2 – Project Description	Describes the Project, its components and main processes involved.
Section 3 – Project Phases	Describes the Alternative Assessment and Project Schedule.
Section 4 – Legal Regulatory Framework of the ESIA	Identifies and briefly describes the National German and international environmental and social legislative context, as well as international best practices applicable to the Project. It also summarises Vulcan´s stakeholder engagement strategy and efforts to date; and provides an overview of what is included in the comprehensive Stakeholder Engagement Plan (SEP).
Section 5 – The ESIA Process	Describes the ESIA process and associated impact assessment methodology to be followed for the Project.
Section 6 – Description of the Existing Environment	Presents details of the physical, biophysical, and socio-economic environments of the Project Area and surroundings.
Section 7 – Impact Assessment	Describes the potential environmental and social impacts that have been identified and proposed mitigation measures.
Section 8 – Cumulative Impact Assessment	Describes the combined environmental and social impacts of the Project with other development projects planned in the area.
Section 9 – Environmental and Social Management Plan	Presents a consolidated summary of the environmental and social (E&S) commitments relevant to the Project.
Appendix A – Biodiversity Baseline	Presents a detailed description of the biological baseline of the Project.
Appendix B – Critical Habitat Assessment	Presents a rapid Critical Habitat assessment performed for the Project.

The parties involved in the Project including their roles and responsibilities are listed in Table 1-2.

TABLE 1-2 PROJECT PARTIES

Responsible Party	Role	Responsibilities
Vulcan Energy	Project Owner	Borrower of the Project finances Development of Project design Land acquisition needed to facilitate the construction and operation of the Project. Implementation of the ESIA including its annexes to ensure all social and environmental management plans are implemented in line with lenders' requirements. Construction and Operation of the Project
BNP Paribas	Advisor for debt financing process	Coordination of debt financing between Vulcan and international banks as well as Export Credit Agencies (ECAs)
ERM GmbH	Independent international sustainability consulting firm engaged by Vulcan Energy	Development of Scoping Report Development of ESIA Report Development of Stakeholder Engagement Plan (SEP)
geox GmbH	Third-party Geothermal Power Plant (now serves as a well site for the GLEP)	Previous owner and operator of the Geothermal Power Plant at Landau, which was acquired by Vulcan Energy in April 2025 and now serves as the Landau Well Site to provide brine water to the GLEP via pipeline.
Infraserv	Industrial Park Höchst Operator	Provision of the Central Lithium Plant site to Vulcan via rental agreement Service provider for utilities, logistics, security, and emergency response
VERCANA GmbH	Contractor responsible for the drilling activities	The execution of deep brine wells for the production of water, thermal water, brine, lithium for project development and execution.
EPC(m) Contractor(s)	Engineering, Procurement and Construction Contractor for the ICPP, LEP, CLP and ORC	TBD

2. PROJECT DESCRIPTION

The Project is mainly centred around the Geothermal Lithium Extraction Plant (GLEP) that is planned to be built in the southeast of Landau (Figure 2-1) within a new industrial park, D12 - Gewerbepark Messegelände Süd-Ost.

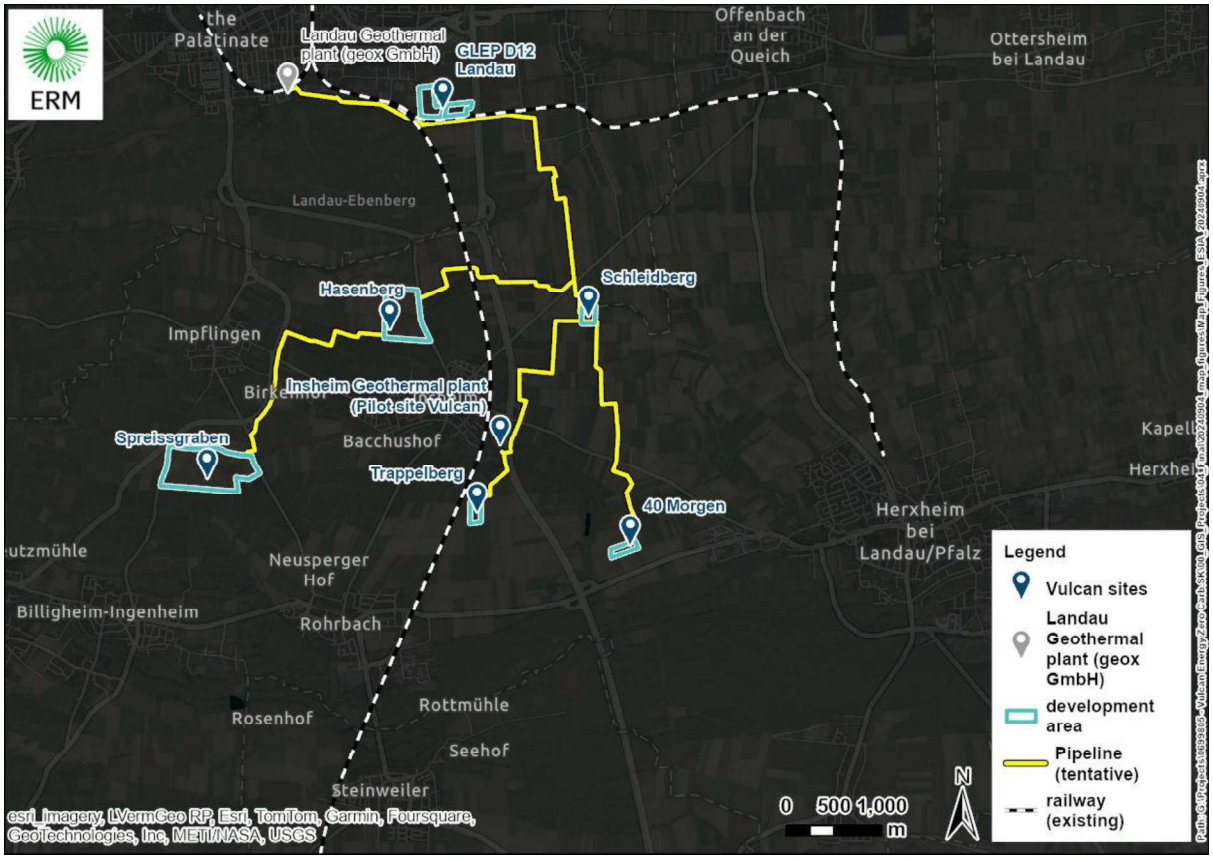


FIGURE 2-1 PROJECT AREA AND PHASE ONE LAYOUT

At the well sites hot brine is pumped out of the ground (sub-surface). A large part of the thermal energy is transferred from brine to industrial water. The various drill sites will be connected to the GLEP via interconnecting pipeline and power (ICPP) system. The brine is circulated from the well sites to the Lithium Extraction Plant (LEP, which is part of the GLEP) and then back to the well site to be re-injected into the ground. Additionally, the existing Geothermal Power Plant Landau previously owned and operated by geox GmbH (the company and Geothermal Plant at Landau was acquired by Vulcan in 2025 will serve as the existing 'Landau Well Site' with the Plant to be shut down and dismantled), and the Geothermal Power Plant Insheim will be connected to the GLEP through the ICPP system[2].

The GLEP will produce heat and power from the heated industrial water, and lithium chloride from the brine. The lithium chloride generated at GLEP will be transported via E-Trucks[3]/diesel trucks to the Central Lithium Plant (CLP), which will be constructed at the Industrial Park Höchst

[2] The ICPP final route is still under design and has not been finalised to date.
[3] E-trucks will not be used at the initial stages due to the existing regulations in place preventing chemicals to be transported by E-trucks, however Vulcan will make a transition plan once the regulations change.

(Figure 2-2). At the Lithium Plant in Höchst lithium chloride will be converted to lithium hydroxide monohydrate.

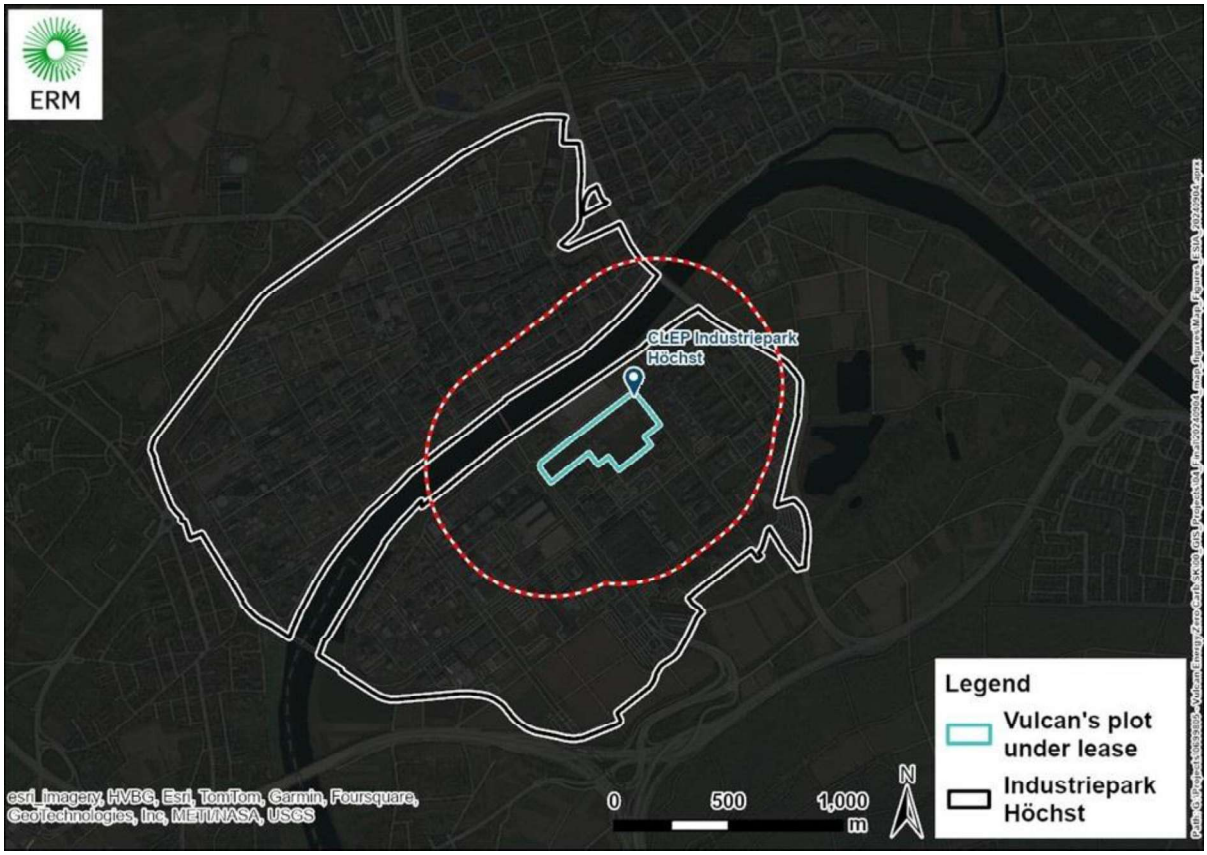


FIGURE 2-2 CENTRAL LITHIUM PLANT (CLP) AT THE INDUSTRIAL PARK HÖCHST

This section and the sub-sections below confirm that the whole Project has been comprehensively described, including all associated and ancillary works available to date (August 2024). The description encompasses all key components such as site preparation, well pad construction, drilling operations, power supply infrastructure, pipeline segments, and control systems, as well as the relevant operational and safety features, in accordance with EC Directive 2011/92/EU on Environmental Impact Assessment (EIA).

The approach followed by ERM aligns with the directive's scope, which stipulates that all significant environmental impacts of the 'whole project' require detailed assessment; ensuring that the study remains focused on aspects with the potential to cause meaningful environmental effects, while maintaining compliance with the directive's requirements.

2.1 KEY PROJECT COMPONENTS

The key Project components are listed below and details on each component are explained in the following sub-sections:

Component	Details
Five New Well Sites	• The Schleidberg well site, located northeast of Insheim bordered by unpaved field paths on three sides and cropland to the east. • The Trappelberg well site, located southwest of Insheim, is bordered by unpaved field paths to the north and south, cropland to the east, and a railway to the west. • The 40 Morgen well site, located southeast of Insheim, is bordered by unpaved field paths to the north and south, with cropland to the east and west. • The Hasenberg well area, located north of Insheim, is bordered by the paved L543 road to the east, a paved path and vineyards to the south, and by cropland and unpaved field paths to the north and west. • The Spreissgraben well area, located south of Impflingen, is bordered by the paved L554 road to the east and west, and by a paved path with vineyards to the south, similar to the Hasenberg Site.
Interconnecting Pipeline & Power (ICPP)	A subsurface four-pipe system will circulate brine and industrial water between the well sites and the central Geothermal Lithium Production Plant (GLEP). The pipeline will initially require a 30-40 m Right of Way during construction, which will be reduced to a 10 m easement afterward, permitting agricultural use except for tree planting. It will transport industrial water for district heating, steam generation, and geothermal power, with sections undergoing pressure testing. The pipeline's alignment is still under review and has not yet been finalised.
Geothermal Lithium Extraction Plant (GLEP);	Located in the D12 industrial park southeast of Landau in the Palatinate, will produce power and lithium chloride from brine. The GLEP will process brine and industrial water separately.
Insheim Geothermal Power Plant	Located in southern Palatinate, was acquired by Vulcan in 2022 and is now operated as NatürLich Insheim GmbH. Originally owned by Pfalzwerke geofuture GmbH since 2012, the plant has an average electrical output of about 3 megawatts and generates around 25,000 megawatt-hours annually, supplying electricity and heat to approximately 8,000 households.
Landau Well Site (existing) (former geox Geothermal Power Plant)	Located in southeast of Landau in the Palatinate and originally operated by geox GmbH, Vulcan acquired its geothermal wells, renewable energy generation assets, and geothermal and lithium licences in April 2025. The existing geothermal power plant will be dismantled, and brine production from the licence area will be increased. This brine will also supply local consumers with renewable energy via the GLEP.
Central Lithium Plant (CLP) Höchst	Located in the Industrial Park Höchst to produce lithium hydroxide (LiOH). The Industrial Park Höchst was established in 1863, the park currently hosts 120 plants, 90 companies, and 22,000 workers.
Lithium chloride transportation from the GLEP to CLP	Vulcan evaluated transporting lithium chloride via train, E-Trucks, and diesel trucks. Diesel trucks are chosen for the initial phase, with E-Trucks considered for future use as regulations and availability improve.

2.1.1 WELL SITES

Process

The system for extracting and processing geothermal brine uses Line Shaft Pumps (LSPs) to draw brine from production wells, with the motor and electrical components located at the

surface, offering cost and maintenance advantages over Electrical Submersible Pumps (ESPs). The brine is pumped upward through multi-stage impellers that generate the necessary pressure to transport it to a lithium extraction plant. Before entering the pipeline system, corrosion and scaling inhibitors are added to prevent pipe degradation and mineral deposits, which are common in geothermal systems. The brine is then transported through a thermally insulated pipeline to a prefilter station, where particles are removed to protect downstream components. The station is fully redundant, allowing for uninterrupted operation even during maintenance, with brine drained during filter changes directed to a brine pond. This design ensures continuous, reliable operation while minimising operational risks.

After filtration, the brine is routed to an industrial water cycle heat exchanger, where shell and tube heat exchangers facilitate heat transfer between the brine and industrial water. Although these exchangers require less maintenance and can handle large mass flows with minimal pressure loss, they are somewhat less efficient in heat transfer. After the brine is cooled, it is sent to a pump station where a centrifugal pump maintains the necessary pressure for transportation to the lithium extraction plant (LEP). The reheated industrial water is then sent to a steam generation plant at LEP. A bypass around the heat exchanger allows for maintenance without interrupting operations, enhancing the plant's reliability. Additionally, a central bypass on the brine pipe can direct brine to a separator and brine pond during start-up or system failures, providing operational flexibility. The brine then passes through a redundant injection filter station to remove smaller particles, protecting the injection wells from clogging and avoiding pressure loss. Finally, injection pumps increase the brine's pressure for its return to the reservoir, with power consumption varying depending on each well site's performance.

The injection rate (across all of the injection wells) will equal the production rate (across all of the production wells) as there will be no storage facility at surface. The maximum injection rate for each well will be maintained below the frack pressure to prevent fracturing of the formation.

Well Construction

The target formation for the brine production and injection is the Buntsandstein Formation, which is at depths of between approximately 2,500 m and 4,000 m below ground level.

The geothermal wells will be constructed with telescopic steel casing which will be concreted in place. The innermost steel casing will be constructed with an anti-corrosion casing, (Figure 2-3). These measures will isolate the overlying formations preventing migration of fluid between formations and aquifers.

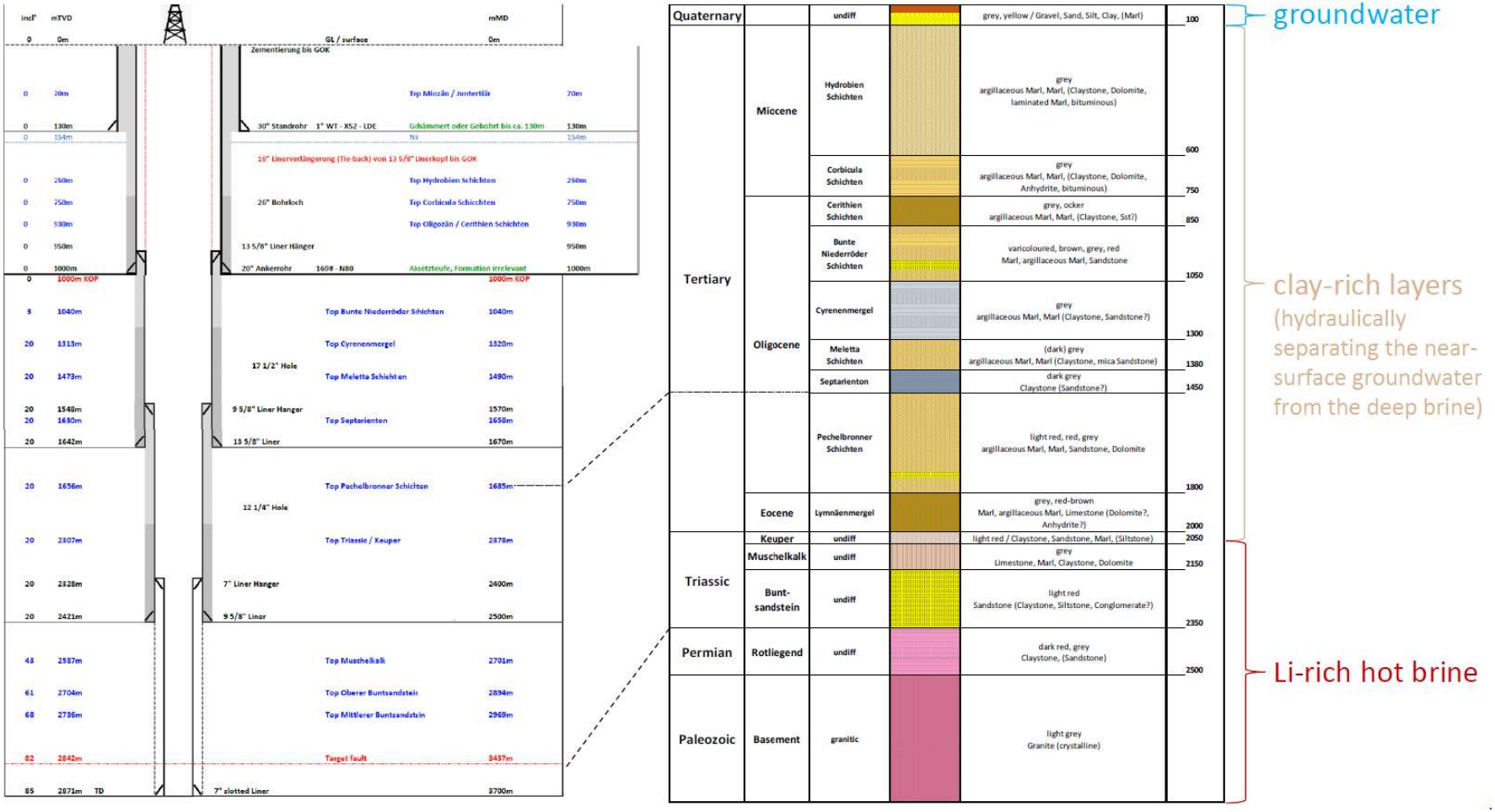


FIGURE 2-3 WELL STRUCTURE

Layout

There are currently 23 planned new wells to be drilled for the increase of current brine production. Wells will be located at six different locations (Figure 2-1): Five new locations and one existing location, which will be extended. The well sites to be newly developed are identical in terms of process technology. They only differ in the number of production and injection wells and the different parameters. Water for drilling will be sourced from recycled rainwater and nearby groundwater wells, and the respective permit applications for the majority of well sites have been submitted to German authorities and several are still awaiting approval. As of September 2025, all necessary permits and approvals for the construction and operation of the Schleidberg well site have been obtained, construction of the well pad has been completed and drilling has commenced only at this well site. Further information on the status of each well site is provided in the sections that follow, with a summary of the approval/permit status for the Project provided in Chapter 3 (Table 3-1). The sites to be newly developed are identically structured. There are only very minor deviations between the well sites, such as a specific access and exit to the well site that is adapted to the respective local conditions. Thus, in Figure 2-4, a standardised well site layout is presented and explained.

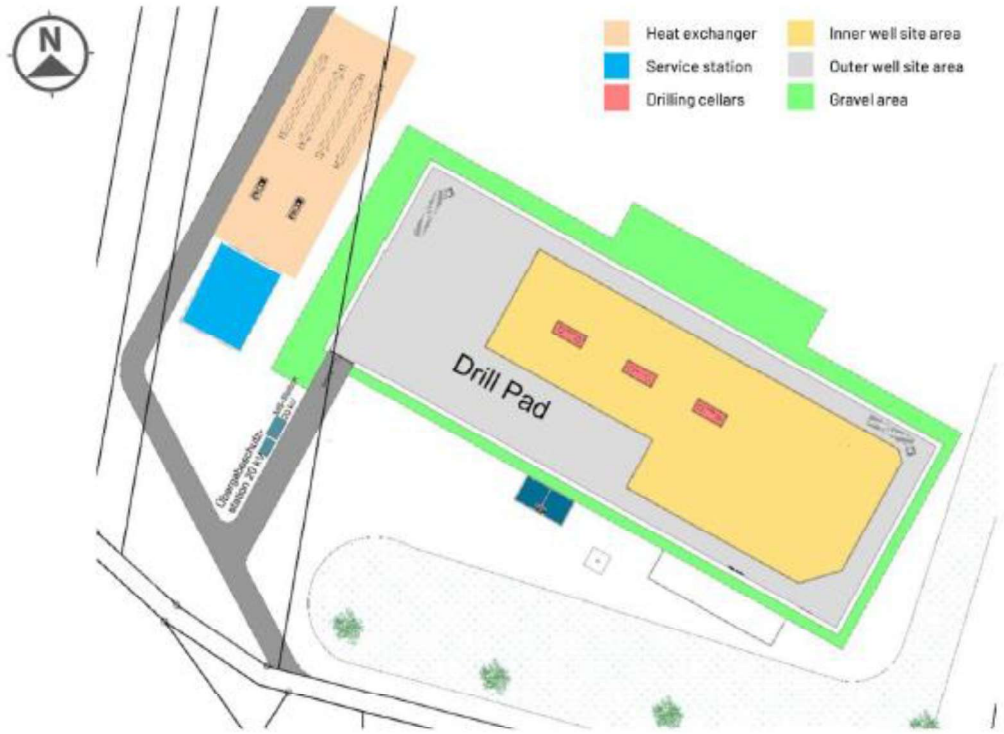


FIGURE 2-4 STANDARDISED NORTH ALIGNED LAYOUT OF A WELL SITE

Source: Vulcan, 2024

The well sites will be developed based on subsoil stability and in line with the guidelines from the German Federal Association for Natural Gas, Petroleum, and Geoenergy (BVEG) as outlined in "Design of the Well Site 08/06." Each well site is divided into an inner and outer area, both surrounded by a gravel perimeter. The design ensures that all parts of the site, including access and exit points, are reachable via designated escape and rescue routes.

The inner well site area houses key equipment such as the drilling rig, tank farm, blending plant, and units related to solids control and drilling mud systems, including mud tanks, centrifuges, desanders, and desilters. It also contains mud pumps, a closing system, emergency generators, a diesel tank for backup power, storage areas for mud materials and lubricants, and cement silos. To protect the environment and prevent water contamination, this area will be constructed with liquid-proof asphalt, ensuring that hazardous liquids cannot seep into the ground. The inner area is designed 10 cm lower than the outer area, with a sloped transition to prevent liquids from flowing outwards. The area also includes a separate drainage system where rainwater is channelled through inlets into a retention or buffer tank.

The outer well site area contains test water tanks, a retention basin for the inner area's drainage, and containers for service companies, workshops, storage, magazines, and offices. Additionally, this area will house sanitary, changing, and tool pusher containers. Consumables are stored in dedicated areas within the outer zone, but substances harmful to water are not kept here. The drilling cellars will be made of waterproof concrete, with the number of boreholes varying depending on the site. During construction, standpipes will be installed to a depth of approximately 60 meters, depending on geological conditions, and cemented to the surface. Adequate lighting will be provided for night operations, and the drilling rig mast will be equipped with an air traffic control light. Each site will also feature a technical building and a transformer station.

The drilling of a well will take between two to five and a half months depending on their depth, number of sidetracks and pathway (geological conditions). Each production well will have its productivity tested using an air lift test. The drilling strategy is currently under development and it is planned to execute testing in parallel while drilling.

During drilling 7,000 to 10,000 m^3 of water per well is required. 24 to 30 people per day will be working on the rig in two shifts of 12 hours. Each drill rig will have a nearby campsite on a separate land plot for the workforce. The drill sites will be powered by grid connection to provide electricity for the pumps and electrical installations.

2.1.1.2 SCHLEIDBERG WELL SITE

The Schleidberg Well Site is northeast of Insheim and is bordered by unpaved field paths to the north, west and south (see Figure 2-5). The eastern boundary of the well site is bordered by cropland. The well area covers an area of about 2.5 ha. The total size of the remaining encroachment areas (including access roads) amounts to approximately 0.36 ha.

Status update 4th September 2025: land acquisition has been completed and all relevant permits/approvals for well pad construction and drilling have been obtained (Pre-EIA decision approval, Main Operating Plan or MOP and Special Operating Plans or SOPs approved). With the necessary approvals and permits in place, construction of the well pad has since been completed, and drilling operations have commenced at Schleidberg.

The existing unpaved dirt access road running from north to south was partly rebuilt (paved) on both a field, and on an unpaved field path. The access road running from west to east will be primarily used at the beginning of the construction activities, for which the unpaved dirt road was lined with gravel and is now a paved surface. The permanent parking area and crew camp were constructed on gravel material. The well site consists of a concrete area of about 5,100 m^2 in the inner area with three drilling cellars. This concrete area is surrounded by an approximately

2,300 m^2 asphalt bypass and a drainage swale of about 560 m^2. Adjacent to the drainage swale is an approximately 4,800 m^2 gravel area. To the east an approximately 2,200 m^2 storage area, 480 m^2 steel storage tank, 310 m^2 dewatering basin, and 3,300 m^2 test water basin have been constructed and are now operational. Two gravelled parking lots with a total area of about 900 m^2 have been developed on the western side of the site. The tallest installation (drilling rig) is 61 m high.

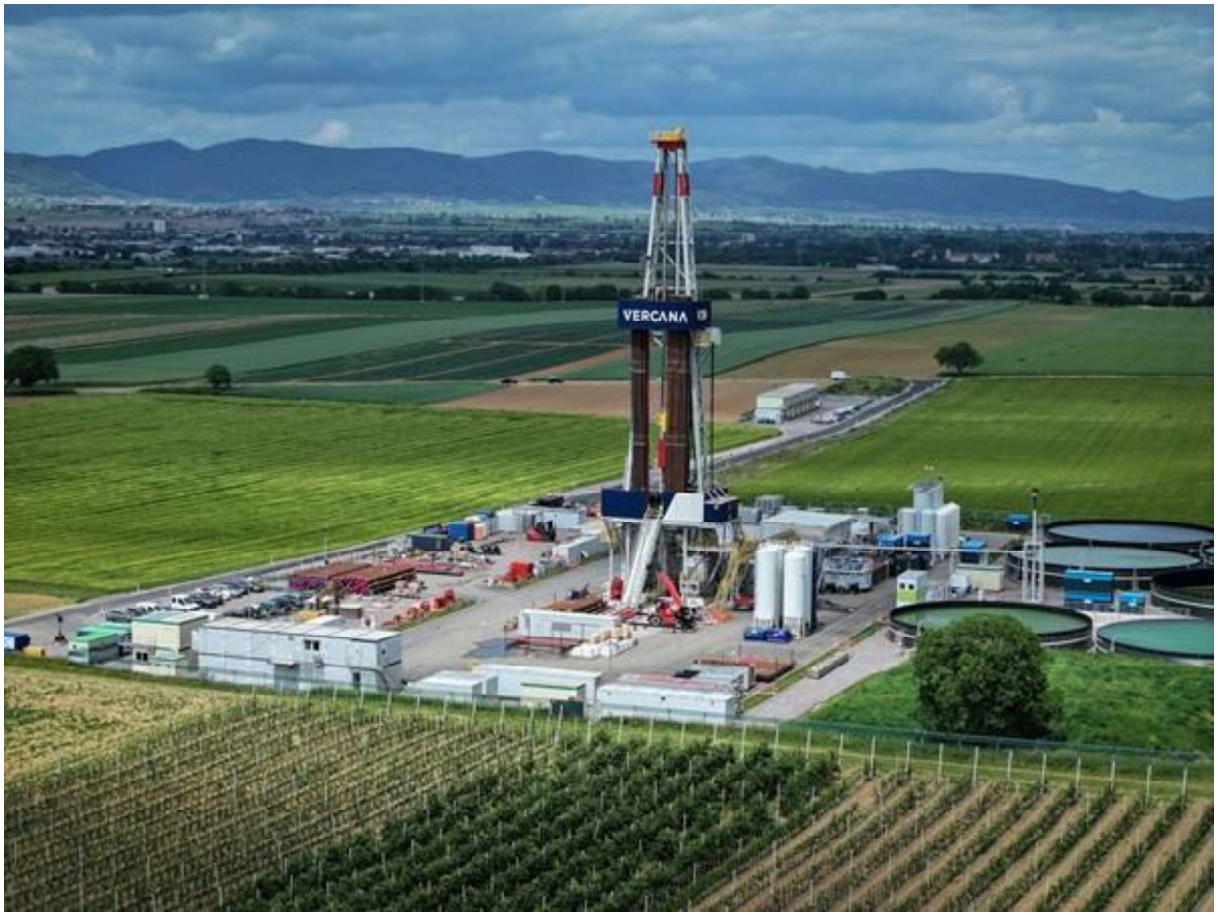


FIGURE 2-5 SCHLEIDBERG WELL SITE

Source: Vulcan, 2025



FIGURE 2-6 AERIAL VIEW SHOWING PAVED ACCESS ROAD TO THE CONSTRUCTED SCHLEIDBERG WELL SITE

Source: Vulcan, 2025

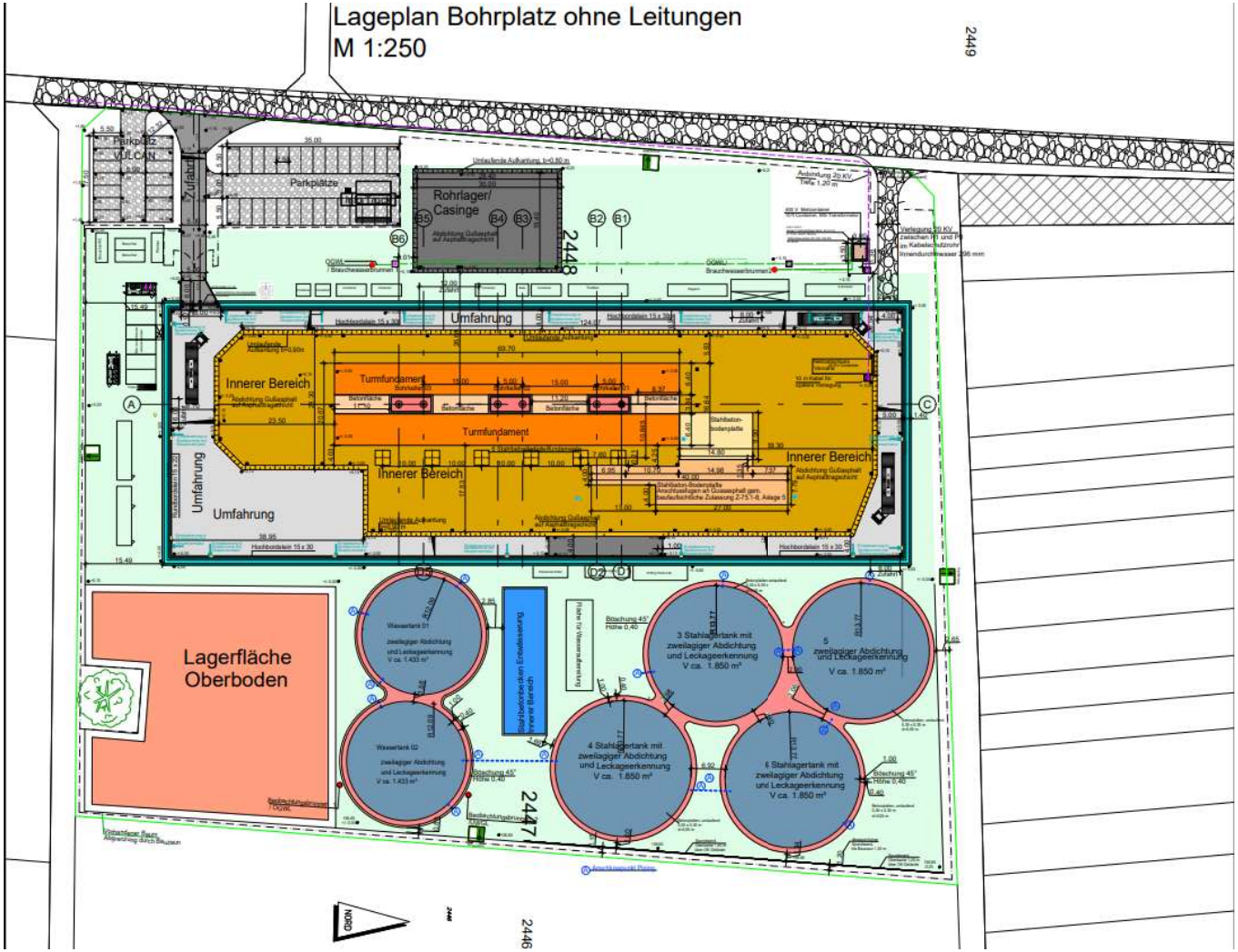


FIGURE 2-7 SITE PLAN FOR THE SCHLEIDBERG WELL SITE

Source: Vulcan, 2024

2.1.1.3 TRAPPELBERG WELL SITE

The Trappelberg Well Site (Figure 2-8) is located southwest of Insheim and is bordered by unpaved field paths to the north and south, by cropland to the east, and by a railway to the west. The original Well Site was planned further west but was moved east of the railway after discussions with the Mayor of Insheim.

Status update 4th September 2025: the MOP for exploration, construction and drilling was approved by the State Mining Authority (Landesamt für Geologie und Bergbau) in June 2025. The land acquisition process has been completed and the permits for construction and drilling (SOPs) have submitted and are available in draft form. Construction and drilling operations have not yet commenced at the site as permits are still pending approval.



FIGURE 2-8 PAVED PATH WITHIN THE TRAPPELBERG WELL SITE

2.1.1.4 40 MORGEN WELL SITE

The 40 Morgen Well Site is located southeast of Insheim, bordered by unpaved field paths to the north and south, and cropland to the east and west (refer to Figure 2-9). The site includes areas believed to have archaeological significance. During ERM's site visit in August 2023, the 40 Morgen Site had already been cleared of vegetation by Vulcan (see Figure 2-10). While clearing, Vulcan ensured no puddles or water accumulations were created to avoid attracting potentially protected species.

Extensive archaeological soundings were conducted by Vulcan in collaboration with local authorities, and the site layout was carefully designed to avoid disrupting any cultural heritage. Vulcan maintains close communication with the Rhineland-Palatinate General Directorate for Cultural Heritage in Speyer regarding future actions. Further details on cultural heritage and archaeological investigations can be found in section 6.18 of this report.

Status update 4th September 2025: land acquisition has been completed and archaeological surveys are still ongoing. The Pre-EIA has not been finalised or submitted for approval. Relevant permits/approvals for construction and drilling (MOP, SOP) remain pending and have not been

compiled or submitted yet for approval. Construction and drilling operations have not yet commenced as approvals/permits remain pending.



FIGURE 2-9 AERIAL OVERVIEW OF THE 40 MORGEN WELL SITE

Source: Vulcan, 2023



FIGURE 2-10 40 MORGEN WELL SITE DURING SITE VISIT (AUGUST 2023)

2.1.1.5 HASSENBERG WELL AREA

The Hasenberg Well Area is located north of Insheim and is bordered by a paved road (L543) in the east and a paved path in the south. Vineyards also border the southern side of the paved path. To the north and west the exploration area is bordered by cropland and unpaved field paths.

Negotiations to acquire land have started, however, the areas for the well location are not fixed yet (only potential land plots have been identified in the exploration area). An early state environmental analysis has been completed for the Hasenberg Well Area.

Status update 4th September 2025: land access to the site has now been clarified, land acquisition process remains ongoing (submission of land purchase package is expected in September 2025) and ICPP connectivity is still under development. The Pre-EIA is under preparation and is planned for submission in January 2026. Relevant permits/approvals for construction and drilling (MOP, SOP) remain pending (planned for submission in mid-2026) and construction and drilling operations have therefore not yet commenced.

2.1.1.6 SPREISSGRABEN WELL AREA

The Spreissgraben Well Area is located south of Impflingen and is bordered by a paved road (L554) to the east and the west and a paved path in the south. Like the Hasenberg Site on the other side of the paved path to the south vineyards can be found (see Figure 2-11). To the north the exploration area is bordered by an unpaved field path and a trench (Spreissgraben).

Negotiations to acquire land have started, however, the areas for the well location are not fixed yet (only potential land plots have been identified in the exploration area). An early state environmental analysis has been completed.

Status update 4th September 2025: land access and acquisition processes are ongoing (submission of land purchase package is expected in September 2025) and ICPP connectivity is still under development. The Pre-EIA is under preparation and is planned for submission in January 2026. Relevant permits/approvals for construction and drilling remain pending and construction and drilling operations have not yet commenced.



FIGURE 2-11 SPREISSGRABEN WELL AREA

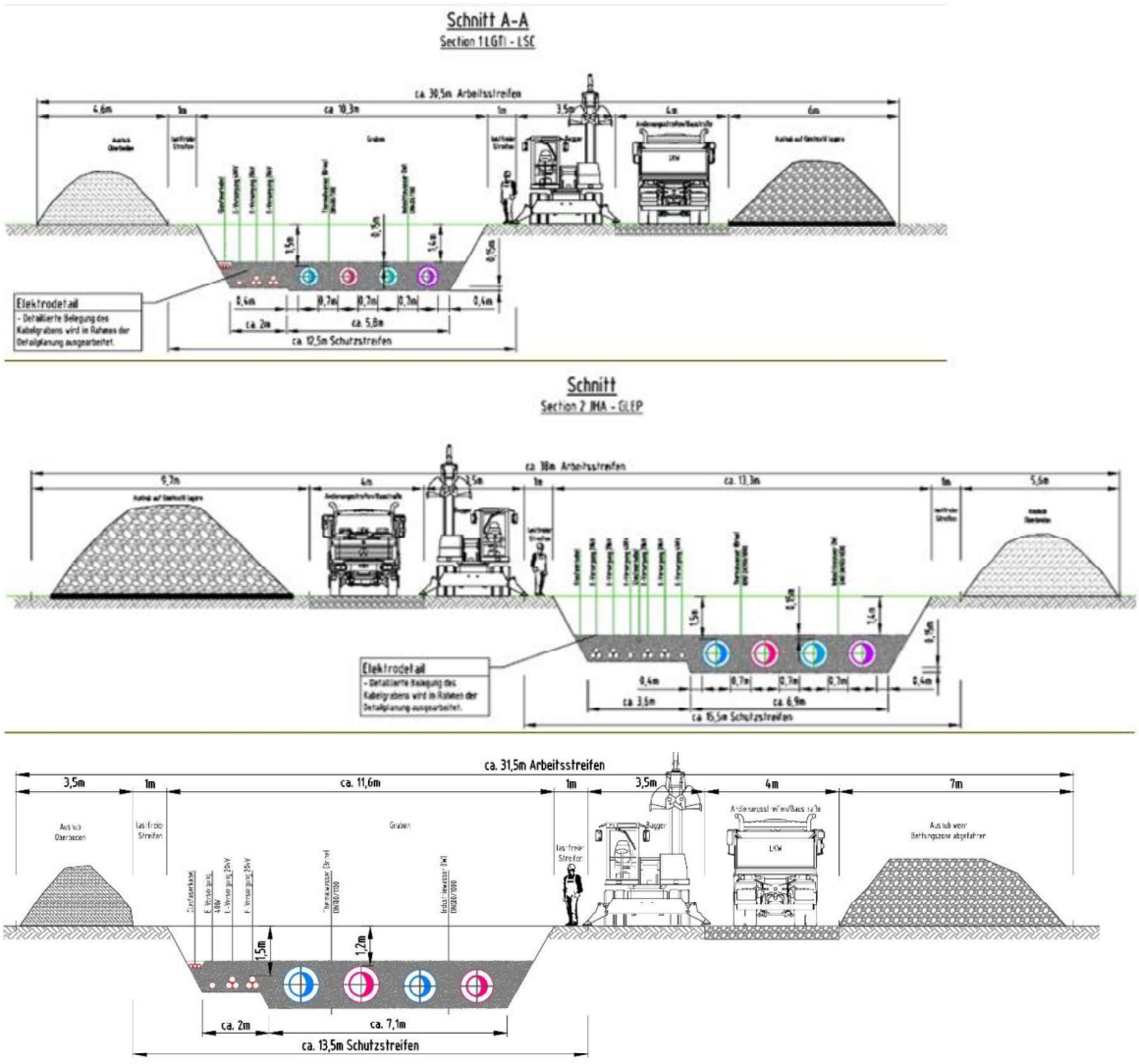
2.1.2 INTERCONNECTING PIPELINE & POWER (ICPP)

As of this reporting period (August 2025), Vulcan is establishing the final technical design and routing of the interconnecting pipeline & power system (ICPP), which has been completed for some sections, with routing agreements with landowners (lessees) still pending largely (secured in August for Section 2 of the ICPP). The pipeline will be established sub-surface with a Right of Way (RoW) of 30 to 40 m (see Figure 2-12). This width will only be needed temporarily during construction to provide adequate space for temporary topsoil and subsoil storage, trenching, and pipe laying. Once the construction is completed, the RoW will be reinstated to its original condition and a permanent easement of about 10 m will be in place. The soil cover on the laid pipe will be around 1.50 m depth and the reinstated land will still be able to be used for agricultural purposes except planting trees and/or deep-rooted plants that may impact the integrity and safety of the pipeline.

Once backfilling and initial reinstatement are completed for each section of the pipeline, the integrity of the completed section will be ascertained by means of pressure testing. This entails sealing off a complete section of pipeline with pre-tested end caps that contain various fittings to facilitate filling with water, pressurising with a pump, and pressure and temperature measurements. After successful conclusion of the test, the line will be dewatered, and the test ends will be removed.

The pipeline route alignment will mainly follow parcel boundaries and agricultural management, and there will be railway, highway, and small access road crossings.

Railway and highway crossings are planned to be carried out by Horizontal Directional Drilling (HDD), whilst smaller access roads will be crossed by an open-cut method. Stream crossing methods need to be defined from case to case with the authorities.



Source: Vulcan, 2024. Pipeline Planning Phase 1.1 and Phase 1.2

FIGURE 2-12 RIGHT OF WAY OF THE PIPELINE

Please note that a preliminary pipeline route has been assessed during the ESIA studies; however, the pipeline route alignment is still under review and has not been finalised. As the Project progresses, further deviations and changes may be necessary. Any adjustments to the route will be carefully evaluated to ensure optimal design and feasibility. Once the final pipeline route design is confirmed, it will undergo a thorough assessment through the Design Change Management procedure to ensure compliance with all relevant standards and Project requirements and appropriate mitigation measures will be implemented. Corresponding documentation will be prepared to supplement the ESIA, and, depending on the type and location of the impact, the relevant studies and documentation will be disclosed with the stakeholders.

The pipelines will have three separate engineering entities, power, brine, and industrial water. The separation of brine water and industrial water (carries the heat) will be conducted to increase the pipeline safety. The pipeline will have a four-pipe system:

- **Two brine pipelines:**
  - Inflow: Medium temperature of 60-85 °C; and
  - Return: Medium temperature of 80 °C.
- **Two industrial water pipelines:**
  - Inflow: Expected medium temperature of 165-170 °C; and
  - Expected medium temperature of 75°C.

The total length of the pipeline will be approximately 15.7 km.

The industrial water is clean water that does not mix with the geothermal brine but instead captures the thermal energy and returns cooled via the heat exchanger for reuse. This water circulates between the well site and the district heating, steam generation and finally the geothermal power plant (ORC) to convey the heat energy to its intended purpose. Thus, the four-pipe pipeline system circulates both brine as well as industrial water and connects all well sites with the central Geothermal Lithium Production Plant (GLEP). The GLEP plant is a combined plant where brine and industrial water are processed separately.

The transport of geothermal energy requires that the planned industrial water pipeline is filled at the first time of use with water of sufficient quality. For this purpose, a well for the abstraction and use of fresh groundwater is planned on the site of the geothermal power plant. Since the industrial water is cycled between well sites and the geothermal plant, there is no need to continuously extract ground water to produce industrial water. Rather, the amount needed is defined by the volume of the two pipelines plus all auxiliary components. Based on the system planned, Vulcan expects a minor amount of groundwater during production to make up for losses in the system. To achieve the required industrial water quality, the groundwater needs to be desalinated, degassed and/or softened by means of a mobile water treatment unit.

The construction of the pipeline will be conducted in segments where each segment is equipped with gate valves based on the pigging and maintenance concept specific to that segment. This involves constructing underground structures at the pipeline's joining points. These shaft structures are designed according to the structural and operational requirements of each segment, serving various functions such as ventilation, drainage, control, and cleaning. They

also accommodate changes in direction, cross-section, and gradient, and are used for crossing, inlet & outlet connections, joining points, and gate valve housing.

The manholes are made from prefabricated concrete elements, available in different diameters, cross-sections, and construction heights, and are equipped with access aids. At each merging point, gate valves and associated fittings are installed for each inlet and outlet, along with electric actuators that include position monitoring. In addition, pressure, temperature, and flow sensors are integrated into the system for monitoring and control. Each segment is also fitted with a control cabinet for segment control, which is linked to a wired leakage monitoring system that connects to the downstream connection point.

A fibre optic cable network connects all segment controls to the main control room located in the GLEP operating building, enabling centralised monitoring and control of all segments from this main control room.

Status update 4th September 2025: a decision on the Pre-EIA submitted for approval for Section 2 (BA2) of the ICPP was obtained on 25th August 2025 and concluded that a full EIA is not required. Routing agreements with all lessees regarding Section 2 were also received during the same period as well as approval from the lower nature conservation authority to commence with early clearance work for pipe laying to cross the railway at D12 for Section 2. Several route crossing approvals are still ongoing/pending as well as Special Operating Plans (SOPs) and Pre-EIAs still to be submitted for approval for several sections of the ICPP route (i.e. sections BA3 – BA7). Construction is therefore expected to commence for the Verification loop (Insheim-Schleidberg) section in Q2 2026, with the remaining sections scheduled to start construction the following year during Q1 2027.

2.1.3 GEOTHERMAL LITHIUM PRODUCTION PLANT

The GLEP is intended to produce power and the production of lithium chloride from brine water in the southeast of Landau in the Palatinate in the planned industrial park D12. The GLEP is a combined plant where brine and industrial water are processed separately.

The GLEP is in the Queichheim district with a size of approximately 9 ha (see Figure 2-13). The following buildings are planned for the GLEP construction (see Figure 2-14).

- Warehouse Building (approx. 1,400 m^2);
- Workshop Building (approx. 1,000 m^2);
- Administration Building (approx. 550 m^2);
- Guard House (approx. 56 m^2);
- District Heating Building (approx. 300 m^2);
- Reverse Osmosis Building (approx. 1.400 m^2);
- Utilities Building (approx. 1,400 m^2); and
- Electrical Building (approx. 900 m^2).

Status update 4th September 2025: Approval was secured for the purchasing of land in the D12 development plan for the GLEP in September 2025. Approval of the final building permit is also expected in September 2025.

2.1.3.1 GEOTHERMAL PROCESS

In the Organic Rankine Cycle (ORC) power plant, the thermal energy of the industrial water is transferred to a working fluid. The ORC plant will have a capacity of 200MW thermal input and 33MW gross electric power.

The working fluid, N-butane, evaporates at temperatures significantly below the evaporation temperature of ordinary water. The evaporated N-butane is passed through a high-pressure turbine and then a low-pressure turbine, which drives a generator.

The N-butane is then cooled in condenser coolers so that it can be fed back to the industrial water heat exchanger in a liquid state, thus establishing a continuous process. Furthermore, the industrial water runs through heat exchangers used to generate steam for the LEP and the district heating system. The industrial water flow towards both ORC as well as steam generation and district heating can be controlled to adjust for differing demand scenarios.[4]

2.1.3.2 LITHIUM PRODUCTION PROCESS

As mentioned above, the brine is cooled down at the well sites to be fed directly to the LEP. Firstly, Direct Lithium Sorption (DLS) brine flows through large adsorption columns. In this process, lithium chloride binds to the sorbent VULSORB® developed by Vulcan. The brine, which is now almost entirely lithium-free (aiming at around 10 ppm Li remaining in the spent brine), flows back to the production points via the pipeline and is reinjected into the deep rock. This closes the brine cycle of the continuous process.

The adsorbed lithium can then be washed off (eluted) the sorbent with water. The resulting eluate already has high lithium concentration. The subsequent Reversed Osmosis (RO) further increases the lithium concentration and reduces the volume of water in the lithium chloride solution. On the other hand, the permeate produced during RO is free of salts and the water recovered this way can be reused in other steps, reducing net water usage. During DLS, minor impurities of the lithium chloride solution by other dissolved salt compounds of the brine cannot be avoided. However, to produce battery-grade lithium salt, a high purity of the concentrated lithium chloride solution is required. In several purification steps (eluate purification – in which precipitations, ion exchangers, and crystallisations are connected in sequence – the impurities (especially Si, Mg, Ca, Na, Cl, Br) are successively removed.[5]

[4] Vulcan, 2023. Introduction to GLEP.
[5] Vulcan, 2023. Introduction to GLEP



FIGURE 2-13 AERIAL OVERVIEW OF THE LAND PLOT FOR THE GEOTHERMAL AND LITHIUM PRODUCTION PLANT (GLEP)

Source: Vulcan, 2023

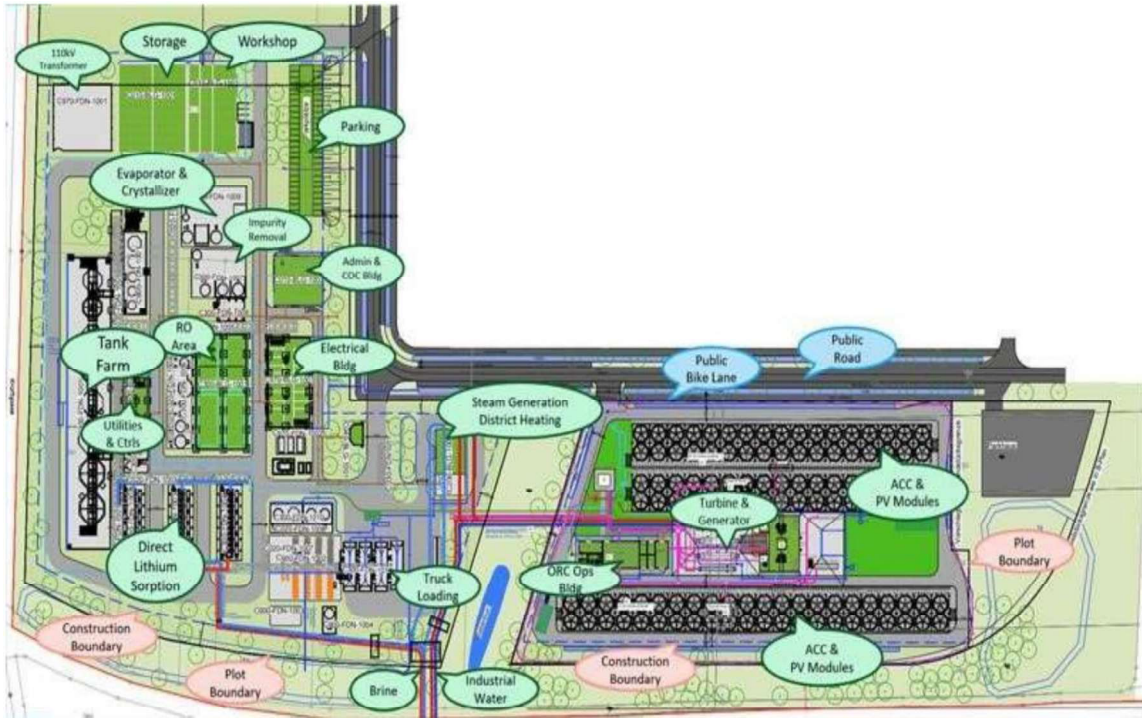


FIGURE 2-14 LAYOUT OVERVIEW OF THE GEOTHERMAL AND LITHIUM PRODUCTION PLANT

Source: Vulcan 2023

2.1.4 INSHEIM GEOTHERMAL PLANT

The Insheim Geothermal power plant is in the southern Palatinate town of Insheim and will serve as brine supplier to the Project. The plant was previously owned by Pfalzwerke geofuture GmbH from November 2012, and since 2022, after acquisition by Vulcan, the plant has been operated under the name of NatürLich Insheim GmbH.

The power plant has an average electrical output of around 3 megawatts and can generate around 25,000 megawatt hours of electrical energy per year. The power plant can supply around 8,000 households with electricity and heat.[6] The Insheim Geothermal Plant operates 24 hours a day and seven days a week with an average availability of 95%. The workforce of the Insheim Geothermal Plant is comprised of six people.

The geothermal plant consists of a thermal water cycle (see Figure 2-15) in which the hot thermal water is extracted from a production well, approx. 3.8 km deep, and after transferring the heat to a working medium, is injected back into the approx. 3.7 km deep injection well. The geothermal plant also comprises an Organic Rankine Cycle (ORC) plant in which the thermal energy from the brine is used to evaporate a working fluid. The high-pressure vapor then moves through a turbine, which is driving the electrical generator. After passing through the turbine, the vapor is cooled down and condenses back into a liquid in the condenser. The liquid is then pumped back to the evaporator to start the cycle again.[7]



FIGURE 2-15 OVERVIEW OF THE INSHEIM GEOTHERMAL PLANT

Source: Vulcan, 2023

[6] Bundesverband Geothermie, 2022. Insheim – Geothermieanlage (Bundesverband Geothermie: Insheim - Geothermieanlage)
[7] TÜV SÜD Industrie Service GmbH, 2015. Konzept zur Verhinderung von Störfällen für das Geothermiekraftwerk in Insheim.

2.1.5 LANDAU WELL SITE (FORMER GEOX GEOTHERMAL POWER PLANT)

Vulcan has a Brine Offtake Framework and Investment Agreement with IKAV Invest S.à.r.l., Geysir Europe GmbH and geox GmbH. The brine offtake volume from the Landau Geothermal Power Plant allows for at least 100 litres/second of brine, which requires an additional re-injection well. The provision does not affect nor limit the use of the brine for geox's heat and electricity production before delivery to Vulcan. Vulcan is currently only factoring in 65l/s of brine supply from the existing operations at the Landau Geothermal Power Plant, corresponding to the current production of the wells and plant.

The Landau Geothermal Power Plant has been in operation from November 2007 until 2014. Since 2014 the Power Plant has been shut down due to a facility upgrade. The maintenance and modernisation measures have been completed.

Status update 4th September 2025: The Landau Geothermal Power Plant is no longer owned by geox GmbH after it was acquired by Vulcan in April 2025. Since its acquisition by Vulcan, the Plant is no longer functioning as a power plant and Vulcan's intention is for this to function as a well site for the Project. It was not previously included in the scope of the ESIA study. However, this updated version of the ESIA completed in 2025 has now included this facility (as the existing 'Landau well site') within scope of the Phase One Lionheart Project. Additionally, a new pipeline construction will be needed from the Landau Well Site to the GLEP, which will be a part of Project components that is considered within the ESIA.

2.1.6 CENTRAL LITHIUM PLANT IN FRANKFURT INDUSTRIAL PARK HÖCHST

Lithium chloride solution produced at the Geothermal Lithium Extraction Plant (GLEP) will be transported to the Central Lithium Plant (CLP), where it will be converted into lithium hydroxide (LiOH). The layout and location are depicted in Figure 2-2.

The CLP will be located within the Frankfurt Industrial Park Höchst (FIPH), which was founded in 1863 and is strategically positioned in the western part of Frankfurt am Main, Germany, within the borough of Höchst. The FIPH is about 10 kilometres from Frankfurt's city centre and benefits from its close proximity to major transportation networks, including highways, rail lines, and Frankfurt International Airport, making it a key industrial hub for both national and international businesses.

Managed by Infraserv Höchst, FIPH hosts approximately 90 companies across diverse industries such as pharmaceuticals, biotechnology, chemicals, crop protection, and food additives, employing around 20,000 people. The park features over 980 rental properties, including 120 production facilities and more than 80 laboratory and office buildings.

The FIPH spans a total area of 460 hectares, with 50 hectares available for new construction, and Vulcan will be one of the tenants, occupying a 7.82-hectare site with an additional 0.3 hectares reserved for future expansion of the CLP. Since 2020, the northern part of the area is used as a set-up and assembly area, and the southern part of the area is currently bare land.[8]

At ERM's meeting with Infraserv and Vulcan on August 10th, 2023, the Infraserv permitting team stated that they would apply on behalf of Vulcan to understand if an EIA would be required for CLP. Infraserv submitted an application in February 2024 and confirmed that, based on their assessment and on experience with other projects located within Höchst Industrial Park, an EIA

[8] Infraserv, 2023. Altlastensituation im Bereich der Pachtfläche G6/G7/G8.

is not expected to be required for the CLP. During further engagement between Vulcan and Infraserv in August 2024, Infraserv provided further information to indicate that, despite the CLP being considered a 'Chemical Installation', an EIA is not mandatory, and a preliminary examination is instead required in accordance with German Law (EIA Act: UVPG). The preliminary examination completed by Infraserv determined that 'no significant adverse environmental effects are expected from the construction and operation of the CLP' and therefore an EIA does not need to be submitted in this case.

A Strategic Environmental Assessment (SEA) has also not been carried out for the Höchst Industrial Park; however, given the sites long history (existence for 161 years), Infraserv indicate that there is no legal basis for, or practical sense in, undertaking an SEA as this would ultimately be relevant to planning of the Industrial Park (which is no longer relevant given the long history of the operating Industrial Park and since there is no planning procedure pending for Höchst Industrial Park).

Status update 4th September 2025: Vulcan successfully secured the necessary permit in September 2025 to build and operate the CLP.



FIGURE 2-16 LAYOUT PLAN OF THE CENTRAL LITHIUM PLANT

Source: Vulcan, 2023

2.1.6.1 LITHIUM REFINEMENT PROCESS

The further processing of the pre-purified and concentrated lithium chloride solution takes place in the Central Lithium Plant (CLP). During the electrolysis process, lithium chloride is converted into lithium hydroxide monohydrate (LHM). In addition to LHM, hydrogen and chlorine gases are also generated as by-products during electrolysis. Both gases react in an HCl synthesis to form hydrochloric acid, which can be used in various process steps to regulate the pH value. While a portion is consumed internally the majority is sold externally.

The LHM is then concentrated through evaporation. This enables the lithium hydroxide monohydrate to crystallise and, after drying, to be packaged as a solid, battery grade powder.[9]

2.2 HAZARDOUS MATERIALS

Vulcan's Phase One Lionheart Project operates as a closed loop system. This means that no brine leaves the cycle. Instead, the brine is reinjected into the reservoir via an injection well. During treatment, solids are first filtered out of the brine and then dissolved, minimising the volume of solids requiring disposal. After dissolution, the remaining insoluble solid phase is separated from the liquid phase. The liquid phase is then piped back into the reinjection well together with the brine from the ORC power plant.

Pigging stations at each site allow for the cleaning of pipeline scale regularly, as the cooling of brine leads to deposits of dissolved substances like heavy metal-rich sulphides and barium-strontium sulphate in heat exchangers and pipelines. Vulcan addresses this issue by reusing materials such as hydrochloric acid and lithium by-products, while any small amounts of sulphate produced are properly disposed of. Scaling is controlled with a phosphonate-based inhibitor, and a corrosion inhibitor is added to thermal water to further reduce the formation of sulphate and metal-rich sulphides.

Vulcan's process is designed to minimise waste, with only a few unavoidable by-products requiring disposal. These consist primarily of precipitates and solids from the brine. All solids are carefully analysed, immobilised according to procedure, and disposed of at certified landfill sites. The entire disposal process is carried out and monitored in cooperation with certified external companies to ensure proper waste management.

2.2.1 NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM)

The geothermal brine in the Upper Rhine Graben reservoir, with a salinity of 100-110 g/l, contains various dissolved ions. As the brine cools in heat exchangers, some of these ions become supersaturated, forming deposits primarily composed of heavy metal-rich sulphides and barium-strontium sulphate. In this reservoir, these deposits often appear as barite and galena, which naturally contain small amounts of radionuclides. Though radionuclides are present in low concentrations in the thermal water, they are transported to the surface and incorporated into the mineral deposits formed in the system.

To manage sulphate scaling, a phosphonate-based inhibitor is added, and a corrosion inhibitor is injected into the thermal water. These treatments, commonly used in the oil industry, have been effectively reducing scaling and metal-rich sulphide deposits at the Insheim geothermal plant for several years. However, areas with larger deposits, such as heat exchangers, filters,

[9] Vulcan, 2023. Introduction to GLEP.

pigging stations, and NORM (Naturally Occurring Radioactive Material) waste storage, tend to have increased radiation levels compared to the local background due to the presence of scaling deposits.

Considering this critical topic, Vulcan follows these specific measures in handling NORMS:

- A designated institute (currently BRENK SYSTEMPLANUNG GMBH in Insheim) provides a radiation protection concept, accessible to controlling authorities at all times.
- All employees, internal and external, receive annual training or before starting radiologically relevant work, in compliance with § 63 StrlSchV.
- Access to areas around open system components, where exposure to deposits is possible, is restricted and designated as "black zones." Only personnel with proper PPE can enter, and PPE must be removed before leaving these areas.
- Specific instructions for handling brine systems and NORM waste are based on hazard assessments, including dose estimates and risk evaluations. These are available at GLEP and can be presented to the authorities.
- The use of a scaling inhibitor minimises sulfate deposits in the thermal water system. Resistant, washable floor coverings are used near heat exchangers and filter units to reduce contamination.
- PPE requirements are site-specific and include disposable suits, gloves, eye protection, safety shoes, and dust masks. All PPE and contaminated materials are stored and disposed of in sealed collection containers.
- Employees are monitored with certified dosimeters (e.g., from Mirion Technologies), and the data is stored by the operator. Local dose rates and surface contamination are regularly measured, especially after major maintenance. Gamma radiation exposure is also routinely monitored on-site.
- NORM waste is stored in secure, lockable containers, with larger items stored in fenced, video-monitored areas. Transport of radiological samples and materials follows strict regulations (ADR12, GGVSEB13).

2.2.1.1 STORAGE AND DISPOSAL OF NORM

Storage:

- Each well site has a warehouse and adjacent open area for NORM storage.
- Residues (e.g., pigging or cleaning debris) are stored in Intermediate Bulk Containers (IBC), while used PPE is kept in PE drums with clamping ring lids.
- Larger parts, like piping material, are temporarily stored in the open area.
- Warehouses are locked, and well sites are fenced and monitored by video surveillance.
- NORM-related waste may be temporarily stored at certified external service companies for decontamination or conditioning.

Disposal of Metal Waste:

- Contaminated steel will be transported to Cleanstream, a specialist environmental services company, for decontamination.
- Cleanstream is authorised by the Thuringian State Office for handling radioactive materials.

- After decontamination, the steel can be conventionally recycled.
- Separated NORM deposits will be disposed of at a DK III landfill in Germany.

Disposal of Mineral Waste:

- Most mineral residues come from cleaning plant components, especially heat exchangers.
- Heat exchanger cleaning is done biennially, generating about half a ton of NORM waste per year per well site.
- Mineral residues must be chemically stabilised before landfilling to comply with waste regulations.
- Conditioning of residues will be done externally at facilities like Cleanstream for more efficient processing and radiation protection.

Disposal of Combustible Residues:

- Combustible residues, including used PPE and plastic films, are classified as waste unless proven otherwise through gamma spectrometric analysis.
- The estimated annual volume of combustible residues per well site is less than one ton.
- These residues are stored in 60-liter PE drums and will be disposed of at hazardous waste incineration plants like HIM or SAVA.

2.2.2 OTHERS

While Vulcan has designed its processes to minimise chemical use, lithium extraction and processing still require the controlled handling of various chemicals and hazardous materials. These substances are managed through precise dosing, controlled reactions, and effective recycling measures to ensure both safety and efficiency throughout the operation.

2.2.2.1 LEP

The table below outlines the various chemicals used in the Lithium Extraction Plant. The focus is on the substances involved in the process, their hazardous classifications, storage details, and safety considerations. It is important to mention that LiCl concentrate is a s significant raw material in this process, stored in large quantities, with various outdoor tanks.

TABLE 2-1 HAZARDOUS MATERIALS IN THE LEP

Substance	Usage	Hazardous Material	WHG Classification	Quantity (kg)
IC-Anion Standard Bromide 1,000 mg/l Br^-	LAB LEP	Yes	Slightly water hazardous (WGK 1)	0.1
IC-Anion Standard Chloride 1,000 mg/l Cl^-	LAB LEP	Yes	Slightly water hazardous (WGK 1)	0.1
IC-Anion Standard Fluoride 1,000 mg/l F^-	LAB LEP	Yes	Non-water hazardous	0.1
IC-Anion Standard Iodide 1,000 mg/l I^-	LAB LEP	Yes	Non-water hazardous	0.1
IC-Anion Standard Silicate 1,000 mg/l	LAB LEP	No	No SDS	0.1

Substance	Usage	Hazardous Material	WHG Classification	Quantity (kg)
IC-Anion Standard Sulphate 1,000 mg/l	LAB LEP	Yes	Slightly water hazardous (WGK 1)	0.1
ICP-Standard Aluminium 1,000 mg/l Al	LAB LEP	Yes	Highly water hazardous (WGK 3)	0.1

2.2.2.2 ORC

The table lists substances used in the ORC power plant, which is involved in converting heat into electricity using organic fluids. Key substances include:

- **N-Butane (97.5% purity)**: Used in turbines and generators, classified as non-water hazardous.
- **Mineral oils (OTE 32)**: Used for lubrication in various components, slightly hazardous to water.

The ORC plant's efficient operation depends on the proper management of these fluids, ensuring both performance and safety.

TABLE 2-2 HAZARDOUS MATERIALS IN THE ORC

Substance	Usage	Hazardous Material	WHG Classification
N-Butane (97.5% purity)	ORC Power Plant (Turbines, ACC, HEX, pumps, etc.)	Yes	Non-water hazardous substance
Mineral oil - OTE 32	ORC Power Plant - HT Lubrication for turbines	Yes	Slightly water hazardous (WGK 1)
Mineral oil - OTE 32	ORC Power Plant - LT Lubrication for turbines	Yes	Slightly water hazardous (WGK 1)
Mineral oil - OTE 32	ORC Power Plant - Lubrication for pumps	Yes	Slightly water hazardous (WGK 1)
Lithium complex grease	ORC Power Plant - Grease for pump motor	Yes	Slightly water hazardous (WGK 1)
Mineral oil - TBD	ORC Power Plant - Bearing pumps	TBD	TBD

2.2.2.3 CLP

The production process at CLP involves the use of several hazardous substances, with lithium chloride being the primary raw material. Other substances include sodium hydroxide, sodium disulfite, and hydrogen. During the permitting process, Vulcan was required to submit detailed information about these substances, including their types, quantities, and safety data. The document outlines the management of hazardous materials, adherence to safety regulations, and the overall process for producing lithium hydroxide monohydrate.

TABLE 2-3 HAZARDOUS MATERIALS AT CLP

Substance	Usage in Process	Quantity (t/a)*	Safety Measures
Lithium Chloride (LiCl)	Primary raw material for lithium hydroxide production	183.514	Stored in controlled environments, handle with appropriate PPE.
Sodium Hydroxide (NaOH)	Used in the electrolysis process and for naturalisation	2.724	Highly caustic, requires corrosion – resistant materials and safety equipment.
Sodium Disulfite (Na2SO5)	Used as inhibitor in the process to prevent unwanted reactions.	1.076	Potentially hazardous; requires careful handling to prevent exposure.
Hydrogen (H2)	Produced as byproduct in the electrolysis process.	100	Highly flammable; must be stored and handled with extreme caution.

**Quantities presented are for both Phase 1 and Phase 2.*

CLP is located in Höchst Industrial Park, the regulation of hazardous chemicals involves strict safety and efficiency measures overseen by Infraserv Höchst. The park has specialised facilities for the storage, handling, and transport of dangerous materials. A hazardous substances warehouse, covering 16,500 square meters, uses advanced fire protection measures such as fire-extinguishing foam systems and compartmentalised storage to prevent accidents[10]. Additionally, its proximity to a 24/7 industrial fire brigade enhances safety in case of emergencies.

The park also relies on extensive digitalisation, which optimises inventory management and ensures safe and efficient handling processes. This warehouse, built to meet the stringent needs of chemical and pharmaceutical industries, also includes temperature-controlled areas for sensitive materials, supporting compliance with regulations like the European SEVESO directive, which controls major accident hazards.

2.2.3 TRANSPORTATION OF HAZARDOUS MATERIALS

Vulcan will use motorways for the transportation of hazardous materials in full compliance with legal requirements, prioritising the safety and well-being of surrounding communities.

In Germany, the transportation of hazardous materials and chemicals is regulated to ensure public safety, environmental protection, and the prevention of accidents. The Gefahrgutverordnung Straße, Eisenbahn und Binnenschifffahrt (GGVSEB) is the primary regulation governing the transport of dangerous goods by road, rail, and inland waterways.

This regulation aligns with international agreements such as the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) and the Regulation concerning the International Carriage of Dangerous Goods by Rail (RID). The GGVSEB outlines specific requirements for packaging, labelling, documentation, and vehicle specifications. Transport companies must ensure that their staff is adequately trained, and that proper emergency response plans are in place.

[10] https://www.industriepark-hoechst.com/en/stp/news/press/press-releases/new-infraserv-hazardous-materials-storage-facility-sets-new-standards-in-safety-and-efficiency.html

The Bundesamt für Güterverkehr (BAG) oversees enforcement, ensuring compliance through regular inspections and penalties for violations. This regulatory framework helps maintain a high standard of safety during the movement of hazardous materials across Germany.

The motorway route from Landau (GLEP) to Frankfurt Industrial Park Höchst (CLP) covers approximately 130 kilometres, relying solely on major motorways and avoiding residential areas. However, despite these precautions, the transportation of hazardous materials may still pose potential risks to both traffic safety and nearby communities which have been furtherly discussed in the "Impacts Related to Traffic and Land Access" section.

2.3 ANCILLARY SERVICES

Vulcan will require aggregates for construction and dumpsites for surplus material generated during the works. A list of ancillary services related to the Project is provided below. Should additional ancillary services be identified upon final design completion, Vulcan will ensure that any environmental or social risks are managed and mitigated in accordance with German legislation, Good International Practice (GIP), and IFC Performance Standards.

None of the facilities, including borrow areas, sand sources, and dumpsites, were identified during the ESIA report preparation. Vulcan will use only those facilities already assessed and licensed by German authorities, which do not require further environmental and social impact assessments.

Vulcan will ensure that the EPC Contractor uses only licensed and authorised dumpsites. Once identified, the EPC Contractor will conduct due diligence on these sites to verify permit validity and ensure compliance with national regulations and international guidelines. Where necessary, recommendations for improving standards at these dumpsites will be provided, with regular monitoring to ensure ongoing compliance. For any new surplus storage sites required for the Project, Vulcan will ensure that the EPC Contractor obtains the necessary permits and licenses and, if required, conducts Environmental and Social Impact Assessments (ESIAs) in accordance with German regulations. Additionally, Vulcan will ensure that environmental and social risks associated with these dumpsites are effectively managed and mitigated in compliance with German legislation, EU directives, GIP, and IFC Performance Standards (PSs).

2.3.1 WORKERS' CAMPS

VERCANA GmbH is the company hired for drilling, and they have already agreed on a contract with Vulcan.

During operations, each drill rig will have a crew camp with 26 container units on a nearby plot of land. The camp will house 52 workers in total, with 26 workers sleeping during the day and 26 at night, as they work in shifts and share the sleeping containers. Each sleeping container has an area of 10.42m² plus a 3.6m² bathroom. Additionally, there will be two larger containers, each 29.38m², serving as sitting rooms or break rooms. Vulcan has already secured permits for the construction of these containers, and a general layout is available in Figure 2-17 below.



FIGURE 2-17 CREW CAMPS' LAYOUT

Source: Vulcan, 2024

Vulcan confirmed that construction workers will commute and won't require accommodation.

2.3.2 ACCESS ROADS

The Project is well connected via the A65 and A5 highway and several national roads. The A65 passes directly through the centre of the Project Area of Influence (AoI), running parallel to the 40 Morgen, Schleidberg site areas, intersecting with the Insheim Geothermal plant, and tangential to the Trappelberg site.

The pipeline route alignment will mainly follow the existing access roads. Additionally, the existing Project design does not foresee construction of any new access roads since all the Project components are nearby existing road infrastructure.

2.3.3 ELECTRICAL INFRASTRUCTURE

The power supply for the geothermal plants in Insheim and Landau involves receiving high-voltage power from the grid and transforming it to lower voltage levels using transformers. This ensures that various parts of the facility are adequately powered. The system features a redundant design with individual fuse protection for each component, enhancing reliability and safety. The distribution system is also equipped with circuit breakers that allow the facility to be disconnected from the grid at multiple points if needed.

In both Insheim and Landau, the power is delivered to the plant via a medium-voltage line. Since these plants are already operational, the primary focus is on powering the components that transport geothermal brine. The incoming medium voltage is transformed to the appropriate levels and distributed across various components of the facility. Safety features such as circuit breakers and backup fuses are integrated into the system to ensure continuous and secure operations. No new transmission lines or substations will be constructed as part of the Project.

2.4 PROJECT ALTERNATIVES

2.4.1.1 "NO PROJECT" ALTERNATIVE

The Phase One Lionheart Project will be the first integrated renewable energy and lithium production project in Europe. Vulcan will use renewable heat derived from the geothermal brine to drive the lithium production process, with no burning of fossil fuels in the process to produce lithium. Indeed, the current need for renewable energy and battery supply for electric vehicles is critical and Vulcan´s Phase One Lionheart Project aims to support that demand.

Renewable energy is one of the most important sources of electricity and is one of the core pillars of Germany's energy transition. Renewable geothermal energy provides additional benefits as it supplies reliable, constant baseload power to support grid stabilisation and ensure energy security. Current geo-political developments (Russia's war in Ukraine and the coinciding energy crisis) have prompted the German government to prioritise and boost the country's renewable energy capacity, and to also accelerate grid planning (see section 3.3 for more detail).

According to the Fraunhofer Institute, geothermal renewable energy can meet a quarter of Germany's heating needs and the Upper Rhine Valley Brine Field has the hottest geothermal resource in central Europe.[11] With their innovative approach, Vulcan aims to produce renewable heat for more than one million people by 2030.[12] In addition, the Project aims to facilitate the

[11] Vulcan Energy, Phase One DFS Presentation 2023 (slide 47)
[12] Based on average per capita per annum heat consumption in Germany of 6,200 kWh (https://www.destatis.de/).and the estimated capacity for heat production from Vulcan's long term development areas beyond Phase One, in a pure heat (no power) scenario.

decrease of emissions to meet EU climate targets and help to limit Germany's reliance on Russian gas.

Furthermore, with the "No Project" alternative, the rapidly increasing demand for batteries would only continue to grow. The current mining of the material suitable for batteries has potential impacts on environment and the climate, and current mining also may not have the capacity to keep up with production. Only small quantities of 1% grade, hard rock mined lithium raw materials have been extracted thus far in Europe, but for ceramics with zero battery grade product derived from local sources. The EU wants to obtain 80 % of the required lithium volume for batteries from domestic sources in the medium to long term.[13]

Vulcan states that their lithium production processes produce net carbon neutral emissions of CO_2 per tonne of lithium produced, which is at least 15 tonnes less CO_2 than current legacy lithium hydroxide production methods, taken as an industry average from evaporation ponds with reagents or from mining.[13] Consequently, without the Project, lithium would continue to have a larger CO_2 footprint. Using a life-cycle analysis of the Project, even Phase One alone has the potential to avoid millions of tons of CO_2 emissions for lithium and renewable energy production.

2.4.1.2 LOCATION SELECTION

The Insheim Geothermal Power Plant was selected for the Project as it is an existing facility, which offered an advantageous starting point. The location for the GLEP (Geothermal Lithium Extraction Plant) was chosen due to its proximity to an established commercial area south of Landau in the Palatinate and near the Landau Geothermal Power Plant. Additionally, the GLEP site selection is strategic as the planned pipeline route mainly crosses agricultural land, minimising environmental and logistical challenges. The GLEP site is within an industrial park, further supporting its suitability for the Project. In general, the site selection process follows a multidisciplinary catalogue, e.g. agriculture, infrastructure, natural reserves, cultural heritage and many more.

There has been extensive engagement with the Rhineland-Palatinate General Directorate for Cultural Heritage throughout the planning process, given the significance of the pipeline route alignment for preserving cultural heritage. Authorities were consulted to ensure the route avoids any known cultural heritage sites.

The well locations were carefully screened to exclude areas with environmental sensitivity. Additionally, 3D seismic monitoring was conducted before selecting well sites. The layout of the 40 Morgen well site was modified following archaeological soundings of potential archaeological sites, conducted in collaboration with the Rhineland-Palatinate General Directorate for Cultural Heritage in Speyer. The Spreissgraben exploration site was selected due to its flat terrain, making it preferable over nearby cropland.

In summary, all pipeline routes, well sites, and plant locations were chosen with careful consideration to avoid environmentally sensitive areas or locations close to such areas.

[13] Winkelmann, M., 2023. Nachschub aus dem Untergrund. Greenpeace Magazine (Greenpeace Magazin | Nachschub aus dem Untergrund (greenpeace-magazin.de))

2.4.1.3 ANALYSIS OF THE PIPELINE ROUTE AND DESIGN

Vulcan considered alternative pipeline routes for the Project. However, the current route was chosen as it is primarily located on cropland and minimises the need for underpasses beneath rivers, roads, and railway lines.

The brine pipeline is designed based on a pre-insulated plastic casing pipe concept. This configuration features an insulated inner steel pipe enclosed within a High-Density Polyethylene (HDPE) outer pipe. The HDPE sheath protects the inner pipe against mechanical stress while also serving as passive corrosion protection. Based on material studies, two options are deemed suitable for corrosion protection of the inner pipe exposed to brine:

- Application of a liner with corrosion-resistant pipe fittings.
- Application of coating with corrosion-resistant pipe fittings.

The industrial water pipeline employs a pre-insulated steel casing pipe system, where an insulated inner steel pipe is encased within a steel sheath. The outer steel pipe protects the inner pipe from mechanical stress and provides passive corrosion protection. As the industrial water will be treated to meet the required quality standard (AGFW FW 510), no additional corrosion protection measures are necessary.

All four pipelines—brine supply and return lines, and industrial water supply and return lines—are equipped with a leakage monitoring system.

Vulcan also evaluated a two-pipe system as an alternative to the four-pipe configuration. However, the four-pipe system was selected despite the higher costs, as it poses lower operational risks. This approach simplifies overall operations by reducing complications related to scale, corrosion, and other technical factors, making it the preferred choice for the Project.

In summary, all pipeline routes, well sites, and plant locations were chosen with careful consideration to avoid environmentally sensitive areas or locations close to such areas.

2.4.1.4 ANALYSIS OF TRANSPORT MEANS

Vulcan is evaluating several options for transporting the lithium chloride solution from the GLEP to the CLP:

- Train: Utilising trains for transportation would require constructing a rail connection to the existing railway system. Although Vulcan has engaged in ongoing discussions with Deutsche Bahn, the German Railway Operator, this option was determined to be economically unfeasible due to the substantial investment required.
- E-Trucks: Effective January 2025, the revised European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) 2025 permits the transportation of dangerous goods, including recycled lithium hydroxide solution, utilizing battery-electric trucks (E-Trucks), contingent upon adherence to all relevant vehicle and packaging regulations. Furthermore, lithium chloride, which is not classified as a dangerous good, continues to be eligible for transport by E-Trucks as previously established. While the regulatory framework now facilitates this mode of transport, practical implementation may still face challenges due to the limited availability of E-Trucks from logistics providers.
- Diesel Trucks: As an alternative to E-Trucks, diesel trucks are considered for the initial stages of the Project. They provide a feasible solution for the immediate transportation needs until E-Truck regulations evolve and suitable electric trucks become available.

Given the current constraints and feasibility considerations, the preferred transportation solution is the use of diesel trucks, with E-Trucks being a potential option for future implementation as regulatory and technological developments permit.

3. PROJECT PHASES

This section provides further information on the following stages of the Project including Pre-Construction, Construction and Operation as presented in Table 3-1.

The status of received and pending approvals/permits is for each component of the Project also reflected in Table 3-1, as of 11th September 2025).

In future, further status updates regarding the acquisition of relevant approvals and permits will be reflected in Vulcan's 'Permitting & Land Acquisition (P&LA) Reporting' which is currently being updated and issued on a monthly basis (last update reflected in the ESIA final version is dated 04.09.2025).

TABLE 3-1 PROJECT PHASES

Phase	Tasks	Action	Approval/Permit Status Update (04.09.2025)
Pre-Construction Phase	Licenses	• Acquisition of the Exploration licenses • Production license granted (heat extraction)	Exploration license for LiThermEx extension approved in March 2025 Submission of final production license documents for LiThermEx planned for September 2025
	Drilling	• Conducting Pre-EIA (P-EIA) and acquiring approvals • Main operating plan (MOP) • Special operating plan SOP): Well pad • Three Special operating plans: Drilling • Securing land	Schleidberg Well Site: • SOP for lifting and reinjection of groundwater for well test #1 and 2 received in July 2025 • SOP approval well pad construction, groundwater monitoring and deep drilling received in April, August and September 2024 (respectively) • MOP (exploration) approval received in July 2023 • Land acquisition completed Landau Well Site (existing): • Acquisition of power plant Landau (Geox GmbH) by Vulcan in April 2025 • SOP for work over of GtLA1 received in June 2024 • MOP for exploitation received in January 2022 Trappelberg Well Site: • MOP for exploration, construction and drilling for wells 1 & 2 received in June 2025 • Land acquisition completed Hasenberg Well Site: • Submission of MOP planned for June 2026

Phase	Tasks	Action	Approval/Permit Status Update (04.09.2025)
			• Submission of P-EIA planned for January 2026 • Land acquisition -process ongoing (submission of land purchase package expected in September 2025) Spreissgraben Well Site: • Submission of MOP planned for June 2026 • Submission of P-EIA planned for January 2026 • Land acquisition -process ongoing (submission of land purchase package expected in September 2025) 40 Morgen Well Site: • Land acquisition completed
	Pipeline and Power Distribution	• Conducting Pre-EIA and acquiring approvals • Securing land (lease) • Special operating plan	Final (full) building permit received for 110Kv Substation in June 2025 Submission of P-EIAs for ICCP Section BA3, BA4 and BA5 planned for April, May and June 2026, respectively Final city council decision on D12 land sale for ICPP expected in September 2025 Draft contract for D12 land acquisition received in August 2025 Routing agreement with all lessees regarding ICPP Section received in August 2025 Decision on ICPP Section 2 P-EIA received in August 2025 (full EIA not required) Approval from the lower nature conservation authority to carry out early clearance work for laying of the empty pipes to cross the railway at D12 received in August 2025 Permitting documents to Deutsche Bahn (DB) for railway crossings of ICPP Section 2 submitted in July 2025
	Organic Rankine Cycle (ORC) Plant	• Pre-EIA conducted and awaiting approval • Land acquisition • Building permit	Final building permit for ORC received in June 2025 BImSchG §23a received in November 2024
	Lithium Production Plant	• Bundes-Immissionsschutzgesetz permit (Act on the	Approval of final building permit expected in September 2025

Phase	Tasks	Action	Approval/Permit Status Update (04.09.2025)
		Protection against Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibrations and Similar Effects) • Conducting Pre-EIA and acquiring approvals • Land acquisition • Building permit	Approval secured for purchase of land in the D12 development plan for the G-LEP in September 2025 MOP for construction approved in February 2025
	Central Lithium Plant	• Bundes-Immissionsschutzgesetz (Act on the Protection against Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibrations and Similar Effects) • Building permit	Approval of BImSchG permit for CLP received in September 2025 BImSchG §8a early works permit received in June 2025 30-year lease agreement to be signed
Construction Phase	General construction activities for the components (excluding pipeline): • Clearing and Grading of the sites • Access road improvements and transportation • Drill site preparation • Drill rig installation and drilling • Initial drilling		Schleidberg well pad constructed and drilling has commenced
	Pipeline activities: • Setting out and surveying of the RoW • Preparing the Right of Way (including topsoil stripping as necessary) • Pipeline stringing • Excavating the trench (other methods may also be used where necessary) • Laying of pipeline in the trench (ditching) • Backfilling with subsoil • Pressure testing • Reinstating the Right of Way (including replacing the topsoil) **Note:** Mainline pipeline construction is currently not planned to be executed through the months of December, January, and February due to the likelihood of inclement weather and risk of inefficient working, hazardous working conditions and potential environmental impacts (soil degradation, runoff to watercourses etc.). Environmental mitigation works will be completed in the winter preceding the start of construction. Pipeline pigging will be undertaken between permanent pigging stations at each wellsite. Pigging of one pipeline segment can be undertaken in parallel with a well site at either end being in operation.	

Phase	Tasks	Action	Approval/Permit Status Update (04.09.2025)
Operation Phase	Landau Well Site (former Geothermal Power Plant previously owned and operated by geox, now acquired by Vulcan): • Provision of up to 100 l/s of brine to GLEP (65 l/s currently factored in) • No longer functions as a Power Plant since Vulcan's acquisition in April 2025		Acquisition of power plant Landau (Geox GmbH) by Vulcan in April 2025
	Insheim Geothermal Power Plant: • Provision of 65l/s of brine to the GLEP. • Supply around 8,000 households with electricity; and • Supply heat to 600 to 800 households;		
	Organic Rankine Cycle (ORC) Plant: • 33 MW and added heat capacity of up to 596 GWh per year		
	Lithium Extraction Plant (LEP): • 24,000tpa LHM equivalent LiCl produced. • Trucking of Lithium Chloride Solution to the CLP.		
	Central Lithium Plant (CLP): • Conversion of lithium chloride to 24,000 tpa battery grade LHM using electrolysis.		

3.1 PROJECT SCHEDULE

A high-level Project schedule with key milestones is shown in Table 3-2

TABLE 3-2 PROJECT SCHEDULE

PROJECT SCHEDULE	
Milestone	**Date**
Main Contract Award	Nov 24
Construction Start	Dec 24
Insheim Complete	Q1 2027
Landau Complete	Q3 2027
Trappelberg Complete	Q3 2027
Schleidberg Complete	Q2 2027
GLEP Start of Production	Q2 2028
CLP Start of Production	Q3 2028
Hasenberg Complete	Q4 2028
40 Morgen Complete	Q2 2029
Spreissgraben Complete	Q1 2029

A number of general assumptions have been made when developing the schedule:

- The sequencing is based on a 3-rig strategy (for the purpose of risk mitigation to ensure that well site development remains on track in a situation where drilling at one of the well sites runs behind schedule).
- An airlift test is completed on each completed well. A circulation test has not been planned.

No parallel work will be conducted on-site during drilling operations. To give a high-level overview and develop the initial project schedule, activities have been grouped into key phases. Main steps include:

- **Obtaining EIA Approval(s):** Secure environmental impact assessment approvals before proceeding.
- **Obtaining MOP/SOP Approval:** Receive approval of the Method of Procedure (MOP) or Standard Operating Procedures (SOP) for the Project.
- **Beginning the Construction Site Setup:** Start construction on the site, including laying conductor piping.
- **Constructing Well Pad:** Build the well pad, ensuring compliance with the Water Resources Act (WHG), and construct areas for drilling cellars, tanks, and hazardous zones (ex-zones). Also include the surface construction for the ICPP connection area.
- **Rig Setup:** Either assemble the drilling rig or move it from another well site.
- **Drilling:** Drill each well (producer or injector) according to the Field Development Plan (FDP) and estimated timelines.
- **Completion of the Equipment Installation & Commissioning:** Install all necessary equipment and complete the commissioning process.
- **Beginning Operations:** Start the operational phase once all construction and equipment are ready.
- **Parallel Activities:** During the Project, ensure that land plot ownership, access road easement, engineering, and procurement are progressing as they follow the critical Project path.
- **Hot Commissioning of the Pipeline**: After the pipeline is built, cleaned, and tested, introduce process fluids from the well site to commission it.

3.2 DECOMMISSIONING

The decommissioning process for the Project will involve several key steps and processes designed to ensure safety and environmental protection, described below:

Pre-closure

- Regulatory Compliance and Planning – Vulcan will secure necessary permits and create a decommissioning plan.
- Site Assessment – Each well site will be evaluated for current conditions and environmental concerns.

- Community Engagement- Vulcan will continue ongoing communication with local communities to address concerns and provide updates on the process.

Closure

- Well Decommissioning – removal of pumps, instrumentation and electrical cables from the brine production wells
- Well Plugging and Abandonment - Each well site will be sealed with cement or other appropriate materials to prevent fluid migration and remove well equipment.
- Removal of Surface Equipment and Infrastructure – Involving dismantling and properly disposing of or recycling of surface facilities such as pipelines, power supply/conveyance, enclosures and storage tanks.
- Site Restoration – Land will be restored through soil remediation and revegetation and clean up any remaining debris.
- Environmental Monitoring – Groundwater monitoring wells at each of the well sites will remain in place and fitted with secure lockable caps to allow regular on-going monitoring.
- Vulcan will implement monitoring measures to ensure no adverse effects from the decommissioning process.

Post Closure Monitoring

A closure water monitoring network and program will be confirmed prior to decommissioning.

At present, there are no fixed plans for the closure or rehabilitation of the Project components, although cost provisions for potential decommissioning works have been estimated as part of Vulcan's CAPEX. It is anticipated that periodic upgrades and rehabilitation will be conducted in response to wear and tear of the components, adhering to German technical standards and environmental and social (E&S) regulations.

As the Project progresses toward closure, dismantling will be conducted in strict accordance with the E&S laws and regulations in force at that time. This will include the implementation of measures to ensure minimal environmental impact and adherence to best practices in recycling and material reuse. Importantly, even after lithium production has ceased, the brines and wells may still be leveraged for renewable energy production, thus maintaining the site's utility as a renewable energy asset.

This section of the ESIA covering the decommissioning and closure of the Project facilities will be subject to review and update at a future date, aligned with Vulcan's progress with the necessary closure planning aspects of the Project which are ongoing.

4. LEGAL AND REGULATORY FRAMEWORK

4.1 INTRODUCTION

This section helps situate the ESIA report within the national and international regulatory and legal context by providing an overview of legal requirements and how they are applied to the Project specifically.

The Project and the ESIA are aligned with the International Finance Corporation (IFC) Performance Standards and adhere to Equator Principle IV (EP4) concerning Environmental and Social Management Systems and the Equator Principles Action Plan. Furthermore, the document

is designed to meet European Commission (EC) directives as stipulated by the European Investment Bank (EIB).

In a legal context, renewable energy refers to: hydropower, wind energy, solar energy, geothermal energy, energy from biomass in accordance with the German Renewable Energy Act.[14] Most geothermal legislation tends to be linked to mining, energy, environmental, water management and geological activities and guidelines. The European Geothermal Energy Council (EGEC) further specifies that geothermal regulatory frameworks should meet the following objectives:

- *"Securing environmentally friendly use of geothermal energy, in particular concerning protection of underground drinking water resources, emissions, etc.*
- *Regulating competing uses and securing sustainable use of geothermal energy.*
- *Granting to the investor a firm right to use geothermal energy in each area and to a given talent, as the basis for business plans."* [15]

4.2 NATIONAL CONTEXT

While German law related to the development and expansion of renewables projects is largely aligned with EU climate objectives, targets, and laws, renewables laws in Germany are also centred around federal laws and directives. The federal government is a key player in the renewable sector and is currently seeking to provide increasing incentives for those concerned with the expansion of renewable energy production. [16]

4.2.1 GERMAN EIA AND PERMITTING OVERVIEW

The Federal Network Agency (BNetzA) is the primary authority for regulating electricity and gas networks in the country – this includes conducting and managing tendering procedures for renewables projects.[17]

Germany has strict regulatory prescriptions and requirements for developing any infrastructure or energy project, and requirements for the construction, commission, and operation of renewables projects differ depending on the mode of generation technology and source of renewable energy.[18] Approval and permitting are also contingent on the potential risks and impact on the health and safety of people and the environment.[19]

[14] Source: International Comparative Legal Guides, Renewable Energy Laws and Regulations Germany 2023, retrieved from: https://iclg.com/practice-areas/renewable-energy-laws-and-regulations/germany, accessed in August 2023.
[15] Source: European Geothermal Energy Council, Key Issue 3: Regulations for Geothermal Energy, retrieved from: http://geodh.eu/wp-content/uploads/2012/11/K4RES-H_Geothermal_Regulations.pdf, accessed in August 2023.
[16] Source: International Comparative Legal Guides, Renewable Energy Laws and Regulations Germany 2023, retrieved from: https://iclg.com/practice-areas/renewable-energy-laws-and-regulations/germany, accessed in August 2023.
[17] They are also responsible for ensuring that connection and access to electricity networks is non-discriminatory.
[18] Source: Lexology, Environmental permits and impact assessments in Germany, retrieved from: https://www.lexology.com/library/detail.aspx?g=acf20081-dbee-47b9-b9c2-6f7da76ff1a7, accessed in August 2023.
[19] Source: International Comparative Legal Guides, Renewable Energy Laws and Regulations Germany 2023, retrieved from: https://iclg.com/practice-areas/renewable-energy-laws-and-regulations/germany, accessed in August 2023.

Indeed, any project with potentially adverse effects on the environment during construction, modification, and operation is required to have a preliminary Environmental Impact Assessment (EIA). [20] The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection states that an EIA is a report that describes and assesses the impact a project may have on humans, animals, plans, biodiversity, soil, water, ambient air, the climate, landscape, and cultural goods. Further and more specific EIA requirements are presented in the Act on the Assessment of Environmental Impacts (UVPG).[21]

Non-binding guidelines related to EIA have also been established at the state level and include more specific input pertaining to applications and interpretations of new EIA regulations.

Upon submission of the EIA report (and further or related documentation) the public must also be able to access the EIA and/or request any missing documentation. Authorities, stakeholders and general public may provide comments, concerns and opinions on the report and authorities are responsible for evaluating an EIA and approving the related project. Stakeholders (especially public participants) reserve the right to contest EIA results and methodology.[22]

The relevant environmental authority is responsible for informing the public of:

- Project details.
- EIA requirements.
- Location and duration of the consultation period;
- Deadlines for statement submissions;
- Foundation for any related legal redress;
- and final decision.[23]

Preliminary EIAs are integrated into permitting procedures. [24] Those P-EIAs are legally binding, and the terminus "preliminary" can be misunderstood. With a negative P-EIA the EIA process ends and no further measures are required. Additionally, permits may be issued at multiple administrative levels depending on the issue but are more frequently regulated at the district or municipal level. Permits and their 'onerous conditions' may be formally contested via third parties or administrative courts one month after publication. If permit rules and decisions are not respected authorities reserve the right to take samples, carry out site-visits, or shut down the activity; fines or criminal liability are also possible outcomes.[25]

[20] Source: Lexology, Environmental permits and impact assessments in Germany, retrieved from: https://www.lexology.com/library/detail.aspx?g=acf20081-dbee-47b9-b9c2-6f7da76ff1a7, accessed in August 2023.
[21] Source: Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, Environmental Assessments EIA/SEA, retrieved from: https://www.bmuv.de/en/topics/education-participation/participation/environmental-assessments-eia-sea#c19048, accessed in August 2023.
[22] contestations are determined in administrative court proceedings.
[23] Source: Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, Environmental Assessments EIA/SEA, retrieved from: https://www.bmuv.de/en/topics/education-participation/participation/environmental-assessments-eia-sea#c19048, accessed in August 2023.
[24] Source: Lexology, Environmental permits and impact assessments in Germany, retrieved from: https://www.lexology.com/library/detail.aspx?g=acf20081-dbee-47b9-b9c2-6f7da76ff1a7, accessed in August 2023.
[25] Source: Lexology, Environmental permits and impact assessments in Germany, retrieved from: https://www.lexology.com/library/detail.aspx?g=acf20081-dbee-47b9-b9c2-6f7da76ff1a7, accessed in August 2023.

Geothermal Projects

Typically, geothermal facilities require construction and water law permits; a permit from the Federal Mining Act (Bundesberggesetz) is also needed, as both mining and geothermal involve the extraction of raw materials from the Earth's interior. [26] Indeed, geothermal drilling at depths greater than 100m must follow mining law/regulations, as specified by § 127 of the Federal Mining Act (BBergG)[27]. The comprehensive Federal Mining Act can be accessed on the German Federal Ministry of Justice website.[28]

A preliminary EIA must be carried out by mining authorities for borehole drilling and extraction or exploration of mineral resources. Depending on the extent of identified potential impacts an outline of operating plan may be required for approval following a 'plan approval procedure'. At this stage, the public reserves the right to challenge the outputs and decisions from the preliminary review. In effect, geothermal projects in Germany tend to face a longer approval process compared to other renewables projects.[29]

Section 4.3.2 describes the application of the EIA and permitting process for the Project.

4.2.2 FEDERAL NATURE CONSERVATION ACT

Germany's Federal Nature Conservation Act or Law (BNatSchG) entered into force on March 1st, 2010, and contains binding environmental regulations for Germany´s federal states. The Nature Conservation Law is considered and examined during subsequent approval procedures for project development. [30]

The act sets out to regulate landscape management in virtue of protecting biological diversity, preserving natural resources for beauty and recreational value, and striving for overall nature conservation in Germany. The Federal Nature Conservation Act emphasises the necessity of proper impact regulation – avoiding notable adverse impacts to the landscape and natural surroundings as often as possible and ensuring adequate compensation (monetary or replacement measures) for non-avoidable impairments.

The main principles to achieve this objective are to respect and preserve:

- Biological diversity (§1);
- The performance and functionality of the natural balance (§1);
- The diversity, distinctiveness and beauty as well as the recreational value (§1);
- Nature conservation in both "external" and "internal areas" (§1).[31]

[26] Source: International Comparative Legal Guides, Renewable Energy Laws and Regulations Germany 2023, retrieved from: https://iclg.com/practice-areas/renewable-energy-laws-and-regulations/germany, accessed in August 2023.
[27] Source: Mining Report, Professor Dr. Walter Frenz, The Current Legal Framework for Geothermal Drilling, retrieved from: https://mining-report.de/english/the-current-legal-framework-for-geothermal-drilling/, accessed in August 2023.
[28] Source: Federal Ministry of Justice, Federal Mining Act, retrieved from: https://www.gesetze-im-internet.de/englisch_bbergg/index.html#gl_p0015, accessed in August 2023.
[29] Source: Bundesverband Geothermie, Environmental Impact Assessment, accessed in August 2023.
[30] Source: Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, Federal Nature Conservation Act, retrieved from: https://www.bmuv.de/en/law/federal-nature-conservation-act-bnatschg, accessed in August 2023.
[31] Source: Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, Federal Nature Conservation Act, retrieved from: https://www.bmuv.de/en/law/federal-nature-conservation-act-bnatschg, accessed in August 2023.

The federal government's respective ministries, namely the Federal Agency for Nature Conservation (BfN) are responsible for ensuring that this legislation is respected and upheld. Different states are permitted to regulate certain deviations from the law but general principles specifying species protection or marine nature conservation for instance must be abided by.

4.2.3 NATIONAL ENERGY AND CLIMATE CHANGE STRATEGIES

Climate Action Program 2023 and Climate Change Act

The coupling of the Climate Action Program 2030 and subsequent Climate Change Act set the regulatory foundation for Germany´s shift towards carbon neutrality. The German Federal Government's Climate Action Program helps orient the country towards a binding reduction in greenhouse gasses by 55% by 2030.

Similarly, the Climate Change Act aims for complete greenhouse gas neutrality by 2045; the Climate Change Act also aims to reduce emissions by 65% of 1990 levels by 2030, and by 2040 the country aspires to have 88% less CO_2. Overall, the allowed CO_2 emissions for sectors such as energy, industry, transport and building per year are to be significantly reduced. In June 2021 the federal government approved an Immediate Action Program of eight billion euros to help guide and achieve these ambitious objectives.[32]

These two programs call for more rigorous and continuous monitoring, where the Council of Experts for Climate Matters will present bi-annual reports of goals that have been met, in addition to measures and trends. The reports will help guide suitable adjustments to budgets and objectives.

Germany's Renewable Energy Act (EEG 2023)

Germany´s Renewable Energy Act (EEG 2023) most recently came into effect in January 2023. It is the largest amendment to Germany´s energy legislation in years, accelerating Germany´s activities towards achieving complete carbon neutrality by 2050. The EEG aims to reduce overall national dependency on fossil fuels, limit climate warming to 1.5 °C, have Germany's power generation be virtually free of any greenhouse gasses by 2035, and have almost 80% of electricity be sourced from renewable energy by 2030. The expansion of the renewables sector lays at the core of this legislative package. [33]

The new EEG package also includes a variety of measures to ease certain burdens on both business and households. For instance, expansion paths for renewables projects, especially for wind and solar energy, have been introduced, in addition to accelerated planning and approval procedures. The prices for geothermal installations have also been reduced and adjusted, accordingly; compensation for renewable electricity being fed into grid networks has consequently generated interest in the upper Rhine area.[34] Moreover, financial participation is

[32] Source: The German Federal Government, Climate Change Act 2021, retrieved from: https://www.bundesregierung.de/breg-de/schwerpunkte/klimaschutz/climate-change-act-2021-1936846, accessed in August 2023.
[33] Source: The German Federal Government, EEG 2023, retrieved from: https://www.bundesregierung.de/breg-de/schwerpunkte/klimaschutz/amendment-of-the-renewables-act-2060448, accessed in August 2023.
[34]Source: Frauenhofer Institute, Roadmap for Deep Geothermal Energy for Germany, retrieved from: https://www.ieg.fraunhofer.de/content/dam/ieg/documents/Roadmap%20Deep%20Geothermal%20Energy%20for%20Germany%20FhG%20HGF%2010102022.pdf, accessed in August 2023.

being promoted by municipal authorities and financial relief may be offered for many households and businesses.

4.3 VULCAN'S APPLICABLE GERMAN REGULATIONS AND PERMITTING STRATEGY

The Phase One Lionheart Project undertaken by Vulcan Energy Resources in Germany is governed under the German Federal Mining Act (Bundesberggesetz: BBergG), which serves as the primary regulatory framework. To ensure full compliance with the requirements for project development approvals, Vulcan is actively engaging with regulatory authorities. This engagement is aimed at maintaining transparency throughout the permitting and operational phases, ensuring all necessary regulations and standards are met.

To date, Vulcan has proactively conducted numerous environmental assessments integral to the permitting process for various segments of the Project. These assessments are focused on initial development activities, including 3D seismic studies in Insheim, well site development, pipeline planning, surface facility planning, and the ongoing operation of the geothermal plant at Insheim. The early initiation of environmental assessment activities demonstrates Vulcan's commitment to integrating stakeholder consultations and adhering to regulatory approval timelines.

Vulcan has developed an extensive communication strategy to engage a broad spectrum of stakeholders across Europe, Germany, and local regions. This strategy employs a variety of channels, including social media, websites, mailings, and open houses, to ensure widespread coverage and transparency regarding the Project. A significant component of Vulcan's communication efforts is aligned with a German national initiative focused on municipal heat planning, highlighting Vulcan's potential contribution to carbon-free heat and lithium supply. The company's communication resources are heavily focused on collaborating with local mayors and policymakers, working together to advance sustainable, carbon-free energy solutions in the municipalities where the Project operates.

Since the Project includes many different construction and operational activities, in several different German states and in various communities, there is an extensive regulatory framework that Vulcan must adhere to. The regulations are established under a large number of Acts. Vulcan has developed a flow diagram to summarise all the activities, the main permits to be acquired, and the assessments needed to meet the regulatory requirements (Figure 4-1).

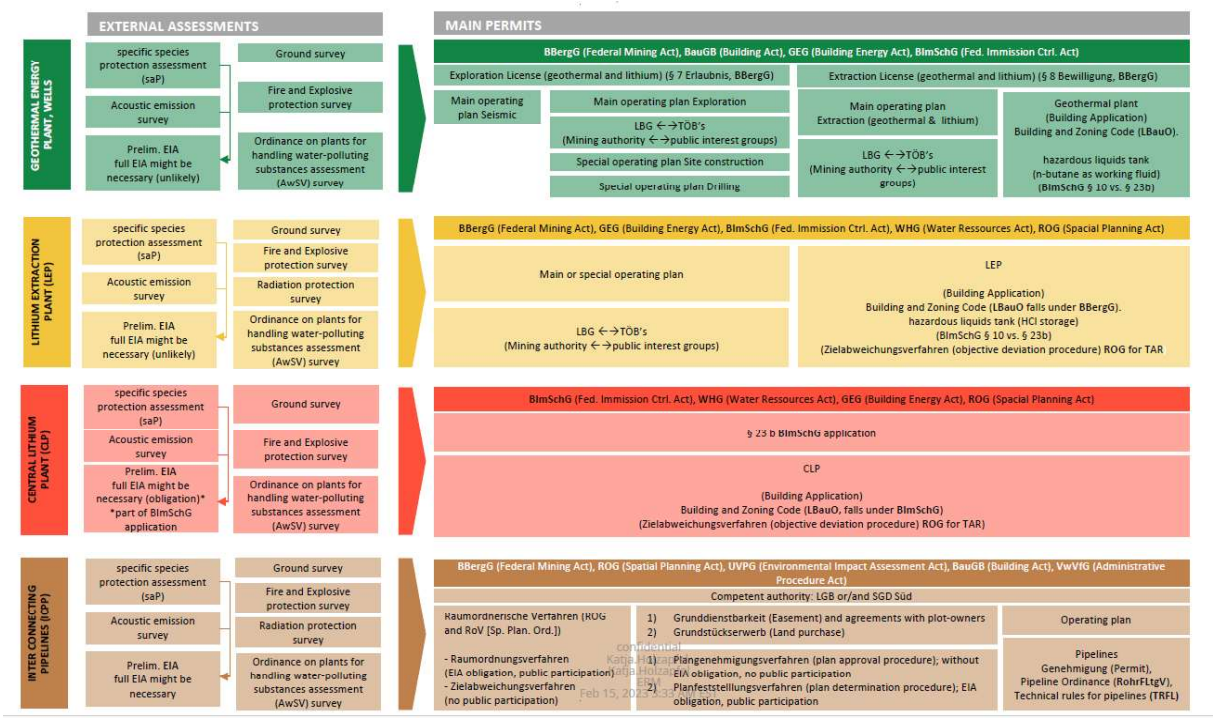


FIGURE 4-1 VULCAN'S PERMITTING FLOW DIAGRAM

Source: Vulcan, 2023

Primary Regulatory Oversight

The drilling, lithium production, energy generation processes, and the LEP associated with Vulcan' Project are primarily regulated under the German Federal Mining Act (Bundesberggesetz: BBergG). This is because all these activities involve the handling of brine, the source from which lithium will be extracted. Consequently, all pipelines transporting brine are also governed by the BBergG.

Specific Regulatory Requirements

The ORC power plant associated with the Project is mainly subject to the German Building Energy Act (Gebäudeenergiegesetz: GEG) and the Building and Zoning Code (Landesbauordnung: LBauO) of Rhineland Palatinate. The BImSchG Act is relevant for the CLP conversion plant.

Sub-Permits and Specialised Studies

Depending on the specific Project activities, additional sub-permits may be required, such as those for the use of water wells. These sub-permits are standard administrative procedures managed by local municipal authorities and generally do not involve public participation. Specialised tasks, including studies on noise and light emissions, handling and disposal of Naturally Occurring Radioactive Materials (NORM), among others, are typically conducted by expert consultancies. While these studies are mandatory components, they do not constitute permits in themselves.

Coordination and Oversight

Within Vulcan, a dedicated individual is responsible for the coordination and supervision of the entire permitting process. This role involves regular discussions in Project development meetings and ongoing communication with the relevant authorities to ensure compliance and progress. The permitting process, along with the associated documentation, is regularly reviewed and discussed with the responsible regulatory bodies to ensure alignment with all legal requirements.

4.3.1 ENVIRONMENTAL IMPACT ASSESSMENT

Vulcan has conducted a number of specific environmental assessments for its Projects, which are embedded in the permitting processes for the various Project segments and are carried out prior to the corresponding applications. Vulcan has completed a Species Conservation Evaluation (saP) as part of the permitting process for its geothermal projects. This assessment, required under Sections 44 and 45 of the Federal Nature Conservation Act (BNatSchG), involves a five-step procedure namely: (i) relevance test, (ii) inventory at the intervention site, (iii) test of prohibited species, (iv) test of early compensatory measures and (v) exception test) to evaluate and mitigate impacts on protected species and habitats. The saP, which is valid for five years unless environmental changes occur, includes an expert report on nature conservation that outlines current conditions, planned interventions, and measures to protect biodiversity. Vulcan must implement specific protective actions to comply with environmental regulations and safeguard local species.tt

4.3.1.1 GERMAN REQUIREMENTS

The Environmental Impact Assessment Act (Gesetz über die Umweltverträglichkeitsprüfung: UVPG) generally applies to all projects that may have a significant impact on the environment. It serves to implement Directive 2011/92/EU into German law. For certain project types, the UVPG refers to the environmental impact assessment laws of the federal states, which may include additional regulations.

For mining projects, including deep geothermal projects, the regulations of the Ordinance on the Environmental Impact Assessment of Mining Projects (Verordnung über die Umweltverträglichkeitsprüfung bergbaulicher Vorhaben: UVP-V Bergbau) also apply. There are two types of assessments under the UVPG: a full environmental impact assessment (Umweltverträglichkeitsprüfung: UVP) and a preliminary environmental assessment (Umweltverträglichkeitsvorprüfung: UVP-V). Both the UVP and UVP-V are assessments of the potential environmental impact of a project and are not permits themselves. These assessments influence the overall permitting process.

Annex 1 of the UVPG specifies which projects must undergo a full environmental impact assessment and which projects may require a UVP based on a preliminary assessment. For the latter, there are two types of preliminary assessments: A general UVP-V and a less detailed site-related UVP-V. For instance, if deforestation is required, a site-related UVP-V may be requested for deforestation of more than 1 hectare, while a general UVP-V is required for deforestation of more than 5 hectares.

In preparation for a preliminary assessment, either site-specific or general, Annex 2 of the UVPG requires that relevant information about the planned project be provided to the competent authority. This information should include a description of the Project and its site, as well as details about the assets that may be affected by the Project. Emissions, land, and water

consumption must also be considered. Additionally, any project characteristics intended to mitigate significant adverse environmental effects can be listed.

Specifically, the criteria for the preliminary assessment are outlined in Annex 3 of the UVPG and are divided into three categories:

1. Characteristics of the Project

2. Location of the Project

3. Type and Characteristics of the Possible Environmental Impacts

The competent authority is generally obliged to carry out the preliminary assessment. However, it is also permissible for the authority to review a preliminary assessment submitted by the Project proponent.

The following figure (Figure 4-2) illustrates the procedure for conducting an environmental assessment. Annex 1 of the UVPG defines the general decision-making process as to whether an UVP obligation exists. In this case, such a preliminary assessment is submitted to the competent authority as a decision guidance document. In this decision guidance, facts are stated, and an evaluation is made from the applicant's point of view. Based on this assessment, the competent authority decides in each individual case whether there is an UVP obligation.

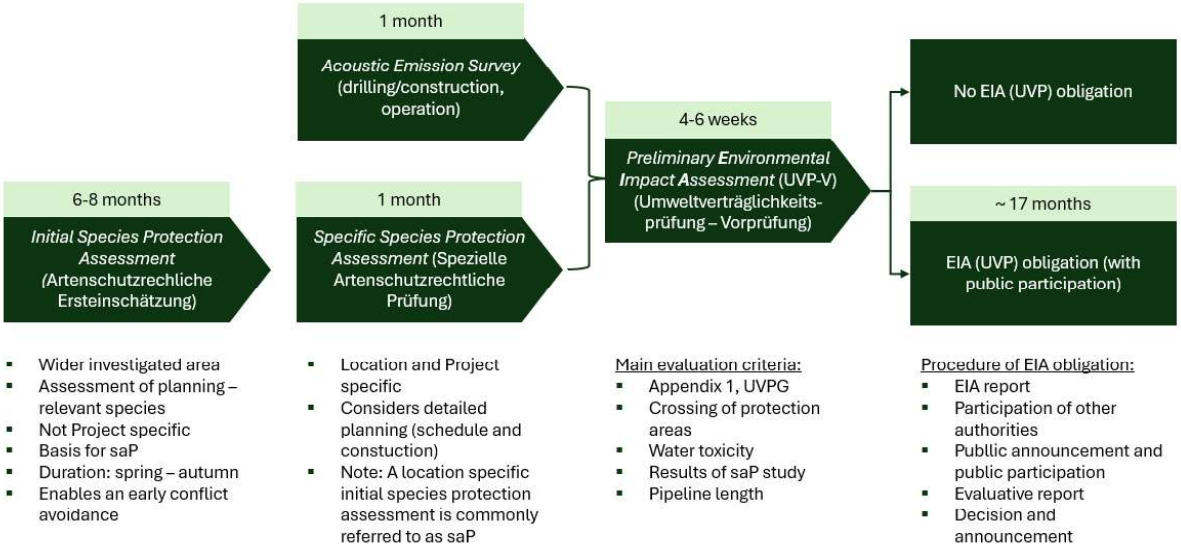


FIGURE 4-2 SELECTION PROCESS FOR ENVIRONMENTAL ASSESSMENT

In the case of an UVP obligation, the following procedure is to be applied:

- Information on the scope of investigation (§ 15 UVPG)
- Preparation of UVP report (§ 16 UVPG)
- Participation of the public and other authorities (§§ 17, 18 UVPG)
- Consideration of UVP report for authorisation decision (§§ 24, 25 UVPG)
- Notification and justification of authorisation decision (§§ 26, 27 UVPG)

In practice the UVP-V process, which is closely aligned with the species assessment procedure (saP), relies heavily on the foundational work already completed by the Institute for Natural History in Southwest Germany. This institute conducted a comprehensive saP for Vulcan's entire

license area (known as the Lionheart Cluster), during the spring and autumn seasons, focusing on large-scale evaluations and animal data collection, such as breeding times. This thorough groundwork allows for more efficient preparation of site-specific saPs. Once these evaluations are submitted to the relevant authority, a review period of approximately 90 days is anticipated, during which all aspects of the Project will be considered in the assessment.

4.3.1.2 PLAN APPROVAL PROCEDURE

Under §1 Abs. 8ff. UVP-V Bergbau, a mandatory environmental assessment for mining activities, including geothermal projects, is required if they impact protected areas under § 23 BNatSchG or if the results of an environmental pre-assessment are unsatisfactory to authorities. Vulcan intentionally avoids sites that fall under § 23 BNatSchG and optimises well site placements to minimise potential impacts to protected areas.

To avoid potential delays, Vulcan typically seeks permits under mining and building law, aiming to mitigate timeline risks and expedite the Project development process.

4.3.1.3 ENVIRONMENTAL CONSTRUCTION SUPERVISION

It is expected that the approval of a project will come with the condition of environmental construction supervision (Umweltbaubegleitung: UBB). This is a mechanism to ensure compliance with legal and technical aspects of environmental protection and nature conservation during the construction phase. The use of UBB aims to prevent unintentional or unauthorised interventions, environmental impacts, or damage, and to avoid possible construction stoppages. It also helps in avoiding associated compensation payments and fines.

UBB operates as an independent advisory service, collaborating with construction supervision and management in an advisory capacity. The environmental construction supervisor guides the Project team to carry out the work according to the plans and requirements. The supervisor has no direct authority over the Project team, except in cases of imminent danger. UBB ensures that environmental and nature conservation concerns are addressed, and environmental damage is avoided. For the Project team, this also reduces disruptions in the construction process and minimises liability risks.

At the beginning of the construction work, the presence of the UBB on the construction site is required to monitor the set-up. During the construction process, UBB conducts inspections both on scheduled dates and spontaneously. These inspections are documented in writing and with photographs, and the reports are made available to the Project team.

4.3.2 PERMITTING

As already mentioned, the environmental assessments described above are done prior to the actual permitting process. As an integral part, these assessments must be submitted together with the actual permit applications.

Due to the integrated nature of the Phase One Lionheart Project, several different permits are relevant. All of them are presented and discussed below (Table 4-1).

TABLE 4-1 PERMITS PERTINENT TO THE PHASE ONE LIONHEART PROJECT

Project Components/Activities	Applicable Permits
Drilling Operations and Well Sites	All mining operations from exploration to extraction and closure fall under Federal Mining Law and must go through the related permitting process. Therefore, all mining operations may only be conducted based on a valid operating plan (Betriebsplan). A distinction must be made between 3 different types of operating plans: A main operating plan (Hauptbetriebsplan: HBP) and a special operating plan (Sonderbetriebsplan: SBP) for specific operations are the most relevant in practice. In certain cases, a frame operating plan (Rahmenbetriebsplan: RBP) must also be submitted. In principle, the main operating plan is the central document for an approval of a specific Project. • **Main Operating Plan Seismic Exploration:** The main operating plan seismic exploration (Hauptbetriebsplan: HBP seismische Aufsuchung) is required for the establishment of a seismic exploratory operation. • **The main operating plan exploration** (Hauptbetriebsplan: HBP Aufsuchung) describes all work steps that lie between seismic exploration, development and actual extraction. A separate regional planning procedure (e.g. deviation procedure) is not required, as the well sites are in line with the regional planning concerns of the Rhine-Neckar Regional Plan, as already confirmed by the responsible authority SGD Süd. • **Special Operating Plan Well Site:** For Vulcan, this concerns the construction of the well site as a preparatory measure for later drilling operations. Specific information on the dimensioning of the well site is provided in the special operating plan well site (Sonderbetriebsplan: SBP Bohrplatz). The current situation and possible expansion of the access roads is also be considered. Specifically, information is provided on compliance with the provisions of the General Federal Mining Ordinance (Bundesberggesetz BBergG) and the law on environmental impact assessment (UVPG). Therefore, comprehensive assessments of the impacts on protected assets and the corresponding protective measures and compensatory measures are specified in the respective description plans. Other relevant topics include operational There will be one MOP for the entire Phase One Project (MOP Lionheart) I. safety and work safety as well as technical information on the drill pad construction measures. An estimated review period of the authorities is of 90 days. • **Special Operating Plan Drilling:** Analogous to the well site, a separate special operation plan is also submitted for drilling itself (Sonderbetriebsplan: SBP Bohren). Similar to the SOP Well Site, comprehensive assessments of the impacts on the protected assets and corresponding protective measures are described according to the law on environmental impact assessment

Project Components/Activities	Applicable Permits
	(UVPG). Furthermore, the drilling and test program with the drilling fluid and waste management concept as well es distinguished safety measures are explained, prioritising environmental protection and operational safety. • **Main Operating Plan Extraction:** Just as the exploration and development, the mining of mineral resources respectively of subsoil assets requires a main operating plan extraction (Hauptbetriebsplan: HBP Gewinnung). • **Frame Operating Plan:** In addition to the operating plans described above, the competent authority may also require a frame operating plan (Rahmenbetriebsplan: RBP). The RBP covers a longer timeframe, usually 10 to 20 years, and contains general information on the operation. Based on information to date, such operating plan is not mandatory for Vulcan's operations.
GLEP Plant	The separation of lithium chloride from the brine is legally classified as processing (*Aufbereitung)* according to the BBergG. As a result, the construction, operation, and closure of the LEP installations require a valid operating plan. Additionally, a building permit will be required for the construction of the LEP plant. • **Construction Permit:** The Construction Regulations (*Landesbauordnung: LBauO)* regulate which construction efforts require a construction permit (*Baugenehmigung),* and how they are to be constructed. Construction regulations are not federal laws, so they vary slightly between federal states. The LBauO will apply to the geothermal plant, the LEP and other surface facilities, for example on-site offices, warehouses, parking, etc., as they are considered buildings by LBauO. • **Main Operating Plan LEP:** While the duration of the construction permit is unlimited, the main operating plan LEP (*Hauptbetriebsplan: HBP LEP*) in accordance with § 52 para. 1 BBergG must be extended every two years. The documents necessary for the application will include a description of the site, as well as many technical details of the Direct Lithium Sorption process (DLS), such as a process description, a flow diagram, flowrates, implemented Health, Safety, Environmental (HSE) measures, interfaces with the wells, ORC, district heating, and many more.
ORC Plant	The ORC plant is subject to an independent permitting process, which will be described in the following. While the ORC plant is in principle covered by building law, the following also deals specifically with the n-butane tanks. These must be approved separately from the rest of the plant under the Federal Immission Control Act.

Project Components/Activities	Applicable Permits
	• **Permits under Building Law:** At the start of a building project, a preliminary building application (*Bauvoranfrage*) is typically submitted. This isn't a full permitting process but helps determine if and how the Project can be carried out. It requires basic engineering details of the ORC plant, a project description, and documents like a cadastral map and site plan. Detailed documents, such as static calculations, are only needed for the full building application. This preliminary application allows for discussion of key legal issues (e.g., height limits, zoning) with the competent authority and helps prepare local authorities for the next steps. While it doesn't guarantee the final permit, it provides some planning security and gives legal validity to approved aspects. For the actual building permit, both the Building Code (LBauO) and the Building Energy Act (GEG) are relevant. **Permits According to BImschG:** For the ORC hazardous substances, which includes large amounts of flammable working medium, a notice according§ 23 a BImSchG is relevant. This regulation is necessary because the working fluid qualifies as an ignitable liquid under the Major Accidents Ordinance (12th BImSchV), which deals with projects involving hazardous substances. If the amount exceeds specified thresholds, an § 23 b BImSchG permit process would be furthermore necessary. Specifically, the responsible authority ensures with the § 23a BImSchG notice that the plant maintains a safe distance from neighbouring protected areas in case of incident and that there is no significant increase in risk, so that no permit under § 23b BImSchG is required. Since the ORC plant itself does not fall under § 23 b BImSchG or § 10 BImSchG, a standard building permit from the municipal building authority will be required instead.
ICPP	According to the current project status, the ICPP is not a spatially significant project and complies with the spatial planning requirements of the Rhine-Neckar regional plan, so that at most a simplified spatial planning assessment will suffice. The ICPP is also classified as a long-distance water pipeline in accordance with the German Environmental Impact Assessment Act (UVPG) and therefore only requires Pre-EIAs for individual sections. The Pre-EIA confirms that there are no significant impacts that require an EIA. For the individual project components such as ICPP, well sites, etc., the environmental impact is assessed cumulatively with each successive Pre-EIA. The Pre-EIA confirms for each project component that there are no significant environmental impacts that require an EIA obligation, so that there is a reduced approval risk

Project Components/Activities	Applicable Permits
	for the overall project, as each individual component is already comprehensively assessed and approved.
CLP	The CLP is subject to the BImSchG. The permit application is prepared by Infraserv on Vulcan's behalf. Since the CLP is clearly mentioned in the 4. BImSchV, a permitting process according to §10 BImSchG is necessary. Also, an UVP-V will be conducted to assess whether an UVP is obligatory, which, based on precedent in the Industrial Park, is not expected to be the case. The situation in Höchst is different from the other permitting processes, as the site is in a pre-established industrial zone for large-scale chemical installations. Vulcan will be supported by Infraserv Höchst as the operator of the chemical park and its infrastructure during the permitting process. Infraserv has specialised personnel to draft the necessary permitting documents and will procure all necessary documents from Vulcan. The necessary documents will include a process description, flow diagrams, apparatus list, installation plans, quantity balance, substance data, waste production, energy efficiency, noise emissions forecast, occupational and workplace safety, fire protection, and handling of hazardous substances. By law, the authority has 7 months to decide on the permit, beginning after the authority asses the provided documents are complete.

4.4 APPLICABLE INTERNATIONAL REGULATIONS

This section presents a summary of the most important international and EU laws and directives that largely shape Germany's own regulatory environment when considering renewables projects.

4.4.1 THE AARHUS CONVENTION

All EU member states are subject to the commitments under the Aarhus Convention, or the United Nations Economic Commission for Europe (UNECE) Convention related to access to information, public participation in decision-making and access to justice in environmental matters. The Aarhus Convention is the primary international agreement on environmental democracy that serves to protect all living people's right to live in a healthy environment. More specifically, it guarantees the protection of three essential rights:

- **Access to information:** The public reserves the right to receive and access environmental information from public authorities. This may include information pertaining to the state of the environment, public health and safety matters, and policies or measures that do/may affect the environment.
- **Public Participation:** The public has the right to participate in environmental decision-making. Participation is encouraged and should be meaningful.

- **Access to Justice**: The public has the right to request or be granted a review in which courts or other independent authorities are expected to ensure that their rights are fully protected, and environmental law is respected.[35]

The consequent directives correlating with the rights listed above are the:

- **Access to Environmental Information Directive** (2003/4/EC);
- **The Public Participation Directive** (2003/35/EC);

Both directives include specific measures to safeguard and specific justice provisions, to ensure that access to justice is sufficiently protected. The European court of Justice has consequently developed a significant and comprehensive system to handle the protection of these rights. [36]

Germany meets the criteria of the Aarhus Convention for Modern Environmental Policy, meaning that: environmental assessments in Germany adhere to both international and European requirements, especially when it concerns permitting decisions related to industrial and infrastructural development and environmental programs and policy. [37]

4.4.2 EUROPEAN UNION DIRECTIVES

As a core member of the European Union, Germany is required to observe and implement EU regulations and directives, as specified in the section above; regulations and directives become binding for member states upon the creation of such legislation. Thus, German law is closely aligned with and shaped by EU law and targets.[38]

Beyond the directives linked to the Aarhus Convention, EU legislation does ascertain fundamental requirements for EIA and SEAs at national levels. The EIA Directive lays out individual steps for member states to include and consider depending on project type; the SEA Directive also stipulates procedural steps for member states. The SEA Directive also specifies which plans and programs require an SEA. Germany has incorporated such provisions into national law: Environmental Impact Assessment Act (UVPG). [39]

4.4.3 ESPOO CONVENTION ON TRANSBOUNDARY EIAS

Germany is a signatory of the 1991 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and its two amendments. This convention is a further call for public participation in environmental planning and decision-making, requiring authorities

[35] Source: European Commission, The Aarhus Convention and the EU, retrieved from: https://environment.ec.europa.eu/law-and-governance/aarhus_en, accessed in August 2023.
[36] Source: European Commission, The Aarhus Convention and the EU, retrieved from: https://environment.ec.europa.eu/law-and-governance/aarhus_en, accessed in August 2023.
[37] Source: Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, Environmental Assessments EIA/SEA, retrieved from: https://www.bmuv.de/en/topics/education-participation/participation/environmental-assessments-eia-sea#c19048, accessed in August 2023.
[38] Source: The Federal Government, Germany and Europe, retrieved from: https://www.bundesregierung.de/breg-en/issues/europe/germany-and-europe-228936#:~:text=Implementing%20European%20acts%20in%20Germany,They%20constitute%20immediately%20applicable%20law., accessed in August 2023. Source: The Federal Government, Germany, and Europe, retrieved a
[39] Source: The Federal Government, Germany and Europe, retrieved from: https://www.bundesregierung.de/breg-en/issues/europe/germany-and-europe-228936#:~:text=Implementing%20European%20acts%20in%20Germany,They%20constitute%20immediately%20applicable%20law., accessed in August 2023. Source: The Federal Government, Germany, and Europe, retrieved a

and any public that might be in potentially affected neighbouring *countries* to be included in a transboundary EIA. The Convention requires states to notify and consult with each other on major project considerations.[40] This must be conducted prior to project approval and in cases where transboundary environmental impacts are foreseen. [41]

The prescribed measures in the Espoo Convention have since been integrated into German national laws and environmental regulations, particularly the UVPG. Participation procedures apply to Germany's neighbouring countries, and concrete agreements have been explicitly signed between Germany and the Netherlands, Poland, France, and Switzerland to ensure that practical applications are effective and feasible.[42] Additional information on the Espoo Convention can be found on the Espoo secretariat website or at the corresponding UNECE webpage here.

UN Protocol on Strategic Environmental Assessments Germany is party to the UNECE Protocol on Strategic Environmental Assessment or SEA Protocol (2003): Requiring signatories to carry out SEA for certain plans and programs and to include extensive public participation in the governmental decision-making process. The protocol came into effect in July 2010. As with other directives and protocols this too has been integrated into national laws and the UVPG. [43]

The protocol is aligned with the UN Millenium Development Goals Targets 1 and 7, "to ensure environmental sustainability and integrate sustainable development into country policies and programs and reverse the loss of environmental resources", respectively; it is also aligned with the Rio Declaration on the Environment and Development, namely Principle 4: "In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it."[44] The full protocol can be accessed as a pdf via the UNECE website here.

4.5 INTERNATIONAL APPLICABLE STANDARDS

In addition to the National regulations, the Project is required to comply with following international standards related to environmental and social aspects:

- **IFC Performance Standards on Social and Environmental Sustainability (2012)**

PS 1: Assessment and Management of Environmental and Social Risks and Impacts
PS 2: Labour and Working Conditions
PS 3: Resource Efficiency and Pollution Prevention
PS 4: Community Health, Safety and Security
PS 5: Land Acquisition and Involuntary Resettlement

[40] Source: United Nations Economic Commission for Europe, Environmental Assessment, retrieved from: https://unece.org/environment-policy/environmental-assessment, accessed in August 2023.
[41] Source: The Federal Government, Germany and Europe, retrieved from: https://www.bundesregierung.de/breg-en/issues/europe/germany-and-europe-228936#:~:text=Implementing%20European%20acts%20in%20Germany,They%20constitute%20immediately%20applicable%20law., accessed in August 2023. Source: The Federal Government, Germany, and Europe, retrieved a
[42] Source: The Federal Government, Germany and Europe, retrieved from: https://www.bundesregierung.de/breg-en/issues/europe/germany-and-europe-228936#:~:text=Implementing%20European%20acts%20in%20Germany,They%20constitute%20immediately%20applicable%20law., accessed in August 2023.
[43] Source: The Federal Government, Germany and Europe, retrieved from: https://www.bundesregierung.de/breg-en/issues/europe/germany-and-europe 228936#:~:text=Implementing%20European%20acts%20in%20Germany,They%20constitute%20immediately%20applicable%20law., accessed in August 2023.
[44] Source: UNECE, Introduction to the SEA Protocol, retrieved from: https://unece.org/introduction-sea-protocol, accessed in August 2023.

PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
PS 7: Indigenous Peoples [45](Not Applicable)
PS 8: Cultural Heritage

- **Equator Principles IV (2020)**
- **European Investment Bank (EIB) Environmental and Social Standards (2022)**
- **IFC General Environmental, Health and Safety (EHS) Guidelines[46]** - The EHS Guidelines are technical reference documents that address IFC's expectations regarding the environmental management performance of its projects. They are designed to assist managers and decision makers with relevant industry background and technical information.
- **International Labour Organisation (ILO)**'s fundamental conventions concerning the abolition of child labour, the elimination of discrimination at the workplace and the elimination of forced and compulsory labour; and
- **International best practice** regarding the mitigation of impacts and consideration of minorities and vulnerable persons.

[45] PS 7 is not applicable as none of the following social and cultural groups were identified in the Project site and/or surroundings: Members self-identified of a distinct indigenous ethnic or cultural group; collectively attached to distinct habitats, traditional lands, or ancestral territories; members with customary cultural, economic, social or political affiliations, speaking a distinct language or dialect.
[46] https://www.ifc.org/wps/wcm/connect/29f5137d-6e17-4660-b1f9-02bf561935e5/Final%2B%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES&CVID=nPtguVM

5. ESIA PROCESS AND METHODOLOGY

The purpose of the ESIA process is to examine how the Project will lead to a measurable difference in the quality of the environment and the quality of life of impacted individuals and communities and to develop suitable mitigation measures.

The key stages for the ESIA process for this Project include:

- Scoping Phase
- Assessment of impacts and identification of mitigation measures
- Stakeholder engagement

Figure 5-1 sets out the approach that ERM adopts during ESIA studies; a methodology that has been well-proven on many successful ESIA projects around the world. It must be noted that the ESIA is not a linear process, but one where several stages will be carried out in parallel and where the assumptions and conclusions are revisited and modified as the Project and ESIA process progresses.

The following sections provide detail on how each stage of the ESIA process were and will continue to be applied to the Project.

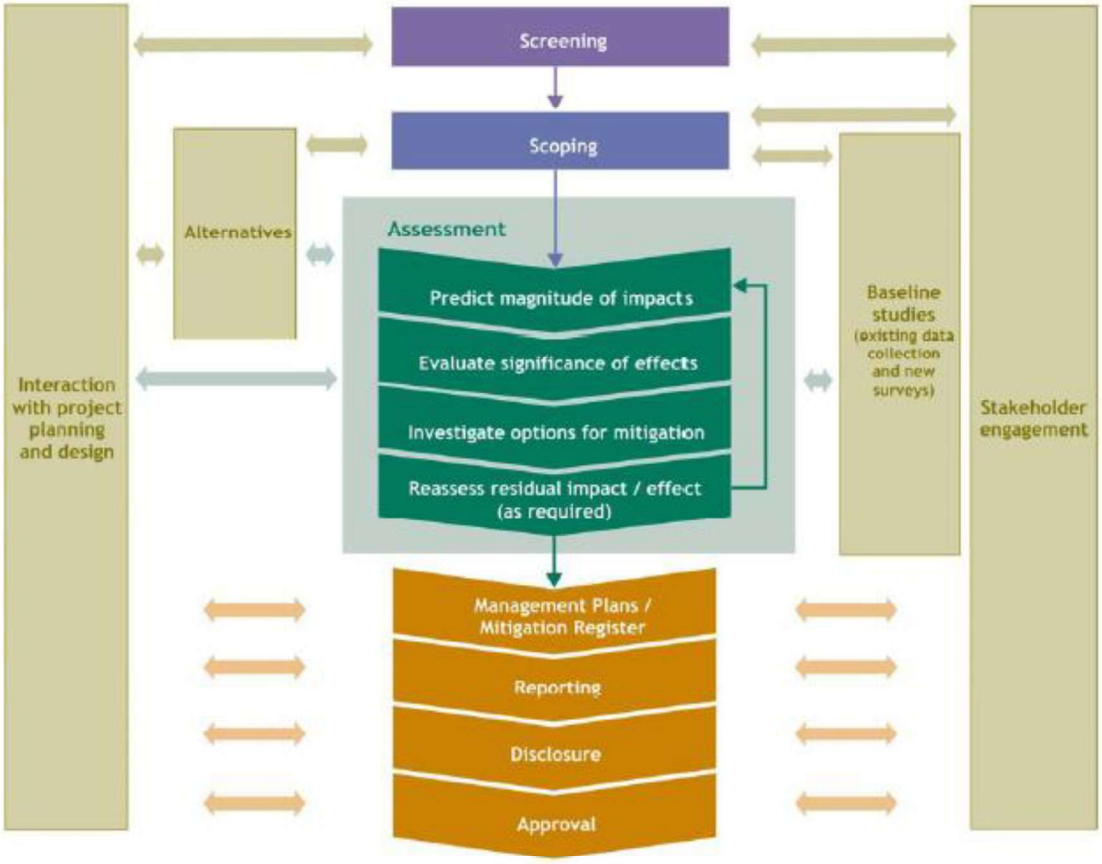


FIGURE 5-1 ERM'S ESIA APPROACH

5.1 SCOPING

In accordance with International Standards and EC Guidelines for EIA, scoping is the first phase of the ESIA process, which is used to identify key sensitivities in relation to the Project's proposed location and affiliated activities that have the potential to contribute to, or cause, significant impacts to environmental and social receptors and resources. The output of the scoping stage was the follow up specialist studies that will be used to inform later stages of the ESIA process.

The Scoping Report prepared by ERM in September 2023 for the Project:

- Presented a description of the Project and the relevant alternatives.
- Presented an overview of relevant German legislation and international best practices that should be followed during the ESIA process.
- Presented the ESIA process (including impact assessment methodology).
- Presented the methods and outcomes associated with initial (scoping) stakeholder engagement and future engagement plans that will be used during the impact assessment process.
- Presented a brief overview or baseline description of the physical, biological, and social characteristics of the Project area.
- Identified and presented the potentially physical, biological, and social impacts that need to be assessed further (as part of the ESIA), and recommendations to address such impacts; and
- Presented the Terms of References (ToR) for the ESIA processes.

5.2 IMPACT ASSESSMENT METHODOLOGY

Environmental impact assessment is the process of determining the types and significance of effects a project will have on the environment, and the various components thereof, and is the core of the ESIA process (Hardner et al., 2015). Impacts typically vary according to the Project being assessed as well as the context of the receiving environment where the Project is located.

The impact assessment process predicts and describes impacts that are expected to occur for different phases of the Project. For this project, construction, operation, and decommissioning phases are assessed as relevant to the infrastructural components and activities.

ERM's standard Impact Assessment Methodology presented in Figure 5-2 follows international good practice as recognised and accepted by Equator Banks, IFC and other international lenders. The potential impacts of the Project (i.e., the interaction of elements of the physical, biological, cultural or human environment) are assessed against the baseline conditions of the Project's Area of Influence (AoI).

The significance of an impact is assessed because of the impact magnitude (which depends on extent, duration and other impact descriptors) and the sensitivity characteristics of resources and receptors. The resulting impact significance is then defined in terms of negligible, minor, moderate, major – or positive.

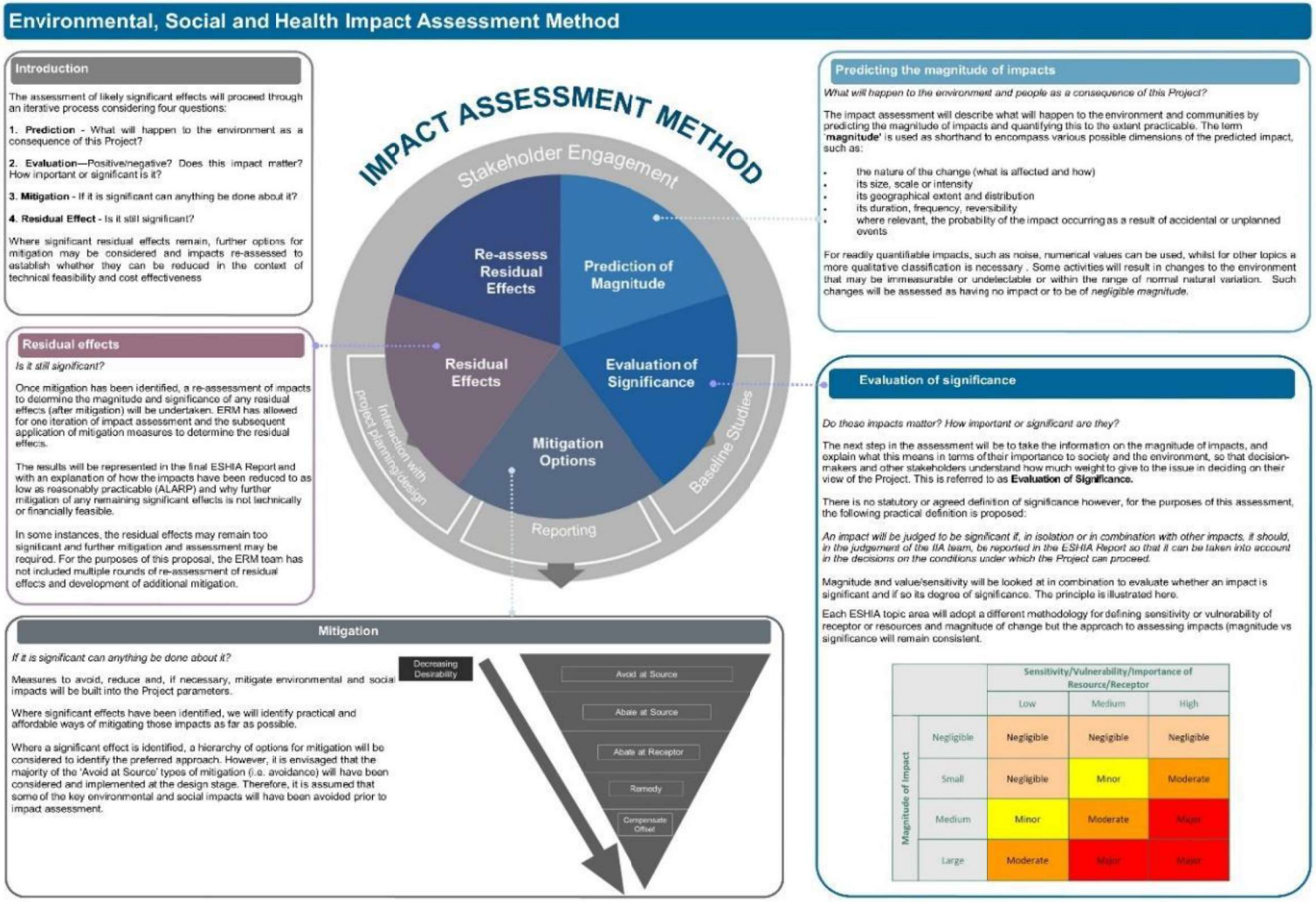


FIGURE 5-2 ERM IMPACT ASSESSMENT METHODOLOGY

5.3 ASSUMPTIONS AND LIMITATIONS

The following assumptions, limitations and information/data gaps apply to the assessment of impacts and baseline data collection informing the ESIA:

- The baseline assessment completed to inform the ESIA deals exclusively with a defined area (the Project AoI) and the extent and nature of receptors present in this focal area of study.
- Limited baseline surveys have been conducted as part of this study and the majority of data has been collected through publicly available databases and information provide by Vulcan.
- ERM has used the latest available global and national spatial information and data for biodiversity, based on the status of these datasets and databases at the time of the assessment. The status of these datasets and databases may however change in future with improved data. Note also that data and information obtained from published articles, reference books, field guides, official databases or any other official published or electronic sources are assumed to be correct, and no review of such data or information was undertaken by ERM.
- The supplementary assessment of the potential occurrence of fauna/flora using IBAT data was informed by the known/modelled distribution of species from the IUCN database of threatened species and ERMs interpretation of the suitability of habitat in the AoI to support these species based on their documented habitat requirements/preferences. The habitat condition / integrity was therefore used as a surrogate indicator of the likelihood of a particular species being present.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field surveys completed by third parties (separate to ERM), ERMs brief site visit and desktop-assessment and based on ERMs working knowledge and experience with similar development projects. The assessment of impacts was also informed by the assessment of baseline conditions concerning ecosystems, habitats and species in the Project AoI at the time of the assessment, in combination with information provided by Vulcan which is deemed to be true and correct at the time of the impact assessment. Any changes to the Project design, layout and activities could potentially result in a change in impact ratings, and these should be reviewed in such instances.
- ERM's assessment has included embedded mitigation (i.e. mitigation measures embedded into Project design and through national level assessments and surveys). ERM has not scrutinised these measures but ensured that additional mitigation listed by ERM aligns with these measures or supports/enhances these and avoids any conflict that implementing mitigation for the various impact topics.
- Measures to mitigate and manage impacts are based on ERMs project-level experience in addressing similar development scenarios, are intended to be site-specific enough to address the nature of the resources and receptors reflected in the baseline and are informed by good international industry practice as far as possible.

5.4 APPROACH AND METHODS

The approach to the assessment of the potential impacts of the Project is as follows:

5.4.1 STEP 1: DEFINING THE AREA OF INFLUENCE

The spatial scope of the Project, including the "Area of Influence" (AoI), is used to describe the boundaries of the extent to which Project impacts may be felt by the various relevant environmental receptors. The AoI of a project can vary depending upon the type of impact being considered and the attributes of the potentially affected receptors and may also extend across administrative areas. The AoI can also typically extend well beyond a Project's physical footprint, to account for not only direct impact but also indirect impacts and even induced impacts in some cases.

Generally, the AoI for the Project has been defined using a composite buffer of 250m for pipeline and 500m for other Project components, (based on distances for noise and dust nuisances mainly from literature review) to encompass:

- The primary Project site and associated infrastructure (pipeline corridor, infrastructure development sites, drill sites and pads);
- Related facilities (including access roads, stockpile areas, dump sites, worker camps, material storage and equipment laydown areas);
- Associated facilities whose viability and existence depend exclusively on the Project;
- Areas potentially impacted by the extraction of raw materials or where construction materials or products may be produced;
- Areas potentially affected by impacts from unplanned but predictable impacts caused by the Project; and
- Areas potentially impacted by cumulative impacts from further planned development of the Project.

Importantly, the AoI can and often is different for environmental vs social aspects of projects, due to the nature of the individual receptors. As such, the AoI is defined for these topics separately in the ESIA report.

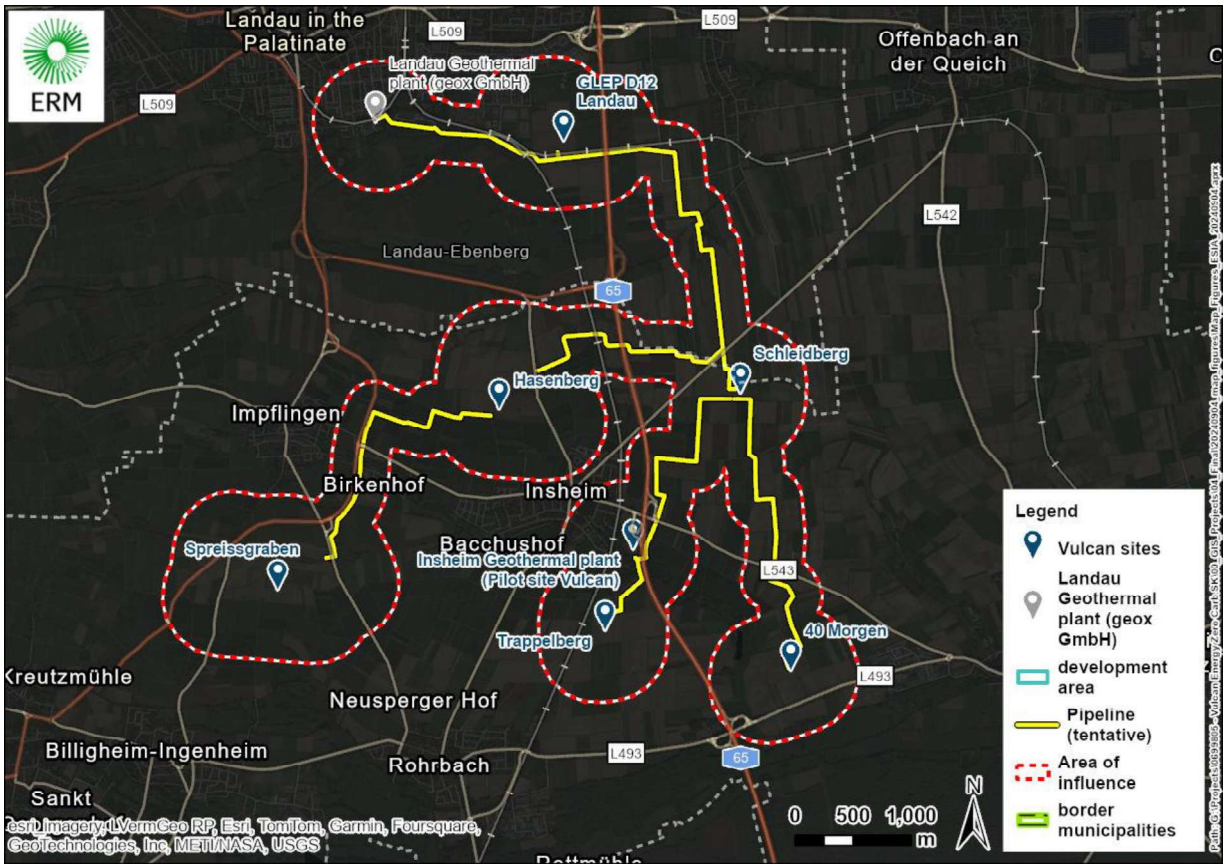


FIGURE 5-3 PROJECT AREA OF INFLUENCE (NOISE & DUST)

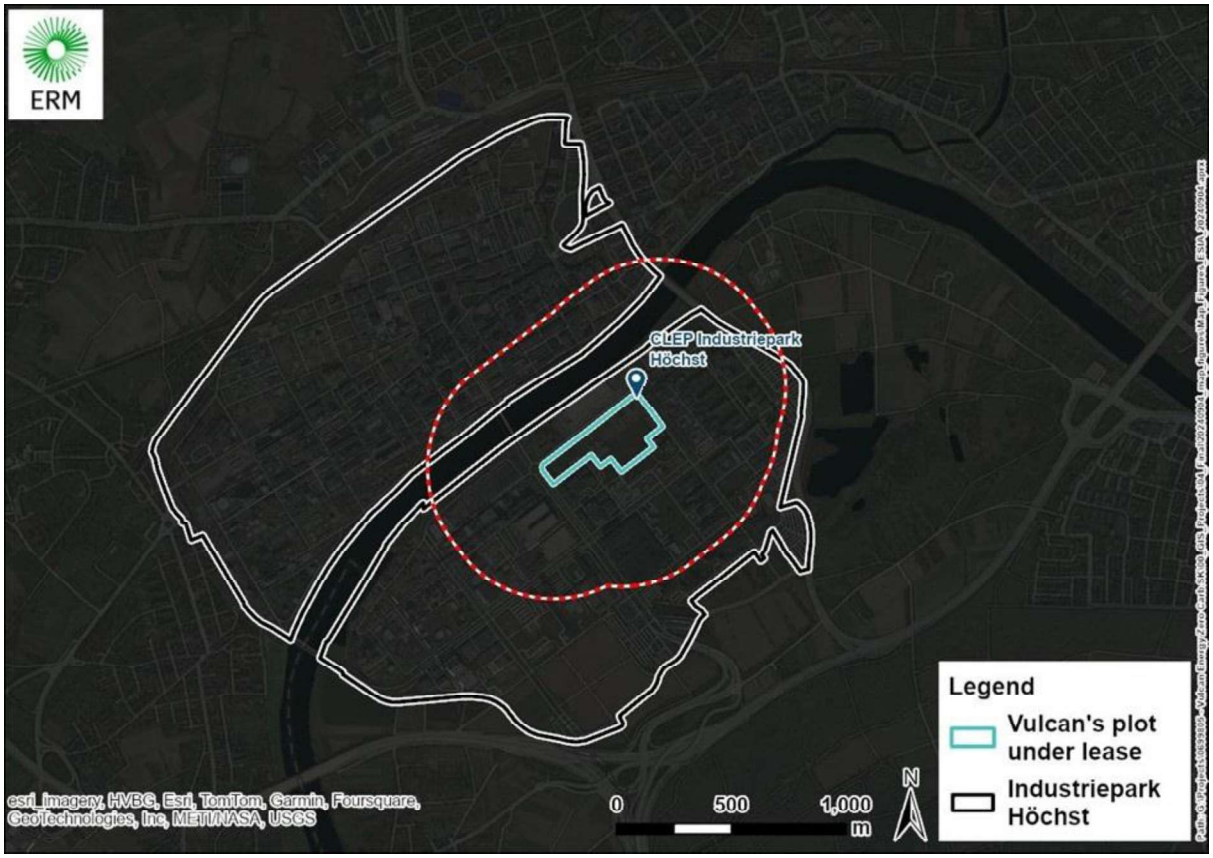


FIGURE 5-4 FRANKFURT HÖCHST AREA OF INFLUENCE (NOISE & DUST)

5.4.2 STEP 2: IDENTIFICATION OF ENVIRONMENTAL RECEPTORS AND VALUES

Once the AoI had been defined, the various environmental receptors for the physical environment, biodiversity (biological environment) and socio-economic environment were identified within the AoI, together with receptor 'values' (*also termed 'features' or 'attributes'*) and the sensitivity of the various environmental receptors was evaluated through baseline assessment (combination of desktop and field surveys conducted to establish the environmental baseline).

5.4.3 STEP 3: IDENTIFICATION OF IMPACTS

Potential impacts of the Project on the environmental receptors and values were identified at the next step, including site-specific direct, indirect, and where relevant - induced impacts. Definitions for each impact category are provided in Table A. The following guidelines were also referred to in identifying and describing impacts:

- "Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning" (Hardner et al., 2015).
- "Impact Significance Determination - Design Approach" (Lawrence, D., 2007).
- ERM Impact Assessment Standard (internal ERM guideline).

TABLE 5-1 IMPACT CATEGORIES AND DEFINITIONS (ADAPTED FROM HARDNER ET AL., 2015)

Impact Category	Definition	Relevance
Direct impacts	*Are those impacts directly linked to the Project and associated with the Project development footprint and related planned activities (e.g., clearing of land and vegetation, extraction of water, contamination of water bodies, blasting, sedimentation and change in water table levels).*	Direct impacts are likely to be the most easily identifiable and manageable.
Indirect impacts	*Are those impacts resulting from the Project and related activities, or 'by-products' thereof, that may occur within the broader Project's AoI (Area of Influence), beyond or downstream of the boundaries of the Project site and/or which may continue sometime after the Project activity has ceased (e.g., migration of pollutants from waste sites, air emissions, reduced flow in downstream rivers).*	Indirect impacts stimulated by projects can be significant and can go undetected in some cases as their link to direct impacts and causal activities or actions may not be easily identifiable.
Induced impacts	*Often included as indirect impacts, induced impacts are somewhat different as they are typically not directly attributable to the Project but are anticipated to occur because of the presence of Project (e.g., impacts of associated industries, establishment of infrastructure likely to result in increased pressure on biodiversity).*	As with indirect impacts, induced impacts can be significant but are inherently difficult to identify and assess and therefore sometimes overlooked.
Cumulative impacts*	*These are successive, incremental and/or combined (aggregated) impacts from the Project and the impacts from other past, existing and reasonably foreseeable future projects or activities that could affect the same biodiversity or natural resources (e.g. a cluster of multiple similar developments occurring in the same catchment or ecosystem type collectively affecting habitat, water quality or flow, or impacting the same locally endemic species).*	Cumulative impacts can be highly significant for sensitive species and ecosystem services but are often overlooked. The need for an assessment of cumulative effects must be considered throughout the ESIA process and generally include an analysis of clusters of projects, land use change trends, and/or foreseeable developments within, or near the Project AoI (Area of Influence).

5.4.4 STEP 4: ASSESSMENT OF IMPACT SIGNIFICANCE

Impact significance is the product of the value or importance of the environmental components that will be impacted and the intensity or magnitude (degree and extent of change) of the impact on those resources, systems and/or components. Put another way, impact significance is defined broadly as a measure of the 'desirability, importance and acceptability of an impact to society' (Lawrence, 2007). Some regulators, lenders, or corporate standards will use the term "significant" to refer to a threshold of consequence and/or risk that requires management or may not be acceptable. Impact categories for significance are presented and described in Table 5-2:

TABLE 5-2 IMPACT SIGNIFICANCE CATEGORIES

Impact Significance	Description and potential implications
Critical	• Typically characterised by an unacceptable and fatally flawed impact or activity. • Such impacts should be avoided and there is generally limited opportunity for offset/compensatory mitigation due to the high level of irreplaceability of the impacted component of the environment. • The proposed activity should only be approved under special circumstances.
Major	• An accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. • Generally unacceptable unless offset/compensated for by positive gains in other aspects of the environment that are of critically high importance (i.e. national or international importance only). • Strict conditions and high levels of compliance and enforcement are required. • The potential impact will have a strong influence on the decision regarding the proposed activity and thus, a clear and substantiated need and desirability for the Project needs to be provided, to justify the associated ecological risks. • It is ultimately the function of regulators and stakeholders to weigh such negative factors against the positive factors of a project, such as the creation of opportunities for employment, in coming to a decision on the Project.
Moderate	• Impact has potential to be significant but is acceptable provided that there are strict conditions and high levels of compliance and enforcement such that the impact remains within accepted limits and standards. • If there is reasonable doubt as to the successful implementation of the strict mitigation measures, the impact should be considered unacceptable. • The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable. • The potential impact should influence the decision regarding the proposed activity and requires a clear and substantiated need and desirability for the Project to justify the risks.
Minor	• An impact of minor significance is one where an effect will be experienced, but the impact magnitude is sufficiently small (with and without mitigation) and will within accepted standards, and/or the receptor is of low sensitivity/value. • Typically, acceptable with moderately-low to moderate risks provided that generic mitigation is applied and routine inspections undertaken. • The potential impact may not have any meaningful influence on the decision regarding the proposed activity.
Insignificant	• An impact of negligible significance (or an insignificant impact) is where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be `negligible` or `imperceptible` or is indistinguishable from natural background variations. • Should not have any meaningful influence on the decision regarding the proposed activity. • Basic duty of care shall be ensured.

The approach to impact significance assessment is based on the traditional risk assessment formula which rates the **magnitude of effect** (see Table 5-3) as the realistic 'worst-case' consequence or end-point of a project activity based on the perceived **importance and/or sensitivity** of a particular environmental receptor (see Table 5-4).

Magnitude (Table 5-3) essentially describes the intensity of the change that is predicted to occur in the resource/receptor because of the impact. A magnitude rating tends to reflect a combination of the size of an area that may be affected, the duration over which the aspect may be altered, and the size, degree or scale of that change. In essence, magnitude is a descriptor for the degree of change that is predicted to occur in the resource or receptor. The term 'magnitude' therefore encompasses all the characteristics of the predicted impact including:

- Extent;
- Scale;
- Duration;
- Frequency; and
- Likelihood or probability.

TABLE 5-3 QUALITATIVE RATINGS OF MAGNITUDE OF EFFECT

Environmental Aspect / Component	Magnitude of Effect			
	Negligible	**Small**	**Medium**	**Large**
Physical	Immeasurable, undetectable or within the range of normal natural variation.	Minimal disturbance to receptor. Slight change in air/water/soil quality expected over a limited area with water quality returning to background levels within a few meters. Discharges are well within benchmark emissions/ effluent discharge limits.	Localised and/or short-term disturbance to receptor. Temporary or localised change in air/water/soil quality with water quality returning to background levels thereafter. Occasional exceedance of benchmark emissions/ effluent discharge limits.	Widespread and/or long-term disturbance or permanent change to receptor. Change in air/water/soil quality over a large area that lasts over the course of several months with quality likely to cause secondary impacts on ecology. Routine exceedance of benchmark emissions/ effluent discharge limits.
Biodiversity	Effect is within the normal range of natural variation for the habitat or population of the species.	Habitat: Affects only a small area of habitat, such that there is no loss of viability / function of the habitat. Species: Effect does not cause a substantial change in the population of the species, or other species dependent on it.	Habitat: Affects a sufficient proportion of the habitat that the viability/function of part of the habitat or the entire habitat is reduced but does not threaten the long-term viability of the habitat or species dependent on it. Species: Effect does not cause a substantial change in the population of the species, or other species dependent on it.	Habitat: Affects the entire habitat or a significant proportion thereof, to the extent that the viability/function of the habitat is threatened. Species: Affects entire population, or a significant part of it causing a substantial decline in abundance and / or change in and recovery of the population (or another dependent on it) is not possible either at all, or within several generations due to natural recruitment (reproduction, immigration from unaffected areas).

Environmental Aspect / Component	Magnitude of Effect			
	Negligible	**Small**	**Medium**	**Large**
Socio-economic	Change remains within the range commonly experienced within the social-economic context.	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.	Clear difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional, and impact may be regional in scale.	Change dominates over baseline conditions. Affects most of the area or population in the Area of Influence and/or persists over many years. The impact may be experienced over a regional or national area.

Characterisation of receptor importance and sensitivity (Table 5-4)requires a range of physical, biological, cultural, or human factors to be taken into account and may also need to include other factors such as legal protection, government policy, stakeholder views and economic values. For a physical or biological resource or receptor (e.g., a water feature, soil parameter or vegetation type), this takes into account its conservation status and importance (on a local, national and international scale), its vulnerability to disturbance, and its resilience to recover or withstand a specific impact or type of impact. Where the receptor is human or cultural, the value of that social and cultural heritage receptor/s and its vulnerability to the impact is considered, considering the receptor's resilience, including ability to adapt to change or use alternatives where available.

TABLE 5-4 QUALITATIVE RATINGS OF RECEPTOR IMPORTANCE & SENSITIVITY

Environmental Aspect / Component	Receptor Importance / Sensitivity			
	Negligible	**Low**	**Medium**	**High**
Physical	Physical environmental values are lacking or are of little to no discernible interest whose loss is most likely to be acceptable and replaceable. Such receptors are considered resilient,	Existing airshed/water/soil quality is good and the ecological resources that it supports are not sensitive to disturbance	Existing airshed/water/soil quality shows some signs of stress and/ or supports ecological resources that could be sensitive to change in quality or physical disturbance (secondary ecological impacts are possible).	Airshed/water/soil quality is already under stress and/ or the ecological resources it supports are very sensitive to change (secondary ecological impacts are likely).

Environmental Aspect / Component	Receptor Importance / Sensitivity			
	Negligible	**Low**	**Medium**	**High**
	having the ability to easily avoid negative Project impacts, or to cope with, resist or recover from the consequences of a such an impact with negligible changes, or will derive little benefit or opportunities from the Project.			
Biodiversity	Habitats with negligible interest for biodiversity. Typically include modified habitats or artificial habitats of low importance. Species with no specific value or importance attached to them, typically common resident species with large global population sizes and stable or increasing populations according to the IUCN.	Habitats with no or local designation / recognition; habitats of significance for species of Least Concern (LC) on IUCN RDL of Threatened Species; habitats which are common and widespread within the region, or with low conservation interest based on expert opinion. Species and sub-species of LC according to the IUCN or not meeting criteria for medium or high value.	Habitats within nationally designated or recognised areas, habitats of significant importance to globally Vulnerable (VU) Near Threatened (NT), or Data Deficient (DD) species, habitats of significant importance for nationally restricted range species, habitats supporting nationally significant concentrations of migratory species and / or congregatory species, and low value habitats used by species of medium value. Species listed by the IUCN as VU, NT, or DD, species protected under national legislation, nationally restricted-range species, nationally important numbers	Includes critical habitats as determined through a formal critical habitat assessment process and high-value natural habitats typically located within internationally designated or recognised areas; habitats of significant importance to globally Critically Endangered (CR) or Endangered (EN) species, habitats of significant importance to endemic and/or globally restricted-range species, habitats supporting globally significant concentrations of migratory species and / or congregatory species, highly threatened and/or unique ecosystems, areas associated with key evolutionary species, and low or medium value habitats used by high value species. Species that typically qualify as critical habitat. Includes species with CR or EN threat status according to the IUCN. Nationally or internationally important populations of Annex II or Annex IV

Environmental Aspect / Component	Receptor Importance / Sensitivity			
	Negligible	**Low**	**Medium**	**High**
			of migratory, or congregatory species, species not meeting criteria for high value, and species vital to the survival of a medium value species. Includes species considered 'Priority Biodiversity Features', regardless of threat status.	species. Species with restricted ranges or global breeding ranges for birds of less than 50,000 km^2. Internationally important concentrations of migratory and/or congregatory species, key evolutionary species, and species vital to the survival of a high value species.
Socio-economic	Social/cultural values are lacking or are of little to no discernible interest whose loss is most likely to be acceptable and replaceable. Such receptors are considered resilient, having the ability to easily avoid negative Project impacts, or to cope with, resist or recover from the consequences of a such an impact with negligible changes, or will derive little benefit or opportunities from the Project.	Minimal vulnerability: Consequently, with a high ability to adapt to changes brought by the Project and opportunities associated with it.	Some, but few areas of vulnerability; still retaining an ability to at least in part adapt to change brought by the Project and opportunities associated with it.	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project and opportunities associated with it.

A qualitative impact rating matrix (Table 5-5) is used to rate impact significance based on the combined understanding of impact magnitude and receptor importance/sensitivity.

TABLE 5-5 MATRIX USED TO RATE IMPACT SIGNIFICANCE

Environmental Receptor Importance / Sensitivity	Magnitude of Effect			
	Negligible	**Small**	**Medium**	**Large**
Negligible	Insignificant	Insignificant	Insignificant	Insignificant
Low	Insignificant	Insignificant	Minor	Moderate
Medium	Insignificant	Minor	Moderate	Major
High	Insignificant	Moderate	Major	Critical

Impacts are assessed assuming that the mitigation measures that form part of the Project design (**embedded measures**) are implemented prior to the implementation of any additional measures. Embedded measures include:

- Design measures that seek to avoid or minimise impacts explored during the Project design phase;
- Alternatives considered already (with justification);
- The client/developers internal ESMS, policies or standard practices for construction/operation;
- Existing environmental permit / authorisation conditions and/or legal requirements around impact mitigation;
- Requirements to mitigate impacts as per an existing feasibility, technical or local EIA study that has been completed and accepted.

5.4.5 STEP 5: IMPACT MITIGATION AND MANAGEMENT MEASURES

Appropriate impact mitigation and management measures are recommended to reduce the magnitude (based on aspects that include the scale, probability, and intensity of impact) and thereby reduce the significance of the impact consequence to an environmentally acceptable level where possible. The following best/good practice guidelines were referred to closely for informing impact management and the suite of mitigation measures listed, which builds on the recommendations made in the local EIA for Germany:

- Good Practices for Biodiversity Inclusive Impact Assessment and Management Planning" (Hardner et al., 2015).
- "A cross-sector guide to implementing the Mitigation Hierarchy" (Ekstrom et al., 2015).

It is important to have a solid basis for recommending mitigation measures. The role of any given ESIA is to help develop an approvable project, and to help clients meet their business objectives in a responsible manner. As a result, all the mitigation measures listed by ERM as part of this study are considered commitments by Vulcan to implement the Project in accordance with

the Project financing requirements. This ensures that the Project aligns with the environmental and social standards set forth by the financiers, demonstrating Vulcan's dedication to responsible development and compliance with international best practices. These commitments are integral to securing project financing and maintaining the trust of stakeholders and regulatory bodies.

Specifically for this kind of Project, determining that mitigation measures are "reasonably practicable" and that risks are "as low as reasonably practicable" (ALARP) involved applying control measures that meet regulatory standards and draw on ERM's experience from past projects.

Impact assessment is about identifying the aspects of a Project that need to be managed and demonstrating how these should be appropriately dealt with through implementation of the Project Environmental and Social Management System (ESMS). A framework ESMS has been developed as part of this ESIA (see Section 9).

As key influencers in the decision-making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high-quality evidence base.

One of the core principles regarding impact mitigation contained in the IFC PS is with regards to application of the 'mitigation hierarchy' (see Figure 5-5 below). In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e. to avoid or reduce the magnitude of the impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e. to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude). Offsets and other measures of compensation are typically considered a 'last resort' option under the mitigation hierarchy and are considered only after other options for mitigation have been exhausted.

An evaluation was undertaken as to how the mitigation hierarchy of controls has been applied in terms of the embedded measures and to determine whether additional measures may be advised to align with the IFC Performance Standards, IFC EHS Guidelines and available/emerging guidance on international good practice.

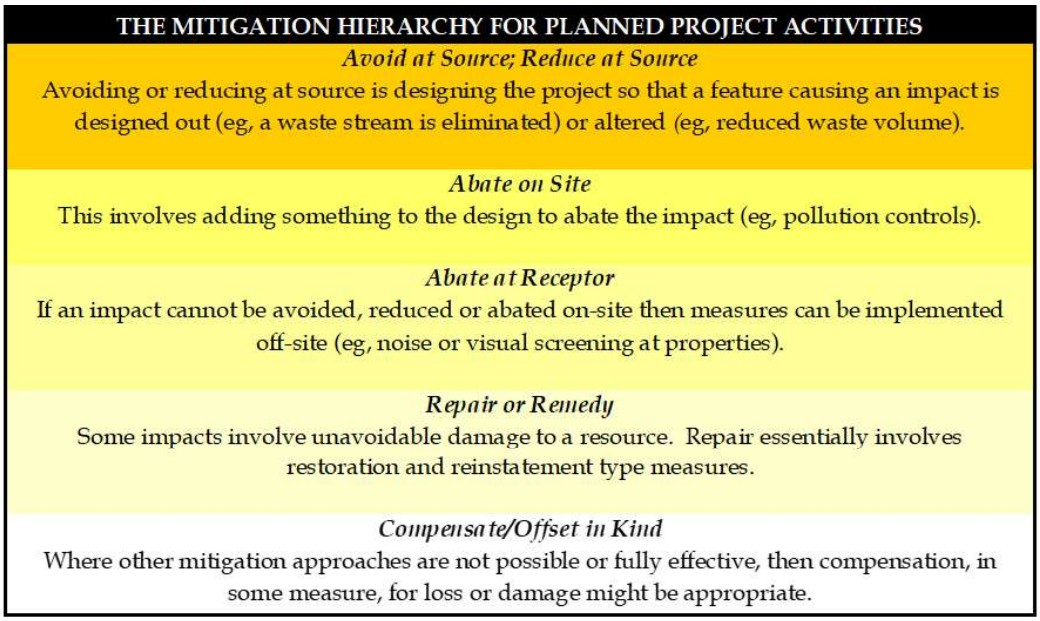


FIGURE 5-5 MITIGATION HIERARCHY

5.4.6 STEP 6: ASSESS RESIDUAL IMPACTS

The final step is to assess residual impacts, which are those impacts that are likely to persist after considering the mitigation and management measures recommended as part of the mitigation strategy for the Project, and their likely implementation success. Residual impacts are assessed following the implementation of additional mitigation measures that are considered necessary by this assessment. Typically, the following can be reassessed post-mitigation:

- Impact extent/scale – mitigation can potentially reduce the extent of physical area or the exposure to deteriorating effects, typically through avoidance measures and layout planning;
- Probability – mitigation can potentially avoid impacts from happening altogether (through avoidance measures for example);
- Magnitude of Effect – mitigation can potentially minimise the proportion of receptors affected; and
- Receptor Importance/Sensitivity – through the application of buffers (development set-backs), and avoidance planning as an example, mitigation can limit exposure of deteriorating effects to the most important and/or sensitive receptors.

Good practice advises that ESIA / EIA should be an iterative process rather than a single, post design, environmental appraisal. In adopting this approach, the findings of the environmental and technical studies are continually used to inform the design of the Development and hence achieve a 'best fit' within the environment.

Significant residual effects will form the basis for recommendations regarding measures to compensate / offset where these are deemed relevant and/or feasible.

5.4.7 ADDRESSING UNCERTAINITIES

In the context of this Project, uncertainties are inherent in the assessment of the main risks and the effectiveness of the proposed mitigations. These uncertainties stem from several factors, including:

- Data limitations: The accuracy of our risk assessments is partly constrained by the availability and quality of site-specific data. Limited historical data or the need to use generalised assumptions specific to the Project area introduce uncertainties in predicting potential impacts and the effectiveness of the proposed mitigations.
- Assumptions used during modelling: The greenhouse gas emissions inventory and groundwater impact assessment of this ESIA report rely on models provided by Vulcan to predict outcomes under various scenarios. These models are based on assumptions tailored to this Project's context but may not fully capture the complexity of real-world conditions, leading to uncertainties in both risk predictions and the anticipated effectiveness of the mitigations.
- Changing environmental conditions: The Project area is subject to environmental variables, such as potential climate change impacts that can alter the risk landscape and affect the performance of mitigation measures. These dynamic factors introduce uncertainties specific to the environmental context of this project.
- Human factors: The effectiveness of the mitigation measures is influenced by human factors, including potential for human error, variations in implementation practices, and the degree of stakeholder engagement. The unpredictability of human behaviour introduces an element of uncertainty specific to the Project's operational phase.
- Possible future regulatory changes: Future changes in local or national regulations or policies could impact both the identified risks associated with this project and the appropriateness of the mitigations currently in place. These potential regulatory shifts contribute to uncertainty in long-term risk management for the Project.

To address these uncertainties, ERM has adopted a precautionary approach, using conservative estimates in risk/impact assessments. Continuous monitoring and stakeholder engagement are key components of our approach, ensuring flexibility in Project planning to respond to possible uncertainties. Additionally, Vulcan is committed to developed contingency plans specific to this Project (e.g. EPRP) to manage unforeseen events or deviations from expected outcomes, therefore minimising risk thresholds to the extent possible.

5.5 STAKEHOLDER ENGAGEMENT

Stakeholder engagement is crucial for Project development because it ensures that the interests, perspectives, and concerns of all relevant parties are considered and addressed throughout the Project lifecycle. IFC PS1 recognises the importance of an open and transparent engagement between the Project's management team, its workers, and local communities.[47] To be effective, it should be initiated at an early stage of the Project cycle and is an on-going process.

Similarly, Equator Principle 4 (EP4) mentions that a Project will tailor its consultation process to:

- The risks and impacts of the Project;
- The Project's phase of development;
- Decision-making process; and
- The needs of vulnerable groups.

[47] Source: International Finance Corporation, Performance Standard 1, 2012, retrieved from: https://www.ifc.org/content/dam/ifc/doc/2010/2012-ifc-performance-standard-1-en.pdf, accessed in August 2023.

The IFC PS1 and EP4 emphasise that grievance mechanisms should be in place and be properly scaled to the risks and impacts of the Project. The Project should provide access to remedy by informing local communities and the Project workforce about their rights to submit grievances and raise concerns without retaliation. Grievance mechanisms should not impede access to judicial or administrative remedies.[48]

The following section provides insight into Vulcan´s stakeholder engagement to date. This section also summarises public and stakeholder perceptions of the Project. Finally, it will provide a general overview of the plans for future stakeholder engagement, which will act as the basis for the comprehensive Stakeholder Engagement Plan (SEP) developed in parallel to this ESIA.

5.5.1 DISCLOSURE AND STAKEHOLDER ENGAGEMENT TO DATE

5.5.1.1 GOVERNANCE

Vulcan has an internal public and investor relations team. Information about Vulcan´s governance is publicly accessible on the company website. Vulcan developed a Corporate Governance Statement for 2025 which includes stakeholder engagement principles.[49] The Project representatives and directors play an active part in stakeholder engagement. The communications team facilitates executing engagement.

5.5.1.2 KEY STAKEHOLDER GROUPS

Table 5-6 below provides an overview of the stakeholder groups that Vulcan has initially identified and engaged with. A more detailed stakeholder identification, mapping, and analysis is included in the comprehensive Stakeholder Engagement Plan (SEP).

TABLE 5-6 PRELIMINARY KEY STAKEHOLDER MAPPING AND ENGAGEMENT APPROACHES

Stakeholder Group	Current Engagement Approach
Local population	Informed via multiple avenues and communication measures. Engagement is primarily dialogue-based (roadshows, citizen information events, info truck) or informational (posters, flyers, print advertisements in local newspapers)
Political and governmental representatives (local councils and political representatives from Landau, Insheim, Herxheim, Rohrbach, Billigheim-Ingenheim, Impflingen)	Vulcan representatives (regional managers and Project-specific representatives) closely consult and meet often with political authorities. The Vulcan team also present Projects in various councils discussing issues, such as: cooperation agreements, heat supply, and land acquisition.
Local public utilities and energy suppliers	ESW, Thüga, MVV, Stadtwerke Viernheim, Stadtwerke Bad Dürkheim, Pfalzwerke, Stadtwerke Neustadt, Technische Werke Ludwigshafen, Stdtwerke Weinheim

[48] Source: Equator Principles, The Equator Principles EP4, July 2020, retrieved from: https://equator-principles.com/app/uploads/The-Equator-Principles_EP4_July2020.pdf, accessed in August 2023.

[49] Source: Vulcan Energy Resources Limited, Corporate Governance Statement, approved by the Board on 25 March 2025, retrieved from: https://api.investi.com.au/api/announcements/vul/d3acd80f-a8e.pdf, accessed in August 2025.

Stakeholder Group	Current Engagement Approach
Local associations and organisations (e.g., NABU, BUND).	Bauern- und Winzerverbände, Landwirtschaftsverbände, Beregnungsverbände, Umweltforum MA mit 16 Umwelt- und Naturverbänden, MRN, TRK, Nachbarschaftsverbände, Träger öffentlicher Belange aus Betriebsplänen
Shareholders	Vulcan has developed a Shareholder Communication Strategy to bolster two-way communication with their investors. The approach specifies various methods of communicating information about the Project to shareholders and highlights that shareholders can register to be notified via email when there are new announcements. This communication approach serves as the basis for shareholders' engagement and timely disclosure of the Project implementation.

5.5.1.3 TYPES OF DISCLOSURE AND ENGAGEMENT TO DATE

Figure 5-6 and Figure 5-7 provide two distinct examples of Vulcan's engagement with the public – these and additional examples can be found in Annex A of the SEP.

Figure 5-6 is a screenshot of one of Vulcan's open door day events in Insheim held in May 2025 – these are annual events that started in 2023. Over 150 visitors took the opportunity to take a look behind the scenes of the geothermal power plant and learn more about renewable energy from deep geothermal energy and climate-neutral lithium production. The company had invited people to the event to give residents living near the power plant and all interested parties the opportunity to obtain information openly and transparently. Guided tours of the power plant site offered guests the opportunity to familiarise themselves first-hand with how the plant works. Experts from Vulcan were also on hand to answer questions about the innovative Project for the simultaneous production of lithium and renewable energy. Representatives from EnergieSüdwest (ESW) and Thüga Energie were also present to answer questions about the climate-neutral district heating supply and provide insights into project development relating to the expansion of the district heating network.

Similarly, Figure 5-7 shows images from the "Maustag Insheim" from earlier stages of the Project on October 3, 2022, where residents and their children were invited to see and understand the operation of the Insheim geothermal plant. Over 200 people attended to learn the basics of geothermal energy and lithium, seeking to inform local stakeholders of various ages.



FIGURE 5-6 OPEN DOOR EVENT INSHEIM ON 17.05.2025



FIGURE 5-7 PUBLIC EVENT AT INSHEIM 03.10.2022

TABLE 5-7 OVERVIEW OF STAKEHOLDER ENGAGEMENT TO-DATE

Mode of Engagement	Engagement Activity	Engagement Summary	Date
Public Information Disclosure	Online/digital media information sharing	Relaunched company/regional websites, social media posts, press releases	January 2022-present
	Print Media Information Publications	Advertisements, large billposting, flyers, construction site signs/information boards, newsletters, technical information and info sheets, specific material for political authorities	January 2022-present
Direct Engagement	Information Trucks	Designated truck that opens to provide interactive information on the entire company and on-going projects.	April-August 2022
	Information Centre	Centre for local population to visit and gather information and materials regarding Vulcan´s endeavours. Visitors can arrange a meeting time or drop in and also have the opportunities to ask questions and discuss questions/concerns with Vulcan representatives.	June 2022-present
	Participatory and dialogue-based events with stakeholders	Monthly citizen consultation hour in Landau information centre for citizens to ask questions, Citizen Dialogue Events, citizen phone/chat-line, information trips to Insheim, citizen surveys, kick-off events with stakeholders per Project phase, technical discussions with target groups, roundtable	April 2022-present

The Vulcan team has initiated numerous stakeholder engagement efforts to date. Their engagement efforts have been frequent, even early in the development phase to avoid unexpected risks, opposition, or conflict with stakeholders later. Their planning and execution are structured and documented. Vulcan team shared an excel document with the ERM team specifying the phase and time in which the engagement will take place (preparation) corresponding to the type of engagement (information, dialogue, active participation, additional ideas, and future brainstorming).

The Vulcan team has emphasised that prior to individual steps or phases in Project development, communication measures are typically intensified in local communities, main public areas (marketplaces), and on social media platforms.

For example, from April to September 2022 Vulcan employees drove along the Southern Palatinate roads to share information on their 3D-seismic survey planned for the region. Additionally, in September 2022 a Vibrotruck[50] was put on display in the town square of Landau in the Palatinate and citizens of all ages and backgrounds were encouraged to exchange ideas and ask questions to Vulcan experts regarding the 3D seismic measurement area/activities. Their goal is to create and act transparently and address concerns or questions from the community.

5.5.1.4 PUBLIC INFORMATION CENTRES

A notable measure of engagement from the Vulcan team are their information truck and information centres. These operate independently of projects and on an on-going basis, used to share information and answer questions about company mission, values, and on-going and future projects.

The first information centre was opened in Landau 2022. ERM visited the info centres during the site visit in August 2023. There were numerous pamphlets presenting Project information in a digestible and non-technical manner for personal stakeholder groups to be able to understand and engage (Figure 5-8).

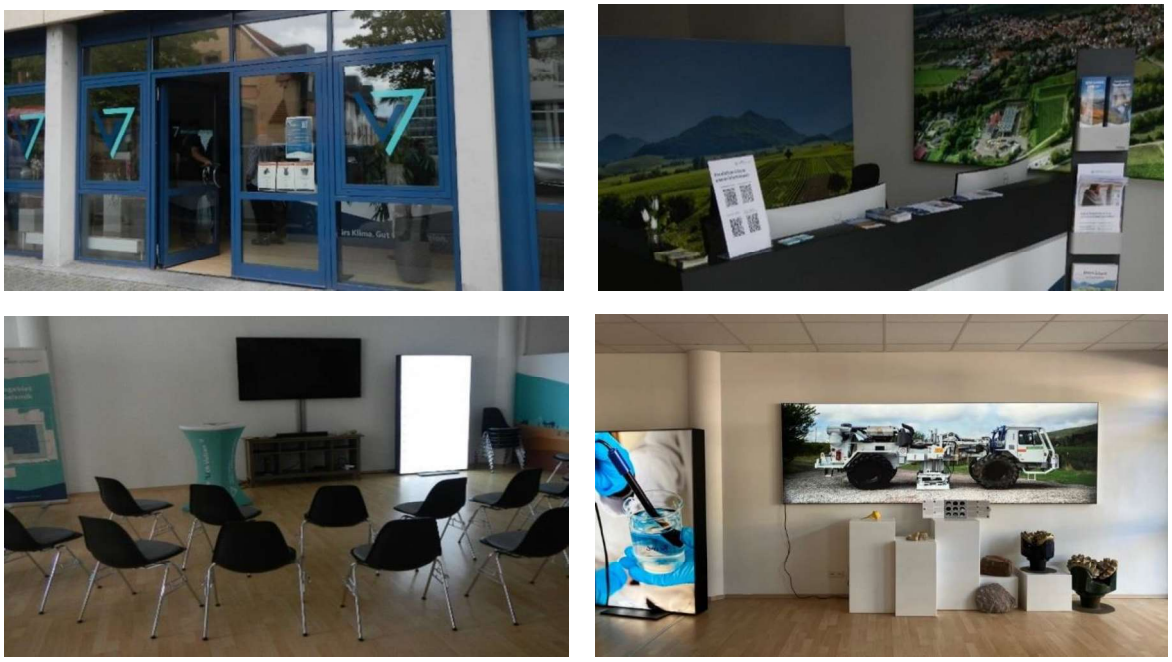


FIGURE 5-8 VULCAN INFORMATION CENTRE LANDAU

Source: ERM site visit, August 2023

[50] Vibrotrucks are special vehicles used during 3D seismic screening. They drive around a particular area and then bring a metal plate to the ground; the plate then vibrates for a few seconds and geophones (earth microphones) are able to pick up the reflected sound waves. This information is from Vulcan, Press Release: Vulcan Conducts 3D seismic survey in the Mannheim Region, retrieved from: https://v-er.eu/de/vulcan-fuehrt-3d-seismik-in-der-region-mannheim-durch/, accessed in August 2023.

At the Insheim Geothermal Plant there is also a visitors' centre in which local stakeholders are encouraged to come visit the plant and learn about carbon neutral lithium production.

The information centres are open on most weekdays, and any person or group are welcome to coordinate a meeting time or call and ask questions.

5.5.1.5 COMMUNICATION CAMPAIGN PLAN

The regional communications team has shared a Communication Campaign Plan (CCP) for information sharing and engagement related to the specific drilling at the Schleidberg site. The CCP is developed into pre-field communication, participation communication and live communication. Information sessions and meetings take place in both English and German; therefore, they are accessible to a wide audience.

During ERM´s visit to the site, the consultants were able to engage with stakeholders and representatives from Infraserv at the Höchst Industrial Park and a local farmer near the Schleidberg drill site (Figure 5-9). The interaction was positive, and the individual was open to speaking with ERM. The discussion indicated that the farmer was aware of the Project, has a long-standing relationship with them, and has frequent engagement with Vulcan.



FIGURE 5-9 ERM AND VULCAN REPRESENTATIVES DISCUSSING WITH LOCAL FARMER

Source: ERM Site Visit, August 2023

5.5.1.6 GRIEVANCE MECHANISM

The Vulcan regional communications team (with support and cooperation from technical departments) currently manages email inboxes, as most grievances tend to be submitted in writing. The team has specified that grievances are recorded accordingly (for more details please see SEP prepared for the Project). The information centres, information trucks, and other forms of direct engagement are additional tools for receiving and managing grievances.

Vulcan also has a regional citizen telephone line to speak with and answer citizen questions. Project-specified email addresses have also been introduced for the seismic surveying and drilling stages.

A comprehensive grievance mechanism for internal and external stakeholders is formally established in the SEP; the Community Grievance Mechanism (CGM) is intended for external stakeholders, especially targeted at residents, and a workforce grievance mechanism. The SEP specifies provisions such as a: Grievance register, roles and responsibilities, and the strategy for and management of the grievance mechanism in line with international requirements.

5.5.2 PUBLIC PERCEPTIONS OF THE PROJECT

Based on desktop research, and conversations with Vulcan, public sentiments around geothermal projects were both neutral and partially negative in the Landau in the Palatinate area – however, Südwestrundfunk (Southwest Broadcasting) (SWR), a regional public broadcasting corporation in Rhineland-Palatinate and Baden-Württemberg, note that in June 2022 the city council overturned the objective of shutting down the Landau (previously geox) geothermal plant. [51] Based on news articles and journalistic resources public scrutiny and opposition mostly comes from lack of understanding of discrepancies between types of geothermal drilling and what the de facto risks vs value added is.[52]

However, Vulcan concludes that stakeholder engagement efforts in recent years have resulted in mostly positive perceptions of the Project. In particular, the Vulcan team emphasises to stakeholders the value added that will result from this Project - the provision of local and renewable heat. Their frequent stakeholder engagement at this stage is also mostly centred around information and knowledge sharing and managing public expectations.

Vulcan notes that this has most recently been demonstrated in the actions of the Landau City Council, and surrounding town councils, of which 8/9 voted in favour of Vulcan's field work plans in 2022. In 2023 the Landau City Council also voted in favour of geothermal development to supply the city with renewable heat, which will be supplied by the Project. In 2023 and in 2024, the Landau City Council voted 41:3 in favour of the land development plan at D12 involving Vulcan's GLEP plant.

5.5.3 FUTURE STAKEHOLDER ENGAGEMENT

The ERM team developed a Stakeholder Engagement Plan. It is built upon Vulcan´s current approach and activities for stakeholder engagement and will be aligned with international best practices and standards, especially IFC Performance Standards on Environmental and Social Sustainability and Equator Principles IV.

The SEP is a "living document" which will be routinely updated by Vulcan as the Project progresses through the various stages of development.

A general overview of the SEP includes the following:

- International and National Regulatory Standards

[51] Source: SWR Aktuell, Landau city council changes attitude to geothermal power plant, retrieved from: https://www.swr.de/swraktuell/rheinland-pfalz/ludwigshafen/landau-sagt-ja-zu-geothermie-100.html, accessed in August 2023.
[52] Source: SWR, Lithium-Hype am Rhein: Chance oder Risiko? SWR Wissen, retrieved from: https://www.youtube.com/watch?v=GXbSI2FJf0k, accessed in August 2023.

- Stakeholder Mapping, Identification and Analysis
- Vulnerability Assessment
- Grievance Mechanism and access to remedy
- Monitoring, Management and Documentation
- Reporting
- Roles and Responsibilities
- Stakeholder Engagement Action Plan

5.5.4 STAKEHOLDER ENGAGEMENT AT FRANKFURT HÖCHST INDUSTRIAL PARK

Infraserv is responsible for managing Frankfurt Höchst Industrial Park (Industriepark Höchst), plays a key role in interacting with nearby communities and ensuring that local residents and businesses are kept informed about activities within the industrial park.

Community Information and Communication Channels

Infraserv Höchst provides various communication channels to keep residents informed about activities at the industrial park. Their dedicated website and social media platforms offer real-time updates on ongoing projects, safety measures, and environmental data. A 24-hour community hotline allows residents to ask questions or report concerns related to noise, emissions, or safety, especially during activities that may impact the surrounding area. Additionally, Infraserv holds regular public information events where residents can engage with company representatives, discuss developments, and raise any concerns.

Emergency Preparedness and Alerts

Infraserv Höchst has robust emergency communication and response systems in place for nearby communities. They maintain a coordinated siren system with local authorities to warn residents of emergencies like chemical spills or fires, complemented by SMS alerts or notification systems for real-time updates. The company collaborates closely with local fire departments, police, and emergency medical services, conducting regular safety drills and joint exercises to ensure swift incident response. Additionally, residents in areas such as Höchst, Sindlingen, and Unterliederbach receive emergency preparedness guidelines, distributed through brochures, local media, and online platforms, detailing appropriate actions during industrial incidents.

Corporate Social Responsibility (CSR) and Community Involvement

Infraserv Höchst actively supports the local community through various initiatives. They sponsor cultural, educational, and sports events, providing funding for schools, sports clubs, and local projects that enhance the quality of life in nearby areas. Additionally, they contribute to local job creation by offering apprenticeship and training programs in collaboration with schools and vocational centres, helping to develop the local workforce. Infraserv also engages in educational outreach, offering programs and guided tours of the industrial park for students and the public, focusing on safety, environmental protection, and industrial processes.

Noise and Traffic Management

Infraserv Höchst prioritises minimising its environmental impact through various initiatives. To address noise pollution, they implement noise reduction measures during construction and maintenance activities and inform residents in advance about any potential disruptions. In

collaboration with local authorities, Infraserv also manages industrial traffic by coordinating transport routes and developing traffic management plans, aiming to reduce congestion and emissions in nearby residential areas.

6. ENVIRONMENTAL AND SOCIAL BASELINE

6.1 PHYSICAL ENVIRONMENT

The physical baseline information for the ESIA report was gathered generally through a review of literature and publicly available data, Phase One Bridging Study (prepared by Vulcan), TCFD Reporting Study (prepared by Baringa 1st February 2023), Report on the contaminated site at the CLP in Höchst (prepared by Infraserv 14th June 2023), preliminary geotechnical study at Industriepark Höchst (prepared by BFM 19th January 2022), statement on the general preliminary environmental impact assessment at Schleidberg Süd (prepared by Vulcan 16th November 2022) as well as information gathered during the site visit in August 2023. This section provides background information on the Project area and its surroundings at state and regional level.

6.2 CLIMATE

Most of the Project components (except the Central Lithium Plant in Höchst) are in the Vorderpfälzische Rheinebene, one of Germany's regions with the mildest winters and hottest summers, as well as low to moderate precipitation. The average yearly temperature ranges from 9 to around 11 °C. In July, the hottest month, the average temperatures are close to or even slightly above 20 °C. This is a result of the frequently warm, south-westerly weather conditions. Föhn[53] effects from sinking air can result in further temperature rises. The precipitation in the Vorderpfälzische Rheinebene ranges from 490 to 850 mm. As a result, irrigation is required in many agricultural regions[54].

The closest weather station to the Project components, near Landau with continuous temperature and precipitation data of the last 30 years is in Herxheimweyer located around 10 km southwest of Landau. The climate in Herxheimweyer is categorised as warm and temperate with precipitation throughout the year. The Köppen-Geiger climate classifications assign the climate the categorisation of Cfb (temperate oceanic climate). Herxheimweyer experiences an average yearly temperature of 10.8 °C and a total of 617 mm of precipitation per year.

[53] A Föhn is a type of dry, relatively warm, downslope wind that occurs in the lee (downside) of a mountain range.
[54] Rheinland-Pfalz Kompetenzzentrum für Klimawandelfolgen. (https://www.klimawandel-rlp.de/index.php?id=12357)

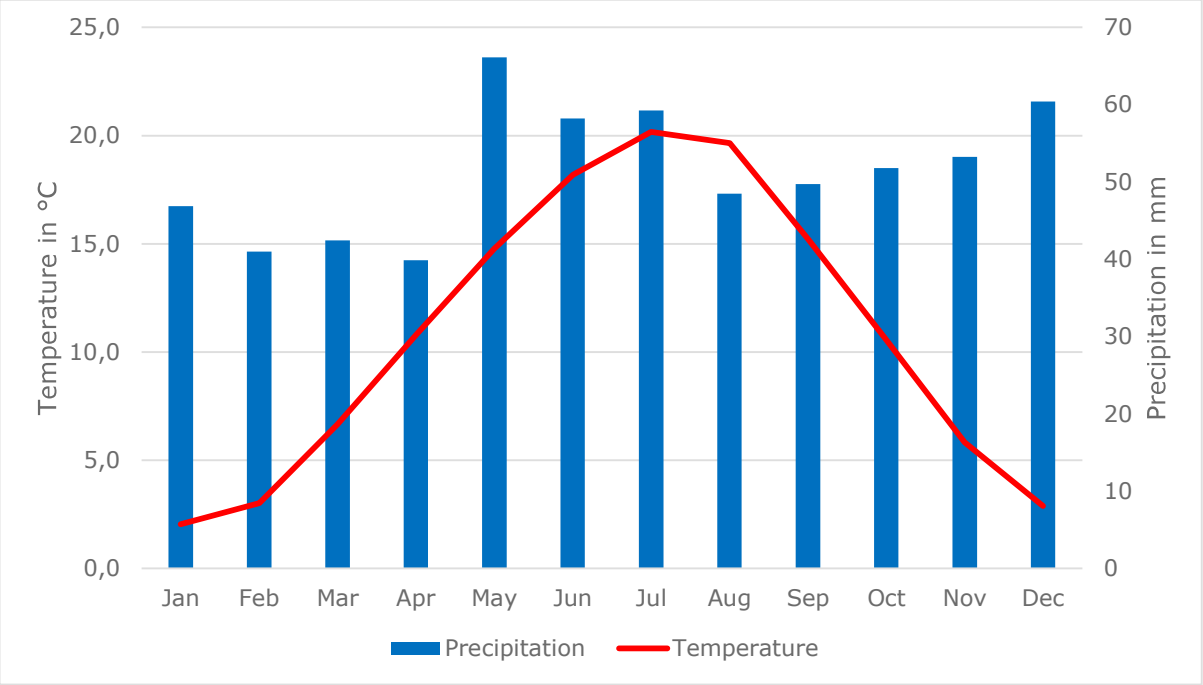


FIGURE 6-1 CLIMATE DIAGRAM HERXHEIMWEYER (1991-2020)

Source: Agrarmeteorologie RLP, 2023

The Central Lithium Plant is in Höchst, which is a city district of Frankfurt am Main. The climate in Frankfurt am Main is categorised as warm and temperate with precipitation throughout the year. The Köppen-Geiger climate classifications assign the climate the categorisation of Cfb (temperate oceanic climate). Frankfurt am Main experiences an average yearly temperature of 11.5 C and a total of 643 mm of precipitation per year.

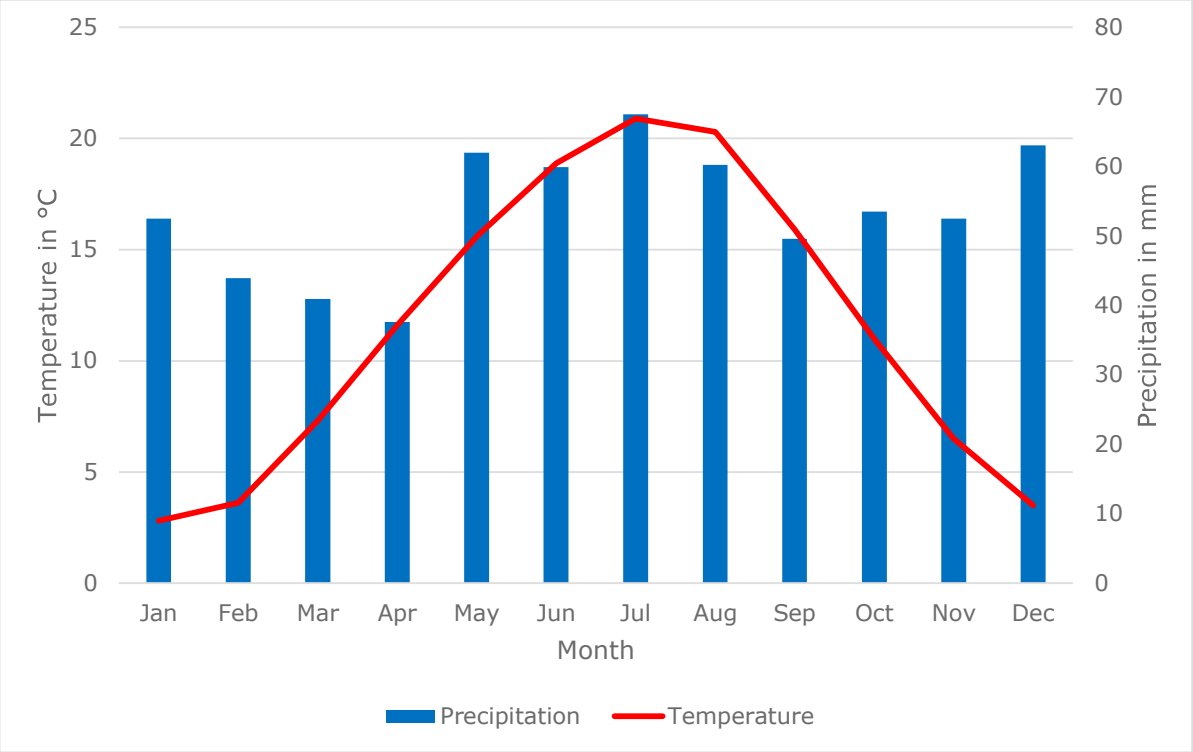


FIGURE 6-2 CLIMATE DIAGRAM FRANKFURT/MAIN-WESTEND (1991-2020)

Source: DWD, 2021. Lufttemperatur und Niederschlag: vieljährige Mittelwerte 1991 – 2020

6.3 CLIMATE CHANGE

Climate change is noticeable in Rhineland-Palatinate and effects are already evident in many areas, such as agriculture and forestry or in biodiversity. Within Germany, Rhineland-Palatinate is one of the regions most affected by climate change. On average, the annual temperature has risen by around 1.7 degrees Celsius over the last 130 years (see Figure 6-3). In addition, extreme weather events such as storms, high and low water levels, and periods of drought and heat are occurring with increasing frequency[55].

[55] Rheinland-Pfalz Kompetenzzentrum für Klimawandelfolgen

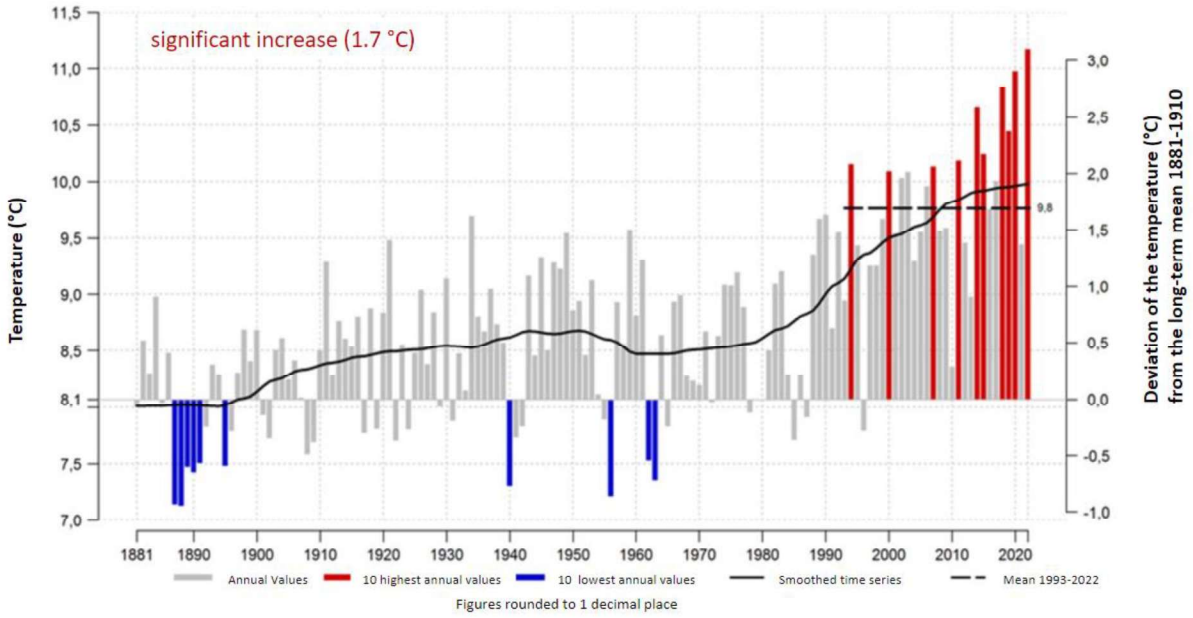


FIGURE 6-3 DEVELOPMENT OF TEMPERATURE IN RHINELAND-PALATINATE FROM 1881 TO 2022

Source: Adapted from Rheinland-Pfalz Kompetenzzentrum für Klimawandelfolgen (www.kwis-rlp.de)

Figure 6-4 shows the possible future temperature development until 2100 for two different scenarios. The first scenario (RCP2.6) assumes the implementation of strong climate protection measures and results in less drastic possible future changes of the climate. The second scenario considered (RCP8.5) assumes that no more extensive climate protection measures are implemented in the future and results in more drastic possible future changes in the climate in Rhineland-Palatinate.

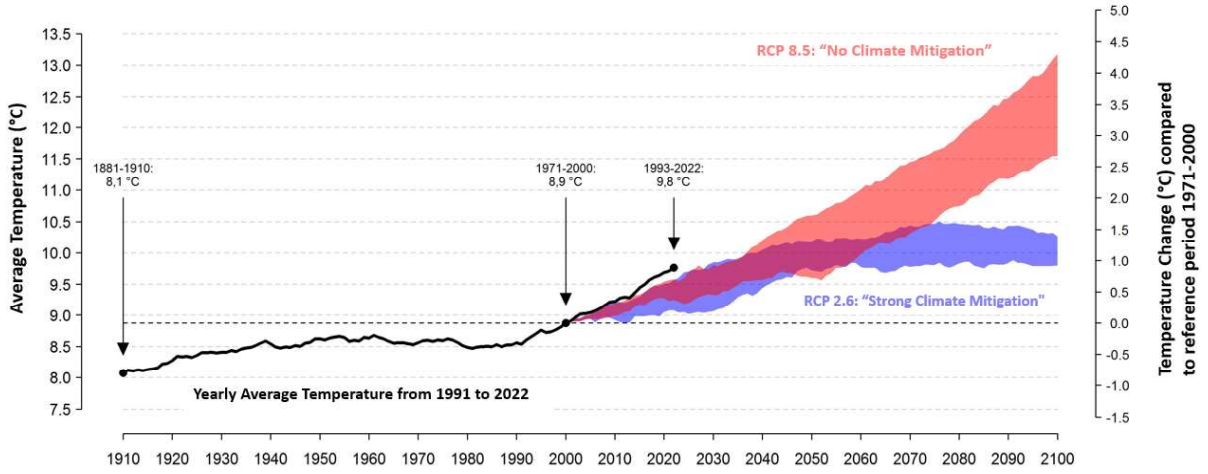


FIGURE 6-4 PROJECTIONS OF THE DEVELOPMENT OF THE MEAN TEMPERATURE IN RHINELAND-PALATINATE UNTIL 2100

Source: Adapted from Rheinland-Pfalz Kompetenzzentrum für Klimawandelfolgen (www.kwis-rlp.de)

Figure 6-4 shows that under RCP2.6 with strong climate protection measures, global warming can be kept to 1.5 degrees compared to pre-industrial times. Under RCP8.5, however, the average temperature would increase by 2.5 to 4.5 degrees by 2100.

In the following Table 6-1 and Table 6-2 Project relevant climate hazards currently present in the Project region (Rhineland Palatinate and South Hesse) are outlined and ranked according to risk thresholds based on the chance of a risk materiality (from very low, to high).

TABLE 6-1 CLIMATE HAZARDS IN RHINELAND PALATINATE

Hazard	Hazard Level Valuation
Water scarcity	Medium
Extreme heat	Medium
Urban floods	Low

Source: ThinkHazard.org (2023).

TABLE 6-2 CLIMATE HAZARDS IN SOUTH HESSE

Hazard	Hazard Level Valuation
Water scarcity	Medium
Urban floods	Medium
Extreme heat	Low

Source: ThinkHazard.org (2023).

Due to the location and geographic features of the Project components, the relevant climate hazards for the Project will relate to water scarcity and extreme heat for all the Project components. For the Geothermal Lithium Production Plant in Landau and the CLP in Höchst urban floods are relevant. R River floods were not included in this assessment because only small streams are present within the AoI of the Project components near Landau (as explained in the Hydrology section of the ESIA). Additionally, the CLP in Höchst is located outside the boundaries of areas affected by extreme floods, so river flooding is not considered relevant for this evaluation. Further details on the flood risk for the CLP is stated in section 6.6.3.

For all the Project components, water scarcity is classified as medium, meaning that there is up to 20% chance droughts will occur in the coming 10 years. The expected return period for droughts is therefore 1 in 45 years[56]. The last drought in Rhineland Palatinate was in summer 2022 where the amount of precipitation was around 56 % below the long-term average[57]. Regarding extreme heat, the classification as medium means that there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years (return period of 1 in 18 years[56]). The low hazard level for extreme heat implies that the chance of at least one period of prolonged exposure to extreme heat is at 5-25 % within the next 5 years (return period of 1 in 18 to 97 years[56]). Urban floods

[56] The return period (T) was calculated using the formula $T=1/1-(1-P)^{1/n}$. Probability (P), n = occurrence.
[57] Rhineland-Palatinate Competence Centre for Climate Change Impacts (2024). Retrieved from: Klimawandelinformationssystem Rheinland-Pfalz | Witterungsrückblick | Willkommen in Rheinland-Pfalz (klimawandel-rlp.de)

are classified as low which suggests that there is a chance of more than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years (return period of 1 in 1,000 years). The estimates given are all regional averages in accordance with Think Hazard[58].

6.4 GREENHOUSE GAS EMISSIONS

6.4.1 OVERVIEW OF GREENHOUSE GAS EMISSIONS IN GERMANY

Germany's greenhouse gas emissions have decreased considerably from 1,251 million metric tons of CO_2 equivalents in 1990 to 746 million metric tons in 2022. This amounts to a decrease of more than 40% overall. If the low values in 2020 and 2021 with unique circumstances (Covid-19) are disregarded, the indicator has a long-term declining trend. Following a period of stagnation, emissions rapidly decreased between 2017 and 2022, mostly because of increasing prices for carbon trading certificates and the growth of renewable energy sources.

A follow-up agreement to the Kyoto Protocol was reached with the Paris Agreement at the end of 2015. Achieving the objectives will require significant climate protection initiatives, according to developments to date. The "Action Program Climate Protection 2020" and the "Action Program Climate Protection 2030" are two such initiatives that the German government has introduced. In order to achieve the greenhouse gas reduction goal of "at least 65%" by 2030 and greenhouse gas neutrality in 2045, the "Federal Climate Protection Act" agreed on mandatory yearly emission limitations as well as monitoring and tightening methods for the various sectors.[59]

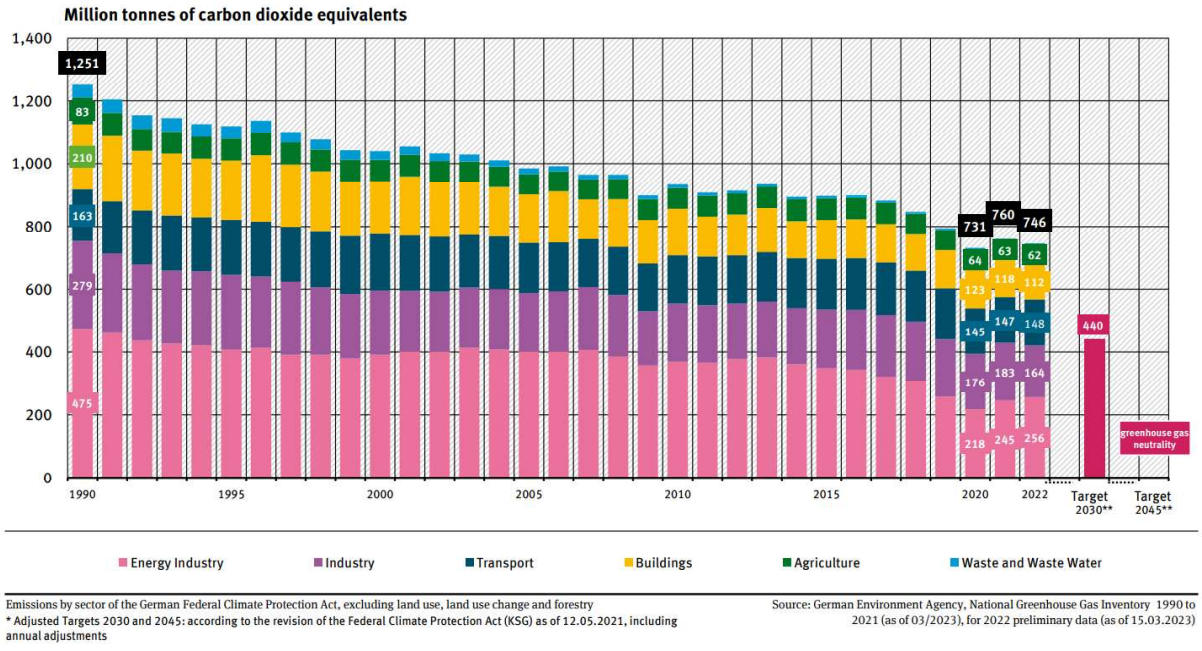


FIGURE 6-5 EMISSION TRENDS IN CO_2 EQUIVALENTS IN GERMANY

Source: German Environment Agency, 2023. Indicator: Greenhouse gas emissions

6.4.2 GREENHOUSE GAS EMISSIONS ON PROJECT LEVEL

A greenhouse gas accounting exercise has been conducted and can be found in Section 0.

[58] Thinkhazard.org (2023). Think Hazard - Area without administration at 2nd level
[59] German Environment Agency, 2023. Indicator: Greenhouse gas emissions

6.5 GEOLOGY, GEOMORPHOLOGY, SOILS AND GEOHAZARDS

6.5.1 METHODOLOGY AND INFORMATION SOURCES

Geological, Geomorphological, Soil and Geohazard features within the area of influence of the Project were identified via a desktop study. The following desktop sources were used to identify these features:

- State Office for Geology and Mining Rhineland Palatinate, Soil Map (BFD50);
- Hessian State Agency for Nature Conservation, Environment and Geology, Soil Map (BFD50);
- Vulcan, 2022. Stellungnahme zur allgemeinen Umweltverträglichkeits-Vorprüfung Schleidberg Süd;
- State Office for Geology and Mining Rhineland Palatinate, 2023. Soil area data of agricultural land;
- State Office for Geology and Mining Rhineland Palatinate, 2023. Map of earthquake events registered by the Rhineland-Palatinate State Earthquake Service; and
- BFM, 2022. Preliminary geotechnical study at Industriepark Höchst.

6.5.2 GEOLOGY AND GEOMORPHOLOGY

The Project is located within the Upper Rhine Graben, a regional rift system bounded by the eastern and western master faults. The rift system is filled by a sequence of fractured sedimentary rocks overlain by recent Quaternary sediments. The Upper Rhine Graben near Landau in der Pfalz is characterised by a rift valley formed through tectonic activity, creating a low-lying area (lowland plane) flanked by higher terrain (graben shoulders)[60]. The floodplains in this region were shaped by the Rhine River's depositional actions, leading to the formation of extensive alluvial plains. Currently, the area is geomorphologically stable with low seismic activity, although historical tectonic movements have left a lasting impact on the landscape[61].

The succession of the geological units in the Project area near Landau is made up of Quaternary and Tertiary syn-rift sediments and Mesozoic to Paleozoic pre-rift sediments covering the crystalline basement. The lowermost syn-rift sediments (= Eocene marls) discordantly overlay the pre-rift sediments and the lowermost pre-rift sediments (= Rotliegend arkoses and clay-stones) discordantly overlay the crystalline basement rocks[62].

The approximately 2000 m thick clay-rich Tertiary layers and the clay-rich top of the Mesozoic pre-rift sediments (= Keuper) hydraulically separate the shallow groundwater from the deep brine. Pleistocene loess and derivates dominate the surface geology in the Project area near Landau (Figure 6-6)[63].

[60] Van Balen, R., 2007. Tectonic geomorphology of the northern Upper Rhine Graben, Germany.
[61] Shipton et al., 2017. Seismic slip on the west flank of the Upper Rhine Graben (France–Germany): evidence from tectonic morphology and cataclastic deformation bands.
[62] Vulcan, 2022. Stellungnahme zur allgemeinen Umweltverträglichkeits-Vorprüfung Schleidberg Süd.
[63] Landesamt für Geologie und Bergbau Rheinland-Pfalz, 2023. Geologische Übersichtskarte Rheinland-Pfalz.

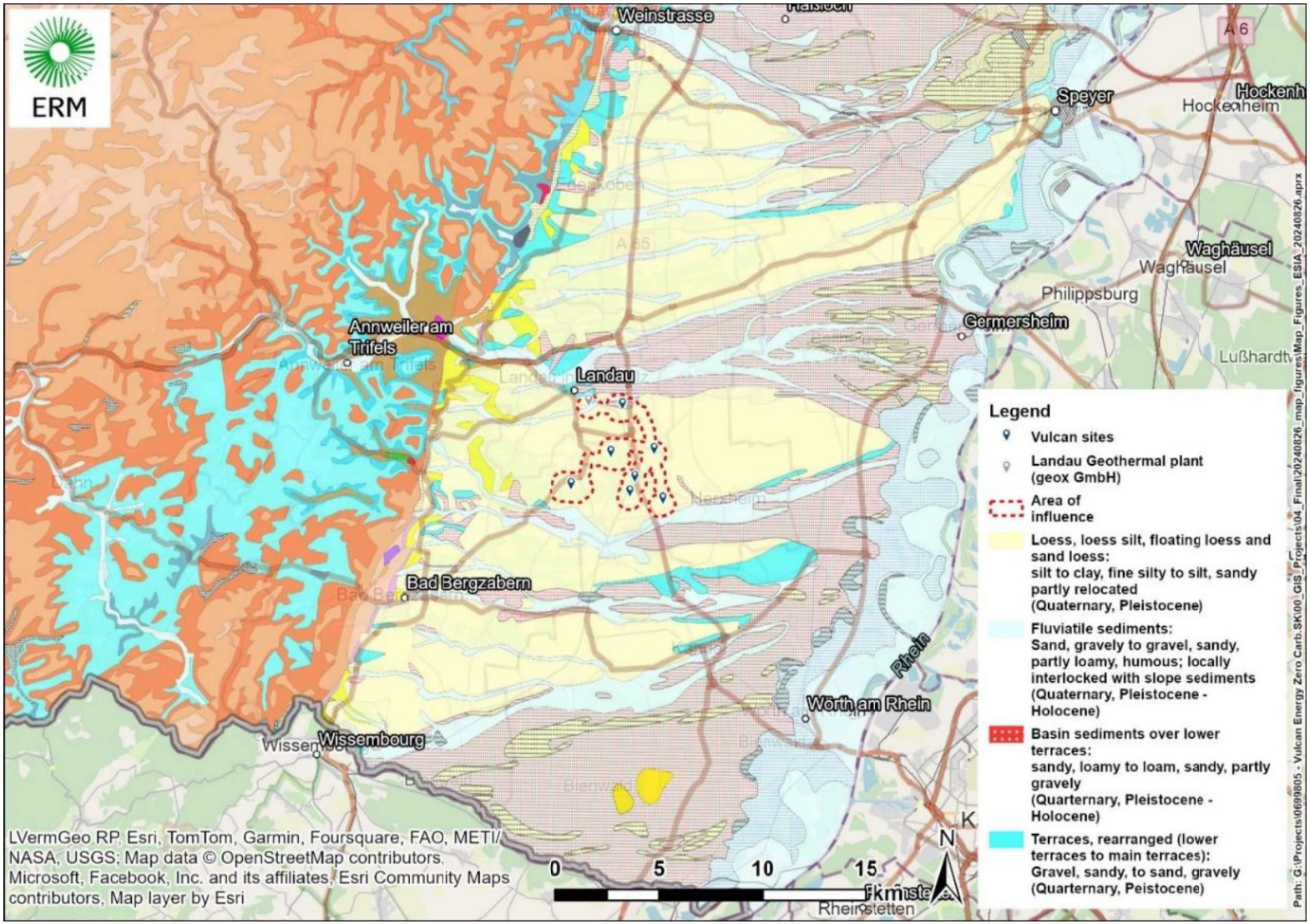


FIGURE 6-6 GEOLOGICAL FEATURES IN THE PROJECT AREA

At the CLP in Höchst, the geology is formed of terraced areas covered with sandy flood loam of the Upper Rhine and Lower Main Plain. The geology consists of sandy floodplain sediments from the Pleistocene as well as silty-loamy alluvial sediments with a with carbonate enrichment horizon [64].

6.5.3 SOILS

To identify the soils in the Project AoI, the soil maps (BFD50) of the Rhineland-Palatinate State Office for Geology and Mining (BFD50) and the Hessian State Agency for Nature Conservation, Environment and Geology were used.

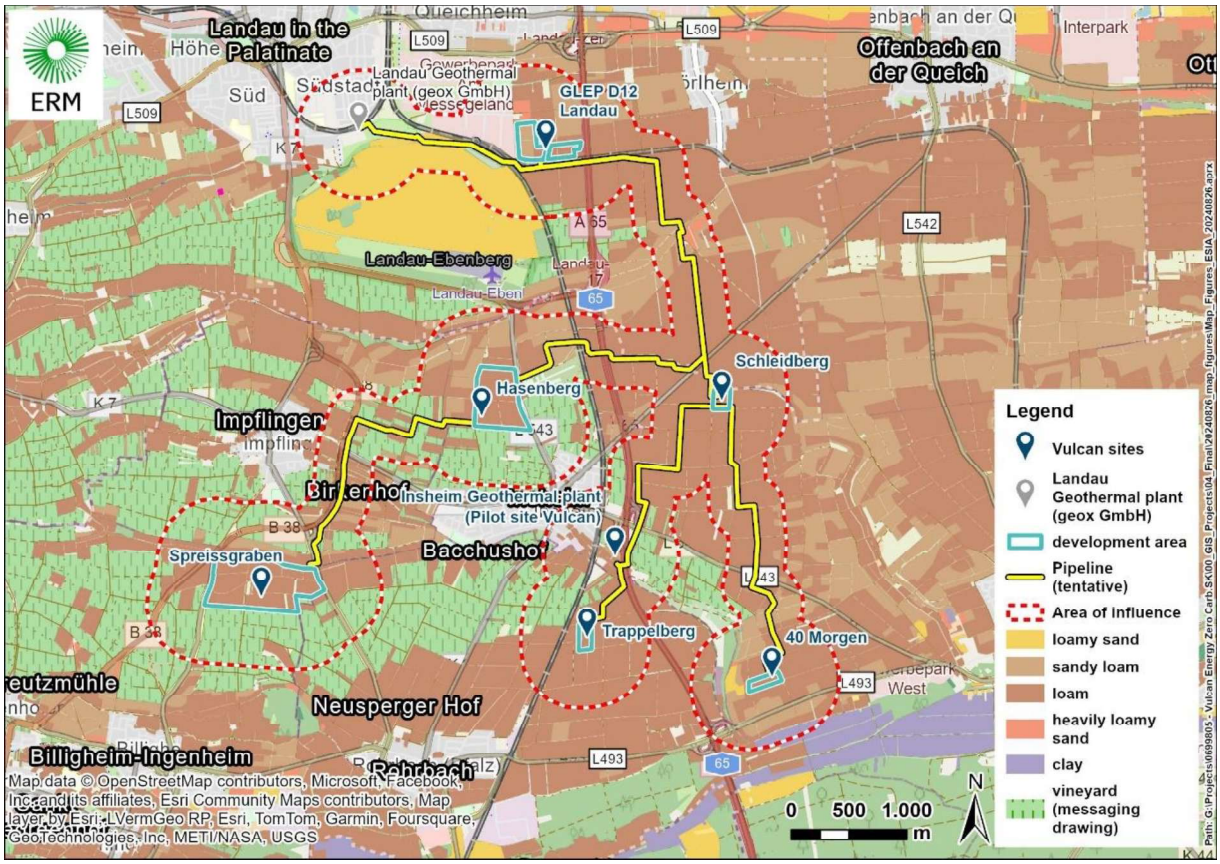


FIGURE 6-7 SOIL MAP OF THE PROJECT AREA

The soil texture in the Project area near Landau is mostly loamy and sandy loamy (Figure 6-7) [65].

Table 6-3 shows the identified soil types at the different Project components.

[64] Hessisches Landesamt für Naturschutz, Umwelt und Geologie, 2023. Bodenviewer Hessen.
[65] Landesamt für Geologie und Bergbau Rheinland-Pfalz, 2023. Bodenflächendaten der landwirtschaftlichen Nutzfläche.

TABLE 6-3 SOIL TYPES AT THE DIFFERENT PROJECT COMPONENTS

Project Component	Soils
GLEP	Phaeozem (Tschernosem-Parabraunerde), eroded, from Pleistocene loess Colluvisol (Kolluvisol) from colluvial loam or colluvial sand loess (Holocene)
Insheim Geothermal Plant	Colluvisol (Kolluvisol) from carbonate-bearing colluvial loess (Holocene) over deep loess (Pleistocene) Gley-colluvisol from loess- and carbonate-bearing colluvial loam (Holocene)
Schleidberg	Phaeozem (Tschernosem-Parabraunerde), eroded, from Pleistocene loess Colluvisol (Kolluvisol) from carbonate-bearing colluvial loess (Holocene) over deep loess (Pleistocene)
40 Morgen	Phaeozem (Tschernosem-Parabraunerde), eroded, from Pleistocene loess
Trappelberg	Phaeozem (Tschernosem-Parabraunerde), eroded, from Pleistocene loess Colluvisol (Kolluvisol) from carbonate-bearing colluvial loess (Holocene) over deep loess (Pleistocene)
Spreissgraben	Colluvisol (Kolluvisol) from carbonate-bearing colluvial loess (Holocene) over deep loess (Pleistocene) Rigosol from Loess (Pleistocene)
Hasenberg	Phaeozem (Tschernosem-Parabraunerde), eroded, from Pleistocene loess
CLP	Luvisol (Parabraunerde) with Pseudogley-Luvisol (Pseudogley-Parabraunerde)

Source: State Office for Geology and Mining Rhineland Palatinate, Soil Map (BFD50); Hessian State Agency for Nature Conservation, Environment and Geology, Soil Map (BFD50).

As shown in Table 6-3 soil types at the GLEP, Schleidberg, 40 Morgen, Trappelberg and Hasenberg are mostly composed of eroded Phaeozems (Tschernosem-Parabraunerde) which developed at the surface of the Pleistocene loess. Phaeozems are characterised by a black, humus-rich surface horizon and a lack of secondary carbonates in the upper meter of the soils. These soils can typically be found in prairie locations[65]. At the Spreissgraben Well site Rigosol, which developed upon loess (Pleistocene) can be found. Rigosols are soil types created by deep ploughing and mixing which is done for vineyard soils every 20 to 40 years. This causes marl and organic fertilisers to be mixed with rock debris[66].

Another soil type at the Insheim Geothermal Plant is Gley-Colluvisol from loess- and carbonate-bearing colluvial loam (Holocene). Characteristics of Gley-Colluvisiols are a high groundwater level and a mineral soil horizon of humic soil material that has been deposited either fluviatile, aeolian or anthropogenically[67].

At the GLEP Colluvisol (Kolluvisol) from colluvial loam or colluvial sand loess (Holocene) can also be found. Another reoccurring soil type at the Project components near Landau is Colluvisol (Kolluvisol) from carbonate-bearing colluvial loess (Holocene) over deep loess (Pleistocene) at the Insheim Geothermal Plant, Schleidberg, Trappelberg and Spreissgraben. Colluvisiols are formed from flushed soil material and is typically rich in fine material, humus, and nutrients[68].

[66] Spektrum, 2001. Lexikon der Geographie, Rigosol.
[67] Federal Agency for Cartography and Geodesy. Kolluvisol-Gley.
[68] Landesamt für Geologie und Bergbau Rheinland-Pfalz, 2007. Begleitheft zur Weinbergsbodenkarte von Rheinland-Pfalz 1:10,000.

This soil type is significantly modified through human activities and is often used for agriculture in Rhineland Palatinate[69].

The soils around the upstream Project area are generally stable, but their stability can be influenced by various factors such as land use and agricultural practices. The soils from aeolian sediments, such as Rigosol from loess and Phaeozems, have good soil stability, as loess has a high binding capacity. However, these soils are susceptible to erosion, particularly in the case of intensive agricultural use and on slopes. The low groundwater levels in the affected area can further increase the susceptibility to erosion, as there is less water available to stabilise the soil structure[70].The soil type at the CLP is Luvisol (Parabraunerde) with Pseudogley-Luvisol (Pseudogley-Parabraunerde). However, according to the preliminary geotechnical study from the Baugrundinstitut Franke-Meißner und Partner GmbH (BFM) in 2022 it can be assumed that the surface of the site has been altered due to remediation measures, e.g., by backfilling. The depth of the backfill varies between 1.5 m and 7 m and is primarily composed of sands, gravels, and silts as well as in some instances also concrete, slag, brick, asphalt deposits and chemical residues[71].

6.5.4 GEOHAZARDS

Regarding seismicity the Project area including the CLP in Höchst[72] is in earthquake zone 1[73]. This means that there is a 10 percent probability that an earthquake between 6.5 and 7.0 (damages to houses are possible) on the Richter scale will be exceeded in 50 years[74].

Only small earthquakes were recorded in the last decades within the Project area. In August and September of 2009, earthquakes of 2.7 magnitude and 2.4 magnitude on the Richter scale occurred in Landau. In December 2010 an earthquake of 2.0 magnitude occurred. Further earthquakes were reported in Insheim in May 2009 (2.0 und 2.1 magnitude), April 2010 (2.2. and 2.4 magnitude), February 2013 (2.0 magnitude) and October 2013 (2.1 magnitude)[75]. Earthquakes with a magnitude of 2.0 to 2.9 can cause hanging objects to swing[76].

6.6 HYDROLOGY – SURFACE AND GROUNDWATER

6.6.1 METHODOLOGY AND INFORMATION SOURCES

Hydrological features within the area of influence of the Project were identified via a desktop study as well as the secondary data collected during ERM's site visit in August 2023. The features include published information on the freshwater environment that is available to establish the baseline prior to construction and operation of the Project. The following desktop sources were used to identify the hydrological features:

- Water Portal Rhineland-Palatinate, Ministry for Climate Protection, Environment, Energy and Mobility in Rhineland Palatinate, 2023;

[69] Ministerium für Umwelt, Energie, Ernährung und Forsten Rheinland-Pfalz, 2016. Bodenzustandsbericht Rheinland-Pfalz.
[70] Yamamoto, S., 2013. Soils on the Loess Plateau.
[71] BFM, 2022. Preliminary geotechnical study at Industriepark Höchst.
[72] Hessisches Landesamt für Naturschutz, Umwelt und Geologie, 2007. Karte der Erdbebenzonen und geologischen Untergrundklassen für Hessen
[73] Landesamt für Geologie und Bergbau, 2023.
[74] Bundesverband für Geothermie, 2020. Erdbebenzone.
[75] Landesamt für Geologie und Bergbau, 2023. Karte der vom LER registrierten Erdbebenereignisse.
[76] Richter Scale & Magnitude (sms-tsunami-warning.com)

- Depth of water table, State Office for Geology and Mining Rhineland-Palatinate, 2023;
- Geochemical rock type for the Upper Aquifer, State Office for Geology and Mining, 2023;
- Report on the contaminated site at the CLP in Höchst, Infraserv, 2023;
- Flood Risk Action Plan for the Industrial Park Höchst, Hessian State Agency for Nature Conservation, Environment and Geology, 2015;
- Flood risk map, Hessian State Agency for Nature Conservation, Environment and Geology, 2015;
- Hydrogeological Mapping and Groundwater Management Rhine-Neckar Area, update 1983-1998. State Office for Geology, Raw Materials and Mining Baden Württemberg, 1999;
- Statement on the general preliminary environmental impact assessment at Schleidberg Süd, Vulcan 2022;
- Internationally Coordinated Management Plan 2022-2027 for the International River Basin District of the Rhine, International Commission for the Protection of the Rhine, 2022; and
- Landesamt fur Umwelt, RhinelandPfalz.

6.6.2AREA OF INFLUENCE

The AoI for surface water includes resources that could potentially be affected by contamination transport processes during construction and operation activities. Regarding groundwater, in the context of this ESIA, the groundwater in the Project area is divided into two categories: Shallow groundwater within the Quaternary sediments and deep brine. The AoI for shallow groundwater encompasses groundwater resources that may be impacted by groundwater abstraction for use in well drilling, pipeline filling, and maintenance, as well as by contamination transport from construction activities.

The AoI for surface and shallow groundwater is shown in Figure 6-8 below.

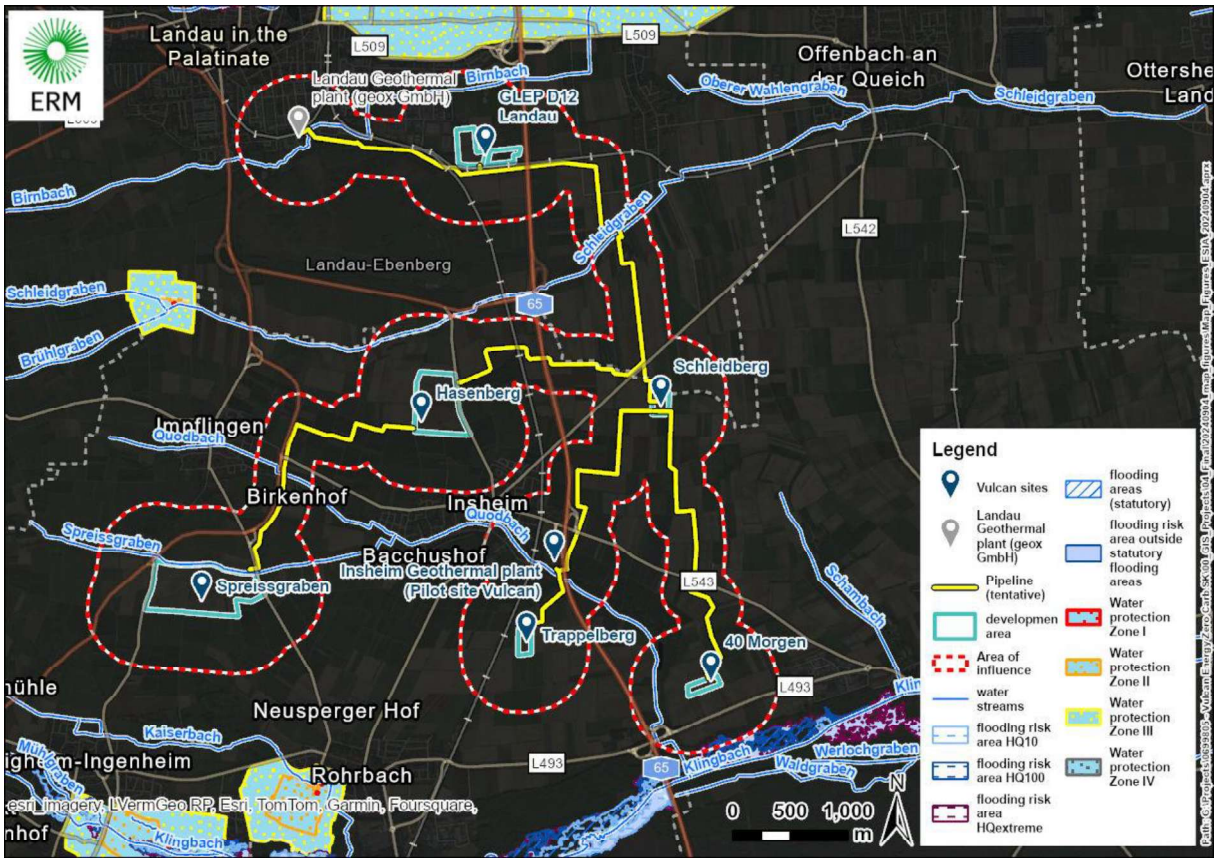


FIGURE 6-8 AOI FOR SURFACE AND SHALLOW GROUNDWATER

6.6.3 SURFACE WATER

Only small streams can be found as hydrological features of the Project components near Landau (Figure 6-9). About 250 m north of the GLEP the Birnbach stream flows from west to east. South of the Well site 40 Morgen streams namely the Klingbach stream (200 m south), Waldgraben stream (400 m south) and Werlochgraben stream (400 m south) can be found. The Quodbach stream is located around 200 m west of 40 Morgen. Around 50 m south of the Insheim Geothermal Plant and 300 m north of the Trappelberg Well site the Quodbach stream flows in a south-easterly direction. The Spreissgraben Well site is bordered by the Spreissgraben stream in the north and flows in an easterly direction. No notable streams could be found in the vicinity of the Schleidberg and Hasenberg Well sites.

All the streams within the AoI are modified. According to the water portal of Rhineland-Palatinate the majority of the streams within the AoI are heavily to completely modified within the stream section of the AoI. Only the Klingbach is moderately modified[77]. The streams in the AoI are modified as a result of development in the catchment, with altered geomorphology and flow regime as well as water quality due to industrial and agricultural runoff or sediment most. Also, straightening of channels is quite common which can especially be seen for Schleidgraben and Spreissgraben. All streams belong to the Rhine catchment area.

[77] State Office for the Environment Rhineland-Palatinate. Water portal. Available at: Geoexplorer. RLP-UMWELT Wasserportal.

200 m northwest of the CLP in Höchst the Main River flows in a south-westerly direction. The Main River is a perennial river, meaning it flows continuously throughout the year, barring extreme drought conditions. It is the longest tributary of the Rhine, stretching approximately 524 kilometres from its source in the Fichtel Mountains to its confluence with the Rhine near Mainz[78]. The catchment area of the Main River is about 27,208 square kilometres, encompassing parts of Bavaria, Hesse, and Baden-Württemberg[79].

[78] Britannica, The Editors of Encyclopedia. "Main River". *Encyclopedia Britannica*, 31 Oct. 2023, https://www.britannica.com/place/Main-River. Accessed 30 August 2024.
[79] Bavarian State Office for the Environment. Table of the Bavarian Waterbody Register. Available at: http://www.lfu.bayern.de/wasser/gewaesserverzeichnisse/doc/tab_alle.xls

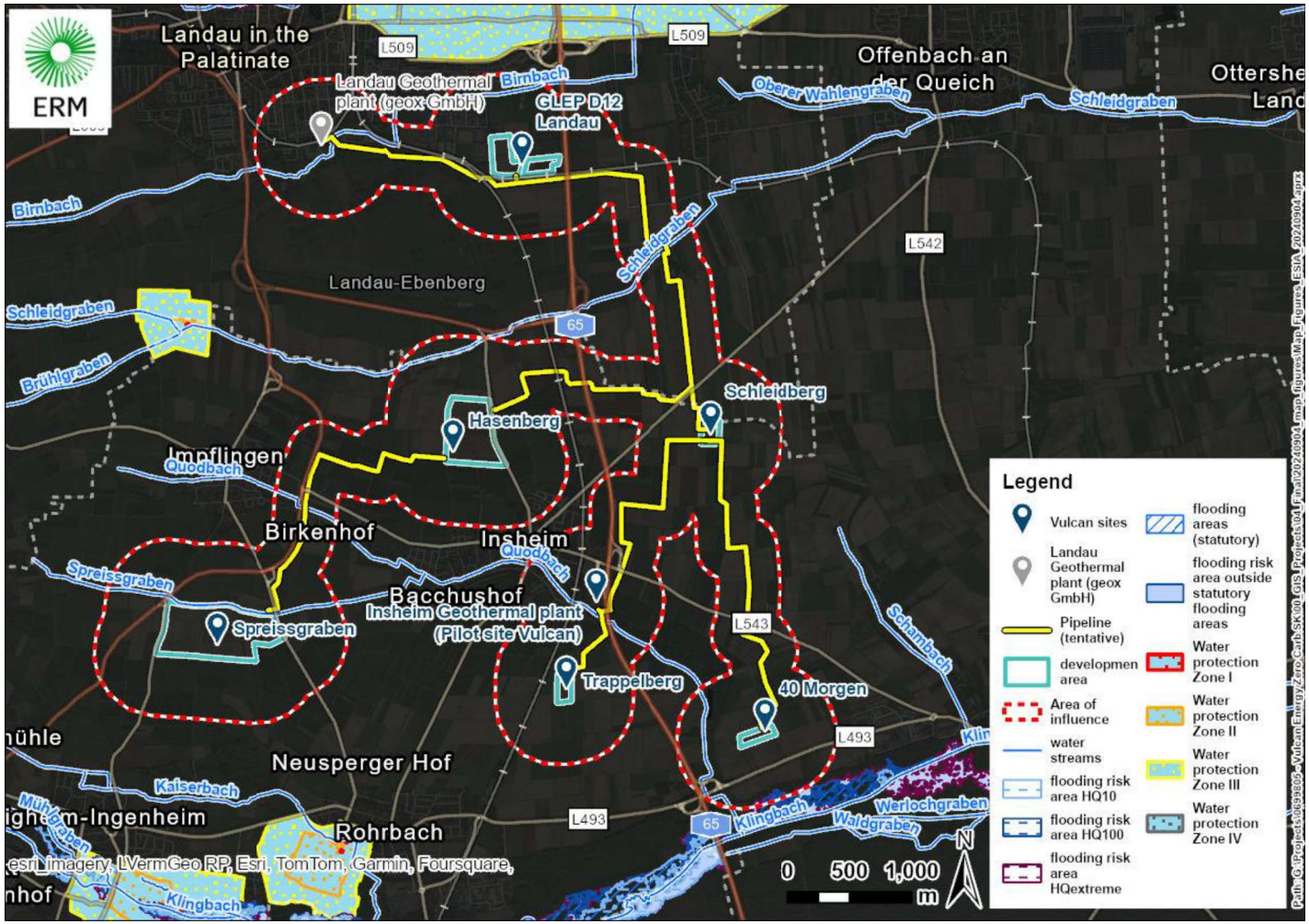


FIGURE 6-9 STREAMS IN THE LANDAU AOI

Source: Data from Ministry for Climate Protection, Environment, Energy and Mobility in Rhineland Palatinate

As presented in Figure 6-9 above, the pipeline will cross the following streams:

- Birnbach – close to the Landau Geothermal plant (previously geox GmbH);
- Schleidgraben – between GLEP and Schleidberg Well site;
- Quodbach – north of Trappelberg Well site, and between Hasenberg and Spreissgraben Well site; and
- Spreissgraben – at Spreissgraben Well site.

According to Vulcan the streams will be crossed with open or closed construction methods depending on the specifications of the various authorities and the classification of the streams.

The industrial park Höchst has its own Flood Risk Action Plan for mitigating flooding. The existing state of the facilities is safe up to an event with a medium likelihood of occurrence (HQ100), in which case wastewater may need to be pumped. A HQ100 designates a flood event that is reached or exceeded with a probability of once in 100 years[80]. The flood protection at the industrial park Höchst is achieved by mobile flood protection components, which are deployed if needed on the northeastern bank of the Main between km 23.95 and 24.4[81]. In 2014, an action program to enhance the present flood protection concept was designed based on the available flood risk maps. With this program in place, the site is protected from flooding even in the unlikely event of an extreme flood. Extreme floods are floods with a low probability of recurrence in Hesse and were calculated as follows: HQ100 (discharge during floods) * 1.3. According to Vulcan's TCFD Report developed by Baringa in 2023 Vulcan's region of operation in the Upper Rhine Valley area sees a modest increase of river floods by 2050.

According to the flood hazard map of the Hessian State Office (Figure 6-10) the original CLP land plot in Höchst is outside the flood limit of an extreme flood[82].

[80] Hessisches Landesamt für Naturschutz, Umwelt und Geologie, 2015. Hochwasserrisikomanagementplan für den hessischen Main.
[81] Hessisches Landesamt für Naturschutz, Umwelt und Geologie, 2015. HWRM-Plan Main in Hessen – Industriepark Höchst.
[82] Hessisches Landesamt für Naturschutz, Umwelt und Geologie, 2015. Hochwassergefahrenkarte.



FIGURE 6-10 ASSESSMENT OF THE FLOOD RISK AT THE CLP IN HÖCHST

Source: Data from the Hessian State Office for the Nature Protection, Environment and Geology, 2015

6.6.4 GROUNDWATER AND HYDROGEOLOGY

The Tertiary syn-rift and Mesozoic to Paleozoic pre-rift sedimentary rocks and recent Quaternary sediments within the Upper Rhine Graben form a sequence of alternating layers of high to moderate permeability units (aquifers) and low permeability units (aquitards). The hydraulic connection between the various aquifers is limited by the presence of the low permeability layers.

The high to moderate permeability Quaternary sediments form a significant groundwater resource in the Upper Rhine Graben. These Quaternary sediments extend to depths of approximately 200m below ground level (Figure 6-11). The target brine resource for the Project is located in the fractured sandstones of the Buntsandstein at depths of between approximately 2,500 m and 4,000 m below ground level.

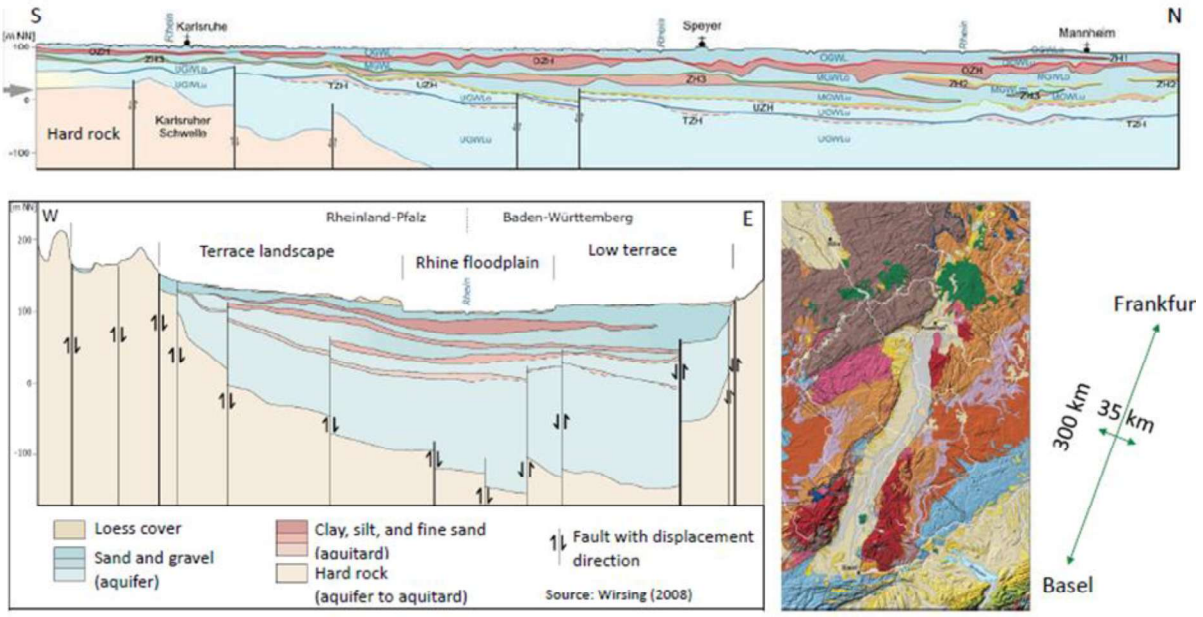


FIGURE 6-11 GEOLOGICAL CROSS-SECTION ILLUSTRATING THE HYDROGEOLOGY OF THE QUATERNARY SEDIMENTS IN THE UPPER RHINE GRABEN

Shallow Groundwater in the Quaternary Sediments

In 2022, Vulcan conducted a general preliminary environmental impact assessment (EIA) at the Schleidberg Well site. Based on this pre-EIA the following hydrogeological horizons are anticipated in the Quaternary sediments within the Project area, where the succession is complete: Lower Aquifer (lower part), Deep Intermediate Horizon, Lower Aquifer (upper part), Lower Intermediate Horizon, Middle Aquifer, Upper Intermediate Horizon, and the Upper Aquifer.[83] It is noted that the Middle Aquifer is not present across the entire Project area, since the Lower Intermediate Horizon was not encountered during drilling at Schleidberg.

Geologically the Upper Aquifer corresponds to the Upper Gravel Bed and consists of fluvial terrace deposits, which include silt and clay lenses. The Upper Intermediate Horizon forms the base of the Upper Aquifer and consists mainly of fine sand with clay and silt deposits. The Upper Intermediate Horizon acts as an aquitard, hydraulically separating the Upper and Middle aquifers. The Middle Aquifer is composed of sandy gravel and sand with minor silt and clay horizons. The Lower Intermediate Horizon consists of silts and clays hydraulically separating the Middle Aquifer from the Lower Aquifer. The Lower Aquifer contains an alternating sequence of sandy and silty layers.[79]

Pumping tests were completed on the existing groundwater monitoring wells installed at the Schleidberg site. The pumping tests indicated that the wells are capable of providing a yield of approximately 10 m^3/hr. Further testing will be completed to confirm potential maximum sustainable yields from the existing groundwater service wells and new groundwater service wells as they are installed. According to measured groundwater levels in the region, the groundwater level in the upper aquifer of the Quaternary deposits varies between approximately 1m and 25m below ground level in the Landau area. At the CLP in Hoechst the uppermost aquifer

[83] Vulcan, 2022. Statement on the general preliminary environmental impact assessment at Schleidberg Süd.

is formed within the quaternary sand and gravels deposits and the groundwater table is approximately 6 to 7 m below ground level[84].

According to regional groundwater levels (Hydrogeological Mapping and Groundwater Management Rhine-Neckar Area, update 1983-1998), the groundwater flow direction in the Upper Aquifer of the Project area is generally eastward, and more specifically at Schleidberg groundwater flow is in a southeastern direction. The groundwater flow in the Middle Aquifer is in a similar direction. [79]

Groundwater recharge areas for the UGWL occur along a north-south longitudinal strip in the Landau area, where groundwater from the upper aquifer flows into the lower aquifer (Belafi, 2016). There is therefore a potential for substance transfer into the lower aquifer. A little further to the east, there is a parallel strip with a drawing zone of the lower aquifer that infiltrates into the upper aquifer (Belafi, 2016).The Project is located in an area designated to be of good quantitative status for groundwater[1]. The groundwater aquifers within the Quaternary sediments are used extensively in the region for agricultural and drinking water supply.

In Rhineland-Palatinate, more than 90 % of the drinking water supply is sourced from groundwater. Due to different land and soil use in the past decades, impairments of the groundwater quality are recognizable, for example, due to diffuse inputs of nitrogen, phosphate, and pesticides. The existing groundwater resources must be protected from influences that reduce their quality and quantity to avoid increasingly costly treatment processes or worse, "drinking water factories" in the future. Water protection areas are generally classified into three zones, for which certain requirements must be met according to the catalogue of protected areas. The first zone is designed to protect the immediate vicinity of the water extraction site from any contamination and any other impact. Zone I is usually enclosed by a fence. The more restricted protection Zone II is intended to ensure protection against contamination and other impairments caused by human activities and facilities which are particularly dangerous due to their proximity to the water extraction site. The main purpose of this zone is to provide protection against bacterial contamination. Zone II stretches from the boundary of Zone I to a line from which the groundwater takes about 50 days to reach the water extraction site. Protection Zone III covers the entire above ground and underground area from which the well is sourcing water (the entire water catchment area of the well). If the basin extends further than 2 km from the water extraction site, it may be divided into protection Zones III A and III B. Within all three protection zones, restrictions can be imposed on land use and groundwater-threatening activities can be prohibited by legal ordinance. By the end of 2006, there were 717 legally binding water conservation areas in Rhineland-Palatinate covering an area of approximately 1,476 km². Around 532 km² of this area is covered by protection Zones I and II and around 944 km² by Zone III (Landesamt für Umwelt Rheinland-Pfalz n.d.; Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz).

There are no water protection areas within the shallow groundwater AoI, and the proposed well sites were specifically chosen to be outside of existing nature conservation areas. The nearest water protection area is the water protection area Dreihof/Offenbacher Wald located 600 m north of the GLEP.

[84] Infraserv, 2023. Altlastensituation im Bereich der Pachtfläche G6/G7/G8 Stellungnahme zur Altlastensituation als Anlage 10 zum Pachtvertrag zwischen der Vulcan Energie und der Infraserv GmbH & Co. Höchst KG

Brine Resource

The target brine source for the Project is located within the fractured sandstones of the Buntsandstein formation, at depths ranging from approximately 2,500 meters to 4,000 meters below ground level. The deep brine system is hydraulically isolated from the shallow groundwater system by thick clay-rich Tertiary sediments and the clay-dominated upper layer of the Mesozoic pre-rift sediments (Keuper), as illustrated in Figure 6-12. This hydraulic separation is further evidenced by the distinct water qualities of the Quaternary groundwater aquifer and the deep brine aquifer, which are discussed in Section 6.6.5.

Currently, the deep brine aquifer is being utilised for renewable energy production in Insheim and Landau. The shallow Quaternary groundwater remains hydraulically separated from the deep brine due to the characteristics and thickness of the intervening sediments. To ensure this separation, the design of the brine abstraction and injection wells prevents any hydraulic connection between the brine and the shallow groundwater. Consequently, the abstraction and injection of deep brine will not affect the shallow groundwater aquifer.

Given the low potential for any impact from the brine extraction on the shallow groundwater, no additional hydrogeological modelling has been conducted for the Project.

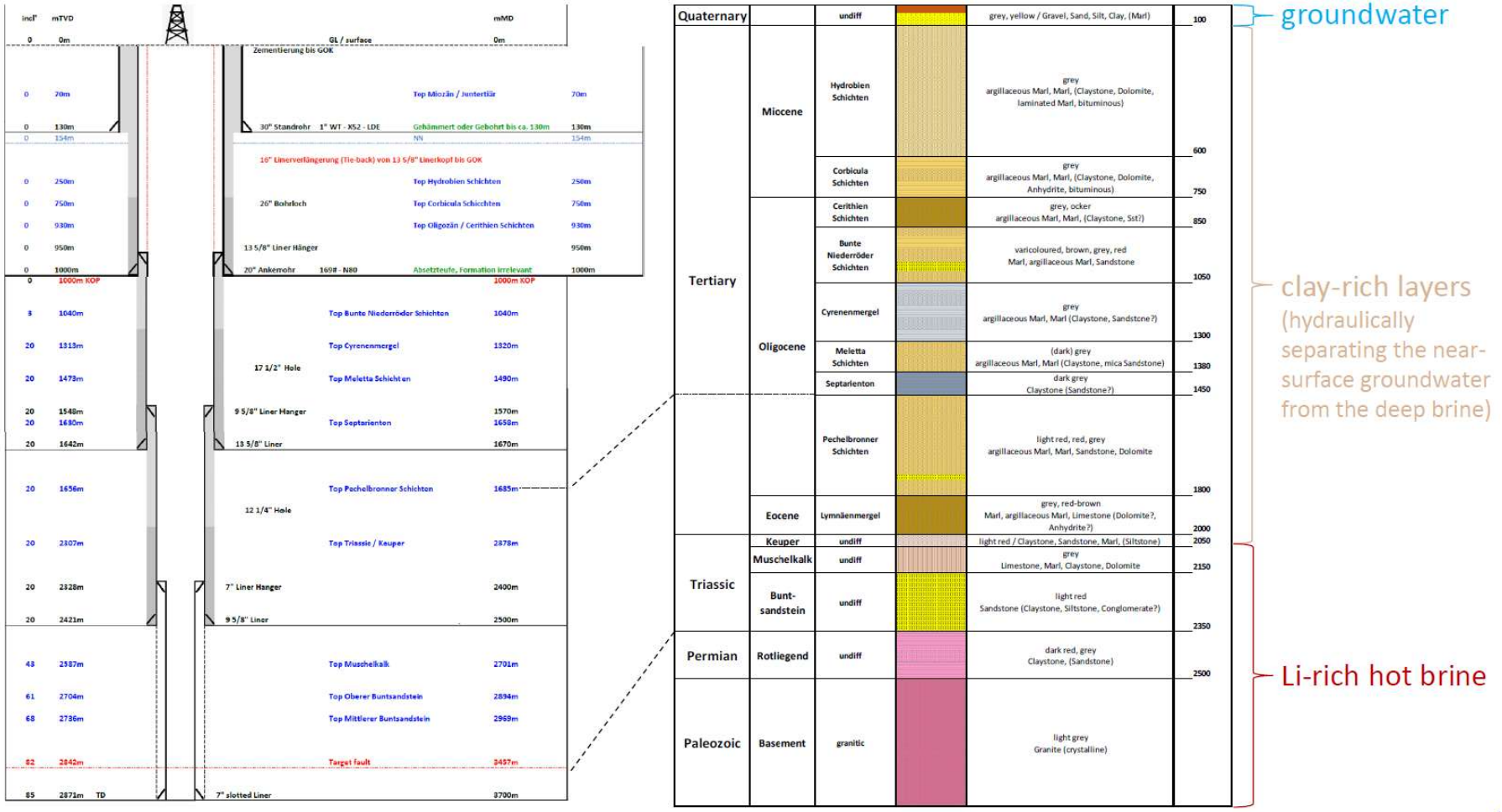


FIGURE 6-12 PROPOSED WELL CONSTRUCTION AND GENERALISED LITHOSTRATIGRAPHY FOR THE UPPER RHINE GRABEN.

6.6.5 GROUNDWATER QUALITY

Several groundwater samples were collected from the Quaternary aquifers in the Project area near Landau[85]. The most recent groundwater samples were collected by a certified laboratory from the newly installed monitoring wells at the Schleidberg site in March 2024. Groundwater samples were also collected in August 2023 from an irrigation well belonging to a local farmer and at the Schleidberg drill site. The irrigation well is located approximately 560 m downstream of the Schleidberg drill site. Further water samples collected in 1982 in Insheim (Lower Aquifer), 1992 at the Schambach Quelle and 2003 in Insheim (Upper Aquifer) are shown for comparison in Table 6-4.

TABLE 6-4 GROUNDWATER QUALITY IN THE PROJECT AREA

Parameter	Unit	Insheim 1425 01.12.1982	Schambach spring 16.12.1992	Insheim 1187 30.10.2003	Farmer Traut 11.08.2023	Schleidberg GWM1 21.03.2024	Schleidberg GWM2 21.03.2024	German Drinking Water Ordinance [84]
Water temperature	°C	11	6.6	12.5	12.5	12.9	14	NA
pH	-	7.3	7.0	7.5	7.5	7.3	7.0	>6.5 and <9.5
Electric conductivity	µS/cm	510	1010	965	940	621	537	2,790
Oxygen	mg/L	4	6.5	5	10.7	7.1	<0.1	NA
Degree of general hardness	dGH	16.2	28.9	28.4	25.9	NA	NA	NA
Na	mg/L	12.4	7	16	7.66	7.1	5.76	NA
K	mg/L	1.8	0.09	<1	0.58	0.82	1.88	NA
Mg	mg/L	17.6	27	26	26.5	23.8	19.3	NA
Ca	mg/L	86.5	162	160	141	90	83.2	NA
Pb	µg/L	NA	<3	<3	<1	<1	<1	10
As	µg/L	NA	<2	<2	<1	<1	5	10
Sb	µg/L	NA	NA	<2	<1	<1	<1	5
Cr	µg/L	NA	<2	<2	4	4	<1	50
Cu	µg/L	NA	<2	<2	<1	<1	<1	2.000
Zn	µg/L	NA	<30	2000	5	5	2	NA
Cd	µg/L	NA	<0.3	0.19	<0.2	<0.2	<0.2	0.5
Mn	mg/L	<0.1	0.19	0.09	<0.001	0.001	0.068	0.05
Fe	mg/L	0.9	0.05	0.28	0.006	<0.005	1.74	0.2

[85] Vulcan, 2023. Messstellen Grundwasser Analysen Umgebung von Schleidberg

Parameter	Unit	Insheim 1425 01.12.1982	Scham-bach spring 16.12.1992	Insheim 1187 30.10.2003	Farmer Traut 11.08.2023	Schleid-berg GWM1 21.03.2024	Schleid-berg GWM2 21.03.2024	German Drinking Water Ordin-ance [84]
Ni	µg/L	NA	<5	<5	<1	<1	<1	20
Si	mg/L	5.7	3.7	5.6	6.76	7.33	5.04	NA
B	mg/L	NA	NA	<0.03	<0.02	0.02	<0.02	1.0
Nitrate (NO_3^-)	mg/L	0.65	62.1	56.6	84	38	<1	50
Nitrite (NO_2^-)	mg/L	<0.02	<0.02	0.02	0.1	<0.01	<0.01	0.5
Ammonium (NH_4^+)	mg/L	0.19	0.08	0.01	<0.06	<0.06	0.08	0.5
Total phosphorus as P	mg/L	0.04	0.06	0.01	<0.020	NA	NA	NA
Orthophosphate (PO_4^{3-})	mg/L	NA	NA	0.01	<0.02	0.09	0.11	0.5
Sulphate (SO_4^{2-})	mg/L	10.3	94.4	73	84	13	NA	250
Chloride (Cl^-)	mg/L	12	55	49	58	37	4.7	250
Dissolved organic carbon (DOC)	mg/L	NA	2.1	1.1	1.4	<1.0	1.8	NA
Adsorbable organic halogen compounds (AOX)	µg/L	NA	13	<10	<10	<10	<10	NA

Note: NA = Not Available.

Source: Vulcan, 2023.

Concentrations of nitrate in excess of the German Drinking water regulations have been detected in three of the water samples collected in the area. The 2023 water sample collected from Landwirt Traut shows a nitrate concentration of 84 mg/l, while the threshold in the German drinking water regulations (TrinkwV) is 50 mg/l.[86]. The elevated nitrate values are likely the results of the intensive agricultural activities within the Project area near Landau[87].

Concentrations of manganese (Mn) and iron (Fe) in excess of German Drinking water regulations were detected in a number of water samples. However, these threshold values are primary for technical and aesthetic purposes. Manganese concentrations over 0.050 mg/l can cause silting in the distribution network and elevated iron concentrations can lead to browning of the water and taste deterioration[88].

The water quality analyses completed suggest that the groundwater in the Quaternary sediments has an electrical conductivity typically less than 1,000 µS/cm and temperature of less

[86] Verordnung über die Qualität von Wasser für den menschlichen Gebrauch (Trinkwasserverordnung - TrinkwV), 2023.
[87] FAQs zu Nitrat im Grund- und Trinkwasser | Umweltbundesamt
[88] Toxikologie des Trinkwassers | Umweltbundesamt

than 13 °C. A chart illustrating the major anions and cations for the groundwater in the shallow Quaternary aquifer is presented in Figure 6-13.

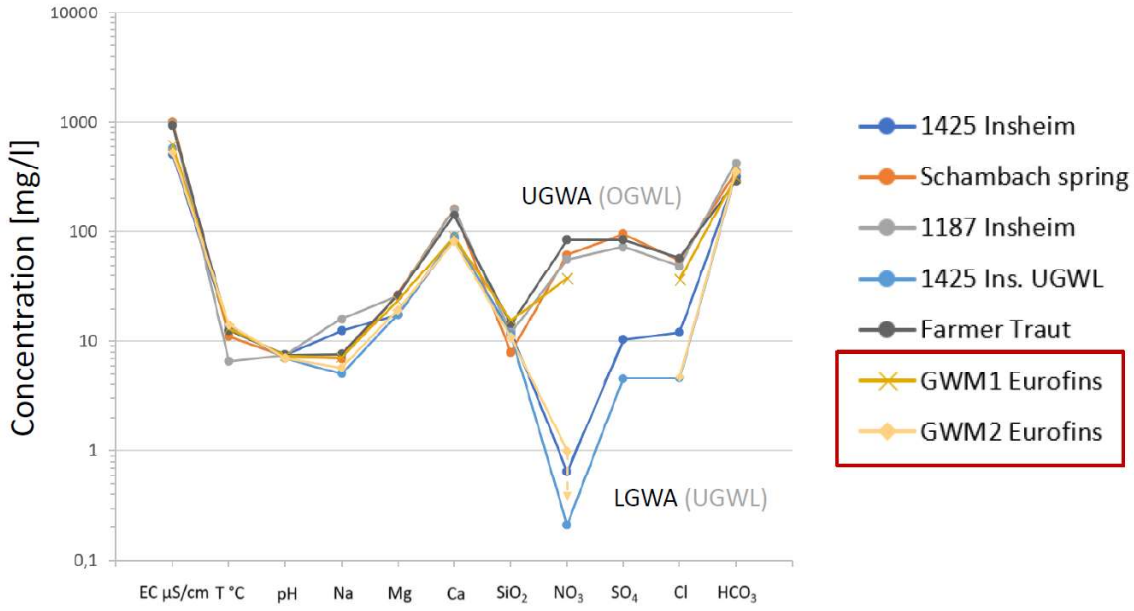


FIGURE 6-13 MAJOR ANIONS AND CATIONS CONCENTRACTION FOR THE GROUNDWATER IN THE SHALLOW QUATERNARY AQUIFER

The water quality for the deep brines, and also the intermediate stagnant brines in the overlying Tertiary deposits, has been evaluated extensively[89]. The water quality analyses suggest that the Na-Cl-dominated brines typically have a total dissolved solid concentration of approximately 120 g/L (equating to an electrical conductivity of approximately 150,000 µS/cm) and temperature of approximately 200 °C. Thus, the shallow groundwater within the Quaternary sediments and the much deeper brines has very different water quality and temperature.

A chart illustrating the major anions and cations for the deep brine and stagnant brines within the Tertiary sediments is presented in Figure 6-14.

[89] Sanjuan.B et al, 2016.

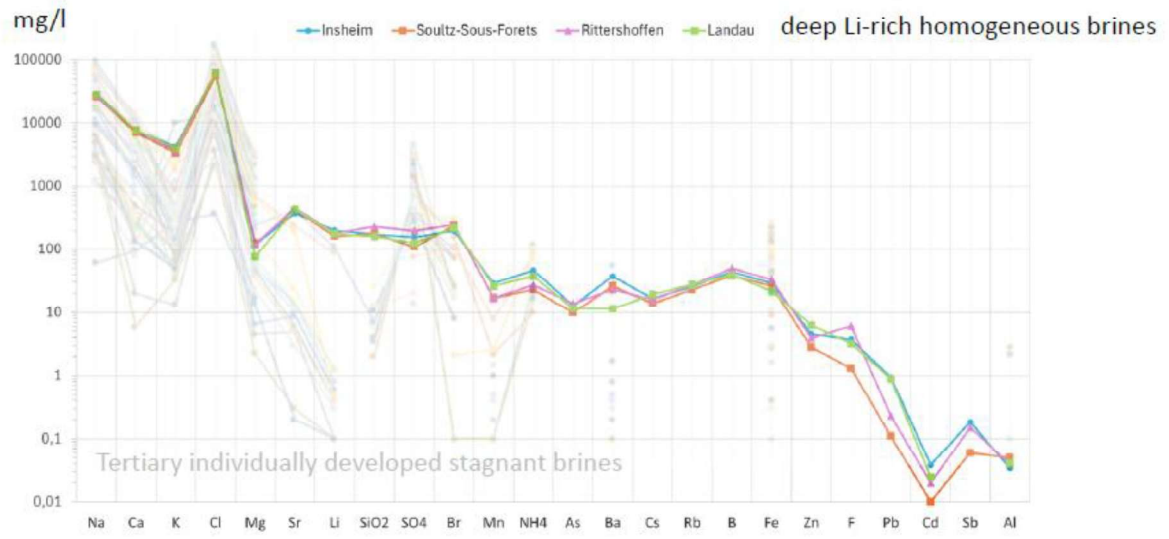


FIGURE 6-14 MAJOR ANIONS AND CATIONS CONCENTRATION FOR THE DEEP BRINE AND STAGNANT BRINES WITHIN THE TERTIARY SEDIMENTS

Regionally, the water quality in the shallow Quaternary aquifers ranges from good to poor.[90]

6.7 AIR QUALITY

6.7.1 METHODOLOGY AND INFORMATION SOURCES

Following data was used to understand the current air quality in the AoI:

- **European Environment Agency – Environment and Health Atlas**[91]: Has information on annual interpolated European air quality data for $PM_{2.5}$, NO_2, and O_3. Air quality thresholds (Very Poor, Poor, Neutral, Moderate, Good) in accordance with the WHO Air Quality Guidelines 2021.
- **German Federal Environment Agency – Air pollution in Germany**[92]**:** Overview map of annual air emissions of PM_{10}, $PM_{2.5}$, NO_2, and O_3. Air quality threshold in accordance with the 39th ordinance on the Implementation of the Federal Emission Control Act.

6.7.2 AIR QUALITY STANDARDS

The AQS relevant to this assessment are set out in Table 6-6. These values originate from WHO Air Quality Guidelines 2021 as well as the German Federal Emission Control Act (BImSchV).

Within the WHO Air Quality Guidelines 2021 the WHO has defined air quality guideline (AQG) levels associated with key public health risks. These levels are not legally binding but provide a tool for countries to advise on their national policy and legislation. The WHO Guideline also established interim targets to guide reduction efforts towards the final and timely achievement of AQG levels for countries that significantly exceed these levels. Table 6-5 shows the thresholds

[90] Landesamt fur Umwelt - wasserportal.rlp-umwelt.de
[91] EEHA - Health Atlas (europa.eu)
[92] 39. BImSchV - nichtamtliches Inhaltsverzeichnis

for air quality variables based on the recommended levels and interim targets of the WHO Air Quality Guidelines.

TABLE 6-5 WHO RECOMMENDED AIR QUALITY GUIDELINE LEVELS AND INTERIM TARGETS

	WHO Recommended Levels and Interim Targets				
Pollutant	**Good**	**Moderate**	**Neutral**	**Poor**	**Very Poor**
$PM_{2.5}$	< 5 µg/m³	≥ 5 and < 10 µg/m³	≥ 10 and < 15 µg/m³	≥ 15 and < 25 µg/m³	≥ 25 µg/m³
PM_{10}	< 15 µg/m³	≥ 15 and < 20 µg/m³	≥ 20 and < 30 µg/m³	≥ 30 and < 50 µg/m³	≥ 50 µg/m³
NO_2	< 5 µg/m³	< 10 µg/m³	≥ 10 and < 20 µg/m³	≥ 20 and < 40 µg/m³	≥ 40 µg/m³
O_3 [93]	< 2,000 µg/m³*d	≥ 2,000 and < 4,000 µg/m³*d	≥ 4,000 and < 6,000 µg/m³*d	≥ 6,000 and < 8,000 µg/m³*d	≥ 8,000 µg/m³*d

Source: WHO Air Quality Guidelines, 2021

It must be noted that the WHO Air Quality Guidelines (AQGs) and the European Commission (EC) Directives on air quality are related but not perfectly aligned. The WHO AQGs are based on the latest scientific evidence regarding the health effects of air pollutants, providing recommended limits for key pollutants like particulate matter (PM2.5 and PM10), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3). These guidelines are intended to protect public health by minimising the risks associated with air pollution.

On the other hand, the EC Directives, such as the Ambient Air Quality Directive (2008/50/EC), set legally binding limits for air quality across the European Union. While these limits are influenced by the WHO guidelines, they are also shaped by practical considerations, such as economic factors and the feasibility of achieving the targets across member states.

In summary, while the EC Directives are influenced by the WHO AQGs, the guidelines are generally more stringent. The differences exist because the EC has to balance health protection with economic and technical feasibility considerations across all member states.

In Germany, the German Federal Emission Control Act (BImSchG) is generally aligned with European Commission (EC) directives, particularly regarding air quality, noise control, and industrial emissions. BImSchG implements EU standards into German law, ensuring compliance with environmental regulations across pollutants like sulfur dioxide (SO_2), nitrogen oxides (NO_x), and particulate matter (PM10 and PM2.5). Although there may be minor differences in implementation, the core objectives of the BImSchG and EC directives are consistent, promoting harmonised environmental protection within the EU.

[93] Variable definition: SOMO35 is the sum of the differences between maximum daily 8-hour running mean concentrations greater than 70 µg/m3 (= 35 parts per billion) and 70 µg/m3

TABLE 6-6 NATIONAL AIR QUALITY STANDARDS IN GERMANY

Pollutant	Averaging Period	Statistic	German Threshold ($\mu g/m^3$)
$PM_{2.5}$	Annual mean		25
PM_{10}	Annual mean		40
PM_{10}	24-hour mean	Not to be exceeded more than 35 times per year	50
NO_2	Annual mean		40
O_3	8-hour mean	Not to be exceeded more than 25 times over three years	120

Source: Bundesimmisionsschutz Verordnung, BImSchV, 2008

6.7.3 AIR QUALITY FEATURES OF THE PROJECT AREA

Air emissions will only be generated during construction, no air emissions are envisaged during operation except the temporary truck emissions to transport the Lithium Chloride solution from GLEP to the CLP in Höchst at the initial stage of the operation[94]. In general, air quality in the region is influenced by emissions from existing road traffic such as the A65 motorway close to the Project components near Landau. Since the CLP is located in the Industrial Park Höchst, air emissions from the surrounding industrial activities are expected and were also noted during the site visit performed in August 2023.

The well sites are located on agricultural fields with no major source of combustion in the vicinity, air quality is assumed to be typical for rural areas.

Baseline air quality values in the Project area for NO2, PM10, PM2.5 and O3 can be found in Table 6-7.

[94] E-trucks will not be used at the initial stages due to the existing regulations in place preventing chemicals to be transported by E-trucks, however Vulcan will make a transition plan once the regulations change.

TABLE 6-7 BASELINE VALUES FOR NO_2, PM_{10}, $PM_{2.5}$ AND O_3

Location (Site)	NO_2 Annual Baseline Concentrations µg/m³	PM_{10} Annual Baseline Concentrations µg/m³	PM_{10} Number of days of 24-Hour Baseline Concentrations over 50 µg/m³	$PM_{2.5}$ Annual Baseline Concentrations µg/m³	O_3 Number of days of 8-Hour Mean over 120 µg/m³ over 3 years	O_3 Sum of Differences between Maximum Daily 8-Hour Mean Concentrations > 70 µg/m³ and 70 µg/m³
German AQS	40	40	35	25	25	-
GLEP	15.8	15-20	< 7	10.1	10-15	5,634.6
WHO Classification	Neutral	Moderate	N/A	Neutral	N/A	Neutral
Insheim GPP	16.5	10-15	< 7	10.1	10-15	5,510.5
WHO Classification	Neutral	Good	N/A	Neutral	N/A	Neutral
CLP	24.2	15-20	< 7	10.9	5-10	4,746.8
WHO Classification	Poor	Moderate	N/A	Neutral	N/A	Neutral
Schleidberg	12.3	10-15	< 7	9.5	10-15	6,034.7
WHO Classification	Neutral	Good	N/A	Moderate	N/A	Poor
Trappelberg	16.5	10-15	< 7	10.1	10-15	5,510.5
WHO Classification	Neutral	Good	N/A	Neutral	N/A	Neutral
Hasenberg	12.2	10-15	< 7	9.5	10-15	6,034.7
WHO Classification	Neutral	Good	N/A	Moderate	N/A	Poor
Spreissgraben	13.2	10-15	< 7	9.7	10-15	5,896.7
WHO Classification	Neutral	Good	N/A	Moderate	N/A	Neutral

Location (Site)	NO_2 Annual Baseline Concentrations µg/m³	PM_{10} Annual Baseline Concentrations µg/m³	PM_{10} Number of days of 24-Hour Baseline Concentrations over 50 µg/m³	$PM_{2.5}$ Annual Baseline Concentrations µg/m³	O_3 Number of days of 8-Hour Mean over 120 µg/m³ over 3 years	O_3 Sum of Differences between Maximum Daily 8-Hour Mean Concentrations > 70 µg/m³ and 70 µg/m³
40 Morgen	12	10-15	< 7	9.6	10-15	6,034.7
WHO Classification	Neutral	Good	N/A	Moderate	N/A	Poor

Sources: Umweltbundestamt, 2020. Luftschadstoffbelastung in Deutschland; European Environment Agency, 2023. Environment and Health Atlas.

Generally, the air quality at all the Project components is well under German Federal Emission Control Act (BImSchV) (see Table 6-7). However, comparing the parameters NO_2, $PM_{2.5}$ and O_3 with the WHO Air Quality Guidelines (2021), some baseline parameters are classified as poor or neutral.

Especially the NO_2 Annual Mean baseline at the CLP in Höchst is classified as "poor" as the concentration exceed 20 µg/m^3. This could be due to the industrial activities surrounding the CLP site. The NO_2 Annual Mean baseline at the other sites is between 10 and 20 µg/m^3 which is classified as "neutral" according to the WHO Guidelines. Besides the CLP the Insheim GPP, the Trappelberg Well site and the GLEP have the highest NO_2 concentrations. The reason is presumably their close distance to major roads and motorways.

Additionally, the O_3 concentration at the planned well sites for Schleidberg, Hasenberg and 40 Morgen is classified as "poor". Usually in rural areas O_3 concentrations are higher because of less sources of precursors (such as Nitrogen Monoxide (NO)). NO, e.g., contained in car exhaust fumes, reacts with ozone. During this reaction, ozone is broken down, which is why ozone pollution in inner cities is significantly lower[95].

The $PM_{2.5}$ standard is between neutral and moderate for all the Project components. The highest value with 10.9 µg/m^3 is at the CLP in Höchst. High $PM_{2.5}$ values are associated with nearby combustion sources.

The PM_{10} baseline concentrations are between moderate and good. The annual concentrations do not exceed 20 µg/m^3.

6.8 NOISE

6.8.1 METHODOLOGY AND INFORMATION SOURCES

The ESIA team has used the following available desktop data to define the current noise levels in the Project AoI:

- Noise Mapping Rhineland-Palatinate 2022[96];
- Noise Mapping Rhineland-Palatinate 2017[97];
- Environmental Noise Mapping Hesse 2022[98];
- Preliminary noise studies from the Gesellschaft für Technische Akustik mbH (GTA) for Schleidberg, 40 Morgen and Trappelberg[99];
- Sixth General Administrative Regulation on the Federal Emission Control Act;
- IFC General EHS Guidelines; and
- EC Directive 2002/49.

6.8.2 NOISE STANDARDS

The EC Noise Directive 2002/49/EC establishes a framework for assessing and managing environmental noise, particularly from transport (road, rail, and air traffic), industry, and other major noise sources. It requires EU member states to prepare noise maps and action plans to

[95] Umweltbundesamt, 2011. Wo treten die höchsten Ozonwerte auf?
[96] Lärmkartierung Rheinland-Pfalz 2022; Lärmkartierung Rheinland-Pfalz 2022 (rlp-umwelt.de)
[97] Lärmkartierung Rheinland-Pfalz 2017; Lärmkartierung Rheinland-Pfalz 2017 (rlp.de)
[98] HLNUG, 2022. Lärm (hlnug.de)
[99] GTA, 2023. Schalltechnische Voruntersuchungen am Standort 40 Morgen, Schleidberg, Trappelberg.

address noise pollution. While the EC directive provides a framework, it does not specify exact noise limits, leaving this to member states. Germany has set specific noise limits in its regulations, which can sometimes be more stringent depending on the local context. Also, the German approach is generally more detailed, with specific guidelines for different types of noise sources (e.g., road traffic, railways, industrial activities) and their impact on residential areas, reflecting local legal and environmental considerations.

Noise emission guide values for noise emission locations outside buildings are covered under the Sixth General Administrative Regulation on the Federal Emission Control Act (Technical Instructions on Noise Abatement - TA Lärm)[100].

TABLE 6-8 GERMAN AND INTERNATIONAL NOISE LEVEL GUIDELINES

Emission Location	TA-Lärm Threshold Value (daytime)	TA-Lärm Threshold Value (nighttime)	DIN 18005 Threshold Value (daytime)	DIN 18005 Threshold Value (daytime)	IFC Threshold Value (daytime)	IFC Threshold Value (nighttime)
Industrial area	70 dB(A)	70 dB(A)	-	-	70 dB(A)	70 dB(A)
Commercial area	65 dB(A)	50 dB(A)	65 dB(A)	55 dB(A)	70 dB(A)	70 dB(A)
Urban area	63 dB(A)	45 dB(A)	60 dB(A)	50 dB(A)	-	-
Village areas and mixed areas	60 dB(A)	45 dB(A)	60 dB(A)	50 dB(A)	-	-
General residential areas and small residential areas	55 dB(A)	40 dB(A)	55 dB(A)	40 dB(A)	55 dB(A)	45 dB(A)
Purely residential areas	50 dB(A)	35 dB(A)	50 dB(A)	35 dB(A)	-	-
Health resorts, for hospitals and nursing homes	45 dB(A)	35 dB(A)	-	-	-	-

Source: TA-Lärm, 2017; DIN 18005; IFC, 2007. General EHS Guidelines

6.8.3 NOISE FEATURES OF THE PROJECT AREA

The Project components are located nearby built up, industrial and rural areas. There are noise sensitive receptors such as residential buildings, farms, commercial buildings, a wastewater plant, and some areas with mixed usage. The proximity of the sensitive receptors to the Project components ranges between 30 m to 780 m. These may be affected by the Project due to noise both during construction and operation stages.

The following Project components were considered for the noise baseline:

- Well Sites;

[100] Sechste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz (Technische Anleitung zum Schutz gegen Lärm – TA Lärm), 2017.

- Interconnecting Pipeline & Power (ICPP);
- Geothermal Lithium Production Plant (GLEP);
- Insheim Geothermal Plant; and
- Central Lithium Plant (CLP) Höchst.

Figure 6-15 and Figure 6-16 show the daytime and nighttime traffic noise from major roads for Project component near Landau. Figure 6-17 and Figure 6-18 indicate the baseline noise emissions from industrial activities (daytime and nighttime) near the CLP in Höchst.

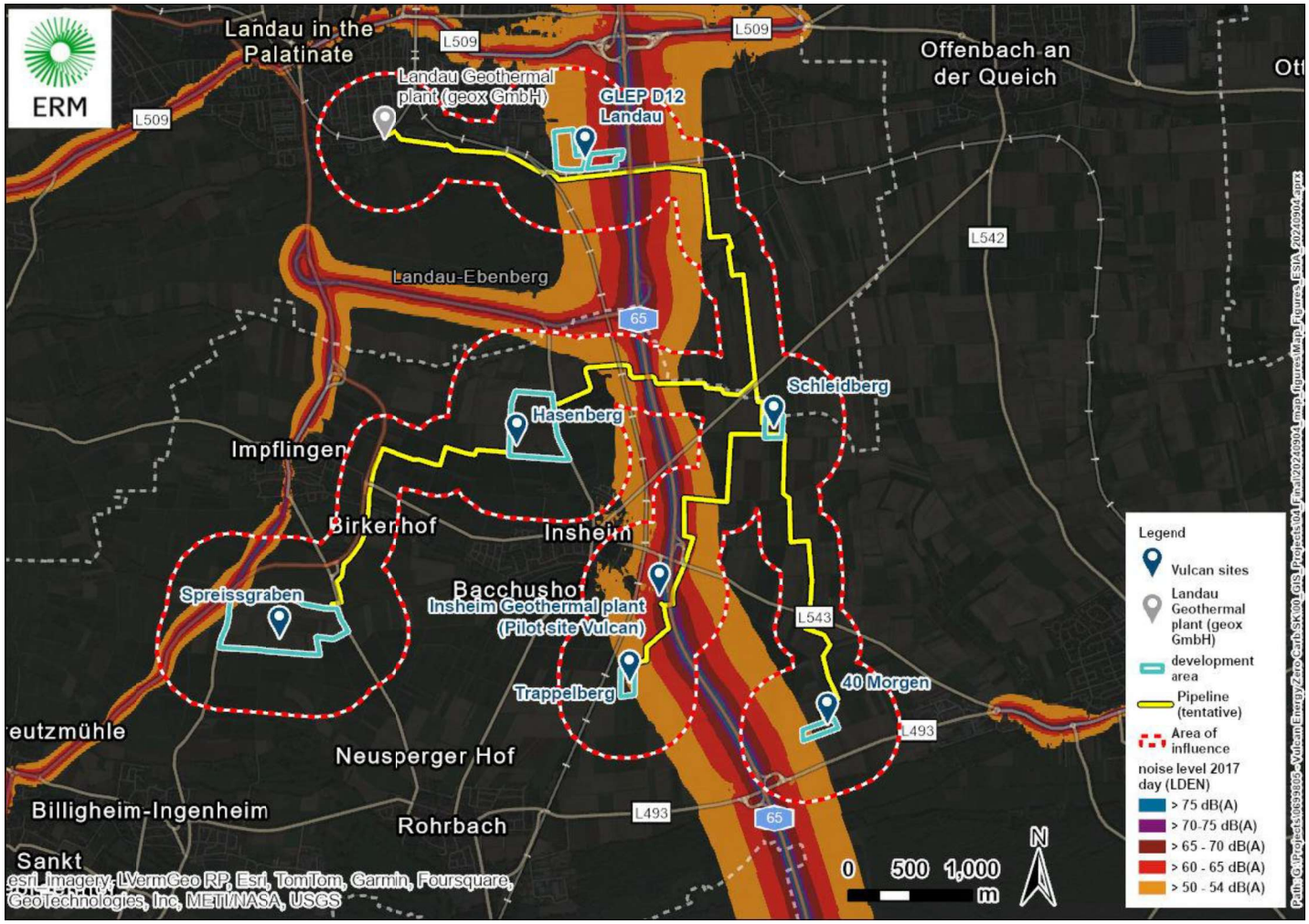


FIGURE 6-15 DAYTIME TRAFFIC NOISE EMISSIONS IN THE LANDAU AREA

Source: Data from the State Office for the Environment Rhineland Palatinate, 2022

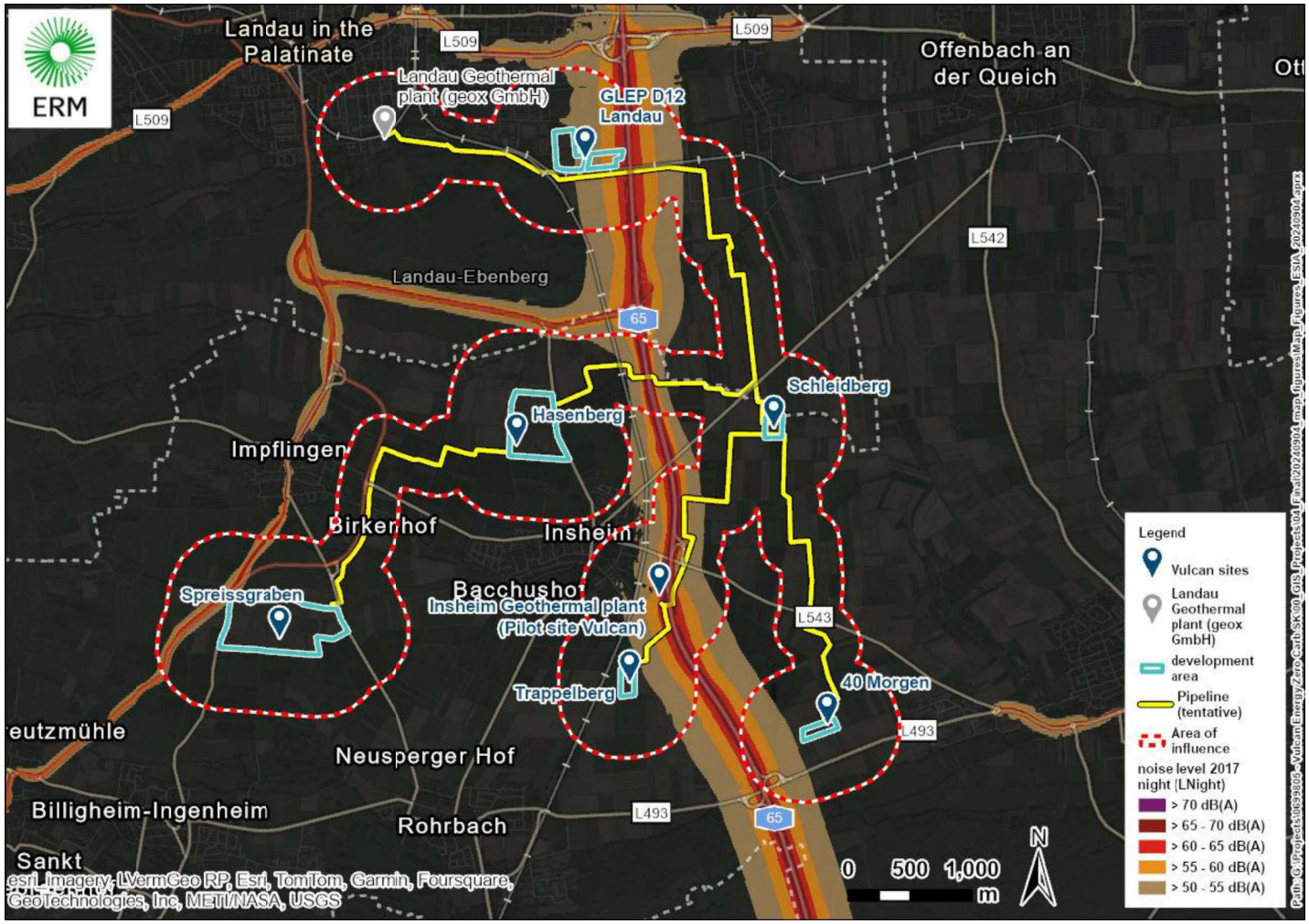


FIGURE 6-16 NIGHTTIME TRAFFIC NOISE EMISSIONS IN THE LANDAU AREA

Source: Data from the State Office for the Environment Rhineland Palatinate, 2022

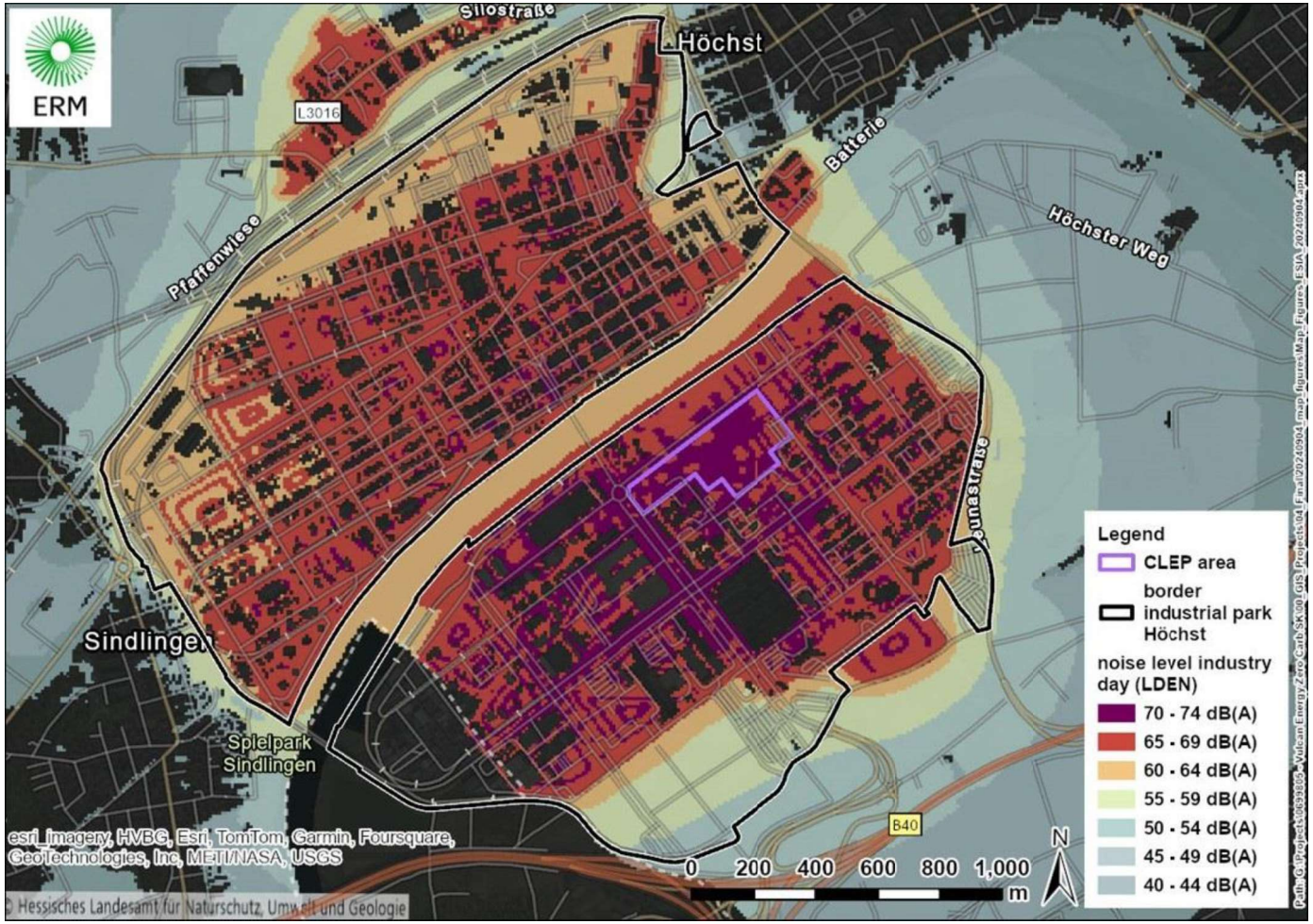


FIGURE 6-17 DAYTIME INDUSTRIAL NOISE AT THE CLP IN HÖCHST

Source: Data from the Hessian State Office for the Nature Protection, Environment and Geology, 2022



FIGURE 6-18 NIGHTTIME INDUSTRIAL NOISE AT THE CLP IN HÖCHST

Source: Data from the Hessian State Office for the Nature Protection, Environment and Geology, 2022

The preliminary noise studies from GTA state that the noise threshold values for the Well sites are classified according to the TA-Lärm[101]. The Well sites are all located in rural areas on agricultural land. Preliminary noise studies for the drilling activities from GTA at Schleidberg, 40 Morgen and Trappelberg have identified the following noise receptors at those Well sites (see Table 6-9). The results of the preliminary noise studies will be discussed in the impact assessment (Section 7.1.4).

TABLE 6-9 NEAREST NOISE RECEPTORS AT THE WELL SITES 40 MORGEN, TRAPPELBERG AND SCHLEIDBERG

Site	Nearest Noise Receptors	Distance
40 Morgen	Herxheim: Farm with residential use, along the L 543 road	1,150 m
	Herxheim: Farm with residential use, Am Schambach 2	1,350 m
	Herxheim: Residential use, Am Gewerbepark West 18	850 m
	Rohrbach: Hotel, Bahnofstraße 61	2,350 m
	Insheim: Residential use OR garden shed, Kreisstraße 21	550 m
Trappelberg	Insheim: Residential use OR garden shed, Kreisstraße 21	1,265 m
	Rohrbach: Hotel, Bahnofstraße 61	1,285 m
	Rohrbach: Commercial area with residential use, In den Gerlachsgärten 6	770 m
	Rohrbach: Commercial area with residential use, In den Gerlachsgärten 7	720 m
	Insheim: Residential use, Martin-Luther-Straße 24	855 m
Schleidberg	Mörlheim: Farm with residential use, Mörlheimer Hauptstraße 130	1,720 m
	Mörlheim: Residential use, Unteres Rappenfeld 80	2,280 m
	Insheim: Farm with residential use, Kreisstraße 21	780 m
	Herxheim: Farm with residential use, along the L 543 road	1,640 m
	Herxheim: Farm with residential use, Am Schambach 2	1,920 m

Source: GTA, 2023. Preliminary Noise Studies for 40 Morgen, Schleidberg and Trappelberg

The ICPP will be built on agricultural land. In some instances, the ICPP will run along existing roads and railway tracks. Therefore, baseline noise emissions from traffic are expected. As shown in Figure 6-15 daytime baseline noise emissions from traffic are highest (>65 to 70 dB(A)) where the pipeline is planned to cross the A65 motorway.

[101] Sechste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz (Technische Anleitung zum Schutz gegen Lärm – TA Lärm), 2017.

For the GLEP the motorway A65 (250 m east) as well as surrounding businesses from the commercial areas D9 (50 m west) and D10 (150 m north) are the essential noise emission sources and represent considerable baseline noise emissions. The Development Plan from the Municipal Building Authority in Landau states that the noise threshold values for the GLEP are classified according to DIN 18005[102]. The Development Plan from the Municipal Building Authority in Landa[103] mentions that MODUS Consult has conducted a noise survey for the planned D12 commercial area. According to MODUS Consult for most of the D12 commercial area orientation values for commercial areas as per DIN 18005 apply. For the existing buildings in the west of the planning area orientation values set for the mixed areas as per DIN 18005 apply.

TABLE 6-10 NOISE MEASUREMENTS WITH EXCEEDANCE OF THE ORIENTATION VALUE

Measurement location	DIN 18005 Threshold Value (daytime)	DIN 18005 Threshold Value (daytime)	Measurements by MODUS Consult (daytime)	Measurements by MODUS Consult (nighttime)
Along A65 Motorway Inside D12 boundaries (Commercial Area)	65	55	74	68

Source: Stadt Landau. Bebauungsplan „D 12, Gewerbepark Messegelände-Südost", 2023.

Table 6-10 shows that the orientation values of DIN 18005 for commercial areas during the daytime and nighttime are exceeded by up to 9 dB(A) (day) / 13 dB(A) (night) during the day/night with free sound propagation within the building boundaries of the planning area (see also Figure 6-17 and Figure 6-18). For the existing buildings in the west of the planning area the noise measurement were below the orientation values for mixed areas of 60 dB(A) during the day and 50 dB(A) at night (as per DIN 18005)[104].

The Development Plan from the Municipal Building Authority in Landau states that measures for protection against traffic noise are necessary at the GLEP due to the exceedance of the threshold values as per DIN 18005 for commercial areas. Therefore, the GLEP will need to be protected from outside noise in accordance with DIN 18005.

The Insheim Geothermal Plant currently in operation has noise barriers installed due to German regulations to mitigate the noise emissions to the nearest receptors located around 130 m northwest of the Plant. However, it must be noted that most of the noise emissions at the nearest receptor stem from the A65 road located in the 100 m east of the Insheim Plant as well as the railway located 100 m west of the Insheim Geothermal Plant.

The industrial noise mapping at the CLP in Höchst from the Hessian State Office for the Nature Protection, Environment and Geology (HLNUG) shows very high baseline noise conditions reaching daytime noise levels of >70 to 74 dB(A) (see Figure 6-17). These levels exceed the daytime noise thresholds from the TA Lärm and IFC for industrial areas which are at 70 dB(A). Measures to protect the CLP against industrial noise are necessary due to the exceedance of the threshold values. However, as shown in Figure 6-18 the nighttime noise levels at the CLP in Höchst do not exceed 69 dB(A).

[102] DIN 18005. Berücksichtigung des Schallschutzes im Städtebau, 1988.
[103] Stadt Landau. Bebauungsplan „D 12, Gewerbepark Messegelände-Südost", 2023.
[104] Stadt Landau. Bebauungsplan „D 12, Gewerbepark Messegelände-Südost", 2023.

6.9 BIOLOGICAL BASELINE

This section provides an overview of the baseline or status quo concerning biodiversity for the Project. For a more comprehensive description of the baseline biodiversity features and values, the reader is referred to the accompanying comprehensive 'Biodiversity Baseline Assessment Report' (ERM, 2023[105]), which is included as Appendix A of the ESIA.

The biodiversity baseline has been developed in accordance with the requirements and guidelines contained in IFC PS6, addressing the baseline biodiversity status of ecosystems, habitats, and species. The report´s purpose is documenting the initial biodiversity conditions in the Project area and plays a crucial role in informing the evaluation of biodiversity impacts and associated mitigation strategies. It offers an extensive overview of the current biodiversity status within the Project's study area, encompassing infrastructure near Landau (Rhineland-Palatinate) and the CLP at Höchst Industrial Park (Hesse).

The biodiversity baseline has been established through a combination of sources, including the synthesis of information gathered from field surveys conducted by the Institut für Naturkunde in Südwestdeutschland during the period 2018 - 2024, which informed the national permitting process for the Project in Germany. Additionally, a rapid site assessment carried out by ERM's ecologist and biodiversity expert in August 2023 and a supplementary desktop literature review and IBAT analysis provided essential data to provide for a comprehensive baseline of the study area and AoI.

6.9.1 GENERAL

The Project is situated in the 'Western European Broadleaf Forests' ecoregion, which covers Western Europe and was once dominated by ancient mountain beech forests that stretched across a significant part of the continent. The main threats to biodiversity in the region include historical habitat destruction and transformation, intensified agricultural land use, reduced habitat quality, alterations to natural watercourses and climate change.

6.9.2 PROTECTED AREAS AND INTERNATIONALLY RECOGNISED AREAS

IFC PS6 recognises **legally protected** areas that meet the IUCN definition: "*A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.*" - IFC (2012). This includes areas proposed by governments for such designation.

The Project is situated in proximity to Protected Areas (PAs) integrated into the European 'Natura 2000' network.

For infrastructure components located near Landau (see Figure 6-19 below):

- The Natura 2000 site "Standortübungsplatz Landau" is partially located within the Project AoI (typically within 250 meters of the pipeline and GLEP). The pipeline route alignment option (ICPP Section 3) from the Landau well site to the GLEP intersects the Natura 2000 site over a distance of approximately 64 meters. Vulcan is currently considering alternative alignment options to avoid crossing the Natura 2000 site.

[105] This baseline report has been updated in 2025 to incorporate additional baseline studies conducted by Vulcan, as the Project has progressed.

- Natura 2000 site: "Erlenbach und Klingbach" is partially located within the Project AoI (i.e., within 500m of the drill site at 40 Morgen)

For the CLP at Höchst Industrial Park:

- Not applicable: Natura 2000 sites are located outside of the AoI and do not stand to be impacted directly or indirectly by the Project:
  - Schwanheimer Wald: Within a distance of ~1.4 km from the lease plot
  - Schwanheimer Düne: Within a distance of ~700 m from the lease plot

IFC PS6 also identifies **internationally recognised areas** as being "*exclusively defined as UNESCO Natural World Heritage Sites, UNESCO Man and the Biosphere Reserves, Key Biodiversity Areas, and wetlands designated under the Convention on Wetlands of International Importance (the Ramsar Convention)"* – IFC (2012).

Notably, there are no Key Biodiversity Areas (KBAs), International Bird and Biodiversity Areas (IBAs), Alliance for Zero Extinction (AZE) sites, RAMSAR wetlands or UNESCO world heritage sites associated with the Project.

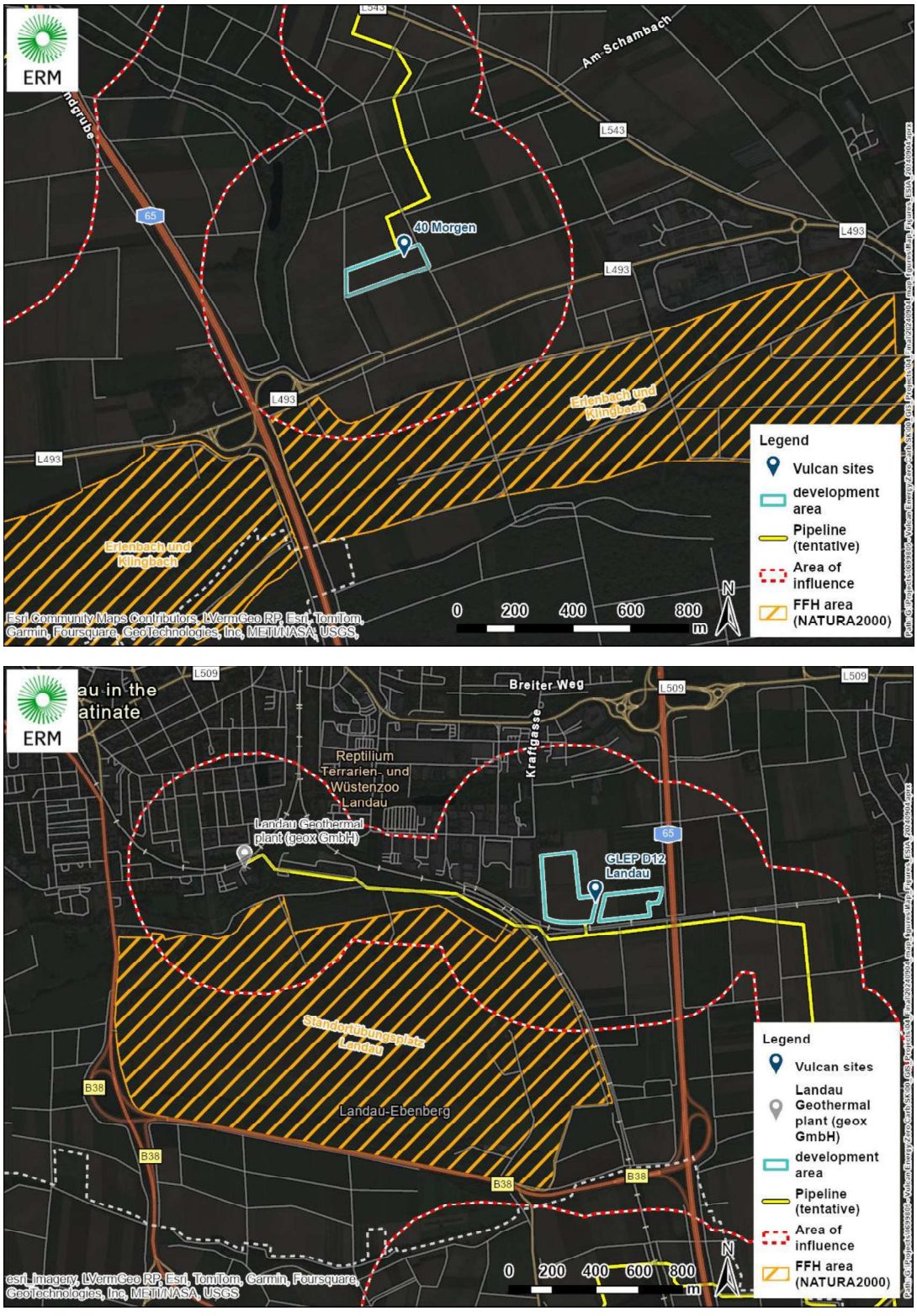


FIGURE 6-19 PROTECTED AREAS NETWORK (NATURA 2000 SITES) IN RELATION TO THE LANDAU PROJECT LAYOUT AND AOI

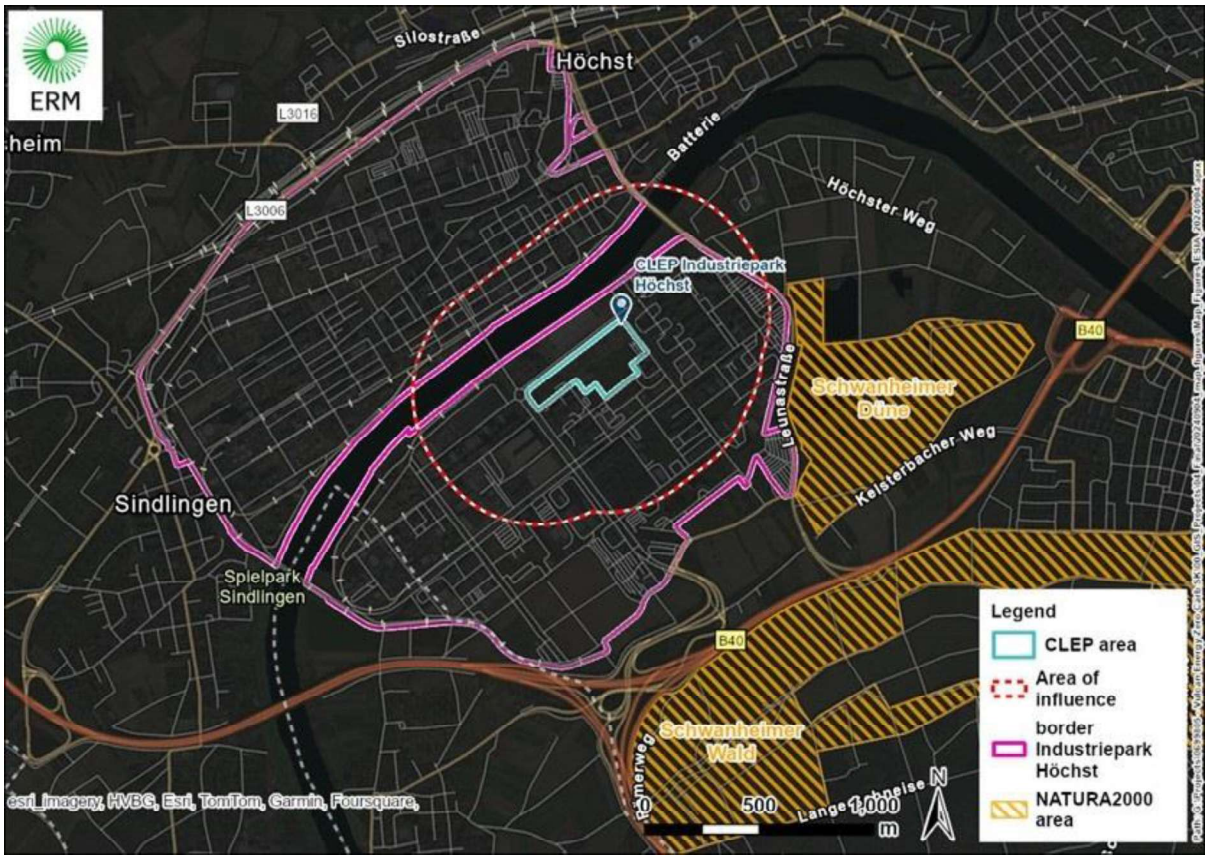


FIGURE 6-20 PROTECTED AREAS (NATURA 2000) RELATIVE TO THE CLP

Data sources: Client data, IBAT (Integrated Biodiversity Assessment Tool), Natura 2000 coverage

6.9.3 NATURAL AND MODIFIED HABITATS

Project components located near Landau:

- Historical land transformation has led to extensive urban, industrial, and agricultural development in the region.
- The once predominant dense broad-leaved forest and grassland mosaic has significantly diminished, with remaining natural habitats primarily found within legally Protected Areas (Natura 2000 sites).
- According to the 'Landscape Management Plan' for the ICPP (L.A.U.B. Ingenieurgesellschaft, 2024), biotope mapping (habitats) undertaken for the Project indicate that there are no protected areas or areas designated for protection under German nature conservation law in the area of the planned pipeline.
- Several biotopes were identified that reflect modified habitat types (in terms of the IFC PS6 definition of modified habitat[106]), and none of these represent natural or reference habitat types. Several are artificial habitats that include, among others: grass paths, paved farm tracks, footpaths, parking areas, unsealed storage areas with sparse vegetation, retaining

[106] Modified habitats are defined in IFC PS6 as follows: *"Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands."* (IFC, 2012).

walls, buildings, lawns, vineyards, orchards, gardens, residential areas, road embankments, etc. Typical modified biotopes/habitats in the study area include:

  - Bush strips
  - Embankment hedges
  - Groups of trees
  - Embankments rich in perennials
  - Orchard meadows
  - Orchard pastures
- Remaining semi-intact / natural habitats are restricted to the network of Protected Areas (Natura 2000). These include grassland and wooded habitats (woodland, forest patches) associated with the Natura 2000 sites near Landau ('Standortübungsplatz Landau' and 'Erlenbach und Klingbach') located within the Project AoI. Direct impacts to Protected Areas will be generally avoided as infrastructure and activities will take place outside of the boundaries of these designated areas. The current ICPP Section 3 (BA3) alignment option from the Landau well site to the GLEP at Landau will be located within the boundary of the Natura 2000 site 'Standortübungsplatz Landau', and this appears to avoid the conserved grassland (hay meadow) habitats; however, potential impacts in terms of vegetation clearing to woodland/shrubland habitat fringing these grassland/meadow habitats could be required and will result in a direct impact to these wooded biotopes and vegetation communities. Vulcan is investigating alternative options to avoid the ICPP crossing the Natura 2000 site (see Section
- The pipeline plans to cross the 'Quodbach', a small stream, at two points. One crossing will be east of the B38 motorway between 'Hasenberg' and 'Spreissgraben'. The second crossing will be east of Insheim, west of the A65 highway. The stream drains in a south-easterly direction, crossing Impflingen and later Insheim and can be considered a highly modified watercourse as a result of agricultural and industrial activities in the catchment, which have likely affected the natural pattern and timing of flows and water quality is also likely affected by agricultural and storm water runoff from hardened surfaces. According to LANIS (state database of the RLP nature conservation administration), there are no legally protected habitats according to § 30 BNatSchG bordering the stream within the AoI. The nearest large river system is the Rhine River, which is located roughly 14 km east of the Project.

CLP at Industrial Park Höchst:

- The CLP will be situated within the pre-existing Industrial Park Höchst on leased land that has undergone prior infilling and modifications.
- The leased plot now consists of infrastructure, hardened surfaces, gravel areas, and secondary vegetation primarily comprising grasses and weeds, classifying these regions as modified habitats with low or negligible biodiversity value.
- The site is notably distant from formally protected areas (Natura 2000 sites), ensuring avoidance of direct and indirect interactions with these areas and their biodiversity.
- The 'Main' River main channel is located to the north of the site to be developed for the CLP, with the Industrial Park Höchst located on both sides of the Main River, which flows in a general westerly direction towards its confluence with the Rhine River. The Main River has

been assessed as being in an 'unsatisfactory' ecological condition, which suggests that a significant level of modification to the river ecosystem and ecology has taken place already.

Importantly, the requirements of IFC PS6 (in terms of assessment and management of impacts on biodiversity and ecosystems) apply only to "*those areas of modified habitat that include significant biodiversity value*". In ERMs opinion, the modified habitats are considered to be of little to no biodiversity value or importance, and therefore this satisfies the requirements of IFC PS6 and areas of modified habitat do not require further examination in the ESIA.

6.9.4 CONSERVATION IMPORTANT SPECIES: FLORA AND FAUNA

A list of 27 threatened species of conservation importance that could possibly occur in the Project AoI was compiled based on overlap with known/modelled species geographical ranges and habitat preferences/requirements being largely met. Triggers for conservation importance are either for a species being threatened according to the IUCN Red List or German Red List or being under special protection according to German law. This includes species that are listed in Annex IV of the EU Habitats Directive (92/43/EEC) as well as all bird species according to the EU Birds Directive (2009/147/EC). Species include:

- European Turtledove, *Streptopelia turtur* (VU) that inhabits woodland and cultivated areas;
- Eight terrestrial invertebrate species (mainly insects/beetles that inhabitant woodland, forest, and cultivated fields (EN, VU and DD status); and
- 17 species of plants (mainly fungi) that occur in forest or grassland areas (EN, VU and DD status).

Based on field surveys completed during 2018 – 2024 for the national permitting process, the following is worth noting concerning fauna:

- One species under strict protection in terms of the EG-ArtSchVO Nr. 338/97 (German council regulation that protects species of wild fauna and flora), as outlined in § 7 (2) No. 14 of the BNatschG (*the German Federal Nature Conservation Act*), the Crested Lark (*Galerida cristata*), was recorded during field surveys. This species is of 'Least Concern' (LC) globally and regionally in Europe.
- Two bird species recorded are strictly protected under the EG-ArtSchVO Nr. 338/97, including the Eurasian buzzard (*Buteo buteo*) and Common Kestrel (*Falco tinnunculus*). These species are under special protection in Germany, despite their LC threat status globally and regionally for Europe.
- One bird species recorded is a globally threatened species with threat status of 'Vulnerable' (VU) according to IUCN, the Rook (*Corvus frugilegus*).
- Also, the Northern Wheatear (*Oenanthe oenanthe*) is a 'Specially Protected Fauna Species' listed in terms of Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats ('Bern Convention'). *O. oenanthe* holds the status *"threatened with extinction"* according to the Red List of Germany and the Red List of Rhineland-Palatinate.
- The '*Landscape conservation support plan with integrated specialist article on species protection'* (L.A.U.B. GmbH, 2025) highlights that for the surveys from 2022 – 2024 in the survey area between the geothermal power plant Insheim to drill site Schleidberg, the nationally/regionally threatened and strictly protected bird species Common linnet (*Carduelis cannabina*), Eurasian skylark (*Alauda arvensis*), House sparrow (*Passer domesticus*), Common kestrel (*Falco tinnunculus*) and Eurasian buzzard (*Buteo buteo*).

Breeding sites of Common kestrel and Eurasian buzzard were only found outside of the project footprint.

- Hazel Dormouse (*Muscardinus avellanarius*, LC globally and in Europe) individuals and their nests were recorded on several woody structures in the search area, and this also applies to a hedge in the narrower planning area, with a concentration in the northern part near the Natura 2000 site (Standortübungsplatz Landau) and the Messegelände Südost D12 site (*Business Park: Messegelände-Südost)*. The species is protected under Annex IV of the EU Habitats Directive (92/43/EEC) and is listed in terms of the German RDL as 'Endangered' at the national level.
- At the Messegelände Südost D12 site (*Business Park: Messegelände-Südost*), European Brown Hare (*Lepus europaeus*, LC globally) was recorded, which is a Category 3 ("threatened") species in terms of the Germany Red Data List.
- Sand Lizard (*Lacerta agilis*, LC globally) was identified at the Schleidberg Sued site, 40 Morgen site and the Messegelände Südost D12 site (*Business Park: Messegelände-Südost*) and generally within the overlapping Landau Sued survey area. The species is listed in terms of Annex IV of the EU Habitats Directive (*animal and plant species of community interest in need of* strict protection) and Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats ('Bern Convention') which lastly strictly protected fauna species.
- Common wall lizard (*Podarcis muralis,* LC globally) was identified at the 40 Morgen site and the Messegelände Südost D12 site (*Business Park: Messegelände-Südost*) and generally within the overlapping Landau Sued survey area. The species is listed in terms of Annex IV of the EU Habitats Directive (*animal and plant species of community interest in need of* strict protection) and Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats('Bern Convention') which lastly strictly protected fauna species. Observations of the Sand lizard and Common wall lizard, and potential refugia identified in the field, were generally aligned with hedgerows, patches of remaining untransformed habitat and wooded vegetation along streams mainly, with a concentration in the northern part near the Natura 2000 site (Standortübungsplatz Landau) and the Messegelände Südost D12 site (*Business Park: Messegelände-Südost)*.
- Whilst some species may utilis the cultivated fields and modified habitats in the study area, such as Eurasian skylark, Crested lark and the European brown hare, the large majority require natural habitat and typically either grassland or forest. These species are therefore likely to be restricted to the natural grassland and forest habitats located within the Protected Areas (Natura 2000 sites) in the study area, including Northern Wheatear and European Turtledove.
- In addition to the above-mentioned species, the '*Faunistic ecological assessment for the project area 'Landau Süd''* (Institut für Naturkunde in Süedwestdeutschland, 2025) found the following species of special conservation importance: Corn bunting (*Emberiza calandra,* LC), Eurasian green woodpecker (*Picus viridis,* LC), Northern lapwing (*Vanellus vanellus,* NT), Lesser whitethroat (*Sylvia curruca,* LC), Red-backed shrike (*Lanius collurio,* LC), Eurasian golden oriole (*Oriolus oriolus,* LC), Grey partridge (*Perdix perdix,* LC), red kite (*Milvus milvus,* LC), whinchat (*Saxicola rubetra,* LC), Common starling (*Sturnus vulgaris,* LC), European turtle-dove (*Streptopelia turtur,* VU) and the long-eared owl (*Asio otus,* LC).

- Northern lapwing (*Vanellus vanellus*) holds the status "**strongly threatened**" according to the Red List of Germany and the status "**threatened with extinction**" according to the Red List of Rhineland-Palatinate.
- Several bird species are also protected in the EU as per their listing in Annex I of the EU Habitats Directive, including:
  - Eurasian Blackbird, *Turdus merula*
  - Common Chaffinch, *Fringilla coelebs*
  - Great Spotted Woodpecker, *Dendrocopos major*
  - Short-toed Treecreeper, *Certhia brachydactyla*
  - Grey-faced Woodpecker, *Picus canus*
  - Hen Harrier, *Circus cyaneus*
  - Red-backed Shrike, *Lanius collurio*
  - Grey Partridge, *Perdix perdix*
  - Common Woodpigeon, *Columba palumbus*
  - Western Marsh-harrier, *Circus aeruginosus*
  - Red Kite, *Milvus milvus*
  - Black Woodpecker, *Dryocopus martius*
  - Eurasian Sparrowhawk, *Accipiter nisus*
  - White Stork, *Ciconia ciconia*
  - Northern Wren, *Troglodytes troglodytes*

Out of the species evaluated for the assessment, none are native exclusively to Germany, and none of these species are limited to specific ranges (no endemic, restricted-range, congregatory, keystone or previously unknown species were identified for the Project).

Full details of the species are included in *Section 3.4 of the Baseline Biodiversity Assessment Report* (Appendix A of the ESIA).

6.9.5 CRITICAL HABITAT

A separate report has been prepared that assessed the potential for 'critical habitat' within the AoI pertaining to the Project (see the Critical Habitat Assessment or CHA Report, included as Appendix B). The CHA considered the possibility for critical habitat to be present within the general study area and AoI for the Project, in accordance with the critical habitat qualifying criteria and associated thresholds outlined in IFC PS 6. The key findings of the CHA are as follows:

- It was determined that the two Natura 2000 sites located near Landau, 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach', are regarded as highly threatened and/or unique ecosystems and qualify as Critical Habitat according to criterion 4 of IFC PS6.
- The requirements of IFC PS6 pertaining to the protection of critical habitat apply to the Project, prohibiting any adverse impacts on the natural grassland and forest/wetland habits associated with both Natura 2000 sites near Landau. The Project will have to implement appropriate mitigation measures to avoid impacting on critical habitat and aim to achieve a Net Gain in critical habitat where impacts are anticipated, as a means of compensation.
- The Project has no direct footprint in either of the Natura 2000 sites, with 'Standortübungsplatz Landau' being located roughly 50 m from the planned pipeline alignment from the existing Landau geothermal plant to the planned GLEP, and approximately 100 m from the GLEP planned near Landau. 'Erlenbach und Klingbach' is located within 500m of the drill site at 40 Morgen. Whilst no direct impact to critical habitat

is likely to take place, potential indirect impacts will need to be managed appropriately so as not to impact on the critical habitat qualifying features/habitats (namely disturbance caused by possible dust/noise/light/vibration). These impacts are addressed in the biodiversity impact assessment contained in the ESIA.

- This is also aligned with the German permitting requirements concerning Natura 2000 sites, that requires appropriate mitigation measures to ensure no negative impacts on Natura 2000 sites and their conservation objectives occur.
- Other parts of the study area and associated habitats do not qualify as Critical Habitat, as the criteria and thresholds have not been met. Whilst the Crested Lark, Northern Wheatear, Grey Partridge, Whinchat and European Turtle Dove were found to not qualify the study area habitats as Critical Habitat, they are still important biodiversity features given their threat status and their strict protection under European Union and German law. An ecologically appropriate and species-specific mitigation approach will be considered in the ESIA, such as construction restrictions during breeding times to avoid disturbance as well as measures to prevent ground breeding species to start breeding within construction sites, for example.

For further detailed information regarding the assessment of critical habitat, the reader is referred to the accompanying '*Critical Habitat Assessment Report'* (ERM, 2023) which is included as Appendix B of the ESIA report).

6.9.6 ECOSYSTEM SERVICES

Due to the modified nature of the landscape (agricultural use for growing crops / pasture), there are no appreciable or key ecological processes associated with those sites. Ecosystem services linked to natural ecosystems are discussed in *Section 3.4 of the Baseline Biodiversity Assessment Report* (Appendix A of the ESIA). These are likely to be restricted to the protected areas (Natura 2000) sites which provide for some carbon capture function (forests and grasslands, wetlands), pollination (especially grasslands), seed dispersal and habitat/refugia for animal and plant life (including rare and protected/threatened species of flora and fauna) as well as recreational opportunities for the public.

6.10 SOCIAL BASELINE

6.10.1 OVERVIEW

This section provides a baseline description of the socio-economic environment within and around the Project area. It defines the social area of influence, with in-depth specifications regarding areas that will be directly and indirectly influenced by Project activities and outcomes. Proper understanding of the human environment within the Project area is necessary for a holistic assessment of potential project risks and impacts, as well as understanding stakeholder interests and needs that may positively or negatively overlap with Project activities. While certain sub-sections such as governance and administration, demographics, education, may seem irrelevant to the discussion of potential impacts, it is good international practice (GIP) to include a detailed description of the social environment to contextualise the operating environment and understand why certain risks and impacts can be scoped out.

6.10.2 METHODOLOGY

The socio-economic baseline data was primarily gathered via desktop-based research and review of publicly available documents. Observations from ERM's two-day site visit (9th and 10th of

August 2023) were also used to supplement descriptions, especially relevant characteristics within the direct Project AoI. The site visit for the purpose of developing the socioeconomic baseline included a site walk over and preliminary engagement with some Project stakeholders.

The desktop information collected was mainly used to obtain contextual socioeconomic and health, information at the state, district, and municipal levels – including information at the lowest level as often as possible. Overarching state and national-level data was also included to properly contextualise information and supplement informational gaps where data referring to the towns, districts, or municipalities was not available. The most recent data available was consulted, when possible, to ensure accuracy. Where up-to-date data pertaining to the direct AoI was not available, then the description refers primarily to the indirect AoI.

The following list provides an overview of the main types of information and data sources used in the development of this socio-economic baseline:

- Information provided by representatives of Vulcan; (e.g., existing policies and procedures, documentation, and plans of to date stakeholder engagement activities, etc.)
- Published literature including supporting gray literature[107] (previous reports, existing studies, etc.) sourced from websites/data portals of the government at federal level, state level (Rhineland-Palatinate), and European Union (EU) institutions such as the European Commission, academic and research institutions, social organisations.
- Online government databases and statistical information, such as the last Demographic Census (2022) from the German Federal Statistical Office, state-level data from Rhineland-Palatinate's State Statistical Office108, and the Denkmalliste for Rhineland-Palatinate (official data on local cultural heritage sites).
- Reports published by international organisations and multilateral organisations, such as the Organisation for International Labour Organisation (ILO), The World Bank, and World Health Organisation (WHO);
- Non-technical literature (newspaper / online articles); and
- Satellite imagery (including archives available through Google Earth).

6.10.3 SOCIAL AREA OF INFLUENCE

The Social AoI for this baseline assessment and Social Impact Assessment (SIA) is presented in Figure 5-3 in section 5.4.1.

The social baseline and IA contextualise the Project and potential impacts through discussion of the direct and indirect AoI. Distinguishing between direct and indirect AoI helps situate the proximity and significance of certain Project impacts to the relevant social receptors and surroundings.

The *Direct Project Area of Influence* (Project footprint) refers to the immediate and tangible impact zone where the Project's activities, changes, or interventions have a clear and

[107] Gray literature refers to materials and research produced by organisations that are outside of commercial or traditional academic publishing/distribution channels. Such articles or documents are not always peer-reviewed or formally published, and therefore reliability and quality can vary. Examples include unpublished technical reports, working papers, research theses/dissertations and papers presented at conferences.
[108] Source: Rheinland-pfalz State Statistical Office, retrieved from: https://www.statistik.rlp.de/de/startseite/

measurable impact. This includes the physical location or community directly affected by the Project, where stakeholders and resources are directly engaged or altered.

The *indirect Project AoI* encompasses the broader, often secondary, or cascading effects that radiate beyond the immediate Project site and main Project facilities (e.g., buffer zone along Project-ancillary services and their road access). It includes the wider community, environment, or ecosystem that may experience indirect consequences or ripple effects due to the Project's actions, such as changes in market dynamics, social dynamics, or environmental conditions. Table 6-11 below defines the indirect AoI for this Project: The state of Rhineland-Palatinate, two key districts and six municipalities through which the Project passes.

TABLE 6-11 INDIRECT SOCIAL AREA OF INFLUENCE

State[109]	District[110]	Municipality[111]
Rhineland-Palatinate	Landau in the Palatinate[112]	Landau in the Palatinate
	Südliche Weinstraße	Billigheim-Ingenheim
		Impflingen
		Insheim
		Rohrbach
		Herxheim by Landau/palatinate

Table 6-12 below represents the proximity of the nearest buildings to each site component and distance from the nearest residential buildings. Overall, there are some commercial buildings and wastewater plants within the Project AoI. There are residential buildings within the AoI near the GLEP D12 site, Hasenberg exploration site, Insheim Geothermal Plant, and Trappelberg Drill Sites. However, almost all these sites are along or near the border of the development areas (in other words within the buffer). Only the residential building on Martin-Luther-Straße, about 130m away from the Insheim Geothermal Plant, lies along the fence line of the existing plant area.

TABLE 6-12 PROXIMITY OF NEAREST BUILDINGS TO PROJECT SITES

Site	Type of Nearest Building	Distance from Site (m)	Site distance from Nearest Residential Building (m)	Within AoI (Yes/No)
GLEP D12 Landau	Commercial/industry	54	49	Yes
Hasenberg	Commercial/industry	400	406	Yes
Schleidberg	Residential	1065	1065	No
Insheim Geothermal Plant	Wastewater plant	110	130	Yes

[109] In German *Bundesland*
[110] In German *Landkreis*
[111] In German *Gemeinde;* Note: Moerlheim is pictured on the preliminary AoI map but it is not a municipality.
[112] Please note that Landau in the Palatinate enjoys the status of an independent city (in German *Kreisstadt*). This means, that in addition to the own and transferred sphere of action of a municipality and district, it also performs the tasks of the lower state administrative authority on behalf of the state in its own competence. In simple terms, an independent city does not belong to a district, but fulfils itself all tasks associated with a district.

Site	Type of Nearest Building	Distance from Site (m)	Site distance from Nearest Residential Building (m)	Within AoI (Yes/No)
Trappelberg	Wastewater plant	462	523	Yes
Spreissgraben	Residential	523	523	No
40 Morgen	Commercial/industry	622	954	No
Ffm Höchst LEP	Mixed usage (residential/industry)	550	660	No

6.10.4 NEARBY SETTLEMENTS TO THE CLP

Referring to the table below and considering the proximity of the Central Lithium Plant (CLP) to various receptors, the CLP is located at a considerable distance from the nearest settlements, which helps ensure minimal impact on local communities. Furthermore, there are no sensitive social receptors, such as residents, schools, or hospitals, in the vicinity of the CLP.

TABLE 6-13 SETTLEMENT PROXIMITY TO THE CLP

Settlement	Distance to CLP	Educational Institutions	Healthcare Facilities
Höchst	1,5 km	The nearest schools and educational institutions are located within the residential centres of Höchst and Griesheim, well-separated from the industrial park.	• Frankfurt Höchst Hospital • St. Elisabethen Hospital in Zeilsheim • Hofheim Hospital in Kelsterbach
Sindlingen	2,5 km		
Zeilsheim	3 km		
Schwanheim	4 km		
Unterliederbach	3 km		
Kelsterbach	5 km		
Eschborn	8 km		
Nied	4 km		

6.11 GOVERNANCE AND ADMINISTRATION

Germany´s Federal States each maintain their own systems of governance, and the respective governments have the capacity to influence federal politics via participation in the Federal Council. Each state may have their own constitution, different state-level parliamentary elections, and distinct government structures. Figure 6-21 below provides an overview of Germany's administrative and territorial governance structure.

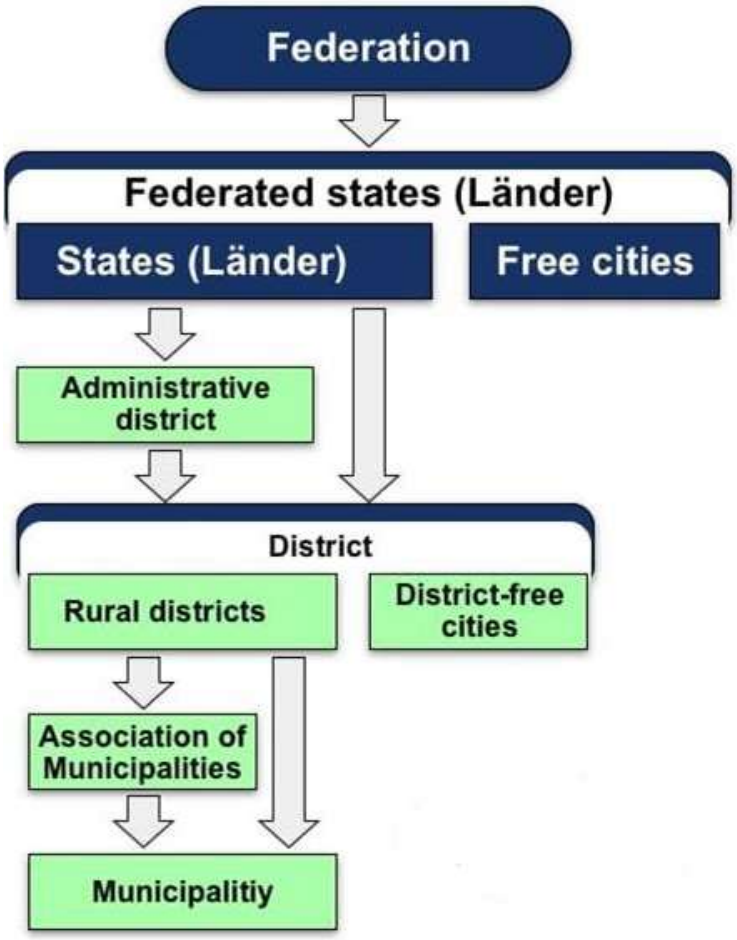


FIGURE 6-21 GERMANY'S ADMINISTRATIVE AND TERRITORIAL STRUCTURE

Source: https://ru-geld.de/en/country/administrative-division.html, accessed in August 2023.

Germany´s Federal States[113] each have various districts and municipalities within them; the districts and municipalities are the administrative divisions for local governance within Germany. The administrative structure is the same between districts and municipalities. The local parliament or District Council is regularly elected by the local population and is the main source of political autonomy in that localised area. In German Basic Law (Article 28) municipalities and cities within Germany reserve the right to local self-governance.

Districts are an association of local authorities from the towns and municipalities within them and have numerous roles and responsibilities. These regional authorities are mostly responsible for handling bureaucratic issues, which tend to be lower-level administrative tasks. If municipalities and towns cannot handle a certain task, then it is delegated to the overarching district. In effect, the main responsibility of larger districts is to deliver services or resolve issues that cannot be tended to by the municipalities. For instance, districts may deal with a particular issue if a municipality has exceeded their budget or resources.

[113] In German *Bundesländer*

The upstream part of the Project takes place in the state of Rhineland-Palatinate (*Rheinland-Pfalz*) of Germany within the district (*Landkreis*) of Südliche Weinstraße. The identified municipalities within the Project AoI are:

- Billigheim-Ingenheim
- Rohrbach
- Insheim
- Impflingen
- Herxheim by Landau (Palatinate)

Further information on Südliche Weinstraße's specific county law, administrative portfolios, and contact lists can be accessed on the official Südliche Weinstraße district website.

Similarly, Landau in the Palatinate is an autonomous town or free city[114]. Though it is technically located within Südliche Weinstraße, they are separate entities with distinct governance. Additional information on Landau in the Palatinate's governance can also be accessed on the official City of Landau in the Palatinate website.[115]

The downstream part of the Project – i.e. the CLP site at Höchst Industrial Park – is located in the state of Hessen, within Frankfurt am Main.

Vulcan has active and on-going engagements with various political stakeholders and actors within the district and subsequent municipalities. Further information on this is included in the SEP and in Section 5.5 of this ESIA.

6.12 DEMOGRAPHICS

This section provides a description of the statistical data related to the population and particular groups within the Project's social area of influence. Some national data is provided to help contextualise information, better understand certain values, and fill informational gaps.

6.12.1 POPULATION OVERVIEW

In June 2023 the Federal Statistical Office estimates that Germany´s population is about 84.4 million people, with approximately 42.8 million women and 41.6 million men. The population has increased by about 1.3%, likely due to the notable net increase in immigration – from 329,000 in 2021 to 1,455,000 in 2022.[116]Comparable to previous years, there were more deaths than births in 2022; in 2021 this number was estimate at 228,000 compared to 327,000 in excess deaths over births in 2022.[117] The Federal Statistical Office estimates that there will be about 82.6 million people in Germany in 2070. [118]

Table 6-14 below presents the key indicators used to understand and evaluate human development in Germany. The urban population in Germany is approximately 65,286,292 people

[114] In German *Kreisstadt*
[115] Source: Stadt Landau in der Pfalz, Stadtverwaltung, retrieved from: https://www.landau.de/, accessed in September 2023.
[116] The influx of refugees from Ukraine have largely contributed to this increase.
[117] Source: Statistiches Bundesamt, Current Population of Germany, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Current-Population/_node.html, accessed in August 2023.
[118] Source: Statistiches Bundesamt, Population projection, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Population-Projection/_node.html, accessed in August 2023.

(78.5 % of the total population); it increased by 1.2% from the previous year by 1.34% since 2011. The birth rate increased by 1.6 since 2011 and the population growth rate also increased substantially. Nonetheless, the Federal Statistical Office notes that the German birth rate is decreasing overall and is substantially more pronounced in East Germany (including Berlin) at -7.4% compared to only -5.6% in Western Germany.[119] Moreover, the median age remained about the same, only increasing by 0.6 years. Further information regarding age can be found in one of the following sections.

TABLE 6-14 KEY HUMAN DEVELOPMENT INDICATORS FOR GERMANY

Human Development Indicator	2011	2022
Urban population (%)	77.16%	78.5%
Birth rate (crude, per 1000 people)	8.4	10[120]
Population growth rate	-1.854 %	1.3%
Median age (years)	44.3	44.9

Source: World Bank Data, 2020, Retrieved from: https://data.worldbank.org/country/DE

6.12.1.1 RHINELAND-PALATINATE

In the state of Rhineland-Palatinate, the total population is 4,159,150 or 4.93% of Germany's total population, as noted by the Federal Statistical Office as of 31.12.2022. Within the state there are about 3,593,124 Germans 566,026 foreigners (13.6% of the state population). [121] In 2021 women made up about 49.45 of the population within Rhineland-Palatinate, compared to 50.6% men. The state's population density is estimated at about 206.8/km^2 and the annual population change from 2011 to 2021 was approximately 0.27%. The greatest number of inhabitants in Rhineland-Palatinate are located within Mainz, Ludwigshafen, and Koblenz, respectively. [122]

In 2021 in Rhineland-Palatinate there were a total of 38,647 births, of which 19,796 were male and 18,851 were female; 75% of all live births in the federal state were German and 25% were foreigners. In 2021 there were also 50,569 deaths – 25,328 male and 25,241 female.

6.12.1.2 SÜDLICHE WEINSTRAßE AND LANDAU IN THE PALATINATE

Population composition for the two districts and their municipalities can be found in Table 6-15 below. Overall, in 2021 the total population in Landau in the Palatinate and Südliche Weinstraße were 46,919 and 111,279, respectively. In both districts the female population was higher than the male population – in Landau in the Palatinate by 2,161 women and 1,603 more women in Südliche Weinstraße. In Landau in the Palatinate the female population was 52.3%, 2.85% greater than the state average and 1.59% greater than the national percentage. In Südliche

[119] Source: Statistiches Bundesamt, Births, retrieved from: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Geburten/geburten-aktuell.html, accessed in August 2023.
[120] As of 2021; data not available for 2022 year.
[121] Source: Statistiches Bundesamt, Population by national and federal states, 2022, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Current-Population/Tables/population-by-laender.html, accessed in August 2023.
[122] Source: City Population, Rheinland Pfalz, retrieved from: https://www.citypopulation.de/en/germany/admin/07__rheinland_pfalz/, accessed in August 2023.

Weinstraße women made up 50.7% of the population – the same as the national percentage, but 1.25% higher than the state percentage.

The population increased by 201 people in Landau in the Palatinate and 159 people in Südliche Weinstraße. Additionally, there were 46 and 143 more deaths than births in Landau in the Palatinate and Südliche Weinstraße, respectively.

TABLE 6-15 POPULATION COMPOSITION WITHIN THE AOI

Administrative Division		Total Population 2021	Male	Female
District	Landau in the Palatinate	46,919	22,379	24,540
	Südliche Weinstraße	111,279	54,838	56,441
Municipality	Insheim	2,166	1,041	1,125
	Impflingen	892	450	442
	Billigheim-Ingenheim	3,806	1,860	1,946
	Rohrbach	1,778	887	891
	Herxheim by Landau (Palatinate)	10,732	5180	5,552

Source: State Statistical Office, Rhineland-Pfalz, Statistical Report, retrieved from: Bevölkerung der Gemeinden am 31. Dezember 2021 (rlp.de), accessed in August 2023.

Of the four municipalities within the study area, Billigheim-Ingenheim has the largest population; it is more than four times the size of Impflingen, which is the smallest of the four municipalities. Though the female population in each municipality, except Impflingen, has more women than men, gender is almost equally distributed amongst the inhabitants. This reflects the same picture from state level – though there are slightly more women than men there is an almost equal number of men compared to women in Germany.

Table 6-16 shows the births, deaths, number of people who moved in and out of the area, and overall population change for the four municipalities in the year 2021. No data was available for Billigheim-Ingenheim.

TABLE 6-16 INDIRECT AOI POPULATION CHANGES 2021

Municipality	Births	Deaths	Moved in	Moved away	Population Change
Insheim	14	9	49	38	16 (0,7%)
Impflingen	4	2	35	52	-15 (-1.7%)
Billigheim-Ingenheim:	n/a	n/a	n/a	n/a	n/a
Rohrbach	6	11	61	69	-13 (-0.7%)
Herxheim by Landau (Palatinate)	66	66	372	398	-24 (-0.2%)

Source: State Statistical Office, Population of the Municipalities on 31. December 2021, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/berichte/A/1033/A1033_202122_hj_G.pdf.

6.12.2 AGE

In 2021 the World Bank noted that the average life expectancy at birth for the German population is 81. Females are projected to live to 83.2 years whereas men only have a life expectancy of 78.3 years. In Rhineland-Palatinate, life expectancy (at the age of 0) for men is 78.54 years (slightly above national average), whereas women have a life expectancy of 83.01 years (same as national average).[123]

In Landau in the Palatinate the general median age is roughly 43.1 years. The male median age is about 42.4 and the female median age is about 43.8 years.[124] In Südliche Weinstraße the median age is 46.2 years: 45.4 male median age and 47 female median age.[125] However, there is no available data regarding the average age within these two districts or AoI.

6.12.3 HOUSEHOLD AND FAMILY COMPOSITION

In Germany there are 40.9 million households, 11.9 million families with children and 2.8 single parents. Overall, most households have 1-2 people, and the least number of households have five or more people. [126]

The Rhineland-Palatinate State Statistical office notes that in March 2022 Landau in the Palatinate 2,114 children were in childcare facilities: 97.4% of which were only in day care facilities and most children in childcare were between the ages of 3-6.[127] In Südliche Weinstraße 4,591 total children were in childcare as of March 2022 – of which 975 were also only in day cares. Most children cared for were also between 3-6 years old. [128]

Further specific data on the household composition for the municipalities within the AoI is not publicly available or up to date.

6.12.4 NATIONALITIES

As of December 21, 2022, the total foreign population by place of birth and selected citizenship in Germany was 13,383,910: 1,610,045 born in Germany and 11,773,865 born abroad. About 14.6% of the German population are foreigners, of which 37.3% are from other European Union

[123] Source: Statistiches Bundesamt, Population: deaths, life expectancy (2022), retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Deaths-Life-Expectancy/_node.html, accessed in August 2023.
[124] Source: City Facts, Südliche Weinstraße, retrieved from: https://www.city-facts.com/suedliche-weinstrasse/population, accessed in September 2023.
[125] Source: City Facts, Landau in der Pfalz, retrieved from: https://www.city-facts.com/landau-in-der-pfalz-rheinland-pfalz/population, accessed in September 2023.
[126] Statistiches Bundesamt, Population: Households and Families, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Households-Families/_node.html, accessed in August 2023.
[127] Source: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Landau in the Palatinate, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdf accessed in October 2023.
[128] Source: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Südliche Weinstraße, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf accessed in October 2023.

(EU) states. In Rhineland-Palatinate, specifically 13.6% of the population are foreigners, of which 41% are from EU member states. [129]

Other than Germans, most of the foreign population are from the continent of Europe (69.65%); 37.84% of the foreign population are from other EU-States and of the EU states most are from Romania, Poland, and Italy, respectively. 24.54% are from EU-candidate countries, Turkey above-all, and as previously mentioned there has been a large influx of people from Ukraine after the onset of the Russian-Ukrainian war. 21.5% of Germany´s foreign population are also from Syria, Afghanistan, Iran, India, and China. [130]

Additionally, there are four officially recognised national minorities in Germany: The Danes, the Frisians, the German Sinti and Roma, and the Sorbs. [131] The Danish population is estimated at about 50,000 people and they are concentrated in the Schleswig-Holstein state; Frisians are mostly based in Eastern and Northern Frisia and have a population of roughly 60,000-70,000; there are approximately 60,000 Sorbs primarily in Saxony and Brandenburg; there are roughly 10,000 Roma and 60,000 Sinti and many hold German citizenship.[132] Germany´s stateless population is also growing and is addressed in greater detail in the section below.

Germany does not gather official country-level data or socio-economic statistics related to ethnicity, therefore there is no further specific data regarding the distribution of nationalities within the Project's nearest districts or municipalities.

6.12.5 RELIGION

In the 2022 report on International Religious Freedom: Germany, the US Department of State estimates that Germany´s religious makeup is:

- 26% Roman Catholics
- 24% Evangelical Christians ("EKD" in German)
- 2.1% Other Protestant denominations (new Apostolic Church, Baptist communities, nondenominational Christians)
- 2% Orthodox Christians
- 6.6% Muslim
- 1% Other

[129] Source: Statistisches Bundesamt, Migration and Integration: foreign population by place of birth and selected citizenships, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Migration-Integration/Tables/foreigner-place-of-birth.html, accessed in August 2023.
[130] Source: Statistisches Bundesamt, Migration and Integration: foreign population by place of birth and selected citizenships, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Migration-Integration/Tables/foreigner-place-of-birth.html, accessed in August 2023.
[131] Source: Federal ministry of the Interior and Community, National minorities, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Migration-Integration/Tables/foreigner-place-of-birth.html, accessed in August 2023.
[132] Source: Minority Rights Group International, Germany, retrieved from: Germany - World Directory of Minorities & Indigenous Peoples (minorityrights.org), accessed in August 2023.

- 39% no religious affiliations or belonging to religious groups not recognised by the government. [133]
- Within Rhineland-Palatinate most inhabitants are Roman Catholic, followed by Protestants. [134]

There is, however, no official data on the population's religious breakdown at the municipal or district level for the AoI.

6.12.6 LANGUAGES

German is the official language of Germany, and the language has 250 wide-ranging dialects. Other spoken languages in Germany include English, French, Spanish, Turkish, Arabic, and Italian. Minority languages include Danish, North and Southern Frisian, Serbian, Bosnian, Croatian, Serbian, Kurdish, Polish, Russian, and Turkish. One can assume that with the influx of Ukrainian refugees Ukrainian and Russian are growing languages amongst German inhabitants.[135]

In the Rhineland-Palatinate state the main dialect is *Pfälzisch;* speakers of this dialect even extend into areas of the Saarland. Schools within this state teach German but many schools (English-German or German-French) also offer bilingual programs. [136]

Nonetheless, there is no official data on German minority groups and thus a lack of data specifying what percentage of populations speak certain German dialects. There is no further or more specific data regarding the percentage of languages spoken within Landau in the Palatinate or Südliche Weinstraße and their smaller municipalities.

6.12.7 MIGRATION

Since 2010 the number of labour migrants moving to Germany from non-EU countries has been consistently increasing. Germany´s net migration for 2021 is around 1.5 million – with 2.7 million arrivals and 1.2 million departures. Germany has about 23.8 million people with a migrant background, 13.4 foreigners, and 168,500 naturalisations, as of 2022.[137] In Germany the average net migration per year is about 290,000 people.

The onset of the 2015 migrant crisis shifted the tides with an enormous flow of asylum seekers into the country. In 2015 immigration in Germany was the highest it had ever been: 2.14 million people immigrated to Germany, while only 998,000 people left the country. Because many refugees and asylum seekers were from outside the EU, the population of EU immigrants was only about 40% of the migrants; Syria, Romania and Poland were the main countries of

[133] Source: US Department of State, 2022 Report on International Religious Freedom: Germany, retrieved from: https://www.state.gov/reports/2022-report-on-international-religious-freedom/germany/#:~:text=The%20constitution%20prohibits%20religious%20discrimination,members%2C%20or%20defaming%20religious%20groups., accessed in August 2023.
[134] Source: Britannica, Rhineland-Palatinate, retrieved from: https://www.britannica.com/place/Rhineland-Palatinate, accessed in August 2023.
[135] Source: Minority Rights Group International, Germany, retrieved from: Germany - World Directory of Minorities & Indigenous Peoples (minorityrights.org), accessed in August 2023.
[136] Welcome Center, Rheinland Pfalz, School education, retrieved from: https://make-it-in.rlp.de/en/living-in-rhineland-palatinate/family/school-education, accessed in August 2023.
[137] Source: Statistisches Bundesamt, Population: Migration and integration, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Migration-Integration/_node.html, accessed in August 2023.

emigration, along with Afghanistan, Bulgaria, Italy, Iraq, Albania, Croatia, Hungary, and others.[138]

Migration patterns were also largely impacted by the COVID pandemic and consequent restrictions in 2020 and 2021. The increases in those years were relatively small compared to the trends in previous years and over the last decade as a whole: In 2020 there was an influx of 16,000 labour migrants and 21,000 people in 2021. In 2022 the number of labour migrants increased by 19% (56,000 people); the catch-up effects after the elimination of many COVID measures were likely the culprit of this drastic increase.

Furthermore, the recent geopolitical conflict between Russia, Ukraine and their allies has spurred another influx of asylum seekers into Germany. In 2022 about 1.1 million people from Ukraine arrived in Germany, and roughly 68% of these migrants arrived within the first three months after Russia initially attacked Ukraine (Feb 24, 2022). Most arrived in March 2022 (roughly 430,681), after which numbers gradually decreased. In October 2022 the Federal Statistical Office estimated that about 1.11% of the population were Ukrainians, compared to only 0.13% of the population in January 2022. [139]

Approximately 29% of the population of Rhineland-Palatinate have a migration background.[140] In 2021 net migration in Landau in the Palatinate was 241 people and 304 in Südliche Weinstraße.[141]

Table 6-16 in the previous section 6.12.1.2 shows more specific migration numbers for each municipality from the year 2021. The following list indicates the number of people that moved to the corresponding municipality:

- Insheim: 49
- Impflingen: 35
- Billigheim-Ingenheim: n/a
- Rohrbach: 61
- and Herxheim by Landau (Palatinate): 372.[142]

There is no available information explaining the reasoning for such migration habits or the characteristics of those who emigrated or immigrated; however, changes may have been due to seeking better or different economic opportunities and/or an influx of refugee migrants.

6.12.7.1 ASYLUM SEEKERS AND REFUGEES

A notable portion of Germany´s migrant population are refugees and asylum seekers. As of December 31, 2022, the total number of persons seeking protection in Germany was 3,078,650

[138] Source: Federal Agency for Civic Education, Historical and Current Development of Migration to and from Germany, retrieved from: https://www.bpb.de/themen/migration-integration/laenderprofile/english-version-country-profiles/262758/historical-and-current-development-of-migration-to-and-from-germany/, accessed in August 2023.
[139] Source: Statistisches Bundesamt, Population: Migration and integration, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Migration-Integration/_node.html, accessed in August 2023.
[140] Source: Rheinland Pfalz Ministry for Family, Women, Culture, and Integration, retrieved from: https://mffki.rlp.de/themen/integration/, accessed in August 2023.
[141] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report, retrieved from: Bevölkerung der Gemeinden am 31. Dezember 2021 (rlp.de), accessed in August 2023.
[142] State Statistical Office, Population of the Municipalities on 31. December 2021, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/berichte/A/1033/A1033_202122_hj_G.pdf.

(3.65% of the total national population). Table 6-17 below provides a comparison of the protection statuses for the national vs state-level populations in 2022. There is no recent publicly available data on the specific number of refugees and asylum seekers in Landau in the Palatinate or Südliche Weinstraße and their specific municipalities.

TABLE 6-17 PROTECTION STATUS FOR GERMAN POPULATION COMPARED TO POPULATION WITHIN INDIRECT AOI IN 2022

Migration/Refugee Status	Germany (people)	Rhineland-Palatinate (people)
Seeking protection	3,078,650	134,790
Unsettled	2,253,875	18,915
Recognised	570,060	105,355
Temporary protection	1,916,630	91,950
Permanent protection	337,245	13,405
Protection refused	254,710	10,520

Source: Statistisches Bundesamt, 2023, Population: Migration and integration, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Migration-Integration/_node.html.

6.12.7.2 STATELESS PEOPLE

Furthermore, the stateless population within Germany is also growing. Often when people register for asylum or as a refugee, they are labelled as a stateless person if they lack or did not have access to correct documentation (i.e., often births are not registered), legislative discrimination gender-based discrimination and so on. The United Nations (UN) defines people as stateless if they are not recognised as being a national or citizen of any state; lacking citizenship, legal protection, voting rights, and making it more challenging to access fundamental state services (education, health care etc.). In 2022, 29,455 people in Germany were recognised as being stateless. This number has doubled since 2014 and one fourth of the nation´s stateless population are under the age of 18. Over half of the stateless population were born in Syria. Other countries of origin (in decreasing order) include Germany, Lebanon, Israel, Russia, and others. The number of stateless people born in Germany has increased very slightly but remained relatively consistent since 2005. [143]

6.13 EDUCATION

6.13.1 EDUCATIONAL ATTAINMENT

School attendance in Germany is mandatory, yet the nation offers a variety of levels and modes of education throughout one´s lifetime. In 2019, the Federal Statistical Office noted that 31.9% of the population was qualified to begin with higher education, 47.5% had vocational qualifications and 17.6% had higher education degrees.

[143] Source: Statistisches Bundesamt, Press Release, 29455 people recognised as being stateless at the end of 2022, retrieved from: https://www.destatis.de/EN/Press/2023/03/PE23_091_125.html, accessed in August 2023.

Table 6-18 below presents the educational levels for Rhineland-Palatinate in 2019; it is based on micro census data from Federal Statistical Office.

TABLE 6-18 GENERAL EDUCATIONAL ATTAINMENT IN RHINELAND-PALATINATE IN 2019 BY GENDER

Educational Level	Number of Men	Number of Women
Still Attending School	61	66
Secondary general school certificate	626	609
Certification of ten-grade school of general education	11	13
Intermediate school certificate or equivalent	374	477
Vocational/Practical school or university entrance qualification	569	527
No data provided on type of qualification attained	n/a	n/a
No general school certificate	68	67
Total	**1,713**	**1,763**

Source: Statistisches Bundesamt, 2023, Educational Level, retrieved at: https://www.destatis.de/EN/Themes/Society-Environment/Education-Research-Culture/Educational-Level/_node.html

The values in the table above are generally equal between men and women. The main noticeable difference is that there are almost 100 more women than men who have an intermediate school certificate or equivalent.

Overall, in Rhineland-Palatinate there were a total of 1,489 schools in the year 2021/2021. This includes all varieties of primary and secondary educational levels and types other than universities. There were 17,726 groups/classes with 49% female students and 51% male students. 6.6% of the student population in the state were from foreign countries. [144] In terms of universities, and higher-level education in Rhineland-Palatinate there were 121,060 students (52.6% female and 47.4% male) in the winter semester 2021/2022. [145]

Furthermore, Table 6-19 below provides an overview of the population of graduate's vs dropouts in the year 2021. There is no publicly available data for the relevant municipalities within the AoI. Overall, there are more women than men without vocational degrees at the federal state level and then in Landau in the Palatinate and Südliche Weinstraße.

[144] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report: Education, General Education Schools in the school year 2021/2022 retrieved at: https://www.statistik.rlp.de/fileadmin/dokumente/berichte/B/1013/B1013_202100_1j_K_T1.pdf, accessed in August 2023.
[145] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report: Education, Students in University in the Winter Semester 2021/2022, retrieved at: https://www.statistik.rlp.de/fileadmin/dokumente/berichte/B/3013/B3013_202200_1j_L.pdf , accessed in August 2023.

TABLE 6-19 DROPOUTS VS GRADUATES WITHIN INDIRECT AOI IN 2021

Area Type	Location	Total (graduates and dropouts)	Without Vocational Degree	With Intermediate Qualifications	With University Entrance Qualifications
Federal State	Rhineland-Palatinate	37,823	Total: 1501	19,345	15,719
			Male: 31.4%		
			Female: 68.6%		
			Migration Background: 66.0%		
Independent Town[146]	Landau in the Palatinate	876	Total: 21%	353	460
			Male: 14.3 %		
			Female: 85.7%		
			Migration Background: 42.9%		
District/county[147]	Südliche Weinstraße	859	Total: 21%	471	333
			Male: 4.8%		
			Female: 95.2%		
			Migration Background: 50%		

Source: State Statistical Office, Rhineland-Pfalz, 2023, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/berichte/B/1013/B1013_202100_1j_K_T1.pdf

6.13.2 EDUCATIONAL FACILITIES IN THE AOI

There are over thirty schools around the AoI and within the indirect AoI. However, there are no educational facilities directly within Project AoI. Figure 6-22, Figure 6-23 , and Figure 6-24 below depict the proximity of educational facilities (schools, kindergartens, training centres, and universities) to the AoI, amongst other social infrastructure (local community houses[148], churches, and social welfare centres).

[146] Kreisfreie Städte
[147] Landkreise
[148] In German *Vereinshaus.*

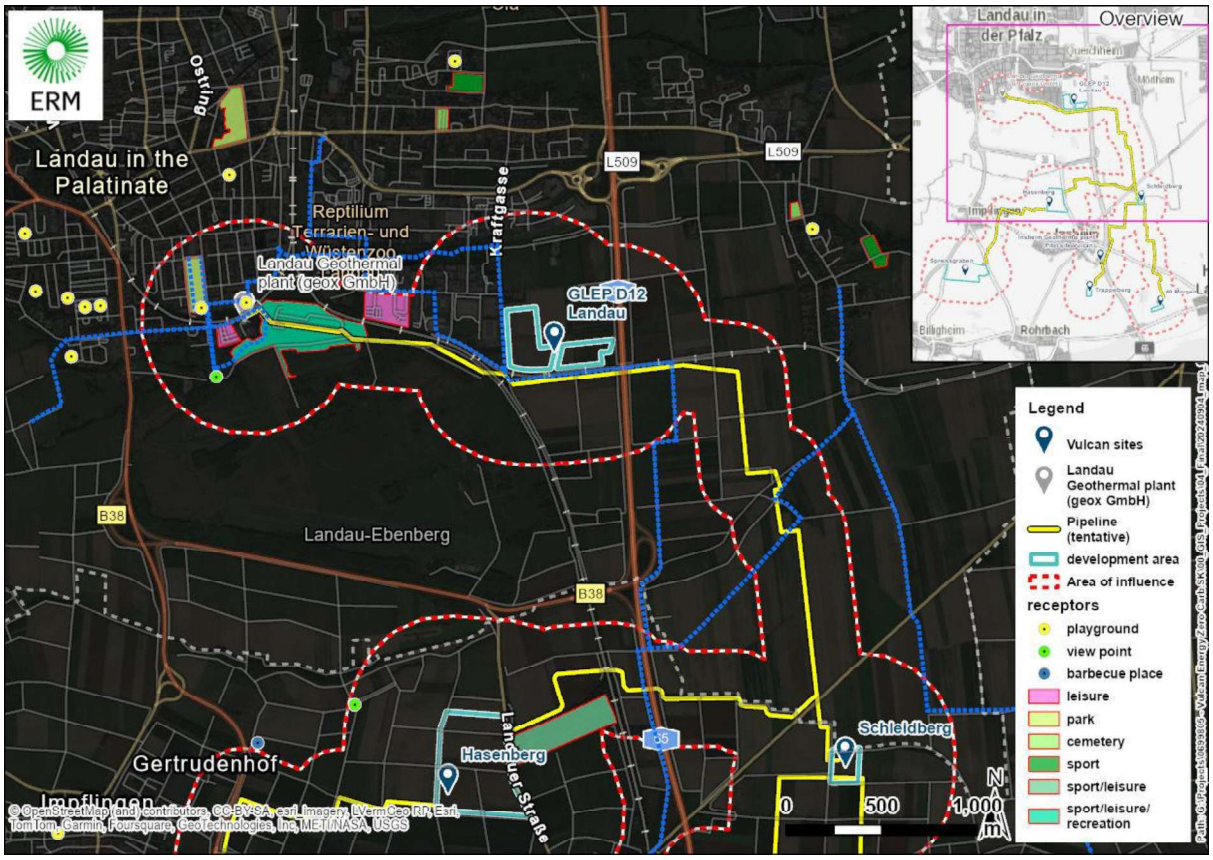


FIGURE 6-22 EDUCATIONAL FACILITIES IN THE NORTHERN REGION OF THE AOI

Figure 6-22 above shows numerous schools in Landau in the Palatinate: four kindergartens, five schools, and five university buildings (most belonging to the University of Koblenz and Landau); there is also one conference or training centre nearby in Queichheim. There is also one kindergarten in Mörlheim, beyond the Project buffer.

There are also kindergartens, a few schools, and local community houses in the surrounding municipalities of Rohrbach, Billigheim-Ingenheim, Impflingen, Herhxheim by Landau (in the Palatinate) as shown in Figure 6-23 and Figure 6-24 below. However, these are quite far from the direct Project area and buffer zone.

Though the social infrastructure in Insheim lies outside of the AoI, the area is surrounded by four different Project sites – Spreissgraben, Hasenberg, the Insheim Geothermal Plant, and Trappelberg, as shown in Figure 6-23.

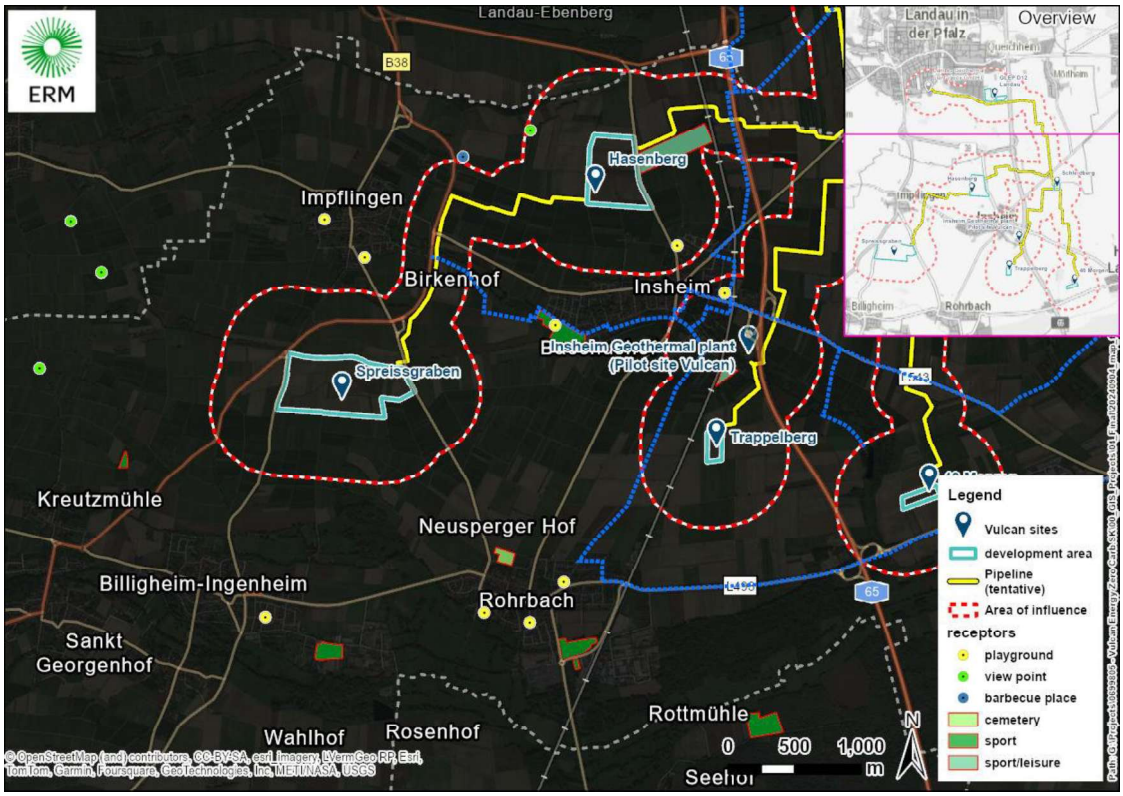


FIGURE 6-23 EDUCATIONAL FACILITIES IN THE SOUTH-WESTERN REGION OF THE AOI

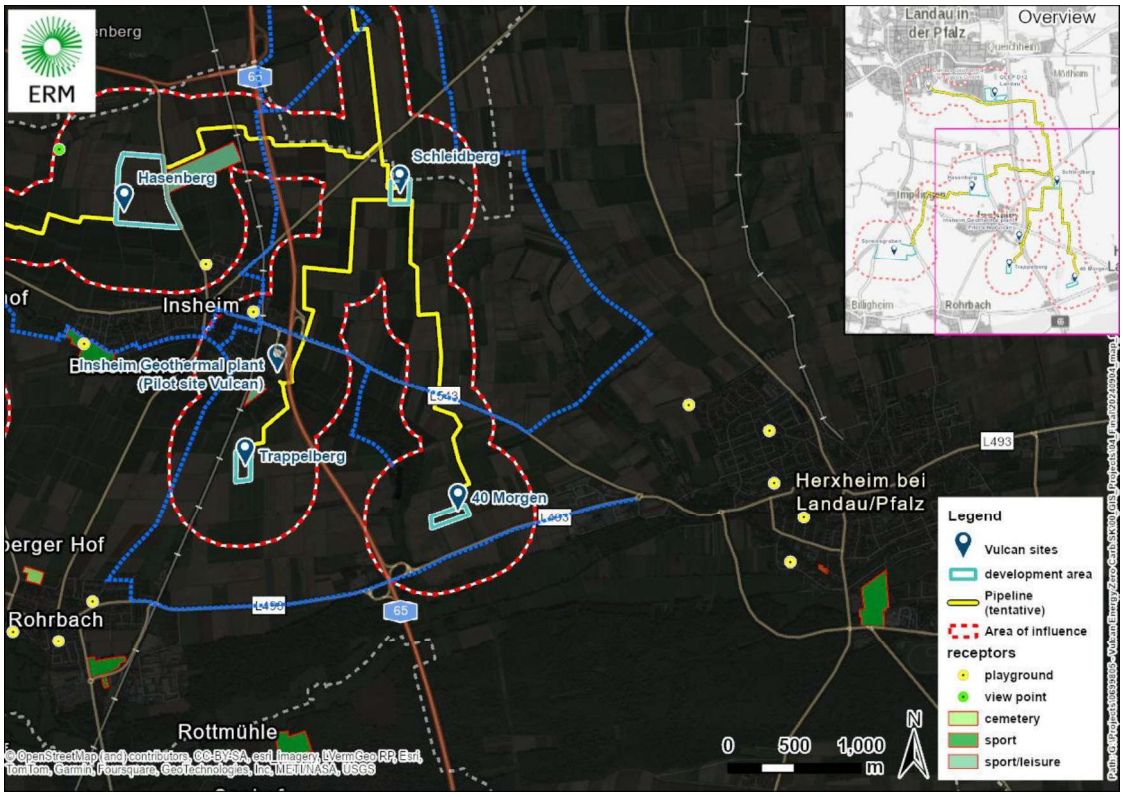


FIGURE 6-24 EDUCATIONAL FACILITIES IN THE SOUTH-EASTERN REGION OF THE AOI

6.14 ECONOMY, EMPLOYMENT, AND INCOME

Germany has a 76.9% employment rate (approximately 45.7 million people). As of June 2023, the adjusted unemployment rate[149] is 3% (1.33 million people). [150] Germany´s youth unemployment is the lowest in the European Union (EU).

Based on the official labour force participation statistics, men are employed at a higher rate than women in Germany for each age group. The rate of employed men is 64.8% compared to 54.9% for women. [151] In 2022, women still earned about 18% less per hour than men on average, and the differences in the pay gap were notably larger in western (19%) than eastern (7%) Germany.[152] The pay gap has slightly decreased since 2016 and the German government aspires to reduce the average gap to only 10% by 2030.

6.14.1 EMPLOYMENT AND INCOME WITHIN THE PROJECT AOI

The Rhineland-Palatinate Ministry for Economy, Transport, Agriculture, and Viticulture note that it has the third lowest unemployment rate in Germany.[153] In July 2023 the Federal Employment Agency noted that the registered unemployment rate in Rhineland-Palatinate was 4.9%. From April 1997-July 2023 the average unemployment rate is 5.7%.[154]

The state Statistical Office of Rhineland-Palatinate notes that in May 2023 there were 107,573 unemployed people compared to 95,369 in the previous year. There was a total of 43,049 reported jobs (decrease in 7.8% from the previous year). There were 475 total bankruptcies in May 2023, an increase of 13.1% from the previous year; 55 were companies (an increase in 9.1%). The total cost of living (consumer price index) in May 2023 was 116.1 (increase in 6.1% from the previous year), compared to the 2020 value of 100. [155]

6.14.1.1 LANDAU IN THE PALATINATE

In 2022 there were 1,378 total unemployed people (ages 15-65) in Landau; this is 4.4% of the population compared to the state average of 3.9%. There were 563 people unemployed over the long-term -- 40.9% of the unemployed population compared to a national average of 34.8%.

[149] Adjusted unemployment rate refers to adjustments made to the figure regarding seasonal data and irregular effects.
[150] Source: DEStatis, Statistisches Bundesamt, Press Release: Employment unchanged in June 2023 compared with previous month, retrieved from, https://www.destatis.de/EN/Themes/Labour/Labour-Market/Employment/_node.html, accessed in August 2023.
[151] Source: DEStatis, Statistisches Bundesamt, Labor Force Participation, https://www.destatis.de/EN/Themes/Labour/Labour-Market/Employment/Tables/et-etq-2021.html, accessed in August 2023.
[152] Source: DEStatis, Statistisches Bundesamt, Quality of employment: Gender Pay Gap, retrieved from, https://www.destatis.de/EN/Themes/Labour/Labour-Market/Quality-Employment/Dimension1/1_5_GenderPayGap.html, accessed in August 2023.
[153] Source: The Rhineland-Palatinate Ministry for Economy, Transport, Agriculture, and Viticulture, Economic Innovation Policy, retrieved from: https://mwvlw.rlp.de/themen/wirtschafts-und-innovationspolitik,accessed in August 2023.
[154] Source: CEIC Data, Registered Unemployment Rate: West Germany: Rheinland Pfalz, retrieved from: https://www.ceicdata.com/en/germany/registered-unemployment-rate/registered-unemployment-rate-west-germany-rheinland-pfalz, accessed in September 2023,
[155] Source: State Statistical Office, Statistical Report: Data on the Economy May 2023, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/berichte/Z/1013/Z1013_202305_mo_L.pdf, accessed in August 2023.

8,733 people were working part-time (34% of the working population compared to the national average of 30.3%). 8% of the employees were self-employed. [156]

Furthermore, Table 6-20 below provides a general overview of the number of employees per sector in Landau in the Palatinate in 2021. Interestingly, most of the population is employed in the service industry in Landau in the Palatinate, suggesting that this sector is of greater economic importance than its overall contributions to the state.

TABLE 6-20 EMPLOYEES PER SECTOR LANDAU IN THE PALATINATE IN 2021

Industry/Sector	% of Working Population
Agriculture, forestry, and fishing	1%
Manufacturing	14.5%
Service Sector	84.5%

Source: State Statistical Office, 2023, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdf

6.14.1.2 SÜDLICHE WEINSTRAßE

In Südliche Weinstraße, specifically, there were 2,536 unemployed people in 2022, 908 of which were long-term unemployed. 10,625 people were employed part-time and 1,261 were apprentices. 11.3% of the working population were also self-employed.

Table 6-21 below provides a general overview of the number of employees per sector in Südliche Weinstraße in 2021. Overall, most employees in Südliche Reinstate work in the service sector (much like the Landau area) but over a quarter of the population is also employed in manufacturing.[157]

TABLE 6-21 EMPLOYEES PER SECTOR IN SÜDLICHE WEINSTRAßE IN 2021

Industry/Sector	% of Working Population
Agriculture, forestry and fishing	6.1%
Manufacturing	25.4%
Service Sector	68.5%

Source: State Statistical Office, 2023, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf

6.14.2 LABOUR AND WORKING CONDITIONS WITHIN THE PROJECT AOI

The Vulcan team estimates that 250 people will be employed before the first plants are in operation in 2026; this refers to personnel required for pre-construction, construction, and for operation. Most employees are mainly technical experts (commissioning managers, project managers, project service managers) and engineers (electrical, process, mechanical, civil).

[156] Source: State Statistical Office, Municipal Data Profile :Landau in the Palatinate, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdf, accessed in August 2023.
[157] Source: State Statistical Office, Municipal Data Profile: Südliche Weinstraße, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf, accessed in August 2023.

VERCANA GmbH is the company hired for drilling, and they have already agreed on a contract with Vulcan are a 100% subsidiary of Vulcan. 24-40 people will work on drill rigs in two 12-hour shifts, depending on the workload. Each drill rig will have approximately 30 container crew camps on a separate land plot close by. The containers are two stories and will sleep about two people per room with a shared kitchen facility and shared lounge area. The kitchen and common area will be in 2 or 3 separate 20 ft containers connected to the sleeping rooms. Sleeping containers have a small bed per person, a wet room, small seating area and cupboards for personal storage. Nearby toilets will also be available for those residing in containers.

6.14.3 ECONOMY AND LIVELIHOODS

The specific region of Rhineland-Palatinate has a diverse economy with various important financial sectors. From 2020-2020 GDP[158] per employed persons increased from 100 to 120 in Rhineland-Palatinate; in Landau in the Palatinate and Landau in the Palatinate's other district cities it increased from 100 to about 115; [159] in Südliche Weinstraße it also increased from 100 to 120. [160]

GDP per person also increased from 2010-2020: in Rhineland-Palatinate and Landau in the Palatinate from 100 to 125; and in the district cities from 100 to approximately 115.[161]

Due to its unique geography – in terms of landscape and connectivity to both other countries and parts of Germany – the area is a hub for international businesses. There are two primary economic sub-regions: along the Rhine and Westpfalz. The state internally borders Nordrhein-Westfalen, Hessen, Baden-Württemberg, and the Saarland, as well as France, Luxembourg, and Belgium, internationally.[162] Most companies and enterprises within the region are medium-sized. [163]

The 2018 export ratio was listed at 57.6% compared to a national average of 50.3% in that same year. Large industrial sectors make up about 25% of Rhineland-Pfalz´s economy. [164] Overall, the most important economic industries in Rhineland-Palatinate are:

- Chemicals and pharmaceuticals

[158] In German *Bruttoinlandsproduct.*
[159] Source: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Südliche Weinstraße, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdf accessed in October 2023.
[160] Source: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Landau in the Palatinate, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf accessed in October 2023.
[161] Source: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdf accessed in October 2023.
[162] Source: AHK Greater China, Rhineland-Pfalz, retrieved from: https://china.ahk.de/market-info/investment-germany/rheinland-pfalz#:~:text=Five%20industries%20characterize%20the%20Rheinland,as%20well%20as%20food%20industries., accessed in August 2023.
[163] Source: The Rhineland-Palatinate Ministry for Economy, Transport, Agriculture, and Viticulture, Economic Innovation Policy, retrieved from: https://mwvlw.rlp.de/themen/wirtschafts-und-innovationspolitik,accessed in August 2023.
[164] Source: The Rhineland-Palatinate Ministry for Economy, Transport, Agriculture, and Viticulture, Economic Innovation Policy, retrieved from: https://mwvlw.rlp.de/themen/wirtschafts-und-innovationspolitik,accessed in August 2023.

- Automotive engineering (including suppliers)
- Metal processing and production
- Mechanical engineering
- Food and beverages.[165]

Tourism and service sectors are also essential contributors to the region´s economy. Tourism provides about 7 billion euros gross per year.

Agriculture is another critical economic sector in the area, especially along the river valleys, low mountain ranges, and in high-altitude areas. There is a diversity of cultural species and special crops dominate 2/3 of the agricultural output. Viticulture – wine production – is of specific economic and cultural importance within the region. 6/13 of Germany´s main wine-growing regions are located within the state of Rhineland-Palatinate; these areas are the: Ahr, Middle Rhine, Moselle, Nahe, palatinate, and Rhenish Hesse. There are over 6,550 wineries and an average annual wine production of about 64 million hl of wine. Over 12% of vineyards in the state produce organic wine, surpassing the German national average.[166]

Table 6-22 provides an overview of Rhineland-Palatinate´s economic sectors in terms of employment and sales contributions. The data below does not include up-to-date information on the service sectors and employment contributions within.

TABLE 6-22 OVERVIEW OF ECONOMIC SECTORS AND EMPLOYMENT IN RHINELAND-PALATINATE IN MAY 2023

Industry	Employed	Total Sales (Mill. EUR)
Manufacturing, mining, and quarrying	260,712	8,929
Intermediate producers of energies and related goods	135,304	4,768
Producers of capital goods	80,077	2,635
Producers of durable goods	4,946	107
Producers of consumer goods	40,385	1,418
Mining and quarrying of earths and stones	374	5
Manufacturing industry	260,338	8,924
Production of chemical products	46,384	2,392
Manufacturing of motor vehicles and related parts	21,337	1,169
Mechanical engineering	37,169	1,070
Manufacturing of rubber and plastic products	22,361	486

[165] Source: AHK Greater China, Rhineland-Pfalz, retrieved from: https://china.ahk.de/market-info/investment-germany/rheinland-pfalz#:~:text=Five%20industries%20characterize%20the%20Rheinland,as%20well%20as%20food%20industries., accessed in August 2023.
[166] Source: The Rhineland-Palatinate Ministry for Economy, Transport, Agriculture, and Viticulture, Viticulture, retrieved from: https://mwvlw.rlp.de/themen in August 2023.

Industry	Employed	Total Sales (Mill. EUR)
Manufacturing of metal products	22,702	448
Production of Food and Animal Feed	14,490	475
Metal production and processing	8,951	501
Production of pharmaceutical products	10,887	349
Manufacturing of paper, cardboard, and related goods	8,675	358
Manufacturing of glass, ceramics, and processing stones and minerals	14,176	342
Beverage Production	5,253	260
Manufacturing of electrical equipment	9,340	170
Main construction trades (site work, building construction, civil engineering)	24,725	n/a

Source: State Statistical Office, 2023, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/berichte/Z/1013/Z1013_202305_mo_L.pdf

Overall, in May 2023 the most lucrative industry was the manufacturing industry overall, especially of mined goods. Other significant contributors were producers of energies and related goods, capital goods, and consumer goods.

6.14.4 POVERTY

In 2022 over 17.3 million people in Germany were affected by poverty: 14.7% of the population were at risk of poverty, 6.1% were affected by severe material and social deprivation, and 9.7% were living in a household with very low work intensity. In Germany the poverty threshold is 15,000 euros per year for people living alone in 2022; for adults with two children under 14 it is 31,500 euros per year.[167]

The income poverty percentages for the region Landau in the Palatinate, Südliche Weinstraße is 9.3% and 9% when corrected for purchasing power.[168] There is no available or official data on the poverty percentages within the relevant municipalities or towns.

[167] Source: Federal Statistical Office, Press Release: Just over one-fifth of Germany´s population at risk of poverty or social exclusion, retrieved from: https://www.destatis.de/EN/Press/2023/05/PE23_190_63.html#:~:text=190%20of%2016%20May%202023&text=WIESBADEN

[168] Source: Datawrapper, Absolte and Relative poverty in Germany, retrieved from: http://cf.datawrapper.de/EYatV/2/, accessed in September 2023.

6.15 LAND USE AND OWNERSHIP

6.15.1 LAND OWNERSHIP

There is no nationwide land registry in Germany, as they are organised under the respective federal states.[169] Changes to land rights only take effect after being officially registered in the land registry (some exceptions do apply depending on the situation and location). [170]

Some of the land that is needed for the Project is already owned by Vulcan. The Spreissgraben and Hasenberg drill sites are the two areas that are still in the land exploration stage. In this area, there are also several land parcels that will be acquired for the Project, but that are not yet in Vulcan ownership but owned by third parties. Land is still needed for the development of access roads around Trappelberg and 40 Morgen, for the trailing curve at Trappelberg, and for crew camp construction at the Schleidberg site. Some negotiations are in progress, and some landowners have yet to be contacted (Table 6-23).

As some of the land areas are not yet owned by Vulcan, they will follow the general land purchase process in Figure 6-25 below. Vulcan has three people on the land acquisition team – one leader and two land acquisition specialists.

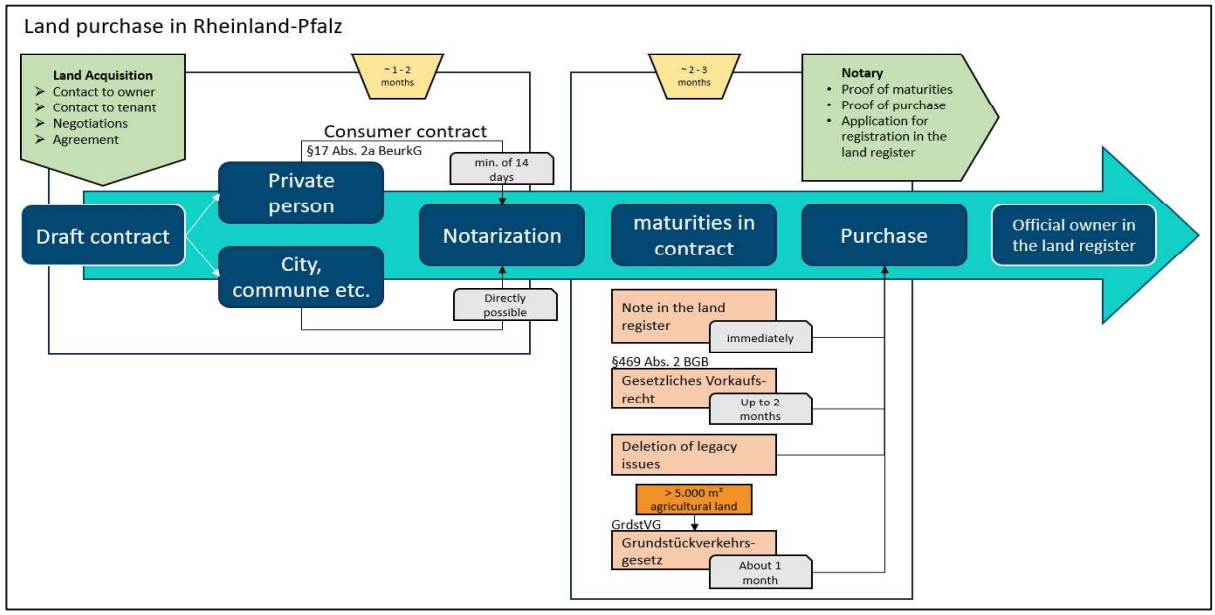


FIGURE 6-25 LAND PURCHASE PROCESS RHINELAND-PALATINATE

Source: Data received from Vulcan; E-Mail dated August 28, 2023.

Table 6-23 and Figure 6-26 below present data on the land ownership status in the direct Project AoI, based on documentation received from the Vulcan project team. There are some areas needed for the Project that Vulcan does not own yet and that are still owned and/or used by

[169] Source: German Probate Lawyer J-H Frank, Fachanwalt Erbrecht, Land Registry (Grundbuch), retrieved from: https://www.german-probate-lawyer.com/en/glossary/def/land-registry-germany.html, accessed in November 2023.
[170] Source: German Probate and Estate Planning Lawyers, Land Registry (Grundbuch), retrieved from: https://www.german-probate-lawyer.com/en/glossary/def/land-registry-germany.html, accessed in August 2023.

third parties. Land plots that are currently under negotiation or whose owners have not yet been contacted for negotiations to purchase their land, have been marked accordingly.

TABLE 6-23 LAND OWNERSHIP DIRECT AOI

Location	Component	Parcel number(s)	Area [m²]	(Former) Owner	Tenant	Acquisition status
All sites	ICPP	Various	Undefined	Various	n/a	Compare to monthly P&LA Report
Frankfurt Höchst Industrial Park	CLP	Various	78,248	Infraserv	Vulcan	Land reservation contract in place. 30-year lease agreement to be signed.
Insheim	Well Site & Geothermal Power Plant	1803	0,143	Vulcan (VNI)	Private	Notarized, purchased
		1806	6,195			
Schleidberg	Well site	2447	3,236	Vulcan (NSG)	No information yet available	Notarized, purchased
		2448	22,051	Vulcan (NSG)	No information yet available	Notarized, purchased
	Access road	545/2	3,300	Vulcan (NSG)	Private	Notarized, purchased
		544/5	2,351	Vulcan (NSG)	Private	Notarized, purchased
	Crew Camp	545/2	3,300	Vulcan (NSG)	Private	Notarized, purchased
Trappelberg	Well site	4960	2,280	Vulcan (NSG)	Private	Notarized, purchased
		4959	5,033	Vulcan (NSG)	Private	Notarized, purchased
		4958	5,153	Vulcan (NSG)	Private	Notarized, purchased
		4957	2,280	Vulcan (NSG)	Private	Notarized, purchased
		4956 (partially)	26,478	Vulcan (NSG)	Private	Notarized, purchased

Location	Component	Parcel number(s)	Area [m²]	(Former) Owner	Tenant	Acquisition status
	Trailingcurve	5011 (partially)	10,141	Private	Private	In contact with owner, verbal agreement
		4996	7,327	Private	Private	Verbal agreement (backup)
	Access road & Passing Bays	5011 (partially)	10,497	Private	Private	In contact with owner, verbal agreement
		5079 (partially)	2,505	Private	Private	Not yet contacted (backup)
		5995 (partially)	9,411	Private	Private	Not yet contacted (backup)
		5078 (partially)	21,343	Private	Self	In contact with owner, verbal agreement
		5920 (partially)	7,297	Private	No information yet available	In contact with owner, verbal agreement
	Access Road	n/a	n/a	Municipality of Rohrbach		License agreement secured
40 Morgen	Well site	8060	4,269	Vulcan (NSG)	Private	Notarized, purchased
		8059	2,457	Vulcan (NSG)	Private	Notarized, purchased
		8058	11,113	Vulcan (NSG)	Private	Notarized, purchased
		8057	6,456	Vulcan (NSG)	Private	Notarized, purchased
	Access road & Passing Bay	8140 (partially)	10,141	Private	Private	In contact with owner, verbal agreement
	Access Road	n/a	n/a	Municipality of Rohrbach	n/a	License agreement secured

Location	Component	Parcel number(s)	Area [m²]	(Former) Owner	Tenant	Acquisition status
Hasenberg	Well site	n/a	n/a	n/a	n/a	Land has been evaluated, currently three options are shortlisted.
Spreissgraben	Well site	n/a	n/a	n/a	n/a	Land has been evaluated, currently three options are shortlisted.
Landau	Well site	n/a	n/a	Eutzinger GmbH	Vulcan	Plant acquired, land plot is leased from Eutzinger for 99 years.
	GLEP	344	3,309	City of Landau	n/a	Land reservation contract in place. Acquisition planed for Q3 2025.
		3445	25,768			
		3446/1	2,551			
		3446/2	1,217			
		3447	62,249			
		3450	2,984			

Source: Data received from Vulcan August 2025.

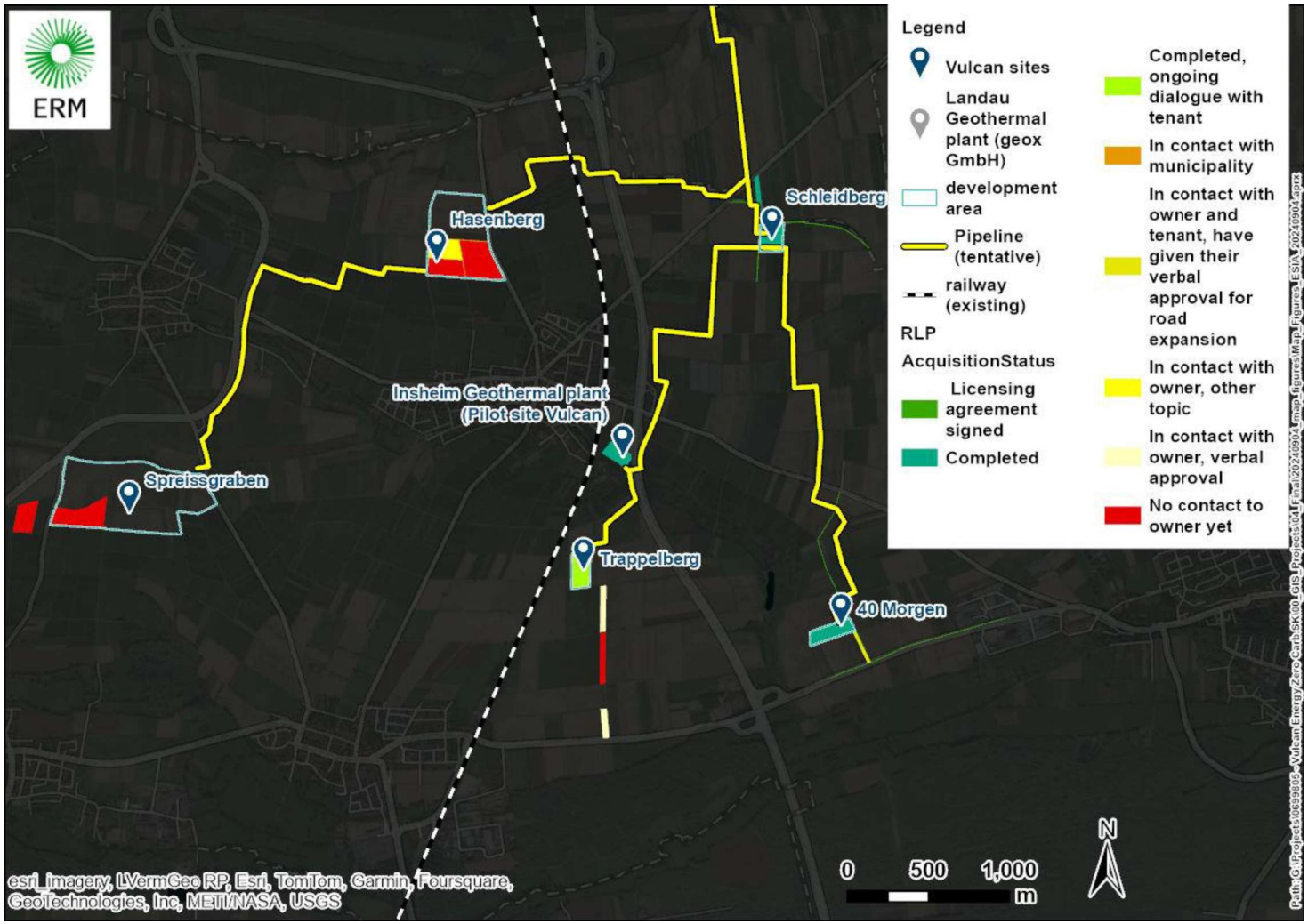


FIGURE 6-26 OVERVIEW OF LAND OWNERSHIP (LANDAU)

6.15.2 LAND USE

The European Commission notes that Rhineland-Palatinate has about 19,854 km^2 of land area: 45% rural land, 36% agricultural land and 42% forestland. [171] This federal state is especially known for viticulture (wine cultivation and production) and the cultivation of other specialised crops throughout the river valleys.

57% of the agricultural land is arable[172], 33% are permanent grasslands, and 10% are areas used for permanent crops. The region´s unique features and highlands are optimal for growing grapes. Indeed, the state has Germany´s largest number of vineyards – 9% of the total agricultural land area. In total there are roughly 16,800 agricultural holdings and 2,100 are over 100 ha. The average size of an agricultural holding is 42 ha, compared to the, significantly, higher national average at 62 ha. [173]

There are increasing efforts to preserve soil quality, water conservation, and preservation of overall biodiversity. Sustainable land management and development of agricultural holdings is a key objective for Rhineland-Palatinate. [174]

Table 6-24 below provides a breakdown of the primary farm and agricultural areas within Rhineland-Palatinate in 2022. Overall, permanent grasslands, cereals for grain production, vineyards are the most common types of land area/use within Rhineland-Palatinate, respectively. Of the grains used for cereal production wheat (not shown in the table) is cultivated the most at 104200 ha (+/- 2%) in 2022.[175]

TABLE 6-24 FARM AREA AND UTILISED AGRICULTURAL AREA/TYPE IN RHINELAND-PALATINATE IN 2022

Main Agricultural Use/Crop	2022 (1,000 ha)	Change from 2021-2022 (%)
Cereals for grain production	217.6 (+/- 2%)	2.2
Plants for green harvesting	55.9 (+/- 2%)	-10.0
Root crops	23.7 (+/- 2-5%)	1.1
Legumes (beans, peas, and legumes for grain production)	8.9 (+/- 2-5%)	8.7
Commercial crops	42.1 (+/- 2%)	11.8
Horticultural products on arable farmland	13.0 (+/- 2%)	-8.3
Seed and seedling production (for grasses and root crops)	1.7 (+/- 5-10%)	-24.3

[171] Source: European Commission, Factsheet on 2014-2020 rural Development Programme for Rhineland-Palatinate (Germany), retrieved from: https://agriculture.ec.europa.eu/system/files/2020-03/rdp-factsheet-rhineland-palatinate_en_0.pdf, accessed in August 2023.
[172] Land under temporary agricultural crops
[173] Source: European Commission, Factsheet on 2014-2020 rural Development Programme for Rhineland-Palatinate (Germany), retrieved from: https://agriculture.ec.europa.eu/system/files/2020-03/rdp-factsheet-rhineland-palatinate_en_0.pdf, accessed in August 2023.
[174] Source: European Commission, Factsheet on 2014-2020 rural Development Programme for Rhineland-Palatinate (Germany), retrieved from: https://agriculture.ec.europa.eu/system/files/2020-03/rdp-factsheet-rhineland-palatinate_en_0.pdf, accessed in August 2023.
[175] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report: Land Use of Farms 2022, accessed in August 2023.

Main Agricultural Use/Crop	2022 (1,000 ha)	Change from 2021-2022 (%)
Other crops on arable land	5.3 (+/- 2-5%)	2.8
Fallow land with/without entitlement to subsidiaries	16.5 (+/- 2%)	-3.3
Tree and soft fruits (including nuts)	4.7 (+/- 2%)	-5.2
Vineyards	64.8 (+/- 2%)	0.3
Nurseries	0.6 (+/- 2-5%)	0.3
Christmas tree cultivation	n/a	n/a
Other permanent crops in open field	0.1 (+/- 10-15%)	38.7
Permanent grasslands	249.5 (+/- 2%)	-1.0
Home/personal use gardens	0.1 (+/- 5-10%)	-2.5
Total Farm Area	770.7 (+/- 2-5 %)[176]	-3.1
Total Agricultural Area	705.0 (+/- 2%)	-0.2

Source: State Statistical Office, Rhineland-Pfalz, 2023.

Wine production in this region is significant. In Rhineland-Palatinate the total yield per hectare of wine in 2022 was 93.8 hl and the harvest quantity was 5,897,416 hl. The yield rebate area in 2022 was also 62,887 ha. More specifically, there is a larger production of white wine compared to red wine that is produced in this region: harvest quantity of 4,253,300 hl of white in 2022 compared to only 1,644,116 hl of red wine; 73.5% of the total grapes cultivated are white wine grape varieties and of these varieties Riesling has the largest harvest quantity (28.2%).[177]

6.15.2.1 LAND USE WITHIN THE AOI

The total land area for Landau in the Palatinate and Südliche Weinstraße are 8,294 ha and 63,993 ha, respectively: 0.42% and 3.22% of the total land area in Rhineland-Palatinate, respectively. Table 6-25 below provides an overview of the land areas and uses broken down for, Landau in the Palatinate and Südliche Weinstraße from December 31, 2021. Agricultural areas and forests make up most of the land area/usages within both Landau in the Palatinate and Südliche Weinstraße.[178]

[176] +/- refers to the relative standard error provided in the original data sets.
[177] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report: Wine Production 2022, Vineyards, accessed: in August 2023.
[178] Source: State Statistical Office, Rhineland-Pfalz, Municipal data profiles: Landau in the Palatinate and Südliche Weinstraße, 2023, retrieved at: https://www.statistik.rlp.de/no_cache/de/regional/kommunaldatenprofil/, accessed in August 2023.

TABLE 6-25 LAND USE BREAKDOWN IN LANDAU IN THE PALATINATE AN SÜDLICHE WEINSTRAßE AS OF 31.12.2021

Area	Type of Land Use	Portion of total district land area (%)
Landau in the Palatinate	Residential Area	6.2
	Traffic and roadways	9.2
	Waterways	0.6
	Industry and commercial space	3.4
	Leisure, recreational, and sports areas	2.6
	Agriculture	43.5
	Forests	29.5
	Wood	2.0
Südliche Weinstraße	Residential Area	3.0
	Traffic and roadways	5.6
	Waterways	0.7
	Industry and commercial space	1.0
	Leisure, recreational, and sports areas	1.6
	Agriculture	40.9
	Forests	43.8
	Wood	1.7

Source: State Statistical Office, Rhineland-Pfalz, 2023, retrieved at: https://www.statistik.rlp.de/no_cache/de/regional/kommunaldatenprofil/,

Moreover, Figure 6-27 below shows the land use within the direct AOI; the boundaries of the direct AoI are marked by the red dotted line (AoI composite buffer) and development areas are pictured in blue.

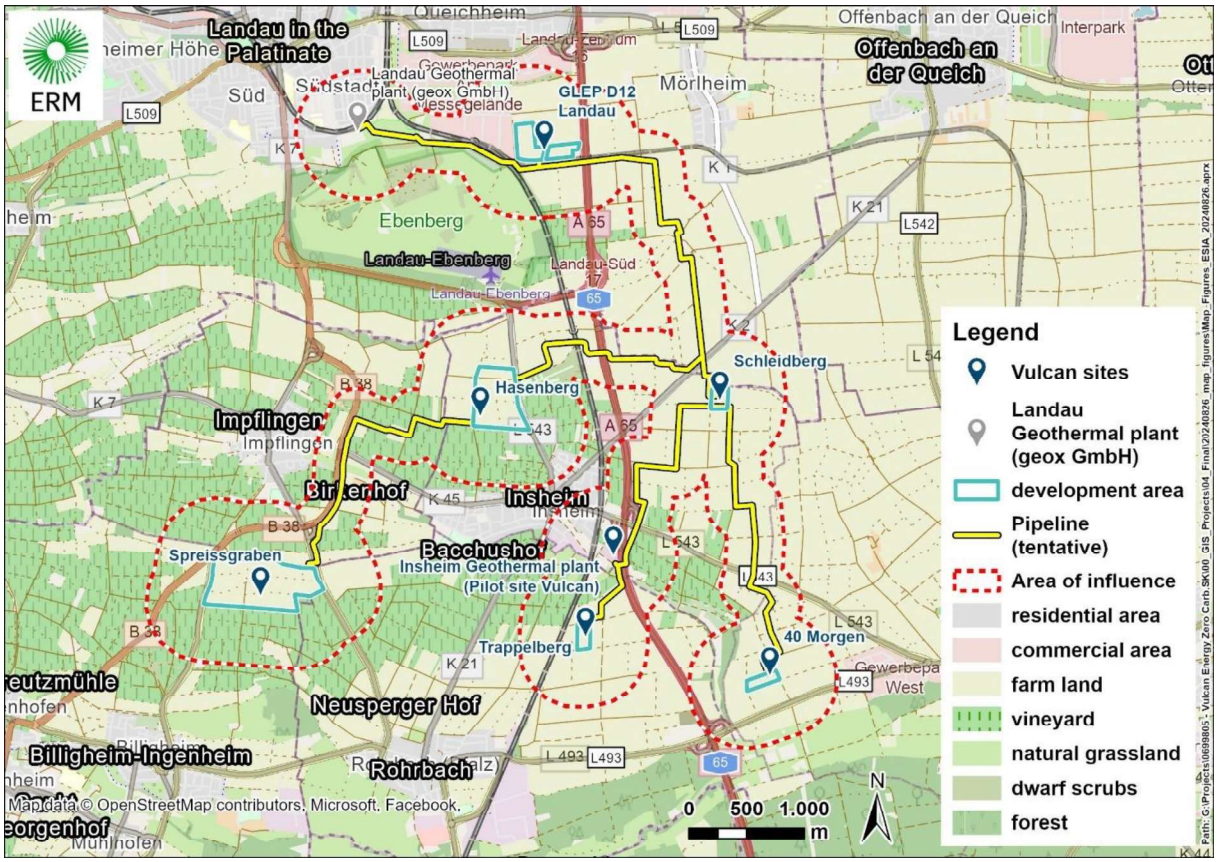


FIGURE 6-27 LAND USE WITHIN THE AOI

Overall, the land within this area is mostly a combination of agricultural and farmland, with some industrial, residential, and commercial areas. Around Insheim, Impflingen, Landau in the Palatinate, and Billigheim-Ingenheim there are mostly vineyards and some natural grasslands. Agriculture and especially wine cultivation and production are considered essential provisioning services[179] within this land area. In the Südliche Weinstraße area, wine production is especially large, having the second highest yield per hectare in 2022 of the other wine-regions in Rhineland-Palatinate; total harvest quantity was the third largest in the state. Specifically, the total yield per hectare of wine in 2022 was 108.1 hl, with a harvest quantity of 1,327,844 hl.[180]

The Landau area is a defined commercial industrial area. Landau in the Palatinate and Insheim are the two main residential centers that overlap with the Project area – namely the Landau (previously geox GmbH) Geothermal Plant and the Insheim Geothermal Plant.

The GLEP D12 site is located on farmland, yet site creation will not lead to economic or livelihood displacement, as Vulcan has stated that during consultations the previous owners specified that they were already intending on selling the land due to low agricultural outputs. Selling the land to Vulcan created additional profits for the previous owners, and the construction of the GLEP D12 site will add to the existing and growing industrial character of the area.

[179] Provisioning services are a type of ecosystem service, in which certain goods are produced or provided for by the ecosystems itself. Ecosystem services are a valuable form of analysing the relationships or nexus between social and environmental land uses.
[180] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report: Wine Production 2022, Vineyards, accessed: in August 2023.

Furthermore, the drill sites (Spreissgraben, Hasenberg, Trappelberg, Schleidberg, and 40 Morgen) are all situated on farmland. During ERM´s site visit the vineyards were visible from the Spreissgraben drill (exploration) site.

The Ebenberg Nature Reserve, which has natural grasslands, is located within the buffer of the AoI but not within the direct development area of GLEP D12. Section 6.16.3 also describes in greater depth the nearby recreational areas around GLEP D12 and other sites.

6.16 INFRASTRUCTURE AND PUBLIC SERVICES

6.16.1 TRANSPORT INFRASTRUCTURE

Germany possesses a highly developed and efficient infrastructure network, including highways, and well-maintained national roads, along with an extensive rail network, and public transit options. The public transport system within and around the Project area is managed by the Rhine-Neckar transport union. [181] Information regarding the real-time traffic situation in Rhineland-Palatinate can be found at the online mobility portal.[182] The shareholders of the company are the three states of Baden-Württemberg, Rhineland-Palatinate, Hesse and the local governments of 24 districts and cities.[183]

6.16.1.1 LANDAU IN THE PALATINATE

The district-free city of Landau in the Palatinate is a midway point or hub for those traveling to Karlsruhe, the Rhine-Neckar region, Alsace, or Ludwigshafen. Karlsruhe is a known region for technological development and infrastructure, suggesting significant transport infrastructure in this region of Rhineland-Palatinate. [184] More specifically, Landau is directly connected to the A65 highway. Other main transport connections in/near Landau include:

- Highway junction A65 connecting Landau, Karlsruhe, and Ludwigshafen
- A5 route from Frankfurt-Basel
- B38 Neutstadt/Weißenburg
- Federal highways B10 connecting Landau, Karlsruhe and Zweibrücken

Nearby airports and landing areas for private (business) jets and aircrafts near Landau:

- Frankfurt airport
- Landau-Ebenberg (glider airfield)
- Speyer Airfield

Other transport infrastructure in Landau includes:

- Harbor waterway Germersheim am Rhein
- ICE/IC/IR railway stations between Mannheim and Karlsruhe

[181] In German *Verkehrsbund Rhein-Neckar (VRN)*
[182] Source: Mobility portal Rhineland-Palatinate, retrieved from: https://autobahn-rlp.de/index.php?lang=20&menu1=10&menu2=&menu3=, accessed in August 2023.
[183] Source: VRN, retrieved from: https://www.vrn.de/verbund/verbund/organisation/index.html, accessed in August 2024.
[184] Source: City of Landau in the Palatinate, City Council: Transport, retrieved from: https://www.landau.de/Wirtschaft-Bildung/Wirtschaft/Verkehrsanbindung/, accessed in August 2023.

- Regional train and public transport in local towns and cities [185]

6.16.1.2 SÜDLICHE WEINSTRAßE

Landau in the Palatinate is a distinct district that is encompassed by Südliche Weinstraße. Thus, the unique geographical positioning of these two areas suggests that the transportation infrastructure is very similar. The main highways routes passing through Südliche Weinstraße are the B10, B38, B48 and B427.

6.16.1.3 TRANSPORT INFRASTRUCTURE DIRECT AOI

Figure 6-28 below provides a map of the transport infrastructure within the direct AoI. The Project area has significant existing transport infrastructure, and smaller municipalities are well-connected to larger settlement areas, towns, and cities.

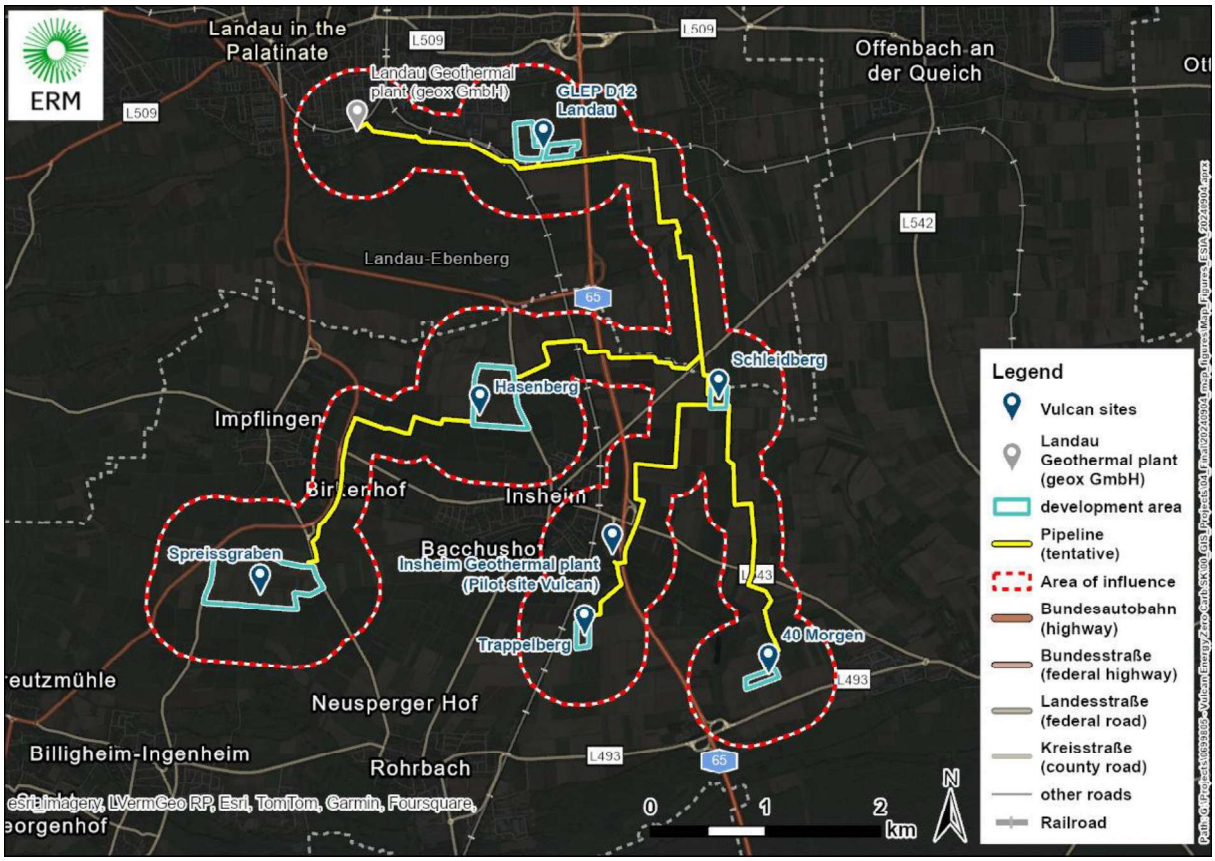


FIGURE 6-28 TRANSPORT INFRASTRUCTURE WITHIN THE AOI

The area where the Project is located is well connected via the A65 and A5 highway and several national roads. The A65 passes directly through the centre of the Project AoI, running parallel to the 40 Morgen, Schleidberg site areas, intersecting with the Insheim Geothermal plant, and tangential to the Trappelberg site.

Road access to the highway will not be prevented by Project activities, but there may be a natural increase in traffic in and around sites. The B38 (federal highway) passes through the Project

[185] Source: City of Landau in the Palatinate, City Council: Transport, retrieved from: https://www.landau.de/Wirtschaft-Bildung/Wirtschaft/Verkehrsanbindung/, accessed in August 2023.

area, extending from Billigheim-Ingenheim to the Landau area. The B38 does fall within the direct AoI near the Spreissgraben site; this will facilitate the movement of materials between Project sites. The B10 is also nearby, connecting Landau, Karlsruhe and Zweibrücken. Smaller county and federal roads also exist within and around the direct AoI – aiding construction activities and limiting the number of access roads that will need to be built for construction.

During ERM's site visit, the team visited the town of Insheim to observe the potential for noise from the nearby Geothermal Plant, however, the sound of the highway overpowered any other noise emissions from existing Project components and activities.

Furthermore, most municipalities and cities are connected via rail (the only municipality without a rail station is Billigheim-Ingenheim). Figure 6-28 above shows a central railroad passing through the centre of the Project area, running perpendicular to the A65 and a large portion of the pipeline (Variant C); this railroad runs through the Landau area, intersecting the existing Landau Geothermal Power Plant, and adjacent to the GLEP D12 site.

There are several secondary roads, mostly used for agricultural transport or recreational activities, such as running or cycling, such as the one pictured in Figure 6-29 below.



FIGURE 6-29 ACCESS ROAD: D12 GLEP SITE

Source: ERM, 2023.

6.16.2 PUBLIC SERVICES

Public services are broadly available throughout Germany. Access to safe water and adequate sanitation is universally ensured, with over 99 %of the population connected to public water supply systems. Rhineland-Palatinate reflects the national trend, with a growing emphasis on

renewable energy. The region benefits from its natural resources, including wind and solar potential, contributing to a cleaner and more sustainable energy grid.[186] Despite the increasing use of energy from renewable sources such as wind power and solar energy, conventional energy sources continue to be of essential importance for the energy supply in Rhineland-Palatinate. This applies above all to the energy sources natural gas and crude oil.[187]

6.16.3 PUBLIC AND RECREATIONAL INFRASTRUCTURE

There are many recreational areas and services near and within Project AoI. There are numerous scenic landscapes that are used for hiking and cycling. Moreover, there is also agrotourism in the area as it is known for wine production. The most relevant area within the AoI to consider is the D12 GLEP site as it is located near a Nature Park and during ERM's site visit many cyclists and pedestrians were observed on the paved roads nearby.

6.16.3.1 LEISURE AND RECREATIONAL AREAS WITHIN THE AOI

Figure 6-30, Figure 6-31, and Figure 6-32 below map the leisure and recreational areas or facilities relative to the AoI. Most areas for leisure and recreational activities are near the Landau area or northern region of the Project AoI.

Most importantly, there are numerous cycling/hiking routes (depicted by the dotted blue line), which pass through the centre of the Project area and overlap with the pipeline (Variant C) near GLEP D12, and north of the Schleidberg site. During ERM's site visit many cyclists and pedestrians were seen using these roads. The Nature reserve Ebenberg is also located south of Landau in the Palatinate but is closer to the Landau Geothermal Power Plant and eventually the D12 GLEP site. It can be assumed that hiking, cycling, and walking is also common amongst pedestrians and civilians here.

[186] Source: Ministry for Economy, Climate protection, energy, and landscape planning, "Energy Transition on the state of
Rhineland Platinate, Germany", retrieved from: Layout 1 (rlp.de), accessed in August 2023.
[187] Source: Statistisches Monatsheft Rheinland Pfalz (2022), „Energieverbrauch in Rheinland Pfalz 2020", retrieved from:
Energieverbrauch in Rheinland-Pfalz 2020 (rlp.de), accessed in August 2023.

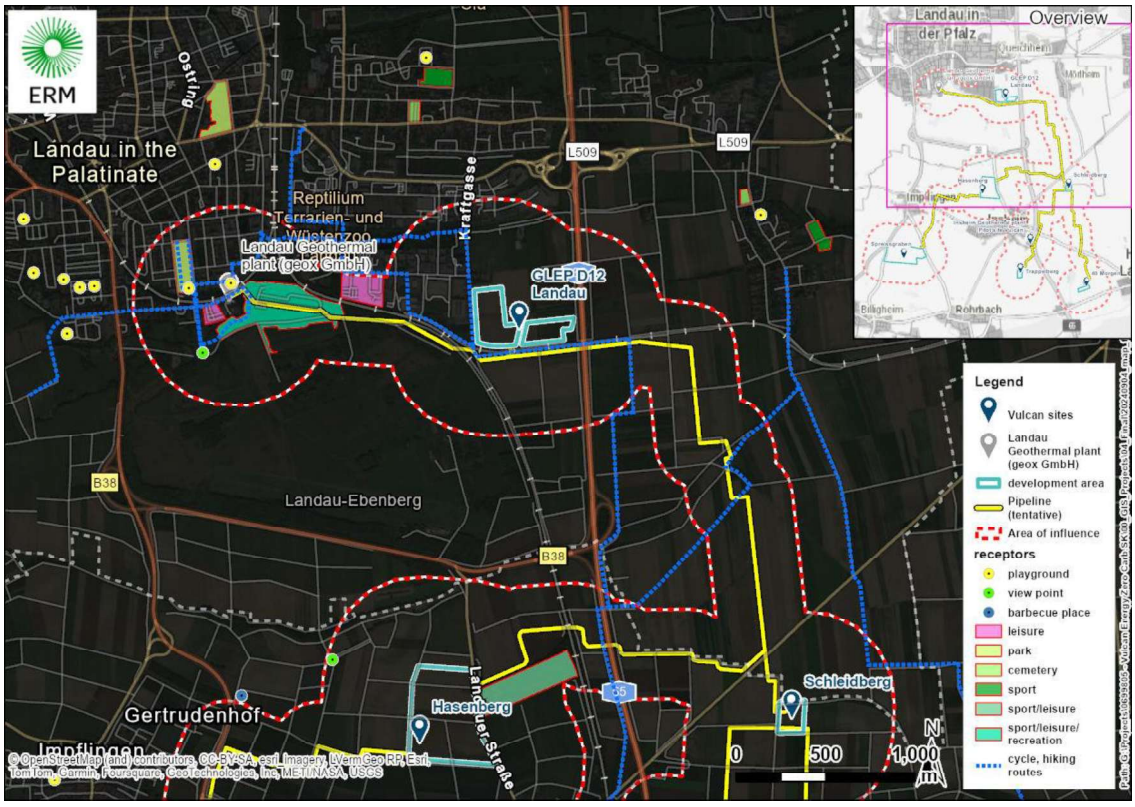


FIGURE 6-30 LEISURE AND RECREATIONAL AREAS (NORTHERN REGION OF AOI)

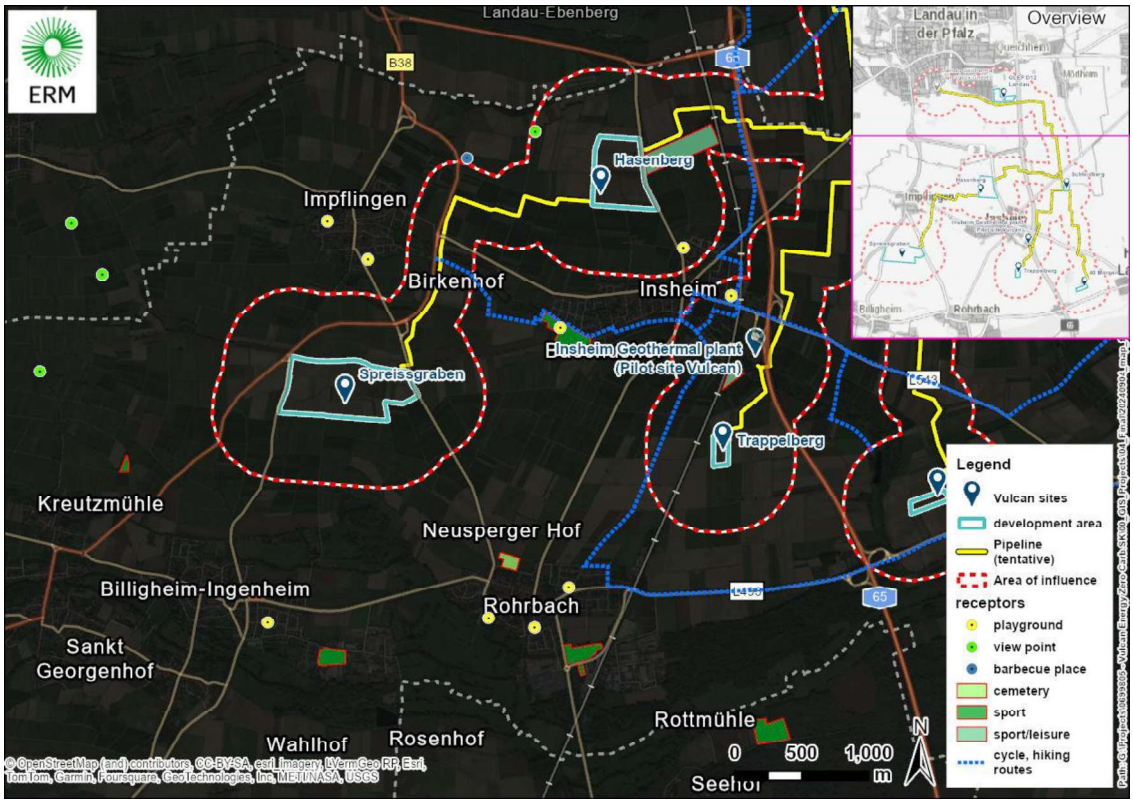


FIGURE 6-31 LEISURE AND RECREATIONAL AREAS (SOUTH-WEST REGION OF AOI)

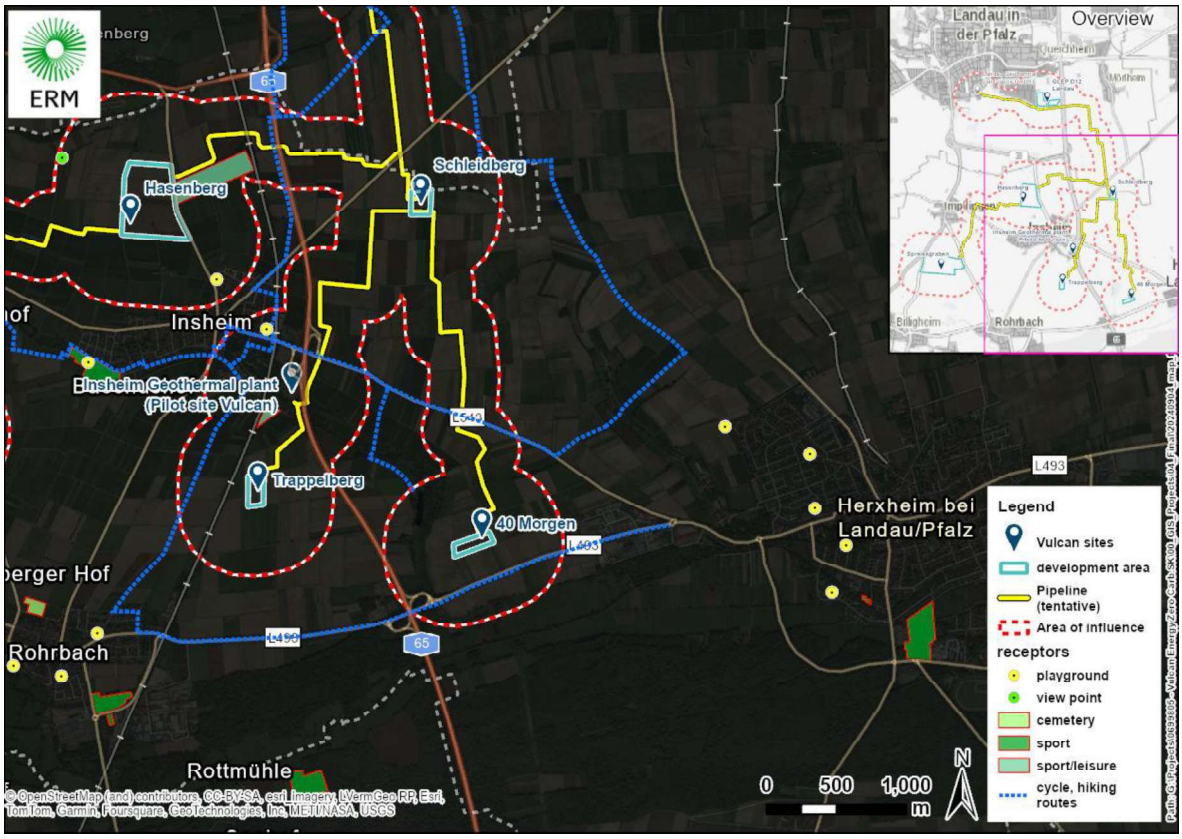


FIGURE 6-32 LEISURE AND RECREATIONAL AREAS (SOUTH-EAST REGION OF AOI)

Within the direct AoI there is one viewpoint outside of the Hasenberg drill site; there are three playgrounds within the AoI, outside of the Hasenberg site, one the buffer zone line near Insheim, and two next to the Landau Geothermal Plant.

6.17 COMMUNITY HEALTH

6.17.1 HEALTHCARE AND HEALTHCARE FACILITIES

Healthcare in Germany, including in the state of Rhineland-Palatinate, is characterised by high-quality medical services and comprehensive coverage. Germany has a universal healthcare system, with mandatory health insurance for all residents, whether through statutory health insurance (SHI) or private health insurance (PHI). SHI covers most of the population (88%).[188]

In Rhineland-Palatinate, residents have access to a network of well-equipped hospitals, clinics, and medical facilities. The healthcare system in Rhineland-Palatinate, like in the rest of Germany, is funded through a combination of contributions from employees, employers, and the government.

In Rhineland-Palatinate there are around 84 hospitals, and the state has a needs-based hospital care system; there is a good level of specialist care and outpatient general practitioner. [189] The closest hospital is in the city of Landau in the Palatinate. However, there are growing demands

[188] Source: Germany: health system review 2020, retrieved at: https://eurohealthobservatory.who.int/countries/germany, accessed in August 2023.
[189] Source: Rheinland Pfalz, Rwanda partnership. Retrieved at: https://www.rlp-ruanda.de/en/the-two-countries/rhineland-palatinate/healthcare/, accessed in August 2023.

in the medical sector leading to changing health infrastructures: higher demand for doctors in rural areas, increased demand for nursing care (as the elderly population compared to other demographics are growing).[190]

TABLE 6-26 HEALTHCARE FACILITIES IN RHINELAND-PALATINATE IN 2017

State	Total number of hospitals	Total number of Clinics (day/night)	Total number of preventative and rehabilitation facilities	Total number of Psychiatric care facilities
Rhineland-Palatinate	84	37	53	70 (hospitals with psychiatric care) and 14 (exclusively for psychiatric care)

Source: Statistisches Landesamt, Rheinland Pfalz, 2019, retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/berichte/A/4023/A4023_201700_1j_K.pdf

Moreover, there are three preventative and one rehabilitative facility in Südliche Weinstraße and Landau in the Palatinate, respectively.

6.17.1.1 HEALTHCARE FACILITIES WITHIN THE AOI

Figure 6-33 below shows the healthcare facilities relative to the Project AoI. The nearest healthcare facilities close to the AoI are in Landau in the Palatinate, where there are two medical practices, a hospital, and a medical centre. However, these are not within the direct AoI.

[190] Source: Rheinland Pfalz, Rwanda partnership. Retrieved at: https://www.rlp-ruanda.de/en/the-two-countries/rhineland-palatinate/healthcare/, accessed in August 2023.

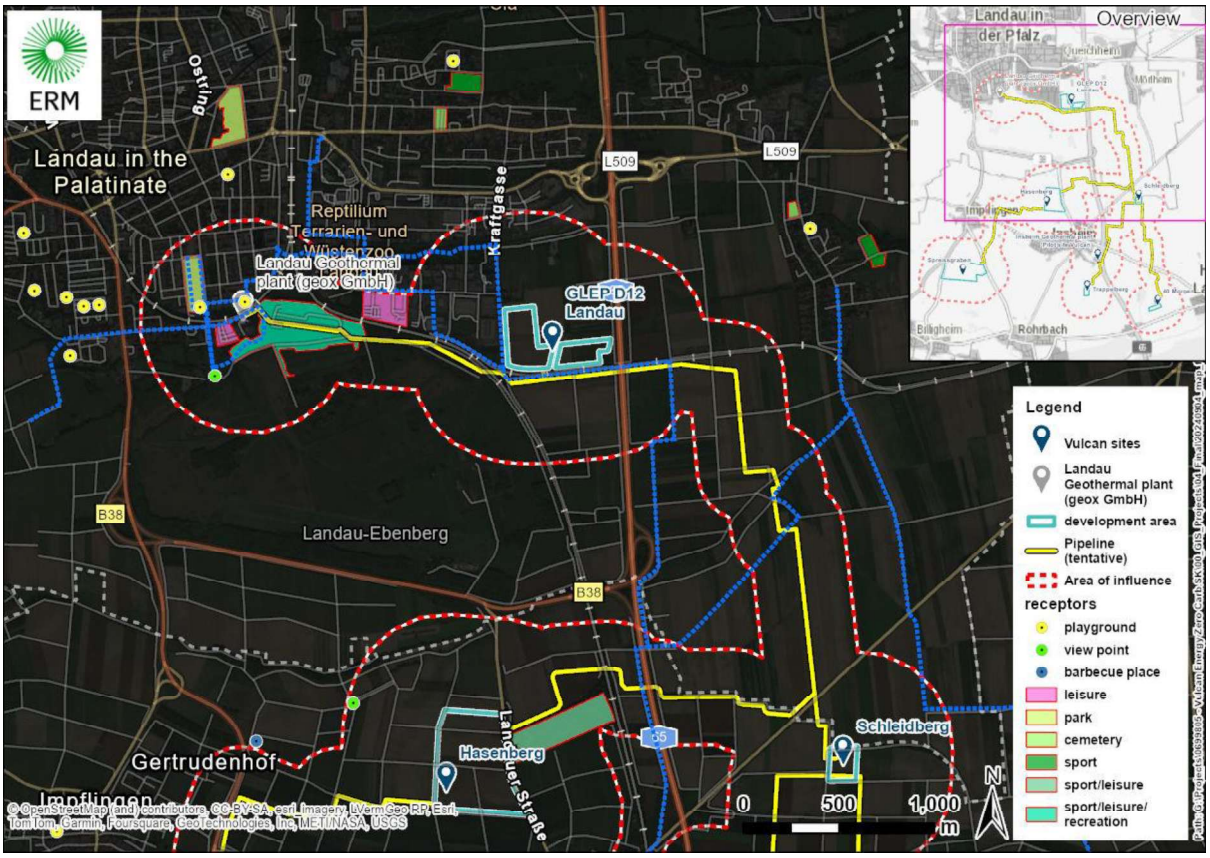


FIGURE 6-33 HEALTHCARE FACILITIES WITHIN THE AOI

6.17.2 HEALTH CONDITIONS

Smoking specific illnesses in Germany are clearly prevalent. In 2021 every adult in Germany averaged about 1,033 in cigarette consumption in 2021, and 375,200 patients were treated in a hospital because of related diagnoses in the same year. 75,500 people died of smoking-specific illnesses in Germany in 2020: 46,100 of these cases were linked to respiratory cancers (lung, bronchial, laryngeal, or tracheal) and 29,400 were due to chronic obstructive pulmonary disease (COPD). Moreover, the number of women dying from lung and bronchial cancer has increased by nearly 73%, significantly, over the past 20 years; similar trends are also being identified for increased COPD in women. The increase in women suffering from these respiratory illnesses is likely due to an increase in female smokers since the 1950s. [191]

State and municipality level information on population health was last gathered in 2017 and there have not been official publications since then. Beyond the general identification of smoking-related illnesses, there is limited information on the specific health conditions or illnesses that primarily affect people within Rhineland-Palatinate and other local communities; specific information on the effects of COIVD within this population area is also limited.

Table 6-27 below provides an overview of the population's health statuses in Rhineland-Palatinate.

[191] Source: Statistisches Bundesamt, Cause of death statistics 2021: 7% of all deaths directly due to COVID-19.

TABLE 6-27 RHINELAND-PALATINATE POPULATION HEALTH STATUS OVERVIEW IN 2017

Health Status/Indicator	Rhineland-Palatinate
Total sick population	14.1% of total population
Victims of accident(s)	1.3% of total population
Sick but employed (ages 15+)	203 people in total
	137 of which have received/were receiving care
	63 of which not receiving/received care
Sick and unemployed	7 people in total
	6 of which are receiving care
Ill and inactive[192]	245 people in total
	169 of which were receiving care
	74 of which were not receiving care

Source: State Statistical Office, Rhineland-Pfalz, 2017

According to the State Statistical Office, in 2017, 14.1% of the total population in Rhineland-Palatinate were sick, and 1.3% of the population were victims of an accident. [193] These percentages are almost the exact same as the national percentages for sick and victims of injury: 14.2% and 1.1%, respectively. [194] These values represent individuals who were suffering from an illness or impairment that prevented them from completing their job or usual occupations at the time of the survey and does not matter whether doctors were consulted or not.

In terms of smoking-related illnesses, 586.1 (16.8% of the total state population) people in Rhineland-Palatinate were smokers in 2017; 107.4 were occasional smokers and 478.7 were regular smokers. Similarly, 209.4 people were between ages 15-40, 309.9 were 40-65 years old, and 67.9 were over the age of 65. 28.8% (603.6 people) of non-smokers were former smokers. The average age at which the population started smoking was 17.7 years old. [195]

More specifically, Table 6-28 below presents the number of people receiving additional care[196] within Landau in the Palatinate an Südliche Weinstraße. This includes health care, long-term care, residential care.

[192] Inactive suggests that some were unemployed and seeking jobs and others were not seeking jobs.
[193] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report: Health Data 2017, accessed in August 2023.
[194] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report: Health Data 2017, accessed in August 2023.
[195] Source: State Statistical Office, Rhineland-Pfalz, Statistical Report: Health Data 2017, accessed in August 2023.
[196] In German *Pflege.*

TABLE 6-28 CARE IN SÜDLICHE WEINSTRAßE AND LANDAU IN THE PALATINATE IN DECEMBER 2021

District	Total number of persons in need of care	Percentage of people in outpatient care	Percentage of people in full stationary care	People only with a care allowance
Landau in the Palatinate	2,695	26.2 %	14.7%	49.1%
Südliche Weinstraße	6,447	16.8%	9.1%	63.5%

Sources: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Landau in the Palatinate, and Südliche Weinstraße retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdfand accessed in October 2023.

6.18 CULTURAL HERITAGE

According to the applicable international standards the term 'cultural heritage' encompasses tangible and intangible heritage, which may be recognised and valued at a local, regional, national, or global level, as follows:

- **Tangible cultural** heritage, which includes movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Tangible cultural heritage may be in urban or rural settings, and may be above or below land or under the water; and
- **Intangible cultural** heritage, which includes practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts, and cultural spaces associated therewith – that communities and groups recognise as part of their cultural heritage, as transmitted from generation to generation and constantly recreated by them in response to their environment, their interaction with nature and their history.

6.18.1 CULTURAL HERITAGE WITHIN THE AOI

The Vulcan Project development team conducted archaeological soundings at the 40 Morgen drill site within the Project AoI, which is known to be rich in archaeological findings. The archaeological sounding was advised by an ecological construction supervisor. Based on preliminary assessments, this specific site area is assumed to have remnants mainly from the Stone and Iron Ages and is thought to have previously been dump sites.

Initial survey work took place from April 4 to April 19 2023, involving 17 test trenches aligned southwest to northeast, with widths of 5 meters and lengths ranging from 20 to 60 meters. Follow-up fieldwork from November 27 to 30 2023, focused on deeper ground interventions (Figure 6-34). The excavation took place in the area of the planned tower foundation (as this is the area that reaches deepest into the ground).

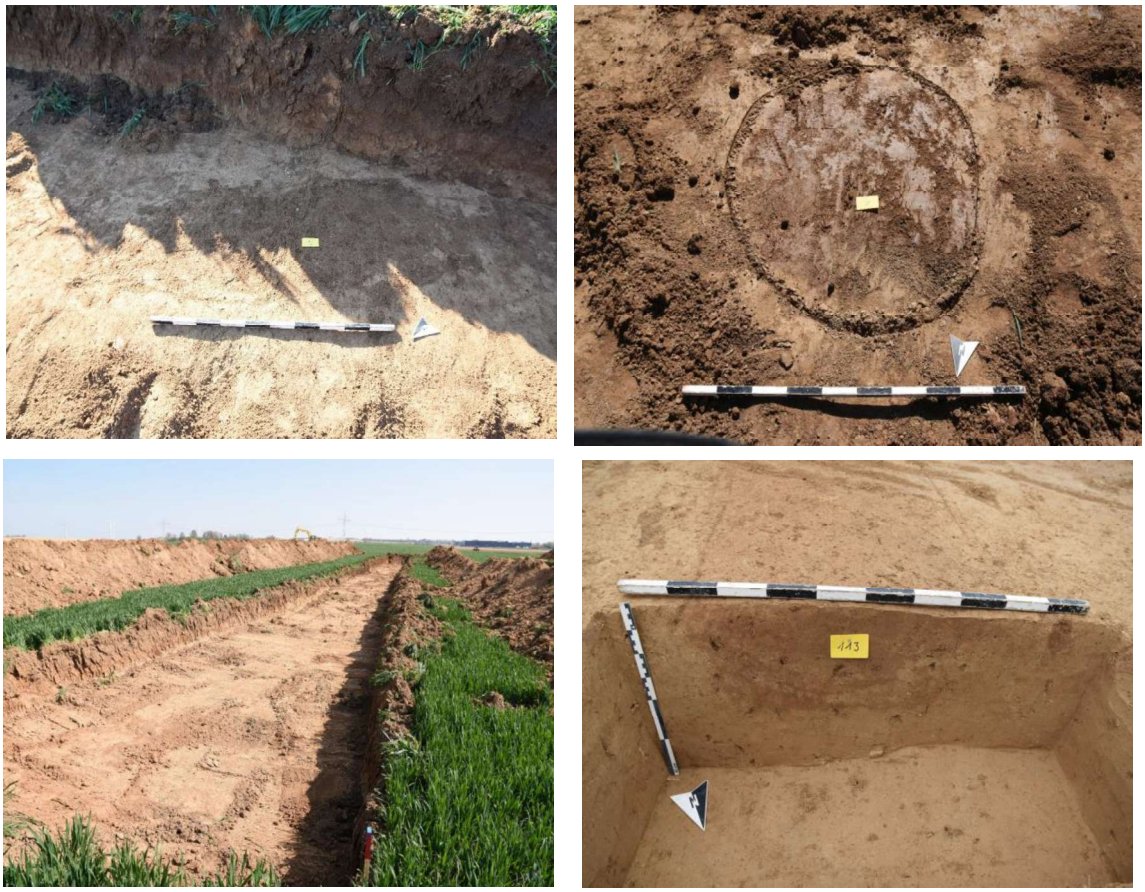


FIGURE 6-34 PHOTOS TAKEN DURING ARCHAEOLOGICAL INVESTIGATIONS

During the excavation, massive layers of red clay were found beneath the topsoil across several sections, with the density of finds decreasing towards the east. A total of 121 archaeological features were discovered. Among these, 18 were identified as prehistoric and 5 as Roman Imperial, while one contained modern materials. Prehistoric finds included pottery fragments and hut clay, while Roman finds included pottery and brick fragments. Many features remain undated due to a lack of materials.

The excavation revealed several types of features, mainly pits, ranging from large backfills to smaller post pits, and ditch-like structures found in 14 locations. Two features showed signs of intense heat, likely from open hearths.

Vulcan has documented and secured all findings. The authorities have determined that the area (40 Morgen) is now free of any archaeological artefacts and can be used for drilling. Based on desktop research there are no further sites of tangible or intangible cultural heritage identified within the AoI. However, when Vulcan acquires new sites for drilling, they will follow the same procedure as for the 40 Morgen site.

6.19 PRESENCE OF VULNERABLE GROUPS

Vulnerable Groups that could potentially be present in the Project AoI are presented below, with a brief explanation on why they may be considered vulnerable.

- **Women:** Women may be considered a vulnerable group due to persistent gender inequalities in areas such as income, representation, and domestic responsibilities, which can result in

economic and social disadvantages. Furthermore, women are more likely to be victims of domestic violence or gender-based harassment.

- **Children:** To access assets or resources, children are often reliant on older members of the household or community. When a child is not adequately represented by an adult or is from a low-income family or an ethnic minority, they may be vulnerable to exploitation within the community or workplace.
- **Youth:** Youth, defined by the United Nations (UN) as the 15 to 24 age group[197], are potentially vulnerable to poor labour practices due to contracting practices, and lack of work experience and skills. Youth who do have qualifications may still face challenges due to a lack of job opportunities. Unemployed youth who have dependents and financial obligations (e.g., families, rents, and other responsibilities) are considered more vulnerable.
- **Elderly/retired:** The elderly people have specific vulnerabilities relating to limited ability to change or increase income levels, access to additional finances, and access to healthcare, as well as being more susceptible to disease and disability. Access to pensions can depend on the number of years in registered employment, with lower income groups more likely to have been informally employed. The burden of chronic diseases, such as cardiovascular disease and diabetes, is highest among elderly residents, while out-of-pocket medical expenses are relatively more unaffordable for lower income retirees.
- **Physical/mental health and disability and underlying health conditions:** Those who lack physical mobility or who have mental health issues may be vulnerable to changes and unable to participate in decision-making or may have hindered access to employment opportunities. Disabled people may also experience varying levels of social exclusion, community marginalisation, and are more vulnerable to change. Those with underlying health issues that may be more sensitive to environmental changes leading to health outcomes.
- **Low-income households:** Low-income households have fewer resources on which to rely and are less likely to have savings and/or access to credit, which make them vulnerable to shocks and change.
- **Ethnic minorities:** Some groups may be marginalised with reduced access to healthcare, education, freedom of speech, credit, and other services. In most cases ethnic minority groups have their own language, which is not the language practiced by the dominant ethnic group.
- **Refugees / asylum seekers and migrant workers:** Refugees, asylum seekers, stateless persons, and irregular migrants are often exposed to heightened risks of harm and require special care, support, and protection. Migration can be an additional risk factor for worse health conditions. For example, migration is often linked with bad working conditions, risk of

[197] Source: United Nations Department of Economic and Social Affairs). 2013. Definition of Youth. Accessed: March 2022.
Retrieved from: retrieved from: Microsoft Word - YOUTH_Definition_2013-1-23.docx (un.org), accessed in August 2023.

poverty in old age, cramped housing conditions, psychic strains, and a lack of German knowledge.[198]

6.19.1 VULNERABLE GROUPS WITHIN AND NEAR THE AOI

It can be assumed that there are women, children, youth, and elderly and potentially other vulnerable groups within the AoI. However, current baseline data does not suggest unique vulnerabilities to the local population, or a disproportionate amount of vulnerable people compared to other regions or state level.

Table 6-28 (in section 6.17.2) shows the population breakdown of those receiving additional care in Landau in the Palatinate and Südliche Weinstraße. There are five and 13 nursing homes in Landau in the Palatinate and Südliche Weinstraße, respectively; in Landau in the Palatinate and Südliche Weinstraße's district cities there are a total of 139 and 444 nursing homes, respectively.[199]

In Südliche Weinstraße and Landau in the Palatinate, respectively the percentage of the population over 65 is 24.1% and 20.1%; this is comparable to the state-level value as 22.5% of Rhineland-Palatinate's total population is over 65 years of age.[200] However, there is no available data regarding the distribution of gender amongst the elderly population.

Nonetheless, a press release from the Federal Statistical Office in March 2023 noted that the gender pay gap even extends to retirement pensions, highlighting a 29.9% pension gap. An income and living conditions survey (EU-SILC) in 2021[201] specified that women over 65 received gross retirement incomes of 17,814 euros per year compared to their male counterparts who received 25,407 euros per year.[202] This large pension gap renders more elderly women vulnerable compared to men, as 1/5 women over the age of 65 are at risk of poverty compared

[198] Source: Social Services for Vulnerable Groups in Germany, Danielle Gluns, University of Münster, March 2018, LoGoSO
Research Papers Nr. 3, retrieved from: 3_Social_Services_for_Vulnerable_Groups_in_Germany.pdf (fu-berlin.de) accessed in
August 2023.

[199] Sources: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Landau in the Palatinate, and Südliche Weinstraße retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf
https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdfand accessed in October 2023.

[200] Sources: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Landau in the Palatinate, and Südliche Weinstraße retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf
https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdfand accessed in October 2023.

[201] Statistisches Bundesamt, Population: Households and Families, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Households-Families/_node.html, accessed in August 2023.

[202] This is likely a result of multiple factors: higher percentages of women than men working in lower paid industries, more women work part-time than men (taking more time off for care work or greater participation in the informal sector), and fewer women than men occupy executive positions in Germany.

to only 17.5% of men over 65; 15% of women over 65 are also overburdened by housing costs compared to only 11% of men. [203]

Table 6-29 below presents the data regarding recipients of social security within the two districts Landau in the Palatinate and Südliche Weinstraße compared to Rhineland-Palatinate. Overall, the number of people receiving basic old age benefits and/or with educed earing capacity has notably increased from 2011-2021 in Rhineland-Palatinate, Landau in the Palatinate and Südliche Weinstraße. [204]

In Rhineland-Palatinate 72.8% of social security recipients receive long-term care assistance, compared to 81.2% in Landau in the Palatinate and 82.6% in Landau in the Palatinate. The remainder of social security recipients receive other types of help (educational subsidiaries, unemployment money, loans etc.)[205]. The Rhineland-Palatinate state statistical office does not include information on data related to integration assistance for disabled people is included in this statistical data.[206]

TABLE 6-29 RECIPIENTS OF SOCIAL SECURITY IN RHINELAND-PALATINATE COMPARED TO LANDAU IN THE PALATINATE AND SÜDLICHE WEINSTRAßE, DECEMBER 2021

Type of Social Security/Circumstance	Rhineland-Palatinate	Landau in the Palatinate	Südliche Weinstraße
Total recipients of basic old age benefits and/or with reduced earning capacity	49,955 people	528 people	909 people
Recipients of basic old age benefits and/or with reduced earning capacity over the age of 18	14.6% per 1,000	13.3% per 1,000	9.7% per 1,000
Those without chargeable income	13,788 people (27.6%)	122 people (23.1%)	207 people (22.8%)

[203] Statistisches Bundesamt, Population: Households and Families, retrieved from: https://www.destatis.de/EN/Themes/Society-Environment/Population/Households-Families/_node.html, accessed in August 2023.
[204] Sources: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Landau in the Palatinate, and Südliche Weinstraße retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdfand accessed in October 2023.

[205] Refers to recipients identified in the SGB XII chapters 3, 5, 8, and 9.
[206] Sources: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Landau in the Palatinate, and Südliche Weinstraße retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdfand accessed in October 2023.

Type of Social Security/Circumstance	Rhineland-Palatinate	Landau in the Palatinate	Südliche Weinstraße
Elderly	25,826 people (51.7%)	267 people (50.65)	470 people (51.7%)
Permanently incapacitated	24,142 people (48.3%)	261 people (49.4%)	439 people (48.3%)

Sources: Rhineland-Palatinate State Statistical Office, May 2023, Municipal Data Profile: Landau in the Palatinate, and Südliche Weinstraße retrieved from: https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KRS337_SuedlicheWeinstrasse.pdf https://www.statistik.rlp.de/fileadmin/dokumente/kreisdatenprofil/ergebnisse/20230522_KS313_Landau.pdfand accessed in October 2023.

Moreover, though emergency shelters tend to be mostly located in larger cities, Project developers should also consider that there may be an increased number of refugees or asylum seekers in the area due to the large migration influx over the past year. The SEP mentions provisions to properly include vulnerable people in engagement efforts.

6.20 HUMAN RIGHTS

Germany is on the Designated Countries' List of the Equator Principles IV; and based on their extensive human rights legislation (Table 6-30) and the Human Rights Risk screening (Table 6-31), Germany has a relatively low human rights risk profile. Similarly, Germany´s Rule of Law Index (RLI)[207] in 2022 was measured at 0.83 (a 0.1 decrease since 2021); the nation is ranked sixth globally (dropped from 5th since 2021), and sixth regionally. Overall, Germany surpasses both regional and global averages at 0.74, and 0.55, respectively, and demonstrates a strong adherence to the rule of law.143 Germany has one of the lowest levels of modern slavery, ranked at 158/160 countries with a prevalence rate of 0.6 (approximately 47,000 people), and is also ranked among one of the countries with the most government response actions to modern slavery, with a response score of 61.5%.147

Furthermore, the nation has firm country-level commitments or embedded mitigation measures to uphold human rights and significant national legislation to mitigate and prevent human rights infringements.

Table 6-30 provides an overview of Germany's key Human Rights legislation.

[207] The World Justice Project´s Rule of Law index (RLI) provides data that used to evaluate the jurisdictions and rule of law for 140 countries worldwide. Constraints on government powers, open government, absence of corruption, fundamental rights are the key indicators used to calculate national indices. Data is gathered from national surveys and expert input to adequately measure the perceptions of and de facto experiences of rule of law within a country.

TABLE 6-30 GERMAN HUMAN RIGHTS LEGISLATION

Human Right	National Legislation	Observation
Anti-discrimination & equal treatment	German Basic Law (GG) General Equal Treatment Act (AGG)	The law prohibits discrimination in all areas of occupation and employment, from recruitment, self-employment, and promotions[208]. Although origin and citizenship are not explicitly listed as grounds of discrimination in the law, victims of such discrimination have other means to assert legal claims. The law obliges employers to protect employees from discrimination at work. The law provides for equal pay for equal work.
Environmental protection, right to clean environment & access to resources	Climate Change Action Program 2030 Climate Change Act (KSG) German Renewable Energy Act (EEG 2023)	In 2021, Germany's top court found lawmakers have a human rights obligation to protect people from the effects of climate change. The court ruled that the German 2019 climate change law does not adequately regulate greenhouse gas emission reduction goals from 2030 onwards, and so violates the Government's obligation to protect human rights.[209] Similarly, the implementation of the EEG 2023 in January 2023 (see section 4.4) adds on to human rights objectives linked to climate risk/change.
Child labour	German Child Labour Protection Law (JArbSchGS) German Youth Protection Act (JSchG) German Supply Chain Due Diligence Law (LkSG)	The country has also implemented specific measures on the prohibition of child and forced labour. The minimum age for employment is 15 and as such in line with the ILO Minimum Age Convention (No.139). On June 11, 2021, the Parliament adopted a new law on supply chains requiring large companies to identify and address human rights and environmental risks in their direct supply chains, including forced labour and child labour. The law only applies to companies with more than 3,000 employees beginning in 2023, and to companies with more than 1,000 employees from 2024.[210]
Corruption & Bribery	German Anti-Corruption Act (KorrBekG) German Works Constitution Act (BetrVG) German Criminal Code (StGB)	German anti-corruption and bribery laws provide for criminal liability of both the giving and the receiving party. The law covers various areas of corruption such as the acceptance of benefits, passive corruption, granting of benefits and bribery. Under circumstances it can apply to offenses committed abroad. There are few preventive, corruption-specific provisions that apply to the public sector only.
Forced labour & human trafficking	German Criminal Code (StGB)	The Constitution and federal law prohibit all forms of forced or compulsory labour. Violations are punished by imprisonment. There are cases

[208] Source: Federal Ministry of Justice, retrieved from: AGG - nichtamtliches Inhaltsverzeichnis (gesetze-im-internet.de), accessed in August 2023.
[209]Source: Rall, K. (2021), "Germany's Top Courts Finds Country's Climate Law Violates Rights," published 29 April 2021 via Human Rights Watch, retrieved from: https://www.hrw.org/news/2021/04/29/germanys-top-court-finds-countrys-climate-law-violates-rights#:~:text=In%20a%20landmark%20decision%20issued,the%20effects%20of%20climate%20change, accessed in August 2023.
[210] Source: Federal Ministry of Labour and Social Affairs, „Draft law on corporate due diligence in supply chains" retrieved from: Entwurf eines Gesetzes über die unternehmerischen Sorgfaltspflichten in Lieferketten (bmas.de), accessed in August 2023.

Human Right	National Legislation	Observation
	German Supply Chain Due Diligence Law (LkSG)	of forced labour mostly among migrants who are employed in unregulated and unskilled sectors. Forced labour exploitation takes place in domestic work due to the hidden nature of this sector, as well as in more closely regulated industries such as construction, agriculture, meat processing, hospitality, retail, transport, and logistics, as well as industrial plants.
Freedom of Association/Collective Bargaining	German Basic Law (GG)	The Constitution, federal legislation, and government regulations provide for the right of employees to form and join independent unions, bargain collectively, and conduct legal strikes.
Migrant workers	German Basic Law (GG) Act on the Residence, Economic Activity, and Integration of Foreigners in the Federal Territory (AufenthG)	Despite the high standards regarding labour rights as stipulated by German laws, migrants have considerable problems when they attempt to enforce these rights[211]. Illegal migrants living in Germany frequently face exploitative working conditions with virtually no way of accessing state help. This is seen most strikingly in the employment conditions of construction workers, in the sex trade, and in private households, which predominantly employ women as domestic help and carers of children or elderly persons. In jobs like these, illegal migrants are sometimes cheated of their wages or paid only a fraction of what they are due. They may also be forced to work under unacceptable conditions. The German government rejects ratification of the United Nations Convention on the Protection of the Rights of all Migrant Workers and their Family Members, because of fears that the convention would place excessive restrictions on the Government's migration and employment policies[212]. Also, the European Convention on the Legal Status of Migrant Workers has been signed in 1977 with reservations but has not yet been ratified.
Working hours & overtime	Working Time Act (ArbZG) Federal Vacation Act (BUrlG)	The law covers all employees except for managerial staff. Federal regulations set the standard workday at 8 hours, with a maximum of 10 hours, and limit the average workweek to 48 hours. For the 54% of employees who are directly covered by collective bargaining agreements, the average agreed working week under existing agreements is 37.7 hours. The law requires a break after no more than 6 hours of work, stipulates regular breaks totalling at least 30 minutes, and sets a minimum of 24 days of paid annual leave in addition to official holidays.

[211] Source: International Labor Organisation, "Germany: Migrant workers fight for rights," retrieved from: https://www.ilo.org/global/about-the-ilo/multimedia/video/video-news-releases/WCMS_067845/lang--en/index.htm, accessed in August 2023.
[212]Source: Spieß, K. (2007), "The UN Migrant Workers Convention," published March 2007 via German Institute for Human Rights, retrieved from: https://www.institut-fuer-menschenrechte.de/fileadmin/_migrated/tx_commerce/summary_the_un_migrant_workers_convention.pdf, accessed in August 2023.

Human Right	National Legislation	Observation
Wages	Minimum Wage Act (MiLoG) General Equal Treatment Act (AGG)	Since 1 January 2015, Germany has a general statutory minimum wage established by law that is adjusted annually. The minimum wage rose to 12.00 EUR per hour on October 1, 2022.[213] In addition to the statutory minimum wage, which applies in principle to all sectors and regions, there are also higher sector-specific minimum wages. The law provides also for equal pay at work.
Women	General Equal Treatment Act (AGG) Maternity Protection Act (MuSchG) Law for the Equal Participation of Women and Men in Executive Positions (FüPoG)	Women's rights are enshrined in the basic law and federal law. Nevertheless, inequality of opportunities is evident in the field of business and politics. The leadership positions law introduces a women's quota by requiring larger private and public companies to increase the proportion of women in their supervisory committees, boards of directors and senior management positions[214]. Sexual and domestic violence, and international trafficking of women are among other critical issues[215]. Expecting mothers are legally protected from being discriminated against when applying for jobs and protection from being dismissed from work because of their pregnancy[216].
Supply Chain	German Supply Chain Act (LkSG)	The law requires large companies to identify and address human rights and environmental risks in their direct supply chains regularly and systematically. Companies will have to publish a report annually outlining the steps they have taken to identify and avert human rights risks, and national authorities will be empowered to initiate administrative action or impose fines on companies that fail to carry out their obligations. The law only applies to companies with more than 3,000 employees beginning in 2023, and to companies with more than 1,000 employees from 2024.217 The law does not incorporate the highest international standards. Companies only must take measures in specific incidents if they have "substantiated knowledge" of potential abuses, and the measures can be of a general preventive nature. The law does not require companies to undertake thorough and systematic due diligence on indirect suppliers further down the supply chain, which is often where the most serious abuses occur. Under international norms, companies have a responsibility to conduct

[213] Source: federal Statistical Office (2023): "Minimum Wage" retrieved from: Minimum wages - German Federal Statistical Office (destatis.de), last accessed in August 2023.
[214] Source: Federal Ministry for Family Affairs, Seniors, Women and Youth, "Second leadership Positions Act," retrieved from: BMFSFJ - Zweites Führungspositionen-Gesetz - FüPoG II, accessed in August 2023.
[215] Source: UN Women, "Global Database on violence against women" – Germany, retrieved from: Germany (unwomen.org), accessed in August 2023.
[216] Source: International Labour Organisation, " Germany – Consolidation of the Federal Act on Maternity Protection, 1997," retrieved from: Germany. CONSOLIDATION OF THE FEDERAL ACT ON MATERNITY PROTECTION, 1997 (ilo.org), accessed in August 2023.
[217] Source: Federal Ministry of Labour and Social Affairs, „Draft law on corporate due diligence in supply chains" retrieved from: Entwurf eines Gesetzes über die unternehmerischen Sorgfaltspflichten in Lieferketten (bmas.de), accessed in August 2023.

Human Right	National Legislation	Observation
		human rights due diligence throughout their whole supply chain – that is, to identify, address, prevent, and remedy abuses – regardless of whether they have foreknowledge of problems. The law also does not create liability for companies that have been implicated in serious human rights abuses and does not require companies to assess the compliance of their supply chain with important international standards in certain treaties, such as the UN Convention on the Rights of the Child, or in the Paris Agreement on Climate Change.218

6.20.1 HUMAN RIGHTS RISK SCREENING

The EP4 provide a list of common human rights risks in projects[219]. The final risk screening for the Project is based on the list provided by the EP4 and is assessed considering the collected data on human rights in the country and project context that is elaborated on in the above sections.

Table 6-31 below presents an overview of human rights risks screening for the Project and indicated that most human rights risks can be considered low for the Project. Human rights issues that show a medium risk level are non-discrimination and migrant workers (based on the contextual country risk).There are no severe or high human rights risks for the Project.

[218] Source: Human Rights Watch (HRW), "World Report 2022: Germany," retrieved from: World Report 2022: Germany | Human Rights Watch (hrw.org) , accessed in August 2023.
[219] See Guidance Note on Implementation of human rights assessments under the Equator Principles, Annex A

TABLE 6-31 HUMAN RIGHTS RISK SCREENING

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
Labor	Child Labour	ILO standards prohibit hazardous work for all persons under 18 years. They also prohibit labour for those under 15, with limited exceptions for developing countries	Yes	No	The country has implemented specific measures on the prohibition of child and forced labour. The minimum age for employment is 15 and as such in line with the ILO Minimum Age Convention (No.139). On June 11, 2021, the Parliament adopted a new law on supply chains requiring large companies to identify and address human rights and environmental risks in their direct supply chains, including forced labour and child labour. The law only applies to companies with more than 3,000 employees beginning in 2023, and to companies with more than 1,000 employees from 2024.	Low
	Collective Bargaining/ Right to Freedom of Association	Collective bargaining: Individuals have the right to form or join trade unions of their choice. Trade unions must be permitted to function freely, subject only to limitations that are in line with international Human Rights standards. Workers have the right to strike, in conformity with	Yes	No	The Constitution, federal legislation, and government regulations provide for the right of employees to form and join independent unions, bargain collectively, and conduct legal strikes.	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
		reasonable legal requirements. These exist in order to promote negotiation between organised workers and their employer or employers to determine wages, hours, rules, and working conditions. Freedom of Association: Protects the right to form or join all types of associations, including political, religious, sporting/recreational, non-governmental, and trade union associations. This freedom of individuals to associate can be an end in and of itself, or as a means of pursuing common objectives.				
	Modern Slavery	Slavery exists when one human effectively owns another. Freedom from servitude covers other forms of severe economic exploitation or degradation, such as in the trafficking of workers or debt bondage. The right to freedom from slavery and servitude are absolute rights. Forced or compulsory labour is defined by the ILO as all work or service that is extracted under menace of any penalty and for which the person has not voluntarily offered themselves. Providing payment does not mean that work is not forced labour if the other aspects of the definition are met.	Yes	No	The Constitution and federal law prohibit all forms of forced or compulsory labour. Violations are punished by imprisonment. There are cases of forced labour mostly among migrants who are employed in unregulated and unskilled sectors. Forced labour exploitation takes place in domestic work due to the hidden nature of this sector, as well as in more closely regulated industries such as construction, agriculture, meat processing, hospitality, retail, transport,	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
					and logistics, as well as industrial plants. Germany has one of the lowest levels of modern slavery, ranked at 158/160 countries with a prevalence rate of 0.6 (approximately 47,000 people). Germany is also ranked among one of the countries with the most government response actions to modern slavery, with a response score of 61.5%.[220]	
	Grievance Mechanism and Remedy	All people have the right to remedy when their rights have been violated. Where business enterprises identify that they have caused or contributed to adverse Human Rights impacts, they should provide for or cooperate in their remediation through legitimate processes, whether through the company's own operational-level grievance mechanism or through cooperation with independent (non)judicial mechanisms	Yes	Yes	The Project provides several avenues to receive grievances. A comprehensive grievance mechanism aligned with the applicable national and international standards has specifically been developed as part of the SEP, that will be a supplementary document to the Project ESIA.	Low
	Job Security/Right to Work	The termination of an employment relationship is likely to be a traumatic experience for a worker, and the loss of income has	Yes	No	There generally isn't a significant human rights risk associated with job security and the right to work for	Low

[220] Source: Walk Free, "Global Slavery Index", retrieved from https://www.walkfree.org/global-slavery-index/, accessed in August 2023.

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
		a direct impact on her or his family's well-being. As more countries seek employment flexibility and globalisation destabilises traditional employment patterns, more workers are likely to face involuntary termination of employment at some point in their professional lifetime. The employment of a worker should not be terminated unless there is a valid reason for such termination connected with the worker's capacity or conduct or based on the operational requirements of the undertaking, establishment, or service. Even where such practice may be legally permissible under local law, many stakeholders now expect companies to exhibit a higher standard of behaviour in line with international standards and good practice.			German citizens and legally residing residents. Germany has strong labour laws and a robust social safety net that protect workers' rights, including the right to fair employment, equal pay for equal work, and protection against discrimination and unfair dismissal. The country also has a well-established system of social welfare, unemployment benefits, and vocational training programs to support individuals during periods of unemployment or job transitions. However, challenges related to job security and the right to work can still exist for certain vulnerable groups, such as refugees and migrants, who may face obstacles in accessing the labour market and job security due to legal restrictions and discrimination.	
	Non-discrimination	The practice of ensuring equal treatment and respect for all individuals regardless of class, race, colour, sex, religion, gender, age, political or other opinion, national or social origin, property,	No	No	The law prohibits discrimination in all areas of occupation and employment, from recruitment, self-employment, and	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
		sexual orientation, disability, employee status, marital status, familial connection, etc. Includes ensuring employees are free from harassment.			promotions. Although origin and citizenship are not explicitly listed as grounds of discrimination in the law, victims of such discrimination have other means to assert legal claims. The law obliges employers to protect employees from discrimination at work. The law provides for equal pay for equal work. However, despite these legal and institutional frameworks, challenges related to discrimination persist in practice. Discrimination, particularly against certain minority groups, can still occur in various aspects of life, including employment, housing, and access to public services.	
	Occupational Health and Safety	A company should provide safe and healthy working conditions for workers. ILO standards require governments to adopt, in consultation with appropriate employer and employee organisations, a national occupational health and safety ("OHS") policy aimed at reducing accidents and injuries to health	Yes	No	Occupational health and safety provisions, including those in the drilling sector, are stringent and well-implemented. Companies engaged in drilling operations are subject to comprehensive regulations and guidelines designed to protect the safety and	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
		arising in the course of employment, and to minimise the causes of inherent workplace hazards. That policy should address, for example, the provision of adequate OHS training regarding the use and maintenance of the 'material elements of work', including workplace environment, tools, machinery and equipment. Workers must be able to remove themselves from work situations where imminent and serious health dangers are reasonably perceived, without undue consequences (intersects with the right to enjoy just and favourable conditions of work).			health of workers. These provisions encompass rigorous risk assessments, mandatory safety training, and the provision of appropriate personal protective equipment. Regular inspections by authorities ensure compliance, and companies are held accountable for safety violations. Additionally, Germany's social accident insurance system provides crucial support in case of work-related accidents or illnesses.	
	Wages	A company must protect the right to remuneration that provides workers with fair wages and equal remuneration for work of equal value. Remuneration must also be enough to provide workers with a decent living for themselves and their families. A minimum wage should be 'fair' and enable families to enjoy the right to a standard of living that includes adequate food, clothing and housing (connects with the right to adequate standard of living for health and well-being).	Yes	No	Since 1 January 2015, Germany has a general statutory minimum wage established by law that is adjusted annually. The minimum wage rose to 12.00 EUR per hour on October 1, 2022. In addition to the statutory minimum wage, which applies in principle to all sectors and regions, there are also higher sector-specific minimum wages. The law provides also for equal pay at work.	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
	Working Hours	The degree of flexibility for employees to start and end the workday to manage familial and personal obligations, while adequately fulfilling their employment duties.	No	No	The law covers all employees except for managerial staff. Federal regulations set the standard workday at 8 hours, with a maximum of 10 hours, and limit the average workweek to 48 hours. For the 54% of employees who are directly covered by collective bargaining agreements, the average agreed working week under existing agreements is 37.7 hours. The law requires a break after no more than 6 hours of work, stipulates regular breaks totalling at least 30 minutes, and sets a minimum of 24 days of paid annual leave in addition to official holidays. Vulcan has also recently implemented a requirement for staff/employees to complete timesheets in order to ensure compliance with local working hour regulations. At the Project level, staff working in the drilling operations, however, face longer working hours of 12-hour-shifts, to reduce handovers and increase safety provisions.	Low
Civil and Political	Freedom of expression	The right to hold opinions free from outside interference is an	Yes	Yes	Germany places a strong emphasis on protecting the	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
		absolute right, with narrow restrictions by States only permissible when in line with international Human Rights standards. Individuals have a right to seek, receive and impart ideas in whatever media or form they choose.			civil and political right to freedom of expression, both in law and practice. Legally, this right is enshrined in the German Basic Law, specifically in Article 5, which guarantees freedom of speech, the press, and artistic expression. While this freedom is not absolute and can be subject to limitations, such as in cases involving hate speech or incitement to violence, any restrictions must be proportionate and justified. In practice, Germany upholds these principles through a robust legal framework, a diverse media landscape, and an independent judiciary. There is a vibrant culture of public debate, investigative journalism, and artistic expression. However, like any country, challenges exist, including concerns about online hate speech and disinformation. Nevertheless, Germany's commitment to protecting freedom of expression remains a cornerstone of its democratic values.	

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
	Right to life and security of person	Individuals have the right not to be deprived of life arbitrarily or unlawfully. This includes the right to have one's life protected, for example, from physical attacks or health and safety risks.	Yes	Yes	The right to life and security of a person is well-protected both in law and practice. Legally, this right is upheld through various provisions in the German Basic Law, ensuring that every individual's life and personal security are inviolable. Law enforcement agencies are subject to strict legal oversight, and the use of force is tightly regulated. The judiciary plays a crucial role in upholding this right by ensuring accountability in cases of violations. In practice, Germany maintains a low crime rate and a strong law enforcement system, contributing to a generally safe and secure environment.	Low
	Privacy	Individuals have a right to be protected from arbitrary, unreasonable, or unlawful interference with their privacy, family, home or correspondence and from attacks on their reputation. The State is allowed to authorise restrictions on privacy in line with international Human Rights standards, but 'arbitrary' restrictions are always prohibited.	No	No	Article 2 of the German Basic Law guarantees the right to personal freedom and privacy. The country has stringent data protection laws, including the General Data Protection Regulation which governs the collection and use of personal data. The Federal Constitutional Court has	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
					consistently upheld the right to privacy as fundamental, with strict criteria for any infringements. In practice, Germany has a robust culture of data protection and privacy awareness, and citizens are generally vigilant about their rights. Data breaches are taken seriously, and individuals have the right to access and control their personal information.	
Economic, Social and Cultural	Right to education	All children have the right to free and compulsory primary education. The right also includes equal access to education and equal enjoyment of educational facilities, among other aspects.	Yes	Yes	The right to education is enshrined in the German Basic Law, emphasising that every individual has the right to education, with primary and secondary education being compulsory and provided free of charge. Germany's federal system ensures that education is primarily a responsibility of its 16 states resulting in a high degree of regional autonomy. This allows for tailored education programs and resources while still adhering to fundamental standards set by federal law. In practice, Germany maintains a high-quality	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
					education system with a strong emphasis on equal access and opportunities. There are comprehensive support structures in place to ensure that all students, including those with disabilities or from disadvantaged backgrounds, have access to quality education.	
	Right to health	Individuals have a right to the highest attainable standard of physical and mental health. This includes the right to have control over one's health and body, and freedom from interference.	Yes	Yes	The country's legal framework ensures access to healthcare as a fundamental right, with the German Basic Law recognising the inviolable right to human dignity, which includes access to healthcare services. Germany operates a universal healthcare system, which provides comprehensive medical care to all residents, financed through a combination of employer and employee contributions. This system guarantees equal access to healthcare services, including preventive care, treatment, and medications. There is an extensive network of hospitals, clinics, and	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
					medical professionals in the country.	
	Right to participate in the cultural life of the community	Individuals have a right to take part in the cultural life of society and enjoy the benefits of scientific progress, especially disadvantaged groups.	No	Yes	Schools and other social and cultural facilities are accessible to the community in Germany. Every individual has the right to education, with primary and secondary education being compulsory and provided free of charge.	Low
	Right to Water	Individuals have the right to water and sanitation	Yes	Yes	Access to safe water and adequate sanitation in Germany is universal. More than 99 percent of users are connected to a public water supply system. The quality of drinking water in Germany is good or very good. It is regularly monitored at short intervals and complies with the stringent quality requirements of the Drinking Water Ordinance.[221]	Low
	Social insurance	This right obliges the State to create and maintain a system of social security that provides adequate benefits for a range of	Yes	No	German citizens are covered by the so-called social insurance system that assists them in emergency	Low

[221] Source: Federal ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, "Drinking Water", retrieved from: BMUV: Drinking water, last accessed August 2023.

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
		issues (such as injury or unemployment).			situations which include illness, unemployment, old age and need for nursing care. The contributions to the system are dependent upon one's income.	
Group Rights/ 'Heightened Risk of Vulnerability'	Children's Rights	The Convention on the Rights of the Child establishes global standards to ensure the protection, survival, and development of all children, without discrimination.	Yes	Yes	In Germany children have all the same basic rights as adults but are also considered to be in need of special protection. Germany is a signatory state to the United Nations Declaration on the Rights of the Child and submits regular reports on trends in children's rights in the Federal Republic of Germany to the United Nations Committee on the Rights of the Child. Article 6 (2) of the Basic Law is to be extended to include the following: "The constitutional rights of children, including their right to develop as responsible individuals must be respected and protected. Children's best interests must be taken into account in an appropriate manner. The constitutional entitlement of children to a fair hearing in front of the law must be ensured. The	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
					primary responsibility of parents shall remain unaffected."	
	Disability Rights	The Convention on the Rights of Persons with Disabilities promotes global standards intended to protect the rights and dignity of people with disabilities in and outside of the workplace.	Yes	No	The Disability Equality Act safeguards those with disabilities from further discrimination and public authorities are expected to protect this right. The Act does not distinguish discrepancies or protections for those with sensory or intellectual disabilities as it is more of a general umbrella of protection for all disabled persons. [222] In practice persons with disabilities faced additional hurdles in finding employment and housing; unemployment amongst disabled persons of working age is notably higher than the average individual. Often there are not enough suitable positions for those with disabilities, despite formal requirements for private sector companies to employ at least 20 people with a disability; many will accept monetary fines	Low

[222] Source: Disability Equality Act, retrieved from: BGG - Gesetz zur Gleichstellung von Menschen mit Behinderungen (gesetze-im-internet.de), accessed in August 2023.

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
					rather than employing disabled persons.	
	Indigenous Peoples	Indigenous Peoples are afforded unique group rights under international law that permits them to give or withhold their consent to projects that may impact them under certain scenarios.	No	Yes	There are no indigenous people affected within the Project AoI.	Low
	Migrant Workers	The International Convention on the Protection of the Rights of All Migrant Workers and Members of their Families establishes how migrant workers, and their families should be protected.	No	No	Despite the high standards regarding labour rights as stipulated by German laws, migrants have considerable problems when they attempt to enforce these rights. Illegal migrants living in Germany frequently face exploitative working conditions with virtually no way of accessing state help. This is seen most strikingly in the employment conditions of construction workers, in the sex trade, and in private households, which predominantly employ women as domestic help and carers of children or elderly persons. In jobs like these, illegal migrants are sometimes cheated of their wages or paid only a fraction of what they are due. They may also be	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
					forced to work under unacceptable conditions. The German government rejects ratification of the United Nations Convention on the Protection of the Rights of all Migrant Workers and their Family Members, because of fears that the convention would place excessive restrictions on the Government's migration and employment policies. Also, the European Convention on the Legal Status of Migrant Workers has been signed in 1977 with reservations but has not yet been ratified.	
	Women's Rights	The Convention on the Elimination of all Forms of Discrimination Against Women exists to promote women's rights and their protection.	Yes	Yes	Women's rights are enshrined in the basic law and federal law. Nevertheless, inequality of opportunities is evident in the field of business and politics. The leadership positions law introduces a women's quota by requiring larger private and public companies to increase the proportion of women in their supervisory committees, boards of directors and senior management positions. Sexual and	Low

Rights Category	Human Rights Issue	International Standard	Risk to workers	Risk to community	Comment/ Potential Negative Impact	Potential Project/Context Risk Level (High/Medium/Low)
					domestic violence, and international trafficking of women are among other critical issues. Expecting mothers are legally protected from being discriminated against when applying for jobs and protection from being dismissed from work as a result of their pregnancy.	

7. IMPACT ASSESSMENT

7.1 PHYSICAL IMPACT ASSESSMENT

7.1.1 IMPACTS RELATED TO CLIMATE CHANGE

Relevance to the Project

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☐	☒	☒
Access roads	☐	☒	☒
Worker camps	☐	☒	☒
Permanent Infrastructure: new			
Pipeline	☐	☒	☒
Well sites	☐	☒	☒
GLEP near Landau	☐	☒	☒
CLP at Höchst Industrial Park	☐	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

Description of impact

Overall, the Project intends to have a net positive impact on climate change. Unlike traditional lithium mining, Vulcan's geothermal process harnesses the Earth's natural heat to extract lithium, avoiding the destructive effects associated with traditional mining methods. By providing a cleaner and more sustainable source of lithium, the Project is actively reducing the carbon footprint of the electric vehicle industry, which plays a crucial role in transitioning away from fossil fuels. This approach aligns with the goals of mitigating climate change and fostering a more sustainable future.

This section discusses the impacts of climate change on the Project. The projections listed below are based on the historical and projected data from the World Bank Climate Change Knowledge Portal (WB-Climate Portal)[223]. This open-source portal provides combined data from the Coupled Model Inter-comparison Project (CMIP6). The objective of the CMIP is to better understand past, present, and future climate changes. This understanding includes assessments of model performance during the historical period and quantifications of the causes of the spread in future projections. The multi-model output includes information from 35 available global circulation models (GCMs) used by the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report[224] and provides projections using different Shared Socioeconomic Pathways (SSP). SSPs describe the different climate future scenarios depending on the GHG emissions emitted in the

[223] The World Bank, 2020. Climate Data Projections Germany, available at: Germany - Summary | Climate Change Knowledge Portal (worldbank.org)
[224] IPCC, 2022

years to come. Table 7-1 lists the SSP so far adopted by the Intergovernmental Panel on Climate Change (IPCC).

TABLE 7-1 REPRESENTATIVE CONCENTRATION PATHWAYS

SSPs	Scenario
SSP 1-1.9 (very low emission)	Very stringent pathway that limits global warming below 1.5°C.
SSP 2-2.6 (low emission)	Stringent pathway that limits global warming below 2°C, requiring CO2 emissions start declining by 2020 and go to zero by 2100.
SSP 2-4.5 (medium-low emission)	Intermediate pathway requiring that CO2 emissions start declining by approximately 2045 to reach roughly half of the levels of 2050 by 2100.[225]
SSP 3-7.0 (medium-high emission)	Intermediate pathway where emissions peak around 2080 and then decline.
SSP 5-8.5 (high emission)	Pathway where emissions continue to rise throughout the 21st century (business-as-usual scenario). Suggesting society does not make efforts to reduce GHG emissions and therefore reflect their worst-case scenario for the physical impacts of climate change.

The WB-Climate Portal gives historical and projected rainfall intensity and temperature conditions for different regions, countries, or watersheds until the end of 21st Century (i.e., 2099). The historical data was generated from thousands of weather stations worldwide which collect temperature and rainfall data and are being widely accepted as reference datasets in climate research. The future rainfall and climate conditions were projected by using about 15 different climate models developed by different climate research institutions. The WB-Climate Portal has regional data for Rhineland-Palatinate and Hesse which was used for this assessment.

Limitations

This Climate Change Risk Assessment (CCRA) provides a relatively high-level review of the possible risks posed to the Project. As a result, this CCRA has been generated with the aims of identifying hazards and areas of the Project design that ERM believes should be assessed further, as planning and design associated with the Project progresses. However, there are also a number of limitations that accompany this type of approach, which should be recognised when interpreting the results of this assessment. These include:

- This assessment uses future projected outputs from Global Climate Models (GCMs) and not from statistically downscaled data, meaning that modelled results are not regionally downscaled and validated for the specific Project location in Landau or Höchst.
- This CCRA is based on numerous assumptions, projections, and models; although the methodology is aligned with the current best-practice, the whole process is subject to a substantial range of uncertainty.
- This high-level, screening exercise should not be considered as a credit risk assessment associated with the proposed financing facility.

The impacts related to climate change are assessed for the year 2024 for construction, 2040 for operation and 2080 for decommissioning. The reference period of the climate model used for

[225] Many plant and animal species will be unable to adapt to the effects of SSP 2-4.5 and higher SSPs.

the assessment (CMIP6 from the World Bank Climate Change Knowledge Portal) is 1995 to 2014. Therefore, this assessment uses projections for the year 2024 (construction phase). Actual data records from 2024 are not used because the climate model was built using statistical and computational assumptions based on the time period from which they are derived (1995-2014). These assumptions include how data is processed, weighted, and analysed. Adding data from outside the original timeframe does not fit the statistical structure of the model, requiring additional adjustments or changes in the model's assumptions.

The baseline assessment has shown that at the Project components near Landau and the CLP in Höchst relevant climate hazards are water scarcity, extreme heat and to some extent also urban floods.

The impact assessment first describes the parameters, and the methodology used to determine the magnitude of the predicted impact and significance of effect during construction, operation and decommissioning from the identified climate hazards for Rhineland-Palatinate and Hesse. As a next step the assessment undertakes a review of how the assessed physical climate risks and their future changes might impact the Project in its construction, operation and decommissioning phases. The risk review specifically assesses how the different physical climate risks will affect key components, or risk areas, of the Project (including broad value chain elements critical to the Project). The risk review is evaluated based upon the risk materiality categories described in Table 7-2 below.

TABLE 7-2 RISK MATERIALITY CATEGORIES AND ASSOCIATED DEFINITIONS

Risk Materiality Category		Definition
Unlikely material		A risk item is considered as being unlikely to cause material impacts to the Project, under baseline or future projected climate conditions. Impacts with this category (such as those related to operational, financial, or other types of impacts) are unlikely to be material. This means that, for example, (a) operational impacts could be expected to be short term, impacting a limited proportion of the overall asset and its operations, or (b) financial impacts would be expected to be minimal relative to the Project's overall revenue and/or costs.
Likely material	**Low to moderate**	This risk item is considered as being likely to have the potential to cause low-moderately material impacts to the Project, under baseline or future projected climate conditions. Impacts with this category (such as those related to operational, financial, or other types of impacts) are likely to be of low-moderate materiality. This means that, for example, (a) operational impacts could be expected to be short to medium term, impacting a low to moderate proportion of the overall asset and its operations, or (b) financial impacts would be expected to be small to moderate relative to the Project's overall revenue and/or costs.
	High	This risk item is considered as being likely to have the potential to cause highly material impacts to the Project, under baseline or future projected climate conditions. Impacts associated with this category (such as those related to operational, financial, or other types of impacts) are likely to be of high materiality. This means that, for example, (a) operational impacts could be expected to be medium to long term, impacting a low to moderate proportion of the overall asset and its operations, or (b) financial impacts would be expected to be moderate to high relative to the Project's overall revenue and/or costs.

7.1.1.1 WATER SCARCITY

The assessment of water scarcity is based on the parameters of "projected precipitation percent change" in annual precipitation as well as the "projected maximum number of consecutive dry days" from the WB-Climate Portal[226]. The "projected precipitation percent change" parameter is used as an indicator to assess future drought risks since it links directly to water availability, is an indicator for climate variability, has an influence on soil moisture and has impacts on agriculture and other ecosystems. The "projected maximum number of consecutive dry days" parameter is used because it is a direct indicator for prolonged water deficits, it predicts drought intensity, can be an indicator for potential agricultural impacts and soil moisture depletion.

The baseline conditions reflect the reference period from 1995 to 2014. For the assessment the medium-low emission scenario (SSP 2-4.5) and the high emission scenario (SSP 5-8.5) are compared. For the conditions during construction the year 2024 is used for analysis. For the operation the year 2040 is used to assess the impacts and for decommissioning the year 2080. The median (50th Percentile) is used for the assessment.

The following assessment methodology is used to assess water scarcity impacts. Table 7-3 and Table 7-4 show the methodology used to assess the magnitude and significance of the water scarcity parameters (projected precipitation percent change and projected maximum number of consecutive dry days) on the two regions (Rhineland-Palatinate and Hesse).

TABLE 7-3 MAGNITUDE AND SIGNIFICANCE OF PROJECTED PRECIPITATION PERCENTAGE CHANGE IMPACT ASSESSMENT

Percentage of change compared to baseline conditions	Magnitude of predicted impact	Resulting Significance of effect
Same or positive change compared to baseline conditions	Negligible	Insignificant
0 up to 5 % reduction	Small	Minor
5 to 10 % reduction	Medium	Moderate
Over 10 % reduction	Large	Major

TABLE 7-4 MAGNITUDE AND SIGNIFICANCE OF CONSECUTIVE DRY DAYS IMPACT ASSESSMENT

Change in number of consecutive dry days	Magnitude of predicted impact	Resulting Significance of effect
Same or less days	Negligible	Insignificant
0 up to 2 days more	Small	Minor
2 up to 4 days more	Medium	Moderate
Over 4 days more	Large	Major

[226] The World Bank, 2020. Climate Data Projections Germany, available at: Germany - Summary | Climate Change Knowledge Portal (worldbank.org)

Description of impact:

Construction phase:

Table 7-5 shows the projected precipitation change in % and the change in number of consecutive dry days during construction for the SSP 2-4.5 and SSP 5-8.5 scenarios in Rhineland-Palatinate and Hesse. The year 2024 was chosen for the construction data.

TABLE 7-5 SIGNIFICANCE OF EFFECT OF WATER SCARCITY PARAMETERS DURING CONSTRUCTION

	Rhineland-Palatinate		**Hesse**	
	SSP 2-4.5 (Construction 2024)	SSP 5-8.5 (Construction 2024)	SSP 2-4.5 (Construction 2024)	SSP 5-8.5 (Construction 2024)
Projected Precipitation Percent Change	+2.47 %	**-2.07 %**	+3.84 %	-0.39 %
Resulting significance of effect	**Insignificant**	**Minor**	**Insignificant**	**Minor**
Change in number of consecutive dry days	+0.9 days	**+2.57 days**	+0.86 days	**+2.12 days**
Resulting significance of effect	**Minor**	**Moderate**	**Minor**	**Moderate**

As shown in the table above the projected precipitation change in % during construction is insignificant (SSP 2-4.5) to minor (SSP 5-8.5) for Rhineland Palatinate and Hesse. The change in number of consecutive dry days is minor for SSP 2-4.5 and moderate for SSP 5-8.5 for Rhineland Palatinate and Hesse.

Operational phase:

Table 7-6 shows the projected precipitation change in % and the change in number of consecutive dry days during operation for the SSP 2-4.5 and SSP 5-8.5 scenarios in Rhineland-Palatinate and Hesse.

TABLE 7-6 SIGNIFICANCE OF EFFECT OF WATER SCARCITY PARAMETERS DURING OPERATION

	Rhineland-Palatinate		Hesse	
	SSP 2-4.5 (Operation 2040)	SSP 5-8.5 (Operation 2040)	SSP 2-4.5 (Operation 2040)	SSP 5-8.5 (Operation 2040)
Projected Precipitation Percent Change	+2.03 %	**-1.66 %**	+2.54 %	+0.03 %
Resulting significance of effect	**Insignificant**	**Minor**	**Insignificant**	**Insignificant**
Change in number of consecutive dry days	-1.03 days	**+1.26 days**	-0.89 days	+0.96 days
Resulting significance of effect	**Insignificant**	**Minor**	**Insignificant**	**Minor**

Source: World Bank, 2020. Climate Knowledge Portal[227].

As presented in the table above the water scarcity risks in terms of projected precipitation change in % and change in number of consecutive dry days are insignificant (SSP 2-4.5) to minor (SSP 5-8.5) for Rhineland-Palatinate. For Hesse the projected precipitation changes in % for both SSP 2-4.5 and SSP 5-8.5 are insignificant while the change in the number of consecutive dry days is insignificant for SSP 2-4.5 but minor for SSP 5-8.5.

Decommissioning phase:

Table 7-7 shows the projected precipitation change in % and the change in number of consecutive dry days during decommissioning for the SSP 2-4.5 and SSP 5-8.5 scenarios in Rhineland-Palatinate and Hesse.

[227] Germany - Mean Projections Expert | Climate Change Knowledge Portal (worldbank.org)

TABLE 7-7 SIGNIFICANCE OF EFFECT OF WATER SCARCITY PARAMETERS DURING DECOMMISSIONING

	Rhineland-Palatinate		Hesse	
	SSP 2-4.5 (Decommis-sioning 2080)	SSP 5-8.5 (Decommis-sioning 2080)	SSP 2-4.5 (Decommis-sioning 2080)	SSP 5-8.5 (Decommis-sioning 2080)
Projected Precipitation Percent Change	**-0.35**	**-7.89**	**-0.57**	**-6.81**
Resulting significance of effect	**Minor**	**Moderate**	**Minor**	**Moderate**
Change in number of consecutive dry days	**+0.29**	**+3.85**	**+0.20**	**+3.34**
Resulting significance of effect	**Minor**	**Moderate**	**Minor**	**Moderate**

Source: World Bank, 2020. Climate Knowledge Portal[228].

As presented in the table above the water scarcity risks in terms of projected precipitation change in % and change in number of consecutive dry days are minor (SSP 2-4.5) to moderate (SSP 5-8.5) during decommissioning. Therefore, water scarcity risks will be highest during decommissioning, especially under SSP 5-8.5.

Risk Review for Water Scarcity

The section above identifies that the significance of effect of water scarcity lies between insignificant to moderate depending on the Project phase, parameter or chosen scenario. This risk review examines how the assessed water scarcity results and their future changes might impact the Project in its operation and decommissioning phases.

A series of potential risks to the Project associated with water scarcity have been identified under future projected climatic conditions. These are described in the Table 7-8 below. The methodology used for the risk materiality category can be found in Table 7-1.

[228] Germany - Mean Projections Expert | Climate Change Knowledge Portal (worldbank.org)

TABLE 7-8 POTENTIAL RISK AREAS AND MATERIALITY – ASSOCIATED WITH WATER SCARCITY

Risk area	Description of potential risks and materiality to the Project	Project phase and risk materiality category	
		Operation (2040)	Decommissioning (2080)
Site personnel OPERATIONS DECOMMISSIONING	Even though the projections for water stress in the region show moderate increase compared to the baseline, materiality is unlikely due to very low baseline hazard level. More drinking water will be needed for workers in the hotter, drier periods of the year, all of which could suffer detrimental impacts during more pronounced spells of water scarcity.	Unlikely to Materialise	Unlikely to Materialise
Equipment and machinery, public utilities OPERATIONS DECOMMISSIONING	During operation and decommissioning, water scarcity could hamper the effectiveness of machinery and equipment requiring an important amount of cooling and cleaning water. A great deal of water might also be needed to limit the spread of dust in dry periods during construction. Increasing drought and severe water shortages can potentially render sanitation systems, such as sewerage systems with long pipelines, inoperable.	Unlikely to Materialise	Unlikely to Materialise
Sustainable brine production OPERATIONS DECOMMISSIONING	Since the groundwater systems are separated from the brine production well and groundwater quality is continuously monitored the brine extraction is not expected to have impacts on water scarcity during operation.	Unlikely to Materialise	Unlikely to Materialise

Given the unlikely material risks to the Project from water scarcity, no further recommendations are warranted for this topic.

7.1.1.2 EXTREME HEAT

The assessment of extreme heat will be based on the projected number of hot days (Tmax >30°C). The baseline conditions reflect the reference period from 1995 to 2014[229]. For the assessment the medium-low emission scenario (SSP 2-4.5) and the high emission scenario (SSP 5-8.5) will be compared. For construction, the year 2024 was chosen for the analysis. For the operation the year 2040 will be used to assess the impacts and for decommissioning the year 2080. The median (50th Percentile) was used for the assessment.

The following assessment methodology is used to assess extreme heat impacts.

[229] The World Bank, 2020. Climate Data Projections Germany, available at: Germany - Summary | Climate Change Knowledge Portal (worldbank.org)

TABLE 7-9 MAGNITUDE AND SIGNIFICANCE OF EXTREME HEAT IMPACT ASSESSMENT

Exceedance of baseline number of hot days	Magnitude of predicted impact	Resulting Significance of effect
Same or below baseline conditions	Negligible	Insignificant
0 up to 10 days above baseline conditions	Small	Minor
10 to 20 days above baseline conditions	Medium	Moderate
20 days above baseline conditions	Large	Major

Extreme heat events have the potential to pose risks to the H&S of the staff and personnel working on-site during the construction, operation and decommissioning. Personnel could experience dehydration, heat stress, heat exhaustion and in extreme cases, heat stroke. Extreme heat events could also mean that personnel require additional breaks, water, and access to shaded areas – potentially reducing their operational efficiency during the course of the Project.

Description of impact:

Construction phase:

Table 7-10 shows the current and projected number of hot days in Rhineland-Palatinate and Hesse for the construction phase (year 2024) under SSP 2-4.5 and SSP 5-8.5.

TABLE 7-10 PROJECTED NUMBER OF HOT DAYS (>30°C TMAX) DURING CONSTRUCTION

		Rhineland-Palatinate		**Hesse**	
	Baseline conditions (1995-2014)	SSP 2-4.5 (Construction 2024)	SSP 5-8.5 (Construction 2024)	SSP 2-4.5 (Construction 2024)	SSP 5-8.5 (Construction 2024)
Projected Number of Hot Days (>30°C)	4.28 (Rhineland-Palatinate) 4.10 (Hesse)	6.89	7.42	6.90	7.17
Difference from baseline conditions		**+2.61**	**+3.14**	**+2.80**	**+3.07**
Resulting significance of effect		**Minor**	**Minor**	**Minor**	**Minor**

Source: World Bank, 2020. Climate Knowledge Portal[230].

In Rhineland-Palatinate the projections for the number of days over 30°C show that during construction (2024) the number of days of 30°C are expected to increase by around 3 days (under SSP 2-4.5) or around 4 days (under SSP 5-8.5). Therefore, the impacts during construction are expected to be minor.

[230] Germany - Mean Projections Expert | Climate Change Knowledge Portal (worldbank.org)

The projections for the number of days over 30°C in Hesse show that the number of days of 30°C are expected to increase by around 3 days (under SSP 2-4.5 and SSP 5-8.5). Therefore, the impacts during construction at the CLP are expected to be minor.

Operational phase:

Table 7-11 shows the current and projected number of hot days in Rhineland-Palatinate and Hesse for the operational phase for SSP 2-4.5 and SSP 5-8.5 based on the model results for 2040 for the operation phase.

TABLE 7-11 PROJECTED NUMBER OF HOT DAYS (>30°C TMAX) DURING OPERATIONS

		Rhineland-Palatinate		Hesse	
	Baseline conditions (1995-2014)	SSP 2-4.5 (Operation 2040)	SSP 5-8.5 (Operation 2040)	SSP 2-4.5 (Operation 2040)	SSP 5-8.5 (Operation 2040)
Projected Number of Hot Days (>30°C)	4.28 (Rhineland-Palatinate) 4.10 (Hesse)	7.62	9.81	6.87	9.50
Difference from baseline conditions		**+3.34**	**+5.53**	**+2.77**	**+5.40**
Resulting significance of effect		**Minor**	**Minor**	**Minor**	**Minor**

Source: World Bank, 2020. Climate Knowledge Portal[231].

In Rhineland-Palatinate the projections for the number of days over 30°C show that during operation (2040) the number of days of 30°C are expected to increase by around 3 days (under SSP 2-4.5) or around 6 days (under SSP 5-8.5). Therefore, the impacts during operation are expected to be minor.

The projections for the number of days over 30°C in Hesse show that the number of days of 30°C are expected to increase by around 3 days (under SSP 2-4.5) or around 5 days (under SSP 5-8.5). Therefore, the impacts during operation at the CLP are expected to be minor.

Decommissioning phase:

Table 7-12 shows the current and projected number of hot days in Rhineland-Palatinate and Hesse for decommissioning (year 2080) for SSP 2-4.5 and SSP 5-8.5.

[231] Germany - Mean Projections Expert | Climate Change Knowledge Portal (worldbank.org)

TABLE 7-12 PROJECTED NUMBER OF HOT DAYS (>30°C TMAX) DURING DECOMMISSIONING

		Rhineland-Palatinate		Hesse	
	Baseline conditions (Construction)	SSP 2-4.5 (Decommis-sioning 2080)	SSP 5-8.5 (Decommis-sioning 2080)	SSP 2-4.5 (Decommis-sioning 2080)	SSP 5-8.5 (Decommis-sioning 2080)
Projected Number of Hot Days (>30°C)	4.28 (Rhineland-Palatinate) 4.10 (Hesse)	15.81	38.05	14.91	37.59
Difference from baseline conditions		**+11.53**	**+33.77**	**+10.81**	**+33.49**
Resulting significance of effect		**Moderate**	**Major**	**Moderate**	**Major**

Source: World Bank, 2020. Climate Knowledge Portal[231].

During decommissioning, the number of days of 30°C in Rhineland-Palatinate are expected to increase by approximately 12 days (under SSP 2-4.5) and 34 days (under SSP 5-8.5) respectively. The impacts during decommissioning are assessed as moderate (under SSP 2-4.5) to major (under SSP 5-8.5).

During decommissioning, the number of days of 30°C are expected to increase by approximately 11 days (under SSP 2-4.5) and 34 days (under SSP 5-8.5) in Hesse. The impacts during decommissioning at the CLP are assessed as moderate (under SSP 2-4.5) to major (under SSP 5-8.5).

Consequently, risks of extreme heat are highest during decommissioning both in Hesse and in Rhineland Palatinate.

Risk Review for Extreme Heat

The section above identifies that the significance of effect of extreme heat lies between minor during construction and operation and moderate to major during decommissioning. This risk review examines how the assessed extreme heat results and their future changes might impact the Project in its operation and decommissioning phases.

A series of potential risks associated with extreme heat to the Project have been identified under future projected climatic conditions. These are described in Table 7-13 below.

TABLE 7-13 POTENTIAL RISK AREAS AND MATERIALITY – ASSOCIATED WITH EXTREME HEAT

Risk area	Description of potential risks and materiality to the Project	Project phase and risk materiality category	
		Operation (2040)	Decommissioning (2080)
Site personnel	Extreme heat events have the potential to pose risks to the H&S of the staff and personnel working on-site during the operation and decommissioning. Personnel could experience dehydration, heat stress, heat exhaustion and in extreme cases, heat stroke. Extreme heat events could also mean that personnel require additional breaks, water, and access to shaded areas – potentially reducing their operational efficiency during the course of the Project. For the decommissioning phase of the Project, extreme heat has the potential to cause delays for decommissioning activities. As a result, the Vulcan management may want to account for impacts associated with adverse weather conditions associated with extreme heat through the development of an Emergency Preparedness and Response Plan (EPRP) for the Project. Provided that an EPRP is followed by site personnel, detrimental impacts associated with extreme heat events and site personnel are understood to be 'Unlikely Material' to the decommissioning phase of the Project. Although future climate projections indicate an increase in average air temperatures in the Project area, the noted projected increases in temperature are not expected to be large enough to increase the materiality of this climate hazard to the Project. Similarly, it is also understood that less site personnel are required on-site during the operational phase of the Project. Therefore, the risk materiality category assigned to the operational phase of the Project is also 'Unlikely Material'.	Unlikely Material	Unlikely Material
Access roads, Infrastructure	During extreme heat events, concrete surfaces absorb heat from sunlight. Depending on the material and colour that the facility is built from, as well as the surrounding air temperature, the surfaces can reach high enough temperatures where they begin to soften and, in some cases, begin to deform, melt, and become damaged. It is noted that, darker coloured surfaces (e.g., asphalt) experience higher surface temperatures in comparison to lighter-coloured counterparts. This therefore has the potential to increase a	Unlikely Material	Unlikely Material

Risk area	Description of potential risks and materiality to the Project	Project phase and risk materiality category	
		Operation (2040)	Decommissioning (2080)
	surfaces risk from melting and becoming damaged/deformed[232]. This poses risks to the construction and to a lesser extent, the operational phase of the Project. During operation, access to the sites by personnel might also be hampered due to the deterioration of access roads caused by extreme heat. During the operational phase of the Project periods of extreme heat might cause damage to infrastructure by overheating and potential thermal expanding of steel infrastructure. However, this is unlikely to materialise since the existing and planned infrastructure is expected to be designed to withstand temperatures over 30 °C.		
Equipment, machinery, Public Utilities	During extreme heat events, any equipment or supporting infrastructure that is sensitive to high temperatures could be impacted by extreme temperatures (this could be associated with high air or road-surface temperatures) – potentially causing disruptions to the completed construction and maintenance of the Project (e.g. if equipment malfunctions inhibiting the operational efficiency of personnel) and could require increased operational expenditure (e.g. to accommodate increased energy demand for cooling any heat-sensitive equipment). Impacts associated with this risk area are expected to be short-term in nature, and financial impacts are anticipated to be limited in comparison to the Projects overall revenue/costs. Also, the existing and planned infrastructure is expected to be designed to withstand temperatures over 30 °C. Therefore, this risk area categorised as 'Unlikely Material'.	Unlikely Material	Unlikely Material
Effect of heat on process efficiency (heat exchangers, cooling system demand etc.)	An increased number of days above 30°C can lead to reduced process efficiency and increased cooling demand, ultimately lowering the overall performance and output of geothermal power plants during operation. Geothermal power plants rely on transferring heat between geothermal fluids and working fluids in a cycle. Higher ambient temperatures reduce the temperature gradient between the working fluid and the environment, decreasing the efficiency of heat exchange. This results in lower power output for the same amount of geothermal heat. The increase in hotter	Low to moderate	Not relevant

[232] Kim et al (2019). A case study of environmental characteristics on urban road-surface and air temperatures during heat-wave days in Seoul. Available at: https://www.tandfonline.com/doi/full/10.1080/16742834.2019.1608791

Risk area	Description of potential risks and materiality to the Project	Project phase and risk materiality category	
		Operation (2040)	Decommissioning (2080)
	days would not drastically affect the annual performance of the geothermal plant, but there would be a noticeable, though not critical, decline in efficiency during those periods.		

The table above shows that the risks identified for site personnel, access road and infrastructure, as well as equipment, machinery and public utilities are within the unlikely material category meaning that it is unlikely that these risks cause material impacts to the Project under future projected climate conditions. Given the unlikely material risks to the Project from extreme heat, no further recommendations are warranted for these topics.

The effect of heat on process efficiency is within the low to moderate materiality category meaning that it is considered as being likely to have the potential to cause low to moderate material impacts to the Project, future projected climate conditions. These are however short term during extreme heat events, and the impacts are expected to be financial rather than environmental or social. Therefore, no further recommendations are warranted for this topic.

7.1.1.3 URBAN FLOODS

The assessment of urban floods will be based on the projected largest 1-Day Precipitation. This parameter was chosen since it reflects the potential for extreme, high-intensity rainfall that can cause flooding in a short period (flash floods). The projected largest 1-day precipitation provides insight into the likelihood and potential severity of flash floods. The baseline conditions reflect the reference period from 1995 to 2014[233]. For the assessment the medium-low emission scenario (SSP 2-4.5) and the high emission scenario (SSP 5-8.5) will be compared. For the conditions during construction the year 2024 will be assessed. For the operation the year 2040 will be used to assess the impacts and for decommissioning the year 2080. The median (50th Percentile) was used for the assessment.

The following assessment methodology is used to assess urban flood impacts.

TABLE 7-14 MAGNITUDE AND SIGNIFICANCE OF URBAN FLOODS IMPACT ASSESSMENT

Exceedance of baseline average largest 1-Day Precipitation	Magnitude of predicted impact	Resulting Significance of effect
Same or below baseline conditions	Negligible	Insignificant
0 up to 5 mm above baseline conditions	Small	Minor
5 to 10 mm above baseline conditions	Medium	Moderate
>10 mm above baseline conditions	Large	Major

[233] The World Bank, 2020. Climate Data Projections Germany, available at: Germany - Summary | Climate Change Knowledge Portal (worldbank.org)

This assessment only covers urban floods and not river floods. River floods were deemed out of scope for the components near Landau since only small streams are within the AoI of the Landau Project components. For the CLP in Höchst river floods are deemed out of scope since they lie the CLP lies outside of the boundaries for extreme floods (see Section 6.6.3).

Description of impact:

Construction phase:

The projected change in the largest 1-Day Precipitation in Rhineland-Palatinate and Hesse during construction for SSP 2-4.5 and SSP 5-8.5 is shown in Table 7-15.

TABLE 7-15 PROJECTED LARGEST 1-DAY PRECIPITATION IN RHINELAND-PALATINATE AND HESSE

		Rhineland-Palatinate		Hesse	
	Baseline conditions (1995-2014)	SSP 2-4.5 (Construction 2024)	SSP 5-8.5 (Construction 2024)	SSP 2-4.5 (Construction 2024)	SSP 5-8.5 (Construction 2024)
Projected Average Largest 1-Day Precipitation	23.54 mm (Rhineland-Palatinate) 20.15 mm (Hesse)	22.60 mm	21.29 mm	21.91	20.45
Difference from baseline conditions		-0.96 mm	-2.25 mm	**+1.74**	**+0.30**
Resulting significance of effect		**Insignificant**	**Insignificant**	**Minor**	**Minor**

Table 7-15 shows that the projected change in the largest 1-day precipitation is expected to be insignificant for the Project components close to the Landau area and minor for the CLP in Höchst during the construction phase for both SSP 2-4.5 and SSP 5-8.5.

Operational phase:

The projected change in the largest 1-Day Precipitation in Rhineland-Palatinate and Hesse during operation for SSP 2-4.5 and SSP 5-8.5 is shown in Table 7-16.

TABLE 7-16 PROJECTED LARGEST 1-DAY PRECIPITATION IN RHINELAND PALATINATE AND HESSE

		Rhineland-Palatinate		Hesse	
	Baseline conditions (1995-2014)	SSP 2-4.5 (Operation 2040)	SSP 5-8.5 (Operation 2040)	SSP 2-4.5 (Construction 2024)	SSP 5-8.5 (Construction 2024)
Projected Average Largest 1-Day Precipitation	23.54 mm (Rhineland-Palatinate) 20.15 mm (Hesse)	23.57 mm	22.51 mm	22.80 mm	21.30 mm
Difference from baseline conditions		**+0.03 mm**	-1.03 mm	**+2.65 mm**	**+1.15 mm**
Resulting significance of effect		**Minor**	**Insignificant**	**Minor**	**Minor**

As presented in the table above the projected change in the largest 1-day precipitation is minor for SSP 2-4.5 and insignificant for SSP 5-8.5 during operation for the Project components near Landau as well as minor for the CLP in Höchst under both scenarios.

Decommissioning phase:

The projected change in the largest 1-Day Precipitation in Rhineland-Palatinate and Hesse during decommissioning for SSP 2-4.5 and SSP 5-8.5 is shown in Table 7-17.

TABLE 7-17 PROJECTED LARGEST 1-DAY PRECIPITATION IN RHINELAND-PALATINATE AND HESSE

		Rhineland-Palatinate		Hesse	
	Baseline conditions (1995-2014)	SSP 2-4.5 (Decommis-sioning 2080)	SSP 5-8.5 (Decommis-sioning 2080)	SSP 2-4.5 (Construction 2024)	SSP 5-8.5 (Construction 2024)
Projected Average Largest 1-Day Precipitation	23.54 mm (Rhineland-Palatinate) 20.15 mm (Hesse)	23.55 mm	23.46 mm	23.55 mm	24.12 mm
Difference from baseline conditions		**+0.01 mm**	-0.08 mm	**+3.39 mm**	**+3.96**
Resulting significance of effect		**Minor**	**Insignificant**	**Minor**	**Minor**

Source: World Bank, 2020. Climate Knowledge Portal[234].

As presented in the table above the projected change in the largest 1-day precipitation is minor for SSP 2-4.5 and insignificant for SSP 5-8.5 during decommissioning for the Project components

[234] Germany - Mean Projections Expert | Climate Change Knowledge Portal (worldbank.org)

near Landau. For the CLP in Höchst the projected change in the largest 1-day precipitation is expected to be minor during the decommission period.

Risk Review for Urban Floods

The section above identifies that the significance of effect of urban floods lies between insignificant and minor during all the Project phases. This risk review examines how the assessed urban flood results and their future changes might impact the Project in its operation and decommissioning phases.

A series of potential risks associated with urban floods to the Project have been identified under future projected climatic conditions. These are described in the Table below.

TABLE 7-18 POTENTIAL RISK AREAS AND MATERIALITY – ASSOCIATED WITH URBAN FLOODS

Risk area	Description of potential risks and materiality to the Project	Project phase and risk materiality category	
		Operation (2040)	Decommissioning (2080)
Site personnel	Urban floods may cause working conditions to become unsafe for on-site personnel during operation and decommissioning of the Project – and may remain unsafe for short to medium periods of time if areas which are inundated by urban floods are not managed effectively. Similarly, during the operational phase of the Project, staff are likely to be returning to repair any damage incurred during urban flood events, potentially increasing their exposure to this hazard. These impacts likely have the potential to cause disruption to the operation and decommissioning of the Project. However, since the change in the largest 1-day precipitation is expected to be insignificant to minor it is unlikely that urban floods cause disruptions to site personnel during operation and decommissioning.	**Unlikely Material**	**Unlikely Material**
Access roads, Infrastructure	Urban floods have the potential to cause both long and short-term damage to Project structures and access road surfaces, and therefore poses a potential material risk to the operational phase of the Project. Risks include: damaged infrastructure from urban floods, inundated access roads preventing personnel accessing the site/workplace and other damage caused to various aspects of the Project. Damage could occur as urban floods can detrimentally influence the durability of the Project, particularly if water is left standing for prolonged periods of time. This has the potential to cause cracks and potholes[235]. Flood waters may also strip the concrete of its binder, leaving it more vulnerable to natural corrosion, and potentially forming depressions within the	**Likely Material – Low - Moderate**	**Likely Material – Low - Moderate**

[235] Lu, D., Tighe, S.L. and Xie, W.C., 2020. Impact of flood hazards on pavement performance. *International Journal of Pavement Engineering*, *21*(6), pp.746-752.

Risk area	Description of potential risks and materiality to the Project	Project phase and risk materiality category	
		Operation (2040)	Decommissioning (2080)
	concrete structure of the buildings or access roads as cars travel over them[235]. Damaged or deformed infrastructure and road surfaces (during both phases of the Project) may require ongoing maintenance and repairs and as a result increased capital and operational expenditure. Similarly, personnel could be exposed to unsafe driving conditions during flood events and may experience delays during periods of time when the building and road damage are being repaired. The impacts specified above may cause low-moderate material impacts during the operational phase and decommissioning phase of the Project.		
Equipment and machinery	Although many items of operation equipment and machinery are built to be water resistant (e.g., resistant to precipitation), there are many items of machinery which could be vulnerable to damage if left outdoors and submerged by flood waters during the operation and decommissioning of the Project. Damage could include the corrosion of electrical components and connections, leading to intermittent but persistent electrical issues on-site. This could result in a required increase in capital expenditure – related to the replacement of damaged equipment. During operations, equipment used outside is designed for outdoor usage. Impacts associated with this risk area can be mitigated by certain measures, e.g., ensuring proper storage, ensuring equipment is not left outdoors during heavy rainfall events, replacing faulty/damaged equipment. Accordingly, the potential for material impacts associated with this risk area are categorised as being unlikely.	**Unlikely Material**	**Unlikely Material**

Embedded mitigation measures for urban floods:

At the GLEP the development plan from the city of Landau aims at avoiding and minimising precipitation water runoff and damage in terms of flood prevention. The GLEP includes, for example, the following measures based on the Länder-Arbeitsgemeinschaft Wasser (LAWA) "LAWA-Strategie für eine effektives Starkregenrisikomanagement" (LAWA strategy for effective heavy rainfall risk management) which are presented in the GLEP development plan[236].

- Selection and planning of properties according to hazard assessment (e.g., keeping depth contours and endangered slopes free, keeping riparian strips free, establishing interceptor ditches to divert outdoor water past new development areas, prohibition of flood-sensitive uses in endangered areas)

[236] Stadt Landau, 2023. Bebauungsplan „D 12, Gewerbepark Messegelände-Südost"

- Avoidance of new sealing (e.g., by using water-permeable materials, e.g., for parking lots),
- Compensation of sealed areas (e.g., by installing infiltration trenches; by constructing infiltration troughs).
- Unsealing of suitable areas (e.g., deconstruction of traffic areas that are no longer needed).
- Securing green spaces and open spaces for retention Increasing groundwater recharge and evaporation through decentralised precipitation water management and retention (e.g., through troughs, infiltration troughs, green roofs, rainwater utilisation, dam roofs, throttles).
- Preservation of existing drainage troughs.

Additional mitigation recommended by ERM:

No additional mitigation measures are proposed by ERM since the impact significance is projected to be minor to insignificant.

7.1.1.4 RESULTS FROM ADDITIONAL VULCAN CCRA

In June 2025, Engie Impact completed an assessment of the physical risks[237] associated with climate change for the Phase One Lionheart Project. The report produced by Engie Impact presents the findings of the climate risk study, which evaluated physical climate risks across ten value chain segments in the Project's key locations, addressing 28 climate hazards as mandated by EU regulations over three distinct time horizons: short-term (0-3 years), medium-term (4-10 years), and long-term (11-40 years).

The assessment considered future climate action pathways, including approximately 1.5°C warming (low scenario), approximately 2.5°C warming (middle scenario, regarded as the "base case"), and approximately 4.3°C warming (high scenario). In collaboration with ENGIE Impact, Vulcan developed a tailored climate change risk matrix to evaluate the likelihood (the probability of an event occurring within a specified timeframe) and severity (the impact of an event on EBIT for non-HSE events and the severity of injury for HSE events) of each identified risk.

From the 28 climate hazards specified by reporting frameworks, 14 were deemed relevant to the Project due to the potential exposure of certain value chain segments. A total of 78 physical climate risks across these 14 hazards were identified, which can be classified into 15 distinct categories, including construction delays, health and safety events, and power failures.

In the middle, base case scenario of approximately 2.5°C warming, and in the absence of mitigation measures and quantitative data, four risks were classified as material: HSE events resulting from heat waves, power failures due to wind-related events, power failures caused by floods, and transportation disruptions stemming from floods. However, when mitigation measures such as backup generators and safety stock for transportation disruptions are implemented, still excluding quantitative data, the number of material risks is reduced to three: HSE events due to heat waves, power failures from wind-related events, and power failures due to floods.

The scenario analysis for the qualitative analysis indicates that the levels of physical climate risks associated with the Project, both mitigated and unmitigated, are correlated with global warming levels. Specifically, in the long-term high scenario, there are five unmitigated material risks, compared to four in both the middle and low scenarios. Conversely, the number of

[237] Engie Impact, 2025. Vulcan Energy – Assessment of Physical Risks from Climate Change. Phase 1 Final Report (Revised) – Qualitative Assessment of Physical Climate Risks for Phase One Lionheart Project.

mitigated material risks in the long-term is four in the high scenario, and three in both the middle and low scenarios.

Three material risks identified in the qualitative assessment were further assessed for their quantitative impact, these include HSE events resulting from heat waves, power failures caused by floods, and transportation disruptions stemming from floods. Power-failures from wind-related events was excluded for the quantitative assessment due to the lack of available high quality and granular data required to draw clear conclusions. Based on the results of the risk quantification exercise, the severity of two physical climate risks (power failure and transport disruptions from floors) decreases and the risks become immaterial.

The results from the Engie Impact Report (2025) differ from the results of this ESIA due to a different methodology applied (using different risk matrices, input parameters, data sources and the quantification of the risks). However, in general similar climate risks were considered. The aspect of heat waves is covered under extreme heat in this ESIA (see 7.1.1.2). Floods are covered under urban floods in this ESIA (see 7.1.1.3). Wind-related events were not covered by this ESIA due to a lack of available data. The Engie Impact Report does not further elaborate on Water Scarcity compared to this ESIA (see 7.1.1.1).

7.1.2 IMPACTS RELATED TO GREENHOUSE GAS EMISSIONS

The IFC's Performance Standard 3 defines a reporting threshold for annual GHG emissions of 25,000 tonnes of CO_2 equivalent (tCO_2e) for Scope 1 and 2 and, requires clients to "*…consider alternatives and implement technically and financially feasible and cost-effective options to reduce Project-related GHG emissions during the design and operation of the Project*".

The three "Scopes" that are mentioned in the IFC PS3 relate to the following categories of emissions[238]:

- Scope 1 – direct emissions from sources owned or under the operational control of the company.
- Scope 2 – indirect emissions from the consumption of purchased electricity; and
- Scope 3 – indirect emissions an optional reporting category allowing for other indirect emissions associated with but not controlled by the company.

Through this assessment, the greenhouse gas (GHG) emissions contributing to climate change at the local and regional level stemming from the Project, during its construction and operation phases are estimated. This was approached through the following tasks:

- To undertake GHG modelling and calculation of the construction and operational carbon footprint of the Project through an impact assessment;
- To contextualise annual emissions against international thresholds; and
- To determine whether expected GHG emissions are deemed to be 'significant'.

The assessment includes two scenarios: The base-case scenario assumes that four out of six well sites will be drilled using electricity (normal grid mix) and the remaining two well sites will be drilled with diesel generators. The plants will run with 50% renewable PPAs and use conventional caustic soda during operation. The transport between LEP und CLP will be done with diesel trucks. The low-case scenario assumes that all well sites will be drilled using electricity (normal grid mix), the plants will run with 100% renewable PPAs and use green caustic soda

238 https://ghgprotocol.org/corporate-standard

during operation. Additionally, the transport between LEP and CLP for the low-case scenario will be done with electric trucks. The use of two scenarios in the GHG inventory provides a range of potential emissions outcomes, reflecting planning-stage uncertainties and associated risks.

This GHG assessment covers emission estimations which are under direct operational control (Scope 1&2), in line with the Applicable Standard as well as with some coverage of Scope 3 emissions that can be estimated at this stage. Further details on the base-case and low-case scenario are provided in section 7.1.2.1 and 7.1.2.2 respectively.

Assumptions and Limitations

- The data utilised for this assessment is derived from a dataset provided by Vulcan in July 2025 (external source: Vulcan Energy, 2025 – Low- and Mid-case GHG Inventory, provided as two separate MS Excel spreadsheets: 'Low-case GHG inventory.xlsx' and 'Mid-case GHG inventory.xlsx'). Assumptions as these relate to the assessment of GHG emissions are based on the information contained in the two GHG inventories. For the majority of sites, the information is grounded in engineering projections of volumes, as direct measurements are not yet accessible due to the current stage of the Project. Conversely, the calculations for the well sites are informed by actual consumption data from the Schleidberg site (constructed and drilling commenced), which has been extrapolated to the remaining five well sites. As a result, while the data for most sites reflects a certain degree of uncertainty due to its estimated nature, the data for the well sites exhibits comparatively lower uncertainty, given its foundation in real operational figures for Schleidberg.
- Regarding Scope 3 emissions, the production of materials in different countries are likely to have varying impacts. The emission factors used in this GHG assessment were taken from previous assessments done by Vulcan (GWP inventory – construction phase I) and are specific to regions where available.
- The GHG emissions were calculated using two scenarios, the base-case scenario and the low-case scenario as described in the section above.
- The construction phase includes both the construction and ramp-up periods, meaning that some Project components will become operational while others are still under construction. Full construction is expected to be completed by 2030, at which point the entire Project will be operational—this timeline is reflected in the assessment.

7.1.2.1 BASE-CASE SCENARIO

During Construction and Ramp-Up (Base-Case)

For the base-case scenario during construction and ramp-up of the Project, GHG emissions will be generated by the following activities (see Figure 7-1**Error! Reference source not found.**):

- Mobile combustion including:
  - Transport of excavated material;
  - Rig move;
  - Transport of LHM products from Landau to Höchst (ramp-up); and
  - Employee travel between facilities (ramp-up).
- Stationary combustion including:
  - Excavation of material;

- Drilling operations;
- Civil works; and
- Natural gas for heating.

- Electricity consumption from:
  - Grid electricity (construction, operation (ramp-up), offices); and
  - Renewable electricity (operation (ramp-up), offices).
- Procured heating;
- Capital goods;
- Fuel and energy-related activities;
- Upstream transportation and distribution;
- Waste generated in operations (ramp-up); and
- Purchased goods and services (ramp-up).

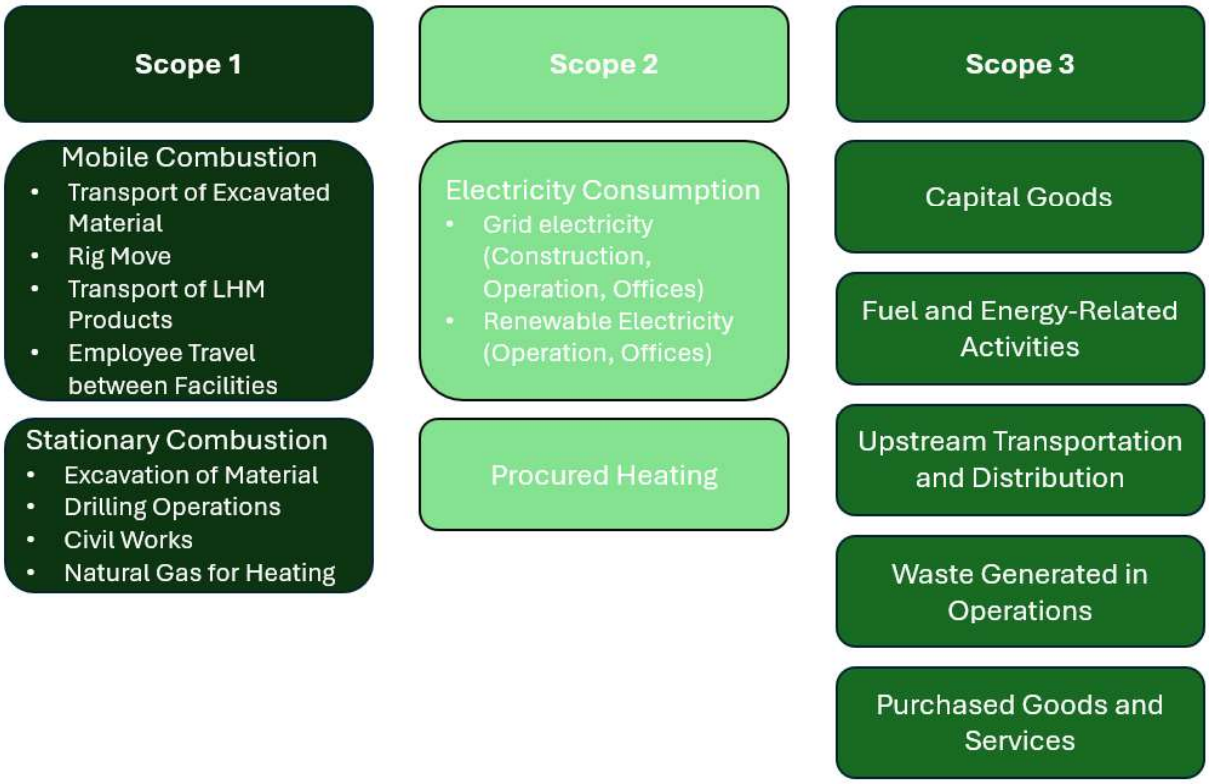


FIGURE 7-1 ORGANISATIONAL BOUNDARIES FOR EMISSIONS DURING CONSTRUCTION AND RAMP-UP – BASE-CASE

Scope 1 Emissions

Emissions from Mobile Combustion

As presented in **Error! Reference source not found.**emissions from mobile combustion include t he transport of excavated material and rig move. The emissions from mobile combustion are associated with the transport of materials, predominantly excess material (soil and drilling cuttings) to the disposal site. It has been assumed that the vehicles used for transport of excess

materials to the disposal site are within the scope 1 emissions category (under operational control of the Project Developer)[239].

The data on the excavation material and drilling cuttings is based on the best current estimate for the Project. These estimates were provided to ERM by Vulcan in April 2025. 592,714 tons of soil are transported in trucks with 24 tons capacity. Over the entire construction period, 24,696 trucks will be needed. Assuming an average consumption of 38 L per 100 km and a depositing site 30 km away from the construction site, 281,539 L will be consumed by trucks transporting soil and cuttings over the entire construction period.

During the ramp-up phase emissions from mobile combustion stem from diesel consumed in the transport of LHM products from Landau to Höchst as well as diesel consumed in light vehicles provided to employees who travel between facilities.

The emissions from mobile combustion for the calendar years (CY) from 2023 to 2029 are presented in Table 7-19**Error! Reference source not found.**.

TABLE 7-19 EMISSIONS FROM MOBILE COMBUSTION DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Amount [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Mobile Combustion	2.27	2.27	33.02	257.98	331.49	126.57	8.46
Mobile Combustion: Operation phase (Ramp-up)	-	-	-	9.00	4.50	178.27	294.69

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Stationary Combustion

Emissions from stationary combustion during construction and ramp-up relate to the excavation of materials, drilling operations, civil works as well as natural gas for heating. The annual figures are based on the total consumption spread across the whole construction and ramp-up period between 2023 to 2029. The data is based on assumptions from Vulcan shared in a GHG Inventory email chain in January 2025.

The emissions from stationary combustion during construction for CY23 to CY29 are shown in Table 7-20.

TABLE 7-20 EMISSIONS FROM STATIONARY COMBUSTION DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Stationary Combustion (diesel)	138.75	138.75	84.87	4,172.18	27,390.18	26,823.38	3,234.00

[239] Would fit into scope 3 in case goods transported by third parties rather than in vehicles operated and controlled by the site.

Stationary Combustion (natural gas for heating)	13.73	15.10	16.61	18.27	20.10	22.11	24.32

Source: Vulcan, 2025. Base-case GHG Inventory.

Scope 2 Emissions

Emissions from Electricity Consumption

During construction and ramp-up electricity will be used for well drilling as well as for the ICPP; CLP and GLEP construction. For well drilling the annual figures are based on the total consumption spread across 2025-2029 for Schleidberg, Trappelberg, 40 Morgen and Landau. Annual figures for Hasenberg and Spreissgraben are covered under scope 1 emissions since in the base-case scenario it is assumed that drilling at these sites will be powered by diesel and therefore fall under stationary combustion. For the CLP and GLEP annual figures are based on the total consumption spread across 2025-2029. Note that PPAs will not be purchased to offset grid electricity consumed during construction. Additionally, electricity consumption includes the grid electricity consumed for the German offices. The grid electricity for the German offices is procured for the following offices (and laboratories): Info Centre Karlsruhe, Info Centre Landau, Office Landau. Another component of electricity consumption is renewable electricity consumed at the German offices. Renewable electricity is procured for Karlsruhe office. Data for CY23 is based on CY23 invoices. Assumes 10% increase per annum as a result of growth of the business.

From CY26 onwards grid electricity as well as renewable electricity from Project components such as the GLEP, CLP, ICPP, well site pumps and air cooler are expected due to some of these components being operational. This is considered as the "ramp-up" phase for this GHG assessment.

Table 7-21 presents the emissions from electricity consumption during the construction and ramp-up phase.

TABLE 7-21 EMISSIONS FROM ELECTRICITY CONSUMPTION DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Grid electricity: Construction phase	0.00	0.00	1,165.19	3,818.05	3,676.20	1,092.04	342.65
Grid electricity: Operation phase (ramp-up)	-	-	-	1,213.53	1,092.18	6,543.44	22,860.46
Grid electricity: offices	26.68	37.66	37.29	36.91	36.55	36.18	35.82
Renewable electricity: Offices	0.50	0.55	0.60	0.66	0.73	0.80	0.88
Renewable electricity: Operation phase (ramp-up)	-	-	-	46.77	46.77	311.35	1,208.60

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Procured Heating

During construction and ramp-up emissions from procured heating related to the heating for German offices. The estimate is provided for VNI office and Info Centre located in Landau.

Table 7-22 presents the emissions from procured heating during the construction and ramp-up phase.

TABLE 7-22 EMISSIONS FROM PROCURED HEATING DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Amount [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Natural gas combustion: Procured heating	2.21	2.43	2.67	2.94	3.24	3.56	3.92

Source: Vulcan, 2025. Base-case GHG Inventory.

Scope 3 Emissions

Emissions from Capital Goods

Emissions from capital goods relate to the procurement of asphalt, carbon steel, steel, concrete, reinforced concrete and cement for the different Project components such as the well sites, CLP, GLEP and ICPP. The annual figures are based on total consumption spread across 2023-2029. Pro-rata data is used for capital goods which refers to the allocation of embodied emissions from

purchased materials and equipment based on the proportion of their use or cost attributed to the specific Project phase.

The emissions from capital goods (pro-rata) during construction and ramp-up for CY23 to CY29 are shown in Table 7-23.

TABLE 7-23 EMISSIONS FROM CAPITAL GOODS (PRO-RATA) DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Capital Goods (Pro-Rata)	5,422.54	5,422.54	11,404.58	61,067.33	90,317.92	49,143.59	7,270.83

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Fuel and Energy-Related Activities

Emissions from fuel and energy-related activities regard the extraction and processing of diesel used in Vulcan's scope 1 emissions sources. The total diesel consumption data was used for this calculation. This also includes emissions associated with processing of diesel used in transport, as transport is under Vulcan's operational control (i.e. scope 1 and 2).

Emissions from fuel and energy-related activities during construction and ramp-up are summarised in Table 7-24.

TABLE 7-24 EMISSIONS FROM FUEL AND ENERGY-RELATED ACTIVITIES DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Fuel and Energy-Related Activities	35.20	35.20	29.77	1,042.35	6,506.79	6,364.83	829.89

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Upstream Transportation and Distribution

Emissions from upstream transportation and distribution are associated with the transportation of construction goods by diesel trucks. The figures estimate an average of 700km by diesel trucks for the construction goods.

Emissions from upstream transportation and distribution during construction and ramp-up are presented in Table 7-25.

TABLE 7-25 EMISSIONS FROM UPSTREAM TRANSPORTATION AND DISTRIBUTION DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Upstream Transportation and Distribution	3,760.37	3,760.37	1,292.59	10,361.59	20,294.23	13,129.09	2,585.45

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Purchased Goods and Services

Emissions from purchased goods and services include emissions correlated with the brine production at the LEP and CLP as well as emissions from the inhibitor and oil for the line shaft pump (LSP). These are applicable to the ramp-up phase and are starting CY28. The estimates are based on the GHG inventory data as well as estimates from the Insheim power plant.

The emissions from purchased goods and services during ramp-up in the calendar years (CY) of 2028 and 2029 are presented in Table 7-26.

TABLE 7-26 EMISSIONS FROM PURCHASED GOODS AND SERVICES DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Purchased Goods and Services	-	-	-	-	-	4,326.83	6,886.97

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Generated Waste

Emissions from generated waste include emissions correlated with the brine production at the LEP and CLP. These are applicable to the ramp-up phase and are starting CY25. The estimates are based on the GHG inventory operations data.

The emissions from generated waste for the ramp-up phase are presented in Table 7-27.

TABLE 7-27 EMISSIONS FROM PURCHASED GENERATED WASTE DURING CONSTRUCTION AND RAMP-UP (BASE-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Waste Generated in Operations (Ramp-up)	-	-	4.99	22.20	44.73	88.96	111.77

Source: Vulcan, 2025. Base-case GHG Inventory.

Summary of Emissions during Construction and Ramp-Up Period

The estimated annual Scope 1, 2 and 3 GHG emissions during construction and ramp-up are presented in Table 7-28**Error! Reference source not found.** below. Total Scope 1, 2 and 3 emissions vary from 9,402.24tCO_2-e in 2023 up to 149,765.60 tCO_2-e in 2027.

TABLE 7-28 TOTAL EXPECTED CONSTRUCTION AND RAMP-UP GHG EMISSIONS (BASE-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	**CY24**	**CY25**	**CY26**	**CY27**	**CY28**	**CY29**
Scope 1							
Mobile Combustion: Construction	2.27	2.27	33.02	257.98	331.49	126.57	8.46
Mobile Combustion: Operation phase (Ramp-up)	-	-	-	9.00	4.50	178.27	294.69
Stationary Combustion (diesel)	138.75	138.75	84.87	4,172.18	27,390.18	26,823.38	3,234.00
Stationary Combustion (natural gas)	13.73	15.10	16.61	18.27	20.10	22.11	24.32
Total Scope 1 Emissions	**154.75**	**156.12**	**134.50**	**4,457.43**	**27,746.27**	**27,150.33**	**3,561.47**
Scope 2							
Grid electricity: Construction phase	0.00	0.00	1,165.19	3,818.05	3,676.20	1,092.04	342.65
Grid electricity: Operation phase (Ramp-up)				1,213.53	1,092.18	6,543.44	22,860.46
Grid electricity: Offices	26.68	37.66	37.29	36.91	36.55	36.18	35.82
Renewable electricity: Offices	0.50	0.55	0.60	0.66	0.73	0.80	0.88
Renewable electricity: Operation phase (Ramp-up)				46.77	46.77	311.35	1,208.60
Natural gas combustion: Procured heating	2.21	2.43	2.67	2.94	3.24	3.56	3.92
Total Scope 2 Emissions	**29.39**	**40.64**	**1,205.75**	**5,118.87**	**4,855.66**	**7,987.37**	**24,452.33**
Total Scope 1 and 2 Emissions	***184.13***	***196.76***	***1,340.26***	***9,576.30***	***32,601.93***	***35,137.70***	***28,013.80***

Scope 3							
Capital Goods (pro-rata data)	5,422.54	5,422.54	11,404.58	61,067.33	90,317.92	49,143.59	7,270.83
Fuel and Energy-Related Activities	35.20	35.20	29.77	1,042.35	6,506.79	6,364.83	829.89
Upstream Transportation and Distribution	3,760.37	3,760.37	1,292.59	10,361.59	20,294.23	13,129.09	2,585.45
Purchased Goods and Services	-	-	-	-	-	4,326.83	6,886.97
Waste Generated in Operations (Ramp-up)	-	-	4.99	22.20	44.73	88.96	111.77
Total Scope 3 Emissions	**9,218.11**	**9,218.11**	**12,731.94**	**72,493.47**	**117,163.68**	**73,053.30**	**17,684.90**
Total							
Total Scope 1, 2 and 3 Emissions	***9,402.24***	***9,414.87***	***14,072.20***	***82,069.77***	***149,765.60***	***108,191.00***	***45,698.69***

Source: Vulcan, 2025. Base-case GHG Inventory.

During Operation (Base-Case)

For the base-case scenario during operation of the Project, GHG emissions will be generated by the following activities (Figure 7-2):

- Mobile combustion including:
  - Transport of LHM products; and
  - Employee travel between facilities.
- Stationary combustion including:
  - Self-generated heating.
- Electricity use;
  - Grid electricity (operation, offices); and
  - Renewable electricity (operation, offices).
- Procured heating;
- Purchased goods and services;
- Fuel and energy related activities; and
- Generated waste.

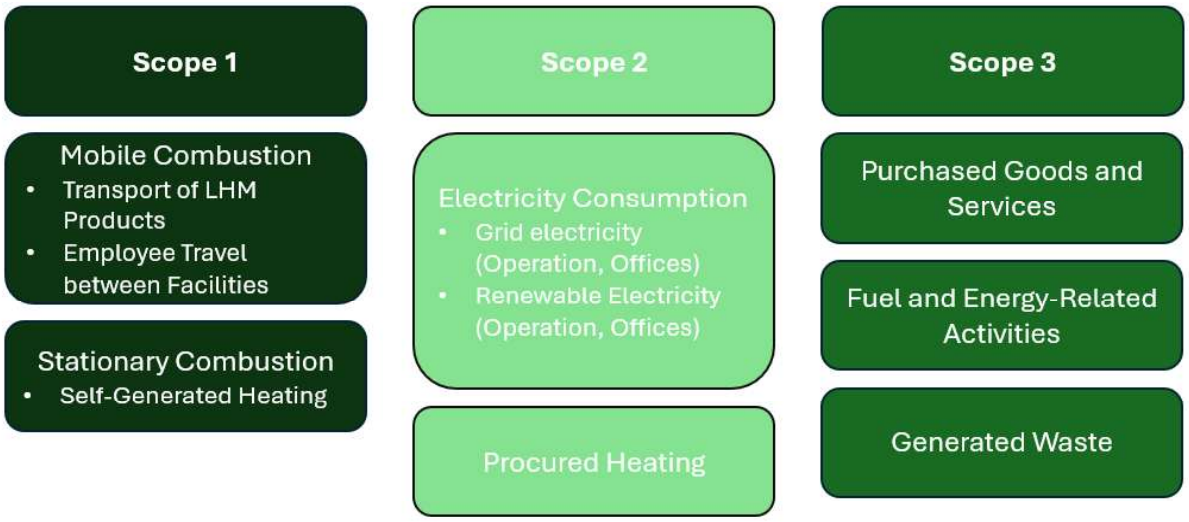


FIGURE 7-2 ORGANISATIONAL BOUNDARIES FOR EMISSIONS DURING OPERATION – BASE-CASE

Emissions during operation have been calculated until the calendar year (CY) 2055. For clarity and consistency, the start of full operation has been designated as 2030, in accordance with the base-case GHG inventory shared by Vulcan in July 2025, with operational years presented at five-year intervals through to 2055.

Scope 1 Emissions

Emissions from Mobile Combustion

As shown in Figure 7-2 emissions from mobile combustion during operation include the transport of LHM products and employee travel between facilities.

The emissions from mobile combustion during operation from 2030 to 2055 at five-year intervals through to 2055 are presented in Table 7-29.

TABLE 7-29 EMISSIONS FROM MOBILE COMBUSTION DURING OPERATION (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Mobile Combustion	411.11	411.11	411.11	411.11	411.11	411.11

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Stationary Combustion

Emissions from stationary combustion during operation relate to self-generated heating of natural gas. The annual figures are based on the total consumption spread across the Info Centre Karlsruhe, VER Office (Bau 34), VER Office (Bau 52).

The emissions from stationary combustion for the start of operation in the calendar year (CY) of 2026 and operational years from 2030 at five-year intervals through to 2055 are presented in Table 7-30.

TABLE 7-30 EMISSIONS FROM STATIONARY COMBUSTION DURING OPERATION (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Stationary Combustion	26.75	43.09	69.39	111.76	179.98	289.86

Source: Vulcan, 2025. Base-case GHG Inventory.

Scope 2 Emissions

Emissions from Electricity Consumption

On-site power generation during operation will involve electricity consumption from the GLEP, CLP, Insheim power plant, ICPP pumps, pumps at the well sites and the ORC air cooler which is summarised as "grid electricity: operational phase" as well as electricity used by the different Vulcan offices summarised as "grid electricity: offices" in Table 7-31. Additionally, renewable electricity will be used during operation. For the GLEP this includes electricity for pumps which transport heated water to suppliers. The data has been adjusted according to annual LHM production. For the CLP this includes electricity for pumps. The renewable electricity used during operation for the GLEP, CLP, Insheim power plant, ICPP pumps, pumps at the well sites and the ORC air cooler is summarised as "renewable electricity: operational phase" as well as electricity used by the different Vulcan offices summarised as "renewable electricity: offices".

The data was provided by Vulcan in July 2025.

TABLE 7-31 EMISSIONS FROM ELECTRICITY CONSUMPTION DURING OPERATION (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Grid Electricity: operational phase	26,972.33	15,056.59	8,519.62	4,428.62	2,314.99	1,007.94
Grid Electricity: offices	35.46	33.72	32.07	30.50	29.00	22.57
Renewable Electricity: operational phase	1,584.43	1,497.85	1,435.32	1,263.53	1,118.54	1,007.94
Renewable Electricity: Offices	0.97	1.56	2.51	4.04	6.51	10.49

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Procured Heating

Emissions from procured heating during operation are associated with the heating of the German offices with natural gas. The annual figures are based on an estimate by Vulcan from July 2025 provided for VNI office and Info Centre Landau.

The emissions from procured heating for the operational years from 2030 at five-year intervals through to 2055 are presented in Table 7-32.

TABLE 7-32 EMISSIONS FROM PROCURED HEATING DURING OPERATION (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Procured Heating: German Offices	4.31	6.94	11.17	17.99	28.97	46.66

Source: Vulcan, 2025. Base-case GHG Inventory.

Scope 3 Emissions

Emissions from Purchased Goods and Services

Emissions from purchased goods and services include emissions correlated with the brine production at the LEP and CLP as well as emissions from the inhibitor and oil for the line shaft pump (LSP). The estimates are based on the GHG inventory operations data as well as estimates based on the Insheim power plant.

The emissions from purchased goods and services for the operational years from 2030 at five-year intervals through to 2055 are presented in Table 7-33.

TABLE 7-33 EMISSIONS FROM PURCHASED GOODS AND SERVICES DURING OPERATION (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Purchased Goods and Services	9,649.06	9,649.06	9,649.06	9,649.06	9,649.06	9,649.06

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Fuel and Energy-Related Activities

Emissions from fuel and energy-related activities regard the extraction and processing of diesel used in Vulcan's scope 1 emissions sources. The total diesel consumption data was used for this calculation. Emissions from fuel and energy-related activities during operation are presented in Table 7-34.

TABLE 7-34 EMISSIONS FROM FUEL AND ENERGY-RELATED ACTIVITIES DURING OPERATION (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Fuel and Energy-Related Activities	96.45	96.45	96.45	96.45	96.45	96.45

Source: Vulcan, 2025. Base-case GHG Inventory.

Emissions from Generated Waste

Emissions from generated waste include emissions correlated with the brine production at the LEP and CLP. The estimates are based on the GHG inventory operations data.

The emissions from generated waste for the operational years from 2030 at five-year intervals through to 2055 are presented in Table 7-35.

TABLE 7-35 EMISSIONS FROM GENERATED WASTE DURING OPERATION (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Generated Waste	147.90	147.90	147.90	147.90	147.90	147.90

Source: Vulcan, 2025. Base-case GHG Inventory.

Summary of Emissions during Operation Period (Base-Case)

The estimated annual Scope 1, 2 and 3 GHG emissions for the base-case scenario during operation are presented in Table 7-36 below. Total Scope 1, 2 and 3 emissions vary from up to 38,928.77 tCO_2-e in 2030 but steadily decline after 2030 reaching annual emissions of 12,689.97 tCO_2-e in 2055. An overview of the annual Scope 1, 2 and 3 emissions for construction, ramp-up and operation emissions for the base-case scenario is presented in Figure 7-3.

TABLE 7-36 TOTAL EXPECTED OPERATION GHG EMISSIONS (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	**CY35**	**CY40**	**CY45**	**CY50**	**CY55**
Scope 1						
Mobile Combustion	411.11	411.11	411.11	411.11	411.11	411.11
Stationary Combustion	26.75	43.09	69.39	111.76	179.98	289.86
Total Scope 1 Emissions	**437.86**	**454.2**	**480.5**	**522.87**	**591.09**	**700.97**
Scope 2						
Grid Electricity: operational phase	26,972.33	15,056.59	8,519.62	4,428.62	2,314.99	1,007.94
Grid Electricity: offices	35.46	33.72	32.07	30.50	29.00	22.57
Renewable Electricity: operational phase	1,584.43	1,497.85	1,435.32	1,263.53	1,118.54	1,007.94
Renewable Electricity: Offices	0.97	1.56	2.51	4.04	6.51	10.49
Procured Heating: German Offices	4.31	6.94	11.17	17.99	28.97	46.66
Total Scope 2 Emissions	**28,597.49**	**16,596.66**	**10,000.69**	**5,744.68**	**3,498.02**	**2,095.59**
Total Scope 1 and 2 Emissions	***29,035.36***	***17,050.85***	***10,481.19***	***6,267.54***	***4,089.11***	***2,796.56***
Scope 3						
Purchased Goods and Services	9,649.06	9,649.06	9,649.06	9,649.06	9,649.06	9,649.06
Fuel & Energy-Related Activities	96.45	96.45	96.45	96.45	96.45	96.45
Generated Waste	147.90	147.90	147.90	147.90	147.90	147.90
Total Scope 3 Emissions	**9,893.41**	**9,893.41**	**9,893.41**	**9,893.41**	**9,893.41**	**9,893.41**
Total						
Total Scope 1, 2 and 3 Emissions	***38,928.77***	***26,944.26***	***20,374.60***	***16,160.95***	***13,982.52***	***12,689.97***

Source: Vulcan, 2025. Base-case GHG Inventory.

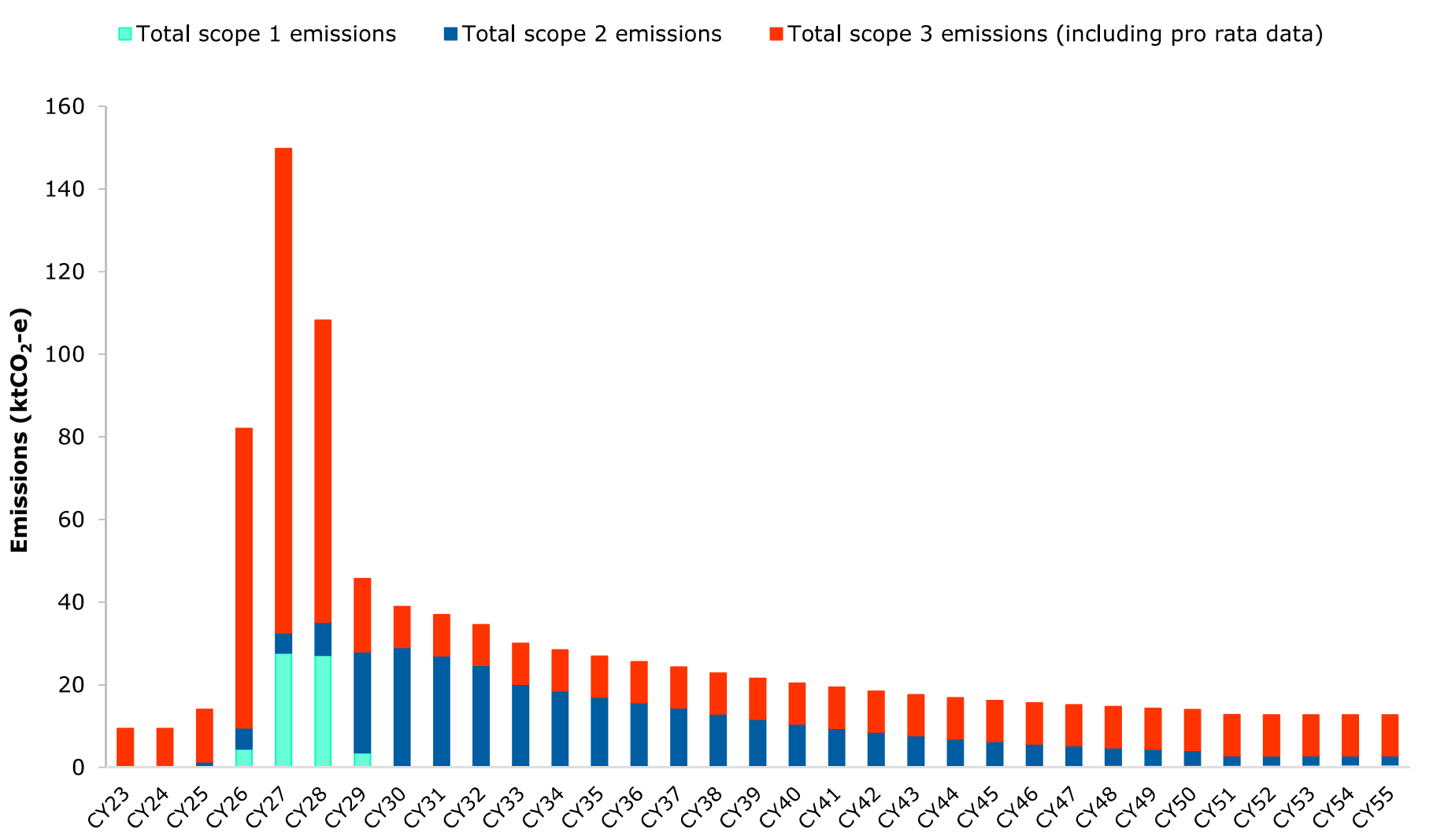


FIGURE 7-3 ANNUAL SCOPE 1, 2 AND 3 EMISSIONS FOR CONSTRUCTION, RAMP-UP AND OPERATION (BASE-CASE)

Source: Vulcan, 2025. Base-case GHG inventory.

Avoided Emissions (Base-Case)

Vulcan will avoid emissions in the value chain through several processes and provisions during their operations. For the base-case scenario emissions are avoided through the following:

- Avoided emissions from the generation of renewable electricity, replacing conventional grid electricity.
- Avoided emissions from the production of geothermal heat, replacing natural gas-based heating.
- Avoided emissions associated with the production of lithium hydroxide monohydrate (LHM), compared to conventional processes.
- Avoided emissions from the extraction and production of lithium, in comparison to standard mining and processing methods.
- Avoided emissions from the production of hydrochloric acid (HCl), replacing conventional manufacturing routes.

Table 7-37 presents the net avoided emissions during operations for the base-case scenario, showing the emissions avoided by Vulcan's Project compared to standard production or processes, after accounting for the emissions generated by Vulcan's own operations.

From 2030 onwards the avoided emissions from renewable electricity steadily decrease due to the assumption that CO_2 intensity of the German grid electricity mix decreases by 10% yearly. The geothermal heat production by Vulcan reaches its maximum in 2042 and does not decline afterwards. However, the emission savings decline due to the assumption that the CO_2 intensity for gas heating declines by 2% yearly. For LHM and lithium production it is assumed that the CO_2 intensity of LHM and lithium declines by 1% yearly, with a production peaking in 2031. For HCl the estimated reduction of CO_2 intensity is 0.5% yearly also with a production peaking in 2031.

Overall, it appears that most emissions during the operation of the Project are avoided through the production of LHM reaching annual net avoided emissions of 312,431.29 tCO_2e in 2030 (see Table 7-37). A comparison between the total Phase 1 emissions during construction, ramp-up and operation and the total avoided emissions throughout 2055 is detailed in Figure 7-4. It can be seen that a total of 8,017,929 tCO_2e are anticipated to be avoided until 2055 compared to 954,598 tCO_2e of expected Phase 1 emissions for the base-case scenario.

TABLE 7-37 NET AVOIDED EMISSIONS DURING OPERATIONS (BASE-CASE)

Avoided Emission Item	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Renewable Electricity	6,410.28	0.00	0.00	0.00	0.00	0.00
Geothermal Heat	37,756.76	69,874.68	87,133.79	83,687.04	75,638.21	68,362.71
LHM Production	312,431.29	300,228.91	267,620.26	226,308.24	193,632.11	168,057.84
Lithium Production	266,102.23	255,513.06	227,575.87	192,279.45	164,366.13	142,518.67
HCl Production	9,484.02	9,377.45	8,602.57	7,488.13	6,596.39	5,895.79

Source: Vulcan, 2025. Base-case GHG Inventory.

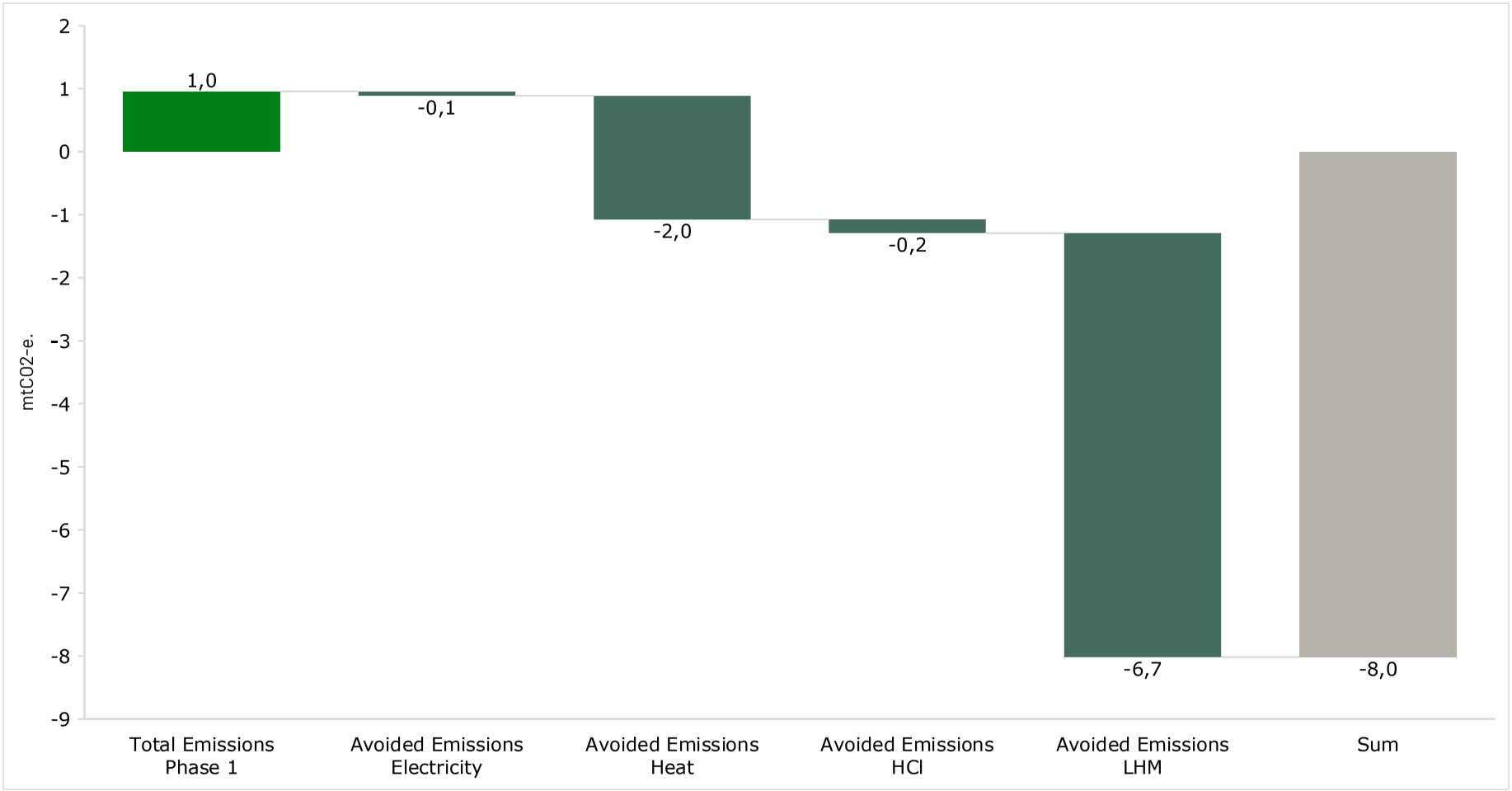


FIGURE 7-4 TOTAL AVOIDED EMISSIONS IN COMPARISON TO TOTAL PHASE 1 EMISSIONS (BASE-CASE)T

Source: Vulcan, 2025. Base-case GHG Inventory.

7.1.2.2 LOW-CASE SCENARIO

During Construction (Low-Case)

For the low-case scenario during construction and ramp-up of the Project, GHG emissions will be generated by the following activities (Figure 7-5):

- Mobile combustion including:
  - Transport of excavated material; and
  - Rig move.
- Stationary combustion including:
  - Excavation of material;
  - Civil works; and
  - Natural gas for heating.
- Electricity consumption including:
  - Grid electricity (construction, offices)
  - Renewable electricity (operation (ramp-up), offices)
- Procured heating;
- Capital goods;
- Upstream transportation and distribution;
- Fuel and energy-related activities;
- Purchased goods and services; and
- Generated waste.

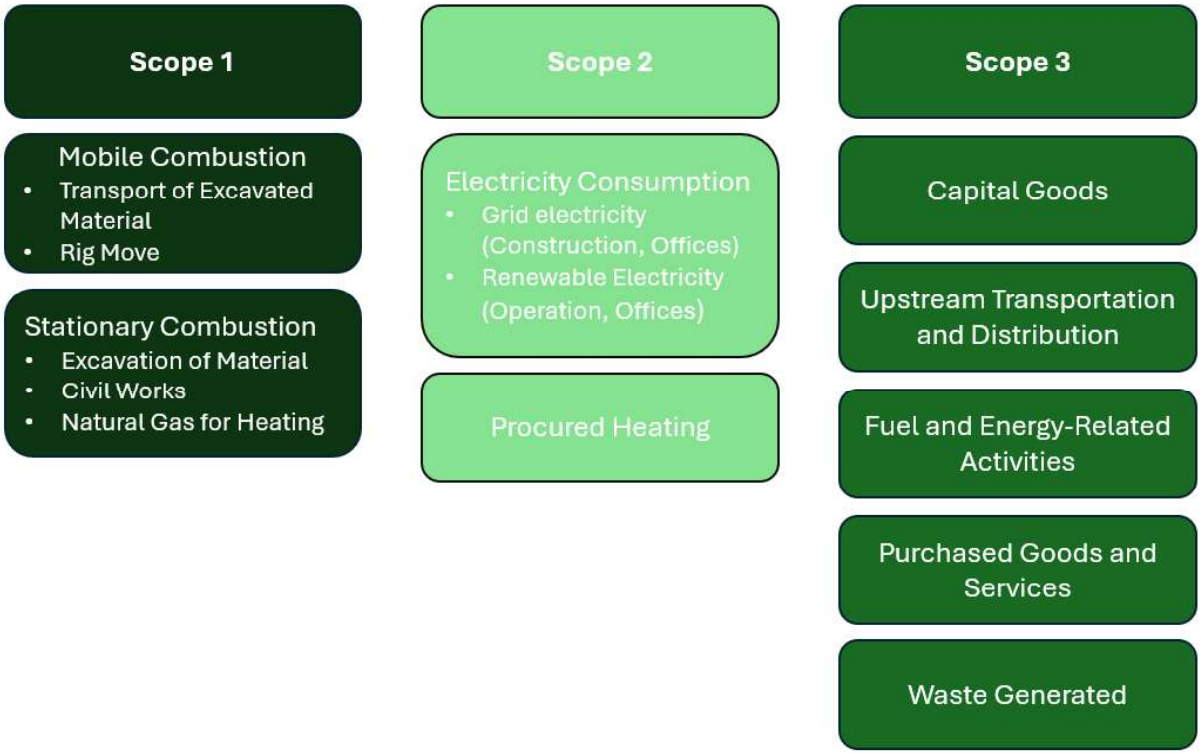


FIGURE 7-5 ORGANISATIONAL BOUNDARIES FOR EMISSIONS DURING CONSTRUCTION AND RAMP-UP – LOW-CASE

Scope 1 Emissions

Emissions from Mobile Combustion

As presented in Figure 7-5 emissions from mobile combustion include the transport of excavated material and rig move. Emissions from mobile combustion are linked to the transportation of materials, mainly excess materials (soil and drilling cuttings) to a disposal site. It is assumed that the vehicles utilised for transporting excess materials to the disposal site fall under the scope 1 emissions category (under operational control of the Project Developer)[240].

The data on the excavation material and drilling cuttings is based on the best current estimate for the Project. These estimates were provided to ERM by Vulcan in July2025. 592,714 tons of soil are transported in trucks with 24 tons capacity. Over the entire construction period, 24,696 trucks will be needed. Assuming an average consumption of 38 L per 100 km and a depositing site 30 km away from the construction site, 281,539 L will be consumed by trucks transporting soil and cuttings over the entire construction period.

The emissions from mobile combustion for the calendar years (CY) from 2023 to 2029 are presented in Table 7-38.

[240] Would fit into scope 3 in case goods transported by third parties rather than in vehicles operated and controlled by the site.

TABLE 7-38 EMISSIONS FROM MOBILE COMBUSTION DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Amount [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Mobile Combustion	2.27	2.27	33.02	257.98	331.49	126.57	-

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Stationary Combustion

Emissions from stationary combustion during construction for the low-case scenario relate to the excavation of materials, civil works and natural gas for heating. In comparison to the base-case scenario no diesel will be consumed for drilling operations. The drilling operations in the low-case scenario will be powered by grid electricity and therefore fall under scope 2 emissions. For stationary combustion annual figures are based on the total consumption spread across the whole construction period between 2023 to 2029. The data is based on assumptions from Vulcan shared in a GHG Inventory email chain in January 2025.

The emissions from stationary combustion during construction for CY23 to CY29 are shown in Table 7-39.

TABLE 7-39 EMISSIONS FROM STATIONARY COMBUSTION DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Stationary Combustion	138.75	138.75	84.87	767.38	1,180.32	613.52	-
Stationary Combustion (natural gas for heating)	13.73	15.10	16.61	18.27	20.10	22.11	-

Source: Vulcan, 2025. Low-case GHG Inventory.

Scope 2 Emissions

Emissions from Electricity Consumption

During construction and ramp-up for the low-case scenario electricity will be used for well drilling as well as for the CLP and GLEP construction. For well drilling the annual figures are based on the total consumption spread across 2023-2029 for all the well sites including Landau. Annual figures for Hasenberg and Spreissgraben are also covered in the electricity consumption compared to the base-case scenario. For the ICPP, CLP and GLEP, the annual figures are derived from the total consumption projected over the period of 2023-2027. It is important to note that PPAs will not be acquired to compensate for grid electricity used during construction. Furthermore, electricity consumption encompasses the grid electricity utilised by the German offices. The grid electricity for the German offices is sourced for the following locations: Info Centre Karlsruhe, Info Centre Landau, and Office Landau. The data for calendar year 2023 is based on invoices from that year and assumes a 10% annual increase due to business growth.

Another aspect of electricity consumption includes renewable electricity used at the German offices, specifically procured for the Karlsruhe office. The data for calendar year 2023 is based on invoices from that year and assumes a 10% annual increase due to business growth.

Table 7-40 presents the emissions from electricity consumption during the construction and ramp-up phase.

TABLE 7-40 EMISSIONS FROM ELECTRICITY CONSUMPTION DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Grid electricity: Construction phase	0.00	0.00	1,165.19	4,079.18	5,485.35	2,720.27	-
Grid electricity: offices	26.68	37.66	37.29	36.91	36.55	36.18	35.82
Renewable electricity: Operational phase (ramp-up)	-	-	-	94.20	94.27	632.13	2,426.71
Renewable electricity: Offices	0.50	0.55	0.60	0.66	0.73	0.80	0.88

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Procured Heating

During construction emissions from procured heating related to the heating for German offices. The estimate is provided for VNI office and Info Centre Landau.

Table 7-41 presents the emissions from procured during the construction and ramp-up phase.

TABLE 7-41 EMISSIONS FROM PROCURED HEATING DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Amount [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Natural gas combustion: Procured heating	2.21	2.43	2.67	2.94	3.24	3.56	3.92

Source: Vulcan, 2025. Low-case GHG Inventory.

Scope 3 Emissions

Emissions from Capital Goods

Emissions associated with capital goods pertain to the acquisition of materials such as asphalt, carbon steel, steel, concrete, reinforced concrete, and cement for various Project components including well sites, CLP, GLEP, and ICPP. The yearly estimates are derived from total consumption projected over the period from 2023 to 2029. The emissions from capital goods for the low-case are also given as pro-rata data and are shown in Table 7-42.

TABLE 7-42 EMISSIONS FROM CAPITAL GOODS (PRO-RATA) DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Capital Goods (Pro-Rata)	5,422.54	5,422.54	11,404.58	61,067.33	90,014.23	48,536.21	-

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Fuel and Energy-Related Activities

Emissions from fuel and energy-related activities regard the extraction and processing of diesel used in Vulcan's scope 1 emissions sources. The emissions from fuel and energy-related activities in the low-case scenario (see Table 7-43) are expected to be less than for the base-case scenario due to the use of less diesel especially due to powering the drilling operations with grid electricity. The total diesel consumption data of scope 1 from the low-case scenario was used for this to calculation. This also includes emissions associated with processing of diesel used in transport, as transport is under Vulcan's operational control (i.e. scope 1 and 2).

TABLE 7-43 EMISSIONS FROM FUEL AND ENERGY-RELATED ACTIVITIES DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Fuel and Energy-Related Activities	34.83	34.83	24.78	986.84	6,434.96	6,338.04	828.11

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Upstream Transportation and Distribution

Emissions from upstream transportation and distribution (see Table 7-44) are associated with the transportation of construction goods by diesel trucks. The figures estimate an average of 700km by diesel trucks for the construction goods and are therefore expected to be the same as for the base-case scenario.

TABLE 7-44 EMISSIONS FROM UPSTREAM TRANSPORTATION AND DISTRIBUTION DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Upstream Transportation and Distribution	3,760.37	3,760.37	1,292.59	10,361.59	20,294.23	13,129.09	2,585.45

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Purchased Goods and Services

Emissions from purchased goods and services include emissions correlated with the brine production at the LEP and CLP as well as emissions from the inhibitor and oil for the line shaft pump (LSP). These are applicable to the ramp-up phase and are starting CY28. The estimates

are based on the GHG inventory operations data as well as estimates based on the Insheim power plant.

The emissions from purchased goods and services for the construction and ramp-up phase are presented in Table 7-45.

TABLE 7-45 EMISSIONS FROM PURCHASED GOODS AND SERVICES DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Purchased Goods and Services (Ramp-Up)	-	-	-	-	-	2,925.52	4,546.84

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Generated Waste

Emissions from generated waste include emissions correlated with the brine production at the LEP and CLP. These are applicable to the ramp-up phase and are starting CY25. The estimates are based on the GHG inventory operations data.

The emissions from generated waste for the construction and ramp-up phase are presented in Table 7-46.

TABLE 7-46 EMISSIONS FROM PURCHASED GENERATED WASTE DURING CONSTRUCTION AND RAMP-UP (LOW-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	CY24	CY25	CY26	CY27	CY28	CY29
Waste Generated in Operations (Ramp-up)	-	-	4.99	22.20	44.73	88.96	111.77

Source: Vulcan, 2025. Low-case GHG Inventory.

Summary of Emissions during Construction and Ramp-Up Period

The estimated annual Scope 1, 2 and 3 GHG emissions during construction and ramp-up are presented in Table 7-47 below. Total Scope 1, 2 and 3 emissions vary from 9,400.13 tCO_2-e in 2023 up to 117,861.59 tCO_2-e in 2027.

TABLE 7-47 TOTAL EXPECTED CONSTRUCTION AND RAMP-UP GHG EMISSIONS (LOW-CASE)

Emission Type	Emissions [tCO_2-e]						
	CY23	**CY24**	**CY25**	**CY26**	**CY27**	**CY28**	**CY29**
Scope 1							
Mobile Combustion	2.27	2.27	33.02	257.98	331.49	126.57	-
Stationary Combustion	138.75	138.75	84.87	767.38	1,180.32	613.52	-
Stationary Combustion (natural gas for heating)	13.73	15.10	16.61	18.27	20.10	22.11	-
Total Scope 1 Emissions	**154.74**	**156.12**	**134.51**	**1,043.64**	**1,531.90**	**762.20**	**24.32**
Scope 2							
Grid electricity: Construction phase	0.00	0.00	1,165.19	4,079.18	5,485.35	2,720.27	-
Grid electricity: offices	26.68	37.66	37.29	36.91	36.55	36.18	35.82
Renewable electricity: Operational phase (Ramp-up)	-	-	-	94.20	94.27	632.13	2,426.71
Renewable electricity: Offices	0.50	0.55	0.60	0.66	0.73	0.80	0.88
Natural gas combustion: Procured heating	2.21	2.43	2.67	2.94	3.24	3.56	3.92
Total Scope 2 Emissions	**29.39**	**40.64**	**1,205.75**	**4,213.90**	**5,620.12**	**3,392.93**	**2,467.32**
Total Scope 1 and 2 Emissions	***184.13***	***196.76***	***1,340.26***	***5,257.54***	***7,152.03***	***4,155.13***	***2,491.64***

Scope 3							
Capital Goods	5,422.54	5,422.54	11,404.58	61,067.33	90,014.23	48,536.21	-
Fuel and Energy-Related Activities	34.83	34.83	24.78	986.84	6,434.96	6,338.04	828.11
Upstream Transportation and Distribution	3,760.37	3,760.37	1,292.59	10,361.59	20,294.23	13,129.09	2,585.45
Purchased Goods and Services (Ramp-Up)	-	-	-	-	-	2,925.52	4,546.84
Waste Generated in Operations (Ramp-up)	-	-	4.99	22.20	44.73	88.96	111.77
Total Scope 3 Emissions	**9,217.74**	**9,217.74**	**12,726.95**	**72,437.96**	**116,788.16**	**71,017.81**	**8,072.16**
Total							
Total Scope 1, 2 and 3 Emissions	***9,400.13***	***9,412.76***	***14,070.09***	***76,950.06***	***117,861.59***	***69,008.54***	***9,757.94***

Source: Vulcan, 2025. Low-case GHG Inventory.

During Operation (Low-Case)

For the low-case scenario during operation of the Project, GHG emissions will be generated by the following activities (Figure 7-6):

- Stationary combustion including:
  - Self-generated heating.
- Electricity consumption from:
  - Grid electricity (offices);
  - Renewable electricity (operation, offices); and
  - Employee travel between facilities.
- Procured heating;
- Purchased goods and services;
- Generated waste; and
- Fuel and energy-related activities.

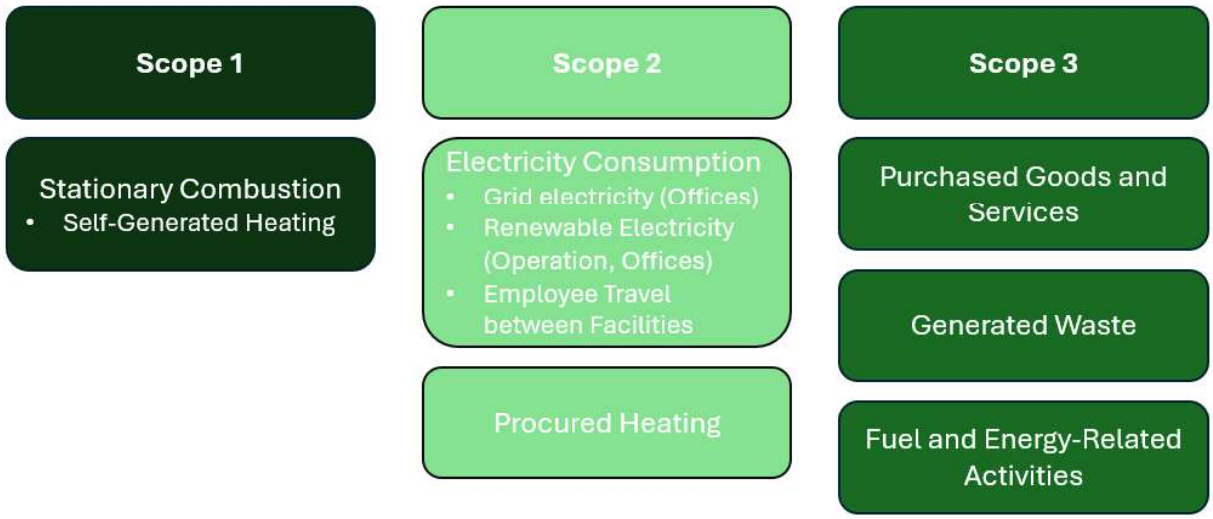


FIGURE 7-6 ORGANISATIONAL BOUNDARIES FOR EMISSIONS DURING OPERATION – LOW-CASE

Same as for the base-case scenario emissions during operation have been calculated until the calendar year (CY) 2055. For clarity and consistency, the start of full operation has been designated as 2030, in accordance with the low-case GHG inventory shared by Vulcan in July2025, with operational years presented at five-year intervals through to 2055.

Scope 1 Emissions

Emissions from Stationary Combustion

Emissions from stationary combustion during operation relate to self-generated heating of natural gas. The annual figures are based on the total consumption spread across the Info Centre Karlsruhe, VER Office (Bau 34), VER Office (Bau 52).

The emissions from stationary combustion for the operational years from 2030 at five-year intervals through to 2055 are presented in Table 7-48.

TABLE 7-48 EMISSIONS FROM STATIONARY COMBUSTION DURING OPERATION (LOW-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Stationary Combustion	26.75	43.09	69.39	111.76	179.98	289.86

Source: Vulcan, 2025. Low-case GHG Inventory.

Scope 2 Emissions

Emissions from Electricity Consumption

For the low-case scenario grid electricity will be used by the different Vulcan offices which is summarised as "grid electricity: offices".

Except for the offices for the low-case scenario during operations it is anticipated that no other grid electricity will be consumed. Only renewable electricity will be used for on-site power generation during operation of the GLEP, CLP, Insheim power plant, ICPP pumps, pumps at the well sites and the ORC air cooler. Additionally, renewable electricity will be used for the GLEP for pumps which transport heated water to suppliers. The data has been adjusted according to annual LHM production. For the CLP this includes electricity for pumps. Also, renewable electricity will be used for the employee transport between facilities using electric vehicles. The renewable energy consumed during operation phase summarised as "renewable electricity: operational phase".

The renewable electricity used by the different Vulcan offices summarised as "renewable electricity: offices". Table 7-49 presents emissions from electricity consumption during operation for the low-case scenario.

The data was provided by Vulcan in July 2025.

TABLE 7-49 EMISSIONS FROM ELECTRICITY CONSUMPTION DURING OPERATION (LOW-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Grid Electricity: offices	35.46	33.72	32.07	30.50	29.00	22.57
Renewable Electricity: operational phase	3,178.46	3,005.89	2,881.79	2,539.73	2,252.23	2,034.99
Renewable Electricity: Offices	0.97	1.56	2.51	4.04	6.51	10.49

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Procured Heating

Emissions from procured heating during operation are associated with the heating of the German offices with natural gas. The emissions from procured heating are expected to be the same for the base-case and low-case scenario. The annual figures are based on an estimate by Vulcan from July 2025 provided for VNI office and Info Centre Landau.

The emissions from procured heating for the start of full operation in the calendar year (CY) of 2030 at five-year intervals through to 2055 are presented in Table 7-50.

TABLE 7-50 EMISSIONS FROM PROCURED HEATING DURING OPERATION (LOW-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Procured Heating: German Offices	4.31	6.94	11.17	17.99	28.97	46.66

Source: Vulcan, 2025. Low-case GHG Inventory.

Scope 3 Emissions

Emissions from Purchased Goods and Services

Emissions from purchased goods and services include emissions correlated with the brine processing at the LEP and CLP as well as emissions from the inhibitor and oil for the line shaft pump (LSP). The estimates are based on the GHG inventory operations data as well as estimates based on the Insheim power plant. For the low-case scenario emissions from purchased goods and services for the LEP and CLP are expected to be lower than for the base-case scenario.

The emissions from purchased goods and services for the start of full operation in the calendar year (CY) of 2030 at five-year intervals through to 2055 are presented in Table 7-51.

TABLE 7-51 EMISSIONS FROM PURCHASED GOODS AND SERVICES DURING OPERATION (LOW-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Purchased Goods and Services	6,370.12	6,370.12	6,370.12	6,370.12	6,370.12	6,370.12

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Fuel and Energy-Related Activities

Emissions from fuel and energy-related activities regard the extraction and processing of diesel used in Vulcan's scope 1 emissions sources. The total diesel consumption data was used for this calculation. Emissions from fuel and energy-related activities during operations are shown in Table 7-52.

TABLE 7-52 EMISSIONS FROM FUEL AND ENERGY-RELATED ACTIVITIES DURING OPERATION (BASE-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Fuel and Energy-Related Activities	96.45	96.45	96.45	96.45	96.45	96.45

Source: Vulcan, 2025. Low-case GHG Inventory.

Emissions from Generated Waste

Emissions from generated waste include emissions correlated with the brine processing at the LEP and CLP. The estimates are based on the GHG inventory operations data and are expected to be the same as for the base-case scenario.

The emissions from generated waste for the start of full operation in 2030 at five-year intervals through to 2055 are presented in Table 7-53.

TABLE 7-53 EMISSIONS FROM GENERATED WASTE DURING OPERATION (LOW-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Generated Waste	147.90	147.90	147.90	147.90	147.90	147.90

Source: Vulcan, 2025. Low-case GHG Inventory.

Summary of Emissions during Operation Period (Low-Case)

The estimated annual Scope 1, 2 and 3 GHG emissions during operation are presented in Table 7-54 below. Total Scope 1, 2 and 3 emissions vary from 9,763.96 tCO2-e in 2030 up to 8,922.59 tCO2-e in 2055. An overview of the annual Scope 1, 2 and 3 emissions for construction, ramp-up and operation emissions for the base-case scenario is presented in Figure 7-7.

TABLE 7-54 TOTAL EXPECTED OPERATION GHG EMISSIONS (LOW-CASE)

Emission Type	Emissions [tCO_2-e]					
	CY30	**CY35**	**CY40**	**CY45**	**CY50**	**CY55**
Scope 1						
Stationary Combustion	26.75	43.09	69.39	111.76	179.98	289.86
Total Scope 1 Emissions	**26.75**	**43.09**	**69.39**	**111.76**	**179.98**	**289.86**
Scope 2						
Grid Electricity: offices	35.46	33.72	32.07	30.50	29.00	22.57
Renewable Electricity: operational phase	3,178.46	3,005.89	2,881.79	2,539.73	2,252.23	2,034.99
Renewable Electricity: Offices	0.97	1.56	2.51	4.04	6.51	10.49
Procured Heating: German Offices	4.31	6.94	11.17	17.99	28.97	46.66
Total Scope 2 Emissions	**3,219.19**	**3,048.11**	**2,927.54**	**2,592.26**	**2,316.72**	**2,114.71**
Total Scope 1 and 2 Emissions	***3,245.94***	***3,091.19***	***2,996.93***	***2,704.02***	***2,496.70***	***2,404.57***
Scope 3						
Purchased Goods and Services	6,370.12	6,370.12	6,370.12	6,370.12	6,370.12	6,370.12
Fuel and Energy-Related Activities	96.45	96.45	96.45	96.45	96.45	96.45
Generated Waste	147.90	147.90	147.90	147.90	147.90	147.90
Total Scope 3 Emissions	**6,614.47**	**6,614.47**	**6,614.47**	**6,614.47**	**6,614.47**	**6,614.47**
Total						
Total Scope 1, 2 and 3 Emissions	***9,763.96***	***9,609.21***	***9,514.94***	***9,222.03***	***9,014.72***	***8,922.59***

Source: Vulcan, 2025. Low-case GHG Inventory.

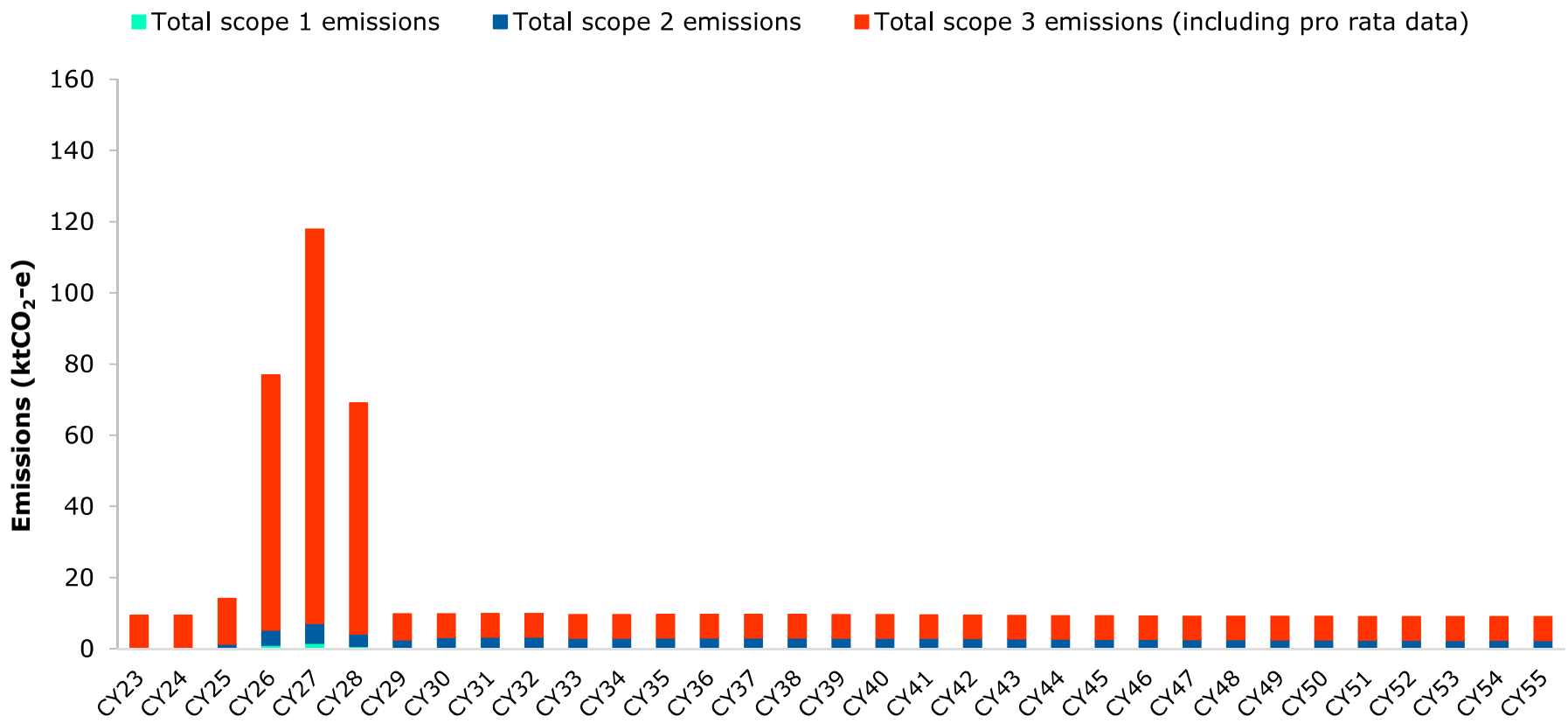


FIGURE 7-7 ANNUAL SCOPE 1, 2 AND 3 EMISSIONS FOR CONSTRUCTION, RAMP-UP AND OPERATION (LOW-CASE)

Source: Vulcan, 2025. Low-case GHG Inventory.

Avoided Emissions (Low-Case)

Vulcan will avoid emissions occurring in the value chain through various processes and provisions during their operations. For the low-case scenario emissions are avoided through the same processes and provisions that for the base-case scenario, namely:

- Avoided emissions from the generation of renewable electricity, replacing conventional grid electricity.
- Avoided emissions from the production of geothermal heat, replacing natural gas-based heating.
- Avoided emissions associated with the production of lithium hydroxide monohydrate (LHM), compared to conventional processes.
- Avoided emissions from the extraction and production of lithium, in comparison to standard mining and processing methods.
- Avoided emissions from the production of hydrochloric acid (HCl), replacing conventional manufacturing routes.

Table 7-55 presents the net avoided emissions during operations for the low-case scenario, illustrating the emissions mitigated by Vulcan in comparison to conventional production methods, after considering the emissions produced by Vulcan's own activities.

Same as for the base-case scenario starting in 2030, the avoided emissions from renewable electricity gradually diminish, based on the premise that the CO_2 intensity of the German electricity grid mix decreases by 10% each year. The geothermal heat output from Vulcan peaks in 2040 and remains stable thereafter. Nonetheless, the emission reductions decrease due to the assumption that the CO_2 intensity for gas heating declines by 2% annually. For LHM and lithium production, it is projected that the CO_2 intensity of both LHM and lithium will decrease by 1% each year, with production reaching its height in 2032. For HCl, the anticipated reduction in CO_2 intensity is 0.5% per year, also with production peaking in 2032.

In summary, similar to the base-case scenario it seems that the majority of emissions during the Project's operation are avoided through the production of LHM, reaching 323,944.82 tCO_2e by 2030. Therefore, in the low-case scenario more emissions are avoided than in the base-case scenario.

A comparison between the total Phase 1 emissions during construction, ramp-up and operation and the total avoided emissions throughout 2055 is detailed in Figure 7-8. It can be seen that a total of 8,703,487 tCO_2e are anticipated to be avoided until 2055 compared to 549,521 tCO_2e of expected Phase 1 emissions for the base-case scenario.

TABLE 7-55 NET AVOIDED EMISSIONS DURING OPERATIONS (LOW-CASE)

Avoided Emission Item	Emissions [tCO_2-e]					
	CY30	CY35	CY40	CY45	CY50	CY55
Renewable Electricity	6,470.31	0.00	0.00	0.00	0.00	0.00
Geothermal Heat	37,772.38	69,906.68	87,177.93	83,733.95	75,685.12	68,409.61
LHM Production	323,944.82	311,903.52	278,603.46	236,112.57	202,489.32	176,176.42
Lithium Production	287,994.08	277,711.18	248,459.31	210,921.40	181,207.23	157,955.33
HCl Production	9,510.68	9,404.49	8,628.00	7,510.83	6,616.90	5,914.59

Source: Vulcan, 2025. Low-case GHG Inventory.

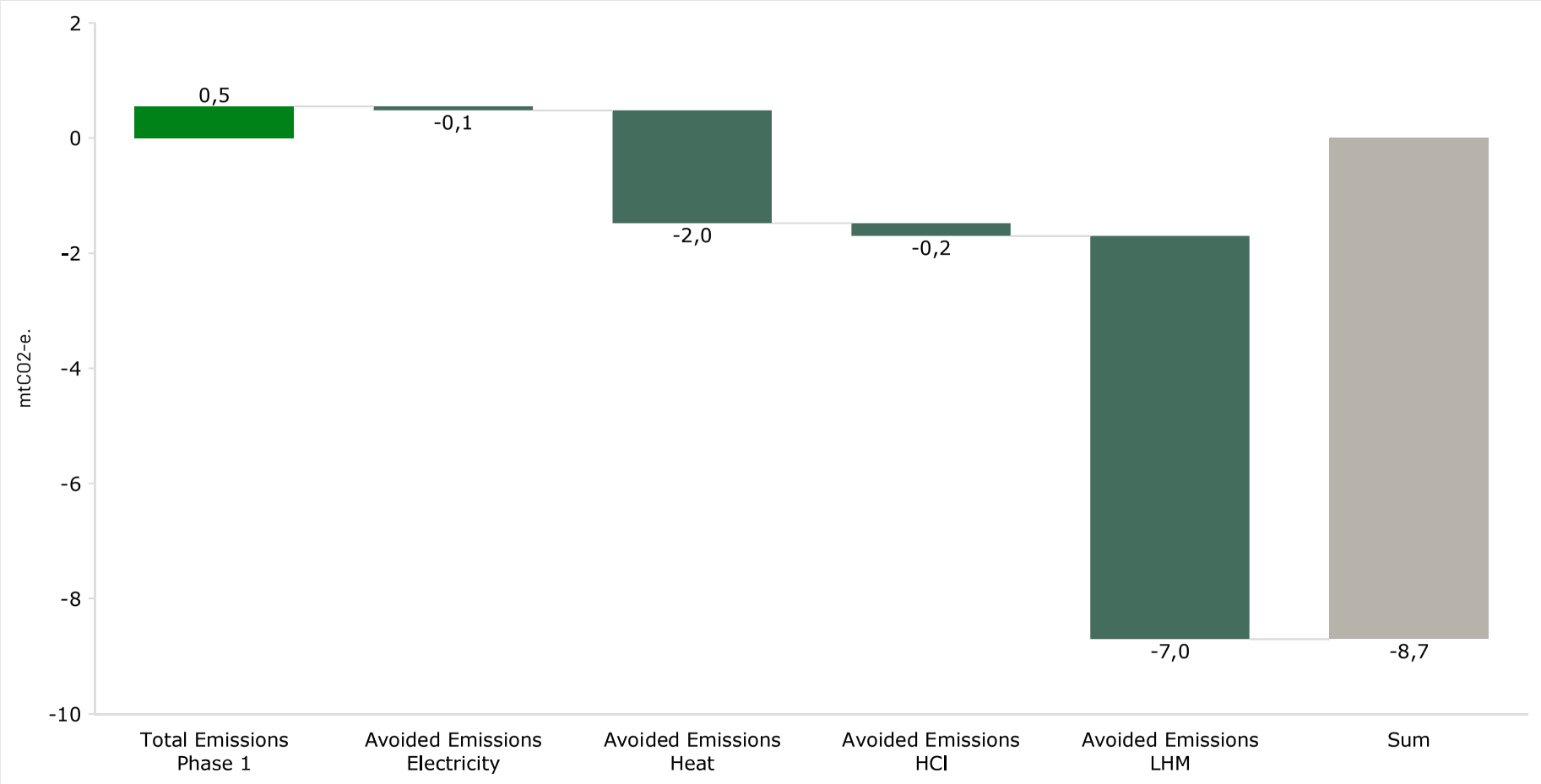


FIGURE 7-8 TOTAL AVOIDED EMISSIONS IN COMPARISON TO TOTAL PHASE 1 EMISSIONS (LOW-CASE)

Source: Vulcan, 2025. Low-case GHG Inventory.

7.1.2.3 COMPARISON BASE-CASE AND LOW-CASE SCENARIO

To summarise, the tables below show the comparison in Scope 1, 2 and 3 emissions for the base-case and low-case scenario during construction (Table 7-56) and operation (Table 7-57).

TABLE 7-56 COMPARISON OF SCOPE 1, 2 AND 3 EMISSIONS FOR THE BASE-CASE AND LOW-CASE SCENARIO DURING CONSTRUCTION AND RAMP-UP

Emission Type	Emissions [tCO_2-e]						
	CY23	**CY24**	**CY25**	**CY26**	**CY27**	**CY28**	**CY29**
Scope 1							
Base-Case	154.75	156.12	134.50	4,457.43	27,746.27	27,150.33	3,561.47
Low-Case	154.74	156.12	134.51	1,043.64	1,531.90	762.20	24.32
Scope 2							
Base-Case	29.39	40.64	1,205.75	5,118.87	4,855.66	7,987.37	24,452.33
Low-Case	29.39	40.64	1,205.75	4,213.90	5,620.12	3,392.93	2,467.32
Scope 3							
Base-Case	9,218.11	9,218.11	12,731.94	72,493.47	117,163.68	73,053.30	17,684.90
Low-Case	9,217.74	9,217.74	12,726.95	72,437.96	116,788.16	71,017.81	8,072.16
Total							
Base-Case	***9,402.24***	***9,414.87***	***14,072.20***	***82,069.77***	***149,765.60***	***108,191.00***	***45,698.69***
Low-Case	***9,400.13***	***9,412.76***	***14,070.09***	***76,950.06***	***117,861.59***	***69,008.54***	***9,757.94***

TABLE 7-57 COMPARISON OF SCOPE 1, 2 AND 3 EMISSIONS FOR THE BASE-CASE AND LOW-CASE SCENARIO DURING OPERATION

Emission Type	Emissions [tCO_2-e]					
	CY30	**CY35**	**CY40**	**CY45**	**CY50**	**CY55**
Scope 1						
Base-Case	437.86	454.2	480.5	522.87	591.09	700.97
Low-Case	26.75	43.09	69.39	111.76	179.98	289.86
Scope 2						
Base-Case	28,597.49	16,596.66	10,000.69	5,744.68	3,498.02	2,095.59
Low-Case	3,219.19	3,048.11	2,927.54	2,592.26	2,316.72	2,114.71
Scope 3						
Base-Case	9,893.41	9,893.41	9,893.41	9,893.41	9,893.41	9,893.41

Low-Case	6,614.47	6,614.47	6,614.47	6,614.47	6,614.47	6,614.47
Total						
Base-Case	***38,928.77***	***26,944.26***	***20,374.60***	***16,160.95***	***13,982.52***	***12,689.97***
Low-Case	***9,763.96***	***9,609.21***	***9,514.94***	***9,222.03***	***9,014.72***	***8,922.59***

During construction and ramp-up the low-case scenario is expected to have significantly less scope 1 emissions starting 2026 due to the use of electricity for well drilling instead of diesel, leading also to less scope 3 emissions from fuel and energy-related activities.

During operation it is anticipated that the low-case scenario has substantially less scope 2 emissions as it assumes 100% green PPAs instead of considering 50% of electricity to be sourced by green PPAs and 50% normal grid mix as for the base-case scenario (see Figure 7-7 compared to Figure 7-3). Also, the low-case scenario assumes the use of green caustic soda and the transport between facilities with electric trucks.

7.1.3 IMPACTS RELATED TO GEOLOGY, SOILS AND SEISMICITY

Impacts associated with the Project are both "area based" and "linear" in nature, and relate to the construction and operation of the drill sites, thermal water pipelines, geothermal power plant and lithium production plant, as well as temporary worker camps and equipment laydown areas, with construction activities that could impact on the local geology, soils and present potential geohazards being mainly:

- Drilling activities;
- Excavations for Pipeline; and
- Construction activities at all Project component

And operational activities mainly linked with the abstraction (pumping) of water from wells at depth.

Typical risks are likely to include:

- Seismic Risks;
- Contaminated Land; and
- Contaminated Spills and Runoff.

Methodology

The evaluation of impact significance was informed by a process of assigning ratings for potential impact magnitude (Table 7-58) and the receptor sensitivity (Table 7-59).

TABLE 7-58 MAGNITUDE OF IMPACT ON GEOLOGY, SOILS AND SEISMICITY

Magnitude	Definition
Large	• Continuous/long-term oil spills during construction activities on soils and during operation (e.g., accidents) (concentrations of pollutants in the soil defined in the Soil Pollution Control Regulations are exceeded to cause long term cancer and hazard risk) • In case of disturbance of contaminated soils, increase contamination in nearby non-contaminated soils to above the background level that will be hazard to human health

Magnitude	Definition
	• Major impacts on the integrity of structures and functionality of the Project (e.g., collapse of the buildings) during a seismic event • Soil stability issues leading to landslides • Soil erosion process during construction that would lead to sediment loading into the sensitive receptors
Medium	• Continuous/long-term oil spills during construction activities on soils and during operation (e.g., accidents) (concentrations of pollutants in the soil defined in the Soil Pollution Control Regulations are exceeded above the generic contamination levels but below the long-term cancer and hazard risk) • In case of disturbance of existing contaminated soils: increase contamination in nearby non-contaminated soils to above the background level that is above the generic risk levels stated in the Soil Pollution Control Regulations but below long-term cancer and hazard • Moderate impacts on the integrity of structures and functionality of the Project (e.g., major cracks in the structures) during a seismic event • Soil stability issues leading to small settlements • Soil erosion process during construction that would lead to sediment loading into local waterways-drainage areas
Small	• Temporary small-scale oil spills during construction and operation (e.g., accidents) activities on soils that lead to contamination below generic contamination levels stated in the German Regulation on Soil Pollution Control and Point Source Contaminated Sites (Soil Pollution Control Regulations) • In case of disturbance of existing contaminated soils: increase contamination in nearby non-contaminated soils to above the background level but below the generic contamination levels stated in the Soil Pollution Control Regulations. • Minor impacts on the integrity of structures and functionality of the Project (e.g., minor cracks in the structures) during a seismic event • Soil stability issues that do not cause health and safety risk concerns • Soil erosion process during construction that would lead to small loading in the amount acceptable to the normal sediment loading process
Negligible	• Temporary use of land (with soil surface) for the storage of excavated materials and construction equipment with no or little impact that is recoverable within a short time scale • No earthquake impact • No soil stability issue • No soil erosion

TABLE 7-59 GEOLOGY, SOILS AND SEISMICITY RECEPTOR SENSITIVITY

Value	Definition
High	• Highly fertile soils for agricultural production • Areas that are extensively impacted from soil stability issues so that community health and safety is impacted • Receiving bodies soil erosion deposition area that feeds directly into sensitive watercourses • Areas falling into seismic zone 2 and 3 (as detailed by GFZ[241])
Medium	• Soils with good quality to support agricultural production • Areas that are locally impacted by soil stability issues • Localised Receiving bodies soil erosion deposition area that does not feed directly into sensitive watercourses • Areas falling into earthquake zone 1 (as detailed by GFZ[241])

[241] GFZ. Die erdbebengerechte Baunorm DIN EN 1998-1/NA (Fassung 2011-01) und die Zuordnung von Orten zu den Erdbebenzonen

Low	• Soils that are not used for agricultural purposes • Areas that are not impacted by soil stability issues • Receiving water bodies located away from soil erosion deposition area • Areas falling into the earthquake zone 0 (as detailed by GFZ[241])
Negligible	• Absence of areas sensitive soil stability issues • Absence of areas sensitive to soil erosion • No Receiving water bodies • Areas outside earthquake zone 0 (as detailed by GFZ[241])

TABLE 7-60 IMPACTS RELATED TO GEOLOGY AND SOILS

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☒	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☒	☒	☐
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

Description of impacts

Construction:

Potential impacts on soil include both permanent and temporary impacts. Temporary impacts are associated with the worker camps, temporary access roads, pipelines, and related areas. For access roads and pipelines, soil will be removed by cuts and/or capped by mineral fill. Normal fill and outcrop dumping will lead to loss of vital soil functions and will require a long period for re-establishment and regeneration. The soil within the RoW of the pipeline will be reused for agricultural purposes once the construction of the pipeline is completed. However, damage to topsoil because of removal to a different location can result in changes to soil fertility, structure, chemical composition. For the temporary unpaved roads, limited water permeability may be retained. Unpaved roads will be restricted to those already used by farm vehicles or covered with gravel. Temporary impacts on soil also include sewage from construction camps. However, the construction camp will be installed in accordance with national standards which is why impacts are expected to be minor.

Permanent impacts are related to natural soils sealed by civil structures (GLEP, CLP, Well sites). At the Schleidberg Well site the construction will lead to the sealing of an area of approximately 2.2 ha (1 ha fully sealed and 1.2 ha semi-sealed through gravel surfaces) plus around 0.4 ha area for drainage basins and storage tanks. Details on all well sites were not available at the

time of this assessment, so it was not possible to assess specific requirements. Nevertheless, Vulcan confirmed that a similar extent of sealing will occur at all other well sites. This results in a total estimated area of approximately 11 ha that is expected to be sealed for the Well sites out of which 6 ha will consist of gravel surfaces.

Lubricating and hydraulic oils used for equipment maintenance, which are kept on the construction site, will only be present in small volumes, contained in drums. Diesel may be present in significantly larger amounts, such as 10 m^3 (i.e., the capacity of a road tanker or fuel oil storage tank). Potential contamination impacts to soils during construction may occur from leaks or spills of diesel or lubricants on the site from equipment or machinery, which can be easily prevented through appropriate management measures and careful handling.

Operation Phase

Like construction, lubricating and hydraulic oils used for equipment maintenance, which are kept on the operating sites, will only be present in small volumes, contained in drums. Diesel may be present in significantly larger amounts, such as 10 m^3 (i.e., the capacity of a road tanker or fuel oil storage tank).

Potential risks to soil during operation may occur from leaks or spills of diesel or lubricants on the site from equipment or machinery, which can be easily prevented through appropriate management measures and careful handling. Other potential risks to soil include potential leaks of the ICPP releasing brine. This can also be easily prevented through appropriate management measures and careful handling.

Decommissioning phase:

Compaction to soils can occur from the movement of heavy vehicles and machinery during decommissioning, subsequently altering the soil structure. However, these impacts are likely to be less intrusive than construction impacts.

Contamination of soil during decommissioning could occur through direct spillage of materials such as fuels and lubricants from vehicles and generators.

Impact significance assessment:

Physical Environment: Geology and Soils			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Direct	Direct	Direct
Receptor	Soil resources		
Receptor sensitivity	High		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Local / Site Level	Local / Site Level	Local / Site Level
Duration	Medium-term	Long-term	Short-term
Frequency	Daily	Daily	Daily
Likelihood	Definite	Possible	Highly likely

Physical Environment: Geology and Soils			
Magnitude of effect	Small	Small	Small
Impact Significance (With embedded mitigation)	**Moderate**	**Minor**	**Minor**
Residual impact (After mitigation)	**Minor**	**Insignificant**	**Insignificant**
Irreplaceable loss of resources	Soil resources	None	None
Reversibility	Irreversible	Recoverable	Recoverable
Evaluation of Mitigation Effectiveness	Difficult to implement, effective	Easy to implement, highly effective	Easy to implement, highly effective
Level of confidence	Medium	Medium	Medium

Embedded mitigation:

- In accordance with the German Building Code (BauGB) the degree of sealing of the plots will be limited to a minimum for ecological reasons.
- Vulcan has implemented topsoil management strategies by separating soil layers and re-using topsoil for local agricultural activities.
- Off-site compensation measures are implemented to compensate for the identified impacts on soil using the "Ökokonto" of the city of Landau.

Additional commitments by Vulcan under Project finance:

Vulcan will follow good practice measures including the following:

- The construction and work sites will be carefully managed and soil in the vicinity will be protected.
- Development and implementation of topsoil removal, transportation, and piling-stocking plans – prior to construction, topsoil will be removed and stockpiled, in a territory selected in advance, for further use. Top-soil stripping will be limited to the footprint.
- Soil will be stored carefully on one side of the construction working area, in such a way that it is not mixed with sub soil or trafficked on by vehicles.
- Soil management will be conducted according to the soil protection concept (BSK) and the soil management expert. Avoid excessive stockpile height to minimize safety risks, maintaining safe slope angles and adjusting height based on stability.
- Limit heavy equipment movement over stockpiles to prevent compression.
- Use protective covers or vegetation to prevent water infiltration and erosion, and ensure proper drainage around stockpiles to avoid water accumulation.
- The construction working area will be reinstated as far as practicable to the same condition as before. This is essential to avoid soil erosion on bare soils.
- Provision of proper drainage facilities to prevent erosion at outcrops, cuts, and fills.

- Stationary equipment that requires refuelling will be located on waterproof surface according to German regulation (AwSV) to minimize risk of soil contamination in case of spills. Refuelling can take place on these locations without having to transport the equipment across the site.
- All diesel, hydraulic oils and lubricating oils will be stored in bunded areas.

TABLE 7-61 IMPACTS RELATED TO GEOHAZARDS

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☐
Access roads	☐	☐	☐
Worker camps	☐	☐	☐
Permanent Infrastructure: new			
Pipeline	☒	☐	☐
Well sites	☒	☒	☐
GLEP near Landau	☐	☐	☐
CLP at Höchst Industrial Park	☐	☐	☐
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☐

Description of impact:

Construction phase:

Potential geohazard impacts of the Project relate to induced seismicity which are seismic events that are caused by human activity. Geothermal fluid injection can lead to mechanical stresses on the bedrock resulting in a seismic event. However, most induced seismic events can only be detected by seismic monitoring stations and are barely noticeable to humans. Induced seismic events rarely exceed magnitudes of 2 or 3 on the Richter scale[242].

Agility and innovation are the core of the reservoir development strategy initiated by Vulcan. Therefore, to seize all geological opportunities, three distinct Field Development Plans were designed for the three geological environments that would be encountered to provide a multi-deterministic range of outcomes that could be encountered.

Induced seismicity is more prone to occur at injection wells that penetrate fault zones than the matrix. A seismic monitoring system will be installed for ongoing surveillance of any induced seismic activities that may result from injection operations or testing. Although the injection wells within the matrix are deliberately situated away from fault zones, and the expectation is

[242] Geothermal Engineering, 2020. Induced seismicity in the context of deep geothermal projects in the Upper Rhine Graben.

that induced seismicity will be minimal, a continuous seismic monitoring system will be implemented as a precautionary measure.

During deep drilling, impacts from mud pressure during cementation or from mud losses into formation can lead to induced seismic events, however these events only rarely occur in practice. According to Geothermal Engineering (2020), induced seismic events from drilling typically occur below the perceptible limit and that damage-relevant seismicity is not to be expected.

Hydraulic testing and stimulation may also lead to seismic events e.g., through injection and circulation tests. The hydraulic permeability in the reservoir and lithology greatly influences induced seismicity. Seismicity occurs predominantly in crystalline rocks compared to sedimentary rocks, which usually have higher hydraulic permeabilities and lower shear strengths. Sedimentary rocks can only cause weak seismicity if any[242]. Since the Project area is located on Rotliegend sedimentary rocks, induced seismicity during hydraulic testing is expected to be of minor concern.

Operational phase:

The volume of water pumped and reinjected is balanced during operation, and the injection pressure is maintained below the critical pressure needed to cause seismic activity. If the injection pressure is excessively high, the production is abruptly stopped, or the production parameters are abruptly altered, induced seismicity may happen. Cooling in the subsurface of the injection side during a geothermal plant's long-term operation is another process that might cause induced seismicity. As a result, the rock mass contracts, altering the in-situ tensions locally and potentially causing seismic activity[242].

Decommissioning phase:

During the decommissioning phase, induced seismicity is not expected because there will be no drilling and/or water pumping and reinjection. Therefore, no impacts from induced seismicity or subsidence of the land are expected during decommissioning.

Impact significance assessment:

Physical Environment: Geohazards			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Direct	Direct	Direct
Receptor	Infrastructure and buildings (both Project and other civil infrastructure nearby)		
Receptor sensitivity	Medium		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Local / Site Level	Local / Site Level	Local / Site Level
Duration	Medium-term	Long-term	Short-term
Frequency	Annually	Annually	Annually
Likelihood	Possible	Probable	Unlikely
Magnitude of effect	Small	Small	Negligible
Impact Significance (With embedded mitigation)	**Minor**	**Minor**	**Insignificant**
Residual impact (After mitigation)	**Minor to Insignificant**	**Minor to Insignificant**	**Insignificant**
Irreplaceable loss of resources	None	None	None
Reversibility	Recoverable	Recoverable	Recoverable
Evaluation of Mitigation Effectiveness	Difficult to implement, effective	Difficult to implement, effective	Easy to implement, highly effective
Level of confidence	Medium	Medium	Medium

Embedded mitigation:

- The Oberrheingraben is one of the most intensively investigated continental rifts worldwide. A large amount of relevant data exists including borehole logs, extensive 2D seismic surveys, and increasing amounts of 3D seismic surveys directly related to lithium and geothermal development. Many scientific publications and research and development Projects throughout the graben provide a comprehensive understanding of this basin.
- 3D seismic data has been acquired in the Lionheart, Mannheim and Lampertheim areas. Structural, geocellular, and dynamic models were created from these data, tied to available well logs and production records from the Insheim and Landau geothermal wells, to determine the resource estimates for the Vulcan licenses within the URG. The seismic data are important for resolving the presence and lateral continuity of the key zones of interest which are the Rotliegend, Buntsandstein, and Muschelkalk successions, as well as the granitic basement.
- Vulcan has adopted a "traffic light system" for seismicity risk mitigation linked to measurement values and specific actions (see Figure 1-1) in accordance with DIN 4150 which specifies mandatory methods for measuring and assessing the effects of vibrations on structures.

- Vulcan has conducted several pre-execution studies such as 3D seismic studies, a geomechanical analysis as well as a seismic risk analysis.
- Vulcan has designed three distinct FDPs for the three geological environments that would be encountered to provide a multi-deterministic range of outcomes. District FDPs are comprehensive, strategic documents that outline the approach and timeline for the development of geothermal resources in a specific geothermal field or district. These plans are critical for guiding the exploration, drilling, and eventual energy production from geothermal resources, ensuring that development is sustainable, economically viable, and environmentally responsible.
    - Base Case (Hybrid FDP) The distribution of injectors between those which target fault corridors and those targeting the matrix is to be carefully balanced and designed to ensure good pressure support to producers while minimising the risk of early decline of lithium concentration in the production stream. Injectors drilled away from fault damage zones target less permeable matrix rock. Therefore, they are planned as multilateral wells to maximise the connection to the reservoir. The maximum injection pressure at wellhead for those ''matrix'' injectors is set to 70 barg, whereas it is restricted to 45 barg for the injectors operating in the FDZ so that the risk of induced seismicity is limited.
    - Low Case (Doublet FDP) It is assumed that only the fault damage zone is charged with lithium to add an extra stress test to the case. There are no multilateral wells. The maximum injection pressure is limited to 45 barg above the initial hydrostatic reservoir pressure to reduce the risk of induced seismicity to a minimum.
    - High Case (Matrix FDP) The development scenario focuses more on the injection into the matrix rather than into the fault zones. The matrix pores as well as the fault zones will be charged with lithium-rich brine. This development plan called the ''high case'' ensures a better sweep of lithium in place and potentially yields a better recovery. Wells are left largely unchanged, however, the number of wells to be drilled is increased to eleven producers and eleven multilateral injectors. Since most injection takes place away from the FDZ (Fault Damage Zone), the risk of induced seismicity is low. That enables setting the maximum injection pressure to 100 barg above the initial hydrostatic reservoir pressure.
- Vulcan has adapted the observation method according to DIN 1053/Eurocode 7 implementing a monitoring network and a response scheme (traffic light system with limit determined with the mining authority (see Figure 7-9).

Additional commitments under Project finance:

- Vulcan is obliged produce a seismological report, take measures for controlled operation and to regularly monitor operation in accordance with the "Ordinance on the Introduction of Environmental Impact Assessments and on Mining Requirements for the Use of Fracking Technology and Deep Drilling"[243];
- Vulcan has insurance to cover damage to Project infrastructure and external third parties in case of unlikely major damage; and

[243] BGBl, 2016. Verordnung zur Einführung von Umweltverträglichkeitsprüfungen und über bergbauliche Anforderungen beim Einsatz der Fracking-Technologie und Tiefbohrungen

- Vulcan is a member of the solidarity fund known as the Mining Damage Failure Fund. It is a solidarity fund covering some public damages if any other coverage of damage has failed and the company is bankrupt.

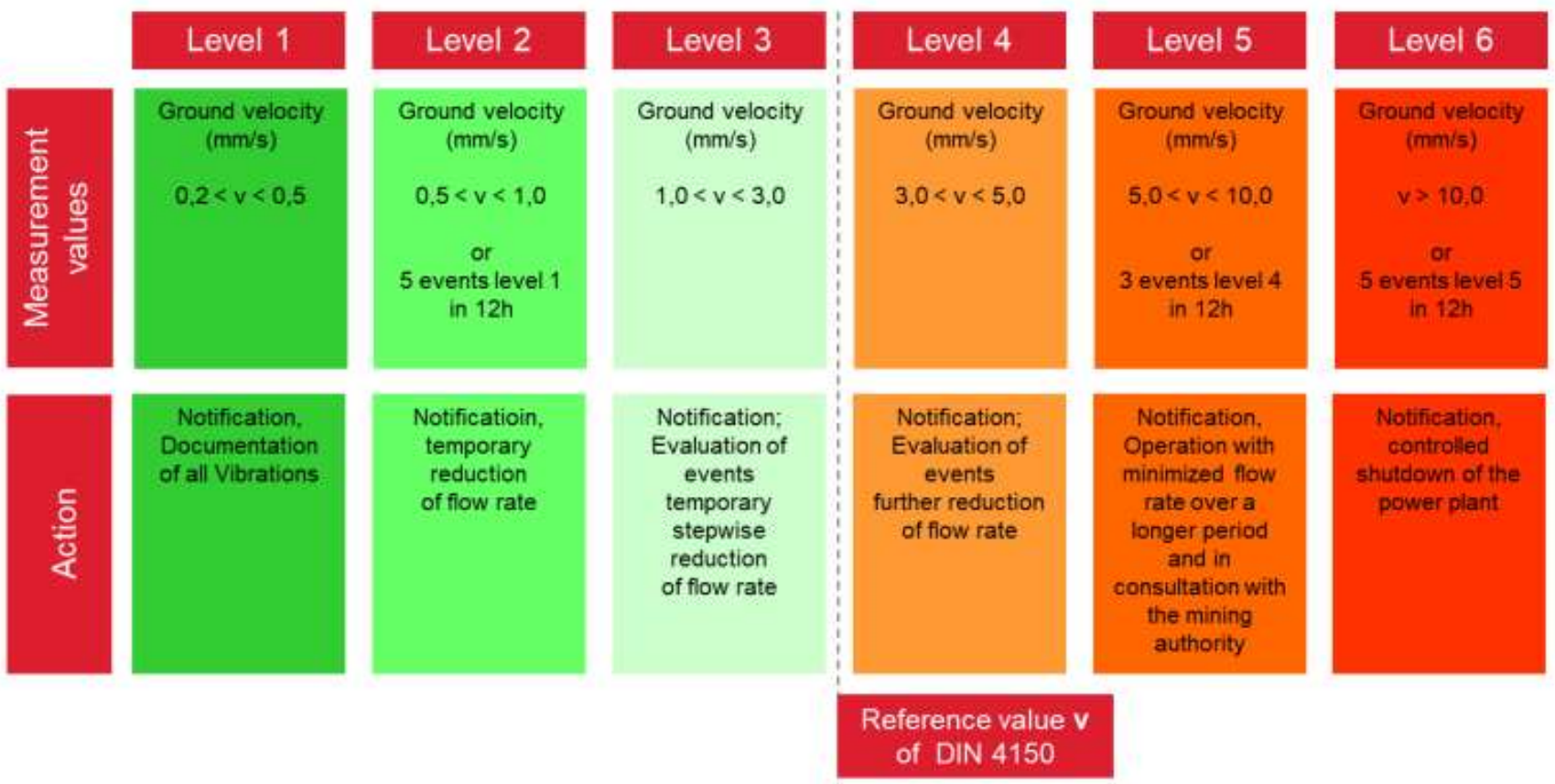


FIGURE 7-9 SEISMICITY RISK MITIGATION OF VULCAN

Source: Vulcan

7.1.4 IMPACTS RELATED TO NOISE

7.1.4.1 METHODOLOGY

It is expected that no blasting will be needed for the ICPP.

Potential impacts of the Project from sound emission and vibration may relate to:

- **Construction:**
- Noise emission during movement of construction vehicles on site (e.g., earthmoving, excavation, transportation);
- Noise emission from operation of other construction equipment (e.g., pneumatic hammers, cranes, drillers, pile drivers, concrete pumps);
- Noise emissions from geothermal drilling activities;
- Noise emission from trucks driving on public roads (e.g., for transportation of materials to and from the site); and
- Vibration from construction equipment (e.g., pile drivers, pneumatic hammers).
- **Operation:**
- Noise from Well operation (e.g., pumps); and
- Noise from geothermal plant operation (GLEP and Insheim Geothermal Plant).
- **Decommissioning**
- Noise emission during movement of decommissioning vehicles on site (e.g., earthmoving, excavation, transportation);
- Noise emission from operation of other decommissioning equipment (e.g., pneumatic hammers, cranes); and
- Noise emission from trucks driving on public roads.

Significance Criteria

When assessing the significance of an impact for the noise and vibration assessment, its significance considers factors such as:

- ***Design details of the noise sensitive property*** **–** for instance, if the construction takes place during a short period of time, significance of the potential impacts may be downgraded.
- ***Sensitivity of the receptor*** **–** receptors sensitive to noise during the daytime only are assessed using criteria that consider the impact of noise on daytime activities, whilst those rated as sensitive during the night-time are assessed using criteria that consider the impact of noise on sleep disturbance.

The magnitude of predicted impact for noise effects are set out below in Table 7-62.

TABLE 7-62 RATING OF MAGNITUDE AND SIGNIFICANCE OF CONSTRUCTION NOISE EFFECTS

Exceedance of criteria, dBA	Magnitude of predicted impact	Other relevant factors
<5 below the criteria	Negligible	Factors which may influence significance of effects, e.g., duration of construction activity, sensitivity of the receptor.
> 5 below, up to the criteria	Small	
Up to 5 dB above the criteria	Medium	
> 5 above the criteria	Large	

Receptor sensitivity for noise is classified in accordance with Table 7-63.

TABLE 7-63 NOISE RECEPTOR SESITIVITY

Receptor Sensitivity	**Definition**
Negligible/Low	Existing construction sites, or industrial areas with existing high levels of background noise or farmland where no sensitive receptors are likely to exist.
Medium	Commercial areas, mixed areas, sports clubs, etc. with moderate levels of background noise.
High	Residential areas, hospitals, schools, retirement homes, recreational areas, nature reserves, etc.

For Well sites, the preliminary noise studies from the Gesellschaft für Technische Akustik mbH (GTA) for the operation of the Well sites of Schleidberg, 40 Morgen and Trappelberg were used to inform the assessment[244]. Furthermore, to evaluate the noise emissions associated with drilling activities at the Well sites, noise emission measurements were carried out by Müller-BBM Industry Solutions GmbH[245] at the Drilling Rig V20, which is operated by Vercana GmbH. These measurements serve as a valuable proxy to enhance the impact assessment of the Project during the drilling phase. Modelling of noise impact from construction activities were calculated based on a typical construction scenario where a construction team is working on a site on flat terrain without any noise shielding effects and from a topography which results in a worst-case (conservative) assessment of noise impacts. This scenario is sufficient to calculate noise levels at various distances from the construction sites, and to calculate noise impacts at receptors.

[244] GTA, 2023. Schalltechnische Voruntersuchungen für den geplanten Betrieb einer Tiefbohranlage am Standort „40 Morgen", Schleidberg und Trappelberg.
[245] Müller-BBM Industry Solutions GmbH, 2025. Vercana GmbH Bohranlage V20 am Standort Insheim.

TABLE 7-64 IMPACTS RELATED TO NOISE

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☐
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

Description of impact:

Construction phase:

Each construction activity will use different types and amount of equipment. The determination of the total sound power level of each construction activity is based on the noise emission characteristics and sound power levels of the equipment type, the maximum number of equipment, and the duration of each equipment being active at one location. Table 7-65 below shows this information for each construction activity, presenting the total sound power level in the last row of each table. The construction equipment sound power level has been derived from BS 5228[246].

TABLE 7-65 EXPECTED EQUIPMENT FOR EARTHWORKS DURING CONSTRUCTION

Earthwork Equipment	Qty.	BS5228	Size	Running time (in %)	Lw, dB(A)
Backhoe	1	C.2.8	62 kW, 8 t	80	95
Bulldozer	2	C.2.11	179 kW, 28 t	70	108
Wheel Loader	1	C.4.13	75 kW, 37 t	80	98
Truck	2	Av C.6.21 & 23	-	50	109
Hydraulic Driller	1	C.3.15	104 kW, 12.5 t	100	111
Vibration Roller	1	D.3.116	50 kW, 7 t	100	106

[246] BS 5228-1:2009+A1:2014. The British Standards Institution 2014

Table 7-66 presents the estimated distances at which the relevant impact magnitude will be met for each construction activity-based noise assessment criteria.

As an example, receptors located within 50 meters from the construction boundaries will typically have a major impact due to earthworks, however receptors located at a distance greater than 160 meters from the construction boundaries, will not have any significant impact due to earthworks. These predicted impacted zones can be applied generally across all sites where earthworks will take place.

TABLE 7-66 CONSTRUCTION NOISE ASSESSMENT CRITERIA

Construction Activity	Noise Level dBA (Impact Magnitude)			
	<65 (Negligible)	**65 – 70 (Small)**	**>70 – 75 (Medium)**	**>75 (Large)**
Earthworks	>160 m	160 – 90 m	<90 – 50 m	<50 m
Roadworks	>145 m	145 – 85 m	<85 - 45 m	<45 m
Structures	>145 m	145 – 85 m	<85 - 45 m	<45 m

In general, the construction noise assessment is based on the construction activity of earthworks (see Table 7-66) as it represents the worst-case scenario (highest noise emission potential). "Roadworks" refers to construction activities such as laying asphalt and concrete, "Structures" refers to activities such as assembling precast materials. These processes are less intense in terms of noise generation because they typically involve lighter, more precise operations.

Table 7-67 presents an overview of the noise receptors within 1 km of the Project components near Landau.

TABLE 7-67 CONSTRUCTION NOISE IMPACT ASSESSMENT FOR RECEPTORS WITHIN THE AOI

Site	Nearest Noise Receptors	Distance to receptor	Magnitude of Impact (linked to Table 7-62)	Receptor Sensitivity
GLEP	Landau: Commercial area	490 m	Negligible	**Medium**
40 Morgen	No noise receptors within the AoI (farmland)	-	Negligible	Low
Trappelberg	No noise receptors within the AoI (farmland)	-	Negligible	Low
Schleidberg	No noise receptors within the AoI (farmland)	-	Negligible	Low
Hasenberg	Insheim: Archery Club (Palatina Bogenschützen e.V.)	400 m	Negligible	**Medium**
Spreissgraben	No noise receptors within the AoI (farmland)	-	Negligible	Low
Pipeline	Insheim: Schützenhaus Diana	120 m	**Small**	**Medium**
CLP	Industrial Park Höchst: Sanofi Office	80 m	**Medium**	Low
	Industrial Park Höchst: Infraserv Höchst Prozesstechnik	100 m	**Small**	Low

Source: GTA, 2023. Preliminary Noise Studies for 40 Morgen, Schleidberg and Trappelberg; ERM, 2023. GIS Data

Table 7-67 shows that the construction noise level for earthworks at the nearest receptors are within negligible impact magnitude except the receptors near the pipeline, the Hasenberg Well site and the CLP. The noise impact during construction of the pipeline is expected to be small for the Schützenhaus Diana, general mitigation measures need to be adopted. For the Archery Club near the Hasenberg Well site, the noise impact for construction noise is expected to be negligible and the receptor sensitivity moderate since the Archery Club is classified as a sports club (see Table 7-63). Note that in July 2025 the exploration area of the Hasenberg Well site was refined. Initially, the Archery Club Palatina Bogenschützen was located 30 m from the Hasenberg Well site, after the update in July 2025 the Archery Club is located around 400 m east of the Hasenberg Well site (see Figure 7-10).

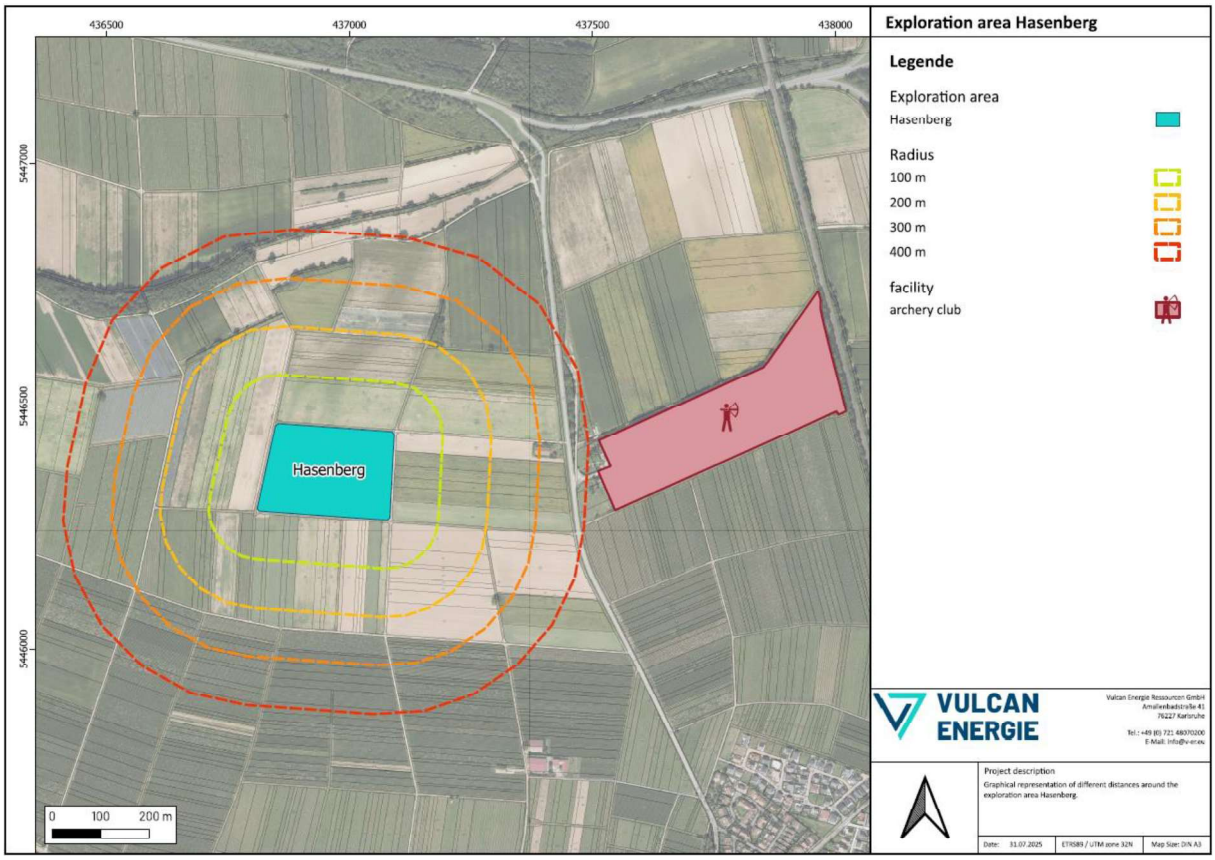


FIGURE 7-10 UPDATED LAYOUT OF THE HASENBERG WELL SITE SHOWING DISTANCE TO CLOSEST RECEPTOR

Source: Vulcan, 2025.

For the CLP Site it needs to be emphasised that the baseline noise levels are above 70 dB(A) which is above the German Noise Level Guidelines. Whilst the magnitude of the noise impact is expected to be medium during construction the receptor sensitivity is low as the background noise level is already high (since the Sanofi Office is located within the Industrial Park Höchst). It is assumed that the buildings within the industrial park are designed to attenuate noise impacts.

The drilling activities[247] at the Well sites will also lead to noise impacts during construction. The Projected noise levels at night during drilling at 40 Morgen, Trappelberg and Schleidberg are shown in Table 7-68, Table 7-69 and Table 7-70. GTA projected the noise levels at night since the German guidelines are stricter for nighttime activities. According to GTA, the daytime noise levels will not deviate from the nighttime noise levels since the drilling procedure remains the same. For all activities, the preliminary noise assessment indicates that German noise limit guideline thresholds will not be exceeded.

[247] These well testing operations, while frequently referred to as 'drilling,' have been classified under the category of construction activities.

TABLE 7-68 PROJECTED NIGHT-TIME NOISE LEVELS DURING DRILLING AT 40 MORGEN

ID	Noise Receptor	Receptor Classification	Noise Assessment Level [dB(A)]	German Noise Level Guidelines (TA-Lärm) [dB(A)]
1	Herxheim: Farm with residential use, along the L 543 road	General residential areas and small residential areas	29.9	40
2	Herxheim: Farm with residential use, Am Schambach 2	General residential areas and small residential areas	27.4	40
3	Herxheim: Residential use, Am Gewerbepark West 18	General residential areas and small residential areas	34.3	40
4	Rohrbach: Hotel, Bahnofstraße 61	General residential areas and small residential areas	26.8	40
5	Insheim: Residential use OR garden shed, Kreisstraße 21	General residential areas and small residential areas	40.0	40

Source: GTA, 2023. Preliminary Noise Study for 40 Morgen.

TABLE 7-69 PROJECTED NIGHT-TIME NOISE LEVELS DURING DRILLING AT TRAPPELBERG

ID	Noise Receptor	Receptor Classification	Noise Assessment Level [dB(A)]	German Noise Level Guidelines (TA-Lärm) [dB(A)]
1	Insheim: Residential use OR garden shed, Kreisstraße 21	General residential areas and small residential areas	19.4	40
2	Rohrbach: Hotel, Bahnofstraße 61	General residential areas and small residential areas	30.2	40
3	Rohrbach: Commercial area with residential use, In den Gerlachsgärten 6	General residential areas and small residential areas	37.7	40
4	Rohrbach: Commercial area with residential use, In den Gerlachsgärten 7	General residential areas and small residential areas	36.0	40
5	Insheim: Residential use, Martin-Luther-Straße 24	General residential areas and small residential areas	36.1	40

Source: GTA, 2023. Preliminary Noise Study for Trappelberg

TABLE 7-70 PROJECTED NIGHT-TIME NOISE LEVELS DURING DRILLING AT SCHLEIDBERG

ID	Noise Receptor	Receptor Classification	Noise Assessment Level [dB(A)]	German Noise Level Guidelines (TA-Lärm) [dB(A)]
1	Mörlheim: Farm with residential use, Mörlheimer Hauptstraße 130	General residential areas and small residential areas	24.2	40
2	Mörlheim: Residential use, Unteres Rappenfeld 80	General residential areas and small residential areas	21.9	40
3	Insheim: Farm with residential use, Kreisstraße 21	General residential areas and small residential areas	34.0	40
4	Herxheim: Farm with residential use, along the L 543 road	General residential areas and small residential areas	26.0	40
5	Herxheim: Farm with residential use, Am Schambach 2	General residential areas and small residential areas	23.4	40

Source: GTA, 2023. Preliminary Noise Study for Schleidberg.

The noise level projections for 40 Morgen, Trappelberg and Schleidberg show that the drilling activities are within the German Noise Level Guidelines (TA-Lärm) for general residential areas and small residential areas. No noise level projections for the Hasenberg and Spreissgraben Well sites for drilling were conducted by Vulcan by the time of this assessment as of September 2024.

To further assess the noise emissions during drilling a noise assessment for noise emissions of drilling sites was conducted in June 2025 by Müller-BBM Industry Solutions GmbH for the Insheim Drilling Rig V20 operated by Vercana GmbH.[248] This noise assessment was conducted considering the guidelines 'Measurement of noise emissions from drilling rigs' by the German Petroleum and Natural Gas Industry Association (2010) which provide a standardised procedure for determining sound power levels, ensuring comparability among drilling rig operators. These measurements provide a valuable proxy to improve the impact assessment of the Project during the drilling phase. The results showing the 45 dB and 60 dB Isophones during drilling around the centre of the borehole are presented in Figure 7-11.

[248] Müller-BBM Industry Solutions GmbH, 2025. Vercana GmbH Bohranlage V20 am Standort Insheim.

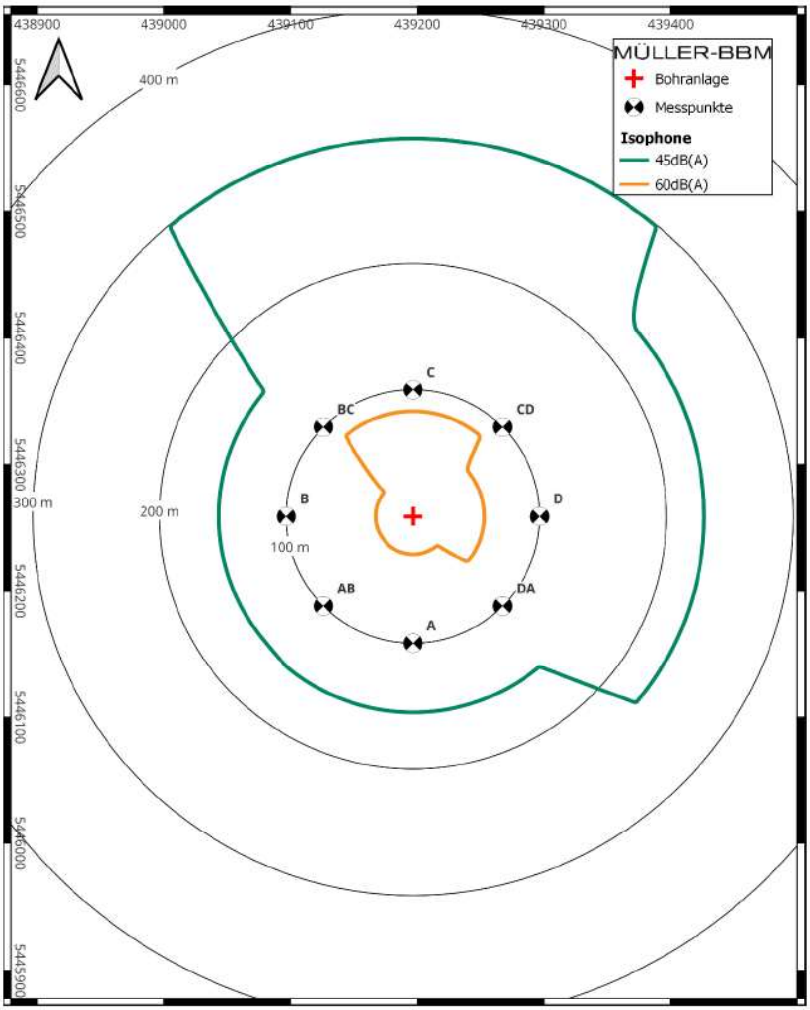


FIGURE 7-11 45 DB AND 60 DB ISOPHONES AROUND THE CENTRE OF THE BOREHOLE

Source: Müller-BBM, 2025.

The results for Insheim Drilling Rig V20 show that the noise emitted during drilling is mainly directed towards the north and, to a lesser extent, towards the east, as all of the plant's auxiliary units (flushing pumps, screens, etc.) are located in these areas. Noise emission is significantly lower in the south and west. The 60 dB isophone extends approximately 80 m from the borehole axis in a northerly direction. The 45 dB isophone is located between 150 m (in a southerly and westerly direction) and approximately 300 m (in a northerly direction) from the borehole axis.

Based on the analysis of these results as a representative measure for the Hasenberg Well site, it is anticipated that noise emissions will not exceed 45 dB during drilling operations at the Archery Club, the nearest receptor located approximately 400 meters to the east. The operational hours of the Archery Club, from 08:00 to 20:00, indicate that daytime noise levels outlined in the German Noise Level Guidelines, specifically 60 dB(A) as per TA-Lärm, will likely be applicable. Consequently, it is expected that the noise levels during drilling at the Archery Club will remain significantly below the 60 dB(A) threshold, ensuring compliance with TA-Lärm regulations.

Considering the results from the study of Müller-BBM (2025) also for the Spreissgraben Well site it can be expected that the noise emissions during drilling will not exceed 45 dB at the nearest noise receptor located 523 m north of the Spreissgraben Well site. This noise receptor is a residential building which is why the German Noise Level Guidelines (TA-Lärm) for general residential areas and small residential areas are applicable which are 40 dB(A). While the available isophone data from the noise report only extends to the 45 dB(A) contour at 300 meters, a conservative extrapolation using standard spherical spreading indicates an expected noise level of approximately 40.17 dB(A) at the receptor. The following formular was used for this extrapolation:

$$L_{\text{target}} = L_{\text{ref}} - 20 \cdot \log_{10}\left(\frac{r_{\text{target}}}{r_{\text{ref}}}\right)$$

The input parameters were the following:

L_{ref} = 45 db(A)

r_{ref} = 300 m

r_{target} = 523 m

$$L_{\text{target}} = 45 - 20 \cdot \log_{10}\left(\frac{523}{300}\right) = \mathbf{40.17}\,\text{dB(A)}$$

This marginal exceedance of the TA Lärm nighttime limit of 40 dB(A) is within the typical modelling uncertainty range and does not account for additional attenuation effects from terrain, vegetation, and atmospheric conditions. Given the temporary nature of drilling activities and the potential for further mitigation, it is reasonable to expect that noise emissions will remain in line with TA Lärm requirements for general residential areas.

Operational phase:

During operation noise emissions can be expected from the Well sites, the GLEP, the currently existing Insheim Geothermal Plant and the CLP in Höchst. GTA has done a preliminary noise study to assess the noise levels at 40 Morgen and Trappelberg during operation (see Table 7-71 and Table 7-72).

TABLE 7-71 PROJECTED NOISE LEVELS DURING OPERATION AT 40 MORGEN

ID	Noise Receptor	Receptor Classification	Noise Assessment Level [dB(A)]	German Noise Level Guidelines (TA-Lärm) [dB(A)]
1	Herxheim: Farm with residential use, along the L 543 road	General residential areas and small residential areas	25.3	40
2	Herxheim: Farm with residential use, Am Schambach 2	General residential areas and small residential areas	18.7	40
3	Herxheim: Residential use, Am Gewerbepark West 18	General residential areas and small residential areas	30.7	40

ID	Noise Receptor	Receptor Classification	Noise Assessment Level [dB(A)]	German Noise Level Guidelines (TA-Lärm) [dB(A)]
4	Rohrbach: Hotel, Bahnofstraße 61	General residential areas and small residential areas	20.2	40
5	Insheim: Residential use OR garden shed, Kreisstraße 21	General residential areas and small residential areas	31.9	40

Source: GTA, 2023. Preliminary Noise Study for 40 Morgen.

TABLE 7-72 PROJECTED NOISE LEVELS DURING OPERATION AT TRAPPELBERG

ID	Noise Receptor	Receptor Classification	Noise Assessment Level [dB(A)]	German Noise Level Guidelines (TA-Lärm) [dB(A)]
1	Insheim: Residential use OR garden shed, Kreisstraße 21	General residential areas and small residential areas	12.9	40
2	Rohrbach: Hotel, Bahnofstraße 61	General residential areas and small residential areas	25.5	40
3	Rohrbach: Commercial area with residential use, In den Gerlachsgärten 6	General residential areas and small residential areas	29.2	40
4	Rohrbach: Commercial area with residential use, In den Gerlachsgärten 7	General residential areas and small residential areas	30.1	40
5	Insheim: Residential use, Martin-Luther-Straße 24	General residential areas and small residential areas	30.9	40

Source: GTA, 2023. Preliminary Noise Studies for Trappelberg.

According to Table 7-71 and Table 7-72 the noise levels at the 40 Morgen and Trappelberg Well sites are within the German Noise Level Guidelines. Since similar distances to the nearest receptors apply for the Schleidberg and Spreissgraben Well sites it is expected that these Well sites are also in line with the German Noise Level Guidelines. For Hasenberg, it is also expected that site will be compliant with the German Noise Level Guidelines since it is expected that noise levels during operation will be lower than during drilling.

MODUS consult has conducted a noise study for the GLEP to assess the compatibility of the planned commercial use with the permissible and existing residential uses in the surrounding commercial, mixed, village and general residential areas. According to MODUS consult, the operation of the GLEP will not lead to a change in the existing noise emission situation that is relevant from a sound engineering point of view and, on the other hand, restricting the existing or future permissible uses in the planning area beyond the extent envisaged in the urban

development plan[249]. However, due to the determined baseline noise levels from road traffic above the orientation values of DIN 18005 for commercial and mixed areas, measures for protection against traffic noise are considered necessary.

Regarding the CLP it is expected that the noise levels during operation are within the Noise Level Regulations for Industrial Parks which are 70 dB(A).

Decommissioning phase:

For decommissioning similar noise levels as per construction are expected, except that drilling will not be required at the Well sites. It is not expected that the decommissioning phase will have significant noise impacts.

Note that noise impacts on wildlife (fauna/animals) is dealt with in the Biodiversity Impact Assessment contained in the ESIA, which should be referred to. These nuisance effects on wildlife are not dealt with here.

[249] MODUS Consult, 2023. Bebauungsplan „D12, Gewerbepark Messegelände-Südost", Fachbeitrag Schall.

Impact significance assessment:

Physical Environment: Noise			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Direct	Direct	Direct
Receptor	Local Population (local businesses, clubs, residents)		
Receptor sensitivity	Medium (Archery club near the Hasenberg Well site)		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Local / Site Level	Local / Site Level	Local / Site Level
Duration	Short-term	Long-term	Short-term
Frequency	Daily	Daily	Daily
Likelihood	Probable	Possible	Probable
Magnitude of effect	Medium	Medium	Small
Impact Significance (With embedded mitigation)	**Moderate**	**Moderate**	**Minor**
Residual impact (After mitigation)	**Minor**	**Minor**	**Insignificant**
Irreplaceable loss of resources	None	None	None
Reversibility	Reversible	Reversible	Reversible
Evaluation of Mitigation Effectiveness	Easy to implement, effective	Easy to implement, highly effective	Easy to implement, effective
Level of confidence	Medium	Medium	Medium

Note: This impact significance has been rated based on the worst-case scenario for the Landau components and Hasenberg drill/well site, whilst impact significance for all other components, including the GLEP and CLP in Höchst will be minor to insignificant for noise.

Embedded mitigation for the GLEP[249]:

- To protect the living, sleeping and recreation rooms from noise pollution caused by traffic and commercial noise, the technical building regulations of the Ministry of Finance dated 8 May 2022 (VV-TB) in accordance with DIN 4109-1:2018-01 and DIN 4109-2:2018-01 must be complied with (cf. A5 of the VV-TB). The respective technical building regulation in the version valid at the time of approval shall apply;
- In the event that the orientation values cannot be complied with, a noise contingent assessment must be carried out in accordance with the specifications of DIN 45691; and
- Implementation of special passive noise protection measures (improvement of the sound insulation of the exterior components of rooms worthy of protection).

Additional commitments under Project finance:

- Only state-of-the-art machinery is used for the construction work[250];
- Vulcan will comply with the principles and requirements of following directive:
  - Sixth General Administrative Regulation on the Federal Emission Control Act (TA-Lärm);
  - IFC General EHS Guidelines; and
  - EC Directive 2002/49.

Construction Equipment and General Earthworks

- Where practicable, noisy equipment will be sited as far away as possible from receptors.
- Where practicable, noisy equipment will be orientated to face away from the receptors at which moderate or major noise impacts are predicted;
- Alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electric-controlled units, will be used, where practicable;
- Where practicable, stationary equipment will be located in an acoustically treated enclosure;
- Throttle settings will be reduced, and equipment turned off, when not being used;
- Onsite chutes and bins will be lined with damping material;
- Equipment will be regularly inspected and maintained to ensure it is in good working order. The condition of mufflers will also be checked. Equipment will not be operated until it is maintained or repaired, where maintenance or repair would address the annoying character of noise identified;
- Compressors, generators, and pumps fitted with properly lined and sealed acoustic covers or enclosures, which will be kept closed whenever the machines are in use, will be used and all ancillary plant (e.g., generators, compressors) will be positioned so as to cause minimum noise disturbance;
- Mufflers or silencers of the type recommended by manufacturers will be fitted;
- For machines with fitted enclosures, doors and door seals will be checked to ensure they are in good working order; also, that the doors close properly against the seals;
- Machines in intermittent use will be shut down in the intervening periods between work;
- Excavated material will be stored between the construction site and the sensitive receptor to form a natural noise barrier (with cover to avoid dust erosion) or other (temporary) noise barriers will be installed for Hasenberg;
- Drop height of materials will be minimalised; and
- Advantage of the natural topography for noise shielding will be taken.

Construction Traffic

The following measures will be implemented for construction traffic including transportation of equipment and material (e.g., borrow areas, spoil areas, etc.) to and from work sites. Material borrow areas and disposal areas are expected to be existing approved facilities and are consequently not further assessed:

- Speed limits (e.g., 30 km/h) will be implemented for trucks while travelling to and from construction sites (as well as within buildings and on village roads of poor condition);

[250] MODUS Consult, 2023. Bebauungsplan „D12, Gewerbepark Messegelände-Südost", Fachbeitrag Schall.

- Slow driving rules in villages (e.g., 30km/h) will be implemented, particularly near sensitive use areas which will be identified (at least one month) prior to start of construction related activities;
- Project traffic routing through community areas will be reduced wherever possible.
- Dedicated site access roads that avoid routing through villages will be used;
- If necessary, to avoid narrow areas near receptors, construction of a new access road will be considered; and
- Hours of operation for specific equipment or operations (e.g., trucks or machines operating in or passing through community areas) will be limited.

Drilling and Operation of the Well site

- Vulcan will consult with the archery club near Hasenberg to confirm their hours of operation and busiest times so that construction and drilling schedules can be optimised around this;
- Implement a simplified Noise Monitoring and (adaptive) Management Plan for the Hasenberg Well site as well as the Spreissgraben Well site, including spot-check monitoring during drilling activities, to confirm that noise levels at the archery club (near Hasenberg) and the nearest residential building from the Spreissgraben Well site remain within the applicable TA Lärm threshold of 60 dB(A) and 40 dB(A), respectively. Full-scale monitoring may be omitted unless future assessments indicate a risk of exceedance. The Plan should be developed in such a way that monitoring results are used to inform whether adaptive measures may be necessary to reduce noise to acceptable levels, where relevant.

7.1.5 IMPACTS RELATED TO AIR

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

Air quality impacts during the construction and drilling activities linked to the air and dust emissions from the use of construction machinery and equipment.

Construction-phase impacts will be more temporary in nature (e.g., temporary areas and emissions) and therefore considerably less significant in the long-term.

It is unlikely that there will be permanent operational air quality impacts of significance associated with the installation and operation of the geothermal power plant, associated water transfer pipelines and lithium production plant. The pipeline will be situated below the ground, which is why no sources of potential air emissions are expected. The other permanent sites (GLEP, CLP, Well sites) will be sealed therefore, no sources of dust are likely. Air emissions from haulage (transport of goods and material) are covered under 0. However, accidental releases during operation might be related to hydrogen sulfide leakage, steam releases with small amounts of non-condensable gases (e.g. CO_2 or CH_4) and operational failures or equipment malfunction.

7.1.5.1 SCOPED OUT IMPACTS

Note that the following potential air quality impacts were initially identified for the project, however a decision was made to exclude them from the assessment of impact significance, with the reasons for excluding impacts provided as follows:

- **Emissions of hydrogen sulfide and mercury associated with geothermal power generation**: the geothermal power plants in Landau and Insheim do not use flash or dry steam technologies but rather a closed system with no emissions of hydrogen sulfide and/or mercury.
- **Emissions during well drilling and flow testing**: Geothermal fluids will be extracted and reinjected by a closed system that will not result in emissions to the atmosphere.

7.1.5.2 METHODOLOGY

As part of this Air Quality Impact Assessment (AQIA), projected results from traffic modelling and dust modelling are compared against relevant air quality standards (AQS). These standards refer to human health impacts of air quality as well as dust deposition/soiling as a nuisance to humans and as an impact to vegetation.

The Air Quality Standards (AQS) relevant to this assessment are based on the European Union (EU) AQS and are set out in Table 7-73.

TABLE 7-73 EUROPEAN AND GERMAN AIR QUALITY STANDARDS

Pollutant	Averaging Period	Unit of Measure	Statistic	EU Threshold	German Threshold
NO_2	Annual mean	µg/m3	N/A	40	40
NO_2	1 hour mean	µg/m3	Not to be exceeded more than 18 times per year	200	-
PM_{10}	Annual mean	µg/m3	N/A	40	40
PM_{10}	24 hours mean	µg/m3	Not to be exceeded more than 35 times per year	50	-
$PM_{2.5}$	Annual mean	µg/m3	N/A	25	25

Pollutant	Averaging Period	Unit of Measure	Statistic	EU Threshold	German Threshold
O_3	Three years	Days	Number of days with maximum 8-hour mean values of the ozone concentration above 120 µg / m^3 averaged over 3 years	-	25

In addition to the above AQS, dust deposition is assessed as an indication of the potential for nuisance to arise due to soiling. The IFC and WHO do not set out guidelines, as dust deposition is a perception and nuisance issue, rather than an issue that directly affects health. Nevertheless, there are several standards and guidelines for dust deposition published by various other bodies, and these are set out in Table 7-74. The TA-Luft (Germany) guideline is a generally reasonable European threshold in which nuisance will occur and was considered in this assessment.

TABLE 7-74 DUST DEPOSITION GUIDELINES

Potential for complaint	Deposition rate (g/m2/day)	Data source
Possible Nuisance	0.600[251] (30-day average)	South Africa National Standards for residential areas
Possible Nuisance	0.350 (monthly mean)	TA-Luft (Germany)
Serious nuisance	0.200	UK recommended nuisance dust deposition rate
Very Likely Nuisance	0.650	TA-Luft (Germany)
First Loss of Amenity	0.133 (monthly mean)	West Australia Nuisance Standard
Unacceptable reduction in air quality	0.333	West Australia Nuisance Standard

Dust emissions can also adversely impact on vegetation close to the construction works. These impacts vary on a species-by-species basis but are typically in the same order of magnitude as nuisance impacts at human receptors[252]. These impacts are covered under the 'Biodiversity Impact Assessment' in the relevant section of the ESIA report. On this basis, the guidelines for the avoidance of nuisance at human receptors can also be used to avoid adverse impacts on vegetation. There are some exceptions, for example agriculture producing soft fruits or leafy vegetables such as the vineyards in the AoI that may be more susceptible to damage and these will need to be considered on a case-by-case basis, if present.

[251] For residential areas can be exceeded 3 times in a year and not in consecutive months.
[252] Farmer, A.M. (1994). The Effects of Dust on Vegetation – A Review.

The assessment of impact significance was informed by assigning ratings for the impact magnitude (Table 7-75) and the receptor sensitivity (Table 7-76) with respect to air quality.

TABLE 7-75 MAGNITUDE OF IMPACT ON AIR QUALITY

Magnitude	Negative Deviation from AQ Standard
Negligible	<10 % of air quality standard
Small	10-25 % of air quality standard
Medium	25-75 % of air quality standard
Large	>75 % of air quality standard

TABLE 7-76 RECEPTOR SENSITIVITY AIR QUALITY

Receptor Sensitivity	Definition
Negligible	Negligible human exposure
Low	Transient human exposure. Examples include public footpaths, playing fields, parks and shopping streets.
Medium	Locations where workers are exposed over a time period relevant to the air quality objectives[253]. Examples include office and shop workers[254]
High	Locations where members of the public are exposed over a time period relevant to the air quality objectives[253]. Examples include residential dwellings, hospitals, schools and residential care homes.

7.1.5.3 IMPACTS ON AIR QUALITY

Description of impact:

Construction phase:

Various construction activities can have an impact on workers and sensitive receptors at and near construction sites and along access roads, primarily through airborne dust. Additionally, combustion gas emissions from construction vehicles and machinery can affect local air quality both in the vicinity of the construction sites and along traffic routes used by trucks.

The number of machines operating at each construction sites may vary from around 8 to 10, the emissions from which are comparable to a similar number of trucks in a first estimate. The truck traffic to and from each construction site varies between 50 and 100 trucks per day during the peak times of the construction phase.

The baseline dust content of the air in the AoI is below the national air quality threshold. This suggests that dust impacts from construction works may become a nuisance for Insheim and southern Landau since these residential areas are located in close proximity to where construction of pipelines and infrastructure will occur, including temporary access roads where

[253] In the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day.
[254] Does not include workers exposure to PM10 as protection is covered by Health and Safety at Work legislation.

needed. This is likely to be amplified by the largely flat to gently undulating topography and large areas of croplands that are generally void of tall vegetation that could otherwise provide a barrier against airborne dust. In some areas though, rows of trees and shrubs form vegetated screens to protect residential areas from dust, especially closer to the settlements themselves.

At the GLEP the expected increase in traffic volume will have an adverse effect on the air quality. The GLEP will be within the eastern urban area of Landau, primarily within the Queichniederung which is important for cold air inflow. These features are crucial for the area's fresh air supply and corresponding air quality. The nearby A65 motorway and the area's heavily utilised access roads already have a detrimental effect on the quality of the air, and these will likely be compounded in the short- to medium-term during construction of the Project. To some extent, the planned green areas within the GLEP site will potentially compensate for the impacts on air quality by increasing the air humidity, binding dust, and having a positive effect on the microclimate. According to Landau's D12 development plan it is not expected that the GLEP will alter the cold air flows[255].

At the Well sites, construction traffic during drilling is expected. During the week, 10–20 trucks are anticipated. No travels are scheduled for Sundays, public holidays, or after usual business hours. The unpaved Well sites access roads may result in an increase in dust emissions because of the increased vehicle traffic. When the access road is paved and extended, it will be turned into a gravel road to prevent dust from accumulating[256].

The CLP in Höchst has a low receptor sensitivity due to its location within an existing industrial site. Therefore insignificant/minor impacts are expected with standard mitigation in accordance with the requirements of the industrial park and German law.

Operational phase:

No significant emissions of air pollutants are expected from the Project components during operation (see screened-out impacts on air in 7.1.5.1). However, emissions from accidental releases and haulage need to be taken into account. During the initial phase of operation, diesel trucks will emit particulate matter (PM) as part of their exhaust. However, the impact of these emissions will be minimal due to the high existing traffic along the transportation route, which already contributes significantly to overall air pollution. Additionally, there are no sensitive receptors, such as residential areas or schools, along the route, further reducing any potential health risks. As a result, the air emissions generated by the diesel trucks are expected to be negligible in comparison to the overall traffic-related emissions. Emissions from accidental releases are covered under 7.14.

Decommissioning phase:

Impacts during decommissioning of the Project infrastructure (demolition and removal of hard infrastructure) are likely to generate dust. Dust impact from decommissioning works may become a nuisance for Insheim and southern Landau since they are located along the access roads, in a similar manner to the construction phase impacts.

[255] Stadt Landau, 2023. Bebauungsplan „D12, Gewerbepark Messegelände-Südost.
[256] Vulcan, 2022. Stellungnahme zur allgemeinen Umweltverträglichkeits-Vorprüfung (UVP-V) – Schleidberg Süd.

Combustion gas emissions from vehicles and machinery for decommissioning can affect local air quality both in the vicinity of the construction sites and along traffic routes used by trucks.

Decommissioning phase impacts, whilst comparable to the construction phase, are likely to be less problematic due to shorter duration and lower intensity of activities, with less potential to generate dust and probably far fewer vehicles emitting fumes. At the stage of decommissioning, technological advancements may also serve to mitigate air quality risks, however these cannot be known with any degree of certainty at this stage.

Impact significance assessment:

Physical Environment: Air Quality			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Direct	Indirect	Direct
Receptor	Workers, Local Communities (residents of Insheim, Landau)		
Receptor sensitivity	Workers: Medium Local Communities: High		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Local	Site Level	Local
Duration	Short-term	Long-term	Short-term
Frequency	Daily	N/A	Daily
Likelihood	Highly likely	Unlikely	Highly likely
Magnitude of effect	Small	Negligible	Small
Impact Significance (With embedded mitigation)	**Minor to Moderate**	**Insignificant**	**Minor to Moderate**
Residual impact (After mitigation)	**Minor to Insignificant**	**Insignificant**	**Minor to Insignificant**
Irreplaceable loss of resources	None	None	None
Reversibility	Reversible	Reversible	Reversible
Evaluation of Mitigation Effectiveness	Easy to implement, highly effective	Easy to implement, highly effective	Easy to implement, highly effective
Level of confidence	High	High	High

Commitments under Project finance include:

- At the Well sites access roads will be lined with gravel to avoid dust turbulence, if required in case of poor road and path conditions.[257]
- At the GLEP air conduction paths will be kept free or cold air production areas will be created.[258]
- Vulcan will comply with the principles and requirements of following directive:

[257] Vulcan, 2022. Stellungnahme zur allgemeinen Umweltverträglichkeits-Vorprüfung (UVP-V) – Schleidberg Süd.
[258] Stadt Landau, 2023. Bebauungsplan „D12, Gewerbepark Messegelände-Südost.

- General Administrative Regulation on the Federal Emission Control Act (Technical Instructions on Air Quality Control - TA Luft).[259]

Given the, in general, the only Insignificant to Minor significance of impacts, specific mitigation measures are not considered necessary besides the implementation of general good practice for construction works to keep exhaust and dust emissions from the construction site as low possible. The ESMMP will include a series of good practices, such as:

- Regular air quality monitoring especially during construction activities (conduct regular site inspections for dust, manage air quality complaints through community grievance mechanism, turn off engines when not in use);
- Soil management will be conducted according to the soil protection concept (BSK) and the soil management expert, works will be suspended when dust cannot be adequately controlled;
- Switching off machinery and vehicles when not in use;
- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible;
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site necessary mitigation measures will be taken;
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate;
- Use enclosed chutes and conveyors and covered skips;
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- Moistening of dusty surfaces and storage piles during dry weather conditions;
- Sheeting of truck loads;
- Cleaning of truck wheels when leaving the construction site;
- Careful selection and maintenance of combustion engines;
- Routine testing of vehicle emissions to ensure compliance with exhaust limits; and
- Awareness training for operators and drivers regarding the generation of pollutant emissions within their activities.

7.1.6 HYDROLOGY

7.1.7 IMPACTS ON SURFACE WATER

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☐
Access roads	☒	☐	☐
Worker camps	☒	☐	☐

[259] Neufassung der Ersten Allgemeinen Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz (Technische Anleitung zur Reinhaltung der Luft – TA Luft) (verwaltungsvorschriften-im-internet.de)

Components	Construction	Operation	Decommissioning
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☐	☐	☐
GLEP near Landau	☐	☐	☐
CLP at Höchst Industrial Park	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☐	☐

Methodology

Table 7-77 and Table 7-78 describes the ratings used for impact magnitude and resource/receptor sensitivity, respectively, when assessing impact significance to surface water resources.

TABLE 7-77 IMPACT MAGNITUDE ON SURFACE WATER

Magnitude	Definition
Large	• Contamination of surface water degrades the existing water quality by 50-100 % of the original water quality. • Potentially severe effects on surface water quality are likely to be long-lasting (e.g., months or more) or permanent and/or give rise to indirect ecological and/or socio-economic impacts. • There are known/expected physical (property, agricultural fields, infrastructure, etc.) or sensitive ecological receptors upstream or downstream within the catchment that could experience a 'significant increase in flood frequency (above baseline conditions) as a result of the Project.
Medium	• Contamination of surface water degrades the existing water quality by 50 % of the original water quality. • Potential localised effects on water quality are likely to be fairly long-lasting (e.g., weeks or months) and/or give rise to indirect ecological and/or socio-economic impacts. • There are known/expected physical (property, agricultural fields, infrastructure, etc.) or sensitive ecological receptors upstream or downstream within the catchment that could experience an increase in flood frequency (above baseline conditions) as a result of the Project.
Small	• Contamination of surface water degrades the surface water run-off quality by 10 % of the original water quality. • Potential short-term localised effects on water quality but which are likely to return to equilibrium conditions within a short timeframe (e.g., hours or days at most). • There are no known/expected physical (property, agricultural fields, infrastructure, etc.) or sensitive ecological receptors upstream or downstream within the catchment that could be affected by the changed drainage regime.
Negligible	• Contamination of surface water that is temporary and that does not degrade the existing surface water run-off quality. • No short-term localised effects on water quality • There is likely to be no alterations to existing drainage regimes and characteristics at any time of year

TABLE 7-78 SURFACE WATER RECEPTOR SENSITIVITY

Value	Definition
High	• Watercourse with high quality e.g., in its natural state and with ecological importance. • The watercourse provides vital ecosystem services. • The watercourse provides urban water supplies, major industrial abstraction or large irrigation supplies.
Medium	• The watercourse supports diverse populations of aquatic habitats. • The watercourse provides ecosystem services to some extent. • Watercourse used for local water supply source, small industrial abstraction • Or minor irrigation scheme.
Low	• Watercourse located in the vicinity that supports some aquatic habitat. • Watercourse already modified from some aspect of a natural condition. • Watercourse with little community use.
Negligible	• Watercourse located in the vicinity that does not support diverse aquatic habitat. • Watercourse already significantly modified from some aspect of a natural condition. • Watercourse with no community use.

Description of Impact:

Construction phase:

The watercourses in the Project area are already modified with little community use which is why the surface water sensitivity can be classified as low. During construction, impacts on surface water relate to potential contamination of the streams from leaks or spills of diesel or lubricants on the site from equipment or machinery. These impacts can be avoided by appropriate management measures and careful handling. Other impacts on surface water during construction relate to the crossing of streams of the pipeline. The pipeline will be crossing the streams close to existing infrastructure. However, risks during construction impacts on the steams relate to the flow diversion, damage of the water course and risks of erosion.

Impacts on sewage from construction camps are addressed in the impact assessment on soils (see section 7.13). Other impacts on surface water during construction might include erosion from stripped areas and topsoil stockpiles as week as water disposal from ICPP trench dewatering. These impacts are however expected to be minor due to embedded mitigation measures.

Operational phase:

During operation, hazardous waste from maintenance materials and chemicals accidentally entering nearby streams might lead to water quality degradation if not managed properly. Also, accidental spills of LiCl concentrate during product transport might impact surface water. This is however deemed unlikely due to embedded mitigation measures.

Importantly, the surface water drainage of the GLEP will be ensured by seven infiltration troughs, three of which are situated further south and four of which are situated on the Birnbach to the north of the GLEP site. The topography of the Project area near Landau is very flat which is why rainwater cannot be collected easily by a rainwater drainage system. Vulcan therefore plans to collect runoff from rain using gently sloping surface drainage ditches. Through this action,

negative impacts from surface runoff on at the GLEP are reduced. Water resources will not be significantly harmed through the actions mentioned above.

Decommissioning phase:

During decommissioning, potential impacts to surface water may occur from leaks or spills of diesel or lubricants on the site from equipment or machinery, which can be avoided by appropriate management measures and careful handling, like the construction phase. Other impacts during decommissioning may occur from the removal of the pipeline at the stream crossings which could temporarily have an impact on the streams.

The impact on surface water during decommissioning is spatially limited and impact magnitude is likely to be small should impacts arise.

Impact significance assessment:

Physical Environment: Surface Water			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Indirect	Indirect	Indirect
Receptor	Watercourses (Main River at Höchst and small streams near Landau project components/pipeline)		
Receptor sensitivity	Low- Medium		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Local	Local	Local
Duration	Short-term	Long-term	Short-term
Frequency	Weekly	Daily	Weekly
Likelihood	Possible	Possible	Possible
Magnitude of effect	Small	Small	Small
Impact Significance (With embedded mitigation)	**Minor**	**Minor**	**Minor**
Residual impact (After mitigation)	**Insignificant / None**	**Insignificant / None**	**Insignificant / None**
Irreplaceable loss of resources	None	None	None
Reversibility	Recoverable	Recoverable	Recoverable
Evaluation of Mitigation Effectiveness	Easy to implement, highly effective	Easy to implement, highly effective	Easy to implement, highly effective
Level of confidence	High	Medium	High

Commitments under Project finance include:

The main mitigation measures will be two-fold:

1) Good practice/standard industry construction controls regarding waste, wastewater, and handling of fuels/chemicals. Etc. which should be detailed in a waste, wastewater, and hazardous substances management plan.

2) Operational controls on surface water runoff to be handled by the operational storm water management system, including separation of clean and dirty storm water, and domestic/industrial wastewater to be treated at a licensed wastewater treatment facility.

- Vulcan will comply with the principles and requirements of following directive:
- European Water Framework Directive (WFD).

Other embedded mitigation includes:

- Creation of infiltration troughs at the GLEP; and
- Creation of surface drainage ditches.

Additionally:

- All facilities and structures will be regularly inspected and maintained to ensure proper and efficient operation at all times, and especially after heavy rainfall. Sediment deposits will be

regularly removed and disposed of either by spreading on-site (if uncontaminated) or at a suitably licensed facility.

- The design of the watercourse crossings will avoid affecting the stability and long-term
  - performance of riverbanks and flood defences.
- Wherever practicable, periods of low flow will be chosen for the open cut watercourse crossings resulting in a quicker deposition from the water column of any sediment released.
- Working within the river channel will be avoided where possible. However, where in-river work is unavoidable, measures such as the deployment of oil booms and straw bales downstream or temporary pumping or diversion of flow will be undertaken to mitigate the potential impacts and minimise any increase in sediment load on the river.
- Construction activities at watercourse crossings will occur over a limited period of time and with the minimum equipment required for safe and efficient working.
- Vegetation clearance along river/stream banks will be minimised.
- Watercourse crossings will be constructed perpendicular to the axis of the river channel where engineering and routing conditions allow.
- All construction material and structures will be removed from all watercourses once construction has been completed.
- River channels, riverbeds and banks will be restored to their original state and enhancement measures will be undertaken wherever appropriate.
- Riverbanks and adjacent upland areas will be stabilised immediately after final grading.
- The right of way of the pipeline route will be inspected on a regular basis during and after construction and any erosion control measures will be repaired and/or restored as needed.
- Diversion pipes or channels will be sized to convey the mean annual flow rate.
- Diversion pipes and channels will be at the same gradient as the river.
- River water should enter and exit at the normal channel invert level i.e. the water should not cascade from the pipe or channel. Measures to facilitate equipment crossings will include timber mats laid adjacent to and across the riverbed, flume pipes covered by fill material (clean gravel or crushed stone), flume pipes covered by fill material overlain with timber mats or portable bridges.
- Where fill for equipment crossings comprises log rip rap or other erodible material, sandbags will be placed within the watercourse, and both upstream and downstream of the crossing point, to stabilise and seal the flume pipes.
- All disturbed areas within the existing channel will be reinstated and stabilised prior to flow being redirected into it. Suitable protection from any disturbed areas that have not been stabilised will be provided for the channel.
- During reinstatement, flume pipes, sandbags and other material will be removed and the watercourse will be restored to its original state.
- Where practical, banks should be stabilised, and permanent sediment barriers installed immediately upon completion of the crossing.
- Refuelling of fixed and mobile plant and vehicles will occur in a designated area at least 30m from drains, watercourses.

- A spillage risk assessment should be undertaken as part of the development of the Emergency Preparedness and Response Plan (EPRP);
- The EPRP Plan should specify that Spill Response Kits will be available, including absorbent materials suitable for the materials to be handled on-site, will be held at secure, clearly signposted locations, instructions will be provided with the kits and personnel will be trained in their use;
- Any spillages will be immediately contained on-site and all contaminated materials including soils will be removed from the site for suitable treatment and disposal;
- All staff and subcontractors will be required to report any incidents, and these will be subject to investigation and remedial and preventive actions will be taken;
- Create a secure and designated storage area for fuels and chemicals, equipped with an impervious cover and adequate containment volume for storing all chemicals. Restrict refuelling of vehicles or equipment to impermeable hard-standing areas with strict spill controls;
- There will be no direct discharge of contaminated run-off from worksites to any watercourse at the construction components; and
- Construction equipment will be cleaned away from surface waters.

7.1.8 IMPACTS ON GROUNDWATER

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☒	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

7.1.8.1 METHODOLOGY

Table 7-79 and Table 7-80 describe the rating designations used for impact magnitude and resource/receptor sensitivity, respectively, when assessing impacts to groundwater resources.

TABLE 7-79 MAGNITUDE OF IMPACT ON GROUNDWATER

Magnitude	Definition
Large	Discharges to groundwater are likely to cause breaches of statutory discharge limits (over extended periods) (provided in Federal Drinking Water Ordinance (TrinkwV)).
Medium	Discharges to groundwater bodies are expected to cause breach(s) of statutory limits (over limited periods) (provided in Federal Drinking Water Ordinance (TrinkwV)).
Small	Discharges to groundwater are expected to be within (but perhaps close to) statutory limits (levels provided in Federal Drinking Water Ordinance (TrinkwV)).
Negligible	Discharges to groundwater are expected to be well within statutory limits.

TABLE 7-80 GROUNDWATER RESOURCE SENSITIVITY

Value	**Definition**
High	• High-quality groundwater that is used for drinking or domestic purposes. • Groundwater that provides baseflow to surface watercourses that have high quality or supports a wetland with ecological importance.
Medium	• Medium quality groundwater. • Groundwater that provides baseflow to surface watercourses used for recreational fishing. • Groundwater that is abstracted for industrial purposes or agriculture (i.e., irrigation purposes).
Low	• Groundwater in deep aquifers. • Low-quality groundwater is not used by the community. • Groundwater that provides very little baseflow to surface watercourses or support habitats.
Negligible	• No aquifer. • Very low-quality groundwater is not used by the community. • Groundwater that does not provide baseflow to surface watercourses or support habitats.

Description of impact:

Construction phase

As outlined in baseline section 6.6.5, the shallow groundwater quality in the Project area near Landau is considered poor due to elevated nitrate levels, primarily resulting from extensive agricultural activities. This groundwater is typically used for agricultural purposes.

During the drilling of brine wells, each well will require between 7,000 and 10,000 m³ of water. To meet this demand, shallow groundwater service wells will be drilled at each well site. With a total of 23 wells planned for the Project, the estimated total water abstraction for drilling will amount to approximately 230,000 m³. In comparison, the non-public sector in Rhineland Palatinate abstracted 1,717.2 million m³ of groundwater in 2019, which includes water use in manufacturing, agriculture, and service sectors. Thus, the water needed for drilling represents about 0.0001% of the region's annual groundwater consumption. Drilling each brine well is expected to take around three months, so the groundwater abstraction for drilling will be temporary.

Dewatering of shallow groundwater will be necessary during pipeline construction where groundwater levels are very shallow and intersect the proposed pipe trenches. After settling any sediment, the extracted groundwater will be discharged into the nearest watercourse. Dewatering will occur only during the construction phase of the pipeline, which includes trench excavation, pipe installation, and backfilling. This process will also be of short duration.

Groundwater will also be needed to initially fill the industrial pipeline before operations begin, with the filling process being carried out in stages. A shallow groundwater service well will be installed at the GLEP to supply around 10,209 m^3 of water for the industrial circuit. Minimal water abstraction (between 1 and 30 m^3) will be required bi-annually for maintenance purposes during production. The initial filling is a one-time event and will be brief.

Potential impacts on the shallow groundwater during construction could arise from leaks or spills of diesel or lubricants from equipment or machinery. These risks will be mitigated by Vulcan through proper management practices and careful handling.

Although the shallow groundwater in the Quaternary sediments is hydraulically separated from the deep brine, there is a potential risk of interaction with deeper aquifers of varying water quality during drilling. Furthermore, construction activities could reduce groundwater infiltration areas due to surface sealing. However, the natural permeability of the soil (loess loam) is already limited, restricting precipitation water from penetrating the surface.

Overall, the potential impact on shallow groundwater during construction is expected to be localised, temporary, and of low magnitude.

Operational phase:

The shallow groundwater in the Quaternary sediments is hydraulically isolated from the deep brine, ensuring no interaction through hydraulic connections during operation. Brine re-injection will be performed at a pressure below the hydraulic fracturing threshold, preventing the formation of potential hydraulic pathways between the brine and the overlying layers.

The brine abstraction and re-injection will follow a "closed-loop" system, with the re-injection rate matching the abstraction rate. As a result, the operation will not affect the overall quantity of the brine resource.

During operation, the brine and industrial water will be transported via pipelines between the wells, processing plant, and geothermal power plants. There is a potential risk of shallow groundwater contamination from leaks in these pipelines.

A shallow groundwater service well at the GLEP will supply water to compensate for minor losses in the industrial system during operation. The water requirements for ICPP maintenance are expected to be minimal, making groundwater abstraction insignificant.

Overall, with the proper implementation of controls, the operation's impact on the shallow groundwater and brine quantity is expected to be negligible.

Decommissioning phase:

Like construction, potential impacts to the groundwater resource during decommissioning may occur from leaks or spills of diesel or lubricants on the site from equipment or machinery.

During decommissioning the lithium brine wells will be sealed with concrete or other appropriate material to prevent fluid migration and avoid hydraulically linking deep aquifers with the shallow groundwater system. However, it is not expected that this will have an impact on groundwater quality.

The impact on groundwater during decommissioning is spatially limited and the impact magnitude is small, provided the wells are properly sealed.

Impact significance assessment:

Physical Environment: Groundwater			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Direct	Direct	Direct
Receptor	Ground water - Water Quality, Water Availability		
Receptor sensitivity	Water Quality: Medium Water Availability: Medium		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Local	Regional	Local
Duration	Short-term	Long-term	Short-term
Frequency	Daily	Daily	Daily
Likelihood	Definite	Definite	Possible
Magnitude of effect	Medium	Medium	Small
Impact Significance (With embedded mitigation)	**Moderate**	**Moderate**	**Minor**
Residual impact (After mitigation)	**Minor**	**Minor**	**Insignificant**
Irreplaceable loss of resources	None	None	None
Reversibility	Reversible	Reversible	Reversible
Evaluation of Mitigation Effectiveness	Easy to implement, highly effective	Easy to implement, highly effective	Easy to implement, highly effective
Level of confidence	Medium	Medium	Medium

Embedded mitigation according to the Special Operating Plan (*Sonderbetriebsplan*) for Groundwater Monitoring in Schleidberg:

- The Project will adhere to the requirements for handling substances hazardous to water in accordance with the legal regulations of the WHG (Water Resources Act).
- For the drilling of the six deep wells at Schleidberg the monitoring wells were placed in a layer of clay below the lower aquifer and tested for leaks. The same process is envisaged at the other well sites.
- Particular attention will be paid to avoiding the hydraulic connection between the aquifers. Groundwater recharge areas for the UGWL occur along a north-south longitudinal strip in the Landau area, where groundwater from the upper aquifer flows into the lower aquifer (Belafi, 2016). There is therefore a potential for substance transfer into the lower aquifer. A little further to the east, there is a parallel strip with a drawing zone of the lower aquifer that

infiltrates into the upper aquifer (Belafi, 2016). The deep lithium brine is hydraulically separated from the shallow groundwater via a thick sequence of low permeability sediments. The wells will be constructed using a multi-barrier system optimised for safety and environmental protection. Therefore, no adverse changes to the local shallow groundwater conditions are to be expected at any time due to the brine abstraction and re-injection.

- During drilling operations, a permanent pressure measurement is carried out to monitor for leakage. The well annulus will be filled with inhibited completion fluid which provides an immediate indication of thermal water escaping near the surface before it infiltrates
- In addition, the continuous groundwater monitoring will provide immediate data on any potential increase in temperature and/or salinity values at the drilling site and thus the integrity of borehole barriers.
- Two groundwater monitoring wells, one in the upper aquifer and one in the lower aquifer were installed to a depth of 26.5 m at the Schleidberg site. These groundwater monitoring wells are positioned directly downstream of the deep Wells at a maximum distance of 94 m from the Well (to the northernmost drilling point at an angle of 122°). Similar groundwater monitoring wells will be installed at the other well sites.
- Two service water wells were also installed into the lower aquifer at the site to provide service water for the Well drilling, which will also be used as monitoring wells once the Well is completed.
- The groundwater in the monitoring wells is analysed extensively by an accredited laboratory before the start of deep drilling to determine reference values (baseline conditions) and to identify any existing groundwater contamination.
- Continuous groundwater monitoring will be completed, including monitoring of conductivity, temperature and pressure in the groundwater monitoring wells, which will be reported in an annual monitoring report. If a limit value is exceeded, the digital values will be provided to the water authority immediately and an additional special report will be prepared promptly, including the results of the hydrochemical analyses and conclusions regarding the cause. If the cause of an increased conductivity value is due to nitrate, for example, it will be agreed with the authority whether the limit value needs to be adjusted accordingly in order to avoid future false alarms.
- Seismic monitoring will be completed in a pilot groundwater well.

Additional commitments under Project finance [260]:

- Vulcan plans to comply with the principles and requirements of following directive:
- Ordinance on the Quality of Water for Human Consumption (Drinking Water Ordinance - TrinkwV), 2023.
- Other mitigation includes:
- Only additives without water danger classification or class 1 classification will be used.
- Use of permitted drilling fluids and cementation and drilling fluids are combined directly at the Well sites.
- Drilling fluid is recirculated and if feasible, repurposed with the proper conditioning and treatment.

[260] Vulcan, 2022. Stellungnahme zur allgemeinen Umweltverträglichkeits-Vorprüfung (UVP-V) – Schleidberg Süd.

- Disposal of drilling mud when it is no longer usable, in accordance with German regulations.
- Appropriate management and careful handling of diesel or lubricants.
- Use of licensed companies authorised to collect and dispose of drilling mud and cuttings.
- Storage of mud and cementing materials and equipment exclusively in the inner drilling site area.
- Wastewater from all construction components will be discharged into the local/municipal sewage network.
- Reinjection of water to the deep brine aquifer as part of the operation.
- Monitor operations to check for local aquifer drawdown effect and any adverse water quality effect
- The size and duration of exposure of areas of the open ground will be kept to a minimum.
- A spillage risk assessment should be undertaken as part of the development of the Emergency Preparedness and Response Plan (EPRP).
- The EPRP Plan should specify that Spill Response Kits will be available, including absorbent materials suitable for the materials to be handled on-site, will be held at secure, clearly signposted locations, instructions will be provided with the kits and personnel will be trained in their use.
- Any spillages will be immediately contained on-site and all contaminated materials including soils will be removed from the site for suitable treatment and disposal.
- All staff and subcontractors will be required to report any incidents, and these will be subject to investigation and remedial and preventive actions will be taken.

7.1.9 IMPACTS FROM WASTE AND WASTEWATER

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

Description of impact:

The Project will generate various types of waste, which will be properly disposed of in accordance with legal requirements. Details of the waste generated (waste classification), and waste disposal approach and methods will be addressed in the separate operational plan documents[261].

Construction phase:

Construction of the Project will generate excess material from earthmoving and site clearance works. Re-using the excavated material e.g., aggregates should be the preferred option.

According to Vulcan, the following waste types will be generated at the Well sites[261]:

- Mud material packaging;
- Drilling mud;
- Cement slurry;
- Drill cuttings;
- Wastewater, oil-free;
- Wastewater, containing oil;
- Wastewater;
- Domestic waste;
- Suction and filter materials;
- Solvent mixtures, halogen-free;
- Non-chlorinated emulsions;
- Laboratory waste;
- Non-chlorinated machine and lubricating;
- Lubricating oils; and
- Iron and steel.

Other types of waste that will be generated during the construction phase and relevant activities/processes at the other Project components will likely include:

- Domestic waste from construction camps;
- Wastewater from construction camps;
- Packaging wastes/recyclable wastes: waste metals, plastics, cables, glass, paper (packaging material, air filters, drums bins, etc.);
- Non-hazardous waste from construction camps and construction operations (e.g., scrap metal, scrap plastic, scrap wood);
- Hazardous waste (chemicals, additives, paints) generated from use of hazardous materials and contaminated/oily fabrics and filters, contaminated packaging material;
- Machinery operation and maintenance related wastes (machinery parts replacement, used filters, etc.);
- Waste oils from trucks or mechanical part of plant and storage tanks;
- Waste batteries and accumulators; and

[261] Vulcan, 2022. Stellungnahme zur allgemeinen Umweltverträglichkeits-Vorprüfung (UVP-V) – Schleidberg Süd.

- Electronic waste from construction activities and construction camps.

Impacts related to drill cuttings are covered in the Soil Impact assessment (see Section 7.1.3). Around 42,000 m^3 of drill cuttings will be produced per drill pad at the Well sites which will be disposed at a certified disposal site.

Throughout the Project's duration, several applications have been explored, and the KIT Innovation Hub will look at one early strategy: using drill cuttings to make paving stones.

Operational phase:

Types of waste that will be generated during the operational phase will likely include:

- Domestic waste from Well sites, GLEP, Insheim Geothermal Power Plan and CLP;
- Wastewater from Well sites, GLEP, Insheim Geothermal Power Plan and CLP;
- Packaging wastes/recyclable wastes: waste metals, plastics, cables, glass, paper (packaging material, air filters, drums bins, etc.);
- Non-hazardous waste from Well sites, GLEP, Insheim Geothermal Power Plan and CLP (e.g., scrap metal, scrap plastic, scrap wood);
- Hazardous waste (chemicals, additives, paints) generated from use of hazardous materials and contaminated/oily fabrics and filters, contaminated packaging material;
- Machinery operation and maintenance related wastes (machinery parts replacement, used filters, etc.);
- Waste oils from trucks or mechanical part of plant and storage tanks; and
- Waste batteries and accumulators.
- At the GLEP, non-contaminated wastewater will be disposed of through the city's own sewers within the existing separation system. The wastewater will be treated in the municipal sewage treatment plant and then channelled into the local receiving waters. Water from uncontaminated rainfall, will also be gathered by the current separation system and sent into seven troughs for infiltration[262].
- At the CLP in Höchst wastewater will be handled and disposed by Infraserv in line with German regulations.
- Operating materials (lubricants, fuels) and flushing additives are stored in the inner area of the Well site, depending on the hazard class[263].

Decommissioning phase:

During decommissioning, the following types of waste are expected:

- Domestic waste from the decommissioning sites;
- Wastewater from the decommissioning sites;
- Packaging wastes/recyclable wastes: waste metals, plastics, cables, glass, paper (packaging material, air filters, drums bins, etc.);
- Non-hazardous waste from decommissioning sites (e.g., scrap metal, scrap plastic, scrap wood);

[262] Stadt Landau, 2023. Bebauungsplan „D 12, Gewerbepark Messegelände-Südost"
[263] Vulcan, 2022. Stellungnahme zur allgemeinen Umweltverträglichkeits-Vorprüfung (UVP-V) – Schleidberg Süd.

- Hazardous waste (chemicals, additives, paints) generated from use of hazardous materials and contaminated/oily fabrics and filters, contaminated packaging material;
- Machinery operation and maintenance related wastes (machinery parts replacement, used filters, etc.);
- Waste oils from trucks or mechanical part of plant and storage tanks;
- Waste batteries and accumulators;
- Electronic waste from construction activities and construction camps; and
- Radioactive waste in the form of contaminated pipes, valves and pumping equipment linked to the inbound brine pipeline.

Impact significance assessment:

Physical Environment: Waste and Wastewater					
			Project Phase		
			Construction	Operation	Decommissioning
Type of impact	Direct	Direct	Direct		
Receptor			Soil, Local communities, Surface water resources		
Receptor sensitivity	Medium to High	Medium to High	Medium to High		
Nature of impact	Negative (-)	Negative (-)	Negative (-)		
Extent / Scale	Site/Local	Site/Local	Site/Local		
Duration			Short-term activity	Long-term	Short-term activity
Frequency			Daily	Daily	Daily
Likelihood			Definite	Definite	Definite
Magnitude of effect			Medium	Small	Medium
Impact Significance (with embedded mitigation)			**Moderate**	**Minor**	**Moderate**
Residual impact (after mitigation)			**Minor**	**Insignificant**	**Minor**
Irreplaceable loss of resources	Soil, water resources	Soil, water resources	Soil, water resources		
Reversibility	Irreversible but treatable	Irreversible but treatable	Irreversible but treatable		
Evaluation of Mitigation Effectiveness			Some measures could be challenging to implement, effective	Some measures could be challenging to implement, effective	Some measures could be challenging to implement, effective
Level of confidence			Medium	Medium	Medium

Mitigation measures proposed by ERM:

To reduce GHG emissions and preserve finite primary resources, Vulcan also envisages methods to use some of the drill cuttings as construction materials as an alternative to the disposal method mentioned above. Since Vulcan is not the only organisation interested in and concerned

about this problem, a collaborative initiative has been started to make use of specialised knowledge from many fields.

Ideas for further uses depend on the nature and composition of the drill cuttings which will become progressively evident during the initial drillings. To secure their support Vulcan has established first contacts in politics, since the prospect of employing recycled construction materials is also highly intriguing during periods of scarcity of building supplies.[264]

- Development of a waste management plan.
- SGD Süd's surface drainage requirements are generally met in cooperation with the city of Landau.
- Vulcan will comply with the principles and requirements of following directives:
  - Waste Framework Directive (Directive 2008/98/EC). It defines key waste-related terms and establishes, a five-level waste hierarchy;
  - Directive on packaging and packaging waste (Directive 94/62/EC);
  - Landfill Directive (Directive 1999/31/EC); and
  - Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment.
- Records will be kept of the types and quantities of wastes that are reused, recycled, recovered or disposed both on and off the site to assess waste hierarchy effectiveness.

Additional mitigation recommended by ERM:

The Waste Management Plan that Vulcan will develop needs to be based on a hierarchy of waste management depending on classification. Following measures are recommended:

- Waste avoidance: Minimising the amount of material that needs to be generated and managed in the first place;
- Re-use on site: Where possible, the re-use of excavated materials within the Project site is to be maximised. This reduces the need to import materials onto the site, reduces the need to find off-site re-use or disposal locations and the associated materials handling and transport issues, reduces fuel use and minimises the Project footprint;
- Re-use off site: Where all attempts to re-use excavated materials on site have been exhausted, re-use opportunities must be found off site. This includes finding sites that are approved by the relevant planning consent authorities to accept the specific wastes; and
- Disposal: Disposal is the last and least preferable management option to be considered.

This will apply to the following:

- Handling of hazardous materials during construction;
- Spoil and construction waste management; and
- Waste management generated during operational phase.

Mitigation measures for waste storage and handling

- Waste generation will be recorded in terms of type (EU Waste Code) and quantity at all points of generation (camps, plants, etc.);

[264] Vulcan, 2023. Abfallmanagement. Entsorgung und Wiederverwendung anfallenden Bohrguts.

- Waste will be collected and segregated according to its type, whether it is reusable, recyclable, non-hazardous, or hazardous waste;
- Waste will be stored according to international best practices (e.g., IFC EHS General Guidelines). Additional measures for storage of hazardous wastes (such as use of secondary containment, access restriction, provision of PPE etc.) will be applied as necessary to prevent harm to construction staff, environment and the public;
- Designated waste collection containers and storage areas will be used for different kinds of waste (hazardous and non-hazardous); and
- Waste collection containers and storage areas will be adequately labelled for different kinds of wastes (hazardous and non-hazardous).

7.2 BIOLOGICAL IMPACT ASSESSMENT

7.2.1 INTRODUCTION

Renewable energy projects such geothermal power play an important role in moving towards a more sustainable energy sector that can assist with combating the negative impacts of non-renewable energy on global climate. However, these 'clean' energy projects can also result in unintended negative impacts and consequences to the environment unless carefully planned and managed. This includes risks and potential impacts to biodiversity, which underpins the resilience and functions of ecosystems and the flow of ecosystem goods and services (Bennun *et al.,* 2021).

Biodiversity impact assessment is the process of determining the types and significance of effects a project will have on biodiversity, and the various components thereof, and is the core of the ESIA process (Hardner *et al*., 2015). Risks and impacts to biodiversity typically vary according to the Project being assessed as well as the context of the receiving environment where the Project is located. The biodiversity impact assessment that follows has been undertaken specifically for this Project in Germany.

7.2.2 APPROACH & METHODS

Please see section 5 of this report.

7.2.3 PROJECT AOI

The AoI (Area of Influence) of the Project was considered for the construction and operational/maintenance phases of the Project and is documented in Table 7-81.

TABLE 7-81 DEFINING THE AOI FOR CONSTRUCTION AND OPERATIONAL/MAINTENANCE COMPONENTS OF THE PROJECT

Project Component	Habitats	Plants	Terrestrial Fauna (volant)	Terrestrial Fauna (non-volant)	Aquatic Ecosystems	Notes
CONSTRUCTION PHASE						
Internal access roads	250 m	250 m	250 m	250 m	500 m	• Based on available literature such as QMJ (2005) and Ministry for the Environment (2016), dust emissions and general fallout distance for intermediate sized particles can reach distances of up to 300m and this is typical of road dust (fine particles can travel further from source but depends on various factors including particle size, wind speed, gusts, wind direction and other ambient environmental conditions). • Dust fallout can affect plants, water and sensitive faunal species (Ministry for the Environment, 2016; Kwon *et al*., 2018). • Based on literature such as Kwon *et al*. (2018), there is a strong possibility that species could be disturbed by noise up to a radius of approximately 250m from the construction site, and outside of the 250m, noise level from construction should have been attenuated to background noise levels, with the exception of when piling occurs in which case which the disturbing zone could be larger. • There are generally no significant aquatic ecosystems (rivers, wetlands) in the AoI for the Project components near Landau, however the pipeline planned will cross small, modified streams.
Worker camps						
Laydown areas						
Parking areas						
Drill site						
Borrow pits						
Construction of the Lithium Extraction Plant at Höchst Industrial Park						• 'Main' River at Industrial Park Höchst.
OPERATIONAL / MAINTENANCE PHASE						
Operation of the GLEP near Landau and	n/a	n/a	500 m	500 m	n/a	

Project Component	Habitats	Plants	Terrestrial Fauna (volant)	Terrestrial Fauna (non-volant)	Aquatic Ecosystems	Notes
existing Geothermal Power Plant at Insheim						• Adjacent areas, including protected areas (Natura 2000 sites), to account for potential risks to volant and non-volant species populations.
Operation of well sites (groundwater production sites)						
Lithium Extraction Plant at Höchst Industrial Park					500 m	
DECOMMISSIONING PHASE						
Removal of site infrastructure and rehabilitation of the affected areas	250 m	250 m	250 m	250 m	500 m	• Similar to construction phase (above). • Rehabilitation. • 'Main' River at Höchst Industrial Park.

7.2.4 KEY RECEPTORS AND BIODIVERSITY VALUES

Key ecological receptors and important biodiversity values linked with the AoI for the Project include the various habitat types and species identified in the Baseline Biodiversity Assessment (see Appendix A of the ESIA). Several medium to high sensitivity ecological receptors and important biodiversity values linked with the Project AoI were identified, and these are summarised in Table 7-82. Critical habitats identified in the CHA (Appendix B) have also been included here, including their value from an ecosystem services perspective.

TABLE 7-82 SUMMARY OF KEY ECOLOGICAL RECEPTORS AND BIODIVERSITY VALUES FOR THE PROJECT AREA

Biodiversity Features / Values	Applicability to the Project
Protected Areas & Internationally Recognised Areas	
Protected Areas	For infrastructure components located near Landau: • Natura 2000 site: 'Standortübungsplatz Landau' is partially located within the Project AoI (i.e., within 250 m of pipeline and GLEP) and stands to be potentially indirectly affected by the Project. The current pipeline route (for ICPP Section 3) intersects the Natura 2000 area over a short distance of approximately 64 meters and may result in impacts to wooded habitat and species associated with the Natura 2000 site. Alternatives to avoid crossing the Natura 2000 site are currently being considered by Vulcan[265]. • Natura 2000 site: "Erlenbach und Klingbach" is partially located within the Project AoI (i.e., within 500m of the drill site at 40 Morgen) and stands to be potentially indirectly affected by the Project. For the CLP at Höchst Industrial Park: • Not applicable: Natura 2000 sites are located outside of the AoI and do not stand to be impacted directly or indirectly by the Project.
Key Biodiversity Areas (KBAs)	Not applicable: Bellheimer Wald mit Queichtal near Landau is a KBA and IBA but is located ~1.4 km from the Project and is therefore outside of the AoI does not stand to be impacted directly or indirectly by the Project.
Important Bird & Biodiversity Areas (IBAs)	
Alliance for Zero Extinction (AZE) Sites	Not applicable: There are no Alliance for Zero Extinction (AZE[266]) sites identified.
RAMSAR wetlands of international importance	Not applicable: There are no RAMSAR sites[267] (wetlands of international importance) associated with the Project area or downstream of the site.
Ecosystems and Habitats	

[265] Based on ERMs current understanding, Vulcan's current planning for ICPP Section 3 (Landau well site to GLEP at Landau) will intersect the Natura 2000 site 'Standortübungsplatz Landau'; however, the company is looking to alternative options to avoid the Natura 2000 site. An option being considered seeks to cross under the existing railway line in such a manner as to avoid the Natura 2000 site entirely, however this requires a land acquisition process to first be fulfilled, with some additional engineering concerns raised by RPM Global for this option.
[266] Alliance for Zero Extinction (AZE) site database. Online at: https://zeroextinction.org/site-identification/2018-global-aze-map [Accessed 23-11-2022]
[267] RAMSAR Wetlands database of sites. Online at: https://www.ramsar.org/wetland/uzbekistan [Accessed 23-11-2022]

Biodiversity Features / Values	Applicability to the Project
Natural habitat	Grassland and wooded habitats associated with the Natura 2000 sites near Landau ('Standortübungsplatz Landau' and 'Erlenbach und Klingbach') located within the Project AoI but will not be directly affected. The exception is the pipeline alignment for Section 3 of the ICPP should this be located partially within the Natura 2000 site 'Standortübungsplatz Landau' that may result in impacts to wooded habitat and species associated with the Natura 2000 site. Alternatives to avoid impacts are still being evaluated by Vulcan.
Critical habitat	Critical habitat was identified through a rapid critical habitat screening assessment and found to be associated with the grassland and wooded habitats linked to the Natura 2000 sites near Landau ('Standortübungsplatz Landau' and 'Erlenbach und Klingbach') located within the Project AoI but will not be directly affected.
Key ecological processes and ecosystem services (e.g., seed dispersal, pollination, primary production, carbon sequestration)	Due to the modified nature of the landscape (agricultural use for growing crops / pasture), there are no appreciable or key ecological processes associated with those sites. Ecosystem services linked to natural ecosystems are discussed in Section 3.4 of the Baseline Biodiversity Assessment Report (Appendix A of the ESIA). These are likely to be restricted to the protected areas (Natura 2000) sites which provide for habitat, some carbon capture function (forests and grasslands), pollination (especially grasslands), seed dispersal and habitat/refugia for animal and plant life.
Species	
Threatened species: fauna and flora	A list of 27 threatened species of conservation importance that could possibly occur in the Project AoI was compiled based on overlap with known/modelled species geographical ranges and habitat preferences/requirements being largely met). Triggers for conservation importance are either for a species being threatened according to the IUCN Red List or German Red List or being under special protection according to German law. This includes species that are listed in Annex IV of the EU habitats directive (92/43/EEC) as well as all bird species according to the EU Birds Directive (2009/147/EC). This includes: • European Turtle-dove, *Streptopelia turtur* (VU) that inhabits woodland and cultivated areas; • Eight terrestrial invertebrate species (mainly insects/beetles that inhabitant woodland, forest, and cultivated fields (EN, VU and DD status); and • 17 species of plants (mainly fungi) that occur in forest or grassland areas (EN, VU and DD status) Whilst some species may utilise the cultivated fields and modified habitats in the study area, the large majority require natural habitat and typically either grassland or forest. These species are therefore likely to be restricted to the natural grassland and forest habitats located within the Protected Areas (Natura 2000 sites) in the study area. Full details of the species are included in Section 3.4 of the Baseline Biodiversity Assessment Report (Appendix A of the ESIA).
Endemic species	None.
Restricted-range species	None.

Biodiversity Features / Values	Applicability to the Project
Large or congregatory species populations	None.
Previously unknown species	None.
Keystone species performing a key ecological role (e.g., key predator, primary producer)	None.

Key to table:

IUCN Global Red List status: EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern, DD = Data Deficient

7.2.5 IDENTIFICATION OF BIODIVERSITY IMPACTS

Detailed information on the Construction Phase of the project (section 3.1 of the ESIA) and Operational/Maintenance Phase (section 3.2) were referred to specifically in identifying and assessing biodiversity impacts. The key sources of potential biodiversity impacts identified in the scoping phase (ERM, 2023) include the following:

- Pre-construction activities (surveys, setting out of works);
- Construction mobilisation activities and earthworks;
- Temporary works including construction camp sites and material/equipment laydown areas;
- Ancillary services such as any material borrow areas;
- Vegetation clearing, topsoil removal, general construction activities associated with access roads;
- Construction workers presence (noise, disturbance);
- Waste management;
- Unplanned events such as erosion/sedimentation, flooding, accidental oil/fuel/chemical spills;
- Water abstraction for construction;
- Operation of project, including geothermal plant, well sites and lithium production plants.

Maintenance has been included in the operational phase.

Note that cumulative impacts are addressed later in the separate Cumulative Impact Assessment (CIA) (ERM, 2023) and include cumulative impacts on biodiversity.

Biodiversity impacts identified for the Project and related activities, and infrastructure have been conceptualised and discussed in detail in Table 7-82. Impacts are defined in terms of construction and operational (including maintenance) project phases, and include direct, indirect, and induced impacts. Pathways of effect are used to understand how biodiversity may be impacted (e.g., direct habitat loss, indirect habitat loss due to disturbance, increased hunting pressure, etc.).

Impacts associated with the Project are considered to be both 'area based' and 'linear' in nature, and relate to the construction and operation of the drill sites, thermal water pipelines, geothermal

power plant and lithium production plant, the planned electricity distribution network (transmission line), as well as temporary worker camps and equipment laydown areas:

- Biodiversity impacts appear most intimately linked with direct and indirect impacts to species of conservation importance rather than habitat, which is largely modified (under cultivation/pasture);
- Construction-phase impacts will be more temporary in nature (e.g., temporary areas, noise, vibrations, and emissions) and therefore considerably less significant in the long-term; and
- There are likely to be a range of permanent operational impacts of lower significance associated with the installation and operation of the geothermal power plant, associated water transfer pipelines and lithium production plant.

7.2.6 SCOPED OUT IMPACTS

Note that the following potential biodiversity-related impacts were screened out of the biodiversity impact assessment, with the reasons for excluding impacts provided briefly:

- **Transformation of habitat**: Habitat identified within the direct footprint of site infrastructure for the Landau Project components is considered 'modified' (combination of agricultural land and built areas with artificial surfaces) and not representative of natural habitat. The leased plot for the CLP at Höchst Industrial Park is characterised by a combination of infrastructure, hardened surfaces and gravel surfaces and secondary vegetation comprised mainly of grasses and weeds that can also be considered 'modified habitat'. The modified habitats in the AoI are of little or negligible biodiversity value or importance, and therefore in ERM's opinion this satisfies the requirements of IFC PS6 in terms of para. 12[268] and areas of modified habitat do not require further examination or impact assessment.
- Remaining semi-intact / natural habitats are restricted to the network of Protected Areas (Natura 2000) which will not be directly affected by the Project. IFC PS6 places certain requirements on the client not to significantly convert or degrade natural habitats under paragraph 13 of the PS6 (IFC, 2012). Whilst the conversion of natural habitat is generally not predicted to take place as infrastructure and activities will be located outside of the Protected Areas hosting natural habitat, the term "degrade" in paragraph 13 of PS6 worth noting, as this speaks in essence to any modification of habitat integrity as a result of change in land or water use that reduces the habitat's ability to maintain viable populations of its native species. Given the location of the pipeline alignment from the existing Landau Geothermal Power Plant and the GLEP being within close proximity to the Natura 2000 site: 'Standortübungsplatz Landau', indirect impacts to the PA/Natura 2000 associated with Project construction and operational phases are to be investigated further, to inform the need for any appropriate and necessary measures to mitigate impacts. This has been addressed under the impact 'Disturbance to fauna and flora caused by noise, vibration, light and dust'.
- **Disturbance/loss of native plant species of conservation importance (protected/endangered species):** Agricultural crops (maize, vineyards, fruit) have

[268] IFC PS6: para 12. "*This Performance Standard applies to those areas of modified habitat that include significant biodiversity value, as determined by the risks and impacts identification process required in Performance Standard 1. The client should minimise impacts on such biodiversity and implement mitigation measures as appropriate*"– IFC (2012).

replaced natural vegetation communities within the areas to be affected by the Project, and plant species of conservation importance are highly unlikely to be associated with these areas (baseline surveys also identified no conservation important plant species). *Native plant species are largely restricted to the remaining semi-intact / natural habitats are restricted to the network of Protected Areas (Natura 2000) which will not be directly affected by the Project. The exception is where the ICPP Section 3 alignment being considered from the Landau well site to the GLEP intersects a small section of the Natura 2000 site 'Standortübungsplatz Landau'. See Impacts in Section 7.8 for further information.*

- **Disturbance to fauna and flora caused by noise, vibration, light and dust at the site of the CLP:** It is unlikely that noise or vibrations during construction could affect nearby Natura 2000 sites which are outside of the AoI defined for the CLP at the Höchst Industrial Park, and also existing ambient environmental noise levels are already high within the operational industrial park. *Disturbance/nuisance impacts are therefore considered only for the infrastructure located near Landau.*
- **Impacts to critical habitat:** The Critical Habitat Assessment (CHA, see Appendix B) identified critical habitat as being associated with the two Natural 2000 protected areas near Landau, which will not be directly affected by the Project as infrastructure will be located outside of these designated protected areas. Nevertheless, the Project still stands to potentially indirectly affect the values associated with the critical habitats, most notably the species of protected/threatened fauna inhabiting these habitats. This is however addressed for the Landau infrastructure in the impact category '*Disturbance to fauna and flora caused by noise, vibration, light and dust'*.
- **Aquatic biodiversity impacts:** There are generally no aquatic ecosystems (rivers, streams, wetlands) in the AoI for infrastructure to be located near Landau. The CLP at Höchst Industrial Park (Frankfurt) is located adjacent to the 'Main' River. *Aquatic biodiversity (water pollution) impacts are therefore considered only for the CLP at Höchst Industrial Park.*
- **Impacts on ecosystem services:** Ecosystem services were considered in the biodiversity baseline report (Appendix A) and were found to be linked mainly to the natural areas associated with the Natura 2000 sites as well as the Main River at Höchst Industrial Park. The Project does not stand to directly affect these areas and minor nuisance impacts (indirect effects) are unlikely to affect these ecosystems and the services provided. Furthermore, the loss of agricultural land will be negligible in relation to the broader extent of agricultural areas in the local region, such that any impact associated with the loss of agriculture/cultivated crops will also be insignificant and not worth assessing further in detail.
- **Increased risk of fire:** Whilst fires can have negative impacts on habitats such as forests that are adapted to lack of fire, the Project is unlikely to pose a significant risk of fire, also being located well away from forest areas. This risk can also be readily mitigated through simple controls and preventative measures during construction and operation.
- **Trophic cascade effects**: Behavioural changes in species can result in cascading effects on the various trophic levels, however these are typically not well-documented or understood and any species-level effects would be purely theoretical and conceptual at this stage and cannot be determined with any high level of confidence or accuracy (long-term species monitoring at the site will be required to study such effects). Such effects are most likely not relevant to the Project as the effect on fauna for a low-risk project such as this is unlikely to be of much significance to the faunal populations in the Project area.

Further information on the impact screening can be found in the Scoping Report for the ESIA compiled by ERM (2023).

7.3 IMPACTS RELATED TO LOSS OF FAUNA

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☐
Access roads	☒	☒	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☐	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☐	☐	☐
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☒	☐	☒

Description of impact:

Construction phase:

The physical footprint of the Project will be relatively small in scale, being localised and limited to the actual footprint of infrastructure where vegetation will be cleared and converted to artificial surfaces (i.e., foundations, access roads, drill pads, building foundations) or maintained as agricultural land. The following habitat and associated vegetation communities will likely be affected:

- Mixed agricultural land (arable land / pasture)
- Built/urban environment.

The perceived importance of the biodiversity loss associated with modified habitat under cultivation is considered low as this type is not representative of the reference habitat type which would have naturally characterised the region prior to human activity and disturbance (i.e., natural dense broadleaved forest and grassland). These areas also do not support vegetation communities containing native flora of conservation concern. Whilst some species may utilise the cultivated fields and modified habitats in the study area, such as skylark (*Alauda arvensis*), the large majority require natural habitat and typically either grassland or forest. These species are therefore likely to be restricted to the natural grassland and forest habitats located within the Protected Areas (Natura 2000 sites) in the study area.

Whilst the general construction area is not predicted to host large concentrations of important species, given the modified nature of the areas under agricultural production mainly, construction vehicles accessing and working within the site pose a risk of colliding with species crossing roads whilst moving between the remaining natural habitats in the AoI. Some species may also be attracted to access roads created as easy corridors to move between areas and these animals

are likely to be more at risk. Slower moving and more sedentary species such as reptiles (e.g., lizards) and amphibians are likely to be at a greater risk of being injured or killed by moving vehicles, even at low speeds, particularly as cold-blooded species such as reptiles may utilise roads for sunning themselves. This is likely to be most relevant to activities occurring in the vicinity of the Natura 2000 site 'Standortübungsplatz Landau' which provides important habitat for several conservation important reptile species (namely Skinks), and most notably for the section of pipeline construction and the new GLEP near Landau. Given that some of these species recorded in the AoI for the Project are protected according to the EU Habitats Directive (e.g., the Sand lizard, *Lacerta agilis,* and Common wall lizard, *Podarcis muralis,* both being threatened species in Germany and protected in accordance with the EU Habitats Directive – Annex IV listing), the ecological importance associated with these species is considered 'Moderate'. Vehicular collisions, whilst possible, are likely to be localised, manageable and therefore also unlikely to diminish populations of the identified species (magnitude of effect is therefore considered 'small').

Operational phase:

The physical destruction/disturbance of vegetation and habitat is primarily a construction-phase impact initiated by construction activities, albeit that the effects will be permanent in many cases where vegetation and habitat is changed. During the operational phase, regular operating staff and delivery vehicles access the GLEP may encounter wildlife, however this is expected to be infrequent based on limited vehicular activity anticipated during operation. Magnitude can therefore be considered 'negligible'.

Decommissioning phase:

Impacts during the decommissioning phase of the Project will be fairly like the construction phase impacts, but less intense and shorter in duration most likely.

Impact significance assessment:

Biodiversity Impact 1: Direct Loss of fauna			
	Project Phase		
	Construction	**Operation**	**Decommissioning**
Type of impact	Direct		
Receptor	Herpetofauna (reptiles, amphibians), breeding birds and small mammals		
Receptor sensitivity	Medium to High		
Nature of impact	Negative (-)		
Extent / Scale	Site/Local		
Duration	Short-term activity, permanent impact	Long-term	Short-term activity, permanent impact
Frequency	Weekly	Once off (immediate)	Weekly
Likelihood	Possible	Unlikely	Possible
Magnitude of effect	Small	Negligible	Small
Impact Significance (with embedded mitigation)	**Minor to Moderate**	**Insignificant**	**Minor**
Residual impact	**Insignificant / None**	**Insignificant / None**	**Insignificant / None**

Biodiversity Impact 1: Direct Loss of fauna			
	Project Phase		
	Construction	Operation	Decommissioning
(after mitigation)			
Irreplaceable loss of resources	None		
Reversibility	Irreversible		
Evaluation of Mitigation Effectiveness	Some measures could be challenging to implement, effective	Easy to implement, effective	
Level of confidence	Medium	High	Medium

Embedded mitigation measures according to the biodiversity baseline surveys completed between 2018-2024 for the national EIA and permitting process:

- To reduce the risk of collision with wildlife resulting in injury/mortality, it is proposed to limit construction works during the breeding season for ground-breeding birds (i.e. Eurasian Skylark. Alauda arvensis) as well as small mammals (April – September).
- The construction activities in the (Schleidberg Sued drill site) area may lead to the displacement of breeding habitat for Eurasian Skylark (*Alauda arvensis*). The field containing the nest, along with an additional 10 m strip surrounding it, should be planned, from development until the conclusion of the breeding season, starting in August 2023, to prevent any disruptions.
- To offset this impact, Skylark-friendly features such lark-friendly windows and floral strips in nearby fields, can be established.
- Refrain from disturbing the woody plants and shrubs which serve as vital habitats for the Sand lizard (*Lacerta agilis*) as well as for the Hazel Dormouse (*Muscardinus avellanarius*) and bird species.
- The removal of shrubs during the key breeding season (1. April – 30th September) is strictly forbidden.
- Implementation of precautionary measures to protect the areas inhabited by the Common Wall lizard (*Podarcis muralis*), which include instalment of reptile fences to create effective barriers around these zones.
- Optimise spatial utilisation in accordance with time regulations for construction purposes.
- If shrubs are to be removed, Dormouse individuals will have to be resettled and additional habitat must be provided as a biodiversity offset.
- Throughout the construction period, continuous monitoring by an ecological specialist is considered essential.

Additional mitigation recommended by ERM:

- In case wooded habitats fall within the construction area, site-specific mitigation measures will be defined by the ecological expert on a case-by-case basis. Avoidance of habitats will be implemented as far as possible or minimisation of the area impacted and/or compensation areas defined where avoidance is not possible entirely. Ecological surveys are conducted by the ecological expert and stated in the landscape plan (LBP), including mitigation measures.

- Demarcate the construction zone on a map and on the ground clearly using appropriate methods/tools, to avoid impacting sensitive areas outside of the permitted construction area.
- Worker staff and vehicle access to the area will be limited to the authorised construction site only.
- Only the vegetation that is necessary to be removed for construction purposes should be cleared, and where possible cut vegetation to ground level instead of stripping areas entirely.
- Use existing access roads or upgrade existing roads wherever possible before considering the construction of new access roads.
- Restrict vehicles to the use of authorised access roads only. A signage concept is to be implemented to regulate who can enter the access roads.
- Place appropriate limits on the number of vehicle movements to and from the construction site.
- Restricting activities to daytime hours where possible when visibility is good and potential fauna collisions with vehicles can be more easily avoided. Where this is not possible, driver awareness training and reduced speed limits on internal roads will be employed.
- Limit vehicle speed on site for construction vehicles and vehicles accessing the site.
- Appropriate signage will be appointed by the city administration or the road traffic authority. Install appropriate wildlife fencing along the Project perimeter where site infrastructure (i.e., the planned pipeline) will be located near to the Natura 2000 site 'Standortübungsplatz Landau' to prevent small mammals and reptiles from entering into the active construction zone and focused on guiding animals to safe points.
- A common mitigative measure to prevent impacts on groundbreaking birds is to prevent them from breeding in the relevant areas in the first place. Suitable visual deterrents, such as coloured ribbons attached to poles/sticks that move in the wind, may be used to scare ground-breeding birds before the start of the breeding period) in areas where species such as Eurasian Skylark could occur.
- Special protection measures such as the establishment of protection zones or the installation of nesting aids for birds should be established. Alternative roosting and resting sites for birds/bats may need to be provided on a case-by-case basis where nesting/roosting species may be disturbed or removed and need to be relocated and this may include the construction of bat/bird friendly structures such as bat/bird boxes and artificial perching sites in adjacent habitat outside of the construction zone (exact requirements and approach to be advised by a wildlife ecologist during pre-construction surveys
- Specific measures to prevent wildlife from entering the construction site will be considered on a case-by-case basis and following consultation, assessment and based on the expertise of the ecological expert.
- All open excavations are to be checked for the presence of animals each morning and immediately prior to backfilling of open excavations/trenches.
- Prevent the establishment of active nests during the nesting season on standing plant and temporary facilities and structures by closing opening and vents and checking equipment before operation.

- Examine heavy equipment and plant stored on site before use, particularly after rainfall events when reptile and amphibian movements occur more often, to ensure use will not harm individuals that might be seeking temporary refuge under vehicles for example.
- Develop and implement pre-construction checklist and survey protocol. Searches and pre-stressing activities are to be carried out by moving progressively through the vegetation to check for animals and nesting activity. If no active nests, roosts or burrows/dens are present, vegetation clearing should be completed within a few days of the initial wildlife checks / inspections.
- Avoid or minimise disturbing or removing cover objects, such as downed trees, rotting stumps, brush piles, stone piles and leaf litter until these have been checked for animal activity, these can then be removed and relocated to similar suitable adjacent habitat outside of the construction zone.
- Wildlife shepherding protocol to be prepared and implemented where construction takes place, to check areas to be worked in prior to construction and remove or shepherd wildlife found on the construction site to safety in adjoining natural habitat (where these animals cannot safely exit the construction site by themselves). When capturing/relocating animals, cover larger animals with a towel or blanket and place in a cardboard box and/or hessian bag, place smaller animals in a cotton bag, tied at the top.
- After removal of the individuals from the construction zone, the area that will be disturbed adjacent to natural habitats during construction and at project specific locations should be fenced off appropriately to exclude re-entry by wildlife.
- Any injured animals are to be transported carefully but efficiently to a local vet for treatment as soon as possible.
- Use non-UV sources of lighting for work sites so as not to attract nocturnal insects and insectivorous bats and other animals that feed on them during nocturnal works.
- Collect and remove waste products and litter from work areas that could attract wildlife to worker camps and construction areas.
- Properly working machinery must be engaged in the process of land preparation and execution of construction works, and the construction site must be secured in accordance with the conditions of the competent authority in Germany.
- Compile a suitable post-construction habitat restoration plan for temporary areas used during construction, to return the land to production (crops) or establish other suitable habitat such as meadows, grassland, shrubland.

7.4 IMPACTS RELATED TO DISTURBANCE TO FAUNA AND FLORA CAUSED BY NOISE, VIBRATION, LIGHT AND DUST

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☐
Access roads	☒	☐	☒
Worker camps	☒	☐	☒

Components	Construction	Operation	Decommissioning
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☐	☐	☐
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

Description of Impact

Construction phase:

General nuisance and disturbance as a by-product of construction activities typically includes that associated with increased noise and vibrations from heavy construction machinery, increased levels of dust due to vehicles travelling on informal dirt roads and through the creation of bare surfaces where vegetation stripping/clearing and bulk earthworks take place and artificial light.

There are few studies available on the distance to which fauna are typically disturbed or displaced during the construction phase of projects, however based on literature such as Kwon et al. (2018), there is a strong possibility that species could be disturbed by noise up to a radius of approximately 250m from the construction site, and outside of the 250m, noise level from construction should be attenuated to background noise levels. The displacement of fauna during construction is mostly associated with noise (for birds, and non-volant mammals) and vibrations (herpetofauna). Locally common species are likely to be less sensitive to noise/light disturbance and can probably become habituated at the site. Given that the existing land use is agricultural, with high levels of existing disturbance and human activity, any additional disturbance due to noise and the visual presence of construction vehicles and workers will be short-term and will unlikely increase the effect of the magnitude of impact to fauna, which are most likely already adapted to the existing disturbance and modifications at the site.

Where large quantities of dust are released, this can potentially travel a fair distance (up to 300m for intermediate sized particles according to QGI, 2005) and smother plant parts and reduce photosynthetic activity due to reduced light penetration to plant leaves that can affect growth rates and plant vigour according to the literatures, and can increase the incidence of plant pests and diseases according to the literature reviewed on the subject (such as Ministry for the Environment, 2016). Whilst this is particularly important for horticultural crops, dust fallout can also negatively affect native plant communities, however this is likely to be a highly localised impact. Faunal impacts are also likely to be largely insignificant related to dust impacts. Impacts of increased dust will also mostly be limited to particularly windy periods and during the operation of heavy vehicles, and the magnitude of effect concerning biodiversity is likely to be 'small'.

The Critical Habitat Assessment (CHA, see Appendix B) has however identified 'critical habitat' as being associated with the two Natural 2000 protected areas near Landau, which will not be

directly affected by the Project as infrastructure will be located outside of these designated protected areas. Nevertheless, the Project still stands to potentially indirectly affect the values associated with the critical habitats, most notably the species of protected/threatened fauna inhabiting these habitats. Most importantly, the Natura 2000 site 'Standortuebungsplatz Landau' is located approximately 50 m from the planned pipeline alignment from the existing Landau Geothermal Power Plant and the GLEP plant near Landau, within the AoI for the Project. Noise, light vibration, and dust fallout impacts could affect sensitive species of reptiles, bats, small mammals, and birds that utilise the Natura 2000 site, several of which are species of conservation importance. Receptor sensitivity / importance is therefore regarded as 'high' due to the critical habitat status and presence of threatened species at the Natura 2000 site (grassland habitats), whilst magnitude of effect is likely to be 'small' given the limited area of influence overlapping the Natura 2000 site and the short-term duration of the impact for the construction phase.

Operational phase:

Noise levels at the existing geothermal plant at Insheim are notably low and appear to be drowned-out by the noise of the nearby motorway (A65) and adjacent railway The planned geothermal plant and lithium plant near Landau, as well as the water well production (drill) sites, will generate very little noise during operation, and given the existing roads, urban and industrial areas and farming activities, additional noise/light impacts on wildlife during operation will probably be negligible/insignificant and it is anticipated that fauna that show less avoidance behaviours can be habituated to the operational activities and disturbance quite easily. Artificial light impacts during operation are likely when specific facilities such as substations may need to be well-lit for safety and security purposes. This can also attract certain species of insects, which can lead to increased activity by insectivorous species such as bats and small reptiles. Noise and visual disturbance from operating geothermal and lithium plants may not pose as much immediate risks to non-volant fauna, so they show less avoidance behaviours and can be habituated to the disturbances quite easily. The operational sites will also be located a reasonable distance from the Natura 2000 sites, such that effects on species that utilise the natural habitats of these areas are not likely to be disturbed during operation.

Dust pollution is highly unlikely to pose a risk to the natural environment during operation.

Decommissioning phase:

Impacts during the decommissioning phase of the Project will be very similar to the construction phase impacts, but less intense and shorter in duration most likely, with fewer workers and vehicles on site capable of generating light, noise disturbance and dust.

Impact significance assessment:

Biodiversity Impact 2: Disturbance to fauna and flora caused by noise, vibration, light, and dust			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Indirect		
Receptor	Fauna species (birds, reptiles, and small mammals mainly), flora		
Receptor sensitivity	**High** (includes 'critical habitat' and CR/EN species)		

Biodiversity Impact 2: Disturbance to fauna and flora caused by noise, vibration, light, and dust			
	Project Phase		
	Construction	Operation	Decommissioning
Nature of impact	Negative (-)		
Extent/Scale	Site/Local		
Duration	Short-term	Long-term	Short-term
Frequency	Daily	Daily	Daily
Likelihood	Likely	Possible	Likely
Magnitude of effect	Small	Negligible-Small	Small
Impact Significance (with embedded mitigation)	**Moderate**	**Minor**	**Moderate**
Residual impact (after mitigation)	**Minor**	**Insignificant / None**	**Minor**
Irreplaceable loss of resources	None		
Reversibility	Recoverable		
Evaluation of Mitigation Effectiveness	Easy to implement, effective		
Level of confidence	Medium	High	Medium

Embedded mitigation measures according to the biodiversity baseline surveys completed between 2018-2024 for the national EIA and permitting process:

- To reduce the risk of interactions with wildlife, it is proposed to limit construction works during the breeding season for sensitive birds (March – September) as well as small mammals (April – September).
- Refrain from disturbing the woody plants and shrubs which serve as vital habitats for the Sand lizard (*Lacerta agilis*) as well as for the Hazel Dormouse (*Muscardinus avellanarius*) and bird species.
- Throughout the construction period, continuous monitoring by an ecological specialist is considered essential.

Commitments under Project finance:

Reduce noise/vibration disturbance impacts through:

- Machinery and equipment which are used intermittently will be shut down/turned off during periods when they are not in use.
- Monitor, and keep in proper working condition, all equipment, devices, and work resources.
- Regular maintenance of plant and machinery will be carried out in order to minimise noise emissions (in particular, attention will be paid to the lubrication of bearings and the integrity of silencers fitted to vehicles/machinery.
- Staff and visitors must be warned not to disturb birds, especially during the nesting period when nests occur on the site or surrounds. According to § 44 BNatSchG it is prohibited to disturb wild birds during the breeding and rearing season.

- Noise monitoring shall be conducted if required by law or in response to any complaints. Limit construction activities to day-time hours to limit impacts to any nocturnal species as far as possible, otherwise limit night-time activities to only essential works to reduce disturbance.
- Maintain vehicles and equipment in good working condition.
- Use noise minimising technology where possible.

Minimise visual and artificial light disturbance impacts through:

- Temporary working areas will be as small as practicable, and areas chosen for the storage of materials will avoid areas of high visual impact.
- Temporary hoardings (site fences) will be introduced to visually screen areas of intense construction activity in close vicinity of visually sensitive areas where moving plant, machinery and vehicles may be a source of visual impact.
- The construction site will only be floodlit when required for health and safety reasons and during Night Works, so the impacts of temporary lighting upon the nighttime landscape and upon views are kept to a minimum.
- To protect bat species known to be present within the Natura 2000 areas near Landau, reduce the intensity of construction works in the vicinity of these areas (i.e., pipeline installation near the 'Standortübungsplatz Landau') from dusk to dawn during the period April-October, when the activity of bats is typically at its highest. During this period, artificial lighting should be restricted only to the construction works zone, with the possibility of encasing the floodlights by protective lids to prevent the diffusion of light.
- Aim lights away from any adjacent sensitive habitats. Use of directional lighting to reduce light spill and prevent light increases in adjacent sensitive habitats such as bushes and wooded habitats.
- Use low intensity lights where possible.

Use appropriate lighting that minimises ecological and physiological effects on wildlife and also limits attraction of insects e.g., use of long-wavelength (warm white, orange, red and infra-red) light instead of short-wavelength (UV, cool white, blue and green LEDs).

Reduce the risk of fugitive dust emissions through:

- Minimise the surface clearing of vegetation to the minimum required.
- Limit or suspend bulk earthworks and vegetation stripping during particularly windy periods.
- Use appropriate dust control facilities (e.g., windbreaks, temporary barriers, netting screens, fences or plastic sheets) to contain dust emissions from dusty areas, during excavations and earthworks.
- Minimising the size of material/spoil/topsoil storage piles.
- Cover soil stockpiles during windy periods with appropriate cover materials if greening is not possible.
- Restrict unnecessary traffic.
- Where practical, compact ground in areas that are heavily used by vehicles and machinery to reduce the potential for mobilisation of loose soil or silt by wind.

- All construction related traffic to maintain speed limits of maximum 30 km/h on all un-surfaced roads, with appropriate speed limit signage provided for these roads.
- Use a suitable cover/tarp when transporting soil/sand by truck that could be liable to spillage or dust pollution.
- Minimise and strictly regulate the offsite hauling of debris.
- Use low-dust-emitting materials for access roads where feasible. Otherwise, implement dust suppression methods.
- Employ suitable dust suppression on bare soil surfaces exposed to wind and dirt roads used by heavy construction vehicles.
- Ensure that any offloading of materials that could easily be suspended in the air (e.g. powders) is carried out in a manner that reduces dust emissions.
- Soil management will be conducted according to the soil protection concept (BSK) and under the guidance and advise of the soil management expert.
- Only non-potable water should be considered for dust suppression activities. Wastewater may not be reused for dust suppression unless this water has been treated to acceptable levels according to national laws for the use in irrigating lands.
- If water is scarce or unavailable, applicable binding agents will be used (additives) for dust suppression.

7.5 IMPACTS RELATED TO CREATION OF BARRIERS TO FAUNAL SPECIES MOVEMENT

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☐
Access roads	☒	☐	☐
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☐
Well sites	☐	☒	☐
GLEP near Landau	☒	☒	☐
CLP at Höchst Industrial Park	☐	☐	☐
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☐

Description of impact

Construction phase:

During the construction phase, the installation of the pipeline near the Natura 2000 site 'Standortuebungsplatz Landau' will pose a temporary barrier to species movement, as mitigation

measures will involve the erection of wildlife screens/fences to limit the movement of species such as reptiles, amphibians, and small mammals into the construction zone. This will be a small and temporary effect. Other potential wildlife barriers include the construction of access roads; however, these too are likely to be of little impact as they will be restricted to modified agricultural areas. The same goes for the drill sites, GLEP and workers camp sites that are all located on modified agricultural land that are not considered important corridors or movement areas for conservation=-important or sensitive faunal species.

Operational phase:

The operational Project will generally not pose a significant barrier to the movement and mobility of volant (flying) species such as birds and bats, however any fencing of the site may restrict the movement of low-flying avifaunal species and especially ground-dwelling small mammals, amphibians, and reptiles potentially. Given the limited extent of the Project, with most of the conservation important species concentrated within nearby Protected Areas outside of the development footprint, it is unlikely that Project will have any appreciable negative influence or population-level effect on species movement (magnitude of effect will therefore be 'small'). Still, it is important to consider species which have been found during the baseline surveys inside the development site (such as the Hazel Dormouse, Common Wall Lizard and Sand Lizard).

Decommissioning phase:

Barriers will be removed during decommissioning.

Impact significance assessment:

Biodiversity Impact 3: Barrier to species movement			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Indirect		n/a
Receptor	Mammals, herpetofauna (reptiles, amphibians) and birds		n/a
Receptor sensitivity	Medium		n/a
Nature of impact	Negative (-)		n/a
Extent/Scale	Site/Local		n/a
Duration	Short-term	Long-term	n/a
Frequency	Daily	Daily	n/a
Likelihood	Possible	Possible	n/a
Magnitude of effect	Small	Small	n/a
Impact Significance (with embedded mitigation)	**Minor**	**Minor**	**n/a**
Residual impact (after mitigation)	**Insignificant / None**	**Insignificant / None**	**n/a**
Irreplaceable loss of resources	None		n/a
Reversibility	Reversible		n/a
Evaluation of Mitigation Effectiveness	Easy to implement, moderately effective		n/a
Level of confidence	Medium	High	n/a

Embedded mitigation measures according to the biodiversity baseline surveys completed between 2018-2023 for the national EIA and permitting process:

- Implementation of precautionary measures to protect the areas inhabited by the Common Wall lizard (*Podarcis muralis*), which include instalment of reptile fences to create effective barriers around these zones.

Additional commitments under Project finance:

- An ecological expert will ensure that species movement is not restricted by construction fences. Any temporary excavations, fences or stockpiles of soil and materials must be removed from the site once construction is complete.
- Wildlife shepherding protocol to be prepared and implemented where construction takes place, to check areas to be worked in prior to construction and remove or shepherd wildlife found on the construction site to safety in adjoining natural habitat (where these animals cannot safely exit the construction site by themselves). When capturing/relocating animals, cover larger animals with a towel or blanket and place in a cardboard box and/or hessian bag, place smaller animals in a cotton bag, tied at the top.
- Investigate opportunities to conserve, better manage or create suitable alternative habitats or enhancement of existing ones to support displaced species where applicable. This will be informed by operational phase monitoring of species.
- Undertake progressive rehabilitation in accordance with a land/habitat rehabilitation and restoration plan.
- Develop and implement a suitable 'Mine Decommissioning and Closure Plan' for the discontinuation of the operation (in German: 'Betriebsplan für die Einstellung des Betriebes, Betriebschronik' in accordance with the German mining law (The Federal Mining Act or "Bundesberggesetz" BBergG), and importantly this plan may be subject to amendment or supplementation in terms of the Federal Mining Act and should therefore be considered a 'living document'. The plan needs to take into consideration the final land use upon closure and implement relevant land and/or habitat restoration measures as necessary.

7.6 IMPACTS RELATED TO AQUATIC ECOSYSTEMS

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☐
Access roads	☐	☐	☐
Worker camps	☐	☐	☐
Permanent Infrastructure: new			
Pipeline	☒	☐	☐
Well sites	☐	☐	☐
GLEP near Landau	☐	☐	☐
CLP at Höchst Industrial Park	☒	☒	☒

Components	Construction	Operation	Decommissioning
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☒	☐	☐

Description of impact

Construction phase:

Fuels, oils, and other chemical substances required by construction crews operating at construction work areas will be liable to potential accidental spillage, and potentially improper disposal in rare cases, unless this is carefully managed. Whilst watercourses and aquatic biodiversity are typically the most sensitive and prone to pollution impacts, these are largely absent from the site and its surroundings near Landau (with the exception of modified watercourses such as small streams and agricultural drains).

However, there is a potential risk (albeit low) that spills could impact on the Main River associated with the CLP development site at Höchst Industrial Park, which could contribute to reduced water quality within the Main River. The Main River has been assessed as being in an 'unsatisfactory' ecological condition, which suggests that a significant level of modification to the river ecosystem and ecology has taken place already (see section 3.3.2 of the Biodiversity Baseline Report in Appendix A of the ESIA). The receptor sensitivity of this section of the Main River is therefore regarded as 'Low to Medium'. The fact that the industrial park is isolated from the river system, and that strict adherence to pollution prevention protocols will need to be followed during construction, greatly reduces the inherent risk of water pollution.

Operational phase:

Treated domestic and/or industrial wastewater generated at the CLP at Höchst Industrial Park could contribute to reduced water quality within the Main River, which is located to the north of the lease site, with the Industrial Park Höchst located on both sides of the river channel. Given that this is likely to be only a fraction of what is being treated and released into the river from other industry and residential areas in the Frankfurt-Main region, it is unlikely to contribute significantly to water quality impacts. Additionally, the Main River is known to be already significantly modified and sensitive or intolerant aquatic species are therefore unlikely to occur. Furthermore, strict adherence to effluent release standards and permitting standards for the existing central treatment plant operated by the industrial park Service Provider ('InfraServ') will ensure that water quality concerns are addressed. There is highly unlikely to be any impact to the ecosystem services provided by the Main River linked to the Project, as the Project is isolated from the instream and riparian habitats of the river.

Decommissioning phase:

Impacts are likely to be the same or similar to the construction phase.

Impact Significance assessment:

Biodiversity Impact 4: Impacts on Aquatic Ecosystems			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Direct	Direct	Direct
Receptor	'Main' River (located adjacent to the Höchst Industrial Park)		
Receptor sensitivity	Medium		
Nature of impact	Negative (-)		
Extent/Scale	Local	Local	Local
Duration	Short-term	Long-term	Short-term
Frequency	Weekly	Daily	Weekly
Likelihood	Possible	Possible	Possible
Magnitude of effect	Small	Small	Negligible
Impact Significance (with embedded mitigation)	**Minor**	**Minor**	**Minor**
Residual impact (after mitigation)	**Insignificant / None**	**Insignificant / None**	**Insignificant / None**
Irreplaceable loss of resources	None		
Reversibility	Recoverable		
Evaluation of Mitigation Effectiveness	Easy to implement, effective		
Level of confidence	High	Medium	High

Embedded mitigation measures according to the biodiversity baseline surveys completed between 2018-2024 for the national EIA and permitting process:

- None

Commitments under Project finance:

- Implement good practice and standard industry construction controls for waste, wastewater, and handling of fuels/chemicals, detailed in a comprehensive waste, wastewater, and hazardous substances management plan. Additionally, enforce operational controls on surface water runoff through the operational stormwater management system, ensuring the separation of clean and dirty stormwater. Domestic and industrial wastewater should be treated at a licensed wastewater treatment facility.
- Industrial and domestic wastewater generated at the CLP will be handled by the Service Provider ('InfraServ') at Höchst Industrial Park. InfraServ will provide the necessary services infrastructure and connections for the leased site, including water, waste, wastewater, storm water runoff and energy. The wastewater will be treated at the existing central wastewater treatment plant at the Industrial Park Höchst, and only suitably treated effluent that meets the legislated discharge water quality standards (as per the InfraServ existing permit for the treatment plant) will be allowed to be released to the environment (i.e. the Main River).
- For the existing geothermal plant at Insheim:
  - The plant operates a conservancy tank for domestic wastewater, with treatment at the local municipal treatment works;

  - A storm water containment pond functions with the dual-function as a PCD (Pollution Control Dam) in the event of a spill, such that this is contained on site;
  - The risk of mechanical failure and leakage associated with the plant is low and pressure gauges installed along the pipes monitor where leaks take place and will shut-down the system in the event of a leak; and
  - Chemicals and other substances liable to spillage are contained within the workshop area and are handled in a controlled manner.
- It is anticipated that the same measures for the existing plant at Insheim will also be adopted for the new GLEP planned near Landau.

Additionally:

- Disposing of waste in the environment is prohibited. Waste products are to be transported to registered waste facilities only for proper disposal.
- Waste generated during the construction works (concrete, metal, plastics, cables) must be collected and submitted to collectors for each type of waste separately.
- Establish a secured designated fuel and chemical storage area, with an impervious cover and sufficient containment volume for the storage of all chemicals.
- Restrict refuelling of vehicles or equipment to impermeable hard-standing areas with strict spill controls.
- Barriers such as fencing or other suitable measures will be employed to safeguard sensitive river and drain areas from the potential impacts of vehicles and construction activities.
- Driving within streams or along their banks will be prohibited, except when unavoidable for the construction of specific structures. In such cases, suitable measures, such as placing metal plates for vehicle passage, will be implemented to protect these sensitive areas.
- All staff and subcontractors will be required to report any incidents, and these will be subject to investigation and remedial and preventive actions will be taken;
- Protection measures to prevent soil erosion after the finalisation of the earthwork will be implemented where required such as:
  - use of grass turf to cover the soil surface;
  - use of erosion-control blankets or mats; and
  - renaturation as soon as feasible.
- Always use drip trays when temporarily storing or handling fuels or when servicing/repairing vehicles on site. Place diesel pumps and similar items on drip trays to collect minor spillages. Check trays regularly and remove any accumulated oil.
- Employ best practice measures in handling and storing fuels, oils, and chemicals liable to spillage.
- A spillage risk assessment should be undertaken as part of the development of the Emergency Preparedness and Response Plan (EPRP).
- The EPRP Plan should specify that Spill Response Kits will be available, including absorbent materials suitable for the materials to be handled on-site, will be held at secure, clearly signposted locations, instructions will be provided with the kits and personnel will be trained in their use.

- Any spillages will be immediately contained on-site and all contaminated materials including soils will be removed from the site for suitable treatment and disposal.
- Inform the relevant authorities as soon as any significant or major spill event takes place.
- Check hoses and valves regularly for leaks to ensure they are turned off and securely locked when not in use.
- Make sure to have recipients that can collect fuels in case of leaks as well as a minimum of 3 kg of environmentally friendly substances able to absorb fuel and other spills.
- Conduct regular inspections of construction vehicles to identify and repair leaks or damaged fuel/lubricant lines.
- There will be no direct discharge of contaminated run-off from worksites to any watercourse at the construction components; and
- Construction equipment will be cleaned away from surface waters.

7.7 IMPACTS RELATED TO INTRODUCTION/SPREAD OF INVASIVE ALIEN PLANTS

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☐
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☐	☒
GLEP near Landau	☒	☐	☒
CLP at Höchst Industrial Park	☐	☐	☐
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☐	☒

Description of impact

Construction phase:

The movement of vehicles, people, and equipment into and through the Project area may facilitate the introduction of Invasive Alien Plants (IAPs) to the area, or contribute to the spread of existing IAP species, primarily through the transport of seed attached to machinery, soils, clothing, etc. The disturbance created by vegetation clearing and earthworks may also create suitable conditions for IAPs and weeds to become established and possibly spread into adjacent habitats. IAPs can have far reaching detrimental effects on native biota and are widely accepted as being a leading cause of biodiversity loss. The introduction and spread of invasive species/weeds that can outcompete native plants and change habitats.

Local site conditions generally determine the susceptibility of a site to invasion and in this sense, certain land use types and particularly agriculture favour the presence and dominance of IAPs. The agricultural lands for example, whilst arguably susceptible to infestation by alien plants, are likely to be of very limited importance from a biodiversity perspective, whilst the natural grasslands associated with the Natura 2000 site 'Standortübungsplatz Landau' would be susceptible to invasion by undesirable plant species and these are considered 'critical habitats' and therefore have been rated as being of 'high' conservation importance and sensitivity. This is particularly relevant given that the pipeline installation is planned within roughly 50 m from the boundary of the Natura 2000 site.

Operational phase:

The introduction of invasive alien plants during the construction phase can last into the operational phase of the Project has the potential to have a significant and lasting negative effect on the habitat and plant communities, that can extend well past the construction phase unless controlled. However, for the sake of the significance assessment below, only the construction and decommissioning phase impacts have been assessed as this is typically when and where such impacts are initiated.

Decommissioning phase:

Impacts during the decommissioning phase of the Project will likely be similar to the construction phase impacts.

Impact significance assessment:

Biodiversity Impact 5: Introduction/spread of Invasive Alien Plants (IAPs)			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Indirect	n/a	Indirect
Receptor	Habitat 1: agricultural land (modified) | Habitat 2: built/urban | Habitat 3: grasslands associated with the Natura 2000 site 'Standortübungsplatz Landau'		
Receptor sensitivity	Low for agricultural and built areas, High for natural grasslands		
Nature of impact	Negative (-)	n/a	Negative (-)
Extent/Scale	Local	n/a	Local
Duration	Long-term	n/a	Long-term
Frequency	Regular	n/a	Regular
Likelihood	Possible	n/a	Possible
Magnitude of effect	Small	n/a	Small
Impact Significance (with embedded mitigation)	**Minor to Moderate**	**n/a**	**Minor**
Residual impact (after mitigation)	**Insignificant / None**	**n/a**	**Insignificant / None**
Irreplaceable loss of resources	None	n/a	None
Reversibility	Recoverable	n/a	Recoverable
Evaluation of Mitigation Effectiveness	Easy to implement, effective	n/a	Easy to implement, effective
Level of confidence	High	n/a	High

Embedded mitigation measures according to the biodiversity baseline surveys completed between 2018-2024 for the national EIA and permitting process:

- None.

Commitments under Project finance:

- Compile and implement a suitable Invasive Alien Plant (IAP) species control plan and program to eradicate dense colonies of alien plants and control the spread of minor species and weeds.
- Identify existing invasive species and potential risks through ongoing monitoring during the construction phase (recommend that seasonal surveys be completed during spring and summer: April – September), during the growing season for plant species).
- Remove invasive plants from the Project site where identified and implement effective disposal methods.
- Inspect construction equipment, vehicles, and materials for hitchhiking seeds, spores, or organisms before they enter the Project site.
- Use local soils and reduce the need for foreign soils from other regions that may carry foreign plant material unless these have been treated.

7.8 IMPACTS TO PROTECTED AREAS

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☐	☐	☐
Access roads	☐	☐	☐
Worker camps	☐	☐	☐
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☐	☐	☐
GLEP near Landau	☐	☐	☐
CLP at Höchst Industrial Park	☐	☐	☐
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☐	☐

Description of impact:

Construction phase:

Direct impacts to Protected Areas will be generally avoided as infrastructure and activities will take place outside of the boundaries of these designated areas. Indirect impacts to Protected Areas (Natura 2000) are addressed in terms of the other five impacts described above.

Vulcan's current planning for ICPP Section 3 (Landau well site to GLEP at Landau) will intersect the Natura 2000 site 'Standortübungsplatz Landau'; however, alternative options to avoid the Natura 2000 site are still being evaluated by Vulcan. An option being considered seeks to cross under the existing railway line in such a manner as to avoid the Natura 2000 site entirely, however this requires a land acquisition process to first be fulfilled, with some additional engineering concerns raised by RPM Global for this option. For the original option that intersects the Natura 2000 site, impacts on habitats and species could result, and of most importance are the grassland and hay meadow habitats conserved within this Natura 2000 site, which are the qualifying features responsible for the site designated in terms of the EU Habitats Directive:

- 6210: Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (important orchid sites)
- 6510: Extensive hay meadows of the planar to submontane stage (Arrhenatherion, Brachypodio-Centaureion nemoralis)

Importantly, the ICPP Section 3 alignment that intersects the Natura 2000 site appears to be located within wooded/shrubland habitat that fringes the more intact/near-natural conserved grassland and hay meadow habitats, such that direct impacts on the conserved Annex I habitats is probably unlikely to occur.

Potential short-term and temporary impacts in terms of vegetation clearing to woodland/shrubland habitat fringing these grassland/meadow habitats could however result and there could also be associated impacts to species of breeding birds, bats and insects that may utilise these habitats for resting, foraging or hunting activities. Based on the assessment of other areas of the Project study area outside of the Natura 2000 site, most habitats (biotopes) appear to be common and modified habitat types that are not protected in terms of German law, and the wooded habitat structures may resemble these types, *however further surveys and biotope mapping will be required to confirm the individual biotopes and their protection status/importance as well as surveys for bats, breeding birds, reptiles, small mammals (dormouse) and invertebrates (insects) to understand the receptor sensitivity and importance and the level of impact anticipated to inform more precise mitigation requirements.*

Operational phase:

During operation, the pipeline is unlikely to result in further impacts as these are predominantly linked to the clearing of vegetation and direct habitat impacts during construction and have therefore been assessed as such.

Decommissioning phase:

Impacts during the decommissioning phase of the Project will be fairly like the construction phase impacts, but less intense and shorter in duration most likely.

Impact significance assessment:

Biodiversity Impact 6: Impact to Protected Areas			
	Project Phase		
	Construction	**Operation**	**Decommissioning**
Type of impact	Direct / Indirect		

Biodiversity Impact 6: Impact to Protected Areas			
	Project Phase		
	Construction	**Operation**	**Decommissioning**
Receptor	Natura 2000 site: Standortübungsplatz Landau (habitats conserved and species of importance: e.g. birds, bats, mammals, reptiles, invertebrates)		
Receptor sensitivity	Medium - High		
Nature of impact	Negative (-)		
Extent / Scale	Site/Local		
Duration	Short-term activity, potentially long-term impact	Long-term	Short-term activity, potentially long-term impact
Frequency	Weekly	Once off (immediate)	Weekly
Likelihood	Possible	Unlikely	Possible
Magnitude of effect	Small	Negligible	Small
Impact Significance (with embedded mitigation)	**Minor to Moderate**	**Insignificant**	**Minor**
Residual impact (after mitigation)	**Minor**	**Insignificant / None**	**Insignificant / None**
Irreplaceable loss of resources	None		
Reversibility	Recoverable		
Evaluation of Mitigation Effectiveness	Some measures could be challenging to implement, effective		
Level of confidence	Low	Medium	Low

Embedded mitigation measures according to the biodiversity baseline surveys completed between 2018-2024 for the national EIA and permitting process:

None yet - An assessment will be required for the alternative alignment of the ICPP Section 3 that traverses the Natura 2000 site 'Standortübungsplatz Landau'.

Additional mitigation recommended by ERM:

- Undertake an Appropriate Assessment (AA) for the ICPP Section 3 pipeline alignment that intersects a portion of the Natura 2000 site 'Standortübungsplatz Landau', in accordance with the requirements of the EU Habitats Directive for project components and activities located within or near Natura 2000 sites where impacts are likely or possible. In essence, the Project will need to establish if the pipeline could result in significant negative effects on the conservation objectives of the Natura 2000 site (in terms of impact screening and possible need for a more detailed 'Appropriate Assessment') in order to comply with Article 6: section 6(4) of the EU Habitats Directive. See the 'information box' below for further information.
- Field surveys and biotope mapping will be required to confirm the individual biotopes and their protection status/importance as well as ecological surveys for bats, breeding birds, reptiles, small mammals (dormouse) and invertebrates (insects) to understand the

receptor sensitivity and importance and the level of impact anticipated to inform the Appropriate Assessment and to recommend more precise mitigation requirements.

- Implement the mitigation hierarchy of controls, in alignment with IFC PS6 requirements, with a focus on prioritizing avoidance and minimisation of impacts on habitats within the Natura 2000 site, before considering measures to restore and finally compensate for residual impacts.
- The mitigation measures for other impacts presented above (will likely also apply to the ICPP Section located within and in close-proximity to the Natura 2000 site 'Standortübungsplatz Landau'.
- Additional measures to be considered should include:
    - Minimise the width of the pipeline construction corridor as far as possible where this is within the Natura 2000 site,
    - Minimise the extent of vegetation clearing to that needed to install the pipeline,
    - Locate any temporary worker/site camps and material or equipment storage/laydown areas and stockpiles of soil outside of the Natura 2000 site as far as possible,
    - Develop a plan to restore temporarily disturbed wooded/shrubland habitats post-construction, and
    - Consult with the relevant local environmental planning office regarding any habitat compensation measures that may be required for impacts to the biotopes associated with the Natura 2000 site 'Standortübungsplatz Landau'.

Information Box: Requirements for Project Components located within or near Protected Areas (Natura 2000 sites)

In terms of Article 6 of the EU Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora), there are several requirements pertaining to the establishment and protection/management of Natura 2000 protected areas. Of particular relevance to the Project, given the proximity of the Project to the Natura 2000 site 'Standortübungsplatz Landau', and position of the alternative pipeline alignment within a section of the Natura 2000 site, is clause 6(3) of Article 6 that mentions that plans or projects that may have a significant impact on Natura 2000 sites, these shall be subject to appropriate assessment of the implications of the project for the site, in view of the site's conservation objectives.

It should be noted that Project components/activities located outside of the Natura 2000 sites should also be considered for assessment as indicated in EU (2019), where it is mentioned that *"a likelihood of significant effects may arise not only from plans or projects located within a protected site but also from plans or projects located outside a protected site"*.

In essence, there are a number of steps required:

- 'screening' under stage 1 is a basic is a basic pre-assessment stage intended to determine whether in isolation or in combination with other projects or plans, the Project is likely to have a significant effect on a Natura 2000 site;

- if the screening concludes that significant effects on the site are likely, an Appropriate Assessment (AA) is required to be carried out under stage 2, which is more detailed and involves the case-by-case evaluation of the possible implications of the development/activity, also in combination with other plans/projects, on the Natura 2000 site whilst considering the sites conservation objectives; and
- once the AA has been completed, the competent national authorities then decide whether to approve the project or not, taking into consideration public opinion also.

The component national authority will need to agree on the project after having concluded that the project will not adversely affect the integrity of the Natura 2000 site, after also having obtained the opinion of the general public (paraphrased from Article 6 of the EU Habitats Directive).

Further assessment will therefore be necessary in order to determine the significance of any possible impacts on the conservation objectives and conserved features/biodiversity values of the Natura 2000 site 'Standortübungsplatz Landau'. Significance of impacts would require understanding factors such as magnitude of impact, type, extent, duration, intensity, timing, probability, cumulative effects and the vulnerability of the habitats and species concerned (EU, 2019). The application of the precautionary principle that underpins Article 6 of the EU Habitats Directive, implies that this would require at least a stage 1 'screening' be undertaken to determine if significant impacts could result from the Project and which would then inform the need for stage 2 'Appropriate Assessment' should there be the possibility for significant adverse effects on a Natura 2000 site. An ecologist would need to undertake such an assessment and determine what mitigation measures would be needed.

7.9 SOCIAL IMPACT ASSESSMENT

7.9.1 INTRODUCTION

In Germany there is widespread social recognition of the need to transition to a green economy. The recent Renewable Energy Act (EEG 2023) is proof of this, as the government seeks to ramp up buy-in for the national expansion of renewable energy. Sustainability, and more importantly, the transition to carbon neutrality must anticipate and consider the impacts to all aspects of the environment – not only the physical environment or biodiversity but extending to people and social issues as well. Indeed, the proper assessment and mitigation of the Project's environmental risks also requires that social risks be comprehensively understood and mitigated so that environmental returns or preservation do not come at the expense of people, their livelihoods, and overall well-being. Whilst some level of trade-off between different aspects of the environment may be involved in any project, the ESIA ultimately aims to inform a sustainable approach to environmental and social management that minimises these trade-offs as far as possible.

A Social Impact Assessment (SIA) includes the examination of issues pertaining to people, and includes cultural heritage, the economy and employment, education, public services and infrastructure, land acquisition, land use, gender and vulnerable communities, community health and safety, etc.

An SIA also utilises a socio-economic baseline to properly identify and evaluate potential social impacts that are directly or indirectly linked to Project activities. Firstly, it is important to understand the social receptors (i.e., who/what may be impacted and how) and to properly understand community needs and interests to identify where potential impacts lie. SIAs can also be particularly valuable in helping to enhance value creation to people within the Project AoI.

The SEP is complementary to the SIA component of the ESIA, helping to identify and understand community interests and needs via extensive engagement and active monitoring and management of risks/impacts via a Grievance Mechanism. The SEP can help fill data gaps that may arise during desktop research of social baselines, as direct engagement with stakeholders and Project Affected Persons is in most instances considered essential – serving as the main source of primary up-to-date information on livelihoods, land use, social infrastructures, local vulnerabilities that may not be publicly available.

7.9.2 APPROACH AND METHODS

The SIA contained in this Section of the ESIA aims to describe potential impacts throughout the entire Project life cycle. For this Project, the construction, operation, and decommissioning phases have been considered, together with the relevant Project components and activities for each of these phases.

The following list presents an overview of steps for the SIA:

- Defining the AoI;
- Identifying Social Receptors and Values within the Project AoI;
- Identifying Potential Social Impacts;
- Assessing Impact Significance;
- Recommending appropriate Mitigation and Management Measures;
- And assessing Residual Impacts (that account for mitigation of impacts).

The full approach and methodology are elaborated upon in more detail in section 5.2 of this report.

7.9.3 SCOPED OUT IMPACTS

Based on the socio-economic baseline and human rights right screening provided in the previous sections there are no relevant vulnerabilities, receptors, indicators, or conditions pertaining to (1) governance and administration, (2) demographics, and (3) education within the Project area that would suggest relevant impacts. Similarly, current baseline data does not suggest that there may be a disproportionate amount of vulnerable people compared to other regions or states.

Table 7-83 below provides an overview of the impacts that have been screened out of the Project scope. Based on the initial ESIA scoping and the full baseline assessment, these already have extensive embedded mitigation measures to reduce the likelihood of such risks and adverse impacts.

TABLE 7-83 SCREENING OF IMPACTS OUT OF SCOPE

Impact	Justification for Scoping Out Impact
Human Rights/GBVH	• Embedded measures from German law and Vulcan policies are in place to suggest that adverse human rights impacts from the Project are unlikely. • Germany is on the Designated Countries' list of the Equator Principles IV (EP4) and generally has a low human rights risk profile. Table 6-30 provides an overview of Germany's most relevant human rights legislation and Table 6-31 provides the Human Rights Risk Screening. There are stringent country-level commitments to protecting human rights. Moreover, ERM previously conducted a Human Rights Screening aligned with EP4 suggesting that there is a low risk for the majority of human rights related topics (see section 6.20).
Land Acquisition/Ownership	• There are no anticipated impacts from land acquisition, such as economic or physical displacement and livelihoods will not be infringed upon. • There are no indigenous groups or other unique local communities with land tenure vulnerabilities. • There is a strict protocol for land ownership and acquisition that the Vulcan team must follow. • Germany (and this region of the country) is also rich in agricultural resources and land, suggesting that if agricultural land is lost or converted on industrial land it will be unlikely (and illegal) that farmers begin encroaching on other land to continue farming.

7.10 VALUE CREATION

The Project aims to create two key benefits: renewable energy provision (heat and power) to local communities and the creation of job opportunities. The following two sub-sections elaborate on these two positive impacts. An impact significance table has not been included for the evaluation of positive impacts.

7.10.1 ENERGY PROVISION

Germany's market for renewable energy is rapidly expanding, especially with the onset of the newest EEG 2023. There is growing public buy-in from local communities and on a higher political level. EU polls in the Spring of 2023 indicate that citizens perceive climate change as one of the most important issues the EU is currently facing, and for Germany it was deemed the most serious global problem.[269] Green energy is a high priority for the German public, as is local access, and the German government plans to ban fossil-fuel run heating systems entirely from 2045 onward.[270] There is also a growing demand for renewable energy in Germany, as prices for energy consumption increase (especially heat) and the country presses to reduce reliance on foreign sources of fuel/energy.

[269] Source: Wettengel, Julian, Clean Energy Wire, August 2023, Polls reveal citizen support for climate action and energy transition, retrieved from: Polls reveal citizen support for climate action and energy transition | Clean Energy Wire, accessed in November 2023.
[270] Source: Sören Amelang, Clean Energy Wire, September 2023, Germany agrees phaseout of fossil fuel heating systems, retrieved from: https://www.cleanenergywire.org/factsheets/qa-germany-debates-phaseout-fossil-fuel-heating-systems, accessed in November 2023; European Heat Pump Association (EPHA), German heating law: watered down but end goal unchanged, retrieved from: https://www.ehpa.org/news-and-resources/news/german-heating-law-watered-down-but-end-goal-unchanged/#:~:text=By%202045%2C%20when%20Germany%20aims,switched%20to%20renewable%20energy%20sources., accessed in November 2023.

Relevance to Project:

TABLE 7-84 ENERGY PROVISION AND RELEVANCE TO THE PROJECT

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☐	☐	☐
Access roads	☐	☐	☐
Worker camps	☐	☐	☐
Permanent Infrastructure: new			
Pipeline	☐	☒	☐
Well sites	☐	☒	☐
GLEP near Landau	☐	☒	☐
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☐

Description of impact:

One of Vulcan's primary objectives with the development of this Project is the provision of renewable (geothermal) energy to the local area.

The Project will generate a new source of renewable heating and electricity supply, which energy suppliers will then be able to distribute to households to augment the existing infrastructure. The Project would ultimately supply approximately up to 596 GWh of heat per year and up to 31 GWh of electricity. Considering average per capita heat consumption in Germany[271], the Project will positively affect ca. 100,000 people.

This positive impact will be created during operation and its success may act as a blueprint for the expansion of similar Projects throughout other areas. The receptor of this impact are residents, and receptor sensitivity would be medium-high in this case due to the increasing demand for clean/renewable energy in the face of global climate change and the need to transition away from fossil fuels.

Construction phase:

Not applicable. The provision of heat and energy will arise during operation.

Operational phase:

During the Project's operation a local heat and electricity supply will be generated for residents. Vulcan is targeting co-production of up to 596 GWh/a[272] of baseload renewable heat and internal consumption as well as up to 31 GWh/a of baseload renewable power, to be sold to the grid at Feed-in Tariff rates. Beneficiaries will primarily be in Insheim or near the Insheim Geothermal Plant, as well as in Landau near the GLEP site. Vulcan currently anticipates the (already

[271] Average per capita heat consumption in Germany of 6,200 kWh (https://www.destatis.de/)
[272] Bridging Study announcement (16 Nov 2023) page 130 Production Target Assumptions and Parameters

operational) Insheim geothermal plant to supply roughly 8k households with electricity and 600-800 households with heat[273]. Considering average per capita heat consumption in Germany[274], The Project's heat supply is equivalent to the demand of 100,000 people.

Decommissioning phase:

Decommissioning suggests an end to the positive impacts from this Project. However, Vulcan hopes that other similar Projects with additional value creation will continue expanding, thus envisaging benefits to extend well beyond this Project.

7.10.2 EMPLOYMENT AND TRAINING

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☐	☒

Description of impact:

Overall, the Project may lead to a positive impact due to job creation. Vulcan estimates that between 790 to 1400 employees will be hired during drilling, construction and operations, most of which are highly skilled or technical workers such as drilling staff, operators, maintenance, and project engineers. It will contribute to employees work experience and skills, especially after they undergo additional training required for their respective positions. This may lead to further employment and additional upskilling, especially in the renewable energy and geothermal sector, which are rapidly expanding in Germany. From construction phase through to operation, Vulcan estimates thousands more direct and indirect jobs will be created, linked to the energy transition, decarbonisation and electrification of transport.

[273] Bundesverband Geothermie, 2022. Insheim – Geothermieanlage (Bundesverband Geothermie: Insheim - Geothermieanlage)
[274] Average per capita heat consumption in Germany of 6,200 kWh (https://www.destatis.de/)

VERCANA GmbH is a subsidiary of Vulcan and is the appointed drilling contractor, whilst the EPC Contractors appointed for each Project component is as follows (as of the beginning of August 2025):

- For the LEP and CLP – Sedgman & Hochtief Joint Venture
- For the ABB – JordProxa & NESI
- For the ORC – Turboden & ROM
- For the ICPP – Strabag & PPS.

Vulcan will prioritise employing local labour, by employing vulnerable or disadvantaged groups for semi-skilled or unskilled labour positions, wherever possible. Successfully achieving this would contribute to positive impact and further local value creation.

The overall magnitude of the impact will likely remain small as only a particular sector of the local or regional population will benefit from such employment opportunities.

Construction phase:

Most of the additional labour will be required during the construction phase, especially for pipeline construction and drilling purposes.

Though employment during construction may only be temporary, it may lead to additional upskilling and employment, especially as new employees can form strong business relationships with Vulcan.

Operational phase:

During operation there will still be opportunities for operational staff, maintenance crews, and other technical employment required for the long-term. Whilst this will only benefit a smaller number of people compared to during construction, it will still generate long-term positive impact. This will, however, be targeted at the skilled operators' market.

Decommissioning phase:

At this stage of Project development, there are no plans yet regarding closure or rehabilitation of the Project components. At some time in the future the whole Project (or parts thereof) will be closed and dismantled/decommissioned, probably in a phased manner that will entail progressive closure and rehabilitation. This will require labour to dismantle, dispose of and rehabilitate the affected areas, requiring multi-disciplinary teams and thereby also having an effect in terms of employment and income generation. How much of this will be accrued to the local areas remains uncertain at this stage. When the lithium production is finished, the brines and wells can still be used to produce renewable energy, thus leaving behind a renewable energy asset which will help to support the employment opportunities as well.

7.11 IMPACTS RELATED TO LAND USE AND VISUAL IMPACTS

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☐	☒
GLEP near Landau	☒	☐	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☐	☐

Most of the area within the AoI is under or related to agricultural land use, with limited use by local communities (recreational purposes via walking or cycling). Much of the recreational use (cycling and walking paths) are concentrated within and in the vicinity of the Natura 2000 nature reserves, that include in the vicinity of the planned pipeline near Landau (D12 industrial park) as well as the Erlenbach and Klingbach reserve in the south near the 40 Morgen drill/well site.

Description of impact

There will only be some minimal land loss for the creation of this Project.

Project sites are mostly built on agricultural areas, but this will not lead to economic displacement as the land is or will be privately owned by Vulcan. Most of the agricultural land will still be able to be used for crop cultivation after decommissioning. Nearby farmers will not be restricted from farming during construction and operation. Disruptions to neighbouring farmers/farmland will be minimal and mainly confined to the construction period and activities. During Project operation, surrounding farmers will be able to resume previous farming activities.

There are some land areas used for leisure and tourism, namely near the Landau D12 sites and near 40 Morgen, that may potentially be impacted by visual impacts or loss of recreational areas. Visual impacts refer to changes in scenery or landscapes and consequent changes in the human optic experience.[275] This will mainly affect the local communities who may have previously enjoyed the nature and landscapes for recreational purposes or leisure (i.e., cycling, hiking, walking), namely near the GLEP D12 site as there are numerous paved roads for cyclists and a nearby nature-park for public use.

[275] Bureau of Land Management, Visual Resources: Visual Impact Assessment Methodologies, retrieved from: https://blmwyomingvisual.anl.gov/assess-simulate/#:~:text=Visual%20impacts%20are%20changes%20to,visual%20experience%20of%20the%20landscape.https://blmwyomingvisual.anl.gov/assess-simulate/ accessed in October 2023.

These are likely to be relatively minor impacts, especially as they may affect some of the local population, but only a small number of them. Moreover, landscapes are relatively flat with a few high points of interest suggesting that views in this area may not even be of high importance to locals. The GLEP D12 site is also next to industrial areas, and next to a national highway, and will be part of a new industrial park. These impacts are reversible. Through mitigation efforts during construction and decommissioning, the impacts significance can be reduced to insignificant.

Construction phase:

Digging required for pipeline construction will lead to a temporary loss of farmland; after construction and removal the crop cultivation on this land can resume almost entirely; additional information on this in Section 7.1.3. Though most of the sites are being built on agricultural farmland, there is still an abundance of such landscapes in the area (and greater region) and there will not be any consequent economic displacement.

Increased noise and workers/personnel may also contribute to nuisance impacts, leading to an environment that is less conducive to relaxation and enjoying the natural scenery associated with the Natura 2000 sites (nature reserves) near the Project. This potential impact is most important to consider around the GLEP D12 site. Reduced access and noise nuisances may temporarily deter leisure and recreation near the AoI but will be a reversible impact. Also, considering that the D12 site is already an industrial area, it is likely that receptor sensitivity in the area will be relatively low, as local people will likely already be used to the industrial activity in the area.

Drill rigs will be located at all drill sites and can possibly obstruct views, but this is also likely to be a minimal impact with low receptor sensitivity. The area is not known to have remarkable views, as it is relatively flat with few vantage points or scenic receptors, thus receptor sensitivity is inherently low from a visual effects perspective.

The drilling of well sites may also decrease the aesthetics of the environment. The highest drilling rig will be 61m at the Schleidberg well site, thus potentially obstructing views from those nearby or in the immediate proximity. It is unlikely that views will be completely obstructed but may rather be a nuisance. The area already has existing power lines and wind turbines within sight.

Operational phase:

There will be permanent access control limiting access to the well sites and GLEP, however given that these are on private agricultural land, the impact is considered negligible. Also, the potential for nuisance impacts due to noise will also be insignificant for operation, as per the conclusions of the Noise Impact Assessment (in 7.1.4).

Decommissioning phase:

Workers, vehicles, and machinery during decommissioning may pose similar impacts as those to construction, however, with less intensity and magnitude of effect.

Digging required for pipeline removal will also lead to the temporary loss of farmland; crop cultivation can resume on this land after pipeline extraction. During land restoration drill pads will also be sealed off, and this small section will not be able to be used for further agricultural/farming activities. However, this is only a small fraction of land that will be lost, and the remaining area can continue to be used for agricultural purposes.

Impact significance assessment:

Socio-Economic Impact 1: Land Use and Visual Impacts			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Indirect	Indirect	Direct
Receptor	Local Communities		
Receptor sensitivity	Low		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Local / Site Level	Local / Site Level	Local / Site Level
Duration	Short-term	Long-Term	Short-term
Frequency	Daily	Weekly	Daily
Likelihood	Likely	Unlikely	Possible
Magnitude of effect	Small	Small	Small
Impact Significance (With embedded mitigation)	**Minor**	**Insignificant**	**Minor**
Residual impact (After mitigation)	**Insignificant**	**Insignificant**	**Insignificant**
Irreplaceable loss of resources	None	None	None
Reversibility	Reversible	Reversible	Reversible
Evaluation of Mitigation Effectiveness	Difficult and effective	Easy and effective	Difficult and effective
Level of confidence	High	Medium	High

Commitments under Project finance:

- Prioritise construction efforts and complete them as quickly and efficiently as possible to allow locals to continue using the natural environment; this should particularly be done for infrastructure located near the nature reserves, especially the pipeline at D12 (i.e., trench, install the pipe, and backfill all within one season rather than keeping these areas open for extended periods and then limiting access to the area).
- Do not mix the topsoil and subsoil during the earthworks. Store the stripped topsoil and preserve to the maximum extent possible to be re-used during re-vegetation of excavated areas, cut and embankment areas.
- Limit the area of soil exposure and disturbance to the construction site as much as possible.
- Reinstate the temporary construction components and disturbed land to its original condition upon completion of the construction activities.
- Provide alternative access roads to nature reserves or consider specific timings for road closure (ex. 12-14:00 available for public use) that allow co-use of the area.
- Keep the construction site tidy and free of litter and debris.

7.12 IMPACTS RELATED TO TRAFFIC AND LAND ACCESS

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

The Project Area is located on mostly arable land -- sites 40 Morgen, Trappelberg, Schleidberg, Hasenberg, Spreissgraben and the Insheim geothermal plant are located on and next to agricultural land and non-irrigated farmland. However, in the Landau area where the GLEP D12 site and Landau geothermal plant are located the area is semi-industrial or peri-urban[276]. Traffic throughout the entire study area is relatively minimal except for the nearest urban centers and villages where roads are narrow and potential 'bottlenecking' can occur at intersections of main routes within these urban centers. During ERM's site visit to the town of Insheim, the Vulcan team noted community concerns about the Project's increased traffic movements and large/heavy vehicles carrying materials within the small town.

Description of impact

As Project activities ensue there may be an increase in traffic or the disruption of access to transport infrastructure within and around the AoI. Increased number of personnel or vehicles on the road may congest the already narrow paved roads and in extreme cases compromise road safety or infringe upon nearby land access. Increased congestion may also pose low risks to occupational health and safety.

Civilians in the town of Insheim have previously expressed concern to the Vulcan team about increased Project-specific traffic in their small towns.

With mitigation this impact significance can likely be minimised to an acceptable level. Proper traffic management can aid in road use coordination to optimise efficiency – controlling the

[276] UNESCO defines per-urban as an area that is transitioning from rural to urban land areas. Source: UNESCO, Peri-Urban Landscapes, retrieved from: https://en.unesco.org/events/peri-urban-landscapes-water-food-and-environmental-security#:~:text=Peri%2Durban%20areas%20are%20zones,centres%20and%20the%20rural%20environment. Accessed in October 2023.

timing of works to avoid peak traffic times. Direct coordination with local communities can help Vulcan establish what times are optimal.

Construction phase:

During construction additional access roads will be built near each component to allow for vehicles carrying equipment and workers to access the sites. There may also be road closures during the process of pipelaying. Thus, locals will be temporarily restricted, namely farmers and landowners, from using certain roads, thus potentially disrupting the use of landscapes that may have previously been used for agriculture and recreation. Alternative routes may be available near some Project components.

Additionally, vehicles driving on these narrow roads will be moving at slow speeds carrying large an abnormal[277] equipment loads. Flat-bed trucks will be used to transport materials such as drill rigs to the site and dump trucks will be used to move gravel, dirt, and earth during construction. Thus, there is a potential risk of congestion on these relatively small and narrow roads. Failure to properly coordinate and manage the influx of traffic may also lead to potential occupational health and safety risks (i.e., collisions and traffic accidents) and reduction(s) in overall efficiency (time and resources).

This impact will likely be a minimal, temporary, and reversible impact and will primarily affect the local community. The severity and duration of the impact will also depend on where these large vehicles need to access the public road network; however, this may still only contribute to minimal impact as large vehicles will probably only need to access main roads at specific times and for short durations. The severity of the impact may also vary across seasons – in winter there may be less activity along these roads due to poor weather conditions (snow, precipitation, impairment to visibility etc.).

Operational phase:

During operation there is a low risk of road congestion or prevention to road access. Vehicles accessing the area and Project AoI will be less frequent after construction and be limited mainly to maintenance, inspection crews, and operational staff visiting the drill rigs. This is likely to pose minimal risk to road access and traffic flow.

During operation trucks will frequently transport brine from the Project AoI to the Höchst Industrial Park.

The motorway route from Landau (GLEP) to Frankfurt Industrial Park Höchst (CLP) covers approximately 130 kilometres, relying solely on major motorways and avoiding residential areas. However, despite these precautions, the transportation of hazardous materials may still pose potential risks to both traffic safety and nearby communities. The potential risks include the following:

- Traffic Safety Risks: Transporting hazardous materials may increase the risk of road accidents. An accident involving a truck or railcar carrying these materials could lead to spills, fires, or explosions, especially if the lithium meets water or other reactive substances.
- Traffic Congestion Risks: Large trucks hazardous materials can contribute to traffic congestion, especially in industrial or urban areas. This increases the likelihood of accidents

[277] Abnormal for the type of vehicles and goods that are normally transported on these narrow roads.

and can cause delays for emergency services, potentially exacerbating the risks in case of a hazardous material spill or other incidents.

- Accidental Spills or Leaks: Accidents involving hazardous material (such as sulfuric acid, used in processing) could lead to spills that endanger nearby communities. Spills may contaminate local water supplies, damage infrastructure, and require emergency evacuations.
- Fires and Explosions: Hazardous materials are highly flammable, and in the event of a collision they may release toxic fumes or causing explosions. This could pose a significant threat to communities near transport routes.

Decommissioning phase:

Though planning for the decommissioning phase is currently unclear, there may also be road closure/access restriction and an increase in the number of Project vehicles on the roads. However, compared to construction decommissioning may take a shorter period and fewer vehicles are likely to be involved, thus, reducing the potential severity of the impact.

Impact significance assessment

Socio-Economic Impact 2: Reduced Road Access/Increased Traffic			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Direct	No impact	Direct
Receptor	Local Infrastructure, traffic, land use		
Receptor sensitivity	Medium		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Local	Local	Local
Duration	Short-term	Long-Term	Short-term
Frequency	Daily	Daily	Daily
Likelihood	Highly Likely	Possible	Probable
Magnitude of effect	Small	Negligible	Small
Impact Significance (With embedded mitigation)	**Minor to Moderate**	**Insignificant**	**Minor to Moderate**
Residual impact (After mitigation)	**Minor**	**Insignificant**	**Minor**
Irreplaceable loss of resources	None	None	None
Reversibility	Reversible	Reversible	Reversible
Evaluation of Mitigation Effectiveness	Easy and effective	Easy and effective	Easy and effective
Level of confidence	Medium	Medium	Medium

Commitments under Project finance:

- Vulcan will develop a Traffic Management Plan (TMP) in coordination with the local authorities. The TMP will include a wide range of measures such as stakeholder engagement before temporary closure and diversion of the roads, appropriate signage, speed limits, drivers' training requirements, etc.

- Vulcan will aim to minimise road closure or access restriction as much as possible by expediting construction processes and by coordinating with local land users.
- Vulcan will identify and inform local stakeholders and land users/owners of alternative routes they may use while road access is restricted.
- Vulcan will limit the hours of operation for specific equipment or operations (*e.g.* trucks or machines operating in or passing through community areas) as much as feasible.
- Vulcan will keep the internal haul routes well maintained.
- Vulcan will ensure that the conditions of roads are at least in the same condition (even improved if possible) after use and closure.

Apart from the measures listed above, Vulcan will implement specific mitigation measures to avoid and minimise any negative impacts generated by the transportation of hazardous material transportation. These measures include the following:

- Vulcan will use specialised vehicles and trained drivers complying with the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). These vehicles will be equipped with advanced safety features, such as reinforced containment systems and crash protection. Drivers will undergo specific hazardous material (HAZMAT) training and adhere to Germany's strict transport regulations.
- Vulcan will secure packaging and containment adhering to the ADR regulations, lithium and related chemicals must be securely packaged in certified containers that can withstand impacts and prevent leaks.
- Vulcan will develop an Emergency Response Plan including coordination with the authorities, fire services, hospitals, and local police. Vulcan emergency response teams will be trained in handling lithium-related incidents, and communities along transport routes should be informed of evacuation procedures. These teams will have access to absorbent materials, neutralising agents, and specialised equipment to clean up spills before they spread into waterways or soil.
- In case needed, Vulcan will conduct sessions to inform residents about the transport of hazardous materials and safety measures in case of emergencies.
- Emergency Response Teams: Germany’s environmental laws require companies to have immediate response teams ready to deal with spills. These teams should have access to absorbent materials, neutralising agents, and specialised equipment to clean up spills before they spread into waterways or soil.
- Vulcan will use secondary containment systems in the transportation vehicles fitted with secondary containment systems that can capture any spilled material if the primary container is breached.

7.13 IMPACTS RELATED TO COMMUNITY HEALTH AND SAFETY

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒

Components	Construction	Operation	Decommissioning
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

Overall, the residents of local communities in the study area have comparable health levels/statuses to the national population in Germany. In other words, there are no additional health risks or conditions that the nearby communities disproportionately suffer from or are vulnerable to.

People in Germany and in Rhineland-Palatinate do suffer from smoking related illnesses, suggesting some general respiratory sensitivities. The local populations have a median age of 43.1 and 46.2 in Landau in the Palatinate and Südliche Weinstraße, respectively. The composition of the local elderly population is also comparable to national levels (national elderly population is approximately 22.5%) and is not considered especially high in the area.

There is also a well-established health care infrastructure to manage and address community health needs.

7.13.1 AIR QUALITY

Please refer to section 7.1.5 for the full Air Quality Impact Assessment. Overall, the impact of the Project on physical air quality is rated as being of minor significance with mitigation.

From a social perspective, the impact on community health and safety is also a minor to insignificant impact. Local communities are a sufficient distance from the Project AoI to presuppose low risk and dust and gas emissions from the Project are not expected to travel or reach receptors over 250m away on average under normal circumstances. Even in the unlikely event that gas that dust and gas particles do travel beyond the borders and buffer of the direct Project AoI, the quantities and concentrations are expected to be small enough to presuppose minimal impacts and little to no potential for long-term health effects. There are also no particularly vulnerable populations identified within the AoI that may be considered especially susceptible to such effects.

This same logic applies for the Höchst Industrial Plan/CLP. It has a low receptor sensitivity due to its location within an existing industrial site and surrounding area. Therefore insignificant/minor impacts are expected with standard mitigation in accordance with the requirements of the industrial park and German law.

7.13.2 NOISE

The full physical Noise Impact Assessment (NIA) in section 7.1.4 concludes that after mitigation there will only be a residual minor impact. The NIA has also considered social receptors.

Overall, noise projections do suggest that drilling at the Hasenberg well site will be above the German Noise Level Guidelines, affecting the Archery Club 'Palatina Bogenschützen'. However, it is anticipated that mitigation measures at this site will reduce this impact to a minor significance. Other social receptors are not close enough to suggest further impacts from noise to community health and safety will arise. It should also be noted that the NIA was conducted based on the worst-case scenario for the Landau and Hasenberg components.

With regards to the CLP in Höchst receptor sensitivity is also low. It is assumed that the buildings within the industrial park are designed to attenuate noise impacts. The area is also a pre-defined industrial site and other social receptors are too far to presuppose significant adverse impacts or disturbances.

7.13.3 SECURITY

Description of impact:

Overall, there is a low underlying security risk to the Project sites and employees, as well as the local community members. Vulcan has already extensive embedded mitigation measures described above. There is no information to suggest that the areas within the Project AoI or the general region suffers from increased security risks or threats. Moreover, the local area does not show any indication of potential risk from excessive use of force from police or employed security against other employees or community members.

Section 7.11 on the Impacts related to Traffic and Land Access also provides additional information on the potential health and safety risks and impacts to members of the local communities.

Construction phase:

The main security risk within the Project AoI would likely be trespassers from the nearby community. If an unauthorised person or group managed to infiltrate the site, they may pose safety risks to themselves, those working, and potentially even others nearby. This is since there are hazardous chemicals, dangerously hot materials, heavy and technical machinery that require extensive training to use etc. – if handled wrong this could result in serious injury or fatality.

Overall, there are greater chances of security risks during construction compared to operation and decommissioning as there are more personnel for temporary employment; this could make it easier for trespassers to get beyond site borders but remains unlikely as official identification is required upon any entrance to the site. 24/7 security will also be present near drill sites to prevent or detect any site infiltration.

There are relatively low security risks because of labour influx that may result in an increase in petty theft and criminal activity. Most labour will come from Vulcan and their subsidiary VERCANA, whose employees are required to strictly adhere to company policies and national laws. Thus, it is also unlikely that labour influxes during construction may contribute to risks of gender-based violence or other security threats to local community members.

Activities during construction are more hazardous than those during operation and drilling – drilling materials, holes around sites, large machinery etc. that may pose direct safety risks if someone broke into the site.

However, Vulcan's security measures are adequate to mitigate these risks and impacts. Similarly, there is no information that presupposes potential security risks to the local community during the construction phase.

Operational phase:

During operation there are minimal to low security risks. Business as usual will continue and the number of personnel will reduce from construction. Existing information does not suggest that there is any potential for the use of excessive force against employees or local community members, or any other security threats to local populations.

Decommissioning phase:

During decommissioning the level of security risks may be similar to construction.

Impact significance assessment:

Socio-Economic Impact 4: Security			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Indirect	Indirect	Indirect
Receptor	Project Employees and Contractors, Local community		
Receptor sensitivity	Low		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Site/Local	Site	Site/Local
Duration	Short-term	Long-term	Short-term
Frequency	Daily	Daily	Daily
Likelihood	Possible	Unlikely	Unlikely
Magnitude of effect	Small	Negligible	Small
Impact Significance (With embedded mitigation)	**Minor**	**Insignificant**	**Minor**
Residual impact (After mitigation)	**Insignificant**	**Insignificant**	**Insignificant**
Irreplaceable loss of resources	None	None	None
Reversibility	Reversible	Reversible	Reversible
Evaluation of Mitigation Effectiveness	Easy and effective	Easy and effective	Easy and effective
Level of confidence	High	High	High

Embedded mitigation measures:

- All of Vulcan's permanent ground installations are/will be secured by a fence, and access control system that have risk-based security coverage. Sites are legally required to be closed off from the public and be able to utilise their access controls at any point in time.
- Access to sites will only be granted after a registration process that requires official identification documents. Vulcan's H&S protocols also document clear guidance and requirements for external individuals/groups who wish to enter a site. Security Risk Assessments in terms of accessing construction sites are typically conducted on a case-to-case basis.

- Currently, the Insheim Geothermal Plant is securely fenced, has a camera detection system, and an intrusion system. The first site for drilling is also already equipped with a fence, camera system, and 24/7 guard.
- Future construction sites will all have secure fencing, 24 hrs security personnel, access control, and camera surveillance.

Additional commitments under Project finance:

- During preparation of the EPRP, adequately consider relevant security risks and protocols to follow as necessary in the case of breach of a breach of site security.
- Implement an incident reporting and corrective actions framework.
- And active and on-going monitoring of security risks throughout the entire Project.
- Provide a Security Management training to security personnel. Security Arrangements will be based on the Voluntary Principles for Security and Human Rights[278] which are international best practice. Additional mitigation measures pertaining to community health and safety during the transport of materials are included in section 7.12.

7.14 IMPACTS RELATED TO OCCUPATIONAL HEALTH AND SAFETY

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☒	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
CLP at Höchst Industrial Park	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☒	☒

There are strict German legal requirements for OHS in the workplace and Vulcan has their own OHS policy, Trusted Based Working Hours Policy, and a Project-specific H&S policy for subcontractors and contractors, namely drilling. There are national requirements to prevent child labour, modern slavery, discrimination, and regulate collective bargaining/freedom of association, grievance mechanisms, job security and rights to work, OHS, wages, and working hours. Based on the initial Human Rights Screening there is also a relatively low risk in terms of human rights infringements on the workforce.

[278] https://www.voluntaryprinciples.org/

There are no identified vulnerable groups within Project AoI that may be particularly susceptible to OHS risks. German OHS laws and regulations also consider the unique needs of vulnerable groups, namely people with disabilities.

Description of Impact

Many activities during all stages of the Project involve heavy injury and handling of complex machines, dealing with hazardous chemicals and hot brine. There is the constant underlying risk of accidents due to human error or from natural disasters (flooding, earthquakes, other forms of extreme weather etc.).

There is also a low underlying risk of exploitation and illegal labour conditions, though company policies, national requirements, and Germany's overall performance in mitigating such events suggests a relatively low likelihood of this occurring.

As working hours are strictly regulated, the risks of infringements to working hours are also considered low to negligible. There is extensive legal coordination to regulate these working conditions and to allow for 12-hour drilling shifts that are not normally permitted by German law.

Embedded mitigations include legal and company requirements, in addition to wearing mandatory safety gear on site. Employees will/have also undergone extensive training to prevent incidents that may compromise OHS.

Overall, this impact may have a relatively low likelihood with embedded mitigation, but if such incidents do occur then the outcome may be severe. Injuries may not be reversible and may require further intervention or compensation on Vulcan's behalf. Embedded mitigations do significantly reduce the severity of such a risk, but a small underlying risk is indelible.

Construction phase:

As mentioned, there are possible OHS risks during all phases of the Project. However, during construction there are added OHS risks from drilling activities and the pipelines – potential injury of oneself or others at any point despite proper mitigation activities.

If drill shifts are not regulated properly, there may be potentially significant impact on OHS. For instance, worker fatigue during long hours of work greatly heightens the risk of injury to themselves or others or potentially can incur damage to site infrastructure/materials/components. Injuries may be minor, major/permanent, or even fatal under the worst case. Nevertheless, the possibility of this happening is considered low with embedded and additional mitigation measures in place to protect workers.

Additional trucks and large vehicles within and around sites require further caution and management to ensure that additional threats to health and safety are not exacerbated. Proper training and oversight in addition to the embedded mitigation measures are vital to maintaining safety, as well as implementing and abiding by specific emergency protocols.

Operational phase:

To assess high-level hazards pertaining to health & safety, and the environment, a HAZID study was conducted by the independent company Hatch (September 2023). The primary objective of this HAZID study was to identify potential hazards associated with the Project's process plants. This included identifying hazards that could arise from equipment, processes, materials, or any

other aspect of the Project. The technical risk register of the HAZID study identified several key risks associated with the handling of combustible materials and potential ignition sources within the system. The primary risks involved combustible materials (solid, liquid, gas), which may lead to flammable conditions, spills, or releases that could result in dangerous situations if not properly managed. The presence of ignition sources further exacerbates these risks, potentially leading to fires or explosions. While some situations were assessed as having no immediate cause for concern due to the nature of the materials or the effectiveness of existing safeguards, others highlighted the need for specific mitigation measures.

During operation, business as usual will ensue and Vulcan will remain responsible for ensuring that their employees are not working more than allowed contractually and within the limits of the labour laws. Violations to working hours during operation are unlikely. However, considering that employees will still be working with heavy machinery, hazardous chemicals, and hot brine, working more than the allowed hours may also bring the potential risk for injury.

Additional risks may also arise during the transport of Lithium Chloride via trucks and/or railway to the Höchst Industrial Park.

Decommissioning phase:

Though decommissioning has not yet been planned, the same underlying OHS risks apply, especially during the deconstruction of the pipeline. Additional traffic and vehicles used for the transfer of personnel, goods, and materials is also to be expected.

Impact significance assessment:

Socio-Economic Impact 6: Occupational Health and Safety			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Direct	Direct	Direct
Receptor	Vulcan and VERCANA workforce		
Receptor sensitivity	Medium-High		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Site	Site	Site
Duration	Long-term/Permanent	Long-term/Permanent	Long-term/Permanent
Frequency	Daily	Daily	Daily
Likelihood	Probable	Probable	Probable
Magnitude of effect	Small	Small	Small
Impact Significance (With embedded mitigation)	**Moderate**	**Minor**	**Minor**
Residual impact (After mitigation)	**Minor**	**Insignificant**	**Insignificant**
Irreplaceable loss of resources	Possible under worst-case	Unlikely	Possible under worst-case
Reversibility	Irreversible (injury/death)	Irreversible (injury/death)	Irreversible (injury/death)
Evaluation of Mitigation Effectiveness	Easy and effective	Easy and effective	Easy and effective
Level of confidence	High	High	High

Embedded mitigation measures:

- Vulcan and its contractor(s) are obliged to comply with German labour law and occupational health and safety requirements.
- In line with German labour law, Vulcan has a functioning workers council where the workers can raise their concerns via workers council to the senior management.
- German permitting process for the Project[279] also requires that all hazardous chemicals be stored in adequate containers, separate rooms or at least in secondary containments. Explosive chemicals (other than hydrogen and butane) will not be used either.
- A fire risk assessment conducted by a third party is legally required upon submission for building applications.
- As a result of the HAZID study:
  - Where high concentrations of methane or other gases are captured, Vulcan will introduce dilution air to the CO_2 scrubbers. This helps to reduce the concentration of potentially flammable gases, thereby minimising the risk of fire or explosion.
  - Conducting regular and rigorous monitoring of systems where combustible materials are handled is crucial. This includes frequent inspections to ensure that safeguards, such as gas detectors and fire suppression systems, are functioning correctly. Additionally,

[279] In German *Gefahrstoffverordnung.*

ignition sources should be regularly inspected and maintained to prevent accidental ignitions.

- Where specific risks are identified, additional physical safeguards such as installing barriers, upgrading fire suppression systems, or improving ventilation to reduce the accumulation of flammable gases will be carried out.
- Maintaining detailed records of all incidents, inspections, and HAZOP reviews is recommended to ensure that there is a clear history of risk management actions. This documentation supports continuous improvement and compliance with safety regulations.

Additional commitments under Project finance:

- Vulcan will prepare an Occupational Health and Safety (OHS) Plan including national requirements and the requirements of the IFC Guidance Note on Labor and Working Conditions (PS2)[280]. In minimum, the OHS Plan will:
  - Include the roles and responsibilities for OHS team.
  - Set out and define the physical hazards, such as equipment, noise and working at height.
  - Set out and define chemical hazards, including air quality, chemical use, fire and explosives.
  - Set out and define biological hazards.
  - Requirements for associated procedures including the OHS risk assessment, job/task risk assessments, and permit to work system.
  - Set out the Personal Protection Equipment (PPE) requirements.
  - Set out the training and awareness requirements.
  - Define the audit and inspection requirements to ensure implementation and compliance with the Plan.
- Prepare an Emergency Preparedness and Response Plan (EPRP) and include provisions for scenarios of extreme weather, natural disasters, accidents, spillages, etc.
- Implement the worker-specific Grievance Mechanism both for internal and external employees to use during construction.
- Conduct routine pipeline inspections of the pipeline for signs of corrosion or scaling and take corrective actions as needed.
- Implement pressure monitoring and relief systems to detect and alleviate any pressure build-up due to scaling.
- Before commencing maintenance, ensure that the pipeline is properly depressurised and follow strict procedures for safely releasing any residual pressure.
- Ensure that pressure relief devices are installed and maintained to manage any unexpected pressure build-up.
- Conduct routine maintenance and checks on all mechanical equipment, particularly those involved in filtration, to prevent malfunctions.

[280] Source: International Finance Corporation, Performance Standard 2, retrieved from: Performance Standard 2: Labour and Working Conditions | International Finance Corporation (IFC), accessed in October 2023.

7.15 IMPACTS RELATED TO CULTURAL HERITAGE AND ARCHEOLOGICAL SURROUNDINGS

Relevance to Project:

Components	Construction	Operation	Decommissioning
Temporary Infrastructure			
Drill pads	☒	☐	☒
Access roads	☒	☐	☒
Worker camps	☒	☐	☒
Permanent Infrastructure: new			
Pipeline	☒	☐	☒
Well sites	☒	☒	☒
GLEP near Landau	☒	☒	☒
Permanent Infrastructure: existing			
Existing Geothermal Plant at Insheim	☐	☐	☐

Description of impact:

Physical ground works, excavations, and deep sub-surface drilling, have the potential to create ground disturbances that may affect medium or highly sensitive cultural heritage or archaeological resources. Ultimately, without proper mitigation and protocols in place, archaeological artefacts can be damaged or lost entirely. The general area in which the Project intends to take place is known for having archaeological artefacts below the earth's surface. Archaeological soundings at the 40 Morgen Drill site have shown that there are archaeological artefacts within the site, however, potential impacts are expected to be minor and insignificant after mitigation.

Before construction work on the drill sites is started, the areas are archaeologically examined in order to avoid destroying the cultural heritage. In the case of archaeological findings, an excavation is carried out prior to construction work, as is the case with 40 Morgen, in order to secure the findings. Overall deterioration of or damage to such artefacts will have a direct effect on items of possible irreplaceable historical importance to society at large.

Construction phase:

The risk of damage to or loss of cultural artefacts and resources will be of primary concern during construction, compared to the other two phases. Increased subsurface activities or earthworks also increase the potential for direct contact with tangible historical artefacts, which can be damaged or permanently destroyed without following proper protocols. Drilling vibrations are localised and are unlikely to affect other sites of significance beyond the AoI (500m).

Vulcan will coordinate with the heritage authority to determine the appropriate course of action, which may involve creating a plan to preserve the site, conducting additional excavations, or altering the construction plans to protect the site and identify an alternative well site.

No physical project activities at the cultural heritage site will begin until the relevant museum directorate has completed its studies, and the official views of the authorities have been obtained.

Operational phase:

During operation there will be no additional drilling activities and vibrations will be minimal and localised. Heritage impacts during operation are therefore highly unlikely.

Decommissioning phase:

The level of potential risk and impact during the decommissioning phase will depend largely on the extent of sub-surface activities that are required. It is unlikely that further drilling procedures, especially at a comparable scale to construction will be needed; but deconstructing and removing the elements of the pipeline may pose additional room for risk. No new areas will need to be touched or affected by decommissioning activities, making it unlikely that Project proponents will encounter new, unidentified artefacts, and therefore the risk of damage to cultural heritage, especially archaeological findings, is likely to be relatively low during this stage. Mitigation measures akin to the construction phase will be designed to mitigate this potentially negative impact.

Impact significance assessment:

Socio-Economic 8: Cultural Heritage and Archaeology			
	Project Phase		
	Construction	Operation	Decommissioning
Type of impact	Indirect	Indirect	Indirect
Receptor	Cultural Heritage Resources		
Receptor sensitivity	Potentially High		
Nature of impact	Negative (-)	Negative (-)	Negative (-)
Extent/Scale	Site	Site	Site
Duration	Permanent	N/A	Permanent
Frequency	Daily	N/A	Daily
Likelihood	Possible	Highly unlikely	Unlikely
Magnitude of effect	Medium	Negligible	Small
Impact Significance (With embedded mitigation)	**Moderate**	**Insignificant**	**Minor**
Residual impact (After mitigation)	**Minor**	**Insignificant**	**Insignificant**
Irreplaceable loss of resources	Yes	No	Yes
Reversibility	Irreversible	N/A	Irreversible
Evaluation of Mitigation Effectiveness	Easy and effective	Easy and effective	Easy and effective
Level of confidence	Medium	High	Medium

Embedded mitigation measures:

- German National Law and regulations already defines the requirements to protect cultural heritage which is already a part of permitting process.

- Directorate of State Archaeology will be present during sub-surface activities, as required in the Site Development Plan[281].
- An excavation has already been done for the 40 Morgen drill site to secure the archaeological findings. The Directorate of State Archaeology requires that Vulcan adheres to the following conditions during construction and implementation at the D12 GLEP site in Landau:
    - Archaeological specialists will oversee any excavations or sub-surface activities to ensure that any features and fins are properly documented and recovered;
    - Four weeks prior to any excavation or "earth works" (e.g., Topsoil removal) Vulcan must report this in writing to the Directorate of State Archaeology, Speyer field office;
    - If any artefacts are discovered during construction they must be reported immediately, and the site will be left unaltered and carefully secured to prevent any losses;
    - Small monuments in the planning area that were not previously identified should be noted but not touched or moved from their historic/ancestral location;
    - Soil finds during construction will be reported to the responsible authorities in accordance with legal requirements;
    - And an appropriate safety distance will be maintained from hazardous incident facilities to limit any effects of serious incidences.

Additional commitments under Project finance:

- Vulcan will coordinate with the heritage authority to determine the appropriate course of action, which may involve creating a plan to preserve the site, conducting additional excavations, or altering the construction plans to protect the site and identify an alternative well site.
- No physical project activities at the cultural heritage site will begin until the relevant museum directorate has completed its studies and the official views of the authorities have been obtained.
- Develop and implement Chance Find Procedure (see section 7.15.1) aligned with IFC PS8.

7.15.1 CHANCE FIND PROCEDURE

Similarly with German Law, IFC PS 8 recommends the cultural heritage to be protected by preservation in its place, since removal is likely to result in irreparable damage or destruction of the cultural heritage. IFC PS 8 requires the clients not to remove any nonreplicable cultural heritage unless all the following conditions are met:

- There are no technically or financially feasible alternatives to removal;
- The overall benefits of the Project conclusively outweigh the anticipated cultural heritage loss from removal; and
- Any removal of cultural heritage is conducted using the best available technique.

The following Chance Find Procedure noted in Table 7-85 will also be followed by Vulcan and its contractors:

[281] In German *Bebauungsplan.*

TABLE 7-85 CHANCE FIND PROCEDURE

Step 1 - Discovery of a Chance Find	
• Implement Chance Find Procedure immediately; • Stop all work at the location; • Notify the works supervisor, Vulcan Project Directors and follow proper requirements stipulated by the German Directorate of State Archaeology; • Cordon off the area and build a protection zone; • Inform supervisor and archaeological expert; • Inform Vulcan Management; • Secure the area with flags and signs; • Limit the vehicle traffic within the sensitive zone; and • Do not move, remove or disturb any finding	
Step 2 - Record the Chance Find	
• Fill the Chance Finds Form; and • Submit the Chance Finds Form to Vulcan	
Step 3 - Inform Third Parties (regulators)	
• Inform the local regulator (Relevant authority responsible for cultural heritage in Project Area)	
Step 4 - Decision of the Regulator Authority	
Construction activities may resume	***Construction activities may not resume***

Vulcan will ensure that Chance Finds are recorded in the proper form and kept for future use/reference. Hard copies of the forms will be kept at sites for use and will then be kept as a physical and electronic copy. Findings will also be recorded in the Chance Finds Register, which will be kept (on site and a digital version in internal documentation folders) and updated by Vulcan. It will be shared with the German Directorate of State Archaeology as needed. A Chance Find will not be considered "closed" until the relevant authorities officially notify Vulcan and/or the contractor(s) that construction work can resume.

Moreover, Vulcan and their contractor(s) should give adequate training to their employees (including the subcontractors) to make them aware of how they should deal with unforeseen damage to archaeological sites. Vulcan and contractor(s) will ensure that all employees are aware of and trained in their responsibilities and use of CFP. Additionally, Vulcan will ensure that construction personnel are trained in CFP and in the appropriate course of action to be taken in the event of archaeological findings being encountered. Training records will be kept.

8. CUMULATIVE IMPACT ASSESSMENT

8.1 INTRODUCTION AND APPROACH

This section presents the Cumulative Impact Assessment (CIA), comprising a description of the potential cumulative impacts of the Project with respect to other identified significant projects being developed within or near the Project's AoI. It also sets out, where applicable (and within the limits of what Vulcan can practically implement), the mitigation measures to either prevent or minimise risks related to potential cumulative impacts in consideration also of those mitigation measures already planned within other topics of the ESIA.

IFC Performance Standard 1 (PS1) specifies that risks and impacts of a project are to be analysed in such a CIA, inter alia, with respect to cumulative impacts from:

- Other existing projects or conditions gathered from baseline surveys, review of available published information and stakeholder engagement activities;
- Other future developments (including future stages of the Project itself) that are realistically defined at the time the ESIA is undertaken and for with the sphere of influence of the various projects or developments may overlap.

Cumulative impacts are thus defined for this ESIA as impacts which result from incremental changes caused by the Project together with other presently ongoing, or reasonably foreseeable future planned actions/projects within the Project Area[282].

Depending on the type/characteristics of other identified projects and their specific impacts, the main issues of concern with respect to the CIA can thus include any type of impact that is considered in the ESIA.

8.2 OBJECTIVES

The objectives of the CIA are the following:

- To determine if the combined impacts of the Project, other projects and activities, and natural environmental and social drivers will result in a Valued Environmental and Social Component (VEC)[283] condition (or "receptors and resources") that may put the sustainability of a VEC at risk (i.e., exceed a threshold for VEC condition which is an unacceptable outcome).
- To determine what management measures could be implemented to prevent an unacceptable VEC condition; this may include additional mitigation of the Project being assessed, additional mitigation of other existing or predictable future projects, or other regional management strategies that could maintain VEC condition within acceptable limits.

The overall aim of the CIA is to avoid/minimise any of the identified cumulative impacts.

[282] The definition is also based on that given in the EC Document "Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions", May 1999; in addition, the IFC Good Practice Handbook "Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, 2013, was used to inform the assessment process.

[283] VECs reflect the public and scientific community's "concern" or special interest about environmental, social, cultural, economic, or aesthetic values. VECs are considered the ultimate recipients of cumulative impacts because they tend to be at the ends of impact pathways. VECs may include: 1. Physical features, habitats, wildlife populations etc., 2. Ecosystem services, 3. Natural processes, 4. Social conditions, 5. Cultural heritage or cultural resources.

8.2.1 ASSESSMENT METHODOLOGY

CIA is an evolving practice and there is no single accepted state of global practice (IFC, 2013). The IFC suggests that 'good practice' requires that, at a minimum, project sponsors assess whether their development may contribute to cumulative impacts on VECs and/ or may be at risk from cumulative effects on VECs they depend on during the ESIA process.

Unlike an environmental and social impact assessment (ESIA), which focuses on a project as a generator of impacts on various environmental and social receptors, CIA focuses on VECs as the receptors of impacts from different projects and activities.

The evaluation of potential cumulative impacts is highly dependent on the locations/activities under review, and therefore each situation is assessed qualitatively on a case-by-case basis.

The approach to the CIA is undertaken in line with the IFC Good Practice Handbook: *Cumulative Impact Assessment and Management Guidance for the Private Sector in Emerging Markets (2013).* In line with the Handbook's proposed approach, a Rapid Cumulative Impact Assessment (RCIA) approach is appropriate for the Project as it considers the challenges to conducting a CIA in an emerging market, which apply in this case, namely:

- Lack of baseline data related to the other project developments;
- Uncertainties associated with anticipated developments; and
- Limited and emergent, strategic regional, sectoral, or integrated resource planning schemes.

In line with IFC PS 1 guidance notes (GN41) that the assessment should be "*commensurate with the incremental contribution, source, extent, and severity of cumulative impacts anticipated*", this assessment attempts to focus only on the potentially significant cumulative impacts, and where the Project's contribution to the cumulative impact is considered to be significant. Per the guidance provided in Section 2 and 3 of the IFC Handbook, potential mitigation measures are designed to focus on cooperation and information-sharing, in recognition of the limited control and direct influence/ decision-making ability of Vulcan, as Project Owner, with respect to the other parties.

In general, these cumulative impacts assessment follows the recommended approach to a RCIA as described by the IFC Handbook and is undertaken through the following methodology (Figure 8-1):

- **Step 1:** Definition of the relevant spatial and temporal boundaries;
- **Step 2:** Identification of key Valued Environmental Components (VECs) and screening/Identification of potentially relevant other projects in the region;
- **Step 3:** Determine present conditions of the VECs; and
- **Step 4,5 & 6:** Assessment of potential cumulative impacts and identification of appropriate mitigation measures[284].

[284] Please note that Steps 4, 5 and 6 are included as one element here within the approach as the results of assessment and proposed mitigation are presented (in one table) for each of the projects where there are considered to be overlapping VECs.

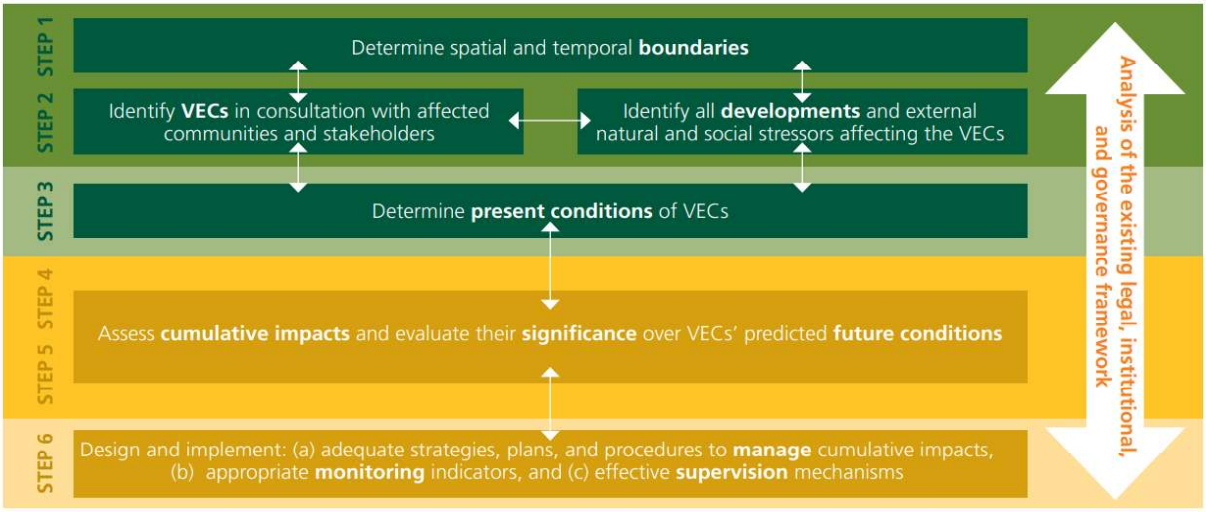


FIGURE 8-1 CUMULATIVE IMPACT ASSESSMENT PROCESS

Source: IFC, 2013

These steps are elaborated in the following sections. No new field-baseline information has been gathered for the purpose of this CIA; where applicable, reference is made concerning baseline information, impacts and mitigation as described in the preceding ESIA sections.

8.2.2 INFORMATION SOURCES

8.3 STEP 1: DEFINING SPATIAL AND TEMPORAL BOUNDARIES

8.3.1 SPATIAL BOUNDARIES

The relevant spatial boundaries for this CIA are essentially the same as the specific Area of Influence (AoI) defined in the ESIA Report for each relevant topic, which includes the direct footprint of planned infrastructure as well as a composite buffer of 250m for pipeline infrastructure and a 500m radius buffer as the AoI from drill sites and the planned GLEP/CLP to account for indirect effects.

For the purpose of the subsequent Screening in Step 2, a regional approach is used considering the same Area of Influence (AoI) of the Project. The intent here in the screening is to be inclusive of projects that might reasonably be relevant for the CIA and excludes projects whose realisation is still uncertain. For the impact assessment in Steps 4, 5 & 6, a narrower focus is then made appropriate for the relevant assessment topics.

An area of influence has been derived for each of the environmental and social aspects of the Project, as detailed in Section 6.

Please note that for this CIA, the planned CLP at Höchst has been scoped out since its location is in an existing Industrial Park that has been operating as such since 1863. The Industrial Park hosts 120 production plants, 90 companies and 22,000 workers.

The CLP at Höchst is subject to rigorous local permitting requirements that specifically address environmental impacts. These permits, issued by local authorities, are designed to assess and mitigate any additional impacts caused by new or modified facilities. This includes an analysis of cumulative impacts alongside existing operations. Because the CLP is integrated within the existing industrial ecosystem, its cumulative environmental impacts—such as air emissions, water discharges, and waste generation—are already incorporated into the site's regulatory framework and therefore, not assessed further in this section.

8.3.2 TEMPORAL BOUNDARIES

The temporal boundary of the CIA formally encompasses the entire Project life cycle, from construction through long-term operations. Nevertheless, the CIA process is inherently constrained by the ability to reasonably predict future events and trends, including (as will be discussed in the Screening in Step 3), the planning/implementation of other relevant projects in the region. Therefore, for the purpose of this CIA, consideration is given of the construction phase and, for operations – to the extent feasible for discussion and assessment of cumulative impacts with other known planned projects.

The time horizon has been set at 5 years, as it is challenging to accurately account for other construction or development activities beyond this period. Once the Project is in place, any further developments planned afterwards are not considered in the present scope of the analysis – and thus not "cumulative". The planners of such future projects would then need to consider the existing Project as part of their baseline and cumulative impacts assessment process.

8.4 STEP 2: IDENTIFICATION OF VECS AND SCREENING OF OTHER PROJECTS IN THE REGION

8.4.1 IDENTIFYING THE VECS

For the purposes of the CIA, VECs are environmental and social attributes that are considered to be important in assessing risks (IFC, 2013). This definition means that the CIA does not evaluate all receptors and resources that were assessed in the ESIA with two key points to note:

- Firstly, this CIA only considers receptors and resources where a residual impact after mitigation has been rated as moderate or greater (so excluding insignificant and minor residual impacts), acknowledging however that several impacts of minor significance could in theory aggregate to have a significant cumulative impact. However, this is likely to be rare and potentially only surface under conditions where there are multiple cumulative impacts acting on the same receptor, in which case minor impact may need to be accounted for as well in the CIA, on a case-by-case basis.
- Secondly, of receptors and resources significantly affected, the CIA only evaluates those that also meet the definition of a VEC. This is generally where the receptor/resource is deemed to be of medium sensitivity or higher. VECs can be affected by a range of stressors, not only from 'projects' but also by other human activity, or natural environmental drivers. For each receptor evaluated, natural changes are also considered.

The way in which VECs can be affected by cumulative impacts from several different projects and activities is illustrated in Figure 8-2.

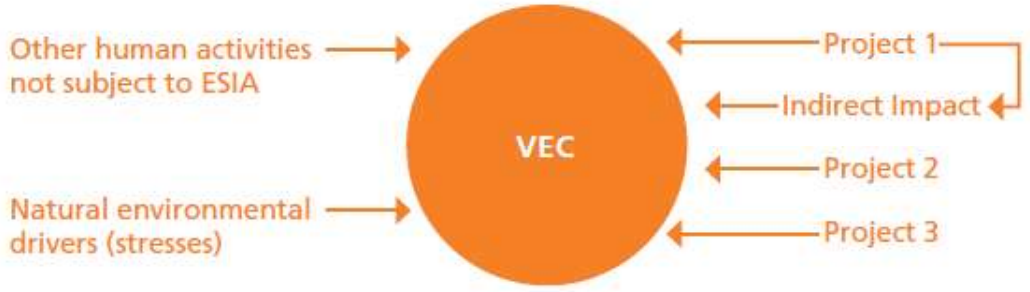


FIGURE 8-2 VEC CONCEPT

Source: IFC, 2013

The outcomes of the impact assessments were reviewed first with respect to receptor sensitivity and perceived environmental stressors (determined broadly through the baseline assessments) to identify VECs that are impacted by the Project, and further narrowed by considering those where the Project would be a significant contributor to any cumulative impact realised. These significant impacts are considered to represent the development's contribution to cumulative impacts. Full details of all receptors and potential impacts are described in the respective ESIA sections.

The systematic screening for the relevant VECs to be considered within the CIA is shown in Table 8-1.

TABLE 8-1 SCREENING OF VECS

Receptor/Resource	Sensitivity	Natural environmental drivers	Residual Impact due to Project	Other human or environmental stressors (in addition to other projects) High/Medium/Low	VEC?
Soil	High	Extreme temperatures, Water stress	Minor	Medium	No
Surface water	Medium	Extreme temperatures, Water stress	Insignificant	Low	No
Groundwater	Medium	Extreme temperatures, Water stress	Moderate	High	Yes
Terrestrial Biodiversity	Medium-High	Extreme temperatures,	Minor	Low	No

Receptor/Resource	Sensitivity	Natural environmental drivers	Residual Impact due to Project	Other human or environmental stressors (in addition to other projects) High/Medium/Low	VEC?
(flora/fauna sensitive areas)		Water stress			
Aquatic Biodiversity (flora/fauna sensitive areas)	Medium-High	Extreme temperatures, Water stress	Insignificant	Low	No
Local communities	Low	N/A	Insignificant	Medium	No

8.4.2 APPROACH TO IDENTIFYING OTHER RELEVANT PROJECTS IN THE REGION

The purpose of the Screening is to identify those other projects and activities in the region that could potentially have impacts that overlap spatially and temporally (per Step 1) with impacts of the Project on any of the VECs identified.

As a first step, a Screening "long-list" is prepared of known and reported larger infrastructure and other projects in some stage of planning or development in the Project region. Each project in the Screening List was then assessed for relevance in the CIA via the evaluation of the Project characteristics (namely type of project, proximity to the Project and expected timing of construction and operations) compared to the following set of Screening Considerations to determine the potential for likely cumulative impacts:

- **Spatial Overlap:** Are the two projects close enough to each other that the Areas of Influence are likely to affect each other?
- **Temporal Overlap:** Do the timelines of key activities (namely Construction and Operations) overlap with each other?
- **Common VECs:** Which VECs may be affected cumulatively by both projects (considering the previous spatial and temporal factors)?

A qualitative conclusion was then given if the specific project is either "Screened In" or "Screened Out" of further consideration in this CIA.

In addition, the status of other projects was evaluated for this CIA as follows:

- For projects already in existence, near completion or operating: any existing emissions/ impacts of the Project would already be reflected in the baseline studies assessed for this ESIA and hence integrated within the impact assessment and any mitigation measures foreseen; as such, they are screened out of the CIA;
- For projects currently under construction or approved and about to commence construction: reasonable assumptions are made about likely emissions/ impacts that may occur with the spatial and temporal boundaries of the CIA; such projects are usually screened in;
- For projects that are reportedly planned, but the start of construction is uncertain: unless such a project potentially has a direct and significant impact on shared VECs spatial and temporal boundaries, such projects are considered speculative and typically screened out.

8.4.3 RESULTS OF SCREENING

Privacy regulations in Germany are exceptionally stringent, often restricting the publication of any planned projects unless they necessitate official disclosure due to permitting requirements. In particular, details of a project are not made public unless it requires a full Environmental Impact Assessment (EIA). Consequently, the public typically only becomes aware of the specifics of a project when it reaches the stage where a full EIA is mandated, reflecting the careful balance between developmental transparency and privacy.

Therefore, to obtain information on planned projects around the defined area, ERM searched in the following available databases:

- Umweltprüfungsportal des Bundes (*Federal Environmental Assessment Portal)*
- Verbund UVP der Länder (*Projects Subject to an EIA*)
- Bebauungspläne in Rheinland-Pfalz (*Legal zoning plans in Rhineland-Palatinate*)
- GeoPortal Landau (*Geoportal of the city of Landau*)
- Netzausbau - Karte (*Federal Network Agency*)
- Stadt Landau in der Pfalz Flächennutzungsplan 2030 (*Land Use Plan 2030 for the city of Landau)*

In addition, Vulcan reached out to the city of Landau to obtain further information on planned projects that might not yet be publicly available.

The ERM screening results indicate that no major new developments are planned around the Project's Area of Influence. Only minor urban maintenance projects, such as road repairs and tree planting, are expected near the GLEP site. While there are plans to expand the D12 industrial park near Landau, specific details were not available at the time of the assessment, and the Vulcan infrastructure is expected to occupy only a small portion of this area. Furthermore, Landau's Land Use Plan focuses primarily on commercial and residential development. Geographic constraints, including the Ebenberg nature reserve to the south and road routes A65 and B10 to the east and north, limit significant new development in this direction, which is also where the Project's components are located (see Figure below).

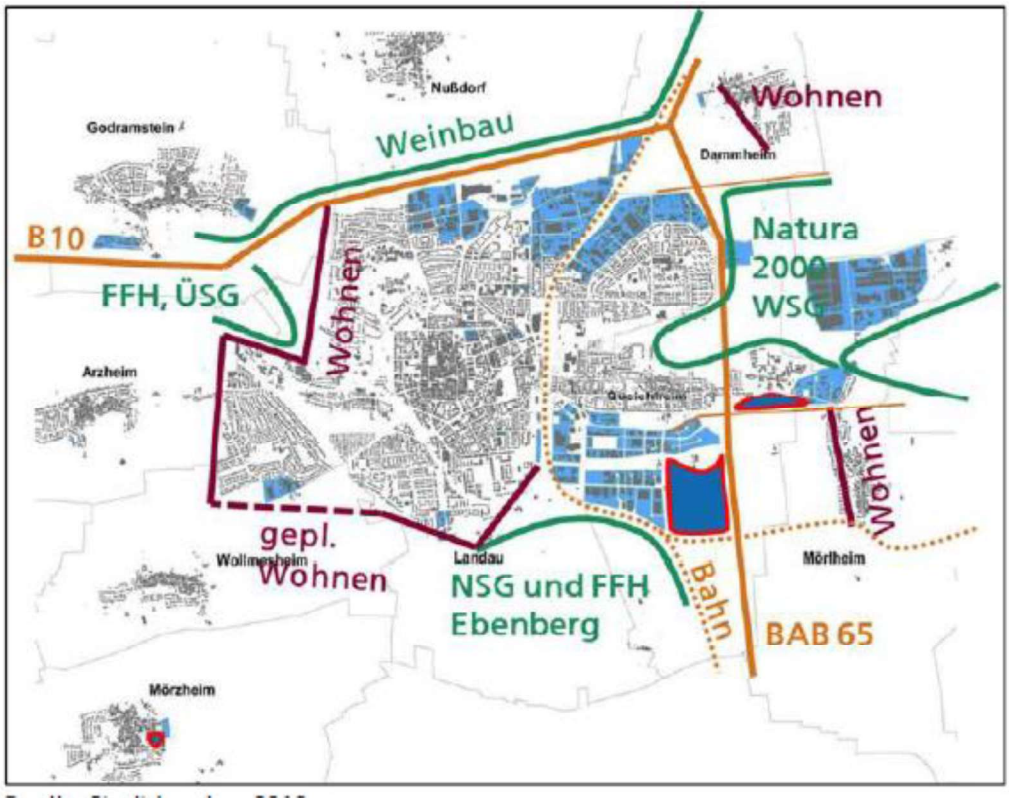


FIGURE 8-3 SPATIAL DEVELOPMENT POTENTIAL FOR COMMERIAL BUILDING AREAS – EXTERIOR TO THE CORE OF THE CITY OF LANDAU

Source: City of Landau, 2019

With regards to groundwater, the existing geothermal plants at Insheim and Landau were incorporated in the dynamic flow modelling completed for the Project and thus, the predicted impact already considers these projects and additional cumulative impact is not required for the existing geothermal sites. No other lithium projects connected to the same brine field have been identified.

Whilst the Project will contribute positively, in a cumulative sense, through employment opportunities created, these are likely to be small contributions when compared to all other industry and commercial activities in the area and are not worth considering further.

Also, the net positive impact of the Project in terms of the provision renewable 'clean' energy/heating can be considered from a cumulative effects perspective (given there are already other geothermal power plants in Landau and surrounds), however the data to quantify such an impact is not yet available for this purpose.

As a result, the next steps of the CIA (Step 3 to Step 6) were not assessed as it can be concluded that the Project will not materially contribute to cumulatively impacts to environmental and social receptors.

9. TRANSBOUNDARY IMPACTS

The region for the Project is in the Upper Rhine Valley (URV) (Figure 9-1) which extends into three countries: Germany, France, and Switzerland.



FIGURE 9-1 UPPER RHINE VALLEY (URV)

The area is located centrally in Europe and is highly developed with many rural and urban centers throughout which are interconnected via roadways, freeways, and railways.

The deep subsurface reservoirs in the Upper Rhine Valley (URV) have been extensively explored and are characterised by high temperatures, making them ideal for geothermal energy production. Since the 1980s, the region has a well-established history of deep well development aimed at both hydrocarbon and geothermal resources. Historically, many wells in the URV were drilled for oil and gas, but there has been notable geothermal research and development as well.

Key geothermal projects in the region include:

- Insheim and Landau, Germany: Commercial geothermal power plants located within Vulcan's planned development area.
- Bruchsal, Germany: Renowned for its research and development in geothermal technologies.
- Soultz, France: A significant site for testing various geothermal power generation technologies.

Considering the above, ERM has conducted a screening of possible transboundary impacts as a result of the Project. The following aspects were considered during the assessment:

- **Geographical distance**: The Project area and its Area of Influence are located at a significant distance from the neighbouring country's border (over 60km distance to France). Due to this considerable separation, it is highly unlikely that any direct environmental or socio-economic impacts would extend across the border.
- **Localised environmental impact**: The E&S impacts of the Project, such as air emissions, water usage, hydrology, and land use changes, are expected to be contained within the Project's vicinity.
- **Lack of pathways for impact transmission**: For a transboundary impact to occur, there must be a clear pathway for transmission, such as shared water bodies, air currents, or migratory species routes. In this case, there are no identified pathways that would allow the Project's impacts to travel the distance required and this further reduces the likelihood of transboundary impacts.
- **Compliance with national regulations**: The Project has been designed and evaluated in accordance with national environmental regulations, which include provisions for preventing any significant adverse impacts beyond Germany's borders.

In summary, the significant geographical distance between the Project area and the neighbouring country, coupled with the lack of transmission pathways and the localised nature of the environmental impacts, justifies why transboundary impacts were not foreseen in this Project.

10. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

10.1 INTRODUCTION

The ESIA has examined the potential biophysical and socio-economic impacts (negative and positive) of all key components of the Project. Where potential adverse impacts have been identified, the Impact Assessment has examined the extent to which these impacts would be mitigated through the adoption of good practice methods of working in line with German laws and regulations and international guidelines.

In certain cases, additional Project and site-specific mitigation measures have been identified to minimise possible disruption to local communities and damage to the natural environment. These actions include optimisation of construction methods, practices and logistics, process and pollution control technology and management procedures.

This Environmental and Social Management Plan (ESMP) was prepared as part of the Project ESIA Package. The purpose of this document is to provide a consolidated summary of the environmental and social (E&S) commitments relevant to the Project and an overview of the E&S Management System being developed and implemented to ensure systematic and effective execution of these commitments along the different Project phases. This document also provides a summary of the relative role and responsibilities of Vulcan Energy as the Project Owner, and the contractors and sub-contractors identified in the ESIA report during the different phases of the Project.

Given the expected lifespan of the Project, as part of the supporting plans to the ESMP, a Decommissioning Management Plan is not warranted, as the Project is not expected to be decommissioned at any foreseeable time.

An operational ESMP will be developed by Vulcan prior to the commencement of the operation of the Project.

10.2 SCOPE

The elements of this framework plan will be taken forward and incorporated into Vulcan's overarching Environmental and Social Management System (ESMS). Within the ESMS, Vulcan will develop and/or require contractors to develop relevant stand-alone management plans, which would need to be approved by Vulcan before mobilisation.

This ESMP describes the structure and processes that will be applied to activities to check and monitor compliance and effectiveness of the mitigation measures to which Vulcan has committed. Each E&S topic is presented in tabular format (section 9.5) and includes the following information:

- A description of the mitigation measures (practical, measurable and auditable actions) that Vulcan or its contractors will implement.
- Designation of responsibility for ensuring full implementation of the required action.
- Parameters that will be monitored to track how effectively actions and mitigation are implemented.
- Timing for implementation of the action to ensure that the objective of mitigation is fully met.

Vulcan is committed to the adoption of all these measures and will carry out ongoing inspection and audit to ensure their implementation and effectiveness.

10.2.1 VULCAN'S CORPORATE POLICIES

Vulcan has several company codes and policies that demonstrate their commitment to respecting and safeguarding human rights and stakeholder engagement principles at the company. All policies are publicly accessible on their official company website.

Vulcan established a Company Constitution in November 2019, underpinned by the Corporations Act 2001[285]. Their Constitution includes but is not limited to: internal protocols related to appointments, hiring, and dismissal, internal structures and responsibilities, processes for the handling shares, shareholders' expectations and rights, remuneration, insurance, dealing with overseas shareholders etc. This Constitution acts as the foundation for other company policies and procedures.

Table 10-1 below provides an overview of other company policies. Vulcan restates their commitment to respecting stakeholders and shareholders in several different policies.

TABLE 10-1 VULCAN'S PRIMARY POLICIES RELATED TO STAKEHOLDER ENGAGEMENT

Charter, Codes and Policies	Purpose/Summary
Board Charter[286]	Defines the role of the Board – providing overall strategy guidance and effective management oversight but is held to the expectations and rules listed in the Company Constitution.
Corporate Code of Conduct and Ethics[287]	Framework for ethical decision-making and minimum standards of behaviour for Vulcan's employee, seeking to affirm Vulcan's commitment to "integrity and fair dealing in business affairs, a commitment to do what is right and honourable and to a duty of care to all employees, clients and stakeholders." It regulates employee conduct both internally and externally, and even states that all stakeholders should be aware of company values and intentions to adhere to these principles.
Corporate Governance Statement[288]	Summarises Vulcan's values, pertaining to governance, the board of directors, diversity, meetings, risk management, business ethics and integrity, and market disclosure. Their main values are integrity, leadership, being future-focused, and sustainability. Their corporate governance statement cross-references their compliance to the ASX Corporate Governance Principles and Recommendations (4th Edition).

[285] The Corporations Act 2001 is an act from the Australian Parliament, determining laws required for Australia's business entities.
[286] Source: Vulcan Energy Zero Carbon Lithium™, Board Charter, February 2020, retrieved from: https://v-er.eu/wp-content/uploads/2021/07/210701-Board-Charter.pdf, accessed in September 2023.
[287]Source: Vulcan Energy Zero Carbon Lithium™, Corporate Conduct and Ethics, February 2020, retrieved from: https://v-er.eu/wp-content/uploads/2022/06/POL_UPDATED-Code-of-Conduct-Ethics.pdf, accessed in September 2023.
[288] Source: Vulcan Energy Zero Carbon Lithium™, Corporate Governance Statement, February 2020, retrieved from: https://www.investi.com.au/api/announcements/vul/e2d67546-693.pdf, accessed in September 2023.

Charter, Codes and Policies	Purpose/Summary
People and Performance Committee Charter[289]	Explains the roles and responsibilities of the people and performance committee and that their main role is to provide assistance and recommendations to the Board. One of their many responsibilities is "reviewing and facilitating shareholder and other stakeholder engagement in relation to the company's remuneration policies and practices".
Anti-Bribery and Anti-Corruption Policy[290]	Outlines Anti-bribery and corruption (ABC) guidelines for employees and company activities. It also mentions that any stakeholders or personnel that feel that their policy has been violated or crimes have been committed should report this to the Board.
Community Relations Policy[291]	States ambition of being a leader in Environmental, Social and Governance (ESG) and aims to create value for stakeholders and have positive impact on communities and environments in which Vulcan operates.
Continuous Disclosure Policy[292]	Policy for information disclosure aligned with ASX Listing Rule 3.1 – "once the company becomes aware of any information concerning it that a reasonable person would expect to have a material effect on the price or value or the company's securities, the company must immediately disclose that information to the ASX".
Diversity Policy[293]	States company (and all affiliate bodies) commitment to workplace diversity, and inclusion at all levels of the organisation – regardless of gender, marital or family status, sexual orientation, gender identity, age, disabilities, ethnicity, religious beliefs, cultural background, socio-economic background, perspective, and experience.
Environmental Policy[294]	States the company's commitment to sustainability in terms of preserving natural resources, protecting biodiversity, reducing waste and resource consumption and enhancing climate resilience whilst meeting highest environmental standards during business activities and operations and acts as a policy

[289] Source: Vulcan Energy Zero Carbon Lithium™, People and Performance Committee Charter, June 2021, retrieved from: https://v-er.eu/wp-content/uploads/2021/09/People-Performance-Charter-FINAL-240821-2.pdf, accessed in September 2023.

[290] Source: Vulcan Energy Zero Carbon Lithium™, Anti-Bribery and Anti-Corruption Policy, February 2020, retrieved from: https://v-er.eu/wp-content/uploads/2021/09/Anti-Bribery-Anti-Corruption-Policy-FINAL-250821.pdf, accessed in September 2023.

[291] Source: Vulcan Energy Zero Carbon Lithium™, Community Relations Policy, May 2022, retrieved from: https://v-er.eu/wp-content/uploads/2022/05/POL_2200525_Community-Relations-Policy.pdf, accessed in September 2023.

[292] Source: Vulcan Energy Zero Carbon Lithium™, Continuous Disclosure Policy, February 2020, retrieved from: https://v-er.eu/wp-content/uploads/2022/08/Continuous-Disclosure-Policy-minor-update-11822.pdf, accessed in September 2023.

[293] Source: Vulcan Energy Zero Carbon Lithium™, Diversity Policy, February 2020, retrieved from: https://v-er.eu/wp-content/uploads/2021/09/Diversity-Policy-FINAL-240821.pdf, accessed in September 2023.

[294]Source: Vulcan Energy, Environmental Policy, 28 May 2025, retrieved from: https:// v-er.eu/app/uploads/2025/06/PL-0303_Environmental-Policy.pdff, accessed in August 2025.

Charter, Codes and Policies	Purpose/Summary
	guideline for company and ESG strategy. Notes that materially improving and safeguarding the environment will also be done via engaging proactively with communities and stakeholders to foster collaboration and supporting reasonable E&S management, as well as partnering with external organisations to enhance sustainability initiatives.
Health and Safety Policy[295]	Affirms Vulcan's commitment to meeting the highest health hand safety standards during execution of operations. This document acts as a guideline for all company employees, contractors, partners, visitors and local communities/ stakeholders. Specifies their commitment to ensuring zero-harm culture that involves embedding preventative measures and encouraging a workplace culture where Vulcan employees, and external contractors alike, are empowered to raise concerns and contribute to a safer working environment.
Shareholder Communications Strategy[296]	Ascertains that shareholders should be informed of all major developments affecting the Company's situation. This is specific for shareholders and does not specify all stakeholders.
Sustainable Supplier Policy[297]	Specifies that suppliers must meet the highest standards of business ethics and integrity and are both fair and transparent. Supply-chain specific policy specifying Vulcan's commitment to creating stakeholder value and positive input in communities and environments in which they operate.
Whistleblower Protection Policy[298]	Vulcan Energy encourages a culture of 'speaking up' against possible unethical, unlawful, or socially irresponsible behaviour without fear of retaliation or risk of being disadvantaged.
Quality Policy[299]	Outlines the company's commitment to exceptional product quality whilst upholding relevant standards and driving continuous improvement across the organisation. Includes fostering a culture of quality and accountability, as well as proactively identifying and addressing quality-related risks and opportunities, that are amongst the key company aims contained in the policy statement.

Other company policies include:

- Project Oversight Committee Charter
- Audit, Risk and ESG Committee Charter
- Nomination Committee Charter

[295]Source: Vulcan Energy, Health and Safety Policy, 28 May 2025, retrieved from: https:// v-er.eu/app/uploads/2025/06/PL-0304_Health-and-Safety-Policy.pdf, accessed in August 2025.

[296] Source: Vulcan Energy, Shareholder Communications Strategy, February 2020, retrieved from: https://v-er.eu/wp-content/uploads/2021/07/210701-Shareholder-Communications-Strategy.pdf, accessed in September 2023.

[297] Source: Vulcan Energy, Sustainable Supplier Policy, September 2021, retrieved from: https://v-er.eu/wp-content/uploads/2021/09/Sustainable-Supplier-Policy-FINAL-310821-1.pdf, accessed in September 2023.

[298] Source: Vulcan Energy, Whistleblower Policy, February 2020, retrieved from: https://v-er.eu/wp-content/uploads/2021/09/Sustainable-Supplier-Policy-FINAL-310821-1.pdf, accessed in September 2023.

[299] Source: Vulcan Energy, Quality Policy, 28 May 2025, retrieved from: https:// v-er.eu/app/uploads/2025/06/PL-0305_Quality-Policy.pdf, accessed in August 2025.

- Conflict Minerals Policy
- Privacy Policy
- Risk Management Policy
- Social Media Policy
- Trading Policy
- Website Terms of Use

Many of these policies, such as the Diversity Policy, have measurable objectives, especially in terms of gender representation. Vulcan is committed to employ individuals that have both diverse backgrounds and skillsets, and they list their data on gender representation in the company´s annual report. Similarly, the board´s measurable gender equality objectives are as follows:

- 40% female representation on the board, which has already been exceeded. Women make up 50% of the board, currently.
- 40% female representation across all company employees. As of June 30, 2023, 30% of company employees were female, a decline of 4% since December 2022. This decrease can be explained by Vulcan's acquisition of Comeback (a company with 50 male employees) and increase in Vercana staff (all men except for one employee).
- 40% female representation in senior executive positions. While only 25% of the current senior executives (any person reporting directly to the managing director) are women, the company has once again confirmed that they are progressing towards their target.
- The company also has a works council, in compliance with German national law that helps employees manage their rights in the workplace.

10.2.2 VULCAN'S ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSTEM

Vulcan will develop an Environmental and Social Management System to manage the potential HSE risks caused by Project activities. The Project's ESMS will be based on Vulcan's, existing policies, internal management systems and compliant with relevant German and international legislation, Project-specific permits, or directions from regulatory authorities.

Vulcan's ESMS will include:

- Policy Statements (both new and existing ones) – which describe Project's E&S objectives which will guide the Project in achieving E&S performance (these policies will include Environmental, Social and Human Resources Policy and Health and Safety Policy).
- Management Program – for environmental and social performance execution which are, in part, detailed below.
- Organisation Capacity/Competency – demonstrated through clear division of responsibility and vetting of individual roles holding responsibility and accountability for environmental and social performance execution.
- Emergency Preparedness and Response – a plan which addresses how potential risk impacts resulting in emergency response will be managed during the Project lifecycle.
- Stakeholder Engagement Plan – A SEP has been developed which includes stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation and ongoing reporting to surrounding communities through life of Project.

- Grievance Mechanism –A Project- specific Grievance Mechanism has been developed as a part of SEP for the Project affected communities as well as for its workers and employees.

In addition, Vulcan's ESMS will be based on international standards 14001 (Environment) and 45001 (Occupational Health and Safety) and reflect the associated international good practice Plan-Do-Check-Act (PDCA) model of systematic management.

10.2.3 SUPPORTING ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

In view of the results of the ESIA, the list below presents an outline of the supporting management plans that need to be developed to manage key environmental and social risks. These plans will set out how the mitigation measures to address potential environmental and social impacts will be put into practice, monitored and upheld.

- Noise Management Plan;
- Traffic Management Plan;
- Waste Management Plan;
- Occupational Health and Safety Plan (OHS);
- Chance Finds Procedure;
- Stakeholder Engagement Plan (already prepared as part of this Project); and
- Emergency Response and Preparedness Plan (EPRP): Vulcan will develop an EPRP for all Project activities and assets prior to key construction and operational milestones. This commitment aligns with relevant EU directives, including the EU Directive 2014/52/EU on Environmental Impact Assessment (EIA) and EU Directive 2012/18/EU on the control of major accident hazards involving dangerous substances (Seveso III Directive). This plan will be developed in consultation with stakeholders and regulatory bodies to ensure compliance with environmental regulations and to address potential risks effectively.

10.2.4 EPC CONTRACTOR(S)

ESIA and ESMP requirements including all relevant plans and procedures of Vulcan will be communicated to the EPC Contractor(s) and these requirements will be included in the EPC Contracts.

EPC Contractor(s) will be required to prepare a Construction Environmental and Social Management Plan (CESMP) including their working methods and procedures in line with ESIA and ESMP requirements. CESMP will be submitted to Vulcan for their review and approval prior to the commencement of construction activities.

The primary objective of the CESMP is to guide the construction phase of the Project and meet the requirements for managing construction-phase risks and impacts identified for the relevant environmental and social aspects, including compliance with National and International legislative requirements as applicable. The CESMP ensures consistency across the development Project site in terms of environmental and social considerations, for the duration of the construction phase.

The CESMP will be applicable to the construction phase of the Project specifically, and the ultimate responsibility for its implementation will reside with the appointed EPC Contractor(s). As a contractual requirement, the EPC Contractor, sub-contractors & suppliers will be required to demonstrate compliance with their activities against the Project Standards listed in Section 4,

ESIA, ESMP, SEP and the CESMP. The CESMP and any associated plans/documents, are intended to be 'living documents' that can be refined and modified as situations change. The CESMP will be reviewed and updated after any change in the context in which the Project operates during the construction phase.

10.3 MANAGING CHANGES TO PROJECT ACTIVITIES

This ESMP is the basis for the future development of the ESMP, which is in turn a living document that should not be regarded as complete or final and requires a mechanism to manage future changes and new developments that cannot be included within the ESIA document.

Changes in the Project may occur due to unanticipated situations. Adaptive changes may also occur during the Project life cycle. Vulcan will develop and implement a Design Change Management Procedure (DCMP) to manage changes in the Project that will apply to all project activities. As such, any changes to the Project design, scope, or new substantive environmental and social findings – occurring after the relevant preparation date of the ESIA - will be evaluated via the Project's DCMP.

Evaluation will be made with respect to the degree of significance of the change, and will be incorporated into the appropriate Project documentation as follows:

- Minor changes will be reflected in updates to the ESMP; and
- Substantive design changes that might potentially alter the ESIA findings (i.e., those that result in changes to the predicted significance of environmental and social impacts) will be subject to re-assessment, further stakeholder consultation, supplementary reporting and revision of the Project's ESMP.

The DCMP will ensure that:

- Proposed changes have a sound technical, safety, environmental, social and commercial justification.
- Changes are reviewed by competent personnel and the impact of changes is reflected in documentation, including operating procedures and drawings.
- Hazards resulting from changes that alter the conditions assessed in the ESIA have been identified and assessed and the impact(s) of changes do not adversely affect the management of health, safety or the environment.
- Changes are communicated to personnel who are provided with the necessary skills, via training, to effectively implement changes; and
- The appropriate Vulcan person accepts the responsibility for the change.

As information regarding the uncertainties becomes available, the Project ESMP will be updated to include that information in subsequent revisions. Environmental and social, as well as engineering feasibility and cost, considerations will be taken into account when choosing between possible alternatives.

10.4 IMPLEMENTATION

10.4.1 RESPONSIBILITIES AND RESOURCES

Overall responsibility for the ESMP implementation lies with Vulcan's Project team, which establishes and maintains an organisational structure that defines further roles, responsibilities, and authority to implement the ESMP for both construction and operation phases of the Project.

Vulcan's organisation is characterised by core functions and roles (Figure 10-1) who report to the overall CEO and include:

- Project Development;
- Project Execution; and
- Production Organisation.

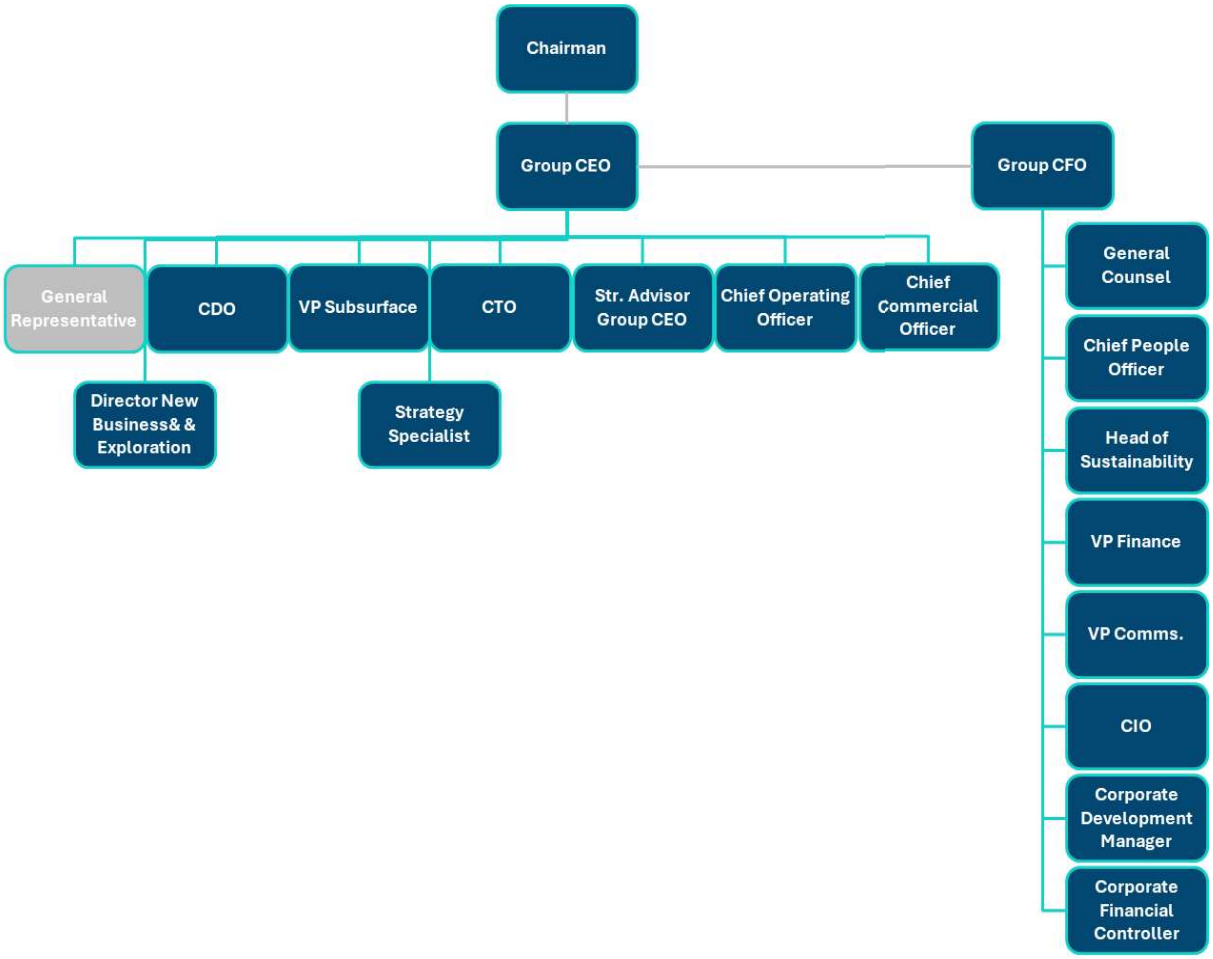


FIGURE 10-1 VULCAN'S ORGANISATIONAL CHART

Source: Vulcan, 2024

Roles and responsibilities with regard to Environmental, Health and Safety topics during the various phases of the Project will be covered mostly by the Project Execution and partially by Production Organisation team.

Most of the Project's construction phase will fall under the responsibility of the Project Execution team (Figure 10-2) with the following roles:

- Director Engineering
- Senior Director Programs
- Director Construction and Commissioning
- Director PMO
- Director HSE/Q

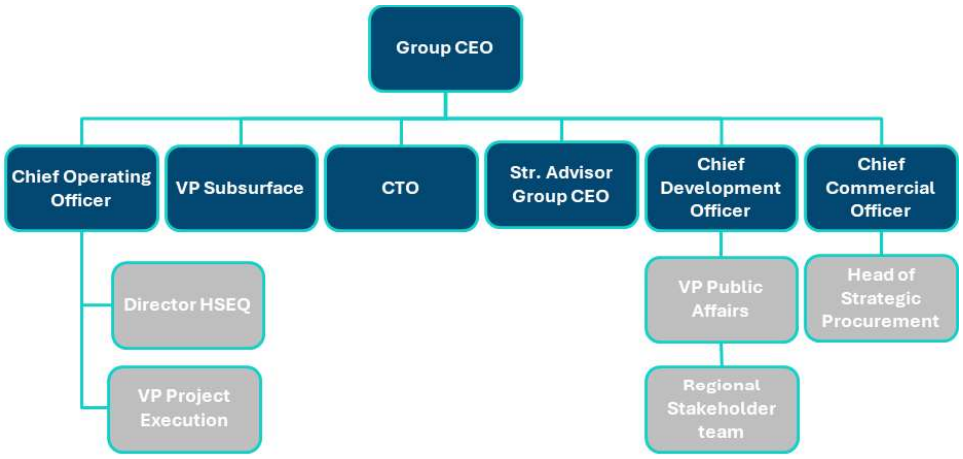


FIGURE 10-2 VULCAN'S ORGANISATIONAL CHART (PROJECT EXECUTION)

In terms of ESMP implementation, these roles are planned to be supported / led by either in house or third-party environmental engineers, and ecological advisors and monitors when required, and will be responsible for supervision and monitoring of the construction activities on site.

Furthermore, Vulcan has already increased organisational capacities and will continue to do so with the following roles:

- Vulcan's Regional Manager(s) (who will also be undertaking the role of CLO(s);
- EHS Experts; and
- An Emergency Response Team.

The Emergency Response team will be part of the HSE/Q division.

TABLE 10-2 VULCAN'S HSE ROLES AND RESPONSIBILITIES

Function	Task
Vulcan Director HSE/Q	• Responsible for monitoring and assurance of the EHS system performance and requirements of the Project. • Reviews Project's plans and procedures and assures that Project requirements are considered. • Monitors performance through review of information provided by Vulcan's (through KPIs, reports, etc.), audits, and meetings. • Report performance to management, lenders, and other related parties. • Ensure that Vulcan's EHS policies are periodically reviewed by the management and conveyed to all Project areas.

Function	Task
	• Establish Emergency Response Teams (ERT) and define roles and responsibilities of ERT members. • Ensure that emergency preparedness and respond plans and procedures (EPRP) are prepared, reviewed and approved. • Ensure that training needs are identified and trainings of ERT and the Project staff for emergency situations in line with the EPRP are provided. • Ensure that the EPRP and related procedures are reviewed periodically and updated as necessary. • Ensure that the functionality and practicality of the EPRP and related procedures are tested by exercises and drills in specified intervals (at least annually). • Ensure that the persons and institutions that will be contacted during emergency response are determined according to type of emergency. • Ensure that communication and coordination means with the district and provincial emergency management centers and responsible organisations are defined. • Coordinate the ERT in order to successfully implement the EPRP and related procedures in emergency situations. • Ensure that the emergency situation is reviewed with the ERT, and the incidence report is prepared after the emergency. • Disclose relevant information to project staff and public) and coordinate activities for raising awareness.
Regional Managers	• Day-to-day implementation of the SEP and Community Grievance Mechanism, including maintaining regular contact with nearby communities through regular community visits to monitor opinions and provide updates on Project activities, and ensuring communication with vulnerable groups. Specific efforts will be made to ensure participation of and disclosure to individuals with hearing or vision disabilities, individuals with limited mobility and the elderly who may not be able to get to venues of meetings. • Produce stakeholder engagement monitoring reports and submit to the Project Manager.
EHS Expert(s)	• Ensure implementation of Project's overall management plans and procedures by all construction organisations. • Develop site specific management plans and procedures as required by the Project under supervision of Vulcan. • Inspect the performance of the works against Project's performance indicators. • Identify non-conformances and potential non-conformances, develop corrective and preventive actions. • Provide trainings to workforce about the HSE requirements of the Project. • Coordinate and implement required pre-construction activities under supervision of Vulcan. • Report the performance of works to site managers and Vulcan's Environment, H&S, and Community Liaison representatives.
Emergency Response Team (ERT)	• Attending the training sections and exercises for implementing the EPRP and related procedures. • Reviewing and improving, if necessary, the EPRP and related procedures annually together with the HSE/Q Chief. • Informing HSE/Q Director when an emergency occurs. • According to type of emergency, implementing the necessary measures in accordance with the EPRP and related procedures. • Notifying the relevant designated contact people and authorities/agencies and liaise with these in the event of offsite effects. • Reviewing the situation with the HSE/Q after the end of emergency, and preparation of the incidence report.

10.4.2 TRAINING AND AWARENESS

One of the most important mechanisms for the enhancement of the Project's environmental performance will be the continued implementation of a program of environmental & social training for all Project personnel including Vulcan, and contractors' personnel. All personnel will be given environmental & social induction and awareness training aimed at achieving 'buy-in' by workers. Key project personnel whose management roles or job responsibilities/activities may have an impact on the environment will also receive specific issue training as appropriate (e.g., in waste management, fuel handling etc.). Environmental & social training will be provided at each stage of the Project, from the initial establishment of logistical facilities through to construction, operation, and decommissioning.

A key message in each of the training programs will be the means, methods, and mechanisms to be employed in the monitoring and audit of environmental management. The priority afforded environmental issues will be highlighted both through the content of the training courses and through the day-to-day scrutiny provided by the HSE Manager, Coordinators, and Inspectors.

10.4.3 DOCUMENTATION

The environmental management activities will be documented and tracked to effectively manage the environmental performance of the Project. Non-compliance observations, decisions on identified issues, solutions, corrective, and preventive actions taken and the results of these actions will be documented.

10.4.4 CHECKING AND CORRECTIVE ACTION

10.4.4.1 INSPECTION AND MONITORING

Inspection and monitoring of the environmental effects of construction, operational and decommissioning activities will enable the effectiveness of environmental mitigation to be evaluated; it will also allow environmental problems to be identified and responded to at an early stage.

The construction contractors will be responsible for the development and implementation of an appropriate inspection and monitoring program to the satisfaction of Vulcan. The monitoring program will include all the monitoring requirements specified by regulatory authorities. This will enable both parties to ensure the works are being carried out in accordance with the requirements of the ESMP and ESIA and to identify and implement any possible improvements.

Construction contractors will be required to undertake appropriate pre-construction survey activities to ascertain the following:

- Pre-construction quality of temporary and permanent access roads;
- The presence, status and extent of sensitive ecological and archaeological resources; and
- Location and suitability of existing licensed borrow areas, stockyards and dumpsites (if needed).

10.4.4.2 AUDITING

Both Vulcan and its EPC Contractor(s) will be required to demonstrate how the requirements of the ESMP and ESIA are being complied with. This will include a program of inspections and audits by both EPC Contractor(s) staff and Vulcan. Site inspections and more formal audits by Vulcan's

EHS Experts will be undertaken using pre-prepared audit protocols that reflect the requirements of the ESMP and the ESIA.

Where issues of non-compliance are identified by either the Vulcan representative or the EPC Contractor(s), they will be immediately reported to Vulcan and corrective action will be identified by the Vulcan representative in conjunction with the EPC Contractor(s).

Following an audit conducted by Vulcan, the EPC Contractor(s) will prepare a Corrective and Preventive Action Plan in accordance with the findings of the audit and the corrective actions and recommendations. This could take the form of, for example, further direct mitigation, or changes to procedures or additional training.

An activity can be stopped by Vulcan representative if he/she is of the opinion that the corrective action is not being appropriately or effectively implemented by the EPC Contractor(s) and its subcontractors. In the case of continued or severe non-compliance, Vulcan may stop work until necessary corrective actions are taken and agreed with Vulcan.

Vulcan will submit to a similar program of independent, external audit with respect to all construction or operational activities directly undertaken by Vulcan personnel.

10.5 ENVIRONMENTAL AND SOCIAL PROJECT COMMITMENTS

A summary of the environmental and social project commitments is provided in Table 10-3, Table 10-4 and Table 10-5. These include the recommended mitigation, monitoring, management, and enhancement measures proposed for each subject and for each Project phase.

The ESMP tables also identify the responsible parties for the implementation of the proposed measures/requirements, as well as the proposed relevant documents to be prepared for each phase and the related performance indicators, timings, and frequencies and whenever applicable or possible to identify, the identification of main sensitive receptors.

These tables are intended to be read in conjunction with the full text of the ESIA report, which provides relevant context and background, as well as description of the impacts which the listed measures aim to mitigate or manage, and any residual impact that may remain

TABLE 10-3 ESMP (PRE-CONSTRUCTION PHASE)

Pre-construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
Terrestrial Habitats	• Develop and implement pre-construction checklist and survey protocol. Searches and pre-stressing activities are to be carried out by moving progressively through the vegetation to check for animals and nesting activity. If no active nests, roosts or burrows/dens are present, vegetation clearing should be completed within a few days of the initial wildlife checks / inspections. • Wildlife shepherding protocol to be prepared and implemented where construction takes place, to check areas to be worked in prior to construction and remove or shepherd wildlife found on the construction site to safety in adjoining natural habitat (where these animals cannot safely exit the construction site by themselves). When capturing/relocating animals, cover larger animals with a towel or blanket and place in a cardboard box and/or hessian bag, place smaller animals in a cotton bag, tied at the top. • Demarcate the construction zone on a map and on the ground clearly using appropriate methods/tools, to avoid impacting sensitive areas outside of the permitted construction area. • Only the vegetation that is necessary to be removed for construction purposes should be cleared, and where possible cut vegetation to ground level instead of stripping areas entirely. • Install appropriate wildlife fencing along the Project perimeter where site infrastructure (i.e. the planned pipeline) will be located near to the Natura 2000 site 'Standortübungsplatz Landau' to prevent small mammals and reptiles from entering the active construction zone and focused on guiding animals to safe points. • Investigate opportunities to conserve, better manage or create suitable alternative habitats or enhancement of existing ones to support displaced species where applicable. • Compile and implement a suitable Invasive Alien Plant (IAP) species control plan and program to eradicate dense colonies of alien plants and control the spread of minor species and weeds.	**Vulcan, EPC Contractor**	• CESMP	• 100% of workers received training on ecological sensitivities • Wildlife fencing in place • Invasive Alien Plant (IAP) Plan in place	• Prior to RoW clearance • Throughout construction
Workers' Camps	Consider "Workers' Accommodation Processes and Standards IFC & EBRD Guidance Note" Iin addition to any German requirements, Workers' Accommodation Processes and Standards IFC & EBRD Guidance Note" will be considered during the design of the Workers' Camps. Apply all these requirements All these requirements will also be applicable for the EPC Contractor and subcontractors, and relevant clauses will to be integrated into contracts.	**Vulcan, EPC Contractor**	• Contract Documents • Campsite Inspection Reports	• Construction Camp design and operation to standards, confirmed in site inspection reports	• Design Stage • Monthly inspections throughout construction
Stakeholder Engagement Grievance Mechanism	• Continue engaging with Project-specific stakeholders • Implement a Project-specific Grievance Mechanism	**Vulcan**	• Stakeholder Engagement Plan (including Grievance Mechanism)	• Number of stakeholder meetings with regard to pre-construction phase and Minutes of Meeting (including photographic data). • Number of actions closed • Number of complaints received and number solved grievances on time.	• Prior to construction start

TABLE 10-4 ESMP (CONSTRUCTION PHASE)

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**

Greenhouse Gases	• Develop of a Traffic Management Plan including the best practices to reduce GHG emissions during construction including the following:
	  ○ Transport logistics (locations/routes) will be optimised to ensure efficient carriage of raw materials and promote fuel efficiency.
	  ○ Consider if feasible, sourcing renewable energy for electricity use.
	  ○ The use of fuel-efficient transportation vehicles will be prioritised, and regular maintenance of vehicles.
	  ○ Provide efficient driving guidelines to transportation vehicle drivers to promote fuel efficiency; and
	  ○ Turn off machinery/equipment when not in use.
	• Consider energy efficiency specifications for new and retrofitted site accommodations and components.
		Vulcan, EPC Contractor	• Traffic Management Plan	• Optimum traffic routes identified and communicated to the drivers (both heavy and light vehicle drivers).
				• 100% of drivers received training on fuel efficiency.
				• Vehicle maintenance records are in place.
					• Throughout construction

Soils	• The construction and work sites will be carefully managed and soil in the vicinity will be protected. • Development and implementation of topsoil removal, transportation, and piling-stocking plans – prior to construction, topsoil will be removed and stockpiled, in a territory selected in advance, for further use. Top-soil stripping will be limited to the footprint. • Soil will be stored carefully on one side of the construction working area, in such a way that it is not mixed with sub soil or trafficked on by vehicles. • Soil management will be conducted according to the soil protection concept (BSK) and the soil management expert. Avoid excessive stockpile height to minimize safety risks, maintaining safe slope angles and adjusting height based on stability. • Limit heavy equipment movement over stockpiles to prevent compression. • Use protective covers or vegetation to prevent water infiltration and erosion, and ensure proper drainage around stockpiles to avoid water accumulation. • The construction working area will be reinstated as far as practicable to the same condition as before. This is essential to avoid soil erosion on bare soils. • Provision of proper drainage facilities to prevent erosion at outcrops, cuts, and fills. • Stationary equipment that requires refuelling will be located on waterproof surface according to German regulation (AwSV) to minimize risk of soil contamination in case of spills. Refuelling can take place on these locations without having to transport the equipment across the site. • All diesel, hydraulic oils and lubricating oils will be stored in bunded areas.	**Vulcan, Vercana, EPC Contractor**	• CESMP	• Number of complaints pertaining to erosion and sediments impacting crops, etc. • Number of non-compliances with regard to topsoil stripping, storage and protection of topsoil in designated areas with appropriate erosion measures. • Number of erosion, slope failure, landslide incidents that have occurred.	• Weekly site inspections throughout construction. • Daily site inspections at specific areas after heavy rainfall.
Noise	General • Vulcan will consult with the archery club near Hasenberg to confirm their hours of operation and busiest times so that construction and drilling schedules can be optimised around this; • Noise monitoring during construction/drilling through a survey at the archery club using a hand-held noise monitor to inform if any further specific noise reduction is required in the absence of having noise modelling for this site. Construction Equipment and General Earthworks • Where practicable, noisy equipment will be sited as far away as possible from receptors.	**Vulcan, Vercana, EPC Contractor**	• Noise Management Plan • Traffic Management Plan • Stakeholder Engagement Plan	• Noise monitoring results compliant to German noise regulatory standards. • Recommendations and corrective actions taken when high audible incidents are noted. • Number of complaints pertaining to excessive noise.	• Throughout construction

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	• Where practicable, noisy equipment will be orientated to face away from the receptors at which moderate or major noise impacts are predicted; • Alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electric-controlled units, will be used, where practicable; • Where practicable, stationary equipment will be located in an acoustically treated enclosure; • Throttle settings will be reduced, and equipment turned off, when not being used; • Onsite chutes and bins will be lined with damping material; • Equipment will be regularly inspected and maintained to ensure it is in good working order. The condition of mufflers will also be checked. Equipment will not be operated until it is maintained or repaired, where maintenance or repair would address the annoying character of noise identified; • Compressors, generators, and pumps fitted with properly lined and sealed acoustic covers or enclosures, which will be kept closed whenever the machines are in use, will be used and all ancillary plant (e.g., generators, compressors) will be positioned so as to cause minimum noise disturbance; • Mufflers or silencers of the type recommended by manufacturers will be fitted; • For machines with fitted enclosures, doors and door seals will be checked to ensure they are in good working order; also, that the doors close properly against the seals; • Machines in intermittent use will be shut down in the intervening periods between work; • Excavated material will be stored between the construction site and the sensitive receptor to form a natural noise barrier (with cover to avoid dust erosion) or other (temporary) noise barriers will be installed for Hasenberg; • Drop height of materials will be minimalised; and • Advantage of the natural topography for noise shielding will be taken. Construction Traffic The following measures will be implemented for construction traffic including transportation of equipment and material (e.g., quarry, spoil areas, etc.) to and from work sites: • Speed limits (e.g., 30 km/h) will be implemented for trucks while travelling to and from construction sites (as well as within buildings and on village roads of poor condition); • Slow driving rules in villages (e.g., 30km/h) will be implemented, particularly near sensitive use areas which will be identified (at least one month) prior to start of construction related activities; • Project traffic routing through community areas will be reduced wherever possible. • Dedicated site access roads that avoid routing through villages will be used; • If necessary, to avoid narrow areas near receptors, construction of a new access road will be considered; and • Hours of operation for specific equipment or operations (e.g., trucks or machines operating in or passing through community areas) will be limited.				
Air Quality	• Regular air quality monitoring especially during construction activities (conduct regular site inspections for dust, manage air quality complaints through community grievance mechanism, turn off engines when not in use).	**Vulcan, Vercana, EPC Contractor**	• CESMP	• Air emissions records, monitoring results below thresholds • Number of grievances pertaining to air quality	• Throughout construction

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	• Soil management will be conducted according to the soil protection concept (BSK) and the soil management expert, works will be suspended when dust cannot be adequately controlled.; • Switching off machinery and vehicles when not in use; • Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible; • Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site necessary mitigation measures will be taken; • Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate; • Use enclosed chutes and conveyors and covered skips; • Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate. • Moistening of dusty surfaces and storage piles during dry weather conditions; • Sheeting of truck loads; • Cleaning of truck wheels when leaving the construction site; • Careful selection and maintenance of combustion engines; • Routine testing of vehicle emissions to ensure compliance with exhaust limits; and • Awareness training for operators and drivers regarding the generation of pollutant emissions within their activities.				

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
Surface water	• All facilities and structures will be regularly inspected and maintained to ensure proper and efficient operation at all times, and especially after heavy rainfall. Sediment deposits will be regularly removed and disposed of either by spreading on-site (if uncontaminated) or at a suitably licensed facility. • The design of the watercourse crossings will avoid affecting the stability and long-term performance of riverbanks and flood defences. • Wherever practicable, periods of low flow will be chosen for the open cut watercourse crossings resulting in a quicker deposition from the water column of any sediment released. • Working within the river channel will be avoided where possible. However, where in-river work is unavoidable, measures such as the deployment of oil booms and straw bales downstream or temporary pumping or diversion of flow will be undertaken to mitigate the potential impacts and minimise any increase in sediment load on the river. • Construction activities at watercourse crossings will occur over a limited period of time and with the minimum equipment required for safe and efficient working. • Vegetation clearance along river/stream banks will be minimised. • Watercourse crossings will be constructed perpendicular to the axis of the river channel where engineering and routing conditions allow. • All construction material and structures will be removed from all watercourses once construction has been completed. • River channels, riverbeds and banks will be restored to their original state and enhancement measures will be undertaken wherever appropriate. • Riverbanks and adjacent upland areas will be stabilised immediately after final grading. • The right of way of the pipeline route will be inspected on a regular basis during and after construction and any erosion control measures will be repaired and/or restored as needed. • Diversion pipes or channels will be sized to convey the mean annual flow rate. • Diversion pipes and channels will be at the same gradient as the river. • River water should enter and exit at the normal channel invert level i.e. the water should not cascade from the pipe or channel. Measures to facilitate equipment crossings will include timber mats laid adjacent to and across the riverbed, flume pipes covered by fill material (clean gravel or crushed stone), flume pipes covered by fill material overlain with timber mats or portable bridges. • Where fill for equipment crossings comprises log rip rap or other erodible material, sandbags will be placed within the watercourse, and both upstream and downstream of the crossing point, to stabilise and seal the flume pipes. • All disturbed areas within the existing channel will be reinstated and stabilised prior to flow being redirected into it. Suitable protection from any disturbed areas that have not been stabilised will be provided for the channel. • During reinstatement, flume pipes, sandbags and other material will be removed, and the watercourse will be restored to its original state. • Where practical, banks should be stabilised, and permanent sediment barriers installed immediately upon completion of the crossing. • Refuelling of fixed and mobile plant and vehicles will occur in a designated area at least 30m from drains, watercourses. • A spillage risk assessment should be undertaken as part of the development of the Emergency Preparedness and Response Plan (EPRP); • The EPRP Plan should specify that Spill Response Kits will be available, including absorbent materials suitable for the materials to be handled on-	**Vulcan, Vercana, EPC Contractor**	• CESMP • EPRP	• Water permits in place. • Water quality analysis results in place. • Number of compliant analysis results vs. non-compliant results • Number of complaints pertaining to water abstraction and water scarcity.	• Water quality analysis on a regular basis

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	site, will be held at secure, clearly signposted locations, instructions will be provided with the kits and personnel will be trained in their use; • Any spillages will be immediately contained on-site and all contaminated materials including soils will be removed from the site for suitable treatment and disposal; • All staff and subcontractors will be required to report any incidents, and these will be subject to investigation and remedial and preventive actions will be taken; • Create a secure and designated storage area for fuels and chemicals, equipped with an impervious cover and adequate containment volume for storing all chemicals. Restrict refuelling of vehicles or equipment to impermeable hard-standing areas with strict spill controls. • There will be no direct discharge of contaminated run-off from worksites to any watercourse at the construction components; and • Construction equipment will be cleaned away from surface waters.				

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
Groundwater	• Only additives without water danger classification or class 1 classification will be used. • Use of permitted drilling fluids and cementation and drilling fluids are combined directly at the Well sites. • Drilling fluid is recirculated and if feasible, repurposed with the proper conditioning and treatment. • Disposal of drilling mud when it is no longer usable, in accordance with German regulations. • Appropriate management and careful handling of diesel or lubricants. • Use of licensed companies authorised to collect and dispose of drilling mud and cuttings. • Storage of mud and cementing materials and equipment exclusively in the inner drilling site area. • Wastewater from all construction components will be discharged into the local/municipal sewage network. • The size and duration of exposure of areas of the open ground will be kept to a minimum. • A spillage risk assessment should be undertaken as part of the development of the Emergency Preparedness and Response Plan (EPRP). • The EPRP should specify that Spill Response Kits will be available, including absorbent materials suitable for the materials to be handled on-site, will be held at secure, clearly signposted locations, instructions will be provided with the kits and personnel will be trained in their use. • Any spillages will be immediately contained on-site and all contaminated materials including soils will be removed from the site for suitable treatment and disposal. • All staff and subcontractors will be required to report any incidents, and these will be subject to investigation and remedial and preventive actions will be taken.	**Vulcan, Vercana, EPC Contractor**	• CESMP • EPRP	• Water permits in place. • Water quality analysis results in place. • Number of compliant analysis results vs. non-compliant results • Number of complaints pertaining to water abstraction and water scarcity.	• Water quality analysis on a regular basis

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
Waste and Wastewater	• Development of a waste management plan. • SGD Süd's surface drainage requirements are generally met in cooperation with the city of Landau. • Vulcan will comply with the principles and requirements of following directives: • Waste Framework Directive (Directive 2008/98/EC). It defines key waste-related terms and establishes, a five-level waste hierarchy; • Directive on packaging and packaging waste (Directive 94/62/EC); • Landfill Directive (Directive 1999/31/EC); and • Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment. • Records will be kept of the types and quantities of wastes that are reused, recycled, recovered or disposed both on and off the site to assess waste hierarchy effectiveness. • The Waste Management Plan that Vulcan will develop needs to be based on a hierarchy of waste management depending on classification. Following measures are recommended: • Waste avoidance: Minimising the amount of material that needs to be generated and managed in the first place; • Re-use on site: Where possible, the re-use of excavated materials within the Project site is to be maximised. This reduces the need to import materials onto the site, reduces the need to find off-site re-use or disposal locations and the associated materials handling and transport issues, reduces fuel use and minimises the Project footprint; • Re-use off site: Where all attempts to re-use excavated materials on site have been exhausted, re-use opportunities must be found off site. This includes finding sites that are approved by the relevant planning consent authorities to accept the specific wastes; and • Disposal: Disposal is the last and least preferable management option to be considered. • This will apply to the following: • Handling of hazardous materials during construction; • Spoil and construction waste management; and • Waste management generated during operational phase. **Waste Storage and Handling** • Waste generation will be recorded in terms of type (EU Waste Code) and quantity at all points of generation (camps, plants, etc.); • Waste will be collected and segregated according to its type, whether it is reusable, recyclable, non-hazardous, or hazardous waste; • Waste will be stored according to international best practices (e.g., IFC EHS General Guidelines). Additional measures for storage of hazardous wastes (such as use of secondary containment, access restriction, provision of PPE etc.) will be applied as necessary to prevent harm to construction staff, environment and the public; • Designated waste collection containers and storage areas will be used for different kinds of waste (hazardous and non-hazardous); • Waste collection containers and storage areas will be adequately labelled for different kinds of wastes (hazardous and non-hazardous);	**Vulcan, Vercana, EPC Contractor**	• Waste Management Plan	• 100% of workers received training on waste management. • Waste storage areas will be designed in compliance with environmental regulations and approved as part of the permitting process by the local environmental authority. Findings of Site Inspection Reports actioned in a timely manner and preventive actions defined. • Waste records and inventories are in place.	• Throughout construction
Loss of Fauna	• In case wooded habitats fall within the construction area, site-specific mitigation measures will be defined by the ecological expert on a case-by-case basis. Avoidance of habitats will be implemented as far as possible or minimisation of the area impacted and/or compensation areas defined where avoidance is not possible entirely. Ecological surveys are	**Vulcan, Vercana, EPC Contractor**	• CESMP • Traffic Management Plan	• EHS expert in place • 100% of the workers received training on possible fauna sensitivities. • Ditches, trenches are fenced off and excavations are covered at night.	• Prior to RoW clearance • Throughout construction

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	conducted by the ecological expert and stated in the landscape plan (LBP), including mitigation measures. Demarcate the construction zone on a map and on the ground clearly using appropriate methods/tools, to avoid impacting sensitive areas outside of the permitted construction area. • Worker staff and vehicle access to the area will be limited to the authorised construction site only. • Only the vegetation that is necessary to be removed for construction purposes should be cleared, and where possible cut vegetation to ground level instead of stripping areas entirely. • Use existing access roads or upgrade existing roads wherever possible before considering the construction of new access roads. • Restrict vehicles to the use of authorised access roads only. A signage concept is to be implemented to regulate who can enter the access roads. • Place appropriate limits on the number of vehicle movements to and from the construction site. • Restricting activities to daytime hours where possible when visibility is good and potential fauna collisions with vehicles can be more easily avoided. Where this is not possible, driver awareness training and reduced speed limits on internal roads will be employed. • Limit vehicle speed on site for construction vehicles and vehicles accessing the site. • Appropriate signage will be appointed by the city administration or the road traffic authority. Install appropriate wildlife fencing along the Project perimeter where site infrastructure (i.e., the planned pipeline) will be located near to the Natura 2000 site 'Standortübungsplatz Landau' to prevent small mammals and reptiles from entering into the active construction zone and focused on guiding animals to safe points. • A common mitigative measure to prevent impacts on groundbreaking birds is to prevent them from breeding in the relevant areas in the first place. Suitable visual deterrents, such as coloured ribbons attached to poles/sticks that move in the wind, may be used to scare ground-breeding birds before the start of the breeding period) in areas where species such as Eurasian Skylark could occur. • Special protection measures such as the establishment of protection zones or the installation of nesting aids for birds should be established. Alternative roosting and resting sites for birds/bats may need to be provided on a case-by-case basis where nesting/roosting species may be disturbed or removed and need to be relocated and this may include the construction of bat/bird friendly structures such as bat/bird boxes and artificial perching sites in adjacent habitat outside of the construction zone (exact requirements and approach to be advised by a wildlife ecologist during pre-construction surveys • Specific measures to prevent wildlife from entering the construction site will be considered on a case-by-case basis and following consultation, assessment and based on the expertise of the ecological expert. All open excavations are to be checked for the presence of animals each morning and immediately prior to backfilling of open excavations/trenches. • Prevent the establishment of active nests during the nesting season on standing plant and temporary facilities and structures by closing opening and vents and checking equipment before operation. • Examine heavy equipment and plant stored on site before use, particularly after rainfall events when reptile and amphibian movements occur more often, to ensure use will not harm individuals that might be seeking temporary refuge under vehicles for example. • Develop and implement pre-construction checklist and survey protocol. Searches and pre-stressing activities are to be carried out by moving			• Preconstruction survey forms are in place. • Roosting, resting places, nests identified and translocated before RoW clearance.	

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	progressively through the vegetation to check for animals and nesting activity. If no active nests, roosts or burrows/dens are present, vegetation clearing should be completed within a few days of the initial wildlife checks / inspections. • Avoid or minimise disturbing or removing cover objects, such as downed trees, rotting stumps, brush piles, stone piles and leaf litter until these have been checked for animal activity, these can then be removed and relocated to similar suitable adjacent habitat outside of the construction zone. • Wildlife shepherding protocol to be prepared and implemented where construction takes place, to check areas to be worked in prior to construction and remove or shepherd wildlife found on the construction site to safety in adjoining natural habitat (where these animals cannot safely exit the construction site by themselves). When capturing/relocating animals, cover larger animals with a towel or blanket and place in a cardboard box and/or hessian bag, place smaller animals in a cotton bag, tied at the top. • After removal of the individuals from the construction zone, the area that will be disturbed adjacent to natural habitats during construction and at project specific locations should be fenced off appropriately to exclude re-entry by wildlife. • Any injured animals are to be transported carefully but efficiently to a local vet for treatment as soon as possible. • Use non-UV sources of lighting for work sites so as not to attract nocturnal insects and insectivorous bats and other animals that feed on them during nocturnal works. • Collect and remove waste products and litter from work areas that could attract wildlife to worker camps and construction areas. • Properly working machinery must be engaged in the process of land preparation and execution of construction works, and the construction site must be secured in accordance with the conditions of the competent authority in Germany. • Compile a suitable post-construction habitat restoration plan for temporary areas used during construction, to return the land to production (crops) or establish other suitable habitat such as meadows, grassland, shrubland.				
Disturbance to fauna and flora by Noise, Vibration, Light and Dust	Reduce noise/vibration disturbance impacts through: • Machinery and equipment which are used intermittently will be shut down/turned off during periods when they are not in use. • Monitor, and keep in proper working condition, all equipment, devices, and work resources. • Regular maintenance of plant and machinery will be carried out in order to minimise noise emissions (in particular, attention will be paid to the lubrication of bearings and the integrity of silencers fitted to vehicles/machinery. • Staff and visitors must be warned not to disturb birds, especially during the nesting period when nests occur on the site or surrounds. According to § 44 BNatSchG it is prohibited to disturb wild birds during the breeding and rearing season. • Monitoring: monthly noise measurement with adequate phonometers. • Limit construction activities to day-time hours to limit impacts to any nocturnal species as far as possible, otherwise limit night-time activities to only essential works to reduce disturbance. • Maintain vehicles and equipment in good working condition. • Use noise minimising technology where possible.	**Vulcan, Vercana, EPC Contractor**	• CESMP • Noise Management Plan • Traffic Management Plan	• EHS expert in place • 100% of the workers received training on possible fauna	• Throughout construction

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	Minimise visual and artificial light disturbance impacts through: • Temporary working areas will be as small as practicable, and areas chosen for the storage of materials will avoid areas of high visual impact. • Temporary hoardings (site fences) will be introduced to visually screen areas of intense construction activity in close vicinity of visually sensitive areas where moving plant, machinery and vehicles may be a source of visual impact. • The construction site will only be floodlit when health and safety requires this and during Night Works, so the impacts of temporary lighting upon the nighttime landscape and upon views are kept to a minimum. • To protect bat species known to be present within the Natura 2000 areas near Landau, reduce the intensity of construction works in the vicinity of these areas (i.e., pipeline installation near the 'Standortübungsplatz Landau') from dusk to dawn during the period April-October, when the activity of bats is typically at its highest. During this period, artificial lighting should be restricted only to the construction works zone, with the possibility of encasing the floodlights by protective lids to prevent the diffusion of light. • Aim lights away from any adjacent sensitive habitats. Use of directional lighting to reduce light spill and prevent light increases in adjacent sensitive habitats such as bushes and wooded habitats. • Use low intensity lights where possible. • Use appropriate lighting that minimises ecological and physiological effects on wildlife and also limits attraction of insects e.g., use of long-wavelength (warm white, orange, red and infra-red) light instead of short-wavelength (UV, cool white, blue and green LEDs). Reduce the risk of fugitive dust emissions through: • Minimise the surface clearing of vegetation to the minimum required. • Limit or suspend bulk earthworks and vegetation stripping during particularly windy periods. • Use appropriate dust control facilities (e.g., windbreaks, temporary barriers, netting screens, fences or plastic sheets) to contain dust emissions from dusty areas, during excavations and earthworks. • Minimising the size of material/spoil/topsoil storage piles. • Cover soil stockpiles during windy periods with appropriate cover materials if greening is not possible.. • Restrict unnecessary traffic. • Where practical, compact ground in areas that are heavily used by vehicles and machinery to reduce the potential for mobilisation of loose soil or silt by wind. • All construction related traffic to maintain speed limits of maximum 30 km/h on all un-surfaced roads, with appropriate speed limit signage provided for these roads. • Use a suitable cover/tarp when transporting soil/sand by truck that could be liable to spillage or dust pollution. • Minimise and strictly regulate the offsite hauling of debris. • Use low-dust-emitting materials for access roads where feasible. Otherwise, implement dust suppression methods. Employ suitable dust suppression on bare soil surfaces exposed to wind and dirt roads used by heavy construction vehicles. • Ensure that any offloading of materials that could easily be suspended in the air (e.g. powders) is carried out in a manner that reduces dust emissions.				

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	• Soil management will be conducted according to the soil protection concept (BSK) and under the guidance and advise of the soil management expert. Only non-potable water should be considered for dust suppression activities. Wastewater may not be reused for dust suppression unless this water has been treated to acceptable levels according to national laws for the use in irrigating lands. • If water is scarce or unavailable, applicable binding agents will be used (additives) for dust suppression.				

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
Terrestrial Habitats	• Wildlife shepherding protocol to be prepared and implemented where construction takes place, to check areas to be worked in prior to construction and remove or shepherd wildlife found on the construction site to safety in adjoining natural habitat (where these animals cannot safely exit the construction site by themselves). When capturing/relocating animals, cover larger animals with a towel or blanket and place in a cardboard box and/or hessian bag, place smaller animals in a cotton bag, tied at the top. • Investigate opportunities to conserve, better manage or create suitable alternative habitats or enhancement of existing ones to support displaced species where applicable.	**Vulcan, Vercana, EPC Contractor**	• CESMP	• EHS expert in place • 100% of workers received training on ecological sensitivities • Wildlife fencing in place	• Throughout construction
Barriers for faunal movement	• Ecological expert will ensure that species movement is not restricted by construction fence. Any temporary excavations, fences or stockpiles of soil and materials must be removed from the site once construction is complete. • Wildlife shepherding protocol to be prepared and implemented where construction takes place, to check areas to be worked in prior to construction and remove or shepherd wildlife found on the construction site to safety in adjoining natural habitat (where these animals cannot safely exit the construction site by themselves). When capturing/relocating animals, cover larger animals with a towel or blanket and place in a cardboard box and/or hessian bag, place smaller animals in a cotton bag, tied at the top.	**Vulcan, Vercana, EPC Contractor**	• CESMP	• EHS expert in place • 100% of workers received training on ecological sensitivities	• Throughout construction
Land Use and Visual Impacts	• Prioritise construction efforts and complete them as quickly and efficiently as possible to allow locals to continue using the natural environment; this should particularly be done for infrastructure located near the nature reserves, especially the pipeline at D12 (i.e., trench, install the pipe, and backfill all within one season rather than keeping these areas open for extended periods and then limiting access to the area). • Do not mix the topsoil and subsoil during the earthworks. Store the stripped topsoil and preserve to the maximum extent possible to be re-used during re-vegetation of excavated areas, cut and embankment areas. • Limit the area of soil exposure and disturbance to the construction site as much as possible. • Reinstate the temporary construction components and disturbed land to its original condition upon completion of the construction activities. • Provide alternative access roads to nature reserves or consider specific timings for road closure (ex. 12-14:00 available for public use) that allow co-use of the area. • Keep the construction site tidy and free of litter and debris.	**Vulcan, Vercana, EPC Contractor**	• CESMP • SEP	• Number of complaints pertaining to land use and visual impacts	• Throughout construction
Traffic and Land Access	• Vulcan will develop a Traffic Management Plan in coordination with the local authorities. The TMP will include a wide range of measures such as stakeholder engagement before temporary closure and diversion of the roads, appropriate signage, speed limits, drivers' training requirements, etc. • Vulcan will aim to minimise road closure or access restriction as much as possible by expediting construction processes and by coordinating with local land users. • Vulcan will identify and inform local stakeholders and land users/owners of alternative routes they may use while road access is restricted. • Vulcan will limit the hours of operation for specific equipment or operations (*e.g.* trucks or machines operating in or passing through community areas) as much as feasible.	**Vulcan, Vercana, EPC Contractor**	• Traffic Management Plan • Stakeholder Engagement Plan	• Percentage of grievances related to severance closed out in line with the timings in the Grievance Mechanism. • Number of issues related to severance raised in stakeholder meetings and percentage closed out in agreed timeframes. • Community satisfaction with alternative routes provided around Construction Camps, laydown areas and construction sites need to be determined to provide alternative or additional routes to maintain connectivity to infrastructure services and social networks.	• Throughout construction

Construction phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	• Vulcan will keep the internal haul routes well maintained. • Vulcan will ensure that the conditions of roads are at least in the same condition (even improved if possible) after use and closure.				
Community Health and Safety/Security	• During preparation of the EPRP, adequately consider relevant security risks and protocols to follow as necessary in the case of breach of a breach of site security. • Implement an incident reporting and corrective actions framework. • Provide active and on-going monitoring of security risks throughout the entire Project. • Provide a Security Management training to security personnel. Security Arrangements will be based on the Voluntary Principles for Security and Human Rights which are international best practice.	**EPC Contractor**	• Security Management trainings • SEP	• 100% of workers received training on security management • Warning signs are in place and in good condition • Number of incidents • Number of grievances recorded	• Throughout construction

Occupational Health and Safety	• Prepare an Occupational Health and Safety (OHS) Plan including national requirements and the requirements of the IFC Guidance Note on Labor and Working Conditions (PS2). In minimum, the OHS Plan will:
	  ○ Include the roles and responsibilities for OHS team.
	  ○ Set out and define the physical hazards, such as equipment, noise and working at height.
	  ○ Set out and define chemical hazards, including air quality, chemical use, fire and explosives.
	  ○ Set out and define biological hazards.
	  ○ Requirements for associated procedures including the OHS risk assessment, job/task risk assessments, and permit to work system.
	  ○ Set out the Personal Protection Equipment (PPE) requirements.
	  ○ Set out the training and awareness requirements.
	  ○ Define the audit and inspection requirements to ensure implementation and compliance with the Plan.
	• Prepare an Emergency Preparedness and Response Plan (EPRP) and include provisions for scenarios of extreme weather, natural disasters, accidents, spillages, etc;
	• Implement the worker-specific Grievance Mechanism both for internal and external employees to use during construction.
	• Conduct routine pipeline inspections of the pipeline for signs of corrosion or scaling and take corrective actions as needed.
	• Implement pressure monitoring and relief systems to detect and alleviate any pressure build-up due to scaling.
	• Before commencing maintenance, ensure that the pipeline is properly depressurised and follow strict procedures for safely releasing any residual pressure.
	• Ensure that pressure relief devices are installed and maintained to manage any unexpected pressure build-up.
	• Conduct routine maintenance and checks on all mechanical equipment, particularly those involved in filtration, to prevent malfunctions.
		Vulcan, Vercana, EPC Contractor	• Occupational Health and Safety Plan
			• EPRP
				• 100% workers (direct employees, subcontractors, and suppliers) that have received HSE induction prior to working on site.
				• 100% workers (direct employees, subcontractors, and suppliers) that have received task specific training.
				• Percentage of workers attending toolbox talks.
				• Number of stop work notices issued by activity.
				• Number and type of non-compliances observed during daily and weekly site inspections.
				• 100% workers received PPE.
				• Zero fatality.
				• Number of Lost Time Incidents involving workers on site.
				• Number of incidents investigated, corrective actions identified and closed out/ not closed out within the required timeframe
					• Throughout construction

Cultural Heritage and Archaeology	• Vulcan will coordinate with the heritage authority to determine the appropriate course of action, which may involve creating a plan to preserve the site, conducting additional excavations, or altering the construction plans to protect the site and identify an alternative well site. • No physical project activities at the cultural heritage site will begin until the relevant museum directorate has completed its studies, and the official views of the authorities have been obtained. • Develop and implement Chance Find Procedure aligned with IFC PS8.	**Vulcan, Vercana, EPC Contractor**	• Chance Finds Procedure	• Archaeological monitoring in place during initial earthworks • Number of grievances raised related to cultural heritage. • 100% workers received training on cultural heritage and awareness on the archaeological sites along the AoI	• Throughout construction

TABLE 10-5 ESMP (OPERATION PHASE)

Operation Phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
Groundwater	Vulcan will comply with the principles and requirements of following directive: • Ordinance on the Quality of Water for Human Consumption (Drinking Water Ordinance - TrinkwV), 2023. Other mitigation includes: • Reinjection of water to the deep brine aquifer as part of the operation. • Monitor operations to check for local aquifer drawdown effect and any adverse water quality effect • The size and duration of exposure of areas of the open ground will be kept to a minimum. • A spillage risk assessment should be undertaken as part of the development of the Emergency Preparedness and Response Plan (EPRP). • The EPRP Plan should specify that Spill Response Kits will be available, including absorbent materials suitable for the materials to be handled on-site, will be held at secure, clearly signposted locations, instructions will be provided with the kits and personnel will be trained in their use. • Any spillages will be immediately contained on-site and all contaminated materials including soils will be removed from the site for suitable treatment and disposal. • All staff and subcontractors will be required to report any incidents, and these will be subject to investigation and remedial and preventive actions will be taken.	**Vulcan**	• EPRP	• Water permits in place. • Water quality analysis results in place. • Number of compliant analysis results vs. non-compliant results • Number of complaints pertaining to water abstraction and water scarcity.	• Water quality analysis on a regular basis • Throughout operations
Waste and Wastewater	Waste Storage and Handling • Waste generation will be recorded in terms of type (EU Waste Code) and quantity at all points of generation (camps, plants, etc.); • Waste will be collected and segregated according to its type, whether it is reusable, recyclable, non-hazardous, or hazardous waste; • Waste will be stored according to international best practices (e.g., IFC EHS General Guidelines). Additional measures for storage of hazardous wastes (such as use of secondary containment, access restriction, provision of PPE etc.) will be applied as necessary to prevent harm to construction staff, environment and the public; • Designated waste collection containers and storage areas will be used for different kinds of waste (hazardous and non-hazardous); • Waste collection containers and storage areas will be adequately labelled for different kinds of wastes (hazardous and non-hazardous);	**Vulcan**	• Waste Management Plan	• 100% of workers received training on waste management. • Waste storage areas will be designed in compliance with environmental regulations and approved as part of the permitting process by the local environmental authority. Findings of Site Inspection Reports actioned in a timely manner and preventive actions defined. • Waste records and inventories are in place.	• Throughout operations
Community Health and Safety/Security	• During preparation of the EPRP, adequately consider relevant security risks and protocols to follow as necessary in the case of breach of a breach of site security. • Implement an incident reporting and corrective actions framework. • Implement active and on-going monitoring of security risks throughout the entire Project. • Provide a Security Management training to security personnel. Security Arrangements will be based on the Voluntary Principles for Security and Human Rights which are international best practice.	**Vulcan**	• Security Management trainings • SEP	• 100% of workers received training on security management • Warning signs are in place and in good condition • Number of incidents • Number of grievances recorded	• Throughout operations
Occupational Health and Safety	Vulcan will prepare an Occupational Health and Safety (OHS) Plan including national requirements and the requirements of the IFC Guidance	**Vulcan**	• OHS Plan • EPRP	• 100% workers (direct employees, subcontractors, and suppliers) that have received HSE induction prior to working on site. • Number of stop work notices issued by activity. • Number and type of non-compliances observed during daily and weekly site inspections.	• Throughout operations

Operation Phase					
Subject	**Mitigation Measures and Monitoring Requirements**	**Responsible Party**	**Relevant Documentation and Management Plan**	**Key Performance Indicator**	**Monitoring Timing and Frequency**
	Note on Labour and Working Conditions (PS2)[300]. In minimum, the OHS Plan will: • Include the roles and responsibilities for OHS team. • Set out and define the physical hazards, such as equipment, noise and working at height. • Set out and define chemical hazards, including air quality, chemical use, fire and explosives. • Set out and define biological hazards. • Requirements for associated procedures including the OHS risk assessment, job/task risk assessments, and permit to work system. • Set out the Personal Protection Equipment (PPE) requirements. • Set out the training and awareness requirements. • Define the audit and inspection requirements to ensure implementation and compliance with the Plan. Other mitigation measures include: • Prepare an Emergency Preparedness and Response Plan (EPRP) and include provisions for scenarios of extreme weather, natural disasters, accidents, spillages, etc. • Implement the worker-specific Grievance Mechanism both for internal and external employees to use during construction. • Conduct routine pipeline inspections of the pipeline for signs of corrosion or scaling and take corrective actions as needed. • Implement pressure monitoring and relief systems to detect and alleviate any pressure build-up due to scaling. • Before commencing maintenance, ensure that the pipeline is properly depressurised and follow strict procedures for safely releasing any residual pressure. • Ensure that pressure relief devices are installed and maintained to manage any unexpected pressure build-up. • Conduct routine maintenance and checks on all mechanical equipment, particularly those involved in filtration, to prevent malfunctions.			• 100% workers received PPE. • Zero fatality. • Number of Lost Time Incidents involving workers on site. • Number of incidents investigated, corrective actions identified and closed out/ not closed out within the required timeframe	

[300] Source: International Finance Corporation, Performance Standard 2, retrieved from: Performance Standard 2: Labour and Working Conditions | International Finance Corporation (IFC), accessed in October 2023.

11. SUMMARY OF THE IMPACT ASSESSMENT

Table 11-1 below provides a summary of potential impacts and significance before the mitigation measures are in place, and after the mitigation measures are implemented.

ESIA study results indicated that there are no major or moderate level of impacts have been envisaged based on the assumption that the embedded measures by German laws and best international practices defined in the ESIA and ESMP are implemented.

TABLE 11-1 SUMMARY OF PROJECT IMPACTS

Identified Impact	Construction Phase		Operation Phase		Decommissioning Phase	
	Pre-mitigation significance	Post-mitigation significance	Pre-mitigation significance	Post-mitigation significance	Pre-mitigation significance	Post-mitigation significance
Physical Environment						
Geology, Soils and Geohazards	Moderate	Minor	Minor	Insignificant	Minor	Insignificant
Noise	Moderate	Minor	Moderate	Minor	Minor	Insignificant
Air quality	Minor to Moderate	Minor to Insignificant	Insignificant	Insignificant	Minor to Moderate	Minor to Insignificant
Surface Water	Minor	Insignificant	Minor	Insignificant	Minor	Insignificant
Groundwater	Moderate	Minor	Moderate	Minor	Minor	Insignificant
Waste and Wastewater	Moderate	Minor	Minor	Insignificant	Moderate	Minor
Biological Environment						
Loss of Fauna	Minor to Moderate	Insignificant	Insignificant	Insignificant	Minor	Insignificant
Disturbance to Fauna (light, noise, vibrations, dust)	Moderate	Minor	Minor	Insignificant	Moderate	Minor
Barriers to Faunal Species Movement	Minor	Insignificant	Minor	Insignificant	N/A	N/A
Pollution of Aquatic Ecosystems	Minor	Insignificant	Minor	Insignificant	Minor	Insignificant
Introduction/Spread of Invasive Alien Plants	Minor to Moderate	Insignificant	N/A	N/A	Minor	Insignificant
Impacts to Protected Areas	Minor to Moderate	Minor	Insignificant	Insignificant	Minor	Insignificant
Social Environment						
Energy Provision	N/A	N/A	Positive	Positive	N/A	N/A
Employment Opportunities	N/A	N/A	Positive	Positive	N/A	N/A
Land Use and Visual Impacts	Minor	Insignificant	Insignificant	Insignificant	Minor	Insignificant
Traffic and Land Access	Minor to Moderate	Insignificant	Insignificant	Insignificant	Minor to Moderate	Insignificant
Security	Minor	Insignificant	Insignificant	Insignificant	Minor	Insignificant
Occupational Health and Safety	Moderate	Minor	Minor	Insignificant	Minor	Insignificant
Cultural Heritage	Moderate	Minor	Insignificant	Insignificant	Minor	Insignificant

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Appendix A: Baseline Biodiversity Assessment Report

Phase One Lionheart Project

PREPARED FOR

Vulcan Energy

DATE
30 September 2025

REFERENCE
0699805



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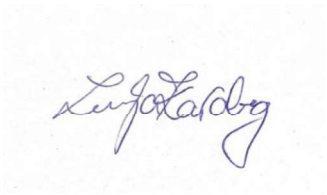
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Appendix A: Baseline Biodiversity Assessment Report

Phase One Lionheart Project

0699805





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CONTENTS

1.	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	PROJECT DESCRIPTION	1
1.3	LOCATION	1
2.	ABOUT THIS DOCUMENT	1
3.	DESKTOP ASSESSMENT	3
3.1	ECOREGION	3
3.2	PROTECTED AREAS AND INTERNATIONALLY RECOGNISED AREAS	4
3.2.1	Protected Areas	4
3.2.2	Internationally Recognized Areas	5
3.3	MAIN ECOSYSTEMS AND HABITATS	12
3.3.1	Project components located near Landau	12
3.3.2	Central Lithium Plant (CLP) at Hoechst Industrial Park	15
3.4	ECOSYSTEM SERVICES	17
3.5	CONSERVATION IMPORTANT SPECIES: FLORA AND FAUNA	19
4.	SUMMARY OF THE FINDINGS OF BASELINE FIELD SURVEYS	27
4.1	BACKGROUND	27
4.2	METHODS	27
4.3	KEY FINDINGS	31
5.	CONCLUSION	38
6.	REFERENCES	39

LIST OF TABLES

TABLE 3-1	DETAILS OF PAS AND KBA IN RELATION TO THE PROJECT	5
TABLE 3-2	MATRIX TO ESTIMATE SCC LIKELIHOOD OF OCCURRENCE	20
TABLE 3-3	STATUS OF CONSERVATION IMPORTANT FLORA AND FAUNA SPECIES POTENTIALLY OCCURRING IN THE AOI	21

LIST OF FIGURES

FIGURE 3-1	MAP SHOWING THE PROTECTED AREA 'STANDORTÜBUNGSPLATZ LANDAU' (NATURA 2000 SITE) IN RELATION TO THE LANDAU PROJECT LAYOUT AND AOI	6
FIGURE 3-2	MAP SHOWING THE PROTECTED AREA 'ERLENBACH UND KLINGBACH' (NATURA 2000 SITES) IN RELATION TO THE LANDAU PROJECT LAYOUT AND AOI	7
FIGURE 3-3	MAP SHOWING THE PROTECTED AREAS NETWORK (NATURA 2000) IN RELATION TO THE HOECHST SITE AND AOL	8
FIGURE 3-4	MAP SHOWING THE ECOLOGICAL STATUS OF RIVERS ACROSS GERMANY	17
FIGURE 3-5	ECOSYSTEM SERVICES CATEGORIZED	19
FIGURE 4-1	MAP SHOWING THE STUDY AREA FOR BIODIVERSITY SURVEYS ASSOCIATED WITH THE SCHLEIDBERG SUED DRILL SITE LANDAU ('YELLOW' HATCHED AREA SHOWING THE STUDY AREA)	29
FIGURE 4-2	MAP SHOWING THE STUDY AREA FOR BIODIVERSITY SURVEYS ASSOCIATED WITH THE GLEP NEAR THE D12 BUSINESS PARK EAST OF LANDAU ('RED' HATCHED AREA SHOWING THE STUDY AREA)	30
FIGURE 4-3	MAP SHOWING THE STUDY AREA 'LANDAU SUED' FOR BIODIVERSITY SURVEYS CONDUCTED IN 2024.	30
FIGURE 4-4	MAP SHOWING THE LOCATION OF SAND LIZARD (*LACERTA AGILIS*) OBSERVATIONS (SHOWN BY THE 'ORANGE' MARKERS) FOR THE SCHLEIDBERG SUED SITE DURING SURVEYS IN 2022	35
FIGURE 4-5	MAP SHOWING THE LOCATION OF SAND LIZARD (*LACERTA AGILIS*) (PINK MARKER POINTS) AND COMMON WALL LIZARD (*PODARCIS MURALIS*) (YELLOW MARKERS) IN THE LANDAU SUED SURVEY AREA WITH ARTIFICIAL HIDING PLACES INDICATED BY THE BLUE MARKERS DURIG SURVEYS IN 2025.	36
FIGURE 4-6	MAP SHOWING THE LOCATION OF HAZEL DORMOUSE (MUSCARDINUS AVELLANARIUS) NESTS (SHOWN BY THE 'TURQUOISE' MARKERS) IDENTIFIED FOR THE SCHLEIDBERG SUED SITE (2022 SURVEY)	37
FIGURE 4-7	MAP SHOWING THE LOCATIONS OF HAZEL DORMOUSE (MUSCARDINUS AVELLANARIUS) NESTS (YELLOW MARKER POINTS) AND NEST-TUBES (BLUE) IN THE 'LANDAU SUED' SURVEY AREA (2024 SURVEY)	38

ACRONYMS AND ABBREVIATIONS

Acronyms	Description
AoI	Area of Influence
AZE	Alliance for Zero Extinction
BNatSchG	Bundesnaturschutzgesetz
CR	Critically Endangered (IUCN Red Data List Threat Status)
CLP	Central Lithium Plant
DD	Data Deficient (IUCN Red Data List Threat Status)
EN	Endangered (IUCN Red Data List Threat Status)
ERM	Environmental Resource Management GmbH
EIA	Environmental Impact Assessment
E&S	Environmental & Social
ES	Ecosystem Services
ESIA	Environmental and Social Impact Assessment
ESDD	Environmental and Social Due Diligence
FFH	Flora-Fauna Habitat
GIS	Geographical Information System
IBA	Important Bird & Biodiversity Area
IBAT	Integrated Biodiversity Assessment Tool
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
KBA	Key Biodiversity Area
LC	Least Concern (IUCN Red Data List Threat Status)
GLEP	Geothermal Lithium Extraction Plant
NT	Near Threatened (IUCN Red Data List Threat Status)
PA	Protected Area
PS	Performance Standard (IFC)
SCA	Special Conservation Area
SCC	Species of Conservation Concern
UNESCO	United Nations Educational, Scientific and Cultural Organization
VU	Vulnerable (IUCN Red Data List Threat Status)
WWF	World-Wide Fund for Nature

1. INTRODUCTION

1.1 BACKGROUND

ERM Environmental Resources Management (ERM GmbH) Germany, was contracted by Vulcan Energy Resources Limited (hereinafter referred to as Vulcan or the Company) to undertake an Environmental and Social Impact Assessment ("ESIA") for Phase I of the Lionheart Project (hereinafter called the Project), in accordance with international Lender's requirements, namely the Performance Standards (PS) of the International Finance Corporation (IFC).

With respect to biodiversity[1], IFC PS6 which covers biodiversity and ecosystems, applies to the ESIA and a separate biodiversity baseline report has been compiled (this document) for the purpose of documenting the baseline status of biodiversity in the Project area and to inform the assessment of impacts to biodiversity and the mitigation thereof.

1.2 PROJECT DESCRIPTION

The first phase of the Project is called "Phase I Lionheart Project": Lithium production and renewable geothermal energy production will take place in the Upper Rhine Valley Brine Field in Rhineland-Palatinate, whereas lithium conversion will take place at the Frankfurt Hoechst Industrial Park. The Project aims to combine the production of renewable energy with lithium extraction from the same deep brine source.

For a detailed description of the Project and components, the reader is referred to the main ESIA report (ERM, 2025).

1.3 LOCATION

The Project is located primarily in the Upper Rhine Valley. The Cenozoic Upper Rhine Graben is part of the European Cenozoic Rift System and is located in west-central Europe. It extends from Basel, Switzerland in the south to Frankfurt (Main), Germany in the north. The 300 km long, 30-40 km wide lowland plain drops from 200 m a.s.l. in the south to below 90 m a.s.l in the north.

For a detailed description of the Project location, the reader is referred to the main ESIA report (ERM, 2025).

2. ABOUT THIS DOCUMENT

This report provides an overview of the baseline (status quo) of biodiversity associated with the study area of the Project, including infrastructure located in the vicinity of Landau (Rheinland-Pfalz) and the Central Lithium Plant site in Hoechst (Hessen).

The baseline established for biodiversity was based on a combination of:

1. review and synthesis of the information obtained from previous surveys conducted by *Institut für Naturkunde in Südwestdeutschland* and *L.A.U.B. Ingenieurgesellschaft mbH*

[1] The term 'biodiversity' refers to the variety of plant and animal life on earth, encompassing ecosystems, habitats, and species, and includes diversity within species, between species and of ecosystems. Biodiversity and ecosystems are covered in IFC PS6: '*Biodiversity Conservation and Sustainable Management of Living Natural Resources'* which recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development (IFC, 2012).

between 2019 and 2025 to inform the national permitting process for the Project in Germany*;*

2. a rapid site assessment[2] completed by the ecologist and biodiversity expert from ERM in August 2023; and
3. supplemented by a literature review and publicly available desktop level information obtained by ERM.

Included is a description of the identified legally protected areas and areas with recognized high biodiversity values (both internationally and nationally/regionally), habitats and species that occur (or are predicted to potentially occur) in this area, and the important biodiversity values associated with the study area.

Existing Project-level biodiversity information was reviewed to support the biodiversity baseline report, this included the following sources of information:

- 'Artenschutzfachliche Ersteinschätzung potenzieller Bohrungsstandorte Vulcan Energie Ressourcen GmbH Projektgebiet Schleidberg Süd' - compiled by the Institut für Naturkunde in Südwestdeutschland (November 2022).
  [English translation: 'Species protection-related initial assessment of potential drilling sites for Vulcan Energie Resources GmbH for the Project area Schleidberg Süd']
- ´Landschaftspflegerischer Begleitplan gemäß § 17 BNatSchG Errichtung des Bohrplatzes „Schleidberg" durch die Vulcan Energie Ressourcen GmbH' – compiled by the Institut für Naturkunde in Südwestdeutschland (May 2023).
  [English translation: 'Landscape conservation support plan in accordance with § 17 BNatSchG for the Construction of the "Schleidberg" drilling site by Vulcan Energie Resources GmbH']
- 'Fachbeitrag Artenschutz, Bebauungsplan D12 Gewerbepark Messegelände-Südost' - compiled by the Institut für Naturkunde in Südwestdeutschland (November 2018).
  [English translation: 'Specialist article on species protection, Development plan D12 Business Park: Messegelände-Südost']
- ‚Tierökologisches Gutachten Projektgebiet Landau Süd' – compiled by the Institut für Naturkunde in Südwestdeutschland (February 2025).
  [English translation: Faunistic ecological assessment for the project area 'Landau Süd']
- ‚Bauabschnitt 1 Geothermiekraftwerk Insheim bis Bohrplatz Schleidberg – Landschaftspflegerischer Begleitplan mit integrierter Prüfung artenschutzrechtlicher Belange' compiled by L.A.U.B. – Ingenieurgesellschaft mbH (November 2024).
  [English translation: 'Construction section 1 geothermal power plant Insheim to drill side Schleidberg - Landscape conservation support plan with integrated specialist article on species protection']

[2] A site visit was conducted by a broad team of environmental and social experts from ERM (including an ecologist and biodiversity expert from ERM) on 9th and 10th of August 2023, aiming to familiarize the team with the Project and localities, rapidly gather information concerning the Project infrastructure locations and processes and the potential environmental receptors (for biodiversity this comprised terrestrial and aquatic ecosystems and habitats).

Desktop studies considered global biodiversity datasets, as well as published and publicly available information. Key information sources included:

- The Integrated Biodiversity Assessment Tool (IBAT), which draws from:
  - The IUCN (International Union for Conservation of Nature) Red List of Threatened Species;
  - Key Biodiversity Area (KBA) database; and
  - The World Database on Protected Areas which encompass nationally and internationally recognized sites, including IUCN management categories I-VI, Ramsar Wetlands of International Importance (Ramsar sites), the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage sites and natural heritage sites.
- The IUCN Red List of Ecosystems.
- German Red List of Ecosystems/Habitats/Species.

3. DESKTOP ASSESSMENT

3.1 ECOREGION

The Project is located within the **'Western European Broadleaf Forests'** ecoregion (ID: PA12). Spanning across western Europe. This ecoregion showcases a diverse range of landscapes, from rolling hills to rugged mountain peaks, encompassing glacial lakes, peat bogs, and deep canyons. Dominated by primeval mountain beech forests, this area once covered a significant portion of Europe. However, large mammals are now scarce, although the Eurasian lynx has been reintroduced in several regions. The region faces various threats, including pollution, logging, tourism development, and deforestation for agriculture. Conservation efforts focus on restoring wetlands and natural forests, raising awareness about the lynx, and improving species management across borders. Source of information: https://www.oneearth.org/ecoregions/western-european-broadleaf-forests/

Principal threats to biodiversity are documented based those described by the WWF for the Western European Broadleaf Forests ecoregion and for fauna and flora of conservation importance (identified as occurring or potentially occurring in the Project area) according to IUCNs online species database[3]. The main threats to biodiversity appear to relate to:

- Historical large-scale destruction, degradation, fragmentation and transformation of natural habitat;
- agricultural land use intensification and changes in land management practices;
- reduced habitat quality;
- hydrological modification, such as modification of natural watercourses including rivers through regulation (e.g. reservoirs construction, canalization and stream diversions);
- disturbance of faunal breeding grounds;
- electrocution of birds due to above ground power lines;

[3] IUCN online Red Data List of threatened species. Available online at: https://www.iucnredlist.org/

- renewable energy development (i.e. wind farms) which are known to be particularly threatening to birds and bats that are generally vulnerable to collision with wind turbines;
- invasive species; and
- climate change.

3.2 PROTECTED AREAS AND INTERNATIONALLY RECOGNISED AREAS

3.2.1 PROTECTED AREAS

IFC PS6 recognizes **legally protected areas** that meet the IUCN definition: "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." - IFC (2012). This includes areas proposed by governments for such designation.

Protected Areas (PAs) identified in close proximity to the Project all form part of the 'Natura 2000' network of protected sites in Europe. Natura 2000 is the largest coordinated network of protected areas in the world and offers a protected landscape for Europe's most valuable and threatened species and habitats listed under the EU Birds Directive, Species Directive and the Habitats Directive (in terms of the 'Bern Convention'). These typically include core breeding and resting sites for rare and threatened species, and some rare natural habitat types which are protected in their own right (https://ec.europa.eu/environment/nature/natura2000/). All sites are designated as Special Areas of Conservation (SACs) under Natura 2000, which are sites designated under the EU Habitats Directive for habitats and species listed in Annex I and II of the Directive, to ensure the favorable conservation of each habitat type and species throughout their range. SACs complement special protection areas and together form a network of protected sites across the European Union.

The location and extent of Natura 2000 sites are shown on the maps in for the Project layout near Landau and for the CLP at Industrial Park Hoechst, with further details provided in Table 3-1. Overall, five PAs have been identified as being in relatively close proximity to the Project (three located near Landau, two near the Industrial Park Hoechst):

Landau site:

1. **Standortübungsplatz Landau:** The Natura 2000 site is partially located within the Project AoI (typically within 250 meters of the pipeline and GLEP). The pipeline route alignment option (ICPP Section 3) from the Landau well site to the GLEP intersects the Natura 2000 site over a distance of approximately 64 meters. Vulcan is currently considering alternative alignment options to avoid crossing the Natura 2000 site.
2. **Bellheimer Wald mit Queichtal**: within a distance of ~1.2 km from the GLEP
3. **Erlenbach und Klingbach**: within a distance of <500 m from the drill site at '40 Morgen'

CLP site at Industrial Park Hoechst:

4. **Schwanheimer Wald:** within a distance of ~1.4 km from the lease plot
5. **Schwanheimer Düne:** within a distance of ~700 m from the lease plot

3.2.2 INTERNATIONALLY RECOGNIZED AREAS

IFC PS6 also recognizes **internationally recognized areas** as being "exclusively defined as UNESCO Natural World Heritage Sites, UNESCO Man and the Biosphere Reserves, Key Biodiversity Areas, and wetlands designated under the Convention on Wetlands of International Importance (the Ramsar Convention)" – IFC (2012). One of the PAs identified near Landau (Bellheimer Wald mit Queichtal) is also recognized as a Key Biodiversity Area (KBA) and this site is an Important Bird and Biodiversity Area (IBA) according to BirdLife International. Further details are contained in Table 3-1. Notably, Alliance for Zero Extinction (AZE), RAMSAR wetlands and UNESCO world heritage sites are not associated with the Project.

TABLE 3-1 DETAILS OF PAS AND KBA IN RELATION TO THE PROJECT

Code	Name	PA?	FFH?	Natura 2000?	Type	KBA?	IBA?	Distance from Project (km or m)	Potential to be impacted by Project?
6814-301	**Standortübungsplatz Landau**	✓	✓	✓	SAC			Initial option: 0 m Alternative: 50 m	Indirect: possible noise and vibration Direct: Habitat loss
6715-302	**Bellheimer Wald mit Queichtal**	✓	✓	✓	SAC	✓	✓	1,2 km	None
6814-302	**Erlenbach und Klingbach**	✓	✓	✓	SAC			~500 m	Indirect: possible noise and vibration
5917-905	**Schwanheimer Wald**	✓	✓	✓	SAC			~1,4 km	None
8917-301	**Schwanheimer Düne**	✓	✓	✓	SAC			~700 m	None

Table key: PA = Protected Area; FFH = Fauna-Flora-Habitat; KBA = Key Biodiversity Area; IBA = Important Bird and Biodiversity Area, SAC = Special Area of Conservation (defined in terms of Natura 2000)



FIGURE 3-1 MAP SHOWING THE PROTECTED AREA 'STANDORTÜBUNGSPLATZ LANDAU' (NATURA 2000 SITE) IN RELATION TO THE LANDAU PROJECT LAYOUT AND AOI

Data sources: Vulcan data, IBAT (Integrated Biodiversity Assessment Tool), Natura 2000 coverage

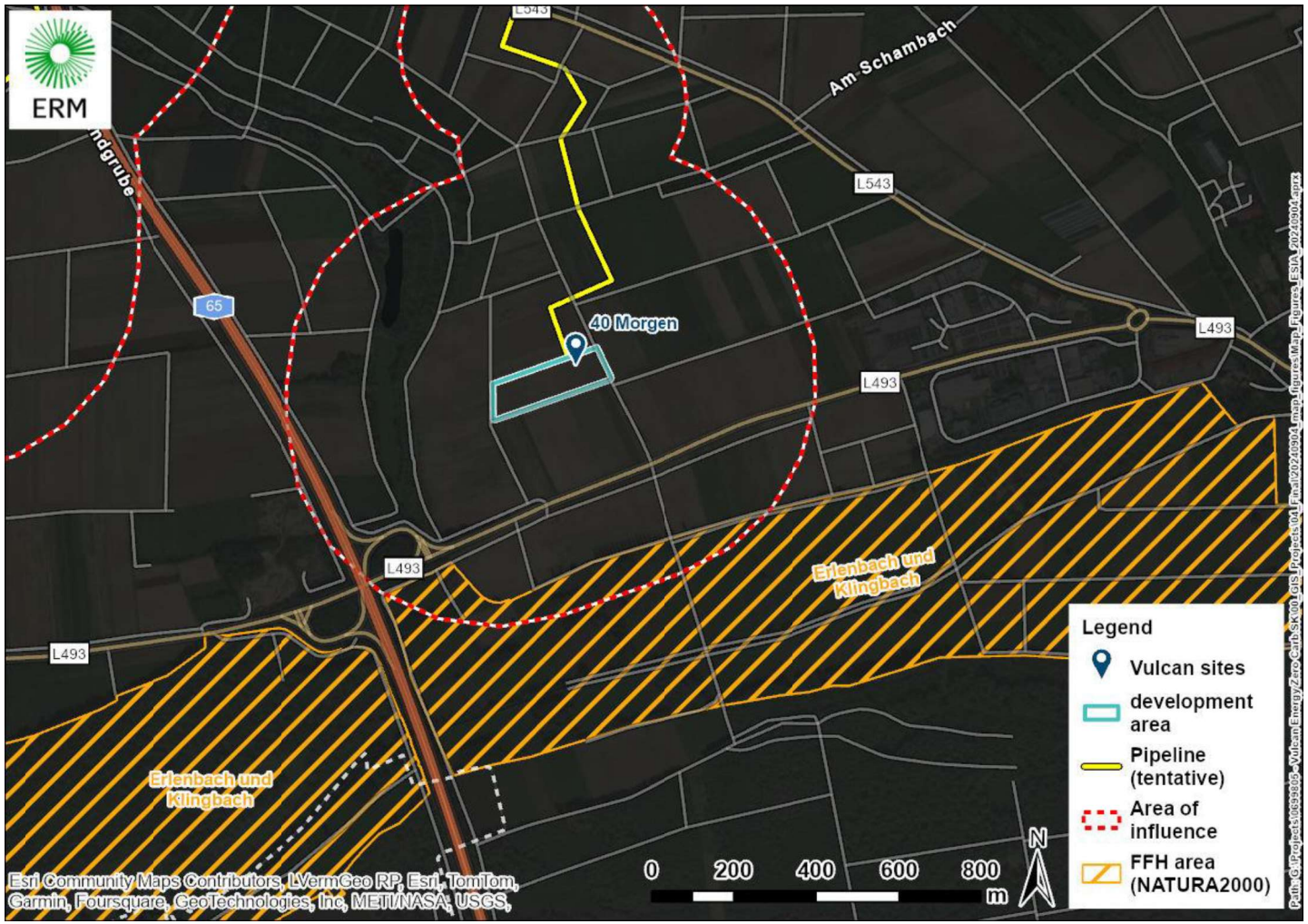


FIGURE 3-2 MAP SHOWING THE PROTECTED AREA 'ERLENBACH UND KLINGBACH' (NATURA 2000 SITES) IN RELATION TO THE LANDAU PROJECT LAYOUT AND AOI

Data sources: Vulcan data, IBAT (Integrated Biodiversity Assessment Tool), Natura 2000 coverage

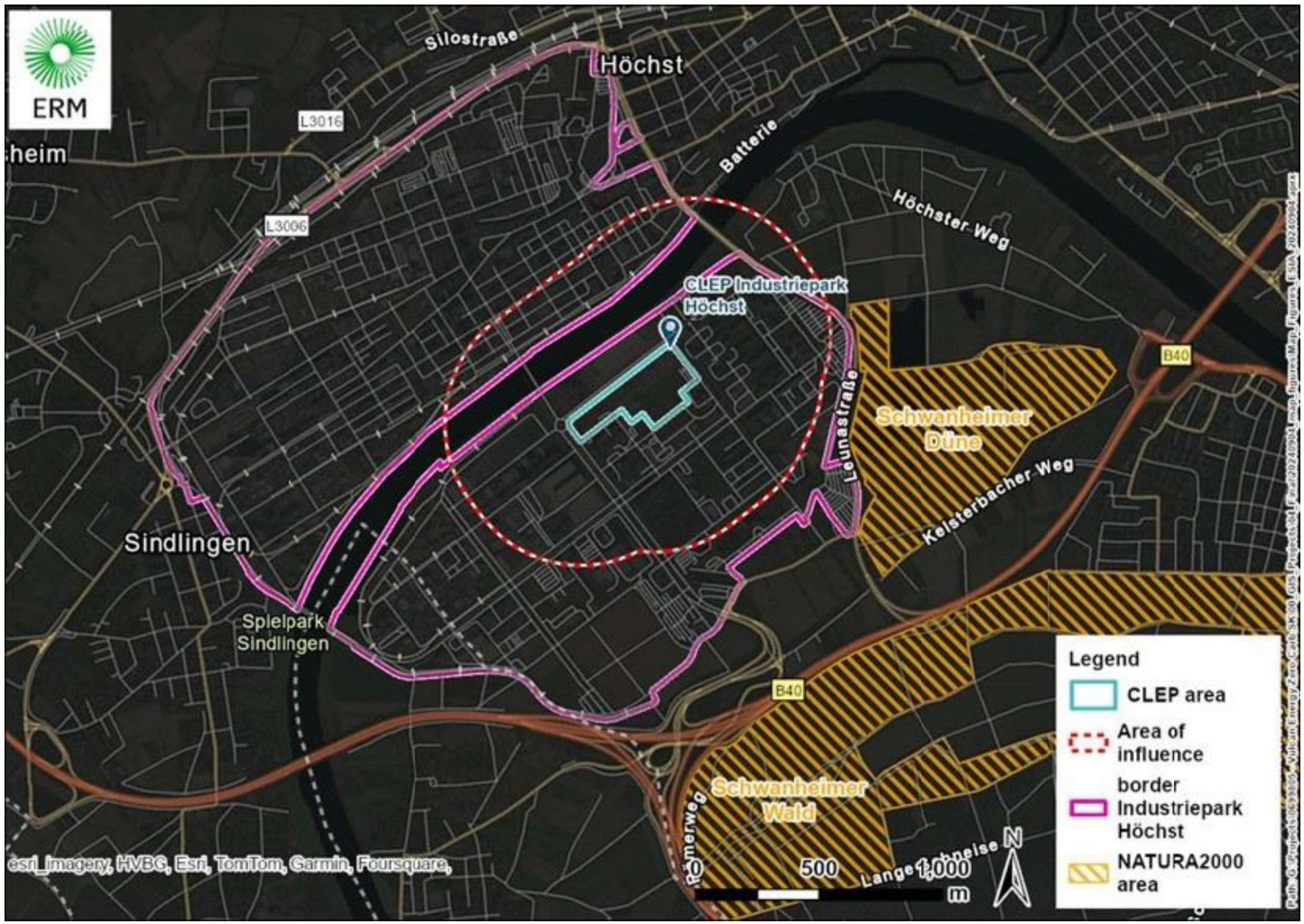


FIGURE 3-3 MAP SHOWING THE PROTECTED AREAS NETWORK (NATURA 2000) IN RELATION TO THE HOECHST SITE AND AOL

Data sources: Vulcan data, IBAT (Integrated Biodiversity Assessment Tool), Natura 2000 coverage

According to paragraph 20 of IFC PS6, in circumstances where a proposed project is located within a legally protected area[4] or an internationally recognized area[5], the client will need to meet the requirements of paragraphs 13 through 19 of the Performance Standard, as applicable." *(i.e. paragraphs related to natural, modified and critical habitats determination and management)* (IFC, 2012). In addition, the client will (in accordance with IFC PS6):

- Demonstrate that the proposed development in such areas is legally permitted;
- Act in a manner consistent with any government recognized management plans for such areas;
- Consult protected area sponsors and managers, Affected Communities, Indigenous Peoples and other stakeholders on the proposed project, as appropriate; and
- Implement additional programs, as appropriate, to promote and enhance the conservation aims and effective management of the area.

Direct impacts to Protected Areas will be generally avoided as infrastructure and activities will take place outside of the boundaries of these designated areas. The current ICPP Section 3 (BA3) alignment option from the Landau well site to the GLEP at Landau will be located within the boundary of the Natura 2000 site **Standortübungsplatz Landau** (see Figure 3-1) and this appears to avoid the conserved grassland (hay meadow) habitats; however, potential impacts in terms of vegetation clearing to woodland/shrubland habitat fringing these grassland/meadow habitats could be required and will result in a direct impact to these wooded biotopes and vegetation communities. Vulcan is investigating alternative options to avoid the ICPP crossing the Natura 2000 site. Where the pipeline alignment option avoiding placement within the boundary of the Natura 2000 site is pursued as the final option, no direct impacts or interactions with the PA or its biodiversity values are envisaged, however there is the potential for indirect effects associated with noise, vibration and/or light during construction as well as operation of the GLEP, since the AoI for the Project does overlap with the PA boundary.

The focus of the baseline for biodiversity has therefore been on documenting this PA (see Information Box 1, below), with a similar situation being true for the **'Erlenbach und Klingbach'** Natura 2000 site to the south where the AoI for the drill site at 40 Morgen slightly overlaps the Natura 2000 site (see Figure 3-2 and Information Box 2).

Note that interactions with the other PAs identified (both for Landau and Hoechst sites) are considered to be unlikely given that these areas are located outside of the Project AoI. Therefore, these PAs are not mentioned in further detail.

[4] **Legally protected areas**: IFC PS6 recognizes legally protected areas that meet the IUCN definition: "*A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*." This includes areas proposed by governments for such designation.

[5] **Internationally recognized areas**: IFC PS6 recognizes internationally recognized areas as being "*Exclusively defined as UNESCO Natural World Heritage Sites, UNESCO Man and the Biosphere Reserves, Key Biodiversity Areas, and wetlands designated under the Convention on Wetlands of International Importance (the Ramsar Convention)".*

Information Box 1. Details for 'Standortübungsplatz Landau' Natura 2000 site

Type: Natura 2000 SAC (Special Areas of Conservation in terms of the EU Habitats Directive)

Extent: 2 km^2

Description: The site encompasses a vast biotope complex comprising open and semi-open land vegetation, with scattered xero-thermic (dry/hot) grasslands as a result of the site experiencing reduced precipitation being in the rain shadow of the Palatinate Forest. The area has been identified as hosting notably high biodiversity in terms of both flora and fauna and is considered essential for the conservation of rare and endangered animal and plant species, providing a unique retreat within an otherwise intensively used agricultural landscape.

Notable biodiversity values include:

- The site harbors approximately 30 to 50% of all plant species expected for the Landau area;
- the presence of loess in the area (in addition to clay-rich soils) contributes to the formation of potential habitats for bees, wasps, and other species;
- the location is also important for bird species, with breeding records of declining species like Whinchat (*Saxicola rubetra*), Grey Bunting (*Emberiza variabilis*), Little Owl (*Athene noctua*), and Northern Wheatear (*Oenanthe oenanthe*) in Rhineland-Palatinate, and potential habitat for the Red-Backed Shrike (*Lanius collurio*);
- The area provides excellent hunting habitat for bats, especially the Common Noctule (*Nyctalus noctula*);
- Although limited data on insect populations have been collected, the area is known to be significant for insect diversity, including rare species like the German Tiger Beetle (*Cicindela germanica*), the oil beetle black May worm (*Meloe proscarabaeus*), and the Currant Beetle (*Agrilus ribesi*), which are among the rarest insect species in the Rhineland-Palatinate.

Key habitats:

- 6210: Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (important orchid sites)
- 6510: Extensive hay meadows of the planar to submontane stage (*Arrhenatherion, Brachypodio-Centaureion nemoralis*)

Key species:

- Greater Mouse-eared Bat (Myotis myotis) - (globally LC); Bern - Revised Annex I of Resolution 6;
- The Jersey Tiger/Spanish Flag (*Euplagia quadripunctaria*); IUCN – Not evaluated; Bern - Revised Annex I of Resolution 6;
- Common Noctule (*Nyctalus noctula*) - (globally LC);
- The German Tiger Beetle (*Cicindela germanica*) – IUCN: Not evaluated;
- The oil beetle black May worm (*Meloe proscarabaeus*) – IUCN: Not evaluated;
- Agrilus ribesi (*Currant beetle*) – IUCN: Not evaluated.

References:

Landau training area | BFN
6814-301 - Landau Training Area | Fauna-Flora-Habitat Areas in RLP

Information Box 2. Details for 'Erlenbach und Klingbach' Natura 2000 site

Type: Natura 2000 SAC (Special Areas of Conservation in terms of the EU Habitats Directive)

Extent: 10 km^2

Description: The site encompasses the broad floodplains and lowlands south of Landau, which play an important role in connecting the Palatinate Forest and Bienwald with the Bellheim Forest, Queichtal, and Hördter Rheinaue. Aquatic ecosystems, along with extensive grasslands, wet meadows, reed beds, and diverse deciduous forests, create a diverse habitat mosaic that fosters a rich and diverse biodiversity.

Notable biodiversity values include:

- The meadows are particularly important habitats for butterflies and birds, several of which are rare and/or threatened species;
- The ditches and aquatic habitats provide important breeding areas for dragonflies;
- The water quality in the area is predominantly good and Klingbach is characterized by a rich fish faunal diversity.

Key habitats:

- 3150: Natural eutrophic lakes with Magnopotamion or Hydrocharition -type vegetation;
- 3260: Water courses of the plain to montane levels with the Ranunculion fluitantis and the Callitricho-Batrachion vegetation;
- 6210: Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (important orchid sites)
- 6430: Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
- 6510: Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*)
- 9130: Asperulo-Fagetum beech forests
- 9160: Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli
- *91E0 (priority habitat type): Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)

Key species:

Fish:

- Bullhead (*Cottus gobio*) – (DD); Bern - Revised Annex I of Resolution 6
- Brook lamprey (*Lampetra planeri*) – IUCN (LC); Bern - Revised Annex I of Resolution 6
- European bitterling (*Rhodeus sericeus amarus*) – (LC); Bern - Revised Annex I of Resolution 6

Invertebrates:

- Large Copper (*Lycaena dispar*) - IUCN Europe (LC); Global (NT); - Annex II Bern Convention; Revised Annex I of Resolution 6
- Bright Meadow Blue (*Maculinea teleius*) – IUCN Europe (VU); IUCN Global (NT); Annex II Bern Convention; Revised Annex I of Resolution 6
- Dark Meadow Blue (*Maculinea nausithous*) – IUCRN global and Europe (NT); Bern - Annex II Bern Convention; Revised Annex I of Resolution 6
- Helmeted azure damsel (*Coenagrion mercuriale*) – IUCN globally (NT); Bern -Annex II Bern Convention; Revised Annex I of Resolution 6

References:

Erlenbach und Klingbach | BFN
6814-302 - Erlenbach and Klingbach | Fauna-Flora-Habitat Areas in RLP

3.3 MAIN ECOSYSTEMS AND HABITATS

Forest ecosystems cover approximately 32% of Germany's territory, with currently 37.4% of terrestrial area being designated as protected areas. Naturally occurring systems encompass alpine grassland steppes, and semi-natural systems including calcareous grasslands with limestone-rich soils, mat-grass sward on acidic soil and humid or mesophilic grasslands used as meadows.

A summary of the main terrestrial and aquatic ecosystems and associated habitats for the Project is provided below, separately for the Project components near Landau and CLP at Hoechst Industrial Park near Frankfurt.

3.3.1 PROJECT COMPONENTS LOCATED NEAR LANDAU

Terrestrial ecosystems and habitats:

A long history of land transformation in the region has resulted in large tracts of land being developed for towns, industry, and agriculture. Where the landscape was once characterized by dense broad-leaved forest and grassland mosaics, this has now been significantly reduced, and any remaining semi-intact / natural forest and grassland habitat is almost entirely restricted to the network of formally and legally Protected Areas (Natura 2000 sites).

Based on the site visit undertaken by ERM and a review of the land use and satellite imagery in GIS, ERM has concluded that all construction work and infrastructure associated with the Project near Landau and Insheim will be located within areas of **modified habitat**[6], which is consistent with the definition of IFC PS6 due to primary ecological functions and species composition for these habitats having been substantially modified such that these no longer represent the natural habitat type. These areas include industrial zones, cultivated lands (for the farming of maize, fruit, and vineyards for the production of grapes to make wine), as well as existing roads and open spaces with secondary vegetation and habitats. Based on the Report '*Landschaftspflegerischer Begleitplan gemäß § 17 BNatSchG - Errichtung des Bohrplatzes „Schleidberg"durch die Vulcan Energie Ressourcen GmbH'* [*English translation: 'Landscape conservation support plan in accordance with § 17 BNatSchG for the Construction of the "Schleidberg" drilling site by Vulcan Energie Resources GmbH']*, according to LANIS (state database of the RLP nature conservation administration), there are **no legally protected habitats** according to § 30 BNatSchG in the planned infrastructure development area and its immediate surroundings.

Importantly, the requirements of IFC PS6 (in terms of assessment and management of impacts on biodiversity and ecosystems) apply only to "*those areas of modified habitat that include significant biodiversity value*". In ERMs opinion, the modified habitats are of little to no biodiversity value or importance, and therefore this satisfies the requirements of IFC PS6 and areas of modified habitat do not require further examination in the ESIA.

[6] Modified habitat is defined in terms of IFC PS6 as follows: "*Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed6 coastal zones, and reclaimed wetlands."* – IFC)2012).



PHOTOGRAPHS TAKEN OF THE MAIZE FIELD AT THE SITE OF THE GLEP NEAR LANDAU (LEFT) AND SHOWING THE TYPICAL AGRICULTURAL LAND USE ASSOCIATED WITH THE PIPELINE ROUTE ALIGNMENT AND DRILLING EXPLORATION SITES (RIGHT)

Source: ERM Site Visit, 9th August 2023

Within the AoI of the Project, the only natural habitat[7] remaining near Landau is associated with the Natura 2000 sites: 'Standortübungsplatz Landau' in the north and 'Erlenbach und Klingbach' in the south. For 'Standortübungsplatz Landau', most notable are the xero-thermic (dry/hot) grassland habitats that are considered important for endangered flora and fauna, providing an important refugia in an intensively transformed agricultural landscape. The habitats have been classified in terms of the EUNIS8 habitat classification system as including a mosaic of:

- 6210: Semi-natural dry grasslands and scrubland facies on calcareous substrates; and
- 6510: Extensive hay meadows of the planar to submontane stage.

The grassland habitat associated with the 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach' Natura 2000 sites is classified as '**Semi-natural dry grasslands and scrubland facies on calcareous substrates'** (revised EUNIS name: Semi-dry perennial calcareous grassland (meadow steppe) (revised code R1A). In terms of the European Red List of Habitats[9], Semi-dry perennial calcareous grassland (Red List code E1.2a) is considered a '**Vulnerable**' habitat type, with criteria determining this status being due to both historic decline and present decline in habitat extent over the last 50 years.

[7] Natural habitat is defined in terms of IFC PS6 as follows: *"Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition."* – IFC (2012).

[8] EUNIS stands for the 'European Nature Information System' developed and implemented by the European Environment Agency. The EUNIS habitat classification system is the system used to classify different habitats in the EU and is directly aligned with the EU Habitats Directive (Annex I habitat types).

[9] European Union (EU) (2016). European Red List of Habitats: Part 2. Terrestrial and freshwater habitats.



PHOTOGRAPH OF THE NATURAL GRASSLAND/MEADOW HABITAT ASSOCIATED WITH 'STANDORTÜBUNGSPLATZ LANDAU' NATURA 2000 SITE

Source: ERM Site Visit, 9th August 2023

For Erlenbach und Klingbach, there are several additional habitat types worth mentioning and these include the following (also with '**Vulnerable**' status according to the EU Red List of Habitats):

- 3150: Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation;
- 6430: Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels; and
- 6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*).

As well as the following '**Near Threatened'** habitat types:

- 3260: Water courses of plain to montane levels with the *Ranunculion fluitantis* and the *Callitricho-Batrachion* vegetation;
- 9130: *Asperulo-Fagetum* beech forests NT Fagus woodland on non-acid soils; and
- 9160: Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli*

These habitat types are all listed in terms of Annex I of the EU Habitats Directive which considers 'Natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation (SACs)'. All these habitats are also listed according to Revised Annex I to Resolution 4 of the Bern Convention as endangered natural habitat types.

An additional habitat type common to the Erlenbach und Klingbach Natura 2000 site worth mentioning is 'Alluvial forests with **Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)' (*91E0)**, which whilst considered to be of 'Least Concern' according to the EU Red List of Habitats, is listed as a **priority habitat type*** according to the EU Habitats Directive.



PHOTOGRAPH OF THE AGRICULTURAL LANDS AT THE 40 MORGEN DRILL SITE WITH THE 'ERLENBACH UND KLINGBACH' NATURA 2000 SITE VISIBLE IN THE DISTANT BACKGROUND

Source: ERM Site Visit, 9th August 2023

Aquatic ecosystems and habitats:

The pipeline will be crossing the 'Quodbach', a small stream, at two points. One crossing will be east of the B38 motorway between 'Hasenberg' and 'Spreissgraben'. The second crossing will be east of Insheim, west of the A65 highway. The stream runs south-eastly, crossing Impflingen and later Insheim and can be considered a highly modified watercourse. According to LANIS (state database of the RLP nature conservation administration), there are **no legally protected habitats** according to § 30 BNatSchG bordering the stream within the AoI. Possible interactions of the development proposed with the stream and associated aquatic biodiversity are worth considering further to examine the need for any relevant mitigation measures. The nearest large river system is the Rhine River, which is located roughly 14 km east of the Project.

3.3.2 CENTRAL LITHIUM PLANT (CLP) AT HOECHST INDUSTRIAL PARK

Terrestrial ecosystems and habitats:

The CLP will be located within the existing Industrial Park Hoechst on a portion of leased land that has already undergone infilling, modification and disturbance. The leased plot is now characterized by a combination of infrastructure, hardened surfaces and gravel surfaces and secondary vegetation comprised mainly of grasses and weeds that can be considered **modified habitat**. These areas are considered to be of negligible biodiversity value or importance.

Aquatic ecosystems and habitats:

The 'Main' River main channel is located to the north of the site to be developed for the CLP, with the Industrial Park Hoechst located on both sides of the Main River, which flows in a general westerly direction towards its confluence with the Rhine River. Possible interactions of

the development proposed with the aquatic ecosystem and associated aquatic biodiversity associated with the Main River reach in the vicinity of the development site are worth considering further to examine the need for any relevant mitigation measures.

Notably, Karthe *et al.* (2017[10]) highlight the fact that Germany's many river systems have experienced a long history of usage and modification, with anthropogenic influences having completely changed the landscape and ecosystems within and around all major lowland rivers in the country. Even with advances in wastewater treatment since the 1960's, high nutrient concentrations linked to domestic effluent and agricultural runoff continues to be a key challenge for river systems. Whilst heavy metals are only sometimes problematic, according to Karthe *et al.* (2017), emerging pollutants and microplastics are another cause of concern in terms of their potential to pollute Germany's inland waters. Fine sediment inputs and pesticides are also worth mentioning and not to forget hydro-morphological degradation and the fact that aquatic and riparian ecosystems also depend on river and floodplain morphology, which has also experienced massive transformation due to construction and straightening as well as the interruption of continuity by instream weirs. Invasive aquatic species have not received as much attention but may further contribute to the alteration of rivers in Germany (Karthe *et al.,* 2017).

According to a report titled '*Gewässer in Deutschland: Zustand und Bewertung'* (English translation: 'Water bodies in Germany: status and assessment') published in 2022[11] by the 'Umweltbundesamt' (English translation: 'Environmental Bureau') in Germany, the Main River has been assessed as being in an **'unsatisfactory' ecological condition**, which suggests that a significant level of modification to the river ecosystem and ecology has taken place already. *This rating is based on a comprehensive river monitoring program in Germany that relies on a suite of ecological and physical environmental indicators to determine the present ecological state or condition of rivers, that includes an analysis of water chemistry, river hydromorphology and the abundance and diversity of aquatic organisms (e.g. algae, phytoplankton, fish and aquatic macro-invertebrate species) in comparison to what would be naturally present.*

Whilst the river habitat associated with the Main River can be argued to be in a 'modified' state (based on the report by the Umweltbundesamt, 2022, see also Figure 3-4), it is thought that the river system may still provide habitat for aquatic species of fish and invertebrates and is likely associated with several ecosystems services, such that its biodiversity value/importance would not be considered negligible or insignificant.

[10] Karthe, D., Chfflard, P., Cyffka, B., Menzel, L., Nacken, H., Raeder, U. Sommerhauser, M. and Weiler, M. (2017). Water research in Germany: from the reconstruction of the Roman Rhine to a risk assessment for aquatic neophytes. In Environ Earth Sci (2017) 76: 549. DOI 10.1007/s12665-017-6863-7

[11] Umweltbundesamt (2022). Gewässer in Deutschland: Zustand und Bewertung. Dessau-Roßlau. Available online at: https://www.umweltbundesamt.de/publikationen [Accessed 31 August 2023].

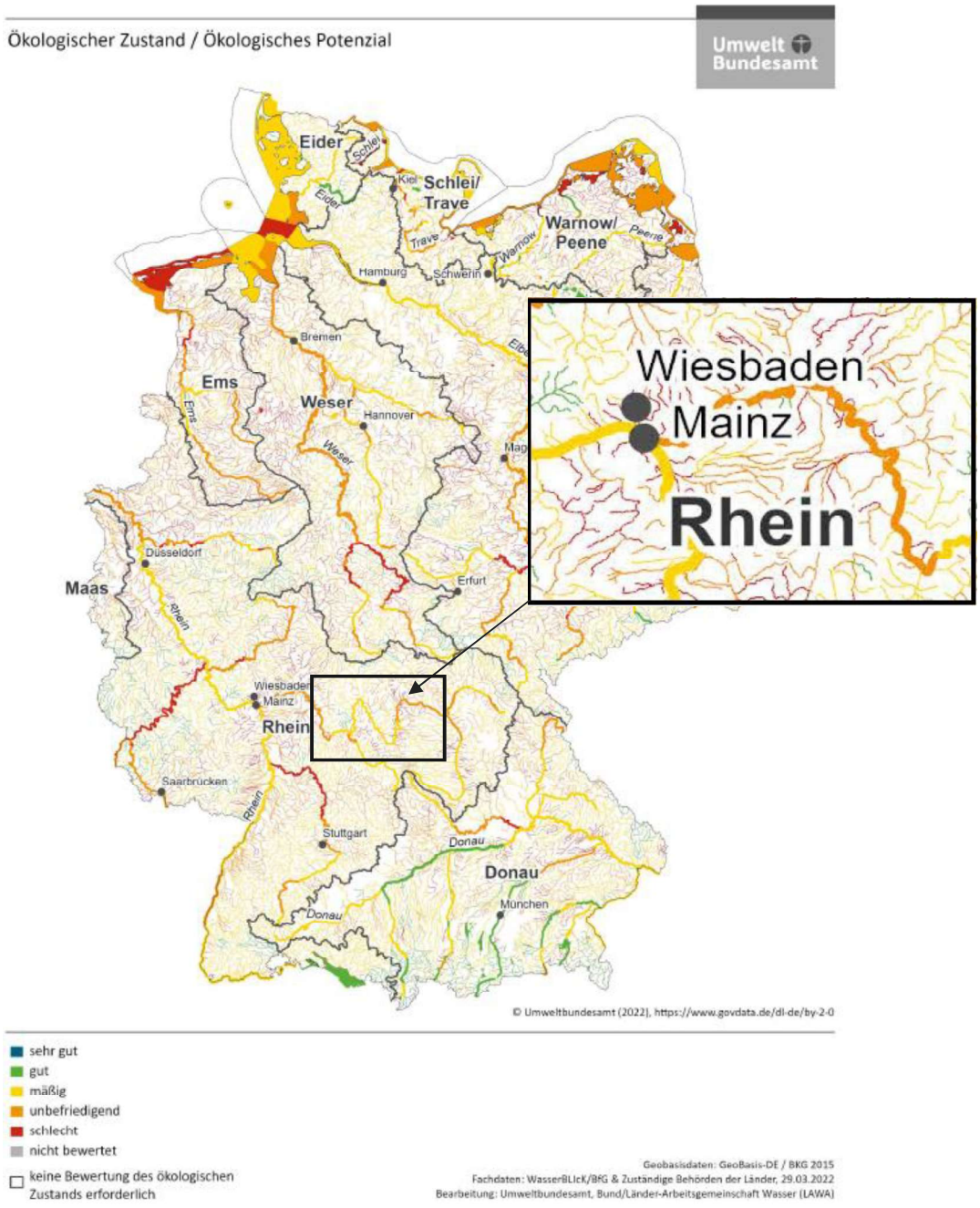


FIGURE 3-4 MAP SHOWING THE ECOLOGICAL STATUS OF RIVERS ACROSS GERMANY

Source: 'Gewässer in Deutschland: Zustand und Bewertung' (Umweltbudesamt, 2022)

3.4 ECOSYSTEM SERVICES

An ecosystem service is any positive benefit that nature provides to people. These are essentially direct and indirect contributions that natural ecosystems (known as natural capital) provide for human well-being and quality of life. This can be in a practical sense through providing food and water and regulating climate, as well as less tangible cultural aspects such as providing spaces for recreation to reduce stress.

What is important to acknowledge is that **underpinning all these services is nature or biodiversity.**

There are a vast number of services provided by ecosystems that are typically categorized into more manageable groups as follows (see also Figure 3-4):

- **Provisioning**: these are the tangible goods or products that people can extract or obtain from nature, such as food, materials (wood/fiber), fuel, medicines and water.
- **Regulating**: these are the benefits obtained from an ecosystem's control of natural processes, such as climate regulation, disease control, erosion prevention, water flow regulation, water filtration and protection from natural hazards (e.g. flood control).
- **Cultural**: these are the nonmaterial benefits obtained from ecosystems, such as recreation and aesthetic enjoyment. These include ways in which nature impacts people's health and wellbeing through recreational and education benefits as well as improving mental health and building spiritual connections.
- **Supporting**: ecosystems could not function without supporting services, such as the nutrient cycle, soil formation and habitat provision for biodiversity, forming the basis for the other three types of services.

Ecosystem services (linked mainly to forests, agricultural lands, and aquatic ecosystems in the study area) may include the following:

- **Forests**: cover approximately one third of the total land area in Germany, thereby providing a high variety of ecosystem services (ES), such as timber production, carbon sequestration, recreation, and other cultural services related to biodiversity production.
- **Aquatic ecosystems (rivers and wetlands):** The Upper Rhine Valley's ecosystems help regulate water flow, reducing the risk of floods. Wetlands and natural vegetation typically act as filters, purifying water by trapping pollutants and sediment. What is important to note however is that modification to rivers and loss of wetlands within the catchment/watershed has likely reduce the potential level of supply of key services linked to aquatic ecosystems.
- **Biodiversity and habitat provision**: The area's diverse landscapes offer habitat to a variety of plant and animal species, contributing to biodiversity conservation. Furthermore, the Natura 2000 reserves also play a significant role in providing essential habitats for biodiversity, encompassing a diverse range of flora and fauna.
- **Agriculture/cultivated crops**: The fertile soils of the Upper Rhine Valley support agricultural production (maize) fruits and wine, and livestock. Ecosystems contribute to pollination of crops by providing habitat for pollinators like bees and butterflies.
- **Recreation and cultural services**: The natural beauty of the region provides recreational opportunities for residents and visitors alike. Outdoor activities such as hiking, birdwatching, and nature photography are popular, contributing to the well-being and cultural experiences of people. This is negated to an extent by the agricultural setting, with key opportunities for recreation and nature-related activities likely to be restricted to the remaining nature reserves associated with the Natura 2000 sites.

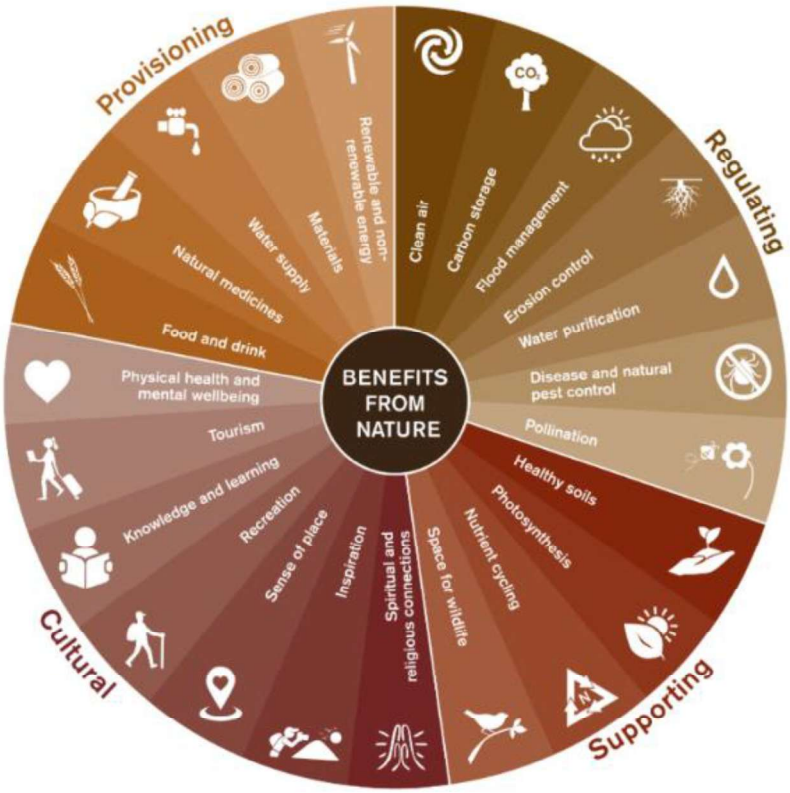


FIGURE 3-5 ECOSYSTEM SERVICES CATEGORIZED

Source: NatureScot (Scotland's Nature Agency)
Online at: https://www.nature.scot/scotlands-biodiversity/scottish-biodiversity-strategy-and-cop15/ecosystem-approach/ecosystem-services-natures-benefits

3.5 CONSERVATION IMPORTANT SPECIES: FLORA AND FAUNA

ERM utilized the Integrated Biodiversity Assessment Tool (IBAT) to run a preliminary analysis of conservation important (threatened) species of fauna and flora likely to occur in the AoI for the Project. IBAT provides consolidated information on known species records and species known or modelled geographical / distributional ranges, provided through the International Union for the Conservation of Nature online database of threatened species (IUCN, 2023[12]). The habitat requirements/preferences for each species identified through the use of IBAT were reviewed (based on available literature) and compared with the habitat occurring in the Project AoI, to estimate the likelihood of these species potentially occurring in the Project AoI (as per the assessment matrix in Table 3-2).

A total of 77 species, including 38 species of fauna belonging to four faunal groups (mammals, birds, fish, invertebrates) and 39 species of flora (plants and fungi) were screened initially. No herpetofauna (reptile and amphibian) species of global conservation importance were identified

[12] International Union for Conservation of Nature (IUCN) (2023). Online database of Threatened Species (Red Data List), Version 3. Accessed 25 August 2023. Online at: https://www.iucnredlist.org/

by IBAT. From this list, 50 species were excluded for further analysis based on one or more of the following reasons:

1. Species are identified as being extinct from the region according to IUCN;
2. Species known or modelled geographical ranges are outside of the study areas according to IUCN; or
3. Species habitat preferences/requirements do not align with the habitats occurring in the study area.

TABLE 3-2 MATRIX TO ESTIMATE SCC LIKELIHOOD OF OCCURRENCE

		HABITAT REQUIREMENTS / PREFERENCES		
		Largely met	Partially met	Not met
SPECIES DISTRIBUTION / RANGE	Project area overlaps known species geographical / altitudinal range	Likely	Possible	Unlikely
	Project area on the edge of known species geographical / altitudinal range	Possible	Unlikely	Highly unlikely
	Project area outside of known species geographical / altitudinal range	Unlikely	Highly unlikely	Highly unlikely

The full species list, including species EXCLUDED from further analysis can be found in **Annexure A.**

The refined list of 27 species that could possibly occur in the Project AoI (see Table 3-3) (based on overlap with known/modelled species geographical ranges and habitat preferences/requirements being largely met) include:

- European Turtle-dove, *Streptopelia turtur* (VU) that inhabits woodland and cultivated areas;
- European eel, *Anguilla anguilla (CR)* that inhabits rivers;
- Eight terrestrial invertebrate species (mainly insects/beetles that inhabitant woodland, forest and cultivated fields (EN, VU and DD status); and
- 17 species of plants (mainly fungi) that occur in forest or grassland areas (EN, VU and DD status)

Whilst some species may utilize the cultivated fields and modified habitats in the study area, the large majority require natural habitat and typically either grassland or forest. These species are therefore likely to be restricted to the natural grassland and forest habitats located within the Protected Areas (Natura 2000 sites) in the study area.

Out of the species evaluated for the assessment, none are native exclusively to Germany, and none of these species are limited to specific ranges.

TABLE 3-3 STATUS OF CONSERVATION IMPORTANT FLORA AND FAUNA SPECIES POTENTIALLY OCCURRING IN THE AOI

Scientific Name	Common Name	IUCN Threat Status (global)	IUCN Threat Status (Europe)	Red Data List (Germany)	Key Habitat (simplified)	Status	Breeding Status	Endemic	Restricted -Range	Congregatory
Birds										
Streptopelia turtur	European Turtle-dove	VU		EN	Woodland	Resident	Breeding	No	No	No
AQUATIC ORGANISMS / FISH										
Anguilla anguilla	European Eel	CR		EN	Rivers	Resident	Non-breeding	No	No	Yes
Invertebrates										
Ampedus brunnicornis	Brown-horned glow worm	VU		CR	Forest	Resident	Breeding	No	No	No
Ampedus hjorti		VU		VU	Forest	Resident	Breeding	No	No	No
Andrena bucephala	Large Copper / Big-headed Mining Bee	DD		VU	Cultivated/pasture	Resident	Breeding	No	No	No
Cerophytum elateroides	Black Mud Beetle	VU		CR	Forest	Resident	Breeding	No	No	No
Corticeus bicoloroides	Darkling Beetle	EN		CR	Forest	Resident	Breeding	No	No	No
Limoniscus violaceus	Violet Click Beetle	EN		CR	Woodland	Resident	Breeding	No	No	No
Nehalennia speciosa	Pygmy Damselfly	VU	NT	CR	Woodland	Resident	Breeding	No	No	No
Pedostrangalia revestita	Almblombock	VU		EN	Forest	Resident		No	No	No
Flora: Plants & Fungi										
Aesculus hippocastanum	Horse Chestnut	VU			Forest	Resident		No	No	No

Scientific Name	Common Name	IUCN Threat Status (global)	IUCN Threat Status (Europe)	Red Data List (Germany)	Key Habitat (simplified)	Status	Breeding Status	Endemic	Restricted -Range	Congregatory
Buglossoporus quercinus	Oak Polypore	VU		CR	Forest	Resident	Breeding	No	No	No
Cortinarius odoratus	Wohlriechender Klumpfuss	VU		DD	Forest	Resident		No	No	No
Cuphophyllus colemannianus	Toasted Waxcap	VU		EN	Steppe: grassland	Resident		No	No	No
Cuphophyllus lacmus	Grey Waxcap	VU		VU	Steppe: grassland	Resident		No	No	No
Entoloma griseocyaneum	Felted Pinkgill	VU		VU	Steppe: grassland	Resident		No	No	No
Entoloma porphyrophaeum	Lilac Pinkgill	VU		VU	Steppe: grassland	Resident		No	No	No
Entoloma prunuloides	Mealy Pinkgill	VU		VU	Steppe: grassland	Resident		No	No	No
Flammulina ononidis	Hauhechel Samtfußrübling	VU		EN	Steppe: grassland	Resident		No	No	No
Galeopsis segetum	Downy Hemp-nettle	DD		NT	Steppe: grassland	Resident		No	No	No
Hygrocybe ovina	Blushing Waxcap	VU		CR	Steppe: grassland	Resident		No	No	No
Hygrocybe punicea	Crimson Waxcap	VU		DD	Steppe: grassland	Resident		No	No	No
Hygrocybe splendidissima	Splendid Waxcap	VU		DD	Steppe: grassland	Resident		No	No	No
Neohygrocybe nitrata	Nitrous Waxcap	VU		VU	Steppe: grassland	Resident		No	No	No
Picipes rhizophilus	Steppengras-Schwarzfußporling	VU			Steppe: grassland	Resident		No	No	No
Pseudotricholoma metapodium	Mealy Meadowcarp	EN			Steppe: grassland	Resident		No	No	No

Scientific Name	Common Name	IUCN Threat Status (global)	IUCN Threat Status (Europe)	Red Data List (Germany)	Key Habitat (simplified)	Status	Breeding Status	Endemic	Restricted -Range	Congregatory
Sarcodontia crocea	Orchard Tooth	VU			Cultivated/pasture	Resident		No	No	No

Table key:
CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient

The IBAT species data was also supplemented with information pertaining to the Natura 2000 sites: (i) 'Standortübungsplatz Landau', and (ii) 'Erlenbach und Klingbach' Natura 2000 site, which are partially located within the Project AoI. As previously mentioned, the grassland and wetland habitats at the two Natura 2000 sites, respectively, are considered important for harbouring species of endangered flora and fauna, providing an important refugia in an intensively transformed agricultural landscape. Key species include:

Bats:

- Whilst the wooded habitats and grassland associated with Standortübungsplatz Landau have been highlighted as important hunting/feeding grounds for bat species, available information suggests that only the Common Noctule (*Nyctalus noctula*) and Greater Mouse-eared Bat (*Myotis myotis*) are present, which are both Least Concern globally.
- *M. myotis* is however listed in the EU Habitats Directive: Annex II (*animal and plant species of community interest whose conservation requires the designation of Special Areas of Conservation*) and Revised Annex I of Resolution 6 (*which lists species requiring specific habitat conservation measures*).
- Also, it is important to note that all Microchiroptera (microbats) are considered 'Specially Protected Fauna Species' in terms of Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats ('Bern Convention') which lastly strictly protected fauna species.

Birds:

- Bird species are all of LC globally and in Europe according to the IUCN and none are listed in the EU Birds Directive.
- Whinchat (*Saxicola rubetra*) and Northern Wheatear (*Oenanthe oenanthe*), that are potentially associated with Standortübungsplatz Landau, are however 'Specially Protected Fauna Species' listed in terms of Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats ('Bern Convention').

Invertebrates:

- Several species of butterflies, damselflies and dragonflies are supported by the grassland and wetland habitats at the two Natura 2000 sites, including:
  - Jersey Tiger/Spanish Flag (*Euplagia quadripunctaria*); IUCN – Not evaluated by IUCN, EU Habitats Directive: Revised Annex I of Resolution 6 (*which lists species requiring specific habitat conservation measures);*
  - The German Tiger Beetle *(Cicindela germanica)* – Globally of LC, considered rare in Germany;
  - Large Copper (*Lycaena dispar*) - IUCN Europe (LC); Global (NT); - Annex II Bern Convention; Revised Annex I of Resolution 6;
  - Bright Meadow Blue (*Maculinea teleius*) – IUCN Europe (VU); IUCN Global (NT); Annex II Bern Convention; Revised Annex I of Resolution 6;
  - Dark Meadow Blue (*Maculinea nausithous*) – IUCRN global and Europe (NT); Bern - Annex II Bern Convention; Revised Annex I of Resolution 6; and
  - Helmeted azure damsel (*Coenagrion mercuriale*) – IUCN globally (NT); Bern -Annex II Bern Convention; Revised Annex I of Resolution 6.

Reptiles:

- Information sign boards inspected during the site surveys indicate that the grassland habitats associated with Standortübungsplatz Landau are important for 'Mauereidechse' (*Podarcis muralis*) [English common name: Common Wall Lizard). This small reptile species is globally of Least Concern and its population is stable according to the IUCN.
- During the ERM site visit on 8th August 2023, the species was encountered in the northern most section of the Natura 200 site: 'Standortübungsplatz Landau', on rocks and sunning itself on the tarred pedestrian/cycling path.
- The species is active during the day and typically suns itself on rocks and artificial paved surfaces that warm up during daytime. It could be that this species may interact with the construction area for the pipeline given the pipelines proposed position near to the Natura 2000 site. According to the IUCN, key threats to this species relate to habitat loss due to agricultural intensification and overuse of pesticides in Northern Europe.

Fish:

- Several species of fish are supported by the instream (riverine) and wetland habitats at the 'Erlenbach und Klingbach' Natura 2000 site, including:
- Bullhead (*Cottus gobio*) – (DD); Bern - Revised Annex I of Resolution 6;
- Brook lamprey (*Lampetra planeri*) – IUCN (LC); Bern - Revised Annex I of Resolution 6; and
- European bitterling (*Rhodeus sericeus amarus*) – (LC); Bern - Revised Annex I of Resolution 6.

Plants:

- The grassland habitat associated with Standortübungsplatz Landau is also highlighted in terms of the EUNIS Classification and EU Red Data List of Habitats as being a potentially important site for orchids, many of which are likely to be threatened species.
- However, considering that the Project will not directly affect the habitats and plant species, no further attention to plants has been given (which are highly unlikely to be affected by the Project).



PHOTOGRAPH OF INFORMATION SIGNAGE INDICATING HABITAT FOR ENDANGERED FLORA ('PFLANZEN') AND FAUNA ('TIERE'), INCLUDING THE COMMON WALL LIZARD: 'MAUEREIDECHSE' (*PODARCIS MURALIS*).

Source: ERM Site Visit, 9th August 2023

4. SUMMARY OF THE FINDINGS OF BASELINE FIELD SURVEYS

4.1 BACKGROUND

The following existing biodiversity baseline studies and survey reports compiled for the national permitting process were reviewed and relevant findings and key content translated to English for use in the baseline and scoping report:

- 'Artenschutzfachliche Ersteinschätzung potenzieller Bohrungsstandorte Vulcan Energie Ressourcen GmbH Projektgebiet Schleidberg Süd' - compiled by the Institut für Naturkunde in Südwestdeutschland (November 2022).
  [English translation: 'Species protection-related initial assessment of potential drilling sites for Vulcan Energie Resources GmbH for the Project area Schleidberg Süd']
- ´Landschaftspflegerischer Begleitplan gemäß § 17 BNatSchG Errichtung des Bohrplatzes „Schleidberg" durch die Vulcan Energie Ressourcen GmbH' – compiled by the Institut für Naturkunde in Südwestdeutschland (May 2023).
  [English translation: 'Landscape conservation support plan in accordance with § 17 BNatSchG for the Construction of the "Schleidberg" drilling site by Vulcan Energie Resources GmbH']
- 'Fachbeitrag Artenschutz, Bebauungsplan D12 Gewerbepark Messegelände-Südost' - compiled by the Institut für Naturkunde in Südwestdeutschland (November 2018).
  [English translation: 'Specialist article on species protection, Development plan D12 Business Park: Messegelände-Südost']
- ‚Tierökologisches Gutachten Projektgebiet Landau Süd' – compiled by the Institut für Naturkunde in Südwestdeutschland (February 2025).
  [English translation: Faunistic ecological assessment for the project area 'Landau Süd']
- ‚Bauabschnitt 1 Geothermiekraftwerk Insheim bis Bohrplatz Schleidberg – Landschaftspflegerischer Begleitplan mit integrierter Prüfung artenschutzrechtlicher Belange' (November 2024).
  [English translation: 'Construction section 1 geothermal power plant Insheim to drill side Schleidberg - Landscape conservation support plan with integrated specialist article on species protection']

4.2 METHODS

Based on the habitat features represented in the study area, the species groups selected for focused surveys and investigation in the field included birds, reptiles, amphibians and small mammals (Hazel dormouse).

The following survey methods, timing and areas were the focus of the biodiversity field surveys:

- **Schleidberg Sued drill site** and surrounds (see study/search area in Figure 4-1):
  - **Amphibian surveys** via nocturnal transect surveys over two nights in spring 2022 (April and May). Additional surveys were conducted in 2024 in the wider 'Landau Sued' survey area (Institut für Naturkunde in Südwestdeutschland, 2025).
  - **Reptile surveys** during the daytime via transects over a period of 16 days and taking place in spring, summer and autumn 2022 (March, April, May, June, July, August, September, October and November). Additional surveys were conducted in 2024 in the

wider 'Landau Sued' survey area (Institut für Naturkunde in Südwestdeutschland, 2025).

- **Breeding bird surveys** using transects over a period of 14 days during spring and summer 2022 (April, May, June and July). Additional surveys were conducted in 2024 in the wider 'Landau Sued' survey area (Institut für Naturkunde in Südwestdeutschland, 2025).
- **Small mammal surveys** focused on Dormouse over a period of 16 days using tube traps deployed in spring, summer and autumn 2022 (March, May, June, July, August, September and November). Additional surveys were conducted in 2024 in the wider 'Landau Sued' survey area (Institut für Naturkunde in Südwestdeutschland, 2025).

- Birds, mammals and reptiles were also investigated in a similar manner to the Schleidberg Sued site for the **GLEP site near the D12 business park east of Landau** (see study/search area in Figure 4-2) and documented in the report '*Specialist article on species protection, Development plan D12 Business Park: Messegelände-Südost'* (Institut für Naturkunde in Südwestdeutschland, 2018). These surveys were performed over the period April, May and June 2018 (covering spring and summer the months).
- **Landau Sued:**
  - **Breeding bird surveys** were undertaken on six occasions between March and July 2024 through visual observations and the use of sound decoys.
  - **Herpetofauna (reptiles and amphibians)** were surveyed on seven occasions between April and October 2024 through visual observations and the use of artificial hiding places.
  - **Hazel Dormouse** using tube traps with searches every 5 weeks between April and November 2024.

Wild bees were also examined for the GLEP site near the D12 business park east of Landau and documented in the report '*Specialist article on species protection, Development plan D12 Business Park: Messegelände-Südost'* (Institut für Naturkunde in Südwestdeutschland, 2018). The survey involved direct observations and capture of bees using nets. A comprehensive overview of the species present in the area, and typical to the region, was obtained by visually assessing habitat elements including flowers and nesting sites over a four day period in April, June, July and August 2018 (covering spring and summer seasons).



FIGURE 4-1 MAP SHOWING THE STUDY AREA FOR BIODIVERSITY SURVEYS ASSOCIATED WITH THE SCHLEIDBERG SUED DRILL SITE LANDAU ('YELLOW' HATCHED AREA SHOWING THE STUDY AREA)

Source: Institut für Naturkunde in Südwestdeutschland (2022)

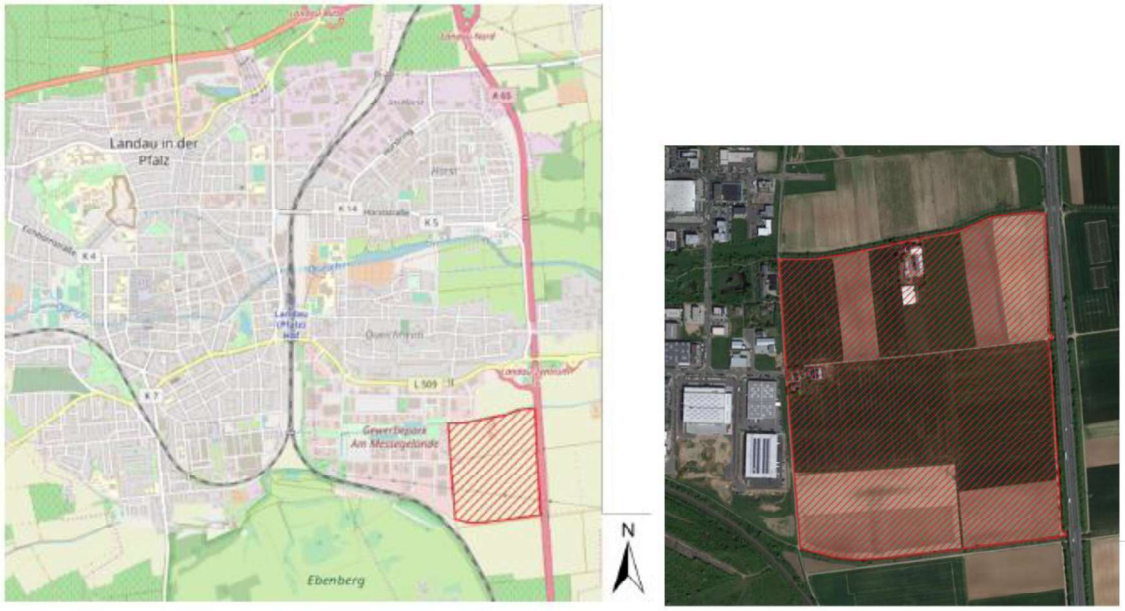


FIGURE 4-2 MAP SHOWING THE STUDY AREA FOR BIODIVERSITY SURVEYS ASSOCIATED WITH THE GLEP NEAR THE D12 BUSINESS PARK EAST OF LANDAU ('RED' HATCHED AREA SHOWING THE STUDY AREA)

Source: Institut für Naturkunde in Südwestdeutschland (2018)

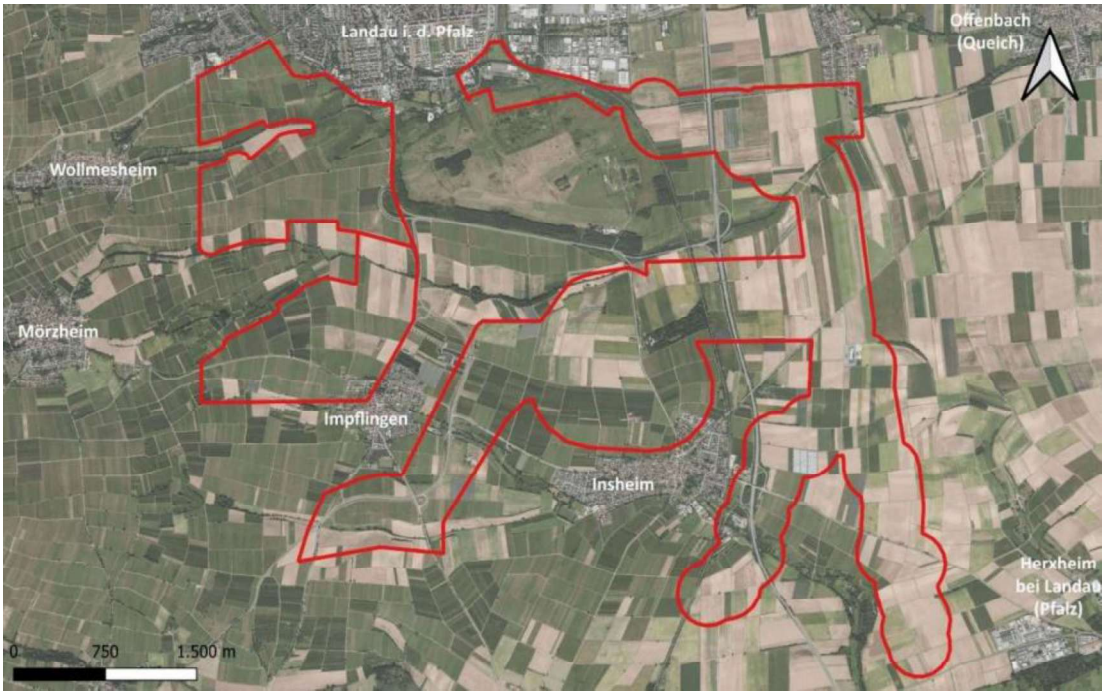


FIGURE 4-3 MAP SHOWING THE STUDY AREA 'LANDAU SUED' FOR BIODIVERSITY SURVEYS CONDUCTED IN 2024.

Source: Institut für Naturkunde in Südwestdeutschland (2024).

4.3 KEY FINDINGS

The main findings of the field surveys and assessments have been categorized according to species group, below:

Birds:

- A total of 70 bird species have been recorded in the study area, including predominantly small passerines (perching birds) as well as a few raptors including kites, kestrels, harriers and fewer waterbirds such as cranes and mallard.
- The majority of bird species are of global Least Concern (LC) and not protected in Europe or Germany, however there are several that are of conservation importance:
    - One species under strict protection in terms of the EG-ArtSchVO Nr. 338/97 (German council regulation that protects species of wild fauna and flora), as outlined in § 7 (2) No. 14 of the BNatschG (*the German Federal Nature Conservation Act*), the Crested Lark (*Galerida cristata*) was recorded. This species is of 'Least Concern' (LC) globally and regionally in Europe.
    - Two species recorded are strictly protected under the EG-ArtSchVO Nr. 338/97 (German council regulation that protects particular species of wild fauna and flora), including the Eurasian buzzard (*Buteo buteo*, LC) and Common Kestrel (*Falco tinnunculus*, LC). These species are under special protection in Germany, despite their LC threat status globally and regionally for Europe.
- Within the area surveyed near the Schleidberg Sued drill site and documented in the report '*Species protection-related initial assessment of potential drilling sites for Vulcan Energie Resources GmbH for the Project area Schleidberg Süd*' (Institut für Naturkunde in Südwestdeutschland, 2022), 81 distinct bird species were recorded. Of these, 19 species were specifically identified within the immediate planning zone. One bird species recorded is a globally threatened species with threat status of 'Vulnerable' (VU) according to IUCN, the Rook (Corvus frugilegus, VU).
    - In addition, the Northern Wheatear (*Oenanthe oenanthe,* LC) is a 'Specially Protected Fauna Species' listed in terms of Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats ('Bern Convention'). *O. oenanthe* holds the status "***threatened with extinction***" according to the Red List of Germany and the Red List of Rhineland-Palatinate. Key threats according to the IUCN are as a result of habitat change through urbanisation and agricultural intensification.
- The '*Landscape conservation support plan with integrated specialist article on species protection'* (L.A.U.B. GmbH, 2025), highlights that for the surveys from 2022 – 2024 in the survey area between the geothermal power plant Insheim to drill site Schleidberg, the following nationally/regionally threatened and strictly protected bird species were recorded (all species of LC in terms of IUCN global/European threat status): Common linnet (*Carduelis cannabina*), Eurasian Skylark (*Alauda arvensis*), House sparrow (*Passer domesticus*), Common kestrel (*Falco tinnunculus*) and Eurasian buzzard (*Buteo buteo*). Breeding sites of Common kestrel and Eurasian buzzard were only found outside of the Project footprint.
- In addition to the above-mentioned species, the '*Faunistic ecological assessment for the project area 'Landau Süd''* (Institut für Naturkunde in Süedwestdeutschland, 2025) found the following species of special conservation importance (with IUCN global/European threat

status indicated): Corn bunting (*Emberiza calandra,* LC), Eurasian green woodpecker (*Picus viridis,* LC), Northern lapwing (*Vanellus vanellus,* NT/VU), Lesser whitethroat (*Sylvia curruca,* LC), Red-backed shrike (*Lanius collurio,* LC), Eurasian golden oriole (*Oriolus oriolus,* LC), grey partridge (*Perdix perdix,* LC), Red kite (*Milvus milvus,* LC), European stonechat (*Saxicola rubicola,* LC), Common starling (*Sturnus vulgaris,* LC), European turtle-dove (*Streptopelia turtur,* VU) and the Long-eared owl (*Asio otus,* LC).

- Northern lapwing (*Vanellus vanellus*) holds the status "**strongly threatened**" according to the Red List of Germany and the status "**threatened with extinction**" according to the Red List of Rhineland-Palatinate.
- Several bird species are also protected in the EU as per their listing in Annex I of the EU Habitats Directive, including:
  - Eurasian Blackbird, *Turdus merula*
  - Common Chaffinch, *Fringilla coelebs*
  - Great Spotted Woodpecker, *Dendrocopos major*
  - Short-toed Treecreeper, *Certhia brachydactyla*
  - Grey-faced Woodpecker, *Picus canus*
  - Hen Harrier, *Circus cyaneus*
  - Red-backed Shrike, *Lanius collurio*
  - Grey Partridge, *Perdix perdix*
  - Common Woodpigeon, *Columba palumbus*
  - Western Marsh-harrier, *Circus aeruginosus*
  - Red Kite, *Milvus milvus*
  - Black Woodpecker, *Dryocopus martius*
  - Eurasian Sparrowhawk, *Accipiter nisus*
  - White Stork, *Ciconia ciconia*
  - Northern Wren, *Troglodytes troglodytes*

Mammals (bats):

- Survey findings at the Messegelände Südost D12 site (*Business Park: Messegelände-Südost)* suggest the likely presence of the Common pipistrelle (*Pipistrellus pipistrellus*, LC) amongst the bat population.
- This particular species tends to favor dwelling in human settlements and in this case, it's likely that they utilize the surrounding farmhouses and barns for summer roosts. As the farm structures are slated for preservation, it's anticipated that there won't be a loss of summer roosts. However, due to ongoing construction activities, the species may experience disturbances, and their foraging habitats may be compromised and/or reduced. Principal threats to the species according to the IUCN are associated with habitat loss due to agricultural intensification and risk of collision with vehicles.

Mammals (other):

- Species confirmed for the site based on the baseline surveys include the Hazel Dormouse (*Muscardinus avellanarius*, LC globally and in Europe) which is protected under Annex IV of the EU Habitats Directive (92/43/EEC) and is listed in terms of the German RDL as 'Endangered' at the national level. Dormouse or dormouse nests were detected on several woody structures in the search area, and this also applies to a hedge in the narrower planning area, with a concentration in the northern part near the Natura 2000 site

(Standortübungsplatz Landau) and the Messegelände Südost D12 site (*Business Park: Messegelände-Südost* (see map in Figure 4-4 showing locations of field observations of *Muscardinus avellanarius* nests associated with the Schleidberg Sued drill site (2022) and Figure 4-7 for observations in 2024 for the entire study area ('Landau Sued'). This shows observations of the Hazel Dormouse identified in the field being aligned with hedgerows and patches of remaining wooded habitat in the study area (hedges, field trees roadside vegetation and woodland associated with streams mainly), with a concentration in the northern part near the Natura 2000 site (Standortübungsplatz Landau) and the Messegelände Südost D12 site (*Business Park: Messegelände-Südost)* as well as areas in the south and east of the Project.

- The Hazel Dormouse has a broad geographical distribution across much of central, southern and eastern Europe. In the broader region of Rhineland-Palatinate, the species is widespread in all natural areas (favours near-natural and structurally rich, open forest areas and field woodlands with dense undergrowth), without any main distribution areas identified. The principal threat to the species is habitat fragmentation as a result of forestry, urbanization and agriculture (IUCN).
- At the Messegelände Südost D12 site (*Business Park: Messegelände-Südost*), European Brown Hare (*Lepus europaeus*, LC) was recorded, which is a Category 3 ("threatened" species in terms of the Germany Red Data List (i.e. *a species showing a significant population decline or one that is probably threatened by human impact*).

Herpetofauna (reptiles and amphibians):

- Within the Schleidberg drill site area and its surrounds, historical records of three distinct amphibian species exist (*Bufo bufo, Rana dalmatina and Pelophylax spp*.). It's important to note, however, that none of these species were observed within the more delimited planning region. No amphibian species were detected during surveys.
- Reptile species have been documented within the surveyed area for the Project, specifically the Sand Lizard (*Lacerta agilis*, LC globally) and the Common wall lizard (*Podarcis muralis,* LC globally) which are listed in terms of Annex IV of the EU Habitats Directive (animal and plant species of community interest in need of strict protection) and Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats ('Bern Convention') which are strictly protected fauna species. In the region (Rhineland-Palatinate), these species are widespread in all natural areas, primarily in the northern Upper Rhine River plains and in the warmer river valley areas. The principal threat to the species is habitat loss mainly because of urbanization and intensive agriculture, as well as overuse of pesticides in some regions (IUCN). See map in Figure 4-6 showing locations of field observations of *Lacerta agilis* in 2022 and Figure 4-5 showing locations of field observations of *Lacerta agilis* and *Podacris muralis* in 2024. Observations of the Sand lizard and Common wall lizard, and potential refugia identified in the field, were generally aligned with hedgerows, patches of remaining untransformed habitat and wooded vegetation along streams mainly, with a concentration in the northern part near the Natura 2000 site (Standortübungsplatz Landau) and the Messegelände Südost D12 site (*Business Park: Messegelände-Südost)*.

Invertebrates:

- The study area comprising the Messegelände Südost D12 site (*Business Park: Messegelände-Südost*) and its significance for bees has been elevated from being considered of high importance due to the presence of three bee species categorized as "highly endangered" nationally, as well as eight "endangered" bee species, to now being classified as of "very high importance".
- The assessment of the Red List in Rhineland-Palatinate might slightly overestimate the status for the Vetch Long-Horned bee (*Eucera interrupta*, LC) and the Four-banded Furrow Bee (*Halictus quadricinctus*, NT). However, the confirmed identification of the French bee (*Andrena gallica*, NT) introduces a nationally classified Red List species and category 2 (critically endangered) that bears the designation of "threatened with extinction."
- It is however important to highlight that the central areas within the study zone are generally unsuitable as habitats for the majority of these species. Instead, these species tend to inhabit the more well-structured peripheries of the area, outside of the planned development areas.

Biotopes (habitats):

According to the 'Landscape Management Plan' for the ICPP (L.A.U.B. Ingenieurgesellschaft, 2024), biotope mapping (habitats) undertaken for the Project indicate that there are no protected areas or areas designated for protection under German nature conservation law in the area of the planned pipeline.

Several biotopes were identified that reflect modified habitat types (in terms of the IFC PS6 definition of modified habitat[13]), and none of these represent natural or reference habitat types. Several are artificial habitats that include, among others: grass paths, paved farm tracks, footpaths, parking areas, unsealed storage areas with sparse vegetation, retaining walls, buildings, lawns, vineyards, orchards, gardens, residential areas, road embankments, etc.

Typical modified biotopes/habitats in the study area include:

- Bush strips
- Embankment hedges
- Groups of trees
- Embankments rich in perennials
- Orchard meadows
- Orchard pastures

[13] Modified habitats are defined in IFC PS6 as follows: "*Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands."* (IFC, 2012).

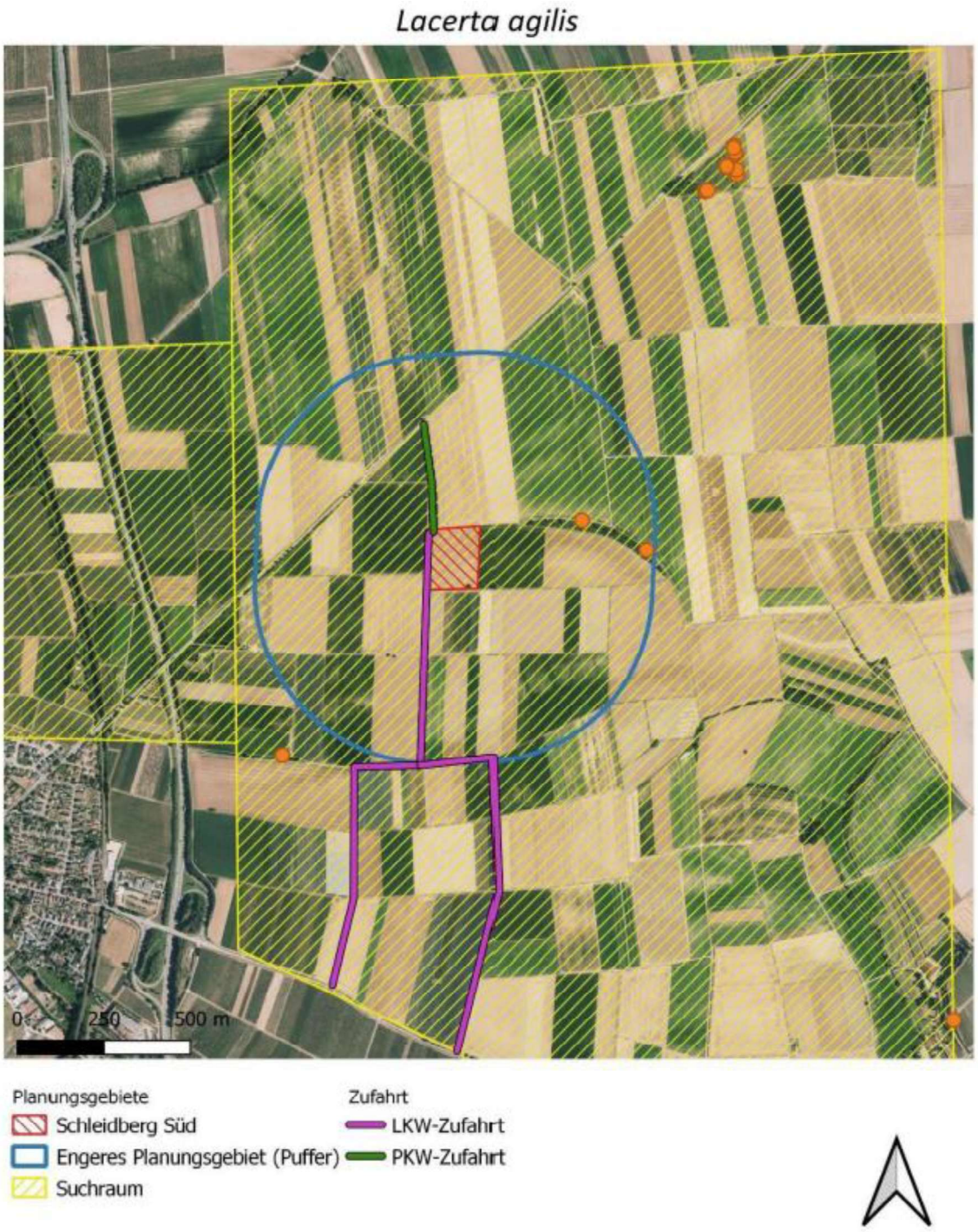


FIGURE 4-4 MAP SHOWING THE LOCATION OF SAND LIZARD (*Lacerta agilis*) OBSERVATIONS (SHOWN BY THE 'ORANGE' MARKERS) FOR THE SCHLEIDBERG SUED SITE DURING SURVEYS IN 2022

Source: Institut für Naturkunde in Südwestdeutschland (2022)

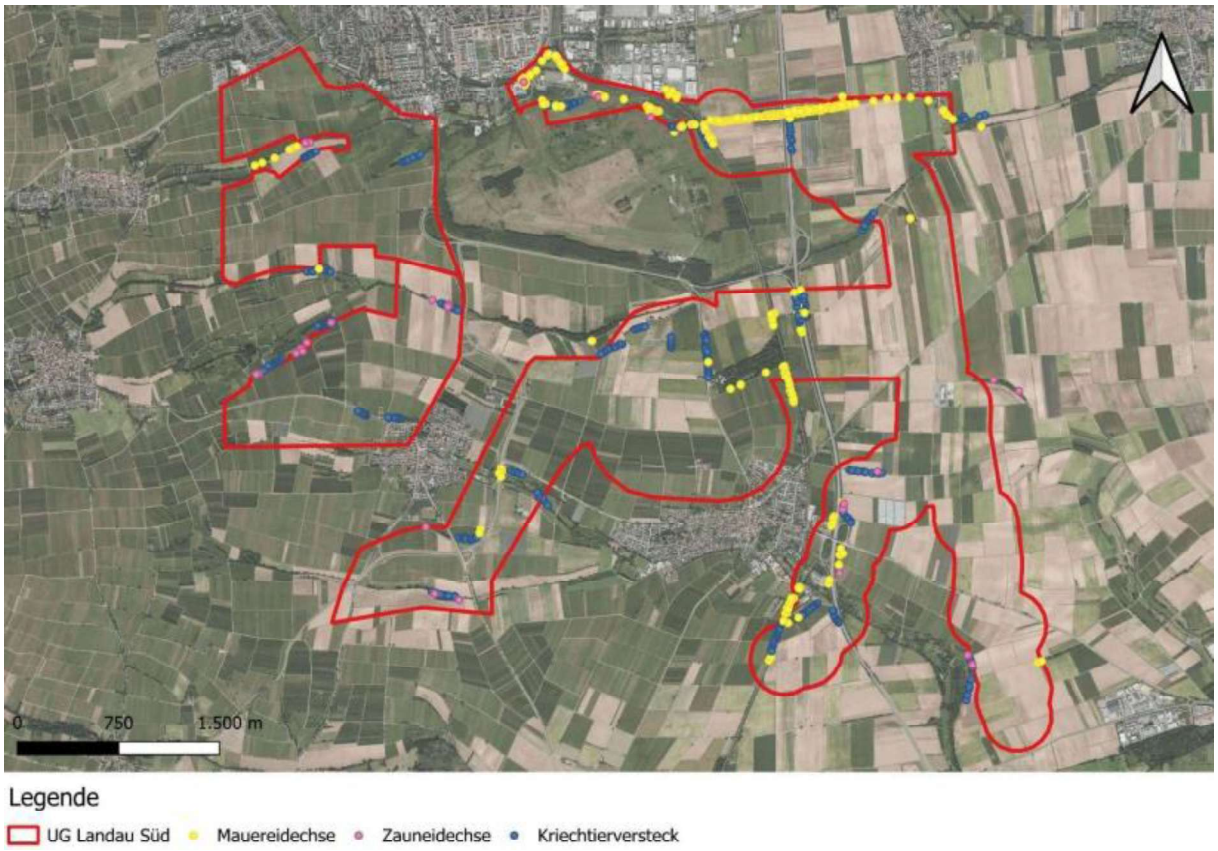


FIGURE 4-5 MAP SHOWING THE LOCATION OF SAND LIZARD (*Lacerta agilis*) (PINK MARKER POINTS) AND COMMON WALL LIZARD (*Podarcis muralis*) (YELLOW MARKERS) IN THE LANDAU SUED SURVEY AREA WITH ARTIFICIAL HIDING PLACES INDICATED BY THE BLUE MARKERS DURIG SURVEYS IN 2025.

Source: Institut für Naturkunde in Südwestdeutschland (2024)

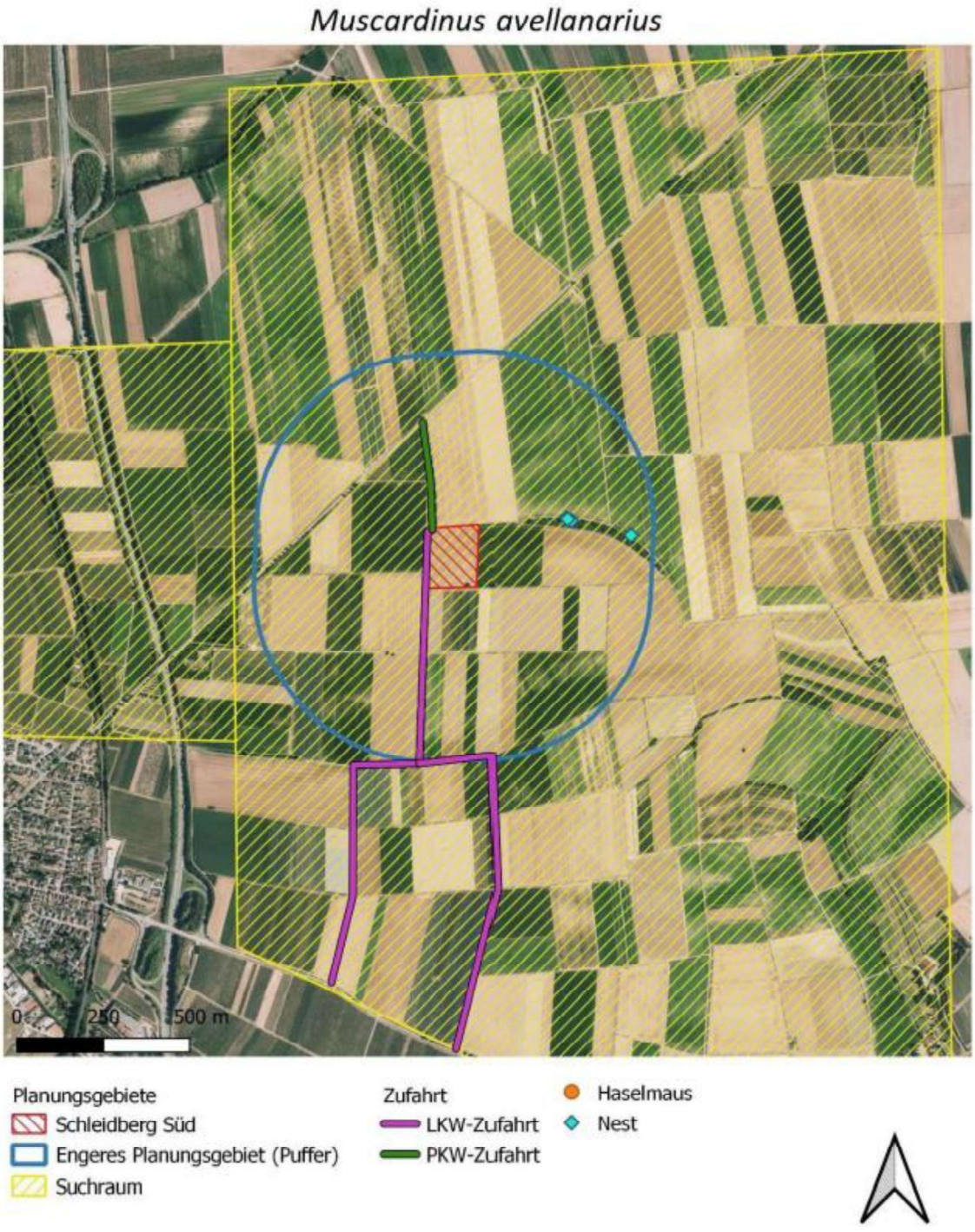


FIGURE 4-6 MAP SHOWING THE LOCATION OF HAZEL DORMOUSE (MUSCARDINUS AVELLANARIUS) NESTS (SHOWN BY THE 'TURQUOISE' MARKERS) IDENTIFIED FOR THE SCHLEIDBERG SUED SITE (2022 SURVEY)

Source: Institut für Naturkunde in Südwestdeutschland (2022)

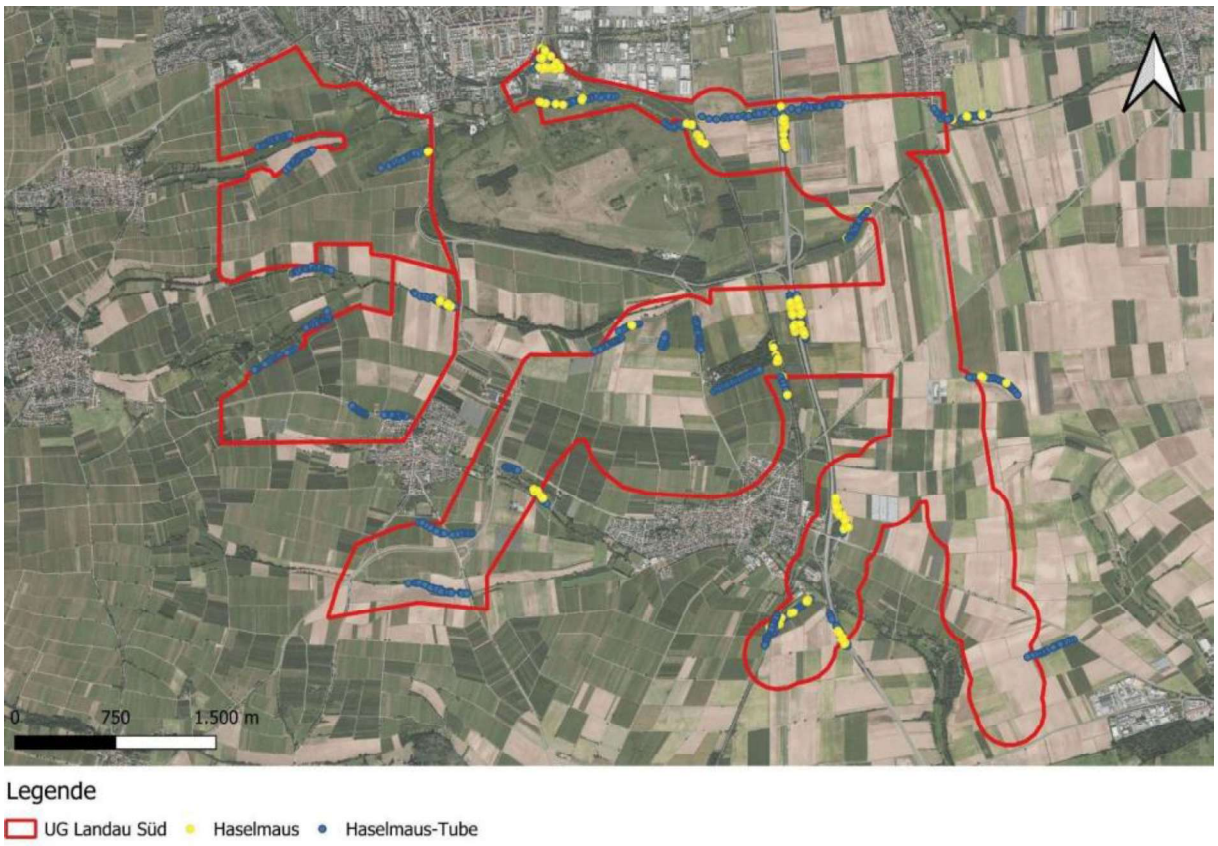


FIGURE 4-7 MAP SHOWING THE LOCATIONS OF HAZEL DORMOUSE (MUSCARDINUS AVELLANARIUS) NESTS (YELLOW MARKER POINTS) AND NEST-TUBES (BLUE) IN THE 'LANDAU SUED' SURVEY AREA (2024 SURVEY)

Source: Institut für Naturkunde in Südwestdeutschland (2025)

5. CONCLUSION

This Biodiversity Baseline Report (ERM, 2023) provides useful information on the status quo of the ecosystems, habitats, flora and fauna through a survey design which was tailored to the Project and site and which included both desktop assessment by ERM and field surveys of habitats, flora and fauna completed for the national permitting process in Germany.

The information contained in the baseline report provides a useful resource for informing the assessment of biodiversity impacts and the recommendation of mitigation measures as part of the ESIA for the Project.

The baseline also provides an important reference for future comparison during any required biomonitoring at the site for the construction and operation phases of the Project.

6. REFERENCES

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Appendix B: Rapid Critical Habitat Assessment Report

Phase One Lionheart Project

PREPARED FOR

Vulcan Energy

DATE
30 September 2025

REFERENCE
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Appendix B: Rapid Critical Habitat Assessment Report

Phase One Lionheart Project

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CONTENTS

EXECUTIVE SUMMARY		IV
1.	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	PURPOSE OF THIS DOCUMENT	1
1.3	PROJECT DESCRIPTION	1
2.	APPROACH AND METHODS	3
2.1	DELINEATE THE STUDY AREA	3
2.1.1	Study area	4
2.2	REVIEW AND VERIFICATION OF AVAILABLE INFORMATION	6
2.3	ASSESS BIODIVERSITY VALUES AGAINST IFC CRITICAL HABITAT CRITERIA	7
2.3.1	Apply critical habitat criteria and tresholds	7
2.4	UNDERTAKE FIELD SURVEYS TO VERIFY POTENTIAL HIGH PRIORITY SPECIES	9
2.5	IDENTIFY NATURAL HABITAT AND MODIFIED HABITAT	10
3.	FINDINGS OF THE CRITICAL HABITAT ASSESSMENT	14
3.1	CRITERIA 1-3 (SPECIES)	14
4.	IMPLICATIONS FOR THE PROJECT	24
4.1	NATURAL HABITAT	24
4.2	CRITICAL HABITAT	25
5.	CONCLUSION	26
6.	REFERENCES	27

LIST OF TABLES

TABLE 2-1	CRITICAL HABITAT QUALIFYING CRITERIA ACCORDING TO IFC PS6	8
TABLE 3-1	GENERIC MATRIX USED TO ESTIMATE SPECIES POTENTIAL OCCURRENCE BASED ON DOCUMENTED HABITAT PREFERENCES AND SPECIES DISTRIBUTIONS.	14
TABLE 3-2	POTENTIAL CRITICAL HABITAT-QUALIFYING SPECIES ASSESSED FOR THE STUDY AREA	15

LIST OF FIGURES

FIGURE 1-1	PHASE ONE PROJECT LAYOUT: LANDAU PROJECT COMPONENTS.	2
FIGURE 1-2	CENTRAL LITHIUM PLANT (CLP) AT THE INDUSTRIAL PARK HOECHST.	3
FIGURE 2-1	CHA STUDY AREA FOR PROJECT COMPONENTS NEAR LANDAU.	5
FIGURE 2-2	CLP AT HOECHST INDUSTRIAL PARK RELATIVE TO PROTECTED AREAS AND 'NATURAL' HABITATS ASSOCIATED WITH NATURA 2000 SITES.	6
FIGURE 2-3	LAND USE MAP FOR THE STUDY AREA	11
FIGURE 2-4	MAP SHOWING THE NATURA 2000 SITE: STANDORTÜBUNGSPLATZ LANDAU	12
FIGURE 2-5	MAP SHOWING THE NATURA 2000 SITE: ERLENBACH UND KLINGBACH	13

ACRONYMS AND ABBREVIATIONS

Acronyms	Description
AoI	Area of Influence
AZE	Alliance for Zero Extinction
BNatSchG	Bundesnaturschutzgesetz
CR	Critically Endangered (IUCN Red Data List Threat Status)
CLP	Central Lithium Plant
DD	Data Deficient (IUCN Red Data List Threat Status)
EN	Endangered (IUCN Red Data List Threat Status)
ERM	Environmental Resource Management GmbH
EIA	Environmental Impact Assessment
E&S	Environmental & Social
ES	Ecosystem Services
ESIA	Environmental and Social Impact Assessment
ESDD	Environmental and Social Due Diligence
FFH	Flora-Fauna Habitat
GIS	Geographical Information System
IBA	Important Bird & Biodiversity Area
IBAT	Integrated Biodiversity Assessment Tool
IFC	International Finance Corporation
IUCN	International Union for the Conservation of Nature
KBA	Key Biodiversity Area
LC	Least Concern (IUCN Red Data List Threat Status)
GLEP	Geothermal Lithium Extraction Plant
NT	Near Threatened (IUCN Red Data List Threat Status)

Acronyms	Description
PA	Protected Area
PS	Performance Standard (IFC)
SCA	Special Conservation Area
SCC	Species of Conservation Concern
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VU	Vulnerable (IUCN Red Data List Threat Status)
WWF	World-Wide Fund for Nature

EXECUTIVE SUMMARY

The Critical Habitat Assessment (CHA) undertaken for the Vulcan Energy Phase One Lionhear Project™' in Rhineland-Palatinate, Germany, considered the five Critical Habitat qualifying criteria and associated thresholds of IFC PS6 (Performance Standard 6) '*Biodiversity Conservation and Sustainable Management of Living Natural Resources'*. The approach to the CHA was as follows:

- A preliminary review of information on the region's ecology was carried out to define the 'Study Area' for the CHA to determine the presence of each species or ecosystem that regularly occurs in the Project's 'Area of Influence' (AoI) that may qualify as Critical Habitat. An AoI of 250 m around the Project activities was adopted, including the pipeline and access roads, worker camps etc. For the drill sites and the operation of the drilling rigs, a 500 m AoI has been adopted.
- A desk-based review of available information on the biodiversity features within the study area was undertaken to inform the CHA. A list of biodiversity features (i.e. species, KBAs, and PAs), potentially present in the study area was compiled from a spatial analysis of global datasets available through the Integrated Biodiversity Assessment Tool (IBAT).
- The biodiversity features likely to occur within the study area were screened against the five (5) criteria defined in terms of IFC PS6 Guidance Note 6 (IFC, 2019):

  Criterion 1: Habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species

  Criterion 2: Habitat of significant importance to endemic and/or restricted-range species

  Criterion 3: Habitat supporting globally significant concentrations of migratory species and/or congregatory species

  Criterion 4: Highly threatened and/or unique ecosystems

  Criterion 5: Areas associated with key evolutionary processes

The key findings of the CHA are:

- There are no endemic or restricted-range, migratory or congregatory species that trigger Critical Habitat and that the study area does not meet the criteria for areas associated with key evolutionary processes.
- However, it was determined that the two Natura 2000 sites 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach' as highly threatened and/or unique ecosystems qualify as Critical Habitat according to criterion 4.
- The Project has no direct footprint in either of the sites. The 'Standortübungsplatz Landau' is located roughly 50 m from the planned pipeline alignment from the existing Geox geothermal plant to the planned GLEP, and approximately 100 m from the GLEP planned near Landau. Erlenbach und Klingbach' is located within 500m of the drill site at 40 Morgen. Due to its close proximity to the Project's footprint, especially the Standortübungsplatz Landau might be affected by indirect impacts, such as noise or vibration nuisance effects to fauna of conservation importance located within the Natura 2000 site.

- The requirements of IFC PS6 will apply, prohibiting any adverse impacts on the Critical Habitat. The Project will have to implement appropriate mitigation measures that are to be specified in the ESIA. Whilst no direct impact to critical habitat is likely to take place, potential indirect impacts will need to be managed appropriately so as not to impact on the critical habitat qualifying features/habitats (namely disturbance caused by possible dust/noise/light/vibration).
- This is also aligned with the German permitting requirements concerning Natura 2000 sites, that requires appropriate mitigation measures to ensure no negative impacts on Natura 2000 sites and their conservation objectives occur.
- Other parts of the study area and associated habitats do not qualify as Critical Habitat, as the criteria and thresholds have not been met. Whilst the Crested Lark, Northern Wheatear, Grey Partridge, Whinchat and European Turtle Dove were found to not qualify the study area habitats as Critical Habitat, they are still important biodiversity features given their threat status and their strict protection under European Union and German law. It is therefore recommended that an ecologically appropriate and species-specific mitigation approach be considered in the ESIA. This may entail construction restrictions during breeding times to avoid disturbance as well as measures to prevent ground breeding species to start breeding within construction sites, and these measures will be detailed further in the main ESIA report

1. INTRODUCTION

1.1 BACKGROUND

ERM Environmental Resources Management (ERM GmbH) Germany, was contracted by Vulcan Energy Resources Limited (hereinafter referred to as Vulcan or the Company) to undertake an Environmental and Social Impact Assessment ("ESIA") for Phase I of the Lionheart Project (hereinafter called the Project), in accordance with international Lender's requirements, namely the Performance Standards (PS) of the International Finance Corporation (IFC).

With respect to biodiversity[1], IFC PS6 covering biodiversity and ecosystems, applies to the ESIA and a separate Critical Habitat[2] Assessment (CHA) report has been compiled (this document) to inform the biodiversity baseline assessment and impact assessment components of the ESIA.

1.2 PURPOSE OF THIS DOCUMENT

This report presents the Critical Habitat Assessment (CHA) for the Project. The CHA has been prepared in support of the Project's alignment with the applicable international standards, which include those of the International Finance Corporation (IFC).

This CHA aims to:

- Carry out an assessment of biodiversity features in accordance with paragraphs 13-19, and associated guidance notes, of IFC PS6 (Performance Standard 6, 2012);
- Present the implications of the CHA findings for the Project; and
- Identify the recommended next steps for the Project.

1.3 PROJECT DESCRIPTION

The first phase of the Project is called "Phase I Lionheart Project": Lithium production and renewable geothermal energy production will take place in the Upper Rhine Valley Brine Field in Rhineland-Palatinate, whereas lithium conversion will take place at the Frankfurt Hoechst Industrial Park. The Project aims to combine the production of renewable energy with lithium extraction from the same deep brine source.

The Project is mainly centered around the Geothermal Lithium Production Plant (GLEP) that is planned to be built in the southeast of Landau (Figure 1-1) within a new industrial park, D12 - Gewerbepark Messegelände Süd-Ost. The GLEP will produce heat, power, and lithium chloride from brine. The lithium chloride generated at GLEP will be transported via E-Trucks/train to the

[1] The term 'biodiversity' refers to the variety of plant and animal life on earth, encompassing ecosystems, habitats and species, and includes diversity within species, between species and of ecosystems. Biodiversity and ecosystems are covered in IFC PS6: '*Biodiversity Conservation and Sustainable Management of Living Natural Resources'* which recognises that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development (IFC, 2012).

[2] Critical Habitat subject to this CHA is defined in paragraph 16 of IFC PS6 as follows. "*Critical Habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes*" (IFC, 2012).

Central Lithium Plant (CLP), which will be constructed at the Industrial Park Hoechst (Figure 1-2). At the CLP, lithium chloride will be converted to lithium hydroxide monohydrate.

For a detailed description of the Project location, the reader is referred to the main ESIA report (ERM, 2025).

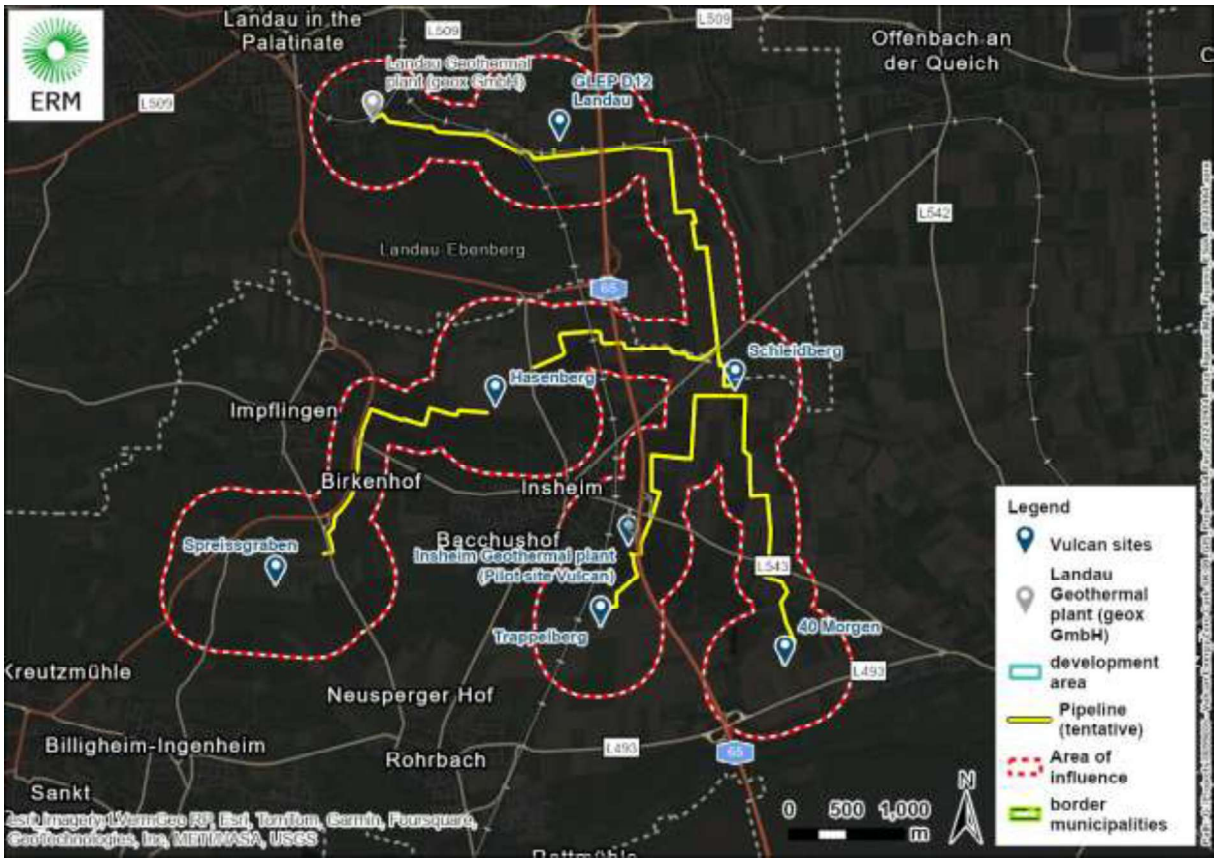


FIGURE 1-1 PHASE ONE PROJECT LAYOUT: LANDAU PROJECT COMPONENTS.

Source: ERM, using Vulcan's data



FIGURE 1-2 CENTRAL LITHIUM PLANT (CLP) AT THE INDUSTRIAL PARK HOECHST.

Source: ERM, using Vulcan data

2. APPROACH AND METHODS

2.1 DELINEATE THE STUDY AREA

A preliminary review of information on the region's ecology was carried out to define the 'Study Area' for the CHA to determine the presence of each species or ecosystem that regularly occurs in the Project's 'Area of Influence' (AoI) that may qualify as Critical Habitat. Delineating the study area requires consideration of: (i) the likely geographic area or extent of anticipated project activities and impacts; (ii) the full extent of ecosystems that might be affected in any way; and (iii) any additional areas that have a functional role in supporting those ecosystems or their associated biodiversity.

The spatial scope should be ecologically determined and defined, encompassing wider distributions of potentially affected biodiversity features and the ecological patterns, processes, and functions that are necessary for maintaining them throughout this distribution. The study area for the CHA can typically extend well beyond a Project's physical footprint and are usually anticipated to be greater than the AoI while taking into account individual species ecology. It is nevertheless permissible to have a study area that captures a number of species or to have a series of areas depending on ecosystem or ecological factors.

2.1.1 STUDY AREA

It is considered appropriate that the AoI for the Project encompass the direct footprint of the Project infrastructure based on the preliminary layout as well as all temporary work areas (such as camp sites, equipment laydown areas, soil/material borrow pits, stockpile areas and any dump sites). This will cover impacts to habitat and vegetation (including any threatened plant species) as well as direct impacts to fauna and glint and glare effect related impact on avifauna, aviation, and local population.

Furthermore, it is recommended that the AoI also considers the potential for indirect impacts such as visual, noise and vibration disturbance to fauna (wildlife) and in this case the literature reviewed (such as Kwon et al., 2018), suggests there is a strong possibility that species could be disturbed by noise up to a radius of approximately 250 m from the construction site, and outside of the 250m, noise level from construction should have been attenuated to background noise levels.

Based on these considerations it is therefore recommended that the AoI should be extended to encompass the terrestrial habitats situated at a minimum distance of 250 m from the Project activities including the pipeline and access roads, worker camps, etc. As noise and vibration from construction of the GLEP and CLP and drill sites, and the operation of the drilling rigs themselves, is likely to be more intense and frequent, a distance of 500 m from the CLEP and CLP and the drilling sites has been proposed, conservatively. This is also informed by the results of noise modelling for the Project. For more details on the AoI please refer to the biodiversity section in the ESIA (ERM, 2023).

The CLP will be built inside the Industrial Park Hoechst in Frankfurt/Main that hosts 120 production plants of 90 companies and 22,000 workers in total as of 2023. It has been operated since 1863. The 500 m AoI lies exclusively within the borders of the industrial park that contains highly modified and artificial areas under industrial development and does not interact with natural habitat areas associated with protected areas for example (see Figure 2-2). Due to the industrial character of the AoI none of the Critical Habitat criteria apply here (see Table 2-1).

Therefore, the CLP at Hoechst was not considered further in the CHA.

The study area is presented on the map in Figure 2-1.



FIGURE 2-1 CHA STUDY AREA FOR PROJECT COMPONENTS NEAR LANDAU.

Source: ERM, using Vulcan data

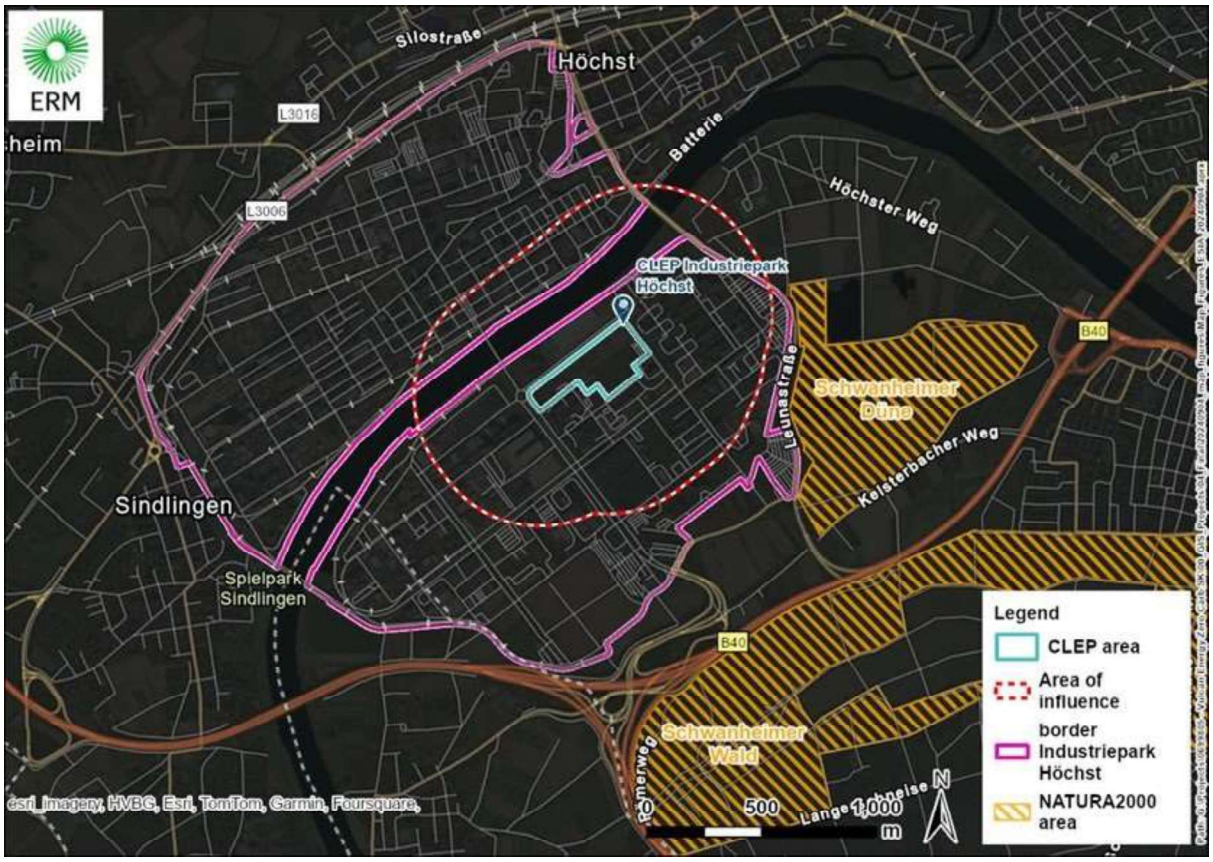


FIGURE 2-2 CLP AT HOECHST INDUSTRIAL PARK RELATIVE TO PROTECTED AREAS AND 'NATURAL' HABITATS ASSOCIATED WITH NATURA 2000 SITES.

Source: ERM, using Vulcan data

2.2 REVIEW AND VERIFICATION OF AVAILABLE INFORMATION

A desk-based review of available information on the biodiversity features within the study area was undertaken to inform the CHA. This included a review of global biodiversity datasets, project-specific biodiversity information, and published and publicly available information (as needed).

A list of biodiversity features (i.e. species, KBAs, and PAs), potentially present in the study area was compiled from a spatial analysis of global datasets available through the Integrated Biodiversity Assessment Tool (IBAT). IBAT is a tool that draws from the IUCN (International Union for Conservation of Nature) Red List of Threatened Species, KBAs, and The World Database on Protected Areas.

Project biodiversity information was also reviewed to support the identification of biodiversity that may qualify the area as Critical Habitat and natural habitat. This included the following sources of information:

- Previous surveys conducted between 2018 and 2025 to inform the national permitting process for the Project in Germany:
  'Artenschutzfachliche Ersteinschätzung potenzieller Bohrungsstandorte Vulcan Energie

Ressourcen GmbH Projektgebiet Schleidberg Süd' - compiled by the Institut für Naturkunde in Südwestdeutschland (November 2022).
[English translation: 'Species protection-related initial assessment of potential drilling sites for Vulcan Energie Ressourcen GmbH for the Project area Schleidberg Süd']

- 'Landschaftspflegerischer Begleitplan gemäß § 17 BNatSchG Errichtung des Bohrplatzes „Schleidberg" durch die Vulcan Energie Ressourcen GmbH' – compiled by the Institut für Naturkunde in Südwestdeutschland (May 2023).
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- 'Bauabschnitt 1 Geothermiekraftwerk Insheim bis Bohrplatz Schleidberg – Landschaftspflegerischer Begleitplan mit integrierter Prüfung artenschutzrechtlicher Belange' compiled by L.A.U.B. – Ingenieurgesellschaft mbH (November 2024).
  [English translation: 'Construction section 1 geothermal power plant Insheim to drill side Schleidberg - Landscape conservation support plan with integrated specialist article on species protection']

2.3 ASSESS BIODIVERSITY VALUES AGAINST IFC CRITICAL HABITAT CRITERIA

2.3.1 APPLY CRITICAL HABITAT CRITERIA AND TRESHOLDS

The biodiversity features likely to occur within the study area were screened against the five (5) criteria defined in terms of IFC PS6 Guidance Note 6 (IFC, 2019):

- **Criterion 1:** Habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species
- **Criterion 2:** Habitat of significant importance to endemic and/or restricted-range species
- **Criterion 3**: Habitat supporting globally significant concentrations of migratory species and/or congregatory species
- **Criterion 4**: Highly threatened and/or unique ecosystems
- **Criterion 5:** Areas associated with key evolutionary processes

The screening process was further informed by additional guidance provided in GN69 to GN97 of the IFC Guidance Note (GN) 6: 'Biodiversity Conservation and Sustainable Management of Living Natural Resources' (2019).

The five criteria are essentially 'triggers' in that if an area of habitat meets any one of the qualifying criteria and is within the defined thresholds (see Table 2-1), it will be considered Critical Habitat irrespective of failing to meet any other criterion. The Critical Habitat criteria therefore have two distinctive characteristics:

- firstly, components of biodiversity are essentially assigned to only two levels of conservation significance, those that trigger Critical Habitat and those that do not; and
- secondly, each criterion is applied separately and not in combination, meaning that the scores are not cumulative, such that a species may be screened in more than one criterion [e.g. a Critically Endangered (CR) species that is also endemic or restricted in terms of range].

In the absence of reliable population data, proxies such as the proportion of a species' distribution in the area, have been used to inform the Critical Habitat determination for criteria 1-3. Appropriate population surrogates including Extent of Occurrence (EOO), range, or known sites of occurrence (mainly derived from the IUCN Red List data), were used to determine significance with respect to the global population (see IFC, 2019: Guidance Note 77). Expert opinion and professional knowledge were sought to inform a reasonable judgement of potential significance where possible. Where there is uncertainty about the population, range and distribution of potentially occurring biodiversity features within the study area, a precautionary approach has been applied, and the feature is retained for further assessment.

TABLE 2-1 CRITICAL HABITAT QUALIFYING CRITERIA ACCORDING TO IFC PS6

IFC PS6 Critical Habitat Criteria and Thresholds	
Criteria	**Thresholds**
Criterion 1: Habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species.	(a) Areas that support globally-important concentrations of an IUCN Red-listed EN or CR species (0.5 % of the global population AND 5 reproductive units of a CR or EN species); (b) Areas that support globally-important concentrations of an IUCN Red-listed VU species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in (a). (c) As appropriate, areas containing nationally/regionally-important concentrations of an IUCN Red-listed EN or CR species.
Criterion 2: Habitat of significant importance to endemic[3] and/or restricted-range species.	(a) Areas that regularly hold ≥ 10 % of the global population size AND ≥ 10 reproductive units of a species.
Criterion 3: Habitat supporting globally significant concentrations of migratory[4] species	(a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 % of the global population of a migratory or congregatory species at any point of the species' lifecycle. (b) Areas that predictably support ≥ 10 % of the global population of a species during periods of environmental stress.

3 In terms of IFC PS6 GN6 (2019), the term 'endemic' is defined as restricted-range, which refers to a limited extent of occurrence (EOO) for a particular species. For terrestrial vertebrates and plants, restricted-range species are defined as those species that have an EOO less than 50,000 km2 (IFC, 2019).

4 Migratory species are defined as any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem) (IFC, 2019).

IFC PS6 Critical Habitat Criteria and Thresholds	
Criteria	**Thresholds**
and/or congregatory[5] species.	
Criterion 4: Highly threatened and/or unique ecosystems6.	(a) Areas representing ≥ 5 % of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN. (b) Other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.
Criterion 5: Areas associated with key evolutionary processes[7].	No set thresholds.
Additional: IFC PS6, para. 20: In circumstances where a proposed Project is located within a legally protected area or an internationally recognised area, the client will meet the requirements of para. 13-19 of the PS, as applicable (i.e. paragraphs related to natural, modified and Critical Habitats determination and management).	*Legally protected area: IFC PS6 recognises legally protected areas that meet the IUCN definition: "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." This includes areas proposed by governments for such designation.* *Internationally recognised area: IFC PS6 recognises internationally recognised areas as being "Exclusively defined as UNESCO Natural World Heritage Sites, UNESCO Man and the Biosphere Reserves, Key Biodiversity Areas, and wetlands designated under the Convention on Wetlands of International Importance (the Ramsar Convention)".*

Source: ERM, adapted from IFC (2012)

2.4 UNDERTAKE FIELD SURVEYS TO VERIFY POTENTIAL HIGH PRIORITY SPECIES

Existing biodiversity baseline field surveys for parts of the study area were used to further verify the presence, distribution and/or abundance of the potential high priority species that were initially screened based on desk-based information, expert consultation and opinion, and professional knowledge (refer to section 2.2).

[5] Congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis (IFC, 2019).

[6] Unique ecosystems encompass those natural systems and environments that are considered to be rare or one-of-a-kind and therefore not widely represented (depending on what scale these are assessed) and therefore may be considered to be of inherently great conservation importance and high irreplaceability value. What makes an ecosystem unique is somewhat open to interpretation but typically requires a multi-faceted assessment of several supporting criteria (IFC, 2019).

[7] Key evolutionary processes that give rise to regional configurations of species and ecological properties can be influenced by the structural attributes of a region, such as its topography, geology, soil, temperature, and vegetation, and combinations of these variables (IFC, 2019).

2.5 IDENTIFY NATURAL HABITAT AND MODIFIED HABITAT

All construction work and infrastructure associated with the Project near Landau and Insheim will be located within areas of **modified habitat**[8], which is consistent with the definition of IFC PS6 due to primary ecological functions and species composition for these habitats having been substantially modified such that these no longer represent the natural habitat type. These areas include industrial zones, cultivated lands (for the farming of maize, fruit and vineyards for the production of grapes to make wine), as well as existing roads and open spaces with secondary vegetation and habitats (Figure 2-3).

Based on biotope (habitat) mapping undertaken for the Project, typical modified biotopes/habitats in the study area include:

- Bush strips
- Embankment hedges
- Groups of trees
- Embankments rich in perennials
- Orchard meadows
- Orchard pastures

In ERMs opinion, these modified habitats are considered to be of little to no biodiversity value or importance. Based on the Report '*Landschaftspflegerischer Begleitplan gemäß § 17 BNatSchG - Errichtung des Bohrplatzes „Schleidberg"durch die Vulcan Energie Ressourcen GmbH'* [*English translation: 'Landscape conservation support plan in accordance with § 17 BNatSchG for the Construction of the "Schleidberg" drilling site by Vulcan Energie Resources GmbH']*, according to LANIS (state database of the RLP nature conservation administration), there are *no legally protected habitats* according to § 30 BNatSchG in the planned infrastructure development area and its immediate surroundings.

Within the AoI of the Project, the only **natural habitat**[9] remaining near Landau is associated with the Natura 2000 sites: 'Standortübungsplatz Landau' in the north and 'Erlenbach und Klingbach' in the south. 'Standortübungsplatz Landau' is located roughly 50 m from the planned pipeline alignment from the existing Geox geothermal plant to the planned GLEP (Figure 2-4)., and approximately 100 m from the GLEP planned near Landau. Erlenbach und Klingbach' is located within 500 m of the drill site at 40 Morgen (Figure 2-5). These sites contain habitat types that are all listed in terms of Annex I of the EU Habitats Directive which considers '*Natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation (SACs)'.* All these habitats are also listed according to Revised Annex I to Resolution 4 of the Bern Convention as endangered natural habitat types.

[8] Modified habitat is defined in terms of IFC PS6 as follows: *"Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed6 coastal zones, and reclaimed wetlands."* – IFC (2012).

[9] Natural habitat is defined in terms of IFC PS6 as follows: *"Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition."* – IFC (2012).

Most notable for 'Standortübungsplatz Landau' are the xero-thermic (dry/hot) grassland habitats that are considered important for endangered flora and fauna:

- 6210: Semi-natural dry grasslands and scrubland facies on calcareous substrates; and
- 6510: Extensive hay meadows of the planar to submontane stage.

For 'Erlenbach und Klingbach' important habitats are:

- 3150: Natural eutrophic lakes with Magnopotamion or Hydrocharition -type vegetation;
- 6430: Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels; and
- 6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*).

For more detailed information please refer to the biodiversity baseline assessment report (ERM, 2025).

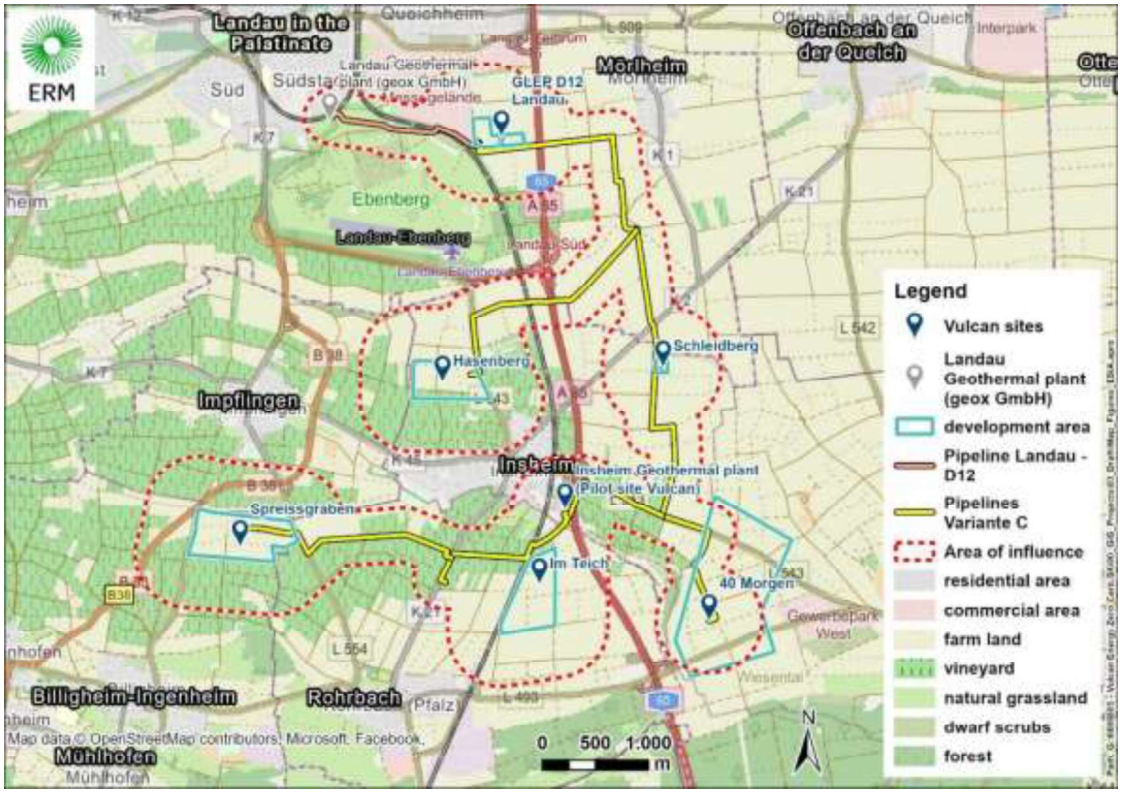


FIGURE 2-3 LAND USE MAP FOR THE STUDY AREA

Data sources: Vulcan data, land use



FIGURE 2-4 MAP SHOWING THE NATURA 2000 SITE: STANDORTÜBUNGSPLATZ LANDAU

Data sources: Vulcan data, Natura 2000 sites

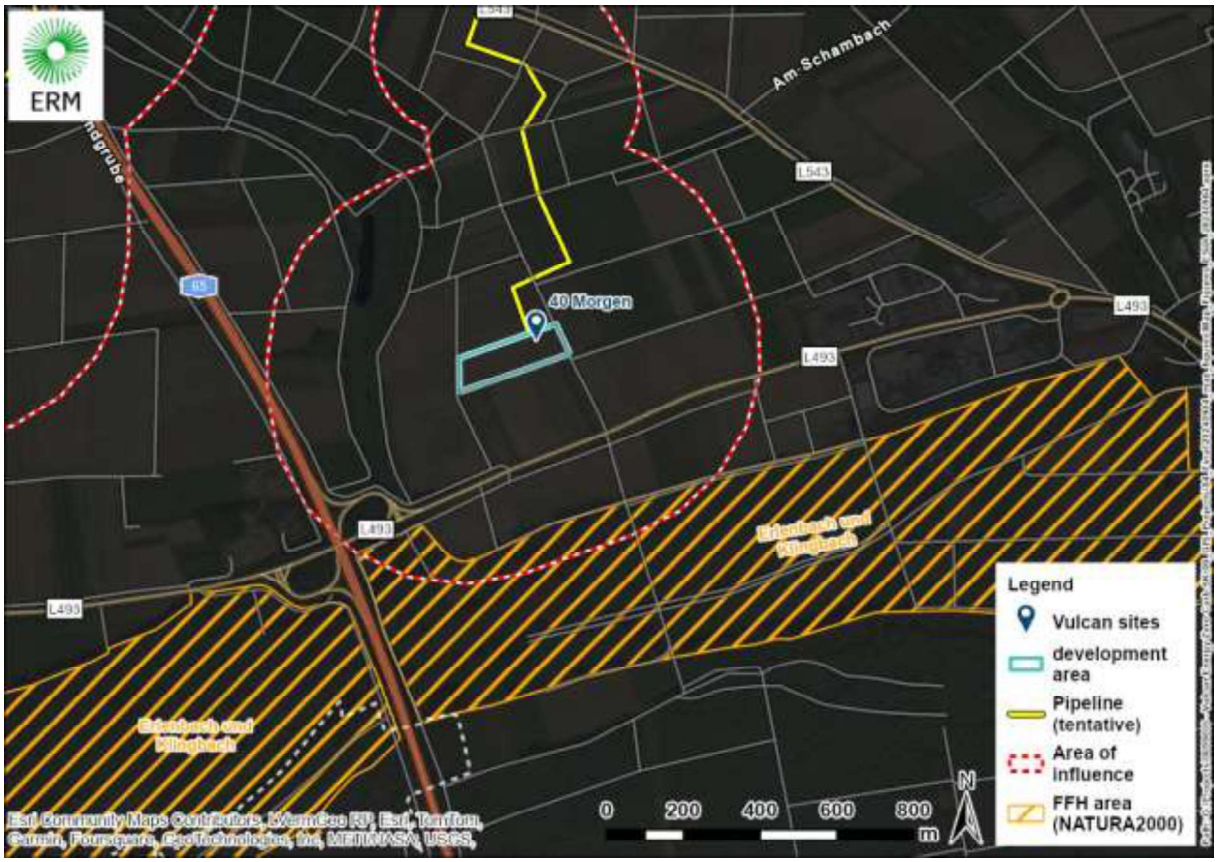


FIGURE 2-5 MAP SHOWING THE NATURA 2000 SITE: ERLENBACH UND KLINGBACH

Data sources: Vulcan data, Natura 2000 sites

3. FINDINGS OF THE CRITICAL HABITAT ASSESSMENT

3.1 CRITERIA 1-3 (SPECIES)

Criteria 1-3 deal primarily with species that are of conservation importance or concern (i.e. CR/EN status, endemic or restricted-range species, migratory species and significant concentrations of congregatory species), the presence of which may typically qualify habitats as 'Critical Habitat'.

Initially, species potential occurrence (or likelihood of occurrence) was assessed at a desktop level based on available information and supplemented by the findings of already existing biodiversity baseline studies (refer to the relevant chapter of the supplementary ESIA). The habitat requirements/preferences for each plant/animal species of conservation concern were reviewed (based on the available literature) and was then compared against the known species distributions and habitat types documented for the study area in order to estimate the potential occurrence of each priority species identified, using the matrix below in Table 3-1.

TABLE 3-1 GENERIC MATRIX USED TO ESTIMATE SPECIES POTENTIAL OCCURRENCE BASED ON DOCUMENTED HABITAT PREFERENCES AND SPECIES DISTRIBUTIONS.

		SPECIES HABITAT REQUIREMENTS / PREFERENCES		
		Fully met	Largely met	Not met / Unsuitable
SPECIES DISTRI-BUTION	Habitat occurs within documented species geographical/altitudinal range	Highly likely	Likely	Unlikely
	Habitat occurs on the edge of documented species geographical/altitudinal range	Possible	Possible	Unlikely
	Habitat occurs outside of documented species geographical/altitudinal range	Unlikely	Unlikely	Highly unlikely or Improbable

Table 3-2 provides a summary of the candidate Critical Habitat-qualifying species of fauna, which includes a combined list of species that potentially qualify the study area as Critical Habitat and which were considered in the assessment. This assessment focused on CR/EN species confirmed or likely to be potentially present in the study area (criterion 1) based on existing faunal baseline studies, the use of IBAT (Integrated Biodiversity Assessment Tool) and priority species included in datasheets / fact sheets for Natura 2000 sites.

Species listed as vulnerable (VU) were not taken further into the assessment. Given the generally low footprint of the Project on predominantly modified habitat, it is highly unlikely that the status of these species would decrease to CR/EN on a global level and that criterion 1b will be triggered (see Table 2-1). With regards to endemic and restricted-range species (criterion 2), no species were identified that qualify.

The study area is not known to support significant concentrations of migratory and/or congregatory species. No IBA and/or N2000-site designated for migratory birds is situated in the study area. Therefore, criterion 3 will not be triggered.

TABLE 3-2 POTENTIAL CRITICAL HABITAT-QUALIFYING SPECIES ASSESSED FOR THE STUDY AREA

S/N	Common Name	Scientific Name	Status	Potential Occurrence in the Study Area	Potential Critical Habitat Qualifying Criteria (IFC) Triggered	Associated Habitat (IUCN)	Habitat in CHA study area suitable?
Birds							
1	Crested Lark	*Galerida cristata*	LC (IUCN), CR (GER)	Confirmed	1, 3	Dry plains with sparse vegetation cover and dry cultivations.	Yes
2	Northern Wheatear	*Oenanthe oenanthe*	LC (IUCN), CR (GER)	Likely	1, 3	Extensively managed grasslands.	Yes
3	Grey Partridge	*Perdix perdix*	LC (IUCN), EN (GER)	Confirmed	1	Open, low-intensity mixed farmland and grasslands with small fields and hedges on grassy banks	Yes
4	Whinchat	*Saxicola rubetra*	LC (IUCN), EN (GER)	Likely	1, 3	Wet meadows, pastures, bogs, upland grassland, bracken-covered hillsides, heath, dry or wet open scrub and the fringes of reedbeds. Requires shattered shrubs, trees or perches.	Yes
5	European Turtle-dove	*Streptopelia turtur*	VU (IUCN), EN (GER)	Likely	1, 3	The species uses a wide variety of woodland types, as well as steppe and semi-desert, frequently relying on agricultural land for feeding.	Yes
Bats							
Not applicable - no CR, EN, endemic or restricted-range species identified in the study area							
Mammals							
Not applicable - no CR, EN, endemic or restricted-range species identified in the study area							

S/N	Common Name	Scientific Name	Status	Potential Occurrence in the Study Area	Potential Critical Habitat Qualifying Criteria (IFC) Triggered	Associated Habitat (IUCN)	Habitat in CHA study area suitable?
Herpetofauna: Reptiles & Amphibians							
Not applicable - no CR, EN, endemic or restricted-range species identified in the study area							
Fish							
1	European Eel	*Anguilla anguilla*	CR (IUCN), EN (GER)	Unlikely	1, 3	Found in a range of habitats from small streams to large rivers and lakes, and in estuaries, lagoons and coastal waters.	No
Invertebrates							
1	Brown-horned glow worm	*Ampedus brunnicornis*	VU (IUCN), CR (GER)	Unlikely	1	Scattered in broad-leaved and mixed forests of lowlands and highlands.	No
2	Black Mud Beetle	*Cerophytum elateroides*	VU (IUCN), CR (GER	Unlikely	1	Found in open forests, in old parks. Old forest relict and high-quality forest indicator.	No
3	German Tiger Beetle	*Cicindela germanica*	LC (IUCN), EN (GER)	Likely	1	Steppe, grasslands.	Yes
4	Helmeted Azure Damsel/Southern Damselfly	*Coenagrion mercuriale*	NT (IUCN), EN (GER)	Likely	1	Small headwater brooks and spring areas.	Yes
5	Darkling Beetle	*Corticeus bicoloroides*	VU (IUCN), CR (GER	Unlikely	1	Old to very old hollow broad leaf trees. Old growth forests.	No

S/N	Common Name	Scientific Name	Status	Potential Occurrence in the Study Area	Potential Critical Habitat Qualifying Criteria (IFC) Triggered	Associated Habitat (IUCN)	Habitat in CHA study area suitable?
6	Violet Click Beetle	*Limoniscus violaceus*	VU (IUCN), CR (GER	Unlikely	1	Hollow trees in old woodland.	No
7	Large Copper	*Lycaena dispar*	LC (IUCN), EN (GER)	Likely	1	Marshy habitats and on the peaty banks of lakes, rivers and streams.	Yes
8	Bright Meadow Blue	*Maculinea teleius*	NT (IUCN), EN (GER)	Likely	1	Marshy habitats with *Sanguisorba officinalis*.	Yes
9	Pygmy Damselfly	*Nehalennia speciosa*	NT (IUCN), CR (GER)	Unlikely	1	Small mire lakes and pools bordered by Sphagnum, transition-mires, fens, and peat bogs.	No
10	Almblombock	*Pedostrangalia revestita*	VU (IUCN), EN (GER)	Unlikely	1	Large old broadleaf trees.	No
Flora: Plants & Fungi							
1	Oak Polypore	*Buglossoporus quercinus*	VU (IUCN), CR (GER)	Unlikely	1	Large old oak trees in pasture woodland, parkland and other mosaic deciduous forests.	No
2	Toasted Waxcap	*Cuphophyllus colemannianus*	VU (IUCN), EN (GER)	Likely	1	Seminatural, nutrient poor, extensively managed grasslands, characterised by calcareous or basic soil.	Yes
3	Hauhechel-Samtfußrubling	*Flammulina ononidis*	VU (IUCN), EN (GER)	Likely	1	Thermophilous, unimproved, semi-natural and extensively managed grasslands.	Yes

S/N	Common Name	Scientific Name	Status	Potential Occurrence in the Study Area	Potential Critical Habitat Qualifying Criteria (IFC) Triggered	Associated Habitat (IUCN)	Habitat in CHA study area suitable?
4	Blushing Waxcap	*Hygrocybe ovina*	VU (IUCN), CR (GER)	Likely	1	Nutrient-poor, semi-natural extensively managed grasslands.	Yes
5	Mealy Meadowcarp	*Pseudotricholoma metapodium*	EN (IUCN)	Likely	1	Nutrient-poor, semi-natural extensively managed grasslands.	Yes

Key to table:
[a] IUCN Global Red List status and German Red List status (GER): CR = Critically Endangered; EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern

Criterion 1: Habitat required for the survival of critically endangered or endangered species

According to the IFC thresholds for criterion 1, the habitats in the study area must support 'globally significant' concentrations of these key species identified (0.5 % of the global population AND 5 reproductive units of a CR or EN species; areas containing nationally/regionally important concentrations of an IUCN Red-listed EN or CR species).

Out of the 21 candidate species screened in **Table 2-1**, eight species are unlikely to be present within the study area due to habitat preferences not being met [i.e. incompatible habitat, particularly aquatic species such as fish/aquatic invertebrates that requires fluvial habitats (perennial rivers for example) that are absent from the study area].

Thirteen species have the potential to occur in the study area based on their distributional range and habitat requirements. These species were assessed further in terms of the IFC thresholds for criterion 1 and included fungi, invertebrates and birds.

Four fungi species:

- Toasted Waxcap (EN in GER)
- *Flammulina ononidis* (EN in GER)
- Blushing Waxcap (CR in GER)
- Mealy Meadowcarp (EN IUCN)

All four of the fungi species listed above only occur on semi-natural, extensively used grassland. Within the study area, that type of habitat can only be found in the Natura 2000 site 'Standortübungsplatz Landau' in the habitat types (EUNIS classification):

- 6210: Semi-natural dry grasslands and scrubland facies on calcareous substrates; and
- 6510: Extensive hay meadows of the planar to submontane stage.

The Project has no direct footprint within the Natura 2000 site's protected habitats, therefore impacts on fungi by the Project can be excluded and fungi are not considered further in this assessment. The same applies for the German Tiger Beetle, that has the same habitat requirements and will also not be affected by direct or indirect Project impacts.

Four invertebrate species:

- German Tiger Beetle [(EN in Germany (GER)]
- Helmeted Azure Damsel (EN in GER)
- Large Copper (EN in GER)
- Bright Meadow Blue (EN in GER)

The Helmeted Azure Damsel, the Large Copper and the Bright Meadow Blue inhabit marshy habitats and spring areas. The Bright Meadow Blue additionally requires the plant *Sanguisorba officinalis* that grows in marshy habitats. In the study area, these habitats only occur within the Natura 2000 site 'Erlenbach und Klingbach'. The site is situated ca. 500 m from the drill site '40 Morgen'. Any direct or indirect impacts by the Project on these species can therefore be excluded and therefore they are not considered further in this assessment.

Five bird species:

- **Crested Lark** (CR in GER)

The Crested Lark was observed during the baseline surveys for the 'Development plan D12 Business Park: Messegelände-Südost' in 2018[10]. The GLEP is planned to be developed in this area. The Crested Lark is critically endangered (CR) according to the German Red Data List and typically inhabits dry plains with sparse vegetation cover with residential and commercial development posing the main threat to the species[11]. The European population is estimated to be in the range of 17,100,000 - 23,800,000 pairs, which equates to 34,300,000 - 47,500,000 mature individuals according to IUCN. Europe forms ca. 20% of the global range, so a very preliminary estimate of the global population size is 175,000,000 - 249,999,999 mature individuals. Although the current number of individuals in the total AoI is unknown, the AoI could not possibly provide sufficient habitat to support a population of upwards of 875,000 individuals that would qualify as critical habitat in terms of criterion 1 (i.e. 0.5 % of the global population). Therefore, Crested Lark does not qualify for Critical Habitat in terms of criterion 1 of IFC PS6.

- **Northern Wheatear** (CR in GER)

The Northern Wheatear is known to occur in the Natura 2000 area 'Standortübungsplatz Landau'. The species requires stony, open ground with sparse vegetation. The European population of the Northern Wheatear is estimated to 5,410,000 - 14,700,000 pairs, which equates to 10,800,000 - 29,300,000 mature individuals. The global population is estimated to 10,000,000 - 500,000,000 mature individuals[12]. To qualify for Critical Habitat in terms of criterion 1, the area would have to support 0.5 % or more of the global population and taking the lower end of the range, this would be 50,000 individuals. The AoI overlaps over approximately 21.3 ha with the 'Standortübungsplatz Landau'. This area cannot possibly support this number of individuals and therefore does not qualify for Critical Habitat.

- **Grey Partridge** (EN in GER)

The Grey Partridge was recorded during baseline studies for both the area around the drill site 'Schleidberg Süd'[13] as well as for the area 'Messegelände Südost', where the GLEP will be developed[10]. Based on its habitat preferences, partridges can be expected to occur across the whole AoI, with its preferred habitat being open, low-intensity mixed farmland with small fields and hedges on grassy banks. It is commonly found in ground cover that is only slightly taller than the bird itself with some dense shrubby patches at intervals such as hedgerows. The European breeding population is estimated at 1,140,000 - 1,880,000 pairs, which equates to 2,290,000 - 3,750,000 mature individuals. The European estimate covers approximately 70%

[10] ‚Fachbeitrag Artenschutz, Bebauungsplan D12 Gewerbepark Messegelände-Südost' -compiled by the Institut für Naturkunde in Südwestdeutschland (November, 2018). [English translation: 'Specialist article on species protection, Development plan D12 Business Park: Messegelände-Südost'].
[11] BirdLife International. 2021. *Galerida cristata* (Europe assessment). The IUCN Red List of Threatened Species 2021: e.T22717383A166394681. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22717383A166394681.en. Accessed on 27 September 2023.
[12] BirdLife International. 2021. *Oenanthe oenanthe* (Europe assessment). The IUCN Red List of Threatened Species 2021: e.T103773898A200214214. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T103773898A200214214.en. Accessed on 29 September 2023.
[13] ‚Artenschutzfachliche Ersteinschätzung potenzieller Bohrungsstandorte Vulcan Energie Ressourcen GmbH Projektgebiet Schleidberg Süd' - compiled by the Institut für Naturkunde in Südwestdeutschland (November 2022). [English translation: 'Species protection-related initial assessment of potential drilling sites for Vulcan Energie Ressourcen GmbH for the Project area Schleidberg Süd']

of the global range, so a preliminary estimate of the global population size is 3,300,000 - 5,300,000 mature individuals[14]. To qualify for Critical Habitat in terms of criterion 1, the study area would need to support 0.5 % or more of the global population and taking the lower end of the range, this would be 16,500 individuals. Considering the mostly highly modified habitat due to intensive agriculture in the AoI, which is not an ideal habitat for the Grey Partridge, the AoI is considered unable to support this number of individuals. Therefore, it does not qualify for Critical Habitat in terms of criterion 1.

- **Whinchat** (EN in GER)

The Whinchat is known to occur in the Natura 2000 area 'Standortübungsplatz Landau'. The species requires scattered shrubs, bushes, trees or man-made perches for song posts and foraging vantages, and low herb cover and bare ground in which to forage (shrubs and herb layer also needed for nesting). In Europe, the breeding population is estimated to number 6,470,000 - 10,700,000 pairs, which equates to 12,900,000 - 21,400,000 mature individuals. Europe forms ca. 75% of the global range, so a very preliminary estimate of the global population size is 17,200,000 - 28,500,000 individuals[15]. To qualify for Critical Habitat in terms of criterion 1, the area would have to support at least 0.5 % of the global population and taking the lower end of the range, this would be 86,000 individuals. The AoI overlaps over approximately 21.3 ha with the 'Standortübungsplatz Landau' that could provide suitable habitat but given the extent of this site and habitats this will not be able to support this number of individuals and therefore does not qualify for Critical Habitat in terms of criterion 1.

- **European Turtle Dove** (EN in GER)

The European Turtle Dove is known to occur in the Natura 2000 area 'Standortübungsplatz Landau'. The species uses a variety of habitats from hedges, young forest, scrubby marshes to young tree plantations. It requires agricultural areas nearby for feeding. The European breeding population is estimated at 2,510,000-4,760,000 pairs, which equates to 5,020,000-9,510,000 mature individuals. Europe forms 25-49% of the global range, so a very preliminary estimate of the global population size is 19,300,000-71,400,000 individuals. This roughly equates to 12,800,000-47,600,000 mature individuals[16]. To qualify for Critical Habitat in terms of criterion 1, the area would have to support 0.5 % of the global population. Taking the lower end of the range, this would be 96,500 individuals. The AoI cannot support that many individuals and therefore criterion 1 is not met and the species does not qualify the habitats in the AoI as Critical Habitat.

The majority of the AoI consists of modified habitat in the form of intensively farmed, agricultural land, except for the two Natura 2000 sites 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach', that both contain valuable habitats that are considered as natural habitats in this assessment, despite being subject to some level of disturbance and modification. Overall, the AoI is unlikely to support globally significant populations of the five

[14] BirdLife International. 2021. *Perdix perdix* (Europe assessment). The IUCN Red List of Threatened Species 2021: e.T22678911A166185485. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22678911A166185485.en. Accessed on 29 September 2023.

[15] BirdLife International. 2021. *Saxicola rubetra* (Europe assessment). The IUCN Red List of Threatened Species 2021: e.T22710156A166355215. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22710156A166355215.en. Accessed on 29 September 2023.

[16] BirdLife International. 2019. *Streptopelia turtur*. The IUCN Red List of Threatened Species 2019: e.T22690419A154373407. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T22690419A154373407.en. Accessed on 29 September 2023.

candidate bird species (Crested Lark, Northern Wheatear, Grey Partridge, Whinchat and European Turtle Dove) that would meet or exceed the 0.5% threshold for Critical Habitat, and therefore the study area does not qualify as Critical Habitat in terms of criterion 1.

Criterion 2: Habitat of significant importance to endemic and/or restricted-range species

No endemic or restricted-range species have been identified for the study area.

The requirements/thresholds for criterion 2 (endemic/restricted-range species) have not been met.

Criterion 3: Habitat supporting globally significant concentrations of migratory species and/or congregatory species

In the study area, suitable habitat for four fully migratory birds (Crested Lark, Northern Wheatear, Whinchat and European Turtle-Dove) has been identified.

According to the IFC thresholds for criterion 3, the habitats in the study area must support 'globally significant' concentrations of these key species identified (≥ 1 % of the global population of a migratory or congregatory species at any point of the species' lifecycle or areas that predictably support ≥ 10 % of the global population of a species during periods of environmental stress). The study area is not known to support significant concentrations of these species (*as already discussed under criterion 1*). No IBA and/or N2000-site designated for migratory birds is located in the study area. In Germany, important areas for migratory birds are usually designated as N2000-sites (SPAs).

The requirements/thresholds for criterion 3 (areas critical for migratory species) have not been met in terms of the key species identified.

Criterion 4: Highly threatened and/or unique ecosystems

Within the study area there are no ecosystems that have been assessed in terms of the IUCN Red List of Ecosystems. However, there are two Natura 2000 sites that lie within the study area: 'Standortübungsplatz Landau' in the north and 'Erlenbach und Klingbach' in the south of Landau. Both sites contain important habitats.

For 'Standortübungsplatz Landau', most notable are the xero-thermic (dry/hot) grassland habitats that are considered important for endangered flora and fauna, providing an important refugia in an intensively transformed agricultural landscape. The habitats have been classified in terms of the EUNIS[17] habitat classification system as including a mosaic of:

- 6210: Semi-natural dry grasslands and scrubland facies on calcareous substrates; and
- 6510: Extensive hay meadows of the planar to submontane stage.

[17] EUNIS stands for the 'European Nature Information System' developed and implemented by the European Environment Agency. The EUNIS habitat classification system is the system used to classify different habitats in the EU and is directly aligned with the EU Habitats Directive (Annex I habitat types).

The grassland habitat associated with the 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach' Natura 2000 sites is classified as '**Semi-natural dry grasslands and scrubland facies on calcareous substrates'** (revised EUNIS name: Semi-dry perennial calcareous grassland (meadow steppe) (revised code R1A). In terms of the European Red List of Habitats[18], Semi-dry perennial calcareous grassland (Red List code E1.2a) is considered a '**Vulnerable**' habitat type, with criteria determining this status being due to both historic decline and present decline in habitat extent over the last 50 years.

For Erlenbach und Klingbach, there are several additional habitat types worth mentioning and these include the following (also with '**Vulnerable**' status according to the EU Red List of Habitats):

- 3150: Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation;
- 6430: Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels; and
- 6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*).

As well as the following '**Near Threatened'** habitat types:

- 3260: Water courses of plain to montane levels with the *Ranunculion fluitantis* and the *Callitricho-Batrachion* vegetation;
- 9130: *Asperulo-Fagetum* beech forests NT Fagus woodland on non-acid soils; and
- 9160: Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli*

These habitat types are all listed in terms of Annex I of the EU Habitats Directive which considers 'Natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation (SACs)'. All these habitats are also listed according to Revised Annex I to Resolution 4 of the Bern Convention as 'endangered natural habitat types'.

An additional habitat type common to the Erlenbach und Klingbach Natura 2000 site worth mentioning is '**Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)' (*91E0)**, which whilst considered to be of 'Least Concern' according to the EU Red List of Habitats, is listed as a **priority habitat type*** according to the EU Habitats Directive.

The aim of the Natura 2000 network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats. Given that both sites contain high value habitat types with conservation significance, they qualify as Critical Habitat according to criterion 4 b): *Other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.*

In conclusion, the habitats associated with both the 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach' Natura 2000 sites can be considered threatened ecosystems at both

[18] European Union (EU) (2016). European Red List of Habitats: Part 2. Terrestrial and freshwater habitats.

the national level for Germany and at the regional level for Europe, in terms of regional directives and classification systems for the European Union.

It is suggested that the requirements for criterion 4 (threatened/unique ecosystems) have been met for 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach' Natura 2000 sites and the terrestrial/aquatic ecosystems and natural/protected habitats associated with the two N2000 sites are considered to qualify as 'critical habitat'.

Criterion 5: Areas associated with key evolutionary processes

The study area is not known to contain landscape features and/or subpopulations of species with unique evolutionary history. In fact, the study area is not characterised by a particular level of isolation, spatial heterogeneity, and wealth of environmental gradients or edaphic interfaces. Moreover, the study area is not considered to be of demonstrated importance as to climate change adaptation or as biological corridor. These considerations suggest that the study area does not support any key evolutionary processes. Therefore, the study area is not expected to qualify as critical habitat according to this criterion.

The requirements/thresholds for criterion 5 (key evolutionary processes) have not been met.

4. IMPLICATIONS FOR THE PROJECT

4.1 NATURAL HABITAT

Most of the study area consists of modified habitat in the form of intensively farmed agricultural land. The exception is the habitats associated with the two Natura 2000 sites 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach', that both contain valuable semi-intact habitats including grasslands, forest, shrubland and wetlands, which are considered 'natural habitat' as per the IFC PS6 definition[19].

IFC PS6 places certain requirements on the client not to significantly convert or degrade natural habitats under paragraph 13 of the PS6 (IFC, 2012). Whilst conversion of natural habitat is not predicted to take place as infrastructure and activities will be located outside of the Protected Areas hosting natural habitat, the term *"degrade"* in paragraph 13 of PS6 worth noting, as this speaks in essence to *any modification of habitat integrity as a result of change in land or water use that reduces the habitat's ability to maintain viable populations of its native species*. Given the location of the pipeline alignment from the existing Geox geothermal plant and the GLEP being within close proximity to the Natura 2000 site: 'Standortübungsplatz Landau', it is recommended that any indirect impacts to the PA/Natura 2000 associated with Project construction and operational phases be investigated further during the ESIA, to inform the need for any appropriate and necessary measures to mitigate impacts and adhere to the IFC PS6 requirements (clauses 14 and 15) concerning the protection of natural habitat, which includes at a minimum:

- Any conversion or degradation is mitigated according to the mitigation hierarchy; and

[19] *"13. Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition."* (IFC, 2012).

- In areas of natural habitat, mitigation measures will be designed to achieve no net loss[20] of biodiversity where feasible.

This is in line with the German legislation regarding Natura 2000 sites, that goes beyond IFC PS6 requirements and strictly prohibits any negative impacts on the site-level conservation objectives of these sites[21].

4.2 CRITICAL HABITAT

Overall, the study area is unlikely to support globally significant populations of the five candidate species (Crested Lark, Northern Wheatear, Grey Partridge, Whinchat and European Turtle Dove) that would meet or exceed the 0.5% threshold for Critical Habitat. However, both Natura 2000 sites contain valuable habitats of conservation significance that qualify as Critical Habitat according to criterion 4 b): *Other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.*

The key requirements for critical habitat in line with IFC PS6 will be associated with the two Natura 2000 sites that are within the Project AoI:

"10. In areas of Critical Habitat, the client will not implement any Project activities unless the following requirements are met:

- There are no measurable adverse impacts on the ability of the Critical Habitat to support the established population of species described in paragraph 9 or the functions of the Critical Habitat described in paragraph 9[22];
- There is no reduction in the population of any recognised critically endangered or endangered species; and
- Any lesser impacts are mitigated in accordance with paragraph 8."

"8. Mitigation measures will be designed to achieve no net loss of biodiversity where feasible, and may include a combination of actions, such as:

- Post-operation restoration of habitats;
- Offset of losses through the creation of ecologically comparable area(s) that is managed for biodiversity; and
- Compensation to direct users of biodiversity."

"G19. Project activities should only be conducted in Critical Habitat if it can be demonstrated that they will not have a measurable adverse impact on the ability of the Critical Habitat to

[20] No net loss is defined in terms of IFC PS6 as "*the point at which Project-related impacts on biodiversity are balanced by measures taken to avoid and minimise the Project's impacts, to undertake on-site restoration and finally to offset significant residual impacts, if any, on an appropriate geographic scale (e.g., local, landscape-level, national, regional).*" – IFC (2012).

[21] According to Article 6 of the EU 'Habitats' Directive 92/43/EEC and §34 BNatSchG, a screening of potential implications of a Project on the site-level conservation objectives is required as part of the permitting process. If a Project is found to have negative impacts on the site-level conservation objectives, it will not be permitted.

[22] "*9. Critical Habitat is a subset of both natural and modified habitat that deserves particular attention. Critical Habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic or cultural importance to local communities.*" (IFC, 2012).

maintain its high biodiversity value. The probability of measurable adverse impacts on Critical Habitat would be determined through a detailed biodiversity assessment. The assessment, using objective data, scientific methodology and analysis, would determine whether the Project would result in a quantifiable reduction in endangered or critically endangered species either directly or indirectly through habitat destruction. Such quantification would describe a high probability adverse outcome in terms expected reductions in population numbers, habitat carrying capacity or other relevant parameters."

Furthermore, whilst the Crested Lark, Northern Wheatear, Grey Partridge, Whinchat and European Turtle Dove were found to not qualify the study area habitats as Critical Habitat, they are still important biodiversity features given their threat status. Moreover, as European birds they are especially protected under the Birds Directive (79/409/EEC) and the §44 BNatSchG, that aims at protecting all naturally occurring wild bird species present in the EU. Therefore, it is recommended that species specific mitigation measures be considered as part of the Biodiversity Impact Assessment (BIA) section of the ESIA. This might entail construction restrictions during breeding times to avoid disturbance as well as measures to prevent ground breeding species within construction sites.

5. CONCLUSION

After screening several species and running through the five Critical Habitat qualifying criteria of IFC PS6, it was determined that the **two Natura 2000 sites 'Standortübungsplatz Landau' and 'Erlenbach und Klingbach' qualify as Critical Habitat according to criterion 4 b)** *Other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.*

The requirements of IFC PS6 will apply, prohibiting any adverse impacts on the Critical Habitat. The Project will have to implement appropriate mitigation measures that are to be specified in the ESIA. This is in line with the German permitting requirements concerning Natura 2000 sites, that requires appropriate mitigation measures to ensure no negative impacts on Natura 2000 sites and their conservation objectives occur. Whilst no direct impact to critical habitat is likely to take place, potential indirect impacts will need to be managed appropriately so as not to impact on the critical habitat qualifying features/habitats (namely disturbance caused by possible dust/noise/light/vibration).

Other parts of the study area and associated habitats do not qualify as Critical Habitat, as the criteria and thresholds have not been met. Whilst the Crested Lark, Northern Wheatear, Grey Partridge, Whinchat and European Turtle Dove were found to not qualify the study area habitats as Critical Habitat, they are still important biodiversity features given their threat status and their strict protection under European and German law. It is therefore recommended that an ecologically appropriate and species-specific mitigation approach be considered in the ESIA.

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