BIODIVERSITY PROTECTION TECHNICAL NOTE

الدقم Duqm
هيئة المنطقة الاقتصادية الخاصة
Special Economic Zone Authority

Environment Regulatory Department

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LIST OF ACRONYMS

AOS	Arabian Oryx Sanctuary
BAP	Biodiversity Action Plan
BIA	Biodiversity Impact Assessment
BPTN	Biodiversity Protection Technical Note
CEMP	Construction Environmental Management Plan
CW	Constructed Wetlands
EIA	Environmental Impact Assessment
EPA	Environmental Permit Application
IBA	Important Bird Area
IDZ	Industrial Development Zone
MECA	Ministry of Environment and Climate Affairs
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority of Duqm
STP	Sewage Treatment Plant
ZoI	Zone of Influence

1 INTRODUCTION

1.1 Objectives of the Biodiversity Protection Technical Note

This Environmental Technical Note on Biodiversity Protection (herein referred to as "BPTN or Technical Note") has been developed as part of a set of technical notes for the environmental requirements of the Special Economic Zone (SEZ) at Duqm.

The purpose of this is to set forth a comprehensive document that will support the achievement of compliance with the required standards and legislations and provide guidance to all Project applicants.

This Technical Note is aimed primarily at applicants where proposed industries may adversely impact terrestrial ecology habitats, flora or fauna. The overall objective is to provide guidance for the area and to ensure there is minimal impact to ecological sensitive receivers that have been identified within the area.

This Technical Note contains the following information:

- Laws and regulation applicable in the SEZ;
- An overview of the ecological environment of the SEZ;
- Identified ecological sensitive receptors of the SEZ;
- Environmental permitting requirements for the SEZ;
- Methodology for biodiversity assessment;
- Biodiversity monitoring methodology; and
- General degradation prevention measures.

1.2 Project Information

The SEZ at Duqm is an integrated economic development area that covers 2,000 square kilometers. The SEZ is located in the Wilayat of Duqm on the south-east coast of Oman. The coastline of Wilayat Duqm is approximately 170 km in length, with the northern boundary lying between Nafun and Sidera, and the southern boundary being approximately 120 km south of Ras al Madrakah. Ghubbat Al Hashish and Barr Al Hikman lie to the north of the Al Wusta Region and Ras al Madrakah in the south.

The SEZ is composed of zones that include the Duqm port, the ship dry dock, the oil refinery, the regional airport, the residential, commercial and tourism area, the logistic services area, fisheries area and the industrial area.

This BP Technical Note applies to all industries in the SEZ area. Figure 1-1 specifies the boundaries of the SEZ as per RD 5/2016.

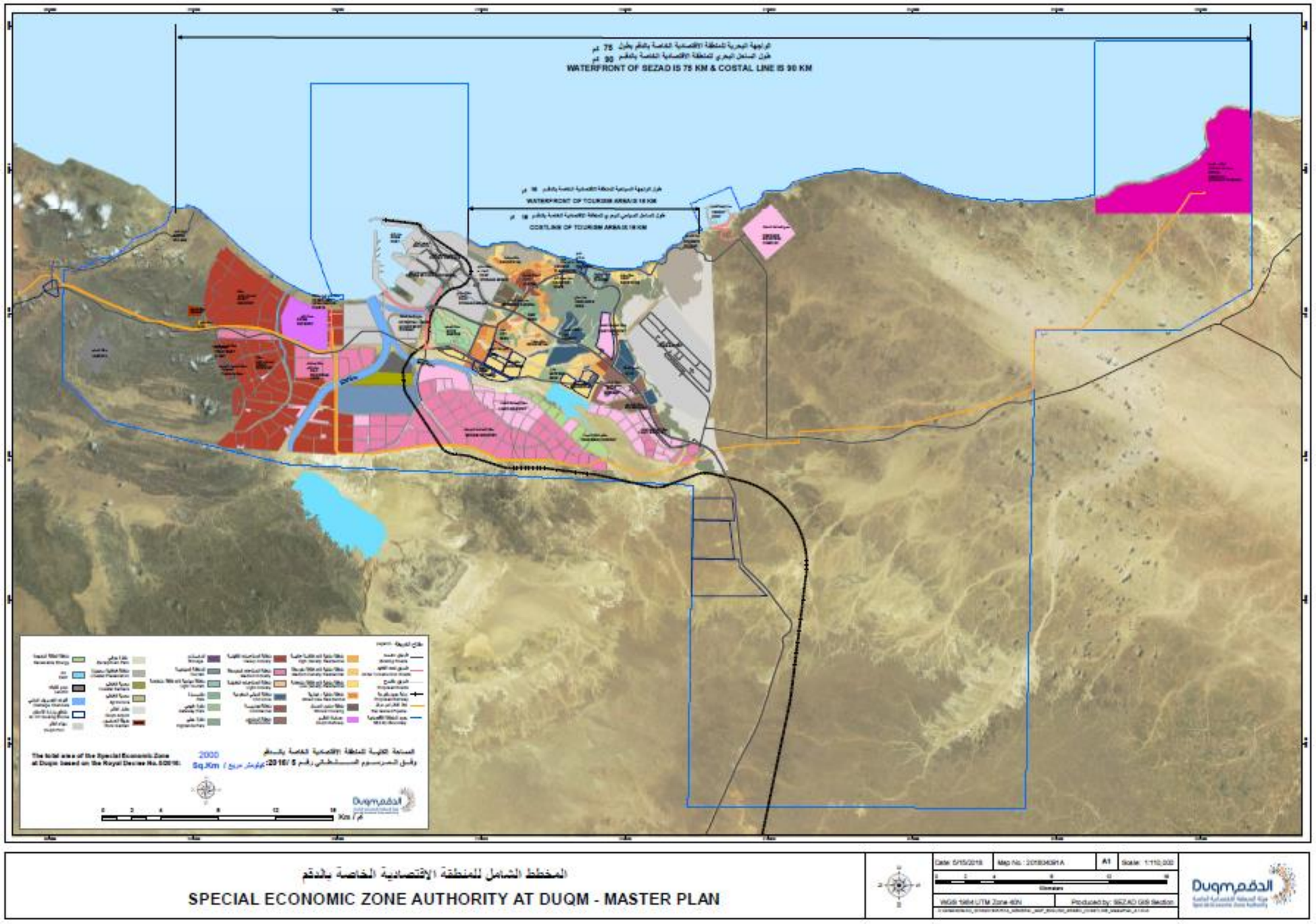

Figure 1-1: SEZD Area

2 APPLICABLE LAWS, REGULATIONS AND STANDARDS

In accordance with RD 79/2013, the Special Economic Zone Authority at Duqm (SEZAD) has the functions of the Ministry of Environment and Climate Affairs (MECA) in relation to issuing environmental permits for projects and implementing environmental regulations within the SEZ.

Environmental compliance within the SEZ is governed by the SEZAD Environmental Regulatory Department. At all times local requirements will override international requirements. The international standards are to be complied with, only in the absence of local standards.

*** It shall be noted that within SEZ, SEZAD will have the authority of concerned Ministries mentioned in the below national regulations.**

2.1 National Regulations

Environmental legislation in Oman is present within a series of Royal Decrees (RDs) and Ministerial Decisions (MDs). Those applicable RD and MDs pertaining to marine environment includes the following:

- RD 114/2001 Law on Conservation of the Environment and Prevention of Pollution
- MD 20/1990 - Rules and Regulation and Specifying Coastal Setbacks
- MD 169/2000 and MD 81/2004 – Regulation on the Cutting of Trees
- MD 101/2002 Ban on Killing, Hunting or Trapping of Wild Animals and Birds
- MD 110/2007 - Regulations of the Law on Nature Reserves and Wildlife Conservation (Implements RD 6/2003)
- RD 8/2003 – Law of Pastures and Animal Wealth Management

The applicable restrictions implemented by some of these laws and regulations are discussed in more details below.

2.1.1 Royal Decree 114/2001 - Law on Conservation of the Environment and Prevention of Pollution

Royal Decree RD 114/2001 (Law on Conservation of the Environment and Prevention of Pollution) outlines regulatory requirements concerning protection of the environment, and includes applicable penalties for offenders.

The articles of RD 114/2001 provide guidance on allowable discharge into the marine environment, and no waste or any other substance of whatever kind, form or state shall be dumped into the marine environment without obtaining appropriate permits.

Furthermore, specific types of mammals and bird species have been afforded protection within the Sultanate of Oman via RD 114/2001. The organisms listed in Appendix 1 and Appendix 2 of the RD are given protection from poaching and/or killing and are listed below in Table 2-1 and Table 2-2 respectively. The organisms listed in Appendix 1 are given the highest level of protection, while those in Appendix 2 of the RD are also considered important to protect.

Marine and marine-associated animals have been highlighted in red in both tables.

Table 2-1- Appendix 1 of RD 114/2001

S. No.	Scientific Name	Common Name
1	*Oryx leucoryx*	Arabian Oryx
2	*Panthera pardus nimr*	Arabian Leopard
3	*Hemitragus jayakari*	Arabian Tahr
4	*Gazella cora*	Arabian Gazelle (Idmi)
5	*Gazella subgutturosa marica*	Sand Gazelle (Reem)
6	*Capra ibex nubiana*	Nubian Ibex
7	*Felis caracal*	Caracal Lynx
8	*Hyena*	Striped Hyena
9	*Felisi sylvestris*	Wild Cat
10	*Canis lupes*	Arabian Wolf
11	*Mellivora capensis*	Honey Badger
12	*Felisi margarita*	Sand Cat
13	*Vulpes reuppelli*	Rueppell's Sand Fox
14	*Lepus capensis*	Cape Hare
15	*Eretmochlys imbricatta*	Hawksbill Turtle
16	*Chalmydotis undulate*	Houbara Bustard

Table 2-2 - Appendix 2 of RD 114/2001

S. No.	Scientific Name	Common Name
1	*Vulpes*	Red Fox
2	*Chelonia mydas*	Green Turtle
3	*Caretta*	Loggerhead Turtle
4	*Lepidochlys olivacea*	Olive Ridley Turtle
5	All falcons, owl, vulture, eagle, flamingo, pelican, gull and tern species	
6	All mammal species not mentioned in Appendix 1, except tamed/domesticated animals	

2.1.2 Ministerial Decision 20/1990 - Rules and Regulation and Specifying Coastal Setbacks

MD 20/1990 (Rules Regulation and Specifying Coastal Setbacks) defines mandatory coastal setbacks which limit development within the open coastal zone (defined as the shore area extending one km from the high tide point towards the mainland within which no settlements exist) of the sultanate. Setbacks are to be measured from the maximum end of the high water tidemark. Specific setbacks are delineated for the following scenarios:

- For coastal areas characterized by scenic views including high cliffs and rocky peaks, no projects shall be allowed within a 300m coastal setback.
- For sandy beaches and khwars (tidal lagoons), no projects shall be allowed within a 150m coastal setback.
- For beaches where construction developments have limited impact on the environment, projects shall be required to abide to a minimum coastal setback of 50m.

2.1.3 Ministerial Decision 200/2000 – Regulations for Crushers, Quarries, and Transport of Sand from Coasts, Beaches and Wadis

MD 200/2000 (Regulations for Crushers, Quarries, and Transport of Sand from Coasts, Beaches and Wadis) includes regulations regarding the areas from which sand and other geologic material can be sourced. Article 10 of MD 200/2000 has relevance to wadi works. The applicable articles provide information on prohibiting excavation of wadi areas, change to wadi courses and specify that permits are required when undertaking works within wadis.

MD 200/2000 states that it is not permitted to make any excavations or remove sand from coasts, beaches or wadis other than specified places. Furthermore, for permitted excavation/sand transport from coasts, beaches and wadis, excavated areas should be re-profiled at the expiry of the excavation permit.

2.1.4 Ministerial Decision 169/2000 and MD 81/2004 – Regulation on the Cutting of Trees

MD 169/2000 and MD 81/2004 pertain to the regulation of cutting of green trees. As of MD 81/2004, it is forbidden to cut green live trees, or gather and transport dry wood from private or public estates without a permit.

2.1.5 Ministerial Decision 101/2002 Ban on Killing, Hunting or Trapping of Wild Animals and Birds

MD 101/2002 is composed of 5 articles and the relevant ones are provided below.

Article 1 bans the killing, hunting, or trapping of wild animals or birds.

Article 2 requires a permit from the Ministry for the taking of specimens of animals or birds for the purpose of science, education or studies on the life of animals or plants.

2.1.6 Ministerial Decision 110/2007 - Regulations of the Law on Nature Reserves and Wildlife Conservation (Implements RD 6/2003)

MD 110/2007 includes regulations to implement RD 6/2003. RD 6/2003 details the establishment and management of nature reserves and wildlife conservation. In addition, RD 6/2003 provides an updated list for the protection of species identified in Appendix 1 and 2 of RD 114/2001. The updated Appendix 1 and 2 from RD 6/2003 are shown below in Table 2-3 and Table 2-4 respectively:

Table 2-3- Appendix 1 of RD 6/2003

S. No.	Scientific Name	Common Name
1	*Oryx leucoryx*	Arabian Oryx
2	*Panthera pardus nimr*	Arabian Leopard
3	*Hemitragus jayakari*	Arabian Tahr
4	*Gazella subgutturosa marica*	Sand Gazelle (Reem)

S. No.	Scientific Name	Common Name
5	*Capra ibex nubiana*	Nubian Ibex
6	*Hyena hyena*	Striped Hyena
7	*Gazella gazella cora*	Arabian Gazelle
8	*Chalmydotis undulate*	Houbara Bustard
9	*Felis caracal*	Caracal

Table 2-4 – Appendix 2 of RD 6/2003

S. No.	Scientific Name	Common Name
1	*Mellivora capensis*	Honey Badger
2	*Lepus capensis*	Hare
3	*Vulpes vulpes*	Red Fox
4	*Chelonia mydas*	Green Turtle
5	*Caretta caretta*	Loggerhead Turtle
6	*Lepidochlys olivacea*	Olive Ridley Turtle
7	*Eretmochlys imbricatta*	Hawksbill Turtle
8	*Felisi sylvestris*	Wild Cat
9	*Felisi margarita*	Sand Cat
10	*Canis lupes*	Arabian Wolf
11	*Vulpes reuppellii*	Rueppell's Sand Fox
12	All falcons, owl, vulture, eagle, flamingo, pelican, gull and tern species	

2.1.7 RD 8/2003 – Law of Pastures and Animal Wealth Management

RD 8/2003 implements the Law on Pastures, Rangeland and Animal Wealth Management which states that the cultivation of pastures, cutting or burning trees and plants, construction of installations, exploitation of pasture products, introduction of new species of plants, grazing and breeding animals, and transfer of the pasture soil shall be prohibited; and, that grazing in defined natural pastures or in protected areas shall be prohibited. RD 8/2003 furthermore requires replanting of deteriorated lands and their protection against overgrazing.

2.2 International Treaties

The Sultanate of Oman is a signatory to the following relevant international conventions:

- International Convention to Combat Desertification, resulting in the issuance of RD 5/1996;
- Convention on Biological Diversity, resulting in the issuance of RD 119/94;
- Conservation of Wildlife and their Habitats in the GCC Countries, resulting in the issuance of RD 67/2002.

3 OVERVIEW OF ECOLOGICAL ENVIRONMENT IN SEZD AREA

An Environmental Impact Assessment (EIA) was undertaken for the Industrial Development Zone (IDZ) of Duqm in 2011 (Five Oceans, 2011). In 2014, a series of baseline surveys were undertaken to update the environmental baseline conditions of the greater Duqm area, including an Ecology Report (HMR Consultants, 2014). The findings of the EIA developed by Five Oceans in 2011 and the Ecology Report developed by HMR Consultants in 2014 have been compiled as part of the baseline of the ecological conditions of the SEZ.

This background information should not be used as a substitute to site specific monitoring that may be required as outlined within other sections of this Technical Note. Due to the ongoing development of the SEZ, each proponent shall conduct their own detailed baseline study that is specific to each proposed project in order to obtain the most recent baseline data.

3.1 Background on Ecological Environment

The terrestrial ecological conditions of the SEZ have been categorized as per the natural habitats occurring within the area. The below provides a description of each type of natural habitat present, along with a narrative of the typical ecological receptors (plant and animal species) found within each habitat.

Figure 3-1 provides the habitat maps produced for the SEZ area as per the ecology report of HMR Consultants. Figure 3-2 provides the habitat map for the industrial zone as per Five Oceans EIA report.

All the habitats in the study area are primarily comprised of arid desert woodland vegetation and the dense morning fog caused by the surface ocean physical processes is a major source of moisture. The fog plays a crucial role in sustenance of existing flora and fauna and fulfills day to day water requirements of the entire region specifically during post-monsoon season.

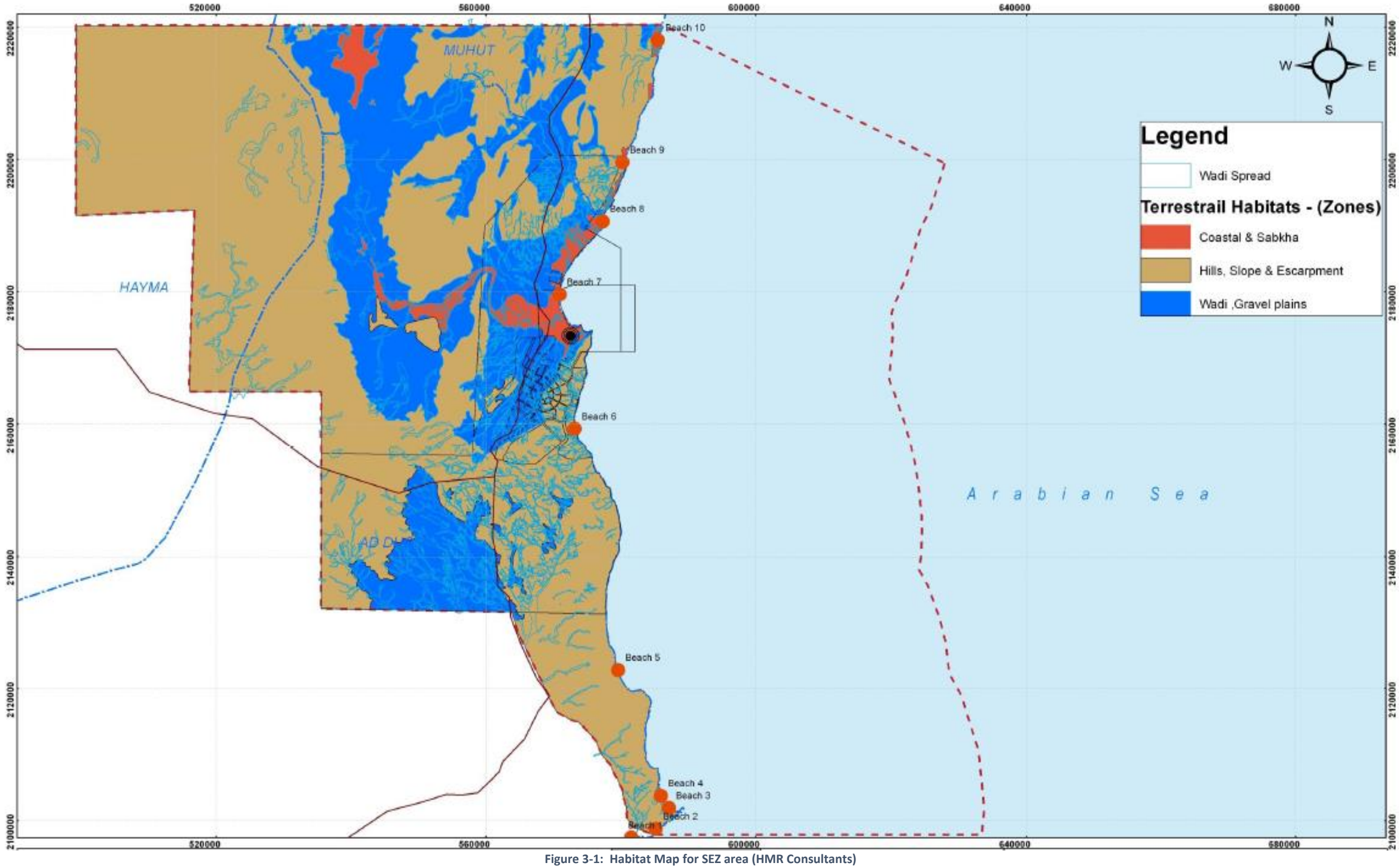

Figure 3-1: Habitat Map for SEZ area (HMR Consultants)

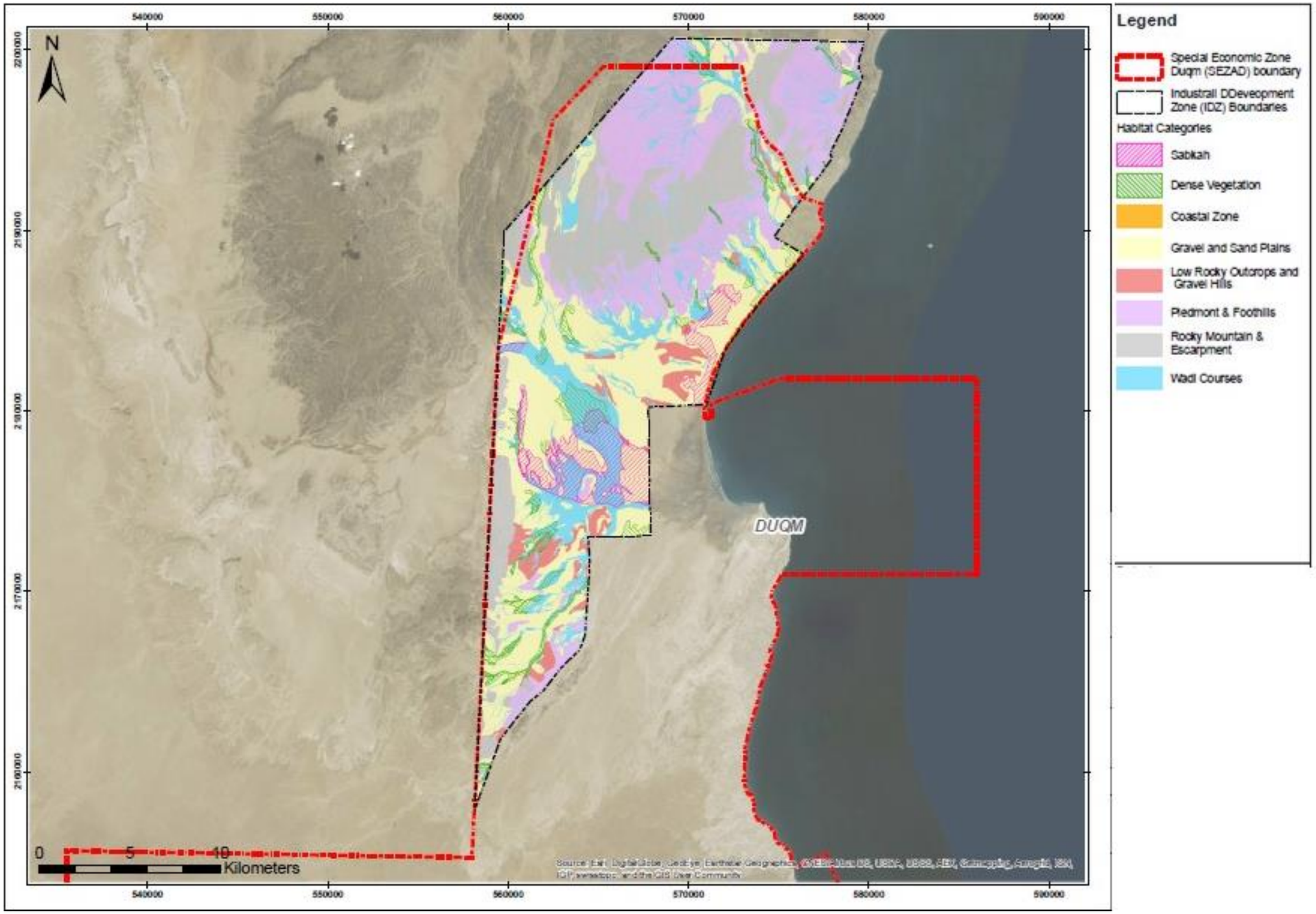

Figure 3-2: Habitat Map for Industrial Zone (Five Oceans, 2011)

3.2 Flora

The Eastern Plateau of SEZ is vegetated with a very open acacia woodland *Acacia tortilis* and *Prosopis cineraria* trees with shrubby *A. ehrenbergiana* growing in shallow sandy depressions, rock fissures and in drainage swales on the gravel plains. Lichens, mainly *Ramalina duriaei,* grow on dead tree branches sustained by the moisture from fog.

Very shallow depression of land over the plateau has higher vegetation like *Haylas*. The perennial grasses that are most important as food for the Oryx and Gazelle are *Lasiurus hirsutus*, *Cymbopogon schoenanthus, Panicum turgidum, Chrysopogon* sp., *Dicanthium fovealatum, Octhocloa compressa, Stipagrostis paradisea* and *S. socotrana*. The plateau diversity is manly represented in the Haylas and the haylas are mostly abundant in *Crotalaria aegyptiaca, Heliotropium becciferum* and *Pulicaria glutinosa.*

The escarpments are the rocky cliffs devoid of any vegetation. They form a front between the lowland wadis and the high elevation plateau. Due to the moisture made available by the morning fog during the post Khareef season, the edges of the escarpment are covered with lichens mostly by *Ramalina duriaei.*

The Wadi ecosystems in the protected area are mostly confined near the eastern fence. The Wadi systems flowing from the West to the eastern coastal region has heterogeneous habitats, because of the length each wadi travels. The habitat and the vegetation type of the Wadis mainly depend on the elevation, slope, proximity from the sea, saltwater intrusion and the type of substratum.

Description of each type of natural habitat present, along with narrative of typical flora found within each habitat is provided below.

3.2.1 Coastal Zone Habitat

Coastal areas close to sandy beaches have a silty and saline surface that supports halophillic vegetation. The strong wind regimes in this region induce a wide spray zone, which brings moisture and salinity on the coastal dunes and adjoining habitats. The plant community in this habitat is segregated due to hypersaline conditions and dune vegetation is restricted by plants with very specialized adaptations.

The sandy beach ecosystem forms the fringe of the terrestrial and marine habitat. These ecotones are unique and important habitat for many faunal species though they are devoid of any terrestrial plant life, except but for seasonal seaweed occurrence. The study area has long sandy beaches, which are major sites for wintering migratory birds given that these are the main feeding grounds for many wading species.

3.2.2 Sabkha Habitat

Sabkahs are low lying areas comprising silty-sand sediments with high moisture content due to sub-surface geological processes. These are unique habitats and are greatly influenced by changes in salinity. Regional rainfall temporarily lowers salinity levels in the substrate leading to seasonal germination and sporadic vegetation. The plants

adapt and go into dormancy following the rains till the next favourable season (Brown and Boer, 2005).

Sabkha habitat stretches from the coastal zone further inland, principally between areas of gravel and sand plains habitats. The EIA developed by Five Oceans in 2011 recorded that tracks have been graded through the sabkha which has caused some fragmentation, and litter has accumulated in areas close to the road. Salinity of sabkha is very high and as a consequence this habitat is generally devoid of vegetation and mainly comprise of *Halopeplis perfoliata, Arthrocnemum macrostachyum, Tamarix aucheriana, Tetraena qatarensis, Cressa cretica and Limonium sarcophyllum*.

The Ecology Report developed by HMR Consultants in 2014 treats Coastal and Sabkha habitats as a single habitat type "Coastal Dune and Sabkha". Plate 3-1 and 3-2 shows the Sabkha habitat and the Ecology Report developed by HMR Consultants in 2014 notes the following about this habitat conglomerate:

- Sabkha areas are dominated by halophytic shrubs.
- Coastal areas are heavily influenced by human activities such as overfishing and fish discard.

Given the high salinity levels, limited fauna is observed at these habitats. Occasionally, the water in the sabkha appears completely red due to the proliferation of halo-tolerant cyanobacteria (*Halobacterium sp. /Aphanothece halophytica*) that thrive in hyper saline conditions.

***Plate 3-1:* Cyano-bacterial bloom in Sabkah**

Plate 3-2: Halopeplis perfoliata in Sabkah

3.2.3 Wadi Courses Habitat

Wadis are predominantly shallow, sandy and gravelly features. The alluvial Wadi fans and foothills of the mountains are dominated by

open, drought-deciduous woodland species mainly composed of *A. tortilis* and *Tetraena qatarensis*. *Prosopis cineraria* are well represented and dispersed in small aggregates of 10-50 numbers across these habitats. Important species that are of concern in this habitat include *Pulicaria glutinosa (Plate 3-3)*, *Echiochilon jugatum* and *E. Riebeckii* which are regionally endemic. Other notable species include *Limonium sarcophyllum* which is endemic and vulnerable, while *Ochradenus harsusiticus* is classified as endemic and endangered as per IUCN categories. Typical woodland in Wadi is depicted in Plate 3-4.

In some areas, the trees were exhibiting signs of stress such as significant leaf loss and root exposure. This is likely caused by a combination of factors, such as over-abstraction of groundwater and freshwater lenses. Evidence was found of widespread heavy grazing pressure exerted by domestic livestock, which will compound stress placed on vegetation. The dominance of unpalatable species such as *Tephrosia apollinea* was evidence of the degradation of this habitat. Despite this, vegetation occurring within Wadi habitat is considered to be relatively resilient and is likely able to recover, provided measures are put in place to reverse effects of over-exploitation of fresh water sources and over-grazing.

This network of vegetated Wadis provides shelter and food to a range of fauna species, and likely serves as a network of wildlife corridors. Resident breeding bird species and a number of occurring reptile species have been recorded as preferring Wadi habitat to other habitat types. Larger mammals typically utilize habitat corridors which are most likely comprised of Wadi courses. In particular, the neighboring Arabian Oryx Sanctuary (AOS), which lies outside of the SEZD, may be connected to habitat patches throughout the greater Duqm region via Wadi courses within run through the SEZD.

Plate 3-3: Pulicaria glutinosa **(HMR, 2014)**

Plate 3-4**: Typical woodland in Wadi**

3.2.4 Gravel and Sandy Plains Habitat

The plains are dominated by ravine consisting of gravel-sands, which are mainly formed due to flash flood during occasional rains. These habitats are mostly fed by moisture during the monsoons. During the post monsoon season, moisture from the fog plays an important role in fulfilling the water requirement of the vegetation. During monsoon, the water from the hilly regions brings alluvial soil and deposits it in the low lying areas.

The EIA developed by Five Oceans in 2011 stated that gravel and sandy plains are not considered to be rare in Oman. The gravel and sandy plains in SEZD area has already been subjected to some modification through development of main roads, grading, off-road driving, and sand-mining. The ground cover of this habitat varies from barren areas to areas which are reasonably well vegetated with scattered *Acacia tortilis* trees and shrubs. Generally, vegetation is more abundant in finer-grained substrate, such as within shallow depressions or runnels. A moderate level of diversity may be supported; plant species recorded within this habitat include the endemics *Pulicaria glutinosa, Echiochilon jugatum, Echiochilon riebeckii* and *Limonium sarcophyllum*.

The Ecology Report developed by HMR Consultants in 2014 treats Wadi Courses and Gravel and Sandy Plains habitats as a single habitat type “Gravely Plains and Wadi Lowlands”. Plate 3-5 shows the Gravel Plains and the Ecology Report developed by HMR Consultants in 2014 notes the following about this habitat conglomerate:

- Livestock grazing pressures result in the suppression of palatable species and can stunt vegetation growth in the long term.
- Feral domestics, especially donkeys, which roam freely, add to the grazing pressures from livestock.
- Anthropogenic actions such as off road driving and firewood collection can also suppress vegetation coverage.
- Utilization of groundwater due to digging wells can result in drought conditions for local vegetation.

Plate 3-5: Gravel Plains Habitat with *Acacia tortillis* (HMR, 2014)

3.2.5 Low Rocky Outcrops and Gravel Hills Habitat

Low rocky outcrops and gravel hills habitat is naturally highly fragmented and covers a relatively small area of the site, but is not considered rare in Oman (Plate 3-6). It generally supports very little vegetation, and has low ecological diversity naturally. The only

endemic recorded to occur within this habitat within the EIA developed by Five Oceans in 2011 was *Pulicaria glutinosa.*

Plate 3-6: Low Rocky Outcrop Habitat (Five Oceans, 2011)

3.2.6 Piedmont and Foothills Habitat

Piedmont and foothills is mostly situated at the base of the mountains. Red shaley rock is interspersed with hollows and runnels that accumulate sand, soil, water and nutrients. Vegetation within this habitat is exclusive to these runnels. Despite being generally barren, 26 species of plant were recorded to occur within this habitat type in the EIA developed by Five Oceans in 2011. *T. qatarensis* occurs frequently within the gullies that border mountainous areas. Endemics recorded include *L. sarcophyllum* and *Halothamnus bottae (*Plate 3-7). Sections of this habitat are in relatively natural condition, although some areas are bisected by roads, tracks, and disturbed due to quarrying activity.

Plate 3-7: *Halothamnus bottae, endemic* (HMR, 2014)

3.2.7 Rocky Mountains and Escarpments Habitat

This habitat consists of table top plains, ravines and gullies with slopes and escarpment. The hill forms micro-habitats such as very shallow gravel runnels and rocky outcrops. Occasional monsoonal rains create these micro-habitats while eroding the surface soils to the Wadi slopes and plains. The pre-monsoon remains harsh for vegetation to sustain and most of the dry shrubs seen in this habitat are the result of moisture unavailability.

Acacia tortilis is the most prevalent tree in the entire region recorded on hill tops, slopes and foot hills and has a different type of growth in the mountainous region. The observed density is 1 to 2 trees per $20m^2$ area. This habitat has very low vegetation in terms of shrubs mostly due to low water availability throughout the year; the ones with high adaptation have survived in these areas. The common and the most

prevalent species is *Tetraena qatarensis*, noted in very shallow sandy and gravel runnels and on dry plateaus. *Anabasis setifera, Convulvulus hystrix dhofarica* and *Pulicaria omanensis* are found in the area with very low occurrence and listed as near endemic and threatened. *Ziziphus leucodermis* is again a species which is regionally endemic.

Plate 3-8 depicts steep slopes with little vegetation in the study area.

Plate 3-8: Steep slopes with little vegetation (Five Oceans, 2011)

In addition to the plants, there is one species of saxicolous lichens growing on the rock. The lichens cover almost the entire area of escarpment and plateaus with rocky topography. This is indicative of the moisture provided by coastal fog and dew (Jurong, 2011) and invariably these lichens vary seasonally and their abundance remains dynamic according to fluctuations in fog distribution.

The Ecology Report developed by HMR Consultants in 2014 treats Low Rocky Outcrops and Gravel Hills, Piedmont and Foothills, and Rocky Mountains and Escarpments as a single habitat type "Hilly Terrain and Escarpments". The Ecology Report developed by HMR Consultants in 2014 module notes the following about this habitat conglomerate:

- The steeper areas of this habitat type show lower vegetation coverage and lower diversity but are more pristine in comparison to other habitat types.
- This habitat type is sensitive due to its support of sensitive fauna such as Gazelle and Oryx.

3.3 Fauna

All the large mammals occurring in the study area have regional and international importance and are provided protection through the Royal Decree - RD 114/2001. The organisms listed in Appendix 2 of the RD are given protection while the organisms stated in Appendix 1 of the RD have high conservation values. The species that are part of Appendix 1 and 2 are presented in Table 3-1 and Table 3-2 respectively.

Table 3-1: Species of SEZ area listed in Appendix (1) of RD 114/2001

Scientific Name	Common Name
Oryx Leucoryx	Arabian Oryx
Panthera pardus nimr	Arabian Leopard
Hemitragus jayakari	Arabian Tahr
Gazella subgutturosa marica	Reem (Sand Gazelle)
Capra ibex nubiana	Nubian Ibex
Hyena hyena sultana	Striped Hyena
Gazella gazelle cora	Arabian Gazelle
Chalmydotis undulata	Houbara Bustard

Scientific Name	Common Name
Felis caracal	Caracal Lynx

Table 3-2: Species of SEZ area listed in Appendix (2) of RD 114/2001

Scientific Name	Common Name
Mellivora capensis	Honey Badger
Lepus capensis	Hare
Vulpes vulps	Red Fox
Chelonia mydas	Green Turtle
Caretta caretta	Loggerhead Turtle
Lepidochlys olivacea	Olive Ridley Turtle
Eretmochlys imbricatta	Hawksbill Turtle
Felisi sylvestris	Wild Cat
Felisi margarita	Sand Cat
Vulpes reuppellii	Rueppell's Sand Fox
Canis lupes	Arabian Wolf

3.3.1 Mammals

Large mammals occurring in the area are the Arabian Oryx, Gazelle and Nubian Ibex which are of conservation importance as listed above. The mountain habitat and escarpments along with the foothills and slopes are the most important areas for resident and transient aforesaid large wild herbivores. Large mammal which may travel between the Oryx Sanctuary and the adjoining areas include the Nubian Ibex and Gazelle.

The Oryx population is confined to the designated Arabian Oryx reserve area. There are records of Nubian Ibex sightings in the Huqf escarpment, Saih Nigaw and the coastal southern cliffs of Khaluf, Salutiyat, Sidrah, Nafun, Ras Markaz and Ras Madrakah (Jurong 2011) and escarpments behind Duqm town (Per. Obs - Diwan of Royal Court - Office for Conservation of the Environment). Another important large herbivore is the Arabian Gazelle which in under the threat on account of poaching activities.

Red Fox (Listed in Appendix II of RD 114/2001) was sighted inside the port area on the breakwater during survey by HMR (Plate 3-9). Fox pugmarks have been observed on the entire coast and coastal dune areas. Small mammals like Gerbils, Jirds and Cape Hare have better distribution compared to larger mammals. Bats have also been reported in the area.

Plate 3-9: *Vulpes vulps* (HMR, 2014)

3.3.2 Herpetofauna

Herpetological checklist of Oman identifies a considerable number of regional and national endemic species.

The rarest group representation in this region is of amphibian; one species of toad has been recorded in the SEZ area. The unavailability

of fresh water throughout the year is the important reason for the absence of this group.

Reptiles are well represented in the area with high abundance and distribution, which includes lizards. A total of 26 lizard species have been documented out of which many have rare occurrence, and few have high abundance (Gardner 1990). The most abundant species recorded were *Mesalina adramitana (*Plate 3-10), *Acanthodactylus boskianus*, *Acanthodactylus opheodurus*. As per HMR reports no snakes were recorded during survey. Considerably large burrows were sighted on the gravel-plains and sandy patches which was reported to be of *Uromastyx thomasi*.

Plate 3-10: *Mesalina adramitana* (Desert Race-runner) (HMR, 2014)

3.3.3 Avifauna

The maximum avifaunal diversity are observed in the coastal region where over-wintering shore birds dominate the beaches. The most prevalent avifauna in the region is the Siberian Gull and the Caspian Gull. These along with Great Black headed Gull, Sooty Gull, Flamingos (Plate 3-11, mostly sub-adults) and five other species of Terns, cover all the sandy beaches of the SEZ area.

***Plate 3-11:* Flamingo (HMR, 2014)**

The coastal habitat is important migratory ground for wintering birds. Other smaller Gulls and Terns (Plate 3-12) are local migratory or resident birds which cover smaller distances to reach these feeding grounds. Upon the onset of summer these birds migrate back to their respective breeding grounds.

The two most significant beaches in the study area are Ras Markaz and the beach from Duqm Port stretching up to Nafun. Shorebirds like Godwits, Sanderlings, Plovers, Dunlins, Oystercatcher, Herons, Egrets, and Cormorants also frequent the area in sizable numbers. Flamingos were spotted on both the beaches although in low numbers (7 and 15 nos). A healthy population of Osprey (Plate 3-13) was also observed all along the coast.

Plate 3-12: Terns (HMR, 2014)

Plate 3-13: Osprey (HMR,2014)

As per the Oman Bird Research Committee (Eriken, 2010) a total of 168 birds species have been recorded from the region. The Wadis and the gravel/sandy plains have good vegetation and hence are inhabited by many birds like shrikes, sparrow-larks, hoopoe larks, laughing dove and wheatears. Open woodlands with scant trees and gravel and stony grounds are other habitats well adopted by ground loving birds such as Coursers, Redstarts, Sandgrouse and species of larks.

Two Red Data avifaunal species were recorded, namely the European Roller (*Coracias garrulus*) and Black -tailed Godwit (*Limosa limosa*). These species are listed as Near Threatened (NT) on the IUCN Red Data List (IUCN, 2013).

3.3.4 Arthropods

The literature available on the diversity and distribution of insects is limited with no authentic checklist, though a considerable population of various insect species was observed in the area. A small size (~3cm) brown grasshopper (Plate 3-14) was observed in good numbers in the northern Wadis and plains of the study area.

Plate 3-14: Acridid Grasshopper (HMR, 2014)

The Desert Blue Butterfly frequents various flowering plants across the entire study area while the same is observed with the Orange Tip (*Colitis sp.*) at select locations.

A sizable population of Pitted Beetle (7-10 numbers/10m_2) was observed in the south Wadis and gravel plains. Dragonflies were also observed throughout the region especially near towns and villages.

All the sites were recorded with the burrow traps made by Antlions which indicate that the area is abundant in the distribution of ants (Plate 3-15). The most abundant and well distributed were the colonies of large black ants.

Plate 3-15: Ant (*Camponotus sp.*) (HMR, 2014)

4 ENVIRONMENTAL PERMITTING REQUIREMENTS

4.1 Environmental Regulatory Procedure

The environmental permitting requirements within SEZ are governed by SEZAD Environmental Regulatory Department. A summary of the permitting procedure is outlined below:

1. In accordance with SEZAD Decision 326/2015, the SEZAD Environmental Regulatory Department have developed a list of projects within the SEZ that require an Environmental Impact Assessment (EIA).
2. MECA regulation promulgated under MD 48/2017, issued in May 2017, has categorised the projects into three types and has listed the projects, which require EIA study. MD 48/2017 shall also be taken into consideration during the permitting requirement.
3. For projects requiring an EIA study, the development shall undergo the following:

- Scoping study, identifying the topics and methodology, that need to be included in the EIA. Reviewing of scoping report takes up to 15 days.
- On approval of scoping study, an EIA study is conducted and submitted to SEZAD. The reviewing of an EIA report shall take 40 days as per SD 326/2015.

4. On approval of the EIA report, a permit application is submitted to SEZAD with required documents.
5. For projects, which do not require an EIA study, the development can directly go for permitting, with the required documents.
6. For projects not listed in SD 326/2015 and/or which falls in Category C of MD 48/2017, a screening exercise is conducted by SEZAD Environmental Regulatory Department, depending on the project application, and a screening opinion,[1] is provided.

4.2 Environmental Impact Assessment (EIA)

The EIA study shall be developed by a MECA registered environmental consultant[2]. SEZAD have the authority to reject environmental reports which are conducted by companies who are not registered with MECA to undertake these studies.

EIA is a procedure undertaken for those projects with major/significant impacts to the environment. For an industrial

[1] SEZAD reserves the right to request EIA study for projects that are not listed in the regulations. This shall be decided during the screening stage of the project and depending on type of project and likely impacts

[2] A list of the MECA registered environmental consultants can be obtained from MECA.

project, the EIA generally would assist in determining site suitability as well as the necessary environmental control and mitigation measures.

The objectives of the EIA are summarized as follows:

- To examine and select the best from the project options available;
- To identify, predict and assess significant residual environmental impacts;
- To recommend and incorporate into the project plan, appropriate abatement and mitigating measures; and
- To identify the environmental costs and benefits of the project to the community.

For details on Environmental Impact Assessment, Refer SEZAD Environmental Impact Assessment Guideline.

4.3 Biodiversity Impact Assessment (BIA)

While all EIAs should include terrestrial ecology in their assessments, some projects due to their location or nature of activities may have larger impacts on biodiversity than others. For such projects, the EIA should require a detailed study of the effects of a proposed project on the biodiversity of the existing ecological environment.

A Biodiversity Impact Assessment (BIA) will be required to be included within the project's EIA for industries whose construction or operation will put pressure on any of the identified sensitive ecological receptors of the SEZ area. If projects meet any of the following criteria and/or if required, a BIA should be included within the EIA for the project:

- If the project will involve damming, re-directing, or engineering of any wadis;
- If the project will include a comprehensive Landscaping Design;
- If the project footprint will occur within Wadi Courses habitat or Rocky Mountain & Escarpment habitat or impact major Wadis;
- If the project location has over 10% vegetation coverage prior to the start of works.

For more details on the appropriate assessment methodology for the BIA, refer to Section 5.

4.4 Biodiversity Action Plan (BAP)

A Biodiversity Action Plan (BAP) will detail all of the required actions to undertake as per the mitigation measures identified during the BIA. Required mitigation measures may vary and will be project-specific and be heavily influenced by spatial and temporal location of project activities.

For more details on the appropriate monitoring methodology for the BAP, refer to Section 5.

4.5 Construction Environmental Management Plan (CEMP) / Operational Environmental Management Plan (OEMP) / Decommissioning Environmental Management Plan (DEMP)

A CEMP/OEMP/DEMP is a practical plan of management measures which are designed to minimise environmental impacts from the construction and operation phase of a project. The document will need to outline the below requirements (at a minimum):

- Site specific activities of the development.
- Address the associated environmental and heritage issues.
- Provide planned management strategies to avoid and minimise impacts.
- A CEMP/OEMP/DEMP will also provide a management plan for how wastes generated by the activities will be contained and cleaned-up appropriately.

Refer SEZAD Environmental Impact Assessment Guideline for details on CEMP/OEMP.

5 MONITORING AND ASSESSMENT METHODOLOGIES

On project specific basis, the project applicant may be required to develop a Biodiversity Impact Assessment (BIA) and a Biodiversity Action Plan (BAP). This section describes the monitoring & assessment methodologies that shall be implemented by the project applicant in accordance with international best management practices. The required mitigation measures are discussed in Section 6.

5.1 BIA Assessment Methodology

A Biodiversity Impact Assessment (BIA) will include three main components: a baseline survey to understand the existing biodiversity receptors present; assessment of impacts that may occur on those receptors from project activities; and calculation of the residual effects expected with the implementation of proposed mitigation measures.

5.1.1 Baseline Survey Methodology

Zone of Influence

The Zone of Influence (ZoI) should be established, the area inclusive of the project location and the surrounding vicinity likely to be impacted by project activities. A buffer zone of 500m is generally considered to be sufficient, although the ZoI may be more extensive for projects expected to have further-reaching impacts, such as those affecting surface water drainage patterns or causing large-scale habitat fragmentation.

Baseline Survey

A baseline biodiversity survey should be undertaken throughout the ZoI, and should cover all aspects of terrestrial ecology, inclusive of habitat classification and identification of flora and fauna species on site.

The methodology of survey will depend on the season(s), duration and level of detail required; however, the following techniques may be employed:

- Remote sensing habitat mapping;
- Vegetation quadrats or transects;
- Diurnal bird surveys;
- Spoor surveys;
- Drive-overs and walk-overs;
- Nocturnal spotlighting;
- Sherman mammal trapping;
- Pit bucket trapping; and
- Camera trapping

Findings of the baseline survey should be summarized to showcase the habitats, flora and fauna present in the ZoI. In cases where rapid assessment or single season surveys have been undertaken, a desktop study to capture potential receptors expected within the ZoI should also be undertaken to compliment the findings of the field survey.

5.1.2 Valuation of Receptors

Once the field survey and desktop study (if applicable) have been completed, a valuation of all ecological receptors present within the ZoI should be undertaken. The valuation is qualitative and is based on a number of factors, such as:

- The rarity of the receptor
- The health of the habitat or species population
- The influence of the receptor (i.e. critical habitats and keystone species)
- The importance of the local receptor relative to the global conservation status

Refer to Table 5-1 for qualitative rankings to be applied when valuating receptors.

5.1.3 Impact Assessment Methodology

Identification of Impacts

In order to appropriately assess project impacts on biodiversity elements, the project components likely to cause impacts should be isolated, and a cause and effect relationship should be extrapolated.

Table 5-2 provides a list of biodiversity threats arising from typical industrial activities that might occur at the main industry types of concern (Petrochemicals, Limestone/Cement, Silica Sand/Glass, Fish Processing, Automotive Industry, Power Generation and Desalination).

Characterization of Impacts

A number of factors characterize an impact. These include: the value of the affected receptor; the extent, duration and magnitude of the impact; whether or not an impact is reversible, and the likelihood that the impact will occur. Table 5-2 provides common qualitative rankings for each factor that can be used when characterizing impacts[3].

[3] Developed utilizing "Guidelines for Ecological Impact Assessment in the United Kingdom", promulgated by The Institute of Ecology and Environmental Management (IEEM). Released in 2006.

Table 5-1: Impact Characterisation

Characterization Factor	Description	Qualitative Rankings	Ranking Definitions
Nature of impact	the beneficial or adverse nature of the impact	Negative	The impact is detrimental to biodiversity receptors
		Positive	The impact is beneficial to biodiversity receptors
Characterization Factor	Description	Qualitative Rankings	Ranking Definitions
		Low	Receptor is common, widespread, and not currently threatened, with stable or increasing populations.
		Medium	Receptor is frequent, widespread, and not currently threatened, although populations may be on the decline.
		High	Receptor is infrequent, threatened, and populations may be on the decline.
		Critical	Receptor is rare and threatened, with few isolated and declining global populations.
Extent of impact	the area over which an impact occurs	On-site	Impact restricted to the project boundary
		Local	Impact restricted to the Zone of Influence (ZoI)
		Regional	Impact may be substantial across a large region
		Global	Impact may be substantial globally
Magnitude of impact	the "size" or "amount" of an impact	Small	A slight amount of receptors are affected.
		Medium	An intermediate amount of receptors are affected.
		Large	A sizable amount of receptors are affected.
Duration of impact	the duration of time the impact occurs	Temporary	Impact occurs only during the initial project activity
		Short-term	Impact occurs only during the project construction/ operation phase

Characterization Factor	Description	Qualitative Rankings	Ranking Definitions
Reversibility of impact	whether or not the impact will be reversible after it has been caused	Long-term	Impact continues past the construction/operation phase
		Permanent	Impact continues beyond the lifetime of the project
		Reversible	An impact from which spontaneous recovery is possible or, for which effective mitigation is possible.
		Irreversible	An impact from which recovery is not possible within a reasonable timescale or for which there is no reasonable chance of action being taken to reverse it.
Frequency of impact	Frequent disturbances are more likely to cause impact than infrequent	Irregular	Impact not expected to occur at regular intervals
		Occasional	Impact expected to occur at regular but infrequent intervals
		Recurrent	Impact expected to occur regularly and frequently
Timing of impact	Some impacts may occur during important life-stages or seasons	Null	The impact is not expected to occur during a critical life-stage/season
		Poor	The impact is expected or assumed (worst case scenario) to occur during a critical life-stage/season
Likelihood of impact	the chance of the impact occurring as predicted	Certain	probability estimated at 95% chance or higher
		Probable	probability estimated above 50% but below 95%
		Unlikely	probability estimated above 5% but less than 50%
		Extremely Unlikely	probability estimated at less than 5%

Table 5-2: Industrial Activity Threat to Biodiversity

Project/Activity	Description/Examples	Applicable Industries	Main Biodiversity Threats
Enabling Works	Works during construction phase related to preparation for infrastructure development, e.g. → Excavation/Trenching → Clearing/Grading → Cut and fill → Backfilling	→ Petrochemicals → Limestone/Cement → Silica Sand/Glass → Fish Processing → Automotive Industry → Infrastructure Projects *(any may require construction of new facilities and infrastructure)*	→ Loss of flora → Loss of fauna → Habitat degradation → Habitat loss
Linear Works	Works occurring along an alignment, e.g. → Laying down of pipelines → Construction and operation of railroads and roadways → Construction of transmission towers	→ Petrochemicals → Limestone/Cement → Silica Sand/Glass → Fish Processing → Automotive Industry → Infrastructure Projects *(any may require access roads or utility pipelines and towers)*	→ Habitat fragmentation
Anthropogenic Disturbances	Construction or operation of factory/plants, e.g. → Movement of vehicles /machinery → Anthropogenic noise → Artificial lighting → Urban infrastructure	→ Petrochemicals → Limestone/Cement → Silica Sand/Glass → Fish Processing → Automotive Industry → Infrastructure Projects *(anthropogenic activities applicable to all)*	→ Edge effects → Loss of sensitive species → Decrease in biodiversity
Discharges to Air	Air pollutants generated from burning of fossil fuels or as a byproduct of chemical reactions are released to atmosphere	→ Petrochemicals stacks and flares release PM_{10}, SO_2, NOx, CO, VOC and GHGs → Limestone/Cement factories release PM_{10}, SO_2, NOx, CO and GHGs → Silica Sand/Glass processes release PM_{10}, SO_2, NOx, CO, VOC, GHGs and Fluoride → Fish Processing release Ammonia, Amines, Amides, Hydrogen Sulphide, Sulphides and Mercaptans → Power Generation releases PM_{10}, SO_2, NOx, CO, VOC, GHGs, Fluoride, Ammonia, Hydrogen Sulphide, Sulphides, and	→ Acid rain impacts on flora → Bioaccumulation of toxins in the local food web → Global warming / climate change

Project/Activity	Description/Examples	Applicable Industries	Main Biodiversity Threats
		Mercaptans, Hydrogen Chloride, Metals, Polycyclic Aromatic Hydrocarbons (PAH), and Dioxins, Polychlorinated Biphenyl (PCB). → Desalination processes release PM_{10}, SO_2, NOx, CO, VOC, GHGs, Fluoride, Ammonia, Hydrogen Sulphide, Sulphides, and Mercaptans, Hydrogen Chloride, Metals, Polycyclic Aromatic Hydrocarbons (PAH), and Dioxins, Polychlorinated Biphenyl (PCB).	
Noise Emissions	Industrial machinery may generate noise emissions higher than baseline conditions	→ Petrochemicals flares, compressors, pumps, turbines, and air coolers → Limestone/Cement raw material extraction, grinding, product handling/transport, and exhaust fans operation → Silica Sand/Glass and Metal Casting foundry operations, scrap metal handling, overhead crane and charger operation → Fish Processing compressors, automatic packing machinery, condensers, ventilation units, and pressurized air → Power Generation include fans, pumps, turbine/generator, combustion exhaust, steam discharges, fuel handling operations, pipe radiation, and electrical transformers → Desalination plants high energy pumps used to pressurize seawater during Reverse Osmosis process, blowers and back-up generators	→ Disturbances to sensitive fauna, particularly breeding birds
Water Usage	Water is commonly utilized as an input or cooling agent, in industrial processes	→ Petrochemical extraction, refining and manufacturing require large quantities of water → Limestone/Cement uses water to leach collected kiln dust and remove soluble alkali → Fish Processing uses water for cleaning and processing purposes → Automotive Industry consumes water for production purposes → Power Generation uses seawater for cooling → Desalination processes use seawater for conversion to potable water.	→ Depletion of available water from the watershed can have far-reaching consequences, degrading habitat, and resulting in loss of flora and fauna

Project/Activity	Description/Examples	Applicable Industries	Main Biodiversity Threats
Discharges to Water	Wastewater generated as a result of industrial operations is released into the environment	→ Petrochemical injection, tank farms, processing, and flushing activities can result in wastewater with chemical pollutants → Limestone/Cement industries typically generate wastewater with high pH, dissolved solids and suspended solids → Fish Processing generates wastewater from leaks, spills, equipment washouts containing BOD, COD, TSS, oil, and grease → Automotive Industry generates wastewater from surface treatment and coating, washing, cooling and boilers → Power Generation wastewater streams include cooling tower blowdown; ash handling wastewater; wet flue-gas desulphurization (FGD) system discharges; material storage runoff; metal cleaning wastewater; and low-volume wastewater, such as air heater and precipitator wash water, boiler blowdown, boiler chemical cleaning waste, floor and yard drains and sumps, laboratory wastes, and backflush from ion exchange boiler water purification units. → Desalination processes discharge brine or concentrate and other treatment process side-streams, such as spent pre-treatment filter backwash water, membrane rinsing water, and treated membrane cleaning water	→ Pollution of groundwater or surface water resulting in health impacts on flora and fauna → Bioaccumulation of toxins in the local food web → Degradation of habitat
Contamination	Industrial operations may result in contamination incidents, e.g. → Spills of toxic or hazardous materials → Improper disposal of hazardous wastes	→ Petrochemicals raw materials include hydrocarbons which can contaminate soil → Limestone/Cement dust build up and leaching from storage and waste areas can contaminate soil → Fish Processing wastewater can contaminate soil as well → Automotive Industry raw materials and waste streams include petroleum products, solvents, rubber, oils, and batteries which can contaminate soil → Power Generation wastewater (e.g. blowdown, ash handling wastewater, material storage runoff, etc.), the solid waste generated due to the high percentage of ash in the fuel (e.g. fly ash, bottom ash, boiler slag, etc.), and the hazardous materials	→ Mortality of directly affected fauna Health impacts or loss of flora species or communities → Degradation of habitat → Bioaccumulation of toxins in the local food web

Project/Activity	Description/Examples	Applicable Industries	Main Biodiversity Threats
		stored and used in the combustion facilities (e.g. liquid fuel, chemicals, etc.) can contaminate soil. → Desalination processes produce brine which can contaminate soil if discharged to disposal ponds. → Infrastructure Projects – Leakage of pipelines etc	
Light Pollution	Industrial factories may require nighttime lighting or may generate light → Natural gas flaring generates light	→ Petrochemicals → Limestone/Cement → Silica Sand/Glass → Fish Processing → Automotive Industry → Power Generation → Desalination → Infrastructure Projects *(any may require nighttime lighting)*	→ Disturbances to circadian rhythm and behavior of fauna

Table 5-3: Impact Scoring

Impact Scoring	Receptor Value	Extent	Magnitude	Duration	Reversibility	Frequency	Timing	Likelihood
Ranking Values	Low (1)	On-site (1)	Small (1)	Temporary (1)	Reversible (1)	N/A (0)	Null (0)	Extremely Unlikely (1)
	Medium (2)	Local (2)	Medium (2)	Short-term (2)	---	Irregular (1)	---	Unlikely (2)
	High (3)	Regional (3)	Large (3)	Long-term (3)	---	Occasional (2)	---	Probable (3)
	Critical (4)	Global (4)	---	Permanent (4)	Irreversible (4)	Recurrent (3)	Poor (4)	Certain (4)

Assessing Impact Significance

Once an impact has been characterized, the impact should be assessed for its significance rating.

For each impact, a relative score can be calculated utilizing the eight characterization factors. Lower scores indicate less significant impacts, while higher scores indicate more significant impacts.

Table 5-3 above provides the value assigned to each qualitative ranking. For each impact, simply add the corresponding score value to calculate the impact's overall score.

The highest maximum score possible utilizing this approach would be 30, while the minimum score possible would be 6.

Notes:

1. The impact nature is not included in the scoring, since this speaks to the beneficial or adverse effect the impact will have;
2. Receptors Value for "Negative" are not allotted a score since they will not be the focus of an impact;
3. The "N/A" category for Frequency is to be used when the factor is not applicable for the impact; and
4. Reversibility and Timing have staggered scoring to indicate the disparity between the two qualitative rankings.

The impact scores can be used to determine the significance of the impacts. Table 5-4 provides the scoring and definitions of impact significance ratings.

Table 5-4: Impact Significance Ratings

Significance Rating	Definition
No Change (Score 6-10)	No significant change to the current baseline conditions is expected as an outcome of the impact.
Negligible (Score 11-15)	Negligible change to the current baseline conditions is expected as an outcome of the impact.
Minor (Score 15-20)	Minor change to the current baseline conditions is expected as an outcome of the impact.
Moderate (Score 20-25)	Moderate change to the current baseline conditions is expected as an outcome of the impact.
Major (Score 25-30)	Major change to the current baseline conditions is expected as an outcome of the impact.

5.1.4 Mitigation and Residual Effects

Mitigation measures should be provided in the BIA for all impacts, and must be provided for any negative impacts of Moderate or higher significance. Although mitigation measures will be project-specific, Table 5-5 presents some typical mitigation approaches to the main biodiversity threats identified earlier.

Once mitigation measures have been proposed, residual effects of impacts should be calculated. The amount of significance reduction that a mitigation measure can achieve will depend entirely on the nature of the mitigation.

Typically, mitigation that alleviates but does not prevent impacts can result in a "step-down" calculation of residual effects; for example, an impact of "Major" significance with applied mitigation may become "Moderate". However, if mitigation prevents a potential impact altogether, the residual effect will be "No change", regardless of the initial significance rating.

Table 5-5: Typical Mitigation Measures

Project/Activity	Main Biodiversity Threats	Typical Mitigation Measures
Enabling Works	→ Loss of flora → Loss of fauna → Habitat degradation → Habitat loss	→ Protection of important flora/fauna species populations and critical habitat → Minimization of enabling works where possible
Linear Works	→ Habitat fragmentation	→ Protection of core habitat mosaics → Provision of wildlife crossing structures
Anthropogenic Disturbances	→ Edge effects → Loss of sensitive species → Decrease in biodiversity	→ Encouragement of high density development and reduction of encroachment into undeveloped areas → Protection of important flora/fauna species populations and critical habitat
Discharges to Air	→ Acid rain impacts on flora → Bioaccumulation of toxins in the local food web → Global warming / climate change	→ Implementation of mitigation to reduce air pollution
Noise Emissions	→ Disturbances to sensitive fauna, particularly breeding birds	→ Implementation of mitigation to reduce noise pollution
Water Usage	→ Depletion of available water from the watershed can have far-reaching consequences, degrading habitat, and resulting in loss of flora and fauna	→ Implementation of mitigation to reduce water consumption → Consideration of provision of artificial recharge of aquifers in specific scenarios
Discharges to Water	→ Pollution of groundwater or surface water resulting in health impacts on flora and fauna → Bioaccumulation of toxins in the local food web → Degradation of habitat	→ Implementation of mitigation to reduce water pollution
Contamination	→ Mortality of directly affected fauna Health impacts or loss of flora species or communities → Degradation of habitat → Bioaccumulation of toxins in the local food web	→ Implementation of mitigation to reduce risk of spills → Appropriate waste management

Project/Activity	Main Biodiversity Threats	Typical Mitigation Measures
Light Pollution	→ Disturbances to circadian rhythm and behavior of fauna	→ Minimization of artificial light usage

5.2 BAP Monitoring Methodology

A Biodiversity Action Plan (BAP) will include two main components: the preventative and protective measures to be followed as proposed by the BIA; and a projected schedule and strategy for monitoring results.

As mentioned, the mitigation measures that will be captured in a BAP will be entirely dependent on the project. However, some guidance can be given in terms of understanding the parameters that might require monitoring, how to distinguish appropriate frequencies and reporting of results.

5.2.1 Monitoring Parameters

A number of parameters can be monitored as a means to ensure compliance with required biodiversity mitigation.

If the receptors identified to be at risk from impacts are habitats or flora, monitoring may involve any of the following methods:

- Habitat mapping via remote sensing and use of GIS technology;
- Visual assessment of vegetation coverage;
- Flora surveys (via quadrating or transects) to assess biodiversity index, species composition, or health of floral communities; or
- Field surveys to check for signs of habitat degradation.

If the receptors identified to be at risk from impacts are fauna, monitoring may involve any of the following methods:

- Faunal surveys (via sighting, spoor or trapping surveys) to assess biodiversity index, species composition, or health of communities; or
- Population surveys of target species.

5.2.2 Establishing Monitoring Frequencies

The actual timing and frequencies of monitoring should be established within the BAP, and will be reviewed and approved by SEZAD Environmental Regulatory Department on a case by case basis. However, general rules of thumb to keep in mind include:

- Birds are generally more active in the early morning hours;
- Nocturnal fauna will only be active during night time hours;
- Seasonal considerations such as breeding season and migratory season will impact monitoring results;
- The flowering season of flora differs amongst flora species;
- Reptiles are more likely to be active during the midday and generally are inactive during the cooler winter months; and
- Trapping of fauna during the peak summer months may not be advisable due to the stress caused by high temperatures.

Annual, bi-annual and monthly frequencies are general monitoring frequencies that might be recommended, depending on the nature of the parameter being monitored.

5.2.3 Reporting Monitoring Results

The findings and results of on-going monitoring should be compiled into a series of monitoring reports. Methodology of monitoring and reporting should remain consistent to ensure that results are comparable. A summary section should be included which highlights any incidents or causes for concern at the conclusion of each monitoring exercise.

6 RESTORATION AND ENHANCEMENT MEASURES

In some cases, the existing ecological conditions of a proposed project location will be of low quality, and may not warrant a BIA or BAP. However, all projects have the opportunity to implement beneficial measures to restore and enhance the biodiversity of the project area.

6.1 Ecological Landscaping

Any project with a sizable footprint has the opportunity to implement ecological landscaping. The landscaping design, strategy and management plan should be formulated in concert with a qualified ecologist in order to maximize the ecological benefits that landscaping can bring to an area. The landscaping design and management plan should include the following elements:

- Planting palate to consist of drought-tolerant, native vegetation species;
- Target floral species to be planted if applicable;
- Minimal irrigation and chemical management (fertilizer/pesticides) to be applied; and
- Utilization of other landscaping elements (rock, water elements) to create microhabitats for fauna.

6.2 Artificial Wetlands[4]

Artificial wetlands provide both an ecological and anthropogenic benefit. Also referred to as Constructed Wetlands (CW), these are able to treat wastewater discharge as well as provide habitat for fauna species which inhabit mudflats and similar ecosystems.

The document, “Guiding Principles for Constructed Treatment Wetlands: Providing for Water Quality and Wildlife Habitat”, published in October 2000 and promulgated by the US Environmental Protection Agency, provides guidance on the siting, design, construction and operation of CWs .

Many industries will require the treatment of wastewater. It would be of significant beneficial value to consider the implementation of CWs in lieu of the traditional Sewage Treatment Plant (STP).

6.2.1 Habitat Restoration

Habitat restoration is undertaken when the goal is to restore an area of land to its original ecological conditions. If any tracts of area within the SEZ are considered undevelopable, but have been degraded due to grazing, water abstraction and other anthropogenic pressures, the opportunity exists to implement habitat restoration.

The basic approach to habitat restoration includes the following steps[5]:

[4] <http://www.epa.gov/wetlands/constructed-wetlands>

[5]<http://www.ser.org/resources/resources-detail-view/guidelines-for-developing-and-managing-ecological-restoration-projects>

1. Conceptual planning, including identification of the site location and boundaries; need for restoration; type of ecosystem to be restored; and restoration goals;
2. Preliminary tasks, including appointment of a technical contractor, preparation of pre-project monitoring and setting of baseline conditions, definition of a list of objectives and goals, and training of project personnel;
3. Implementation planning, including preparation of performance standards and monitoring protocols, obtaining equipment and supplies, and preparing a budget;
4. Implementation tasks, including marking of boundaries and work areas, installation of permanent features, and implementation of restoration actions;
5. Post-implementation tasks, including protection against disturbance, maintenance, monitoring against goals and standards, and implementation of adaptive management procedures as needed; and
6. Evaluation and publicity, including assessment of monitoring data to determine success rate, ecological evaluation of completed project, and publicizing written accounts of the completed project.

Within the SEZ, restoration of critical wadi and runnel habitat may be the most effective use of resources put towards habitat restoration.

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