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Environmental Impact Asessment of 3D Seismic Acquisition in The Badra Oilfield , Iraq

Dr. Mohammad N. Hussain, Jamal A. Zaidan, Abbas M. Ali, Rusul M. Khazaal
Ministry of Oil - PRDC

ABSTRACT:

This study represents the Environmental Impact Assessment (EIA) of 3D Seismic Acquisition in the Badra oilfield, Wasit province, Iraq. Seismic acquisition is part of works under the contract for the development of the Badra oilfield, with a planned capacity of 2 billion barrels of oil, and its associated linear facilities to be located in Wasit, 160 km southeast of Baghdad, Iraq. The study was prepared for the Company – Gazprom Neft Badrah B.V. (GPN) in 2010.

An Environmental Impact Assessment (EIA) study was prepared to identify and assess the potential environmental effects of seismic operations, and in order to accomplish that goal, a baseline environment study was conducted first to illustrate the climate, geology, topography, natural resources, industrial activities, social and natural environment (flora and fauna) of the region based on field visit and desktop history.

Based on the baseline study, mitigation measures forming Environmental Management Plan was proposed aiming to minimize environmental and socio-economic adverse effects such as waste water, solid wastes, air pollution and to maximize positive ones.

The study also illustrated all related national and international laws and regulations to force the company to oblige them during work on the Iraqi land. It also detailed the national and international limits of air emission and liquid effluent quality not to be exceeded.

Introduction:

This document represents the Environmental Impact Assessment (EIA) of 3D Seismic Acquisition in the Badra oilfield, Wasit province, Iraq. Seismic acquisition is part of works under the contract for the development of the Badra oilfield, with a planned capacity of 2 billion barrels of oil, and its associated linear facilities, referred to as "the Project", to be located in Wasit, 160 km southeast of Baghdad, Iraq. The document was prepared by PRDC of the Iraqi Ministry of oil (MoO), for the Company – Gazprom Neft Badrah B.V. (GPN).

Iraq is having the third-largest oil reserve worldwide. It is estimated at 115 billion barrels, after Saudi Arabia and Canada. Iraq produces about 2 million barrels per day (bpd), and exports about 1.6 million bpd of oil. Iraq's North Oil Company, the (NOC), which is the Project "Proponent", is proposing to develop Badra oilfield, which has been awarded to JSC Gazprom Neft, also, Korea's Kogas, Malaysia's Petronas and Turkish TPAO companies. As an operator, Gazprom Neft holds 30% in the project, Kogas 22.5%, Petronas 15%, TPAO 7.5%, while the Iraqi Government represented in the consortium by Iraqi Oil Exploration Company which has a 25% stake in the project. GPN is operating the field under the Service Contract with Iraqi government represented by NOC.

The field has a reserve estimated at 2 billion barrels of oil, and is to be developed on two phases. The first phase production target will be 15,000-25,000 bopd with a plateau production target of 170,000 bopd in the second phase.

An Environmental Impact Assessment (EIA) study was prepared to identify and assess the potential environmental effects of seismic operations. It also proposes mitigation measures forming Environmental Management Plan aimed to minimize environmental and socio-economic adverse effects and to maximize positive ones.

1. List of Acronyms

AAQO	Ambient Air Quality Objective
AAQS	Ambient Air Quality Standard
API	American Petroleum Institute
AQM	Air Quality Monitor
bpd	barrels-per-day
COD	Chemical Oxygen Demand
dB	Decibel
EHS	Environmental, Health, and Safety
EIA	Environmental Impact Assessment
FEED	Front End Engineering Design
FOGC	Federal oil and Gas Council
GPN	Gazprom Neft Badra B.V.
HSE	Health, Safety and Environment
IFC	International Finance Cooperation
MoMPW	Ministry of Municipalities and Public Works
MoO	Ministry of Oil
MoST	Ministry of Science and Technology
MoSTCA	Ministry of State for Tourism and Culture Affairs
MoT	Ministry of Transportation
MoWR	Ministry of Water Resources
NOC	North Oil Company
PRDC	Petroleum research & development center
SCOP	State Company for Oil Projects
SOMO	State Oil Marketing Organization
TOC	Total Organic Carbon
UNEP	United Nations Environment Program
VEC	Valued Ecosystem Component
WWTP	Waste Water Treatment Plant

2 . Regulatory framework:

2.1 National Environmental Laws and Regulations

The regulatory agency responsible for the application of the law and the various rules, regulations and guidelines issued on environmental protection is the The Iraqi Ministry of Environment (MoE).

The basic law on environmental protection in the Republic of Iraq is the "Protection and Improving the Environment Law", law No.3 first issued in 1997.

The various national (Iraqi) laws and regulations on environment identified and available in English are summarized in chronological order in the table (1).

Table (1) Iraqi law and regulation list.

1	Regulation No. (25) of 1967 "Preservation Of Rivers and Public Waters from Pollution"
2	Law No. (99) of 1980 "Protection from the Ionic Radiations"
3	Public Health Act No. (89) of 1981, Article 3, Paragraph 6 & 7 "The Professional Heath Instructions to Protect Workers From Vibrations"
4	Instructions No (2) of 1984 (Chemical Carcinogens)
5	The Hydrocarbon Preservation Law No. (84) of 1985 (Articles related to the environment only)
6	Instruction No.(4) of 1989 Safety in Storing And Handling Chemical Materials
7	Instructions: No. (7) for the year 1993 on the lighting in the work Environment
8	act No.B (2) of 2001 Amendment Iraqi regulation for the preservation of water sources
9	Iraqi Legislation No. (417) of 2001 Standard Specification for Drinking water
10	Law No. (27) of 2009 "Protection And Improvement of the Environment"
11	The determinant of National Emissions activities: "Maximum allowable emission limits of air pollutants emitted from stationary sources"

12	Specification of Sanitary Landfill of Wastes, 1980
13	Environmental instruction for the Industrial Projects
14	Adopted of Ambient Air Quality standards
15	Technical Service Contract, Article 41, Protection of the environment, April 23, 2009
16	Soil remediation policy must use the Holland soil remediation intervention values, "regulations for soil/sediment and groundwater indicative levels for serious contamination and target values" according to 'Risk Management [Omgaan met risico's], The risk-based approach in environmental policy (Ministry of Housing, Spatial Planning and the Environment (VROM), Lower House of Parliament, parliamentary proceedings 1988-1989, 21 137, no. 5). Other valuable standards and regulations to be considered. These are presented in the Circular on target values and intervention values for soil remediation presented in the Holland Convention, Version, February 4th, 2000.
17	(IFC,EHS Guide line for Onshore –oil & Gas Development) \ 2007 are to be considered during the development of this project.
18	Standards for equipment design (API), fire protection (NFPA), and the emergency response (IPIECA) , standards are to be implemented during development of this project.
19	Implementation of the "Environmental and safety management standards "according to the regulation of the "International Standards Organization "(ISO 14000, ISO 18000 series) are to be achieved whenever possible during the development of this project.

2.2 International Conventions & Protocols on Environment:

Iraq is a signatory to several regional and international conventions and protocols on environment, presented in table (2).

Table (2) International Conventions and Protocols.

Convention	DATE	TYPE
Convention for the Protection of Cultural Property in the Event of Armed Conflict with Regulations for the Execution of the Convention. The Hague, 14 May 1954.	21/12/1967	Ratification
Protocol to the Convention for the Protection of Cultural Property in the Event of Armed Conflict. The Hague, 14 May 1954.	21/12/1967	Ratification
Convention concerning the Protection of the World Cultural and Natural Heritage. Paris, 16 Nov. 1972.	05/03/1974	Acceptance
United Nations Convention on the Law of the Sea	10/12/1982	
Vienna Convention for the Protection of the Ozone Layer	22/03/1985	
Convention on Wetlands of International Importance especially as Waterfowl Habitat	02/02/1971	
Protocol concerning Marine Pollution resulting from Exploration and Exploitation of the Continental Shelf	29/03/1989	
Protocol for the Protection of the Marine Environment against Pollution from Land-Based Sources	21/02/1990	
Convention on Biological Diversity	05/06/1992	
International Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa	17/06/1994	
Convention on the Law of the Non-Navigational Uses of International Watercourses	21/05/1997	
Kyoto Protocol to the United Nations Framework Convention on Climate Change	11/12/1997	
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	03/12/1999	
Convention on Wetlands of International Importance especially as Waterfowl Habitat. Ramsar, 2 February 1971.	17/10/2007	Accession
Convention for the Safeguarding of the Intangible Cultural Heritage. Paris, 17 October 2003.	06/01/2010	Ratification
Rotterdam Convention (RC) on the Prior Informed Consent Procedure for Certain Hazardous and International Trade (PIC) .		
Stockholm Convention on Persistent Organic pollution (POPs).		

3 .Baseline Environment

3.1 General Features

Badra Oilfield is located in the eastern part of Iraq 160 km South East of Baghdad near Badra town close to Iran-Iraq border. Administratively, the oilfield site is in the Wasit province. The total area of the Wasit province is 17 153 km^2, the population number (2007) exceeded 1 022 thousand people. The administrative center of the province is El-Kut city, it is illustrated in figure (1).

Fig. (1) Iraqi administrative boundaries.

The territory of the province has been under the control of the U.S peace-keeping forces since 2005. The Wasit province is considered to be one of the calmest in modern Iraq; there are very few acts of violence and

explosions reported there, and in 2009 the control of the province was delegated to the Government of the Republic of Iraq.

The Badra town is located on the right and left banks of the Gallal-Badra river flowing from the territory of Iran passing through Mehran town on the border with Iraq. On the Iraq territory the river is called Gazi River. At present the river on the Iraq territory is dry. It is stated that thus is due to damming activities on the Iranian side [1].

3.2 Topography and Landscape

The Bardra Field is characterized by undulating rocky terrain with sparse vegetation, see figures (2,3).

Fig. (2) One well in Badra field.

Fig. (3) Territory in the area of Badra 2 well.

The land in and around the field consists of hills with low elevation, with salty valley beds, and low/no plant coverage. The area is traversed by small wadis (natural channels), which are dry most of the year. There are no human settlements within or near the field [2].

3.3 Sources of Water

The town water is supplied from underground water sources. The wells are 65 m depth.

Water wells are many, for gravel and breakstone washing is performed on large scale, and there are washing systems everywhere working even if there is no washing. Both banks of the river are lined with palm forests.

3.4 Energy

The local authorities report unstable electric power supply. Sometimes power supply is off for 2-3 hours a day

3.5 Climate

3.5.1 Overview

Iraq is one of the typical countries of arid zone. The climate of the central Iraq is subtropical continental, featuring long hot summers and short moderate winters.

The meteorological data is taken from the Baghdad station located 160 km to the Northwest of the study area (elevation – 34,1 m abs.).

3.5.2 Temperature and humidity

The average annual air temperature is 22,9 °C. The warmest month is July with the average monthly temperature 34,8 °C; the coldest –January with the average monthly temperature 10 °C.

The absolute maximum of the temperature for the record period is 50,2 °C, the absolute minimum was 8,5 °C. The information about the average monthly maximal and minimal temperatures are shown in table (3).

Table (3) Average monthly maximal and minimal air temperature (°C).

Air temp.	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Month ave.	**10,0**	12,3	16,3	21,9	28,4	33,0	**34,8**	34,4	30,6	24,6	17,1	11,0
Abs. max	25,0	30,0	34, 2	41,7	44,6	48,03	50,0	50,2	46,6	42,0	34,8	26,6
Abs min.	-8,5	-6,0	-2,8	1,2	10,0	13,5	16,6	17,8	10,5	3,5	-3,0	-6,7

The annual average absolute air moisture in the piedmont and plain parts of the Tigris river watershed is low: 9,3-11,2 mb. The annual rate of absolute air humidity is the same as that of the air temperature with the maximum in summer (10 -14 mb) and minimum in winter (8-9 mb).

The annual values of relative moisture are 40-45%. The changes of relative moisture are of annual nature with the maximums in winter (65-80%) and

minimums in summer (20-30%). In summer the relative moisture of the air lowers down to 12-13%, at night this increases up to 65-80%.

3.5.3 Precipitation

The annual average precipitation in the Badra region is 150 mm, and near the Iran border with the relief elevation it is up to 17,5 mm. The whole territory features almost absolute absence of precipitation in summer period (June-September). Figure (4) show the seasonal distribution of rainfall.

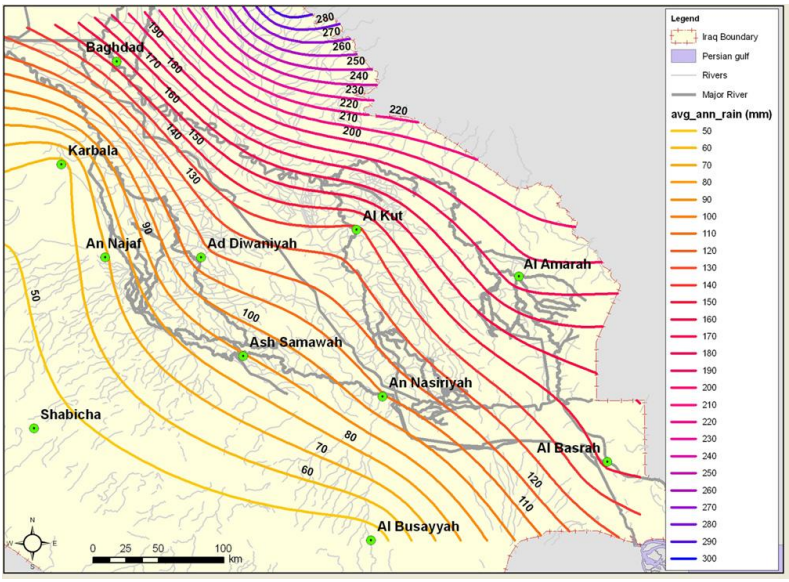

Fig. (4) Annual Rainfall distribution (mm).

The observed daily maximum of precipitation is 65,5 mm. The information of monthly average precipitations is shown in table (4).

Table (4) Average monthly precipitation (mm).

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
25,8	25,3	24,9	22,5	7,3	0,1	0,0	0,0	0,3	3,7	17,4	22,7

3.5.4 Regional Wind Speed and Direction

The predominant wind direction for the major part of the Tigris watershed is northwest with the frequency ratio of about 40%.

The total frequency of north, northwest and west winds is close to 70%. The average annual wind speed is 3,5 m/s. The fastest monthly average wind speeds are during the warm period of the year (June-July) – 4,2-4,5 m/s. Wind speeds exceeding 10 m/s is reported less than 1% annually. The information of the average monthly wind speeds is shown in table (5).

Table (5) Average monthly wind speed (m/s).

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
3,1	3,6	3,9	3,8	3,8	4,2	4,5	4,0	3,3	2,8	2,6	2,7

3.6 Geology and Soil

Iraqi Soil Types

Fig. (5) Badra soil.

In various parts of Iraq, parent rocks are different by age and origin. Among them a special place is occupied by quaternary deposits.

The quaternary system is widely spread in Iraq and represented both by ancient and recent continental deposits. They make up overflow lands and terraces above the flood lands, as well as vast plains of the country.

Generally the quaternary deposits are separated into alluvial, dealluvial-proluvial, alluvial lacustrine-boggy, sedentary, chemogenic and irrigational.

Among the alluvial deposits there are ancient, middle-upper-quaternary and recent. The ancient alluvial deposits are developed in the valleys of all big rivers. As a rule, they do not differ much from the basement series Bakhtyar, and their separation is but conditional. In the Tigris River valley alluvium is more common, and on greater areas; in the Euphrates river valley it is only on separate small areas mainly on the left bank of the river making up the surface of relatively well preserved top terrace. These deposits are also observed in the valleys of the main tributes of the Tigris River (Tanjero, Penjwin, Rania, Sharazur, Kala-Dize etc.).

In the valleys of Tigris and Euphrates rivers the ancient alluvium is well sorted and rolled by semi gravel-cobble-boulder material of volcanic and sedimentary nature with various aggregate – from sands to argillaceous sand ground often cemented into conglomerate. The size of cobble and boulders in the Tigris alluvium varies from 0,1 to 0,2 m and more, in the Euphrates river – up to 0,1 m.

The thickness of the ancient alluvium in the Tigris river valley varies widely.

Usually, on the base of the bedding rock it does not exceed 5-10 м; in the synclinal bowings and on the overdeepening areas of the river valley it amounts to 40-50 m, see figure (5).

3.7 Hydrology and Hydrogeology

3.7.1 Hydrographic Network, Hydrological and Hydrochemical Conditions of Surface Water

The main rivers of Iraq are the Tigris and the Euphrates that cross its territory from the northwest to the southeast. Both have their sources in Turkey and are mainly fed in the high-mountain region of the Eastern Anatolia. Their watershed basins are located in extensive low areas limited by the Anti-Lebanon and Taurus Mountains in the west, by the Pontic range of mountains and Ararat plateau in the north, and by the Zagros Mountains bordering with Iran. The catchment area of the Tigris and Euphrates Rivers is 784,500 sq. km with the area of 359,300 sq. km located within the Iraqi borders, 162,200 sq. km in Turkey, 70,900 sq. km in Syria, 146,500 sq. km in Iran, and 45,600 sq. km in Saudi Arabia. These rivers are fed predominantly by snow and partially by rains. The regime of rivers is characterized by great instability; disastrous floods usually alternated with periods of sharp decline in levels and flows. As a rule, rivers have two floods - in spring and in the late autumn. Spring flood is considered the attainment of a river's maximum level.

The Tigris is one of the largest and abundant rivers in the Middle East. It originates in southeast Turkey, near the city of Elazig as a result of the merging of small water flows originating in Lake Gölcük (Hazar) at the height of approximately 1,200 meters.

The width of the river valley in this area ranges from 3 to 7 km with the stream channel width ranging between 100 and 150 meters; the river depth at rapids does not exceed 1.5-2 meters, while the width at reaches increases to several meters. The river flow rate is 0.8-1.0 mps with the increase to 5 mps during floods; the gradient of the river is 0.0007-0.0008.

Near the town of Kut al-Amara, the river makes a sharp turn to northeast and after forming a wide bend passes close to the border with Iran. In this area, left-bank rivers do not reach the stream channel of the Tigris and feed encountered lakes or spread all over the plain creating extensive swamps.

Near the town of Kut al-Amara where there is a barrage, the Tigris River is joined by Gharraf, the largest channel in Iraq that flows mainly along the old stream channel of the Shatt al-Gharraf River. In about 30 km from the above mentioned town, the Tigris is joined by its last left tributary - the Changuleh River, and up to the town of Qurnah it flows in under-populated and uncultivated swampland with a big area of saline lands. The height of river banks in this area is usually below 2 meters and even lower near the Kalat-Salih village. In its lower reach, the river is divided into many branches that disappear in swamps and lakes. From this point, the express water flow appears again and joins the north branch of the Euphrates near the city of Qurnah fed by swamps in Amarah region.

Due to large amount of silts carried by the river, its outflow is much silted; the width of the stream channel in some parts decreases to 50 meters limiting its capacity dramatically.

Wandering around an extensive plain in the past and having changed its stream channel for several times, the Tigris left many dead channels that were filled with alluvial deposits to different extents and evolved into inland low areas where the lakes occurred.

Within the borders of the Mesopotamian Plain, the Tigris's stream channel is embanked due to the fact that during floods its level was increasing above the surrounding surface level. The total length of the Tigris is 1,900 km with about 1,500 km flowing within the Iraqi borders. The catchment area of the river reaches 370,000 sq. km.

Near the city of Kut al-Amara, the annual water yield decreases to 37 km³ and to 7 km³ near the town of Amara. The maximum estimated flow of the Tiger river given 0.01-percent water supply rate near Mosul is 10,970 m³/s, for Fat'ha village - 24,000 m³/s; given 1-percent water supply for the same areas - 6,700 and 14,000 m³/s.

3.7.2 Groundwater

There are several groundwater surfaces within the study area.

The groundwater of the upper fare are related to the weakly developed sandstone streaks, and this makes for small water content of the whole formation. The mode of water occurrence is layer-linear. Within the synclinal wells they are of pressure nature. The water salinity varies in different regions from 1 to 25-30 g/L, the content is sulfate-chloride with the predominance of sodions.

The groundwater of Pleistocene deposits is related to cobble-sand deposits of Bakhtiyar series that, despite their condensation, are of rather water-permeable nature. The waters of this layer have no pressure, the mode of their occurrence is porous and seldom – linear. The salinity of the water seldom exceeds 2-5 g/L; abundance of the layer is considerable but variable. The total flow of groundwater is directed south and southeastward where it joins the groundwater of the lower terraces of the Tigris river.

The groundwater of recent deposits are related to boulder-cobble-sand deposits of alluvial-prolluvial aprons and go along the Iran-Iraq border. Depending on the composition of enclosing rocks and circulation conditions the depth of water occurrence varies from 0-1 m to 15-20 m.

The waters salinity varies from 3 g/L in the active zone to 10-15 g/L in the discharge zone. The water content is sulfate and sulfate-chloride.

3.8 Industrial Activities

In this chapter, the existing sources of environmental pollution in the study area are discussed.

3.8.1 Processing Industry

The processing industry growth in 2008 reached 10%, and 32.9% in 2009, but a decrease is estimated for 2010 see figure (6). Surviving enterprises continue to work in such industries as oil processing, assembly of cars, agricultural equipment, electrical products, production of building materials; there are a number of small enterprises and workshops that produce traditional products to satisfy every-day public needs. One half of processing companies not related to oil processing is concentrated in Baghdad. The craftsmen share continues to be high.

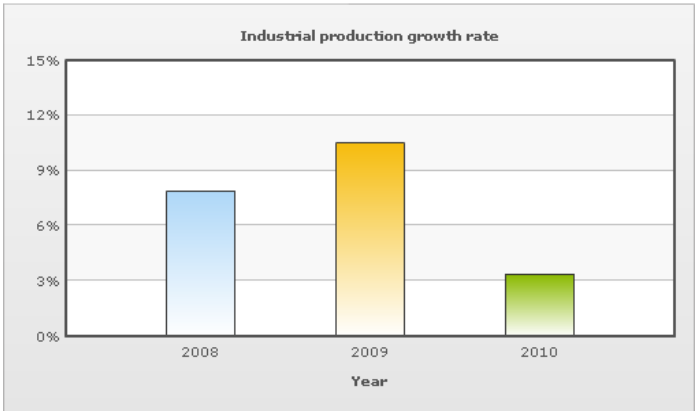

Fig. (6) Industrial production growth rate.

3.8.2 Mining Industry

Oil production is concentrated mainly at the fields located in Kirkuk and Mosul regions in the north, and near Basra and Al-Rumaila in the southeast. There are a number of smaller fields under development in other parts of the country. Crude oil is transferred to oil refineries (Basra, Al-Daura, Baiji, Salah ad-Din, etc.) and chemical plants (Az Zubayr, Baghdad and surroundings). In Mishrak, westward of Mosul, sulfur ore deposits are being developed.

Sulfur ore is used for production of sulfur and sulfuric acid. Phosphorites are extracted at two fields northward of Baghdad. They are used for production of mineral fertilizers at chemical plants in Al-Kaim and Baiji.

It is assumed that there is some basic industry in the town at Badra, 10 km from the project site. Generic impacts associated with industries are discussed below.

Waste products:

The waste products generated in the industrial units and released into the environment may result in some degree of environmental pollution, depending on their level of treatment, quantities released and characteristics. The waste products released into the environment from the various industries would mainly include the following:

- Air emissions (stack gases and fugitive emissions)
- Wastewaters
- Solid wastes (hazardous and non-hazardous)
- Noise

The main pollutants in the air emissions include particulate matter (PM), sulphur dioxide (SO_2), oxides of nitrogen (NO_X), carbon monoxide (CO),

unburnt hydrocarbons (HC) and other volatile organic compounds (VOC). In addition, greenhouse gases, particularly carbon dioxide (CO_2) and methane (CH_4) is released into the atmosphere from some industrial units.

The wastewaters released from the industrial units would contain a number of organic and inorganic pollutants. Untreated wastewaters are expected to contain high concentrations of total dissolved solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), oil and grease (O&G) and, in some cases, heavy metals. Sewage generated from industrial units would additionally contain pathogens.

Both hazardous and non-hazardous solid and semi-solid wastes would be generated from the industrial units. It is understood from UNEP survey that hazardous wastes from industries are sometimes disposed of with non-hazardous wastes.

All industrial units consist of sources of high noise generation. Some could be continuous sources and some intermittent. In general units with noise levels exceeding 90Db(A) may be considered as potential sources of environmental noise.

3.8.3 Agricultural Activities

Arable lands have an area of about 5,460 thousand ha (1/8 of the Iraqi territory). Up to 4,000 thousand ha are used for pastures. The remaining lands are excluded from agricultural turnover due to dry weather conditions and soil salination, including that caused by insufficient drainage of previously irrigated cultivated lands. The main agricultural crops include dates, wheat, barley and rice.

In Wasit Government, agriculture is hindered dramatically due to semi arid conditions of this area.

The waste products generated from agricultural and animal husbandry activities and released into the environment include the following:

- Irrigation drainage
- Methane emissions

Environmental pollution and greenhouse gases:

In terms of environmental pollution, irrigation drainage is the most significant in agriculture. Due to the application of fertilizers and pesticides, the irrigation drainage water would contain significant concentrations of TDS and pesticides. This could increase the salinity of soils and groundwater as well as introducing pesticides into water sources. Considering that irrigation is quite widespread in both provinces, irrigation drainage is potentially one of the most significant sources of environmental pollution in the study area.

The generation of methane from natural biological processes in agriculture and animal husbandry is known be a significant source of greenhouse gases.

3.8.4 Transport Activities

The road transport sector, particularly in urban areas, is a significant source of environmental pollution due to air emissions from engine exhausts.

The engine exhausts from both gasoline and diesel vehicles contain PM, SO_2, NO_X, CO and HC. Particularly, the concentrations of NO_X, CO and HC would be quite significant. The unburnt hydrocarbons would include highly toxic substances such as benzene, which is known to be a carcinogen. In addition, gasoline engines using leaded fuel would release lead particles into the atmosphere.

NO_X and HC released from transport vehicles, in the presence of sunlight, undergo photochemical oxidation to produce ground level ozone, which is the cause of severe respiratory health hazards particularly in urban areas [3].

3.8.5 Commercial and Residential Activities

Commercial and residential activities generate and release a number of waste products into the environment. The commercial units include service centers and workshops, hotels and restaurants, commercial warehouses, offices and other similar establishments. The significant releases into the environment from the activities associated with this category are sewage, municipal solid wastes, and occasionally air emissions and noise (from diesel generators).

Sewage and solid waste from commercial and residential activities:

When compared to all the other sources, the quantities of wastewater (sewage) and solid waste (municipal waste) from commercial and residential activities are the most significant. Raw sewage contains TSS, TDS, BOD, COD, O&G and pathogens at varying concentrations depending on water usage. Municipal waste, although containing mostly non-hazardous waste, may contain some hazardous wastes due to the disposal of waste chemicals, pesticides etc. into general waste.

In most areas of both provinces, the sewage treatment and municipal waste disposal facilities are inadequate. Only the major towns and cities have sewage handling and waste collection systems. In villages and small towns, raw sewage is either discharged into septic tanks/soak pits or simply released onto land.

Waste is dumped in low-lying lands. As a result, it poses a great risk to water and soil pollution, which in turn pose a threat to public health.

3.8.6 Military Activities

The existence of landmines in the project development is a significant threat to the environment and humans. It is reported that one million landmines were laid

during the Iran-Iraq war in the provinces bordering Iraq. Out of this, an estimated one-third is yet to be removed. The study area was exposed to fierce artillery and mortar battles during the war. Parts of the study area, especially the area along the border, contain hazardous Unexploded Ordnance. The Unexploded Ordnances are potentially hazardous to humans and animals if disrupted and detonated. Furthermore, the Unexploded Ordnance may be lethal and disruptive to the soil pattern and the local plant coverage, if detonated.

3.9 Natural Environment

3.9.1 Flora

Climatic conditions of Iraq vary in longitudinal direction and to some extent, in latitudinal direction. There is a fairly obvious tendency to the increase in the annual productivity of vegetation community from the north to the south and from the west to the east. Based on these factors, the territory of Iraq may be divided in four vegetation zones, see figure (7).

Fig. (7) Vegetation on the oilfield.

Zone 1: Deserts and Semideserts, covers 3/4 of the country's area. The main vegetative cover is much thinned due to extraordinary climate and is damaged by pasturing; key floral forms include suffrutices, grasses and lichens. Just in a few

places with more favorable humidity conditions, there are scattered gramineous and grass vegetation with presence of mesophytes and phreatophytes.

Zone 2: Hilly undulating piedmont plain of northern Iraq. This area has grass vegetation. The only vegetation form is represented mainly by grass and lily families. To date, this vegetation cover has grown much thinner as a result of rapacious usage of these lands as pastures.

Zone 3: Northeastern part of the country with the annual rainfall ranging from 500 to 1,000 mm. The slopes of Kurdistan's mountains features averagely light forests comprising of Greek oak (Quercus aegilopus), arabian oak (Q, persica) that maintains dry leaves during winter, pistachio (Pistcia khinjuk), Jerusalem thorn (Polirus aculeatus), fig tree (Ficus carica), sumac (Rhus coriaria) and other species. In the upper area, vegetation is represented by Lebanese oak (Q. livani), Greek oak, pistachio, buckthorn (Rhamus curdica), and ephedra (Ephedra sp).

However, in fact there are closed forests up to the Alpian border. They can only be seen along river banks. First terrace features southern osier (Salix acmophyll), eastern plane (Platanus orientalis) and ash (Fraxinus oxycarpa) in some cases. Dense stand of trees on the second terrace is represented mainly by Greek and arabian oaks. High density of trees in this area should be explained by the proximity of ground waters fed by rivers. Poplars may not be seen at all among vegetation of the second terrace.

Forest vegetation ends at the height of 1,750-1,800 meters. There are no subalpine belt of forests. A belt of xerophytic bushes represented by Astragalus and Acantholimon species growing at the height of 2,750-3,000 meters serves as a transition zone from forest vegetation to Alpine area. Light forests are exploited by local population as pastures and wood source. There are many cutover patches, especially in populated areas. However, trees are recovered by sprouting rapidly. All tree species growing in this area are characterized by a high shoot-forming capacity.

Zone 4: "Ahwar" Lakes and swamps or marshland. This area covers marshland flats ("choirs") mainly in central and southern Iraq. Vegetation is represented by thick sets of bulrush and reed reaching giant height (5 meters or over). Under this vegetative cover, swamp soils are formed.

`Some of the plants have chosen stream channels of irrigation networks as their headquarters and adopted to these conditions.

They include Typhya angustata, Phragmites communis, Cyperus rotundus, Echinochloa crasgalli, Agrostis semireticillatus, Alopecurus myosuroides, Dichanthium annulatum, Digitaria sanguinalis, Eragrostis ciliarensis, Eragrostis poacides, Imperata cylindrica, Paricum repens, Paspalum distiehum, Phalaris maijor, Sorghum halepense, Tuncus maritimus, Sorpus littoralis, Trifolium resupinatum, Glycerrhiza glabra, and Lippia nodiflora.

3.9.2 Fauna

Fauna of Iraq contains approximately 100 species of mammals, about 400 species of birds, and around 80 species of creepers. Rodents and creepers are dominant in deserts and semideserts; wild goats and sheep, wolves, dog foxes, hyenas, and leopards are common for mountain and submountain regions of central Iraq; brown bears, Eurasian pigs, American elks and roes can be seen in mountains of northern Iraq; fruit-bats, mongooses, chameleons, etc. are typical for tropic regions in the south and southeast.

3.9.2.1 Mammals

- **Near the studied area:**

Seventy-one species from eight orders are found in Ilam province and forty-nine species from five orders are found in Khuzestan province.

From the order Insectivora a single species of hedgehogs and 5 species of shrews are found in both provinces. From the order Chiroptera, 19 species from 4 families are found in Ilam province and 12 species from 5 families in Khuzestan province. From class Lagomorpha, two species of hare and pika can be found in the province. From order Rodentia, 22 species are found in Ilam province and 28 species in Khuzestan province. One of the important species of this order is the arabian Squirrel. From order Carnivora, 19 species are found in Ilam province and 21 species in Khuzestan province. Wolf, Otter and Caracal are rare species and Leopard and Blanford's Fox or Afghan Fox are endangered species of this order. The large sized carnivores of the region include Leopard and Bear, whose number has tremendously decreased due to the decrease of the large-sized herbivores like Gazelle, Wild goat and Wild sheep. The Sand Cat, which has only been seen in Musian and Dasht-e Abbas, is also among the carnivores. Despite the large number of Otters in Iran, they are very scarcely found in Ilam and have only been seen in Dehloran. The Iranian Lion is among the extinct species of Khuzestan province. From order Artiodactyla, there are 4 significant species in the province, three of whose population is dwindling. One of the main reasons that the artiodactyls have been so seriously damaged in this region is the eight-year war, which turned their habitats into battlefields. At the moment, the number of artiodactyls in Ilam Province is estimated at 100. From order Perissodactyla, there are species of family Equidae (horse and ass) that are found as domestic animals.

3.9.2.2 Birds

The region has a rich diversity of bird species. Out of 500 species of birds from 70 families found in adjacent area of Iran as permanent residents, winter dwelling, summer dwelling or passing migratory birds. In adjacent area of Khuzestan province, migratory birds (mostly aquatic) are often found in Shadegan, Hurl old-Azim, Bamdezh, Miyangaran lagoons

and other small and large lakes and swamps. Some of them enter the province in early autumn to pass the winter and gradually leave the area by mid April.

All these species, which include White-fronted Goose, Red-breasted Goose, and Marbled Teal are regarded as critically endangered. A wide variety of species found in these two provinces, including insectivores, ortolans, and carnivorous bears indicate a rich ecosystem.

3.9.2.3 Reptiles

The snake fauna of Iraq consists of 37 species belonging to seven families (Typhlopidae, Leptotyphlopidae, Boidae, Colubridae, Elapidae, Viperidae and Hydiopfiiidae). All snakes of Iraq are terrestrial, except species of the family Hydiopfiiidae, which are exclusively marine. About one-fourth of the snakes of Iraq are poisonous, and the last three families include the venomous forms with a total of 9 species.

The size of the Iraqi snakes varied from as small as 15 cm such as the blind snakes to as large as 3 m long observed in Coluber juguaris and S. diadema. Snakes are found in deserts, mountains and agricultural areas.

3.10 Social Environment

3.10.1 Demographic Profile

As of 2008 estimate, the total Iraqi population is 29 million.

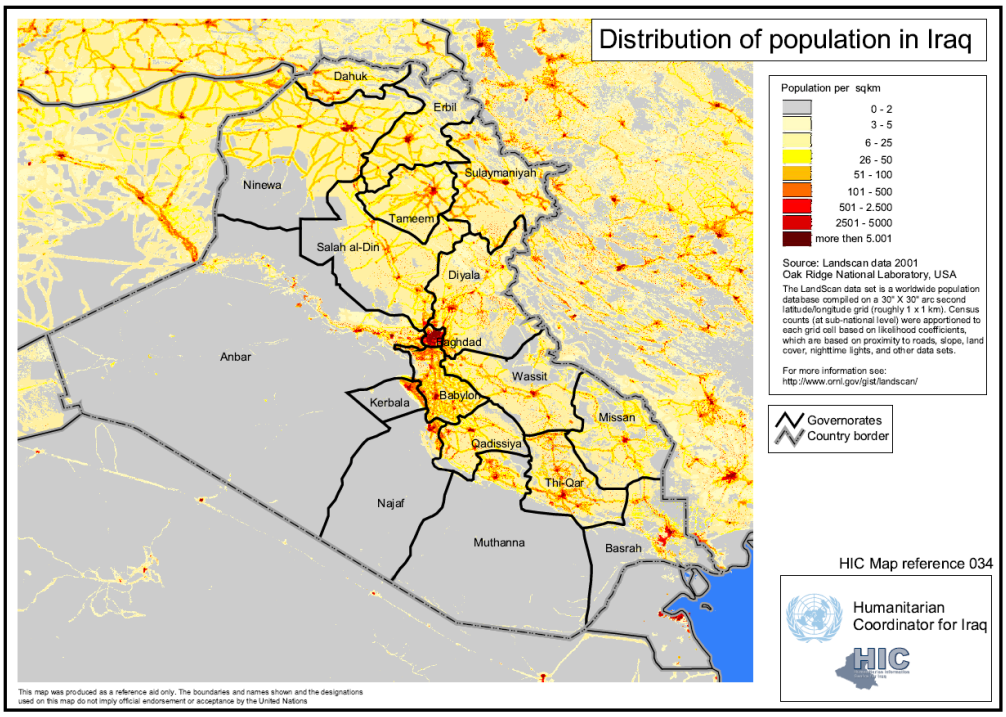

Fig. (8) Distribution of population in Iraq.

Over the past several decades, the Iraqi population was growing at a high pace due to the high natural increase. Starting from 1957 with the population estimated at 6.4 million and up to 1998, the growth rate exceeded 2.5 percent per year. The birth rate was decreasing gradually from 4.9 percent in 1950s to less than 3.2 percent in 1990s. Urban population in 1957 accounted for 39 percent of the total population and 72 percent in 1997. Death rate was reducing even faster than the birth rate: from 2.2 percent in early 1950s to 0.8 percent in late 1990s, mainly due to reduction of infant and child mortality rate. According to estimates, 42 percent of citizens were children under 15 years old, 55 percent - 15-64 years, and 3 percent - 65 years and over, figure (8) shows the distribution of population in Iraq

Despite the breakdown, food and medical service shortages, the average anticipated life expectancy still remains at a quite high level as compared to the majority of developing countries (69 years). The number of children under 14 years old is also very high reaching 40 percent. Apparently, the consequences will

become evident in the years immediately ahead. According to Arab mass media estimates, as early as in the middle of 2006 there were 2.3 million widows in Iraq.

As of 2007 estimate, the population of Wasit Government where the project site is located is 1,022.461 thousand.

There are no sizable facilities or enterprises in the province, and the major problem remains that of unemployment. The population is mainly occupied in break stone, gravel, sand industries, agriculture and animal husbandry (sheep, camels, chicken, etc.).

3.10.2 Religion and Culture

The Arabs account for 75 percent of the national population, the Kurds for 18 percent, and the Turkmen, Assyrians, Armenians and other minor ethnic groups for 7 percent of the population. The Kurds form a majority of population in northern and north-eastern regions of the country, Initially. the Kurds belonged predominantly to semi-sedentary tribes, but then switched to sedentary life. The Turkmen reside mainly in the city of Kirkuk. The Assyrians initially belonged to the ancient Christian community alike the Armenians the majority of which belongs to descendants of refugees who arrived to Iraq during and immediately after the First World War.

Arabic is the most widely spread language used in governmental and educational institutions. Kurdish spoken in the North of the country is also recognized as the official language in Kurdistan region of Iraq.

The overwhelming number of the Iraqi population (95 percent) follows Islam. Many of the religious sanctuaries are located in Iraq are found in Najaf, Kerbela, Samarra and Al-Kazimiyyah and Al Adhamyah (two of the city districts of Baghdad). Christianity is followed by 3 percent of the population.

3.10.3 Education

42% of the Iraqi population is illiterate because only 47% of the population over the age of 10 has had a formal schooling.

21% of the people have had primary education, while 12% have had secondary education. 4% have received undergraduate or post-graduate education.

In the Wasit government, between 31 to 45%of men have no formal education and between 49 to 63% of women.

The percentage of illiteracy in the man population in Wasit Government is comprised between 8-22% and 25-30% for female population.

3.10.4 Infrastructure

3.10.4.1Roadways

A major road network was constructed to facilitate troop and supply movement during the Iran/Iraq war. Tarmac roads connect most main towns; the network spreads from Baghdad, which is at the center of the country, The road from Baghdad to Al Basrah near the Kuwaiti border extends some 560 kilometers. By June 1990, most sections had been completed on a 6-lane, 1,264-kilometer international express highway linking Safwan on the Kuwaiti border with the Syrian and Turkish borders. All these roads take in the major towns along their routes. Iraq has 37,851 km kilometers of paved roads.

3.10.4.2 Waterways

There are 1,015 km of navigable waterways. Shatt al Arab is usually navigable by maritime traffic for about 130 km; channel has been dredged to 3 m and is in use; Tigris and Euphrates Rivers have navigable sections for shallow-

draft watercraft; Shatt al Basrah canal was navigable by shallow-draft craft before closing in 1991 because of the Gulf War.

Euphrates River (2,815 km), Tigris River (1,899 km), and Third River (565 km) are principal waterways .

3.11 Archaeology and Cultural Heritage

3.11.1 Background

Iraq is a part of greater Mesopotamia, which is one of the birthplaces of civilization.

3.11.2 Archaeological Sites

3.11.2.1 Classification of Sites

According to appearance and form, archaeological sites are divided into five general groups:

- Open Sites or Caves (O&C)

This group is generally related to Paleolithic cultures. Open sites are generally the remains of seasonal settlements. Sometimes, as shown in below, open sites may contain the remains of several periods.

- Archaeological Architecture (AA)

Buildings and architectural remains are one of the most general kinds of archaeological remains. The buildings are in some cases unique in a region and in

some cases in a group. These buildings are mostly related to the contemporary periods; however, there are some historical period architectural buildings.

- Graveyards (G)

Graveyards are related to settlements. Graveyards related to a permanent settlement are generally not far from the settlement. Extended graveyards relate to nomadic settlements. Graveyards provide valuable information on mortuary practices of past societies.

- Stone Relieves (SR)

Stone relieves the monuments of past artistic and historical cultures.

4 Impact Inventory and Assessment

4.1 Impact on Air Quality

In order to examine the potential impacts arising from seismic operations, it is important to understand the sources and nature of the emissions and their relative contribution to atmospheric impacts, both local and those related to global issues such as stratospheric ozone depletion and climate change. This section describes the primary sources of atmospheric emissions from seismic operations [4,5].

4.1.1

4.1.2 Fuel combustion processes

In reference to Badra Oil field development, the following data have been established for the combustion of fuel (diesel and gasoline) in the internal combustion engines of both vehicles and generators.

The emission of these gases may change the balance of oxygen in the air and cause environmental pollution.

4.1.3 Fugitive gases and odors

Fugitive gases from fuel storage such as CH_4, C_2H_6, C_3H_8 and C_4H_{10} gases, which arise mostly from gasoline and fugitive gases and odors, may arise from sewage such as CH_4, CO_2, NH_3 and H_2S due to the biological decomposition of sewage.

4.1.4 Air born particulates

Air born particulates from soil disturbance and from vehicle traffics, this may affect plant and animal communities directly. This impact can be limited by speed restricting to minimize dust generation.

Particulates from other sources may be generated, such as detonations, and this could be minimized if explosions were to be conducted in a distance not less than 100 m from the nearest building or personal fixture.

In general the fugitive gases and air born particulates impacts considered to be low due to restricted emission amounts and the large distance between the project site and the nearest population settlements which is more than 14 Km distance from all directions and the lack of flora and fauna in the project site.

As all together, potential of emissions from seismic operations is not to cause serious atmospheric impacts and accordingly the impacts are considered low.

4.2 Impacts on Surface and Ground Water

4.3 Use of Water Recourses

Although there is no plan to drill fresh water supply well for the seismic camp water demands, the local water resources will be used anyway. The plan is to supply water from existing water wells in Badrah village if the water will be of acceptable quality. The daily fresh water demands can be estimated as:

150 liter/ capita/ day * 425 people = 64 m3 / day

4.4 Wastewater (sewage) discharge

Wastewater (sewage) discharge, from camping activities may result in pollution of ground and surface water, and since no surface water bodies are found within and around the contract area, no impact will be expected on surface water.

As for ground water, there will not be a possibility of water quality deterioration since ground water is not less than 65m deep.

During seismic operations, over 425 workers will be camping in the assessed area, generating about 50 m3 a day , this amount of discharged water will either be collected in a septic tank of appropriate size to be transported to waste infiltration /evaporation pond, and/ or to use Badrah and Kut waste treatment facilities. The accumulated sludge produced would have to be placed in a landfill. This landfill could be on-site or the waste could be taken to an existing off-site landfill. Table (6) illustrates wastewater discharged from various purposes:

Table (6) Wastewater generation rates

Purpose	Quantity liter/ capita/ day (l/ C/ day)
Cooking and washing	10 – 12
Flushing in W.C	30 – 40
Bathing and washing	40 – 60
Other needs	10
Total	90 - 122

Calculation

Total number of workers in the seismic operations = 425

Total max. water consumption rate = 122 l/C/day * 425

=51850 l/day

=51.850 m^3/day

4.4.1 Spills and leakage

Contamination may arise from spills and leakage of fuel causing possible impact to soil and consequently to ground water. A plan should be prepared to prevent and contain accidental fuel spillages by fitting all equipments with drip

trays. Seismic Contractor shall furnish the fuel storage areas with the secondary contaminant with the capacity not less than 110% of the volume of the biggest storage tank. Such secondary contaminant can be made from the impermeable film at the bottom and bund wall. Such techniques will effectively remove any potential impact arising from small spills and leakage on site.

4.4.2 Impact due to organic solid waste decomposition

No ground water contamination is expected due to low water table at Badrah site, and as for shallow water if ever exist, it will not be used as drinking water.

4.5 Potential Impacts on Soils

4.5.1 Drilling cuttings

Drilling holes during seismic operations for explosion purposes will result in the generation of some quantities of drilling cuttings from up hole drilling and from drilling of explosive holes grid. These cuttings can be estimated at a total volume of drilling cuttings up to 300m^3. This volume of drilling cuttings is considered to be low, which can be used to plug the same hole after explosion is done. The remaining cuttings around the hole would be spread on land so that they are less than one inch in thickness.

4.5.2 Domestic Waste Generation and Disposal

Typical solid wastes generated by campers will include paper, plastic, glass, wood, food waste, and miscellaneous. These wastes will be collected separately from the industrial waste in a specific area for storage. Biodegradable and non bio-degradable wastes such as glasses and plastics shall be buried on-site to minimize scavenging by wild life and to prevent insects gathering. The discharge of biodegradable wastes if any occurred might result in localized increases in

nutrient levels, which may stimulate microbial activity and therefore act as a food source for birds and animals. Soil would not be significantly affected by solid waste leachate because the waste dumping will be kept dry due to local hot climate, and waste will be gathered or collected in specified area. Seismic contractor will keep the records of quantities of waste generation and disposal.

All wastes will be governed by the Waste Management Plan where the camp should be adopting environmental practices and programs that bring about a positive environmental awareness among campers and staff. Domestic wastes generation rate can be estimated as follows:

Solid waste generation rate = 0.74 (Kg/C/day)

Total number of workers in the seismic operations = 425

Total solid waste generation rate = 0.74 (Kg/C/day)* 425 = 318.75 (Kg/day)

4.5.3 Footprint

During seismic survey, increasing access and footprint by vehicle to the survey area is likely to increase the most significant impacts. Environmental impacts will directly result from the cutting and clearing the seismic lines, access roads and camp pad; compaction of these areas and removing of vegetations. The size of the impact territory will be the entire area of seismic acquisition (169 km2) but the directly affected area is limited by the square of seismic lines + access roads and camp, that is about 2,5 km2.

All these impacts can be minimized if they managed properly by periodically cleaning of vehicles and reduction of roads used for transportation inside the project site.

4.6 Potential Impacts On Biodiversity

Data on biodiversity in Iraq is extremely limited and only recently species were recorded. However, indications suggest that biodiversity is declining in fact many different species are regarded as critically endangered.

The main vegetative cover in Badra site is much thinned due to extraordinary climate and is damaged by pasturing; key floral forms include suffrutices, grasses and lichens. Just in a few places with more favorable humidity conditions, there are scattered vegetation mostly reflected in dwarf shrub, semi shrubs and grass.

It need to be considered that animals and plants at Badra site have been seriously damaged while the eight-year war, which turned their habitats into battlefields. Animals communities may also be directly affected by changes in their environment through variation in water, air and soil and through disturbance by noise extraneous light and change in vegetation covers.

The noise of vehicles and equipments may drive away the wild animals in the area. Rodents and creepers that are dominant in arid and semi arid land may run away into remote areas due to vibration and noise pollution caused by seismic operations.

4.6.1 Noise and vibration

Seismic surveys use acoustic sources to create sound waves. Various seismic noise exposure levels have been tested for small organisms such as crustaceans, fish, small animals, wild animals, eggs and larvae, with no observed organism damage occurring outside 10 m from the source (K.R, 2000).

McCauley et al. (1998) studied the effects of seismic noise on different animals in the Exmouth Gulf region of Western Australia. Localized avoidance behavior was noted during the production of seismic noise and it was concluded that the animals are at low risk of physiological effects unless they are close (perhaps to within a few hundred meters) to the seismic air gun array. However,

the predicted increase is not expected to exceed the ambient noise during the daytime at distances greater than 50 m.

As for Badra oil field, since the closest people settlements are located in a distance of about some kms away from the project site. The potential environmental effects of the project on Public Health and Safety in relation to changes in sound quality are irrelevant.

Noise level excepted can be calculated as follows:

$$db = 20 \log (p/p_0)$$

where:

p: sound pressure (µbar)

p_0 : constant = 0.0002 µbar

Range of sound pressure for diesel engines is (2 – 20) µbar.

Accordingly, the range of noise expected (80 - 100) db in direct vicinity of generators.

4.6.2 Light

The site will be well lit at night and during times of poor visibility, to ensure safe operations of the survey. Lights used shall meet the required safety standards are aimed to decrease the attraction of the site light to fauna.

4.7 Impact Summary

All previous mentioned environmental impacts arising from seismic operations are summarized in table (7):

Table (7) Summary of seismic operations potential environmental impacts.

Environmental Element	Sources of Impact	Impact Evaluation
Air Quality	➢ Fuel combustion processes ➢ Fugitive gases and odours ➢ Air born particulates	Low level impact due to restricted emission amounts and the large distance between the project site and the nearest population settlements.
Surface and Ground Water	➢ Use of fresh water ➢ Wastewater (sewage) discharge ➢ Spills and leakage ➢ Potential pollution from solid waste decomposition	Low level impact if good managed.
Soil	➢ Solid waste generation and disposal ➢ Footprint ➢ Soil erosion	Low level impact due to the nature of land, which can be describe as semi-arid.
Flora and Fauna	➢ Footprint ➢ Soil erosion ➢ Noise ➢ Vibration ➢ Extraneous light ➢ Air pollution	Low level impact due to the lack of vegetation cover in the area and accordingly low biodiversity.
Social Environment	➢ Use of resources ➢ Increased access ➢ Employment	Low level of both positive and negative impact due to the short time of conducting seismic operations

5 Environmental Management Plan (EMP)

5.1 Waste Management

- Workforce (including subcontractors) will be briefed to minimize, and properly dispose of waste (and the reasons for this) and set targets in order to 1) understand the volume and type of waste being generated, and 2) actively reduce the volumes [6].
- The waste collection area in the camp will be on a non permeable surface and storage containers will be monitored regularly for leakage.
- Waste for offsite disposal will be transported for recycling or disposal at an appropriate licensed facility.
- Areas where waste disposal sites are to be constructed will be photographed.
- The waste disposal sites will be located away from camp and waste taken to pit each day.
- Location of waste disposal sites will be recorded by GPS taking into account topography i.e. runoff direction in the event of rainfall, down gradient from water wells, springs and aquifer outcrops to prevent water pollution.
- Whilst resulting in emissions, waste will be buried regularly (to minimize scavenging by wildlife etc).
- On decommissioning, the waste disposal sites will be covered by a 1 m cap of clean material and the location recorded.
- Photographs will be taken before and after and once the site is restored as close as practicable to pre activity appearance.

- Trash burning is prohibited.
- All wastes will be returned to camp from worksites.

5.2 Water Management

- Fresh water used for domestic needs (at the sanitation facilities) will be tested by qualified laboratory to ensure there is no bacteriological contamination and quality is suitable for the camp water supply network.
- Quality of potable (drinking) water provided to personnel will be in compliance with the Iraqi Legislation No. (417) - 2001 Standard Specification for Drinking Water.
- Workforce (including Sub contractor) will be educated to minimized the usage of and ensure proper disposal of all liquid wastes.
- Sewage will be disposed into the infiltration/evaporation pond located at a distance not closer than 50 m to the camp in downwind direction.
- A sample of discharged sewage will be taken once while camp is operational to analyze the content of the fluid (GPN responsibility).
- At the demobilization stage the evaporation pond will be buried in such a way that the area returned to its original state as much as practicable.
- The location of the sewage disposal pond will be photographed before making the pond, once while it is in use and after decommissioning.

5.3 Atmospheric Emission Control

- **Clean vehicles** periodically to minimize dust generation.
- Restrict speed of vehicles.
- Regular maintenance of vehicles and diesel generators will be undertaken to minimize poor combustion.

- Camp sites and other fugitive dust generating areas will be wetted down periodically (where appropriate) to reduce the generation of airborne dusts that could lead to hazardous health conditions for contract personnel.

5.4 Landscape

- Ensure that shot holes are backfilled after the charge is fired, and suitably plugged with dry unconsolidated fill and the disturbed area restored as near as possible to it's original state.
- Camp area will be photographed prior to clearing and on decommissioning the site.
- Sites will be restored on decommissioning to as close to their original state as possible, reinstating vegetation if necessary.
- The camp will be kept clean and tidy and all materials will be stored in a compound.

6 . Conclusions

The seismic specific impacts are inventoried and assessed in the presented Seismic EIA study. The overall evaluation of the impact is non-significant due to the short duration of the operations and their nature. At the same time there will be impacts such as waste, sewage generation, atmospheric emissions and others that shall be properly managed in compliance with Iraqi regulations and international standards described in the Section 3 of the study. The Environmental Management Plan is developed for that purposes, provided in the Section 5.

The most visible impact of the planned seismic operations will be the footprint on the landscape which will be naturally recovered in some months or years for some places. The disturbance to the flora and fauna will be unavoidable but due to poor biodiversity existing in the Badra area this impact is also evaluated as low.

The main positive impact to the local social environment is limited by possible short term employment for the local people. Considering the seismic operations as the beginning of the entire Badra project development the positive impact to the social environment and economy will be increased in the next stages of the operations.

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